Coulomb dissociation of ^{8}B: determination of the E2 component

F. Schümann[1], F. Hammache[2], S. Typel[3], Z. Sun[2], F. Uhlig[4], K. Sümmerer[2],
and the S223 Collaboration

[1]Ruhr-Universität Bochum, [2]GSI Darmstadt, [3]MSU East Lansing, [4]TU Darmstadt

Recently, the solar fusion reaction ^{7}Be(p,γ)^{8}B has received renewed interest: on one hand, it represents the source of the high-energy neutrinos that have been measured in the SNO and Super-Kamiokande experiments to pin down neutrino oscillations; the zero-energy S_{17}-factor is directly proportional to the predicted solar neutrino flux to be compared to the SNO and Super-K experiments. On the other hand, new discrepancies in the most recent direct capture experiments [1,2] have made it desirable to check their results by an independent measurement.

One indirect method is Coulomb dissociation (CD) of ^{8}B. We have previously performed such an experiment [3]. The analysis that allows to extract the zero-energy S-factor $S_{17}(0)$ from CD experiments requires a precise knowledge of the multipolarity contributions. Here, discrepancies among different CD experiments were observed: The GSI and a similar RIKEN experiment [4] concluded from their angular distributions that the multipolarity in CD was predominantly E1, whereas a MSU experiment [5] found evidence for a finite E2 contribution from an analysis of ^{7}Be longitudinal momentum spectra..

We have repeated the CD experiment at GSI with an improved setup. A 254 A MeV ^{8}B beam was produced and purified at the FRS; the breakup was measured in complete kinematics at KaoS. The new setup allowed to track the incident ^{8}B beam at the ^{208}Pb breakup target with good angular resolution (≈0.5 mrad). Downstream from the target, the breakup products, p and ^{7}Be, were tracked with two pairs of small-pitch (100 μm) Si strip detectors. This allowed to measure the angular correlations of the breakup products both in the reaction plane and perpendicular to it.

Fig.1 shows in the top panel the distribution of the breakup angles, Φ, of the p-^{7}Be system relative to the incoming ^{8}B beam and transverse to the reaction plane. The bottom panel shows the transverse momenta in the reaction plane, p_t^{in}. Both distributions can be well approximated with pure E1 multipolarity. The theoretical curves shown in Fig.1 have been calculated with E1 plus 10% of the theoretical E2 multipolarity, this gives roughly an upper limit to the E2 amplitude that is compatible with the data. The in-plane angles, θ, (not shown) are symmetric around 90 degrees and are also compatible with this theoretical description, even though the data show a somewhat larger anisotropy.

These findings confirm the analyses of the earlier GSI and RIKEN experiments [3,4], which were done under the assumption of pure E1 multipolarity. The preliminary result for $S_{17}(0)$ from the present experiment is 19.7 ± 1.2 eV b, in good agreement with our previous experiment [3] and with the direct measurements of Ref.[1]. We cannot confirm, however, the higher value published by Junghans *et al.* [2].

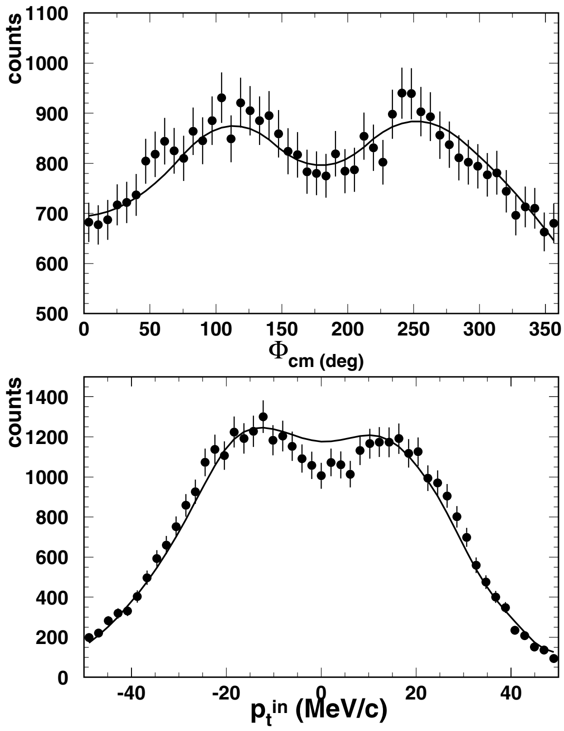

Figure 1: Angular distributions of the p-^{7}Be breakup vector with respect to the ^{8}B beam. Top: out-of-plane angles Φ; bottom: in-plane transverse momenta, p_t^{in}. The smooth curves represent theoretical calculations using 1.order perturbation theory; they include the full E1 and 10% of the E2-amplitude from a single-particle model.

References

[1] F. Hammache *et al.*, Phys.Rev.Lett. **86**, 3985 (2001).

[2] A. Junghans *et al.*, Phys.Rev.Lett. **88**, 041101 (2001).

[3] N. Iwasa *et al.*, Phys.Rev.Lett. **83**, 2910 (1999).

[4] T. Kikuchi *et al.*, Eur.Phys.J. A **3**, 213 (1998).

[5] B. Davids *et al.*, Phys.Rev.C **63**, 065806 (2001).