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Faint light of old neutron stars and detectability at the James Webb Space Telescope and exploring the analytics of multiple scattering of dark matter.

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Isolated ideal neutron stars (NS) of age $> 10^9$ yrs exhaust thermal and rotational energies and cool down to temperatures below $\mathcal{O}(100)$ K. Accretion of particle dark matter (DM) by such NS can heat them up through kinetic and annihilation processes. This increases the NS surface temperature to a maximum of ~ 2550 K in the best case scenario. The maximum accretion rate depends on the DM ambient density and velocity dispersion, and on the NS equation of state and their velocity distributions. Upon scanning over these variables, we find that the effective surface temperature varies at most by $\sim 40\%$. Black body spectrum of such warm NS peak at near infrared wavelengths with magnitudes in the range potentially detectable by the James Webb Space Telescope (JWST). Using the JWST exposure time calculator, we demonstrate that NS with surface temperatures
$gtrsim 2400$ K, located at a distance of 10\,pc can be detected through the F150W2 (F322W2) filters of the NIRCAM instrument at SNR\,
$gtrsim 10$ (5) within 24 hours of exposure time. Independently of DM, an observation of NS with surface temperatures
$gtrsim 2500$ K will be a formative step towards testing the minimal cooling paradigm during late evolutionary stages.
Further, we explored the analytics of scattering probability and capture rate for the multiscatter case if the DM is heavy
$gtrsim 10^6$ GeV. We analyse this scenario with different opacity.

Track type

Dark Matter

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