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Double-strangeness production with antiprotons at the AD

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One of the outstanding fundamental problems in hadron physics today is the question of the origin of the large hadron masses made up of light quarks. A possible way to gain information is to study how the meson mass changes in a nuclear medium. The mass shift of a meson in a nuclear medium will provide evidence of the partial restoration of spontaneous broken chiral symmetry.

The use of antiprotons for the production of double-strangeness was recently discussed by Weise and Kienle [Int. Jour. Mod. Phys. A 22 (2007) 365] and indeed, it would be very challenging to produce and study such "double-strange nuclei" in the view of the prediction of Akaishi and Yamazaki [Phys. Lett. B 535 (2002) 70] that double-antikaon bound nuclear systems with strangeness (S = -2) will be formed with binding energies up to 200-300 MeV. Such binding energies might result in an increase of the average density to more than 3 times the average nuclear density. If such dense systems really exist they will indeed represent ideal conditions to investigate how the spontaneous and explicit symmetry breaking pattern of low-energy QCD changes in a dense nuclear medium.
First results on events with the production of two K+ mesons were reported by the DIANA collaboration [Nucl. Phys. A 558 (1993) 361] and recently a reanalysis of part of the OBELIX data measured at LEAR [Nucl. Phys. A 797 (2007) 109] was published, giving a probability of ~10-4 for the production of two K+ mesons.
Based on this observation we plan a dedicated experiment to search for double strange nuclear cluster formation following antiproton annihilation at rest in various targets using missing mass and invariant mass spectroscopy. One possible target might be helium, where the antiproton is stopped and a double strange tri-baryon system is produced:

pbar +4He ⟶ K+ + K+ + pnnK-K-

To investigate such systems a detector system with three different detector components are planned with almost 4π coverage and excellent particle identification and spectroscopy capabilities. As central detector, an essential part of this experimental setup, a Time Projection Chamber (TPC) for charged particle tracking is foreseen. Within a Joint Research Activity of the FP7 program HadronPhysics 2, the study and development of a similar prototype TPC is already planned.

A first experiment could be performed at the CERN/AD using the MUSASHI trap (ASACUSA), which provides slow extraction. In future more detailed studies are planned at FLAIR.

Summary

A dedicated detector system will enable us studying in detail the whole reaction mechanism involved in the production of multi-baryon systems with strangeness S=-2 and searching for antikon-mediated deeply bound nuclear clusters, which is a very interesting topic in the study of chiral restoration in a nuclear medium.

Primary author: Dr ZMESKAL, Johann (Stefan Meyer Institute Vienna)

Co-authors: Dr GUARALDO, Carlo (LNF-INFN Frascati); Dr CURCEANU, Catalina (LNF-INFN Frascati); Prof. WIDMANN, Eberhard (Stefan Meyer Institute Vienna); Dr MARTON, Johann (Stefan Meyer Institute Vienna); Prof. FABIETTI, Laura (TU Munich); Dr KURODA, Naofumi (University of Tokyo); Prof. KIENLE, Paul (SMI Vienna &

TU Munich); Prof. GOLSER, Robin (University of Vienna); Prof. BRESSANI, Tullio (Università di Torino); Prof. YAMAZAKI, Yasunori (University of Tokyo)

Presenter: WIDMANN, Eberhard (Stefan Meyer Institute for Subatomic Physics)

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