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Avoiding Pair Instability in Massive Stars by Adding Non-Nuclear Energy

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Models of the evolution of stars with initial masses of approximately $80 - 240 M_\odot$ include instability due to the production of electron positron pairs in some portion of the star. The resulting supernovae do not leave behind a black hole remnant, meaning that no black holes in the mass range $50 - 120 M_\odot$ are expected to form. However, a fundamental assumption in these models is that the only source of energy injection into the star comes from nuclear fusion. However, there are scenarios in which nuclear reactions may not be the only energy source of note in a star. For instance, in the early universe, it may be possible for self-annihilation of dark matter in a star may provide a non-negligible source of energy. Therefore, we explore the effect that introducing a non-nuclear energy source into a star can have on its evolution, specifically on the pair instability. As a test case, we were able to show that a star with an initial mass of $180 M_\odot$ can completely avoid a pair instability supernova if approximately half of the energy needed to support it comes from a non-nuclear source.

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