Plasma environment effects on K-lines of astrophysical interest

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X-ray emission lines from accreting black holes, most notably K-lines, have observed widths and shifts which imply an origin very close to the compact object [1]. The intensity of these lines can provide insight into the effects of special and general relativity in the emitting region as well as insight into some properties of the compact object itself. As an example, the spin of an accreting black hole can be inferred by modeling the distortion of the Fe K emission complex [2]. Magnetohydrodynamics simulations of accreting black holes computed by Schnittman *et al.* [3] seem to reveal that the plasma conditions in such an environment should be characterized by an electronic temperature ranging from 10^5 to 10^7 K and an electronic density ranging from 10^{18} to 10^{21} cm^{-3}. Such physical conditions may affect the atomic structure and processes corresponding to the ionic species present in the plasma. However, atomic data used in the standard programs to model astrophysical X-ray spectra arise from isolated ion approximation calculations. This shortcoming is thought to be the leading candidate cause of inconsistencies observed in the results [4].

The main goal of the present work is to estimate the effects of plasma environment on the atomic parameters associated with the K-vacancy states in cosmologically abundant elements such as oxygen and iron ions within the astrophysical context of accretion disks around black holes. In this purpose, relativistic atomic structure calculations have been carried out by using the multiconfiguration Dirac-Fock (MCDF) method, in which a time averaged Debye-Hückel potential has been considered for both the electron-nucleus and electron-electron interactions in order to model the plasma environment, using a combination of the GRASP92 [5] and of the RATIP [6] codes.

In this contribution, a sample of results concerning the plasma effects on the atomic structure and on some atomic parameters related to K-lines in oxygen ions will be presented. A comparison with the results obtained by another independent computational method, namely the Breit-Pauli relativistic approximation as implemented in the AUTOSTRUCTURE code [7, 8], will also be discussed in detail, showing that both approaches are in excellent agreement regarding the plasma effects.

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