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α-clustering in the ground states of neutron-rich beryllium isotopes

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α-clustering is well established in light nuclei, both experimentally and in theoretical models such as Anti-Symmetrised Molecular Dynamics. For example 8Be has been well described as two α-particles. These models also predict the possibility of ground state clustering in the neutron-rich beryllium isotopes, however there is a lack of experimental evidence to support this due to the technical challenge of examining clustering in the ground state. α-clustering has generally been examined by measuring cluster breakup from excited states above the cluster decay threshold; this method cannot therefore be used for the ground state.

To investigate the ground state, the XBe(p, pα) reaction was used in quasi-free kinematics. Quasi-free kinematics is an established technique for examining single particle states via nucleon-knockout. In quasi-free kinematics the centre of mass energy is sufficiently high (200-1000 MeV/nucleon) that the nucleon-nucleon cross-section is minimal, this means that only the knocked out particle participates in the reaction, and the recoil fragment remains un-excited. As a CH2 target was used, the target proton will recoil significantly and can be detected along with the knocked out α particle. Events can then be selected with an azimuthal separation of roughly 180 degrees between the proton and the α particle. By conversation of momentum, this selection ensures that neither particle was excited by the reaction. By this method clustering in the ground state can be examined.

The result of the investigation will be a comparison between the cross-sections and hopefully angular distributions of α particle knockout, compared to single nucleon knockout. Because neutrons become important in stabilising the clustered system, the relationship between clustering and neutron number will also be investigated.

The analysis is currently at the stage of refining the reaction channel. The incoming detectors can be used to isolate the desired isotope of beryllium. The double sided silicon strip detectors are mostly calibrated. These can be used to identify and measure the recoiling proton and α particle. The crystal ball is being investigated as a means of improving identification and measurement of these particles. This is of greater importance, since some of the silicon detectors are not operational.

The analysis is on-going.

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