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New 511 keV line data provides strongest sub-GeV dark matter constraints

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We explore the 511 keV emission associated to sub-GeV dark matter (DM) particles that can produce electron-positron pairs and form positronium after thermalizing. We use $\sim$ 16 yr of SPI data from INTEGRAL to constrain DM properties, including the full positron propagation and losses, and the free electron density suppression away from the Galactic plane. We show that the predicted longitude and latitude profiles vary significantly for different DM masses, unlike previous assumptions, and obtain the strongest limits on sub-GeV DM (from the MeV to a few GeV) so far, excluding cross-sections down to $\langle \sigma v \rangle$
$lesssim 10^{-32}$ cm^3 s^{-1} for $m_\chi \sim 1$ MeV and $\langle \sigma v \rangle$
$lesssim 10^{-26}$ cm^3 s^{-1} for $m_\chi \sim 5$ GeV and lifetimes up to τ
$gtrsim 10^{29}$ s for $m_\chi \sim 1$ MeV and τ
$gtrsim 10^{27}$ s for $m_\chi \sim 5$ GeV for the typical Navarro-Frenk-White DM profile. Our derived limits are robust within a factor of a few due to systematic uncertainties.

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