Momentum Distributions in ^{8}B Coulomb Breakup ◇

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The determination of fragment momentum distributions from breakup experiments in heavy ion collisions may provide considerable insight into the structure of halo nuclei. E.g., the longitudinal momentum distribution is often considered to directly reflect the Fourier transform of the wave function of the halo nucleon. However, the correct interpretation has to be investigated in the framework of the theoretical description of the breakup process.

^{8}B is a possible example for a nucleus with a proton halo in the ground state. Information on the asymptotic proton wave function is of considerable interest for nuclear astrophysics. Its asymptotic normalization is directly related to the low energy astrophysical S-factor of the ^{7}Be(p,γ)^{8}B reaction which is relevant for the high energy solar neutrino problem.

The longitudinal momentum distribution was investigated in a breakup experiment with 1.471 A GeV ^{8}B projectiles at GSI [1]. The small width (FWHM) of (81 ± 6) MeV/c of the distribution suggested that ^{8}B has a large proton halo. This was concluded from a comparison of the experimental distribution with the Fourier transform of the proton ground state wave function from a QRPA model calculation.

At high projectile energies and for highly charged targets the projectile breakup is dominated by Coulomb dissociation, which is fairly well described in a first order semi-classical calculation. Correction due to nuclear breakup and higher order effects in the electromagnetic breakup are sufficiently small to be neglected in first approximation. We have calculated proton momentum distributions directly from the Coulomb breakup cross section using a simple single-particle model for the ^{7}Be-p relative motion. In this model Woods-Saxon potentials are used to generate the wave functions; their strength is individually adjusted in the different partial waves to give the correct energies of the ground state and of the resonances in the continuum. Our model predicts a low-energy S-factor of S(20 keV)=22.08 keV mb, consistent with other calculations and experimental findings from direct capture experiments.

Fig. 1 shows the proton distributions in different directions for the conditions of the experiment in Ref. [1]. E1 and E2 interference in the breakup produces slightly asymmetric distributions, except for the transverse-out of plane case, where the distribution is symmetric with respect to the scattering plane.

The longitudinal momentum distribution, calculated from the Coulomb dissociation cross section, with a width (FWHM) of 80.1 MeV/c matches well the experimental result (Fig. 2). The corresponding Fourier transform of the ground state wave function clearly shows a much wider momentum distribution. It also gives the same symmetric distribution independent of the direction of the relative momentum.

Our calculation shows that the observed momentum distribution of the fragments in the breakup experiment can be explained without assuming a marked proton halo in the ^{8}B ground state. A small width of the momentum distribution does not necessarily imply an extended ground state halo. The correct interpretation of a fragment momentum distribution is only possible if the breakup mechanism is treated properly.

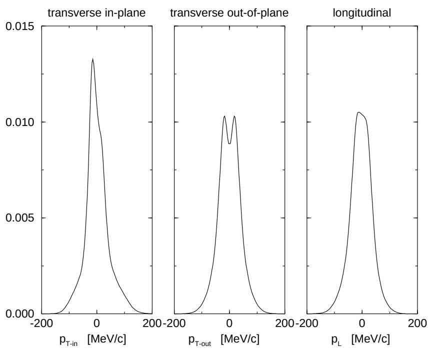

Fig. 1: Proton momentum distributions obtained from the Coulomb dissociation cross section for a projetile energy of 1.471 A GeV scattered on ^{208}Pb as a function of the ^{7}Be-p relative momentum.

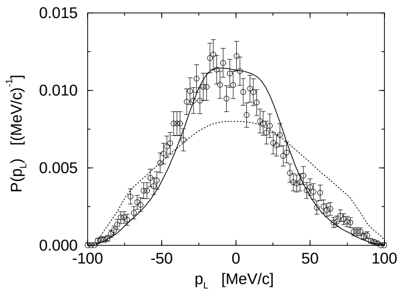

Fig. 2: Longitudinal momentum distribution of the proton (corrected for experimental transmission) in comparison with the experimental distribution of Ref. [1]. Full line: Coulomb breakup result, dotted line: Fourier transform of ground state wave function.

References

[1] W. Schwab *et al.*, Z. Phys. **A350** (1995) 283

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