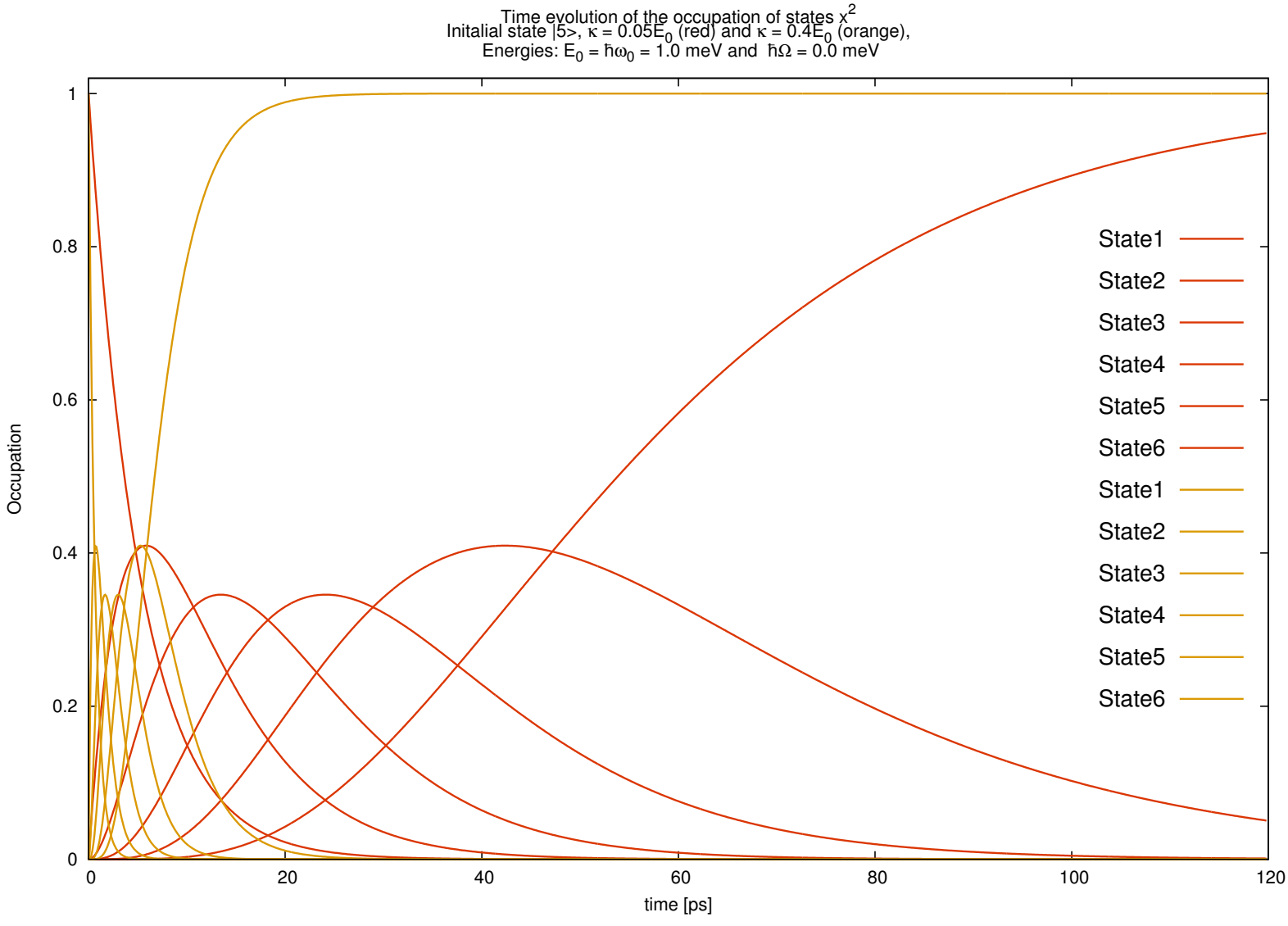
Comparison of hamiltonians and dissipation strength

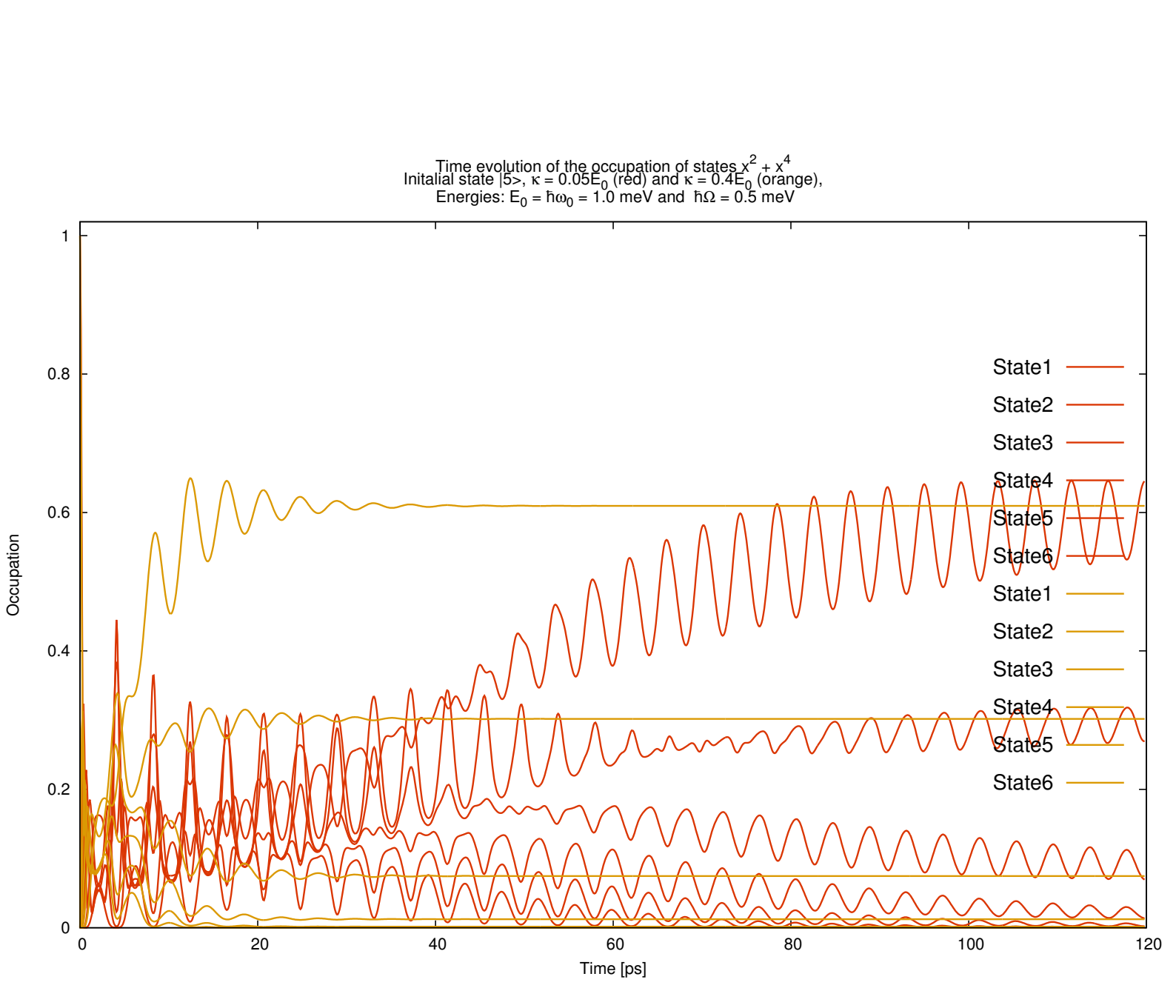
Let a be the lowering operator of the harmonic oscillator and $a^\dagger$ it's hermitian transpose. Let $H_0 = \hbar\omega(a^\dagger a + \frac{1}{2})$ be the harmonic oscillator, and let $\aleph = \frac{1}{\sqrt{2}}(a + a^\dagger)$ be the position operator. Here we will compare the time evolution of systems with hamiltonians $H = H_0$, $H = H_0 + \lambda\aleph$, and $H = H_0 + \lambda\aleph^4$ and differing damping strengths, κ. The evolution of each system is governed by

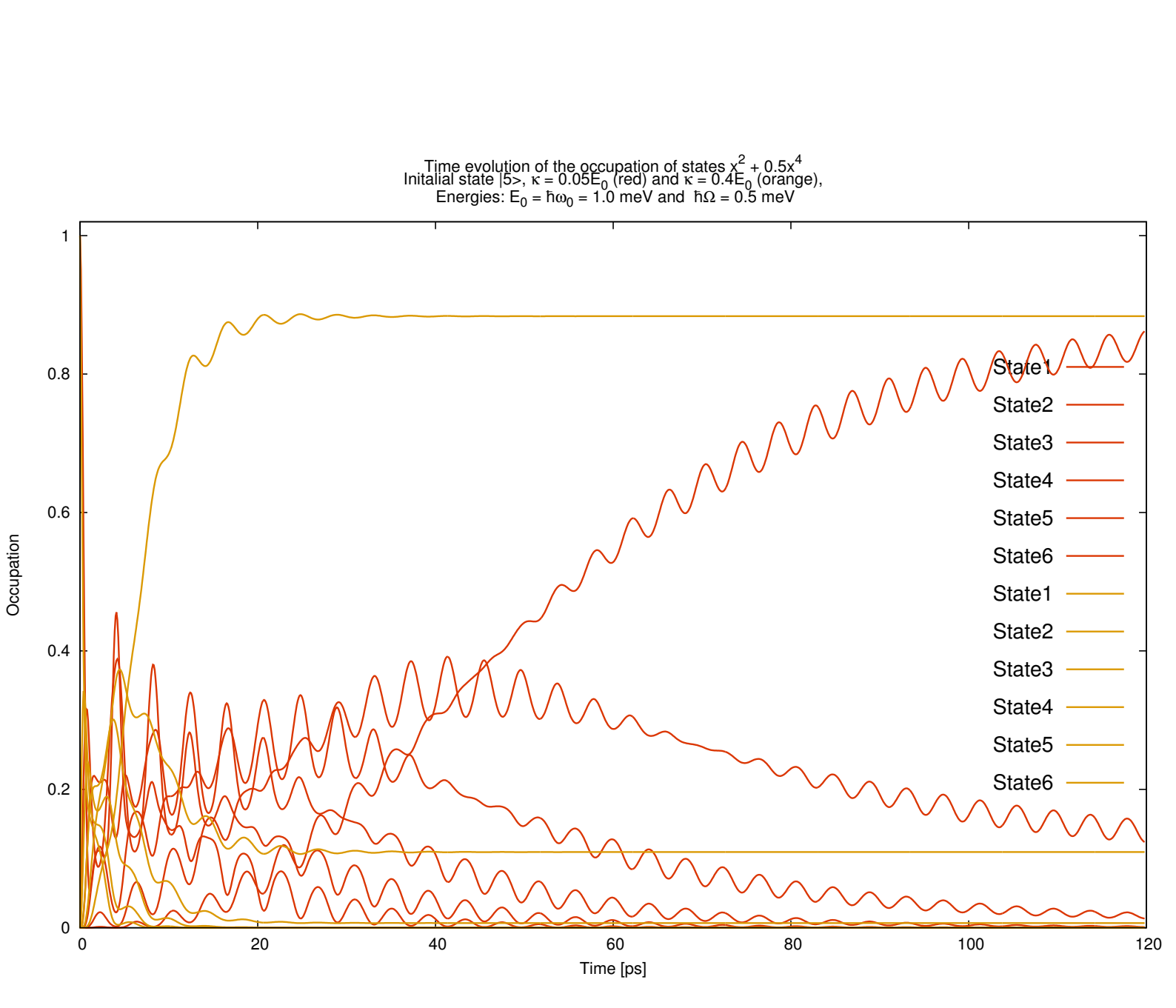
$$i\hbar\dot{\rho} = [H, \rho] + i\tfrac{\kappa}{2}\{[a, \rho a^\dagger] + [a\rho, a^\dagger]\}$$

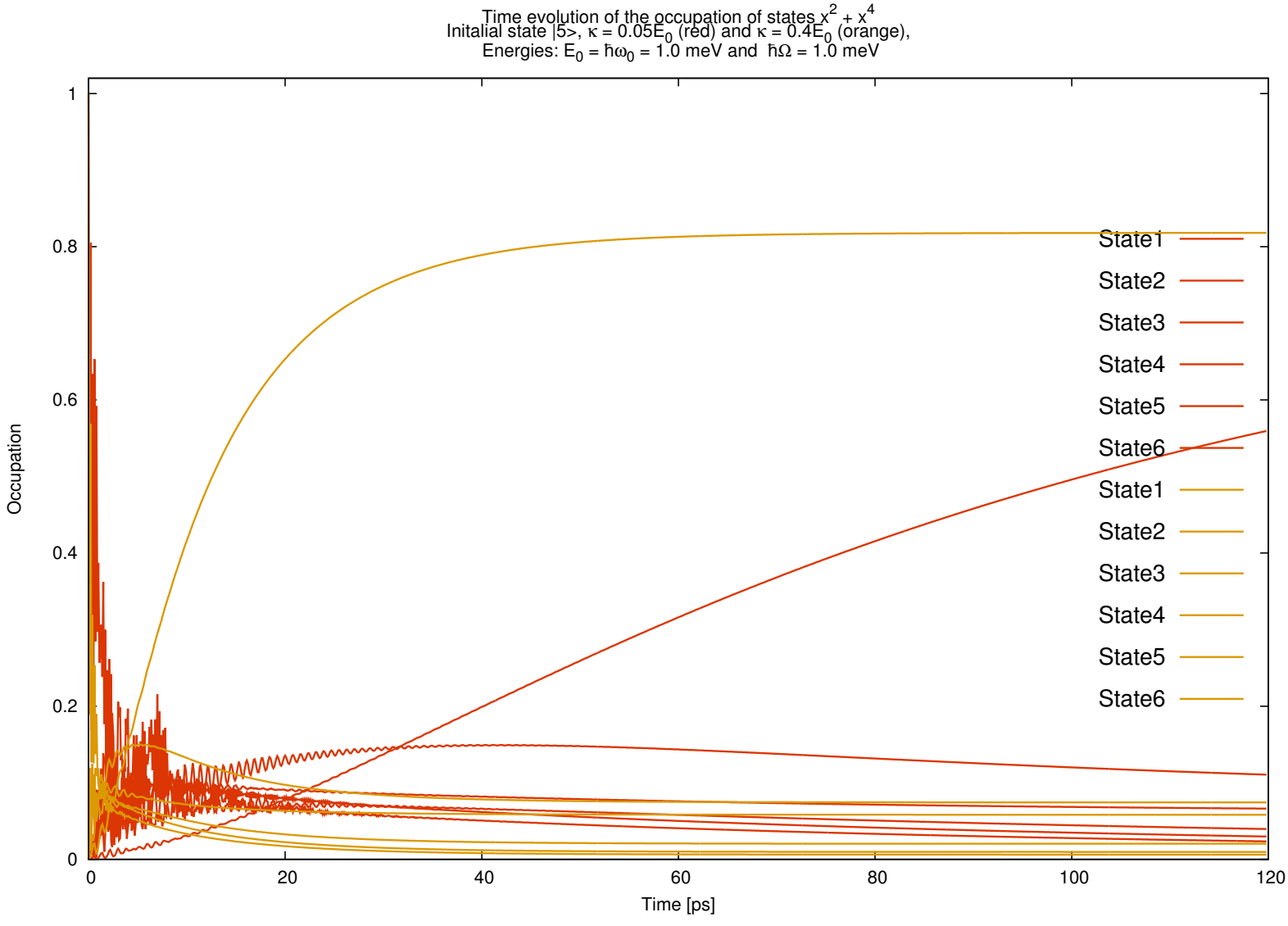
and shown below for a couple of values of λ and κ. In all the plots the initial state of the system is the following (using a matrix representation in the basis of the harmonic oscillator):

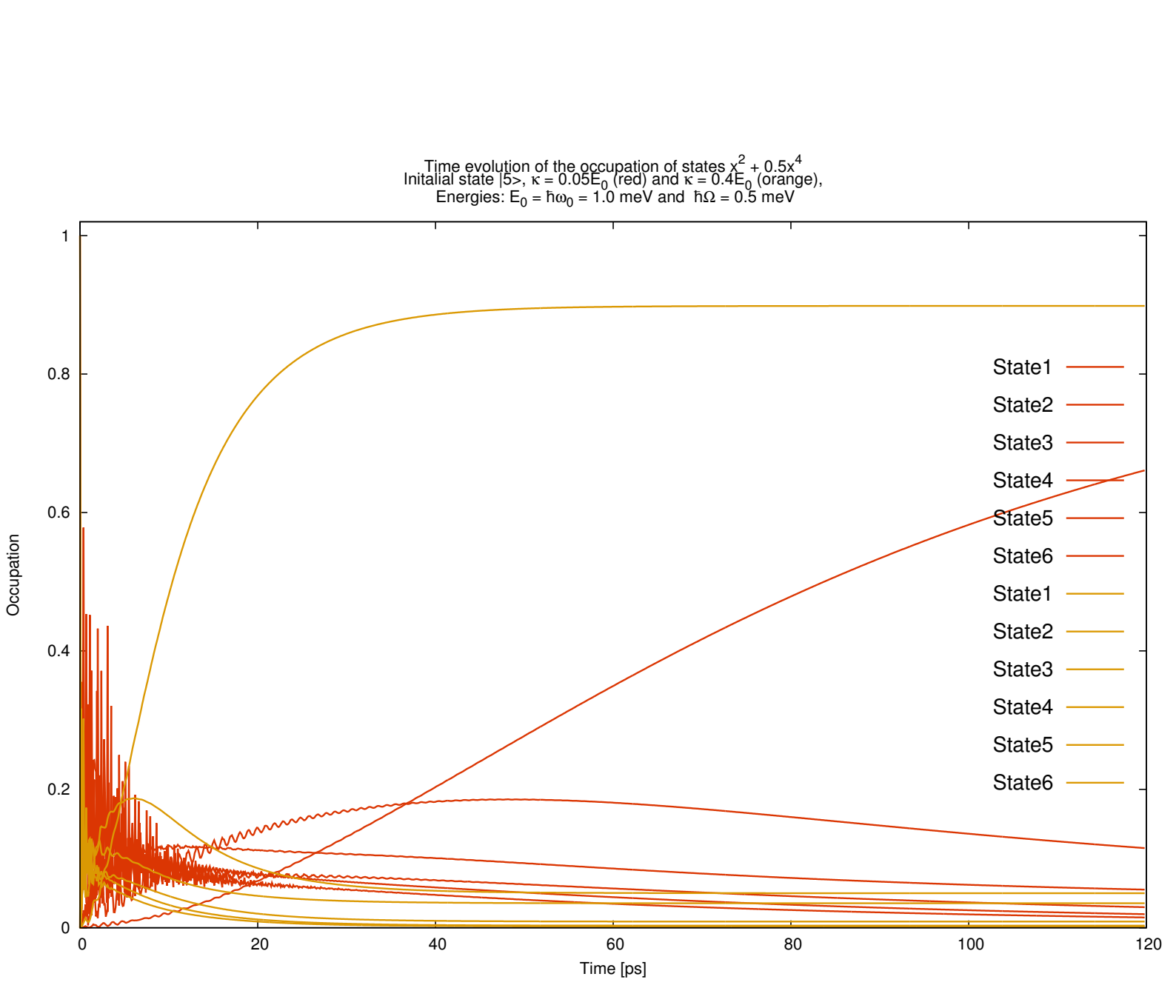
$$\rho = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & 0 & 1 & 0 & \dots \\ 0 & 0 & 0 & 0 & 0 & 0 & \dots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$


Time evolution of the occupation of states x^2
Initalial state |5>, κ = 0.05E0 (red) and κ = 0.4E0 (orange),
Energies: E0 = ħω0 = 1.0 meV and ħΩ = 0.0 meV
Occupation
time [ps]
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
120
State1
State2
State3
State4
State5
State6
State1
State2
State3
State4
State5
State6


Time evolution of the occupation of states $x^2 + x^4$
Initalial state |5>, $\kappa = 0.05E_0$ (red) and $\kappa = 0.4E_0$ (orange),
Energies: $E_0 = \hbar\omega_0 = 1.0$ meV and $\hbar\Omega = 0.5$ meV
Occupation
Time [ps]
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
120
State1
State2
State3
State4
State5
State6
State1
State2
State3
State4
State5
State6


Time evolution of the occupation of states x^2 + 0.5x^4
Initalial state |5>, κ = 0.05E0 (red) and κ = 0.4E0 (orange),
Energies: E0 = ħω0 = 1.0 meV and ħΩ = 0.5 meV
Occupation
Time [ps]
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
120
State1
State2
State3
State4
State5
State6
State1
State2
State3
State4
State5
State6


Time evolution of the occupation of states $x^2 + x^4$
Initalial state |5>, $\kappa = 0.05E_0$ (red) and $\kappa = 0.4E_0$ (orange),
Energies: $E_0 = \hbar\omega_0 = 1.0$ meV and $\hbar\Omega = 1.0$ meV
Occupation
Time [ps]
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
120
State1
State2
State3
State4
State5
State6
State1
State2
State3
State4
State5
State6


Time evolution of the occupation of states x^2 + 0.5x^4
Initalial state |5>, κ = 0.05E0 (red) and κ = 0.4E0 (orange),
Energies: E0 = ħω0 = 1.0 meV and ħΩ = 0.5 meV
Occupation
Time [ps]
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
120
State1
State2
State3
State4
State5
State6
State1
State2
State3
State4
State5
State6