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Thermalization of optically excited Fermi systems: electron-electron collisions in solid metals

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Ultrafast optical excitation of metals induces a non-equilibrium energy distribution in the electronic system, with a characteristic step-structure determined by Pauli blocking. On a femtosecond timescale, electron-electron scattering drives the electrons towards a hot Fermi distribution.
In this work, we present a derivation of the full electron-electron Boltzmann collision integral within the random-k approximation. Building on this approach, we trace the temporal evolution of the electron energy distribution towards equilibrium, for an excited but strongly degenerate Fermi system. Furthermore, we examine to which extent the resulting dynamics can be captured by the numerically simpler relaxation time approach, applying a constant and an energy-dependent relaxation time derived from Fermi-liquid theory.
We find a better agreement with the latter, while specific features caused by the balance of scattering and reoccupation can only be captured with a full collision integral.

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