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Weak decay of Lambda–hypernuclei

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The information coming from the study of the Lambda-hypernuclei weak decay channels complements the knowledge of strange nuclear systems obtained by both missing mass and gamma-ray spectroscopy measurements. Lambda-hypernuclei decay through both the mesonic weak decay (MWD) processes:

AΛZ ⟶A(Z+1) + pi- (Γpi-) (1)
AΛZ ⟶(A)Z + pi0 (Γpi0) (2)

and the non-mesonic weak decay (NMWD) processes:

AΛZ ⟶(A-2)Z-1 + p + n (Γp) (3)
AΛZ ⟶(A-2)Z + n + n (Γn) (4)
AΛZ ⟶(A-3)Z'+ N + N + N (Γ2) (5)

The channel (5) is indicated as two-nucleon induced (2N) decay and refers to the interaction of the Λ with a couple of strongly correlated nucleons; Z' stands for Z, Z−1 or Z−2 depending on the particular nucleons combination. The FINUDA experiment performed a complete analysis of the charged particles (pi− and p) spectra following the MWD and
NMWD of 5ΛHe, 7ΛLi, 9ΛBe, 11ΛB, 12ΛC, 13ΛC, 15ΛN and 16ΛO hypernuclei.
MWD spectra and decay rates have been obtained for 7ΛLi, 9ΛBe, 11ΛB and 15ΛN, for the first time and compared with previous measurements and calculations. The spin-parity assign-ment Jp(15ΛNg.s.) = 3/2+ was made for the first time and the results have been published[1].
The FINUDA Collaboration also analyzed the proton energy spectra of 5ΛHe, 7ΛLi, 9ΛBe, 11ΛB, 12ΛC, 13ΛC, 15ΛN and 16ΛOwith good resolution (deltap/p=2% FWHM for protons of 80 MeV) and with a detection threshold of 15 MeV. All measured spectra showed a similar behaviour, i.e. a bump at about 80 MeV, roughly at the energy expected from reaction
(3)(with an incertitude of about 10 MeV due to several nuclear structure and interaction effects). The bump is quite well defined in the high energy portion, whereas at low energies it is blurred in a continuum generated by FSI, superimposed to the 2N-induced NMWD contribution. With very simple hypotheses and a model–independent method the contributions from FSI and 2N-induced NMWD were disentangled, providing a value of Γ2N/Γp of 0.43±0.25 and Γ2N/(ΓNMWD of 0.24±0.10 [2]. This method was recently improved with the further detection of a neutron, from which we determined the value of Γ2N/ΓNMWD with an error reduced of a factor about two respect to the previous FINUDA determination [2]. In fact, in spite of the low statistics, we determined the value of Γnp/Γp=0.39±0.16stat+0.04sys−0.03sys and Γ2N/ΓNMWD=0.21±0.07stat +0.03sys−0.02sys. The value is in agreement, within the errors, with previous evaluations, model dependent or not, and with theoretical calculations [3].

References

[1] M. Agnello et al., Phys. Lett. B 681 (2009) 139.
[2] M. Agnello et al., Phys. Lett. B 685 (2010) 247.
[3] M. Agnello et al., Phys. Lett. B (2011), doi:10.1016/j.physletb.2011.06.035

Primary author: Dr BUFALINO, Stefania (TO)

Presenter: Dr BUFALINO, Stefania (TO)

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