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Study of the first excited state of the 4He nucleus in coupled-channels Halo EFT

This work focuses on investigating the first excited state ($J^{\pi} = 0^{+}$) of the ⁴He nucleus, the α -particle. This excited state, probably associated with a four-body Efimov state, is found between the $p + {}^{3}$ H and $n + {}^{3}$ He thresholds, allowing for the use of coupled-channels formalism. It is thought to have a 3 + 1 halo structure, making it suitable for investigation using a Halo effective field theory framework. This resonance may influence the 3 H($p, e^{+}e^{-}$)³He reaction and shed light on the ATOMKI anomaly reported by Krasznahorkay *et al.*, where an excess of produced lepton pairs suggests the existence of a new boson, with an approximate mass of 17 MeV, and that can be a possible candidate for dark matter.

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