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WIMP cross-section limits from radio observations of dwarf spheroidal galaxies

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Dark matter (DM) consisting of weakly interacting massive particles (WIMPs) self-annihilates into baryonic matter and provides a possibility for indirect detection. We observe dwarf spheroidal galaxies (dSph) because they are rich in DM but baryonic emissions are low. In the magnetic field of dSph, the particles produced in DM self-annihilation emit synchrotron radiation which peaks at low radio frequencies.

We use the non-detection of 150 MHz radio continuum emission from six dSph with the LOw-Frequency ARray (LOFAR) to derive constraints on the annihilation cross section of WIMPs where electron-positron pairs are produced. Our main underlying assumption is that the transport of the cosmic rays can be described by the diffusion approximation, requiring a non-zero magnetic field strength. We compute limits for multiple values of magnetic field and diffusion coefficient, taking the known measured values as the benchmark model.

The resulting limits exclude thermal WIMPs with masses below 20 GeV. Our limits are comparable to the limits set by FermiLAT using gamma-ray observations of multiple dSph and probe unique regions of low mass WIMPs. We also explore the improvement of the results with stacking and the potentially high uncertainty due to the choice of diffusion model parameters.

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