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Axion-like particles as probes of the SN core

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Pseudo-scalar particles, like QCD axions and Axion-like-Particles (ALPs), emerge in many extension of the Standard Model and have been recognized to be among the best Dark Matter candidates. Even if very weakly interacting, ALPs can be copiously in the core of massive stars at the end of their life. In this regard, Core-Collapse Supernovae (SNe) are expected to be powerful sources of novel exotic particles. Thus, a future Galactic SN may represent a
once-in-a-lifetime opportunity for the detection of such Dark Matter candidate. In this talk, I will discuss how ALPs with masses $m_a < 10^{-10}$ eV may be efficiently produced in SN cores by means of their coupling to nucleons. Then, they can leave the star unimpeded and convert into photons inside galactic magnetic fields, giving rise to an ALP-induced γ-ray burst at energies E
$gtrsim 50\,\mathrm{MeV}$, which might be detectable in the Fermi-LAT experiment.
Moreover, since ALP production mechanisms are sensitive to the conditions of the inner regions of the SN core, I will argue how ALPs can be employed to probe some important properties of Proto-Neutron Stars (PNS). In particular, I will show that the detection of the ALP burst may provide some insights about the presence of a relevant fraction of pions in SN cores and, eventually, lead to the reconstruction of the temperature in the inner region of the PNS.

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