§17. Relativistic CI Calculations of Spectroscopic Data for the $2p^6$ and $2p^53l$ Configurations in Ne-like Ions

Jönsson, P. (Malmö Univ.),
Hara, H., Watanabe, T. (NAOJ),
Nakamura, N. (UEC),
Yamamoto, N. (Osaka Univ.),
Kato, D., Murakami, I., Sakaue, H.A.

Ne-like ions are abundant in plasmas of wide ranges of temperatures, because the ground state has an L-shell closed electronic configuration. Since Ne-like Fe XVII lines of extreme ultraviolet wavelengths (EUV) are observed in the active regions of the solar atmosphere, the lines are thought potentially useful to study mechanisms of the corona heating. Doschek et al. [1] examined Skylab observations of a solar flare and reported that lines at 204.6 Å and 254.8 Å, identified as electric-dipole (E1) transitions of $2p^53p\ (^1S_0) \rightarrow 2p^53s\ (3/2, 1/2)_1$ and $\rightarrow 2p^53s\ (1/2, 1/2)_1$, respectively, had the strongest and almost the same intensities.

Since both of the lines share the identical upper level (the lines are indicated by thick dashed arrows in Fig. 1), their line intensity ratio can be evaluated with atomic transition probabilities (branching ratio) only. It is noted that here the plasma is presumably transparent for the lines, though validity of this assumption needs to be studied more rigorously. Fig. 2 shows calculated intermediate-couplings in $2p^53p$ and $2p^53s$ states of Fe XVII by means of grasp2K [2]. The nearly equal branching ratio of the atomic data is ascribed to strong intermediate-coupling between ^3P and ^1P terms in the $2p^53s$ state.

However, new observation of a solar flare by means of the EUV Imaging Spectrometer (EIS) on *Hinode* satellite [3] has shown difficulty in reconciling the available atomic data with observed Fe XVII line intensities. The EIS measurements [4] have shown the branching ratio of the line at 204.6 Å about twice as large as that of the line at 254.8 Å, while the available atomic data gave the almost equal branching ratio for the each line. Although the discrepancy may be ascribed partially to calibration issues, re-investigation of the relevant atomic data seems to be necessary for a better understanding.

Recently, benchmark calculations for ions in the iron group have been done by Ishikawa et al. using a relativistic multireference Möller - Plesset scheme [5,6]. The high accuracy of these calculations made it possible to revise the identification of several lines. The present work is motivated by the need to extend the term analysis to more highly ionized ions and to give a full set of consistent and high accuracy transition rates including also M1, E2, and M2 multipoles for large parts of the isoelectronic sequence.

In the present work [7], energies, E1, M1, E2, M2 transition rates, oscillator strengths, and lifetimes from relativistic configuration interaction calculations were calculated for the states of the $2p^6$, $2p^53s$, $2p^53p$, and $2p^53d$, configurations in all Ne-like ions between Mg III and Kr XXVII. Core-valence and core-core correlation effects were accounted for through SD-expansions to increasing sets of active orbitals. The Breit interaction and leading QED effects are included as perturbations. The results were compared with experiments and other recent benchmark calculations. In Mg III, Al IV, Si V, P VI, S VII, and Ar IX, for which experimental energies were known to high accuracy, the mean error in the calculated energies was only 0.011%.

This work is supported by the Research Cooperation program in the National Institutes of Natural Sciences (NINS).

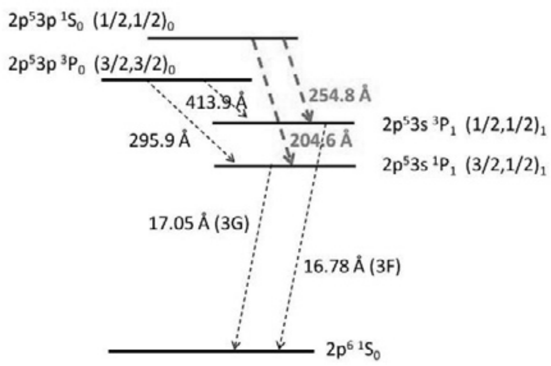

Fig. 1. Energy level diagram of Ne-like Fe XVII.

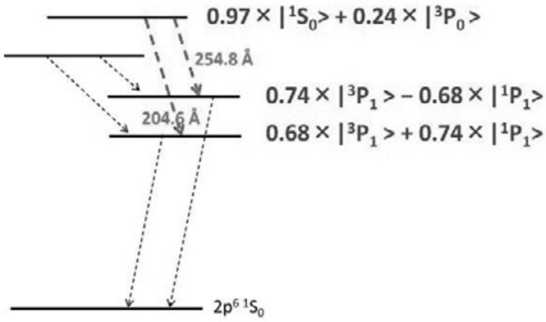

Fig. 2. Intermediate-coupling in $2p^53p$ and $2p^53s$ states of Fe XVII. Coefficients of the intermediate-coupling were calculated by means of grasp2K.

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