On the Stark broadening parameters of Al IV spectral lines for stellar spectra analysis and synthesis

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For different astrophysical research topics, as e.g. modelling of stellar atmospheres and subphotospheric layers or analysis and synthesis of spectral lines, data on Stark broadening of spectral lines, namely broadening of spectral lines by interactions with electric microfield of surrounding charged particles, are usful. Such data enter in the calculations of absorption coefficient, opacity, radiative transfer, abundance determination, acceleration of gravity etc. They are also of importance for laboratory plasma diagnostic and modelling, inertial fusion plasma investigation, laser design and development, laser produced plasma research and plasmas in different technologies and industries.

The importance of aluminum in stellar plasma and spectra research is due to its high cosmic abundance since it is the twelfth most common element in the Universe, and spectral lines of this element and its ions are commonly present in stellar spectra. Since for astronomy are particularly important lines in the visible part of the spectrum, we calculated Stark widths for 23 Al IV transitions in this part of the spectrum, employing the modified semiempirical method (Dimitrijević and Konjević 1980). Calculations have been performed for an electron density of 10^{17} cm^{-3} and electron temperatures of 10,000, 20,000, 40,000, 80,000 and 160,000 K.

We used the obtained results to examine the influence of Stark broadening on Al IV spectral lines in A-type stellar atmospheres, as well as in DB and DO white dwarfs. In comparison with lines in UV (Dimitrijević and Christova 2022), the influence of Stark broadening in the visible part of the spectrum is higher due to the influence of higher wavelengths. Namely, in the modified semiempirical method and other Stark broadening theories, the wavelength enters as a square and the formula for Doppler width has linear behavior with wavelength. Therefore, for the higher wavelengths of spectral lines Stark width values will be larger in comparison with Doppler ones. Consequently, in the visible part of the spectrum, the corresponding Stark width will be higher in comparison with Doppler width, than in the UV part.

Additionally, since all examined transitiona are in Jl coupling, we examined similarities of Stark widths within multiplets and supermultiplets for this type of coupling. We found that for the analyzed Al IV transition in the Jl coupling, these differences may be of the order of 10–20 percent if expressed in angular frequency units, which enables a rough check of consistency of existing experimental and theoretical data or an approximate check during experiment or calculation. In the case of considered Al IV supermultiplets in Jl coupling, differences are between 210% and 61%, so that there is no similarities which could be used for checking the consistency of Stark width values or to estimate the missing Stark width in a supermultiplet from the known ones, like in the case of LS coupling.

Since such results are also of interest for Virtual Observatories we will prepare them additionally for implementation in STARK-B database (Sahal-Brechot, et al. 2015), which is also a part of Virtual Atomic and Molecular Data Center - VAMDC (Dubernet et al. 2010).

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