Observation of enhanced monopole strength and clustering in ^{12}Be

Supported by the National Natural Science Foundation of China, Prof. Ye Yanlin and his team from Peking University reported their recent research results in an article "Observation of enhanced monopole strength and clustering in ^{12}Be" in *Physical Review Letters* (2014, 112: 162501).

Clustering is an intriguing phenomenon appearing in many systems, including nuclide, and has fundamental importance in structure studies at all levels. So far the cluster structure has been experimentally identified in several states in stable nuclei, but the observation in unstable nuclei is still very scarce and often under disputing. A clear finding of a cluster state in a nucleus is very challenging, since it requires experimental determination of the excitation energy and spin systematics associated with a rotational band, the cluster decay partial width and, more convincingly, the characteristic transition strength, such as monopole strength.

An inelastic excitation and decay experiment for unstable ^{12}Be at 29 MeV/nucleon was performed at the HIRFL-RIBLL facility in Lanzhou, China. For the first time a remarkably large peak around 10.3 MeV with a spin-parity of 0^+ was identified, leading to an enhanced monopole matrix element of 7.0 +/− 1.0 fm^2 in the ^{4}He + ^{8}He decay channel. This resonant state possesses a large cluster-decay branching ratio, corresponding to a large dimensionless reduced width of 0.53(10). These results reveal a typical cluster state in ^{12}Be, in agreement with the GTCM prediction. The figure shows the determination of the spin of the 10.3 MeV resonance (a), and the extraction of the monopole matrix element from a DWBA calculation which fits the experimental data (b). The application of a zero degree telescope was essential in this experiment, which focused on the detection of the near-threshold resonances. It would be desirable to further apply this technique to investigate the strong monopole transition related to cluster formation in unstable nuclei.

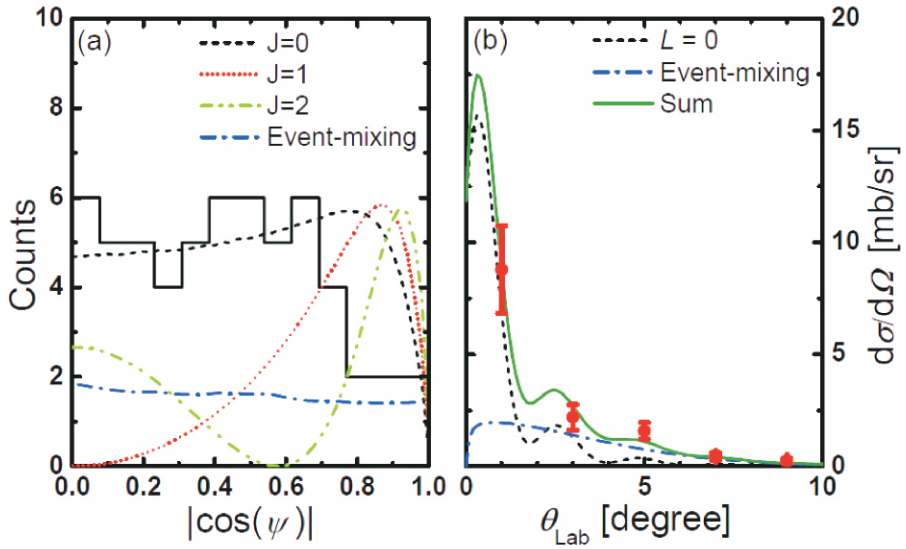

Figure (a) Fragment correlation spectrum reconstructed from the ^{4}He+^{8}He decay channel of the 10.3 MeV resonance in ^{12}Be, in comparison to the calculations with various spin components plus the even-mixing background. (b) Differential cross sections of the inelastic scattering (10.3 MeV excitation) of ^{12}Be from a carbon target, fitted by a DWBA calculation together with a background distribution.