Pionic hydrogen

D. Gotta

Institut für Kernphysik, FZ Jülich
for the PIONIC–HYDROGEN collaboration

The measurement of ground–state transitions in pionic hydrogen allows to determine the isoscalar and isovector scattering lengths a^+ and a^-, which describe the πN s–wave interaction at threshold. In addition, the πN coupling constant is extracted from a^- by means of the Goldhaber–Miyazawa–Oehme sum rule.

To improve on the accuracy achieved by previous measurements [1], a thorough study of the atomic cascade has been performed at the Paul–Scherrer–Institut using the new cyclotron trap, a cryogenic target, and a Bragg spectrometer equipped with spherically bent crystals and a large–area CCD array (PSI experiment R–98.01 [2]). At first, the possibility of radiative de–excitation of the πH atom – when bound into complex molecules formed during collisions $\pi^- p + H_2 \rightarrow [(pp\pi^-)p]ee$ – was studied by searching for a density dependence of the πH(3p-1s) transition energy. No density effect was found and, consequently, the measured line shift ϵ_{1s} can be attributed exclusively to the strong interaction. The value of ϵ_{1s}, obtained from these measurements, was found to be in good agreement with the result of the previous experiment. The error was improved by more than a factor of two.

The measurement of the Bragg crystal response function by using X–rays emitted by an electron–cyclotron resonance ion trap (ECRIT) allows the determination of the contributions to the line width with unprecedented accuracy [3]. First analyses show that the hadronic width and therefore the isovector scattering length a^- has been underestimated significantly.

[1] H.–Ch. Schröder et al., Eur. Phys. J. C 21 (2001) 433.

[2] PSI experiment R–98.01, http://pihydrogen.web.psi.ch.

[3] D. F. Anagnostopoulos et al., Nucl. Instr. Meth. B 205 (2003) 9.

E-mail: d.gotta@fz-juelich.de