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Supermassive black hole seeding via dark stars in light of PTA observations

The global network of Pulsar Timing Arrays (PTAs) recently announced the detection of a stochastic gravitational wave background (SGWB) in the nano-Hz frequency regime with 3σ significance. The conservative interpretation is that this SGWB originated from the population of inspiraling super-massive black hole (SMBH) binaries distributed across the universe. The conventional approach assumes that these SMBHs grew from smaller seeds via hierarchical episodes of mass accretion and mergers. However, it is also possible that many of these SMBHs originated from massive seeds formed in the early universe. Direct Collapse Black Holes (DCBHs) are a widely studied candidate for these massive seeds. Yet, current models suggest that DCBHs may struggle to account for a significant fraction of the observed SMBH population. On the other hand, dark matter powered stars (dark stars) could seed SMBH with much higher efficiency.

To this end, I will discuss the expected SGWB energy density spectrum (spanning both the PTA and the upcoming LISA mission frequency bands) when SMBHs are seeded by the collapse of *WIMP dark matter-powered* supermassive dark stars and contrast it with the DCBH scenario. I will show how this pathway may explain the observed SGWB amplitude while reducing reliance on rapid gas-driven growth and simultaneously reproduce the empirically determined black hole-halo mass relations at lower redshifts.

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