A normal form of your dynamical system

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

Specified dynamical system

$\dot{x}_1 = -w_1 y_1 \sigma$

$\dot{y}_1 = w_1 x_1 \sigma - y_1$

off echo;

Time dependent normal form coordinates

$y_1 = O(\varepsilon^4, \sigma^2) + \mathrm{e}^{-1t} \star w_1 \, X_1 \sigma + Y_1$

$x_1 = O(\varepsilon^4, \sigma^2) + \mathrm{e}^{t} \star w_1 \, Y_1 \sigma + X_1$

Result normal form DEs

$\dot{Y}_1 = O(\varepsilon^5, \sigma^3) + \mathrm{e}^{1t} \star w_1 \, w_1 Y_1 \sigma^2 - Y_1$

$\dot{X}_1 = O(\varepsilon^5, \sigma^3) - \mathrm{e}^{-1t} \star w_1 \, w_1 X_1 \sigma^2$