

PSALter results panel

Wave operator and propagator

<div><div><div><div><div><math>0^+h^+</math></div><div><math>0^+h^\parallel</math></div><div><math>0^+\mathcal{A}_3^\parallel</math></div></div><div><div><math>0^+\mathcal{A}_5^{+t}</math></div><div><math>0^+\mathcal{A}_6^\parallel</math></div><div><math>0^+\mathcal{A}_5^{+h}</math></div></div><div><div><math>0^+\mathcal{A}_a^\parallel</math></div></div></div><div><div><math>0^+h^+\dagger</math></div><div><math>0^+h^\parallel\dagger</math></div><div><math>0^+\mathcal{A}_a^\parallel\dagger</math></div></div><div><div><math>0^+\mathcal{A}_5^{+t}\dagger</math></div><div><math>0^+\mathcal{A}_5^\parallel\dagger</math></div><div><math>0^+\mathcal{A}_5^{+h}\dagger</math></div></div><div><div><math>0^+\mathcal{A}_a^\parallel\dagger</math></div></div></div><div><div><math>0^+h^+</math></div><div><math>0^+h^\parallel</math></div><div><math>0^+\mathcal{A}_3^\parallel</math></div></div><div><div><math>0^+\mathcal{A}_5^{+t}</math></div><div><math>0^+\mathcal{A}_6^\parallel</math></div><div><math>0^+\mathcal{A}_5^{+h}</math></div></div><div><div><math>0^+\mathcal{A}_a^\parallel</math></div></div></div> <div><div><math>0^+h^+\dagger</math></div><div><math>0^+h^\parallel\dagger</math></div><div><math>0^+\mathcal{A}_a^\parallel\dagger</math></div></div> <div><div><math>0^+\mathcal{A}_5^{+t}\dagger</math></div><div><math>0^+\mathcal{A}_5^\parallel\dagger</math></div><div><math>0^+\mathcal{A}_5^{+h}\dagger</math></div></div> <div><div><math>0^+\mathcal{A}_a^\parallel\dagger</math></div></div>
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$2^+\mathcal{T}^\perp_{\alpha\beta}$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta}$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta}$

$2^+\mathcal{W}_5^\perp_{\alpha\beta}$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta\chi}$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta\chi}$

$2^+\mathcal{T}^\perp_{\alpha\beta}\dagger$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{W}_5^\perp_{\alpha\beta}\dagger$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta\chi}\dagger$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta\chi}\dagger$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}\dagger$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}\dagger$

$2^+h^\parallel_{\alpha\beta}$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta}$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta}$

$2^+\mathcal{A}_5^\perp_{\alpha\beta}$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta\chi}$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}$

$2^+h^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{A}_5^\perp_{\alpha\beta}\dagger$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta\chi}\dagger$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}\dagger$

$0^+\mathcal{T}^\perp$

$0^+\mathcal{T}^\parallel$

$0^+\mathcal{W}_a^\parallel$

$0^+\mathcal{W}_5^{+t}$

$0^+\mathcal{W}_5^\parallel$

$0^+\mathcal{W}_5^{+h}$

$0^+\mathcal{W}_a^\parallel$

$0^+\mathcal{T}^\perp\dagger$

$0^+\mathcal{T}^\parallel\dagger$

$0^+\mathcal{W}_a^\parallel\dagger$

$0^+\mathcal{W}_5^{+t}\dagger$

$0^+\mathcal{W}_5^\parallel\dagger$

$0^+\mathcal{W}_5^{+h}\dagger$

$0^+\mathcal{W}_a^\parallel\dagger$

$0^+h^+$

$0^+h^\parallel$

$0^+\mathcal{A}_3^\parallel$

$0^+\mathcal{A}_5^{+t}$

$0^+\mathcal{A}_6^\parallel$

$0^+\mathcal{A}_5^{+h}$

$0^+\mathcal{A}_a^\parallel$

$0^+h^+\dagger$

$0^+h^\parallel\dagger$

$0^+\mathcal{A}_a^\parallel\dagger$

$0^+\mathcal{A}_5^{+t}\dagger$

$0^+\mathcal{A}_5^\parallel\dagger$

$0^+\mathcal{A}_5^{+h}\dagger$

$0^+\mathcal{A}_a^\parallel\dagger$

$2^+\mathcal{T}^\perp_{\alpha\beta}$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta}$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta}$

$2^+\mathcal{W}_5^\perp_{\alpha\beta}$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta\chi}$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta\chi}$

$2^+\mathcal{T}^\perp_{\alpha\beta}\dagger$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{W}_5^\perp_{\alpha\beta}\dagger$

$2^+\mathcal{W}_a^\parallel_{\alpha\beta\chi}\dagger$

$2^+\mathcal{W}_5^\parallel_{\alpha\beta\chi}\dagger$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}\dagger$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}$

$3^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}\dagger$

$2^+h^\parallel_{\alpha\beta}$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta}$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta}$

$2^+\mathcal{A}_5^\perp_{\alpha\beta}$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta\chi}$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}$

$2^+h^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta}\dagger$

$2^+\mathcal{A}_5^\perp_{\alpha\beta}\dagger$

$2^+\mathcal{A}_a^\parallel_{\alpha\beta\chi}\dagger$

$2^+\mathcal{A}_5^\parallel_{\alpha\beta\chi}\dagger$

$0^+\mathcal{T}^\perp$

$0^+\mathcal{T}^\parallel$

$0^+\mathcal{W}_a^\parallel$

$0^+\mathcal{W}_5^{+t}$

$0^+\mathcal{W}_5^\parallel$

$0^+\mathcal{W}_5^{+h}$

$0^+\mathcal{W}_a^\parallel$

$0^+\mathcal{T}^\perp\dagger$

$0^+\mathcal{T}^\parallel\dagger$

$0^+\mathcal{W}_a^\parallel\dagger$

$0^+\mathcal{W}_5^{+t}\dagger$

$0^+\mathcal{W}_5^\parallel\dagger$

$0^+\mathcal{W}_5^{+h}\dagger$

$0^+\mathcal{W}_a^\parallel\dagger$

$$\begin{aligned} \mathcal{S} = & \iiint\!\!\!\int (\frac{1}{24} (4(-2\,a_0+2\,a_1+a_2-12\,a_6+2\,a_9)\,\mathcal{A}^\mu_\alpha\,\mathcal{A}^{\alpha\beta}_\beta-3(a_0+8\,a_1-2\,a_5-18\,a_7+4\,a_9) \\ & \mathcal{A}_{a\beta\mu}\,\mathcal{A}^{\alpha\beta\mu}_\beta-3\,a_0\,\mathcal{A}_{a\mu\beta}\,\mathcal{A}^{\alpha\beta\mu}_\beta-12\,a_2\,\mathcal{A}_{a\mu\beta}\,\mathcal{A}^{\alpha\beta\mu}_\beta+ \\ & 6\,a_5\,\mathcal{A}_{a\mu\beta}\,\mathcal{A}^{\alpha\beta\mu}_\beta+54\,a_7\,\mathcal{A}_{a\mu\beta}\,\mathcal{A}^{\alpha\beta\mu}_\beta-12\,a_9\,\mathcal{A}_{a\mu\beta}\,\mathcal{A}^{\alpha\beta\mu}_\beta- \\ & 12\,a_2\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\beta a\mu}-12\,a_5\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\beta a\mu}-12\,a_0\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\beta\mu\alpha}+ \\ & 24\,a_2\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\beta\mu\alpha}-24\,a_5\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\beta\mu\alpha}+12\,a_9\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\beta\mu\alpha}+ \\ & 2\,a_0\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}-16\,a_1\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}-8\,a_2\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+ \\ & 12\,a_5\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+12\,a_7\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}-12\,a_9\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+ \\ & 2\,a_0\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+12\,a_5\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+12\,a_7\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}- \\ & 4\,a_9\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+24\,a_1\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\mu\beta\alpha}-12\,a_5\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\mu\beta\alpha}+ \\ & 12\,a_9\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\mathcal{A}_{\mu\beta\alpha}+4\,a_0\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}-24\,a_7\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+ \\ & 4\,a_9\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}-12\,a_7\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\beta\mu}+8\,a_1\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\mu\beta}+ \\ & 4\,a_2\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\mu\beta}-12\,a_7\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\mu\beta}+4\,a_9\,\mathcal{A}^{\alpha\beta}_\alpha\,\mathcal{A}^\mu_{\mu\beta}+ \\ & 24\,\mathcal{A}^{\alpha\beta\chi}_{\alpha\beta\chi}\,\mathcal{W}_{\alpha\beta\chi}+24\,\mathcal{T}^{\alpha\beta}_{\alpha\beta}\,h_{\alpha\beta}-6\,a_0\,h^\mu_\mu\,\partial_\beta\mathcal{A}^{\alpha\beta}_\alpha+6\,a_0\,h^\mu_\mu\,\partial_\beta\mathcal{A}^{\alpha\beta}_\alpha- \\ & 12\,a_0\,h_{a\mu}\,\partial_\beta\mathcal{A}^{\alpha\beta\mu}_\beta-12\,a_0\,\mathcal{A}^{\alpha\beta\mu}_\beta\,\partial_\beta h^\mu_{a\mu}-6\,a_0\,\mathcal{A}^{\alpha\beta}_\alpha\,\partial_\beta h^\mu_\mu+ \\ & 6\,a_0\,\mathcal{A}^{\alpha\beta}_\alpha\,\partial_\beta h^\mu_\mu+6\,a_0\,h^{\alpha\beta}\,\partial_\beta\partial_a h^\mu_\mu-3\,a_0\,\partial_\beta h^\mu_\mu\,\partial^\beta h^\alpha_\alpha+ \\ & 12\,a_0\,\mathcal{A}^{\alpha\beta}_\alpha\,\partial_\mu h^\mu_\beta+6\,a_0\,\partial^\beta h^\alpha_\alpha\,\partial_\mu h^\mu_\beta-12\,a_0\,h^{\alpha\beta}\,\partial_\mu\partial_\beta h^\mu_\alpha+ \\ & 6\,a_0\,h^\alpha_\alpha\,\partial_\mu\partial_\beta h^{\beta\mu}+6\,a_0\,h^{\alpha\beta}\,\partial_\mu\partial^\mu h_{\alpha\beta}-6\,a_0\,h^\alpha_\alpha\,\partial_\mu\partial^\mu h^\beta_\beta+ \\ & 12\,a_0\,h_{\beta\mu}\,\partial^\mu\mathcal{A}^{\alpha\beta}_\alpha+24\,c_{13}\,\partial_a\mathcal{A}^\vee_{\mu\vee}\,\partial^\mu\mathcal{A}^{\alpha\beta}_\beta-24\,c_{13}\,\partial_\mu\mathcal{A}^\vee_{\alpha\vee}\,\partial^\mu\mathcal{A}^{\alpha\beta}_\beta- \\ & 6\,a_0\,\partial_\beta h^\mu_{a\mu}\,\partial^\mu h^{\alpha\beta}_\alpha+3\,a_0\,\partial_\mu h^\mu_{a\beta}\,\partial^\mu h^{\alpha\beta}_\alpha)) [t,x,y,z] d\,z\,d\,y\,d\,x\,d\,t \end{aligned}$$

Massive and massless spectra

Spin:  
Parity:

1  
Odd

Square mass:

$\frac{1}{4c_{13}} > 0$

Pole residue:

$\frac{1}{4c_{13}} > 0$

Polarisations:

$\frac{1}{4c_{13}} > 0$

Massive particle

Massless particle

Unitarity conditions

$$(a_5\,|\,a_6.)\in\mathbb{R}\,\&\&\,a_0.<0\,\&\&\,a_7.>\frac{1}{10}\,(3\,a_.-2\,a_5.+16\,a_6.)\,\&\&\,c_{13}.>0$$

Spin-parity form	Covariant form	Multiplicities	
$0^+\mathcal{W}_5^\parallel+3\,0^+\mathcal{W}_5^{+t}==2\,0^+\mathcal{W}_5^{+h}$	$\partial_a\mathcal{W}^{a\beta}_\beta==2(\partial_\beta\mathcal{W}^{a\beta}_\alpha+\partial_\beta\mathcal{W}^{a\beta}_a)$	1	
$0^+\mathcal{W}_a^\parallel==0$	$\partial_\beta\mathcal{W}^{a\beta}_a==\partial_\beta\mathcal{W}^{a\beta}_a$	1	
$0^+\mathcal{T}^\perp==0$	$\partial_\beta\partial_a\mathcal{T}^{a\beta}==0$	1	
$2(\,1^+\mathcal{W}_5^{\parallel\alpha}+\,1^+\mathcal{W}_5^{\perp\alpha})==\,1^+\mathcal{W}_5^{\parallel\alpha}+\,1^+\mathcal{W}_5^{\perp\alpha}$	$\partial_\beta\partial^\alpha\mathcal{W}^{\beta\chi}_\chi+2(\partial_\chi\partial^\alpha\mathcal{W}^{\beta\alpha}_\beta+\partial_\chi\partial^\alpha\mathcal{W}^{\beta\alpha}_\beta)==2\,\partial_\chi\partial^\alpha\mathcal{W}^{\beta\chi}_\beta+\,2\,\partial_\chi\partial^\alpha\mathcal{W}^{\beta\chi}_\beta+\partial_\chi\partial^\alpha\mathcal{W}^{\alpha\beta}_\beta$	3	
$1^+\mathcal{W}_a^{\parallel\alpha}==\,1^+\mathcal{W}_a^{\perp\alpha}$	$\partial_\beta\partial^\alpha\mathcal{W}^{\beta\delta}_\delta+\partial_\beta\partial^\alpha\mathcal{W}^{\beta\alpha}_\beta==\partial_\beta\partial^\alpha\mathcal{W}^{\beta\delta}_\delta+\partial_\beta\partial^\alpha\mathcal{W}^{\beta\alpha}_\beta$	3	
$1^+\mathcal{T}^\perp_{\alpha\beta}==0$	$\partial_\chi\partial_\beta\partial^\alpha\mathcal{T}^{\beta\chi}==\partial_\chi\partial^\alpha\partial_\beta\mathcal{T}^{\beta\chi}$	3	
Total expected gauge generators:		12	