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Conditions for Dark Matter Ignition of White Dwarf Stars

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Dark matter constitutes approximately 84\% of the total matter in the universe, yet despite decades of experimental effort, no direct detection has been achieved. We focus on Weakly Interacting Massive Particles (WIMPs) as a dark matter candidate. Their extremely weak interactions with ordinary matter place them beyond the reach of current detectors here on Earth. White dwarfs offer possible alternative detection method: their strong gravitational wells can capture and accumulate WIMPs over billions of years, potentially reaching densities where self-annihilation produces observable heating effects. This thesis investigates the conditions under which WIMP accumulation in white dwarf cores can trigger either catastrophic thermonuclear ignition (Type Ia supernovae occurring before the Chandrasekhar limit is reached) or detectable thermal anomalies in cooling curves. A theoretical framework is developed encompassing WIMP capture rates, thermalization timescales, and annihilation heating in degenerate stellar cores across a range of WIMP masses ($10^5 - 10^8$ GeV) and scattering cross-sections ($10^{-45} - 10^{-40}$ cm^2). The predicted observational signatures are deficits of old white dwarfs in high dark matter density regions and anomalously luminous white dwarfs that could provide indirect evidence for dark matter.

Field of Research/Work

Cosmology, Astrophysics, and Gravitation

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