Correlation studies of the unstable heavy ^{5}H system[B,G]

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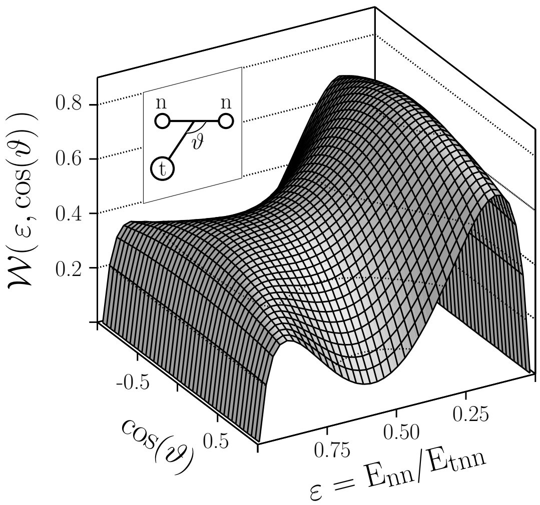

Figure 1: Two dimensional plot of the probability distribution $\mathcal{W}(\varepsilon, \cos(\vartheta))$, as given in Eq. (1) with amplitudes adjusted to the experimental data. The inset sketches the used coordinate system.

Experimental studies of heavy hydrogen isotopes have recently attracted much interest and some intriguing results [1] have been reported. The structure of heavy hydrogen nuclei is expected to be similar to that of neutron-rich helium isotopes, i.e., an inert core (here triton) surrounded by valence neutrons. The experiment was performed using a ^{6}He beam with 240 MeV/nucleon from the FRS impinging on a carbon target and the one proton knockout channel has been investigated. Advantageous in this case is that the momentum transfer in the reaction is small ($\lesssim 30$ MeV/c) and the data can be analyzed in the framework of the sudden approximation. The kinematically complete measurement was done at the ALADIN-LAND reaction setup; the relative momenta of all particles in the t+n+n final state could be reconstructed. Momentum distributions, relative energy spectra together with partial energy distributions (e.g. $\varepsilon = E_{nn}/E_{tnn}$) and angular correlations could thus be deduced in this experiment. The weights of different configurations in the t+n+n system were determined from experimental data, using a method proposed in Ref. [2]. It is based on a series expansion of the final state wave function into hyperspherical harmonics and represents a three-body generalization of the expansion in sperical harmonics known from two-body systems. The data are presented in two different coordinate systems in momentum space: (i) the T system shown in the inset in Figure 1 where the lines point along the directions of the relative momenta of all involved particles in the center of mass and (ii) the Y system, where one of the two neutrons is exchanged with the triton. In both coordinate frames the explicit expression for the probability distribution, can be written as:

$$\mathcal{W}(\varepsilon,\vartheta) = \frac{4}{\pi}\sqrt{\varepsilon(1-\varepsilon)}\cdot\left\{8\varepsilon(1-\varepsilon)\sin^2\vartheta\left|C_{1211}\right|^2 + \left|C_{0000} - 2(2\varepsilon-1)C_{0200} + 4\sqrt{\varepsilon(1-\varepsilon)}C_{0211}\cos\vartheta\right|^2\right\}, \quad (1)$$

where $\mathcal{W}(\varepsilon,\vartheta)$ is normalized to unity. The transformation of the complex amplitudes $C_{SKl_xl_y}$ from T to Y coordinates and vice versa are fixed through Raynal-Revai coefficients. The projections $\int \mathcal{W}(\varepsilon,\vartheta)d\varepsilon$ and $\int \mathcal{W}(\varepsilon,\vartheta)d\cos(\vartheta)$ where fitted to the data in both coordinate systems. As result, the $C_{SKl_xl_y}$ were determined and the corresponding probability distribution $\mathcal{W}(\varepsilon, \cos(\vartheta))$ is shown in Figure 1. The strongest component in the mixed ground state configuration is related to spin and parity $J^\pi = 1/2^+$. This observation is in agreement with recent theoretical work [3], and is further supported by direct comparison with the measured energy spectrum of the t+n+n system shown in Figure 2.

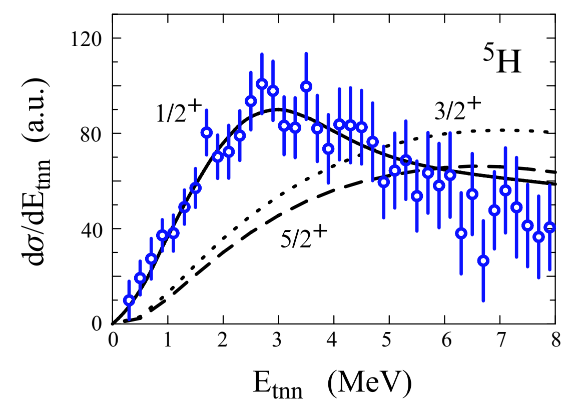

Figure 2: Relative energy spectrum of the $t + n + n$ system. The curves show results of theoretical calculations [3] assuming different spins and parities J^π for the ^{5}H ground state.

The current work [4] presents a successful application of hypersperical harmonics to the analysis of few body continuum states. The method can readily be extended to reveal information about the three-body continuum structure of heavier exotic nuclei, e.g., ^{11}Li and ^{14}Be.

References

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