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Pressure from dark matter annihilation and the rotation curve of spiral galaxies

The rotation curves of spiral galaxies are one of the basic predictions of the cold dark matter paradigm, and their shape in the innermost regions has been hotly debated over the last decades. The present work shows that dark matter annihilation into electron-positron pairs may affect the observed rotation curve by a significant amount. We adopt a model-independent approach, where all the electrons and positrons are injected with the same initial energy E_0 ~ m_dm*c^2 in the range from 1 MeV to 1 TeV and the injection rate is constrained by INTEGRAL, Fermi, and HESS data. The pressure of the relativistic electron-positron gas is determined by solving the diffusion-loss equation, considering inverse Compton scattering, synchrotron radiation, Coulomb collisions, bremsstrahlung, and ionization. For values of the gas density and magnetic field that are representative of the Milky Way, it is estimated that pressure gradients are strong enough to balance gravity in the central parts if E_0 < 1 GeV. The exact value depends somewhat on the astrophysical parameters, and it changes dramatically with the slope of the dark matter density profile. For very steep slopes, as those expected from adiabatic contraction, the rotation curves of spiral galaxies would be affected on ~kpc scales for most values of E_0. By comparing the predicted rotation curves with observations of dwarf and low surface brightness galaxies, we show that the pressure from dark matter annihilation may improve the agreement between theory and observations in some cases, but it also imposes severe constraints on the model parameters (most notably, the inner slope of halo density profile, as well as the mass and the annihilation cross-section of dark matter particles into electron-positron pairs).

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