The Anticyclotron Project

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For trapping large numbers of antiprotons one needs an intermediate stage between the main source of antiprotons (like the Antiproton Decelerator or the former LEAR at CERN) of typically a few MeV energy and the trap which requires 10-100 keV antiprotons.

The anticyclotron project was started at CERN in 1990 based on the cyclotron trap developed at Karlsruhe and PSI/SIN for studying the pbar X-ray cascades in low-pressure gases. The anticyclotron is a small superconducting cyclotron with no RF field, operating in an inverse way: radial injection and --- after deceleration in a low pressure gas --- axial extraction. It was proposed to serve as a basic apparatus to provide an ultra-low energy antiproton beam at LEAR with a predicted transmission efficiency up to 20% using 0.3 mbar hydrogen as moderator gas [1-3].

The anticyclotron tests started at LEAR with 2 MeV antiprotons decelerating in a low--pressure gas and continued in the early 90's at PSI with 4 MeV negative muons with a thin Mylar foil in the median plane as a moderator medium, providing a 5-25 keV negative muon beam extracted with a 2% efficiency. Based on the experience with the original apparatus a new anticyclotron was designed [1] and built at PSI. It is used for precision pionic hydrogen measurements [4] as well as a source of low-energy negative muons [3, 5].

[1] L. M. Simons: Hyperfine Interactions 81 (1993) 253.
[2] D. Horvath et al.: Nucl. Instr. Meth. B 85 (1994) 736.
[3] P. DeCecco et al.: Nucl. Instr. Meth. A 394 (1997) 287.
[4] D. Gotta: Prog. Part. Nucl. Phys. 52 (2004) 133.
[5] F. Kottmann et al.: Hyperfine Interactions 138 (2001) 55.

The Deepest Symmetries of Nature

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The structure of matter is related to symmetries on every level of study. CPT symmetry is one of the most important laws of field theory: it states the invariance of physical propoerties when simultaneously changing the signs of the charge and of the spatial and time coordinates of particles. Although in general opinion CPT symmetry cannot be violated in Nature, there are theoretical attempts to develope CPT-violating models. The Antiproton Decelerator at CERN was built to test CPT invariance.

Several observations imply that there might be another deep symmetry, supersymmetry (SUSY), between basic fermions and bosons. SUSY assumes that every fermion and boson observed so far has supersymmetric partners of the opposite nature. In addition to some theoretical problems of the Standard Model of elementary particles supersymmetry may provide solution to the constituents of the mysterious dark matter of the Universe. However, as opposed to CPT, SUSY is necessarily violated at low energies as so far none of the predicted supersymmetric partners of existing particles was observed experimentally. The LHC experiments at CERN aim to search for these particles.