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*Invited lecture*

# RYDBERG ATOMS IN ASTROPHYSICS

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We present the results of spectropolarimetric and photometric observations of isolated magnetic white dwarfs made at 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences (spectropolarimetry) and at $1.1-mAZT-24$ telescope of the Pulkovo Observatory, located in Campo-Imperatore, Italy ( infrared photometry). The observed effects - rotation of the polarization plane and depression of the IR radiation of white dwarfs with strong magnetic fields are explained by the absorption of radiation by collisionally-excited Rydberg atoms in the strong magnetic field. By analogy with well-known collision-induced absorption (CIA) in cool dwarfs we call this effect in magnetic white dwarfs by "magnetic CIA". These and other new experimental results require an improvement a known constant of elementary processes (with Rydberg atoms) experimental data.

Rydberg's atoms give a significant contribution to the kinetics of the solar atmosphere, taking a part in chemi-ionization/recombination atomic collision processes, as well as in the processes of (n-n')-mixing. It has been shown that both type of processes have an important role in the large region of the Solar atmosphere, where they are comparable, or even dominant, to the other relevant processes. Because of that the chemi-ionization/recombination and (n-n')-mixing processes in symmetric atom-Rydberg atom collisions have to be included in any modeling of the weakly ionized layers in the Solar atmosphere, especially in the region of the temperature minimum in the Solar photosphere. In a stochastic ionization model interesting moments arise in the presence of highly excited states when collision complexes with multiple level crossings and overlapping dynamic resonances are formed, which evolve to fragmentations through various channels. Such evolution is associated with random, stochastic changes of the energy state of Rydberg electron, and they are likely to influence the nuclear dynamics. An important feature of kinetics coefficients of the corresponding Fokker-Plank equations consists of their dependence on dipole matrix elements of optical transitions. This allows manipulating and even blockading the regime of chaotic dynamics du to changes of interatomic potential by external fields in the vicinity of Foster resonance. Foster resonance corresponds to the double photon resonance, i.e. a Rydberg l-state should be situated exactly in the middle between two neighbor l'=l+1-states (or l-1-states). Quantitatively, this situation occurs when the difference between quantum defects of the states equal to 1/2 and is known as Seaton criterion for suppressed the corresponding dipole matrix elements. The latter can be realized in astrophysical samples (plasma, or dust, for instance) containing alkalis neutral atoms due to the Stark or Zeeman shifts of levels under the presence of electrical/magnetic fields. Experimentally, it is manifests itself as an anomalous weak fluorescence of the radiation escaping from a star/planet atmosphere or as a reduced ionization channel output in chemiionization reactions.

*Invited lecture*

## ACCURATE COLLISIONAL BROADENING PROFILES FOR ALKALI RESONANCE LINES IN SUBSTELLAR ATMOSPHERE MODELS

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The optical and far red (up to 1 $\mu$m) spectral energy distribution of the coolest substellar atmospheres is shaped by prominent absorption features due to the alkali resonance lines of Na I and K I. Broadening by collisions with neutral perturbers, predominantly molecular hydrogen and helium, can extend the far wings of these lines out to several 1000 Å. In the dense and mostly dust-free and clear atmospheres of T dwarfs these lines, together with the weaker features of the less abundant alkalis Li, Rb and Cs, probe the photosphere over many pressure scale heights. The resulting spectral profile is a product not only of interactions with perturbers at far and near distances, but as well of thermal structure and the distribution of neutral alkali gases as a function of height. It allows thus to test models for convection-driven energy transport and vertical mixing extending into the overshoot region, and for the efficiency of condensation. Observations of such lines in brown dwarf spectra provide an important test case for the understanding of these same processes in extrasolar gas giant planets, including the more complex case of irradiation in hot Jupiters.