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Theoretical study of the 3H(p, e+e-)4He and 3He(n,e+e-)4He processes and the X17 anomaly

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A rather puzzling anomaly has been recently observed in the emission of electron-positron pairs in the 7Li(p,e+e-)8Be and 3H(p,e+e-)4He reactions [1,2]. This anomaly has been interpreted as the signature of a particle not foreseen in the standard model of particle physics (hereafter X17 boson) with mass M=16.8 MeV. The X17 boson could be a mediator of a fifth force, characterized by a strong coupling suppression of protons compared to neutrons [3]. This scenario can explain, at least partially, the long standing anomaly of the magnetic moment of muon found experimentally. In this contribution, we present an ab-initio study of the 3H(p, e+e-)4He and 3He(n,e+e-)4He processes [4]. We first analyze the pair production as a purely electromagnetic process in the context of a state-of-the-art approach to nuclear strong-interaction dynamics and nuclear electromagnetic currents, derived from chiral effective field theory (chiEFT). Next, we examine how the exchange of a hypothetical low-mass boson would impact the cross section for such a process. We consider several possibilities, that this boson is either a scalar, pseudoscalar, vector, or axial particle.

We also provide an overview of an experiment probing pair production in the 3He(n,e+e-)4He at the n_TOF facility at CERN, currently in preparation [5]. We discuss also of other experimental searches of the X17 boson in nuclear reactions, as that performed by the MEG collaboration at PSI (Switzerland), which are currently repeating the 7Li(p,e+e-)8Be experiment, or as in the 2H(p,e+e-)3He and 2H(n,e+e-)3H reactions, proposed in order to test the "protophobicity" of X17.

[1] A. J. Krasznahorkay et al., Phys. Rev. Lett. 116, 042501 (2016)

[2] A. J. Krasznahorkay et al., Phys. Rev. C 104, 044003 (2021)

[3] J. L. Feng et al., Phys. Rev. Lett. 117, 071803 (2016)

[4] M. Viviani et al., Phys. Rev. C 105, 014001 (2022)

[5] E. Cisbani et al. CERN-INTC-2021-041 (2021) [https://cds.cern.ch/record/2766541]

Attendance

Remote

Contact Email

michele.viviani@pi.infn.it

Scheduling Constraints

Primary author: VIVIANI, Michele (INFN-Pisa)

Presenter: VIVIANI, Michele (INFN-Pisa)