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Detection of Axion Anti-quark Nuggets via their interactions in kt liquid detectors

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In the standard lambda cold dark matter (ΛCDM) model of cosmology, the distribution of matter and energy in the Universe is as follows: 5% is represented by ordinary matter, 26.8% by dark matter, and 68.2% by dark energy. However, the nature of dark matter and dark energy is not yet known. In the context of particle physics, dark matter may consist of one or several new particles, which are expected to be either massive or very light, millicharged or electrically neutral, uncoloured, weakly interacting, and stable. Unfortunately, none of these hypothetical
particles have been observed so far. The axion (anti)Quark Nuggets (AQN / A$\bar{Q}$N) model, proposed by Ariel Zhitnitsky in 2003 [1], builds on Edward Witten's idea [2] and involves 'new fields'representing 'new phases' (color superconducting) of quarks from the Standard Model and is able to explain the distribution of different forms of matter and energy.
Following a concise review of the primary characteristics of axion antiquark nuggets, in this contribution, we investigate potential experimental signatures that could be used to detect these stable supermassive particles in upcoming surface and underground experiments using liquefied noble gases (LAr, LXe) as Time Projection Chambers (TPCs) or water Cherenkov detectors. These anticipated signals are examined concerning the unique features of each detection system. Starting from the emission mechanisms of A$\bar{Q}$Ns considered in accordance with their struc-
ture, we investigate the expected signals: (a) atoms or molecules from the environment can be captured by the A$\bar{Q}$N, penetrate up to its core, and undergo annihilation; (b) the annihilation of positrons from the electrosphere and the emission of gamma radiation [3]. The analysis of the particles and radiation resulting from these interaction mechanisms is
analysed with the aim of exploiting them for the direct detection in the liquid materials considered in this contribution.
References
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