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Eu III oscillator strengths and Europium abundances in Ap stars

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Abstract

We present our calculations of the spectrum and oscillator strengths for the 4f7 - (4f65d + 4f66s) Eu III transitions. The calculations were performed with Cowan's RCN-RCG-RCE codes in the single-configuration approximation. A comparison of computed level lifetimes with experimental data for three levels shows that the scale of theoretical oscillator strengths could be overestimated by a factor of 3. The theoretical oscillator strengths of red Eu III lines are two orders of magnitude smaller than their astrophysical oscillator strengths derived by Ryabchikova et al. (1999) from the condition of ionization balance. The new oscillator strengths were tested by analyzing the Eu abundance using Eu II and Eu III lines in the spectra of hot peculiar stars (α2 CVn is a typical representative) and cool peculiar stars (β CrB is a typical representative). First, we computed non-LTE corrections, which proved to be significant for α2 CVn. We also analyzed the Eu II λ6645.11-Å line as well as ultraviolet and optical Eu III lines. We show that the new oscillator strengths together with the non-LTE corrections allow the contradiction between the Eu abundances derived by Ryabchikova et al. (1999) separately from optical Eu II and Eu III lines in α2 CVn to be resolved. The new Eu abundance, log(Eu/Ntot) = -6.5, also faithfully describes the blended near-ultraviolet resonance Eu III lines. Using the new Eu III oscillator strengths to analyze the spectrum of the cool Ap star β CrB, we found a significant deviation of the n(Eu II)/n(Eu III) ratio from its equilibrium value. For a chemically homogeneous model atmosphere, to obtain the observed intensity of the Eu III λ6666.35-Å line, the Eu abundance must be increased by two orders of magnitude compared to that required to describe the Eu II λ6645.11-Å line. We discuss the possibility of explaining the observed intensities of Eu II and Eu III lines in the spectrum of β CrB by the presence of an inhomogeneous atmosphere with Eu concentrated in its uppermost layers. In such atmospheres, the role of non-LTE effects becomes dominant. © 2002 MAIK "Nauka/Interperiodica".

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Keywords

Stars-variable and peculiar