The clusterization of alpha-conjugate nuclei

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We reported in several previous years on a study probing the clusterization of alpha conjugate nuclei [1,2]. As noted, data was taken with NIMROD on a number of systems that are composed of alpha conjugate nuclei. Two experiments were performed, one with a Ca beam at 35, 25 and 10 MeV/u and the other with at Si beam at 35 and 15 MeV/u. Data were collected with each of the beams using Ca, Si, C and Ta targets. The previous reports focused on the analysis of the 35 MeV/u Ca + Ca system.

We have extended the study by progressing in the analysis of the 35 MeV/u Ca + C, Ca + C, Ca + Ta, Si + C, Si + Si, Si + Ta systems. This extension of the analysis allows a systematic comparison of the breakup of alpha-conjugate nuclei for different projectile/target comparisons. In all of these systems, we observe a strong propensity of the system to break up into nuclei that are alpha-like in nature. We also observe a strong enhancement of emission from a defined neck-like region in the systems where the target is an alpha-conjugate nucleus. This enhancement is absent in the systems with the Ta target.

Fig. 1 shows how the various systems have a significant probability to break up into

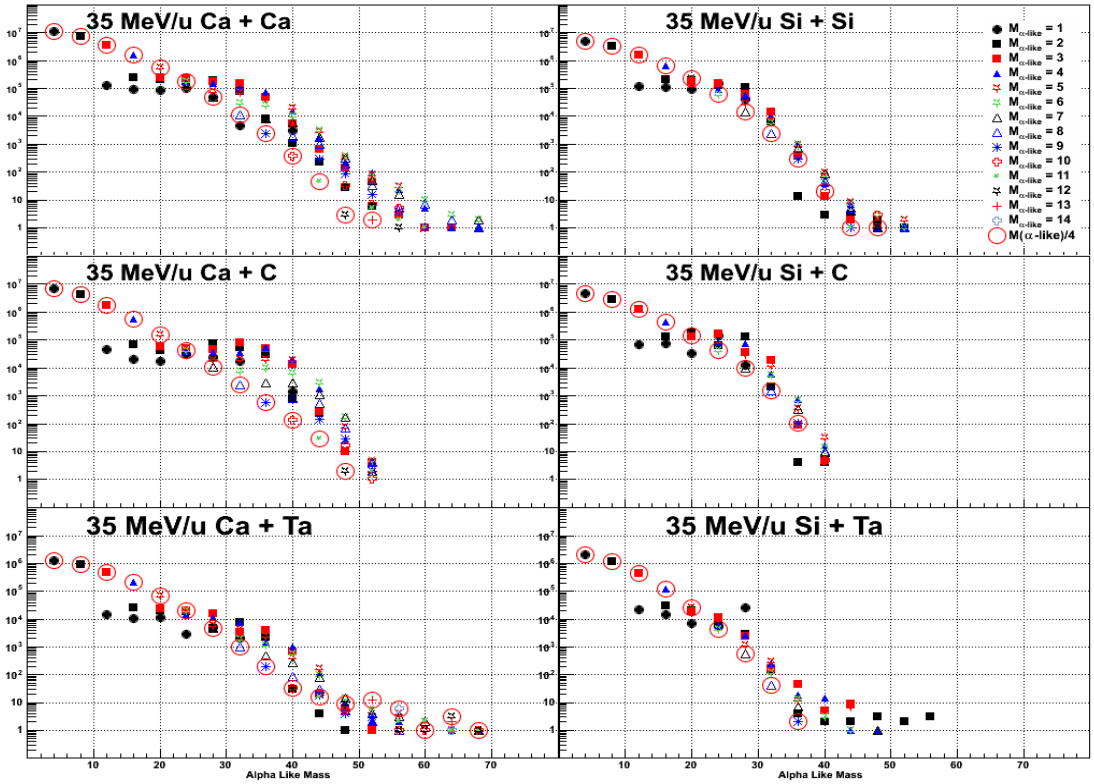

FIG. 1. Probability distributions of various breakup channels for the different systems studied. The x axis shows the alpha like mass and the y axis shows the probability of the breakup into different channels as depicted by the various symbols. The open circles indicate the probability the total alpha like mass being contained in alpha particles.

predominantly alpha like masses. The x axis shows the value of the total mass contained in alpha like nuclei (alpha-like-mass) and the y axis shows the probability of the various decay channels into alpha like nuclei. The open circles indicate the probability that all of the alpha like mass is contained in alpha particles. We see on all of these plots that there is a significant probability of breakup of a large fraction of the complete system into alpha like mass. We note that this occurs on all of the studied systems.

In Ref. [1], we showed a strong neck like origin of the alpha particles as well as fragments having an alpha like mass. Fig. 2 shows invariant velocity plots of the products that originate from events selected to have a total detected alpha-like mass of 40. We show the emission patterns for the various

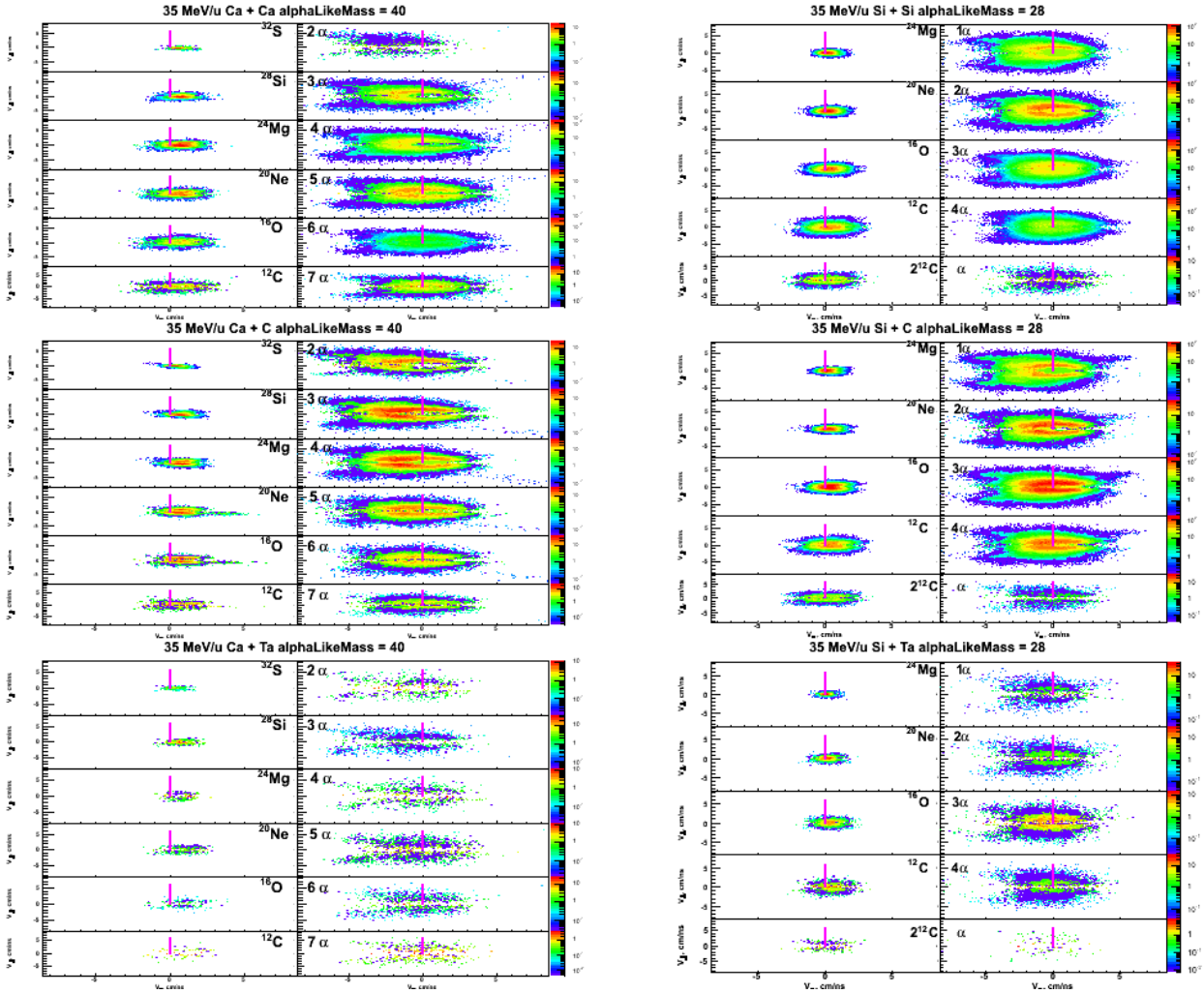

FIG. 2. Invariant velocity distributions of products resulting from the various decays channels of a decaying source reconstructed in events having a detected alpha like mass of 40 for the Ca beams and 28 for the Si beams. The vertical lines indicate vz=0, the frame of the reconstructed source.

decay channels that lead to an alpha-like mass of 40 for all of the systems that were studied. The left side of the frame of each system shows the velocity distributions of the heavier alpha like fragments and the right side shows the velocity distributions of the alpha particles associated with those heavier fragments. The vertical lines indicate the location vz=0 which is the frame of the reconstructed decaying system. This distribution shows that the neck like origin of the alpha particles is present in the reactions where the

complete system is composed of alpha-like nuclei. We note that the majority of the alpha-particles are at velocities less than that of the emitting source in the defined neck region. It is also shown that the heavy partner is found at a velocity larger than that of the reconstructed source.

We note, however, that the alpha-like heavier fragments and the alpha-particles themselves do not exhibit such behavior in the reactions with the Ta target for both the Ca and Si beams. The emission of fragments and alpha particles are more or less symmetric around the velocity of the reconstructed source suggesting different dynamics when the nucleus is not an alpha conjugate nucleus.

Since the data from these systems are calibrated, we are now in a position extract systematics from the various projectile/target combinations and expect to make significant progress on the analysis in the coming months. We have the, Ca+Si and Si+Ca systems where the calibrations are in the early stages. The calibrations of the data at 25 and 10 MeV/u for both beams are also in the initial stages. We hope to make progress on these calibrations in the coming year.

[1] K. Schmidt *et al., Progress in Research*, Cyclotron Institute, Texas A&M University (2012-2013), p. II-20.

[2] K. Schmidt *et al., Progress in Research*, Cyclotron Institute, Texas A&M University (2011-2012), p. II-9.