A centre-unstable manifold of your dynamical system

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Generally, the lowest order, most important, terms are near the end of each expression.

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Specified dynamical system

$\dot{x}_1 = \varepsilon(- x_1y_1 + y_2)$

$\dot{x}_2 = \varepsilon(- x_2y_1 - x_1y_2 + y_3)$

$\dot{x}_3 = \sigma\varepsilon w_1 + \varepsilon(- x_3y_1 - 2x_2y_2 - x_1y_3)$

$\dot{y}_1 = \varepsilon(x_2 - 1/2x_1^2 - 1/2y_1^2) - y_1$

$\dot{y}_2 = \varepsilon(x_3 - x_2x_1 - y_2y_1) - y_2$

$\dot{y}_3 = \sigma\varepsilon w_2 + \varepsilon(- x_3x_1 - x_2^2 - y_3y_1 - y_2^2) - y_3$

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Time dependent centre-unstable manifold coordinates

$y_1 = \varepsilon(X_2 - 1/2X_1^2)$

$$y_2 = \varepsilon(X_3 - X_2X_1)$$

$$y_3 = \sigma\varepsilon \mathrm{e}^{-1t} \star w_2 \ + \varepsilon(- X_3X_1 - X_2^2)$$

$$x_1 = X_1$$

$$x_2 = X_2$$

$$x_3 = X_3$$

Result centre-unstable manifold DEs

$$\dot{X}_1 = \varepsilon^2(X_3 - 2X_2X_1 + 1/2X_1^3)$$

$$\dot{X}_2 = \sigma\varepsilon^2 w_2 + \varepsilon^2(- 2X_3X_1 - 2X_2^2 + 3/2X_2X_1^2)$$

$$\dot{X}_3 = -\sigma\varepsilon^2 w_2 X_1 + \sigma\varepsilon w_1 + \varepsilon^2(- 3X_3X_2 + 3/2X_3X_1^2 + 3X_2^2X_1)$$