

Universal product angular-momentum distributions in photodissociation and reaction collisions

G. G. Balint-Kurti¹, P. S. Shternin², O. S. Vasyutinskii²

¹*School of Chemistry, University of Bristol, Bristol BS8 ITS, UK*

²*Ioffe Institute, Russian Academy of Sciences, 194021 St.Petersburg, Russia*

osv@pms.ioffe.ru

The talk reviews recent results on the full quantum mechanical treatment of the spin and orbital angular momentum recoil angle distributions of the products of *chemical* and *photochemical reactions* in diatomic and polyatomic molecules. The distributions obtained are presented in the body frame and in the molecular frame using the spherical tensor formalism. The main result is that the recoil angle distribution can be written *irrespective of the reaction mechanism* in a universal form in terms of the anisotropy transforming coefficients \mathbf{c}_{K,q_i}^K which contain all information regarding the reaction dynamics and can be either directly determined from experiment, or calculated from theory.

The coefficients are scalar values which depend on the photofragment state multipole rank (K), on the initial reagent spherical tensor rank (K_i), and on component q_i of the ranks K and K_i projected onto the recoil direction \mathbf{k} . An important new conservation rule is revealed through the analysis, namely that the component q_i is preserved in any scattering, or photolysis reaction. The coefficients \mathbf{c}_{K,q_i}^K act as transformation coefficients between the angular momentum anisotropy of the reactants and that of the product. The results obtained are generalized to the case where the reaction reagents possess spin, or orbital electronic angular momentum polarization.

General expressions for the anisotropy-transforming coefficients beyond the axial recoil limit contain scattering S -matrix elements and take into account all possible types of nonadiabatic interactions in the reaction complex, as well as the full range of possible coherence effects. Several important particular cases of these expressions are discussed. These are: (a) the role of the Coriolis interactions in the photolysis of linear molecules which result is the molecular helicity non-conservation; (b) quasiclassical approximation of the molecular scattering function in the high- J limit.

The talk also reviews recent experimental results on photodissociation of a number of polyatomic molecules and shows how the investigation of the determined values of the speed-dependent parameter β and higher rank anisotropy parameters supported the interpretation of the photodissociation dynamics.

References

- [1] A. G. Smolin, O. S. Vasyutinskii, A.J. Orr-Ewing, *Mol. Phys.* **105**, 885 (2007)
- [2] P. S. Shternin and O.S. Vasyutinskii, *J. Chem. Phys.* **128**, 194314 (2008).
- [3] A. G. Suits and O. S. Vasyutinskii, *Chem. Rev.* **106**, 3706 (2008).
- [4] V. V. Kuznetsov, P. S. Shternin, O. S. Vasyutinskii, *J. Chem. Phys.*, **130**, 134312 (2009).
- [5] G. G. Balint-Kurti and O. S. Vasyutinskii, *J. Phys. Chem. A*, **113**, 14281 (2009)
- [6] M. B. Krasilnikov, V. V. Kuznetsov, A. G. Suits, O. S. Vasyutinskii, *PCCP*, **13**, 8163 (2011)