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Thermal Production of Extremely Weakly Interacting Particles in the Early Universe

Today one of the most pressing scientific questions is the understanding of the origin of cosmic dark matter. While the established standard model of particle physics is highly successful in describing phenomena at particle accelerators with an impressive precision, it contains no particle that can describe dark matter. There are also fine-tuning problems such as the hierarchy problem or the strong CP problem that call independently for new physics. Those problems can be alleviated by postulating two new fundamental symmetries: supersymmetry (SUSY) and the Peccei–Quinn symmetry. Extending the standard model with those symmetries, new fields are predicted to exist that have much weaker interactions than neutrinos: the axion, the axino, and the gravitino. These fields are compelling dark matter candidates and constitute a new category of extremely weakly interacting particles (EWIPs). The objectives of this PhD project aim at clarifying the role of EWIPs in cosmology. By applying up-to-date techniques of thermal field theory and new developments thereof, the production of EWIPs in the hot primordial plasma will be described with unprecedented reliability. The planned computations will be essential to test the well-motivated possibility that dark matter is composed of EWIPs. The results will be crucial to probe the reheating temperature after inflation and the viability of baryogenesis/leptogenesis models.