Invited Lecture

AUTOIONIZATION WIDTHS OF COLD RYDBERG ATOMIC COMPLEXES

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Autoionization processes in Rydberg collisional complexes were considered in work Gnedin et al. (2009). It showed the important role of the development of the dynamic chaos regime for various ionization phenomena occurred in cold astrophysical environments. As a continuation of those studies, our paper presents novel original results related to the following problems: (i) Analysis of the nontrivial temporal dynamics of the angular momentum $L(t)$ of a Rydberg atom in external electromagnetic fields along with the influence of that dynamic on the ionization efficiency; (ii) The fluorescence spectrum of a Rydberg atom which it emits upon its diffusion ionization stimulated by an external microwave radiation; (iii) Analysis of autoionization widths Γ_N of quasi-molecules formed by two cold Rydberg atoms in different quantum states (N) and subject to the long-range dipole-dipole interaction.

We have obtained new data to control the rate constants of ionization phenomena in cold environments under the presence of both external and internal atomic electromagnetic fields. Using the example of Rydberg alkali metal atoms, it has been demonstrated the possibility of a substantial increase (by orders of magnitude - see Figure 1) of the rates Γ_N of the charged particles formation in cold media due to an optimal selection of quantum numbers $N = (n_d l_d, n_i l_i)$ of two Rydberg atoms participating in the Penning ionization process $A^{**}(n_d l_d) + A^{**}(n_i l_i) \rightarrow A^{**}(n'_d l'_d) + A^+ + e^-$ at the internuclear distance R.

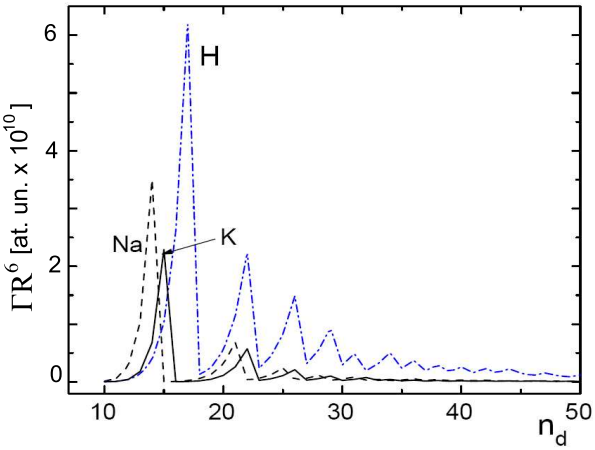

Figure 1: Reduced Penning autoionization widths $\mathrm{R}^6\Gamma_N$ for s-s ($l_i = l_d = 0$) pairs of Na, K and H atoms as functions of the principal quantum number n_d with the fixed $n_i = 50$ quantum number of the ionizing atom.

References

Gnedin, Yu. N., Mihajlov, A. A. et al.: 2009, *New Astron. Rev.*, **53**, 329 (see also Mihajlov, A. A., Ignjatović, L. M., Srećković, V. A., Dimitrijević, M. S.: 2011, *Astrophys. J., Suppl. Ser.*, **2**, 193).