CONFIRMATION OF A DOORWAY MECHANISM AS THE PRINCIPAL DECAY MODE IN THE HEAVY ION RADIATIVE CAPTURE REACTION ^{12}C(^{12}C,γ)^{24}Mg

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Little is known about radiative capture involving heavy ions, where the cross-sections are very small and competition from particle emission is overwhelming. The most extensively studied heavy-ion radiative capture reaction is ^{12}C(^{12}C,γ). Using a single large sodium iodide detector to detect high energy capture gamma rays to the ground state and low-lying excited states, Sandorfi *et al.* inferred the presence of several prominent resonances in this reaction in the energy range, $E_{c.m}$ = 5.0 - 11.0 MeV [1]. While these measurements showed that the capture cross-section was as large as 1 μb, they could not address the possibility of high-lying 'doorway' states being populated following capture, due to pile-up of low energy gamma rays in the NaI detector.

We have revisited the topic of heavy ion radiative capture, by searching for a doorway mechanism whereby the capture decay would favorably populate high-lying states with a larger structural overlap with the entry resonance. A plausible candidate for such doorway states might be the long-predicted 'shape-isomeric' band in ^{24}Mg, whose band-head should lie around 10 MeV. Measurements, using the FMA at ANL to detect fused ^{24}Mg residues, indicate that the ^{12}C(^{12}C,γ) cross-section at $E_{c.m}$=8.0 MeV is considerably larger (>3μb) than previously thought. In order to search for doorway states, the high-resolution of the Gammasphere array was exploited. In this experiment performed at LBNL, where a recoil separator was not available, selectivity for the capture channel was obtained by using the Gammasphere array as a sum energy calorimeter. Having separated decay cascades with the highest sum energies, corresponding to radiative capture, the cascades were unfolded into their component gamma-ray transitions. This procedure indicated that the K=2 and K=4 rotational bands as well as several states around 10 MeV in ^{24}Mg were selectively populated.

Very recently, three known resonances in the ^{12}C(^{12}C,γ) reaction at $E_{c.m}$=6.0, 6.7 and 8.0 MeV have been studied using the combination of the DRAGON recoil separator and BGO array at TRIUMF. Preliminary analysis of this data confirms that a doorway mechanism is the dominant decay mode at all of the resonance energies considered. Moreover, the same very close-lying set of states around 10 MeV in ^{24}Mg appears to be involved in each case. This implies a special character for the states in this region which must have a strong overlap with the entry ^{12}C+^{12}C resonance.

[1] A.M.Nathan, A.M.Sandorfi and T.J.Bowles, Phys. Rev. C **24**, 932 (1981)