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Pion Production in Antiproton-Nucleus Interactions

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The upcoming FAIR Facility provides unique possibilities to study nuclear structure. With the availability of antiprotons as probes, independent information on the properties of exotic nuclei can be achieved. A corresponding experimental setup is proposed by the Antiproton Ion Collider (AIC) at FAIR@GSI, allowing to perform colliding-beam antiproton-nucleus experiments. The focus of our research is twofold: first to find a consistent theoretical description of the interactions of antiprotons with beta-stable and unstable nuclei leading to elastic scattering and particle production and second to utilize these processes for nuclear structure studies. Both topics are of interest in themselves. The antiproton-nucleus interaction is dominated by annihilation reactions where the major component leads on average to five pions. In the energy regime of interest, these processes are well described microscopically by hadronic models. We use antinucleon-nucleon interactions from the Paris model and the Bonn model. Both models are based on the G-parity transformed nucleon-nucleon amplitudes but treat the coupling to the annihilation channels in a different manner. We pay particular attention to the coupling to the two-meson exit channels by treating them explicitly while the other reaction channels are taken into account globally by effective interactions. The nuclear structure input, i.e. ground state densities, single particle wave functions and spectral distributions are treated microscopically by HFB calculations. The antiproton-nucleus optical potential is obtained within a folding approach using the free-space antiproton-nucleon T-matrix and nuclear HFB densities. Meson production is described by annihilation on the target nucleons described by wave functions and spectral densities obtained from self-consistent calculations. An interesting method, particular well suited for the AIC, is to use the produced pions from the annihilation process as probes for nuclear structure studies. The pion-nucleon interaction is described by an extended Kisslinger optical-potential combined with higher resonances beyond the Delta(1232)-state. First results for elastic antiproton-nucleus cross sections and pion production cross sections are presented for nuclei along isotopic chains. The cross sections show a pronounced sensitivity on the nuclear density distributions and single particle wave functions.

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