Dissociative Excitation of Molecules in Photonic and Electronic Collisions. Formation and Dissociation Dynamics of Molecular Superexcited States.

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Abstract

A survey is given of recent progress in experimental studies of the dissociative excitation of molecules in photonic and electronic collisions with molecules in the excitation-energy range of 10-50 eV with a particular emphasis placed on the formation and dissociation dynamics of molecular superexcited states which have been recently substantiated experimentally. In photonic collision experiments synchrotron radiation as an excitation photon source combined with newly developed coincidence or two-dimensional spectroscopy-techniques have been used for studying optically allowed superexcited states, while in electronic collision experiments newly developed coincident electron energy-loss spectroscopy has been used for studying optically forbidden superexcited states. Molecules studied are ranged from simple diatomic and triatomic molecules to polyatomic molecules such as hydrocarbons. Most of the observed superexcited states are high Rydberg states which are vibrationally (or/and rotationally), doubly, or inner-core excited and converge to each of ion states. Non-Rydberg superexcited states are also observed. Dissociation into neutral fragments in comparison with ionization is of unexpectedly great importance in the observed decay of each of these states. Dissociation dynamics as well as its products are remarkably different from those for lower excited states below about ionization thresholds. These experimental results have motivated much new developments of theoretical investigations of molecular superexcited states and their dissociation

dynamics as well as of optical oscillator strength distributions. Some remarks are also presented of superexcited states as collision complex in electron-ion recombination, electron attachment, and Penning ionization processes. As related perspectives, comments are presented on an important role of molecular superexcited states in phenomena in ionized gases and further on these states in the condensed phase.

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