Towards Observation of Anderson Localization in Rotating Molecules

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The periodically kicked rotor is a textbook model in nonlinear dynamics. The classical kicked rotor can exhibit truly chaotic motion, whilst in the quantum regime this chaotic motion is either suppressed by Anderson localization [1], or the rotational excitation is enhanced due to the so-called quantum resonance (see, e.g. [2]). Up to now, all the experiments on quantum chaos of the kicked rotor were done in a substitute system, cold atoms interacting with a pulsed standing light wave [3]. Recently [4], we drew attention to the fact that current technology used for laser alignment of non-polar molecules offers tools for the first observation of dynamical Anderson localization in a material rotating system, a diatomic molecule.Here we show that the non-rigidity of the molecules suggests an additional mechanism for quantum localization, which makes its observation even more feasible.If a molecule is kicked by a periodic train of short linearly polarized laser pulses separated by the rotational revival time $t_{rev}=h/2B$ (quantum resonance), the angular momentum J shows a ballistic growth. This is shown in Fig.1 (a), where we plot the simulated angular momentum distribution of periodically kicked $^{14}N_2$ molecules as a function of the number of kicks. We found that due to the centrifugal distortion of fast spinning molecules, all the quasi-energy states become localized via the Anderson mechanism above some critical value $J=J_{cr}$. As a result, the angular momentum distribution of resonantly kicked molecules cannot penetrate beyond $J=J_{cr}$, and it is "reflected" [see Fig.1 (a)]. This effect can be observed with current laser technology. In Fig.1 (b) we show the simulated alignment signal of periodically kicked $^{14}N_2$ molecules at room temperature. The signal reflects well the predicted oscillations of the angular momentum in Fig.1 (a), and it can be measured by optical methods.

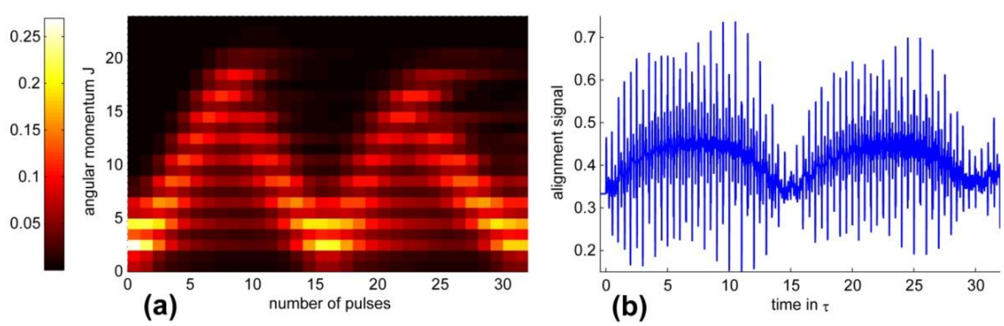

Fig.1: Angular momentum distribution (a) and alignment signal (b) for $^{14}N_2$ molecules

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