Transition probabilities in the Xe V spectrum


* GAPHYOR, LPGP, UMR 8578, University of Paris-sud XI, Orsay, 91400, France
1 IPNAS, Université de Liège, Sart Tilman B15, B-4000 Liège, Belgium
2 NDS, IAEA, Wagramerstr. 5, A-1400 Vienna, Austria

Synopsis The structure and spectrum of Xe V have been investigated and transition probabilities involving many configurations were evaluated on the basis of the existing data, of quasi-classical Coulomb approximation results in LS coupling and of ab initio theoretical calculations based on the pseudo-relativistic Hartree-Fock (HFR), the Distorted Wave (DW) and the First Order Many Body Theory (FOMBT) approximations.

In the 5p^2 outer shell of the Xe V ion only two of the neutral rare gas six equivalent p electrons (which give the typical characteristics of the rare gases spectrum) are left. The Xe V spectrum can be present in the emission spectra of experimental devices, provided sufficient energy is available for the corresponding ionization, as is the case in EBIT sources and energetic ion beams, hence Xe V lines are of interest to a number of industrial applications including lasers, Tokamaks, Stellarators, plasma reactors and electric propulsion. The Xe V spectrum can also be important for astrophysical applications.

In the majority of these applications, the plasmas are not in Local Thermodynamic Equilibrium (LTE). Therefore, “zero dimension” Collisional-Radiative (C-R) models are needed to evaluate the populations of the main excited states of the ionization stages, a prerequisite to obtain correct emission spectroscopy diagnostics on the basis of measured line intensities. In addition to diagnostics applications, C-R models are also important for the correct modeling of the emitting plasma, allowing the evaluation of the total cooling rate and the creation-destination rate of each stage of ionization.

In order to identify observed Xe V lines, the energy levels (E_i) and the corresponding wavelengths must be sufficiently well known. Theoretical values from ab initio calculations are often not of sufficient accuracy for this task. Therefore, experimental and/or evaluated data are necessary for the identification of most lines.

Structure data and E_i available for Xe V were reviewed and evaluated in recent work [1] where an extensive bibliography is found. Moreover, experimental line intensities are important for the study of the plasma:

Observed line intensities compared to the calculated ones can validate the identification of the lines and allow a plasma diagnostics giving the electron density and electron temperature from the observed plasma spectrum.

The line intensities in the theoretical spectra calculated with C-R models depend on the transition probabilities A_{ij} and on the electron collision excitation cross sections populating the upper levels. We have studied the Xe V spectrum lines and the A_{ij}, the excitation cross sections being addressed elsewhere [2]. When C-R models are applied for diagnostic purposes, precise E_i and A_{ij} values are mandatory. The present status of the Xe V A_{ij} data was reviewed in [3], where A_{ij} connecting the 5p^2, 5p4f, 5p5d, 5p6s, and 5p6p configurations were also calculated and evaluated. A_{ij} involving the 5s5p^0 configuration, also studied previously [3] are not addressed here. The available experimental E_i values are insufficient to characterize some of the observed lines in the case of Xe V spectra.

The present paper aims to improve on the knowledge of the Xe V structure data and to perform evaluations of the A_{ij} for the most pertinent transitions.

References