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Formation of ultracold molecules by photoassociation : interpretation as an optical Feshbach resonance

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Our group has been working for a few years at the theoretical description of photoassociation of ultracold atoms with chirped laser pulses [1], and formation of stable ultracold molecules in pump-dump experiments [2]. During the photoassociation pulse, the continuum state describing two colliding atoms in their ground state is at resonance with a bound vibrational level in an excited electronic state of the molecule. We have investigated [3] how this pulse is carving out a *dynamical hole* in the stationary scattering wavefunction of the initial state. Considering photoassociation into loosely bound levels of Cs_2 $0_g^-(6P_{3/2})$, we analyze the depletion of the ground triplet state wavepacket and its evolution after the pulse. We show that, due to a "momentum kick", a significant flux of population is moving towards short distances, at the timescale of the vibrational motion in the excited state. This compression effect markedly increases the density probability at short distances, suggesting new photoassociation schemes.

In photoassociation experiments with cw lasers, the *resonant coupling mechanism* is very efficient [4,5]. The name of *resonant coupling* refers to a strong channel interaction, when a series of loosely bound vibrational levels of a diatomic molecule is perturbed by another vibrational series. We shall recall some of the theoretical work that led to disclose the phenomenon, including numerical developments [6] and generalization of Lu-Fano plots for qualitative interpretation [7]. More recently [8], we have looked for a time-dependent signature of resonant coupling in photoassociation of cold rubidium atoms : when a laser pulse couples the ground state continuum state to bound vibrational levels of Rb_2 $0_u^+(5P_{1/2})$ and $0_u^+(5P_{3/2})$, the non-adiabatic coupling between two excited channels induces time-dependent beatings in the populations. These oscillations could be exploited in the experiments as a probe tool.

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