Electron/molecular-cation collisions in cold plasmas: super-excited states at "zero" energy

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We will discuss the role of excited states in cold ionized media, as resonances in reactive collisions, and as initial states of the target in non-equilibrium regime.

Dissociative recombination (DR) [1,2]:

$$AB^+(N_i^+,v_i^+)+e^-\rightarrow AB^*,AB^{**}\rightarrow A+B, \qquad (1)$$

the major recombination process in low pressure ionized gases, is often notably fast at "zero" (i.e. low) energy of the incident electrons, since it occurs via super-excited molecular states singly- (AB*) or doubly- (AB**) excited, embedded in the ionization continuum of the target ion. This process is competed by ro-vibrational and dissociative excitation:

$$AB^+(N_i^+,v_i^+)+e^-\rightarrow AB^*,AB^{**}\rightarrow AB^+(N_f^+,v_f^+)+e^-, \qquad (2)$$

$$\rightarrow A+B^+(N_f^+,v_f^+)+e^-. \qquad (3)$$

The use of the Multichannel Quantum Defect Theory [3] resulted in accurate state-to-state cross sections and rate coefficients, displaying a resonant character and a strong dependence on the target state. These features are particularly important for the collisional-radiative modeling of the cold ionized gases – Fig. 1 - in various environments - interstellar space, comets, planetary ionospheres, shock-waves in the entries of spacecrafts, ionic propulsion devices, industrial and edge fusion plasmas - and containing various cations - H_2^+, BeH^+, BF^+ [2,4], N_2^+[5], CO^+[6], SH^+, ArH^+, H_3^+[7], BF_2^+, etc.

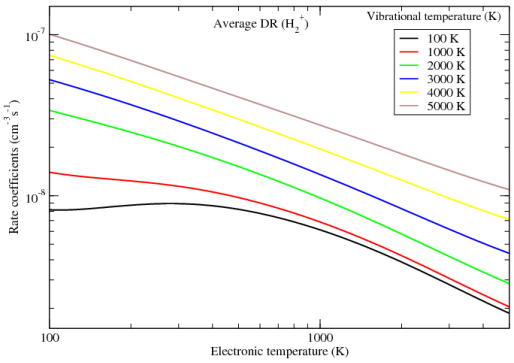

Fig.1. Maxwell rate coefficients for the Dissociative Recombination (DR) of H_2^+: dependence on the vibrational temperature of the ions.

References

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