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Soft Scattering Evaporation of Dark Matter Subhalos by Inner Galactic Gases

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The large gap between a galactic dark matter subhalo's velocity and its own gravitational binding velocity creates the situation that small subhalos can be evaporated before dark matter thermalize with baryons due to the low binding velocity. In case dark matter acquires an electromagnetic dipole moment, the survival of low-mass subhalos requires stringent limits on the photon-mediated soft scattering. Within the current direct detection limits, we calculate the DM kinetic decoupling temperature in the Early Universe and evaluate the smallest protohalo mass. In the late Universe, low-mass subhalos can be evaporated via soft collision by ionizied gas and accelerated cosmic rays. We calculate the subhalo evaporation rate via dipole-charge scattering and place an upper limit on the DM's dipole form factor by assuming the survival of subhalos in the ionized Galactic interior.

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