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Impact of positrons on electrical conductivity of hot and dense astrophysical plasma

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We study the influence of positrons on the outer crusts of neutron stars and the interiors of white dwarfs, introducing them as a novel component in both the composition of matter and in transport processes. We solve a system of coupled Boltzmann kinetic equations for the electron and positron distribution functions in the relaxation-time approximation, taking into account electron–ion, positron–ion, and electron–positron collisions. The relevant scattering matrix elements are calculated from one-plasmon exchange diagrams, with in-medium polarization tensors derived within the hard–thermal–loop effective theory. Numerical results are obtained for matter composed of carbon, iron and helium nuclei. We find that the conductivity rises with temperature, following a power law $\sigma \propto T^4$ in the semi-degenerate regime and $\sigma \propto T$ in the nondegenerate regime, due to the intense creation of thermal electron–positron pairs and the resulting collisions among them. These results highlight the importance of including positrons in the transport properties of heated, dense astrophysical plasmas.

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