Coulomb Dissociation of ^{8}B ◇

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The Coulomb dissociation of projectiles in fast peripheral heavy ion collisions has interesting applications in the investigation of nuclear structure and in specific questions of nucleosynthesis in astrophysics. The method relies on the assumption that first order perturbation theory is applicable [1]. Therefore deviations caused by higher order and nuclear effects have to be kept under control.

The astrophysical S-factor of the ^{7}Be(p,γ)^{8}B reaction which is relevant for the solar neutrino problem can be determined from the Coulomb breakup of ^{8}B as an alternative to direct measurements. A first experiment has been performed at RIKEN with 46.5 A MeV projectiles [2] and a further experiment with 250 A MeV ^{8}B is planned at GSI.

We have studied second and third order effects in the Coulomb dissociation of ^{8}B in the approximation of small but finite adiabaticity parameters [3]. This method can easily be applied to different nuclear models and gives a ready estimate of the dependence of the effects on the experimental conditions. We describe the ^{7}Be-p system in a simple two-body model with Woods-Saxon-potentials which are adjusted to give the correct energies of the bound state and the resonances in the continuum. For the unbound final states s-, p-, d-, and f-waves are considered.

The dissociation cross section (Fig. 1) is dominated by the first order breakup (solid lines) which includes E1 and a small E2 contribution, also shown separately (dashed lines). Fig. 2 gives the corrections to the pure E1 first order result by the E2 contribution (dashed lines) and additionally by the second order (dash-dotted lines) and second+third order (solid lines) contributions. These become important at larger scattering angles and smaller projectile energy.

This has to be taken into account for the extraction of the low energy S-factor which is completely determined by E1 transitions to the ^{8}B ground state. In the future we will study the dependence of the first order E2 and higher order contributions on the nuclear model. For that purpose we will go beyond the simple single-particle model.

The electromagnetic breakup of light projectiles dominates the nuclear breakup for highly charged targets for small angle scattering. However, diffraction effects caused by the nuclear absorption affect the angular dependence of the cross section. We account for this effect in an approximation obtained from a comparison of the Glauber calculation [4] with the semiclassical method. We assume a complete absorption for impact parameters smaller than the sum of the target and projectile radii. Our results for the first order E1+E2 Coulomb dissociation including the diffraction (dotted lines in Fig. 1) also show a distinct decrease of this effect at higher projectile energies.

The calculations indicate that the low-energy S-factor of the ^{7}Be(p,γ)^{8}B reaction can be reliably extracted from the Coulomb dissociation of ^{8}B at the high projectile energies which are planned for the experiments at GSI.

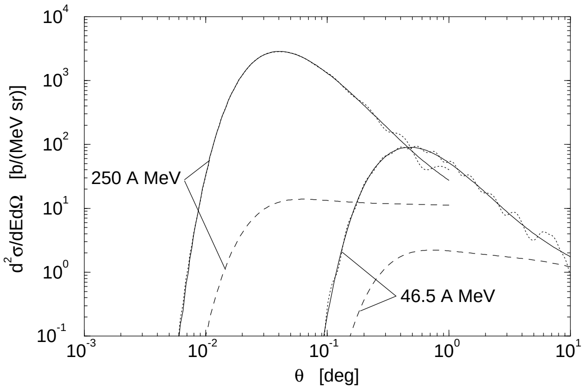

Fig. 1: Differential Coulomb dissociation cross section of ^{8}B scattered on Pb as a function of the scattering angle for the fixed ^{7}Be-p energy of 0.3 MeV at the given projectile energies. See text for further explanation.

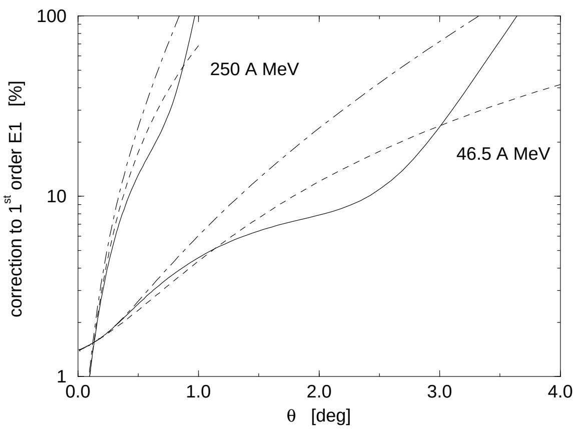

Fig. 2: Correction to the first order E1 result for the differential Coulomb dissociation cross section of ^{8}B from first order E2 and higher order effects for the same conditions as in Fig. 1.

References

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