

All axion dark matter from supersymmetric models

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Supersymmetric models accompanied by certain anomaly-free discrete R-symmetries Z_n^R are attractive in that 1. the R-symmetry (which can arise from compactified string theory as a remnant of the broken 10-d Lorentz symmetry) forbids unwanted superpotential terms while allowing for the generation of an accidental, approximate global $U(1)_{PQ}$ symmetry needed to solve the strong CP problem and 2. they provide a *raison d'être* for an otherwise ad-hoc R-parity conservation. We augment the minimal supersymmetric Standard Model (MSSM) by two additional Z_n^R - and PQ-charged fields X and Y wherein SUSY breaking at an intermediate scale m_{hidden} leads to PQ breaking at a scale $f_a \sim 10^{11}$ GeV leading to a SUSY DFSZ axion. The same SUSY breaking can trigger R-parity breaking via higher-dimensional operators leading to tiny R-violating couplings of order $(f_a/m_P)^N$ and a WIMP quality problem. For Z_4^R and Z_8^R , we find only an $N=1$ suppression. Then the lightest SUSY particle (LSP) of the MSSM becomes unstable with a lifetime of order $\sim 10^3$ - 10^4 seconds so the LSPs all decay away before the present epoch. That leaves a universe with all axion cold dark matter and no WIMPs in accord with recent LZ-2024 WIMP search results.

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