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“Alpha-decays” of $^{10}_{\Lambda}$Be and $^{10}_{\Lambda}$B hypernuclei

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Abstract

The non-mesonic weak decays of Λ-hypernuclei and the explanation of the Γ^n/Γ^p ratio, in particular, are still one of the hot topics in hypernuclear physics. In the course of searching for a new strategy we continue the discussion of our suggestion presented at HYP00 to study non-mesonic weak decays of the two hypernuclei, $^{10}_{\Lambda}$Be and $^{10}_{\Lambda}$B.

1. Spectroscopy of $^{9}\mathrm{Be} \to {}^{8}\mathrm{Be} + n$

We have proposed [1] to use the unique feature of the ^{9}Be nucleus: after removing a neutron from its ground state *several groups of α-particles* appear from different excited states of the residual nucleus ^{8}Be. In Fig. 1, the relevant states of $A = 8$ isotopes are displayed [2]. Due to their salient cluster structure—$\alpha\alpha N\Lambda$—it may be possible to measure in the $^{10}_{\Lambda}$Be and $^{10}_{\Lambda}$B hypernuclei the partial “alpha-decay widths” $\Gamma^{\tau}_{\alpha\alpha i}$, corresponding to states of the residual nucleus $^8\mathrm{Be}^*(E_i; J_i^{\pi}, T_i)$ which decays through $\alpha\alpha$-channel. In such a way we can determine the *one-nucleon stimulated* process $\Lambda N \to nN$ unambiguously. Here, $\tau = N$ in Γ above. Obviously, the role of the two-nucleon stimulated process

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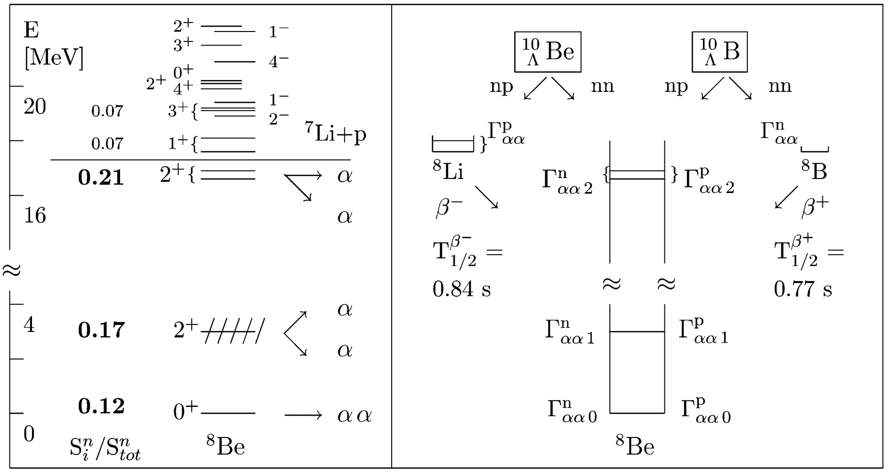

Fig. 1. Left panel: pattern of the ^{8}Be spectra produced in the ^{9}Be$(p,d)^8$Be* reaction. Right panel: "$\alpha\alpha$"-decay of $^{10}_{\Lambda}$Be and $^{10}_{\Lambda}$B hypernuclei and notation of $\Gamma^{\tau}_{\alpha\alpha i}$.

$\Lambda np \to nnp$, could be seen by detection of the α-particles in the decay of the hypernucleus $^{11}_{\Lambda}\mathrm{B} \to {}^8\mathrm{Be} + nnp$ ($\tau = np$ in Γ above).

The energy of the α-particles determines the final state of the residual nucleus ^{8}Be, its quantum numbers, hence also the actual weight of the four possible wave functions of the $N\Lambda$-pair: $p_{1/2}s_{\Lambda}$ with $J = 0, 1$ and $p_{3/2}s_{\Lambda}$ with $J = 1, 2$.

2. Relativistic hypernuclei

The partial widths $\Gamma^{\tau}_{\alpha\alpha i}$ can be determined through detection of tagged α-particles. Such tagged α-particles were recognized as 'hammer tracks' in the emulsion and were efficiently used for identification of $^8_{\Lambda}$Li ($\to \pi^-\, {}^8$Be*) [3].

However, there is also another possibility: to explore the production of hypernuclei in relativistic heavy ion collisions. The complementarity of kinematics typical for the hypernuclear production by a meson beam (strangeness exchange reaction) and by a relativistic heavy ion beam is compared in Table 1.

The first experiments with relativistic hypernuclei were done many years ago by Bowen at Berkeley [4] and Khorozov at Dubna [5,6]. They demonstrated not only that such ex-

Table 1
Kinematics for hypernuclear production

				Secondaries		
Beam		Target		Slow		Fast
K^-	$+$	^AZ	$\to$	$^A_{\Lambda}Z$	$+$	π^-
^AZ	$+$	p	$\to$	K^+	$+$	$\boxed{^A_{\Lambda}Z} + n$