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Annihilation studies with slow extracted antiprotons

Antiproton-nucleus annihilation at rest is a process that is not well understood, despite substantial previous experimental and theoretical work on its different aspects. One of the main reasons for its complexity are final-state interactions (FSIs), i.e. the interactions between the primary mesons produced and the residual nucleus. A model that accounts for all the observed effects is still missing, as well as measurements at ultra-low energies, to validate the nuclear models in this regime. The antiproton-nucleus reactions at rest have a notable application in experiments at the Antiproton Decelerator (AD) at CERN, the purpose of which are atomic-physics and high-precision tests of fundamental symmetries [1,2,3,4,5]. They rely on simulation models that were developed for high energy physics, and behave unsatisfactorily at energies relevant for these experiments.

In this talk we will present the experimental work on antiproton-nucleus annihilation at the ASACUSA experiment at CERN using slow extracted antiprotons [6], including preliminary results from an initial study with carbon, molybdenum and gold nuclei. We will also introduce a recently started project aiming to measure, for individual annihilation events the multiplicity of the prongs, their angular distribution and their energy in almost 4Pi solid angle, for a representative set of about 15 different nuclei. The results are expected to have twofold application: on one hand, they will allow to validate new calculation within the INCL (Intranuclear Cascade of Liège) model [7] and to tune the Geant4 [8] simulations, thus providing the first reliable model for low energy antiproton-nucleus annihilation. On the other hand, they will yield quantitative and qualitative information about the final state interactions and their evolution with the atomic number, potentially identifying novel nuclear physics process not yet included in the models.

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