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Electrical conductivity for hot and dense astrophysical plasma

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We investigate the electrical conductivity of hot and dense plasma relevant to the outer crusts of neutron stars and the interiors of white dwarfs. The main novelty of the work is the inclusion of positrons in the composition of matter and in the transport. We solve a system of coupled Boltzmann kinetic equations for electrons' and positrons' distribution functions in the relaxation time approximation, taking into account the electron-ion, positron-ion and electron-positron collisions. The relevant scattering matrix elements are calculated from one-plasmon exchange diagrams with the inclusion of in-medium polarization tensors derived within the hard-thermal-loop effective theory. Preliminary numerical results are obtained for matter consisting of carbon nuclei. We found that the conductivity rises with the temperature following a power-law $\sigma \propto T^4$ in the nondegenerate regime because of intense creation of thermal electron-positron pairs.

These results highlight the importance of inclusion of positrons in the transport of heated dense astrophysical plasmas.

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