Electron-molecule collision for plasma physics applications

Jonathan Tennyson

Department of Physics and Astronomy, University College London, London WC1E 6BT, UK

Plasma models require data on electron driven process for a wide variety of species. Cool plasmas are substantially molecular. These occur at edge of fusion plasmas, naturally in the Earth's ionosphere and the interstellar medium, or are being harnessed for a wide variety of technological processes. These molecular plasma include many transient species whose behavior when colliding with electrons is poorly known and hard to characterize experimentally. My group performs calculations which use the fully quantum-mechanical R-matrix method [1, 2] to perform calculations on a variety of plasma problems including rotational excitation of interstellar molecular ions, excitation of fusion plasma edge species and collisions with molecules important for plasma etching. My talk will feature illustrative examples of such applications including:

- Rotational excitation and dissociative recombination of the argonium ion (ArH^+) which was recently been found to be ubiquitous in diffuse interstellar molecular clouds [1, 2];
- Development of a radiative-collisional model for BeH/BeD/BeT, a species whose emission spectra is being actively monitored in fusion plasmas [1, 2];
- An electron chemistry of NF_3 and its fragments (NF_2 and NF) which are important in remote plasma sources which are being developed for isotropic etching and thin film deposition in microelectronics fabrication [7, 8].

Finally mention will be made of the Quantemol database (QDB) [9] which is constructed to store both individual chemical reactions of importance for plasma models as, induced by both electron and heavy particle collisions, as well as entire (validated) plasma chemistries.

[1] J. Tennyson, Phys. Rep. **491**, 29 (2010).
[2] J.M. Carr *et al.*, Euro. J. Phys. D **66**, 58 (2012).
[3] J. R. Hamilton, A. Faure and J. Tennyson, Mon. Not. R. astr. Soc., **455**, 3281 (2016).
[4] A. Abdoulanziz *et al.*, Mon. Not. R. astr. Soc., submitted (2018).
[5] J.R. Hamilton, J. Tennyson, S. Huang and M.J. Kushner, Plasma Sources Sci. Technol, **26**, 065010 (2017).
[6] S. Huang *et al.*, J. Vac. Sci. Technol. A., **35**, 031302 (2017),
[7] D. Darby-Lewis, Z. Masin and J. Tennyson, J. Phys. B: At. Mol. Opt. Phys., **50**, 175201 (2017).
[8] D. Darby-Lewis, J. Tennyson, K.D. Lawson, S.N. Yurchenko, M.F. Stamp, A. Shaw, S. Brezinsek and JET Contributor, J. Phys. B: At. Mol. Opt. Phys., submitted (2018).
[9] J. Tennyson *et al.*, Plasma Sources Sci. Technol, **26**, 055014 (2017).