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DREAMuS - Searching for Muon-philic Dark Matter with a GeV Muon Beam at HIAF

We propose DREAMuS (Dark matter REsearch with Advanced Muon Source), a fixed-target experiment at the High-Intensity Heavy-Ion Accelerator Facility (HIAF) in China, designed to search for muon-philic dark-sector particles. DREAMuS uses a GeV-scale muon beam to probe light mediators that preferentially couple to muons and induce lepton-flavor-violating muon-nucleus interactions, followed by invisible decays into dark-sector particles.

The signal is characterized by a single electron candidate with large transverse momentum or large scattering angle, missing momentum. The detector concept has been optimized toward a low-cost scintillator-based design: a segmented lead target is combined with near-target scintillator stations and a multi-layer scintillator-strip barrel to reconstruct and veto muon-related backgrounds, including large-angle scattered muons, muon decays after multiple scattering, and muon-nuclear interactions. The projected sensitivity shows that DREAMuS can probe light muon-philic dark-sector particles over a broad sub-GeV to GeV mass range. A complementary positive-muon beam configuration further improves the low-mass reach through the invisible annihilation channel.

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