Does Break-Up Affect ^{9}Be+^{209}Bi Fusion Around the Coulomb Barrier?

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The barrier distributions of the ^{9}Be+^{209}Bi system have been studied in the energy range 36 to 50 MeV. These distributions were extracted from the precision fusion cross section data, described in the 1997 annual report, and from the elastic scattering data which had been collected in the same run since the 8k ADC's allowed an energy range up to 100 MeV.

The main goal of this study was to search for possible break–up (BU) effects of the loosely bound ^{9}Be nucleus (S_n = 1.67 MeV) in these distributions; a priori one expects a first BU step leading to ^{8}Be+n followed by a second one when the unbound ^{8}Be nucleus splits in two α–particles.

The barrier distributions from the fusion cross sections were calculated applying the usual formulas:

$$D(E) = \frac{1}{\pi R^2}\frac{d^2(E\sigma)}{dE^2}$$

while for the elastic scattering the formula adopted was

$$D^{el}(E) = \frac{1}{\pi R^2}\left(\frac{d\sigma^{el}(E)}{d\sigma_R(E)}\right)^{1/2}$$

which is valid for very backward scattering angles, in principle 180°.

The detectors were located at 150° and 135° with angular acceptances between ±9° and ±7° in order to optimize the fusion cross section determination (i.e. large solid angles for good statistics in the case of small cross sections) therefore some caution has to be adopted before using the formula in the present case. However a recent work [1] has demonstrated that useful data could be obtained from detectors located between 156° and 164° over an 8° range; moreover the 135° data show very clear absorption and a trend very similar to the 150° ones as shown in the figure. The extracted barrier distributions are presented in the same figure together with the theoretical predictions. For the fusion data the calculations were done within the Dasso Vitturi approach [2] with one break–up channel with moderate strength and a potential adjusted in order to reproduce the well studied system ^{16}O+^{208}Pb [3] for which no BU effects are expected. For the scattering case the calculations were done with the code PTOLEMY over the same angular range of the data; the potential adopted had a Woods–Saxon shape with parameters deduced from an elastic scattering run that is not yet fully analyzed. The data show only one barrier which is narrower for the fusion than for the scattering. It is not clear whether this difference should be assigned to the fact that the scattering data can be influenced from both BU mechanisms mentioned above, while the fusion can only be affected by the first one since only the evaporation residues of ^{8,9}Be fusion were detected, or is simply inherent to the technique itself. Further experiments on all these topics are planned.

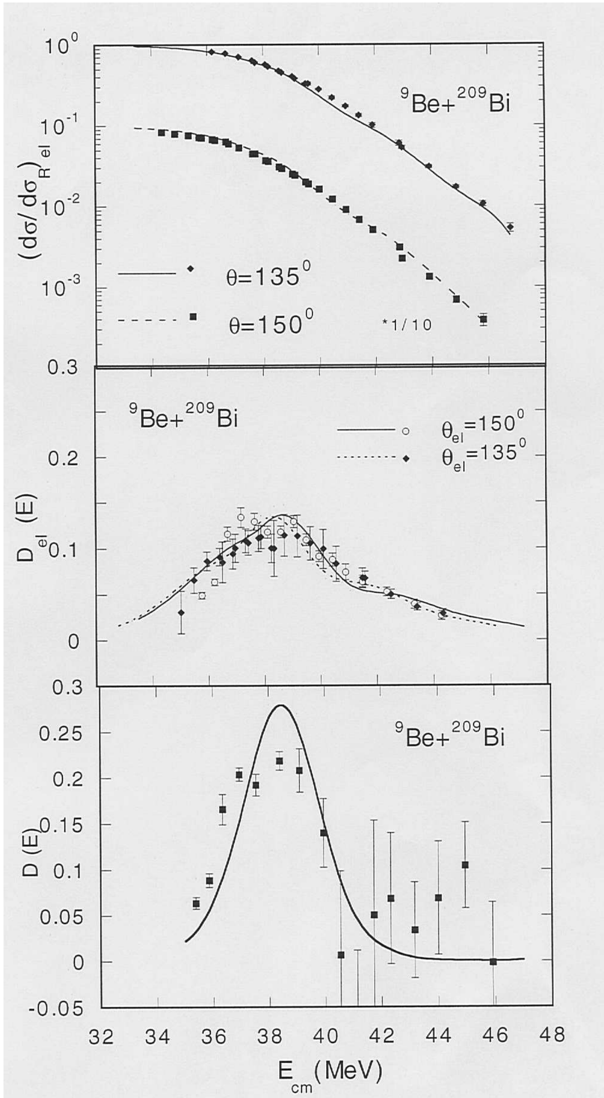

Fig. 1: Elastic scattering excitation functions (top), barrier distributions from these data (medium) and from fusion excitation functions (bottom).

References

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[3] C.R. Morton *et al.*, Phys.Rev. **C52** (1995) 243