

Target equation:

$$-ia_1u^{(1,0)}(x,t)+a_{10}u^{(10,0)}(x,t)-ia_{11}u^{(11,0)}(x,t)+a_{12}u^{(12,0)}(x,t)-ia_{13}u^{(13,0)}(x,t)+a_{14}u^{(14,0)}(x,t)-ia_{15}u^{(15,0)}(x,t)+a_{16}u^{(16,0)}(x,t)+a_2u^{(2,0)}(x,t)-ia_3u^{(3,0)}(x,t)+a_4u^{(4,0)}(x,t)-ia_5u^{(5,0)}(x,t)+a_6u^{(6,0)}(x,t)-ia_7u^{(7,0)}(x,t)+a_8u^{(8,0)}(x,t)-ia_9u^{(9,0)}(x,t)-bu(x,t)|u(x,t)|^2+iu^{(0,1)}(x,t)=0$$

Substitutions:

$$N = 8$$

$$u(x,t) \rightarrow y(z)e^{i(kx-\omega t)}$$

$$z \rightarrow x - C_0t$$

$$y(z) \rightarrow AR(z)^8$$

$$R'(z)^2 = R(z)^2 (1 - \chi R(z)^2)$$

Imaginary part of equation after substitutions:

$$\begin{aligned} & y'(z)(a_1 + k(k(k(k(k(-10a_{10}k^3 - 11a_{11}k^4 + 12a_{12}k^5 + 13a_{13}k^6 - 14a_{14}k^7 - 15a_{15}k^8 + 16a_{16}k^9 - 7a_7 + \\ & y^{(3)}(z)(k(k(k(k(120a_{10}k^3 + 165a_{11}k^4 - 220a_{12}k^5 - 286a_{13}k^6 + 364a_{14}k^7 + 455a_{15}k^8 - 560a_{16}k^9 + 35a_7 - \\ & 252a_{10}k^5y^{(5)}(z) + 120a_{10}k^3y^{(7)}(z) - 10a_{10}ky^{(9)}(z) - 462a_{11}k^6y^{(5)}(z) + 330a_{11}k^4y^{(7)}(z) - 55a_{11}k^2y^{(9)}(z) + \\ & a_{11}y^{(11)}(z) + 792a_{12}k^7y^{(5)}(z) - 792a_{12}k^5y^{(7)}(z) + 220a_{12}k^3y^{(9)}(z) - 12a_{12}ky^{(11)}(z) + 1287a_{13}k^8y^{(5)}(z) - \\ & 1716a_{13}k^6y^{(7)}(z) + 715a_{13}k^4y^{(9)}(z) - 78a_{13}k^2y^{(11)}(z) + a_{13}y^{(13)}(z) - 2002a_{14}k^9y^{(5)}(z) + 3432a_{14}k^7y^{(7)}(z) - \\ & 2002a_{14}k^5y^{(9)}(z) + 364a_{14}k^3y^{(11)}(z) - 14a_{14}ky^{(13)}(z) - 3003a_{15}k^{10}y^{(5)}(z) + 6435a_{15}k^8y^{(7)}(z) - \\ & 5005a_{15}k^6y^{(9)}(z) + 1365a_{15}k^4y^{(11)}(z) - 105a_{15}k^2y^{(13)}(z) + a_{15}y^{(15)}(z) + 4368a_{16}k^{11}y^{(5)}(z) - 11440a_{16}k^9y^{(7)}(z) + \\ & 11440a_{16}k^7y^{(9)}(z) - 4368a_{16}k^5y^{(11)}(z) + 560a_{16}k^3y^{(13)}(z) - 16a_{16}ky^{(15)}(z) + a_5y^{(5)}(z) - 6a_6ky^{(5)}(z) - \\ & 21a_7k^2y^{(5)}(z) + a_7y^{(7)}(z) + 56a_8k^3y^{(5)}(z) - 8a_8ky^{(7)}(z) + 126a_9k^4y^{(5)}(z) - 36a_9k^2y^{(7)}(z) + a_9y^{(9)}(z) = \\ & 0 \end{aligned}$$

Real part of equation after substitutions:

$$\begin{aligned} & y(z)(a_1k - a_{10}k^{10} - a_{11}k^{11} + a_{12}k^{12} + a_{13}k^{13} - a_{14}k^{14} - a_{15}k^{15} + a_{16}k^{16} - a_2k^2 - a_3k^3 + a_4k^4 + a_5k^5 - a_6k^6 \\ & y''(z)(k(k(k(k(k(45a_{10}k^3 + 55a_{11}k^4 - 66a_{12}k^5 - 78a_{13}k^6 + 91a_{14}k^7 + 105a_{15}k^8 - 120a_{16}k^9 + 21a_7 - 28a_8 \\ & 210a_{10}k^6y^{(4)}(z) + 210a_{10}k^4y^{(6)}(z) - 45a_{10}k^2y^{(8)}(z) + a_{10}y^{(10)}(z) - 330a_{11}k^7y^{(4)}(z) + 462a_{11}k^5y^{(6)}(z) - \\ & 165a_{11}k^3y^{(8)}(z) + 11a_{11}ky^{(10)}(z) + 495a_{12}k^8y^{(4)}(z) - 924a_{12}k^6y^{(6)}(z) + 495a_{12}k^4y^{(8)}(z) - 66a_{12}k^2y^{(10)}(z) + \\ & a_{12}y^{(12)}(z) + 715a_{13}k^9y^{(4)}(z) - 1716a_{13}k^7y^{(6)}(z) + 1287a_{13}k^5y^{(8)}(z) - 286a_{13}k^3y^{(10)}(z) + 13a_{13}ky^{(12)}(z) - \\ & 1001a_{14}k^{10}y^{(4)}(z) + 3003a_{14}k^8y^{(6)}(z) - 3003a_{14}k^6y^{(8)}(z) + 1001a_{14}k^4y^{(10)}(z) - 91a_{14}k^2y^{(12)}(z) + \\ & a_{14}y^{(14)}(z) - 1365a_{15}k^{11}y^{(4)}(z) + 5005a_{15}k^9y^{(6)}(z) - 6435a_{15}k^7y^{(8)}(z) + 3003a_{15}k^5y^{(10)}(z) - 455a_{15}k^3y^{(12)}(z) + \\ & 15a_{15}ky^{(14)}(z) + 1820a_{16}k^{12}y^{(4)}(z) - 8008a_{16}k^{10}y^{(6)}(z) + 12870a_{16}k^8y^{(8)}(z) - 8008a_{16}k^6y^{(10)}(z) + \\ & 1820a_{16}k^4y^{(12)}(z) - 120a_{16}k^2y^{(14)}(z) + a_{16}y^{(16)}(z) + a_4y^{(4)}(z) + 5a_5ky^{(4)}(z) - 15a_6k^2y^{(4)}(z) + \\ & a_6y^{(6)}(z) - 35a_7k^3y^{(4)}(z) + 7a_7ky^{(6)}(z) + 70a_8k^4y^{(4)}(z) - 28a_8k^2y^{(6)}(z) + a_8y^{(8)}(z) + 126a_9k^5y^{(4)}(z) - \\ & 84a_9k^3y^{(6)}(z) + 9a_9ky^{(8)}(z) - by(z)^3 = 0 \end{aligned}$$

Constraints on coefficients from imaginary part of equation:

$$a_{15} \rightarrow 16a_{16}k$$

$$a_{13} \rightarrow 14(a_{14}k + 80a_{16}k^3)$$

$$a_{11} \rightarrow 4(3a_{12}k + 182a_{14}k^3 + 17472a_{16}k^5)$$

$$a_9 \rightarrow 2(5a_{10}k + 220a_{12}k^3 + 16016a_{14}k^5 + 1555840a_{16}k^7)$$

$$a_7 \rightarrow 8(30a_{10}k^3 + 1584a_{12}k^5 + 116688a_{14}k^7 + 11348480a_{16}k^9 + a_8k)$$

$$a_5 \rightarrow 2(2016a_{10}k^5 + 107712a_{12}k^7 + 7943936a_{14}k^9 + 772681728a_{16}k^{11} + 3a_6k + 56a_8k^3)$$

$$a_3 \rightarrow 4k(8160a_{10}k^6 + 436480a_{12}k^8 + 32195072a_{14}k^{10} + 3131555840a_{16}k^{12} + a_4 + 10a_6k^2 + 224a_8k^4) \blacksquare$$

$$C0 \rightarrow a_1 - 79360a_{10}k^9 - 4245504a_{12}k^{11} - 313155584a_{14}k^{13} - 30460116992a_{16}k^{15} - 2a_2k - 8a_4k^3 - 96a_6k^5 - 2176a_8k^7$$

Constraints on coefficients from real part of equation:

$$b \rightarrow \frac{5129368400572416000a_{16}\chi^8}{A^2}$$

$$a_{14} \rightarrow -24a_{16}(5k^2 + 82)$$

$$a_{12} \rightarrow 28(65a_{16}k^4 + 6396a_{16}k^2 + 57768a_{16})$$

$$a_{10} \rightarrow -88(91a_{16}k^6 + 22386a_{16}k^4 + 1213128a_{16}k^2 + 8210528a_{16})$$

$$a_8 \rightarrow 66(195a_{16}k^8 + 89544a_{16}k^6 + 12131280a_{16}k^4 + 492631680a_{16}k^2 + 2895231104a_{16})$$

$$a_6 \rightarrow -56(143a_{16}k^{10} + 105534a_{16}k^8 + 26688816a_{16}k^6 + 2709474240a_{16}k^4 + 95542626432a_{16}k^2 + 5447251936a_{16})$$

$$a_4 \rightarrow 4(455a_{16}k^{12} + 492492a_{16}k^{10} + 200166120a_{16}k^8 + 37932639360a_{16}k^6 + 3343991925120a_{16}k^4 + 114392256000a_{16}k^2 + 11439225600a_{16})$$

$$a_2 \rightarrow -24(5a_{16}k^{14} + 7462a_{16}k^{12} + 4448136a_{16}k^{10} + 1354737120a_{16}k^8 + 222932795008a_{16}k^6 + 190653817800a_{16}k^4 + 114392256000a_{16}k^2 + 11439225600a_{16})$$

$$\omega \rightarrow -a_1k - 15a_{16}k^{16} - 25584a_{16}k^{14} - 17792544a_{16}k^{12} - 6502738176a_{16}k^{10} - 1337596770048a_{16}k^8 -$$

$$152523054243840a_{16}k^6 - 8570941601415168a_{16}k^4 - 142797659701248000a_{16}k^2 + 2900606834442240000a_{16} \blacksquare$$

y(z) - function:

$$\frac{65536a^8A}{(4a^2e^z + \chi e^{-z})^8}$$

u(x, t) - function:

$$\frac{65536a^8Ae^{i(kx-\omega t)}}{(4a^2e^{C0t+x} + \chi e^{-C0t-x})^8}$$