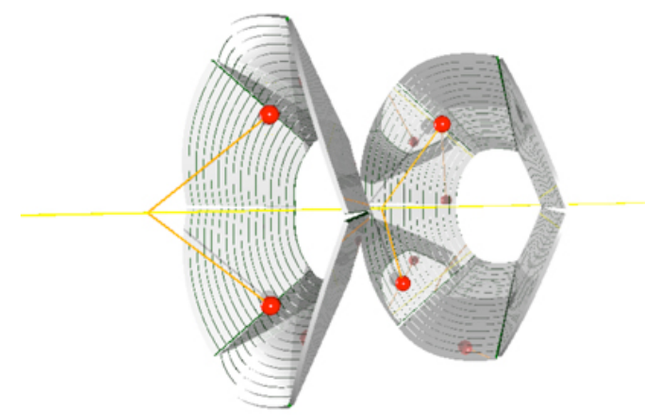
Resonant Scattering of ^{10}Be on ^{4}He

The structure of the beryllium isotopes is rather unusual, but highlights the spectrum of possible structural characteristics of light nuclei. The nucleus ^{8}Be is well-known to posses a structure which can be described in terms of two alpha-particle clusters. From an experimental perspective the ground state rotational band may be described by a moment of inertia commensurate with two touching alpha-particles. The addition of neutrons to the ^{8}Be nucleus to form isotopes such as ^{9,10}Be produces some rather interesting characteristics. Rather than destroying the symmetries responsible for the clustering in ^{8}Be, the two alpha-particle cluster structure remains and the valence neutrons are exchanged between the two alpha-particle cores in a covalent, molecular, manner. The orbitals of the neutrons have either σ or π character, just as electrons exchanged in atomic molecules. The nature of the bonds depends on the orientation of the p-orbitals which are occupied by the neutrons at each alpha-particle centre.

When the orbitals are aligned perpendicular to the separation axis then π-bonding results, whereas if the alignment is parallel the bonding is of σ-character. In the ground-state of ^{10}Be the two neutrons, asymptotically, have π-behaviour. Such systems are nuclear dimers. The question then arises as to if it is possible to form trimers, i.e. three-alpha-particles and valance neutrons. From a theoretical perspective the answer appears to be yes though the precise geometric arrangement of the alpha-particles is unclear (linear or triangular). Data taken by the collaboration led by researchers from the University of Birmingham (UK) are currently being analyzed and will hopefully shed light on the origin of nuclear clustering.



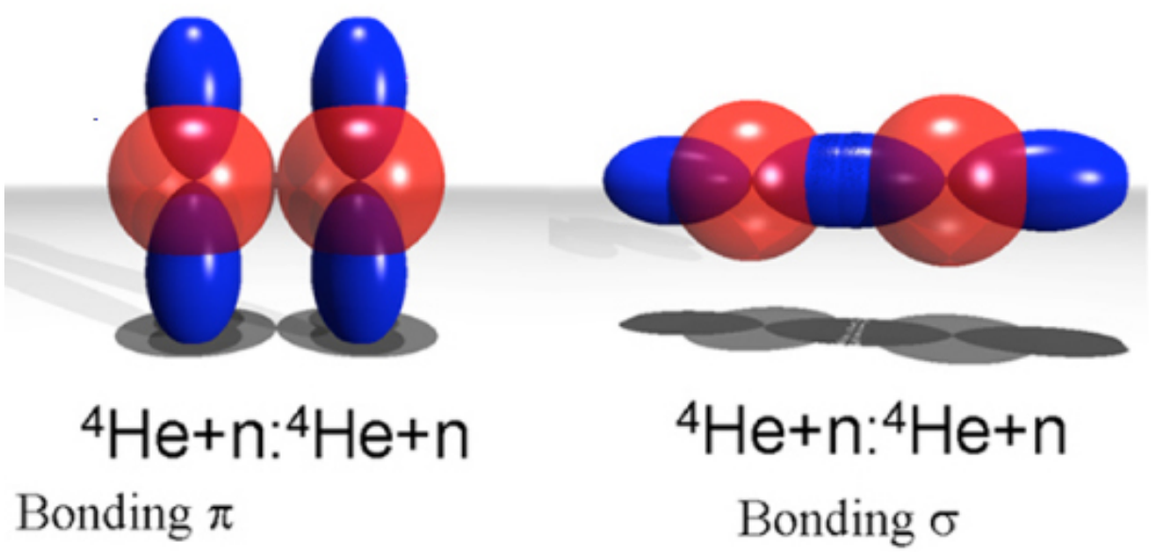


Fig. 1 - Images depicting two bonding configurations of ^{10}Be. Blue represents neutrons and red represents ^{4}He (alpha particles) clusters.

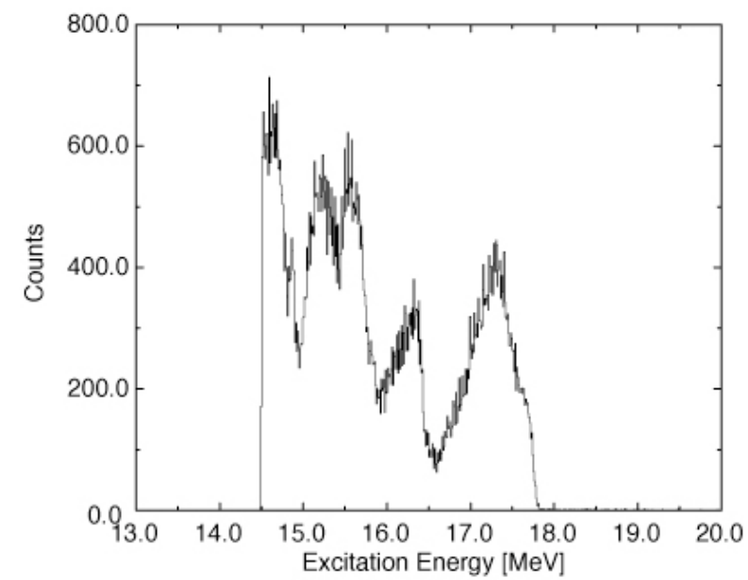


Fig. 2 - (Top) Detector configuration illustrating the detection of ^{10}Be and alpha particles. (Bottom) Energy spectrum of ^{14}C populated in the ^{4}He+^{10}Be resonant scattering at 25 MeV.