

# Summary of symmetry calculations

October 24, 2021



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# Chapter 1

## DBH\_model

Run 01\_10PM\_24\_October-2021

Degree in tangential ansätze: 2.  
The system of ODEs is given by:

$$\begin{aligned}\frac{dw_1}{dt} &= -w_1w_2 - w_1w_3 + w_2w_3, \\ \frac{dw_2}{dt} &= -w_1w_2 + w_1w_3 - w_2w_3, \\ \frac{dw_3}{dt} &= w_1w_2 - w_1w_3 - w_2w_3.\end{aligned}$$

The calculated generators are:

ODE solutions:

$$\mathbf{c} = \begin{bmatrix} C_1 - C_{17}t - C_{24}t + C_{31}t^2 + C_{32}t - C_{40} + c_{32}(t) \\ C_2 \\ C_3 \\ C_4 \\ C_2t + C_4t + C_5 - C_7t \\ C_6 \\ C_7 \\ C_2t - C_4t + C_7t + C_8 \\ -C_2t + C_4t + C_7t + C_9 \\ C_{10} \\ C_{11} \\ -C_{11}t + C_{12} + C_{21}t \\ C_{11}t^2 - C_{12}t + C_{13} - C_{21}t^2 + C_{22}t \\ -C_{11}t + C_{14} + C_{31}t \\ -C_{11}t^2 + C_{15} - 2C_{17}t + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ C_{11}t^2 - C_{14}t + C_{16} - C_{31}t^2 + C_{34}t \\ C_{17} - C_{21}t - C_{31}t \\ C_{12}t - C_{14}t + C_{17}t + C_{18} + C_{21}t^2 - C_{22}t + C_{24}t + C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{12}t + C_{14}t + C_{17}t + C_{19} - C_{32}t - C_{34}t + C_{37}t + C_{40} - c_{32}(t) \\ C_{20} - C_{27}t - C_{37}t \\ C_{21} \\ C_{11}t - C_{21}t + C_{22} \\ -C_{11}t^2 + C_{12}t + C_{21}t^2 - C_{22}t + C_{23} \\ -C_{11}t + C_{24} - C_{31}t \\ C_{11}t^2 - C_{12}t + C_{14}t + C_{17}t + C_{22}t + C_{24}t + C_{25} - C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{14}t + C_{26} - C_{34}t \\ -C_{21}t + C_{27} + C_{31}t \\ -C_{21}t^2 - 2C_{24}t + C_{28} + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ -C_{22}t + C_{24}t + C_{27}t + C_{29} - C_{32}t + C_{34}t - C_{37}t + C_{40} - c_{32}(t) \\ C_{21}t^2 - C_{27}t + C_{30} - C_{31}t^2 + C_{37}t \\ C_{31} \\ -C_{11}t - C_{21}t + C_{32} \\ -C_{12}t - C_{22}t + C_{33} \\ C_{11}t - C_{31}t + C_{34} \\ C_{11}t^2 + C_{12}t - C_{14}t + C_{17}t - C_{31}t^2 - C_{32}t + C_{34}t + C_{35} - C_{37}t + C_{40} - c_{32}(t) \\ -C_{11}t^2 + C_{14}t + C_{31}t^2 - C_{34}t + C_{36} \\ C_{21}t - C_{31}t + C_{37} \\ C_{21}t^2 + C_{22}t + C_{24}t - C_{27}t - C_{31}t^2 - C_{32}t - C_{34}t + C_{37}t + C_{38} + C_{40} - c_{32}(t) \\ -C_{21}t^2 + C_{27}t + C_{31}t^2 - C_{37}t + C_{39} \end{bmatrix}$$

$$f_1$$

**WARNING:**

*Some of the calculated generators did not satisfy the linearised symmetry conditions. Thus, the presented list here is not complete and consists exclusively of the calculated generators that satisfy the linearised symmetry conditions.*

The execution time of the script was:

0 hours 3 minutes 30 seconds.

**Run 01\_14PM\_24\_October-2021**

Degree in tangential ansätze: 2.

The system of ODEs is given by:

$$\begin{aligned}\frac{dw_1}{dt} &= -w_1w_2 - w_1w_3 + w_2w_3, \\ \frac{dw_2}{dt} &= -w_1w_2 + w_1w_3 - w_2w_3, \\ \frac{dw_3}{dt} &= w_1w_2 - w_1w_3 - w_2w_3.\end{aligned}$$

The calculated generators are:



ODE solutions:

$$\mathbf{c} = \begin{bmatrix} C_1 - C_{17}t - C_{24}t + C_{31}t^2 + C_{32}t - C_{40} + c_{32}(t) \\ C_2 \\ C_3 \\ C_4 \\ C_2t + C_4t + C_5 - C_7t \\ C_6 \\ C_7 \\ C_2t - C_4t + C_7t + C_8 \\ -C_2t + C_4t + C_7t + C_9 \\ C_{10} \\ C_{11} \\ -C_{11}t + C_{12} + C_{21}t \\ C_{11}t^2 - C_{12}t + C_{13} - C_{21}t^2 + C_{22}t \\ -C_{11}t + C_{14} + C_{31}t \\ -C_{11}t^2 + C_{15} - 2C_{17}t + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ C_{11}t^2 - C_{14}t + C_{16} - C_{31}t^2 + C_{34}t \\ C_{17} - C_{21}t - C_{31}t \\ C_{12}t - C_{14}t + C_{17}t + C_{18} + C_{21}t^2 - C_{22}t + C_{24}t + C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{12}t + C_{14}t + C_{17}t + C_{19} - C_{32}t - C_{34}t + C_{37}t + C_{40} - c_{32}(t) \\ C_{20} - C_{27}t - C_{37}t \\ C_{21} \\ C_{11}t - C_{21}t + C_{22} \\ -C_{11}t^2 + C_{12}t + C_{21}t^2 - C_{22}t + C_{23} \\ -C_{11}t + C_{24} - C_{31}t \\ C_{11}t^2 - C_{12}t + C_{14}t + C_{17}t + C_{22}t + C_{24}t + C_{25} - C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{14}t + C_{26} - C_{34}t \\ -C_{21}t + C_{27} + C_{31}t \\ -C_{21}t^2 - 2C_{24}t + C_{28} + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ -C_{22}t + C_{24}t + C_{27}t + C_{29} - C_{32}t + C_{34}t - C_{37}t + C_{40} - c_{32}(t) \\ C_{21}t^2 - C_{27}t + C_{30} - C_{31}t^2 + C_{37}t \\ C_{31} \\ -C_{11}t - C_{21}t + C_{32} \\ -C_{12}t - C_{22}t + C_{33} \\ C_{11}t - C_{31}t + C_{34} \\ C_{11}t^2 + C_{12}t - C_{14}t + C_{17}t - C_{31}t^2 - C_{32}t + C_{34}t + C_{35} - C_{37}t + C_{40} - c_{32}(t) \\ -C_{11}t^2 + C_{14}t + C_{31}t^2 - C_{34}t + C_{36} \\ C_{21}t - C_{31}t + C_{37} \\ C_{21}t^2 + C_{22}t + C_{24}t - C_{27}t - C_{31}t^2 - C_{32}t - C_{34}t + C_{37}t + C_{38} + C_{40} - c_{32}(t) \\ -C_{21}t^2 + C_{27}t + C_{31}t^2 - C_{37}t + C_{39} \end{bmatrix}$$



The execution time of the script was:

0 hours 3 minutes 30 seconds.

**Run 01\_17PM\_24\_October-2021**

Degree in tangential ansätze: 2.  
The system of ODEs is given by:

$$\begin{aligned}\frac{dw_1}{dt} &= -w_1w_2 - w_1w_3 + w_2w_3, \\ \frac{dw_2}{dt} &= -w_1w_2 + w_1w_3 - w_2w_3, \\ \frac{dw_3}{dt} &= w_1w_2 - w_1w_3 - w_2w_3.\end{aligned}$$

The calculated generators are:

ODE solutions:

$$\mathbf{c} = \begin{bmatrix} C_1 - C_{17}t - C_{24}t + C_{31}t^2 + C_{32}t - C_{40} + c_{32}(t) \\ C_2 \\ C_3 \\ C_4 \\ C_2t + C_4t + C_5 - C_7t \\ C_6 \\ C_7 \\ C_2t - C_4t + C_7t + C_8 \\ -C_2t + C_4t + C_7t + C_9 \\ C_{10} \\ C_{11} \\ -C_{11}t + C_{12} + C_{21}t \\ C_{11}t^2 - C_{12}t + C_{13} - C_{21}t^2 + C_{22}t \\ -C_{11}t + C_{14} + C_{31}t \\ -C_{11}t^2 + C_{15} - 2C_{17}t + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ C_{11}t^2 - C_{14}t + C_{16} - C_{31}t^2 + C_{34}t \\ C_{17} - C_{21}t - C_{31}t \\ C_{12}t - C_{14}t + C_{17}t + C_{18} + C_{21}t^2 - C_{22}t + C_{24}t + C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{12}t + C_{14}t + C_{17}t + C_{19} - C_{32}t - C_{34}t + C_{37}t + C_{40} - c_{32}(t) \\ C_{20} - C_{27}t - C_{37}t \\ C_{21} \\ C_{11}t - C_{21}t + C_{22} \\ -C_{11}t^2 + C_{12}t + C_{21}t^2 - C_{22}t + C_{23} \\ -C_{11}t + C_{24} - C_{31}t \\ C_{11}t^2 - C_{12}t + C_{14}t + C_{17}t + C_{22}t + C_{24}t + C_{25} - C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{14}t + C_{26} - C_{34}t \\ -C_{21}t + C_{27} + C_{31}t \\ -C_{21}t^2 - 2C_{24}t + C_{28} + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ -C_{22}t + C_{24}t + C_{27}t + C_{29} - C_{32}t + C_{34}t - C_{37}t + C_{40} - c_{32}(t) \\ C_{21}t^2 - C_{27}t + C_{30} - C_{31}t^2 + C_{37}t \\ C_{31} \\ -C_{11}t - C_{21}t + C_{32} \\ -C_{12}t - C_{22}t + C_{33} \\ C_{11}t - C_{31}t + C_{34} \\ C_{11}t^2 + C_{12}t - C_{14}t + C_{17}t - C_{31}t^2 - C_{32}t + C_{34}t + C_{35} - C_{37}t + C_{40} - c_{32}(t) \\ -C_{11}t^2 + C_{14}t + C_{31}t^2 - C_{34}t + C_{36} \\ C_{21}t - C_{31}t + C_{37} \\ C_{21}t^2 + C_{22}t + C_{24}t - C_{27}t - C_{31}t^2 - C_{32}t - C_{34}t + C_{37}t + C_{38} + C_{40} - c_{32}(t) \\ -C_{21}t^2 + C_{27}t + C_{31}t^2 - C_{37}t + C_{39} \end{bmatrix}$$

0 hours 3 minutes 27 seconds.

## Run 01\_21PM\_24\_October-2021

Degree in tangential ansätze: 2.

The system of ODEs is given by:

$$\begin{aligned}\frac{dw_1}{dt} &= -w_1w_2 - w_1w_3 + w_2w_3, \\ \frac{dw_2}{dt} &= -w_1w_2 + w_1w_3 - w_2w_3, \\ \frac{dw_3}{dt} &= w_1w_2 - w_1w_3 - w_2w_3.\end{aligned}$$

The calculated generators are:

ODE solutions:

$$\mathbf{c} = \begin{bmatrix} C_1 - C_{17}t - C_{24}t + C_{31}t^2 + C_{32}t - C_{40} + c_{32}(t) \\ C_2 \\ C_3 \\ C_4 \\ C_2t + C_4t + C_5 - C_7t \\ C_6 \\ C_7 \\ C_2t - C_4t + C_7t + C_8 \\ -C_2t + C_4t + C_7t + C_9 \\ C_{10} \\ C_{11} \\ -C_{11}t + C_{12} + C_{21}t \\ C_{11}t^2 - C_{12}t + C_{13} - C_{21}t^2 + C_{22}t \\ -C_{11}t + C_{14} + C_{31}t \\ -C_{11}t^2 + C_{15} - 2C_{17}t + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ C_{11}t^2 - C_{14}t + C_{16} - C_{31}t^2 + C_{34}t \\ C_{17} - C_{21}t - C_{31}t \\ C_{12}t - C_{14}t + C_{17}t + C_{18} + C_{21}t^2 - C_{22}t + C_{24}t + C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{12}t + C_{14}t + C_{17}t + C_{19} - C_{32}t - C_{34}t + C_{37}t + C_{40} - c_{32}(t) \\ C_{20} - C_{27}t - C_{37}t \\ C_{21} \\ C_{11}t - C_{21}t + C_{22} \\ -C_{11}t^2 + C_{12}t + C_{21}t^2 - C_{22}t + C_{23} \\ -C_{11}t + C_{24} - C_{31}t \\ C_{11}t^2 - C_{12}t + C_{14}t + C_{17}t + C_{22}t + C_{24}t + C_{25} - C_{27}t - C_{31}t^2 - 2C_{32}t + C_{40} - c_{32}(t) \\ -C_{14}t + C_{26} - C_{34}t \\ -C_{21}t + C_{27} + C_{31}t \\ -C_{21}t^2 - 2C_{24}t + C_{28} + C_{31}t^2 + 2C_{32}t - C_{40} + c_{32}(t) \\ -C_{22}t + C_{24}t + C_{27}t + C_{29} - C_{32}t + C_{34}t - C_{37}t + C_{40} - c_{32}(t) \\ C_{21}t^2 - C_{27}t + C_{30} - C_{31}t^2 + C_{37}t \\ C_{31} \\ -C_{11}t - C_{21}t + C_{32} \\ -C_{12}t - C_{22}t + C_{33} \\ C_{11}t - C_{31}t + C_{34} \\ C_{11}t^2 + C_{12}t - C_{14}t + C_{17}t - C_{31}t^2 - C_{32}t + C_{34}t + C_{35} - C_{37}t + C_{40} - c_{32}(t) \\ -C_{11}t^2 + C_{14}t + C_{31}t^2 - C_{34}t + C_{36} \\ C_{21}t - C_{31}t + C_{37} \\ C_{21}t^2 + C_{22}t + C_{24}t - C_{27}t - C_{31}t^2 - C_{32}t - C_{34}t + C_{37}t + C_{38} + C_{40} - c_{32}(t) \\ -C_{21}t^2 + C_{27}t + C_{31}t^2 - C_{37}t + C_{39} \end{bmatrix}$$

