Electrical conductivity of plasma in DB white dwarf atmospheres

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The data on electrical conductivity of plasma of stars with a magnetic field or moving in the magnetic field of the other component in a binary system could be of significant interest, since they are useful for the study of thermal evolution of such objects (cooling, nuclear burning of accreted matter) and the investigation of their magnetic fields. An additional interest for data on electrical conductivity in white dwarf atmospheres may be stimulated by the search for extra-solar planets. Namely a planetary core in orbit around a white dwarf may reveal its presence through its interaction with the stellar magnetosphere. Such an interaction will generate electrical currents that will directly heat the atmosphere near its magnetic poles. This heating may be detected within the optical wavelength range as H_α emission. For investigation and modelling of such electrical currents, the data on electrical conductivity in white dwarf atmospheres will be useful. In this contribution, an adequate method for calculations of electrical conductivity of dense, partially ionized helium plasmas, convenient for the conditions in DB white dwarf atmospheres, is developed. This method represents a generalization of the modified random-phase approximation (RPA) method, and gives a possibility to estimate the real contribution of the neutral component to the static electrical conductivity of the considered helium plasmas. The static electrical conductivity of non-ideal, dense, partially ionized helium plasma was calculated within a wide range of plasma parameters of interest for DB white dwarf atmospheres with effective temperatures $1 \cdot 10^4\mathrm{K} \lesssim T_{eff} \lesssim 2 \cdot 10^4\mathrm{K}$. The method developed in this paper represents a powerful tool for research into white dwarfs with different atmospheric compositions (DA, DC etc.), and for the investigation of some other stars (M type red dwarfs, Sun etc.). Finally, the presented method provides a basis for the development of methods to describe the other transport characteristics which are important for the study of all the mentioned astrophysical objects, such as the electronic thermo-conductivity in the star atmosphere layers with large electron density, electrical conductivity in the presence of strong magnetic fields and dynamic (high frequency) electrical conductivity.