

Beamtime proposals for the Pelletron beam cycle May-July 2024

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a) Consent of Local collaborator : N/A

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Title of Experiment: Investigation of breakup probabilities in $^{10}\text{B}+^{159}\text{Tb}$ system

Beam Time Requirement (in number of shift): 21 shifts (7 days)

Beam, Energy(MeV) & Current (pnA): ^{10}B beam, 40-60 MeV, 2 pnA

Beam port and Experimental setup: Hall 1, 30 D

If any hazardous or safety related material will be used in the experiment (eg Gas etc):

N/A

Motivation of Experiment:

The study of the reaction dynamics involving weakly bound nuclei, having low breakup thresholds has become one of the most intriguing and challenging problems in low energy nuclear physics [1,2]. The interest in understanding the influence of breakup on other reaction channels has indeed received a fillip in recent years, especially because of the recent advent of radioactive ion beam (RIB) facilities in different laboratories around the world. Some of the stable nuclei viz., ^6Li , ^9Be , ^{10}B have known cluster structures and also are weakly bound. These nuclei can be accelerated with higher intensities contrary to RIBs where the beam intensities are limited at present. Hence, foundation studies with these nuclei are necessary. With the upgradation in intensities of RIBs, more unstable isotopes of Lithium, beryllium or boron can be studied and compared with the stable ones.

There are now various inclusive and exclusive breakup studies [1-7] done with ^6Li , ^7Li and ^9Be having breakup thresholds 1.47, 2.47, 1.57 MeV respectively. ^{10}B having breakup threshold of 4.46 MeV and cluster structure of $^6\text{Li}+\alpha$ [8], is not well studied so far. Similarly, the possibility of cluster structure of $^8\text{Be}+d$ ($E_{\text{th}}=6.03$ MeV) and $^9\text{Be}+p$ ($E_{\text{th}}=6.59$ MeV) is also not well studied [9]. In the 2021 beam cycle, we had taken beamtime and measured inclusive and exclusive breakup cross sections using silicon strip detector telescope array covering a wide angular range from 20 – 160 deg for $^{10}\text{B}+^{209}\text{Bi}$, ^{197}Au , ^{159}Tb systems at 54 MeV. In the inclusive, we could get the elastic and light particles alpha (α) angular distributions. Preliminary analysis of exclusive data was also carried out indicating a strong

α - α correlation. Further detailed analysis and theoretical calculations are in progress. In continuation with this activity, we would like to do similar measurement with ^{159}Tb target for a wide energy range covering below to above barrier from which we would like to infer the energy dependence of these breakup observables.

References

1. L. F. Canto *et al.*, Phys. Rep. 596, 1 (2015)
2. N. Keeley *et al.*, Prog. Part. Nucl. Phys. 63, 396 (2009)
3. V. Jha, V. V. Parkar, S. Kailas, Phys. Rep. 845, 1 (2020)
4. S. Santra *et al.*, Phys. Rev. C 83, 034616 (2011)
5. S. K. Pandit *et al.*, Phys. Rev. C 93, 061602(R) (2016), Phys. Rev. C 100, 014618 (2019)
6. D. Chattopadhyay *et al.*, Phys. Rev. C 94, 061602(R) (2016), Phys. Rev. C 97, 051601(R) (2018), Phys. Rev. C 98, 014609 (2018)
7. A. Shrivastava *et al.*, Phys. Lett. B 633, 463 (2006)
8. A. N. Bice *et al.*, Phys. Lett. B 101, 27 (1981)
9. N. Curtis *et al.*, Phys. Rev. C 72, 044320 (2005)

Description of Experiment:

^{159}Tb targets of 1 mg/cm^2 thickness will be used in the experiment. Seven strip detector telescope array covering a range of 90 deg and few Si surface barrier detector telescopes will be used for detection of charged particles. Mesytec electronics and VME based data acquisition system will be used. We will be doing coincidence measurement to look for ^6Li - α and α - α -d and ^9Be -p events.

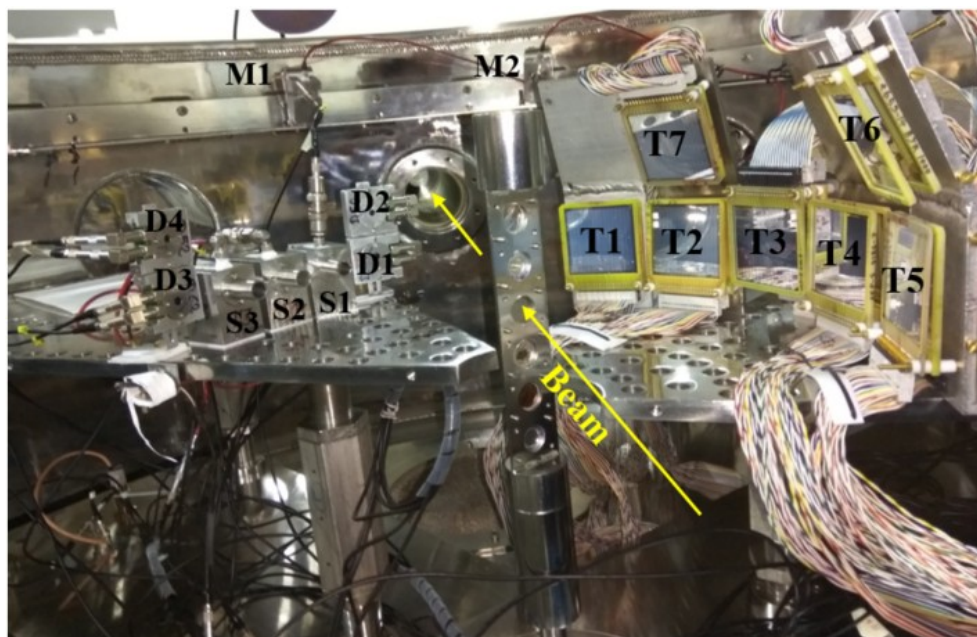


Figure 1 : Experimental Setup for inclusive and exclusive breakup study

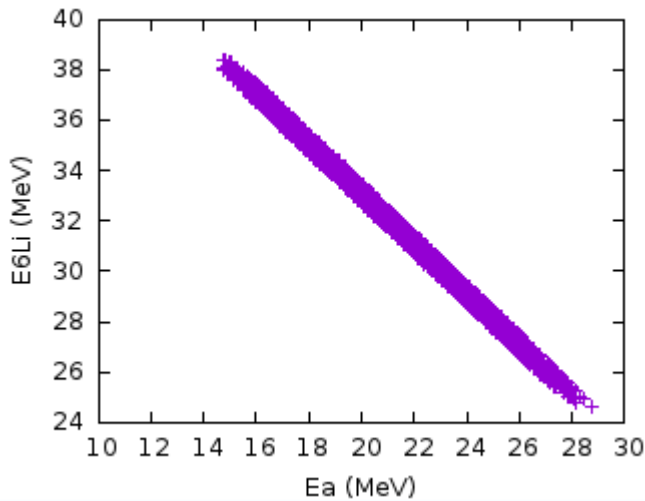


Figure 2: Simulated $E(^6\text{Li})$ vs. $E(^4\text{He})$ Correlation plot in $^{10}\text{B}+^{159}\text{Tb}$ reaction at $E_{\text{lab}} = 60$ MeV

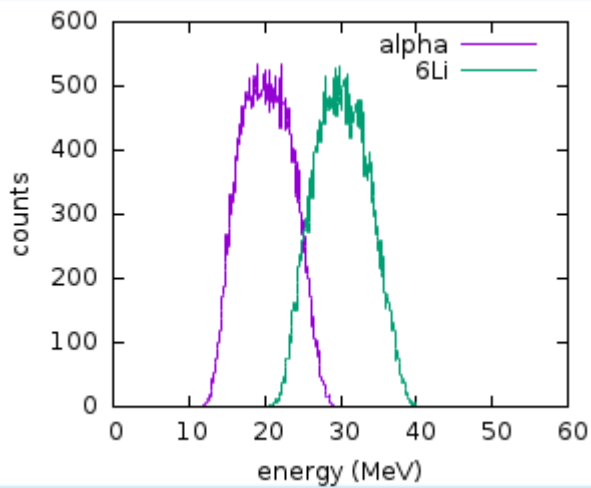


Figure 3: Simulated Energy regions of ^4He and ^6Li spectra in $^{10}\text{B}+^{159}\text{Tb}$ reaction at $E_{\text{lab}} = 60$ MeV

Count Rate estimation:

Typical exclusive breakup cross sections are in the range of 0.1-20 mb from below to above barrier energies, populating resonant states.

For ^{10}B beam 2 pA, ^{159}Tb Target 1 mg/cm² thick

$V_{\text{lab}} = 43.7$ MeV

$E_{\text{beam}} = 42, 45, 50, 55, 60$ MeV

Total: 21 shifts

- **Whether the experiment is part of PhD /Post Doc. work**
Yes
- **Details of Beam time availed of in recent past on this experiment and / or by the PI:** Yes in September 2021 on different targets at one energy 54 MeV

List of publication from previous experiments:

1. Elastic scattering and α production with ^{10}B projectile; **Prabhat Mishra** *et al.*,
Proc. of the DAE Symp. on Nucl. Phys. 67, 439 (2023)
2. Satbir Kaur *et al.* Proc. of the DAE Symp. on Nucl. Phys. 66, 383 (2022),
Proc. of the DAE Symp. on Nucl. Phys. 67, 385 (2023)
3. S. K. Pandit *et al.*, Phys. Rev. C 93, 061602(R) (2016), Phys. Rev. C 100, 014618 (2019)
4. Satbir Kaur *et al.* Nucl. Phy. A 1046, 122864 (2024)