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Correlations effect on driven dynamics of complex quantum systems

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Correlations effect on driven dynamics of complex quantum systems

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I study the perturbative response of a complex quantum system on time variations of a classical external variable Q . Such a study is important to clarify the nature of dissipative and fluctuative properties of large-amplitude collective motion in highly-excited heavy nuclei.

The driven quantum dynamics is considered in adiabatic basis of the system's Hamilton operator $\hat{H}[Q(t)]$. Within a random matrix approach, I derived non-Markovian master equation for the occupancies, $|a_{nn}|^2(t)$, of the adiabatic states:

$$d|a_{nn}|^2(t) = -\dot{Q}(t) \int_0^t \dot{Q}(t') dt' \frac{\sum_{m \neq n} K(t-t') [|a_{nn}|^2(t') - |a_{mm}|^2(t')]}{|a_{nn}|^2(t)}$$

Here, the memory kernel, $K(t-t')$, is proportional to the distribution of the coupling matrix elements $\left(\frac{\partial \hat{H}(Q)}{\partial Q}\right)_{nm}$, which are treated as independent normally distributed random numbers with zero mean value and autocorrelation function:

$$\left\langle \left(\frac{\partial \hat{H}}{\partial Q}\right)_{nm}(Q) \left(\frac{\partial \hat{H}}{\partial Q}\right)_{n'm'}(Q') \right\rangle \propto \frac{1}{1 + ([E_n - E_m]/\Gamma)^2} \times \exp\left(-\frac{|Q-Q'|}{\xi}\right).$$

The spreading width Γ measures the overlap between the complex eigen-states of the system's Hamilton operator and the correlation width ξ is introduced to include into consideration possible correlations between the coupling matrix elements, caused by their dependence on the macroscopic variable $Q(t)$.

By requiring the constancy of an expectation value of the $\hat{H}[Q(t)]$, I obtained an equation of motion for the classical macroscopic variable $Q(t)$. This equation was then applied to schematic description of the fission width and time of descent from the fission barrier of highly-excited heavy nuclei. I measured the impact of the parameters of the coupling matrix elements' distribution on the nuclear fission's observables.

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