# Transfer reactions using a low-energy $^{11}$Be beam

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The bound states of $^{10}$Be and $^{12}$Be have been studied through transfer reactions using a low-energy $^{11}$Be incident on a deuteron target. Scattering of $^{11}$Be on deuterons has been observed as well, and the effect of the halo structure of $^{11}$Be has been studied both for (d,d) and (p,p).

Beryllium isotopes close to $^{11}$Be have been studied intensively both theoretically and experimentally. The inversion of states has been identified in $^{11}$Be and $^{12}$Be leading to the breaking of the $N = 8$ magic number in $^{12}$Be. The experimental approaches have so far been limited to high energy reactions. The first results from a low-energy study of $^{12}$Be, including spectroscopic factors for the bound states, were published in 2009 [1]. On the theoretical site the structure of $^{12}$Be has been studied in several different approaches. One of them [2] describes $^{12}$Be as a three particle cluster of $^{10}$Be and two neutrons. The model describes the bound states in $^{12}$Be as single particle excitations of the two neutrons.

Two experiments were performed at the REX-ISOLDE facility at CERN, first in 2005 and again in october 2009. ISOLDE is the ISOL facility with the largest range of beams, and with the REX post accelerator it is possible to produce bunches of exotic nuclei with kinetic energy up to 3 MeV per nucleon. The experiment in 2005 was a short run designed to gain information about possible reaction channels, and two double sided silicon strip detectors were used for particle detection. The resolution was too low to seperate levels with small seperation energy and the setup was improved for the 2009 experiment where germanium detectors (the MINIBALL array) were used to detect gamma decays. Cross sections have been determined from the 2005 data and are compared to optical model calculations in order to determine spectroscopic factors. The results from the 2005 experiement will be presented along with preliminary results from the 2009 experiment.

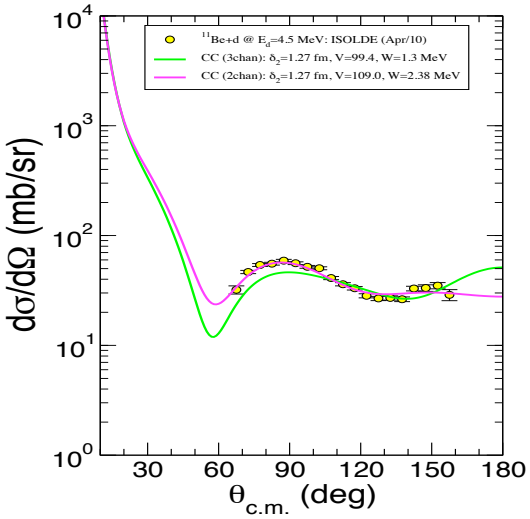


Figure 1: *Experimentally determined cross section for $^{11}$Be(d,d)$^{11}$Be (dots) compared to two coupled channel calculations. The coupled channels are calculated using a modified optical potential from $^{11}$B.*

* On behalf of the IS430 collaboration.

[1] R. Kanungo *et al.*, Phys. Lett. **B 682**, 391-395 (2010).

[2] C. Romero-Redondo *et al.*, Phys. Rev. **C 77**, 054313 (2008).