A NEW METHOD OF SELECTIVE LASER DISSOCIATION OF DIATOMIC MOLECULES

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This paper presents the concept of a new method of selective dissociation for diatomic molecules through one-color, multiphoton, successive excitations in a laser field and a well-determined set of physical parameters. The method of fluctuations and a quantum description of the system within the density matrix formalism are used to elaborate the model described in the following. The fluctuations of the electric dipole moment μ_{mn} of the molecules during transitions in the vibronic spectrum are studied with the help of the temporal correlation relations, which are used to calculate the average values. The selection rule $\Delta\nu_{mn} = \nu_n - \nu_m = 1$ is followed, where ν_m and ν_n are the principal quantum numbers of vibration. To realize the mechanism proposed here, two conditions need to be satisfied: one in energy and one in time. Doppler and collision broadening of the characteristic resonance line of the molecules, ν_e are taken into account and the resulting broadening is handled as the convolution of the two distributions, considered independent.

The excitations are resonant under specific conditions calculated here, a particular window of physical parameters and quantum numbers, characteristic of the system studied. A new dissociation method is proposed, based on this mechanism, which could open a new selective and efficient way of action upon molecules. The probability of dissociation as a result of successive absorption of energy in the multiphoton laser field is derived.

The innovative character of the method described here is that it makes use of phenomena that are usually considered perturbing (negative) to the interactions between the molecules and radiation. Such phenomena are the thermal degeneration of energy levels in the vibronic spectrum of the molecules, usually perturbing to determinations of physical conditions and quantum numbers of the interaction medium studied.

The theory presented here allowed the development of a new method of producing ozone with a yield that is significantly superior to the other methods currently used. The method presented here would allow the selective action in resonant conditions, specific to every diatomic molecule, which would have a ”label” precisely determined and characteristic to their dissociation through this method. Given the large yield, the rather complete consumption of the dissociating gas atmosphere, and the large selectivity with respect to the dissociating bond, this method could open a new way of study of molecular dissociation, and new applications in science and technology.