In[◦]:= **Get@FileNameJoin@{NotebookDirectory[], "Run.m"};**

First we import some formatting...

...okay, that's better, from now on any commentary written inside this
  Calibration.m wrapper will present as blue text (i.e. this text is not
  part of PSALTer, it is just a use-case). Next we load the PSALTer package:

——

Package xAct`xPerm` version 1.2.3, {2015, 8, 23}

CopyRight (C) 2003–2020, Jose M. Martin–Garcia, under the General Public License.

Connecting to external linux executable...

Connection established.

——

Package xAct`xTensor` version 1.2.0, {2021, 10, 17}

CopyRight (C) 2002–2021, Jose M. Martin–Garcia, under the General Public License.

——

Package xAct`xPert` version 1.0.6, {2018, 2, 28}

CopyRight (C) 2005–2020, David Brizuela, Jose M. Martin–Garcia
   and Guillermo A. Mena Marugan, under the General Public License.

** Variable $PrePrint assigned value ScreenDollarIndices

** Variable $CovDFormat changed from Prefix to Postfix

** Option AllowUpperDerivatives of ContractMetric changed from False to True

** Option MetricOn of MakeRule changed from None to All

** Option ContractMetrics of MakeRule changed from False to True

——

Package xAct`Invar` version 2.0.5, {2013, 7, 1}

CopyRight (C) 2006–2020, J. M. Martin–Garcia,
   D. Yllanes and R. Portugal, under the General Public License.

** DefConstantSymbol: Defining constant symbol sigma.

** DefConstantSymbol: Defining constant symbol dim.

** Option CurvatureRelations of DefCovD changed from True to False

** Variable $CommuteCovDsOnScalars changed from True to False

——

Package xAct`xCoba` version 0.8.6, {2021, 2, 28}

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   Jose M. Martin–Garcia, under the General Public License.

```
------------------------------------------------------------
```

Package xAct`SymManipulator` version 0.9.5, {2021, 9, 14}

CopyRight (C) 2011–2021, Thomas Bäckdahl, under the General Public License.

```
------------------------------------------------------------
```

Package xAct`xTras` version 1.4.2, {2014, 10, 30}

CopyRight (C) 2012–2014, Teake Nutma, under the General Public License.

** Variable $CovDFormat changed from Postfix to Prefix

** Option CurvatureRelations of DefCovD changed from False to True

```
------------------------------------------------------------
```

Package xAct`HiGGS` version 2.0.0–developer, {2023, 1, 1}

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```
------------------------------------------------------------
```

HiGGS incorporates code by Cyril Pitrou.

```
------------------------------------------------------------
```

Package xAct`PSALTer` version 1.0.0–developer, {2023, 1, 2}

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```
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```

These packages come with ABSOLUTELY NO WARRANTY; for details type
   Disclaimer[]. This is free software, and you are welcome to redistribute
   it under certain conditions. See the General Public License for details.

```
------------------------------------------------------------
```

Now we set up the general Lagrangian:

$$-\lambda_\bullet\ \mathcal{R}^{ij}{}_{ij} + \left(\frac{r_{\dot 1}}{3} + \frac{r_{\dot 2}}{6}\right)\mathcal{R}_{ij\hbar l}\ \mathcal{R}^{ij\hbar l} + \left(\frac{2\,r_{\dot 1}}{3} - \frac{2\,r_{\dot 2}}{3}\right)\mathcal{R}_{i\hbar jl}\ \mathcal{R}^{ij\hbar l} +$$

$$\left(r_{\dot 4} + r_{\dot 5}\right)\mathcal{R}_i{}^l{}_{jl}\ \mathcal{R}^{i\hbar j}{}_\hbar + \left(r_{\dot 4} - r_{\dot 5}\right)\mathcal{R}^{i\hbar j}{}_\hbar\ \mathcal{R}_j{}^l{}_{il} + \left(\frac{r_{\dot 1}}{3} + \frac{r_{\dot 2}}{6} - r_{\dot 3}\right)\mathcal{R}^{ij\hbar l}\ \mathcal{R}_{\hbar lij} +$$

$$\left(\frac{\lambda_\bullet}{4} + \frac{t_{\dot 1}}{3} + \frac{t_{\dot 2}}{12}\right)\mathcal{T}_{ij\hbar}\ \mathcal{T}^{ij\hbar} + \left(-\frac{\lambda_\bullet}{2} - \frac{t_{\dot 1}}{3} + \frac{t_{\dot 2}}{6}\right)\mathcal{T}^{ij\hbar}\ \mathcal{T}_{j\hbar i} + \left(-\lambda_\bullet - \frac{t_{\dot 1}}{3} + \frac{2\,t_{\dot 3}}{3}\right)\mathcal{T}_i{}^{ji}\ \mathcal{T}_{\hbar j}{}^\hbar$$

We also knock up some simple tools to linearise the Lagrangian:

** DefConstantSymbol: Defining constant symbol PerturbativeParameter.

We are now ready to check that PSALTer is getting the
   physics right by running it on the 58 theories in arXiv:1910.14197.

Performing the survey

Case 1

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 1 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\, r_2\, \mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} - \frac{2}{3}\, r_2\, \mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + \left(\frac{r_3}{2} + r_5\right)\mathcal{R}^{ij}{}_i{}^{h}\ \mathcal{R}_j{}^l{}_{hl} +$$

$$\frac{1}{6}\left(r_2 - 6\, r_3\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} + \frac{1}{2}\left(r_3 - 2\, r_5\right)\mathcal{R}^{ij}{}_i{}^{h}\ \mathcal{R}_h{}^l{}_{jl} + \frac{1}{12}\, t_2\, \mathcal{T}_{ijh}\ \mathcal{T}^{ijh} - \frac{1}{6}\, t_2\, \mathcal{T}^{ijh}\ \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3}\, t_2\, \mathcal{A}_{ijh}\ \mathcal{A}^{ijh} - \frac{2}{3}\, t_2\, \mathcal{A}_{ihj}\ \mathcal{A}^{ijh} - \frac{1}{2}\, r_3\, \partial_i\mathcal{A}^{hl}{}_h\ \partial^i\mathcal{A}_l{}^{a}{}_a - r_5\, \partial_i\mathcal{A}^{hl}{}_h\ \partial^i\mathcal{A}_l{}^{a}{}_a + \frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}^{ja}{}_h\ \partial_j\mathcal{A}_{aa'}{}^{h} -$$

$$\frac{1}{3}\, r_2\, \partial_j\mathcal{A}_{aa'}{}^{h}\partial_h\mathcal{A}^{aa'j} - \frac{2}{3}\, r_2\, \partial_j\mathcal{A}_{aa'}{}^{h}\partial_h\mathcal{A}^{jaa'} + \frac{1}{2}\, r_3\, \partial_a\mathcal{A}_l{}^{a}{}_j\ \partial_h\mathcal{A}^{jhl} - r_5\, \partial_a\mathcal{A}_l{}^{a}{}_j\ \partial_h\mathcal{A}^{jhl} -$$

$$\frac{1}{2}\, r_3\, \partial_j\mathcal{A}_l{}^{a}{}_a\ \partial_h\mathcal{A}^{jhl} + r_5\, \partial_j\mathcal{A}_l{}^{a}{}_a\ \partial_h\mathcal{A}^{jhl} - \frac{1}{2}\, r_3\, \partial_a\mathcal{A}_l{}^{a}{}_j\ \partial_h\mathcal{A}^{hlj} - r_5\, \partial_a\mathcal{A}_l{}^{a}{}_j\ \partial_h\mathcal{A}^{hlj} +$$

$$r_3\, \partial_j\mathcal{A}_l{}^{a}{}_a\ \partial_h\mathcal{A}^{hlj} + 2\, r_5\, \partial_j\mathcal{A}_l{}^{a}{}_a\ \partial_h\mathcal{A}^{hlj} + \frac{1}{3}\, r_2\, \partial_h\mathcal{A}^{aa'j}\ \partial^h\mathcal{A}_{aa'j} + \frac{2}{3}\, r_2\, \partial_h\mathcal{A}^{jaa'}\ \partial^h\mathcal{A}_{aa'j} +$$

$$\frac{1}{6}\, t_2\, \partial^a f_{jh}\ \partial^h f_a{}^j - \frac{1}{6}\, t_2\, \partial^a f_h{}^l\ \partial^h f_{al} + \frac{1}{3}\, t_2\, \mathcal{A}_{ih}{}^{a}\ \partial^h f^i{}_a - \frac{1}{6}\, t_2\, \partial^a f_{ih}\ \partial^h f^i{}_a - \frac{1}{3}\, t_2\, \mathcal{A}_{ijh}\ \partial^h f^{ij} +$$

$$\frac{1}{3}\, t_2\, \mathcal{A}_{ih}{}^{l}\ \partial^h f^i{}_l - \frac{1}{3}\, t_2\, \mathcal{A}_i{}^{l}{}_h\ \partial^h f^i{}_l - \frac{1}{3}\, t_2\, \mathcal{A}^l{}_{hi}\ \partial^h f^i{}_l + \frac{1}{6}\, t_2\, \partial_h f_i{}^{l}\ \partial^h f^i{}_l + \frac{1}{6}\, t_2\, \partial^a f_h{}^{l}\ \partial^h f_{la} -$$

$$\frac{1}{3}\, t_2\, \mathcal{A}_{jh}{}^{l}\ \partial^h f_l{}^j - \frac{1}{6}\, t_2\, \partial_h f_j{}^{l}\ \partial^h f_l{}^j - \frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}_i{}^{al}\ \partial_l\mathcal{A}_{aa'}{}^{i} + \frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}_i{}^{la}\ \partial_l\mathcal{A}_{aa'}{}^{i} -$$

$$4\, r_3\, \partial^{a'}\mathcal{A}_i{}^{la}\ \partial_l\mathcal{A}_{aa'}{}^{i} - \frac{1}{2}\, r_3\, \partial_a\mathcal{A}_l{}^{a}{}_j\ \partial^l\mathcal{A}^{jh}{}_h + r_5\, \partial_a\mathcal{A}_l{}^{a}{}_j\ \partial^l\mathcal{A}^{jh}{}_h + \frac{1}{2}\, r_3\, \partial_j\mathcal{A}_l{}^{a}{}_a\ \partial^l\mathcal{A}^{jh}{}_h - r_5\, \partial_j\mathcal{A}_l{}^{a}{}_a\ \partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2\, r_2 + t_2\right),\ \begin{pmatrix} \frac{k^2\, t_2}{3} & \frac{1}{3}\, i\, \sqrt{2}\, k\, t_2 & \frac{i k t_2}{3} \\ -\frac{1}{3}\, i\, \sqrt{2}\, k\, t_2 & \frac{1}{2}\left(2\, k^2\left(2\, r_3 + r_5\right) + \frac{4 t_2}{3}\right) & \frac{\sqrt{2}\, t_2}{3} \\ -\frac{1}{3}\, i\, k\, t_2 & \frac{\sqrt{2}\, t_2}{3} & \frac{t_2}{3} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2}\, k^2\left(r_3 + 2\, r_5\right) & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & -\frac{3\, k^2\, r_3}{2} \end{pmatrix},\ (0)\right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0, \; {}^{0^+}_{\bullet}\sigma^{\flat\|} == 0, \; {}^{0^+}_{\bullet}\tau^{\flat\|} == 0, \; -i\, {}^{1^+}_{\bullet}\tau^{\flat\|}{}^{ab} == k\, {}^{1^+}_{\bullet}\sigma^{\flat\perp}{}^{ab}, \right.$$

$$\left. {}^{1^-}_{\bullet}\sigma^{\flat\perp}{}^{a} == 0, \; {}^{1^-}_{\bullet}\tau^{\flat\perp}{}^{a} == 0, \; {}^{1^-}_{\bullet}\tau^{\flat\|}{}^{a} == 0, \; {}^{2^+}_{\bullet}\tau^{\flat\|}{}^{ab} == 0, \; {}^{2^-}_{\bullet}\sigma^{\flat\|}{}^{abc} == 0\right\}$$

The Drazin (Moore–Penrose) inverses of these a–matrices, which are functionally analogous to the inverse b–matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(\frac{1}{k^2\, r_2 + t_2}\right), \; \begin{pmatrix} \frac{3k^2\left(2 r_3 + r_5\right)+2 t_2}{(1+k^2)^2\left(2 r_3 + r_5\right)t_2} & -\frac{i\sqrt{2}}{k(1+k^2)\left(2 r_3 + r_5\right)} & \frac{i\left(3k^2\left(2 r_3 + r_5\right)+2 t_2\right)}{k(1+k^2)^2\left(2 r_3 + r_5\right)t_2} \\ \frac{i\sqrt{2}}{k(1+k^2)\left(2 r_3 + r_5\right)} & \frac{1}{k^2\left(2 r_3 + r_5\right)} & -\frac{\sqrt{2}}{k^2(1+k^2)\left(2 r_3 + r_5\right)} \\ -\frac{i\left(3k^2\left(2 r_3 + r_5\right)+2 t_2\right)}{k(1+k^2)^2\left(2 r_3 + r_5\right)t_2} & -\frac{\sqrt{2}}{k^2(1+k^2)\left(2 r_3 + r_5\right)} & \frac{3k^2\left(2 r_3 + r_5\right)+2 t_2}{(k+k^3)^2\left(2 r_3 + r_5\right)t_2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{2}{k^2\left(r_3 + 2 r_5\right)} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & -\frac{2}{3k^2 r_3} \end{pmatrix}, \; (0)\right\}$$

Square masses:

$$\left\{ \{\}, \; \left\{ -\frac{t_2}{r_2}\right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\}\right\}$$

Massive pole residues:

$$\left\{ \{\}, \; \left\{ -\frac{1}{r_2}\right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\}\right\}$$

Massless eigenvalues:

$$\left\{ -\frac{45 r_3^2 + 20 r_3 r_5 + 4 r_5^2}{r_3\left(2 r_3 + r_5\right)\left(r_3 + 2 r_5\right)}, \; -\frac{45 r_3^2 + 20 r_3 r_5 + 4 r_5^2}{r_3\left(2 r_3 + r_5\right)\left(r_3 + 2 r_5\right)}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_2}, \; 0^-, \; -\frac{t_2}{r_2}\right\}, \; \left\{ -\frac{45 r_3^2 + 20 r_3 r_5 + 4 r_5^2}{r_3\left(2 r_3 + r_5\right)\left(r_3 + 2 r_5\right)}\right\}\right\}$$

Overall unitarity conditions:

$$\left(r_2 < 0 \;\&\&\; r_3 < 0 \;\&\&\; r_5 < -\frac{r_3}{2} \;\&\&\; t_2 > 0\right) \;||$$

$$\left(r_2 < 0 \;\&\&\; r_3 < 0 \;\&\&\; r_5 > -2 r_3 \;\&\&\; t_2 > 0\right) \;||\; \left(r_2 < 0 \;\&\&\; r_3 > 0 \;\&\&\; -2 r_3 < r_5 < -\frac{r_3}{2} \;\&\&\; t_2 > 0\right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_2 < 0 \,\&\&\, r_3 < 0 \,\&\&\, r_5 < -\frac{r_3}{2} \,\&\&\, t_2 > 0\right) \,||$$

$$\left(r_2 < 0 \,\&\&\, r_3 < 0 \,\&\&\, r_5 > -2\,r_3 \,\&\&\, t_2 > 0\right) \,||\, \left(r_2 < 0 \,\&\&\, r_3 > 0 \,\&\&\, -2\,r_3 < r_5 < -\frac{r_3}{2} \,\&\&\, t_2 > 0\right)$$

Okay, that concludes the analysis of this theory.

Case 2

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 2 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \left(\frac{r_3}{2} + r_5\right) \mathcal{R}^{ij}{}_i{}^{h} \, \mathcal{R}_j{}^{l}{}_{hl} + \frac{1}{6}\left(r_2 - 6\,r_3\right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$\frac{1}{2}\left(r_3 - 2\,r_5\right) \mathcal{R}^{ij}{}_i{}^{h} \, \mathcal{R}_h{}^{l}{}_{jl} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} - \frac{2}{3} t_3 \, \mathcal{T}^{i}{}_i{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \, \mathcal{A}_i{}^{l}{}_l \, \mathcal{A}^{ij}{}_j + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - \frac{1}{2} r_3 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_l{}^{a}{}_a - r_5 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_l{}^{a}{}_a +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} + \frac{1}{2} r_3 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial_h \mathcal{A}^{jhl} -$$

$$r_5 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial_h \mathcal{A}^{jhl} - \frac{1}{2} r_3 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial_h \mathcal{A}^{jhl} - \frac{1}{2} r_3 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial_h \mathcal{A}^{hlj} - r_5 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial_h \mathcal{A}^{hlj} +$$

$$r_3 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial_h \mathcal{A}^{hlj} + 2\,r_5 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^{j} -$$

$$\frac{1}{6} t_2 \, \partial^a f_h{}^{l} \, \partial^h f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{a} \, \partial^h f^i{}_a - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{2}{3} t_3 \, \mathcal{A}_h{}^{a}{}_a \, \partial^h f^i{}_i - \frac{2}{3} t_3 \, \mathcal{A}_h{}^{l}{}_l \, \partial^h f^i{}_i -$$

$$\frac{4}{3} t_3 \, \partial^a f_{ah} \, \partial^h f^i{}_i + \frac{2}{3} t_3 \, \partial_h f^l{}_l \, \partial^h f^i{}_i - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{l} \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^{l}{}_h \, \partial^h f^i{}_l -$$

$$\frac{1}{3} t_2 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial_h f_i{}^{l} \, \partial^h f^i{}_l + \frac{2}{3} t_3 \, \partial^a f_a{}^{l}{}_a \, \partial^h f_{ha} + \frac{2}{3} t_3 \, \mathcal{A}_j{}^{l}{}_l \, \partial^h f_h{}^{j} + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} +$$

$$\frac{1}{6} t_2 \, \partial^a f_h{}^{l} \, \partial^h f_{la} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_l{}^{j} - \frac{1}{6} t_2 \, \partial_h f_j{}^{l} \, \partial^h f_l{}^{j} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{ql} \, \partial_l \mathcal{A}_{aa'}{}^{i} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} -$$

$$4\,r_3 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{1}{2} r_3 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial^l \mathcal{A}^{jh}{}_h + r_5 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial^l \mathcal{A}^{jh}{}_h + \frac{1}{2} r_3 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial^l \mathcal{A}^{jh}{}_h - r_5 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
2\,k^2\,t_3 & i\,\sqrt{2}\,k\,t_3 & 0 \\
-i\,\sqrt{2}\,k\,t_3 & t_3 & 0 \\
0 & 0 & 0
\end{pmatrix},\;
\left(k^2\,r_2 + t_2\right),\;
\begin{pmatrix}
\dfrac{k^2\,t_2}{3} & \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_2 & \dfrac{i\,k\,t_2}{3} \\[2mm]
-\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_2 & \dfrac{1}{2}\left(2\,k^2\left(2\,r_3 + r_5\right) + \dfrac{4\,t_2}{3}\right) & \dfrac{\sqrt{2}\,t_2}{3} \\[2mm]
-\dfrac{1}{3}\,i\,k\,t_2 & \dfrac{\sqrt{2}\,t_2}{3} & \dfrac{t_2}{3}
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
\dfrac{2\,k^2\,t_3}{3} & \dfrac{2\,i\,k\,t_3}{3} & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_3 \\[2mm]
-\dfrac{2}{3}\,i\,k\,t_3 & k^2\left(\dfrac{r_3}{2} + r_5\right) + \dfrac{2\,t_3}{3} & 0 & -\dfrac{\sqrt{2}\,t_3}{3} \\[2mm]
0 & 0 & 0 & 0 \\[2mm]
\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_3 & -\dfrac{\sqrt{2}\,t_3}{3} & 0 & \dfrac{t_3}{3}
\end{pmatrix},\;
\begin{pmatrix}
0 & 0 \\
0 & -\dfrac{3\,k^2\,r_3}{2}
\end{pmatrix},\; (0)
\right\}
$$

Gauge constraints on source currents:

$$
\left\{ \overset{0^+}{\bullet}\tau^{\flat\perp} == 0,\; -i\,\overset{0^+}{\bullet}\tau^{\flat\|} == 2\,k\,\overset{0^+}{\bullet}\sigma^{\flat\|},\; -i\,\overset{1^+}{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == k\,\overset{1^+}{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}}, \right.
$$

$$
\left. i\,\overset{1^-}{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2\,k\,\overset{1^-}{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\; \overset{1^-}{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\; \overset{2^+}{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 0,\; \overset{2^-}{\bullet}\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}\,\mathfrak{c}} == 0 \right\}
$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2mm]
-\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2mm]
0 & 0 & 0
\end{pmatrix},\;
\left(\dfrac{1}{k^2\,r_2 + t_2}\right),
\right.
$$

$$
\begin{pmatrix}
\dfrac{3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2}{\left(1+k^2\right)^2\left(2\,r_3 + r_5\right)t_2} & -\dfrac{i\,\sqrt{2}}{k\left(1+k^2\right)\left(2\,r_3 + r_5\right)} & \dfrac{i\left(3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2\right)}{k\left(1+k^2\right)^2\left(2\,r_3 + r_5\right)t_2} \\[2mm]
\dfrac{i\,\sqrt{2}}{k\left(1+k^2\right)\left(2\,r_3 + r_5\right)} & \dfrac{1}{k^2\left(2\,r_3 + r_5\right)} & -\dfrac{\sqrt{2}}{k^2\left(1+k^2\right)\left(2\,r_3 + r_5\right)} \\[2mm]
-\dfrac{i\left(3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2\right)}{k\left(1+k^2\right)^2\left(2\,r_3 + r_5\right)t_2} & -\dfrac{\sqrt{2}}{k^2\left(1+k^2\right)\left(2\,r_3 + r_5\right)} & \dfrac{3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2}{\left(k+k^3\right)^2\left(2\,r_3 + r_5\right)t_2}
\end{pmatrix},
$$

$$
\begin{pmatrix}
\dfrac{6\,k^2\left(r_3 + 2\,r_5\right) + 8\,t_3}{\left(1+2\,k^2\right)^2\left(r_3 + 2\,r_5\right)t_3} & -\dfrac{4\,i}{k\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} & 0 & -\dfrac{i\,\sqrt{2}\left(3\,k^2\left(r_3 + 2\,r_5\right) + 4\,t_3\right)}{k\left(1+2\,k^2\right)^2\left(r_3 + 2\,r_5\right)t_3} \\[2mm]
\dfrac{4\,i}{k\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} & \dfrac{2}{k^2\left(r_3 + 2\,r_5\right)} & 0 & \dfrac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} \\[2mm]
0 & 0 & 0 & 0 \\[2mm]
\dfrac{i\,\sqrt{2}\left(3\,k^2\left(r_3 + 2\,r_5\right) + 4\,t_3\right)}{k\left(1+2\,k^2\right)^2\left(r_3 + 2\,r_5\right)t_3} & \dfrac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} & 0 & \dfrac{3\,k^2\left(r_3 + 2\,r_5\right) + 4\,t_3}{\left(k+2\,k^3\right)^2\left(r_3 + 2\,r_5\right)t_3}
\end{pmatrix},\;
\begin{pmatrix}
0 & 0 \\
0 & -\dfrac{2}{3\,k^2\,r_3}
\end{pmatrix},\; (0)
\right\}
$$

Square masses:

$$
\left\{ \{\},\; \left\{-\dfrac{t_2}{r_2}\right\},\; \{\},\; \{\},\; \{\},\; \{\} \right\}
$$

Massive pole residues:

$$
\left\{ \{\},\; \left\{-\dfrac{1}{r_2}\right\},\; \{\},\; \{\},\; \{\},\; \{\} \right\}
$$

Massless eigenvalues:

$$\left\{-\frac{403\,r_3{}^2 + 172\,r_3\,r_5 + 28\,r_5{}^2}{6\,r_3\left(2\,r_3 + r_5\right)\left(r_3 + 2\,r_5\right)} , \; -\frac{403\,r_3{}^2 + 172\,r_3\,r_5 + 28\,r_5{}^2}{6\,r_3\left(2\,r_3 + r_5\right)\left(r_3 + 2\,r_5\right)}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2} , \; 0^- , \; -\frac{t_2}{r_2}\right\}, \; \left\{-\frac{403\,r_3{}^2 + 172\,r_3\,r_5 + 28\,r_5{}^2}{6\,r_3\left(2\,r_3 + r_5\right)\left(r_3 + 2\,r_5\right)}\right\}\right\}$$

Overall unitarity conditions:

$$\left(r_2 < 0 \;\&\&\; r_3 < 0 \;\&\&\; r_5 < -\frac{r_3}{2} \;\&\&\; t_2 > 0\right) \,||$$

$$\left(r_2 < 0 \;\&\&\; r_3 < 0 \;\&\&\; r_5 > -2\,r_3 \;\&\&\; t_2 > 0\right) || \left(r_2 < 0 \;\&\&\; r_3 > 0 \;\&\&\; -2\,r_3 < r_5 < -\frac{r_3}{2} \;\&\&\; t_2 > 0\right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_2 < 0 \;\&\&\; r_3 < 0 \;\&\&\; r_5 < -\frac{r_3}{2} \;\&\&\; t_2 > 0\right) \,||$$

$$\left(r_2 < 0 \;\&\&\; r_3 < 0 \;\&\&\; r_5 > -2\,r_3 \;\&\&\; t_2 > 0\right) || \left(r_2 < 0 \;\&\&\; r_3 > 0 \;\&\&\; -2\,r_3 < r_5 < -\frac{r_3}{2} \;\&\&\; t_2 > 0\right)$$

Okay, that concludes the analysis of this theory.

Case 3

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 3 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\,r_2\,\mathcal{R}_{ijhl}\;\mathcal{R}^{ijhl} - \frac{2}{3}\,r_2\,\mathcal{R}_{ihjl}\;\mathcal{R}^{ijhl} + r_5\,\mathcal{R}^{ij}{}_i{}^{h}\;\mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{6}\,r_2\,\mathcal{R}^{ijhl}\;\mathcal{R}_{hlij} -$$

$$r_5\,\mathcal{R}^{ij}{}_i{}^{h}\;\mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{4}\,t_1\,\mathcal{T}_{ijh}\;\mathcal{T}^{ijh} + \frac{1}{2}\,t_1\,\mathcal{T}^{ijh}\;\mathcal{T}_{jih} + \frac{1}{3}\,t_1\,\mathcal{T}^{ij}{}_i{}^{j}\;\mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\,t_{\bullet_1}\,\mathcal{A}_{i}{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_{j}+t_{\bullet_1}\,\mathcal{A}_{i\hbar j}\,\mathcal{A}^{ij\hbar}-r_{\bullet_5}\,\partial_i\mathcal{A}^{\hbar l}{}_{\hbar}\,\partial^i\mathcal{A}_{l}{}^{a}{}_{a}+\frac{2}{3}\,r_{\bullet_2}\,\partial^{a'}\mathcal{A}^{ja}{}_{\hbar}\,\partial_j\mathcal{A}_{aa'}{}^{\hbar}-$$

$$\frac{1}{3}\,r_{\bullet_2}\,\partial_j\mathcal{A}_{aa'}{}^{\hbar}\,\partial_{\hbar}\mathcal{A}^{aa'j}-\frac{2}{3}\,r_{\bullet_2}\,\partial_j\mathcal{A}_{aa'}{}^{\hbar}\,\partial_{\hbar}\mathcal{A}^{jaa'}-r_{\bullet_5}\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}+r_{\bullet_5}\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}-$$

$$r_{\bullet_5}\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar lj}+2\,r_{\bullet_5}\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar lj}+\frac{1}{3}\,r_{\bullet_2}\,\partial_{\hbar}\mathcal{A}^{aa'j}\,\partial^{\hbar}\mathcal{A}_{aa'j}+\frac{2}{3}\,r_{\bullet_2}\,\partial_{\hbar}\mathcal{A}^{jaa'}\,\partial^{\hbar}\mathcal{A}_{aa'j}-$$

$$\frac{1}{2}\,t_{\bullet_1}\,\partial^a f_{j\hbar}\,\partial^{\hbar}f_{a}{}^{j}+\frac{1}{2}\,t_{\bullet_1}\,\partial^a f_{\hbar}{}^{l}\,\partial^{\hbar}f_{al}-\frac{1}{2}\,t_{\bullet_1}\,\partial^a f_{i\hbar}\,\partial^{\hbar}f^{i}{}_{a}+\frac{1}{3}\,t_{\bullet_1}\,\mathcal{A}_{\hbar}{}^{a}{}_{a}\,\partial^{\hbar}f^{i}{}_{i}+\frac{1}{3}\,t_{\bullet_1}\,\mathcal{A}_{\hbar}{}^{l}{}_{l}\,\partial^{\hbar}f^{i}{}_{i}+$$

$$\frac{2}{3}\,t_{\bullet_1}\,\partial^a f_{a\hbar}\,\partial^{\hbar}f^{i}{}_{i}-\frac{1}{3}\,t_{\bullet_1}\,\partial_{\hbar}f^{l}{}_{l}\,\partial^{\hbar}f^{i}{}_{i}+t_{\bullet_1}\,\mathcal{A}^{l}{}_{\hbar i}\,\partial^{\hbar}f^{i}{}_{l}+\frac{1}{2}\,t_{\bullet_1}\,\partial_{\hbar}f^{i}{}_{i}\,\partial^{\hbar}f^{i}{}_{l}-\frac{1}{3}\,t_{\bullet_1}\,\partial^{a'}f_{a'}{}^{a}\,\partial^{\hbar}f_{\hbar a}-$$

$$\frac{1}{3}\,t_{\bullet_1}\,\mathcal{A}_{j}{}^{l}{}_{l}\,\partial^{\hbar}f_{\hbar}{}^{j}-\frac{1}{3}\,t_{\bullet_1}\,\mathcal{A}^{la}{}_{a}\,\partial^{\hbar}f_{\hbar l}-\frac{1}{2}\,t_{\bullet_1}\,\partial^a f_{\hbar}{}^{l}\,\partial^{\hbar}f_{la}+t_{\bullet_1}\,\mathcal{A}_{j\hbar}{}^{l}\,\partial^{\hbar}f_{l}{}^{j}+\frac{1}{2}\,t_{\bullet_1}\,\partial_{\hbar}f_{j}{}^{l}\,\partial^{\hbar}f_{l}{}^{j}-$$

$$\frac{2}{3}\,r_{\bullet_2}\,\partial^{a'}\mathcal{A}_{i}{}^{al}\,\partial_l\mathcal{A}_{aa'}{}^{i}+\frac{2}{3}\,r_{\bullet_2}\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^{i}+r_{\bullet_5}\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^l\mathcal{A}^{j\hbar}{}_{\hbar}-r_{\bullet_5}\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^l\mathcal{A}^{j\hbar}{}_{\hbar}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with

the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2\,r_{\bullet_2}-t_{\bullet_1}\right),\ \begin{pmatrix} 0 & -\frac{ikt_{\bullet_1}}{\sqrt{2}} & 0 \\ \frac{ikt_{\bullet_1}}{\sqrt{2}} & \frac{1}{2}\left(2\,k^2\,r_{\bullet_5}-t_{\bullet_1}\right) & -\frac{t_{\bullet_1}}{\sqrt{2}} \\ 0 & -\frac{t_{\bullet_1}}{\sqrt{2}} & 0 \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \frac{2k^2 t_{\bullet_1}}{3} & -\frac{1}{3}\,ik\,t_{\bullet_1} & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet_1} \\ \frac{ikt_{\bullet_1}}{3} & k^2\,r_{\bullet_5}+\frac{t_{\bullet_1}}{6} & 0 & \frac{t_{\bullet_1}}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet_1} & \frac{t_{\bullet_1}}{3\sqrt{2}} & 0 & \frac{t_{\bullet_1}}{3} \end{pmatrix},\ \begin{pmatrix} k^2\,t_{\bullet_1} & \frac{ikt_{\bullet_1}}{\sqrt{2}} \\ -\frac{ikt_{\bullet_1}}{\sqrt{2}} & \frac{t_{\bullet_1}}{2} \end{pmatrix},\ \left(\frac{t_{\bullet_1}}{2}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp}==0,\ {}^{0^+}_{\bullet}\sigma^{\flat\parallel}==0,\ {}^{0^+}_{\bullet}\tau^{\flat\parallel}==0,\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel ab}==k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp ab},\ i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel a}==2k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp a},\ {}^{1^-}_{\bullet}\tau^{\flat\perp a}==0,\ -i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel ab}==2k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel ab}\right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally

analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2\, r_2 - t_1} \right), \begin{pmatrix} \frac{-2\,k^4\,r_5 + k^2\,t_1}{(1+k^2)^2\,t_1^2} & -\frac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & -\frac{i\left(2\,k^3\,r_5 - k\,t_1\right)}{(1+k^2)^2\,t_1^2} \\ \frac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & 0 & -\frac{\sqrt{2}}{t_1 + k^2\,t_1} \\ \frac{i\left(2\,k^3\,r_5 - k\,t_1\right)}{(1+k^2)^2\,t_1^2} & -\frac{\sqrt{2}}{t_1 + k^2\,t_1} & \frac{-2\,k^2\,r_5 + t_1}{(1+k^2)^2\,t_1^2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{6\,k^2\,r_5 + t_1}{(1+2\,k^2)^2\,r_5\,t_1} & \frac{i}{k\,r_5 + 2\,k^3\,r_5} & 0 & -\frac{i\left(6\,k^2\,r_5 + t_1\right)}{\sqrt{2}\,k\,(1+2\,k^2)^2\,r_5\,t_1} \\ -\frac{i}{k\,r_5 + 2\,k^3\,r_5} & \frac{1}{k^2\,r_5} & 0 & -\frac{1}{\sqrt{2}\left(k^2\,r_5 + 2\,k^4\,r_5\right)} \\ 0 & 0 & 0 & 0 \\ \frac{i\left(6\,k^2\,r_5 + t_1\right)}{\sqrt{2}\,k\,(1+2\,k^2)^2\,r_5\,t_1} & -\frac{1}{\sqrt{2}\left(k^2\,r_5 + 2\,k^4\,r_5\right)} & 0 & \frac{6\,k^2\,r_5 + t_1}{2\,(k+2\,k^3)^2\,r_5\,t_1} \end{pmatrix}, \begin{pmatrix} \frac{4\,k^2}{(1+2\,k^2)^2\,t_1} & \frac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} \\ -\frac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} & \frac{2}{(1+2\,k^2)^2\,t_1} \end{pmatrix}, \left(\frac{2}{t_1} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \left\{ \frac{t_1}{r_2} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \left\{ -\frac{1}{r_2} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massless eigenvalues:

$$\left\{ -\frac{7\,t_1^2 + 2\,r_5\,t_1\,p^2 + 4\,r_5^2\,p^4}{2\,r_5\,t_1^2}, \; -\frac{7\,t_1^2 + 2\,r_5\,t_1\,p^2 + 4\,r_5^2\,p^4}{2\,r_5\,t_1^2} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_2}, \; 0^-, \; \frac{t_1}{r_2} \right\}, \left\{ -\frac{7\,t_1^2 + 2\,r_5\,t_1\,p^2 + 4\,r_5^2\,p^4}{2\,r_5\,t_1^2} \right\} \right\}$$

Overall unitarity conditions:

$$p \in \mathbb{R} \;\&\&\; r_2 < 0 \;\&\&\; r_5 < 0 \;\&\&\; t_1 < 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \;\&\&\; r_5 < 0 \;\&\&\; t_1 < 0$$

Okay, that concludes the analysis of this theory.

Case 4

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 4 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3} r_1 \mathcal{R}_{ijhl} \mathcal{R}^{ijhl} + \frac{2}{3} r_1 \mathcal{R}_{ihjl} \mathcal{R}^{ijhl} + r_5 \mathcal{R}^{ij}{}_{i}{}^{h} \mathcal{R}^{l}{}_{jhl} - \frac{2}{3} r_1 \mathcal{R}^{ijhl} \mathcal{R}_{hlij} -$$

$$r_5 \mathcal{R}^{ij}{}_{i}{}^{h} \mathcal{R}^{l}{}_{hjl} + \frac{1}{4} t_1 \mathcal{T}_{ijh} \mathcal{T}^{ijh} + \frac{1}{2} t_1 \mathcal{T}^{ijh} \mathcal{T}_{jih} + \frac{1}{3} t_1 \mathcal{T}^{i}{}_{i}{}^{j} \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \mathcal{A}_{i}{}^{l}{}_{l} \mathcal{A}^{ij}{}_{j} + t_1 \mathcal{A}_{ihj} \mathcal{A}^{ijh} - r_5 \partial_i \mathcal{A}^{hl}{}_{h} \partial^j \mathcal{A}_{l}{}^{a}{}_{a} - \frac{2}{3} r_1 \partial^{a'} \mathcal{A}^{ja}{}_{h} \partial_j \mathcal{A}_{aa'}{}^{h} -$$

$$\frac{2}{3} r_1 \partial_j \mathcal{A}_{aa'}{}^{h} \partial_h \mathcal{A}^{aa'j} + \frac{2}{3} r_1 \partial_j \mathcal{A}_{aa'}{}^{h} \partial_h \mathcal{A}^{jaa'} - r_5 \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \partial_h \mathcal{A}^{jhl} + r_5 \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \partial_h \mathcal{A}^{jhl} -$$

$$r_5 \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \partial_h \mathcal{A}^{hlj} + 2 r_5 \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \partial_h \mathcal{A}^{aa'j} \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} r_1 \partial_h \mathcal{A}^{jaa'} \partial^h \mathcal{A}_{aa'j} -$$

$$\frac{1}{2} t_1 \partial^a f_{jh} \partial^h f_a{}^{j} + \frac{1}{2} t_1 \partial^a f_h{}^{l} \partial^h f_{al} - \frac{1}{2} t_1 \partial^a f_{ih} \partial^h f^{i}{}_{a} + \frac{1}{3} t_1 \mathcal{A}_{h}{}^{a}{}_{a} \partial^h f^{i}{}_{i} + \frac{1}{3} t_1 \mathcal{A}_{h}{}^{l}{}_{l} \partial^h f^{i}{}_{i} +$$

$$\frac{2}{3} t_1 \partial^a f_{ah} \partial^h f^{i}{}_{i} - \frac{1}{3} t_1 \partial_h f^{l}{}_{l} \partial^h f^{i}{}_{i} + t_1 \mathcal{A}^{l}{}_{hi} \partial^h f^{i}{}_{l} + \frac{1}{2} t_1 \partial_h f^{i}{}_{l} \partial^h f^{l}{}_{i} - \frac{1}{3} t_1 \partial^{a'} f_{a'}{}^{a} \partial^h f_{ha} -$$

$$\frac{1}{3} t_1 \mathcal{A}_{j}{}^{l}{}_{l} \partial^h f_h{}^{j} - \frac{1}{3} t_1 \mathcal{A}^{la}{}_{a} \partial^h f_{hl} - \frac{1}{2} t_1 \partial^a f_h{}^{l} \partial^h f_{la} + t_1 \mathcal{A}_{jh}{}^{l} \partial^h f_{l}{}^{j} + \frac{1}{2} t_1 \partial_h f_j{}^{l} \partial^h f_{l}{}^{j} +$$

$$\frac{2}{3} r_1 \partial^{a'} \mathcal{A}_{i}{}^{al} \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{8}{3} r_1 \partial^{a'} \mathcal{A}_{i}{}^{la} \partial_l \mathcal{A}_{aa'}{}^{i} + r_5 \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \partial^l \mathcal{A}^{jh}{}_{h} - r_5 \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \partial^l \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-t_1 \right), \begin{pmatrix} 0 & -\frac{ikt_1}{\sqrt{2}} & 0 \\ \frac{ikt_1}{\sqrt{2}} & \frac{1}{2}\left(2k^2\left(2r_1 + r_5 \right) - t_1 \right) & -\frac{t_1}{\sqrt{2}} \\ 0 & -\frac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2k^2 t_1}{3} & -\frac{1}{3} i k t_1 & 0 & -\frac{1}{3} i \sqrt{2} k t_1 \\ \frac{ikt_1}{3} & k^2\left(r_1 + r_5 \right) + \frac{t_1}{6} & 0 & \frac{t_1}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2} k t_1 & \frac{t_1}{3\sqrt{2}} & 0 & \frac{t_1}{3} \end{pmatrix}, \begin{pmatrix} k^2 t_1 & \frac{ikt_1}{\sqrt{2}} \\ -\frac{ikt_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \left(\frac{1}{2}\left(2k^2 r_1 + t_1 \right) \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{b\perp} == 0, \; {}^{0^+}\!\sigma^{b\parallel} == 0, \; {}^{0^+}\!\tau^{b\parallel} == 0, \; -i\, {}^{1^+}\!\tau^{b\parallel\,ab} == k\, {}^{1^+}\!\sigma^{b\perp\,ab}, \; i\, {}^{1^-}\!\tau^{b\parallel\,a} == 2k\, {}^{1^-}\!\sigma^{b\perp\,a}, \; {}^{1^-}\!\tau^{b\perp\,a} == 0, \; -i\, {}^{2^+}\!\tau^{b\parallel\,ab} == 2k\, {}^{2^+}\!\sigma^{b\parallel\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-\frac{1}{t_1} \right), \begin{pmatrix} \frac{-2k^4\left(2r_1+r_5\right)+k^2 t_1}{(1+k^2)^2 t_1^2} & -\frac{i\sqrt{2}\,k}{t_1+k^2 t_1} & \frac{-2ik^3\left(2r_1+r_5\right)+ikt_1}{(1+k^2)^2 t_1^2} \\ \frac{i\sqrt{2}\,k}{t_1+k^2 t_1} & 0 & -\frac{\sqrt{2}}{t_1+k^2 t_1} \\ \frac{i\left(2k^3\left(2r_1+r_5\right)-kt_1\right)}{(1+k^2)^2 t_1^2} & -\frac{\sqrt{2}}{t_1+k^2 t_1} & \frac{-2k^2\left(2r_1+r_5\right)+t_1}{(1+k^2)^2 t_1^2} \end{pmatrix}, \right. $$

$$\left. \begin{pmatrix} \frac{6k^2\left(r_1+r_5\right)+t_1}{(1+2k^2)^2\left(r_1+r_5\right)t_1} & \frac{i}{k\left(1+2k^2\right)\left(r_1+r_5\right)} & 0 & -\frac{i\left(6k^2\left(r_1+r_5\right)+t_1\right)}{\sqrt{2}\,k\left(1+2k^2\right)^2\left(r_1+r_5\right)t_1} \\ -\frac{i}{k\left(1+2k^2\right)\left(r_1+r_5\right)} & \frac{1}{k^2\left(r_1+r_5\right)} & 0 & -\frac{1}{\sqrt{2}\left(k^2+2k^4\right)\left(r_1+r_5\right)} \\ 0 & 0 & 0 & 0 \\ \frac{i\left(6k^2\left(r_1+r_5\right)+t_1\right)}{\sqrt{2}\,k\left(1+2k^2\right)^2\left(r_1+r_5\right)t_1} & -\frac{1}{\sqrt{2}\left(k^2+2k^4\right)\left(r_1+r_5\right)} & 0 & \frac{6k^2\left(r_1+r_5\right)+t_1}{2\left(k+2k^3\right)^2\left(r_1+r_5\right)t_1} \end{pmatrix}, \begin{pmatrix} \frac{4k^2}{(1+2k^2)^2 t_1} & \frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1} \\ -\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & \frac{2}{(1+2k^2)^2 t_1} \end{pmatrix}, \left(\frac{2}{2k^2 r_1+t_1} \right) \right\} $$

Square masses:

$$\left\{ \{\}, \{\}, \{\}, \{\}, \{\}, \left\{ -\frac{t_1}{2r_1} \right\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \{\}, \{\}, \{\}, \{\}, \left\{ -\frac{1}{r_1} \right\} \right\}$$

Massless eigenvalues:

$$\left\{ -\frac{7t_1^2 + 2r_1 t_1 p^2 + 2r_5 t_1 p^2 + 4r_1^2 p^4 + 8r_1 r_5 p^4 + 4r_5^2 p^4}{2\left(r_1+r_5\right)t_1^2}, \right.$$

$$\left. -\frac{7t_1^2 + 2r_1 t_1 p^2 + 2r_5 t_1 p^2 + 4r_1^2 p^4 + 8r_1 r_5 p^4 + 4r_5^2 p^4}{2\left(r_1+r_5\right)t_1^2} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_1}, \; 2^-, \; -\frac{t_1}{2r_1} \right\}, \left\{ -\frac{7t_1^2 + 2r_1 t_1 p^2 + 2r_5 t_1 p^2 + 4r_1^2 p^4 + 8r_1 r_5 p^4 + 4r_5^2 p^4}{2\left(r_1+r_5\right)t_1^2} \right\} \right\}$$

Overall unitarity conditions:

$$p \in \mathbb{R} \; \&\& \; r_1 < 0 \; \&\& \; r_5 < -r_1 \; \&\& \; t_1 > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$r_1 < 0 \,\&\&\, r_5 < -r_1 \,\&\&\, t_1 > 0$

Okay, that concludes the analysis of this theory.

Case 5

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 5 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3} r_1 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} + \frac{2}{3} r_1 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_5 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{j}{}^{l}{}_{hl} - \frac{2}{3} r_1 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} -$$

$$r_5 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{3} t_1 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} + \frac{1}{3} t_1 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} + t_1 \, \mathcal{T}^{i}{}_{i}{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_1 \, \mathcal{A}_{i}{}^{l}{}_{l} \, \mathcal{A}^{ij}{}_{j} + \frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} + \frac{1}{3} t_1 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - r_5 \, \partial_i \mathcal{A}^{hl}{}_{h} \, \partial^j \mathcal{A}_{l}{}^{a}{}_{a} - \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} -$$

$$\frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} + \frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} - r_5 \, \partial_a \mathcal{A}^{a}{}_{l}{}_{j} \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}^{a}{}_{l}{}_{a} \, \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}^{a}{}_{l}{}_{j} \, \partial_h \mathcal{A}^{hlj} +$$

$$2 r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{3} t_1 \, \partial^a f_{jh} \, \partial^h f_{a}{}^{j} + \frac{1}{3} t_1 \, \partial^a f_{h}{}^{l} \, \partial^h f_{al} +$$

$$\frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^{a} \, \partial^h f^{i}{}_{a} - \frac{2}{3} t_1 \, \partial^a f_{ih} \, \partial^h f^{i}{}_{a} + t_1 \, \mathcal{A}_{h}{}^{a}{}_{a} \, \partial^h f^{i}{}_{i} + t_1 \, \mathcal{A}_{h}{}^{l}{}_{l} \, \partial^h f^{i}{}_{i} + 2 t_1 \, \partial^a f_{ah} \, \partial^h f^{i}{}_{i} - t_1 \, \partial_h f^{l}{}_{l} \, \partial^h f^{i}{}_{i} -$$

$$\frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^{l} \, \partial^h f^{i}{}_{l} - \frac{1}{3} t_1 \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^h f^{i}{}_{l} + \frac{2}{3} t_1 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_{l} + \frac{2}{3} t_1 \, \partial_h f^{l}{}_{i} \, \partial^h f^{i}{}_{l} -$$

$$t_1 \, \partial^{a'} f_{a'}{}^{a} \, \partial^h f_{ha} - t_1 \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^h f_{h}{}^{j} - t_1 \, \mathcal{A}^{la}{}_{a} \, \partial^h f_{hl} - \frac{1}{3} t_1 \, \partial^a f_{h}{}^{l} \, \partial^h f_{la} + \frac{2}{3} t_1 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_{l}{}^{j} +$$

$$\frac{1}{3} t_1 \, \partial_h f_{j}{}^{l} \, \partial^h f_{l}{}^{j} + \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}_{i}{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{8}{3} r_1 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} + r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial^l \mathcal{A}^{jh}{}_{h} - r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial^l \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -2k^2 t_1 & -i\sqrt{2}\,k\,t_1 & 0 \\ i\sqrt{2}\,k\,t_1 & -t_1 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ (0),\ \begin{pmatrix} \dfrac{k^2 t_1}{3} & -\dfrac{i k t_1}{3\sqrt{2}} & \dfrac{i k t_1}{3} \\[2mm] \dfrac{i k t_1}{3\sqrt{2}} & \dfrac{1}{2}\left(2k^2\left(2r_1+r_5\right)+\dfrac{t_1}{3}\right) & -\dfrac{t_1}{3\sqrt{2}} \\[2mm] -\dfrac{1}{3}i k t_1 & -\dfrac{t_1}{3\sqrt{2}} & \dfrac{t_1}{3} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} 0 & -i k t_1 & 0 & 0 \\[1mm] i k t_1 & k^2\left(r_1+r_5\right)-\dfrac{t_1}{2} & 0 & \dfrac{t_1}{\sqrt{2}} \\[1mm] 0 & 0 & 0 & 0 \\[1mm] 0 & \dfrac{t_1}{\sqrt{2}} & 0 & 0 \end{pmatrix},\ \begin{pmatrix} k^2 t_1 & \dfrac{i k t_1}{\sqrt{2}} \\[2mm] -\dfrac{i k t_1}{\sqrt{2}} & \dfrac{t_1}{2} \end{pmatrix},\ \left(\dfrac{1}{2}\left(2k^2 r_1+t_1\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\|} == 2k\,{}^{0^+}_{\bullet}\sigma^{\flat\|},\ {}^{0^-}_{\bullet}\sigma^{\flat\|} == 0,\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\|\,ab} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab},\right.$$
$$\left. i\,{}^{1^-}_{\bullet}\tau^{\flat\|\,a} == 2k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0,\ -i\,{}^{2^+}_{\bullet}\tau^{\flat\|\,ab} == 2k\,{}^{2^+}_{\bullet}\sigma^{\flat\|\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -\dfrac{2k^2}{(1+2k^2)^2 t_1} & -\dfrac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & 0 \\[2mm] \dfrac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & -\dfrac{1}{(1+2k^2)^2 t_1} & 0 \\[2mm] 0 & 0 & 0 \end{pmatrix},\ (0),\right.$$

$$\begin{pmatrix} \dfrac{6k^2\left(2r_1+r_5\right)+t_1}{2(1+k^2)^2\left(2r_1+r_5\right)t_1} & \dfrac{i}{\sqrt{2}\,(k+k^3)\left(2r_1+r_5\right)} & \dfrac{i\left(6k^2\left(2r_1+r_5\right)+t_1\right)}{2k(1+k^2)^2\left(2r_1+r_5\right)t_1} \\[3mm] -\dfrac{i}{\sqrt{2}\,(k+k^3)\left(2r_1+r_5\right)} & \dfrac{1}{k^2\left(2r_1+r_5\right)} & \dfrac{1}{\sqrt{2}\,(k^2+k^4)\left(2r_1+r_5\right)} \\[3mm] -\dfrac{i\left(6k^2\left(2r_1+r_5\right)+t_1\right)}{2k(1+k^2)^2\left(2r_1+r_5\right)t_1} & \dfrac{1}{\sqrt{2}\,(k^2+k^4)\left(2r_1+r_5\right)} & \dfrac{6k^2\left(2r_1+r_5\right)+t_1}{2(k+k^3)^2\left(2r_1+r_5\right)t_1} \end{pmatrix},$$

$$\begin{pmatrix} \dfrac{-4k^4\left(r_1+r_5\right)+2k^2 t_1}{\left(t_1+2k^2 t_1\right)^2} & -\dfrac{2ik}{t_1+2k^2 t_1} & 0 & \dfrac{i\sqrt{2}\,k\left(2k^2\left(r_1+r_5\right)-t_1\right)}{\left(t_1+2k^2 t_1\right)^2} \\[3mm] \dfrac{2ik}{t_1+2k^2 t_1} & 0 & 0 & \dfrac{\sqrt{2}}{t_1+2k^2 t_1} \\[3mm] 0 & 0 & 0 & 0 \\[3mm] -\dfrac{i\sqrt{2}\,k\left(2k^2\left(r_1+r_5\right)-t_1\right)}{\left(t_1+2k^2 t_1\right)^2} & \dfrac{\sqrt{2}}{t_1+2k^2 t_1} & 0 & \dfrac{-2k^2\left(r_1+r_5\right)+t_1}{\left(t_1+2k^2 t_1\right)^2} \end{pmatrix},$$
$$\left.\begin{pmatrix} \dfrac{4k^2}{(1+2k^2)^2 t_1} & \dfrac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1} \\[2mm] -\dfrac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & \dfrac{2}{(1+2k^2)^2 t_1} \end{pmatrix},\ \left(\dfrac{2}{2k^2 r_1+t_1}\right)\right\}$$

Square masses:

$$\left\{0,\ 0,\ 0,\ 0,\ 0,\ \left\{-\dfrac{t_1}{2r_1}\right\}\right\}$$

Massive pole residues:

$$\left\{0,\ 0,\ 0,\ 0,\ 0,\ \left\{-\dfrac{1}{r_1}\right\}\right\}$$

Massless eigenvalues:

$$\left\{ \frac{9\,t_1{}^2 + 4\,r_1\,t_1\,p^2 + 2\,r_5\,t_1\,p^2 + 8\,r_1{}^2\,p^4 + 8\,r_1\,r_5\,p^4 + 2\,r_5{}^2\,p^4}{\left(2\,r_1 + r_5\right)t_1{}^2} \, , \right.$$

$$\left. \frac{9\,t_1{}^2 + 4\,r_1\,t_1\,p^2 + 2\,r_5\,t_1\,p^2 + 8\,r_1{}^2\,p^4 + 8\,r_1\,r_5\,p^4 + 2\,r_5{}^2\,p^4}{\left(2\,r_1 + r_5\right)t_1{}^2} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_1}\, ,\ 2^-,\ -\frac{t_1}{2\,r_1}\right\},\ \left\{\frac{9\,t_1{}^2 + 4\,r_1\,t_1\,p^2 + 2\,r_5\,t_1\,p^2 + 8\,r_1{}^2\,p^4 + 8\,r_1\,r_5\,p^4 + 2\,r_5{}^2\,p^4}{\left(2\,r_1 + r_5\right)t_1{}^2}\right\}\right\}$$

Overall unitarity conditions:

$$p \in \mathbb{R} \ \&\&\ r_1 < 0 \ \&\&\ r_5 > -2\,r_1 \ \&\&\ t_1 > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_1 < 0 \ \&\&\ r_5 > -2\,r_1 \ \&\&\ t_1 > 0$$

Okay, that concludes the analysis of this theory.

Case 6

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 6 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\,r_2\,\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} - \frac{2}{3}\,r_2\,\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + \left(2\,r_3 + r_5\right)\mathcal{R}^{ij}{}_i{}^{h}\ \mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{6}\left(r_2 - 6\,r_3\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} +$$

$$\left(2\,r_3 - r_5\right)\mathcal{R}^{ij}{}_i{}^{h}\ \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{4}\,t_1\,\mathcal{T}_{ijh}\ \mathcal{T}^{ijh} + \frac{1}{2}\,t_1\,\mathcal{T}^{ijh}\ \mathcal{T}_{jih} + \frac{1}{3}\,t_1\,\mathcal{T}^{i}{}_{i}{}^{j}\ \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}t_{\bullet 1}\mathcal{A}_{i\;\;l}^{\;l}\mathcal{A}^{ij}_{\;\;j}+t_{\bullet 1}\mathcal{A}_{i\hbar j}\mathcal{A}^{ij\hbar}-2r_{\bullet 3}\partial_i\mathcal{A}^{\hbar l}_{\;\;\hbar}\partial^i\mathcal{A}_{l\;\;\alpha}^{\;\alpha}-r_{\bullet 5}\partial_i\mathcal{A}^{\hbar l}_{\;\;\hbar}\partial^i\mathcal{A}_{l\;\;\alpha}^{\;\alpha}+\frac{2}{3}r_{\bullet 2}\partial^{\alpha'}\mathcal{A}^{j\alpha}_{\;\;\hbar}\partial_j\mathcal{A}_{\alpha\alpha'}^{\;\;\;\hbar}-$$

$$\frac{1}{3}r_{\bullet 2}\partial_j\mathcal{A}_{\alpha\alpha'}^{\;\;\;\hbar}\partial_\hbar\mathcal{A}^{\alpha\alpha'j}-\frac{2}{3}r_{\bullet 2}\partial_j\mathcal{A}_{\alpha\alpha'}^{\;\;\;\hbar}\partial_\hbar\mathcal{A}^{j\alpha\alpha'}+2r_{\bullet 3}\partial_\alpha\mathcal{A}_{l\;\;j}^{\;\alpha}\partial_\hbar\mathcal{A}^{j\hbar l}-r_{\bullet 5}\partial_\alpha\mathcal{A}_{l\;\;j}^{\;\alpha}\partial_\hbar\mathcal{A}^{j\hbar l}-$$

$$2r_{\bullet 3}\partial_j\mathcal{A}_{l\;\;\alpha}^{\;\alpha}\partial_\hbar\mathcal{A}^{j\hbar l}+r_{\bullet 5}\partial_j\mathcal{A}_{l\;\;\alpha}^{\;\alpha}\partial_\hbar\mathcal{A}^{j\hbar l}-2r_{\bullet 3}\partial_\alpha\mathcal{A}_{l\;\;j}^{\;\alpha}\partial_\hbar\mathcal{A}^{\hbar l j}-r_{\bullet 5}\partial_\alpha\mathcal{A}_{l\;\;j}^{\;\alpha}\partial_\hbar\mathcal{A}^{\hbar l j}+4r_{\bullet 3}\partial_j\mathcal{A}_{l\;\;\alpha}^{\;\alpha}\partial_\hbar\mathcal{A}^{\hbar l j}+$$

$$2r_{\bullet 5}\partial_j\mathcal{A}_{l\;\;\alpha}^{\;\alpha}\partial_\hbar\mathcal{A}^{\hbar l j}+\frac{1}{3}r_{\bullet 2}\partial_\hbar\mathcal{A}^{\alpha\alpha'j}\partial^\hbar\mathcal{A}_{\alpha\alpha'j}+\frac{2}{3}r_{\bullet 2}\partial_\hbar\mathcal{A}^{j\alpha\alpha'}\partial^\hbar\mathcal{A}_{\alpha\alpha'j}-\frac{1}{2}t_{\bullet 1}\partial^\alpha f_{j\hbar}\partial^\hbar f_\alpha^{\;j}+\frac{1}{2}t_{\bullet 1}\partial^\alpha f_\hbar^{\;l}\partial^\hbar f_{\alpha l}-$$

$$\frac{1}{2}t_{\bullet 1}\partial^\alpha f_{i\hbar}\partial^\hbar f_{\;\;\alpha}^i+\frac{1}{3}t_{\bullet 1}\mathcal{A}_{\hbar\;\;\alpha}^{\;\alpha}\partial^\hbar f_{\;\;i}^i+\frac{1}{3}t_{\bullet 1}\mathcal{A}_{\hbar\;\;l}^{\;l}\partial^\hbar f_{\;\;i}^i+\frac{2}{3}t_{\bullet 1}\partial^\alpha f_{\alpha\hbar}\partial^\hbar f_{\;\;i}^i-\frac{1}{3}t_{\bullet 1}\partial_\hbar f^l_{\;\;l}\partial^\hbar f_{\;\;i}^i+$$

$$t_{\bullet 1}\mathcal{A}_{\hbar i}^{\;l}\partial^\hbar f_{\;\;l}^i+\frac{1}{2}t_{\bullet 1}\partial_\hbar f_{\;\;i}^l\partial^\hbar f_{\;\;l}^i-\frac{1}{3}t_{\bullet 1}\partial^{\alpha'}f_{\alpha'}^{\;\alpha}\partial^\hbar f_{\hbar\alpha}-\frac{1}{3}t_{\bullet 1}\mathcal{A}_{j\;\;l}^{\;l}\partial^\hbar f_\hbar^{\;j}-\frac{1}{3}t_{\bullet 1}\mathcal{A}^{l\alpha}_{\;\;\alpha}\partial^\hbar f_{\hbar l}-$$

$$\frac{1}{2}t_{\bullet 1}\partial^\alpha f_\hbar^{\;l}\partial^\hbar f_{l\alpha}+t_{\bullet 1}\mathcal{A}_{j\hbar}^{\;l}\partial^\hbar f_{\;\;l}^j+\frac{1}{2}t_{\bullet 1}\partial_\hbar f_{\;\;j}^l\partial^\hbar f_{\;\;l}^j-\frac{2}{3}r_{\bullet 2}\partial^{\alpha'}\mathcal{A}_{\;\;i}^{\alpha l}\partial_l\mathcal{A}_{\alpha\alpha'}^{\;\;\;i}+\frac{2}{3}r_{\bullet 2}\partial^{\alpha'}\mathcal{A}_{\;\;i}^{l\alpha}\partial_l\mathcal{A}_{\alpha\alpha'}^{\;\;\;i}-$$

$$4r_{\bullet 3}\partial^{\alpha'}\mathcal{A}_{\;\;i}^{l\alpha}\partial_l\mathcal{A}_{\alpha\alpha'}^{\;\;\;i}-2r_{\bullet 3}\partial_\alpha\mathcal{A}_{l\;\;j}^{\;\alpha}\partial^l\mathcal{A}^{j\hbar}_{\;\;\hbar}+r_{\bullet 5}\partial_\alpha\mathcal{A}_{l\;\;j}^{\;\alpha}\partial^l\mathcal{A}^{j\hbar}_{\;\;\hbar}+2r_{\bullet 3}\partial_j\mathcal{A}_{l\;\;\alpha}^{\;\alpha}\partial^l\mathcal{A}^{j\hbar}_{\;\;\hbar}-r_{\bullet 5}\partial_j\mathcal{A}_{l\;\;\alpha}^{\;\alpha}\partial^l\mathcal{A}^{j\hbar}_{\;\;\hbar}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix}0&0&0\\0&6k^2r_{\bullet 3}&0\\0&0&0\end{pmatrix},\;\left(k^2r_{\bullet 2}-t_{\bullet 1}\right),\;\begin{pmatrix}0&-\frac{ikt_{\bullet 1}}{\sqrt{2}}&0\\\frac{ikt_{\bullet 1}}{\sqrt{2}}&\frac{1}{2}\left(2k^2\left(2r_{\bullet 3}+r_{\bullet 5}\right)-t_{\bullet 1}\right)&-\frac{t_{\bullet 1}}{\sqrt{2}}\\0&-\frac{t_{\bullet 1}}{\sqrt{2}}&0\end{pmatrix},\right.$$

$$\left.\begin{pmatrix}\frac{2k^2t_{\bullet 1}}{3}&-\frac{1}{3}ikt_{\bullet 1}&0&-\frac{1}{3}i\sqrt{2}\,kt_{\bullet 1}\\\frac{ikt_{\bullet 1}}{3}&k^2\left(2r_{\bullet 3}+r_{\bullet 5}\right)+\frac{t_{\bullet 1}}{6}&0&\frac{t_{\bullet 1}}{3\sqrt{2}}\\0&0&0&0\\\frac{1}{3}i\sqrt{2}\,kt_{\bullet 1}&\frac{t_{\bullet 1}}{3\sqrt{2}}&0&\frac{t_{\bullet 1}}{3}\end{pmatrix},\;\begin{pmatrix}k^2t_{\bullet 1}&\frac{ikt_{\bullet 1}}{\sqrt{2}}\\-\frac{ikt_{\bullet 1}}{\sqrt{2}}&\frac{t_{\bullet 1}}{2}\end{pmatrix},\;\left(\frac{t_{\bullet 1}}{2}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp}==0,\;{}^{0^+}_{\bullet}\tau^{\flat\parallel}==0,\;-i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel\alpha b}==k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\alpha b},\;i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel\alpha}==2k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\alpha},\;{}^{1^-}_{\bullet}\tau^{\flat\perp\alpha}==0,\;-i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel\alpha b}==2k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel\alpha b}\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{6\,k^2\,r_3} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\dfrac{1}{k^2\,r_2 - t_1} \right),\ \begin{pmatrix} \dfrac{-2\,k^4\left(2\,r_3 + r_5\right) + k^2\,t_1}{\left(1+k^2\right)^2 t_1^{\,2}} & -\dfrac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & \dfrac{-2\,i\,k^3\left(2\,r_3 + r_5\right) + i\,k\,t_1}{\left(1+k^2\right)^2 t_1^{\,2}} \\[2mm] \dfrac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & 0 & -\dfrac{\sqrt{2}}{t_1 + k^2\,t_1} \\[2mm] \dfrac{i\left(2\,k^3\left(2\,r_3 + r_5\right) - k\,t_1\right)}{\left(1+k^2\right)^2 t_1^{\,2}} & -\dfrac{\sqrt{2}}{t_1 + k^2\,t_1} & \dfrac{-2\,k^2\left(2\,r_3 + r_5\right) + t_1}{\left(1+k^2\right)^2 t_1^{\,2}} \end{pmatrix}, \right. $$

$$\left. \begin{pmatrix} \dfrac{6\,k^2\left(2\,r_3 + r_5\right) + t_1}{\left(1+2\,k^2\right)^2\left(2\,r_3 + r_5\right)t_1} & \dfrac{i}{k\left(1+2\,k^2\right)\left(2\,r_3 + r_5\right)} & 0 & -\dfrac{i\left(6\,k^2\left(2\,r_3 + r_5\right) + t_1\right)}{\sqrt{2}\,k\left(1+2\,k^2\right)^2\left(2\,r_3 + r_5\right)t_1} \\[2mm] -\dfrac{i}{k\left(1+2\,k^2\right)\left(2\,r_3 + r_5\right)} & \dfrac{1}{k^2\left(2\,r_3 + r_5\right)} & 0 & -\dfrac{1}{\sqrt{2}\left(k^2 + 2\,k^4\right)\left(2\,r_3 + r_5\right)} \\ 0 & 0 & 0 & 0 \\[2mm] \dfrac{i\left(6\,k^2\left(2\,r_3 + r_5\right) + t_1\right)}{\sqrt{2}\,k\left(1+2\,k^2\right)^2\left(2\,r_3 + r_5\right)t_1} & -\dfrac{1}{\sqrt{2}\left(k^2 + 2\,k^4\right)\left(2\,r_3 + r_5\right)} & 0 & \dfrac{6\,k^2\left(2\,r_3 + r_5\right) + t_1}{2\left(k + 2\,k^3\right)^2\left(2\,r_3 + r_5\right)t_1} \end{pmatrix},\ \begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\[2mm] -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_1} \end{pmatrix},\ \left(\dfrac{2}{t_1} \right) \right\}\right\}$$

Square masses:

$$\left\{0,\ \left\{\dfrac{t_1}{r_2}\right\},\ 0,\ 0,\ 0,\ 0\right\}$$

Massive pole residues:

$$\left\{0,\ \left\{-\dfrac{1}{r_2}\right\},\ 0,\ 0,\ 0,\ 0\right\}$$

Massless eigenvalues:

$$\left\{-\dfrac{7\,t_1^{\,2} + 4\,r_3\,t_1\,p^2 + 2\,r_5\,t_1\,p^2 + 16\,r_3^{\,2}\,p^4 + 16\,r_3\,r_5\,p^4 + 4\,r_5^{\,2}\,p^4}{2\left(2\,r_3 + r_5\right)t_1^{\,2}},\right.$$
$$\left. -\dfrac{7\,t_1^{\,2} + 4\,r_3\,t_1\,p^2 + 2\,r_5\,t_1\,p^2 + 16\,r_3^{\,2}\,p^4 + 16\,r_3\,r_5\,p^4 + 4\,r_5^{\,2}\,p^4}{2\left(2\,r_3 + r_5\right)t_1^{\,2}}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\dfrac{1}{r_2},\ 0^-,\ \dfrac{t_1}{r_2}\right\},\ \left\{-\dfrac{7\,t_1^{\,2} + 4\,r_3\,t_1\,p^2 + 2\,r_5\,t_1\,p^2 + 16\,r_3^{\,2}\,p^4 + 16\,r_3\,r_5\,p^4 + 4\,r_5^{\,2}\,p^4}{2\left(2\,r_3 + r_5\right)t_1^{\,2}}\right\}\right\}$$

Overall unitarity conditions:

$$\left(p\ \middle|\ r_3\right) \in \mathbb{R}\ \&\&\ r_2 < 0\ \&\&\ r_5 < -2\,r_3\ \&\&\ t_1 < 0$$

So, that's the end of the PSALTer output for this theory. You can check the particle content against TABLE IV. in arXiv:1910.14197. If you take the overall unitarity conditions from the final column in TABLE V., and decompose them using Mathematica's Reduce function, you get the following (to be compared with the PSALTer conditions above):

$r_3 \in \mathbb{R} \,\&\&\, r_2 < 0 \,\&\&\, r_5 < -2\,r_3 \,\&\&\, t_1 < 0$

Okay, that concludes the analysis of this theory.

Case 7

Now for a new theory. Here is the full nonlinear Lagrangian for
Case 7 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_1\,\mathcal{R}_{ijhl}\,\mathcal{R}^{ijhl} + \frac{2}{3}\,r_1\,\mathcal{R}_{ihjl}\,\mathcal{R}^{ijhl} + \left(-2\,r_1 + 2\,r_3 + r_5\right)\mathcal{R}^{ij}{}_i{}^{h}\,\mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{3}\left(r_1 - 3\,r_3\right)\mathcal{R}^{ijhl}\,\mathcal{R}_{hlij} + $$

$$\left(-2\,r_1 + 2\,r_3 - r_5\right)\mathcal{R}^{ij}{}_i{}^{h}\,\mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{4}\,t_1\,\mathcal{T}_{ijh}\,\mathcal{T}^{ijh} + \frac{1}{2}\,t_1\,\mathcal{T}^{ijh}\,\mathcal{T}_{jih} + \frac{1}{3}\,t_1\,\mathcal{T}^{i}{}_i{}^{j}\,\mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\,t_1\,\mathcal{A}_{i}{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_j + t_1\,\mathcal{A}_{ihj}\,\mathcal{A}^{ijh} + 2\,r_1\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_{l}{}^{a}{}_a - 2\,r_3\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_{l}{}^{a}{}_a - r_5\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_{l}{}^{a}{}_a - $$

$$\frac{2}{3}\,r_1\,\partial^{a'}\mathcal{A}^{ja}{}_h\,\partial_j\mathcal{A}_{aa'}{}^{h} - \frac{2}{3}\,r_1\,\partial_j\mathcal{A}_{aa'}{}^{h}\,\partial_h\mathcal{A}^{aa'j} + \frac{2}{3}\,r_1\,\partial_j\mathcal{A}_{aa'}{}^{h}\,\partial_h\mathcal{A}^{jaa'} - 2\,r_1\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{jhl} + $$

$$2\,r_3\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{jhl} - r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{jhl} + 2\,r_1\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{jhl} - 2\,r_3\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{jhl} + r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{jhl} + $$

$$2\,r_1\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{hlj} - 2\,r_3\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{hlj} - r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{hlj} - 4\,r_1\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{hlj} + $$

$$4\,r_3\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{hlj} + 2\,r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{hlj} + \frac{2}{3}\,r_1\,\partial_h\mathcal{A}^{aa'j}\,\partial^h\mathcal{A}_{aa'j} - \frac{2}{3}\,r_1\,\partial_h\mathcal{A}^{jaa'}\,\partial^h\mathcal{A}_{aa'j} - $$

$$\frac{1}{2}\,t_1\,\partial^a f_{jh}\,\partial^h f_{a}{}^{j} + \frac{1}{2}\,t_1\,\partial^a f_{h}{}^{l}\,\partial^h f_{al} - \frac{1}{2}\,t_1\,\partial^a f_{ih}\,\partial^h f^{i}{}_a + \frac{1}{3}\,t_1\,\mathcal{A}_{h}{}^{a}{}_a\,\partial^h f^{i}{}_i + \frac{1}{3}\,t_1\,\mathcal{A}_{h}{}^{l}{}_l\,\partial^h f^{i}{}_i + $$

$$\frac{2}{3}\,t_1\,\partial^a f_{ah}\,\partial^h f^{i}{}_i - \frac{1}{3}\,t_1\,\partial_h f^{l}{}_l\,\partial^h f^{i}{}_i + t_1\,\mathcal{A}^{l}{}_{hi}\,\partial^h f^{i}{}_l + \frac{1}{2}\,t_1\,\partial_h f_{i}{}^{l}\,\partial^h f^{i}{}_l - \frac{1}{3}\,t_1\,\partial^{a'} f_{a}{}^{a}\,\partial^h f_{ha} - $$

$$\frac{1}{3}\,t_1\,\mathcal{A}_{j}{}^{l}{}_l\,\partial^h f_{h}{}^{j} - \frac{1}{3}\,t_1\,\mathcal{A}^{la}{}_a\,\partial^h f_{hl} - \frac{1}{2}\,t_1\,\partial^a f_{h}{}^{l}\,\partial^h f_{la} + t_1\,\mathcal{A}_{jh}{}^{l}\,\partial^h f_{l}{}^{j} + \frac{1}{2}\,t_1\,\partial_h f_{j}{}^{l}\,\partial^h f_{l}{}^{j} + $$

$$\frac{2}{3}\,r_1\,\partial^{a'}\mathcal{A}_{i}{}^{al}\,\partial_l\mathcal{A}_{aa'}{}^{i} + \frac{4}{3}\,r_1\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^{i} - 4\,r_3\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^{i} + 2\,r_1\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial^l\mathcal{A}^{jh}{}_h - $$

$$2\,r_3\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial^l\mathcal{A}^{jh}{}_h + r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial^l\mathcal{A}^{jh}{}_h - 2\,r_1\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial^l\mathcal{A}^{jh}{}_h + 2\,r_3\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial^l\mathcal{A}^{jh}{}_h - r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 6\,k^2\left(-r_{\underset{1}{\bullet}}+r_{\underset{3}{\bullet}}\right) & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(-t_{\underset{1}{\bullet}}\right),\ \begin{pmatrix} 0 & -\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 \\ \dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\left(2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)-t_{\underset{1}{\bullet}}\right) & -\dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\ 0 & -\dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \dfrac{2\,k^2\,t_{\underset{1}{\bullet}}}{3} & -\dfrac{1}{3}\,i\,k\,t_{\underset{1}{\bullet}} & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} \\ \dfrac{i\,k\,t_{\underset{1}{\bullet}}}{3} & \dfrac{1}{6}\left(-6\,k^2\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)+t_{\underset{1}{\bullet}}\right) & 0 & \dfrac{t_{\underset{1}{\bullet}}}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & \dfrac{t_{\underset{1}{\bullet}}}{3\sqrt{2}} & 0 & \dfrac{t_{\underset{1}{\bullet}}}{3} \end{pmatrix},\ \begin{pmatrix} k^2\,t_{\underset{1}{\bullet}} & \dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} \\ -\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{t_{\underset{1}{\bullet}}}{2} \end{pmatrix},\ \left(\dfrac{1}{2}\left(2\,k^2\,r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{\overset{0^+}{\bullet}}\tau^{\flat\perp} == 0,\ {\overset{0^+}{\bullet}}\tau^{\flat\|} == 0,\ -i\ {\overset{1^+}{\bullet}}\tau^{\flat\|}{}^{\mathfrak{a}\,\mathfrak{b}} == k\ {\overset{1^+}{\bullet}}\sigma^{\flat\perp}{}^{\mathfrak{a}\,\mathfrak{b}},\ i\ {\overset{1^-}{\bullet}}\tau^{\flat\|}{}^{\mathfrak{a}} == 2\,k\ {\overset{1^-}{\bullet}}\sigma^{\flat\perp}{}^{\mathfrak{a}},\ {\overset{1^+}{\bullet}}\tau^{\flat\perp}{}^{\mathfrak{a}} == 0,\ -i\ {\overset{2^+}{\bullet}}\tau^{\flat\|}{}^{\mathfrak{a}\,\mathfrak{b}} == 2\,k\ {\overset{2^+}{\bullet}}\sigma^{\flat\|}{}^{\mathfrak{a}\,\mathfrak{b}}\right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{6\,k^2\left(-r_{\underset{1}{\bullet}}+r_{\underset{3}{\bullet}}\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(-\dfrac{1}{t_{\underset{1}{\bullet}}}\right),\right.$$

$$\left.\begin{pmatrix} \dfrac{-2\,k^4\left(2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)+k^2\,t_{\underset{1}{\bullet}}}{(1+k^2)^2\,t_{\underset{1}{\bullet}}{}^2} & -\dfrac{i\,\sqrt{2}\,k}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} & \dfrac{-2\,i\,k^3\left(2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)+i\,k\,t_{\underset{1}{\bullet}}}{(1+k^2)^2\,t_{\underset{1}{\bullet}}{}^2} \\ \dfrac{i\,\sqrt{2}\,k}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} & 0 & -\dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} \\ \dfrac{i\left(2\,k^3\left(2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)-k\,t_{\underset{1}{\bullet}}\right)}{(1+k^2)^2\,t_{\underset{1}{\bullet}}{}^2} & -\dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} & \dfrac{-2\,k^2\left(2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)+t_{\underset{1}{\bullet}}}{(1+k^2)^2\,t_{\underset{1}{\bullet}}{}^2} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \dfrac{\dfrac{1}{-r_{\underset{1}{\bullet}}+2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}}+\dfrac{6\,k^2}{t_{\underset{1}{\bullet}}}}{\left(1+2\,k^2\right)^2} & \dfrac{i}{k\left(1+2\,k^2\right)\left(-r_{\underset{1}{\bullet}}+2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)} & 0 & -\dfrac{i\left(6\,k^2\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)-t_{\underset{1}{\bullet}}\right)}{\sqrt{2}\,k\left(1+2\,k^2\right)^2\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)t_{\underset{1}{\bullet}}} \\ \dfrac{i}{k\left(1+2\,k^2\right)\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)} & \dfrac{1}{k^2\left(-r_{\underset{1}{\bullet}}+2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}\right)} & 0 & \dfrac{1}{\sqrt{2}\left(k^2+2\,k^4\right)\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\left(6\,k^2\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)-t_{\underset{1}{\bullet}}\right)}{\sqrt{2}\,k\left(1+2\,k^2\right)^2\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)t_{\underset{1}{\bullet}}} & \dfrac{1}{\sqrt{2}\left(k^2+2\,k^4\right)\left(r_{\underset{1}{\bullet}}-2\,r_{\underset{3}{\bullet}}-r_{\underset{5}{\bullet}}\right)} & 0 & \dfrac{\dfrac{1}{-r_{\underset{1}{\bullet}}+2\,r_{\underset{3}{\bullet}}+r_{\underset{5}{\bullet}}}+\dfrac{6\,k^2}{t_{\underset{1}{\bullet}}}}{2\left(k+2\,k^3\right)^2} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2\,t_{\underset{1}{\bullet}}} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\underset{1}{\bullet}}} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\underset{1}{\bullet}}} & \dfrac{2}{\left(1+2\,k^2\right)^2\,t_{\underset{1}{\bullet}}} \end{pmatrix},\ \left(\dfrac{2}{2\,k^2\,r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}}\right)\right\}$$

Square masses:

$$\left\{\{\},\ \{\},\ \{\},\ \{\},\ \{\},\ \left\{-\dfrac{t_{\underset{1}{\bullet}}}{2\,r_{\underset{1}{\bullet}}}\right\}\right\}$$

Massive pole residues:

$$\left\{\{\},\ \{\},\ \{\},\ \{\},\ \{\},\ \left\{-\dfrac{1}{r_{\underset{1}{\bullet}}}\right\}\right\}$$

Massless eigenvalues:

$$\left\{ \frac{7\, t_1^2 - 2\, r_1 t_1\, p^2 + 4\, r_3 t_1\, p^2 + 2\, r_5 t_1\, p^2 + 4\, r_1^2\, p^4 - 16\, r_1 r_3\, p^4 + 16\, r_3^2\, p^4 - 8\, r_1 r_5\, p^4 + 16\, r_3 r_5\, p^4 + 4\, r_5^2\, p^4}{2\left(r_1 - 2\, r_3 - r_5\right) t_1^2} \right., $$

$$\left. \frac{7\, t_1^2 - 2\, r_1 t_1\, p^2 + 4\, r_3 t_1\, p^2 + 2\, r_5 t_1\, p^2 + 4\, r_1^2\, p^4 - 16\, r_1 r_3\, p^4 + 16\, r_3^2\, p^4 - 8\, r_1 r_5\, p^4 + 16\, r_3 r_5\, p^4 + 4\, r_5^2\, p^4}{2\left(r_1 - 2\, r_3 - r_5\right) t_1^2} \right\} $$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_1},\ 2^-,\ -\frac{t_1}{2\, r_1} \right\}, \right. $$

$$\left. \left\{ \frac{7\, t_1^2 - 2\, r_1 t_1\, p^2 + 4\, r_3 t_1\, p^2 + 2\, r_5 t_1\, p^2 + 4\, r_1^2\, p^4 - 16\, r_1 r_3\, p^4 + 16\, r_3^2\, p^4 - 8\, r_1 r_5\, p^4 + 16\, r_3 r_5\, p^4 + 4\, r_5^2\, p^4}{2\left(r_1 - 2\, r_3 - r_5\right) t_1^2} \right\} \right\} \right\} $$

Overall unitarity conditions:

$$\left(p \mid r_3\right) \in \mathbb{R}\ \&\&\ r_1 < 0\ \&\&\ r_5 < r_1 - 2\, r_3\ \&\&\ t_1 > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_3 \in \mathbb{R}\ \&\&\ r_1 < 0\ \&\&\ r_5 < r_1 - 2\, r_3\ \&\&\ t_1 > 0$$

Okay, that concludes the analysis of this theory.

Case 8

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 8 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\, r_1\, \mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\, r_1\, \mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + r_5\, \mathcal{R}^{ij\ h}_{\ \ i}\ \mathcal{R}^{\ \ l}_{j\ hl} -$$

$$\frac{2}{3}\, r_1\, \mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} - r_5\, \mathcal{R}^{ij\ h}_{\ \ i}\ \mathcal{R}^{\ \ l}_{h\ jl} - \frac{2}{3}\, t_3\, \mathcal{T}^{i\ j}_{\ i}\ \mathcal{T}^{h}_{\ jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \, \mathcal{A}_{i\;\;l}^{\;l} \;\; \mathcal{A}^{ij}_{\;\;j} - r_5 \, \partial_i \mathcal{A}^{hl}_{\;\;\;h} \; \partial^i \mathcal{A}_{l\;\;a}^{\;a} - \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}^{ja}_{\;\;\;h} \; \partial_j \mathcal{A}_{aa'}^{\;\;\;\;h} - \frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}^{\;\;\;\;h} \; \partial_h \mathcal{A}^{aa'j} +$$

$$\frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}^{\;\;\;\;h} \; \partial_h \mathcal{A}^{jaa'} - r_5 \, \partial_a \mathcal{A}_{l\;\;j}^{\;a} \; \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_{l\;\;a}^{\;a} \; \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}_{l\;\;j}^{\;a} \; \partial_h \mathcal{A}^{hlj} +$$

$$2 r_5 \, \partial_j \mathcal{A}_{l\;\;a}^{\;a} \; \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{aa'j} \; \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{jaa'} \; \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} t_3 \, \mathcal{A}_{h\;\;a}^{\;a} \; \partial^h f^i_{\;\;i} -$$

$$\frac{2}{3} t_3 \, \mathcal{A}_{h\;\;l}^{\;l} \; \partial^h f^i_{\;\;i} - \frac{4}{3} t_3 \, \partial^a f_{ah} \; \partial^h f^i_{\;\;i} + \frac{2}{3} t_3 \, \partial_h f^l_{\;\;l} \; \partial^h f^i_{\;\;i} + \frac{2}{3} t_3 \, \partial^{a'} f_{a'}^{\;\;a} \; \partial^h f_{ha} + \frac{2}{3} t_3 \, \mathcal{A}_{j\;\;l}^{\;l} \; \partial^h f_{h}^{\;j} +$$

$$\frac{2}{3} t_3 \, \mathcal{A}_{\;\;\;a}^{la} \; \partial^h f_{hl} + \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}_{i}^{\;al} \; \partial_l \mathcal{A}_{aa'}^{\;\;\;\;i} - \frac{8}{3} r_1 \, \partial^{a'} \mathcal{A}_{i}^{\;la} \; \partial_l \mathcal{A}_{aa'}^{\;\;\;\;i} + r_5 \, \partial_a \mathcal{A}_{l\;\;j}^{\;a} \; \partial^l \mathcal{A}^{jh}_{\;\;\;h} - r_5 \, \partial_j \mathcal{A}_{l\;\;a}^{\;a} \; \partial^l \mathcal{A}^{jh}_{\;\;\;h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2 k^2 t_3 & i \sqrt{2} \, k t_3 & 0 \\ -i \sqrt{2} \, k t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; (0), \; \begin{pmatrix} 0 & 0 & 0 \\ 0 & k^2 \left(2 r_1 + r_5 \right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2 k^2 t_3}{3} & \frac{2 i k t_3}{3} & 0 & -\frac{1}{3} i \sqrt{2} \, k t_3 \\[2mm] -\frac{2}{3} i k t_3 & k^2 \left(r_1 + r_5 \right) + \frac{2 t_3}{3} & 0 & -\frac{\sqrt{2}\, t_3}{3} \\[2mm] 0 & 0 & 0 & 0 \\[2mm] \frac{1}{3} i \sqrt{2} \, k t_3 & -\frac{\sqrt{2}\, t_3}{3} & 0 & \frac{t_3}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; \left(k^2 r_1 \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ \overset{0^+}{\bullet} \tau^{\flat\perp} == 0, \; -i \, \overset{0^+}{\bullet} \tau^{\flat\parallel} == 2 k \, \overset{0^+}{\bullet} \sigma^{\flat\parallel}, \; \overset{0^-}{\bullet} \sigma^{\flat\parallel} == 0, \; \overset{1^+}{\bullet} \sigma^{\flat\perp ab} == 0, \right.$$

$$\left. \overset{1^+}{\bullet} \tau^{\flat\parallel ab} == 0, \; i \, \overset{1^-}{\bullet} \tau^{\flat\parallel a} == 2 k \, \overset{1^-}{\bullet} \sigma^{\flat\perp a}, \; \overset{1^-}{\bullet} \tau^{\flat\perp a} == 0, \; \overset{2^+}{\bullet} \sigma^{\flat\parallel ab} == 0, \; \overset{2^+}{\bullet} \tau^{\flat\parallel ab} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \frac{2 k^2}{\left(1+2 k^2\right)^2 t_3} & \frac{i \sqrt{2}\, k}{\left(1+2 k^2\right)^2 t_3} & 0 \\[2mm] -\frac{i \sqrt{2}\, k}{\left(1+2 k^2\right)^2 t_3} & \frac{1}{\left(1+2 k^2\right)^2 t_3} & 0 \\[2mm] 0 & 0 & 0 \end{pmatrix}, \; (0), \; \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{k^2 \left(2 r_1 + r_5 \right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{6 k^2 \left(r_1 + r_5 \right) + 4 t_3}{\left(1+2 k^2\right)^2 \left(r_1 + r_5 \right) t_3} & -\frac{2 i}{k \left(1+2 k^2\right) \left(r_1 + r_5 \right)} & 0 & -\frac{i \sqrt{2} \left(3 k^2 \left(r_1 + r_5 \right) + 2 t_3 \right)}{k \left(1+2 k^2\right)^2 \left(r_1 + r_5 \right) t_3} \\[3mm] \frac{2 i}{k \left(1+2 k^2\right) \left(r_1 + r_5 \right)} & \frac{1}{k^2 \left(r_1 + r_5 \right)} & 0 & \frac{\sqrt{2}}{k^2 \left(1+2 k^2\right) \left(r_1 + r_5 \right)} \\[3mm] 0 & 0 & 0 & 0 \\[3mm] \frac{i \sqrt{2} \left(3 k^2 \left(r_1 + r_5 \right) + 2 t_3 \right)}{k \left(1+2 k^2\right)^2 \left(r_1 + r_5 \right) t_3} & \frac{\sqrt{2}}{k^2 \left(1+2 k^2\right) \left(r_1 + r_5 \right)} & 0 & \frac{3 k^2 \left(r_1 + r_5 \right) + 2 t_3}{\left(k + 2 k^3\right)^2 \left(r_1 + r_5 \right) t_3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; \left(\frac{1}{k^2 r_1} \right) \right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{ \frac{-5\,r_1{}^2 - 4\,r_1\,r_5 - 3\,r_5{}^2}{r_1\left(r_1 + r_5\right)\left(2\,r_1 + r_5\right)} ,\ \frac{-5\,r_1{}^2 - 4\,r_1\,r_5 - 3\,r_5{}^2}{r_1\left(r_1 + r_5\right)\left(2\,r_1 + r_5\right)} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{ \frac{-5\,r_1{}^2 - 4\,r_1\,r_5 - 3\,r_5{}^2}{r_1\left(r_1 + r_5\right)\left(2\,r_1 + r_5\right)} \right\}\right\}$$

Overall unitarity conditions:

$$\left(r_1 < 0 \ \&\&\ \left(r_5 < -r_1 \ \|\ r_5 > -2\,r_1\right)\right) \| \left(r_1 > 0 \ \&\&\ -2\,r_1 < r_5 < -r_1\right)$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$\left(r_1 < 0 \ \&\&\ \left(r_5 < -r_1 \ \|\ r_5 > -2\,r_1\right)\right) \| \left(r_1 > 0 \ \&\&\ -2\,r_1 < r_5 < -r_1\right)$$

Okay, that concludes the analysis of this theory.

Case 9

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 9 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_1\,\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\,r_1\,\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + r_5\,\mathcal{R}^{ij}{}_i{}^h\ \mathcal{R}_{j}{}^l{}_{hl} - \frac{2}{3}\,r_1\,\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} - r_5\,\mathcal{R}^{ij}{}_i{}^h\ \mathcal{R}_{h}{}^l{}_{jl}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-r_5\,\partial_i\mathcal{A}^{hl}{}_h\ \partial^i\mathcal{A}_l{}^a{}_a - \frac{2}{3}\,r_1\,\partial^{a'}\mathcal{A}^{ja}{}_h\ \partial_j\mathcal{A}_{aa'}{}^h - \frac{2}{3}\,r_1\,\partial_j\mathcal{A}_{aa'}{}^h\ \partial_h\mathcal{A}^{aa'j} + \frac{2}{3}\,r_1\,\partial_j\mathcal{A}_{aa'}{}^h\ \partial_h\mathcal{A}^{jaa'} -$$

$$r_5\,\partial_a\mathcal{A}_l{}^a{}_j\ \partial_h\mathcal{A}^{jhl} + r_5\,\partial_j\mathcal{A}_l{}^a{}_a\ \partial_h\mathcal{A}^{jhl} - r_5\,\partial_a\mathcal{A}_l{}^a{}_j\ \partial_h\mathcal{A}^{hlj} + 2\,r_5\,\partial_j\mathcal{A}_l{}^a{}_a\ \partial_h\mathcal{A}^{hlj} + \frac{2}{3}\,r_1\,\partial_h\mathcal{A}^{aa'j}\ \partial^h\mathcal{A}_{aa'j} -$$

$$\frac{2}{3}\,r_1\,\partial_h\mathcal{A}^{jaa'}\ \partial^h\mathcal{A}_{aa'j} + \frac{2}{3}\,r_1\,\partial^{a'}\mathcal{A}_i{}^{al}\ \partial_l\mathcal{A}_{aa'}{}^i - \frac{8}{3}\,r_1\,\partial^{a'}\mathcal{A}_i{}^{la}\ \partial_l\mathcal{A}_{aa'}{}^i + r_5\,\partial_a\mathcal{A}_l{}^a{}_j\ \partial^l\mathcal{A}^{jh}{}_h - r_5\,\partial_j\mathcal{A}_l{}^a{}_a\ \partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, (0), \begin{pmatrix} 0 & 0 & 0 \\ 0 & k^2\left(2\,r_{\underset{1}{\bullet}} + r_{\underset{5}{\bullet}}\right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & k^2\left(r_{\underset{1}{\bullet}} + r_{\underset{5}{\bullet}}\right) & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \left(k^2\,r_{\underset{1}{\bullet}}\right) \right\}$$

Gauge constraints on source currents:

$$\left\{ \overset{0^+}{\bullet}\tau^{\flat\perp} == 0,\ \overset{0^+}{\bullet}\sigma^{\flat\parallel} == 0,\ \overset{0^+}{\bullet}\tau^{\flat\parallel} == 0,\ \overset{0^-}{\bullet}\sigma^{\flat\parallel} == 0,\ \overset{1^+}{\bullet}\sigma^{\flat\perp\,a\,b} == 0, \right.$$

$$\left. \overset{1^+}{\bullet}\tau^{\flat\parallel\,a\,b} == 0,\ \overset{1^-}{\bullet}\sigma^{\flat\perp\,a} == 0,\ \overset{1^-}{\bullet}\tau^{\flat\perp\,a} == 0,\ \overset{1^-}{\bullet}\tau^{\flat\parallel\,a} == 0,\ \overset{2^+}{\bullet}\sigma^{\flat\parallel\,a\,b} == 0,\ \overset{2^+}{\bullet}\tau^{\flat\parallel\,a\,b} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a–matrices, which are functionally
   analogous to the inverse b–matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, (0), \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{k^2\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{1}{k^2\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2\,r_{\underset{1}{\bullet}}}\right) \right\}$$

Square masses:

$\{\{\}, \{\}, \{\}, \{\}, \{\}, \{\}\}$

Massive pole residues:

$\{\{\}, \{\}, \{\}, \{\}, \{\}, \{\}\}$

Massless eigenvalues:

$$\left\{ \frac{-4\,r_{\underset{1}{\bullet}}^2 - 4\,r_{\underset{1}{\bullet}}\,r_{\underset{5}{\bullet}} - 3\,r_{\underset{5}{\bullet}}^2}{r_{\underset{1}{\bullet}}\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)},\ \frac{-4\,r_{\underset{1}{\bullet}}^2 - 4\,r_{\underset{1}{\bullet}}\,r_{\underset{5}{\bullet}} - 3\,r_{\underset{5}{\bullet}}^2}{r_{\underset{1}{\bullet}}\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{ \frac{-4\,r_{\underset{1}{\bullet}}^2 - 4\,r_{\underset{1}{\bullet}}\,r_{\underset{5}{\bullet}} - 3\,r_{\underset{5}{\bullet}}^2}{r_{\underset{1}{\bullet}}\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)} \right\}\right\}$$

Overall unitarity conditions:

$$\left(r_{\underset{1}{\bullet}} < 0\ \&\&\ \left(r_{\underset{5}{\bullet}} < -r_{\underset{1}{\bullet}}\ ||\ r_{\underset{5}{\bullet}} > -2\,r_{\underset{1}{\bullet}} \right) \right) || \left(r_{\underset{1}{\bullet}} > 0\ \&\&\ -2\,r_{\underset{1}{\bullet}} < r_{\underset{5}{\bullet}} < -r_{\underset{1}{\bullet}} \right)$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$\left(r_{\underset{1}{\bullet}} < 0\ \&\&\ \left(r_{\underset{5}{\bullet}} < -r_{\underset{1}{\bullet}}\ ||\ r_{\underset{5}{\bullet}} > -2\,r_{\underset{1}{\bullet}} \right) \right) || \left(r_{\underset{1}{\bullet}} > 0\ \&\&\ -2\,r_{\underset{1}{\bullet}} < r_{\underset{5}{\bullet}} < -r_{\underset{1}{\bullet}} \right)$$

Okay, that concludes the analysis of this theory.

Case 10

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 10 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\left(\frac{r_3}{2}+r_5\right)\mathcal{R}^{ij\;h}_{\;\;\;i}\;\mathcal{R}_{j\;hl}^{\;l}-r_3\,\mathcal{R}^{ijhl}\;\mathcal{R}_{hlij}+\frac{1}{2}\left(r_3-2\,r_5\right)\mathcal{R}^{ij\;h}_{\;\;\;i}\;\mathcal{R}_{h\;jl}^{\;l}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{2}\,r_3\,\partial_i\mathcal{A}^{hl}_{\;\;\;h}\,\partial^i\mathcal{A}_{l\;a}^{\;a}-r_5\,\partial_i\mathcal{A}^{hl}_{\;\;\;h}\,\partial^i\mathcal{A}_{l\;a}^{\;a}+\frac{1}{2}\,r_3\,\partial_a\mathcal{A}_{l\;j}^{\;a}\,\partial_h\mathcal{A}^{jhl}-r_5\,\partial_a\mathcal{A}_{l\;j}^{\;a}\,\partial_h\mathcal{A}^{jhl}-\frac{1}{2}\,r_3\,\partial_j\mathcal{A}_{l\;a}^{\;a}\,\partial_h\mathcal{A}^{jhl}+$$

$$r_5\,\partial_j\mathcal{A}_{l\;a}^{\;a}\,\partial_h\mathcal{A}^{jhl}-\frac{1}{2}\,r_3\,\partial_a\mathcal{A}_{l\;j}^{\;a}\,\partial_h\mathcal{A}^{hlj}-r_5\,\partial_a\mathcal{A}_{l\;j}^{\;a}\,\partial_h\mathcal{A}^{hlj}+r_3\,\partial_j\mathcal{A}_{l\;a}^{\;a}\,\partial_h\mathcal{A}^{hlj}+2\,r_5\,\partial_j\mathcal{A}_{l\;a}^{\;a}\,\partial_h\mathcal{A}^{hlj}-$$

$$4\,r_3\,\partial^{a'}\mathcal{A}_{i}^{\;la}\,\partial_i\mathcal{A}_{aa'}^{\;\;\;i}-\frac{1}{2}\,r_3\,\partial_a\mathcal{A}_{l\;j}^{\;a}\,\partial^l\mathcal{A}^{jh}_{\;\;\;h}+r_5\,\partial_a\mathcal{A}_{l\;j}^{\;a}\,\partial^l\mathcal{A}^{jh}_{\;\;\;h}+\frac{1}{2}\,r_3\,\partial_j\mathcal{A}_{l\;a}^{\;a}\,\partial^l\mathcal{A}^{jh}_{\;\;\;h}-r_5\,\partial_j\mathcal{A}_{l\;a}^{\;a}\,\partial^l\mathcal{A}^{jh}_{\;\;\;h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix},(0),\begin{pmatrix}0&0&0\\0&k^2\left(2\,r_3+r_5\right)&0\\0&0&0\end{pmatrix},\begin{pmatrix}0&0&0&0\\0&\frac{1}{2}\,k^2\left(r_3+2\,r_5\right)&0&0\\0&0&0&0\\0&0&0&0\end{pmatrix},\begin{pmatrix}0&0\\0&-\frac{3\,k^2\,r_3}{2}\end{pmatrix},(0)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_\bullet\tau^{\flat\perp}==0,\;{}^{0^+}_\bullet\sigma^{\flat\parallel}==0,\;{}^{0^+}_\bullet\tau^{\flat\parallel}==0,\;{}^{0^-}_\bullet\sigma^{\flat\parallel}==0,\;{}^{1^+}_\bullet\sigma^{\flat\perp\,ab}==0,\right.$$

$$\left.{}^{1^+}_\bullet\tau^{\flat\parallel\,ab}==0,\;{}^{1^-}_\bullet\sigma^{\flat\perp\,a}==0,\;{}^{1^-}_\bullet\tau^{\flat\perp\,a}==0,\;{}^{1^-}_\bullet\tau^{\flat\parallel\,a}==0,\;{}^{2^+}_\bullet\tau^{\flat\parallel\,ab}==0,\;{}^{2^-}_\bullet\sigma^{\flat\parallel\,abc}==0\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix},(0),\begin{pmatrix}0&0&0\\0&\frac{1}{k^2\left(2\,r_3+r_5\right)}&0\\0&0&0\end{pmatrix},\begin{pmatrix}0&0&0&0\\0&\frac{2}{k^2\left(r_3+2\,r_5\right)}&0&0\\0&0&0&0\\0&0&0&0\end{pmatrix},\begin{pmatrix}0&0\\0&-\frac{2}{3\,k^2\,r_3}\end{pmatrix},(0)\right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{-\frac{33\,r_3^2+20\,r_3\,r_5+4\,r_5^2}{r_3\left(2\,r_3+r_5\right)\left(r_3+2\,r_5\right)},\;-\frac{33\,r_3^2+20\,r_3\,r_5+4\,r_5^2}{r_3\left(2\,r_3+r_5\right)\left(r_3+2\,r_5\right)}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{33\,r_3^2 + 20\,r_3\,r_5 + 4\,r_5^2}{r_3\left(2\,r_3 + r_5\right)\left(r_3 + 2\,r_5\right)}\right\}\right\}$$

Overall unitarity conditions:

$$\left(r_3 < 0\ \&\&\ \left(r_5 < -\frac{r_3}{2}\ ||\ r_5 > -2\,r_3\right)\right)\ ||\ \left(r_3 > 0\ \&\&\ -2\,r_3 < r_5 < -\frac{r_3}{2}\right)$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$\left(r_3 < 0\ \&\&\ \left(r_5 < -\frac{r_3}{2}\ ||\ r_5 > -2\,r_3\right)\right)\ ||\ \left(r_3 > 0\ \&\&\ -2\,r_3 < r_5 < -\frac{r_3}{2}\right)$$

Okay, that concludes the analysis of this theory.

Case 11

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 11 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\,r_2\,\mathcal{R}_{ijhl}\,\mathcal{R}^{ijhl} - \frac{2}{3}\,r_2\,\mathcal{R}_{ihjl}\,\mathcal{R}^{ijhl} +$$

$$\left(\frac{r_3}{2} + r_5\right)\mathcal{R}^{ij}{}_i{}^h\,\mathcal{R}_j{}^l{}_{hl} + \frac{1}{6}\left(r_2 - 6\,r_3\right)\mathcal{R}^{ijhl}\,\mathcal{R}_{hlij} + \frac{1}{2}\left(r_3 - 2\,r_5\right)\mathcal{R}^{ij}{}_i{}^h\,\mathcal{R}_h{}^l{}_{jl}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{2}\,r_3\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_l{}^a{}_a - r_5\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_l{}^a{}_a + \frac{2}{3}\,r_2\,\partial^{a'}\mathcal{A}^{ja}{}_h\,\partial_j\mathcal{A}_{aa'}{}^h - \frac{1}{3}\,r_2\,\partial_j\mathcal{A}_{aa'}{}^h\,\partial_h\mathcal{A}^{aa'j} -$$

$$\frac{2}{3}\,r_2\,\partial_j\mathcal{A}_{aa'}{}^h\,\partial_h\mathcal{A}^{jaa'} + \frac{1}{2}\,r_3\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{jhl} - r_5\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{jhl} - \frac{1}{2}\,r_3\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{jhl} +$$

$$r_5\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{jhl} - \frac{1}{2}\,r_3\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{hlj} - r_5\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{hlj} + r_3\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{hlj} + 2\,r_5\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{hlj} +$$

$$\frac{1}{3}\,r_2\,\partial_h\mathcal{A}^{aa'j}\,\partial^h\mathcal{A}_{aa'j} + \frac{2}{3}\,r_2\,\partial_h\mathcal{A}^{jaa'}\,\partial^h\mathcal{A}_{aa'j} - \frac{2}{3}\,r_2\,\partial^{a'}\mathcal{A}_i{}^{al}\,\partial_l\mathcal{A}_{aa'}{}^i + \frac{2}{3}\,r_2\,\partial^{a'}\mathcal{A}_i{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^i -$$

$$4\,r_3\,\partial^{a'}\mathcal{A}_i{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^i - \frac{1}{2}\,r_3\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial^l\mathcal{A}^{jh}{}_h + r_5\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial^l\mathcal{A}^{jh}{}_h + \frac{1}{2}\,r_3\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial^l\mathcal{A}^{jh}{}_h - r_5\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2\, r_2 \right), \begin{pmatrix} 0 & 0 & 0 \\ 0 & k^2\left(2\, r_3 + r_5\right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2}\, k^2\left(r_3 + 2\, r_5\right) & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & -\frac{3\, k^2\, r_3}{2} \end{pmatrix}, \left(0 \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0, \; {}^{0^+}_{\bullet}\sigma^{\flat\|} == 0, \; {}^{0^+}_{\bullet}\tau^{\flat\|} == 0, \; {}^{1^+}_{\bullet}\sigma^{\flat\perp\, a\, b} == 0, \; {}^{1^+}_{\bullet}\tau^{\flat\|\, a\, b} == 0, \right.$$

$$\left. {}^{1^-}_{\bullet}\sigma^{\flat\perp\, a} == 0, \; {}^{1^-}_{\bullet}\tau^{\flat\perp\, a} == 0, \; {}^{1^-}_{\bullet}\tau^{\flat\|\, a} == 0, \; {}^{2^+}_{\bullet}\tau^{\flat\|\, a\, b} == 0, \; {}^{2^-}_{\bullet}\sigma^{\flat\|\, a\, b\, c} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally

analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2\, r_2} \right), \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{k^2\left(2\, r_3 + r_5\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{2}{k^2\left(r_3 + 2\, r_5\right)} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & -\frac{2}{3\, k^2\, r_3} \end{pmatrix}, \left(0 \right) \right\}$$

Square masses:

$\{\{\}, \{\}, \{\}, \{\}, \{\}, \{\}\}$

Massive pole residues:

$\{\{\}, \{\}, \{\}, \{\}, \{\}, \{\}\}$

Massless eigenvalues:

$$\left\{ -\frac{33\, r_3^2 + 20\, r_3\, r_5 + 4\, r_5^2}{r_3\left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)}, \; -\frac{33\, r_3^2 + 20\, r_3\, r_5 + 4\, r_5^2}{r_3\left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{33\, r_3^2 + 20\, r_3\, r_5 + 4\, r_5^2}{r_3\left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)} \right\} \right\}$$

Overall unitarity conditions:

$$\left(r_3 < 0 \;\&\&\; \left(r_5 < -\frac{r_3}{2} \;\|\; r_5 > -2\, r_3 \right) \right) \;\|\; \left(r_3 > 0 \;\&\&\; -2\, r_3 < r_5 < -\frac{r_3}{2} \right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_3 < 0 \;\&\&\; \left(r_5 < -\frac{r_3}{2} \;\|\; r_5 > -2\, r_3 \right) \right) \;\|\; \left(r_3 > 0 \;\&\&\; -2\, r_3 < r_5 < -\frac{r_3}{2} \right)$$

Okay, that concludes the analysis of this theory.

Case 12

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 12 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\left(\frac{r_3}{2}+r_5\right)\mathcal{R}^{ij}{}_i{}^{\hbar}\,\mathcal{R}_{j}{}^{l}{}_{\hbar l}-r_3\,\mathcal{R}^{ij\hbar l}\,\mathcal{R}_{\hbar lij}+\frac{1}{2}\left(r_3-2\,r_5\right)\mathcal{R}^{ij}{}_i{}^{\hbar}\,\mathcal{R}_{\hbar}{}^{l}{}_{jl}+\frac{1}{12}\,t_2\,\mathcal{T}_{ij\hbar}\,\mathcal{T}^{ij\hbar}-\frac{1}{6}\,t_2\,\mathcal{T}^{ij\hbar}\,\mathcal{T}_{ji\hbar}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3}\,t_2\,\mathcal{A}_{ij\hbar}\,\mathcal{A}^{ij\hbar}-\frac{2}{3}\,t_2\,\mathcal{A}_{i\hbar j}\,\mathcal{A}^{ij\hbar}-\frac{1}{2}\,r_3\,\partial_i\mathcal{A}^{\hbar l}{}_{\hbar}\,\partial^j\mathcal{A}_{l}{}^{a}{}_{a}-r_5\,\partial_i\mathcal{A}^{\hbar l}{}_{\hbar}\,\partial^j\mathcal{A}_{l}{}^{a}{}_{a}+\frac{1}{2}\,r_3\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}-$$

$$r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}-\frac{1}{2}\,r_3\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}+r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}-\frac{1}{2}\,r_3\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar lj}-$$

$$r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar lj}+r_3\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar lj}+2\,r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar lj}+\frac{1}{6}\,t_2\,\partial^a f_{j\hbar}\,\partial^{\hbar}f_{a}{}^{j}-\frac{1}{6}\,t_2\,\partial^a f_{\hbar}{}^{l}\,\partial^{\hbar}f_{al}+$$

$$\frac{1}{3}\,t_2\,\mathcal{A}_{i\hbar}{}^{a}\,\partial^{\hbar}f^i{}_{a}-\frac{1}{6}\,t_2\,\partial^a f_{i\hbar}\,\partial^{\hbar}f^i{}_{a}-\frac{1}{3}\,t_2\,\mathcal{A}_{ij\hbar}\,\partial^{\hbar}f^{ij}+\frac{1}{3}\,t_2\,\mathcal{A}_{i\hbar}{}^{l}\,\partial^{\hbar}f^i{}_{l}-\frac{1}{3}\,t_2\,\mathcal{A}_{i}{}^{l}{}_{\hbar}\,\partial^{\hbar}f^i{}_{l}-$$

$$\frac{1}{3}\,t_2\,\mathcal{A}^{l}{}_{\hbar i}\,\partial^{\hbar}f^i{}_{l}+\frac{1}{6}\,t_2\,\partial_{\hbar}f_i{}^{l}\,\partial^{\hbar}f^i{}_{l}+\frac{1}{6}\,t_2\,\partial^a f_{\hbar}{}^{l}\,\partial^{\hbar}f_{la}-\frac{1}{3}\,t_2\,\mathcal{A}_{j\hbar}{}^{l}\,\partial^{\hbar}f_{l}{}^{j}-\frac{1}{6}\,t_2\,\partial_{\hbar}f_j{}^{l}\,\partial^{\hbar}f_l{}^{j}-$$

$$4\,r_3\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^{i}-\frac{1}{2}\,r_3\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^l\mathcal{A}^{j\hbar}{}_{\hbar}+r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^l\mathcal{A}^{j\hbar}{}_{\hbar}+\frac{1}{2}\,r_3\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^l\mathcal{A}^{j\hbar}{}_{\hbar}-r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^l\mathcal{A}^{j\hbar}{}_{\hbar}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix},\,\left(t_2\right),\,\begin{pmatrix}\frac{k^2 t_2}{3}&\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2&\frac{i\,k\,t_2}{3}\\-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2&\frac{1}{2}\left(2\,k^2\left(2\,r_3+r_5\right)+\frac{4\,t_2}{3}\right)&\frac{\sqrt{2}\,t_2}{3}\\-\frac{1}{3}\,i\,k\,t_2&\frac{\sqrt{2}\,t_2}{3}&\frac{t_2}{3}\end{pmatrix},\,\begin{pmatrix}0&0&0&0\\0&\frac{1}{2}\,k^2\left(r_3+2\,r_5\right)&0&0\\0&0&0&0\\0&0&0&0\end{pmatrix},\,\begin{pmatrix}0&0\\0&-\frac{3\,k^2\,r_3}{2}\end{pmatrix},\,(0)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp}==0,\,{}^{0^+}_{\bullet}\sigma^{\flat\|}==0,\,{}^{0^+}_{\bullet}\tau^{\flat\|}==0,\,-i\,{}^{1^+}_{\bullet}\tau^{\flat\|}{}^{ab}==k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab},\right.$$

$$\left.{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a}==0,\,{}^{1^-}_{\bullet}\tau^{\flat\perp\,a}==0,\,{}^{1^-}_{\bullet}\tau^{\flat\|\,a}==0,\,{}^{2^+}_{\bullet}\tau^{\flat\|\,ab}==0,\,{}^{2^-}_{\bullet}\sigma^{\flat\|\,abc}==0\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix},\,\left(\frac{1}{t_2}\right),\,\begin{pmatrix}\frac{3\,k^2\left(2\,r_3+r_5\right)+2\,t_2}{\left(1+k^2\right)^2\left(2\,r_3+r_5\right)t_2}&-\frac{i\,\sqrt{2}}{k\left(1+k^2\right)\left(2\,r_3+r_5\right)}&\frac{i\left(3\,k^2\left(2\,r_3+r_5\right)+2\,t_2\right)}{k\left(1+k^2\right)^2\left(2\,r_3+r_5\right)t_2}\\\frac{i\,\sqrt{2}}{k\left(1+k^2\right)\left(2\,r_3+r_5\right)}&\frac{1}{k^2\left(2\,r_3+r_5\right)}&-\frac{\sqrt{2}}{k^2\left(1+k^2\right)\left(2\,r_3+r_5\right)}\\-\frac{i\left(3\,k^2\left(2\,r_3+r_5\right)+2\,t_2\right)}{k\left(1+k^2\right)^2\left(2\,r_3+r_5\right)t_2}&-\frac{\sqrt{2}}{k^2\left(1+k^2\right)\left(2\,r_3+r_5\right)}&\frac{3\,k^2\left(2\,r_3+r_5\right)+2\,t_2}{\left(k+k^3\right)^2\left(2\,r_3+r_5\right)t_2}\end{pmatrix},\,\begin{pmatrix}0&0&0&0\\0&\frac{2}{k^2\left(r_3+2\,r_5\right)}&0&0\\0&0&0&0\\0&0&0&0\end{pmatrix},\,\begin{pmatrix}0&0\\0&-\frac{2}{3\,k^2\,r_3}\end{pmatrix},\,(0)\right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{-\frac{45\, r_3^{\,2} + 20\, r_3\, r_5 + 4\, r_5^{\,2}}{r_3\left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)},\ -\frac{45\, r_3^{\,2} + 20\, r_3\, r_5 + 4\, r_5^{\,2}}{r_3\left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{45\, r_3^{\,2} + 20\, r_3\, r_5 + 4\, r_5^{\,2}}{r_3\left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)}\right\}\right\}$$

Overall unitarity conditions:

$$\left(r_3 < 0\ \&\&\ \left(r_5 < -\frac{r_3}{2}\ \|\ r_5 > -2\, r_3\right)\right)\ \|\ \left(r_3 > 0\ \&\&\ -2\, r_3 < r_5 < -\frac{r_3}{2}\right)$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$\left(r_3 < 0\ \&\&\ \left(r_5 < -\frac{r_3}{2}\ \|\ r_5 > -2\, r_3\right)\right)\ \|\ \left(r_3 > 0\ \&\&\ -2\, r_3 < r_5 < -\frac{r_3}{2}\right)$$

Okay, that concludes the analysis of this theory.

Case 13

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 13 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\, r_1\, \mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\, r_1\, \mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + \left(-2\, r_1 + 2\, r_3 + r_5\right)\mathcal{R}^{ij}{}_i{}^h\ \mathcal{R}_j{}^l{}_{hl} +$$

$$\frac{1}{3}\left(r_1 - 3\, r_3\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} + \left(-2\, r_1 + 2\, r_3 - r_5\right)\mathcal{R}^{ij}{}_i{}^h\ \mathcal{R}_h{}^l{}_{jl}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$2\,r_{1}\,\partial_{i}\mathcal{A}^{\hbar\,l}{}_{\hbar}\,\partial^{j}\mathcal{A}_{l}{}^{a}{}_{a} - 2\,r_{3}\,\partial_{i}\mathcal{A}^{\hbar\,l}{}_{\hbar}\,\partial^{j}\mathcal{A}_{l}{}^{a}{}_{a} - r_{5}\,\partial_{i}\mathcal{A}^{\hbar\,l}{}_{\hbar}\,\partial^{j}\mathcal{A}_{l}{}^{a}{}_{a} - \frac{2}{3}\,r_{1}\,\partial^{a'}\mathcal{A}^{j\,a}{}_{\hbar}\,\partial_{j}\mathcal{A}_{aa'}{}^{\hbar} -$$

$$\frac{2}{3}\,r_{1}\,\partial_{j}\mathcal{A}_{aa'}{}^{\hbar}\,\partial_{\hbar}\mathcal{A}^{aa'j} + \frac{2}{3}\,r_{1}\,\partial_{j}\mathcal{A}_{aa'}{}^{\hbar}\,\partial_{\hbar}\mathcal{A}^{jaa'} - 2\,r_{1}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar\,l} + 2\,r_{3}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar\,l} -$$

$$r_{5}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar\,l} + 2\,r_{1}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar\,l} - 2\,r_{3}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar\,l} + r_{5}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar\,l} +$$

$$2\,r_{1}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar\,l\,j} - 2\,r_{3}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar\,l\,j} - r_{5}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar\,l\,j} - 4\,r_{1}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar\,l\,j} +$$

$$4\,r_{3}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar\,l\,j} + 2\,r_{5}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar\,l\,j} + \frac{2}{3}\,r_{1}\,\partial_{\hbar}\mathcal{A}^{aa'j}\,\partial^{\hbar}\mathcal{A}_{aa'j} - \frac{2}{3}\,r_{1}\,\partial_{\hbar}\mathcal{A}^{jaa'}\,\partial^{\hbar}\mathcal{A}_{aa'j} +$$

$$\frac{2}{3}\,r_{1}\,\partial^{a'}\mathcal{A}_{i}{}^{a\,l}\,\partial_{l}\mathcal{A}_{aa'}{}^{i} + \frac{4}{3}\,r_{1}\,\partial^{a'}\mathcal{A}_{i}{}^{l\,a}\,\partial_{l}\mathcal{A}_{aa'}{}^{i} - 4\,r_{3}\,\partial^{a'}\mathcal{A}_{i}{}^{l\,a}\,\partial_{l}\mathcal{A}_{aa'}{}^{i} + 2\,r_{1}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar} -$$

$$2\,r_{3}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar} + r_{5}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar} - 2\,r_{1}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar} + 2\,r_{3}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar} - r_{5}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 6\,k^2\left(-r_{1}+r_{3}\right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, (0), \begin{pmatrix} 0 & 0 & 0 \\ 0 & k^2\left(2\,r_{3}+r_{5}\right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & k^2\left(-r_{1}+2\,r_{3}+r_{5}\right) & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \left(k^2\,r_{1}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ {}^{0^+}_{\bullet}\tau^{\flat\|} == 0,\ {}^{0^-}_{\bullet}\sigma^{\flat\|} == 0,\ {}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab} == 0,\ {}^{1^+}_{\bullet}\tau^{\flat\|\,ab} == 0,\right.$$

$$\left.{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a} == 0,\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0,\ {}^{1^-}_{\bullet}\tau^{\flat\|\,a} == 0,\ {}^{2^+}_{\bullet}\sigma^{\flat\|\,ab} == 0,\ {}^{2^+}_{\bullet}\tau^{\flat\|\,ab} == 0\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{6\,k^2\left(-r_{1}+r_{3}\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, (0), \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{k^2\left(2\,r_{3}+r_{5}\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{1}{k^2\left(-r_{1}+2\,r_{3}+r_{5}\right)} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2\,r_{1}}\right)\right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{\frac{8\,r_{1}^2 - 16\,r_{1}\,r_{3} + 12\,r_{3}^2 - 8\,r_{1}\,r_{5} + 12\,r_{3}\,r_{5} + 3\,r_{5}^2}{r_{1}\left(r_{1} - 2\,r_{3} - r_{5}\right)\left(2\,r_{3} + r_{5}\right)},\ \frac{8\,r_{1}^2 - 16\,r_{1}\,r_{3} + 12\,r_{3}^2 - 8\,r_{1}\,r_{5} + 12\,r_{3}\,r_{5} + 3\,r_{5}^2}{r_{1}\left(r_{1} - 2\,r_{3} - r_{5}\right)\left(2\,r_{3} + r_{5}\right)}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{ \frac{8\, r_1^2 - 16\, r_1 r_3 + 12\, r_3^2 - 8\, r_1 r_5 + 12\, r_3 r_5 + 3\, r_5^2}{r_1 \left(r_1 - 2\, r_3 - r_5 \right) \left(2\, r_3 + r_5 \right)} \right\}\right\}$$

Overall unitarity conditions:

$$r_3 \in \mathbb{R} \,\&\&\, \left(\left(r_1 < 0 \,\&\&\, \left(r_5 < r_1 - 2\, r_3 \,\|\, r_5 > -2\, r_3 \right) \right) \,\|\, \left(r_1 > 0 \,\&\&\, -2\, r_3 < r_5 < r_1 - 2\, r_3 \right) \right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_3 \in \mathbb{R} \,\&\&\, \left(\left(r_1 < 0 \,\&\&\, \left(r_5 < r_1 - 2\, r_3 \,\|\, r_5 > -2\, r_3 \right) \right) \,\|\, \left(r_1 > 0 \,\&\&\, -2\, r_3 < r_5 < r_1 - 2\, r_3 \right) \right)$$

Okay, that concludes the analysis of this theory.

Case 14

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 14 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\left(\frac{r_3}{2} + r_5 \right) \mathcal{R}^{ij\,h}{}_i \; \mathcal{R}_{j}{}^{l}{}_{h\,l} - r_3 \, \mathcal{R}^{ijhl} \; \mathcal{R}_{hlij} + \frac{1}{2}\left(r_3 - 2\, r_5 \right) \mathcal{R}^{ij\,h}{}_i \; \mathcal{R}_{h}{}^{l}{}_{jl} - \frac{2}{3}\, t_3 \, \mathcal{T}^{i\,j}{}_i \; \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3}\, t_3 \, \mathcal{A}_{i}{}^{l}{}_{l} \; \mathcal{A}^{ij}{}_j - \frac{1}{2}\, r_3 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_{l}{}^{a}{}_a - r_5 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_{l}{}^{a}{}_a + \frac{1}{2}\, r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_j \, \partial_h \mathcal{A}^{jhl} -$$

$$r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_j \, \partial_h \mathcal{A}^{jhl} - \frac{1}{2}\, r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_a \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_a \, \partial_h \mathcal{A}^{jhl} - \frac{1}{2}\, r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_j \, \partial_h \mathcal{A}^{hlj} -$$

$$r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_j \, \partial_h \mathcal{A}^{hlj} + r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_a \, \partial_h \mathcal{A}^{hlj} + 2\, r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_a \, \partial_h \mathcal{A}^{hlj} - \frac{2}{3}\, t_3 \, \mathcal{A}_{h}{}^{a}{}_a \, \partial^h f^i{}_i - \frac{2}{3}\, t_3 \, \mathcal{A}_{h}{}^{l}{}_l \, \partial^h f^i{}_i -$$

$$\frac{4}{3}\, t_3 \, \partial^a f_{ah} \, \partial^h f^i{}_i + \frac{2}{3}\, t_3 \, \partial_h f^l{}_l \, \partial^h f^i{}_i + \frac{2}{3}\, t_3 \, \partial^{a'} f_{a'}{}^{a} \, \partial^h f_{ha} + \frac{2}{3}\, t_3 \, \mathcal{A}_{j}{}^{l}{}_l \, \partial^h f_{h}{}^{j} + \frac{2}{3}\, t_3 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} -$$

$$4\, r_3 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{1}{2}\, r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_j \, \partial^l \mathcal{A}^{jh}{}_h + r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_j \, \partial^l \mathcal{A}^{jh}{}_h + \frac{1}{2}\, r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_a \, \partial^l \mathcal{A}^{jh}{}_h - r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2\,k^2\,t_{\bullet_3} & i\,\sqrt{2}\,k\,t_{\bullet_3} & 0 \\ -i\,\sqrt{2}\,k\,t_{\bullet_3} & t_{\bullet_3} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ (0),\ \begin{pmatrix} 0 & 0 & 0 \\ 0 & k^2\left(2\,r_{\bullet_3}+r_{\bullet_5}\right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2\,k^2\,t_{\bullet_3}}{3} & \dfrac{2\,i\,k\,t_{\bullet_3}}{3} & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet_3} \\ -\dfrac{2}{3}\,i\,k\,t_{\bullet_3} & k^2\left(\dfrac{r_{\bullet_3}}{2}+r_{\bullet_5}\right)+\dfrac{2\,t_{\bullet_3}}{3} & 0 & -\dfrac{\sqrt{2}\,t_{\bullet_3}}{3} \\ 0 & 0 & 0 & 0 \\ \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet_3} & -\dfrac{\sqrt{2}\,t_{\bullet_3}}{3} & 0 & \dfrac{t_{\bullet_3}}{3} \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & -\dfrac{3\,k^2\,r_{\bullet_3}}{2} \end{pmatrix},\ (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\|} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\|},\ {}^{0^-}_{\bullet}\sigma^{\flat\|} == 0,\ {}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}} == 0, \right.$$

$$\left. {}^{1^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 0,\ i\,{}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\ {}^{2^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 0,\ {}^{2^-}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}\,\mathfrak{c}} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally

analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \dfrac{2\,k^2}{\left(1+2\,k^2\right)^2\,t_{\bullet_3}} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet_3}} & 0 \\ -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet_3}} & \dfrac{1}{\left(1+2\,k^2\right)^2\,t_{\bullet_3}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ (0),\ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{k^2\left(2\,r_{\bullet_3}+r_{\bullet_5}\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{6\,k^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)+8\,t_{\bullet_3}}{\left(1+2\,k^2\right)^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)t_{\bullet_3}} & -\dfrac{4\,i}{k\left(1+2\,k^2\right)\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)} & 0 & -\dfrac{i\,\sqrt{2}\left(3\,k^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)+4\,t_{\bullet_3}\right)}{k\left(1+2\,k^2\right)^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)t_{\bullet_3}} \\ \dfrac{4\,i}{k\left(1+2\,k^2\right)\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)} & \dfrac{2}{k^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)} & 0 & \dfrac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\,\sqrt{2}\left(3\,k^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)+4\,t_{\bullet_3}\right)}{k\left(1+2\,k^2\right)^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)t_{\bullet_3}} & \dfrac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)} & 0 & \dfrac{3\,k^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)+4\,t_{\bullet_3}}{\left(k+2\,k^3\right)^2\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)t_{\bullet_3}} \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & -\dfrac{2}{3\,k^2\,r_{\bullet_3}} \end{pmatrix},\ (0) \right\}$$

Square masses:

$\{\{\}, \{\}, \{\}, \{\}, \{\}, \{\}\}$

Massive pole residues:

$\{\{\}, \{\}, \{\}, \{\}, \{\}, \{\}\}$

Massless eigenvalues:

$$\left\{ \frac{-445\,r_{\bullet_3}^2 - 268\,r_{\bullet_3}\,r_{\bullet_5} - 52\,r_{\bullet_5}^2}{12\,r_{\bullet_3}\left(2\,r_{\bullet_3}+r_{\bullet_5}\right)\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)},\ \frac{-445\,r_{\bullet_3}^2 - 268\,r_{\bullet_3}\,r_{\bullet_5} - 52\,r_{\bullet_5}^2}{12\,r_{\bullet_3}\left(2\,r_{\bullet_3}+r_{\bullet_5}\right)\left(r_{\bullet_3}+2\,r_{\bullet_5}\right)} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{\frac{-445\,r_{3}{}^{2}-268\,r_{3}\,r_{5}-52\,r_{5}{}^{2}}{12\,r_{3}\left(2\,r_{3}+r_{5}\right)\left(r_{3}+2\,r_{5}\right)}\right\}\right\}$$

Overall unitarity conditions:

$$\left(r_{3}<0\,\&\&\,\left(r_{5}<-\frac{r_{3}}{2}\,\|\,r_{5}>-2\,r_{3}\right)\right)\,\|\,\left(r_{3}>0\,\&\&-2\,r_{3}<r_{5}<-\frac{r_{3}}{2}\right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_{3}<0\,\&\&\,\left(r_{5}<-\frac{r_{3}}{2}\,\|\,r_{5}>-2\,r_{3}\right)\right)\,\|\,\left(r_{3}>0\,\&\&-2\,r_{3}<r_{5}<-\frac{r_{3}}{2}\right)$$

Okay, that concludes the analysis of this theory.

Case 15

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 15 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\left(\frac{r_{3}}{2}+r_{5}\right)\mathcal{R}^{ijh}{}_{i}\,\mathcal{R}_{j}{}^{l}{}_{hl}-r_{3}\,\mathcal{R}^{ijhl}\,\mathcal{R}_{hlij}+\frac{1}{2}\left(r_{3}-2\,r_{5}\right)\mathcal{R}^{ijh}{}_{i}\,\mathcal{R}_{h}{}^{l}{}_{jl}+$$

$$\frac{1}{12}\,t_{2}\,\mathcal{T}_{ijh}\,\mathcal{T}^{ijh}-\frac{1}{6}\,t_{2}\,\mathcal{T}^{ijh}\,\mathcal{T}_{jih}-\frac{2}{3}\,t_{3}\,\mathcal{T}^{i}{}_{i}{}^{j}\,\mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3}\,t_{3}\,\mathcal{A}_{i}{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_{j}+\frac{1}{3}\,t_{2}\,\mathcal{A}_{ijh}\,\mathcal{A}^{ijh}-\frac{2}{3}\,t_{2}\,\mathcal{A}_{ihj}\,\mathcal{A}^{ijh}-\frac{1}{2}\,r_{3}\,\partial_{i}\mathcal{A}^{hl}{}_{h}\,\partial^{i}\mathcal{A}_{l}{}^{a}{}_{a}-r_{5}\,\partial_{i}\mathcal{A}^{hl}{}_{h}\,\partial^{i}\mathcal{A}_{l}{}^{a}{}_{a}+$$

$$\frac{1}{2}\,r_{3}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{h}\mathcal{A}^{jhl}-r_{5}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{h}\mathcal{A}^{jhl}-\frac{1}{2}\,r_{3}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{h}\mathcal{A}^{jhl}+r_{5}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{h}\mathcal{A}^{jhl}-$$

$$\frac{1}{2}\,r_{3}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{h}\mathcal{A}^{hlj}-r_{5}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{h}\mathcal{A}^{hlj}+r_{3}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{h}\mathcal{A}^{hlj}+2\,r_{5}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{h}\mathcal{A}^{hlj}+$$

$$\frac{1}{6}\,t_{2}\,\partial^{a}f_{jh}\,\partial^{h}f_{a}{}^{j}-\frac{1}{6}\,t_{2}\,\partial^{a}f_{h}{}^{l}\,\partial^{h}f_{al}+\frac{1}{3}\,t_{2}\,\mathcal{A}_{ih}{}^{a}\,\partial^{h}f^{i}{}_{a}-\frac{1}{6}\,t_{2}\,\partial^{a}f_{ih}\,\partial^{h}f^{i}{}_{a}-\frac{2}{3}\,t_{3}\,\mathcal{A}_{h}{}^{a}{}_{a}\,\partial^{h}f^{i}{}_{i}-$$

$$\frac{2}{3}\,t_{3}\,\mathcal{A}_{h}{}^{l}{}_{l}\,\partial^{h}f^{i}{}_{i}-\frac{4}{3}\,t_{3}\,\partial^{a}f_{ah}\,\partial^{h}f^{i}{}_{i}+\frac{2}{3}\,t_{3}\,\partial_{h}f^{l}{}_{l}\,\partial^{h}f^{i}{}_{i}-\frac{1}{3}\,t_{2}\,\mathcal{A}_{ijh}\,\partial^{h}f^{ij}+\frac{1}{3}\,t_{2}\,\mathcal{A}_{ih}{}^{l}\,\partial^{h}f^{i}{}_{l}-$$

$$\frac{1}{3}\,t_{2}\,\mathcal{A}_{ih}{}^{l}\,\partial^{h}f^{i}{}_{l}-\frac{1}{3}\,t_{2}\,\mathcal{A}^{l}{}_{hi}\,\partial^{h}f^{i}{}_{l}+\frac{1}{6}\,t_{2}\,\partial_{h}f^{l}{}_{i}\,\partial^{h}f^{i}{}_{l}+\frac{2}{3}\,t_{3}\,\partial^{a'}f_{a'}{}^{a}\,\partial^{h}f_{ha}+\frac{2}{3}\,t_{3}\,\mathcal{A}_{j}{}^{l}{}_{l}\,\partial^{h}f_{h}{}^{j}+$$

$$\frac{2}{3}\,t_{3}\,\mathcal{A}^{la}{}_{a}\,\partial^{h}f_{hl}+\frac{1}{6}\,t_{2}\,\partial^{a}f_{h}{}^{l}\,\partial^{h}f_{la}-\frac{1}{3}\,t_{2}\,\mathcal{A}_{jh}{}^{l}\,\partial^{h}f_{l}{}^{j}-\frac{1}{6}\,t_{2}\,\partial_{h}f^{l}{}_{j}\,\partial^{h}f_{l}{}^{j}-4\,r_{3}\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}-$$

$$\frac{1}{2}\,r_{3}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{jh}{}_{h}+r_{5}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{jh}{}_{h}+\frac{1}{2}\,r_{3}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{jh}{}_{h}-r_{5}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2\,k^2\,t_3 & i\,\sqrt{2}\,k\,t_3 & 0 \\ -i\,\sqrt{2}\,k\,t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \;\; \left(t_2 \right), \;\; \begin{pmatrix} \frac{k^2\,t_2}{3} & \frac{1}{3}\,i\,\sqrt{2}\,k\,t_2 & \frac{i\,k\,t_2}{3} \\ -\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2 & \frac{1}{2}\left(2\,k^2\left(2\,r_3 + r_5 \right) + \frac{4\,t_2}{3} \right) & \frac{\sqrt{2}\,t_2}{3} \\ -\frac{1}{3}\,i\,k\,t_2 & \frac{\sqrt{2}\,t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{2\,k^2\,t_3}{3} & \frac{2\,i\,k\,t_3}{3} & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3 \\ -\frac{2}{3}\,i\,k\,t_3 & k^2\left(\frac{r_3}{2} + r_5 \right) + \frac{2\,t_3}{3} & 0 & -\frac{\sqrt{2}\,t_3}{3} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\,t_3 & -\frac{\sqrt{2}\,t_3}{3} & 0 & \frac{t_3}{3} \end{pmatrix}, \;\; \begin{pmatrix} 0 & 0 \\ 0 & -\frac{3\,k^2\,r_3}{2} \end{pmatrix}, \;\; \left(0 \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{\flat\perp} == 0, \;\; -i\,{}^{0^+}\!\tau^{\flat\parallel} == 2\,k\,{}^{0^+}\!\sigma^{\flat\parallel}, \;\; -i\,{}^{1^+}\!\tau^{\flat\parallel\,ab} == k\,{}^{1^+}\!\sigma^{\flat\perp\,ab}, \right.$$

$$\left. i\,{}^{1^-}\!\tau^{\flat\parallel\,a} == 2\,k\,{}^{1^-}\!\sigma^{\flat\perp\,a}, \;\; {}^{1^-}\!\tau^{\flat\perp\,a} == 0, \;\; {}^{2^+}\!\tau^{\flat\parallel\,ab} == 0, \;\; {}^{2^-}\!\sigma^{\flat\parallel\,abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \frac{2\,k^2}{\left(1+2\,k^2\right)^2\,t_3} & \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_3} & 0 \\ -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_3} & \frac{1}{\left(1+2\,k^2\right)^2\,t_3} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \;\; \left(\frac{1}{t_2} \right), \right.$$

$$\begin{pmatrix} \frac{3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2}{\left(1+k^2\right)^2\left(2\,r_3 + r_5\right)\,t_2} & -\frac{i\,\sqrt{2}}{k\left(1+k^2\right)\left(2\,r_3 + r_5\right)} & \frac{i\left(3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2\right)}{k\left(1+k^2\right)^2\left(2\,r_3 + r_5\right)\,t_2} \\ \frac{i\,\sqrt{2}}{k\left(1+k^2\right)\left(2\,r_3 + r_5\right)} & \frac{1}{k^2\left(2\,r_3 + r_5\right)} & -\frac{\sqrt{2}}{k^2\left(1+k^2\right)\left(2\,r_3 + r_5\right)} \\ -\frac{i\left(3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2\right)}{k\left(1+k^2\right)^2\left(2\,r_3 + r_5\right)\,t_2} & -\frac{\sqrt{2}}{k^2\left(1+k^2\right)\left(2\,r_3 + r_5\right)} & \frac{3\,k^2\left(2\,r_3 + r_5\right) + 2\,t_2}{\left(k+k^3\right)^2\left(2\,r_3 + r_5\right)\,t_2} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{6\,k^2\left(r_3 + 2\,r_5\right) + 8\,t_3}{\left(1+2\,k^2\right)^2\left(r_3 + 2\,r_5\right)\,t_3} & -\frac{4\,i}{k\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} & 0 & -\frac{i\,\sqrt{2}\left(3\,k^2\left(r_3 + 2\,r_5\right) + 4\,t_3\right)}{k\left(1+2\,k^2\right)^2\left(r_3 + 2\,r_5\right)\,t_3} \\ \frac{4\,i}{k\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} & \frac{2}{k^2\left(r_3 + 2\,r_5\right)} & 0 & \frac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} \\ 0 & 0 & 0 & 0 \\ \frac{i\,\sqrt{2}\left(3\,k^2\left(r_3 + 2\,r_5\right) + 4\,t_3\right)}{k\left(1+2\,k^2\right)^2\left(r_3 + 2\,r_5\right)\,t_3} & \frac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_3 + 2\,r_5\right)} & 0 & \frac{3\,k^2\left(r_3 + 2\,r_5\right) + 4\,t_3}{\left(k+2\,k^3\right)^2\left(r_3 + 2\,r_5\right)\,t_3} \end{pmatrix}, \;\; \begin{pmatrix} 0 & 0 \\ 0 & -\frac{2}{3\,k^2\,r_3} \end{pmatrix}, \;\; \left(0 \right) \right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{ -\frac{403\, r_3^2 + 172\, r_3\, r_5 + 28\, r_5^2}{6\, r_3 \left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)} \,, \; -\frac{403\, r_3^2 + 172\, r_3\, r_5 + 28\, r_5^2}{6\, r_3 \left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{ -\frac{403\, r_3^2 + 172\, r_3\, r_5 + 28\, r_5^2}{6\, r_3 \left(2\, r_3 + r_5\right)\left(r_3 + 2\, r_5\right)} \right\}\right\}$$

Overall unitarity conditions:

$$\left(r_3 < 0 \; \&\& \; \left(r_5 < -\frac{r_3}{2} \; || \; r_5 > -2\, r_3 \right) \right) \; || \; \left(r_3 > 0 \; \&\& -2\, r_3 < r_5 < -\frac{r_3}{2} \right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_3 < 0 \; \&\& \; \left(r_5 < -\frac{r_3}{2} \; || \; r_5 > -2\, r_3 \right) \right) \; || \; \left(r_3 > 0 \; \&\& -2\, r_3 < r_5 < -\frac{r_3}{2} \right)$$

Okay, that concludes the analysis of this theory.

Case 16

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 16 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\, r_2\, \mathcal{R}_{ijhl}\, \mathcal{R}^{ijhl} - \frac{2}{3}\, r_2\, \mathcal{R}_{ihjl}\, \mathcal{R}^{ijhl} + \left(\frac{r_3}{2} + r_5 \right) \mathcal{R}^{ij}{}_{i}{}^{h}\, \mathcal{R}_{j}{}^{l}{}_{hl} +$$

$$\frac{1}{6}\left(r_2 - 6\, r_3 \right) \mathcal{R}^{ijhl}\, \mathcal{R}_{hlij} + \frac{1}{2}\left(r_3 - 2\, r_5 \right) \mathcal{R}^{ij}{}_{i}{}^{h}\, \mathcal{R}_{h}{}^{l}{}_{jl} - \frac{2}{3}\, t_3\, \mathcal{T}^{ij}{}_{i}\, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \, \mathcal{A}_{i}{}^{l}{}_{l} \, \mathcal{A}^{ij}{}_{j} - \frac{1}{2} r_3 \, \partial_i \mathcal{A}^{hl}{}_{h} \, \partial^i \mathcal{A}_{l}{}^{a}{}_{a} - r_5 \, \partial_i \mathcal{A}^{hl}{}_{h} \, \partial^l \mathcal{A}_{l}{}^{a}{}_{a} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} + \frac{1}{2} r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{jhl} - \frac{1}{2} r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{jhl} -$$

$$\frac{1}{2} r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{hlj} - r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{hlj} + r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{hlj} + 2 r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} t_3 \, \mathcal{A}_{h}{}^{a}{}_{a} \, \partial^h f^i{}_i - \frac{2}{3} t_3 \, \mathcal{A}_{h}{}^{l}{}_{l} \, \partial^h f^i{}_i - \frac{4}{3} t_3 \, \partial^a f_{ah} \, \partial^h f^i{}_i + \frac{2}{3} t_3 \, \partial_h f^l{}_l \, \partial^h f^i{}_i +$$

$$\frac{2}{3} t_3 \, \partial^{a'} f_{a'}{}^{a} \, \partial^h f_{ha} + \frac{2}{3} t_3 \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^h f_{h}{}^{j} + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_{a} \, \partial^h f_{hl} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} -$$

$$4 r_3 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{1}{2} r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial^l \mathcal{A}^{jh}{}_{h} + r_5 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial^l \mathcal{A}^{jh}{}_{h} + \frac{1}{2} r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial^l \mathcal{A}^{jh}{}_{h} - r_5 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial^l \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with

the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2 k^2 t_3 & i \sqrt{2} \, k t_3 & 0 \\ -i \sqrt{2} \, k t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 \right), \; \begin{pmatrix} 0 & 0 & 0 \\ 0 & k^2 \left(2 r_3 + r_5 \right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \right.$$

$$\begin{pmatrix} \dfrac{2 k^2 t_3}{3} & \dfrac{2 i k t_3}{3} & 0 & -\dfrac{1}{3} i \sqrt{2} \, k t_3 \\[2mm] -\dfrac{2}{3} i k t_3 & k^2 \left(\dfrac{r_3}{2} + r_5 \right) + \dfrac{2 t_3}{3} & 0 & -\dfrac{\sqrt{2} \, t_3}{3} \\[2mm] 0 & 0 & 0 & 0 \\[2mm] \dfrac{1}{3} i \sqrt{2} \, k t_3 & -\dfrac{\sqrt{2} \, t_3}{3} & 0 & \dfrac{t_3}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & -\dfrac{3 k^2 r_3}{2} \end{pmatrix}, \; (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{b\perp} == 0, \; -i \, {}^{0^+}\!\tau^{b\|} == 2 k \, {}^{0^+}\!\sigma^{b\|}, \; {}^{1^+}\!\sigma^{b\perp \, ab} == 0, \; {}^{1^+}\!\tau^{b\| \, ab} == 0, \right.$$

$$\left. i \, {}^{1^-}\!\tau^{b\| \, a} == 2 k \, {}^{1^-}\!\sigma^{b\perp \, a}, \; {}^{1^-}\!\tau^{b\perp \, a} == 0, \; {}^{2^+}\!\tau^{b\| \, ab} == 0, \; {}^{2^-}\!\sigma^{b\| \, abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally

analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex] -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex] 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} \dfrac{1}{k^2\,r_2} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 \\[1ex] 0 & \dfrac{1}{k^2\left(2\,r_3+r_5\right)} & 0 \\[1ex] 0 & 0 & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{6\,k^2\left(r_3+2\,r_5\right)+8\,t_3}{\left(1+2\,k^2\right)^2\left(r_3+2\,r_5\right)t_3} & -\dfrac{4\,i}{k\left(1+2\,k^2\right)\left(r_3+2\,r_5\right)} & 0 & -\dfrac{i\,\sqrt{2}\left(3\,k^2\left(r_3+2\,r_5\right)+4\,t_3\right)}{k\left(1+2\,k^2\right)^2\left(r_3+2\,r_5\right)t_3} \\[2ex] \dfrac{4\,i}{k\left(1+2\,k^2\right)\left(r_3+2\,r_5\right)} & \dfrac{2}{k^2\left(r_3+2\,r_5\right)} & 0 & \dfrac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_3+2\,r_5\right)} \\[2ex] 0 & 0 & 0 & 0 \\[2ex] \dfrac{i\,\sqrt{2}\left(3\,k^2\left(r_3+2\,r_5\right)+4\,t_3\right)}{k\left(1+2\,k^2\right)^2\left(r_3+2\,r_5\right)t_3} & \dfrac{2\,\sqrt{2}}{k^2\left(1+2\,k^2\right)\left(r_3+2\,r_5\right)} & 0 & \dfrac{3\,k^2\left(r_3+2\,r_5\right)+4\,t_3}{\left(k+2\,k^3\right)^2\left(r_3+2\,r_5\right)t_3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\[1ex] 0 & -\dfrac{2}{3\,k^2\,r_3} \end{pmatrix}, \; \left(0 \right) \right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{ \frac{-445\,r_3^2 - 268\,r_3\,r_5 - 52\,r_5^2}{12\,r_3\left(2\,r_3+r_5\right)\left(r_3+2\,r_5\right)}, \; \frac{-445\,r_3^2 - 268\,r_3\,r_5 - 52\,r_5^2}{12\,r_3\left(2\,r_3+r_5\right)\left(r_3+2\,r_5\right)} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ \frac{-445\,r_3^2 - 268\,r_3\,r_5 - 52\,r_5^2}{12\,r_3\left(2\,r_3+r_5\right)\left(r_3+2\,r_5\right)} \right\} \right\}$$

Overall unitarity conditions:

$$\left(r_3 < 0 \; \&\& \; \left(r_5 < -\frac{r_3}{2} \; || \; r_5 > -2\,r_3 \right) \right) \; || \; \left(r_3 > 0 \; \&\& \; -2\,r_3 < r_5 < -\frac{r_3}{2} \right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_3 < 0 \; \&\& \; \left(r_5 < -\frac{r_3}{2} \; || \; r_5 > -2\,r_3 \right) \right) \; || \; \left(r_3 > 0 \; \&\& \; -2\,r_3 < r_5 < -\frac{r_3}{2} \right)$$

Okay, that concludes the analysis of this theory.

Case 17

Now for a new theory. Here is the full nonlinear Lagrangian for

Case 17 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$r_5\, \mathcal{R}^{i\,j\,\hbar}{}_i\; \mathcal{R}_{j}{}^{l}{}_{\hbar\,l} - r_5\, \mathcal{R}^{i\,j\,\hbar}{}_i\; \mathcal{R}_{\hbar}{}^{l}{}_{j\,l} + \frac{1}{4}\, t_1\, \mathcal{T}_{i\,j\,\hbar}\; \mathcal{T}^{i\,j\,\hbar} + \frac{1}{2}\, t_1\, \mathcal{T}^{i\,j\,\hbar}\; \mathcal{T}_{j\,i\,\hbar} + \frac{1}{3}\, t_1\, \mathcal{T}^{i}{}_i{}^{j}\; \mathcal{T}^{\hbar}{}_{j\,\hbar}$$

To use PSALTer, you have to first linearise

this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\, t_1\, \mathcal{A}_i{}^{l}{}_l\; \mathcal{A}^{i\,j}{}_j + t_1\, \mathcal{A}_{i\,\hbar\,j}\; \mathcal{A}^{i\,j\,\hbar} - r_5\, \partial_i\mathcal{A}^{\hbar\,l}{}_\hbar\; \partial^j\mathcal{A}_{l}{}^{a}{}_a - r_5\, \partial_a\mathcal{A}_{l}{}^{a}{}_j\; \partial_\hbar\mathcal{A}^{j\,\hbar\,l} +$$

$$r_5\, \partial_j\mathcal{A}_{l}{}^{a}{}_a\; \partial_\hbar\mathcal{A}^{j\,\hbar\,l} - r_5\, \partial_a\mathcal{A}_{l}{}^{a}{}_j\; \partial_\hbar\mathcal{A}^{\hbar\,l\,j} + 2\,r_5\, \partial_j\mathcal{A}_{l}{}^{a}{}_a\; \partial_\hbar\mathcal{A}^{\hbar\,l\,j} - \frac{1}{2}\, t_1\, \partial^a f_{j\,\hbar}\; \partial^\hbar f_a{}^{j} + \frac{1}{2}\, t_1\, \partial^a f_\hbar{}^{l}\; \partial^\hbar f_{a\,l} -$$

$$\frac{1}{2}\, t_1\, \partial^a f_{i\,\hbar}\; \partial^\hbar f^{i}{}_a + \frac{1}{3}\, t_1\, \mathcal{A}_\hbar{}^{a}{}_a\; \partial^\hbar f^{i}{}_i + \frac{2}{3}\, t_1\, \mathcal{A}_\hbar{}^{l}{}_l\; \partial^\hbar f^{i}{}_i + \frac{2}{3}\, t_1\, \partial^a f_{a\,\hbar}\; \partial^\hbar f^{i}{}_i - \frac{1}{3}\, t_1\, \partial_\hbar f^{l}{}_l\; \partial^\hbar f^{i}{}_i +$$

$$t_1\, \mathcal{A}^{l}{}_{\hbar\,i}\; \partial^\hbar f^{i}{}_l + \frac{1}{2}\, t_1\, \partial_\hbar f^{l}{}_i\; \partial^\hbar f^{i}{}_l - \frac{1}{3}\, t_1\, \partial^{a'} f_{a}{}^{a}\; \partial^\hbar f_{\hbar\,a} - \frac{1}{3}\, t_1\, \mathcal{A}_j{}^{l}{}_l\; \partial^\hbar f_\hbar{}^{j} - \frac{1}{3}\, t_1\, \mathcal{A}^{l\,a}{}_a\; \partial^\hbar f_{\hbar\,l} -$$

$$\frac{1}{2}\, t_1\, \partial^a f_\hbar{}^{l}\; \partial^\hbar f_{l\,a} + t_1\, \mathcal{A}_{j\,\hbar}{}^{l}\; \partial^\hbar f_l{}^{j} + \frac{1}{2}\, t_1\, \partial_\hbar f_j{}^{l}\; \partial^\hbar f_l{}^{j} + r_5\, \partial_a\mathcal{A}_{l}{}^{a}{}_j\; \partial^l\mathcal{A}^{j\,\hbar}{}_\hbar - r_5\, \partial_j\mathcal{A}_{l}{}^{a}{}_a\; \partial^l\mathcal{A}^{j\,\hbar}{}_\hbar$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with

the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(-t_1 \right), \; \begin{pmatrix} 0 & -\dfrac{i\,k\,t_1}{\sqrt{2}} & 0 \\[2mm] \dfrac{i\,k\,t_1}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\,r_5 - t_1 \right) & -\dfrac{t_1}{\sqrt{2}} \\[2mm] 0 & -\dfrac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2\,k^2\,t_1}{3} & -\dfrac{1}{3}\,i\,k\,t_1 & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_1 \\[2mm] \dfrac{i\,k\,t_1}{3} & k^2\,r_5 + \dfrac{t_1}{6} & 0 & \dfrac{t_1}{3\,\sqrt{2}} \\[2mm] 0 & 0 & 0 & 0 \\[2mm] \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_1 & \dfrac{t_1}{3\,\sqrt{2}} & 0 & \dfrac{t_1}{3} \end{pmatrix}, \; \begin{pmatrix} k^2\,t_1 & \dfrac{i\,k\,t_1}{\sqrt{2}} \\[2mm] -\dfrac{i\,k\,t_1}{\sqrt{2}} & \dfrac{t_1}{2} \end{pmatrix}, \; \left(\dfrac{t_1}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{\flat\perp} == 0, \; {}^{0^+}\!\sigma^{\flat\|} == 0, \; {}^{0^+}\!\tau^{\flat\|} == 0, \; -i\,{}^{1^+}\!\tau^{\flat\|}{}^{a\,b} == k\,{}^{1^+}\!\sigma^{\perp}{}^{a\,b}, \; i\,{}^{1^-}\!\tau^{\flat\|}{}^{a} == 2\,k\,{}^{1^-}\!\sigma^{\flat\perp}{}^{a}, \; {}^{1^-}\!\tau^{\flat\perp}{}^{a} == 0, \; -i\,{}^{2^+}\!\tau^{\flat\|}{}^{a\,b} == 2\,k\,{}^{2^+}\!\sigma^{\flat\|}{}^{a\,b} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \ \left(-\frac{1}{t_1} \right), \ \begin{pmatrix} \frac{-2\,k^4\,r_5+k^2\,t_1}{(1+k^2)^2\,t_1^2} & -\frac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & -\frac{i\left(2\,k^3\,r_5-k\,t_1\right)}{(1+k^2)^2\,t_1^2} \\ \frac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & 0 & -\frac{\sqrt{2}}{t_1+k^2\,t_1} \\ \frac{i\left(2\,k^3\,r_5-k\,t_1\right)}{(1+k^2)^2\,t_1^2} & -\frac{\sqrt{2}}{t_1+k^2\,t_1} & \frac{-2\,k^2\,r_5+t_1}{(1+k^2)^2\,t_1^2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{6\,k^2\,r_5+t_1}{\left(1+2\,k^2\right)^2\,r_5\,t_1} & \frac{i}{k\,r_5+2\,k^3\,r_5} & 0 & -\frac{i\left(6\,k^2\,r_5+t_1\right)}{\sqrt{2}\,k\left(1+2\,k^2\right)^2\,r_5\,t_1} \\ -\frac{i}{k\,r_5+2\,k^3\,r_5} & \frac{1}{k^2\,r_5} & 0 & -\frac{1}{\sqrt{2}\left(k^2\,r_5+2\,k^4\,r_5\right)} \\ 0 & 0 & 0 & 0 \\ \frac{i\left(6\,k^2\,r_5+t_1\right)}{\sqrt{2}\,k\left(1+2\,k^2\right)^2\,r_5\,t_1} & -\frac{1}{\sqrt{2}\left(k^2\,r_5+2\,k^4\,r_5\right)} & 0 & \frac{6\,k^2\,r_5+t_1}{2\left(k+2\,k^3\right)^2\,r_5\,t_1} \end{pmatrix}, \ \begin{pmatrix} \frac{4\,k^2}{\left(1+2\,k^2\right)^2\,t_1} & \frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_1} \\ -\frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_1} & \frac{2}{\left(1+2\,k^2\right)^2\,t_1} \end{pmatrix}, \ \left(\frac{2}{t_1} \right) \right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{ -\frac{7\,t_1^2 + 2\,r_5\,t_1\,p^2 + 4\,r_5^2\,p^4}{2\,r_5\,t_1^2}, \ -\frac{7\,t_1^2 + 2\,r_5\,t_1\,p^2 + 4\,r_5^2\,p^4}{2\,r_5\,t_1^2} \right\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{7\,t_1^2 + 2\,r_5\,t_1\,p^2 + 4\,r_5^2\,p^4}{2\,r_5\,t_1^2} \right\} \right\}$$

Overall unitarity conditions:

$$p \in \mathbb{R} \ \&\&\ r_5 < 0 \ \&\&\ \left(t_1 < 0 \ || \ t_1 > 0 \right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$t_1 \neq 0 \ \&\&\ r_5 < 0$$

Okay, that concludes the analysis of this theory.

Case 18

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 18 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$r_{5} \, \mathcal{R}^{ij\hbar}{}_{i} \, \mathcal{R}_{j}{}^{l}{}_{\hbar l} - r_{5} \, \mathcal{R}^{ij\hbar}{}_{i} \, \mathcal{R}_{\hbar}{}^{l}{}_{jl} + \frac{1}{3} \, t_{1} \, \mathcal{T}_{ij\hbar} \, \mathcal{T}^{ij\hbar} + \frac{1}{3} \, t_{1} \, \mathcal{T}^{ij\hbar} \, \mathcal{T}_{ji\hbar} + t_{1} \, \mathcal{T}^{i}{}_{i}{}^{j} \, \mathcal{T}^{\hbar}{}_{j\hbar}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_{1} \, \mathcal{A}_{i}{}^{l}{}_{l} \, \mathcal{A}^{ij}{}_{j} + \frac{1}{3} \, t_{1} \, \mathcal{A}_{ij\hbar} \, \mathcal{A}^{ij\hbar} + \frac{1}{3} \, t_{1} \, \mathcal{A}_{i\hbar j} \, \mathcal{A}^{ij\hbar} - r_{5} \, \partial_{i}\mathcal{A}^{\hbar l}{}_{\hbar} \, \partial^{i}\mathcal{A}_{l}{}^{a}{}_{a} -$$

$$r_{5} \, \partial_{a}\mathcal{A}_{l}{}^{a}{}_{j} \, \partial_{\hbar}\mathcal{A}^{j\hbar l} + r_{5} \, \partial_{j}\mathcal{A}_{l}{}^{a}{}_{a} \, \partial_{\hbar}\mathcal{A}^{j\hbar l} - r_{5} \, \partial_{a}\mathcal{A}_{l}{}^{a}{}_{j} \, \partial_{\hbar}\mathcal{A}^{\hbar l j} + 2 \, r_{5} \, \partial_{j}\mathcal{A}_{l}{}^{a}{}_{a} \, \partial_{\hbar}\mathcal{A}^{\hbar l j} - \frac{1}{3} \, t_{1} \, \partial^{a}f_{j\hbar} \, \partial^{\hbar}f_{a}{}^{j} +$$

$$\frac{1}{3} \, t_{1} \, \partial^{a}f_{\hbar}{}^{l} \, \partial^{\hbar}f_{a l} + \frac{1}{3} \, t_{1} \, \mathcal{A}_{i\hbar}{}^{a} \, \partial^{\hbar}f^{i}{}_{a} - \frac{2}{3} \, t_{1} \, \partial^{a}f_{i\hbar} \, \partial^{\hbar}f^{i}{}_{a} + t_{1} \, \mathcal{A}_{\hbar}{}^{a}{}_{a} \, \partial^{\hbar}f^{i}{}_{i} + t_{1} \, \mathcal{A}_{\hbar}{}^{l}{}_{l} \, \partial^{\hbar}f^{i}{}_{i} +$$

$$2 \, t_{1} \, \partial^{a}f_{a\hbar} \, \partial^{\hbar}f^{i}{}_{i} - t_{1} \, \partial_{\hbar}f^{l}{}_{l} \, \partial^{\hbar}f^{i}{}_{i} - \frac{1}{3} \, t_{1} \, \mathcal{A}_{ij\hbar} \, \partial^{\hbar}f^{ij} + \frac{1}{3} \, t_{1} \, \mathcal{A}_{i\hbar}{}^{l} \, \partial^{\hbar}f^{i}{}_{l} - \frac{1}{3} \, t_{1} \, \mathcal{A}_{i}{}^{l}{}_{\hbar} \, \partial^{\hbar}f^{i}{}_{l} +$$

$$\frac{2}{3} \, t_{1} \, \mathcal{A}^{l}{}_{\hbar i} \, \partial^{\hbar}f^{i}{}_{l} + \frac{2}{3} \, t_{1} \, \partial_{\hbar}f_{i}{}^{l} \, \partial^{\hbar}f^{i}{}_{l} - t_{1} \, \partial^{a'}f_{a'}{}^{a} \, \partial^{\hbar}f_{\hbar a} - t_{1} \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^{\hbar}f_{\hbar}{}^{j} - t_{1} \, \mathcal{A}^{l a}{}_{a} \, \partial^{\hbar}f_{\hbar l} -$$

$$\frac{1}{3} \, t_{1} \, \partial^{a}f_{\hbar}{}^{l} \, \partial^{\hbar}f_{l a} + \frac{2}{3} \, t_{1} \, \mathcal{A}_{j\hbar}{}^{l} \, \partial^{\hbar}f_{l}{}^{j} + \frac{1}{3} \, t_{1} \, \partial_{\hbar}f_{j}{}^{l} \, \partial^{\hbar}f_{l}{}^{j} + r_{5} \, \partial_{a}\mathcal{A}_{l}{}^{a}{}_{j} \, \partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar} - r_{5} \, \partial_{j}\mathcal{A}_{l}{}^{a}{}_{a} \, \partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2\,k^2\,t_{1} & -i\,\sqrt{2}\,k\,t_{1} & 0 \\ i\,\sqrt{2}\,k\,t_{1} & -t_{1} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ (0),\right.$$

$$\begin{pmatrix} \dfrac{k^2\,t_{1}}{3} & -\dfrac{i\,k\,t_{1}}{3\,\sqrt{2}} & \dfrac{i\,k\,t_{1}}{3} \\[2mm] \dfrac{i\,k\,t_{1}}{3\,\sqrt{2}} & \dfrac{1}{6}\left(6\,k^2\,r_{5}+t_{1}\right) & -\dfrac{t_{1}}{3\,\sqrt{2}} \\[2mm] -\dfrac{1}{3}\,i\,k\,t_{1} & -\dfrac{t_{1}}{3\,\sqrt{2}} & \dfrac{t_{1}}{3} \end{pmatrix},\ \begin{pmatrix} 0 & -i\,k\,t_{1} & 0 & 0 \\ i\,k\,t_{1} & k^2\,r_{5}-\dfrac{t_{1}}{2} & 0 & \dfrac{t_{1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \dfrac{t_{1}}{\sqrt{2}} & 0 & 0 \end{pmatrix},\ \begin{pmatrix} k^2\,t_{1} & \dfrac{i\,k\,t_{1}}{\sqrt{2}} \\[2mm] -\dfrac{i\,k\,t_{1}}{\sqrt{2}} & \dfrac{t_{1}}{2} \end{pmatrix},\ \left(\dfrac{t_{1}}{2}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^{+}}\!\tau^{\flat\perp} == 0,\ -i\ {}^{0^{+}}\!\tau^{\flat\|} == 2\,k\ {}^{0^{+}}\!\sigma^{\flat\|},\ {}^{0^{-}}\!\sigma^{\flat\|} == 0,\ -i\ {}^{1^{+}}\!\tau^{\flat\|}{}^{ab} == k\ {}^{1^{+}}\!\sigma^{\flat\perp ab},\right.$$

$$\left. i\ {}^{1^{-}}\!\tau^{\flat\| a} == 2\,k\ {}^{1^{-}}\!\sigma^{\flat\perp a},\ {}^{1^{-}}\!\tau^{\flat\perp a} == 0,\ -i\ {}^{2^{+}}\!\tau^{\flat\|}{}^{ab} == 2\,k\ {}^{2^{+}}\!\sigma^{\flat\| ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -\frac{2k^2}{(1+2k^2)^2 t_1} & -\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & 0 \\ \frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & -\frac{1}{(1+2k^2)^2 t_1} & 0 \\ 0 & 0 & 0 \end{pmatrix},\;(0),\;\begin{pmatrix} \frac{6k^2 r_5 + t_1}{2(1+k^2)^2 r_5 t_1} & \frac{i}{\sqrt{2}(k r_5 + k^3 r_5)} & \frac{i(6k^2 r_5 + t_1)}{2k(1+k^2)^2 r_5 t_1} \\ -\frac{i}{\sqrt{2}(k r_5 + k^3 r_5)} & \frac{1}{k^2 r_5} & \frac{1}{\sqrt{2}(k^2 r_5 + k^4 r_5)} \\ -\frac{i(6k^2 r_5 + t_1)}{2k(1+k^2)^2 r_5 t_1} & \frac{1}{\sqrt{2}(k^2 r_5 + k^4 r_5)} & \frac{6k^2 r_5 + t_1}{2(k+k^3)^2 r_5 t_1} \end{pmatrix},\right.$$

$$\begin{pmatrix} \frac{-4k^4 r_5 + 2k^2 t_1}{(t_1 + 2k^2 t_1)^2} & -\frac{2ik}{t_1 + 2k^2 t_1} & 0 & \frac{i\sqrt{2}\,k(2k^2 r_5 - t_1)}{(t_1 + 2k^2 t_1)^2} \\ \frac{2ik}{t_1 + 2k^2 t_1} & 0 & 0 & \frac{\sqrt{2}}{t_1 + 2k^2 t_1} \\ 0 & 0 & 0 & 0 \\ -\frac{i\sqrt{2}\,k(2k^2 r_5 - t_1)}{(t_1 + 2k^2 t_1)^2} & \frac{\sqrt{2}}{t_1 + 2k^2 t_1} & 0 & \frac{-2k^2 r_5 + t_1}{(t_1 + 2k^2 t_1)^2} \end{pmatrix},\;\begin{pmatrix} \frac{4k^2}{(1+2k^2)^2 t_1} & \frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1} \\ -\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1} & \frac{2}{(1+2k^2)^2 t_1} \end{pmatrix},\;\left(\frac{2}{t_1}\right)\right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{\frac{9t_1^2 + 2r_5 t_1 p^2 + 2r_5^2 p^4}{r_5 t_1^2},\;\frac{9t_1^2 + 2r_5 t_1 p^2 + 2r_5^2 p^4}{r_5 t_1^2}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{\frac{9t_1^2 + 2r_5 t_1 p^2 + 2r_5^2 p^4}{r_5 t_1^2}\right\}\right\}$$

Overall unitarity conditions:

$$p \in \mathbb{R} \;\&\&\; r_5 > 0 \;\&\&\; (t_1 < 0 \,\|\, t_1 > 0)$$

So, that's the end of the PSALTer output for this theory. You can check the particle content against TABLE IV. in arXiv:1910.14197. If you take the overall unitarity conditions from the final column in TABLE V., and decompose them using Mathematica's Reduce function, you get the following (to be compared with the PSALTer conditions above):

$$t_1 \neq 0 \;\&\&\; r_5 > 0$$

Okay, that concludes the analysis of this theory.

Case 19

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 19 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\left(2\,r_3 + r_5\right) \mathcal{R}^{ij\,\hbar}{}_i \; \mathcal{R}_{j\;\hbar l}{}^l - r_3 \; \mathcal{R}^{ij\hbar l} \; \mathcal{R}_{\hbar lij} +$$

$$\left(2\,r_3 - r_5\right) \mathcal{R}^{ij\,\hbar}{}_i \; \mathcal{R}_{\hbar\;jl}{}^l + \frac{1}{4}\,t_1\, \mathcal{T}_{ij\hbar}\; \mathcal{T}^{ij\hbar} + \frac{1}{2}\,t_1\, \mathcal{T}^{ij\hbar}\; \mathcal{T}_{ji\hbar} + \frac{1}{3}\,t_1\, \mathcal{T}^i{}_i{}^j\; \mathcal{T}^\hbar{}_{j\hbar}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\,t_1\, \mathcal{A}_i{}^l{}_l\; \mathcal{A}^{ij}{}_j + t_1\, \mathcal{A}_{i\hbar j}\; \mathcal{A}^{ij\hbar} - 2\,r_3\, \partial_i \mathcal{A}^{\hbar l}{}_\hbar\; \partial^j \mathcal{A}_l{}^a{}_a - r_5\, \partial_i \mathcal{A}^{\hbar l}{}_\hbar\; \partial^i \mathcal{A}_l{}^a{}_a +$$

$$2\,r_3\, \partial_a \mathcal{A}_l{}^a{}_j\; \partial_\hbar \mathcal{A}^{j\hbar l} - r_5\, \partial_a \mathcal{A}_l{}^a{}_j\; \partial_\hbar \mathcal{A}^{j\hbar l} - 2\,r_3\, \partial_j \mathcal{A}_l{}^a{}_a\; \partial_\hbar \mathcal{A}^{j\hbar l} + r_5\, \partial_j \mathcal{A}_l{}^a{}_a\; \partial_\hbar \mathcal{A}^{j\hbar l} -$$

$$2\,r_3\, \partial_a \mathcal{A}_l{}^a{}_j\; \partial_\hbar \mathcal{A}^{\hbar l j} - r_5\, \partial_a \mathcal{A}_l{}^a{}_j\; \partial_\hbar \mathcal{A}^{\hbar l j} + 4\,r_3\, \partial_j \mathcal{A}_l{}^a{}_a\; \partial_\hbar \mathcal{A}^{\hbar l j} + 2\,r_5\, \partial_j \mathcal{A}_l{}^a{}_a\; \partial_\hbar \mathcal{A}^{\hbar l j} -$$

$$\frac{1}{2}\,t_1\, \partial^a f_{j\hbar}\; \partial^\hbar f_a{}^j + \frac{1}{2}\,t_1\, \partial^a f_\hbar{}^l\; \partial^\hbar f_{al} - \frac{1}{2}\,t_1\, \partial^a f_{i\hbar}\; \partial^\hbar f^i{}_a + \frac{1}{3}\,t_1\, \mathcal{A}_\hbar{}^a{}_a\; \partial^\hbar f^i{}_i + \frac{1}{3}\,t_1\, \mathcal{A}_\hbar{}^l{}_l\; \partial^\hbar f^i{}_i +$$

$$\frac{2}{3}\,t_1\, \partial^a f_{a\hbar}\; \partial^\hbar f^i{}_i - \frac{1}{3}\,t_1\, \partial_\hbar f^l{}_l\; \partial^\hbar f^i{}_i + t_1\, \mathcal{A}^l{}_{\hbar i}\; \partial^\hbar f^i{}_l + \frac{1}{2}\,t_1\, \partial_\hbar f_i{}^l\; \partial^\hbar f^i{}_l - \frac{1}{3}\,t_1\, \partial^{a'} f_{a'}{}^a\; \partial^\hbar f_{\hbar a} -$$

$$\frac{1}{3}\,t_1\, \mathcal{A}_j{}^l{}_l\; \partial^\hbar f_\hbar{}^j - \frac{1}{3}\,t_1\, \mathcal{A}^{la}{}_a\; \partial^\hbar f_{\hbar l} - \frac{1}{2}\,t_1\, \partial^a f_\hbar{}^l\; \partial^\hbar f_{la} + t_1\, \mathcal{A}_{j\hbar}{}^l\; \partial^\hbar f_l{}^j + \frac{1}{2}\,t_1\, \partial_\hbar f_j{}^l\; \partial^\hbar f_l{}^j -$$

$$4\,r_3\, \partial^{a'} \mathcal{A}_i{}^{la}\; \partial_l \mathcal{A}_{aa'}{}^i - 2\,r_3\, \partial_a \mathcal{A}_l{}^a{}_j\; \partial^l \mathcal{A}^{j\hbar}{}_\hbar + r_5\, \partial_a \mathcal{A}_l{}^a{}_j\; \partial^l \mathcal{A}^{j\hbar}{}_\hbar + 2\,r_3\, \partial_j \mathcal{A}_l{}^a{}_a\; \partial^l \mathcal{A}^{j\hbar}{}_\hbar - r_5\, \partial_j \mathcal{A}_l{}^a{}_a\; \partial^l \mathcal{A}^{j\hbar}{}_\hbar$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6\,k^2\,r_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(-t_1\right), \; \begin{pmatrix} 0 & -\frac{i\,k\,t_1}{\sqrt{2}} & 0 \\ \frac{i\,k\,t_1}{\sqrt{2}} & \frac{1}{2}\left(2\,k^2\left(2\,r_3 + r_5\right) - t_1\right) & -\frac{t_1}{\sqrt{2}} \\ 0 & -\frac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{2\,k^2\,t_1}{3} & -\frac{1}{3}\,i\,k\,t_1 & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\,t_1 \\ \frac{i\,k\,t_1}{3} & k^2\left(2\,r_3 + r_5\right) + \frac{t_1}{6} & 0 & \frac{t_1}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\,t_1 & \frac{t_1}{3\sqrt{2}} & 0 & \frac{t_1}{3} \end{pmatrix}, \; \begin{pmatrix} k^2\,t_1 & \frac{i\,k\,t_1}{\sqrt{2}} \\ -\frac{i\,k\,t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \; \left(\frac{t_1}{2}\right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{\flat\perp} == 0, \; {}^{0^+}\!\tau^{\flat\|} == 0, \; -i\,{}^{1^+}\!\tau^{\flat\|}{}^{ab} == k\,{}^{1^+}\!\sigma^{\flat\perp}{}^{ab}, \; i\,{}^{1^-}\!\tau^{\flat\|}{}^a == 2\,k\,{}^{1^-}\!\sigma^{\flat\perp}{}^a, \; {}^{1^-}\!\tau^{\flat\perp}{}^a == 0, \; -i\,{}^{2^+}\!\tau^{\flat\|}{}^{ab} == 2\,k\,{}^{2^+}\!\sigma^{\flat\|}{}^{ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{6\,k^2\,r_3} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-\dfrac{1}{t_1}\right), \begin{pmatrix} \dfrac{-2\,k^4\,\left(2\,r_3+r_5\right)+k^2\,t_1}{\left(1+k^2\right)^2\,t_1^{\,2}} & -\dfrac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & \dfrac{-2\,i\,k^3\,\left(2\,r_3+r_5\right)+i\,k\,t_1}{\left(1+k^2\right)^2\,t_1^{\,2}} \\ \dfrac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & 0 & -\dfrac{\sqrt{2}}{t_1+k^2\,t_1} \\ \dfrac{i\,\left(2\,k^3\,\left(2\,r_3+r_5\right)-k\,t_1\right)}{\left(1+k^2\right)^2\,t_1^{\,2}} & -\dfrac{\sqrt{2}}{t_1+k^2\,t_1} & \dfrac{-2\,k^2\,\left(2\,r_3+r_5\right)+t_1}{\left(1+k^2\right)^2\,t_1^{\,2}} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \dfrac{6\,k^2\,\left(2\,r_3+r_5\right)+t_1}{\left(1+2\,k^2\right)^2\,\left(2\,r_3+r_5\right)\,t_1} & \dfrac{i}{k\,\left(1+2\,k^2\right)\,\left(2\,r_3+r_5\right)} & 0 & -\dfrac{i\,\left(6\,k^2\,\left(2\,r_3+r_5\right)+t_1\right)}{\sqrt{2}\,k\,\left(1+2\,k^2\right)^2\,\left(2\,r_3+r_5\right)\,t_1} \\ -\dfrac{i}{k\,\left(1+2\,k^2\right)\,\left(2\,r_3+r_5\right)} & \dfrac{1}{k^2\,\left(2\,r_3+r_5\right)} & 0 & -\dfrac{1}{\sqrt{2}\,\left(k^2+2\,k^4\right)\,\left(2\,r_3+r_5\right)} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\,\left(6\,k^2\,\left(2\,r_3+r_5\right)+t_1\right)}{\sqrt{2}\,k\,\left(1+2\,k^2\right)^2\,\left(2\,r_3+r_5\right)\,t_1} & -\dfrac{1}{\sqrt{2}\,\left(k^2+2\,k^4\right)\,\left(2\,r_3+r_5\right)} & 0 & \dfrac{6\,k^2\,\left(2\,r_3+r_5\right)+t_1}{2\,\left(k+2\,k^3\right)^2\,\left(2\,r_3+r_5\right)\,t_1} \end{pmatrix}, \begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2\,t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_1} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2\,t_1} \end{pmatrix}, \left(\dfrac{2}{t_1}\right)\right\}\right\}$$

Square masses:

{{}, {}, {}, {}, {}, {}}

Massive pole residues:

{{}, {}, {}, {}, {}, {}}

Massless eigenvalues:

$$\left\{-\dfrac{7\,t_1^{\,2}+4\,r_3\,t_1\,p^2+2\,r_5\,t_1\,p^2+16\,r_3^{\,2}\,p^4+16\,r_3\,r_5\,p^4+4\,r_5^{\,2}\,p^4}{2\,\left(2\,r_3+r_5\right)\,t_1^{\,2}},\right.$$

$$\left.-\dfrac{7\,t_1^{\,2}+4\,r_3\,t_1\,p^2+2\,r_5\,t_1\,p^2+16\,r_3^{\,2}\,p^4+16\,r_3\,r_5\,p^4+4\,r_5^{\,2}\,p^4}{2\,\left(2\,r_3+r_5\right)\,t_1^{\,2}}\right\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\dfrac{7\,t_1^{\,2}+4\,r_3\,t_1\,p^2+2\,r_5\,t_1\,p^2+16\,r_3^{\,2}\,p^4+16\,r_3\,r_5\,p^4+4\,r_5^{\,2}\,p^4}{2\,\left(2\,r_3+r_5\right)\,t_1^{\,2}}\right\}\right\}$$

Overall unitarity conditions:

$$\left(p \mid r_3\right) \in \mathbb{R}\ \&\&\ r_5 < -2\,r_3\ \&\&\ \left(t_1 < 0 \,\|\, t_1 > 0\right)$$

$$r_3 \in \mathbb{R}\ \&\&\ t_1 \neq 0\ \&\&\ r_5 < -2\,r_3$$

Okay, that concludes the analysis of this theory.

Case 20

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 20 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\, r_2\, \mathcal{R}_{ijhl}\; \mathcal{R}^{ijhl} - \frac{2}{3}\, r_2\, \mathcal{R}_{ihjl}\; \mathcal{R}^{ijhl} + \frac{1}{6}\, r_2\, \mathcal{R}^{ijhl}\; \mathcal{R}_{hlij} +$$

$$\frac{1}{12}\left(4\, t_1 + t_2\right)\mathcal{T}_{ijh}\; \mathcal{T}^{ijh} + \frac{1}{6}\left(2\, t_1 - t_2\right)\mathcal{T}^{ijh}\; \mathcal{T}_{jih} + \frac{1}{3}\left(t_1 - 2\, t_3\right)\mathcal{T}^{i\;j}_{\;\;i}\; \mathcal{T}^{h}_{\;jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\, t_1\, \mathcal{A}^{\;\;\;l}_{i\;\;l}\; \mathcal{A}^{ij}_{\;\;\;j} + \frac{2}{3}\, t_3\, \mathcal{A}^{\;\;\;l}_{i\;\;l}\; \mathcal{A}^{ij}_{\;\;\;j} + \frac{1}{3}\, t_1\, \mathcal{A}_{ijh}\; \mathcal{A}^{ijh} + \frac{1}{3}\, t_2\, \mathcal{A}_{ijh}\; \mathcal{A}^{ijh} +$$

$$\frac{1}{3}\, t_1\, \mathcal{A}_{ihj}\; \mathcal{A}^{ijh} - \frac{2}{3}\, t_2\, \mathcal{A}_{ihj}\; \mathcal{A}^{ijh} + \frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}^{ja}_{\;\;\;\;h}\, \partial_j \mathcal{A}_{aa'}^{\;\;\;\;h} - \frac{1}{3}\, r_2\, \partial_j \mathcal{A}_{aa'}^{\;\;\;\;h}\, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3}\, r_2\, \partial_j \mathcal{A}_{aa'}^{\;\;\;\;h}\, \partial_h \mathcal{A}^{jaa'} + \frac{1}{3}\, r_2\, \partial_h \mathcal{A}^{aa'j}\, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3}\, r_2\, \partial_h \mathcal{A}^{jaa'}\, \partial^h \mathcal{A}_{aa'j} - \frac{1}{3}\, t_1\, \partial^a f_{jh}\, \partial^h f_a^{\;\;j} +$$

$$\frac{1}{6}\, t_2\, \partial^a f_{jh}\, \partial^h f_a^{\;\;j} + \frac{1}{3}\, t_1\, \partial^a f_h^{\;\;l}\, \partial^h f_{al} - \frac{1}{6}\, t_2\, \partial^a f_h^{\;\;l}\, \partial^h f_{al} + \frac{1}{3}\, t_1\, \mathcal{A}_{ih}^{\;\;\;a}\, \partial^h f^i_{\;\;a} + \frac{1}{3}\, t_2\, \mathcal{A}_{ih}^{\;\;\;a}\, \partial^h f^i_{\;\;a} -$$

$$\frac{2}{3}\, t_1\, \partial^a f_{ih}\, \partial^h f^i_{\;\;a} - \frac{1}{6}\, t_2\, \partial^a f_{ih}\, \partial^h f^i_{\;\;a} + \frac{1}{3}\, t_1\, \mathcal{A}_{h}^{\;\;a}\, \partial^h f^i_{\;\;i} - \frac{2}{3}\, t_3\, \mathcal{A}_{h}^{\;\;a}\, \partial^h f^i_{\;\;i} + \frac{1}{3}\, t_1\, \mathcal{A}_{h}^{\;\;l}\, \partial^h f^i_{\;\;i} -$$

$$\frac{2}{3}\, t_3\, \mathcal{A}_{h}^{\;\;l}\, \partial^h f^i_{\;\;i} + \frac{2}{3}\, t_1\, \partial^a f_{ah}\, \partial^h f^i_{\;\;i} - \frac{4}{3}\, t_3\, \partial^a f_{ah}\, \partial^h f^i_{\;\;i} - \frac{1}{3}\, t_1\, \partial_h f^l_{\;\;l}\, \partial^h f^i_{\;\;i} + \frac{2}{3}\, t_3\, \partial_h f^l_{\;\;l}\, \partial^h f^i_{\;\;i} -$$

$$\frac{1}{3}\, t_1\, \mathcal{A}_{ijh}\, \partial^h f^{ij} - \frac{1}{3}\, t_2\, \mathcal{A}_{ijh}\, \partial^h f^{ij} + \frac{1}{3}\, t_1\, \mathcal{A}_{ih}^{\;\;\;l}\, \partial^h f^i_{\;\;l} + \frac{1}{3}\, t_2\, \mathcal{A}_{ih}^{\;\;\;l}\, \partial^h f^i_{\;\;l} - \frac{1}{3}\, t_1\, \mathcal{A}_{i\;h}^{\;\;l}\, \partial^h f^i_{\;\;l} -$$

$$\frac{1}{3}\, t_2\, \mathcal{A}_{i\;h}^{\;\;l}\, \partial^h f^i_{\;\;l} + \frac{2}{3}\, t_1\, \mathcal{A}^l_{\;\;hi}\, \partial^h f^i_{\;\;l} - \frac{1}{3}\, t_2\, \mathcal{A}^l_{\;\;hi}\, \partial^h f^i_{\;\;l} + \frac{2}{3}\, t_1\, \partial_h f^l_{\;\;i}\, \partial^h f^i_{\;\;l} + \frac{1}{6}\, t_2\, \partial_h f^l_{\;\;i}\, \partial^h f^i_{\;\;l} -$$

$$\frac{1}{3}\, t_1\, \partial^{a'} f_{a'}^{\;\;a}\, \partial^h f_{ha} + \frac{2}{3}\, t_3\, \partial^{a'} f_{a'}^{\;\;a}\, \partial^h f_{ha} - \frac{1}{3}\, t_1\, \mathcal{A}_{j\;\;l}^{\;\;l}\, \partial^h f_h^{\;\;j} + \frac{2}{3}\, t_3\, \mathcal{A}_{j\;\;l}^{\;\;l}\, \partial^h f_h^{\;\;j} - \frac{1}{3}\, t_1\, \mathcal{A}^{la}_{\;\;\;\;a}\, \partial^h f_{hl} +$$

$$\frac{2}{3}\, t_3\, \mathcal{A}^{la}_{\;\;\;\;a}\, \partial^h f_{hl} - \frac{1}{3}\, t_1\, \partial^a f_h^{\;\;l}\, \partial^h f_{la} + \frac{1}{6}\, t_2\, \partial^a f_h^{\;\;l}\, \partial^h f_{la} + \frac{2}{3}\, t_1\, \mathcal{A}_{jh}^{\;\;\;l}\, \partial^h f_l^{\;\;j} - \frac{1}{3}\, t_2\, \mathcal{A}_{jh}^{\;\;\;l}\, \partial^h f_l^{\;\;j} +$$

$$\frac{1}{3}\, t_1\, \partial_h f_j^{\;\;l}\, \partial^h f_l^{\;\;j} - \frac{1}{6}\, t_2\, \partial_h f_j^{\;\;l}\, \partial^h f_l^{\;\;j} - \frac{2}{3}\, r_2\, \partial^{a'} \mathcal{A}^{\;\;al}_i\, \partial_l \mathcal{A}_{aa'}^{\;\;\;\;i} + \frac{2}{3}\, r_2\, \partial^{a'} \mathcal{A}^{\;\;la}_i\, \partial_l \mathcal{A}_{aa'}^{\;\;\;\;i}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2\,k^2\,t_{\bullet\,3} & i\,\sqrt{2}\,k\,t_{\bullet\,3} & 0 \\ -i\,\sqrt{2}\,k\,t_{\bullet\,3} & t_{\bullet\,3} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2\,r_{\bullet\,2}+t_{\bullet\,2} \right), \begin{pmatrix} \frac{1}{3}\,k^2\left(t_{\bullet\,1}+t_{\bullet\,2}\right) & -\frac{i\,k\left(t_{\bullet\,1}-2\,t_{\bullet\,2}\right)}{3\,\sqrt{2}} & \frac{1}{3}\,i\,k\left(t_{\bullet\,1}+t_{\bullet\,2}\right) \\ \frac{i\,k\left(t_{\bullet\,1}-2\,t_{\bullet\,2}\right)}{3\,\sqrt{2}} & \frac{1}{6}\left(t_{\bullet\,1}+4\,t_{\bullet\,2}\right) & \frac{-t_{\bullet\,1}+2\,t_{\bullet\,2}}{3\,\sqrt{2}} \\ -\frac{1}{3}\,i\,k\left(t_{\bullet\,1}+t_{\bullet\,2}\right) & \frac{-t_{\bullet\,1}+2\,t_{\bullet\,2}}{3\,\sqrt{2}} & \frac{t_{\bullet\,1}+t_{\bullet\,2}}{3} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2}{3}\,k^2\left(t_{\bullet\,1}+t_{\bullet\,3}\right) & -\frac{1}{3}\,i\,k\left(t_{\bullet\,1}-2\,t_{\bullet\,3}\right) & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\left(t_{\bullet\,1}+t_{\bullet\,3}\right) \\ \frac{1}{3}\,i\,k\left(t_{\bullet\,1}-2\,t_{\bullet\,3}\right) & \frac{1}{6}\left(t_{\bullet\,1}+4\,t_{\bullet\,3}\right) & 0 & \frac{t_{\bullet\,1}-2\,t_{\bullet\,3}}{3\,\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\left(t_{\bullet\,1}+t_{\bullet\,3}\right) & \frac{t_{\bullet\,1}-2\,t_{\bullet\,3}}{3\,\sqrt{2}} & 0 & \frac{t_{\bullet\,1}+t_{\bullet\,3}}{3} \end{pmatrix}, \begin{pmatrix} k^2\,t_{\bullet\,1} & \frac{i\,k\,t_{\bullet\,1}}{\sqrt{2}} \\ -\frac{i\,k\,t_{\bullet\,1}}{\sqrt{2}} & \frac{t_{\bullet\,1}}{2} \end{pmatrix}, \left(\frac{t_{\bullet\,1}}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\|} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\|},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}},\ i\,{}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\ -i\,{}^{2^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 2\,k\,{}^{2^+}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \frac{2\,k^2}{\left(1+2\,k^2\right)^2\,t_{\bullet\,3}} & \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet\,3}} & 0 \\ -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet\,3}} & \frac{1}{\left(1+2\,k^2\right)^2\,t_{\bullet\,3}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2\,r_{\bullet\,2}+t_{\bullet\,2}} \right), \begin{pmatrix} \frac{k^2\left(t_{\bullet\,1}+4\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,2}} & \frac{i\,\sqrt{2}\,k\left(t_{\bullet\,1}-2\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)\,t_{\bullet\,1}\,t_{\bullet\,2}} & \frac{i\,k\left(t_{\bullet\,1}+4\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,2}} \\ -\frac{i\,\sqrt{2}\,k\left(t_{\bullet\,1}-2\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)\,t_{\bullet\,1}\,t_{\bullet\,2}} & \frac{2\left(t_{\bullet\,1}+t_{\bullet\,2}\right)}{3\,t_{\bullet\,1}\,t_{\bullet\,2}} & \frac{\sqrt{2}\left(t_{\bullet\,1}-2\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)\,t_{\bullet\,1}\,t_{\bullet\,2}} \\ -\frac{i\,k\left(t_{\bullet\,1}+4\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,2}} & \frac{\sqrt{2}\left(t_{\bullet\,1}-2\,t_{\bullet\,2}\right)}{3\left(1+k^2\right)\,t_{\bullet\,1}\,t_{\bullet\,2}} & \frac{t_{\bullet\,1}+4\,t_{\bullet\,2}}{3\left(1+k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,2}} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2\,k^2\left(t_{\bullet\,1}+4\,t_{\bullet\,3}\right)}{3\left(1+2\,k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,3}} & \frac{2\,i\,k\,t_{\bullet\,1}-4\,i\,k\,t_{\bullet\,3}}{3\,t_{\bullet\,1}\,t_{\bullet\,3}+6\,k^2\,t_{\bullet\,1}\,t_{\bullet\,3}} & 0 & -\frac{i\,\sqrt{2}\,k\left(t_{\bullet\,1}+4\,t_{\bullet\,3}\right)}{3\left(1+2\,k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,3}} \\ -\frac{2\,i\,k\,t_{\bullet\,1}-4\,i\,k\,t_{\bullet\,3}}{3\,t_{\bullet\,1}\,t_{\bullet\,3}+6\,k^2\,t_{\bullet\,1}\,t_{\bullet\,3}} & \frac{2\left(t_{\bullet\,1}+t_{\bullet\,3}\right)}{3\,t_{\bullet\,1}\,t_{\bullet\,3}} & 0 & -\frac{\sqrt{2}\left(t_{\bullet\,1}-2\,t_{\bullet\,3}\right)}{3\left(1+2\,k^2\right)\,t_{\bullet\,1}\,t_{\bullet\,3}} \\ 0 & 0 & 0 & 0 \\ \frac{i\,\sqrt{2}\,k\left(t_{\bullet\,1}+4\,t_{\bullet\,3}\right)}{3\left(1+2\,k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,3}} & -\frac{\sqrt{2}\left(t_{\bullet\,1}-2\,t_{\bullet\,3}\right)}{3\left(1+2\,k^2\right)\,t_{\bullet\,1}\,t_{\bullet\,3}} & 0 & \frac{t_{\bullet\,1}+4\,t_{\bullet\,3}}{3\left(1+2\,k^2\right)^2\,t_{\bullet\,1}\,t_{\bullet\,3}} \end{pmatrix}, \begin{pmatrix} \frac{4\,k^2}{\left(1+2\,k^2\right)^2\,t_{\bullet\,1}} & \frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet\,1}} \\ -\frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet\,1}} & \frac{2}{\left(1+2\,k^2\right)^2\,t_{\bullet\,1}} \end{pmatrix}, \left(\frac{2}{t_{\bullet\,1}} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \left\{ -\frac{t_{\bullet\,2}}{r_{\bullet\,2}} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \left\{ -\frac{1}{r_{\bullet\,2}} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massless eigenvalues:

$$\{\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\bullet 2}},\ 0^-,\ -\frac{t_{\bullet 2}}{r_{\bullet 2}}\right\},\ \{\}\right\}$$

Overall unitarity conditions:

$$r_{\bullet 2} < 0 \,\&\&\, t_{\bullet 2} > 0$$

So, that's the end of the PSALTer output for this theory. You
 can check the particle content against TABLE IV. in arXiv:1910.14197.
 If you take the overall unitarity conditions from the final column in
 TABLE V., and decompose them using Mathematica's Reduce function, you
 get the following (to be compared with the PSALTer conditions above):

$$r_{\bullet 2} < 0 \,\&\&\, t_{\bullet 2} > 0$$

Okay, that concludes the analysis of this theory.

Case 21

Now for a new theory. Here is the full nonlinear Lagrangian for
 Case 21 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_{\bullet 2}\, \mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} - \frac{2}{3} r_{\bullet 2}\, \mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + \frac{1}{6} r_{\bullet 2}\, \mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} +$$

$$\frac{1}{4} t_{\bullet 1}\, \mathcal{T}_{ijh}\ \mathcal{T}^{ijh} + \frac{1}{2} t_{\bullet 1}\, \mathcal{T}^{ijh}\ \mathcal{T}_{jih} + \frac{1}{3}\left(t_{\bullet 1} - 2\, t_{\bullet 3}\right) \mathcal{T}^{i}{}_{i}{}^{j}\ \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
 this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_{\bullet 1}\, \mathcal{A}_{i}{}^{l}{}_{l}\ \mathcal{A}^{ij}{}_{j} + \frac{2}{3} t_{\bullet 3}\, \mathcal{A}_{i}{}^{l}{}_{l}\ \mathcal{A}^{ij}{}_{j} + t_{\bullet 1}\, \mathcal{A}_{ihj}\ \mathcal{A}^{ijh} + \frac{2}{3} r_{\bullet 2}\, \partial^{a'}\mathcal{A}^{ja}{}_{h}\ \partial_{j}\mathcal{A}_{aa'}{}^{h} -$$

$$\frac{1}{3} r_{\bullet 2}\, \partial_{j}\mathcal{A}_{aa'}{}^{h}\ \partial_{h}\mathcal{A}^{aa'j} - \frac{2}{3} r_{\bullet 2}\, \partial_{j}\mathcal{A}_{aa'}{}^{h}\ \partial_{h}\mathcal{A}^{jaa'} + \frac{1}{3} r_{\bullet 2}\, \partial_{h}\mathcal{A}^{aa'j}\ \partial^{h}\mathcal{A}_{aa'j} + \frac{2}{3} r_{\bullet 2}\, \partial_{h}\mathcal{A}^{jaa'}\ \partial^{h}\mathcal{A}_{aa'j} -$$

$$\frac{1}{2} t_{\bullet 1}\, \partial^{a}f_{jh}\ \partial^{h}f_{a}{}^{j} + \frac{1}{2} t_{\bullet 1}\, \partial^{a}f_{h}{}^{l}\ \partial^{h}f_{al} - \frac{1}{2} t_{\bullet 1}\, \partial^{a}f_{ih}\ \partial^{h}f^{i}{}_{a} + \frac{1}{3} t_{\bullet 1}\, \mathcal{A}_{h}{}^{a}{}_{a}\ \partial^{h}f^{i}{}_{i} - \frac{2}{3} t_{\bullet 3}\, \mathcal{A}_{h}{}^{a}{}_{a}\ \partial^{h}f^{i}{}_{i} +$$

$$\frac{1}{3} t_{\bullet 1}\, \mathcal{A}_{h}{}^{l}{}_{l}\ \partial^{h}f^{i}{}_{i} - \frac{2}{3} t_{\bullet 3}\, \mathcal{A}_{h}{}^{l}{}_{l}\ \partial^{h}f^{i}{}_{i} + \frac{2}{3} t_{\bullet 1}\, \partial^{a}f_{ah}\ \partial^{h}f^{i}{}_{i} - \frac{4}{3} t_{\bullet 3}\, \partial^{a}f_{ah}\ \partial^{h}f^{i}{}_{i} - \frac{1}{3} t_{\bullet 1}\, \partial_{h}f^{l}{}_{l}\ \partial^{h}f^{i}{}_{i} +$$

$$\frac{2}{3} t_{\bullet 3}\, \partial_{h}f^{l}{}_{l}\ \partial^{h}f^{i}{}_{i} + t_{\bullet 1}\, \mathcal{A}^{l}{}_{hi}\ \partial^{h}f^{i}{}_{l} + \frac{1}{2} t_{\bullet 1}\, \partial_{h}f_{i}{}^{l}\ \partial^{h}f^{i}{}_{l} - \frac{1}{3} t_{\bullet 1}\, \partial^{a'}f_{a}{}^{a}\ \partial^{h}f_{ha} + \frac{2}{3} t_{\bullet 3}\, \partial^{a'}f_{a}{}^{a}\ \partial^{h}f_{ha} -$$

$$\frac{1}{3} t_{\bullet 1}\, \mathcal{A}_{j}{}^{l}{}_{l}\ \partial^{h}f_{h}{}^{j} + \frac{2}{3} t_{\bullet 3}\, \mathcal{A}_{j}{}^{l}{}_{l}\ \partial^{h}f_{h}{}^{j} - \frac{1}{3} t_{\bullet 1}\, \mathcal{A}^{la}{}_{a}\ \partial^{h}f_{hl} + \frac{2}{3} t_{\bullet 3}\, \mathcal{A}^{la}{}_{a}\ \partial^{h}f_{hl} - \frac{1}{2} t_{\bullet 1}\, \partial^{a}f_{h}{}^{l}\ \partial^{h}f_{la} +$$

$$t_{\bullet 1}\, \mathcal{A}_{jh}{}^{l}\ \partial^{h}f_{l}{}^{j} + \frac{1}{2} t_{\bullet 1}\, \partial_{h}f_{j}{}^{l}\ \partial^{h}f_{l}{}^{j} - \frac{2}{3} r_{\bullet 2}\, \partial^{a'}\mathcal{A}_{i}{}^{al}\ \partial_{l}\mathcal{A}_{aa'}{}^{i} + \frac{2}{3} r_{\bullet 2}\, \partial^{a'}\mathcal{A}_{i}{}^{la}\ \partial_{l}\mathcal{A}_{aa'}{}^{i}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
 the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2\,k^2\,t_3 & i\,\sqrt{2}\,k\,t_3 & 0 \\ -i\,\sqrt{2}\,k\,t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2\,r_2 - t_1 \right),\ \begin{pmatrix} 0 & -\frac{i\,k\,t_1}{\sqrt{2}} & 0 \\ \frac{i\,k\,t_1}{\sqrt{2}} & -\frac{t_1}{2} & -\frac{t_1}{\sqrt{2}} \\ 0 & -\frac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2}{3}\,k^2\left(t_1 + t_3\right) & -\frac{1}{3}\,i\,k\left(t_1 - 2\,t_3\right) & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\left(t_1 + t_3\right) \\ \frac{1}{3}\,i\,k\left(t_1 - 2\,t_3\right) & \frac{1}{6}\left(t_1 + 4\,t_3\right) & 0 & \frac{t_1 - 2\,t_3}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\left(t_1 + t_3\right) & \frac{t_1 - 2\,t_3}{3\sqrt{2}} & 0 & \frac{t_1 + t_3}{3} \end{pmatrix},\ \begin{pmatrix} k^2\,t_1 & \frac{i\,k\,t_1}{\sqrt{2}} \\ -\frac{i\,k\,t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix},\ \left(\frac{t_1}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}\!\tau^{\flat\|} == 2\,k\,{}^{0^+}\!\sigma^{\flat\|},\ -i\,{}^{1^+}\!\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == k\,{}^{1^+}\!\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}},\ i\,{}^{1^-}\!\tau^{\flat\|\,\mathfrak{a}} == 2\,k\,{}^{1^-}\!\sigma^{\flat\perp\,\mathfrak{a}},\ {}^{1^-}\!\tau^{\flat\perp\,\mathfrak{a}} == 0,\ -i\,{}^{2^+}\!\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 2\,k\,{}^{2^+}\!\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally

analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \frac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\ -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \frac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2\,r_2 - t_1} \right),\ \begin{pmatrix} \frac{k^2}{\left(1+k^2\right)^2 t_1} & -\frac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & \frac{i\,k}{\left(1+k^2\right)^2 t_1} \\ \frac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & 0 & -\frac{\sqrt{2}}{t_1 + k^2\,t_1} \\ -\frac{i\,k}{\left(1+k^2\right)^2 t_1} & -\frac{\sqrt{2}}{t_1 + k^2\,t_1} & \frac{1}{\left(1+k^2\right)^2 t_1} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2\,k^2\left(t_1 + 4\,t_3\right)}{3\left(1+2\,k^2\right)^2 t_1\,t_3} & \frac{2\,i\,k\,t_1 - 4\,i\,k\,t_3}{3\,t_1\,t_3 + 6\,k^2\,t_1\,t_3} & 0 & -\frac{i\,\sqrt{2}\,k\left(t_1 + 4\,t_3\right)}{3\left(1+2\,k^2\right)^2 t_1\,t_3} \\ -\frac{2\,i\,k\,t_1 - 4\,i\,k\,t_3}{3\,t_1\,t_3 + 6\,k^2\,t_1\,t_3} & \frac{2\left(t_1 + t_3\right)}{3\,t_1\,t_3} & 0 & -\frac{\sqrt{2}\left(t_1 - 2\,t_3\right)}{3\left(1+2\,k^2\right)t_1\,t_3} \\ 0 & 0 & 0 & 0 \\ \frac{i\,\sqrt{2}\,k\left(t_1 + 4\,t_3\right)}{3\left(1+2\,k^2\right)^2 t_1\,t_3} & -\frac{\sqrt{2}\left(t_1 - 2\,t_3\right)}{3\left(1+2\,k^2\right)t_1\,t_3} & 0 & \frac{t_1 + 4\,t_3}{3\left(1+2\,k^2\right)^2 t_1\,t_3} \end{pmatrix},\ \begin{pmatrix} \frac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\ -\frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \frac{2}{\left(1+2\,k^2\right)^2 t_1} \end{pmatrix},\ \left(\frac{2}{t_1} \right) \right\}$$

Square masses:

$$\left\{ 0,\ \left\{ \frac{t_1}{r_2} \right\},\ 0,\ 0,\ 0,\ 0 \right\}$$

Massive pole residues:

$$\left\{ 0,\ \left\{ -\frac{1}{r_2} \right\},\ 0,\ 0,\ 0,\ 0 \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\cdot 2}}, \; 0^-, \; \frac{t_{\cdot 1}}{r_{\cdot 2}}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$r_{\cdot 2} < 0 \,\&\&\, t_{\cdot 1} < 0$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$r_{\cdot 2} < 0 \,\&\&\, t_{\cdot 1} < 0$

Okay, that concludes the analysis of this theory.

Case 22

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 22 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_{\cdot 2} \, \mathcal{R}_{ijhl} \; \mathcal{R}^{ijhl} - \frac{2}{3} r_{\cdot 2} \, \mathcal{R}_{ihjl} \; \mathcal{R}^{ijhl} + \frac{1}{6} r_{\cdot 2} \, \mathcal{R}^{ijhl} \; \mathcal{R}_{hlij} +$$

$$\frac{1}{12}\left(4\, t_{\cdot 1} + t_{\cdot 2}\right) \mathcal{T}_{ijh} \; \mathcal{T}^{ijh} + \frac{1}{6}\left(2\, t_{\cdot 1} - t_{\cdot 2}\right) \mathcal{T}^{ijh} \; \mathcal{T}_{jih} + t_{\cdot 1} \, \mathcal{T}^{i}{}_{i}{}^{j} \; \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_{\cdot 1} \, \mathcal{A}_{i}{}^{l}{}_{l} \; \mathcal{A}^{ij}{}_{j} + \frac{1}{3} t_{\cdot 1} \, \mathcal{A}_{ijh} \; \mathcal{A}^{ijh} + \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ijh} \; \mathcal{A}^{ijh} + \frac{1}{3} t_{\cdot 1} \, \mathcal{A}_{ihj} \; \mathcal{A}^{ijh} - \frac{2}{3} t_{\cdot 2} \, \mathcal{A}_{ihj} \; \mathcal{A}^{ijh} +$$

$$\frac{2}{3} r_{\cdot 2} \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_{j}\mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_{\cdot 2} \, \partial_{j}\mathcal{A}_{aa'}{}^{h} \, \partial_{h}\mathcal{A}^{aa'j} - \frac{2}{3} r_{\cdot 2} \, \partial_{j}\mathcal{A}_{aa'}{}^{h} \, \partial_{h}\mathcal{A}^{jaa'} + \frac{1}{3} r_{\cdot 2} \, \partial_{h}\mathcal{A}^{aa'j} \, \partial^{h}\mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_{\cdot 2} \, \partial_{h}\mathcal{A}^{jaa'} \, \partial^{h}\mathcal{A}_{aa'j} - \frac{1}{3} t_{\cdot 1} \, \partial^{a}f_{jh} \, \partial^{h}f_{a}{}^{j} + \frac{1}{6} t_{\cdot 2} \, \partial^{a}f_{jh} \, \partial^{h}f_{a}{}^{j} + \frac{1}{3} t_{\cdot 1} \, \partial^{a}f_{h} \, \partial^{h}f_{al} - \frac{1}{6} t_{\cdot 2} \, \partial^{a}f_{h} \, \partial^{h}f_{al} +$$

$$\frac{1}{3} t_{\cdot 1} \, \mathcal{A}_{ih}{}^{a} \, \partial^{h}f^{i}{}_{a} + \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ih}{}^{a} \, \partial^{h}f^{i}{}_{a} - \frac{2}{3} t_{\cdot 1} \, \partial^{a}f_{ih} \, \partial^{h}f^{i}{}_{a} - \frac{1}{6} t_{\cdot 2} \, \partial^{a}f_{ih} \, \partial^{h}f^{i}{}_{a} + t_{\cdot 1} \, \mathcal{A}_{h}{}^{a}{}_{a} \, \partial^{h}f^{i}{}_{i} +$$

$$t_{\cdot 1} \, \mathcal{A}_{h}{}^{l}{}_{l} \, \partial^{h}f^{i}{}_{i} + 2\, t_{\cdot 1} \, \partial^{a}f_{ah} \, \partial^{h}f^{i}{}_{i} - t_{\cdot 1} \, \partial_{h}f^{l}{}_{l} \, \partial^{h}f^{i}{}_{i} - \frac{1}{3} t_{\cdot 1} \, \mathcal{A}_{ijh} \, \partial^{h}f^{ij} - \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ijh} \, \partial^{h}f^{ij} +$$

$$\frac{1}{3} t_{\cdot 1} \, \mathcal{A}_{ih}{}^{l} \, \partial^{h}f^{i}{}_{l} + \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ih}{}^{l} \, \partial^{h}f^{i}{}_{l} - \frac{1}{3} t_{\cdot 1} \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^{h}f^{i}{}_{l} - \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^{h}f^{i}{}_{l} + \frac{2}{3} t_{\cdot 1} \, \mathcal{A}^{l}{}_{hi} \, \partial^{h}f^{i}{}_{l} -$$

$$\frac{1}{3} t_{\cdot 2} \, \mathcal{A}^{l}{}_{hi} \, \partial^{h}f^{i}{}_{l} + \frac{2}{3} t_{\cdot 1} \, \partial_{h}f^{l}{}_{i} \, \partial^{h}f^{i}{}_{l} + \frac{1}{6} t_{\cdot 2} \, \partial_{h}f^{l}{}_{i} \, \partial^{h}f^{i}{}_{l} - t_{\cdot 1} \, \partial^{a'}f_{a}{}^{a} \, \partial^{h}f_{ha} - t_{\cdot 1} \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^{h}f_{h}{}^{j} -$$

$$t_{\cdot 1} \, \mathcal{A}^{la}{}_{a} \, \partial^{h}f_{hl} - \frac{1}{3} t_{\cdot 1} \, \partial^{a}f_{h}{}^{l} \, \partial^{h}f_{la} + \frac{1}{6} t_{\cdot 2} \, \partial^{a}f_{h}{}^{l} \, \partial^{h}f_{la} + \frac{2}{3} t_{\cdot 1} \, \mathcal{A}_{jh}{}^{l} \, \partial^{h}f_{l}{}^{j} - \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{jh}{}^{l} \, \partial^{h}f_{l}{}^{j} +$$

$$\frac{1}{3} t_{\cdot 1} \, \partial_{h}f_{j}{}^{l} \, \partial^{h}f_{l}{}^{j} - \frac{1}{6} t_{\cdot 2} \, \partial_{h}f_{j}{}^{l} \, \partial^{h}f_{l}{}^{j} - \frac{2}{3} r_{\cdot 2} \, \partial^{a'}\mathcal{A}_{i}{}^{al} \, \partial_{l}\mathcal{A}_{aa'}{}^{i} + \frac{2}{3} r_{\cdot 2} \, \partial^{a'}\mathcal{A}_{i}{}^{la} \, \partial_{l}\mathcal{A}_{aa'}{}^{i}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2\,k^2\,t_{\cdot 1} & -i\,\sqrt{2}\,k\,t_{\cdot 1} & 0 \\ i\,\sqrt{2}\,k\,t_{\cdot 1} & -t_{\cdot 1} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2\,r_{\cdot 2}+t_{\cdot 2} \right), \right.$$

$$\begin{pmatrix} \frac{1}{3}\,k^2\left(t_{\cdot 1}+t_{\cdot 2}\right) & -\frac{i\,k\left(t_{\cdot 1}-2\,t_{\cdot 2}\right)}{3\,\sqrt{2}} & \frac{1}{3}\,i\,k\left(t_{\cdot 1}+t_{\cdot 2}\right) \\ \frac{i\,k\left(t_{\cdot 1}-2\,t_{\cdot 2}\right)}{3\,\sqrt{2}} & \frac{1}{6}\left(t_{\cdot 1}+4\,t_{\cdot 2}\right) & \frac{-t_{\cdot 1}+2\,t_{\cdot 2}}{3\,\sqrt{2}} \\ -\frac{1}{3}\,i\,k\left(t_{\cdot 1}+t_{\cdot 2}\right) & \frac{-t_{\cdot 1}+2\,t_{\cdot 2}}{3\,\sqrt{2}} & \frac{t_{\cdot 1}+t_{\cdot 2}}{3} \end{pmatrix}, \begin{pmatrix} 0 & -i\,k\,t_{\cdot 1} & 0 & 0 \\ i\,k\,t_{\cdot 1} & -\frac{t_{\cdot 1}}{2} & 0 & \frac{t_{\cdot 1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{t_{\cdot 1}}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \begin{pmatrix} k^2\,t_{\cdot 1} & \frac{i\,k\,t_{\cdot 1}}{\sqrt{2}} \\ -\frac{i\,k\,t_{\cdot 1}}{\sqrt{2}} & \frac{t_{\cdot 1}}{2} \end{pmatrix}, \left(\frac{t_{\cdot 1}}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{\flat\perp}==0,\ -i\,{}^{0^+}\!\tau^{\flat\|}==2\,k\,{}^{0^+}\!\sigma^{\flat\|},\ -i\,{}^{1^+}\!\tau^{\flat\|\,ab}==k\,{}^{1^+}\!\sigma^{b\perp\,ab},\ i\,{}^{1^-}\!\tau^{\flat\|\,a}==2\,k\,{}^{1^-}\!\sigma^{\flat\perp\,a},\ {}^{1^-}\!\tau^{\flat\perp\,a}==0,\ -i\,{}^{2^+}\!\tau^{\flat\|\,ab}==2\,k\,{}^{2^+}\!\sigma^{\flat\|\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\frac{2\,k^2}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & 0 \\ \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & -\frac{1}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2\,r_{\cdot 2}+t_{\cdot 2}} \right), \right.$$

$$\begin{pmatrix} \frac{k^2\left(t_{\cdot 1}+4\,t_{\cdot 2}\right)}{3\left(1+k^2\right)^2 t_{\cdot 1}\,t_{\cdot 2}} & \frac{i\,\sqrt{2}\,k\left(t_{\cdot 1}-2\,t_{\cdot 2}\right)}{3\left(1+k^2\right)t_{\cdot 1}\,t_{\cdot 2}} & \frac{i\,k\left(t_{\cdot 1}+4\,t_{\cdot 2}\right)}{3\left(1+k^2\right)^2 t_{\cdot 1}\,t_{\cdot 2}} \\ -\frac{i\,\sqrt{2}\,k\left(t_{\cdot 1}-2\,t_{\cdot 2}\right)}{3\left(1+k^2\right)t_{\cdot 1}\,t_{\cdot 2}} & \frac{2\left(t_{\cdot 1}+t_{\cdot 2}\right)}{3\,t_{\cdot 1}\,t_{\cdot 2}} & \frac{\sqrt{2}\left(t_{\cdot 1}-2\,t_{\cdot 2}\right)}{3\left(1+k^2\right)t_{\cdot 1}\,t_{\cdot 2}} \\ -\frac{i\,k\left(t_{\cdot 1}+4\,t_{\cdot 2}\right)}{3\left(1+k^2\right)^2 t_{\cdot 1}\,t_{\cdot 2}} & \frac{\sqrt{2}\left(t_{\cdot 1}-2\,t_{\cdot 2}\right)}{3\left(1+k^2\right)t_{\cdot 1}\,t_{\cdot 2}} & \frac{t_{\cdot 1}+4\,t_{\cdot 2}}{3\left(1+k^2\right)^2 t_{\cdot 1}\,t_{\cdot 2}} \end{pmatrix},$$

$$\begin{pmatrix} \frac{2\,k^2}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & -\frac{2\,i\,k}{t_{\cdot 1}+2\,k^2\,t_{\cdot 1}} & 0 & -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} \\ \frac{2\,i\,k}{t_{\cdot 1}+2\,k^2\,t_{\cdot 1}} & 0 & 0 & \frac{\sqrt{2}}{t_{\cdot 1}+2\,k^2\,t_{\cdot 1}} \\ 0 & 0 & 0 & 0 \\ \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & \frac{\sqrt{2}}{t_{\cdot 1}+2\,k^2\,t_{\cdot 1}} & 0 & \frac{1}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} \end{pmatrix}, \begin{pmatrix} \frac{4\,k^2}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & \frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} \\ -\frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} & \frac{2}{\left(1+2\,k^2\right)^2 t_{\cdot 1}} \end{pmatrix}, \left(\frac{2}{t_{\cdot 1}} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \left\{ -\frac{t_{\cdot 2}}{r_{\cdot 2}} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \left\{ -\frac{1}{r_{\cdot 2}} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{2}}, 0^{-}, -\frac{t_{2}}{r_{2}}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$$r_{2} < 0 \,\&\&\, t_{2} > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_{2} < 0 \,\&\&\, t_{2} > 0$$

Okay, that concludes the analysis of this theory.

Case 23

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 23 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_{2}\, \mathcal{R}_{ijhl}\, \mathcal{R}^{ijhl} - \frac{2}{3} r_{2}\, \mathcal{R}_{ihjl}\, \mathcal{R}^{ijhl} + \frac{1}{6} r_{2}\, \mathcal{R}^{ijhl}\, \mathcal{R}_{hlij} +$$

$$\frac{1}{12}\left(-4\,r_{2} + t_{2}\right) \mathcal{T}_{ijh}\, \mathcal{T}^{ijh} + \frac{1}{6}\left(-2\,r_{2} - t_{2}\right)\mathcal{T}^{ijh}\, \mathcal{T}_{jih} - r_{2}\, \mathcal{T}^{i\ j}_{\ i}\, \mathcal{T}^{h}_{\ jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$r_{2}\, \mathcal{A}_{i\ l}^{\ l}\, \mathcal{A}^{ij}_{\ j} - \frac{1}{3} r_{2}\, \mathcal{A}_{ijh}\, \mathcal{A}^{ijh} + \frac{1}{3} t_{2}\, \mathcal{A}_{ijh}\, \mathcal{A}^{ijh} - \frac{1}{3} r_{2}\, \mathcal{A}_{ihj}\, \mathcal{A}^{ijh} - \frac{2}{3} t_{2}\, \mathcal{A}_{ihj}\, \mathcal{A}^{ijh} +$$

$$\frac{2}{3} r_{2}\, \partial^{a'}\mathcal{A}^{ja}_{\ \ h}\, \partial_{j}\mathcal{A}_{aa'}^{\ \ \ h} - \frac{1}{3} r_{2}\, \partial_{j}\mathcal{A}_{aa'}^{\ \ \ h}\, \partial_{h}\mathcal{A}^{aa'j} - \frac{2}{3} r_{2}\, \partial_{j}\mathcal{A}_{aa'}^{\ \ \ h}\, \partial_{h}\mathcal{A}^{jaa'} + \frac{1}{3} r_{2}\, \partial_{h}\mathcal{A}^{aa'j}\, \partial^{h}\mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_{2}\, \partial_{h}\mathcal{A}^{jaa'}\, \partial^{h}\mathcal{A}_{aa'j} + \frac{1}{3} r_{2}\, \partial^{a}f_{jh}\, \partial^{h}f_{a}^{\ j} + \frac{1}{6} t_{2}\, \partial^{a}f_{jh}\, \partial^{h}f_{a}^{\ j} - \frac{1}{3} r_{2}\, \partial^{a}f_{h}^{\ l}\, \partial^{h}f_{al} - \frac{1}{6} t_{2}\, \partial^{a}f_{h}^{\ l}\, \partial^{h}f_{al} -$$

$$\frac{1}{3} r_{2}\, \mathcal{A}_{ih}^{\ \ a}\, \partial^{h}f_{a}^{\ i} + \frac{1}{3} t_{2}\, \mathcal{A}_{ih}^{\ \ a}\, \partial^{h}f_{a}^{\ i} + \frac{2}{3} r_{2}\, \partial^{a}f_{ih}\, \partial^{h}f_{a}^{\ i} - \frac{1}{6} t_{2}\, \partial^{a}f_{ih}\, \partial^{h}f_{a}^{\ i} - r_{2}\, \mathcal{A}_{h\ a}^{\ a}\, \partial^{h}f_{\ i}^{i} -$$

$$r_{2}\, \mathcal{A}_{h\ l}^{\ l}\, \partial^{h}f_{\ i}^{i} - 2\,r_{2}\, \partial^{a}f_{ah}\, \partial^{h}f_{\ i}^{i} + r_{2}\, \partial_{h}f_{\ l}^{l}\, \partial^{h}f_{\ i}^{i} + \frac{1}{3} r_{2}\, \mathcal{A}_{ijh}\, \partial^{h}f^{ij} - \frac{1}{3} t_{2}\, \mathcal{A}_{ijh}\, \partial^{h}f^{ij} -$$

$$\frac{1}{3} r_{2}\, \mathcal{A}_{ih}^{\ \ l}\, \partial^{h}f_{\ l}^{i} + \frac{1}{3} t_{2}\, \mathcal{A}_{ih}^{\ \ l}\, \partial^{h}f_{\ l}^{i} + \frac{1}{3} r_{2}\, \mathcal{A}_{\ ih}^{l}\, \partial^{h}f_{\ l}^{i} - \frac{1}{3} t_{2}\, \mathcal{A}_{\ ih}^{l}\, \partial^{h}f_{\ l}^{i} - \frac{2}{3} r_{2}\, \mathcal{A}^{l}_{\ hi}\, \partial^{h}f_{\ l}^{i} -$$

$$\frac{1}{3} t_{2}\, \mathcal{A}^{l}_{\ hi}\, \partial^{h}f_{\ l}^{i} - \frac{2}{3} r_{2}\, \partial_{h}f_{\ i}^{l}\, \partial^{h}f_{\ l}^{i} + \frac{1}{6} t_{2}\, \partial_{h}f_{\ i}^{l}\, \partial^{h}f_{\ l}^{i} + r_{2}\, \partial^{a'}f_{a'}^{\ a}\, \partial^{h}f_{ha} + r_{2}\, \mathcal{A}_{j\ l}^{\ l}\, \partial^{h}f_{h}^{\ j} +$$

$$r_{2}\, \mathcal{A}^{la}_{\ \ a}\, \partial^{h}f_{hl} + \frac{1}{3} r_{2}\, \partial^{a}f_{h}^{\ l}\, \partial^{h}f_{la} + \frac{1}{6} t_{2}\, \partial^{a}f_{h}^{\ l}\, \partial^{h}f_{la} - \frac{2}{3} r_{2}\, \mathcal{A}_{jh}^{\ \ l}\, \partial^{h}f_{\ l}^{j} - \frac{1}{3} t_{2}\, \mathcal{A}_{jh}^{\ \ l}\, \partial^{h}f_{\ l}^{j} -$$

$$\frac{1}{3} r_{2}\, \partial_{h}f_{j}^{\ l}\, \partial^{h}f_{\ l}^{j} - \frac{1}{6} t_{2}\, \partial_{h}f_{j}^{\ l}\, \partial^{h}f_{\ l}^{j} - \frac{2}{3} r_{2}\, \partial^{a'}\mathcal{A}_{i}^{\ al}\, \partial_{l}\mathcal{A}_{aa'}^{\ \ \ i} + \frac{2}{3} r_{2}\, \partial^{a'}\mathcal{A}_{i}^{\ la}\, \partial_{l}\mathcal{A}_{aa'}^{\ \ \ i}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 2\,k^2\,r_{\bullet\atop 2} & i\,\sqrt{2}\,k\,r_{\bullet\atop 2} & 0 \\ -i\,\sqrt{2}\,k\,r_{\bullet\atop 2} & r_{\bullet\atop 2} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2\,r_{\bullet\atop 2}+t_{\bullet\atop 2}\right),\right.$$

$$\begin{pmatrix} \frac{1}{3}\,k^2\left(-r_{\bullet\atop 2}+t_{\bullet\atop 2}\right) & \frac{i\,k\left(r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}\right)}{3\,\sqrt{2}} & -\frac{1}{3}\,i\,k\left(r_{\bullet\atop 2}-t_{\bullet\atop 2}\right) \\ -\frac{i\,k\left(r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}\right)}{3\,\sqrt{2}} & \frac{1}{6}\left(-r_{\bullet\atop 2}+4\,t_{\bullet\atop 2}\right) & \frac{r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}}{3\,\sqrt{2}} \\ \frac{1}{3}\,i\,k\left(r_{\bullet\atop 2}-t_{\bullet\atop 2}\right) & \frac{r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}}{3\,\sqrt{2}} & \frac{1}{3}\left(-r_{\bullet\atop 2}+t_{\bullet\atop 2}\right) \end{pmatrix},\ \begin{pmatrix} 0 & i\,k\,r_{\bullet\atop 2} & 0 & 0 \\ -i\,k\,r_{\bullet\atop 2} & \frac{r_{\bullet\atop 2}}{2} & 0 & -\frac{r_{\bullet\atop 2}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & -\frac{r_{\bullet\atop 2}}{\sqrt{2}} & 0 & 0 \end{pmatrix},\ \begin{pmatrix} -k^2\,r_{\bullet\atop 2} & -\frac{i\,k\,r_{\bullet\atop 2}}{\sqrt{2}} \\ \frac{i\,k\,r_{\bullet\atop 2}}{\sqrt{2}} & -\frac{r_{\bullet\atop 2}}{2} \end{pmatrix},\ \left(-\frac{r_{\bullet\atop 2}}{2}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\|} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\|},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\|\,ab} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab},\ i\,{}^{1^-}_{\bullet}\tau^{\flat\|\,a} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0,\ -i\,{}^{2^+}_{\bullet}\tau^{\flat\|\,ab} == 2\,k\,{}^{2^+}_{\bullet}\sigma^{\flat\|\,ab}\right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} \frac{2\,k^2}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & 0 \\ -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & \frac{1}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2\,r_{\bullet\atop 2}+t_{\bullet\atop 2}}\right),\ \begin{pmatrix} \frac{k^2\left(r_{\bullet\atop 2}-4\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)^2\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} & \frac{i\,\sqrt{2}\,k\left(r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} & \frac{i\,k\left(r_{\bullet\atop 2}-4\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)^2\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} \\ -\frac{i\,\sqrt{2}\,k\left(r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} & \frac{2}{3}\left(-\frac{1}{r_{\bullet\atop 2}}+\frac{1}{t_{\bullet\atop 2}}\right) & \frac{\sqrt{2}\left(r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} \\ -\frac{i\,k\left(r_{\bullet\atop 2}-4\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)^2\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} & \frac{\sqrt{2}\left(r_{\bullet\atop 2}+2\,t_{\bullet\atop 2}\right)}{3\left(1+k^2\right)\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} & \frac{r_{\bullet\atop 2}-4\,t_{\bullet\atop 2}}{3\left(1+k^2\right)^2\,r_{\bullet\atop 2}\,t_{\bullet\atop 2}} \end{pmatrix},\right.$$

$$\begin{pmatrix} -\frac{2\,k^2}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & \frac{2\,i\,k}{r_{\bullet\atop 2}+2\,k^2\,r_{\bullet\atop 2}} & 0 & \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} \\ -\frac{2\,i\,k}{r_{\bullet\atop 2}+2\,k^2\,r_{\bullet\atop 2}} & 0 & 0 & -\frac{\sqrt{2}}{r_{\bullet\atop 2}+2\,k^2\,r_{\bullet\atop 2}} \\ 0 & 0 & 0 & 0 \\ -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & -\frac{\sqrt{2}}{r_{\bullet\atop 2}+2\,k^2\,r_{\bullet\atop 2}} & 0 & -\frac{1}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} \end{pmatrix},\ \begin{pmatrix} -\frac{4\,k^2}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & -\frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} \\ \frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} & -\frac{2}{\left(1+2\,k^2\right)^2\,r_{\bullet\atop 2}} \end{pmatrix},\ \left(-\frac{2}{r_{\bullet\atop 2}}\right)\right\}$$

Square masses:

$$\left\{\{\},\ \left\{-\frac{t_{\bullet\atop 2}}{r_{\bullet\atop 2}}\right\},\ \{\},\ \{\},\ \{\},\ \{\}\right\}$$

Massive pole residues:

$$\left\{\{\},\ \left\{-\frac{1}{r_{\bullet\atop 2}}\right\},\ \{\},\ \{\},\ \{\},\ \{\}\right\}$$

Massless eigenvalues:

$\{\}$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2}, \; 0^-, \; -\frac{t_2}{r_2}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$$r_2 < 0 \,\&\&\, t_2 > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \,\&\&\, t_1 < 0$$

Okay, that concludes the analysis of this theory.

Case 24

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 24 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_5 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}^{l}{}_{jhl} + \frac{1}{6} r_2 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} -$$

$$r_5 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}^{l}{}_{hjl} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} - \frac{2}{3} t_3 \, \mathcal{T}^{i}{}_{i}{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \, \mathcal{A}_{i}{}^{l}{}_{l} \, \mathcal{A}^{ij}{}_{j} + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - r_5 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_l{}^a{}_a +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} - r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{jhl} +$$

$$r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{hlj} + 2 r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^j - \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a -$$

$$\frac{2}{3} t_3 \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i - \frac{2}{3} t_3 \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i - \frac{4}{3} t_3 \, \partial^a f_{ah} \, \partial^h f^i{}_i + \frac{2}{3} t_3 \, \partial_h f^l{}_l \, \partial^h f^i{}_i - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} +$$

$$\frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial_h f_i{}^l \, \partial^h f^i{}_l + \frac{2}{3} t_3 \, \partial^{a'} f_{a'}{}^a \, \partial^h f_{ha} +$$

$$\frac{2}{3} t_3 \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} + \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{la} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{6} t_2 \, \partial_h f_j{}^l \, \partial^h f^j{}_l -$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i + r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial^l \mathcal{A}^{jh}{}_h - r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
2\,k^2\,t_{\bullet 3} & i\,\sqrt{2}\,k\,t_{\bullet 3} & 0 \\
-i\,\sqrt{2}\,k\,t_{\bullet 3} & t_{\bullet 3} & 0 \\
0 & 0 & 0
\end{pmatrix},
\left(k^2\,r_{\bullet 2} + t_{\bullet 2}\right),
\begin{pmatrix}
\dfrac{k^2\,t_{\bullet 2}}{3} & \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet 2} & \dfrac{i\,k\,t_{\bullet 2}}{3} \\
-\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet 2} & \dfrac{1}{2}\left(2\,k^2\,r_{\bullet 5} + \dfrac{4\,t_{\bullet 2}}{3}\right) & \dfrac{\sqrt{2}\,t_{\bullet 2}}{3} \\
-\dfrac{1}{3}\,i\,k\,t_{\bullet 2} & \dfrac{\sqrt{2}\,t_{\bullet 2}}{3} & \dfrac{t_{\bullet 2}}{3}
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
\dfrac{2\,k^2\,t_{\bullet 3}}{3} & \dfrac{2\,i\,k\,t_{\bullet 3}}{3} & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet 3} \\
-\dfrac{2}{3}\,i\,k\,t_{\bullet 3} & k^2\,r_{\bullet 5} + \dfrac{2\,t_{\bullet 3}}{3} & 0 & -\dfrac{\sqrt{2}\,t_{\bullet 3}}{3} \\
0 & 0 & 0 & 0 \\
\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet 3} & -\dfrac{\sqrt{2}\,t_{\bullet 3}}{3} & 0 & \dfrac{t_{\bullet 3}}{3}
\end{pmatrix},
\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},
(0)\right\}
$$

Gauge constraints on source currents:

$$
\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\parallel},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel\,ab} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab},\right.
$$

$$
\left. i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel\,a} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a},\ {}^{1^+}_{\bullet}\tau^{\flat\perp\,a} == 0,\ {}^{2^+}_{\bullet}\sigma^{\flat\parallel\,ab} == 0,\ {}^{2^+}_{\bullet}\tau^{\flat\parallel\,ab} == 0,\ {}^{2^-}_{\bullet}\sigma^{\flat\parallel\,abc} == 0\right\}
$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_{\bullet 3}} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\bullet 3}} & 0 \\
-\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\bullet 3}} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_{\bullet 3}} & 0 \\
0 & 0 & 0
\end{pmatrix},
\left(\dfrac{1}{k^2\,r_{\bullet 2} + t_{\bullet 2}}\right),
\right.
$$

$$
\begin{pmatrix}
\dfrac{3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 2}}{\left(1+k^2\right)^2 r_{\bullet 5}\,t_{\bullet 2}} & -\dfrac{i\,\sqrt{2}}{k\,r_{\bullet 5} + k^3\,r_{\bullet 5}} & \dfrac{i\left(3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 2}\right)}{k\left(1+k^2\right)^2 r_{\bullet 5}\,t_{\bullet 2}} \\
\dfrac{i\,\sqrt{2}}{k\,r_{\bullet 5} + k^3\,r_{\bullet 5}} & \dfrac{1}{k^2\,r_{\bullet 5}} & -\dfrac{\sqrt{2}}{k^2\,r_{\bullet 5} + k^4\,r_{\bullet 5}} \\
-\dfrac{i\left(3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 2}\right)}{k\left(1+k^2\right)^2 r_{\bullet 5}\,t_{\bullet 2}} & -\dfrac{\sqrt{2}}{k^2\,r_{\bullet 5} + k^4\,r_{\bullet 5}} & \dfrac{3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 2}}{\left(k + k^3\right)^2 r_{\bullet 5}\,t_{\bullet 2}}
\end{pmatrix},
$$

$$
\begin{pmatrix}
\dfrac{6\,k^2\,r_{\bullet 5} + 4\,t_{\bullet 3}}{\left(1+2\,k^2\right)^2 r_{\bullet 5}\,t_{\bullet 3}} & -\dfrac{2\,i}{k\,r_{\bullet 5} + 2\,k^3\,r_{\bullet 5}} & 0 & -\dfrac{i\,\sqrt{2}\left(3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 3}\right)}{k\left(1+2\,k^2\right)^2 r_{\bullet 5}\,t_{\bullet 3}} \\
\dfrac{2\,i}{k\,r_{\bullet 5} + 2\,k^3\,r_{\bullet 5}} & \dfrac{1}{k^2\,r_{\bullet 5}} & 0 & \dfrac{\sqrt{2}}{k^2\,r_{\bullet 5} + 2\,k^4\,r_{\bullet 5}} \\
0 & 0 & 0 & 0 \\
\dfrac{i\,\sqrt{2}\left(3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 3}\right)}{k\left(1+2\,k^2\right)^2 r_{\bullet 5}\,t_{\bullet 3}} & \dfrac{\sqrt{2}}{k^2\,r_{\bullet 5} + 2\,k^4\,r_{\bullet 5}} & 0 & \dfrac{3\,k^2\,r_{\bullet 5} + 2\,t_{\bullet 3}}{\left(k + 2\,k^3\right)^2 r_{\bullet 5}\,t_{\bullet 3}}
\end{pmatrix},
\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},
(0)\right\}
$$

Square masses:

$$
\left\{\{\},\ \left\{-\dfrac{t_{\bullet 2}}{r_{\bullet 2}}\right\},\ \{\},\ \{\},\ \{\},\ \{\}\right\}
$$

Massive pole residues:

$$
\left\{\{\},\ \left\{-\dfrac{1}{r_{\bullet 2}}\right\},\ \{\},\ \{\},\ \{\},\ \{\}\right\}
$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\cdot 2}}, \, \mathbb{0}^-, \, -\frac{t_{\cdot 2}}{r_{\cdot 2}}\right\}, \, \{\}\right\}$$

Overall unitarity conditions:

$$r_{\cdot 2} < 0 \,\&\&\, t_{\cdot 2} > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_{\cdot 2} < 0 \,\&\&\, t_{\cdot 2} > 0$$

Okay, that concludes the analysis of this theory.

Case 25

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 25 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_{\cdot 2} \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_{\cdot 2} \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \frac{1}{6} r_{\cdot 2} \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$\frac{1}{12} t_{\cdot 2} \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_{\cdot 2} \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} - \frac{2}{3} t_{\cdot 3} \, \mathcal{T}^i{}_{i}{}^{j} \, \mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_{\cdot 3} \, \mathcal{A}_i{}^l{}_l \, \mathcal{A}^{ij}{}_j + \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_{\cdot 2} \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + \frac{2}{3} r_{\cdot 2} \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_{\cdot 2} \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_{\cdot 2} \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} + \frac{1}{3} r_{\cdot 2} \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_{\cdot 2} \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_{\cdot 2} \, \partial^a f_{jh} \, \partial f_a{}^j -$$

$$\frac{1}{6} t_{\cdot 2} \, \partial^a f_h{}^l \, \partial^h f_{al} + \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a - \frac{1}{6} t_{\cdot 2} \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{2}{3} t_{\cdot 3} \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i - \frac{2}{3} t_{\cdot 3} \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i -$$

$$\frac{4}{3} t_{\cdot 3} \, \partial^a f_{ah} \, \partial^h f^i{}_i + \frac{2}{3} t_{\cdot 3} \, \partial_h f^l{}_l \, \partial^h f^i{}_i - \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l -$$

$$\frac{1}{3} t_{\cdot 2} \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l + \frac{1}{6} t_{\cdot 2} \, \partial_h f_i{}^l \, \partial^h f^i{}_l + \frac{2}{3} t_{\cdot 3} \, \partial^a f_{a'}{}^a \, \partial^h f_{ha} + \frac{2}{3} t_{\cdot 3} \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j + \frac{2}{3} t_{\cdot 3} \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} +$$

$$\frac{1}{6} t_{\cdot 2} \, \partial^a f_h{}^l \, \partial^h f_{la} - \frac{1}{3} t_{\cdot 2} \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{6} t_{\cdot 2} \, \partial_h f_j{}^l \, \partial^h f_l{}^j - \frac{2}{3} r_{\cdot 2} \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_{\cdot 2} \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 2\,k^2\,t_{\bullet\,3} & i\,\sqrt{2}\,k\,t_{\bullet\,3} & 0 \\ -i\,\sqrt{2}\,k\,t_{\bullet\,3} & t_{\bullet\,3} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2\,r_{\bullet\,2} + t_{\bullet\,2}\right),\right.$$

$$\begin{pmatrix} \frac{k^2\,t_{\bullet\,2}}{3} & \frac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet\,2} & \frac{i\,k\,t_{\bullet\,2}}{3} \\ -\frac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet\,2} & \frac{2\,t_{\bullet\,2}}{3} & \frac{\sqrt{2}\,t_{\bullet\,2}}{3} \\ -\frac{1}{3}\,i\,k\,t_{\bullet\,2} & \frac{\sqrt{2}\,t_{\bullet\,2}}{3} & \frac{t_{\bullet\,2}}{3} \end{pmatrix},\ \begin{pmatrix} \frac{2\,k^2\,t_{\bullet\,3}}{3} & \frac{2\,i\,k\,t_{\bullet\,3}}{3} & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet\,3} \\ -\frac{2}{3}\,i\,k\,t_{\bullet\,3} & \frac{2\,t_{\bullet\,3}}{3} & 0 & -\frac{\sqrt{2}\,t_{\bullet\,3}}{3} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet\,3} & -\frac{\sqrt{2}\,t_{\bullet\,3}}{3} & 0 & \frac{t_{\bullet\,3}}{3} \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},\ (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\|} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\|},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\|\,ab} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\|\,ab} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\|\,ab},\right.$$

$$\left. i\,{}^{1^-}_{\bullet}\tau^{\flat\|\,a} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0,\ -i\,{}^{1^-}_{\bullet}\tau^{\flat\|\,a} == k\,{}^{1^-}_{\bullet}\sigma^{\flat\|\,a},\ {}^{2^+}_{\bullet}\sigma^{\flat\|\,ab} == 0,\ {}^{2^+}_{\bullet}\tau^{\flat\|\,ab} == 0,\ {}^{2^-}_{\bullet}\sigma^{\flat\|\,abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
   analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \frac{2\,k^2}{(1+2\,k^2)^2\,t_{\bullet\,3}} & \frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\,3}} & 0 \\ -\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\,3}} & \frac{1}{(1+2\,k^2)^2\,t_{\bullet\,3}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2\,r_{\bullet\,2}+t_{\bullet\,2}}\right),\ \begin{pmatrix} \frac{3\,k^2}{(3+k^2)^2\,t_{\bullet\,2}} & \frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_{\bullet\,2}} & \frac{3\,i\,k}{(3+k^2)^2\,t_{\bullet\,2}} \\ -\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_{\bullet\,2}} & \frac{6}{(3+k^2)^2\,t_{\bullet\,2}} & \frac{3\,\sqrt{2}}{(3+k^2)^2\,t_{\bullet\,2}} \\ -\frac{3\,i\,k}{(3+k^2)^2\,t_{\bullet\,2}} & \frac{3\,\sqrt{2}}{(3+k^2)^2\,t_{\bullet\,2}} & \frac{3}{(3+k^2)^2\,t_{\bullet\,2}} \end{pmatrix},\right.$$

$$\left. \begin{pmatrix} \frac{6\,k^2}{(3+2\,k^2)^2\,t_{\bullet\,3}} & \frac{6\,i\,k}{(3+2\,k^2)^2\,t_{\bullet\,3}} & 0 & -\frac{3\,i\,\sqrt{2}\,k}{(3+2\,k^2)^2\,t_{\bullet\,3}} \\ -\frac{6\,i\,k}{(3+2\,k^2)^2\,t_{\bullet\,3}} & \frac{6}{(3+2\,k^2)^2\,t_{\bullet\,3}} & 0 & -\frac{3\,\sqrt{2}}{(3+2\,k^2)^2\,t_{\bullet\,3}} \\ 0 & 0 & 0 & 0 \\ \frac{3\,i\,\sqrt{2}\,k}{(3+2\,k^2)^2\,t_{\bullet\,3}} & -\frac{3\,\sqrt{2}}{(3+2\,k^2)^2\,t_{\bullet\,3}} & 0 & \frac{3}{(3+2\,k^2)^2\,t_{\bullet\,3}} \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},\ (0) \right\}$$

Square masses:

$$\left\{ \{\},\ \left\{ -\frac{t_{\bullet\,2}}{r_{\bullet\,2}} \right\},\ \{\},\ \{\},\ \{\},\ \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\},\ \left\{ -\frac{1}{r_{\bullet\,2}} \right\},\ \{\},\ \{\},\ \{\},\ \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2}, \; 0^-, \; -\frac{t_2}{r_2^2}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$$r_2 < 0 \;\&\&\; t_2 > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \;\&\&\; t_2 > 0$$

Okay, that concludes the analysis of this theory.

Case 26

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 26 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \frac{1}{6} r_2 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^j -$$

$$\frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} +$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial_h f_i{}^l \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{la} -$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{6} t_2 \, \partial_h f_j{}^l \, \partial^h f_l{}^j - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 + t_2\right), \; \begin{pmatrix} \dfrac{k^2 t_2}{3} & \dfrac{1}{3} i \sqrt{2}\, k t_2 & \dfrac{i k t_2}{3} \\[2mm] -\dfrac{1}{3} i \sqrt{2}\, k t_2 & \dfrac{2 t_2}{3} & \dfrac{\sqrt{2}\, t_2}{3} \\[2mm] -\dfrac{1}{3} i k t_2 & \dfrac{\sqrt{2}\, t_2}{3} & \dfrac{t_2}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ \overset{0^+}{\underset{\bullet}{\tau}}{}^{\flat\perp} == 0,\ \overset{0^+}{\underset{\bullet}{\sigma}}{}^{\flat\parallel} == 0,\ \overset{0^+}{\underset{\bullet}{\tau}}{}^{\flat\parallel} == 0,\ -i\ \overset{1^+}{\underset{\bullet}{\tau}}{}^{\flat\parallel\,ab} == k\ \overset{1^+}{\underset{\bullet}{\sigma}}{}^{\flat\perp\,ab},\ -i\ \overset{1^+}{\underset{\bullet}{\tau}}{}^{\flat\parallel\,ab} == k\ \overset{1^+}{\underset{\bullet}{\sigma}}{}^{\flat\parallel\,ab}, \right.$$

$$\left. \overset{1^-}{\underset{\bullet}{\sigma}}{}^{\flat\perp\,a} == 0,\ \overset{1^-}{\underset{\bullet}{\tau}}{}^{\flat\perp\,a} == 0,\ \overset{1^-}{\underset{\bullet}{\sigma}}{}^{\flat\parallel\,a} == 0,\ \overset{1^-}{\underset{\bullet}{\tau}}{}^{\flat\parallel\,a} == 0,\ \overset{2^+}{\underset{\bullet}{\sigma}}{}^{\flat\parallel\,ab} == 0,\ \overset{2^+}{\underset{\bullet}{\tau}}{}^{\flat\parallel\,ab} == 0,\ \overset{2^-}{\underset{\bullet}{\sigma}}{}^{\flat\parallel\,abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2\,r_{\underset{2}{\bullet}} + t_{\underset{2}{\bullet}}} \right),\ \begin{pmatrix} \dfrac{3\,k^2}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} & \dfrac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} & \dfrac{3\,i\,k}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} \\[2ex] -\dfrac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} & \dfrac{6}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} & \dfrac{3\,\sqrt{2}}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} \\[2ex] -\dfrac{3\,i\,k}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} & \dfrac{3\,\sqrt{2}}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} & \dfrac{3}{(3+k^2)^2\,t_{\underset{2}{\bullet}}} \end{pmatrix},\ \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},\ (0) \right\}$$

Square masses:

$$\left\{ 0,\ \left\{ -\frac{t_{\underset{2}{\bullet}}}{r_{\underset{2}{\bullet}}} \right\},\ 0,\ 0,\ 0,\ 0 \right\}$$

Massive pole residues:

$$\left\{ 0,\ \left\{ -\frac{1}{r_{\underset{2}{\bullet}}} \right\},\ 0,\ 0,\ 0,\ 0 \right\}$$

Massless eigenvalues:

$$\{\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_{\underset{2}{\bullet}}},\ 0^-,\ -\frac{t_{\underset{2}{\bullet}}}{r_{\underset{2}{\bullet}}} \right\},\ 0 \right\}$$

Overall unitarity conditions:

$$r_{\underset{2}{\bullet}} < 0\ \&\&\ t_{\underset{2}{\bullet}} > 0$$

So, that's the end of the PSALTer output for this theory. You can check the particle content against TABLE IV. in arXiv:1910.14197. If you take the overall unitarity conditions from the final column in TABLE V., and decompose them using Mathematica's Reduce function, you get the following (to be compared with the PSALTer conditions above):

$$r_{\underset{2}{\bullet}} < 0\ \&\&\ t_{\underset{2}{\bullet}} > 0$$

Okay, that concludes the analysis of this theory.

Case 27

Now for a new theory. Here is the full nonlinear Lagrangian for Case 27 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\, r_2\, \mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} - \frac{2}{3}\, r_2\, \mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} + \frac{1}{6}\left(r_2 - 6\, r_3\right) \mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} +$$

$$r_3\, \mathcal{R}^{ij}{}_i{}^{h}\ \mathcal{R}^{l}{}_{h\,jl} + \frac{1}{12}\, t_2\, \mathcal{T}_{ijh}\ \mathcal{T}^{ijh} - \frac{1}{6}\, t_2\, \mathcal{T}^{ijh}\ \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3}\, t_2\, \mathcal{A}_{ijh}\ \mathcal{A}^{ijh} - \frac{2}{3}\, t_2\, \mathcal{A}_{ihj}\ \mathcal{A}^{ijh} + \frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}^{ja}{}_h\ \partial_j\mathcal{A}_{aa'}{}^h - \frac{1}{3}\, r_2\, \partial_j\mathcal{A}_{aa'}{}^h\ \partial_h\mathcal{A}^{aa'j} -$$

$$\frac{2}{3}\, r_2\, \partial_j\mathcal{A}_{aa'}{}^h\ \partial_h\mathcal{A}^{jaa'} + r_3\, \partial_a\mathcal{A}^{l}{}_{l\,j}\ \partial_h\mathcal{A}^{jhl} - r_3\, \partial_j\mathcal{A}^{l}{}_{l\,a}\ \partial_h\mathcal{A}^{jhl} + \frac{1}{3}\, r_2\, \partial_h\mathcal{A}^{aa'j}\ \partial^h\mathcal{A}_{aa'j} +$$

$$\frac{2}{3}\, r_2\, \partial_h\mathcal{A}^{jaa'}\ \partial^h\mathcal{A}_{aa'j} + \frac{1}{6}\, t_2\, \partial^a f_{jh}\ \partial^h f_a{}^{j} - \frac{1}{6}\, t_2\, \partial^a f_h{}^{l}\ \partial^h f_{al} + \frac{1}{3}\, t_2\, \mathcal{A}_{ih}{}^{a}\ \partial^h f^{i}{}_a -$$

$$\frac{1}{6}\, t_2\, \partial^a f_{ih}\ \partial^h f^{i}{}_a - \frac{1}{3}\, t_2\, \mathcal{A}_{ijh}\ \partial^h f^{ij} + \frac{1}{3}\, t_2\, \mathcal{A}_{ih}{}^{l}\ \partial^h f^{i}{}_l - \frac{1}{3}\, t_2\, \mathcal{A}^{l}{}_{i\,h}\ \partial^h f^{i}{}_l - \frac{1}{3}\, t_2\, \mathcal{A}^{l}{}_{hi}\ \partial^h f^{i}{}_l +$$

$$\frac{1}{6}\, t_2\, \partial_h f^{l}{}_i\ \partial^h f^{i}{}_l + \frac{1}{6}\, t_2\, \partial^a f_h{}^{l}\ \partial^h f_{la} - \frac{1}{3}\, t_2\, \mathcal{A}_{jh}{}^{l}\ \partial^h f^{j}{}_l - \frac{1}{6}\, t_2\, \partial_h f_j{}^{l}\ \partial^h f^{j}{}_l - \frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}_i{}^{al}\ \partial_l\mathcal{A}_{aa'}{}^{i} +$$

$$\frac{2}{3}\, r_2\, \partial^{a'}\mathcal{A}_i{}^{la}\ \partial_l\mathcal{A}_{aa'}{}^{i} - 4\, r_3\, \partial^{a'}\mathcal{A}_i{}^{la}\ \partial_l\mathcal{A}_{aa'}{}^{i} - r_3\, \partial_a\mathcal{A}^{l}{}_{l\,j}\ \partial^l\mathcal{A}^{jh}{}_h + r_3\, \partial_j\mathcal{A}^{l}{}_{l\,a}\ \partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2\, r_2 + t_2 \right),\ \begin{pmatrix} \frac{k^2\, t_2}{3} & \frac{1}{3}\, i\, \sqrt{2}\, k\, t_2 & \frac{i\, k\, t_2}{3} \\ -\frac{1}{3}\, i\, \sqrt{2}\, k\, t_2 & \frac{1}{2}\left(3\, k^2\, r_3 + \frac{4\, t_2}{3}\right) & \frac{\sqrt{2}\, t_2}{3} \\ -\frac{1}{3}\, i\, k\, t_2 & \frac{\sqrt{2}\, t_2}{3} & \frac{t_2}{3} \end{pmatrix},\ \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & -\frac{3\, k^2\, r_3}{2} \end{pmatrix},\ (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{b\perp} == 0,\ {}^{0^+}_{\bullet}\sigma^{b\parallel} == 0,\ {}^{0^+}_{\bullet}\tau^{b\parallel} == 0,\ -i\ {}^{1^+}_{\bullet}\tau^{b\parallel\,ab} == k\ {}^{1^+}_{\bullet}\sigma^{b\perp\,ab}, \right.$$

$$\left. {}^{1^-}_{\bullet}\sigma^{b\perp\,a} == 0,\ {}^{1^-}_{\bullet}\tau^{b\perp\,a} == 0,\ {}^{1^-}_{\bullet}\sigma^{b\parallel\,a} == 0,\ {}^{1^-}_{\bullet}\tau^{b\parallel\,a} == 0,\ {}^{2^+}_{\bullet}\tau^{b\parallel\,ab} == 0,\ {}^{2^-}_{\bullet}\sigma^{b\parallel\,abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2\, r_2 + t_2} \right),\ \begin{pmatrix} \frac{9\, k^2\, r_3 + 4\, t_2}{3\,(1+k^2)^2\, r_3\, t_2} & -\frac{2\, i\, \sqrt{2}}{3\, k\, r_3 + 3\, k^3\, r_3} & \frac{i\left(9\, k^2\, r_3 + 4\, t_2\right)}{3\, k\,(1+k^2)^2\, r_3\, t_2} \\ \frac{2\, i\, \sqrt{2}}{3\, k\, r_3 + 3\, k^3\, r_3} & \frac{2}{3\, k^2\, r_3} & -\frac{2\, \sqrt{2}}{3\, k^2\, r_3 + 3\, k^4\, r_3} \\ -\frac{i\left(9\, k^2\, r_3 + 4\, t_2\right)}{3\, k\,(1+k^2)^2\, r_3\, t_2} & -\frac{2\, \sqrt{2}}{3\, k^2\, r_3 + 3\, k^4\, r_3} & \frac{9\, k^2\, r_3 + 4\, t_2}{3\,(k+k^3)^2\, r_3\, t_2} \end{pmatrix},\ \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & -\frac{2}{3\, k^2\, r_3} \end{pmatrix},\ (0) \right\}$$

Square masses:

$$\left\{0, \left\{-\frac{t_2}{r_2}\right\}, 0, 0, 0, 0\right\}$$

Massive pole residues:

$$\left\{0, \left\{-\frac{1}{r_2}\right\}, 0, 0, 0, 0\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2}, 0^-, -\frac{t_2}{r_2}\right\}, 0\right\}$$

Overall unitarity conditions:

$r_2 < 0 \,\&\&\, t_2 > 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_2 < 0 \,\&\&\, t_2 > 0$

Okay, that concludes the analysis of this theory.

Case 28

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 28 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_5 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{j}{}^{l}{}_{hl} +$$

$$\frac{1}{6} r_2 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} - r_5 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_{\bullet 2} \mathcal{A}_{ijh} \mathcal{A}^{ijh} - \frac{2}{3} t_{\bullet 2} \mathcal{A}_{ihj} \mathcal{A}^{ijh} - r_{\bullet 5} \partial_i \mathcal{A}^{hl}{}_h \partial^i \mathcal{A}_{la}{}^a + \frac{2}{3} r_{\bullet 2} \partial^{a'} \mathcal{A}^{ja}{}_h \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_{\bullet 2} \partial_j \mathcal{A}_{aa'}{}^h \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_{\bullet 2} \partial_j \mathcal{A}_{aa'}{}^h \partial_h \mathcal{A}^{jaa'} - r_{\bullet 5} \partial_a \mathcal{A}_{lj}{}^a \partial_h \mathcal{A}^{jhl} + r_{\bullet 5} \partial_j \mathcal{A}_{la}{}^a \partial_h \mathcal{A}^{jhl} - r_{\bullet 5} \partial_a \mathcal{A}_{lj}{}^a \partial_h \mathcal{A}^{hlj} +$$

$$2 r_{\bullet 5} \partial_j \mathcal{A}_{la}{}^a \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_{\bullet 2} \partial_h \mathcal{A}^{aa'j} \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_{\bullet 2} \partial_h \mathcal{A}^{jaa'} \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_{\bullet 2} \partial^a f_{jh} \partial^h f_a{}^j -$$

$$\frac{1}{6} t_{\bullet 2} \partial^a f_h{}^l \partial^h f_{al} + \frac{1}{3} t_{\bullet 2} \mathcal{A}_{ih}{}^a \partial^h f^i{}_a - \frac{1}{6} t_{\bullet 2} \partial^a f_{ih} \partial^h f^i{}_a - \frac{1}{3} t_{\bullet 2} \mathcal{A}_{ijh} \partial^h f^{ij} + \frac{1}{3} t_{\bullet 2} \mathcal{A}_{ih}{}^l \partial^h f^i{}_l -$$

$$\frac{1}{3} t_{\bullet 2} \mathcal{A}_i{}^l{}_h \partial^h f^i{}_l - \frac{1}{3} t_{\bullet 2} \mathcal{A}^l{}_{hi} \partial^h f^i{}_l + \frac{1}{6} t_{\bullet 2} \partial_h f_i{}^l \partial^h f^i{}_l + \frac{1}{6} t_{\bullet 2} \partial^a f_h{}^l \partial^h f_{la} - \frac{1}{3} t_{\bullet 2} \mathcal{A}_{jh}{}^l \partial^h f^j{}_l -$$

$$\frac{1}{6} t_{\bullet 2} \partial_h f_j{}^l \partial^h f^j{}_l - \frac{2}{3} r_{\bullet 2} \partial^{a'} \mathcal{A}_i{}^{al} \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_{\bullet 2} \partial^{a'} \mathcal{A}_i{}^{la} \partial_l \mathcal{A}_{aa'}{}^i + r_{\bullet 5} \partial_a \mathcal{A}_{lj}{}^a \partial^l \mathcal{A}^{jh}{}_h - r_{\bullet 5} \partial_j \mathcal{A}_{la}{}^a \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_{\bullet 2} + t_{\bullet 2} \right), \; \begin{pmatrix} \frac{k^2 t_{\bullet 2}}{3} & \frac{1}{3} i \sqrt{2}\, k t_{\bullet 2} & \frac{i k t_{\bullet 2}}{3} \\ -\frac{1}{3} i \sqrt{2}\, k t_{\bullet 2} & \frac{1}{2}\left(2 k^2 r_{\bullet 5} + \frac{4 t_{\bullet 2}}{3} \right) & \frac{\sqrt{2}\, t_{\bullet 2}}{3} \\ -\frac{1}{3} i k t_{\bullet 2} & \frac{\sqrt{2}\, t_{\bullet 2}}{3} & \frac{t_{\bullet 2}}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & k^2 r_{\bullet 5} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{b\perp} == 0, \; {}^{0^+}_{\bullet}\sigma^{b\parallel} == 0, \; {}^{0^+}_{\bullet}\tau^{b\parallel} == 0, \; -i\, {}^{1^+}_{\bullet}\tau^{b\parallel} == k\, {}^{1^+}_{\bullet}\sigma^{b\perp ab}, \right.$$

$$\left. {}^{1^-}_{\bullet}\sigma^{b\perp a} == 0, \; {}^{1^-}_{\bullet}\tau^{b\perp a} == 0, \; {}^{1^-}_{\bullet}\tau^{b\parallel a} == 0, \; {}^{2^+}_{\bullet}\sigma^{b\parallel ab} == 0, \; {}^{2^+}_{\bullet}\tau^{b\parallel ab} == 0, \; {}^{2^-}_{\bullet}\sigma^{b\parallel abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(\frac{1}{k^2 r_{\bullet 2} + t_{\bullet 2}} \right), \; \begin{pmatrix} \frac{3 k^2 r_{\bullet 5} + 2 t_{\bullet 2}}{(1+k^2)^2 r_{\bullet 5} t_{\bullet 2}} & -\frac{i \sqrt{2}}{k r_{\bullet 5} + k^3 r_{\bullet 5}} & \frac{i\left(3 k^2 r_{\bullet 5} + 2 t_{\bullet 2} \right)}{k (1+k^2)^2 r_{\bullet 5} t_{\bullet 2}} \\ \frac{i \sqrt{2}}{k r_{\bullet 5} + k^3 r_{\bullet 5}} & \frac{1}{k^2 r_{\bullet 5}} & -\frac{\sqrt{2}}{k^2 r_{\bullet 5} + k^4 r_{\bullet 5}} \\ -\frac{i\left(3 k^2 r_{\bullet 5} + 2 t_{\bullet 2} \right)}{k (1+k^2)^2 r_{\bullet 5} t_{\bullet 2}} & -\frac{\sqrt{2}}{k^2 r_{\bullet 5} + k^4 r_{\bullet 5}} & \frac{3 k^2 r_{\bullet 5} + 2 t_{\bullet 2}}{(k+k^3)^2 r_{\bullet 5} t_{\bullet 2}} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{1}{k^2 r_{\bullet 5}} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; (0) \right\}$$

Square masses:

$$\left\{ 0, \; \left\{ -\frac{t_{\bullet 2}}{r_{\bullet 2}} \right\}, \; 0, \; 0, \; 0, \; 0 \right\}$$

Massive pole residues:

$$\left\{ 0, \; \left\{ -\frac{1}{r_{\bullet 2}} \right\}, \; 0, \; 0, \; 0, \; 0 \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\underset{2}{\bullet}}},\ 0^-,\ -\frac{t_{\underset{2}{\bullet}}}{r_{\underset{2}{\bullet}}}\right\},\ \{\}\right\}$$

Overall unitarity conditions:

$r_{\underset{2}{\bullet}} < 0\ \&\&\ t_{\underset{2}{\bullet}} > 0$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$r_{\underset{2}{\bullet}} < 0\ \&\&\ t_{\underset{2}{\bullet}} > 0$

Okay, that concludes the analysis of this theory.

Case 29

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 29 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{2}{\bullet}}\right)\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl}+\frac{2}{3}\left(r_{\underset{1}{\bullet}}-r_{\underset{2}{\bullet}}\right)\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl}-2\,r_{\underset{1}{\bullet}}\,\mathcal{R}^{ij\ h}_{\ \ i}\ \mathcal{R}^{\ \ l}_{j\ hl}+\frac{1}{6}\left(-4\,r_{\underset{1}{\bullet}}+r_{\underset{2}{\bullet}}\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij}+$$

$$2\,r_{\underset{1}{\bullet}}\,\mathcal{R}^{ij\ h}_{\ \ i}\ \mathcal{R}^{\ \ l}_{h\ jl}+\frac{1}{12}\,t_{\underset{2}{\bullet}}\,\mathcal{T}_{ijh}\ \mathcal{T}^{ijh}-\frac{1}{6}\,t_{\underset{2}{\bullet}}\,\mathcal{T}^{ijh}\ \mathcal{T}_{jih}-\frac{2}{3}\,t_{\underset{3}{\bullet}}\,\mathcal{T}^{i\ j}_{\ i}\ \mathcal{T}^{h}_{\ jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \, \mathcal{A}_i{}^l{}_l \, \mathcal{A}^{ij}{}_j + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + 2 r_1 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_l{}^a{}_a -$$

$$\frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} +$$

$$\frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} + 2 r_1 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{jhl} - 2 r_1 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{jhl} +$$

$$2 r_1 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{hlj} - 4 r_1 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} -$$

$$\frac{2}{3} r_1 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^j - \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{al} +$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{2}{3} t_3 \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i - \frac{2}{3} t_3 \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i - \frac{4}{3} t_3 \, \partial^a f_{ah} \, \partial^h f^i{}_i +$$

$$\frac{2}{3} t_3 \, \partial_h f^l{}_l \, \partial^h f^i{}_i - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l +$$

$$\frac{1}{6} t_2 \, \partial_h f_i{}^l \, \partial^h f^i{}_l + \frac{2}{3} t_3 \, \partial^{a'} f_a{}^a \, \partial^h f_{ha} + \frac{2}{3} t_3 \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} + \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{la} -$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{6} t_2 \, \partial_h f_j{}^l \, \partial^h f_l{}^j + \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i -$$

$$\frac{8}{3} r_1 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i - 2 r_1 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial^l \mathcal{A}^{jh}{}_h + 2 r_1 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2 k^2 t_3 & i \sqrt{2}\, k\, t_3 & 0 \\ -i \sqrt{2}\, k\, t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 + t_2 \right), \; \begin{pmatrix} \frac{k^2 t_2}{3} & \frac{1}{3} i \sqrt{2}\, k\, t_2 & \frac{i k t_2}{3} \\ -\frac{1}{3} i \sqrt{2}\, k\, t_2 & \frac{2 t_2}{3} & \frac{\sqrt{2}\, t_2}{3} \\ -\frac{1}{3} i k\, t_2 & \frac{\sqrt{2}\, t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2 k^2 t_3}{3} & \frac{2 i k t_3}{3} & 0 & -\frac{1}{3} i \sqrt{2}\, k\, t_3 \\ -\frac{2}{3} i k\, t_3 & -k^2 r_1 + \frac{2 t_3}{3} & 0 & -\frac{\sqrt{2}\, t_3}{3} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2}\, k\, t_3 & -\frac{\sqrt{2}\, t_3}{3} & 0 & \frac{t_3}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; \left(k^2 r_1 \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{b\perp} == 0, \; -i\, {}^{0^+}\!\tau^{b\|} == 2 k\, {}^{0^+}\!\sigma^{b\|}, \; -i\, {}^{1^+}\!\tau^{b\|}{}^{ab} == k\, {}^{1^+}\!\sigma^{b\perp}{}^{ab}, \right.$$

$$\left. -i\, {}^{1^+}\!\tau^{b\|}{}^{ab} == k\, {}^{1^+}\!\sigma^{b\|}{}^{ab}, \; i\, {}^{1^-}\!\tau^{b\|}{}^{a} == 2 k\, {}^{1^-}\!\sigma^{b\perp}{}^{a}, \; {}^{1^-}\!\tau^{b\perp}{}^{a} == 0, \; {}^{2^+}\!\sigma^{b\|}{}^{ab} == 0, \; {}^{2^+}\!\tau^{b\|}{}^{ab} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
   analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex] -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex] 0 & 0 & 0 \end{pmatrix}, \ \begin{pmatrix} \dfrac{1}{k^2\,r_2+t_2} \end{pmatrix}, \ \begin{pmatrix} \dfrac{3\,k^2}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,i\,\sqrt{2}\,k}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,i\,k}{\left(3+k^2\right)^2 t_2} \\[2ex] -\dfrac{3\,i\,\sqrt{2}\,k}{\left(3+k^2\right)^2 t_2} & \dfrac{6}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,\sqrt{2}}{\left(3+k^2\right)^2 t_2} \\[2ex] -\dfrac{3\,i\,k}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,\sqrt{2}}{\left(3+k^2\right)^2 t_2} & \dfrac{3}{\left(3+k^2\right)^2 t_2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{6\,k^2\,r_1-4\,t_3}{\left(1+2\,k^2\right)^2 r_1\,t_3} & \dfrac{2\,i}{k\,r_1+2\,k^3\,r_1} & 0 & -\dfrac{i\,\sqrt{2}\left(3\,k^2\,r_1-2\,t_3\right)}{k\left(1+2\,k^2\right)^2 r_1\,t_3} \\[2ex] -\dfrac{2\,i}{k\,r_1+2\,k^3\,r_1} & -\dfrac{1}{k^2\,r_1} & 0 & -\dfrac{\sqrt{2}}{k^2\,r_1+2\,k^4\,r_1} \\[2ex] 0 & 0 & 0 & 0 \\[2ex] \dfrac{i\,\sqrt{2}\left(3\,k^2\,r_1-2\,t_3\right)}{k\left(1+2\,k^2\right)^2 r_1\,t_3} & -\dfrac{\sqrt{2}}{k^2\,r_1+2\,k^4\,r_1} & 0 & \dfrac{3\,k^2\,r_1-2\,t_3}{\left(k+2\,k^3\right)^2 r_1\,t_3} \end{pmatrix}, \ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \ \begin{pmatrix} \dfrac{1}{k^2\,r_1} \end{pmatrix} \right\}$$

Square masses:

$$\left\{ \{\}, \ \left\{ -\dfrac{t_2}{r_2} \right\}, \ \{\}, \ \{\}, \ \{\}, \ \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \ \left\{ -\dfrac{1}{r_2} \right\}, \ \{\}, \ \{\}, \ \{\}, \ \{\} \right\}$$

Massless eigenvalues:

$\{\}$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2}, \ 0^-, \ -\dfrac{t_2}{r_2} \right\}, \ \{\} \right\}$$

Overall unitarity conditions:

$r_2 < 0 \,\&\&\, t_2 > 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_2 < 0 \,\&\&\, t_2 > 0$

Okay, that concludes the analysis of this theory.

Case 30

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 30 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\left(2\,r_1 + r_2\right)\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\left(r_1 - r_2\right)\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} - 2\,r_1\,\mathcal{R}^{ij\ h}_{\ \ i}\ \mathcal{R}^{\ \ l}_{j\ hl} +$$

$$\frac{1}{6}\left(-4\,r_1 + r_2\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} + 2\,r_1\,\mathcal{R}^{ij\ h}_{\ \ i}\ \mathcal{R}^{\ l}_{h\ jl} + \frac{1}{12}\,t_2\,\mathcal{T}_{ijh}\ \mathcal{T}^{ijh} - \frac{1}{6}\,t_2\,\mathcal{T}^{ijh}\ \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise

this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3}\,t_2\,\mathcal{A}_{ijh}\ \mathcal{A}^{ijh} - \frac{2}{3}\,t_2\,\mathcal{A}_{ihj}\ \mathcal{A}^{ijh} + 2\,r_1\,\partial_i\mathcal{A}^{h\ l}_{\ \ h}\ \partial^i\mathcal{A}^{\ \ q}_{l\ q} - \frac{2}{3}\,r_1\,\partial^{q'}\mathcal{A}^{jq}_{\ \ h}\ \partial_j\mathcal{A}^{\ \ h}_{qq'} +$$

$$\frac{2}{3}\,r_2\,\partial^{q'}\mathcal{A}^{jq}_{\ \ h}\ \partial_j\mathcal{A}^{\ \ h}_{qq'} - \frac{2}{3}\,r_1\,\partial_j\mathcal{A}^{\ \ h}_{qq'}\ \partial_h\mathcal{A}^{qq'j} - \frac{1}{3}\,r_2\,\partial_j\mathcal{A}^{\ \ h}_{qq'}\ \partial_h\mathcal{A}^{qq'j} + \frac{2}{3}\,r_1\,\partial_j\mathcal{A}^{\ \ h}_{qq'}\ \partial_h\mathcal{A}^{jqq'} -$$

$$\frac{2}{3}\,r_2\,\partial_j\mathcal{A}^{\ \ h}_{qq'}\ \partial_h\mathcal{A}^{jqq'} + 2\,r_1\,\partial_q\mathcal{A}^{\ \ q}_{l\ j}\ \partial_h\mathcal{A}^{jhl} - 2\,r_1\,\partial_j\mathcal{A}^{\ \ q}_{l\ q}\ \partial_h\mathcal{A}^{jhl} + 2\,r_1\,\partial_q\mathcal{A}^{\ \ q}_{l\ j}\ \partial_h\mathcal{A}^{hlj} -$$

$$4\,r_1\,\partial_j\mathcal{A}^{\ \ q}_{l\ q}\ \partial_h\mathcal{A}^{hlj} + \frac{2}{3}\,r_1\,\partial_h\mathcal{A}^{qq'j}\ \partial^h\mathcal{A}_{qq'j} + \frac{1}{3}\,r_2\,\partial_h\mathcal{A}^{qq'j}\ \partial^h\mathcal{A}_{qq'j} - \frac{2}{3}\,r_1\,\partial_h\mathcal{A}^{jqq'}\ \partial^h\mathcal{A}_{qq'j} +$$

$$\frac{2}{3}\,r_2\,\partial_h\mathcal{A}^{jqq'}\ \partial^h\mathcal{A}_{qq'j} + \frac{1}{6}\,t_2\,\partial^q f_{jh}\ \partial^h f^{\ j}_q - \frac{1}{6}\,t_2\,\partial^q f^{\ l}_h\ \partial^h f_{ql} + \frac{1}{3}\,t_2\,\mathcal{A}^{\ \ q}_{ih}\ \partial^h f^i_{\ q} - \frac{1}{6}\,t_2\,\partial^q f_{ih}\ \partial^h f^i_{\ q} -$$

$$\frac{1}{3}\,t_2\,\mathcal{A}_{ijh}\ \partial^h f^{ij} + \frac{1}{3}\,t_2\,\mathcal{A}^{\ \ l}_{ih}\ \partial^h f^i_{\ l} - \frac{1}{3}\,t_2\,\mathcal{A}^{\ l}_{i\ h}\ \partial^h f^i_{\ l} - \frac{1}{3}\,t_2\,\mathcal{A}^{\ l}_{hi}\ \partial^h f^i_{\ l} + \frac{1}{6}\,t_2\,\partial_h f^{\ l}_i\ \partial^h f^i_{\ l} +$$

$$\frac{1}{6}\,t_2\,\partial^q f^{\ l}_h\ \partial^h f_{lq} - \frac{1}{3}\,t_2\,\mathcal{A}^{\ \ l}_{jh}\ \partial^h f^{\ j}_l - \frac{1}{6}\,t_2\,\partial_h f^{\ l}_j\ \partial^h f^{\ j}_l + \frac{2}{3}\,r_1\,\partial^{q'}\mathcal{A}^{\ ql}_i\ \partial_l\mathcal{A}^{\ \ i}_{qq'} - \frac{2}{3}\,r_2\,\partial^{q'}\mathcal{A}^{\ ql}_i\ \partial_l\mathcal{A}^{\ \ i}_{qq'} -$$

$$\frac{8}{3}\,r_1\,\partial^{q'}\mathcal{A}^{\ lq}_i\ \partial_l\mathcal{A}^{\ \ i}_{qq'} + \frac{2}{3}\,r_2\,\partial^{q'}\mathcal{A}^{\ lq}_i\ \partial_l\mathcal{A}^{\ \ i}_{qq'} - 2\,r_1\,\partial_q\mathcal{A}^{\ \ q}_{l\ j}\ \partial^l\mathcal{A}^{jh}_{\ \ h} + 2\,r_1\,\partial_j\mathcal{A}^{\ \ q}_{l\ q}\ \partial^l\mathcal{A}^{jh}_{\ \ h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with

the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2\,r_2 + t_2\right), \begin{pmatrix} \dfrac{k^2\,t_2}{3} & \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_2 & \dfrac{i\,k\,t_2}{3} \\ -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_2 & \dfrac{2\,t_2}{3} & \dfrac{\sqrt{2}\,t_2}{3} \\ -\dfrac{1}{3}\,i\,k\,t_2 & \dfrac{\sqrt{2}\,t_2}{3} & \dfrac{t_2}{3} \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -k^2\,r_1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \left(k^2\,r_1\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_\bullet\tau^{b\perp} == 0,\ {}^{0^+}_\bullet\sigma^{b\|} == 0,\ {}^{0^+}_\bullet\tau^{b\|} == 0,\ -i\,{}^{1^+}_\bullet\tau^{b\|}{}^{qb} == k\,{}^{1^+}_\bullet\sigma^{b\perp\,qb},\right.$$

$$\left.-i\,{}^{1^+}_\bullet\tau^{b\|}{}^{qb} == k\,{}^{1^+}_\bullet\sigma^{b\|}{}^{qb},\ {}^{1^-}_\bullet\sigma^{b\perp\,q} == 0,\ {}^{1^-}_\bullet\tau^{b\perp\,q} == 0,\ {}^{1^-}_\bullet\tau^{b\|\,q} == 0,\ {}^{2^+}_\bullet\sigma^{b\|}{}^{qb} == 0,\ {}^{2^+}_\bullet\tau^{b\|}{}^{qb} == 0\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\dfrac{1}{k^2\,r_2 + t_2}\right), \begin{pmatrix} \dfrac{3\,k^2}{(3+k^2)^2\,t_2} & \dfrac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_2} & \dfrac{3\,i\,k}{(3+k^2)^2\,t_2} \\ -\dfrac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_2} & \dfrac{6}{(3+k^2)^2\,t_2} & \dfrac{3\,\sqrt{2}}{(3+k^2)^2\,t_2} \\ -\dfrac{3\,i\,k}{(3+k^2)^2\,t_2} & \dfrac{3\,\sqrt{2}}{(3+k^2)^2\,t_2} & \dfrac{3}{(3+k^2)^2\,t_2} \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -\dfrac{1}{k^2\,r_1} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \left(\dfrac{1}{k^2\,r_1}\right)\right\}$$

Square masses:

$$\left\{ \{\}, \left\{ -\frac{t_{\cdot 2}}{r_{\cdot 2}} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \left\{ -\frac{1}{r_{\cdot 2}} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massless eigenvalues:

$\{\}$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_{\cdot 2}}, \, 0^-, \, -\frac{t_{\cdot 2}}{r_{\cdot 2}} \right\}, \, \{\} \right\}$$

Overall unitarity conditions:

$r_{\cdot 2} < 0 \, \&\& \, t_{\cdot 2} > 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_{\cdot 2} < 0 \, \&\& \, t_{\cdot 2} > 0$

Okay, that concludes the analysis of this theory.

Case 31

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 31 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_{\cdot 2} \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_{\cdot 2} \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \frac{1}{6} \left(r_{\cdot 2} - 6 \, r_{\cdot 3} \right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$4 \, r_{\cdot 3} \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12} t_{\cdot 2} \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_{\cdot 2} \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_2 \mathcal{A}_{ijh} \mathcal{A}^{ijh} - \frac{2}{3} t_2 \mathcal{A}_{ihj} \mathcal{A}^{ijh} + \frac{2}{3} r_2 \partial^{a'} \mathcal{A}^{ja}{}_h \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_2 \partial_j \mathcal{A}_{aa'}{}^h \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_2 \partial_j \mathcal{A}_{aa'}{}^h \partial_h \mathcal{A}^{jaa'} + 4 r_3 \partial_a \mathcal{A}_l{}^a{}_j \partial_h \mathcal{A}^{jhl} - 4 r_3 \partial_j \mathcal{A}_l{}^a{}_a \partial_h \mathcal{A}^{jhl} + \frac{1}{3} r_2 \partial_h \mathcal{A}^{aa'j} \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_2 \partial_h \mathcal{A}^{jaa'} \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \partial^a f_{jh} \partial^h f_a{}^j - \frac{1}{6} t_2 \partial^a f_h{}^l \partial^h f_{al} + \frac{1}{3} t_2 \mathcal{A}_{ih}{}^a \partial^h f^i{}_a -$$

$$\frac{1}{6} t_2 \partial^a f_{ih} \partial^h f^i{}_a - \frac{1}{3} t_2 \mathcal{A}_{ijh} \partial^h f^{ij} + \frac{1}{3} t_2 \mathcal{A}_{ih}{}^l \partial^h f^i{}_l - \frac{1}{3} t_2 \mathcal{A}_i{}^l{}_h \partial^h f^i{}_l - \frac{1}{3} t_2 \mathcal{A}^l{}_{hi} \partial^h f^i{}_l +$$

$$\frac{1}{6} t_2 \partial_h f_i{}^l \partial^h f^i{}_l + \frac{1}{6} t_2 \partial^a f_h{}^l \partial^h f_{la} - \frac{1}{3} t_2 \mathcal{A}_{jh}{}^l \partial^h f^j{}_l - \frac{1}{6} t_2 \partial_h f_j{}^l \partial^h f_l{}^j - \frac{2}{3} r_2 \partial^{a'} \mathcal{A}_i{}^{al} \partial_l \mathcal{A}_{aa'}{}^i +$$

$$\frac{2}{3} r_2 \partial^{a'} \mathcal{A}_i{}^{la} \partial_l \mathcal{A}_{aa'}{}^i - 4 r_3 \partial^{a'} \mathcal{A}_i{}^{la} \partial_l \mathcal{A}_{aa'}{}^i - 4 r_3 \partial_a \mathcal{A}_l{}^a{}_j \partial^l \mathcal{A}^{jh}{}_h + 4 r_3 \partial_j \mathcal{A}_l{}^a{}_a \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with

the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6k^2 r_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2 r_2 + t_2 \right), \begin{pmatrix} \frac{k^2 t_2}{3} & \frac{1}{3} i \sqrt{2} k t_2 & \frac{ikt_2}{3} \\ -\frac{1}{3} i \sqrt{2} k t_2 & \frac{2 t_2}{3} & \frac{\sqrt{2} t_2}{3} \\ -\frac{1}{3} i k t_2 & \frac{\sqrt{2} t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\tau^{b\perp} == 0, \; {}^{0^+}\tau^{b\parallel} == 0, \; -i \; {}^{1^+}\tau^{b\parallel}{}^{ab} == k \; {}^{1^+}\sigma^{b\perp}{}^{ab}, \; -i \; {}^{1^+}\tau^{b\parallel}{}^{ab} == k \; {}^{1^+}\sigma^{b\parallel}{}^{ab}, \; {}^{1^-}\sigma^{b\perp}{}^{a} == 0, \right.$$

$$\left. {}^{1^-}\tau^{b\perp}{}^{a} == 0, \; {}^{1^-}\sigma^{b\parallel}{}^{a} == 0, \; {}^{1^-}\tau^{b\parallel}{}^{a} == 0, \; {}^{2^+}\sigma^{b\parallel}{}^{ab} == 0, \; {}^{2^+}\tau^{b\parallel}{}^{ab} == 0, \; {}^{2^-}\sigma^{b\parallel}{}^{abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{6k^2 r_3} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2 r_2 + t_2} \right), \begin{pmatrix} \frac{3k^2}{(3+k^2)^2 t_2} & \frac{3i\sqrt{2}k}{(3+k^2)^2 t_2} & \frac{3ik}{(3+k^2)^2 t_2} \\ -\frac{3i\sqrt{2}k}{(3+k^2)^2 t_2} & \frac{6}{(3+k^2)^2 t_2} & \frac{3\sqrt{2}}{(3+k^2)^2 t_2} \\ -\frac{3ik}{(3+k^2)^2 t_2} & \frac{3\sqrt{2}}{(3+k^2)^2 t_2} & \frac{3}{(3+k^2)^2 t_2} \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, (0) \right\}$$

Square masses:

$$\left\{ \{\}, \left\{ -\frac{t_2}{r_2} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \left\{ -\frac{1}{r_2} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\cdot 2}}, \ 0^-, \ -\frac{t_{\cdot 2}}{r_{\cdot 2}}\right\}, \ \{\}\right\}$$

Overall unitarity conditions:

$$r_{\cdot 2} < 0 \ \&\& \ t_{\cdot 2} > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_{\cdot 2} < 0 \ \&\& \ t_{\cdot 2} > 0$$

Okay, that concludes the analysis of this theory.

Case 32

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 32 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_{\cdot 2} \mathcal{R}_{ijhl} \ \mathcal{R}^{ijhl} - \frac{2}{3} r_{\cdot 2} \mathcal{R}_{ihjl} \ \mathcal{R}^{ijhl} + \frac{1}{6} r_{\cdot 2} \mathcal{R}^{ijhl} \ \mathcal{R}_{hlij} +$$

$$\frac{1}{12}\left(4 t_{\cdot 1} + t_{\cdot 2}\right) \mathcal{T}_{ijh} \ \mathcal{T}^{ijh} + \frac{1}{6}\left(2 t_{\cdot 1} - t_{\cdot 2}\right) \mathcal{T}^{ijh} \ \mathcal{T}_{jih} + \frac{1}{3} t_{\cdot 1} \mathcal{T}^i{}_i{}^j \ \mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_{\cdot 1} \mathcal{A}_i{}^l{}_l \ \mathcal{A}^{ij}{}_j + \frac{1}{3} t_{\cdot 1} \mathcal{A}_{ijh} \ \mathcal{A}^{ijh} + \frac{1}{3} t_{\cdot 2} \mathcal{A}_{ijh} \ \mathcal{A}^{ijh} + \frac{1}{3} t_{\cdot 1} \mathcal{A}_{ihj} \ \mathcal{A}^{ijh} - \frac{2}{3} t_{\cdot 2} \mathcal{A}_{ihj} \ \mathcal{A}^{ijh} +$$

$$\frac{2}{3} r_{\cdot 2} \partial^{a'} \mathcal{A}^{ja}{}_h \ \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_{\cdot 2} \partial_j \mathcal{A}_{aa'}{}^h \ \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_{\cdot 2} \partial_j \mathcal{A}_{aa'}{}^h \ \partial_h \mathcal{A}^{jaa'} + \frac{1}{3} r_{\cdot 2} \partial_h \mathcal{A}^{aa'j} \ \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_{\cdot 2} \partial_h \mathcal{A}^{jaa'} \ \partial^h \mathcal{A}_{aa'j} - \frac{1}{3} t_{\cdot 1} \partial^a f_{jh} \ \partial^h f_a{}^j + \frac{1}{6} t_{\cdot 2} \partial^a f_{jh} \ \partial^h f_a{}^j + \frac{1}{3} t_{\cdot 1} \partial^a f_h{}^l \ \partial^h f_{al} - \frac{1}{6} t_{\cdot 2} \partial^a f_h{}^l \ \partial^h f_{al} +$$

$$\frac{1}{3} t_{\cdot 1} \mathcal{A}_{ih}{}^a \ \partial^h f^i{}_a + \frac{1}{3} t_{\cdot 2} \mathcal{A}_{ih}{}^a \ \partial^h f^i{}_a - \frac{2}{3} t_{\cdot 1} \partial^a f_{ih} \ \partial^h f^i{}_a - \frac{1}{6} t_{\cdot 2} \partial^a f_{ih} \ \partial^h f^i{}_a + \frac{1}{3} t_{\cdot 1} \mathcal{A}_h{}^a{}_a \ \partial^h f^i{}_i +$$

$$\frac{1}{3} t_{\cdot 1} \mathcal{A}_h{}^l{}_l \ \partial^h f^i{}_i + \frac{2}{3} t_{\cdot 1} \partial^a f_{ah} \ \partial^h f^i{}_i - \frac{1}{3} t_{\cdot 1} \partial_h f^l{}_l \ \partial^h f^i{}_i - \frac{1}{3} t_{\cdot 1} \mathcal{A}_{ijh} \ \partial^h f^{ij} - \frac{1}{3} t_{\cdot 2} \mathcal{A}_{ijh} \ \partial^h f^{ij} +$$

$$\frac{1}{3} t_{\cdot 1} \mathcal{A}_{ih}{}^l \ \partial^h f^i{}_l + \frac{1}{3} t_{\cdot 2} \mathcal{A}_{ih}{}^l \ \partial^h f^i{}_l - \frac{1}{3} t_{\cdot 1} \mathcal{A}_i{}^l{}_h \ \partial^h f^i{}_l - \frac{1}{3} t_{\cdot 2} \mathcal{A}_i{}^l{}_h \ \partial^h f^i{}_l + \frac{2}{3} t_{\cdot 1} \mathcal{A}^l{}_{hi} \ \partial^h f^i{}_l -$$

$$\frac{1}{3} t_{\cdot 2} \mathcal{A}^l{}_{hi} \ \partial^h f^i{}_l + \frac{2}{3} t_{\cdot 1} \partial_h f_i{}^l \ \partial^h f^i{}_l + \frac{1}{6} t_{\cdot 2} \partial_h f_i{}^l \ \partial^h f^i{}_l - \frac{1}{3} t_{\cdot 1} \partial^{a'} f_{a'}{}^a \ \partial^h f_{ha} - \frac{1}{3} t_{\cdot 1} \mathcal{A}_j{}^l{}_l \ \partial^h f_h{}^j -$$

$$\frac{1}{3} t_{\cdot 1} \mathcal{A}^{la}{}_a \ \partial^h f_{hl} - \frac{1}{3} t_{\cdot 1} \partial^a f_h{}^l \ \partial^h f_{la} + \frac{1}{6} t_{\cdot 2} \partial^a f_h{}^l \ \partial^h f_{la} + \frac{2}{3} t_{\cdot 1} \mathcal{A}_{jh}{}^l \ \partial^h f_l{}^j - \frac{1}{3} t_{\cdot 2} \mathcal{A}_{jh}{}^l \ \partial^h f_l{}^j +$$

$$\frac{1}{3} t_{\cdot 1} \partial_h f_j{}^l \ \partial^h f_l{}^j - \frac{1}{6} t_{\cdot 2} \partial_h f_j{}^l \ \partial^h f_l{}^j - \frac{2}{3} r_{\cdot 2} \partial^{a'} \mathcal{A}_i{}^{al} \ \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_{\cdot 2} \partial^{a'} \mathcal{A}_i{}^{la} \ \partial_l \mathcal{A}_{aa'}{}^i$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2 r_2 + t_2\right),\ \begin{pmatrix} \frac{1}{3}k^2\left(t_1 + t_2\right) & -\frac{i k\left(t_1 - 2 t_2\right)}{3\sqrt{2}} & \frac{1}{3} i k\left(t_1 + t_2\right) \\ \frac{i k\left(t_1 - 2 t_2\right)}{3\sqrt{2}} & \frac{1}{6}\left(t_1 + 4 t_2\right) & \frac{-t_1 + 2 t_2}{3\sqrt{2}} \\ -\frac{1}{3} i k\left(t_1 + t_2\right) & \frac{-t_1 + 2 t_2}{3\sqrt{2}} & \frac{t_1 + t_2}{3} \end{pmatrix},\right.$$

$$\begin{pmatrix} \frac{2k^2 t_1}{3} & -\frac{1}{3} i k t_1 & 0 & -\frac{1}{3} i \sqrt{2}\, k t_1 \\ \frac{i k t_1}{3} & \frac{t_1}{6} & 0 & \frac{t_1}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2}\, k t_1 & \frac{t_1}{3\sqrt{2}} & 0 & \frac{t_1}{3} \end{pmatrix},\ \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix},\ \left(\frac{t_1}{2}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ {}^{0^+}_{\bullet}\sigma^{\flat\|} == 0,\ {}^{0^+}_{\bullet}\tau^{\flat\|} == 0,\ -i\, {}^{1^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == k\, {}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}},\right.$$

$$\left. i\, {}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2 k\, {}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\ i\, {}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2 k\, {}^{1^-}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}},\ -i\, {}^{2^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 2 k\, {}^{2^+}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}}\right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2 r_2 + t_2}\right),\ \begin{pmatrix} \frac{k^2\left(t_1 + 4 t_2\right)}{3\left(1+k^2\right)^2 t_1 t_2} & \frac{i \sqrt{2}\, k\left(t_1 - 2 t_2\right)}{3\left(1+k^2\right) t_1 t_2} & \frac{i k\left(t_1 + 4 t_2\right)}{3\left(1+k^2\right)^2 t_1 t_2} \\ -\frac{i \sqrt{2}\, k\left(t_1 - 2 t_2\right)}{3\left(1+k^2\right) t_1 t_2} & \frac{2\left(t_1 + t_2\right)}{3 t_1 t_2} & \frac{\sqrt{2}\left(t_1 - 2 t_2\right)}{3\left(1+k^2\right) t_1 t_2} \\ -\frac{i k\left(t_1 + 4 t_2\right)}{3\left(1+k^2\right)^2 t_1 t_2} & \frac{\sqrt{2}\left(t_1 - 2 t_2\right)}{3\left(1+k^2\right) t_1 t_2} & \frac{t_1 + 4 t_2}{3\left(1+k^2\right)^2 t_1 t_2} \end{pmatrix},\right.$$

$$\begin{pmatrix} \frac{24 k^2}{\left(3+4 k^2\right)^2 t_1} & -\frac{12 i k}{\left(3+4 k^2\right)^2 t_1} & 0 & -\frac{12 i \sqrt{2}\, k}{\left(3+4 k^2\right)^2 t_1} \\ \frac{12 i k}{\left(3+4 k^2\right)^2 t_1} & \frac{6}{\left(3+4 k^2\right)^2 t_1} & 0 & \frac{6\sqrt{2}}{\left(3+4 k^2\right)^2 t_1} \\ 0 & 0 & 0 & 0 \\ \frac{12 i \sqrt{2}\, k}{\left(3+4 k^2\right)^2 t_1} & \frac{6\sqrt{2}}{\left(3+4 k^2\right)^2 t_1} & 0 & \frac{12}{\left(3+4 k^2\right)^2 t_1} \end{pmatrix},\ \begin{pmatrix} \frac{4 k^2}{\left(1+2 k^2\right)^2 t_1} & \frac{2 i \sqrt{2}\, k}{\left(1+2 k^2\right)^2 t_1} \\ -\frac{2 i \sqrt{2}\, k}{\left(1+2 k^2\right)^2 t_1} & \frac{2}{\left(1+2 k^2\right)^2 t_1} \end{pmatrix},\ \left(\frac{2}{t_1}\right)\right\}$$

Square masses:

$$\left\{\{\},\ \left\{-\frac{t_2}{r_2}\right\},\ \{\},\ \{\},\ \{\},\ \{\}\right\}$$

Massive pole residues:

$$\left\{0, \left\{-\frac{1}{r_2}\right\}, 0, 0, 0, 0\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2}, 0^-, -\frac{t_2}{r_2}\right\}, 0\right\}$$

Overall unitarity conditions:

$$r_2 < 0 \,\&\&\, t_2 > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \,\&\&\, t_2 > 0$$

Okay, that concludes the analysis of this theory.

Case 33

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 33 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \frac{1}{6} r_2 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$\frac{1}{4} t_1 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} + \frac{1}{2} t_1 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} + \frac{1}{3} t_1 \, \mathcal{T}^{i}{}_{i}{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \, \mathcal{A}_{i}{}^{l}{}_{l} \, \mathcal{A}^{ij}{}_{j} + t_1 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} +$$

$$\frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{2} t_1 \, \partial^a f_{jh} \, \partial^h f_a{}^{j} + \frac{1}{2} t_1 \, \partial^a f_h{}^{l} \, \partial^h f_{al} -$$

$$\frac{1}{2} t_1 \, \partial^a f_{ih} \, \partial^h f^{i}{}_a + \frac{1}{3} t_1 \, \mathcal{A}_h{}^{a}{}_a \, \partial^h f^{i}{}_i + \frac{1}{3} t_1 \, \mathcal{A}_h{}^{l}{}_l \, \partial^h f^{i}{}_i + \frac{2}{3} t_1 \, \partial^a f_{ah} \, \partial^h f^{i}{}_i - \frac{1}{3} t_1 \, \partial_h f^{l}{}_l \, \partial^h f^{i}{}_i +$$

$$t_1 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_l + \frac{1}{2} t_1 \, \partial_h f^{i}{}_i \, \partial^h f^{i}{}_l - \frac{1}{3} t_1 \, \partial^{a'} f_a{}^{a} \, \partial^h f_{ha} - \frac{1}{3} t_1 \, \mathcal{A}_j{}^{l}{}_l \, \partial^h f_h{}^{j} - \frac{1}{3} t_1 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} -$$

$$\frac{1}{2} t_1 \, \partial^a f_h{}^{l} \, \partial^h f_{la} + t_1 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_l{}^{j} + \frac{1}{2} t_1 \, \partial_h f_j{}^{l} \, \partial^h f_l{}^{j} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2 r_2 - t_1\right), \begin{pmatrix} 0 & -\frac{i k t_1}{\sqrt{2}} & 0 \\ \frac{i k t_1}{\sqrt{2}} & -\frac{t_1}{2} & -\frac{t_1}{\sqrt{2}} \\ 0 & -\frac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \begin{pmatrix} \frac{2 k^2 t_1}{3} & -\frac{1}{3} i k t_1 & 0 & -\frac{1}{3} i \sqrt{2} k t_1 \\ \frac{i k t_1}{3} & \frac{t_1}{6} & 0 & \frac{t_1}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2} k t_1 & \frac{t_1}{3\sqrt{2}} & 0 & \frac{t_1}{3} \end{pmatrix}, \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \left(\frac{t_1}{2}\right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ {}^{0^+}_{\bullet}\sigma^{\flat\|} == 0,\ {}^{0^+}_{\bullet}\tau^{\flat\|} == 0,\ -i\ {}^{1^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\mathfrak{b}} == k\ {}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\mathfrak{b}}, \right.$$

$$\left. i\ {}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2 k\ {}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\ i\ {}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 2 k\ {}^{1^-}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}},\ -i\ {}^{2^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\mathfrak{b}} == 2 k\ {}^{2^+}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}\mathfrak{b}} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{k^2 r_2 - t_1}\right), \begin{pmatrix} \frac{k^2}{(1+k^2)^2 t_1} & -\frac{i \sqrt{2}\, k}{t_1 + k^2 t_1} & \frac{i k}{(1+k^2)^2 t_1} \\ \frac{i \sqrt{2}\, k}{t_1 + k^2 t_1} & 0 & -\frac{\sqrt{2}}{t_1 + k^2 t_1} \\ -\frac{i k}{(1+k^2)^2 t_1} & -\frac{\sqrt{2}}{t_1 + k^2 t_1} & \frac{1}{(1+k^2)^2 t_1} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{24 k^2}{(3+4 k^2)^2 t_1} & -\frac{12 i k}{(3+4 k^2)^2 t_1} & 0 & -\frac{12 i \sqrt{2}\, k}{(3+4 k^2)^2 t_1} \\ \frac{12 i k}{(3+4 k^2)^2 t_1} & \frac{6}{(3+4 k^2)^2 t_1} & 0 & \frac{6 \sqrt{2}}{(3+4 k^2)^2 t_1} \\ 0 & 0 & 0 & 0 \\ \frac{12 i \sqrt{2}\, k}{(3+4 k^2)^2 t_1} & \frac{6 \sqrt{2}}{(3+4 k^2)^2 t_1} & 0 & \frac{12}{(3+4 k^2)^2 t_1} \end{pmatrix}, \begin{pmatrix} \frac{4 k^2}{(1+2 k^2)^2 t_1} & \frac{2 i \sqrt{2}\, k}{(1+2 k^2)^2 t_1} \\ -\frac{2 i \sqrt{2}\, k}{(1+2 k^2)^2 t_1} & \frac{2}{(1+2 k^2)^2 t_1} \end{pmatrix}, \left(\frac{2}{t_1}\right) \right\}$$

Square masses:

$$\left\{0,\ \left\{\frac{t_1}{r_2}\right\},\ 0,\ 0,\ 0,\ 0\right\}$$

Massive pole residues:

$$\left\{0,\ \left\{-\frac{1}{r_2}\right\},\ 0,\ 0,\ 0,\ 0\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2},\ 0^-,\ \frac{t_1}{r_2}\right\},\ 0\right\}$$

Overall unitarity conditions:

$r_2 < 0 \,\&\&\, t_1 < 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_2 < 0 \,\&\&\, t_1 < 0$

Okay, that concludes the analysis of this theory.

Case 34

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 34 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_3 \, \mathcal{R}^{ij\,h}_{\ \ i} \, \mathcal{R}_{j\,hl}^{\ l} +$$

$$\frac{1}{6} \left(r_2 - 6 \, r_3 \right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} + 3 \, r_3 \, \mathcal{R}^{ij\,h}_{\ \ i} \, \mathcal{R}_{h\ jl}^{\ l} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - r_3 \, \partial_i \mathcal{A}^{hl}_{\ \ h} \, \partial^i \mathcal{A}_{l\ a}^{\ a} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}_{\ \ h} \, \partial_j \mathcal{A}_{aa'}^{\ \ h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}^{\ \ h} \, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}^{\ \ h} \, \partial_h \mathcal{A}^{jaa'} + 3 \, r_3 \, \partial_a \mathcal{A}^{\ a}_{l\ j} \, \partial_h \mathcal{A}^{jhl} - 3 \, r_3 \, \partial_j \mathcal{A}^{\ a}_{l\ a} \, \partial_h \mathcal{A}^{jhl} - r_3 \, \partial_a \mathcal{A}^{\ a}_{l\ j} \, \partial_h \mathcal{A}^{hlj} + 2 \, r_3 \, \partial_j \mathcal{A}^{\ a}_{l\ a} \, \partial_h \mathcal{A}^{hlj} +$$

$$\frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a^{\ j} - \frac{1}{6} t_2 \, \partial^a f_h^{\ l} \, \partial^h f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}^{\ \ a} \, \partial^h f^i_{\ a} -$$

$$\frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i_{\ a} - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}^{\ \ l} \, \partial^h f^i_{\ l} - \frac{1}{3} t_2 \, \mathcal{A}_{i\ h}^{\ l} \, \partial^h f^i_{\ l} - \frac{1}{3} t_2 \, \mathcal{A}^l_{\ hi} \, \partial^h f^i_{\ l} +$$

$$\frac{1}{6} t_2 \, \partial_h f_i^{\ l} \, \partial^h f^i_{\ l} + \frac{1}{6} t_2 \, \partial^a f_h^{\ l} \, \partial^h f_{la} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}^{\ \ l} \, \partial^h f^j_{\ l} - \frac{1}{6} t_2 \, \partial_h f_j^{\ l} \, \partial^h f^j_{\ l} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i^{\ al} \, \partial_l \mathcal{A}_{aa'}^{\ \ i} +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i^{\ la} \, \partial_l \mathcal{A}_{aa'}^{\ \ i} - 4 \, r_3 \, \partial^{a'} \mathcal{A}_i^{\ la} \, \partial_l \mathcal{A}_{aa'}^{\ \ i} - 3 \, r_3 \, \partial_a \mathcal{A}^{\ a}_{l\ j} \, \partial^l \mathcal{A}^{jh}_{\ \ h} + 3 \, r_3 \, \partial_j \mathcal{A}^{\ a}_{l\ a} \, \partial^l \mathcal{A}^{jh}_{\ \ h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6 k^2 r_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2 r_2 + t_2 \right), \begin{pmatrix} \frac{k^2 t_2}{3} & \frac{1}{3} i \sqrt{2} \, k t_2 & \frac{i k t_2}{3} \\ -\frac{1}{3} i \sqrt{2} \, k t_2 & \frac{1}{2} \left(2 k^2 r_3 + \frac{4 t_2}{3} \right) & \frac{\sqrt{2} \, t_2}{3} \\ -\frac{1}{3} i k t_2 & \frac{\sqrt{2} \, t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & k^2 r_3 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0, \; {}^{0^+}_{\bullet}\tau^{\flat\|} == 0, \; -i \; {}^{1^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == k \; {}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}}, \; {}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}} == 0, \right.$$

$$\left. {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0, \; {}^{1^-}_{\bullet}\tau^{\flat\|\,\mathfrak{a}} == 0, \; {}^{2^+}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 0, \; {}^{2^+}_{\bullet}\tau^{\flat\|\,\mathfrak{a}\,\mathfrak{b}} == 0, \; {}^{2^-}_{\bullet}\sigma^{\flat\|\,\mathfrak{a}\,\mathfrak{b}\,\mathfrak{c}} == 0 \right\}$$

The Drazin (Moore-Penrose) inverses of these *a*-matrices, which are functionally analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{6\,k^2\,r_3} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(\frac{1}{k^2\,r_2 + t_2} \right), \; \begin{pmatrix} \frac{3\,k^2\,r_3 + 2\,t_2}{(1+k^2)^2\,r_3\,t_2} & -\frac{i\,\sqrt{2}}{k\,r_3 + k^3\,r_3} & \frac{i\left(3\,k^2\,r_3 + 2\,t_2\right)}{k\,(1+k^2)^2\,r_3\,t_2} \\ \frac{i\,\sqrt{2}}{k\,r_3 + k^3\,r_3} & \frac{1}{k^2\,r_3} & -\frac{\sqrt{2}}{k^2\,r_3 + k^4\,r_3} \\ -\frac{i\left(3\,k^2\,r_3 + 2\,t_2\right)}{k\,(1+k^2)^2\,r_3\,t_2} & -\frac{\sqrt{2}}{k^2\,r_3 + k^4\,r_3} & \frac{3\,k^2\,r_3 + 2\,t_2}{(k+k^3)^2\,r_3\,t_2} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & \frac{1}{k^2\,r_3} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}, \; (\,0\,) \right\}$$

Square masses:

$$\left\{ \{\}, \; \left\{ -\frac{t_2}{r_2} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \; \left\{ -\frac{1}{r_2} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massless eigenvalues:

$\{\}$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_2}, \; 0^-, \; -\frac{t_2}{r_2} \right\}, \; \{\} \right\}$$

Overall unitarity conditions:

$$r_2 < 0 \; \&\& \; t_2 > 0$$

$$r_2 < 0 \; \&\& \; t_2 > 0$$

Okay, that concludes the analysis of this theory.

Case 35

Now for a new theory. Here is the full nonlinear Lagrangian for Case 35 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} - \frac{3}{2} r_3 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{j}{}^{l}{}_{hl} +$$

$$\frac{1}{6} \left(r_2 - 6 r_3 \right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} + \frac{5}{2} r_3 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + \frac{3}{2} r_3 \, \partial_i \mathcal{A}^{hl}{}_{h} \, \partial^j \mathcal{A}_{l}{}^{a}{}_{a} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} -$$

$$\frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \partial_h \mathcal{A}^{jaa'} + \frac{5}{2} r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{jhl} - \frac{5}{2} r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{jhl} +$$

$$\frac{3}{2} r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{hlj} - 3 r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_{a}{}^{j} - \frac{1}{6} t_2 \, \partial^a f_{h}{}^{l} \, \partial^h f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{a} \, \partial^h f^{i}{}_{a} - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^{i}{}_{a} - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} +$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{l} \, \partial^h f^{i}{}_{l} - \frac{1}{3} t_2 \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^h f^{i}{}_{l} - \frac{1}{3} t_2 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_{l} + \frac{1}{6} t_2 \, \partial_h f_{i}{}^{l} \, \partial^h f^{i}{}_{l} +$$

$$\frac{1}{6} t_2 \, \partial^a f_{h}{}^{l} \, \partial^h f_{la} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_{l}{}^{j} - \frac{1}{6} t_2 \, \partial_h f_{j}{}^{l} \, \partial^h f_{l}{}^{j} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - 4 r_3 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{5}{2} r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial^l \mathcal{A}^{jh}{}_{h} + \frac{5}{2} r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial^l \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 + t_2 \right), \; \begin{pmatrix} \frac{k^2 t_2}{3} & \frac{1}{3} i \sqrt{2} \, k t_2 & \frac{i k t_2}{3} \\ -\frac{1}{3} i \sqrt{2} \, k t_2 & \frac{2 t_2}{3} & \frac{\sqrt{2} \, t_2}{3} \\ -\frac{1}{3} i k t_2 & \frac{\sqrt{2} \, t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -\frac{3 k^2 r_3}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & -\frac{3 k^2 r_3}{2} \end{pmatrix}, \; (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{b\perp} == 0, \; {}^{0^+}_{\bullet}\sigma^{b\|} == 0, \; {}^{0^+}_{\bullet}\tau^{b\|} == 0, \; -i \, {}^{1^+}_{\bullet}\tau^{b\|\,ab} == k \, {}^{1^+}_{\bullet}\sigma^{b\perp\,ab}, \right.$$

$$\left. -i \, {}^{1^+}_{\bullet}\tau^{b\|\,ab} == k \, {}^{1^+}_{\bullet}\sigma^{b\perp\,ab}, \; {}^{1^-}_{\bullet}\sigma^{b\perp\,a} == 0, \; {}^{1^-}_{\bullet}\tau^{b\perp\,a} == 0, \; {}^{1^-}_{\bullet}\tau^{b\|\,a} == 0, \; {}^{2^+}_{\bullet}\tau^{b\|\,ab} == 0, \; {}^{2^-}_{\bullet}\sigma^{b\|\,abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(\frac{1}{k^2 r_2 + t_2} \right), \; \begin{pmatrix} \frac{3 k^2}{(3+k^2)^2 t_2} & \frac{3 i \sqrt{2} \, k}{(3+k^2)^2 t_2} & \frac{3 i k}{(3+k^2)^2 t_2} \\ -\frac{3 i \sqrt{2} \, k}{(3+k^2)^2 t_2} & \frac{6}{(3+k^2)^2 t_2} & \frac{3 \sqrt{2}}{(3+k^2)^2 t_2} \\ -\frac{3 i k}{(3+k^2)^2 t_2} & \frac{3 \sqrt{2}}{(3+k^2)^2 t_2} & \frac{3}{(3+k^2)^2 t_2} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -\frac{2}{3 k^2 r_3} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & -\frac{2}{3 k^2 r_3} \end{pmatrix}, \; (0) \right\}$$

Square masses:

$$\left\{ 0,\ \left\{ -\frac{t_{\bullet 2}}{r_{\bullet 2}} \right\},\ 0,\ 0,\ 0,\ 0 \right\}$$

Massive pole residues:

$$\left\{ 0,\ \left\{ -\frac{1}{r_{\bullet 2}} \right\},\ 0,\ 0,\ 0,\ 0 \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_{\bullet 2}},\ 0^-,\ -\frac{t_{\bullet 2}}{r_{\bullet 2}} \right\},\ 0 \right\}$$

Overall unitarity conditions:

$$r_{\bullet 2} < 0\ \&\&\ t_{\bullet 2} > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_{\bullet 2} < 0\ \&\&\ t_{\bullet 2} > 0$$

Okay, that concludes the analysis of this theory.

Case 36

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 36 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\left(2\,r_{\bullet 1} + r_{\bullet 2}\right)\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\left(r_{\bullet 1} - r_{\bullet 2}\right)\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} - 2\,r_{\bullet 1}\,\mathcal{R}^{ij\ h}_{\quad i}\ \mathcal{R}^{\ l}_{j\ hl} +$$

$$\frac{1}{6}\left(2\,r_{\bullet 1} + r_{\bullet 2} - 6\,r_{\bullet 3}\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} + \left(-2\,r_{\bullet 1} + 4\,r_{\bullet 3}\right)\mathcal{R}^{ij\ h}_{\quad i}\ \mathcal{R}^{\ l}_{h\ jl} + \frac{1}{12}\,t_{\bullet 2}\,\mathcal{T}_{ijh}\ \mathcal{T}^{ijh} - \frac{1}{6}\,t_{\bullet 2}\,\mathcal{T}^{ijh}\ \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_{\dot{2}}\, \mathcal{A}_{ijh}\, \mathcal{A}^{ijh} - \frac{2}{3} t_{\dot{2}}\, \mathcal{A}_{ihj}\, \mathcal{A}^{ijh} + 2 r_{\dot{1}}\, \partial_i \mathcal{A}^{hl}{}_h\, \partial^j \mathcal{A}_l{}^a - \frac{2}{3} r_{\dot{1}}\, \partial^{a'} \mathcal{A}^{ja}{}_h\, \partial_j \mathcal{A}_{aa'}{}^h + \frac{2}{3} r_{\dot{2}}\, \partial^{a'} \mathcal{A}^{ja}{}_h\, \partial_j \mathcal{A}_{aa'}{}^h -$$

$$\frac{2}{3} r_{\dot{1}}\, \partial_j \mathcal{A}_{aa'}{}^h\, \partial_h \mathcal{A}^{aa'j} - \frac{1}{3} r_{\dot{2}}\, \partial_j \mathcal{A}_{aa'}{}^h\, \partial_h \mathcal{A}^{aa'j} + \frac{2}{3} r_{\dot{1}}\, \partial_j \mathcal{A}_{aa'}{}^h\, \partial_h \mathcal{A}^{jaa'} - \frac{2}{3} r_{\dot{2}}\, \partial_j \mathcal{A}_{aa'}{}^h\, \partial_h \mathcal{A}^{jaa'} -$$

$$2 r_{\dot{1}}\, \partial_a \mathcal{A}_l{}^a{}_j\, \partial_h \mathcal{A}^{jhl} + 4 r_{\dot{3}}\, \partial_a \mathcal{A}_l{}^a{}_j\, \partial_h \mathcal{A}^{jhl} + 2 r_{\dot{1}}\, \partial_j \mathcal{A}_l{}^a{}_a\, \partial_h \mathcal{A}^{jhl} - 4 r_{\dot{3}}\, \partial_j \mathcal{A}_l{}^a{}_a\, \partial_h \mathcal{A}^{jhl} +$$

$$2 r_{\dot{1}}\, \partial_a \mathcal{A}_l{}^a{}_j\, \partial_h \mathcal{A}^{hlj} - 4 r_{\dot{1}}\, \partial_j \mathcal{A}_l{}^a{}_a\, \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_{\dot{1}}\, \partial_h \mathcal{A}^{aa'j}\, \partial^h \mathcal{A}_{aa'j} + \frac{1}{3} r_{\dot{2}}\, \partial_h \mathcal{A}^{aa'j}\, \partial^h \mathcal{A}_{aa'j} -$$

$$\frac{2}{3} r_{\dot{1}}\, \partial_h \mathcal{A}^{jaa'}\, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_{\dot{2}}\, \partial_h \mathcal{A}^{jaa'}\, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_{\dot{2}}\, \partial^a f_{jh}\, \partial^h f_a{}^j - \frac{1}{6} t_{\dot{2}}\, \partial^a f_h{}^l\, \partial^h f_{al} +$$

$$\frac{1}{3} t_{\dot{2}}\, \mathcal{A}_{ih}{}^a\, \partial^h f^i{}_a - \frac{1}{6} t_{\dot{2}}\, \partial^a f_{ih}\, \partial^h f^i{}_a - \frac{1}{3} t_{\dot{2}}\, \mathcal{A}_{ijh}\, \partial^h f^{ij} + \frac{1}{3} t_{\dot{2}}\, \mathcal{A}_{ih}{}^l\, \partial^h f^i{}_l - \frac{1}{3} t_{\dot{2}}\, \mathcal{A}_i{}^l{}_h\, \partial^h f^i{}_l -$$

$$\frac{1}{3} t_{\dot{2}}\, \mathcal{A}^l{}_{hi}\, \partial^h f^i{}_l + \frac{1}{6} t_{\dot{2}}\, \partial_h f_i{}^l\, \partial^h f^i{}_l + \frac{1}{6} t_{\dot{2}}\, \partial^a f_h{}^l\, \partial^h f_{la} - \frac{1}{3} t_{\dot{2}}\, \mathcal{A}_{jh}{}^l\, \partial^h f_l{}^j - \frac{1}{6} t_{\dot{2}}\, \partial_h f_j{}^l\, \partial^h f_l{}^j +$$

$$\frac{2}{3} r_{\dot{1}}\, \partial^{a'} \mathcal{A}_i{}^{al}\, \partial_l \mathcal{A}_{aa'}{}^i - \frac{2}{3} r_{\dot{2}}\, \partial^{a'} \mathcal{A}_i{}^{al}\, \partial_l \mathcal{A}_{aa'}{}^i + \frac{4}{3} r_{\dot{1}}\, \partial^{a'} \mathcal{A}_i{}^{la}\, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_{\dot{2}}\, \partial^{a'} \mathcal{A}_i{}^{la}\, \partial_l \mathcal{A}_{aa'}{}^i -$$

$$4 r_{\dot{3}}\, \partial^{a'} \mathcal{A}_i{}^{la}\, \partial_l \mathcal{A}_{aa'}{}^i + 2 r_{\dot{1}}\, \partial_a \mathcal{A}_l{}^a{}_j\, \partial^l \mathcal{A}^{jh}{}_h - 4 r_{\dot{3}}\, \partial_a \mathcal{A}_l{}^a{}_j\, \partial^l \mathcal{A}^{jh}{}_h - 2 r_{\dot{1}}\, \partial_j \mathcal{A}_l{}^a{}_a\, \partial^l \mathcal{A}^{jh}{}_h + 4 r_{\dot{3}}\, \partial_j \mathcal{A}_l{}^a{}_a\, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6 k^2 \left(-r_{\dot{1}} + r_{\dot{3}} \right) & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^2 r_{\dot{2}} + t_{\dot{2}} \right),\ \begin{pmatrix} \frac{k^2 t_{\dot{2}}}{3} & \frac{1}{3} i \sqrt{2}\, k t_{\dot{2}} & \frac{i k t_{\dot{2}}}{3} \\ -\frac{1}{3} i \sqrt{2}\, k t_{\dot{2}} & \frac{2 t_{\dot{2}}}{3} & \frac{\sqrt{2}\, t_{\dot{2}}}{3} \\ -\frac{1}{3} i k t_{\dot{2}} & \frac{\sqrt{2}\, t_{\dot{2}}}{3} & \frac{t_{\dot{2}}}{3} \end{pmatrix},\ \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -k^2 r_{\dot{1}} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},\ \left(k^2 r_{\dot{1}} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ \overset{0^+}{\bullet}\tau^{\flat\perp} == 0,\ \overset{0^+}{\bullet}\tau^{\flat\parallel} == 0,\ -i\ \overset{1^+}{\bullet}\tau^{\flat\parallel\,ab} == k\ \overset{1^+}{\bullet}\sigma^{\flat\perp\,ab},\ -i\ \overset{1^+}{\bullet}\tau^{\flat\parallel\,ab} == k\ \overset{1^+}{\bullet}\sigma^{\flat\parallel\,ab}, \right.$$

$$\left. \overset{1^-}{\bullet}\sigma^{\flat\perp\,a} == 0,\ \overset{1^-}{\bullet}\tau^{\flat\perp\,a} == 0,\ \overset{1^-}{\bullet}\tau^{\flat\parallel\,a} == 0,\ \overset{2^+}{\bullet}\sigma^{\flat\parallel\,ab} == 0,\ \overset{2^+}{\bullet}\tau^{\flat\parallel\,ab} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{6 k^2 \left(-r_{\dot{1}} + r_{\dot{3}} \right)} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2 r_{\dot{2}} + t_{\dot{2}}} \right),\ \begin{pmatrix} \frac{3 k^2}{(3+k^2)^2 t_{\dot{2}}} & \frac{3 i \sqrt{2}\, k}{(3+k^2)^2 t_{\dot{2}}} & \frac{3 i k}{(3+k^2)^2 t_{\dot{2}}} \\ -\frac{3 i \sqrt{2}\, k}{(3+k^2)^2 t_{\dot{2}}} & \frac{6}{(3+k^2)^2 t_{\dot{2}}} & \frac{3 \sqrt{2}}{(3+k^2)^2 t_{\dot{2}}} \\ -\frac{3 i k}{(3+k^2)^2 t_{\dot{2}}} & \frac{3 \sqrt{2}}{(3+k^2)^2 t_{\dot{2}}} & \frac{3}{(3+k^2)^2 t_{\dot{2}}} \end{pmatrix},\ \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{k^2 r_{\dot{1}}} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},\ \left(\frac{1}{k^2 r_{\dot{1}}} \right) \right\}$$

Square masses:

$$\left\{ \{\},\ \left\{ -\frac{t_{\dot{2}}}{r_{\dot{2}}} \right\},\ \{\},\ \{\},\ \{\},\ \{\} \right\}$$

Massive pole residues:

$$\left\{0, \left\{-\frac{1}{r_2}\right\}, 0, 0, 0, 0\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2}, 0^-, -\frac{t_2}{r_2}\right\}, 0\right\}$$

Overall unitarity conditions:

$r_2 < 0 \,\&\&\, t_2 > 0$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$r_2 < 0 \,\&\&\, t_2 > 0$

Okay, that concludes the analysis of this theory.

Case 37

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 37 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} - \frac{3}{2} r_3 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{6}\left(r_2 - 6\, r_3\right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$\frac{5}{2} r_3 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} - \frac{2}{3} t_3 \, \mathcal{T}^{i}{}_{i}{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \mathcal{A}_{i\ l}^{\ l} \mathcal{A}^{ij}_{\ \ j} + \frac{1}{3} t_2 \mathcal{A}_{ijh} \mathcal{A}^{ijh} - \frac{2}{3} t_2 \mathcal{A}_{ihj} \mathcal{A}^{ijh} + \frac{3}{2} r_3 \partial_i \mathcal{A}^{hl}_{\ \ h} \partial^i \mathcal{A}_{l\ a}^{\ a} + \frac{2}{3} r_2 \partial^{a'} \mathcal{A}_{\ \ h}^{ja} \partial_j \mathcal{A}_{aa'}^{\ \ \ h} -$$

$$\frac{1}{3} r_2 \partial_j \mathcal{A}_{aa'}^{\ \ \ h} \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \partial_j \mathcal{A}_{aa'}^{\ \ \ h} \partial_h \mathcal{A}^{jaa'} + \frac{5}{2} r_3 \partial_a \mathcal{A}_{l\ j}^{\ a} \partial_h \mathcal{A}^{jhl} - \frac{5}{2} r_3 \partial_j \mathcal{A}_{l\ a}^{\ a} \partial_h \mathcal{A}^{jhl} +$$

$$\frac{3}{2} r_3 \partial_a \mathcal{A}_{l\ j}^{\ a} \partial_h \mathcal{A}^{hlj} - 3 r_3 \partial_j \mathcal{A}_{l\ a}^{\ a} \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \partial_h \mathcal{A}^{aa'j} \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \partial_h \mathcal{A}^{jaa'} \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{1}{6} t_2 \partial^a f_{jh} \partial^h f_a^{\ j} - \frac{1}{6} t_2 \partial^a f_h^{\ l} \partial^h f_{al} + \frac{1}{3} t_2 \mathcal{A}_{ih}^{\ \ a} \partial^h f^i_{\ a} - \frac{1}{6} t_2 \partial^a f_{ih} \partial^h f^i_{\ a} - \frac{2}{3} t_3 \mathcal{A}_{h\ a}^{\ a} \partial^h f^i_{\ i} -$$

$$\frac{2}{3} t_3 \mathcal{A}_{h\ l}^{\ l} \partial^h f^i_{\ i} - \frac{4}{3} t_3 \partial^a f_{ah} \partial^h f^i_{\ i} + \frac{2}{3} t_3 \partial_h f^l_{\ l} \partial^h f^i_{\ i} - \frac{1}{3} t_2 \mathcal{A}_{ijh} \partial^h f^{ij} + \frac{1}{3} t_2 \mathcal{A}_{ih}^{\ \ l} \partial^h f^i_{\ l} -$$

$$\frac{1}{3} t_2 \mathcal{A}_{i\ h}^{\ l} \partial^h f^i_{\ l} - \frac{1}{3} t_2 \mathcal{A}_{\ hi}^{l} \partial^h f^i_{\ l} + \frac{1}{6} t_2 \partial_h f_i^{\ l} \partial^h f^i_{\ l} + \frac{2}{3} t_3 \partial^{a'} f_{a'}^{\ a} \partial^h f_{ha} + \frac{2}{3} t_3 \mathcal{A}_{j\ l}^{\ l} \partial^h f_h^{\ j} +$$

$$\frac{2}{3} t_3 \mathcal{A}^{la}_{\ \ a} \partial^h f_{hl} + \frac{1}{6} t_2 \partial^a f_h^{\ l} \partial^h f_{la} - \frac{1}{3} t_2 \mathcal{A}_{jh}^{\ \ l} \partial^h f_l^{\ j} - \frac{1}{6} t_2 \partial_h f_j^{\ l} \partial^h f_l^{\ j} - \frac{2}{3} r_2 \partial^{a'} \mathcal{A}_{i}^{\ al} \partial_l \mathcal{A}_{aa'}^{\ \ \ i} +$$

$$\frac{2}{3} r_2 \partial^{a'} \mathcal{A}_{i}^{\ la} \partial_l \mathcal{A}_{aa'}^{\ \ \ i} - 4 r_3 \partial^{a'} \mathcal{A}_{i}^{\ la} \partial_l \mathcal{A}_{aa'}^{\ \ \ i} - \frac{5}{2} r_3 \partial_a \mathcal{A}_{l\ j}^{\ a} \partial^l \mathcal{A}^{jh}_{\ \ h} + \frac{5}{2} r_3 \partial_j \mathcal{A}_{l\ a}^{\ a} \partial^l \mathcal{A}^{jh}_{\ \ h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2k^2 t_3 & i\sqrt{2}\,k\,t_3 & 0 \\ -i\sqrt{2}\,k\,t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \ \left(k^2 r_2 + t_2 \right), \ \begin{pmatrix} \frac{k^2 t_2}{3} & \frac{1}{3} i\sqrt{2}\,k\,t_2 & \frac{ik t_2}{3} \\ -\frac{1}{3} i\sqrt{2}\,k\,t_2 & \frac{2t_2}{3} & \frac{\sqrt{2}\,t_2}{3} \\ -\frac{1}{3} i\,k\,t_2 & \frac{\sqrt{2}\,t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2k^2 t_3}{3} & \frac{2ik t_3}{3} & 0 & -\frac{1}{3} i\sqrt{2}\,k\,t_3 \\ -\frac{2}{3} i\,k\,t_3 & \frac{1}{6}\left(-9k^2 r_3 + 4 t_3\right) & 0 & -\frac{\sqrt{2}\,t_3}{3} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i\sqrt{2}\,k\,t_3 & -\frac{\sqrt{2}\,t_3}{3} & 0 & \frac{t_3}{3} \end{pmatrix}, \ \begin{pmatrix} 0 & 0 \\ 0 & -\frac{3k^2 r_3}{2} \end{pmatrix}, \ (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}\!\tau^{b\perp} == 0, \ -i\,{}^{0^+}\!\tau^{b\|} == 2k\,{}^{0^+}\!\sigma^{b\|}, \ -i\,{}^{1^+}\!\tau^{b\|}{}^{ab} == k\,{}^{1^+}\!\sigma^{b\perp ab}, \right.$$

$$\left. -i\,{}^{1^+}\!\tau^{b\|}{}^{ab} == k\,{}^{1^+}\!\sigma^{b\|}{}^{ab}, \ i\,{}^{1^-}\!\tau^{b\|}{}^{a} == 2k\,{}^{1^-}\!\sigma^{b\perp a}, \ {}^{1^-}\!\tau^{b\perp a} == 0, \ {}^{2^+}\!\tau^{b\|}{}^{ab} == 0, \ {}^{2^-}\!\sigma^{b\|}{}^{abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex] -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex] 0 & 0 & 0 \end{pmatrix}, \left(\dfrac{1}{k^2\,r_2 + t_2} \right), \begin{pmatrix} \dfrac{3\,k^2}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,i\,\sqrt{2}\,k}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,i\,k}{\left(3+k^2\right)^2 t_2} \\[2ex] -\dfrac{3\,i\,\sqrt{2}\,k}{\left(3+k^2\right)^2 t_2} & \dfrac{6}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,\sqrt{2}}{\left(3+k^2\right)^2 t_2} \\[2ex] -\dfrac{3\,i\,k}{\left(3+k^2\right)^2 t_2} & \dfrac{3\,\sqrt{2}}{\left(3+k^2\right)^2 t_2} & \dfrac{3}{\left(3+k^2\right)^2 t_2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2\left(9\,k^2\,r_3 - 4\,t_3\right)}{3\left(1+2\,k^2\right)^2 r_3\,t_3} & \dfrac{4\,i}{3\,k\,r_3 + 6\,k^3\,r_3} & 0 & -\dfrac{i\,\sqrt{2}\left(9\,k^2\,r_3 - 4\,t_3\right)}{3\,k\left(1+2\,k^2\right)^2 r_3\,t_3} \\[2ex] -\dfrac{4\,i}{3\,k\,r_3 + 6\,k^3\,r_3} & -\dfrac{2}{3\,k^2\,r_3} & 0 & -\dfrac{2\,\sqrt{2}}{3\,k^2\,r_3 + 6\,k^4\,r_3} \\[2ex] 0 & 0 & 0 & 0 \\[2ex] \dfrac{i\,\sqrt{2}\left(9\,k^2\,r_3 - 4\,t_3\right)}{3\,k\left(1+2\,k^2\right)^2 r_3\,t_3} & -\dfrac{2\,\sqrt{2}}{3\,k^2\,r_3 + 6\,k^4\,r_3} & 0 & \dfrac{9\,k^2\,r_3 - 4\,t_3}{3\left(k+2\,k^3\right)^2 r_3\,t_3} \end{pmatrix}, \begin{pmatrix} 0 & 0 \\[2ex] 0 & -\dfrac{2}{3\,k^2\,r_3} \end{pmatrix}, (\,0\,) \right\}$$

Square masses:

$$\left\{ 0, \left\{ -\dfrac{t_2}{r_2} \right\}, 0, 0, 0, 0 \right\}$$

Massive pole residues:

$$\left\{ 0, \left\{ -\dfrac{1}{r_2} \right\}, 0, 0, 0, 0 \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2},\ 0^-,\ -\dfrac{t_2}{r_2} \right\}, 0 \right\}$$

Overall unitarity conditions:

$$r_2 < 0 \,\&\&\, t_2 > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \,\&\&\, t_2 > 0$$

Okay, that concludes the analysis of this theory.

Case 38

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 38 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \; \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \; \mathcal{R}^{ijhl} + \frac{1}{6} \left(r_2 - 6 r_3 \right) \mathcal{R}^{ijhl} \; \mathcal{R}_{hlij} +$$

$$4 r_3 \, \mathcal{R}^{ij}{}_{i}{}^{h} \; \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12} \left(4 t_1 + t_2 \right) \mathcal{T}_{ijh} \; \mathcal{T}^{ijh} + \frac{1}{6} \left(2 t_1 - t_2 \right) \mathcal{T}^{ijh} \; \mathcal{T}_{jih} + \frac{1}{3} t_1 \, \mathcal{T}^{i}{}_{i}{}^{j} \; \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \, \mathcal{A}_i{}^{i}{}_{l} \; \mathcal{A}^{ij}{}_{j} + \frac{1}{3} t_1 \, \mathcal{A}_{ijh} \; \mathcal{A}^{ijh} + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \; \mathcal{A}^{ijh} + \frac{1}{3} t_1 \, \mathcal{A}_{ihj} \; \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \; \mathcal{A}^{ijh} +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} + 4 r_3 \, \partial_a \mathcal{A}^{a}{}_{l}{}_{j} \, \partial_h \mathcal{A}^{jhl} -$$

$$4 r_3 \, \partial_j \mathcal{A}^{a}{}_{l}{}_{a} \, \partial_h \mathcal{A}^{jhl} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{3} t_1 \, \partial^a f_{jh} \, \partial^h f_a{}^{j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^{j} +$$

$$\frac{1}{3} t_1 \, \partial^a f_h{}^{l} \, \partial^h f_{al} - \frac{1}{6} t_2 \, \partial^a f_h{}^{l} \, \partial^h f_{al} + \frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^{a} \, \partial^h f^{i}{}_{a} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{a} \, \partial^h f^{i}{}_{a} - \frac{2}{3} t_1 \, \partial^a f_{ih} \, \partial^h f^{i}{}_{a} -$$

$$\frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^{i}{}_{a} + \frac{1}{3} t_1 \, \mathcal{A}_{h}{}^{a}{}_{a} \, \partial^h f^{i}{}_{i} + \frac{1}{3} t_1 \, \mathcal{A}_{h}{}^{l}{}_{l} \, \partial^h f^{i}{}_{i} + \frac{2}{3} t_1 \, \partial^a f_{ah} \, \partial^h f^{i}{}_{i} - \frac{1}{3} t_1 \, \partial_h f^{l}{}_{l} \, \partial^h f^{i}{}_{i} -$$

$$\frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^{l} \, \partial^h f^{i}{}_{l} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{l} \, \partial^h f^{i}{}_{l} - \frac{1}{3} t_1 \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^h f^{i}{}_{l} -$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^h f^{i}{}_{l} + \frac{2}{3} t_1 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_{l} - \frac{1}{3} t_2 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_{l} + \frac{2}{3} t_1 \, \partial_h f_i{}^{l} \, \partial^h f^{i}{}_{l} + \frac{1}{6} t_2 \, \partial_h f_i{}^{l} \, \partial^h f^{i}{}_{l} -$$

$$\frac{1}{3} t_1 \, \partial^{a'} f_{a'}{}^{a} \, \partial^h f_{ha} - \frac{1}{3} t_1 \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^h f_h{}^{j} - \frac{1}{3} t_1 \, \mathcal{A}^{la}{}_{a} \, \partial^h f_{hl} - \frac{1}{3} t_1 \, \partial^a f_h{}^{l} \, \partial^h f_{la} + \frac{1}{6} t_2 \, \partial^a f_h{}^{l} \, \partial^h f_{la} +$$

$$\frac{2}{3} t_1 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_l{}^{j} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_l{}^{j} + \frac{1}{3} t_1 \, \partial_h f_j{}^{l} \, \partial^h f_l{}^{j} - \frac{1}{6} t_2 \, \partial_h f_j{}^{l} \, \partial^h f_l{}^{j} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - 4 r_3 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - 4 r_3 \, \partial_a \mathcal{A}^{a}{}_{l}{}_{j} \, \partial^l \mathcal{A}^{jh}{}_{h} + 4 r_3 \, \partial_j \mathcal{A}^{a}{}_{l}{}_{a} \, \partial^l \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6 k^2 r_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 + t_2 \right), \; \begin{pmatrix} \frac{1}{3} k^2 \left(t_1 + t_2 \right) & -\frac{i k \left(t_1 - 2 t_2 \right)}{3 \sqrt{2}} & \frac{1}{3} i k \left(t_1 + t_2 \right) \\ \frac{i k \left(t_1 - 2 t_2 \right)}{3 \sqrt{2}} & \frac{1}{6} \left(t_1 + 4 t_2 \right) & \frac{-t_1 + 2 t_2}{3 \sqrt{2}} \\ -\frac{1}{3} i k \left(t_1 + t_2 \right) & \frac{-t_1 + 2 t_2}{3 \sqrt{2}} & \frac{t_1 + t_2}{3} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2 k^2 t_1}{3} & -\frac{1}{3} i k t_1 & 0 & -\frac{1}{3} i \sqrt{2} \, k t_1 \\ \frac{i k t_1}{3} & \frac{t_1}{6} & 0 & \frac{t_1}{3 \sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2} \, k t_1 & \frac{t_1}{3 \sqrt{2}} & 0 & \frac{t_1}{3} \end{pmatrix}, \; \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \; \left(\frac{t_1}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_\bullet\tau^{b\perp} == 0, \; {}^{0^+}_\bullet\tau^{b\|} == 0, \; -i\; {}^{1^+}_\bullet\tau^{b\|\,ab} == k\; {}^{1^+}_\bullet\sigma^{b\perp\,ab}, \right.$$

$$\left. i\; {}^{1^-}_\bullet\tau^{b\|\,a} == 2\,k\; {}^{1^-}_\bullet\sigma^{b\perp\,a}, \; {}^{1^-}_\bullet\tau^{b\perp\,a} == 0, \; i\; {}^{1^-}_\bullet\tau^{b\|\,a} == 2\,k\; {}^{1^-}_\bullet\sigma^{b\|\,a}, \; -i\; {}^{2^+}_\bullet\tau^{b\|\,ab} == 2\,k\; {}^{2^+}_\bullet\sigma^{b\|\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{6\,k^2\,r_{\bullet 3}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(\dfrac{1}{k^2\,r_{\bullet 2} + t_{\bullet 2}} \right), \right.$$

$$\left. \begin{pmatrix} \dfrac{k^2\left(t_{\bullet 1}+4\,t_{\bullet 2}\right)}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} & \dfrac{i\,\sqrt{2}\,k\left(t_{\bullet 1}-2\,t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} & \dfrac{i\,k\left(t_{\bullet 1}+4\,t_{\bullet 2}\right)}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} \\[2mm] -\dfrac{i\,\sqrt{2}\,k\left(t_{\bullet 1}-2\,t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} & \dfrac{2\left(t_{\bullet 1}+t_{\bullet 2}\right)}{3\,t_{\bullet 1} t_{\bullet 2}} & \dfrac{\sqrt{2}\left(t_{\bullet 1}-2\,t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} \\[2mm] -\dfrac{i\,k\left(t_{\bullet 1}+4\,t_{\bullet 2}\right)}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} & \dfrac{\sqrt{2}\left(t_{\bullet 1}-2\,t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} & \dfrac{t_{\bullet 1}+4\,t_{\bullet 2}}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{24\,k^2}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} & -\dfrac{12\,i\,k}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} & 0 & -\dfrac{12\,i\,\sqrt{2}\,k}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} \\[2mm] \dfrac{12\,i\,k}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} & \dfrac{6}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} & 0 & \dfrac{6\,\sqrt{2}}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} \\[2mm] 0 & 0 & 0 & 0 \\[2mm] \dfrac{12\,i\,\sqrt{2}\,k}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} & \dfrac{6\,\sqrt{2}}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} & 0 & \dfrac{12}{\left(3+4\,k^2\right)^2 t_{\bullet 1}} \end{pmatrix}, \; \begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_{\bullet 1}} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\bullet 1}} \\[2mm] -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\bullet 1}} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_{\bullet 1}} \end{pmatrix}, \; \left(\dfrac{2}{t_{\bullet 1}} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \; \left\{ -\dfrac{t_{\bullet 2}}{r_{\bullet 2}} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \; \left\{ -\dfrac{1}{r_{\bullet 2}} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_{\bullet 2}}, \; 0^-, \; -\dfrac{t_{\bullet 2}}{r_{\bullet 2}} \right\}, \; \{\} \right\}$$

Overall unitarity conditions:

$$r_{\bullet 2} < 0 \; \&\& \; t_{\bullet 2} > 0$$

So, that's the end of the PSALTer output for this theory. You
can check the particle content against TABLE IV. in arXiv:1910.14197.
If you take the overall unitarity conditions from the final column in
TABLE V., and decompose them using Mathematica's Reduce function, you
get the following (to be compared with the PSALTer conditions above):

$$r_{\bullet 2} < 0 \; \&\& \; t_{\bullet 2} > 0$$

Okay, that concludes the analysis of this theory.

Case 39

Now for a new theory. Here is the full nonlinear Lagrangian for
Case 39 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \; \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \; \mathcal{R}^{ijhl} + \frac{1}{6} \left(r_2 - 6 r_3 \right) \mathcal{R}^{ijhl} \; \mathcal{R}_{hlij} +$$

$$4 r_3 \, \mathcal{R}^{ij\,h}{}_{i} \; \mathcal{R}_{h\,jl}{}^{l} + \frac{1}{4} t_1 \, \mathcal{T}_{ijh} \; \mathcal{T}^{ijh} + \frac{1}{2} t_1 \, \mathcal{T}^{ijh} \; \mathcal{T}_{jih} + \frac{1}{3} t_1 \, \mathcal{T}^{i\,j}{}_{i} \; \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \, \mathcal{A}_{i}{}^{l}{}_{l} \; \mathcal{A}^{ij}{}_{j} + t_1 \, \mathcal{A}_{ihj} \; \mathcal{A}^{ijh} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'\,j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} +$$

$$4 r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{jhl} - 4 r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{jhl} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'\,j} \, \partial^h \mathcal{A}_{aa'\,j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'\,j} - \frac{1}{2} t_1 \, \partial^a f_{jh} \, \partial^h f_{a}{}^{j} +$$

$$\frac{1}{2} t_1 \, \partial^a f_{h}{}^{l} \, \partial^h f_{al} - \frac{1}{2} t_1 \, \partial^a f_{ih} \, \partial^h f^{i}{}_{a} + \frac{1}{3} t_1 \, \mathcal{A}_{h}{}^{a}{}_{a} \, \partial^h f^{i}{}_{i} + \frac{1}{3} t_1 \, \mathcal{A}_{h}{}^{l}{}_{l} \, \partial^h f^{i}{}_{i} + \frac{2}{3} t_1 \, \partial^a f_{ah} \, \partial^h f^{i}{}_{i} -$$

$$\frac{1}{3} t_1 \, \partial_h f^{l}{}_{l} \, \partial^h f^{i}{}_{i} + t_1 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_{l} + \frac{1}{2} t_1 \, \partial_h f^{i}{}_{i} \, \partial^h f^{i}{}_{l} - \frac{1}{3} t_1 \, \partial^{a'} f_{a}{}^{a} \, \partial^h f_{ha} - \frac{1}{3} t_1 \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^h f_{h}{}^{j} -$$

$$\frac{1}{3} t_1 \, \mathcal{A}^{la}{}_{a} \, \partial^h f_{hl} - \frac{1}{2} t_1 \, \partial^a f_{h}{}^{l} \, \partial^h f_{la} + t_1 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_{l}{}^{j} + \frac{1}{2} t_1 \, \partial_h f_{j}{}^{l} \, \partial^h f_{l}{}^{j} - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} +$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - 4 r_3 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - 4 r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial^l \mathcal{A}^{jh}{}_{h} + 4 r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial^l \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6 k^2 r_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 - t_1 \right), \; \begin{pmatrix} 0 & -\dfrac{i k t_1}{\sqrt{2}} & 0 \\ \dfrac{i k t_1}{\sqrt{2}} & -\dfrac{t_1}{2} & -\dfrac{t_1}{\sqrt{2}} \\ 0 & -\dfrac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2 k^2 t_1}{3} & -\dfrac{1}{3} i k t_1 & 0 & -\dfrac{1}{3} i \sqrt{2} \, k t_1 \\ \dfrac{i k t_1}{3} & \dfrac{t_1}{6} & 0 & \dfrac{t_1}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \dfrac{1}{3} i \sqrt{2} \, k t_1 & \dfrac{t_1}{3\sqrt{2}} & 0 & \dfrac{t_1}{3} \end{pmatrix}, \; \begin{pmatrix} k^2 t_1 & \dfrac{i k t_1}{\sqrt{2}} \\ -\dfrac{i k t_1}{\sqrt{2}} & \dfrac{t_1}{2} \end{pmatrix}, \; \left(\dfrac{t_1}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0, \; {}^{0^+}_{\bullet}\tau^{\flat\parallel} == 0, \; -i \, {}^{1^+}_{\bullet}\tau^{\flat\parallel\,ab} == k \, {}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab}, \right.$$

$$\left. i \, {}^{1^-}_{\bullet}\tau^{\flat\parallel\,a} == 2 k \, {}^{1^-}_{\bullet}\sigma^{\flat\perp\,a}, \; {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0, \; i \, {}^{1^-}_{\bullet}\tau^{\flat\parallel\,a} == 2 k \, {}^{1^-}_{\bullet}\sigma^{\flat\parallel\,a}, \; -i \, {}^{2^+}_{\bullet}\tau^{\flat\parallel\,ab} == 2 k \, {}^{2^+}_{\bullet}\sigma^{\flat\parallel\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{6\,k^2\,r_3} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(\frac{1}{k^2\,r_2 - t_1} \right), \; \begin{pmatrix} \frac{k^2}{(1+k^2)^2\,t_1} & -\frac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & \frac{i\,k}{(1+k^2)^2\,t_1} \\ \frac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & 0 & -\frac{\sqrt{2}}{t_1 + k^2\,t_1} \\ -\frac{i\,k}{(1+k^2)^2\,t_1} & -\frac{\sqrt{2}}{t_1 + k^2\,t_1} & \frac{1}{(1+k^2)^2\,t_1} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{24\,k^2}{(3+4\,k^2)^2\,t_1} & -\frac{12\,i\,k}{(3+4\,k^2)^2\,t_1} & 0 & -\frac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_1} \\ \frac{12\,i\,k}{(3+4\,k^2)^2\,t_1} & \frac{6}{(3+4\,k^2)^2\,t_1} & 0 & \frac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_1} \\ 0 & 0 & 0 & 0 \\ \frac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_1} & \frac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_1} & 0 & \frac{12}{(3+4\,k^2)^2\,t_1} \end{pmatrix}, \; \begin{pmatrix} \frac{4\,k^2}{(1+2\,k^2)^2\,t_1} & \frac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} \\ -\frac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} & \frac{2}{(1+2\,k^2)^2\,t_1} \end{pmatrix}, \; \left(\frac{2}{t_1} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \; \left\{ \frac{t_1}{r_2} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \; \left\{ -\frac{1}{r_2} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massless eigenvalues:

$$\{\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_2}, \; 0^-, \; \frac{t_1}{r_2} \right\}, \; \{\} \right\}$$

Overall unitarity conditions:

$$r_2 < 0 \; \&\& \; t_1 < 0$$

So, that's the end of the PSALTer output for this theory. You can check the particle content against TABLE IV. in arXiv:1910.14197. If you take the overall unitarity conditions from the final column in TABLE V., and decompose them using Mathematica's Reduce function, you get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \; \&\& \; t_1 < 0$$

Okay, that concludes the analysis of this theory.

Case 40

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 40 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \frac{1}{6} \left(r_2 - 6 r_3 \right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$2 r_4 \, \mathcal{R}^{ij\,h}{}_i \, \mathcal{R}_{h\,jl}{}^l + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$\frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + \frac{2}{3} r_2 \, \partial^{a'}\mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} + 2 r_4 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{jhl} - 2 r_4 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{jhl} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^j - \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a -$$

$$\frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l +$$

$$\frac{1}{6} t_2 \, \partial_h f_i{}^l \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{la} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{6} t_2 \, \partial_h f_j{}^l \, \partial^h f_l{}^j - \frac{2}{3} r_2 \, \partial^{a'}\mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i +$$

$$\frac{2}{3} r_2 \, \partial^{a'}\mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i - 4 r_3 \, \partial^{a'}\mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i - 2 r_4 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial^l \mathcal{A}^{jh}{}_h + 2 r_4 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & -2 k^2 \left(r_3 - 2 r_4 \right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2 r_2 + t_2 \right), \right.$$

$$\left. \begin{pmatrix} \frac{k^2 t_2}{3} & \frac{1}{3} i \sqrt{2} \, k t_2 & \frac{i k t_2}{3} \\ -\frac{1}{3} i \sqrt{2} \, k t_2 & \frac{1}{2} \left(k^2 \left(4 r_3 - 2 r_4 \right) + \frac{4 t_2}{3} \right) & \frac{\sqrt{2} \, t_2}{3} \\ -\frac{1}{3} i k t_2 & \frac{\sqrt{2} \, t_2}{3} & \frac{t_2}{3} \end{pmatrix}, \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & 0 \\ 0 & k^2 \left(-2 r_3 + r_4 \right) \end{pmatrix}, (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{b\perp} == 0, \; {}^{0^+}_{\bullet}\tau^{b\|} == 0, \; -i \, {}^{1^+}_{\bullet}\tau^{b\|}{}^{ab} == k \, {}^{1^+}_{\bullet}\sigma^{b\perp\,ab}, \; {}^{1^-}_{\bullet}\sigma^{b\perp\,a} == 0, \right.$$

$$\left. {}^{1^-}_{\bullet}\tau^{b\perp\,a} == 0, \; {}^{1^-}_{\bullet}\sigma^{b\|\,a} == 0, \; {}^{1^-}_{\bullet}\tau^{b\|\,a} == 0, \; {}^{2^+}_{\bullet}\tau^{b\|\,ab} == 0, \; {}^{2^-}_{\bullet}\sigma^{b\|\,abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{-2\,k^2\,r_3 + 4\,k^2\,r_4} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} \dfrac{1}{k^2\,r_2 + t_2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{\frac{1}{r_4} - \frac{3\,k^2}{t_2}}{r_3 - \frac{t_2}{2}} & -\dfrac{i\,\sqrt{2}}{k\,(1+k^2)\left(2\,r_3 - r_4\right)} & \dfrac{i\left(k^2\left(6\,r_3 - 3\,r_4\right) + 2\,t_2\right)}{k\,(1+k^2)^2\left(2\,r_3 - r_4\right)t_2} \\ \dfrac{i\,\sqrt{2}}{k\,(1+k^2)\left(2\,r_3 - r_4\right)} & \dfrac{1}{k^2\left(2\,r_3 - r_4\right)} & -\dfrac{\sqrt{2}}{k^2\,(1+k^2)\left(2\,r_3 - r_4\right)} \\ -\dfrac{i\left(k^2\left(6\,r_3 - 3\,r_4\right) + 2\,t_2\right)}{k\,(1+k^2)^2\left(2\,r_3 - r_4\right)t_2} & -\dfrac{\sqrt{2}}{k^2\,(1+k^2)\left(2\,r_3 - r_4\right)} & \dfrac{k^2\left(6\,r_3 - 3\,r_4\right) + 2\,t_2}{(k+k^3)^2\left(2\,r_3 - r_4\right)t_2} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & \dfrac{1}{k^2\left(-2\,r_3 + r_4\right)} \end{pmatrix}, \; (\, 0 \,) \right\}$$

Square masses:

$$\left\{ \{\}, \; \left\{ -\dfrac{t_2}{r_2} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \; \left\{ -\dfrac{1}{r_2} \right\}, \; \{\}, \; \{\}, \; \{\}, \; \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2}, \; 0^-, \; -\dfrac{t_2}{r_2} \right\}, \; \{\} \right\}$$

Overall unitarity conditions:

$r_2 < 0 \,\&\&\, t_2 > 0$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$r_2 < 0 \,\&\&\, t_2 > 0$

Okay, that concludes the analysis of this theory.

Case 41

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 41 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + \frac{1}{6} \left(r_2 - 6 r_3 \right) \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$r_3 \, \mathcal{R}^{ij}{}_{i}{}^{h} \, \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12} t_2 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} - \frac{1}{6} t_2 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} - \frac{2}{3} t_3 \, \mathcal{T}^{i}{}_{i}{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$\frac{2}{3} t_3 \, \mathcal{A}_{i}{}^{l}{}_{l} \, \mathcal{A}^{ij}{}_{j} + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_{h} \, \partial_j \mathcal{A}_{aa'}{}^{h} - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} -$$

$$\frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} + r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial_h \mathcal{A}^{jhl} - r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial_h \mathcal{A}^{jhl} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^{h} \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^{h} \mathcal{A}_{aa'j} + \frac{1}{6} t_2 \, \partial^{a} f_{jh} \, \partial^{h} f_{a}{}^{j} - \frac{1}{6} t_2 \, \partial^{a} f_{h}{}^{l} \, \partial^{h} f_{al} + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{a} \, \partial^{h} f^{i}{}_{a} - \frac{1}{6} t_2 \, \partial^{a} f_{ih} \, \partial^{h} f^{i}{}_{a} -$$

$$\frac{2}{3} t_3 \, \mathcal{A}_{ha}{}^{a} \, \partial^{h} f^{i}{}_{i} - \frac{2}{3} t_3 \, \mathcal{A}_{h}{}^{l}{}_{l} \, \partial^{h} f^{i}{}_{i} - \frac{4}{3} t_3 \, \partial^{a} f_{ah} \, \partial^{h} f^{i}{}_{i} + \frac{2}{3} t_3 \, \partial_h f^{l}{}_{l} \, \partial^{h} f^{i}{}_{i} - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^{h} f^{ij} +$$

$$\frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^{l} \, \partial^{h} f^{i}{}_{l} - \frac{1}{3} t_2 \, \mathcal{A}_{i}{}^{l}{}_{h} \, \partial^{h} f^{i}{}_{l} - \frac{1}{3} t_2 \, \mathcal{A}^{l}{}_{hi} \, \partial^{h} f^{i}{}_{l} + \frac{1}{6} t_2 \, \partial_h f^{l}{}_{i} \, \partial^{h} f^{i}{}_{l} + \frac{2}{3} t_3 \, \partial^{a'} f_{a'}{}^{a} \, \partial^{h} f_{ha} +$$

$$\frac{2}{3} t_3 \, \mathcal{A}_{j}{}^{l}{}_{l} \, \partial^{h} f_{h}{}^{j} + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_{a} \, \partial^{h} f_{hl} + \frac{1}{6} t_2 \, \partial^{a} f_{h}{}^{l} \, \partial^{h} f_{la} - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^{l} \, \partial^{h} f_{l}{}^{j} - \frac{1}{6} t_2 \, \partial_h f^{l}{}_{j} \, \partial^{h} f_{l}{}^{j} -$$

$$\frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{al}{}_{i} \, \partial_l \mathcal{A}_{aa'}{}^{i} + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - 4 r_3 \, \partial^{a'} \mathcal{A}_{i}{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} - r_3 \, \partial_a \mathcal{A}_{l}{}^{a}{}_{j} \, \partial^{l} \mathcal{A}^{jh}{}_{h} + r_3 \, \partial_j \mathcal{A}_{l}{}^{a}{}_{a} \, \partial^{l} \mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2 k^2 t_3 & i \sqrt{2} \, k t_3 & 0 \\ -i \sqrt{2} \, k t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \; \left(k^2 r_2 + t_2 \right), \; \begin{pmatrix} \dfrac{k^2 t_2}{3} & \dfrac{1}{3} i \sqrt{2} \, k t_2 & \dfrac{i k t_2}{3} \\[2mm] -\dfrac{1}{3} i \sqrt{2} \, k t_2 & \dfrac{1}{2}\left(3 k^2 r_3 + \dfrac{4 t_2}{3} \right) & \dfrac{\sqrt{2} \, t_2}{3} \\[2mm] -\dfrac{1}{3} i k t_2 & \dfrac{\sqrt{2} \, t_2}{3} & \dfrac{t_2}{3} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2 k^2 t_3}{3} & \dfrac{2 i k t_3}{3} & 0 & -\dfrac{1}{3} i \sqrt{2} \, k t_3 \\[2mm] -\dfrac{2}{3} i k t_3 & \dfrac{2 t_3}{3} & 0 & -\dfrac{\sqrt{2} \, t_3}{3} \\[2mm] 0 & 0 & 0 & 0 \\[2mm] \dfrac{1}{3} i \sqrt{2} \, k t_3 & -\dfrac{\sqrt{2} \, t_3}{3} & 0 & \dfrac{t_3}{3} \end{pmatrix}, \; \begin{pmatrix} 0 & 0 \\ 0 & -\dfrac{3 k^2 r_3}{2} \end{pmatrix}, \; (0) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet} \tau^{b\perp} == 0, \; -i \, {}^{0^+}_{\bullet} \tau^{b\|} == 2 k \, {}^{0^+}_{\bullet} \sigma^{b\|}, \; -i \, {}^{1^+}_{\bullet} \tau^{b\|}{}^{ab} == k \, {}^{1^+}_{\bullet} \sigma^{b\perp}{}^{ab}, \right.$$

$$\left. i \, {}^{1^-}_{\bullet} \tau^{b\|}{}^{a} == 2 k \, {}^{1^-}_{\bullet} \sigma^{b\perp}{}^{a}, \; {}^{1^-}_{\bullet} \tau^{b\perp}{}^{a} == 0, \; -i \, {}^{1^-}_{\bullet} \tau^{b\|}{}^{a} == k \, {}^{1^-}_{\bullet} \sigma^{b\|}{}^{a}, \; {}^{2^+}_{\bullet} \tau^{b\|}{}^{ab} == 0, \; {}^{2^-}_{\bullet} \sigma^{b\|}{}^{abc} == 0 \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
   analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} \dfrac{2k^2}{(1+2k^2)^2 t_3} & \dfrac{i\sqrt{2}\,k}{(1+2k^2)^2 t_3} & 0 \\ -\dfrac{i\sqrt{2}\,k}{(1+2k^2)^2 t_3} & \dfrac{1}{(1+2k^2)^2 t_3} & 0 \\ 0 & 0 & 0 \end{pmatrix},\; \begin{pmatrix} \dfrac{1}{k^2 r_2 + t_2} \end{pmatrix},\; \begin{pmatrix} \dfrac{9k^2 r_3 + 4t_2}{3(1+k^2)^2 r_3 t_2} & -\dfrac{2i\sqrt{2}}{3kr_3 + 3k^3 r_3} & \dfrac{i(9k^2 r_3 + 4t_2)}{3k(1+k^2)^2 r_3 t_2} \\ \dfrac{2i\sqrt{2}}{3kr_3 + 3k^3 r_3} & \dfrac{2}{3k^2 r_3} & -\dfrac{2\sqrt{2}}{3k^2 r_3 + 3k^4 r_3} \\ -\dfrac{i(9k^2 r_3 + 4t_2)}{3k(1+k^2)^2 r_3 t_2} & -\dfrac{2\sqrt{2}}{3k^2 r_3 + 3k^4 r_3} & \dfrac{9k^2 r_3 + 4t_2}{3(k+k^3)^2 r_3 t_2} \end{pmatrix},\right.$$

$$\left. \begin{pmatrix} \dfrac{6k^2}{(3+2k^2)^2 t_3} & \dfrac{6ik}{(3+2k^2)^2 t_3} & 0 & -\dfrac{3i\sqrt{2}\,k}{(3+2k^2)^2 t_3} \\ -\dfrac{6ik}{(3+2k^2)^2 t_3} & \dfrac{6}{(3+2k^2)^2 t_3} & 0 & -\dfrac{3\sqrt{2}}{(3+2k^2)^2 t_3} \\ 0 & 0 & 0 & 0 \\ \dfrac{3i\sqrt{2}\,k}{(3+2k^2)^2 t_3} & -\dfrac{3\sqrt{2}}{(3+2k^2)^2 t_3} & 0 & \dfrac{3}{(3+2k^2)^2 t_3} \end{pmatrix},\; \begin{pmatrix} 0 & 0 \\ 0 & -\dfrac{2}{3k^2 r_3} \end{pmatrix},\; \begin{pmatrix} 0 \end{pmatrix} \right\}$$

Square masses:

$$\left\{ \{\}, \left\{ -\dfrac{t_2}{r_2} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \left\{ -\dfrac{1}{r_2} \right\}, \{\}, \{\}, \{\}, \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2},\; 0^-,\; -\dfrac{t_2}{r_2} \right\},\; \{\} \right\}$$

Overall unitarity conditions:

$$r_2 < 0\; \&\&\; t_2 > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0\; \&\&\; t_2 > 0$$

Okay, that concludes the analysis of this theory.

Case 42

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 42 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_5 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{6} r_2 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} -$$

$$r_5 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_h{}^l{}_{jl} + \frac{1}{4} t_1 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} + \frac{1}{2} t_1 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} + \frac{1}{3} \left(t_1 - 2 t_3 \right) \mathcal{T}^{i}{}_i{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \, \mathcal{A}_i{}^l{}_l \, \mathcal{A}^{ij}{}_j + \frac{2}{3} t_3 \, \mathcal{A}_i{}^l{}_l \, \mathcal{A}^{ij}{}_j + t_1 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - r_5 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^j \mathcal{A}_l{}^a{}_a + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h -$$

$$\frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} - r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{hlj} +$$

$$2 r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} + \frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{2} t_1 \, \partial^a f_{jh} \, \partial^h f_a{}^j +$$

$$\frac{1}{2} t_1 \, \partial^a f_h{}^l \, \partial^h f_{al} - \frac{1}{2} t_1 \, \partial^a f_{ih} \, \partial^h f^i{}_a + \frac{1}{3} t_1 \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i - \frac{2}{3} t_3 \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i + \frac{1}{3} t_1 \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i -$$

$$\frac{2}{3} t_3 \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i + \frac{2}{3} t_1 \, \partial^a f_{ah} \, \partial^h f^i{}_i - \frac{4}{3} t_3 \, \partial^a f_{ah} \, \partial^h f^i{}_i - \frac{1}{3} t_1 \, \partial_h f^l{}_l \, \partial^h f^i{}_i + \frac{2}{3} t_3 \, \partial_h f^l{}_l \, \partial^h f^i{}_i +$$

$$t_1 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l + \frac{1}{2} t_1 \, \partial_h f_i{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_1 \, \partial^{a'} f_{a'}{}^a \, \partial^h f_{ha} + \frac{2}{3} t_3 \, \partial^{a'} f_{a'}{}^a \, \partial^h f_{ha} - \frac{1}{3} t_1 \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j +$$

$$\frac{2}{3} t_3 \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j - \frac{1}{3} t_1 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} - \frac{1}{2} t_1 \, \partial^a f_h{}^l \, \partial^h f_{la} + t_1 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j +$$

$$\frac{1}{2} t_1 \, \partial_h f_j{}^l \, \partial^h f_l{}^j - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i + r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial^l \mathcal{A}^{jh}{}_h - r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2 k^2 t_3 & i \sqrt{2} \, k t_3 & 0 \\ -i \sqrt{2} \, k t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2 r_2 - t_1 \right), \begin{pmatrix} 0 & -\frac{i k t_1}{\sqrt{2}} & 0 \\ \frac{i k t_1}{\sqrt{2}} & \frac{1}{2} \left(2 k^2 r_5 - t_1 \right) & -\frac{t_1}{\sqrt{2}} \\ 0 & -\frac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{2}{3} k^2 \left(t_1 + t_3 \right) & -\frac{1}{3} i k \left(t_1 - 2 t_3 \right) & 0 & -\frac{1}{3} i \sqrt{2} \, k \left(t_1 + t_3 \right) \\ \frac{1}{3} i k \left(t_1 - 2 t_3 \right) & \frac{1}{6} \left(6 k^2 r_5 + t_1 + 4 t_3 \right) & 0 & \frac{t_1 - 2 t_3}{3 \sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2} \, k \left(t_1 + t_3 \right) & \frac{t_1 - 2 t_3}{3 \sqrt{2}} & 0 & \frac{t_1 + t_3}{3} \end{pmatrix}, \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \left(\frac{t_1}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{b\perp} == 0, \ -i \, {}^{0^+}_{\bullet}\tau^{b\|} == 2 k \, {}^{0^+}_{\bullet}\sigma^{b\|}, \ -i \, {}^{1^+}_{\bullet}\tau^{b\|}{}^{ab} == k \, {}^{1^+}_{\bullet}\sigma^{b\perp ab}, \ i \, {}^{1^-}_{\bullet}\tau^{b\|}{}^{a} == 2 k \, {}^{1^-}_{\bullet}\sigma^{b\perp a}, \ {}^{1^-}_{\bullet}\tau^{b\perp a} == 0, \ -i \, {}^{2^+}_{\bullet}\tau^{b\|}{}^{ab} == 2 k \, {}^{2^+}_{\bullet}\sigma^{b\|}{}^{ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
  analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} \dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[6pt] -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[6pt] 0 & 0 & 0 \end{pmatrix},\; \begin{pmatrix} \dfrac{1}{k^2\,r_2 - t_1} \end{pmatrix},\; \begin{pmatrix} \dfrac{-2\,k^4\,r_5 + k^2\,t_1}{\left(1+k^2\right)^2 t_1^{\,2}} & -\dfrac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & -\dfrac{i\left(2\,k^3\,r_5 - k\,t_1\right)}{\left(1+k^2\right)^2 t_1^{\,2}} \\[6pt] \dfrac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & 0 & -\dfrac{\sqrt{2}}{t_1 + k^2\,t_1} \\[6pt] \dfrac{i\left(2\,k^3\,r_5 - k\,t_1\right)}{\left(1+k^2\right)^2 t_1^{\,2}} & -\dfrac{\sqrt{2}}{t_1 + k^2\,t_1} & \dfrac{-2\,k^2\,r_5 + t_1}{\left(1+k^2\right)^2 t_1^{\,2}} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \dfrac{2\,k^2\left(6\,k^2\,r_5 + t_1 + 4\,t_3\right)}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} & \dfrac{2\,i\,k\left(t_1 - 2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} & 0 & -\dfrac{i\,\sqrt{2}\,k\left(6\,k^2\,r_5 + t_1 + 4\,t_3\right)}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} \\[6pt] -\dfrac{2\,i\,k\left(t_1 - 2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} & \dfrac{2\left(t_1 + t_3\right)}{3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)} & 0 & -\dfrac{\sqrt{2}\left(t_1 - 2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} \\[6pt] 0 & 0 & 0 & 0 \\[6pt] \dfrac{i\,\sqrt{2}\,k\left(6\,k^2\,r_5 + t_1 + 4\,t_3\right)}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} & -\dfrac{\sqrt{2}\left(t_1 - 2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} & 0 & \dfrac{6\,k^2\,r_5 + t_1 + 4\,t_3}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3 + 2\,k^2\,r_5\left(t_1 + t_3\right)\right)} \end{pmatrix},\; \begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\[6pt] -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_1} \end{pmatrix},\; \left(\dfrac{2}{t_1}\right) \left.\right\}$$

Square masses:

$$\left\{ 0,\; \left\{ \dfrac{t_1}{r_2} \right\},\; 0,\; \left\{ -\dfrac{3\,t_1\,t_3}{2\,r_5\,t_1 + 2\,r_5\,t_3} \right\},\; 0,\; 0 \right\}$$

Massive pole residues:

$$\left\{ 0,\; \left\{ -\dfrac{1}{r_2} \right\},\; 0,\; \left\{ \dfrac{6\,t_1\,t_3\left(t_1 + t_3\right) - 3\,r_5\left(t_1^{\,2} + 2\,t_3^{\,2}\right)}{2\,r_5\left(t_1 + t_3\right)\left(-3\,t_1\,t_3 + r_5\left(t_1 + t_3\right)\right)} \right\},\; 0,\; 0 \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2},\; 0^-,\; \dfrac{t_1}{r_2} \right\},\; \left\{ \dfrac{6\,t_1\,t_3\left(t_1 + t_3\right) - 3\,r_5\left(t_1^{\,2} + 2\,t_3^{\,2}\right)}{2\,r_5\left(t_1 + t_3\right)\left(-3\,t_1\,t_3 + r_5\left(t_1 + t_3\right)\right)},\; 1^-,\; -\dfrac{3\,t_1\,t_3}{2\,r_5\,t_1 + 2\,r_5\,t_3} \right\},\; 0 \right\}$$

Overall unitarity conditions:

$$r_2 < 0\ \&\&\ r_5 < 0\ \&\&\ t_1 < 0\ \&\&\ 0 < t_3 < -t_1$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0\ \&\&\ r_5 < 0\ \&\&\ t_1 < 0\ \&\&\ 0 < t_3 < -t_1$$

Okay, that concludes the analysis of this theory.

Case 43

Now for a new theory. Here is the full nonlinear Lagrangian for
Case 43 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6} r_2 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} - \frac{2}{3} r_2 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_5 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{6} r_2 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} -$$

$$r_5 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_h{}^{l}{}_{jl} + \frac{1}{12} \left(4 t_1 + t_2 \right) \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} + \frac{1}{6} \left(2 t_1 - t_2 \right) \mathcal{T}^{ijh} \, \mathcal{T}_{jih} + t_1 \, \mathcal{T}^{i}{}_i{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
this Lagrangian to second order around the desired vacuum:

$$-t_1 \, \mathcal{A}_i{}^l{}_l \, \mathcal{A}^{ij}{}_j + \frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} + \frac{1}{3} t_1 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} -$$

$$r_5 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_l{}^a{}_a + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{1}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} - \frac{2}{3} r_2 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} -$$

$$r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{hlj} + 2 r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{hlj} + \frac{1}{3} r_2 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} +$$

$$\frac{2}{3} r_2 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{3} t_1 \, \partial^a f_{jh} \, \partial^h f_a{}^j + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^j + \frac{1}{3} t_1 \, \partial^a f_h{}^l \, \partial^h f_{al} - \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{al} +$$

$$\frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a - \frac{2}{3} t_1 \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a + t_1 \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i +$$

$$t_1 \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i + 2 t_1 \, \partial^a f_{ah} \, \partial^h f^i{}_i - t_1 \, \partial_h f^l{}_l \, \partial^h f^i{}_i - \frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} +$$

$$\frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_1 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l + \frac{2}{3} t_1 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l -$$

$$\frac{1}{3} t_2 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l + \frac{2}{3} t_1 \, \partial_h f^i{}_i \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial_h f^i{}_i \, \partial^h f^i{}_l - t_1 \, \partial^{a'} f_{a'}{}^a \, \partial^h f_{ha} - t_1 \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j - t_1 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} -$$

$$\frac{1}{3} t_1 \, \partial^a f_h{}^l \, \partial^h f_{la} + \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{la} + \frac{2}{3} t_1 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j + \frac{1}{3} t_1 \, \partial_h f_j{}^l \, \partial^h f_l{}^j -$$

$$\frac{1}{6} t_2 \, \partial_h f_j{}^l \, \partial^h f_l{}^j - \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i + \frac{2}{3} r_2 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i + r_5 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial^l \mathcal{A}^{jh}{}_h - r_5 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2 k^2 t_1 & -i \sqrt{2} \, k \, t_1 & 0 \\ i \sqrt{2} \, k \, t_1 & -t_1 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(k^2 r_2 + t_2 \right), \right.$$

$$\begin{pmatrix} \frac{1}{3} k^2 \left(t_1 + t_2 \right) & -\frac{i k \left(t_1 - 2 t_2 \right)}{3 \sqrt{2}} & \frac{1}{3} i k \left(t_1 + t_2 \right) \\ \frac{i k \left(t_1 - 2 t_2 \right)}{3 \sqrt{2}} & \frac{1}{6} \left(6 k^2 r_5 + t_1 + 4 t_2 \right) & \frac{-t_1 + 2 t_2}{3 \sqrt{2}} \\ -\frac{1}{3} i k \left(t_1 + t_2 \right) & \frac{-t_1 + 2 t_2}{3 \sqrt{2}} & \frac{t_1 + t_2}{3} \end{pmatrix}, \begin{pmatrix} 0 & -i k t_1 & 0 & 0 \\ i k t_1 & k^2 r_5 - \frac{t_1}{2} & 0 & \frac{t_1}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{t_1}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \left(\frac{t_1}{2} \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0, \ -i \, {}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2\,k\, {}^{0^+}_{\bullet}\sigma^{\flat\parallel}, \ -i\, {}^{1^+}_{\bullet}\tau^{\flat\parallel\,ab} == k\, {}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab}, \ i\, {}^{1^-}_{\bullet}\tau^{\flat\parallel\,a} == 2\,k\, {}^{1^-}_{\bullet}\sigma^{\flat\perp\,a}, \ {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0, \ -i\, {}^{2^+}_{\bullet}\tau^{\flat\parallel\,ab} == 2\,k\, {}^{2^+}_{\bullet}\sigma^{\flat\parallel\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\dfrac{2\,k^2}{(1+2\,k^2)^2\,t_1} & -\dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} & 0 \\[2mm] \dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} & -\dfrac{1}{(1+2\,k^2)^2\,t_1} & 0 \\[2mm] 0 & 0 & 0 \end{pmatrix}, \ \begin{pmatrix} \dfrac{1}{k^2\,r_2+t_2} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \dfrac{k^2\left(6\,k^2\,r_5 t_1 + 4\,t_2\right)}{(1+k^2)^2\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} & \dfrac{i\,\sqrt{2}\,k\left(t_1 - 2\,t_2\right)}{(1+k^2)\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} & \dfrac{i\,k\left(6\,k^2\,r_5 t_1 + 4\,t_2\right)}{(1+k^2)^2\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} \\[3mm] -\dfrac{i\,\sqrt{2}\,k\left(t_1 - 2\,t_2\right)}{(1+k^2)\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} & \dfrac{2\left(t_1 + t_2\right)}{3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)} & \dfrac{\sqrt{2}\left(t_1 - 2\,t_2\right)}{(1+k^2)\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} \\[3mm] -\dfrac{i\,k\left(6\,k^2\,r_5 t_1 + 4\,t_2\right)}{(1+k^2)^2\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} & \dfrac{\sqrt{2}\left(t_1 - 2\,t_2\right)}{(1+k^2)\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} & \dfrac{6\,k^2\,r_5 t_1 + 4\,t_2}{(1+k^2)^2\left(3\,t_1 t_2 + 2\,k^2\,r_5\left(t_1 + t_2\right)\right)} \end{pmatrix},$$

$$\left. \begin{pmatrix} \dfrac{-4\,k^4\,r_5 + 2\,k^2\,t_1}{\left(t_1 + 2\,k^2\,t_1\right)^2} & -\dfrac{2\,i\,k}{t_1 + 2\,k^2\,t_1} & 0 & \dfrac{i\,\sqrt{2}\,k\left(2\,k^2\,r_5 - t_1\right)}{\left(t_1 + 2\,k^2\,t_1\right)^2} \\[3mm] \dfrac{2\,i\,k}{t_1 + 2\,k^2\,t_1} & 0 & 0 & \dfrac{\sqrt{2}}{t_1 + 2\,k^2\,t_1} \\[3mm] 0 & 0 & 0 & 0 \\[3mm] -\dfrac{i\,\sqrt{2}\,k\left(2\,k^2\,r_5 - t_1\right)}{\left(t_1 + 2\,k^2\,t_1\right)^2} & \dfrac{\sqrt{2}}{t_1 + 2\,k^2\,t_1} & 0 & \dfrac{-2\,k^2\,r_5 + t_1}{\left(t_1 + 2\,k^2\,t_1\right)^2} \end{pmatrix}, \ \begin{pmatrix} \dfrac{4\,k^2}{(1+2\,k^2)^2\,t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} \\[2mm] -\dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1} & \dfrac{2}{(1+2\,k^2)^2\,t_1} \end{pmatrix}, \ \begin{pmatrix} \dfrac{2}{t_1} \end{pmatrix} \right\}$$

Square masses:

$$\left\{ \{\}, \ \left\{ -\dfrac{t_2}{r_2} \right\}, \ \left\{ -\dfrac{3\,t_1 t_2}{2\,r_5 t_1 + 2\,r_5 t_2} \right\}, \ \{\}, \ \{\}, \ \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \ \left\{ -\dfrac{1}{r_2} \right\}, \ \left\{ \dfrac{-3\,t_1 t_2\left(t_1 + t_2\right) + 3\,r_5\left(t_1^2 + 2\,t_2^2\right)}{r_5\left(t_1 + t_2\right)\left(-3\,t_1 t_2 + 2\,r_5\left(t_1 + t_2\right)\right)} \right\}, \ \{\}, \ \{\}, \ \{\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2}, \ 0^-, \ -\dfrac{t_2}{r_2} \right\}, \ \left\{ \dfrac{-3\,t_1 t_2\left(t_1 + t_2\right) + 3\,r_5\left(t_1^2 + 2\,t_2^2\right)}{r_5\left(t_1 + t_2\right)\left(-3\,t_1 t_2 + 2\,r_5\left(t_1 + t_2\right)\right)}, \ 1^+, \ -\dfrac{3\,t_1 t_2}{2\,r_5 t_1 + 2\,r_5 t_2} \right\}, \ \{\} \right\}$$

Overall unitarity conditions:

$$r_2 < 0 \ \&\& \ r_5 > 0 \ \&\& \ t_1 < 0 \ \&\& \ t_2 > -t_1$$

So, that's the end of the PSALTer output for this theory. You
can check the particle content against TABLE IV. in arXiv:1910.14197.
If you take the overall unitarity conditions from the final column in
TABLE V., and decompose them using Mathematica's Reduce function, you
get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \,\&\&\, r_5 > 0 \,\&\&\, t_1 < 0 \,\&\&\, t_2 > -t_1$$

Okay, that concludes the analysis of this theory.

Case 44

Now for a new theory. Here is the full nonlinear Lagrangian for
Case 44 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3} r_1 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} + \frac{2}{3} r_1 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} + r_5 \, \mathcal{R}^{ij}{}_i{}^{h} \, \mathcal{R}_{jhl}{}^{l} - \frac{2}{3} r_1 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} -$$

$$r_5 \, \mathcal{R}^{ij}{}_i{}^{h} \, \mathcal{R}_{hjl}{}^{l} + \frac{1}{4} t_1 \, \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} + \frac{1}{2} t_1 \, \mathcal{T}^{ijh} \, \mathcal{T}_{jih} + \frac{1}{3} \left(t_1 - 2 t_3 \right) \mathcal{T}^{i}{}_i{}^{j} \, \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \, \mathcal{A}_i{}^{l}{}_l \, \mathcal{A}^{ij}{}_j + \frac{2}{3} t_3 \, \mathcal{A}_i{}^{l}{}_l \, \mathcal{A}^{ij}{}_j + t_1 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - r_5 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^j \mathcal{A}_l{}^{a}{}_a - \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^{h} -$$

$$\frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{aa'j} + \frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^{h} \, \partial_h \mathcal{A}^{jaa'} - r_5 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial_h \mathcal{A}^{jhl} + r_5 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial_h \mathcal{A}^{jhl} - r_5 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial_h \mathcal{A}^{hlj} +$$

$$2 r_5 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{2} t_1 \, \partial^a f_{jh} \, \partial^h f_a{}^{j} +$$

$$\frac{1}{2} t_1 \, \partial^a f_h{}^{l} \, \partial^h f_{al} - \frac{1}{2} t_1 \, \partial^a f_{ih} \, \partial^h f^{i}{}_a + \frac{1}{3} t_1 \, \mathcal{A}_h{}^{a}{}_a \, \partial^h f^{i}{}_i - \frac{2}{3} t_3 \, \mathcal{A}_h{}^{a}{}_a \, \partial^h f^{i}{}_i + \frac{1}{3} t_1 \, \mathcal{A}_h{}^{l}{}_l \, \partial^h f^{i}{}_i -$$

$$\frac{2}{3} t_3 \, \mathcal{A}_h{}^{l}{}_l \, \partial^h f^{i}{}_i + \frac{2}{3} t_1 \, \partial^a f_{ah} \, \partial^h f^{i}{}_i - \frac{4}{3} t_3 \, \partial^a f_{ah} \, \partial^h f^{i}{}_i - \frac{1}{3} t_1 \, \partial_h f^{l}{}_l \, \partial^h f^{i}{}_i + \frac{2}{3} t_3 \, \partial_h f^{l}{}_l \, \partial^h f^{i}{}_i +$$

$$t_1 \, \mathcal{A}^{l}{}_{hi} \, \partial^h f^{i}{}_l + \frac{1}{2} t_1 \, \partial_h f_i{}^{l} \, \partial^h f^{i}{}_l - \frac{1}{3} t_1 \, \partial^{a'} f_{a'}{}^{a} \, \partial^h f_{ha} + \frac{2}{3} t_3 \, \partial^{a'} f_{a'}{}^{a} \, \partial^h f_{ha} - \frac{1}{3} t_1 \, \mathcal{A}_j{}^{l}{}_l \, \partial^h f_h{}^{j} +$$

$$\frac{2}{3} t_3 \, \mathcal{A}_j{}^{l}{}_l \, \partial^h f_h{}^{j} - \frac{1}{3} t_1 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} + \frac{2}{3} t_3 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} - \frac{1}{2} t_1 \, \partial^a f_h{}^{l} \, \partial^h f_{la} + t_1 \, \mathcal{A}_{jh}{}^{l} \, \partial^h f_l{}^{j} +$$

$$\frac{1}{2} t_1 \, \partial_h f_j{}^{l} \, \partial^h f_l{}^{j} + \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^{i} - \frac{8}{3} r_1 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^{i} + r_5 \, \partial_a \mathcal{A}_l{}^{a}{}_j \, \partial^l \mathcal{A}^{jh}{}_h - r_5 \, \partial_j \mathcal{A}_l{}^{a}{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} 2\,k^2\,t_{\cdot\,3} & i\,\sqrt{2}\,k\,t_{\cdot\,3} & 0 \\ -i\,\sqrt{2}\,k\,t_{\cdot\,3} & t_{\cdot\,3} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(-t_{\cdot\,1}\right),\ \begin{pmatrix} 0 & -\dfrac{i\,k\,t_{\cdot\,1}}{\sqrt{2}} & 0 \\ \dfrac{i\,k\,t_{\cdot\,1}}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\left(2\,r_{\cdot\,1}+r_{\cdot\,5}\right)-t_{\cdot\,1}\right) & -\dfrac{t_{\cdot\,1}}{\sqrt{2}} \\ 0 & -\dfrac{t_{\cdot\,1}}{\sqrt{2}} & 0 \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \frac{2}{3}\,k^2\left(t_{\cdot\,1}+t_{\cdot\,3}\right) & -\frac{1}{3}\,i\,k\left(t_{\cdot\,1}-2\,t_{\cdot\,3}\right) & 0 & -\frac{1}{3}\,i\,\sqrt{2}\,k\left(t_{\cdot\,1}+t_{\cdot\,3}\right) \\ \frac{1}{3}\,i\,k\left(t_{\cdot\,1}-2\,t_{\cdot\,3}\right) & \frac{1}{6}\left(6\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)+t_{\cdot\,1}+4\,t_{\cdot\,3}\right) & 0 & \frac{t_{\cdot\,1}-2\,t_{\cdot\,3}}{3\,\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3}\,i\,\sqrt{2}\,k\left(t_{\cdot\,1}+t_{\cdot\,3}\right) & \frac{t_{\cdot\,1}-2\,t_{\cdot\,3}}{3\,\sqrt{2}} & 0 & \frac{t_{\cdot\,1}+t_{\cdot\,3}}{3} \end{pmatrix},\ \begin{pmatrix} k^2\,t_{\cdot\,1} & \dfrac{i\,k\,t_{\cdot\,1}}{\sqrt{2}} \\ -\dfrac{i\,k\,t_{\cdot\,1}}{\sqrt{2}} & \dfrac{t_{\cdot\,1}}{2} \end{pmatrix},\ \left(\frac{1}{2}\left(2\,k^2\,r_{\cdot\,1}+t_{\cdot\,1}\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\cdot}\tau^{b\perp} == 0,\ -i\,{}^{0^+}_{\cdot}\tau^{b\|} == 2\,k\,{}^{0^+}_{\cdot}\sigma^{b\|},\ -i\,{}^{1^+}_{\cdot}\tau^{b\|\,ab} == k\,{}^{1^+}_{\cdot}\sigma^{b\perp\,ab},\ i\,{}^{1^-}_{\cdot}\tau^{b\|\,a} == 2\,k\,{}^{1^-}_{\cdot}\sigma^{b\perp\,a},\ {}^{1^-}_{\cdot}\tau^{b\perp\,a} == 0,\ -i\,{}^{2^+}_{\cdot}\tau^{b\|\,ab} == 2\,k\,{}^{2^+}_{\cdot}\sigma^{b\|\,ab}\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} \dfrac{2\,k^2}{\left(1+2\,k^2\right)^2\,t_{\cdot\,3}} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\cdot\,3}} & 0 \\ -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\cdot\,3}} & \dfrac{1}{\left(1+2\,k^2\right)^2\,t_{\cdot\,3}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(-\frac{1}{t_{\cdot\,1}}\right),\ \begin{pmatrix} \dfrac{-2\,k^4\left(2\,r_{\cdot\,1}+r_{\cdot\,5}\right)+k^2\,t_{\cdot\,1}}{\left(1+k^2\right)^2\,t_{\cdot\,1}^2} & -\dfrac{i\,\sqrt{2}\,k}{t_{\cdot\,1}+k^2\,t_{\cdot\,1}} & \dfrac{-2\,i\,k^3\left(2\,r_{\cdot\,1}+r_{\cdot\,5}\right)+i\,k\,t_{\cdot\,1}}{\left(1+k^2\right)^2\,t_{\cdot\,1}^2} \\ \dfrac{i\,\sqrt{2}\,k}{t_{\cdot\,1}+k^2\,t_{\cdot\,1}} & 0 & -\dfrac{\sqrt{2}}{t_{\cdot\,1}+k^2\,t_{\cdot\,1}} \\ \dfrac{i\left(2\,k^3\left(2\,r_{\cdot\,1}+r_{\cdot\,5}\right)-k\,t_{\cdot\,1}\right)}{\left(1+k^2\right)^2\,t_{\cdot\,1}^2} & -\dfrac{\sqrt{2}}{t_{\cdot\,1}+k^2\,t_{\cdot\,1}} & \dfrac{-2\,k^2\left(2\,r_{\cdot\,1}+r_{\cdot\,5}\right)+t_{\cdot\,1}}{\left(1+k^2\right)^2\,t_{\cdot\,1}^2} \end{pmatrix},\right.$$

$$\begin{pmatrix} \dfrac{2\,k^2\left(6\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)+t_{\cdot\,1}+4\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)^2\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} & \dfrac{2\,i\,k\left(t_{\cdot\,1}-2\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} & 0 & -\dfrac{i\,\sqrt{2}\,k\left(6\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)+t_{\cdot\,1}+4\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)^2\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} \\ -\dfrac{2\,i\,k\left(t_{\cdot\,1}-2\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} & \dfrac{2\left(t_{\cdot\,1}+t_{\cdot\,3}\right)}{3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)} & 0 & -\dfrac{\sqrt{2}\left(t_{\cdot\,1}-2\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\,\sqrt{2}\,k\left(6\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)+t_{\cdot\,1}+4\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)^2\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} & -\dfrac{\sqrt{2}\left(t_{\cdot\,1}-2\,t_{\cdot\,3}\right)}{\left(1+2\,k^2\right)\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} & 0 & \dfrac{6\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)+t_{\cdot\,1}+4\,t_{\cdot\,3}}{\left(1+2\,k^2\right)^2\left(3\,t_{\cdot\,1}\,t_{\cdot\,3}+2\,k^2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)\right)} \end{pmatrix},$$

$$\left.\begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2\,t_{\cdot\,1}} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\cdot\,1}} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\cdot\,1}} & \dfrac{2}{\left(1+2\,k^2\right)^2\,t_{\cdot\,1}} \end{pmatrix},\ \left(\frac{2}{2\,k^2\,r_{\cdot\,1}+t_{\cdot\,1}}\right)\right\}$$

Square masses:

$$\left\{\{\},\ \{\},\ \{\},\ \left\{-\frac{3\,t_{\cdot\,1}\,t_{\cdot\,3}}{2\left(r_{\cdot\,1}+r_{\cdot\,5}\right)\left(t_{\cdot\,1}+t_{\cdot\,3}\right)}\right\},\ \{\},\ \left\{-\frac{t_{\cdot\,1}}{2\,r_{\cdot\,1}}\right\}\right\}$$

Massive pole residues:

$$\left\{0,\, 0,\, 0,\, \left\{-\frac{3\left(-2\, t_{\underset{1}{.}}\, t_{\underset{3}{.}}\, \left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)+r_{\underset{1}{.}}\left(t_{\underset{1}{.}}^2+2\, t_{\underset{3}{.}}^2\right)+r_{\underset{5}{.}}\left(t_{\underset{1}{.}}^2+2\, t_{\underset{3}{.}}^2\right)\right)}{2\left(r_{\underset{1}{.}}+r_{\underset{5}{.}}\right)\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)\left(-3\, t_{\underset{1}{.}}\, t_{\underset{3}{.}}+r_{\underset{1}{.}}\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)+r_{\underset{5}{.}}\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)\right)}\right\},\, 0,\, \left\{-\frac{1}{r_{\underset{1}{.}}}\right\}\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{3\left(-2\, t_{\underset{1}{.}}\, t_{\underset{3}{.}}\, \left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)+r_{\underset{1}{.}}\left(t_{\underset{1}{.}}^2+2\, t_{\underset{3}{.}}^2\right)+r_{\underset{5}{.}}\left(t_{\underset{1}{.}}^2+2\, t_{\underset{3}{.}}^2\right)\right)}{2\left(r_{\underset{1}{.}}+r_{\underset{5}{.}}\right)\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)\left(-3\, t_{\underset{1}{.}}\, t_{\underset{3}{.}}+r_{\underset{1}{.}}\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)+r_{\underset{5}{.}}\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)\right)},\, 1^-,\, -\frac{3\, t_{\underset{1}{.}}\, t_{\underset{3}{.}}}{2\left(r_{\underset{1}{.}}+r_{\underset{5}{.}}\right)\left(t_{\underset{1}{.}}+t_{\underset{3}{.}}\right)}\right\},\, \left\{-\frac{1}{r_{\underset{1}{.}}},\, 2^-,\, -\frac{t_{\underset{1}{.}}}{2\, r_{\underset{1}{.}}}\right\},\, \{\}\right\}$$

Overall unitarity conditions:

$$r_{\underset{1}{.}} < 0 \,\&\&\, r_{\underset{5}{.}} < -r_{\underset{1}{.}} \,\&\&\, t_{\underset{1}{.}} > 0 \,\&\&\, \left(t_{\underset{3}{.}} < -t_{\underset{1}{.}} \,\|\, t_{\underset{3}{.}} > 0\right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_{\underset{1}{.}} < 0 \,\&\&\, r_{\underset{5}{.}} < -r_{\underset{1}{.}} \,\&\&\, t_{\underset{1}{.}} > 0 \,\&\&\, t_{\underset{3}{.}} < -t_{\underset{1}{.}}\right) \,\|\, \left(r_{\underset{1}{.}} < 0 \,\&\&\, r_{\underset{5}{.}} < -r_{\underset{1}{.}} \,\&\&\, t_{\underset{1}{.}} > 0 \,\&\&\, t_{\underset{3}{.}} > 0\right)$$

Okay, that concludes the analysis of this theory.

Case 45

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 45 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\, r_{\underset{1}{.}}\, \mathcal{R}_{ijhl}\, \mathcal{R}^{ijhl} + \frac{2}{3}\, r_{\underset{1}{.}}\, \mathcal{R}_{ihjl}\, \mathcal{R}^{ijhl} + r_{\underset{5}{.}}\, \mathcal{R}^{ij\,h}_{\ \ \ i}\, \mathcal{R}_{j\ hl}^{\ l} - \frac{2}{3}\, r_{\underset{1}{.}}\, \mathcal{R}^{ijhl}\, \mathcal{R}_{hlij} -$$

$$r_{\underset{5}{.}}\, \mathcal{R}^{ij\,h}_{\ \ \ i}\, \mathcal{R}_{h\ jl}^{\ l} + \frac{1}{12}\left(4\, t_{\underset{1}{.}} + t_{\underset{2}{.}}\right)\mathcal{T}_{ijh}\, \mathcal{T}^{ijh} + \frac{1}{6}\left(2\, t_{\underset{1}{.}} - t_{\underset{2}{.}}\right)\mathcal{T}^{ijh}\, \mathcal{T}_{jih} + t_{\underset{1}{.}}\, \mathcal{T}^{i\ j}_{\ i}\, \mathcal{T}^{h}_{\ jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_1 \mathcal{A}_{i\ l}^{\ l} \mathcal{A}^{ij}_{\ \ j} + \frac{1}{3} t_1 \mathcal{A}_{ijh} \mathcal{A}^{ijh} + \frac{1}{3} t_2 \mathcal{A}_{ijh} \mathcal{A}^{ijh} + \frac{1}{3} t_1 \mathcal{A}_{ihj} \mathcal{A}^{ijh} - \frac{2}{3} t_2 \mathcal{A}_{ihj} \mathcal{A}^{ijh} -$$

$$r_5 \partial_i \mathcal{A}^{hl}_{\ \ h} \partial^i \mathcal{A}_{l\ a}^{\ a} - \frac{2}{3} r_1 \partial^{a'} \mathcal{A}^{ja}_{\ \ h} \partial_j \mathcal{A}_{aa'}^{\ \ \ h} - \frac{2}{3} r_1 \partial_j \mathcal{A}_{aa'}^{\ \ \ h} \partial_h \mathcal{A}^{aa'j} + \frac{2}{3} r_1 \partial_j \mathcal{A}_{aa'}^{\ \ \ h} \partial_h \mathcal{A}^{jaa'} -$$

$$r_5 \partial_a \mathcal{A}_{l\ j}^{\ a} \partial_h \mathcal{A}^{jhl} + r_5 \partial_j \mathcal{A}_{l\ a}^{\ a} \partial_h \mathcal{A}^{jhl} - r_5 \partial_a \mathcal{A}_{l\ j}^{\ a} \partial_h \mathcal{A}^{hlj} + 2 r_5 \partial_j \mathcal{A}_{l\ a}^{\ a} \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \partial_h \mathcal{A}^{aa'j} \partial^h \mathcal{A}_{aa'j} -$$

$$\frac{2}{3} r_1 \partial_h \mathcal{A}^{jaa'} \partial^h \mathcal{A}_{aa'j} - \frac{1}{3} t_1 \partial^a f_{jh} \partial^h f_a^{\ j} + \frac{1}{6} t_2 \partial^a f_{jh} \partial^h f_a^{\ j} + \frac{1}{3} t_1 \partial^a f_h^{\ l} \partial^h f_{al} - \frac{1}{6} t_2 \partial^a f_h^{\ l} \partial^h f_{al} +$$

$$\frac{1}{3} t_1 \mathcal{A}_{ih}^{\ \ a} \partial^h f_a^{\ i} + \frac{1}{3} t_2 \mathcal{A}_{ih}^{\ \ a} \partial^h f_a^{\ i} - \frac{2}{3} t_1 \partial^a f_{ih} \partial^h f_a^{\ i} - \frac{1}{6} t_2 \partial^a f_{ih} \partial^h f_a^{\ i} + t_1 \mathcal{A}_{h\ a}^{\ a} \partial^h f_{\ i}^{\ i} +$$

$$t_1 \mathcal{A}_{h\ l}^{\ l} \partial^h f_{\ i}^{\ i} + 2 t_1 \partial^a f_{ah} \partial^h f_{\ i}^{\ i} - t_1 \partial_h f_{\ l}^{\ l} \partial^h f_{\ i}^{\ i} - \frac{1}{3} t_1 \mathcal{A}_{ijh} \partial^h f^{ij} - \frac{1}{3} t_2 \mathcal{A}_{ijh} \partial^h f^{ij} +$$

$$\frac{1}{3} t_1 \mathcal{A}_{ih}^{\ \ l} \partial^h f_{\ l}^{\ i} + \frac{1}{3} t_2 \mathcal{A}_{ih}^{\ \ l} \partial^h f_{\ l}^{\ i} - \frac{1}{3} t_1 \mathcal{A}_{i\ h}^{\ l} \partial^h f_{\ l}^{\ i} - \frac{1}{3} t_2 \mathcal{A}_{i\ h}^{\ l} \partial^h f_{\ l}^{\ i} + \frac{2}{3} t_1 \mathcal{A}_{\ hi}^{l} \partial^h f_{\ l}^{\ i} -$$

$$\frac{1}{3} t_2 \mathcal{A}_{\ hi}^{l} \partial^h f_{\ l}^{\ i} + \frac{2}{3} t_1 \partial_h f_{\ i}^{\ l} \partial^h f_{\ l}^{\ i} + \frac{1}{6} t_2 \partial_h f_{\ i}^{\ l} \partial^h f_{\ l}^{\ i} - t_1 \partial^{a'} f_{a'}^{\ a} \partial^h f_{ha} - t_1 \mathcal{A}_{j\ l}^{\ l} \partial^h f_{\ h}^{\ j} - t_1 \mathcal{A}_{\ a}^{la} \partial^h f_{hl} -$$

$$\frac{1}{3} t_1 \partial^a f_h^{\ l} \partial^h f_{la} + \frac{1}{6} t_2 \partial^a f_h^{\ l} \partial^h f_{la} + \frac{2}{3} t_1 \mathcal{A}_{jh}^{\ \ l} \partial^h f_{\ l}^{\ j} - \frac{1}{3} t_2 \mathcal{A}_{jh}^{\ \ l} \partial^h f_{\ l}^{\ j} + \frac{1}{3} t_1 \partial_h f_j^{\ l} \partial^h f_{\ l}^{\ j} -$$

$$\frac{1}{6} t_2 \partial_h f_j^{\ l} \partial^h f_{\ l}^{\ j} + \frac{2}{3} r_1 \partial^{a'} \mathcal{A}_{i}^{\ al} \partial_l \mathcal{A}_{aa'}^{\ \ \ i} - \frac{8}{3} r_1 \partial^{a'} \mathcal{A}_{i}^{\ la} \partial_l \mathcal{A}_{aa'}^{\ \ \ i} + r_5 \partial_a \mathcal{A}_{l\ j}^{\ a} \partial^l \mathcal{A}^{jh}_{\ \ h} - r_5 \partial_j \mathcal{A}_{l\ a}^{\ a} \partial^l \mathcal{A}^{jh}_{\ \ h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2 k^2 t_1 & -i \sqrt{2} k t_1 & 0 \\ i \sqrt{2} k t_1 & -t_1 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} t_2 \end{pmatrix}, \begin{pmatrix} \frac{1}{3} k^2 \left(t_1 + t_2 \right) & -\frac{i k \left(t_1 - 2 t_2 \right)}{3 \sqrt{2}} & \frac{1}{3} i k \left(t_1 + t_2 \right) \\ \frac{i k \left(t_1 - 2 t_2 \right)}{3 \sqrt{2}} & \frac{1}{6} \left(6 k^2 \left(2 r_1 + r_5 \right) + t_1 + 4 t_2 \right) & \frac{-t_1 + 2 t_2}{3 \sqrt{2}} \\ -\frac{1}{3} i k \left(t_1 + t_2 \right) & \frac{-t_1 + 2 t_2}{3 \sqrt{2}} & \frac{t_1 + t_2}{3} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} 0 & -i k t_1 & 0 & 0 \\ i k t_1 & k^2 \left(r_1 + r_5 \right) - \frac{t_1}{2} & 0 & \frac{t_1}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{t_1}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \begin{pmatrix} \frac{1}{2} \left(2 k^2 r_1 + t_1 \right) \end{pmatrix} \right\}$$

Gauge constraints on source currents:

$$\left\{ \overset{0^+}{\bullet} \tau^{b\perp} == 0, \ -i \overset{0^+}{\bullet} \tau^{b\|} == 2 k \overset{0^+}{\bullet} \sigma^{b\|}, \ -i \overset{1^+}{\bullet} \tau^{b\|}{}^{ab} == k \overset{1^+}{\bullet} \sigma^{b\perp ab}, \ i \overset{1^-}{\bullet} \tau^{b\|}{}^{a} == 2 k \overset{1^-}{\bullet} \sigma^{b\perp a}, \ \overset{1^-}{\bullet} \tau^{b\perp a} == 0, \ -i \overset{2^+}{\bullet} \tau^{b\|}{}^{ab} == 2 k \overset{2^+}{\bullet} \sigma^{b\|}{}^{ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_1} & -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & 0 \\[2mm] \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & -\dfrac{1}{\left(1+2\,k^2\right)^2 t_1} & 0 \\[2mm] 0 & 0 & 0 \end{pmatrix}, \ \left(\dfrac{1}{t_2} \right), \right.$$

$$\begin{pmatrix} \dfrac{k^2\left(6\,k^2\left(2\,r_1+r_5\right)+t_1+4\,t_2\right)}{(1+k^2)^2\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} & \dfrac{i\,\sqrt{2}\,k\left(t_1-2\,t_2\right)}{(1+k^2)\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} & \dfrac{i\,k\left(6\,k^2\left(2\,r_1+r_5\right)+t_1+4\,t_2\right)}{(1+k^2)^2\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} \\[3mm] -\dfrac{i\,\sqrt{2}\,k\left(t_1-2\,t_2\right)}{(1+k^2)\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} & \dfrac{2\left(t_1+t_2\right)}{3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)} & \dfrac{\sqrt{2}\left(t_1-2\,t_2\right)}{(1+k^2)\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} \\[3mm] -\dfrac{i\,k\left(6\,k^2\left(2\,r_1+r_5\right)+t_1+4\,t_2\right)}{(1+k^2)^2\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} & \dfrac{\sqrt{2}\left(t_1-2\,t_2\right)}{(1+k^2)\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} & \dfrac{6\,k^2\left(2\,r_1+r_5\right)+t_1+4\,t_2}{(1+k^2)^2\left(3\,t_1\,t_2+2\,k^2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\right)} \end{pmatrix},$$

$$\left. \begin{pmatrix} \dfrac{-4\,k^4\left(r_1+r_5\right)+2\,k^2\,t_1}{\left(t_1+2\,k^2\,t_1\right)^2} & -\dfrac{2\,i\,k}{t_1+2\,k^2\,t_1} & 0 & \dfrac{i\,\sqrt{2}\,k\left(2\,k^2\left(r_1+r_5\right)-t_1\right)}{\left(t_1+2\,k^2\,t_1\right)^2} \\[3mm] \dfrac{2\,i\,k}{t_1+2\,k^2\,t_1} & 0 & 0 & \dfrac{\sqrt{2}}{t_1+2\,k^2\,t_1} \\[3mm] 0 & 0 & 0 & 0 \\[3mm] -\dfrac{i\,\sqrt{2}\,k\left(2\,k^2\left(r_1+r_5\right)-t_1\right)}{\left(t_1+2\,k^2\,t_1\right)^2} & \dfrac{\sqrt{2}}{t_1+2\,k^2\,t_1} & 0 & \dfrac{-2\,k^2\left(r_1+r_5\right)+t_1}{\left(t_1+2\,k^2\,t_1\right)^2} \end{pmatrix}, \ \begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\[3mm] -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_1} \end{pmatrix}, \ \left(\dfrac{2}{2\,k^2\,r_1+t_1} \right) \right\}$$

Square masses:

$$\left\{ 0, \ 0, \ \left\{ -\dfrac{3\,t_1\,t_2}{2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)} \right\}, \ 0, \ 0, \ \left\{ -\dfrac{t_1}{2\,r_1} \right\} \right\}$$

Massive pole residues:

$$\left\{ 0, \ 0, \ \left\{ \dfrac{-3\,t_1\,t_2\left(t_1+t_2\right)+6\,r_1\left(t_1^{\,2}+2\,t_2^{\,2}\right)+3\,r_5\left(t_1^{\,2}+2\,t_2^{\,2}\right)}{\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\left(-3\,t_1\,t_2+4\,r_1\left(t_1+t_2\right)+2\,r_5\left(t_1+t_2\right)\right)} \right\}, \ 0, \ 0, \ \left\{ -\dfrac{1}{r_1} \right\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ \dfrac{-3\,t_1\,t_2\left(t_1+t_2\right)+6\,r_1\left(t_1^{\,2}+2\,t_2^{\,2}\right)+3\,r_5\left(t_1^{\,2}+2\,t_2^{\,2}\right)}{\left(2\,r_1+r_5\right)\left(t_1+t_2\right)\left(-3\,t_1\,t_2+4\,r_1\left(t_1+t_2\right)+2\,r_5\left(t_1+t_2\right)\right)}, \ 1^+, \ -\dfrac{3\,t_1\,t_2}{2\left(2\,r_1+r_5\right)\left(t_1+t_2\right)} \right\}, \ \left\{ -\dfrac{1}{r_1}, \ 2^-, \ -\dfrac{t_1}{2\,r_1} \right\}, \ 0 \right\}$$

Overall unitarity conditions:

$$r_1 < 0 \ \&\& \ r_5 > -2\,r_1 \ \&\& \ t_1 > 0 \ \&\& \ -t_1 < t_2 < 0$$

So, that's the end of the PSALTer output for this theory. You
 can check the particle content against TABLE IV. in arXiv:1910.14197.
 If you take the overall unitarity conditions from the final column in
 TABLE V., and decompose them using Mathematica's Reduce function, you
 get the following (to be compared with the PSALTer conditions above):

$$r_1 < 0 \;\&\&\; r_5 > -2\,r_1 \;\&\&\; t_1 > 0 \;\&\&\; -t_1 < t_2 < 0$$

Okay, that concludes the analysis of this theory.

Case 46

Now for a new theory. Here is the full nonlinear Lagrangian for
 Case 46 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\left(2\,r_1 + r_2\right)\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\left(r_1 - r_2\right)\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} - 2\,r_1\,\mathcal{R}^{ij\,h}{}_{i}\ \mathcal{R}_{j}{}^{l}{}_{hl} + \frac{1}{6}\left(-4\,r_1 + r_2\right)\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} +$$

$$2\,r_1\,\mathcal{R}^{ij\,h}{}_{i}\ \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{12}\left(4\,t_1 + t_2\right)\mathcal{T}_{ijh}\ \mathcal{T}^{ijh} + \frac{1}{6}\left(2\,t_1 - t_2\right)\mathcal{T}^{ijh}\ \mathcal{T}_{jih} + t_1\,\mathcal{T}^{i\,j}{}_{i}\ \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
 this Lagrangian to second order around the desired vacuum:

$$-t_1\,\mathscr{A}_{i}{}^{l}{}_{l}\ \mathscr{A}^{ij}{}_{j} + \frac{1}{3}\,t_1\,\mathscr{A}_{ijh}\ \mathscr{A}^{ijh} + \frac{1}{3}\,t_2\,\mathscr{A}_{ijh}\ \mathscr{A}^{ijh} + \frac{1}{3}\,t_1\,\mathscr{A}_{ihj}\ \mathscr{A}^{ijh} - \frac{2}{3}\,t_2\,\mathscr{A}_{ihj}\ \mathscr{A}^{ijh} +$$

$$2\,r_1\,\partial_i\mathscr{A}^{hl}{}_{h}\ \partial^i\mathscr{A}_{l}{}^{a}{}_{a} - \frac{2}{3}\,r_1\,\partial^{a'}\mathscr{A}^{ja}{}_{h}\ \partial_j\mathscr{A}_{aa'}{}^{h} + \frac{2}{3}\,r_2\,\partial^{a'}\mathscr{A}^{ja}{}_{h}\ \partial_j\mathscr{A}_{aa'}{}^{h} - \frac{2}{3}\,r_1\,\partial_j\mathscr{A}_{aa'}{}^{h}\ \partial_h\mathscr{A}^{aa'j} -$$

$$\frac{1}{3}\,r_2\,\partial_j\mathscr{A}_{aa'}{}^{h}\ \partial_h\mathscr{A}^{aa'j} + \frac{2}{3}\,r_1\,\partial_j\mathscr{A}_{aa'}{}^{h}\ \partial_h\mathscr{A}^{jaa'} - \frac{2}{3}\,r_2\,\partial_j\mathscr{A}_{aa'}{}^{h}\ \partial_h\mathscr{A}^{jaa'} + 2\,r_1\,\partial_a\mathscr{A}_{l}{}^{a}{}_{j}\ \partial_h\mathscr{A}^{jhl} -$$

$$2\,r_1\,\partial_j\mathscr{A}_{l}{}^{a}{}_{a}\ \partial_h\mathscr{A}^{jhl} + 2\,r_1\,\partial_a\mathscr{A}_{l}{}^{a}{}_{j}\ \partial_h\mathscr{A}^{hlj} - 4\,r_1\,\partial_j\mathscr{A}_{l}{}^{a}{}_{a}\ \partial_h\mathscr{A}^{hlj} + \frac{2}{3}\,r_1\,\partial_h\mathscr{A}^{aa'j}\ \partial^h\mathscr{A}_{aa'j} +$$

$$\frac{1}{3}\,r_2\,\partial_h\mathscr{A}^{aa'j}\ \partial^h\mathscr{A}_{aa'j} - \frac{2}{3}\,r_1\,\partial_h\mathscr{A}^{jaa'}\ \partial^h\mathscr{A}_{aa'j} + \frac{2}{3}\,r_2\,\partial_h\mathscr{A}^{jaa'}\ \partial^h\mathscr{A}_{aa'j} - \frac{1}{3}\,t_1\,\partial^a f_{jh}\ \partial^h f_{a}{}^{j} +$$

$$\frac{1}{6}\,t_2\,\partial^a f_{jh}\ \partial^h f_{a}{}^{j} + \frac{1}{3}\,t_1\,\partial^a f_{h}{}^{l}\ \partial^h f_{al} - \frac{1}{6}\,t_2\,\partial^a f_{h}{}^{l}\ \partial^h f_{al} + \frac{1}{3}\,t_1\,\mathscr{A}_{ih}{}^{a}\ \partial^h f^i{}_{a} + \frac{1}{3}\,t_2\,\mathscr{A}_{ih}{}^{a}\ \partial^h f^i{}_{a} -$$

$$\frac{2}{3}\,t_1\,\partial^a f_{ih}\ \partial^h f^i{}_{a} - \frac{1}{6}\,t_2\,\partial^a f_{ih}\ \partial^h f^i{}_{a} + t_1\,\mathscr{A}_{h}{}^{a}{}_{a}\ \partial^h f^i{}_{i} + t_1\,\mathscr{A}_{h}{}^{l}{}_{l}\ \partial^h f^i{}_{i} + 2\,t_1\,\partial^a f_{ah}\ \partial^h f^i{}_{i} - t_1\,\partial_h f^l{}_{l}\ \partial^h f^i{}_{i} -$$

$$\frac{1}{3}\,t_1\,\mathscr{A}_{ijh}\ \partial^h f^{ij} - \frac{1}{3}\,t_2\,\mathscr{A}_{ijh}\ \partial^h f^{ij} + \frac{1}{3}\,t_1\,\mathscr{A}_{ih}{}^{l}\ \partial^h f^i{}_{l} + \frac{1}{3}\,t_2\,\mathscr{A}_{ih}{}^{l}\ \partial^h f^i{}_{l} - \frac{1}{3}\,t_1\,\mathscr{A}_{i}{}^{l}{}_{h}\ \partial^h f^i{}_{l} -$$

$$\frac{1}{3}\,t_2\,\mathscr{A}_{i}{}^{l}{}_{h}\ \partial^h f^i{}_{l} + \frac{2}{3}\,t_1\,\mathscr{A}^{l}{}_{hi}\ \partial^h f^i{}_{l} - \frac{1}{3}\,t_2\,\mathscr{A}^{l}{}_{hi}\ \partial^h f^i{}_{l} + \frac{2}{3}\,t_1\,\partial_h f_i{}^{l}\ \partial^h f^i{}_{l} + \frac{1}{6}\,t_2\,\partial_h f_i{}^{l}\ \partial^h f^i{}_{l} -$$

$$t_1\,\partial^{a'} f_{a'}{}^{a}\ \partial^h f_{ha} - t_1\,\mathscr{A}_{j}{}^{l}{}_{l}\ \partial^h f_{h}{}^{j} - t_1\,\mathscr{A}^{la}{}_{a}\ \partial^h f_{hl} - \frac{1}{3}\,t_1\,\partial^a f_{h}{}^{l}\ \partial^h f_{la} + \frac{1}{6}\,t_2\,\partial^a f_{h}{}^{l}\ \partial^h f_{la} + \frac{2}{3}\,t_1\,\mathscr{A}_{jh}{}^{l}\ \partial^h f_{l}{}^{j} -$$

$$\frac{1}{3}\,t_2\,\mathscr{A}_{jh}{}^{l}\ \partial^h f_{l}{}^{j} + \frac{1}{3}\,t_1\,\partial_h f_j{}^{l}\ \partial^h f_{l}{}^{j} - \frac{1}{6}\,t_2\,\partial_h f_j{}^{l}\ \partial^h f_{l}{}^{j} + \frac{2}{3}\,r_1\,\partial^{a'}\mathscr{A}_{i}{}^{al}\ \partial_l\mathscr{A}_{aa'}{}^{i} - \frac{2}{3}\,r_2\,\partial^{a'}\mathscr{A}_{i}{}^{al}\ \partial_l\mathscr{A}_{aa'}{}^{i} -$$

$$\frac{8}{3}\,r_1\,\partial^{a'}\mathscr{A}_{i}{}^{la}\ \partial_l\mathscr{A}_{aa'}{}^{i} + \frac{2}{3}\,r_2\,\partial^{a'}\mathscr{A}_{i}{}^{la}\ \partial_l\mathscr{A}_{aa'}{}^{i} - 2\,r_1\,\partial_a\mathscr{A}_{l}{}^{a}{}_{j}\ \partial^l\mathscr{A}^{jh}{}_{h} + 2\,r_1\,\partial_j\mathscr{A}_{l}{}^{a}{}_{a}\ \partial^l\mathscr{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2k^2 t_{\bullet 1} & -i\sqrt{2}\,k t_{\bullet 1} & 0 \\ i\sqrt{2}\,k t_{\bullet 1} & -t_{\bullet 1} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \ \left(k^2 r_{\bullet 2} + t_{\bullet 2}\right), \ \begin{pmatrix} \frac{1}{3}k^2\left(t_{\bullet 1}+t_{\bullet 2}\right) & -\frac{i k\left(t_{\bullet 1}-2t_{\bullet 2}\right)}{3\sqrt{2}} & \frac{1}{3}i k\left(t_{\bullet 1}+t_{\bullet 2}\right) \\ \frac{i k\left(t_{\bullet 1}-2t_{\bullet 2}\right)}{3\sqrt{2}} & \frac{1}{6}\left(t_{\bullet 1}+4t_{\bullet 2}\right) & \frac{-t_{\bullet 1}+2t_{\bullet 2}}{3\sqrt{2}} \\ -\frac{1}{3}i k\left(t_{\bullet 1}+t_{\bullet 2}\right) & \frac{-t_{\bullet 1}+2t_{\bullet 2}}{3\sqrt{2}} & \frac{t_{\bullet 1}+t_{\bullet 2}}{3} \end{pmatrix}, \right.$$

$$\begin{pmatrix} 0 & -i k t_{\bullet 1} & 0 & 0 \\ i k t_{\bullet 1} & -k^2 r_{\bullet 1}-\frac{t_{\bullet 1}}{2} & 0 & \frac{t_{\bullet 1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{t_{\bullet 1}}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \ \begin{pmatrix} k^2 t_{\bullet 1} & \frac{i k t_{\bullet 1}}{\sqrt{2}} \\ -\frac{i k t_{\bullet 1}}{\sqrt{2}} & \frac{t_{\bullet 1}}{2} \end{pmatrix}, \ \left(\frac{1}{2}\left(2k^2 r_{\bullet 1}+t_{\bullet 1}\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0, \ -i\,{}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2k\,{}^{0^+}_{\bullet}\sigma^{\flat\parallel}, \ -i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}\,\mathfrak{b}} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\,\mathfrak{b}}, \ i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}} == 2k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}}, \ {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0, \ -i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}\,\mathfrak{b}} == 2k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel\,\mathfrak{a}\,\mathfrak{b}} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\frac{2k^2}{\left(1+2k^2\right)^2 t_{\bullet 1}} & -\frac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\bullet 1}} & 0 \\ \frac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\bullet 1}} & -\frac{1}{\left(1+2k^2\right)^2 t_{\bullet 1}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \ \left(\frac{1}{k^2 r_{\bullet 2}+t_{\bullet 2}}\right), \ \begin{pmatrix} \frac{k^2\left(t_{\bullet 1}+4t_{\bullet 2}\right)}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} & \frac{i\sqrt{2}\,k\left(t_{\bullet 1}-2t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} & \frac{i k\left(t_{\bullet 1}+4t_{\bullet 2}\right)}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} \\ -\frac{i\sqrt{2}\,k\left(t_{\bullet 1}-2t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} & \frac{2\left(t_{\bullet 1}+t_{\bullet 2}\right)}{3 t_{\bullet 1} t_{\bullet 2}} & \frac{\sqrt{2}\left(t_{\bullet 1}-2t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} \\ -\frac{i k\left(t_{\bullet 1}+4t_{\bullet 2}\right)}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} & \frac{\sqrt{2}\left(t_{\bullet 1}-2t_{\bullet 2}\right)}{3\left(1+k^2\right) t_{\bullet 1} t_{\bullet 2}} & \frac{t_{\bullet 1}+4t_{\bullet 2}}{3\left(1+k^2\right)^2 t_{\bullet 1} t_{\bullet 2}} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{2k^2\left(2k^2 r_{\bullet 1}+t_{\bullet 1}\right)}{\left(t_{\bullet 1}+2k^2 t_{\bullet 1}\right)^2} & -\frac{2ik}{t_{\bullet 1}+2k^2 t_{\bullet 1}} & 0 & -\frac{i\sqrt{2}\,k\left(2k^2 r_{\bullet 1}+t_{\bullet 1}\right)}{\left(t_{\bullet 1}+2k^2 t_{\bullet 1}\right)^2} \\ \frac{2ik}{t_{\bullet 1}+2k^2 t_{\bullet 1}} & 0 & 0 & \frac{\sqrt{2}}{t_{\bullet 1}+2k^2 t_{\bullet 1}} \\ 0 & 0 & 0 & 0 \\ \frac{i\sqrt{2}\,k\left(2k^2 r_{\bullet 1}+t_{\bullet 1}\right)}{\left(t_{\bullet 1}+2k^2 t_{\bullet 1}\right)^2} & \frac{\sqrt{2}}{t_{\bullet 1}+2k^2 t_{\bullet 1}} & 0 & \frac{2k^2 r_{\bullet 1}+t_{\bullet 1}}{\left(t_{\bullet 1}+2k^2 t_{\bullet 1}\right)^2} \end{pmatrix}, \ \begin{pmatrix} \frac{4k^2}{\left(1+2k^2\right)^2 t_{\bullet 1}} & \frac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\bullet 1}} \\ -\frac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\bullet 1}} & \frac{2}{\left(1+2k^2\right)^2 t_{\bullet 1}} \end{pmatrix}, \ \left(\frac{2}{2k^2 r_{\bullet 1}+t_{\bullet 1}}\right)\right\}$$

Square masses:

$$\left\{ \{\}, \ \left\{-\frac{t_{\bullet 2}}{r_{\bullet 2}}\right\}, \ \{\}, \ \{\}, \ \{\}, \ \left\{-\frac{t_{\bullet 1}}{2r_{\bullet 1}}\right\}\right\}$$

Massive pole residues:

$$\left\{ \{\}, \ \left\{-\frac{1}{r_{\bullet 2}}\right\}, \ \{\}, \ \{\}, \ \{\}, \ \left\{-\frac{1}{r_{\bullet 1}}\right\}\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_2}\,,\;0^-\,,\;-\frac{t_2}{r_2}\right\},\;\left\{-\frac{1}{r_1}\,,\;2^-\,,\;-\frac{t_1}{2\,r_1}\right\},\;\{\}\right\}$$

Overall unitarity conditions:

$$r_1 < 0\;\&\&\;r_2 < 0\;\&\&\;t_1 > 0\;\&\&\;t_2 > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_1 < 0\;\&\&\;r_2 < 0\;\&\&\;t_1 > 0\;\&\&\;t_2 > 0$$

Okay, that concludes the analysis of this theory.

Case 47

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 47 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$r_5\,\mathcal{R}^{ij\,\hbar}{}_i\,\mathcal{R}_j{}^l{}_{\hbar l} - r_5\,\mathcal{R}^{ij\,\hbar}{}_i\,\mathcal{R}_\hbar{}^l{}_{jl} + \frac{1}{4}\,t_1\,\mathcal{T}_{ij\hbar}\,\mathcal{T}^{ij\hbar} + \frac{1}{2}\,t_1\,\mathcal{T}^{ij\hbar}\,\mathcal{T}_{ji\hbar} + \frac{1}{3}\left(t_1 - 2\,t_3\right)\mathcal{T}^i{}_i{}^j\,\mathcal{T}^\hbar{}_{j\hbar}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\,t_1\,\mathcal{A}_i{}^l{}_l\,\mathcal{A}^{ij}{}_j + \frac{2}{3}\,t_3\,\mathcal{A}_i{}^l{}_l\,\mathcal{A}^{ij}{}_j + t_1\,\mathcal{A}_{i\hbar j}\,\mathcal{A}^{ij\hbar} - r_5\,\partial_i\mathcal{A}^{\hbar l}{}_\hbar\,\partial^j\mathcal{A}_l{}^q{}_q - r_5\,\partial_q\mathcal{A}_l{}^q{}_j\,\partial_\hbar\mathcal{A}^{j\hbar l} +$$

$$r_5\,\partial_j\mathcal{A}_l{}^q{}_q\,\partial_\hbar\mathcal{A}^{j\hbar l} - r_5\,\partial_q\mathcal{A}_l{}^q{}_j\,\partial_\hbar\mathcal{A}^{\hbar l j} + 2\,r_5\,\partial_j\mathcal{A}_l{}^q{}_q\,\partial_\hbar\mathcal{A}^{\hbar l j} - \frac{1}{2}\,t_1\,\partial^q f_{j\hbar}\,\partial^\hbar f_q{}^j + \frac{1}{2}\,t_1\,\partial^q f_\hbar{}^l\,\partial^\hbar f_{q l} -$$

$$\frac{1}{2}\,t_1\,\partial^q f_{i\hbar}\,\partial^\hbar f^i{}_q + \frac{1}{3}\,t_1\,\mathcal{A}_\hbar{}^q{}_q\,\partial^\hbar f^i{}_i - \frac{2}{3}\,t_3\,\mathcal{A}_\hbar{}^q{}_q\,\partial^\hbar f^i{}_i + \frac{1}{3}\,t_1\,\mathcal{A}_\hbar{}^l{}_l\,\partial^\hbar f^i{}_i - \frac{2}{3}\,t_3\,\mathcal{A}_\hbar{}^l{}_l\,\partial^\hbar f^i{}_i +$$

$$\frac{2}{3}\,t_1\,\partial^q f_{q\hbar}\,\partial^\hbar f^i{}_i - \frac{4}{3}\,t_3\,\partial^q f_{q\hbar}\,\partial^\hbar f^i{}_i - \frac{1}{3}\,t_1\,\partial_\hbar f^l{}_l\,\partial^\hbar f^i{}_i + \frac{2}{3}\,t_3\,\partial_\hbar f^l{}_l\,\partial^\hbar f^i{}_i + t_1\,\mathcal{A}^l{}_{\hbar i}\,\partial^\hbar f^i{}_l + \frac{1}{2}\,t_1\,\partial_\hbar f^i{}_i\,\partial^\hbar f^i{}_l -$$

$$\frac{1}{3}\,t_1\,\partial^{q'} f_{q'}{}^q\,\partial^\hbar f_{\hbar q} + \frac{2}{3}\,t_3\,\partial^{q'} f_{q'}{}^q\,\partial^\hbar f_{\hbar q} - \frac{1}{3}\,t_1\,\mathcal{A}_j{}^l{}_l\,\partial^\hbar f_\hbar{}^j + \frac{2}{3}\,t_3\,\mathcal{A}_j{}^l{}_l\,\partial^\hbar f_\hbar{}^j - \frac{1}{3}\,t_1\,\mathcal{A}^{lq}{}_q\,\partial^\hbar f_{\hbar l} +$$

$$\frac{2}{3}\,t_3\,\mathcal{A}^{lq}{}_q\,\partial^\hbar f_{\hbar l} - \frac{1}{2}\,t_1\,\partial^q f_\hbar{}^l\,\partial^\hbar f_{l q} + t_1\,\mathcal{A}_{j\hbar}{}^l\,\partial^\hbar f_l{}^j + \frac{1}{2}\,t_1\,\partial_\hbar f_j{}^l\,\partial^\hbar f_l{}^j + r_5\,\partial_q\mathcal{A}_l{}^q{}_j\,\partial^l\mathcal{A}^{j\hbar}{}_\hbar - r_5\,\partial_j\mathcal{A}_l{}^q{}_q\,\partial^l\mathcal{A}^{j\hbar}{}_\hbar$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
2\,k^2\,t_3 & i\,\sqrt{2}\,k\,t_3 & 0 \\
-i\,\sqrt{2}\,k\,t_3 & t_3 & 0 \\
0 & 0 & 0
\end{pmatrix},\;
\left(-t_1\right),\;
\begin{pmatrix}
0 & -\dfrac{i\,k\,t_1}{\sqrt{2}} & 0 \\
\dfrac{i\,k\,t_1}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\,r_5 - t_1\right) & -\dfrac{t_1}{\sqrt{2}} \\
0 & -\dfrac{t_1}{\sqrt{2}} & 0
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
\dfrac{2}{3}\,k^2\left(t_1+t_3\right) & -\dfrac{1}{3}\,i\,k\left(t_1-2\,t_3\right) & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\left(t_1+t_3\right) \\
\dfrac{1}{3}\,i\,k\left(t_1-2\,t_3\right) & \dfrac{1}{6}\left(6\,k^2\,r_5+t_1+4\,t_3\right) & 0 & \dfrac{t_1-2\,t_3}{3\,\sqrt{2}} \\
0 & 0 & 0 & 0 \\
\dfrac{1}{3}\,i\,\sqrt{2}\,k\left(t_1+t_3\right) & \dfrac{t_1-2\,t_3}{3\,\sqrt{2}} & 0 & \dfrac{t_1+t_3}{3}
\end{pmatrix},
\begin{pmatrix}
k^2\,t_1 & \dfrac{i\,k\,t_1}{\sqrt{2}} \\
-\dfrac{i\,k\,t_1}{\sqrt{2}} & \dfrac{t_1}{2}
\end{pmatrix},
\left(\dfrac{t_1}{2}\right)
\right\}
$$

Gauge constraints on source currents:

$$
\left\{
{}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\;
-i\,{}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\parallel},\;
-i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}\mathfrak{b}} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\mathfrak{b}},\;
i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\;
{}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\;
-i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}\mathfrak{b}} == 2\,k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel\,\mathfrak{a}\mathfrak{b}}
\right\}
$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally
  analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\
-\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\
0 & 0 & 0
\end{pmatrix},\;
\left(-\dfrac{1}{t_1}\right),\;
\begin{pmatrix}
\dfrac{-2\,k^4\,r_5+k^2\,t_1}{\left(1+k^2\right)^2 t_1^2} & -\dfrac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & -\dfrac{i\left(2\,k^3\,r_5-k\,t_1\right)}{\left(1+k^2\right)^2 t_1^2} \\
\dfrac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & 0 & -\dfrac{\sqrt{2}}{t_1+k^2\,t_1} \\
\dfrac{i\left(2\,k^3\,r_5-k\,t_1\right)}{\left(1+k^2\right)^2 t_1^2} & -\dfrac{\sqrt{2}}{t_1+k^2\,t_1} & \dfrac{-2\,k^2\,r_5+t_1}{\left(1+k^2\right)^2 t_1^2}
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
\dfrac{2\,k^2\left(6\,k^2\,r_5+t_1+4\,t_3\right)}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} & \dfrac{2\,i\,k\left(t_1-2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} & 0 & -\dfrac{i\,\sqrt{2}\,k\left(6\,k^2\,r_5+t_1+4\,t_3\right)}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} \\
-\dfrac{2\,i\,k\left(t_1-2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} & \dfrac{2\left(t_1+t_3\right)}{3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)} & 0 & -\dfrac{\sqrt{2}\left(t_1-2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} \\
0 & 0 & 0 & 0 \\
\dfrac{i\,\sqrt{2}\,k\left(6\,k^2\,r_5+t_1+4\,t_3\right)}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} & -\dfrac{\sqrt{2}\left(t_1-2\,t_3\right)}{\left(1+2\,k^2\right)\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)} & 0 & \dfrac{6\,k^2\,r_5+t_1+4\,t_3}{\left(1+2\,k^2\right)^2\left(3\,t_1\,t_3+2\,k^2\,r_5\left(t_1+t_3\right)\right)}
\end{pmatrix},
\begin{pmatrix}
\dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\
-\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_1}
\end{pmatrix},
\left(\dfrac{2}{t_1}\right)
\right\}
$$

Square masses:

$$
\left\{0,\,0,\,0,\,\left\{-\dfrac{3\,t_1\,t_3}{2\,r_5\,t_1+2\,r_5\,t_3}\right\},\,0,\,0\right\}
$$

Massive pole residues:

$$
\left\{0,\,0,\,0,\,\left\{\dfrac{6\,t_1\,t_3\left(t_1+t_3\right)-3\,r_5\left(t_1^2+2\,t_3^2\right)}{2\,r_5\left(t_1+t_3\right)\left(-3\,t_1\,t_3+r_5\left(t_1+t_3\right)\right)}\right\},\,0,\,0\right\}
$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{\frac{6\,t_1\,t_3\left(t_1+t_3\right)-3\,r_5\left(t_1{}^2+2\,t_3{}^2\right)}{2\,r_5\left(t_1+t_3\right)\left(-3\,t_1\,t_3+r_5\left(t_1+t_3\right)\right)},\ 1^-,\ -\frac{3\,t_1\,t_3}{2\,r_5\,t_1+2\,r_5\,t_3}\right\},\ \{\}\right\}$$

Overall unitarity conditions:

$$r_5<0\ \&\&\ \left(\left(t_1<0\ \&\&\ 0<t_3<-t_1\right)\ ||\ \left(t_1>0\ \&\&\ \left(t_3<-t_1\ ||\ t_3>0\right)\right)\right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$\left(r_5<0\ \&\&\ t_1<0\ \&\&\ 0<t_3<-t_1\right)\ ||\ \left(r_5<0\ \&\&\ t_1>0\ \&\&\ t_3<-t_1\right)\ ||\ \left(r_5<0\ \&\&\ t_1>0\ \&\&\ t_3>0\right)$$

Okay, that concludes the analysis of this theory.

Case 48

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 48 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$r_5\,\mathcal{R}^{ij\,h}{}_i\,\mathcal{R}_{j\,h\,l}{}^l-r_5\,\mathcal{R}^{ij\,h}{}_i\,\mathcal{R}_{h\,j\,l}{}^l+\frac{1}{12}\left(4\,t_1+t_2\right)\mathcal{T}_{ij\,h}\,\mathcal{T}^{ij\,h}+\frac{1}{6}\left(2\,t_1-t_2\right)\mathcal{T}^{ij\,h}\,\mathcal{T}_{j\,i\,h}+t_1\,\mathcal{T}^i{}_i{}^j\,\mathcal{T}^h{}_{j\,h}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_1\,\mathcal{A}_i{}^l{}_l\,\mathcal{A}^{ij}{}_j+\frac{1}{3}\,t_1\,\mathcal{A}_{ij\,h}\,\mathcal{A}^{ij\,h}+\frac{1}{3}\,t_2\,\mathcal{A}_{ij\,h}\,\mathcal{A}^{ij\,h}+\frac{1}{3}\,t_1\,\mathcal{A}_{ih\,j}\,\mathcal{A}^{ij\,h}-$$

$$\frac{2}{3}\,t_2\,\mathcal{A}_{ih\,j}\,\mathcal{A}^{ij\,h}-r_5\,\partial_i\mathcal{A}^{h\,l}{}_h\,\partial^i\mathcal{A}_l{}^a{}_a-r_5\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{jh\,l}+r_5\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{jh\,l}-$$

$$r_5\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{h\,l\,j}+2\,r_5\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{h\,l\,j}-\frac{1}{3}\,t_1\,\partial^a f_{j\,h}\,\partial^h f_a{}^j+\frac{1}{6}\,t_2\,\partial^a f_{j\,h}\,\partial^h f_a{}^j+\frac{1}{3}\,t_1\,\partial^a f_h{}^l\,\partial^h f_{a\,l}-$$

$$\frac{1}{6}\,t_2\,\partial^a f_h{}^l\,\partial^h f_{a\,l}+\frac{1}{3}\,t_1\,\mathcal{A}_{ih}{}^a\,\partial^h f^i{}_a+\frac{1}{3}\,t_2\,\mathcal{A}_{ih}{}^a\,\partial^h f^i{}_a-\frac{2}{3}\,t_1\,\partial^a f_{ih}\,\partial^h f^i{}_a-\frac{1}{6}\,t_2\,\partial^a f_{ih}\,\partial^h f^i{}_a+$$

$$t_1\,\mathcal{A}_h{}^a{}_a\,\partial^h f^i{}_i+t_1\,\mathcal{A}_h{}^l{}_l\,\partial^h f^i{}_i+2\,t_1\,\partial^a f_{ah}\,\partial^h f^i{}_i-t_1\,\partial_h f^l{}_l\,\partial^h f^i{}_i-\frac{1}{3}\,t_1\,\mathcal{A}_{ij\,h}\,\partial^h f^{ij}-$$

$$\frac{1}{3}\,t_2\,\mathcal{A}_{ij\,h}\,\partial^h f^{ij}+\frac{1}{3}\,t_1\,\mathcal{A}_{ih}{}^l\,\partial^h f^i{}_l+\frac{1}{3}\,t_2\,\mathcal{A}_{ih}{}^l\,\partial^h f^i{}_l-\frac{1}{3}\,t_1\,\mathcal{A}_i{}^l{}_h\,\partial^h f^i{}_l-\frac{1}{3}\,t_2\,\mathcal{A}_i{}^l{}_h\,\partial^h f^i{}_l+$$

$$\frac{2}{3}\,t_1\,\mathcal{A}^l{}_{h\,i}\,\partial^h f^i{}_l-\frac{1}{3}\,t_2\,\mathcal{A}^l{}_{h\,i}\,\partial^h f^i{}_l+\frac{2}{3}\,t_1\,\partial_h f^i{}_i\,\partial^h f^i{}_l+\frac{1}{6}\,t_2\,\partial_h f^i{}_i\,\partial^h f^i{}_l-t_1\,\partial^{a'} f_{a'}{}^a\,\partial^h f_{h\,a}-$$

$$t_1\,\mathcal{A}^l{}_{j\,l}\,\partial^h f_h{}^j-t_1\,\mathcal{A}^{l\,a}{}_a\,\partial^h f_{h\,l}-\frac{1}{3}\,t_1\,\partial^a f_h{}^l\,\partial^h f_{l\,a}+\frac{1}{6}\,t_2\,\partial^a f_h{}^l\,\partial^h f_{l\,a}+\frac{2}{3}\,t_1\,\mathcal{A}_{j\,h}{}^l\,\partial^h f_l{}^j-$$

$$\frac{1}{3}\,t_2\,\mathcal{A}_{j\,h}{}^l\,\partial^h f_l{}^j+\frac{1}{3}\,t_1\,\partial_h f_j{}^l\,\partial^h f_l{}^j-\frac{1}{6}\,t_2\,\partial_h f_j{}^l\,\partial^h f_l{}^j+r_5\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial^l\mathcal{A}^{jh}{}_h-r_5\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2k^2 t_{\cdot_1} & -i\sqrt{2}\,k\,t_{\cdot_1} & 0 \\ i\sqrt{2}\,k\,t_{\cdot_1} & -t_{\cdot_1} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} t_{\cdot_2} \end{pmatrix}, \begin{pmatrix} \frac{1}{3}k^2\left(t_{\cdot_1}+t_{\cdot_2}\right) & -\frac{i\,k\left(t_{\cdot_1}-2t_{\cdot_2}\right)}{3\sqrt{2}} & \frac{1}{3}i\,k\left(t_{\cdot_1}+t_{\cdot_2}\right) \\ \frac{i\,k\left(t_{\cdot_1}-2t_{\cdot_2}\right)}{3\sqrt{2}} & \frac{1}{6}\left(6k^2 r_{\cdot_5}+t_{\cdot_1}+4t_{\cdot_2}\right) & \frac{-t_{\cdot_1}+2t_{\cdot_2}}{3\sqrt{2}} \\ -\frac{1}{3}i\,k\left(t_{\cdot_1}+t_{\cdot_2}\right) & \frac{-t_{\cdot_1}+2t_{\cdot_2}}{3\sqrt{2}} & \frac{t_{\cdot_1}+t_{\cdot_2}}{3} \end{pmatrix}, \right.$$

$$\begin{pmatrix} 0 & -i\,k\,t_{\cdot_1} & 0 & 0 \\ i\,k\,t_{\cdot_1} & k^2 r_{\cdot_5}-\frac{t_{\cdot_1}}{2} & 0 & \frac{t_{\cdot_1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{t_{\cdot_1}}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \begin{pmatrix} k^2 t_{\cdot_1} & \frac{i\,k\,t_{\cdot_1}}{\sqrt{2}} \\ -\frac{i\,k\,t_{\cdot_1}}{\sqrt{2}} & \frac{t_{\cdot_1}}{2} \end{pmatrix}, \begin{pmatrix} \frac{t_{\cdot_1}}{2} \end{pmatrix} \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\cdot}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\cdot}\tau^{\flat\|} == 2k\,{}^{0^+}_{\cdot}\sigma^{\flat\|},\ -i\,{}^{1^+}_{\cdot}\tau^{\flat\|}{}^{ab} == k\,{}^{1^+}\sigma^{\flat\perp}{}^{ab},\ i\,{}^{1^-}_{\cdot}\tau^{\flat\|}{}^{a} == 2k\,{}^{1^-}_{\cdot}\sigma^{\flat\perp}{}^{a},\ {}^{1^-}_{\cdot}\tau^{\flat\perp}{}^{a} == 0,\ -i\,{}^{2^+}_{\cdot}\tau^{\flat\|}{}^{ab} == 2k\,{}^{2^+}_{\cdot}\sigma^{\flat\|}{}^{ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
   analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\frac{2k^2}{\left(1+2k^2\right)^2 t_{\cdot_1}} & -\frac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\cdot_1}} & 0 \\ \frac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\cdot_1}} & -\frac{1}{\left(1+2k^2\right)^2 t_{\cdot_1}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} \frac{1}{t_{\cdot_2}} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{k^2\left(6k^2 r_{\cdot_5}+t_{\cdot_1}+4t_{\cdot_2}\right)}{\left(1+k^2\right)^2\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} & \frac{i\sqrt{2}\,k\left(t_{\cdot_1}-2t_{\cdot_2}\right)}{\left(1+k^2\right)\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} & \frac{i\,k\left(6k^2 r_{\cdot_5}+t_{\cdot_1}+4t_{\cdot_2}\right)}{\left(1+k^2\right)^2\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} \\ -\frac{i\sqrt{2}\,k\left(t_{\cdot_1}-2t_{\cdot_2}\right)}{\left(1+k^2\right)\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} & \frac{2\left(t_{\cdot_1}+t_{\cdot_2}\right)}{3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)} & \frac{\sqrt{2}\left(t_{\cdot_1}-2t_{\cdot_2}\right)}{\left(1+k^2\right)\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} \\ -\frac{i\,k\left(6k^2 r_{\cdot_5}+t_{\cdot_1}+4t_{\cdot_2}\right)}{\left(1+k^2\right)^2\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} & \frac{\sqrt{2}\left(t_{\cdot_1}-2t_{\cdot_2}\right)}{\left(1+k^2\right)\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} & \frac{6k^2 r_{\cdot_5}+t_{\cdot_1}+4t_{\cdot_2}}{\left(1+k^2\right)^2\left(3t_{\cdot_1}t_{\cdot_2}+2k^2 r_{\cdot_5}\left(t_{\cdot_1}+t_{\cdot_2}\right)\right)} \end{pmatrix},$$

$$\begin{pmatrix} \frac{-4k^4 r_{\cdot_5}+2k^2 t_{\cdot_1}}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} & -\frac{2ik}{t_{\cdot_1}+2k^2 t_{\cdot_1}} & 0 & \frac{i\sqrt{2}\,k\left(2k^2 r_{\cdot_5}-t_{\cdot_1}\right)}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} \\ \frac{2ik}{t_{\cdot_1}+2k^2 t_{\cdot_1}} & 0 & 0 & \frac{\sqrt{2}}{t_{\cdot_1}+2k^2 t_{\cdot_1}} \\ 0 & 0 & 0 & 0 \\ -\frac{i\sqrt{2}\,k\left(2k^2 r_{\cdot_5}-t_{\cdot_1}\right)}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} & \frac{\sqrt{2}}{t_{\cdot_1}+2k^2 t_{\cdot_1}} & 0 & \frac{-2k^2 r_{\cdot_5}+t_{\cdot_1}}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} \end{pmatrix}, \begin{pmatrix} \frac{4k^2}{\left(1+2k^2\right)^2 t_{\cdot_1}} & \frac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\cdot_1}} \\ -\frac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\cdot_1}} & \frac{2}{\left(1+2k^2\right)^2 t_{\cdot_1}} \end{pmatrix}, \begin{pmatrix} \frac{2}{t_{\cdot_1}} \end{pmatrix} \right\}$$

Square masses:

$$\left\{ \{\}, \{\}, \left\{ -\frac{3t_{\cdot_1}t_{\cdot_2}}{2r_{\cdot_5}t_{\cdot_1}+2r_{\cdot_5}t_{\cdot_2}} \right\}, \{\}, \{\}, \{\} \right\}$$

Massive pole residues:

$$\left\{0,\ 0,\ \left\{\frac{-3\,t_1\,t_2\left(t_1+t_2\right)+3\,r_5\left(t_1{}^2+2\,t_2{}^2\right)}{r_5\left(t_1+t_2\right)\left(-3\,t_1\,t_2+2\,r_5\left(t_1+t_2\right)\right)}\right\},\ 0,\ 0,\ 0\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{\frac{-3\,t_1\,t_2\left(t_1+t_2\right)+3\,r_5\left(t_1{}^2+2\,t_2{}^2\right)}{r_5\left(t_1+t_2\right)\left(-3\,t_1\,t_2+2\,r_5\left(t_1+t_2\right)\right)},\ 1^+,\ -\frac{3\,t_1\,t_2}{2\,r_5\,t_1+2\,r_5\,t_2}\right\},\ 0\right\}$$

Overall unitarity conditions:

$$r_5>0\ \&\&\ \left(\left(t_1<0\ \&\&\ \left(t_2<0\ \|\ t_2>-t_1\right)\right)\ \|\ \left(t_1>0\ \&\&\ -t_1<t_2<0\right)\right)$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_5>0\ \&\&\ \left(\left(t_1<0\ \&\&\ 0<t_2<-t_1\right)\ \|\ \left(t_1>0\ \&\&\ \left(t_2<-t_1\ \|\ t_2>0\right)\right)\right)$$

Okay, that concludes the analysis of this theory.

Case 49

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 49 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\,r_2\,\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl}-\frac{2}{3}\,r_2\,\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl}+r_5\,\mathcal{R}^{ij}{}_i{}^h\ \mathcal{R}_j{}^l{}_{hl}+\frac{1}{6}\,r_2\,\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij}-$$
$$r_5\,\mathcal{R}^{ij}{}_i{}^h\ \mathcal{R}_h{}^l{}_{jl}+\frac{1}{4}\,t_1\,\mathcal{T}_{ijh}\ \mathcal{T}^{ijh}+\frac{1}{2}\,t_1\,\mathcal{T}^{ijh}\ \mathcal{T}_{jih}+t_1\,\mathcal{T}^i{}_i{}^j\ \mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_{\underset{1}{\bullet}}\,\mathcal{A}_{i}{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_{j}+t_{\underset{1}{\bullet}}\,\mathcal{A}_{i\hbar j}\,\mathcal{A}^{ij\hbar}-r_{\underset{5}{\bullet}}\,\partial_{i}\mathcal{A}^{\hbar l}{}_{\hbar}\,\partial^{i}\mathcal{A}_{l}{}^{a}{}_{a}+\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial^{a'}\mathcal{A}^{ja}{}_{\hbar}\,\partial_{j}\mathcal{A}_{aa'}{}^{\hbar}-\frac{1}{3}\,r_{\underset{2}{\bullet}}\,\partial_{j}\mathcal{A}_{aa'}{}^{\hbar}\,\partial_{\hbar}\mathcal{A}^{aa'j}-$$

$$\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial_{j}\mathcal{A}_{aa'}{}^{\hbar}\,\partial_{\hbar}\mathcal{A}^{jaa'}-r_{\underset{5}{\bullet}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}+r_{\underset{5}{\bullet}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{j\hbar l}-r_{\underset{5}{\bullet}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{\hbar}\mathcal{A}^{\hbar l j}+2\,r_{\underset{5}{\bullet}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{\hbar}\mathcal{A}^{\hbar l j}+$$

$$\frac{1}{3}\,r_{\underset{2}{\bullet}}\,\partial_{\hbar}\mathcal{A}^{aa'j}\,\partial^{\hbar}\mathcal{A}_{aa'j}+\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial_{\hbar}\mathcal{A}^{jaa'}\,\partial^{\hbar}\mathcal{A}_{aa'j}-\frac{1}{2}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{j\hbar}\,\partial^{\hbar}f_{a}{}^{j}+\frac{1}{2}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{\hbar}{}^{l}\,\partial^{\hbar}f_{al}-\frac{1}{2}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{i\hbar}\,\partial^{\hbar}f^{i}{}_{a}+$$

$$t_{\underset{1}{\bullet}}\,\mathcal{A}_{\hbar}{}^{a}{}_{a}\,\partial^{\hbar}f^{i}{}_{i}+t_{\underset{1}{\bullet}}\,\mathcal{A}_{\hbar}{}^{l}{}_{l}\,\partial^{\hbar}f^{i}{}_{i}+2\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{a\hbar}\,\partial^{\hbar}f^{i}{}_{i}-t_{\underset{1}{\bullet}}\,\partial_{\hbar}f^{l}{}_{l}\,\partial^{\hbar}f^{i}{}_{i}+t_{\underset{1}{\bullet}}\,\mathcal{A}^{l}{}_{\hbar i}\,\partial^{\hbar}f^{i}{}_{l}+\frac{1}{2}\,t_{\underset{1}{\bullet}}\,\partial_{\hbar}f_{i}{}^{l}\,\partial^{\hbar}f^{i}{}_{l}-$$

$$t_{\underset{1}{\bullet}}\,\partial^{a'}f_{a'}{}^{a}\,\partial^{\hbar}f_{\hbar a}-t_{\underset{1}{\bullet}}\,\mathcal{A}_{j}{}^{l}{}_{l}\,\partial^{\hbar}f_{\hbar}{}^{j}-t_{\underset{1}{\bullet}}\,\mathcal{A}^{la}{}_{a}\,\partial^{\hbar}f_{\hbar l}-\frac{1}{2}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{\hbar}{}^{l}\,\partial^{\hbar}f_{la}+t_{\underset{1}{\bullet}}\,\mathcal{A}_{j\hbar}{}^{l}\,\partial^{\hbar}f_{l}{}^{j}+$$

$$\frac{1}{2}\,t_{\underset{1}{\bullet}}\,\partial_{\hbar}f_{j}{}^{l}\,\partial^{\hbar}f_{l}{}^{j}-\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial^{a'}\mathcal{A}_{i}{}^{al}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}+\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}+r_{\underset{5}{\bullet}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar}-r_{\underset{5}{\bullet}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{j\hbar}{}_{\hbar}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -2\,k^{2}\,t_{\underset{1}{\bullet}} & -i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & 0 \\ i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & -t_{\underset{1}{\bullet}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ \left(k^{2}\,r_{\underset{2}{\bullet}}\ -t_{\underset{1}{\bullet}}\right),\right.$$

$$\begin{pmatrix} 0 & -\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 \\ \dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^{2}\,r_{\underset{5}{\bullet}}-t_{\underset{1}{\bullet}}\right) & -\dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\ 0 & -\dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 \end{pmatrix},\ \begin{pmatrix} 0 & -i\,k\,t_{\underset{1}{\bullet}} & 0 & 0 \\ i\,k\,t_{\underset{1}{\bullet}} & k^{2}\,r_{\underset{5}{\bullet}}-\dfrac{t_{\underset{1}{\bullet}}}{2} & 0 & \dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 & 0 \end{pmatrix},\ \begin{pmatrix} k^{2}\,t_{\underset{1}{\bullet}} & \dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} \\ -\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{t_{\underset{1}{\bullet}}}{2} \end{pmatrix},\ \left(\dfrac{t_{\underset{1}{\bullet}}}{2}\right)\right\}$$

Gauge constraints on source currents:

$$\left\{\overset{0^{+}}{\bullet}\tau^{\flat\perp}==0,\ -i\,\overset{0^{+}}{\bullet}\tau^{\flat\parallel}==2\,k\,\overset{0^{+}}{\bullet}\sigma^{\flat\parallel},\ -i\,\overset{1^{+}}{\bullet}\tau^{\flat\parallel\,ab}==k\,\overset{1^{+}}{\bullet}\sigma^{\flat\perp\,ab},\ i\,\overset{1^{-}}{\bullet}\tau^{\flat\parallel\,a}==2\,k\,\overset{1^{-}}{\bullet}\sigma^{\flat\perp\,a},\ \overset{1^{-}}{\bullet}\tau^{\flat\perp\,a}==0,\ -i\,\overset{2^{+}}{\bullet}\tau^{\flat\parallel\,ab}==2\,k\,\overset{2^{+}}{\bullet}\sigma^{\flat\parallel\,ab}\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally
  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_1} & -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & 0 \\ \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & -\dfrac{1}{\left(1+2\,k^2\right)^2 t_1} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \ \left(\dfrac{1}{k^2\,r_2 - t_1} \right), \ \begin{pmatrix} \dfrac{-2\,k^4\,r_5 + k^2\,t_1}{\left(1+k^2\right)^2 t_1^{\,2}} & -\dfrac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & -\dfrac{i\left(2\,k^3\,r_5 - k\,t_1\right)}{\left(1+k^2\right)^2 t_1^{\,2}} \\ \dfrac{i\,\sqrt{2}\,k}{t_1 + k^2\,t_1} & 0 & -\dfrac{\sqrt{2}}{t_1 + k^2\,t_1} \\ \dfrac{i\left(2\,k^3\,r_5 - k\,t_1\right)}{\left(1+k^2\right)^2 t_1^{\,2}} & -\dfrac{\sqrt{2}}{t_1 + k^2\,t_1} & \dfrac{-2\,k^2\,r_5 + t_1}{\left(1+k^2\right)^2 t_1^{\,2}} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{-4\,k^4\,r_5 + 2\,k^2\,t_1}{\left(t_1 + 2\,k^2\,t_1\right)^2} & -\dfrac{2\,i\,k}{t_1 + 2\,k^2\,t_1} & 0 & \dfrac{i\,\sqrt{2}\,k\left(2\,k^2\,r_5 - t_1\right)}{\left(t_1 + 2\,k^2\,t_1\right)^2} \\ \dfrac{2\,i\,k}{t_1 + 2\,k^2\,t_1} & 0 & 0 & \dfrac{\sqrt{2}}{t_1 + 2\,k^2\,t_1} \\ 0 & 0 & 0 & 0 \\ -\dfrac{i\,\sqrt{2}\,k\left(2\,k^2\,r_5 - t_1\right)}{\left(t_1 + 2\,k^2\,t_1\right)^2} & \dfrac{\sqrt{2}}{t_1 + 2\,k^2\,t_1} & 0 & \dfrac{-2\,k^2\,r_5 + t_1}{\left(t_1 + 2\,k^2\,t_1\right)^2} \end{pmatrix}, \ \begin{pmatrix} \dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_1} \end{pmatrix}, \ \left(\dfrac{2}{t_1} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \ \left\{ \dfrac{t_1}{r_2} \right\}, \ \{\}, \ \{\}, \ \{\}, \ \{\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \ \left\{ -\dfrac{1}{r_2} \right\}, \ \{\}, \ \{\}, \ \{\}, \ \{\} \right\}$$

Massless eigenvalues:

$$\{\}$$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_2}, \ 0^-, \ \dfrac{t_1}{r_2} \right\}, \ \{\} \right\}$$

Overall unitarity conditions:

$$r_2 < 0 \ \&\& \ t_1 < 0$$

So, that's the end of the PSALTer output for this theory. You
    can check the particle content against TABLE IV. in arXiv:1910.14197.
    If you take the overall unitarity conditions from the final column in
    TABLE V., and decompose them using Mathematica's Reduce function, you
    get the following (to be compared with the PSALTer conditions above):

$$r_2 < 0 \ \&\& \ t_1 < 0$$

Okay, that concludes the analysis of this theory.

Case 50

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 50 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\, r_1\, \mathcal{R}_{ijħl}\; \mathcal{R}^{ijħl} + \frac{2}{3}\, r_1\, \mathcal{R}_{iħjl}\; \mathcal{R}^{ijħl} - r_1\, \mathcal{R}^{ij\;ħ}_{\quad i}\; \mathcal{R}^{\;\;l}_{j\;ħl} - \frac{2}{3}\, r_1\, \mathcal{R}^{ijħl}\; \mathcal{R}_{ħlij} +$$

$$r_1\, \mathcal{R}^{ij\;ħ}_{\quad i}\; \mathcal{R}^{\;\;l}_{ħ\;jl} + \frac{1}{4}\, t_1\, \mathcal{T}_{ijħ}\; \mathcal{T}^{ijħ} + \frac{1}{2}\, t_1\, \mathcal{T}^{ijħ}\; \mathcal{T}_{jiħ} + \frac{1}{3}\left(t_1 - 2\, t_3\right) \mathcal{T}^{i\;j}_{\;i}\; \mathcal{T}^{ħ}_{\;jħ}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\, t_1\, \mathcal{A}^{\;\;l}_{i\;l}\; \mathcal{A}^{ij}_{\quad j} + \frac{2}{3}\, t_3\, \mathcal{A}^{\;\;l}_{i\;l}\; \mathcal{A}^{ij}_{\quad j} + t_1\, \mathcal{A}_{iħj}\; \mathcal{A}^{ijħ} + r_1\, \partial_i\mathcal{A}^{ħl}_{\quad ħ}\; \partial^j\mathcal{A}^{\;\;a}_{l\;a} - \frac{2}{3}\, r_1\, \partial^{a'}\mathcal{A}^{ja}_{\quad ħ}\; \partial_j\mathcal{A}_{aa'}^{\quad ħ} -$$

$$\frac{2}{3}\, r_1\, \partial_j\mathcal{A}_{aa'}^{\quad ħ}\; \partial_ħ\mathcal{A}^{aa'j} + \frac{2}{3}\, r_1\, \partial_j\mathcal{A}_{aa'}^{\quad ħ}\; \partial_ħ\mathcal{A}^{jaa'} + r_1\, \partial_a\mathcal{A}^{\;\;a}_{l\;j}\; \partial_ħ\mathcal{A}^{jħl} - r_1\, \partial_j\mathcal{A}^{\;\;a}_{l\;a}\; \partial_ħ\mathcal{A}^{jħl} + r_1\, \partial_a\mathcal{A}^{\;\;a}_{l\;j}\; \partial_ħ\mathcal{A}^{ħlj} -$$

$$2\, r_1\, \partial_j\mathcal{A}^{\;\;a}_{l\;a}\; \partial_ħ\mathcal{A}^{ħlj} + \frac{2}{3}\, r_1\, \partial_ħ\mathcal{A}^{aa'j}\; \partial^ħ\mathcal{A}_{aa'j} - \frac{2}{3}\, r_1\, \partial_ħ\mathcal{A}^{jaa'}\; \partial^ħ\mathcal{A}_{aa'j} - \frac{1}{2}\, t_1\, \partial^a f_{jħ}\; \partial^ħ f_a^{\;\;j} +$$

$$\frac{1}{2}\, t_1\, \partial^a f^{\;\;l}_{ħ}\; \partial^ħ f_{al} - \frac{1}{2}\, t_1\, \partial^a f_{iħ}\; \partial^ħ f^{\;\;i}_{a} + \frac{1}{3}\, t_1\, \mathcal{A}^{\;\;a}_{ħ\;a}\; \partial^ħ f^{\;\;i}_{\quad i} - \frac{2}{3}\, t_3\, \mathcal{A}^{\;\;a}_{ħ\;a}\; \partial^ħ f^{\;\;i}_{\quad i} + \frac{1}{3}\, t_1\, \mathcal{A}^{\;\;l}_{ħ\;l}\; \partial^ħ f^{\;\;i}_{\quad i} -$$

$$\frac{2}{3}\, t_3\, \mathcal{A}^{\;\;l}_{ħ\;l}\; \partial^ħ f^{\;\;i}_{\quad i} + \frac{2}{3}\, t_1\, \partial^a f_{aħ}\; \partial^ħ f^{\;\;i}_{\quad i} - \frac{4}{3}\, t_3\, \partial^a f_{aħ}\; \partial^ħ f^{\;\;i}_{\quad i} - \frac{1}{3}\, t_1\, \partial_ħ f^{\;\;l}_{\quad l}\; \partial^ħ f^{\;\;i}_{\quad i} + \frac{2}{3}\, t_3\, \partial_ħ f^{\;\;l}_{\quad l}\; \partial^ħ f^{\;\;i}_{\quad i} +$$

$$t_1\, \mathcal{A}^{l}_{\;ħi}\; \partial^ħ f^{\;\;i}_{\quad l} + \frac{1}{2}\, t_1\, \partial_ħ f^{\;\;l}_{\;i}\; \partial^ħ f^{\;\;i}_{\quad l} - \frac{1}{3}\, t_1\, \partial^{a'} f^{\;\;a}_{a'}\; \partial^ħ f_{ħa} + \frac{2}{3}\, t_3\, \partial^{a'} f^{\;\;a}_{a'}\; \partial^ħ f_{ħa} - \frac{1}{3}\, t_1\, \mathcal{A}^{\;\;l}_{j\;l}\; \partial^ħ f^{\;\;j}_{\quad ħ} +$$

$$\frac{2}{3}\, t_3\, \mathcal{A}^{\;\;l}_{j\;l}\; \partial^ħ f^{\;\;j}_{\quad ħ} - \frac{1}{3}\, t_1\, \mathcal{A}^{la}_{\quad a}\; \partial^ħ f_{ħl} + \frac{2}{3}\, t_3\, \mathcal{A}^{la}_{\quad a}\; \partial^ħ f_{ħl} - \frac{1}{2}\, t_1\, \partial^a f^{\;\;l}_{ħ}\; \partial^ħ f_{la} + t_1\, \mathcal{A}_{jħ}^{\quad l}\; \partial^ħ f^{\;\;j}_{\quad l} +$$

$$\frac{1}{2}\, t_1\, \partial_ħ f^{\;\;j}_{j}\; \partial^ħ f^{\;\;l}_{\quad l} + \frac{2}{3}\, r_1\, \partial^{a'}\mathcal{A}^{\;\;al}_{i}\; \partial_l\mathcal{A}_{aa'}^{\quad i} - \frac{8}{3}\, r_1\, \partial^{a'}\mathcal{A}^{\;\;la}_{i}\; \partial_l\mathcal{A}_{aa'}^{\quad i} - r_1\, \partial_a\mathcal{A}^{\;\;a}_{l\;j}\; \partial^l\mathcal{A}^{jħ}_{\quad ħ} + r_1\, \partial_j\mathcal{A}^{\;\;a}_{l\;a}\; \partial^l\mathcal{A}^{jħ}_{\quad ħ}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 2\, k^2\, t_3 & i\, \sqrt{2}\, k\, t_3 & 0 \\ -i\, \sqrt{2}\, k\, t_3 & t_3 & 0 \\ 0 & 0 & 0 \end{pmatrix},\; \left(-t_1 \right),\; \begin{pmatrix} 0 & -\dfrac{i\, k\, t_1}{\sqrt{2}} & 0 \\ \dfrac{i\, k\, t_1}{\sqrt{2}} & \dfrac{1}{2}\left(2\, k^2\, r_1 - t_1\right) & -\dfrac{t_1}{\sqrt{2}} \\ 0 & -\dfrac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2}{3}\, k^2\left(t_1 + t_3\right) & -\dfrac{1}{3}\, i\, k\left(t_1 - 2\, t_3\right) & 0 & -\dfrac{1}{3}\, i\, \sqrt{2}\, k\left(t_1 + t_3\right) \\ \dfrac{1}{3}\, i\, k\left(t_1 - 2\, t_3\right) & \dfrac{1}{6}\left(t_1 + 4\, t_3\right) & 0 & \dfrac{t_1 - 2\, t_3}{3\, \sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \dfrac{1}{3}\, i\, \sqrt{2}\, k\left(t_1 + t_3\right) & \dfrac{t_1 - 2\, t_3}{3\, \sqrt{2}} & 0 & \dfrac{t_1 + t_3}{3} \end{pmatrix},\; \begin{pmatrix} k^2\, t_1 & \dfrac{i\, k\, t_1}{\sqrt{2}} \\ -\dfrac{i\, k\, t_1}{\sqrt{2}} & \dfrac{t_1}{2} \end{pmatrix},\; \left(\dfrac{1}{2}\left(2\, k^2\, r_1 + t_1\right) \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\;\bullet}\tau^{ь\perp} == 0,\; -i\, {}^{0^+}_{\;\bullet}\tau^{ь\|} == 2\, k\, {}^{0^+}_{\;\bullet}\sigma^{ь\|},\; -i\, {}^{1^+}_{\;\bullet}\tau^{ь\|\,ab} == k\, {}^{1^+}_{\;\bullet}\sigma^{ь\perp\,ab},\; i\, {}^{1^-}_{\;\bullet}\tau^{ь\|\,a} == 2\, k\, {}^{1^-}_{\;\bullet}\sigma^{ь\perp\,a},\; {}^{1^-}_{\;\bullet}\tau^{ь\|\,a} == 0,\; -i\, {}^{2^+}_{\;\bullet}\tau^{ь\|\,ab} == 2\, k\, {}^{2^+}_{\;\bullet}\sigma^{ь\|\,ab} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex]
-\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_3} & \dfrac{1}{\left(1+2\,k^2\right)^2 t_3} & 0 \\[2ex]
0 & 0 & 0
\end{pmatrix},
\left(-\dfrac{1}{t_1} \right),
\begin{pmatrix}
\dfrac{-2\,k^4\,r_1+k^2\,t_1}{\left(1+k^2\right)^2 t_1{}^2} & -\dfrac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & -\dfrac{i\left(2\,k^3\,r_1-k\,t_1\right)}{\left(1+k^2\right)^2 t_1{}^2} \\[2ex]
\dfrac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1} & 0 & -\dfrac{\sqrt{2}}{t_1+k^2\,t_1} \\[2ex]
\dfrac{i\left(2\,k^3\,r_1-k\,t_1\right)}{\left(1+k^2\right)^2 t_1{}^2} & -\dfrac{\sqrt{2}}{t_1+k^2\,t_1} & \dfrac{-2\,k^2\,r_1+t_1}{\left(1+k^2\right)^2 t_1{}^2}
\end{pmatrix},
\right.
$$

$$
\begin{pmatrix}
\dfrac{2\,k^2\left(t_1+4\,t_3\right)}{3\left(1+2\,k^2\right)^2 t_1\,t_3} & \dfrac{2\,i\,k\,t_1-4\,i\,k\,t_3}{3\,t_1\,t_3+6\,k^2\,t_1\,t_3} & 0 & -\dfrac{i\,\sqrt{2}\,k\left(t_1+4\,t_3\right)}{3\left(1+2\,k^2\right)^2 t_1\,t_3} \\[2ex]
-\dfrac{2\,i\,k\,t_1-4\,i\,k\,t_3}{3\,t_1\,t_3+6\,k^2\,t_1\,t_3} & \dfrac{2\left(t_1+t_3\right)}{3\,t_1\,t_3} & 0 & -\dfrac{\sqrt{2}\left(t_1-2\,t_3\right)}{3\left(1+2\,k^2\right)t_1\,t_3} \\[2ex]
0 & 0 & 0 & 0 \\[2ex]
\dfrac{i\,\sqrt{2}\,k\left(t_1+4\,t_3\right)}{3\left(1+2\,k^2\right)^2 t_1\,t_3} & -\dfrac{\sqrt{2}\left(t_1-2\,t_3\right)}{3\left(1+2\,k^2\right)t_1\,t_3} & 0 & \dfrac{t_1+4\,t_3}{3\left(1+2\,k^2\right)^2 t_1\,t_3}
\end{pmatrix},
$$

$$
\begin{pmatrix}
\dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} \\[2ex]
-\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_1} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_1}
\end{pmatrix},
\left(\dfrac{2}{2\,k^2\,r_1+t_1} \right)
\right\}
$$

Square masses:

$$
\left\{0,\,0,\,0,\,0,\,0,\,\left\{-\dfrac{t_1}{2\,r_1}\right\}\right\}
$$

Massive pole residues:

$$
\left\{0,\,0,\,0,\,0,\,0,\,\left\{-\dfrac{1}{r_1}\right\}\right\}
$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$
\left\{\left\{-\dfrac{1}{r_1},\,2^-,\,-\dfrac{t_1}{2\,r_1}\right\},\,\{\}\right\}
$$

Overall unitarity conditions:

$r_1 < 0\ \&\&\ t_1 > 0$

So, that's the end of the PSALTer output for this theory. You can check the particle content against TABLE IV. in arXiv:1910.14197. If you take the overall unitarity conditions from the final column in TABLE V., and decompose them using Mathematica's Reduce function, you get the following (to be compared with the PSALTer conditions above):

$r_1 < 0\ \&\&\ t_1 > 0$

Okay, that concludes the analysis of this theory.

Case 51

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 51 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3} r_1 \, \mathcal{R}_{ijhl} \, \mathcal{R}^{ijhl} + \frac{2}{3} r_1 \, \mathcal{R}_{ihjl} \, \mathcal{R}^{ijhl} - 2 r_1 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{jhl}{}^l - \frac{2}{3} r_1 \, \mathcal{R}^{ijhl} \, \mathcal{R}_{hlij} +$$

$$2 r_1 \, \mathcal{R}^{ij}{}_i{}^h \, \mathcal{R}_{hjl}{}^l + \frac{1}{12} \left(4 t_1 + t_2 \right) \mathcal{T}_{ijh} \, \mathcal{T}^{ijh} + \frac{1}{6} \left(2 t_1 - t_2 \right) \mathcal{T}^{ijh} \, \mathcal{T}_{jih} + t_1 \, \mathcal{T}^i{}_i{}^j \, \mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_1 \, \mathcal{A}_i{}^l{}_l \, \mathcal{A}^{ij}{}_j + \frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} + \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \mathcal{A}^{ijh} + \frac{1}{3} t_1 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} - \frac{2}{3} t_2 \, \mathcal{A}_{ihj} \, \mathcal{A}^{ijh} +$$

$$2 r_1 \, \partial_i \mathcal{A}^{hl}{}_h \, \partial^i \mathcal{A}_l{}^a{}_a - \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}^{ja}{}_h \, \partial_j \mathcal{A}_{aa'}{}^h - \frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{aa'j} + \frac{2}{3} r_1 \, \partial_j \mathcal{A}_{aa'}{}^h \, \partial_h \mathcal{A}^{jaa'} +$$

$$2 r_1 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{jhl} - 2 r_1 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{jhl} + 2 r_1 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial_h \mathcal{A}^{hlj} - 4 r_1 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial_h \mathcal{A}^{hlj} +$$

$$\frac{2}{3} r_1 \, \partial_h \mathcal{A}^{aa'j} \, \partial^h \mathcal{A}_{aa'j} - \frac{2}{3} r_1 \, \partial_h \mathcal{A}^{jaa'} \, \partial^h \mathcal{A}_{aa'j} - \frac{1}{3} t_1 \, \partial^a f_{jh} \, \partial^h f_a{}^j + \frac{1}{6} t_2 \, \partial^a f_{jh} \, \partial^h f_a{}^j + \frac{1}{3} t_1 \, \partial^a f_h{}^l \, \partial^h f_{al} -$$

$$\frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{al} + \frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^a \, \partial^h f^i{}_a - \frac{2}{3} t_1 \, \partial^a f_{ih} \, \partial^h f^i{}_a - \frac{1}{6} t_2 \, \partial^a f_{ih} \, \partial^h f^i{}_a +$$

$$t_1 \, \mathcal{A}_h{}^a{}_a \, \partial^h f^i{}_i + t_1 \, \mathcal{A}_h{}^l{}_l \, \partial^h f^i{}_i + 2 t_1 \, \partial^a f_{ah} \, \partial^h f^i{}_i - t_1 \, \partial_h f^l{}_l \, \partial^h f^i{}_i - \frac{1}{3} t_1 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} - \frac{1}{3} t_2 \, \mathcal{A}_{ijh} \, \partial^h f^{ij} +$$

$$\frac{1}{3} t_1 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l + \frac{1}{3} t_2 \, \mathcal{A}_{ih}{}^l \, \partial^h f^i{}_l - \frac{1}{3} t_1 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l - \frac{1}{3} t_2 \, \mathcal{A}_i{}^l{}_h \, \partial^h f^i{}_l + \frac{2}{3} t_1 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l -$$

$$\frac{1}{3} t_2 \, \mathcal{A}^l{}_{hi} \, \partial^h f^i{}_l + \frac{2}{3} t_1 \, \partial_h f_i{}^l \, \partial^h f^i{}_l + \frac{1}{6} t_2 \, \partial_h f_i{}^l \, \partial^h f^i{}_l - t_1 \, \partial^{a'} f_a{}^a \, \partial^h f_{ha} - t_1 \, \mathcal{A}_j{}^l{}_l \, \partial^h f_h{}^j - t_1 \, \mathcal{A}^{la}{}_a \, \partial^h f_{hl} -$$

$$\frac{1}{3} t_1 \, \partial^a f_h{}^l \, \partial^h f_{la} + \frac{1}{6} t_2 \, \partial^a f_h{}^l \, \partial^h f_{la} + \frac{2}{3} t_1 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j - \frac{1}{3} t_2 \, \mathcal{A}_{jh}{}^l \, \partial^h f_l{}^j + \frac{1}{3} t_1 \, \partial_h f_j{}^l \, \partial^h f_l{}^j -$$

$$\frac{1}{6} t_2 \, \partial_h f_j{}^l \, \partial^h f_l{}^j + \frac{2}{3} r_1 \, \partial^{a'} \mathcal{A}_i{}^{al} \, \partial_l \mathcal{A}_{aa'}{}^i - \frac{8}{3} r_1 \, \partial^{a'} \mathcal{A}_i{}^{la} \, \partial_l \mathcal{A}_{aa'}{}^i - 2 r_1 \, \partial_a \mathcal{A}_l{}^a{}_j \, \partial^l \mathcal{A}^{jh}{}_h + 2 r_1 \, \partial_j \mathcal{A}_l{}^a{}_a \, \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2\,k^2\,t_{\bullet \atop 1} & -i\,\sqrt{2}\,k\,t_{\bullet \atop 1} & 0 \\ i\,\sqrt{2}\,k\,t_{\bullet \atop 1} & -t_{\bullet \atop 1} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} t_{\bullet \atop 2} \end{pmatrix}, \begin{pmatrix} \frac{1}{3}\,k^2\left(t_{\bullet}+t_{\bullet \atop 2}\right) & -\frac{i\,k\left(t_{\bullet \atop 1}-2\,t_{\bullet \atop 2}\right)}{3\,\sqrt{2}} & \frac{1}{3}\,i\,k\left(t_{\bullet}+t_{\bullet \atop 2}\right) \\ \frac{i\,k\left(t_{\bullet \atop 1}-2\,t_{\bullet \atop 2}\right)}{3\,\sqrt{2}} & \frac{1}{6}\left(t_{\bullet \atop 1}+4\,t_{\bullet \atop 2}\right) & \frac{-t_{\bullet \atop 1}+2\,t_{\bullet \atop 2}}{3\,\sqrt{2}} \\ -\frac{1}{3}\,i\,k\left(t_{\bullet}+t_{\bullet \atop 2}\right) & \frac{-t_{\bullet \atop 1}+2\,t_{\bullet \atop 2}}{3\,\sqrt{2}} & \frac{t_{\bullet \atop 1}+t_{\bullet \atop 2}}{3} \end{pmatrix}, \right.$$

$$\begin{pmatrix} 0 & -i\,k\,t_{\bullet \atop 1} & 0 & 0 \\ i\,k\,t_{\bullet \atop 1} & -k^2\,r_{\bullet \atop 1}-\frac{t_{\bullet \atop 1}}{2} & 0 & \frac{t_{\bullet \atop 1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \frac{t_{\bullet \atop 1}}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \begin{pmatrix} k^2\,t_{\bullet \atop 1} & \frac{i\,k\,t_{\bullet \atop 1}}{\sqrt{2}} \\ -\frac{i\,k\,t_{\bullet \atop 1}}{\sqrt{2}} & \frac{t_{\bullet \atop 1}}{2} \end{pmatrix}, \left(\frac{1}{2}\left(2\,k^2\,r_{\bullet \atop 1}+t_{\bullet \atop 1}\right) \right) \Bigg\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\parallel},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel \mathfrak{a}\mathfrak{b}} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp \mathfrak{a}\mathfrak{b}},\ i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel \mathfrak{a}} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp \mathfrak{a}},\ {}^{1^-}_{\bullet}\tau^{\flat\perp \mathfrak{a}} == 0,\ -i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel \mathfrak{a}\mathfrak{b}} == 2\,k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel \mathfrak{a}\mathfrak{b}} \right\}$$

The Drazin (Moore–Penrose) inverses of these $\mathfrak{a}$-matrices, which are functionally analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\frac{2\,k^2}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} & -\frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} & 0 \\ \frac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} & -\frac{1}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(\frac{1}{t_{\bullet \atop 2}} \right), \begin{pmatrix} \frac{k^2\left(t_{\bullet \atop 1}+4\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)^2\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} & \frac{i\,\sqrt{2}\,k\left(t_{\bullet \atop 1}-2\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} & \frac{i\,k\left(t_{\bullet \atop 1}+4\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)^2\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} \\ -\frac{i\,\sqrt{2}\,k\left(t_{\bullet \atop 1}-2\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} & \frac{2\left(t_{\bullet \atop 1}+t_{\bullet \atop 2}\right)}{3\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} & \frac{\sqrt{2}\left(t_{\bullet \atop 1}-2\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} \\ -\frac{i\,k\left(t_{\bullet \atop 1}+4\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)^2\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} & \frac{\sqrt{2}\left(t_{\bullet \atop 1}-2\,t_{\bullet \atop 2}\right)}{3\left(1+k^2\right)\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} & \frac{t_{\bullet \atop 1}+4\,t_{\bullet \atop 2}}{3\left(1+k^2\right)^2\,t_{\bullet \atop 1}\,t_{\bullet \atop 2}} \end{pmatrix}, \right.$$

$$\begin{pmatrix} \frac{2\,k^2\left(2\,k^2\,r_{\bullet \atop 1}+t_{\bullet \atop 1}\right)}{\left(t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}\right)^2} & -\frac{2\,i\,k}{t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}} & 0 & -\frac{i\,\sqrt{2}\,k\left(2\,k^2\,r_{\bullet \atop 1}+t_{\bullet \atop 1}\right)}{\left(t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}\right)^2} \\ \frac{2\,i\,k}{t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}} & 0 & 0 & \frac{\sqrt{2}}{t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}} \\ 0 & 0 & 0 & 0 \\ \frac{i\,\sqrt{2}\,k\left(2\,k^2\,r_{\bullet \atop 1}+t_{\bullet \atop 1}\right)}{\left(t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}\right)^2} & \frac{\sqrt{2}}{t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}} & 0 & \frac{2\,k^2\,r_{\bullet \atop 1}+t_{\bullet \atop 1}}{\left(t_{\bullet \atop 1}+2\,k^2\,t_{\bullet \atop 1}\right)^2} \end{pmatrix}, \begin{pmatrix} \frac{4\,k^2}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} & \frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} \\ -\frac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} & \frac{2}{\left(1+2\,k^2\right)^2\,t_{\bullet \atop 1}} \end{pmatrix}, \left(\frac{2}{2\,k^2\,r_{\bullet \atop 1}+t_{\bullet \atop 1}} \right) \Bigg\}$$

Square masses:

$$\left\{ 0,\ 0,\ 0,\ 0,\ 0,\ \left\{ -\frac{t_{\bullet \atop 1}}{2\,r_{\bullet \atop 1}} \right\} \right\}$$

Massive pole residues:

$$\left\{ 0,\ 0,\ 0,\ 0,\ 0,\ \left\{ -\frac{1}{r_{\bullet \atop 1}} \right\} \right\}$$

Massless eigenvalues:

$$\{\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_i}, \ 2^-, \ -\frac{t_i}{2\,r_i}\right\}, \ \{\}\right\}$$

Overall unitarity conditions:

$$r_i < 0 \ \&\& \ t_i > 0$$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$$r_i < 0 \ \&\& \ t_i > 0$$

Okay, that concludes the analysis of this theory.

Case 52

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 52 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_i\,\mathcal{R}_{ijhl}\,\mathcal{R}^{ijhl} + \frac{2}{3}\,r_i\,\mathcal{R}_{ihjl}\,\mathcal{R}^{ijhl} + r_5\,\mathcal{R}^{ij}{}_i{}^{h}\,\mathcal{R}_{j}{}^{l}{}_{hl} - \frac{2}{3}\,r_i\,\mathcal{R}^{ijhl}\,\mathcal{R}_{hlij} - $$

$$r_5\,\mathcal{R}^{ij}{}_i{}^{h}\,\mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{4}\,t_i\,\mathcal{T}_{ijh}\,\mathcal{T}^{ijh} + \frac{1}{2}\,t_i\,\mathcal{T}^{ijh}\,\mathcal{T}_{jih} + t_i\,\mathcal{T}^{i}{}_{i}{}^{j}\,\mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_i\,\mathcal{A}_i{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_{j} + t_i\,\mathcal{A}_{ihj}\,\mathcal{A}^{ijh} - r_5\,\partial_i\mathcal{A}^{hl}{}_{h}\,\partial^i\mathcal{A}_{l}{}^{a}{}_{a} - \frac{2}{3}\,r_i\,\partial^{a'}\mathcal{A}^{ja}{}_{h}\,\partial_j\mathcal{A}_{aa'}{}^{h} - \frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{aa'}{}^{h}\,\partial_h\mathcal{A}^{aa'j} +$$

$$\frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{aa'}{}^{h}\,\partial_h\mathcal{A}^{jaa'} - r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_h\mathcal{A}^{jhl} + r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_h\mathcal{A}^{jhl} - r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_h\mathcal{A}^{hlj} + 2\,r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_h\mathcal{A}^{hlj} +$$

$$\frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{aa'j}\,\partial^h\mathcal{A}_{aa'j} - \frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{jaa'}\,\partial^h\mathcal{A}_{aa'j} - \frac{1}{2}\,t_i\,\partial^a f_{jh}\,\partial^h f_{a}{}^{j} + \frac{1}{2}\,t_i\,\partial^a f_{h}{}^{l}\,\partial^h f_{al} - \frac{1}{2}\,t_i\,\partial^a f_{ih}\,\partial^h f^{i}{}_{a} +$$

$$t_i\,\mathcal{A}_{h}{}^{a}{}_{a}\,\partial^h f^{i}{}_{i} + t_i\,\mathcal{A}_{h}{}^{l}{}_{l}\,\partial^h f^{i}{}_{i} + 2\,t_i\,\partial^a f_{ah}\,\partial^h f^{i}{}_{i} - t_i\,\partial_h f^{l}{}_{l}\,\partial^h f^{i}{}_{i} + t_i\,\mathcal{A}^{l}{}_{hi}\,\partial^h f^{i}{}_{l} + \frac{1}{2}\,t_i\,\partial_h f_{i}{}^{l}\,\partial^h f^{i}{}_{l} -$$

$$t_i\,\partial^{a'} f_{a'}{}^{a}\,\partial^h f_{ha} - t_i\,\mathcal{A}_{j}{}^{l}{}_{l}\,\partial^h f_{h}{}^{j} - t_i\,\mathcal{A}^{la}{}_{a}\,\partial^h f_{hl} - \frac{1}{2}\,t_i\,\partial^a f_{h}{}^{l}\,\partial^h f_{la} + t_i\,\mathcal{A}_{jh}{}^{l}\,\partial^h f_{l}{}^{j} +$$

$$\frac{1}{2}\,t_i\,\partial_h f_{j}{}^{l}\,\partial^h f_{l}{}^{j} + \frac{2}{3}\,r_i\,\partial^{a'}\mathcal{A}_{i}{}^{al}\,\partial_l\mathcal{A}_{aa'}{}^{i} - \frac{8}{3}\,r_i\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^{i} + r_5\,\partial_a\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^l\mathcal{A}^{jh}{}_{h} - r_5\,\partial_j\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^l\mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
-2\,k^2\,t_{\underset{1}{\bullet}} & -i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & 0 \\
i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & -t_{\underset{1}{\bullet}} & 0 \\
0 & 0 & 0
\end{pmatrix},
\;\left(-t_{\underset{1}{\bullet}}\right),
\begin{pmatrix}
0 & -\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 \\
\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)-t_{\underset{1}{\bullet}}\right) & -\dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\
0 & -\dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
0 & -i\,k\,t_{\underset{1}{\bullet}} & 0 & 0 \\
i\,k\,t_{\underset{1}{\bullet}} & k^2\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)-\dfrac{t_{\underset{1}{\bullet}}}{2} & 0 & \dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\
0 & 0 & 0 & 0 \\
0 & \dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 & 0
\end{pmatrix},
\begin{pmatrix}
k^2\,t_{\underset{1}{\bullet}} & \dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} \\
-\dfrac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{t_{\underset{1}{\bullet}}}{2}
\end{pmatrix},
\;\left(\dfrac{1}{2}\left(2\,k^2\,r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)\right)\right\}
$$

Gauge constraints on source currents:

$$
\left\{\overset{0^+}{_\bullet}\tau^{\flat\perp}==0,\; -i\,\overset{0^+}{_\bullet}\tau^{\flat\|}==2\,k\,\overset{0^+}{_\bullet}\sigma^{\flat\|},\; -i\,\overset{1^+}{_\bullet}\tau^{\flat\|\,\alpha b}==k\,\overset{1^+}{_\bullet}\sigma^{\flat\perp\,\alpha b},\; i\,\overset{1^-}{_\bullet}\tau^{\flat\|\,\alpha}==2\,k\,\overset{1^-}{_\bullet}\sigma^{\flat\perp\,\alpha},\; \overset{1^-}{_\bullet}\tau^{\flat\perp\,\alpha}==0,\; -i\,\overset{2^+}{_\bullet}\tau^{\flat\|\,\alpha b}==2\,k\,\overset{2^+}{_\bullet}\sigma^{\flat\|\,\alpha b}\right\}
$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally

analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
-\dfrac{2\,k^2}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} & 0 \\
\dfrac{i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{1}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} & 0 \\
0 & 0 & 0
\end{pmatrix},
\;\left(-\dfrac{1}{t_{\underset{1}{\bullet}}}\right),
\begin{pmatrix}
\dfrac{-2\,k^4\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)+k^2\,t_{\underset{1}{\bullet}}}{\left(1+k^2\right)^2 t_{\underset{1}{\bullet}}^2} & -\dfrac{i\,\sqrt{2}\,k}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} & \dfrac{-2\,i\,k^3\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)+i\,k\,t_{\underset{1}{\bullet}}}{\left(1+k^2\right)^2 t_{\underset{1}{\bullet}}^2} \\
\dfrac{i\,\sqrt{2}\,k}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} & 0 & -\dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} \\
\dfrac{i\left(2\,k^3\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)-k\,t_{\underset{1}{\bullet}}\right)}{\left(1+k^2\right)^2 t_{\underset{1}{\bullet}}^2} & -\dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+k^2\,t_{\underset{1}{\bullet}}} & \dfrac{-2\,k^2\left(2\,r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)+t_{\underset{1}{\bullet}}}{\left(1+k^2\right)^2 t_{\underset{1}{\bullet}}^2}
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
\dfrac{-4\,k^4\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)+2\,k^2\,t_{\underset{1}{\bullet}}}{\left(t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}\right)^2} & -\dfrac{2\,i\,k}{t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}} & 0 & \dfrac{i\,\sqrt{2}\,k\left(2\,k^2\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)-t_{\underset{1}{\bullet}}\right)}{\left(t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}\right)^2} \\
\dfrac{2\,i\,k}{t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}} & 0 & 0 & \dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}} \\
0 & 0 & 0 & 0 \\
-\dfrac{i\,\sqrt{2}\,k\left(2\,k^2\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)-t_{\underset{1}{\bullet}}\right)}{\left(t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}\right)^2} & \dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}} & 0 & \dfrac{-2\,k^2\left(r_{\underset{1}{\bullet}}+r_{\underset{5}{\bullet}}\right)+t_{\underset{1}{\bullet}}}{\left(t_{\underset{1}{\bullet}}+2\,k^2\,t_{\underset{1}{\bullet}}\right)^2}
\end{pmatrix},
\begin{pmatrix}
\dfrac{4\,k^2}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} \\
-\dfrac{2\,i\,\sqrt{2}\,k}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{2}{\left(1+2\,k^2\right)^2 t_{\underset{1}{\bullet}}}
\end{pmatrix},
\;\left(\dfrac{2}{2\,k^2\,r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}}\right)\right\}
$$

Square masses:

$$
\left\{0,\,0,\,0,\,0,\,0,\,\left\{-\dfrac{t_{\underset{1}{\bullet}}}{2\,r_{\underset{1}{\bullet}}}\right\}\right\}
$$

Massive pole residues:

$$
\left\{0,\,0,\,0,\,0,\,0,\,\left\{-\dfrac{1}{r_{\underset{1}{\bullet}}}\right\}\right\}
$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_i}, \, 2^-, \, -\frac{t_i}{2\,r_i}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$r_i < 0 \,\&\&\, t_i > 0$

So, that's the end of the PSALTer output for this theory. You
  can check the particle content against TABLE IV. in arXiv:1910.14197.
  If you take the overall unitarity conditions from the final column in
  TABLE V., and decompose them using Mathematica's Reduce function, you
  get the following (to be compared with the PSALTer conditions above):

$r_i < 0 \,\&\&\, t_i > 0$

Okay, that concludes the analysis of this theory.

Case 53

Now for a new theory. Here is the full nonlinear Lagrangian for
  Case 53 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_i\,\mathcal{R}_{ijhl}\,\mathcal{R}^{ijhl} + \frac{2}{3}\,r_i\,\mathcal{R}_{ihjl}\,\mathcal{R}^{ijhl} - r_i\,\mathcal{R}^{ij}{}_i{}^{h}\,\mathcal{R}_{j}{}^{l}{}_{hl} - \frac{2}{3}\,r_i\,\mathcal{R}^{ijhl}\,\mathcal{R}_{hlij} +$$

$$r_i\,\mathcal{R}^{ij}{}_i{}^{h}\,\mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{4}\,t_i\,\mathcal{T}_{ijh}\,\mathcal{T}^{ijh} + \frac{1}{2}\,t_i\,\mathcal{T}^{ijh}\,\mathcal{T}_{jih} + t_i\,\mathcal{T}^{i}{}_{i}{}^{j}\,\mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
  this Lagrangian to second order around the desired vacuum:

$$-t_i\,\mathcal{A}_i{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_j + t_i\,\mathcal{A}_{ihj}\,\mathcal{A}^{ijh} + r_i\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_{l}{}^{a}{}_a - \frac{2}{3}\,r_i\,\partial^{a'}\mathcal{A}^{ja}{}_h\,\partial_j\mathcal{A}_{aa'}{}^{h} - \frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{aa'}{}^{h}\,\partial_h\mathcal{A}^{aa'j} +$$

$$\frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{aa'}{}^{h}\,\partial_h\mathcal{A}^{jaa'} + r_i\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{jhl} - r_i\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{jhl} + r_i\,\partial_a\mathcal{A}_{l}{}^{a}{}_j\,\partial_h\mathcal{A}^{hlj} - 2\,r_i\,\partial_j\mathcal{A}_{l}{}^{a}{}_a\,\partial_h\mathcal{A}^{hlj} +$$

$$\frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{aa'j}\,\partial^h\mathcal{A}_{aa'j} - \frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{jaa'}\,\partial^h\mathcal{A}_{aa'j} - \frac{1}{2}\,t_i\,\partial^a f_{jh}\,\partial^h f_a{}^{j} + \frac{1}{2}\,t_i\,\partial^a f_h{}^{l}\,\partial^h f_{al} - \frac{1}{2}\,t_i\,\partial^a f_{ih}\,\partial^h f^{i}{}_a +$$

$$t_i\,\mathcal{A}_h{}^{a}{}_a\,\partial^h f^{i}{}_i + t_i\,\mathcal{A}_h{}^{l}{}_l\,\partial^h f^{i}{}_i + 2\,t_i\,\partial^a f_{ah}\,\partial^h f^{i}{}_i - t_i\,\partial_h f^{l}{}_l\,\partial^h f^{i}{}_i + t_i\,\mathcal{A}^l{}_{hi}\,\partial^h f^{i}{}_l + \frac{1}{2}\,t_i\,\partial_h f_i{}^{l}\,\partial^h f^{i}{}_l -$$

$$t_i\,\partial^{a'} f_{a'}{}^{a}\,\partial^h f_{ha} - t_i\,\mathcal{A}_j{}^{l}{}_l\,\partial^h f_h{}^{j} - t_i\,\mathcal{A}^{la}{}_a\,\partial^h f_{hl} - \frac{1}{2}\,t_i\,\partial^a f_h{}^{l}\,\partial^h f_{la} + t_i\,\mathcal{A}_{jh}{}^{l}\,\partial^h f_l{}^{j} +$$

$$\frac{1}{2}\,t_i\,\partial_h f_j{}^{l}\,\partial^h f_l{}^{j} + \frac{2}{3}\,r_i\,\partial^{a'}\mathcal{A}_i{}^{al}\,\partial_l\mathcal{A}_{aa'}{}^{i} - \frac{8}{3}\,r_i\,\partial^{a'}\mathcal{A}_i{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^{i} - r_i\,\partial_a\mathcal{A}_l{}^{a}{}_j\,\partial^l\mathcal{A}^{jh}{}_h + r_i\,\partial_j\mathcal{A}_l{}^{a}{}_a\,\partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
  the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -2\,k^2\,t_{\bullet\atop 1} & -i\,\sqrt{2}\,k\,t_{\bullet\atop 1} & 0 \\ i\,\sqrt{2}\,k\,t_{\bullet\atop 1} & -t_{\bullet\atop 1} & 0 \\ 0 & 0 & 0 \end{pmatrix},\; \left(-t_{\bullet\atop 1}\right),\; \begin{pmatrix} 0 & -\dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & 0 \\ \dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\,r_{\bullet\atop 1} - t_{\bullet\atop 1}\right) & -\dfrac{t_{\bullet\atop 1}}{\sqrt{2}} \\ 0 & -\dfrac{t_{\bullet\atop 1}}{\sqrt{2}} & 0 \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} 0 & -i\,k\,t_{\bullet\atop 1} & 0 & 0 \\ i\,k\,t_{\bullet\atop 1} & -\dfrac{t_{\bullet\atop 1}}{2} & 0 & \dfrac{t_{\bullet\atop 1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \dfrac{t_{\bullet\atop 1}}{\sqrt{2}} & 0 & 0 \end{pmatrix},\; \begin{pmatrix} k^2\,t_{\bullet\atop 1} & \dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} \\ -\dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & \dfrac{t_{\bullet\atop 1}}{2} \end{pmatrix},\; \left(\dfrac{1}{2}\left(2\,k^2\,r_{\bullet\atop 1} + t_{\bullet\atop 1}\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{{}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\; -i\,{}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\parallel},\; -i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel\,ab} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,ab},\; i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel\,a} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,a},\; {}^{1^-}_{\bullet}\tau^{\flat\perp\,a} == 0,\; -i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel\,ab} == 2\,k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel\,ab}\right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

  analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -\dfrac{2\,k^2}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & -\dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & 0 \\ \dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & -\dfrac{1}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\; \left(-\dfrac{1}{t_{\bullet\atop 1}}\right),\; \begin{pmatrix} \dfrac{-2\,k^4\,r_{\bullet\atop 1}+k^2\,t_{\bullet\atop 1}}{(1+k^2)^2\,t_{\bullet\atop 1}^2} & -\dfrac{i\,\sqrt{2}\,k}{t_{\bullet\atop 1}+k^2\,t_{\bullet\atop 1}} & -\dfrac{i\left(2\,k^3\,r_{\bullet\atop 1}-k\,t_{\bullet\atop 1}\right)}{(1+k^2)^2\,t_{\bullet\atop 1}^2} \\ \dfrac{i\,\sqrt{2}\,k}{t_{\bullet\atop 1}+k^2\,t_{\bullet\atop 1}} & 0 & -\dfrac{\sqrt{2}}{t_{\bullet\atop 1}+k^2\,t_{\bullet\atop 1}} \\ \dfrac{i\left(2\,k^3\,r_{\bullet\atop 1}-k\,t_{\bullet\atop 1}\right)}{(1+k^2)^2\,t_{\bullet\atop 1}^2} & -\dfrac{\sqrt{2}}{t_{\bullet\atop 1}+k^2\,t_{\bullet\atop 1}} & \dfrac{-2\,k^2\,r_{\bullet\atop 1}+t_{\bullet\atop 1}}{(1+k^2)^2\,t_{\bullet\atop 1}^2} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \dfrac{2\,k^2}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & -\dfrac{2\,i\,k}{t_{\bullet\atop 1}+2\,k^2\,t_{\bullet\atop 1}} & 0 & -\dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} \\ \dfrac{2\,i\,k}{t_{\bullet\atop 1}+2\,k^2\,t_{\bullet\atop 1}} & 0 & 0 & \dfrac{\sqrt{2}}{t_{\bullet\atop 1}+2\,k^2\,t_{\bullet\atop 1}} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{\sqrt{2}}{t_{\bullet\atop 1}+2\,k^2\,t_{\bullet\atop 1}} & 0 & \dfrac{1}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} \end{pmatrix},\; \begin{pmatrix} \dfrac{4\,k^2}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{2}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} \end{pmatrix},\; \left(\dfrac{2}{2\,k^2\,r_{\bullet\atop 1}+t_{\bullet\atop 1}}\right)\right\}$$

Square masses:

$$\left\{0,\,0,\,0,\,0,\,0,\,\left\{-\dfrac{t_{\bullet\atop 1}}{2\,r_{\bullet\atop 1}}\right\}\right\}$$

Massive pole residues:

$$\left\{0,\,0,\,0,\,0,\,0,\,\left\{-\dfrac{1}{r_{\bullet\atop 1}}\right\}\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\dot{\imath}}},\ 2^{-},\ -\frac{t_{\dot{\imath}}}{2\,r_{\dot{\imath}}}\right\},\ \{\}\right\}$$

Overall unitarity conditions:

$r_{\dot{\imath}} < 0\ \&\&\ t_{\dot{\imath}} > 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_{\dot{\imath}} < 0\ \&\&\ t_{\dot{\imath}} > 0$

Okay, that concludes the analysis of this theory.

Case 54

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 54 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_{\dot{\imath}}\,\mathcal{R}_{ijhl}\ \mathcal{R}^{ijhl} + \frac{2}{3}\,r_{\dot{\imath}}\,\mathcal{R}_{ihjl}\ \mathcal{R}^{ijhl} - 2\,r_{\dot{\imath}}\,\mathcal{R}^{ij}{}_{i}{}^{h}\ \mathcal{R}_{j}{}^{l}{}_{hl} - \frac{2}{3}\,r_{\dot{\imath}}\,\mathcal{R}^{ijhl}\ \mathcal{R}_{hlij} +$$

$$2\,r_{\dot{\imath}}\,\mathcal{R}^{ij}{}_{i}{}^{h}\ \mathcal{R}_{h}{}^{l}{}_{jl} + \frac{1}{4}\,t_{\dot{\imath}}\,\mathcal{T}_{ijh}\ \mathcal{T}^{ijh} + \frac{1}{2}\,t_{\dot{\imath}}\,\mathcal{T}^{ijh}\ \mathcal{T}_{jih} + t_{\dot{\imath}}\,\mathcal{T}^{i}{}_{i}{}^{j}\ \mathcal{T}^{h}{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-t_{\dot{\imath}}\,\mathcal{A}_{i}{}^{l}{}_{l}\ \mathcal{A}^{ij}{}_{j} + t_{\dot{\imath}}\,\mathcal{A}_{ihj}\ \mathcal{A}^{ijh} + 2\,r_{\dot{\imath}}\,\partial_{i}\mathcal{A}^{hl}{}_{h}\ \partial\mathcal{A}_{l}{}^{a}{}_{a} - \frac{2}{3}\,r_{\dot{\imath}}\,\partial^{a'}\mathcal{A}^{ja}{}_{h}\ \partial_{j}\mathcal{A}_{aa'}{}^{h} - \frac{2}{3}\,r_{\dot{\imath}}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}\ \partial_{h}\mathcal{A}^{aa'j} +$$

$$\frac{2}{3}\,r_{\dot{\imath}}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}\ \partial_{h}\mathcal{A}^{jaa'} + 2\,r_{\dot{\imath}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\ \partial_{h}\mathcal{A}^{jhl} - 2\,r_{\dot{\imath}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\ \partial_{h}\mathcal{A}^{jhl} + 2\,r_{\dot{\imath}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\ \partial_{h}\mathcal{A}^{hlj} -$$

$$4\,r_{\dot{\imath}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\ \partial_{h}\mathcal{A}^{hlj} + \frac{2}{3}\,r_{\dot{\imath}}\,\partial_{h}\mathcal{A}^{aa'j}\ \partial^{h}\mathcal{A}_{aa'j} - \frac{2}{3}\,r_{\dot{\imath}}\,\partial_{h}\mathcal{A}^{jaa'}\ \partial^{h}\mathcal{A}_{aa'j} - \frac{1}{2}\,t_{\dot{\imath}}\,\partial^{a}f_{jh}\ \partial^{h}f_{a}{}^{j} + \frac{1}{2}\,t_{\dot{\imath}}\,\partial^{a}f_{h}{}^{l}\ \partial^{h}f_{al} -$$

$$\frac{1}{2}\,t_{\dot{\imath}}\,\partial^{a}f_{ih}\ \partial^{h}f^{i}{}_{a} + t_{\dot{\imath}}\,\mathcal{A}_{h}{}^{a}{}_{a}\ \partial^{h}f^{i}{}_{i} + t_{\dot{\imath}}\,\mathcal{A}_{h}{}^{l}{}_{l}\ \partial^{h}f^{i}{}_{i} + 2\,t_{\dot{\imath}}\,\partial^{a}f_{ah}\ \partial^{h}f^{i}{}_{i} - t_{\dot{\imath}}\,\partial_{h}f^{l}{}_{l}\ \partial^{h}f^{i}{}_{i} + t_{\dot{\imath}}\,\mathcal{A}^{l}{}_{hi}\ \partial^{h}f^{i}{}_{l} +$$

$$\frac{1}{2}\,t_{\dot{\imath}}\,\partial_{h}f_{i}{}^{l}\ \partial^{h}f^{i}{}_{l} - t_{\dot{\imath}}\,\partial^{a'}f_{a'}{}^{a}\ \partial^{h}f_{ha} - t_{\dot{\imath}}\,\mathcal{A}_{j}{}^{l}{}_{l}\ \partial^{h}f_{h}{}^{j} - t_{\dot{\imath}}\,\mathcal{A}^{la}{}_{a}\ \partial^{h}f_{hl} - \frac{1}{2}\,t_{\dot{\imath}}\,\partial^{a}f_{h}{}^{l}\ \partial^{h}f_{la} + t_{\dot{\imath}}\,\mathcal{A}_{jh}{}^{l}\ \partial^{h}f_{l}{}^{j} +$$

$$\frac{1}{2}\,t_{\dot{\imath}}\,\partial_{h}f_{j}{}^{l}\ \partial^{h}f_{l}{}^{j} + \frac{2}{3}\,r_{\dot{\imath}}\,\partial^{a'}\mathcal{A}_{i}{}^{al}\ \partial_{l}\mathcal{A}_{aa'}{}^{i} - \frac{8}{3}\,r_{\dot{\imath}}\,\partial^{a'}\mathcal{A}_{i}{}^{la}\ \partial_{l}\mathcal{A}_{aa'}{}^{i} - 2\,r_{\dot{\imath}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\ \partial^{l}\mathcal{A}^{jh}{}_{h} + 2\,r_{\dot{\imath}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\ \partial^{l}\mathcal{A}^{jh}{}_{h}$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -2\,k^2\,t_{\bullet\atop 1} & -i\,\sqrt{2}\,k\,t_{\bullet\atop 1} & 0 \\ i\,\sqrt{2}\,k\,t_{\bullet\atop 1} & -t_{\bullet\atop 1} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-t_{\bullet\atop 1}\right), \begin{pmatrix} 0 & -\dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & 0 \\ \dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & -\dfrac{t_{\bullet\atop 1}}{2} & -\dfrac{t_{\bullet\atop 1}}{\sqrt{2}} \\ 0 & -\dfrac{t_{\bullet\atop 1}}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} 0 & -i\,k\,t_{\bullet\atop 1} & 0 & 0 \\ i\,k\,t_{\bullet\atop 1} & -k^2\,r_{\bullet\atop 1} - \dfrac{t_{\bullet\atop 1}}{2} & 0 & \dfrac{t_{\bullet\atop 1}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \dfrac{t_{\bullet\atop 1}}{\sqrt{2}} & 0 & 0 \end{pmatrix}, \begin{pmatrix} k^2\,t_{\bullet\atop 1} & \dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} \\ -\dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & \dfrac{t_{\bullet\atop 1}}{2} \end{pmatrix}, \left(\dfrac{1}{2}\left(2\,k^2\,r_{\bullet\atop 1} + t_{\bullet\atop 1}\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{\flat\perp} == 0,\ -i\,{}^{0^+}_{\bullet}\tau^{\flat\parallel} == 2\,k\,{}^{0^+}_{\bullet}\sigma^{\flat\parallel},\ -i\,{}^{1^+}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}\mathfrak{b}} == k\,{}^{1^+}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}\mathfrak{b}},\ i\,{}^{1^-}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}} == 2\,k\,{}^{1^-}_{\bullet}\sigma^{\flat\perp\,\mathfrak{a}},\ {}^{1^-}_{\bullet}\tau^{\flat\perp\,\mathfrak{a}} == 0,\ -i\,{}^{2^+}_{\bullet}\tau^{\flat\parallel\,\mathfrak{a}\mathfrak{b}} == 2\,k\,{}^{2^+}_{\bullet}\sigma^{\flat\parallel\,\mathfrak{a}\mathfrak{b}} \right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\dfrac{2\,k^2}{(1+2\,k^2)^2\,t_{\bullet}} & -\dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet}} & 0 \\ \dfrac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet}} & -\dfrac{1}{(1+2\,k^2)^2\,t_{\bullet}} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-\dfrac{1}{t_{\bullet}}\right), \begin{pmatrix} \dfrac{k^2}{(1+k^2)^2\,t_{\bullet}} & -\dfrac{i\,\sqrt{2}\,k}{t_{\bullet}+k^2\,t_{\bullet}} & \dfrac{i\,k}{(1+k^2)^2\,t_{\bullet}} \\ \dfrac{i\,\sqrt{2}\,k}{t_{\bullet}+k^2\,t_{\bullet}} & 0 & -\dfrac{\sqrt{2}}{t_{\bullet}+k^2\,t_{\bullet}} \\ -\dfrac{i\,k}{(1+k^2)^2\,t_{\bullet}} & -\dfrac{\sqrt{2}}{t_{\bullet}+k^2\,t_{\bullet}} & \dfrac{1}{(1+k^2)^2\,t_{\bullet}} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2\,k^2\left(2\,k^2\,r_{\bullet}+t_{\bullet}\right)}{\left(t_{\bullet}+2\,k^2\,t_{\bullet}\right)^2} & -\dfrac{2\,i\,k}{t_{\bullet}+2\,k^2\,t_{\bullet}} & 0 & -\dfrac{i\,\sqrt{2}\,k\left(2\,k^2\,r_{\bullet}+t_{\bullet}\right)}{\left(t_{\bullet}+2\,k^2\,t_{\bullet}\right)^2} \\ \dfrac{2\,i\,k}{t_{\bullet}+2\,k^2\,t_{\bullet}} & 0 & 0 & \dfrac{\sqrt{2}}{t_{\bullet}+2\,k^2\,t_{\bullet}} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\,\sqrt{2}\,k\left(2\,k^2\,r_{\bullet}+t_{\bullet}\right)}{\left(t_{\bullet}+2\,k^2\,t_{\bullet}\right)^2} & \dfrac{\sqrt{2}}{t_{\bullet}+2\,k^2\,t_{\bullet}} & 0 & \dfrac{2\,k^2\,r_{\bullet}+t_{\bullet}}{\left(t_{\bullet}+2\,k^2\,t_{\bullet}\right)^2} \end{pmatrix}, \begin{pmatrix} \dfrac{4\,k^2}{(1+2\,k^2)^2\,t_{\bullet}} & \dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet}} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet}} & \dfrac{2}{(1+2\,k^2)^2\,t_{\bullet}} \end{pmatrix}, \left(\dfrac{2}{2\,k^2\,r_{\bullet}+t_{\bullet}}\right)\right\}$$

Square masses:

$$\left\{0,\ 0,\ 0,\ 0,\ 0,\ \left\{-\dfrac{t_{\bullet\atop 1}}{2\,r_{\bullet\atop 1}}\right\}\right\}$$

Massive pole residues:

$$\left\{0,\ 0,\ 0,\ 0,\ 0,\ \left\{-\dfrac{1}{r_{\bullet\atop 1}}\right\}\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_i}, \, 2^-, \, -\frac{t_i}{2\,r_i}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$r_i < 0 \,\&\&\, t_i > 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_i < 0 \,\&\&\, t_i > 0$

Okay, that concludes the analysis of this theory.

Case 55

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 55 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_i\,\mathcal{R}_{ijhl}\,\mathcal{R}^{ijhl} + \frac{2}{3}\,r_i\,\mathcal{R}_{ihjl}\,\mathcal{R}^{ijhl} - r_i\,\mathcal{R}^{ij}{}_i{}^h\,\mathcal{R}_{jhl}{}^l - \frac{2}{3}\,r_i\,\mathcal{R}^{ijhl}\,\mathcal{R}_{hlij} +$$

$$r_i\,\mathcal{R}^{ij}{}_i{}^h\,\mathcal{R}_{hjl}{}^l + \frac{1}{4}\,t_i\,\mathcal{T}_{ijh}\,\mathcal{T}^{ijh} + \frac{1}{2}\,t_i\,\mathcal{T}^{ijh}\,\mathcal{T}_{jih} + \frac{1}{3}\,t_i\,\mathcal{T}^i{}_i{}^j\,\mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3}\,t_i\,\mathcal{A}_i{}^l{}_l\,\mathcal{A}^{ij}{}_j + t_i\,\mathcal{A}_{ihj}\,\mathcal{A}^{ijh} + r_i\,\partial_i\mathcal{A}^{hl}{}_h\,\partial^i\mathcal{A}_l{}^a{}_a - \frac{2}{3}\,r_i\,\partial^{a'}\mathcal{A}^{ja}{}_h\,\partial_j\mathcal{A}_{aa'}{}^h -$$

$$\frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{aa'}{}^h\,\partial_h\mathcal{A}^{aa'j} + \frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{aa'}{}^h\,\partial_h\mathcal{A}^{jaa'} + r_i\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{jhl} - r_i\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{jhl} +$$

$$r_i\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial_h\mathcal{A}^{hlj} - 2\,r_i\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial_h\mathcal{A}^{hlj} + \frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{aa'j}\,\partial^h\mathcal{A}_{aa'j} - \frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{jaa'}\,\partial^h\mathcal{A}_{aa'j} -$$

$$\frac{1}{2}\,t_i\,\partial^a f_{jh}\,\partial^h f_a{}^j + \frac{1}{2}\,t_i\,\partial^a f_h{}^l\,\partial^h f_{al} - \frac{1}{2}\,t_i\,\partial^a f_{ih}\,\partial^h f^i{}_a + \frac{1}{3}\,t_i\,\mathcal{A}_h{}^a{}_a\,\partial^h f^i{}_i + \frac{1}{3}\,t_i\,\mathcal{A}_h{}^l{}_l\,\partial^h f^i{}_i +$$

$$\frac{2}{3}\,t_i\,\partial^a f_{ah}\,\partial^h f^i{}_i - \frac{1}{3}\,t_i\,\partial_h f^l{}_l\,\partial^h f^i{}_i + t_i\,\mathcal{A}^l{}_{hi}\,\partial^h f^i{}_l + \frac{1}{2}\,t_i\,\partial_h f_i{}^l\,\partial^h f^i{}_l - \frac{1}{3}\,t_i\,\partial^{a'} f_a{}^a\,\partial^h f_{ha} -$$

$$\frac{1}{3}\,t_i\,\mathcal{A}_j{}^l{}_l\,\partial^h f_h{}^j - \frac{1}{3}\,t_i\,\mathcal{A}^{la}{}_a\,\partial^h f_{hl} - \frac{1}{2}\,t_i\,\partial^a f_h{}^l\,\partial^h f_{la} + t_i\,\mathcal{A}_{jh}{}^l\,\partial^h f_l{}^j + \frac{1}{2}\,t_i\,\partial_h f_j{}^l\,\partial^h f_l{}^j +$$

$$\frac{2}{3}\,r_i\,\partial^{a'}\mathcal{A}_i{}^{al}\,\partial_l\mathcal{A}_{aa'}{}^i - \frac{8}{3}\,r_i\,\partial^{a'}\mathcal{A}_i{}^{la}\,\partial_l\mathcal{A}_{aa'}{}^i - r_i\,\partial_a\mathcal{A}_l{}^a{}_j\,\partial^l\mathcal{A}^{jh}{}_h + r_i\,\partial_j\mathcal{A}_l{}^a{}_a\,\partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) *a*-matrices associated with
   the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-t_{\bullet\atop 1} \right), \begin{pmatrix} 0 & -\dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & 0 \\ \dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & \dfrac{1}{2}\left(2\,k^2\,r_{\bullet\atop 1} - t_{\bullet\atop 1} \right) & -\dfrac{t_{\bullet\atop 1}}{\sqrt{2}} \\ 0 & -\dfrac{t_{\bullet\atop 1}}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2\,k^2\,t_{\bullet\atop 1}}{3} & -\dfrac{1}{3}\,i\,k\,t_{\bullet\atop 1} & 0 & -\dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet\atop 1} \\ \dfrac{i\,k\,t_{\bullet\atop 1}}{3} & \dfrac{t_{\bullet\atop 1}}{6} & 0 & \dfrac{t_{\bullet\atop 1}}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \dfrac{1}{3}\,i\,\sqrt{2}\,k\,t_{\bullet\atop 1} & \dfrac{t_{\bullet\atop 1}}{3\sqrt{2}} & 0 & \dfrac{t_{\bullet\atop 1}}{3} \end{pmatrix}, \begin{pmatrix} k^2\,t_{\bullet\atop 1} & \dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} \\ -\dfrac{i\,k\,t_{\bullet\atop 1}}{\sqrt{2}} & \dfrac{t_{\bullet\atop 1}}{2} \end{pmatrix}, \left(\dfrac{1}{2}\left(2\,k^2\,r_{\bullet\atop 1} + t_{\bullet\atop 1} \right) \right) \right\}$$

Gauge constraints on source currents:

$$\left\{ \overset{0^+}{\bullet}\tau^{\flat\perp} == 0, \ \overset{0^+}{\bullet}\sigma^{\flat\|} == 0, \ \overset{0^+}{\bullet}\tau^{\flat\|} == 0, \ -i\,\overset{1^+}{\bullet}\tau^{\flat\|\,a\,b} == k\,\overset{1^+}{\bullet}\sigma^{\flat\perp\,a\,b}, \right.$$

$$\left. i\,\overset{1^-}{\bullet}\tau^{\flat\|\,a} == 2\,k\,\overset{1^-}{\bullet}\sigma^{\flat\perp\,a}, \ \overset{1^-}{\bullet}\tau^{\flat\perp\,a} == 0, \ i\,\overset{1^-}{\bullet}\tau^{\flat\|\,a} == 2\,k\,\overset{1^-}{\bullet}\sigma^{\flat\|\,a}, \ -i\,\overset{2^+}{\bullet}\tau^{\flat\|\,a\,b} == 2\,k\,\overset{2^+}{\bullet}\sigma^{\flat\|\,a\,b} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*-matrices, which are functionally

analogous to the inverse *b*-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-\dfrac{1}{t_{\bullet\atop 1}} \right), \begin{pmatrix} \dfrac{-2\,k^4\,r_{\bullet\atop 1} + k^2\,t_{\bullet\atop 1}}{(1+k^2)^2\,t_{\bullet\atop 1}^{\,2}} & -\dfrac{i\,\sqrt{2}\,k}{t_{\bullet\atop 1} + k^2\,t_{\bullet\atop 1}} & -\dfrac{i\left(2\,k^3\,r_{\bullet\atop 1} - k\,t_{\bullet\atop 1} \right)}{(1+k^2)^2\,t_{\bullet\atop 1}^{\,2}} \\ \dfrac{i\,\sqrt{2}\,k}{t_{\bullet\atop 1} + k^2\,t_{\bullet\atop 1}} & 0 & -\dfrac{\sqrt{2}}{t_{\bullet\atop 1} + k^2\,t_{\bullet\atop 1}} \\ \dfrac{i\left(2\,k^3\,r_{\bullet\atop 1} - k\,t_{\bullet\atop 1} \right)}{(1+k^2)^2\,t_{\bullet\atop 1}^{\,2}} & -\dfrac{\sqrt{2}}{t_{\bullet\atop 1} + k^2\,t_{\bullet\atop 1}} & \dfrac{-2\,k^2\,r_{\bullet\atop 1} + t_{\bullet\atop 1}}{(1+k^2)^2\,t_{\bullet\atop 1}^{\,2}} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{24\,k^2}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} & -\dfrac{12\,i\,k}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} & 0 & -\dfrac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} \\ \dfrac{12\,i\,k}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{6}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} & 0 & \dfrac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} \\ 0 & 0 & 0 & 0 \\ \dfrac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} & 0 & \dfrac{12}{(3+4\,k^2)^2\,t_{\bullet\atop 1}} \end{pmatrix}, \begin{pmatrix} \dfrac{4\,k^2}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} & \dfrac{2}{(1+2\,k^2)^2\,t_{\bullet\atop 1}} \end{pmatrix}, \left(\dfrac{2}{2\,k^2\,r_{\bullet\atop 1} + t_{\bullet\atop 1}} \right) \right\}$$

Square masses:

$$\left\{ \{\}, \{\}, \{\}, \{\}, \{\}, \left\{ -\dfrac{t_{\bullet\atop 1}}{2\,r_{\bullet\atop 1}} \right\} \right\}$$

Massive pole residues:

$$\left\{ \{\}, \{\}, \{\}, \{\}, \{\}, \left\{ -\dfrac{1}{r_{\bullet\atop 1}} \right\} \right\}$$

Massless eigenvalues:

$$\{\}$$

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_i}, \; 2^-, \; -\frac{t_i}{2\,r_i}\right\}, \{\}\right\}$$

Overall unitarity conditions:

$$r_i < 0 \;\&\&\; t_i > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_i < 0 \;\&\&\; t_i > 0$$

Okay, that concludes the analysis of this theory.

Case 56

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 56 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3}\,r_i\,\mathcal{R}_{ijhl}\;\mathcal{R}^{ijhl} + \frac{2}{3}\,r_i\,\mathcal{R}_{ihjl}\;\mathcal{R}^{ijhl} - 2\,r_i\,\mathcal{R}^{ij}{}_i{}^h\,\mathcal{R}_j{}^l{}_{hl} - \frac{2}{3}\,r_i\,\mathcal{R}^{ijhl}\;\mathcal{R}_{hlij} +$$

$$2\,r_i\,\mathcal{R}^{ij}{}_i{}^h\,\mathcal{R}_h{}^l{}_{jl} + \frac{1}{3}\,t_i\,\mathcal{T}_{ijh}\;\mathcal{T}^{ijh} + \frac{1}{3}\,t_i\,\mathcal{T}^{ijh}\;\mathcal{T}_{jih} + t_i\,\mathcal{T}^i{}_i{}^j\;\mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$-t_i\,\mathcal{A}_i{}^l{}_l\;\mathcal{A}^{ij}{}_j + \frac{1}{3}\,t_i\,\mathcal{A}_{ijh}\;\mathcal{A}^{ijh} + \frac{1}{3}\,t_i\,\mathcal{A}_{ihj}\;\mathcal{A}^{ijh} + 2\,r_i\,\partial_i\mathcal{A}^{hl}{}_h\;\partial^j\mathcal{A}_l{}^q{}_q -$$

$$\frac{2}{3}\,r_i\,\partial^{q'}\mathcal{A}^{jq}{}_h\,\partial_j\mathcal{A}_{qq'}{}^h - \frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{qq'}{}^h\,\partial_h\mathcal{A}^{qq'j} + \frac{2}{3}\,r_i\,\partial_j\mathcal{A}_{qq'}{}^h\,\partial_h\mathcal{A}^{jqq'} + 2\,r_i\,\partial_q\mathcal{A}_l{}^q{}_j\,\partial_h\mathcal{A}^{jhl} -$$

$$2\,r_i\,\partial_j\mathcal{A}_l{}^q{}_q\,\partial_h\mathcal{A}^{jhl} + 2\,r_i\,\partial_q\mathcal{A}_l{}^q{}_j\,\partial_h\mathcal{A}^{hlj} - 4\,r_i\,\partial_j\mathcal{A}_l{}^q{}_q\,\partial_h\mathcal{A}^{hlj} + \frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{qq'j}\,\partial^h\mathcal{A}_{qq'j} -$$

$$\frac{2}{3}\,r_i\,\partial_h\mathcal{A}^{jqq'}\,\partial^h\mathcal{A}_{qq'j} - \frac{1}{3}\,t_i\,\partial^q f_{jh}\,\partial^h f_q{}^j + \frac{1}{3}\,t_i\,\partial^q f_h{}^l\,\partial^h f_{ql} + \frac{1}{3}\,t_i\,\mathcal{A}_{ih}{}^q\,\partial^h f^i{}_q - \frac{2}{3}\,t_i\,\partial^q f_{ih}\,\partial^h f^i{}_q +$$

$$t_i\,\mathcal{A}_h{}^q{}_q\,\partial^h f^i{}_i + t_i\,\mathcal{A}_h{}^l{}_l\,\partial^h f^i{}_i + 2\,t_i\,\partial^q f_{qh}\,\partial^h f^i{}_i - t_i\,\partial_h f^l{}_l\,\partial^h f^i{}_i - \frac{1}{3}\,t_i\,\mathcal{A}_{ijh}\,\partial^h f^{ij} +$$

$$\frac{1}{3}\,t_i\,\mathcal{A}_{ih}{}^l\,\partial^h f^i{}_l - \frac{2}{3}\,t_i\,\mathcal{A}_i{}^l{}_h\,\partial^h f^i{}_l + \frac{2}{3}\,t_i\,\mathcal{A}^l{}_{hi}\,\partial^h f^i{}_l + \frac{2}{3}\,t_i\,\partial_h f^i{}_i\,\partial^h f^i{}_i - t_i\,\partial^{q'} f_{q'}{}^q\,\partial^h f_{hq} -$$

$$t_i\,\mathcal{A}_j{}^l{}_l\,\partial^h f_h{}^j - t_i\,\mathcal{A}^{lq}{}_q\,\partial^h f_{hl} - \frac{1}{3}\,t_i\,\partial^q f_h{}^l\,\partial^h f_{lq} + \frac{2}{3}\,t_i\,\mathcal{A}_{jh}{}^l\,\partial^h f^j{}_l + \frac{1}{3}\,t_i\,\partial_h f_j{}^l\,\partial^h f^j{}_l +$$

$$\frac{2}{3}\,r_i\,\partial^{q'}\mathcal{A}_i{}^{ql}\,\partial_l\mathcal{A}_{qq'}{}^i - \frac{8}{3}\,r_i\,\partial^{q'}\mathcal{A}_i{}^{lq}\,\partial_l\mathcal{A}_{qq'}{}^i - 2\,r_i\,\partial_q\mathcal{A}_l{}^q{}_j\,\partial^l\mathcal{A}^{jh}{}_h + 2\,r_i\,\partial_j\mathcal{A}_l{}^q{}_q\,\partial^l\mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -2k^2 t_{\underset{1}{\bullet}} & -i\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & 0 \\ i\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & -t_{\underset{1}{\bullet}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ (0),\ \begin{pmatrix} \dfrac{k^2 t_{\underset{1}{\bullet}}}{3} & -\dfrac{ikt_{\underset{1}{\bullet}}}{3\sqrt{2}} & \dfrac{ikt_{\underset{1}{\bullet}}}{3} \\ \dfrac{ikt_{\underset{1}{\bullet}}}{3\sqrt{2}} & \dfrac{t_{\underset{1}{\bullet}}}{6} & -\dfrac{t_{\underset{1}{\bullet}}}{3\sqrt{2}} \\ -\dfrac{1}{3}ikt_{\underset{1}{\bullet}} & -\dfrac{t_{\underset{1}{\bullet}}}{3\sqrt{2}} & \dfrac{t_{\underset{1}{\bullet}}}{3} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} 0 & -ikt_{\underset{1}{\bullet}} & 0 & 0 \\ ikt_{\underset{1}{\bullet}} & -k^2 r_{\underset{1}{\bullet}}-\dfrac{t_{\underset{1}{\bullet}}}{2} & 0 & \dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ 0 & \dfrac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 & 0 \end{pmatrix},\ \begin{pmatrix} k^2 t_{\underset{1}{\bullet}} & \dfrac{ikt_{\underset{1}{\bullet}}}{\sqrt{2}} \\ -\dfrac{ikt_{\underset{1}{\bullet}}}{\sqrt{2}} & \dfrac{t_{\underset{1}{\bullet}}}{2} \end{pmatrix},\ \left(\dfrac{1}{2}\left(2k^2 r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)\right)\right\}$$

Gauge constraints on source currents:

$$\left\{\underset{\bullet}{\overset{0^+}{}}\tau^{\flat\perp} == 0,\ -i\,\underset{\bullet}{\overset{0^+}{}}\tau^{\flat\|} == 2k\,\underset{\bullet}{\overset{0^+}{}}\sigma^{\flat\|},\ \underset{\bullet}{\overset{0^-}{}}\sigma^{\flat\|} == 0,\ -i\,\underset{\bullet}{\overset{1^+}{}}\tau^{\flat\|}{}^{\mathfrak{a}\mathfrak{b}} == k\,\underset{\bullet}{\overset{1^+}{}}\sigma^{\flat\perp}{}^{\mathfrak{a}\mathfrak{b}},\right.$$

$$\left. i\,\underset{\bullet}{\overset{1^+}{}}\tau^{\flat\|}{}^{\mathfrak{a}\mathfrak{b}} == 2k\,\underset{\bullet}{\overset{1^+}{}}\sigma^{\flat\|}{}^{\mathfrak{a}\mathfrak{b}},\ i\,\underset{\bullet}{\overset{1^-}{}}\tau^{\flat\|}{}^{\mathfrak{a}} == 2k\,\underset{\bullet}{\overset{1^-}{}}\sigma^{\flat\perp}{}^{\mathfrak{a}},\ \underset{\bullet}{\overset{1^-}{}}\tau^{\flat\perp}{}^{\mathfrak{a}} == 0,\ -i\,\underset{\bullet}{\overset{2^+}{}}\tau^{\flat\|}{}^{\mathfrak{a}\mathfrak{b}} == 2k\,\underset{\bullet}{\overset{2^+}{}}\sigma^{\flat\|}{}^{\mathfrak{a}\mathfrak{b}}\right\}$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally
analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{\begin{pmatrix} -\dfrac{2k^2}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} & 0 \\ \dfrac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{1}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} & 0 \\ 0 & 0 & 0 \end{pmatrix},\ (0),\ \begin{pmatrix} \dfrac{12k^2}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{6i\sqrt{2}\,k}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{12ik}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} \\ \dfrac{6i\sqrt{2}\,k}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{6}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{6\sqrt{2}}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} \\ -\dfrac{12ik}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} & -\dfrac{6\sqrt{2}}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{12}{\left(3+2k^2\right)^2 t_{\underset{1}{\bullet}}} \end{pmatrix},\right.$$

$$\left.\begin{pmatrix} \dfrac{2k^2\left(2k^2 r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)}{\left(t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}\right)^2} & -\dfrac{2ik}{t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}} & 0 & -\dfrac{i\sqrt{2}\,k\left(2k^2 r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)}{\left(t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}\right)^2} \\ \dfrac{2ik}{t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}} & 0 & 0 & \dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}} \\ 0 & 0 & 0 & 0 \\ \dfrac{i\sqrt{2}\,k\left(2k^2 r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)}{\left(t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}\right)^2} & \dfrac{\sqrt{2}}{t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}} & 0 & \dfrac{2k^2 r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}}{\left(t_{\underset{1}{\bullet}}+2k^2 t_{\underset{1}{\bullet}}\right)^2} \end{pmatrix},\ \begin{pmatrix} \dfrac{4k^2}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} \\ -\dfrac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} & \dfrac{2}{\left(1+2k^2\right)^2 t_{\underset{1}{\bullet}}} \end{pmatrix},\ \left(\dfrac{2}{2k^2 r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}}\right)\right\}$$

Square masses:

$$\left\{\{\},\{\},\{\},\{\},\{\},\left\{-\dfrac{t_{\underset{1}{\bullet}}}{2r_{\underset{1}{\bullet}}}\right\}\right\}$$

Massive pole residues:

$$\left\{\{\},\{\},\{\},\{\},\{\},\left\{-\dfrac{1}{r_{\underset{1}{\bullet}}}\right\}\right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{\left\{-\frac{1}{r_{\bullet_1}}, \; 2^-, \; -\frac{t_{\bullet_1}}{2\,r_{\bullet_1}}\right\}, \; \{\}\right\}$$

Overall unitarity conditions:

$r_{\bullet_1} < 0 \,\&\&\, t_{\bullet_1} > 0$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$r_{\bullet_1} < 0 \,\&\&\, t_{\bullet_1} > 0$

Okay, that concludes the analysis of this theory.

Case 57

Now for a new theory. Here is the full nonlinear Lagrangian for
   Case 57 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{6}\left(2\,r_{\bullet_1} + r_{\bullet_2}\right)\mathcal{R}_{ijhl}\;\mathcal{R}^{ijhl} + \frac{2}{3}\left(r_{\bullet_1} - r_{\bullet_2}\right)\mathcal{R}_{ihjl}\;\mathcal{R}^{ijhl} - 2\,r_{\bullet_1}\,\mathcal{R}^{ij}{}_i{}^h\;\mathcal{R}_j{}^l{}_{hl} +$$

$$\frac{1}{6}\left(-4\,r_{\bullet_1} + r_{\bullet_2}\right)\mathcal{R}^{ijhl}\;\mathcal{R}_{hlij} + 2\,r_{\bullet_1}\,\mathcal{R}^{ij}{}_i{}^h\;\mathcal{R}_h{}^l{}_{jl} + \frac{1}{3}\,t_{\bullet_1}\,\mathcal{T}_{ijh}\;\mathcal{T}^{ijh} + \frac{1}{3}\,t_{\bullet_1}\,\mathcal{T}^{ijh}\;\mathcal{T}_{jih} + t_{\bullet_1}\,\mathcal{T}^{ij}{}_i{}^j\;\mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
   this Lagrangian to second order around the desired vacuum:

$$
-t_{\underset{1}{\bullet}}\,\mathcal{A}_{i}{}^{l}{}_{l}\,\mathcal{A}^{ij}{}_{j}+\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{ijh}\,\mathcal{A}^{ijh}+\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{ihj}\,\mathcal{A}^{ijh}+2\,r_{\underset{1}{\bullet}}\,\partial_{i}\mathcal{A}^{hl}{}_{h}\,\partial^{i}\mathcal{A}_{l}{}^{a}{}_{a}-\frac{2}{3}\,r_{\underset{1}{\bullet}}\,\partial^{a'}\mathcal{A}^{ja}{}_{h}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}+
$$

$$
\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial^{a'}\mathcal{A}^{ja}{}_{h}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}-\frac{2}{3}\,r_{\underset{1}{\bullet}}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}\,\partial_{h}\mathcal{A}^{aa'j}-\frac{1}{3}\,r_{\underset{2}{\bullet}}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}\,\partial_{h}\mathcal{A}^{aa'j}+\frac{2}{3}\,r_{\underset{1}{\bullet}}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}\,\partial_{h}\mathcal{A}^{jaa'}-
$$

$$
\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial_{j}\mathcal{A}_{aa'}{}^{h}\,\partial_{h}\mathcal{A}^{jaa'}+2\,r_{\underset{1}{\bullet}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{h}\mathcal{A}^{jhl}-2\,r_{\underset{1}{\bullet}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{h}\mathcal{A}^{jhl}+2\,r_{\underset{1}{\bullet}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial_{h}\mathcal{A}^{hlj}-
$$

$$
4\,r_{\underset{1}{\bullet}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial_{h}\mathcal{A}^{hlj}+\frac{2}{3}\,r_{\underset{1}{\bullet}}\,\partial_{h}\mathcal{A}^{aa'j}\,\partial^{h}\mathcal{A}_{aa'j}+\frac{1}{3}\,r_{\underset{2}{\bullet}}\,\partial_{h}\mathcal{A}^{aa'j}\,\partial^{h}\mathcal{A}_{aa'j}-\frac{2}{3}\,r_{\underset{1}{\bullet}}\,\partial_{h}\mathcal{A}^{jaa'}\,\partial^{h}\mathcal{A}_{aa'j}+
$$

$$
\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial_{h}\mathcal{A}^{jaa'}\,\partial^{h}\mathcal{A}_{aa'j}-\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{jh}\,\partial^{h}f_{a}{}^{j}+\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{h}{}^{l}\,\partial^{h}f_{al}+\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{ih}{}^{a}\,\partial^{h}f^{i}{}_{a}-\frac{2}{3}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{ih}\,\partial^{h}f^{i}{}_{a}+
$$

$$
t_{\underset{1}{\bullet}}\,\mathcal{A}_{h}{}^{a}{}_{a}\,\partial^{h}f^{i}{}_{i}+t_{\underset{1}{\bullet}}\,\mathcal{A}_{h}{}^{l}{}_{l}\,\partial^{h}f^{i}{}_{i}+2\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{ah}\,\partial^{h}f^{i}{}_{i}-t_{\underset{1}{\bullet}}\,\partial_{h}f^{l}{}_{l}\,\partial^{h}f^{i}{}_{i}-\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{ijh}\,\partial^{h}f^{ij}+\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{ih}{}^{l}\,\partial^{h}f^{i}{}_{l}-
$$

$$
\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{ih}{}^{l}\,\partial^{h}f^{i}{}_{l}+\frac{2}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}^{l}{}_{hi}\,\partial^{h}f^{i}{}_{l}+\frac{2}{3}\,t_{\underset{1}{\bullet}}\,\partial_{h}f_{i}{}^{l}\,\partial^{h}f^{i}{}_{l}-t_{\underset{1}{\bullet}}\,\partial^{a'}f_{a'}{}^{a}\,\partial^{h}f_{ha}-t_{\underset{1}{\bullet}}\,\mathcal{A}_{j}{}^{l}{}_{l}\,\partial^{h}f_{h}{}^{j}-t_{\underset{1}{\bullet}}\,\mathcal{A}^{la}{}_{a}\,\partial^{h}f_{hl}-
$$

$$
\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\partial^{a}f_{h}{}^{l}\,\partial^{h}f_{la}+\frac{2}{3}\,t_{\underset{1}{\bullet}}\,\mathcal{A}_{jh}{}^{l}\,\partial^{h}f_{l}{}^{j}+\frac{1}{3}\,t_{\underset{1}{\bullet}}\,\partial_{h}f_{j}{}^{l}\,\partial^{h}f_{l}{}^{j}+\frac{2}{3}\,r_{\underset{1}{\bullet}}\,\partial^{a'}\mathcal{A}_{i}{}^{al}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}-\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial^{a'}\mathcal{A}_{i}{}^{al}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}-
$$

$$
\frac{8}{3}\,r_{\underset{1}{\bullet}}\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}+\frac{2}{3}\,r_{\underset{2}{\bullet}}\,\partial^{a'}\mathcal{A}_{i}{}^{la}\,\partial_{l}\mathcal{A}_{aa'}{}^{i}-2\,r_{\underset{1}{\bullet}}\,\partial_{a}\mathcal{A}_{l}{}^{a}{}_{j}\,\partial^{l}\mathcal{A}^{jh}{}_{h}+2\,r_{\underset{1}{\bullet}}\,\partial_{j}\mathcal{A}_{l}{}^{a}{}_{a}\,\partial^{l}\mathcal{A}^{jh}{}_{h}
$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with

the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$
\left\{
\begin{pmatrix}
-2\,k^2\,t_{\underset{1}{\bullet}} & -i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & 0 \\
i\,\sqrt{2}\,k\,t_{\underset{1}{\bullet}} & -t_{\underset{1}{\bullet}} & 0 \\
0 & 0 & 0
\end{pmatrix},
\left(k^2\,r_{\underset{2}{\bullet}}\right),
\begin{pmatrix}
\frac{k^2\,t_{\underset{1}{\bullet}}}{3} & -\frac{i\,k\,t_{\underset{1}{\bullet}}}{3\sqrt{2}} & \frac{i\,k\,t_{\underset{1}{\bullet}}}{3} \\
\frac{i\,k\,t_{\underset{1}{\bullet}}}{3\sqrt{2}} & \frac{t_{\underset{1}{\bullet}}}{6} & -\frac{t_{\underset{1}{\bullet}}}{3\sqrt{2}} \\
-\frac{1}{3}\,i\,k\,t_{\underset{1}{\bullet}} & -\frac{t_{\underset{1}{\bullet}}}{3\sqrt{2}} & \frac{t_{\underset{1}{\bullet}}}{3}
\end{pmatrix},
\right.
$$

$$
\left.
\begin{pmatrix}
0 & -i\,k\,t_{\underset{1}{\bullet}} & 0 & 0 \\
i\,k\,t_{\underset{1}{\bullet}} & -k^2\,r_{\underset{1}{\bullet}}-\frac{t_{\underset{1}{\bullet}}}{2} & 0 & \frac{t_{\underset{1}{\bullet}}}{\sqrt{2}} \\
0 & 0 & 0 & 0 \\
0 & \frac{t_{\underset{1}{\bullet}}}{\sqrt{2}} & 0 & 0
\end{pmatrix},
\begin{pmatrix}
k^2\,t_{\underset{1}{\bullet}} & \frac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} \\
-\frac{i\,k\,t_{\underset{1}{\bullet}}}{\sqrt{2}} & \frac{t_{\underset{1}{\bullet}}}{2}
\end{pmatrix},
\left(\frac{1}{2}\left(2\,k^2\,r_{\underset{1}{\bullet}}+t_{\underset{1}{\bullet}}\right)\right)\right\}
$$

Gauge constraints on source currents:

$$
\left\{{}^{0^+}_{\bullet}\tau^{b\perp}==0,\ -i\,{}^{0^+}_{\bullet}\tau^{b\parallel}==2\,k\,{}^{0^+}_{\bullet}\sigma^{b\parallel},\ -i\,{}^{1^+}_{\bullet}\tau^{b\parallel}{}^{ab}==k\,{}^{1^+}_{\bullet}\sigma^{b\perp\,ab},\right.
$$

$$
\left. i\,{}^{1^+}_{\bullet}\tau^{b\parallel\,ab}==2\,k\,{}^{1^+}_{\bullet}\sigma^{b\parallel\,ab},\ i\,{}^{1^-}_{\bullet}\tau^{b\parallel\,a}==2\,k\,{}^{1^-}_{\bullet}\sigma^{b\perp\,a},\ {}^{1^-}_{\bullet}\tau^{b\perp\,a}==0,\ -i\,{}^{2^+}_{\bullet}\tau^{b\parallel\,ab}==2\,k\,{}^{2^+}_{\bullet}\sigma^{b\parallel\,ab}\right\}
$$

The Drazin (Moore–Penrose) inverses of these a-matrices, which are functionally

analogous to the inverse b-matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} -\dfrac{2k^2}{(1+2k^2)^2 t_{\cdot_1}} & -\dfrac{i\sqrt{2}\,k}{(1+2k^2)^2 t_{\cdot_1}} & 0 \\[2mm] \dfrac{i\sqrt{2}\,k}{(1+2k^2)^2 t_{\cdot_1}} & -\dfrac{1}{(1+2k^2)^2 t_{\cdot_1}} & 0 \\[2mm] 0 & 0 & 0 \end{pmatrix}, \left(\dfrac{1}{k^2 r_{\cdot_2}} \right), \begin{pmatrix} \dfrac{12k^2}{(3+2k^2)^2 t_{\cdot_1}} & -\dfrac{6i\sqrt{2}\,k}{(3+2k^2)^2 t_{\cdot_1}} & \dfrac{12 i k}{(3+2k^2)^2 t_{\cdot_1}} \\[2mm] \dfrac{6i\sqrt{2}\,k}{(3+2k^2)^2 t_{\cdot_1}} & \dfrac{6}{(3+2k^2)^2 t_{\cdot_1}} & -\dfrac{6\sqrt{2}}{(3+2k^2)^2 t_{\cdot_1}} \\[2mm] -\dfrac{12 i k}{(3+2k^2)^2 t_{\cdot_1}} & -\dfrac{6\sqrt{2}}{(3+2k^2)^2 t_{\cdot_1}} & \dfrac{12}{(3+2k^2)^2 t_{\cdot_1}} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{2k^2\left(2k^2 r_{\cdot_1}+t_{\cdot_1}\right)}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} & -\dfrac{2ik}{t_{\cdot_1}+2k^2 t_{\cdot_1}} & 0 & -\dfrac{i\sqrt{2}\,k\left(2k^2 r_{\cdot_1}+t_{\cdot_1}\right)}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} \\[3mm] \dfrac{2ik}{t_{\cdot_1}+2k^2 t_{\cdot_1}} & 0 & 0 & \dfrac{\sqrt{2}}{t_{\cdot_1}+2k^2 t_{\cdot_1}} \\[3mm] 0 & 0 & 0 & 0 \\[3mm] \dfrac{i\sqrt{2}\,k\left(2k^2 r_{\cdot_1}+t_{\cdot_1}\right)}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} & \dfrac{\sqrt{2}}{t_{\cdot_1}+2k^2 t_{\cdot_1}} & 0 & \dfrac{2k^2 r_{\cdot_1}+t_{\cdot_1}}{\left(t_{\cdot_1}+2k^2 t_{\cdot_1}\right)^2} \end{pmatrix}, \begin{pmatrix} \dfrac{4k^2}{(1+2k^2)^2 t_{\cdot_1}} & \dfrac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_{\cdot_1}} \\[2mm] -\dfrac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_{\cdot_1}} & \dfrac{2}{(1+2k^2)^2 t_{\cdot_1}} \end{pmatrix}, \left(\dfrac{2}{2k^2 r_{\cdot_1}+t_{\cdot_1}} \right) \right\}$$

Square masses:

$$\left\{ 0,\, 0,\, 0,\, 0,\, 0,\, \left\{ -\frac{t_{\cdot_1}}{2\,r_{\cdot_1}} \right\} \right\}$$

Massive pole residues:

$$\left\{ 0,\, 0,\, 0,\, 0,\, 0,\, \left\{ -\frac{1}{r_{\cdot_1}} \right\} \right\}$$

Massless eigenvalues:

$\{\}$

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\frac{1}{r_{\cdot_1}},\, 2^-,\, -\frac{t_{\cdot_1}}{2\,r_{\cdot_1}} \right\},\, \{\} \right\}$$

Overall unitarity conditions:

$r_{\cdot_1} < 0\ \&\&\ t_{\cdot_1} > 0$

So, that's the end of the PSALTer output for this theory. You can check the particle content against TABLE IV. in arXiv:1910.14197. If you take the overall unitarity conditions from the final column in TABLE V., and decompose them using Mathematica's Reduce function, you get the following (to be compared with the PSALTer conditions above):

$r_{\cdot_1} < 0\ \&\&\ t_{\cdot_1} > 0$

Okay, that concludes the analysis of this theory.

Case 58

Now for a new theory. Here is the full nonlinear Lagrangian for
Case 58 as defined by the second column of TABLE V. in arXiv:1910.14197:

$$\frac{1}{3} r_1 \mathcal{R}_{ijhl} \mathcal{R}^{ijhl} + \frac{2}{3} r_1 \mathcal{R}_{ihjl} \mathcal{R}^{ijhl} - r_1 \mathcal{R}^{ij}{}_i{}^h \mathcal{R}_{jhl}{}^l + \frac{1}{3}\left(r_1 - 3 r_3\right) \mathcal{R}^{ijhl} \mathcal{R}_{hlij} +$$

$$\left(-3 r_1 + 4 r_3\right) \mathcal{R}^{ij}{}_i{}^h \mathcal{R}_h{}^l{}_{jl} + \frac{1}{4} t_1 \mathcal{T}_{ijh} \mathcal{T}^{ijh} + \frac{1}{2} t_1 \mathcal{T}^{ijh} \mathcal{T}_{jih} + \frac{1}{3} t_1 \mathcal{T}^i{}_i{}^j \mathcal{T}^h{}_{jh}$$

To use PSALTer, you have to first linearise
this Lagrangian to second order around the desired vacuum:

$$-\frac{1}{3} t_1 \mathcal{A}_i{}^l{}_l \mathcal{A}^{ij}{}_j + t_1 \mathcal{A}_{ihj} \mathcal{A}^{ijh} + r_1 \partial_i \mathcal{A}^{hl}{}_h \partial^i \mathcal{A}_l{}^a{}_a - \frac{2}{3} r_1 \partial^a \mathcal{A}^{ja}{}_h \partial_j \mathcal{A}_{aa'}{}^h - \frac{2}{3} r_1 \partial_j \mathcal{A}_{aa'}{}^h \partial_h \mathcal{A}^{aa'j} +$$

$$\frac{2}{3} r_1 \partial_j \mathcal{A}_{aa'}{}^h \partial_h \mathcal{A}^{jaa'} - 3 r_1 \partial_a \mathcal{A}_l{}^a{}_j \partial_h \mathcal{A}^{jhl} + 4 r_3 \partial_a \mathcal{A}_l{}^a{}_j \partial_h \mathcal{A}^{jhl} + 3 r_1 \partial_j \mathcal{A}_l{}^a{}_a \partial_h \mathcal{A}^{jhl} -$$

$$4 r_3 \partial_j \mathcal{A}_l{}^a{}_a \partial_h \mathcal{A}^{jhl} + r_1 \partial_a \mathcal{A}_l{}^a{}_j \partial_h \mathcal{A}^{hlj} - 2 r_1 \partial_j \mathcal{A}_l{}^a{}_a \partial_h \mathcal{A}^{hlj} + \frac{2}{3} r_1 \partial_h \mathcal{A}^{aa'j} \partial^h \mathcal{A}_{aa'j} -$$

$$\frac{2}{3} r_1 \partial_h \mathcal{A}^{jaa'} \partial^h \mathcal{A}_{aa'j} - \frac{1}{2} t_1 \partial^a f_{jh} \partial^h f_a{}^j + \frac{1}{2} t_1 \partial^a f_h{}^l \partial^h f_{al} - \frac{1}{2} t_1 \partial^a f_{ih} \partial^h f^i{}_a + \frac{1}{3} t_1 \mathcal{A}_h{}^a{}_a \partial^h f^i{}_i +$$

$$\frac{1}{3} t_1 \mathcal{A}_h{}^l{}_l \partial^h f^i{}_i + \frac{2}{3} t_1 \partial^a f_{ah} \partial^h f^i{}_i - \frac{1}{3} t_1 \partial_h f^l{}_l \partial^h f^i{}_i + t_1 \mathcal{A}^l{}_{hi} \partial^h f^i{}_l + \frac{1}{2} t_1 \partial_h f_i{}^l \partial^h f^i{}_l -$$

$$\frac{1}{3} t_1 \partial^{a'} f_{a'}{}^a \partial^h f_{ha} - \frac{1}{3} t_1 \mathcal{A}_j{}^l{}_l \partial^h f_h{}^j - \frac{1}{3} t_1 \mathcal{A}^{la}{}_a \partial^h f_{hl} - \frac{1}{2} t_1 \partial^a f_h{}^l \partial^h f_{la} + t_1 \mathcal{A}_{jh}{}^l \partial^h f_l{}^j +$$

$$\frac{1}{2} t_1 \partial_h f_j{}^l \partial^h f_l{}^j + \frac{2}{3} r_1 \partial^{a'} \mathcal{A}_i{}^{al} \partial_l \mathcal{A}_{aa'}{}^i + \frac{4}{3} r_1 \partial^{a'} \mathcal{A}_i{}^{la} \partial_l \mathcal{A}_{aa'}{}^i - 4 r_3 \partial^{a'} \mathcal{A}_i{}^{la} \partial_l \mathcal{A}_{aa'}{}^i +$$

$$3 r_1 \partial_a \mathcal{A}_l{}^a{}_j \partial^l \mathcal{A}^{jh}{}_h - 4 r_3 \partial_a \mathcal{A}_l{}^a{}_j \partial^l \mathcal{A}^{jh}{}_h - 3 r_1 \partial_j \mathcal{A}_l{}^a{}_a \partial^l \mathcal{A}^{jh}{}_h + 4 r_3 \partial_j \mathcal{A}_l{}^a{}_a \partial^l \mathcal{A}^{jh}{}_h$$

Now we pass this theory into the PSALTer package, which computes the particle spectrum:

The (possibly singular) a-matrices associated with
the Lagrangian, as defined below Eq. (18) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 6 k^2\left(-r_1 + r_3\right) & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} -t_1 \end{pmatrix}, \begin{pmatrix} 0 & -\frac{i k t_1}{\sqrt{2}} & 0 \\ \frac{i k t_1}{\sqrt{2}} & \frac{1}{2}\left(2 k^2 r_1 - t_1\right) & -\frac{t_1}{\sqrt{2}} \\ 0 & -\frac{t_1}{\sqrt{2}} & 0 \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \frac{2 k^2 t_1}{3} & -\frac{1}{3} i k t_1 & 0 & -\frac{1}{3} i \sqrt{2} k t_1 \\ \frac{i k t_1}{3} & \frac{t_1}{6} & 0 & \frac{t_1}{3\sqrt{2}} \\ 0 & 0 & 0 & 0 \\ \frac{1}{3} i \sqrt{2} k t_1 & \frac{t_1}{3\sqrt{2}} & 0 & \frac{t_1}{3} \end{pmatrix}, \begin{pmatrix} k^2 t_1 & \frac{i k t_1}{\sqrt{2}} \\ -\frac{i k t_1}{\sqrt{2}} & \frac{t_1}{2} \end{pmatrix}, \left(\frac{1}{2}\left(2 k^2 r_1 + t_1\right)\right) \right\}$$

Gauge constraints on source currents:

$$\left\{ {}^{0^+}_{\bullet}\tau^{b\perp} == 0, \; {}^{0^+}_{\bullet}\tau^{b\parallel} == 0, \; -i \; {}^{1^+}_{\bullet}\tau^{b\parallel\,a\,b} == k \; {}^{1^+}_{\bullet}\sigma^{b\perp\,a\,b}, \right.$$

$$\left. i \; {}^{1^-}_{\bullet}\tau^{b\parallel\,a} == 2\,k \; {}^{1^-}_{\bullet}\sigma^{b\perp\,a}, \; {}^{1^-}_{\bullet}\tau^{b\perp\,a} == 0, \; i \; {}^{1^-}_{\bullet}\tau^{b\parallel\,a} == 2\,k \; {}^{1^-}_{\bullet}\sigma^{b\parallel\,a}, \; -i \; {}^{2^+}_{\bullet}\tau^{b\parallel\,a\,b} == 2\,k \; {}^{2^+}_{\bullet}\sigma^{b\parallel\,a\,b} \right\}$$

The Drazin (Moore–Penrose) inverses of these *a*–matrices, which are functionally
   analogous to the inverse *b*–matrices described below Eq. (21) of arXiv:1812.02675:

$$\left\{ \begin{pmatrix} 0 & 0 & 0 \\ 0 & \dfrac{1}{6\,k^2\left(-r_{\bullet 1}+r_{\bullet 3}\right)} & 0 \\ 0 & 0 & 0 \end{pmatrix}, \left(-\dfrac{1}{t_{\bullet 1}}\right), \begin{pmatrix} \dfrac{-2\,k^4\,r_{\bullet 1}+k^2\,t_{\bullet 1}}{(1+k^2)^2\,t_{\bullet 1}^2} & -\dfrac{i\,\sqrt{2}\,k}{t_{\bullet 1}+k^2\,t_{\bullet 1}} & -\dfrac{i\left(2\,k^3\,r_{\bullet 1}-k\,t_{\bullet 1}\right)}{(1+k^2)^2\,t_{\bullet 1}^2} \\ \dfrac{i\,\sqrt{2}\,k}{t_{\bullet 1}+k^2\,t_{\bullet 1}} & 0 & -\dfrac{\sqrt{2}}{t_{\bullet 1}+k^2\,t_{\bullet 1}} \\ \dfrac{i\left(2\,k^3\,r_{\bullet 1}-k\,t_{\bullet 1}\right)}{(1+k^2)^2\,t_{\bullet 1}^2} & -\dfrac{\sqrt{2}}{t_{\bullet 1}+k^2\,t_{\bullet 1}} & \dfrac{-2\,k^2\,r_{\bullet 1}+t_{\bullet 1}}{(1+k^2)^2\,t_{\bullet 1}^2} \end{pmatrix}, \right.$$

$$\left. \begin{pmatrix} \dfrac{24\,k^2}{(3+4\,k^2)^2\,t_{\bullet 1}} & -\dfrac{12\,i\,k}{(3+4\,k^2)^2\,t_{\bullet 1}} & 0 & -\dfrac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_{\bullet 1}} \\ \dfrac{12\,i\,k}{(3+4\,k^2)^2\,t_{\bullet 1}} & \dfrac{6}{(3+4\,k^2)^2\,t_{\bullet 1}} & 0 & \dfrac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_{\bullet 1}} \\ 0 & 0 & 0 & 0 \\ \dfrac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_{\bullet 1}} & \dfrac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_{\bullet 1}} & 0 & \dfrac{12}{(3+4\,k^2)^2\,t_{\bullet 1}} \end{pmatrix}, \begin{pmatrix} \dfrac{4\,k^2}{(1+2\,k^2)^2\,t_{\bullet 1}} & \dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet 1}} \\ -\dfrac{2\,i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_{\bullet 1}} & \dfrac{2}{(1+2\,k^2)^2\,t_{\bullet 1}} \end{pmatrix}, \left(\dfrac{2}{2\,k^2\,r_{\bullet 1}+t_{\bullet 1}}\right) \right\}$$

Square masses:

$$\left\{ 0, 0, 0, 0, 0, \left\{ -\dfrac{t_{\bullet 1}}{2\,r_{\bullet 1}} \right\} \right\}$$

Massive pole residues:

$$\left\{ 0, 0, 0, 0, 0, \left\{ -\dfrac{1}{r_{\bullet 1}} \right\} \right\}$$

Massless eigenvalues:

{}

FeynArts representation of particle spectrum:

$$\left\{ \left\{ -\dfrac{1}{r_{\bullet 1}}, 2^-, -\dfrac{t_{\bullet 1}}{2\,r_{\bullet 1}} \right\}, \{\} \right\}$$

Overall unitarity conditions:

$$r_{\bullet 1} < 0 \;\&\&\; t_{\bullet 1} > 0$$

So, that's the end of the PSALTer output for this theory. You
   can check the particle content against TABLE IV. in arXiv:1910.14197.
   If you take the overall unitarity conditions from the final column in
   TABLE V., and decompose them using Mathematica's Reduce function, you
   get the following (to be compared with the PSALTer conditions above):

$$r_{\bullet 1} < 0 \;\&\&\; t_{\bullet 1} > 0$$

Okay, that concludes the analysis of this theory.

How long did this take?

Okay, that's all the cases. You can see from the timing
  below (in seconds) that each theory takes about a minute to process:

{{78.2368, Null}, {58.1253, Null}, {52.595, Null}, {53.502, Null},
 {59.0326, Null}, {52.2503, Null}, {58.2074, Null}, {59.2463, Null},
 {45.3526, Null}, {41.606, Null}, {43.496, Null}, {61.2587, Null}, {47.1293, Null},
 {56.4629, Null}, {58.864, Null}, {61.718, Null}, {52.4741, Null}, {56.3463, Null},
 {52.9976, Null}, {54.2086, Null}, {51.9032, Null}, {55.2739, Null}, {55.4292, Null},
 {62.8221, Null}, {56.3309, Null}, {57.7178, Null}, {60.2233, Null}, {53.1001, Null},
 {65.6412, Null}, {50.6723, Null}, {59.4323, Null}, {56.7369, Null}, {57.0034, Null},
 {54.9432, Null}, {69.5691, Null}, {53.291, Null}, {65.9632, Null}, {64.5204, Null},
 {61.7354, Null}, {54.1412, Null}, {66.7003, Null}, {63.3309, Null}, {64.1882, Null},
 {68.028, Null}, {70.1613, Null}, {67.0951, Null}, {66.7715, Null}, {68.6685, Null},
 {61.1124, Null}, {64.3089, Null}, {71.2816, Null}, {65.7503, Null}, {64.4256, Null},
 {66.4711, Null}, {66.9801, Null}, {69.8179, Null}, {72.6349, Null}, {68.5825, Null}}