ZERO-WIDTH RESONANCES and EXCEPTIONAL POINTS in MOLECULAR PHOTODISSOCIATION

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The interaction of a molecule with a cw laser field is described by a time-periodic Hamiltonian. The wave equation has solutions given by the Floquet formalism, with eigenvalues called the quasi-energies. If the field can lead to photodissociation of the molecule, these quasi-energies are complex, with an imaginary part yielding the photofragmention rate. These resonance energies are in fact the poles of the scattering matrix. In the case of intense fields, there is a richness of new processes. Some of the resonances, when varying the intensity for a given wavelength, can present a zero width. This ensures the stability of the molecule even in the presence of an intense field. This can be turned into a filtration scenario, where all states presenting this property are the only surviving states at the end of a pulse [1]. There is also the possibility, with an appropriate choice of laser frequency and intensity, to provoke the degeneracy of two Floquet quasi-energies. The corresponding point in parameter plane is called exceptional. Such points have recently been studied in many areas of physics, either classical or quantum . They have a number of very important consequences. At an exceptional point the two resonance wave functions merge into a single one, which is "self-orthogonal". The concept of self-orthogonality is due to the special scalar product valid for resonance wave functions. With an adiabatic variation of the parameters along a closed contour around an exceptional point, it is possible to go from one field-free vibrational state to another. In order to realize such a transfer, it is necessary to reach a compromise between two conflicting conditions: the laser pulse must vary slowly enough for an adiabatic transfer to take place, but fast enough to keep a fair amount of undissociated molecules. Cooling scenarios can then be formulated [2-3]. The two molecular species which are studied are H_2^+ and Na_2, the latter being a strong candidate for molecular cooling.

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