

Equation of state of fully ionized electron-ion plasmas: Analytical approximations for astrophysical applications

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We develop analytical approximations of thermodynamic functions of fully ionized nonideal electron-ion plasmas. First, we present corrections and improvements to previously published formulae for these functions. Second, we take into account arbitrary magnetic fields. Third, we perform hypernetted-chain calculations of the free energy, internal energy, and pressure for mixtures of different ion species and introduce a correction to the linear mixing rule, which allows a smooth transition from strong to weak Coulomb coupling in agreement with the numerical results. The presented formulae are applicable in a wide range of plasma parameters, including the domains of nondegenerate and degenerate, nonrelativistic and relativistic electrons, weakly and strongly coupled Coulomb liquids, classical and quantum Coulomb crystals.

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