Forced synchronization of quantum system

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As shown in the plots of final-state distribution of Li Rydberg atoms after an irradiation of a microwave pulse in Figs. 6 and 7 of Ref. [1], the atoms subjected to an external oscillating field tend to be pulled into the 1/2 order subharmonic resonance state when initially in one of states in the vicinity of the subharmonic resonance. The authors have suggested that the motion of the Rydberg electron is phase locked to the applied microwave field.

Later Maeda and Gallagher have demonstrated that a nondispersing Rydberg wave packet can be made by exposing a Rydberg atom to a weak microwave whose frequency nearly equals to the Kepler frequency of the Rydberg atom [2,3]. Orbital motion of the Rydberg wave packet was found to be phase locked to the microwave field, which remained for an extremely long time [2,3].

Here we show that the nondispersing wave packet is in fact responsible for pulling the atom into the resonant state. In other words, forced synchronization of atomic system with an external driving field causes atomic transition to the resonant state.

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