

活性因子-抑制因子系の数値シミュレーション： パターンの崩壊

1/mar/10

$$\begin{cases} u_t = \varepsilon^2 u_{xx} - u + \frac{u^2}{v} & (0 < x < \ell, t > 0) \\ \tau v_t = D_v v_{xx} - v + u^2 & (0 < x < \ell, t > 0) \end{cases}$$

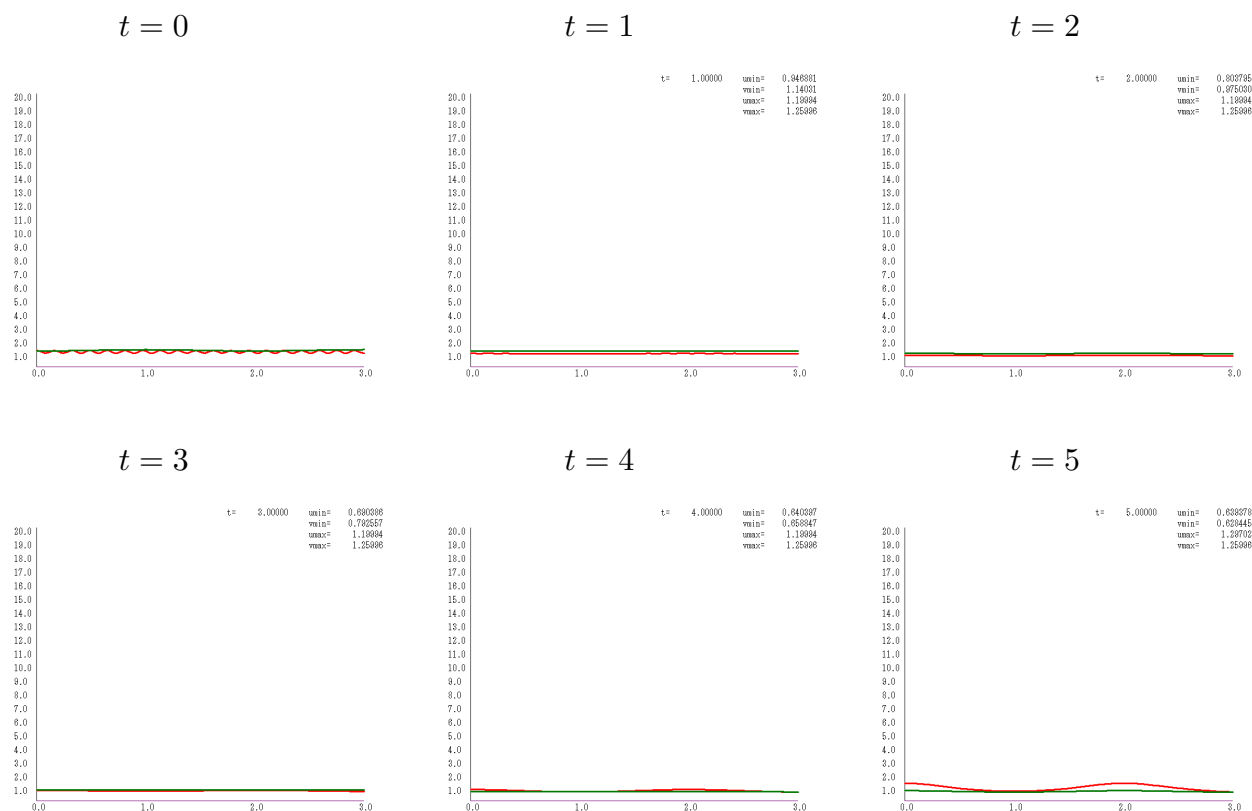
境界条件と初期条件は

$$\begin{aligned} u_x(x, t) = v_x(x, t) &= 0, & (x = 0, \ell), \\ u(x, 0) &= u_0(x), & v(x, 0) = v_0(x). \end{aligned}$$

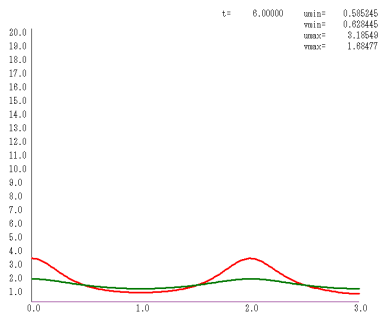
パラメータの値は次のとおり：

$$\begin{aligned} \varepsilon &= 0.05, & D_v &= 0.5, & \tau &= 1.55, & \ell &= 3, & \text{mesh} &= 0.02 \\ u_0(x) &= 1.1 + \frac{1}{10} \cos(87.654\pi x), & v_0(x) &= 1.21 - \frac{1}{20} \cos(\pi x). \end{aligned}$$

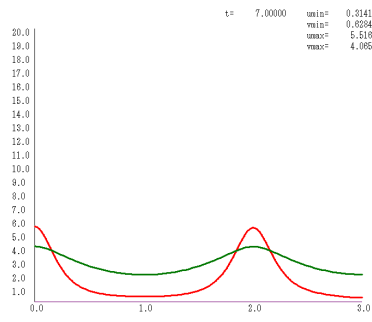
最初は殆ど一様な初期値からパターンが形成される (赤は活性因子, 緑は抑制因子のグラフ):



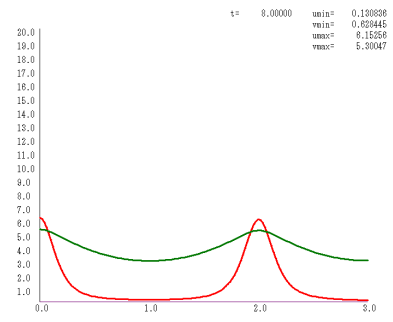
$t = 6$



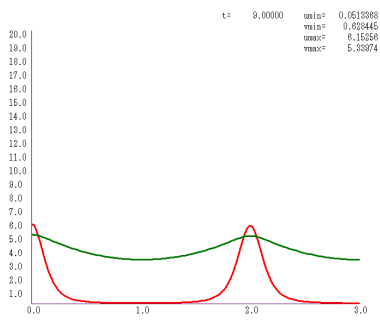
$t = 7$



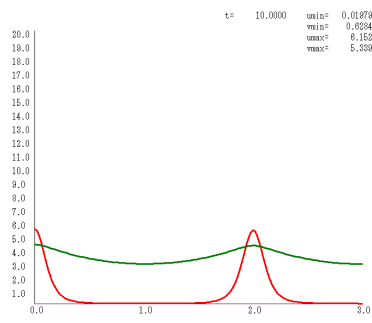
$t = 8$



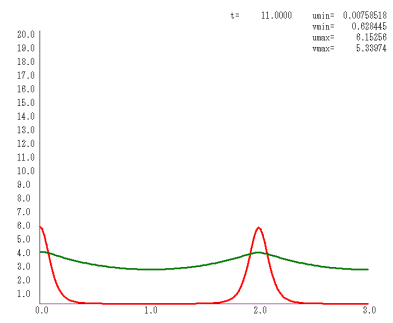
$t = 9$



$t = 10$

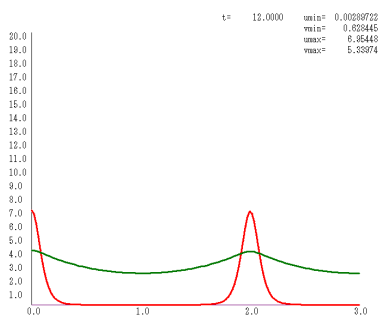


$t = 11$

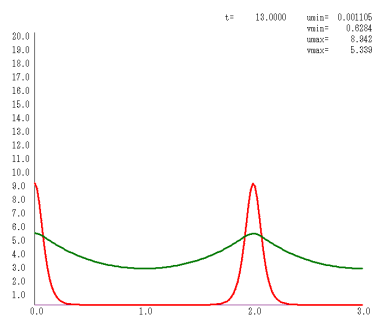


解が振動し始める

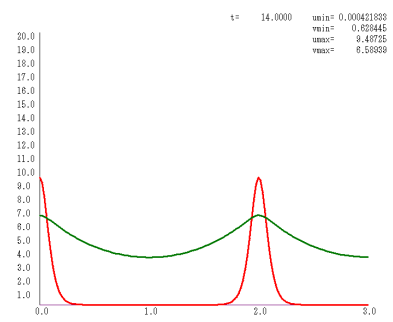
$t = 12$



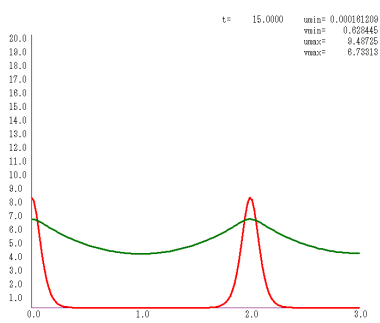
$t = 13$



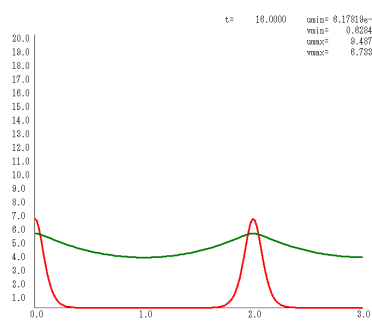
$t = 14$



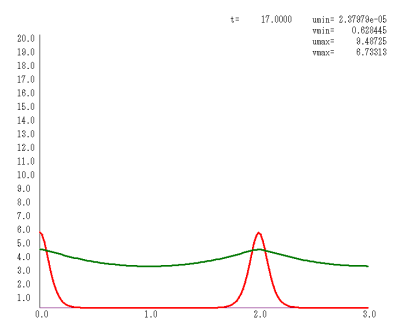
$t = 15$



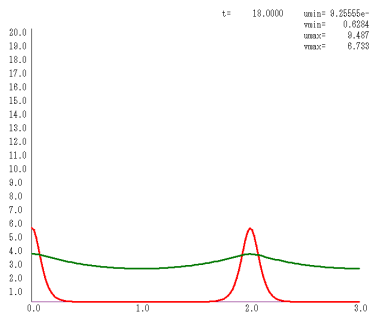
$t = 16$



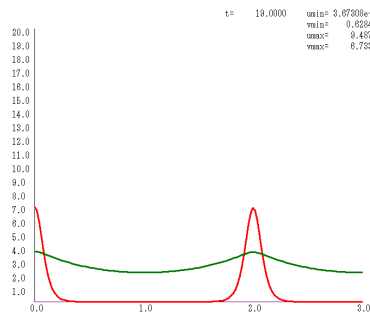
$t = 17$



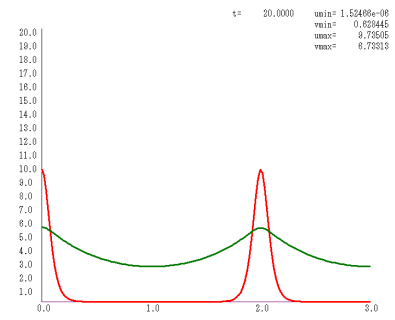
$t = 18$



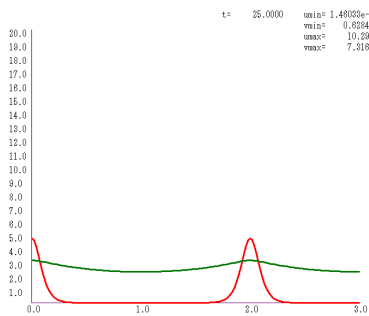
$t = 19$



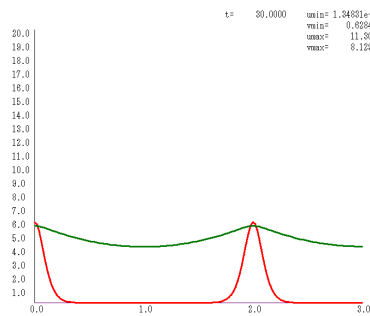
$t = 20$



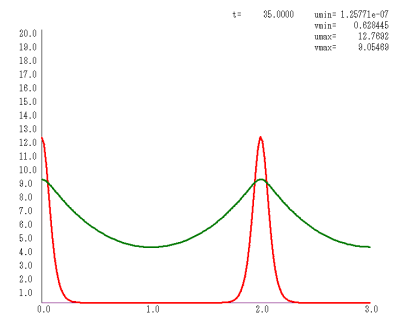
→ $t = 25$



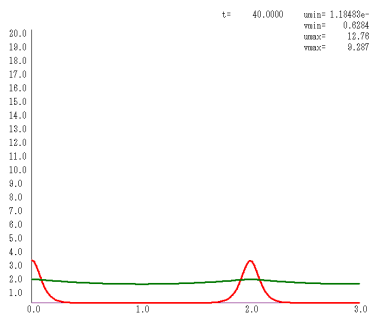
→ $t = 30$



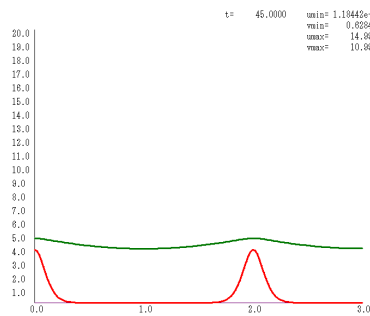
→ $t = 35$



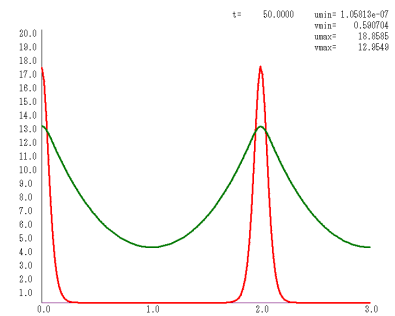
→ $t = 40$



→ $t = 45$



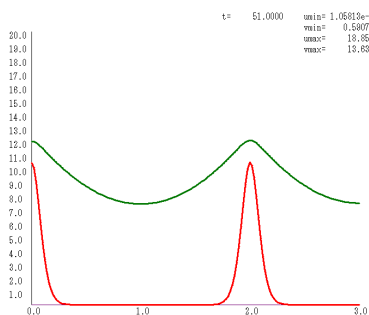
→ $t = 50$



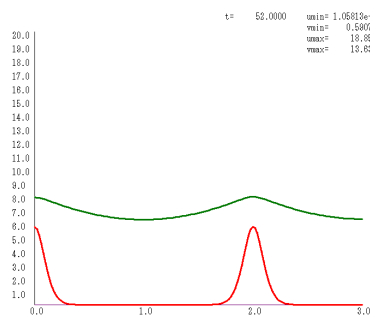
抑制因子が活性因子を押さえ込むようになる

$t = 51$

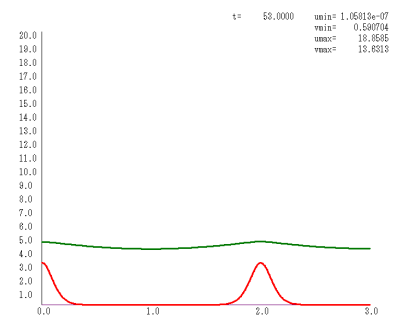
しかし活性因子もねばり,



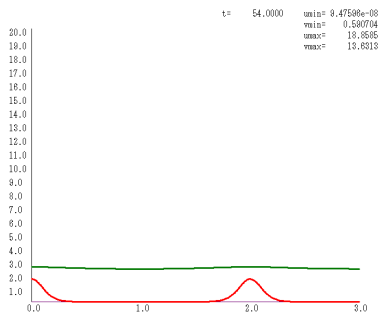
$t = 52$



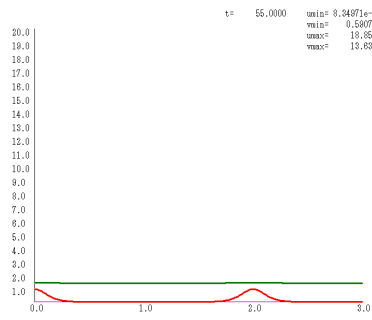
$t = 53$



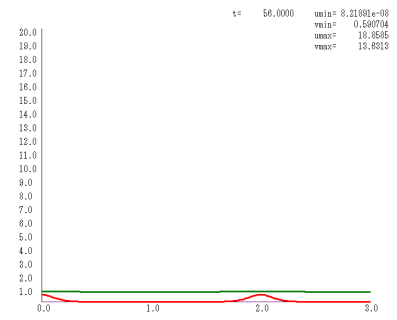
$t = 54$



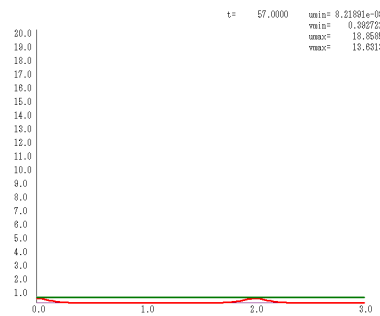
$t = 55$



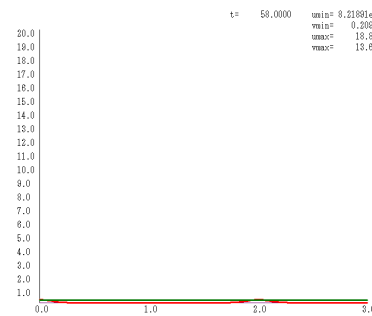
$t = 56$



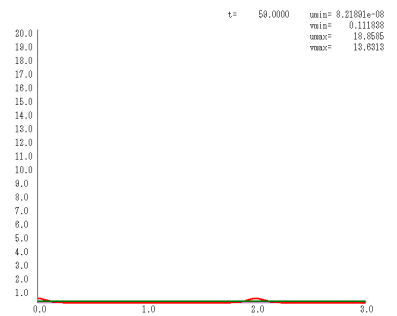
$t = 57$



$t = 58$

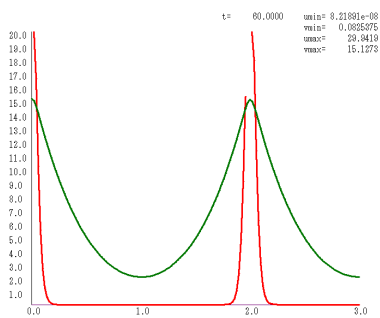


$t = 59$

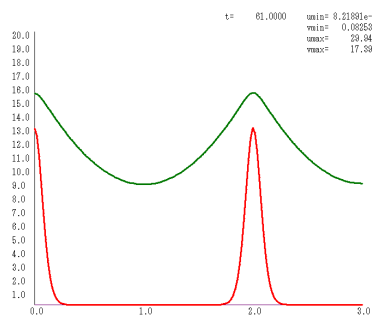


$t = 60$

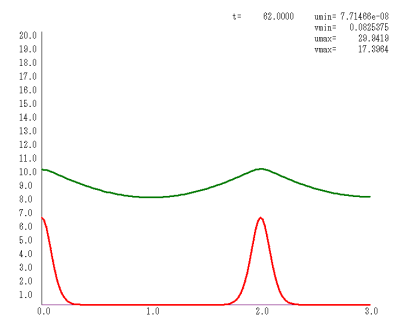
突然，非常に大きくなるが



$t = 61$

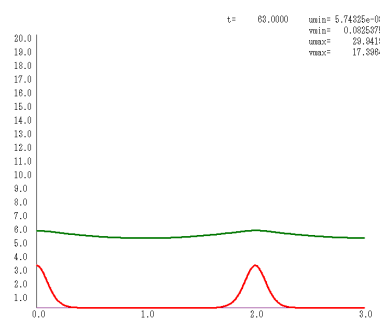


$t = 62$

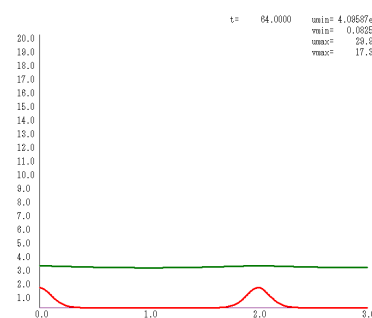


$t = 63$

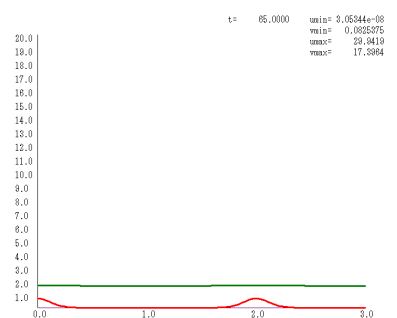
やがて，振動がおさまる



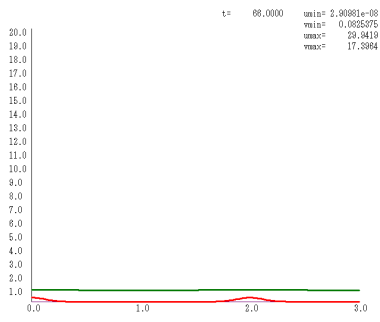
$t = 64$



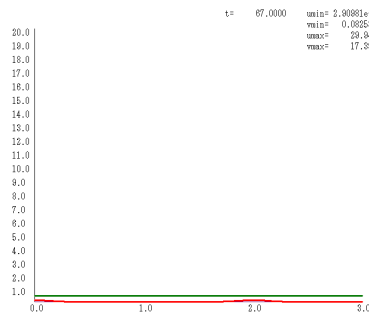
$t = 65$



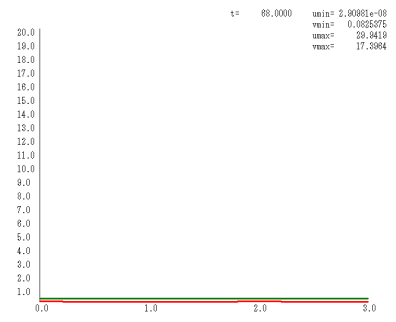
$t = 66$



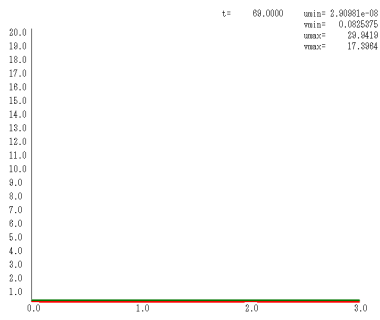
$t = 67$



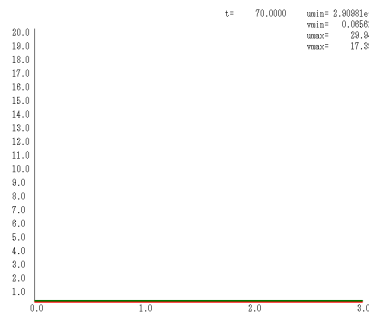
$t = 68$



$t = 69$

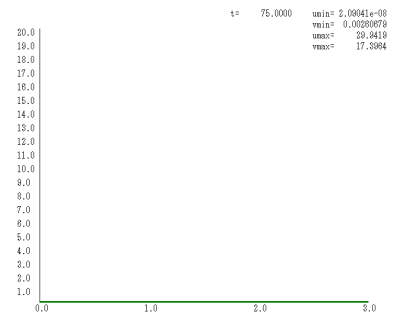


$t = 70$

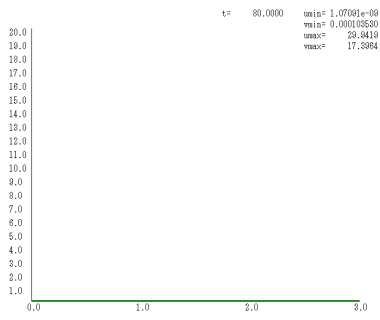


→

$t = 75$

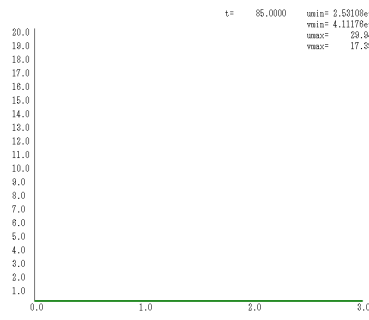


→ $t = 80$



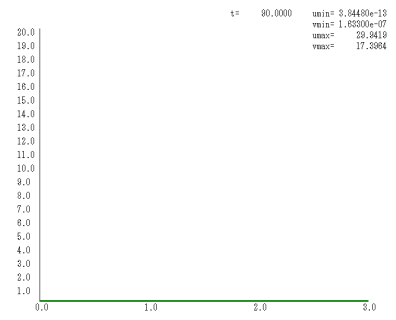
→

$t = 85$



→

$t = 90$



パターンが消滅する .