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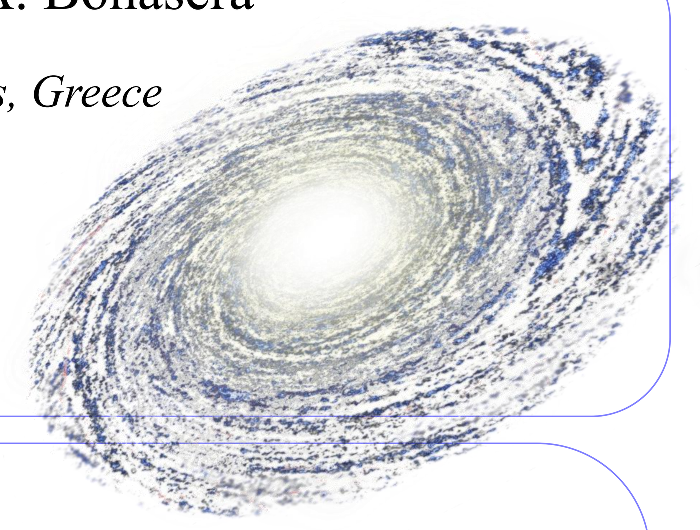
Multinucleon Transfer and Incomplete Fusion at 15 MeV/nucleon for the ^{86}Kr + ^{27}Al System

K. Gkatzogias [1], G.A. Souliotis [1], Ch. Giannitsa [1], S. Koulouris [1], A. Pakou [2], M. Veselsky [3], S.J. Yennello [4], A. Bonasera [4]

[1] *Laboratory of Physical Chemistry, Department of Chemistry, National and Kapodistrian University of Athens, 157 71, Athens, Greece*
[2] *Department of Physics, The University of Ioannina, 451 10, Ioannina, Greece*
[3] *Institute of Experimental and Applied Physics, Czech Technical University, Prague, 110 00, Czech Republic*
[4] *Cyclotron Institute, Texas A&M University, College Station, Texas, 77843, USA*

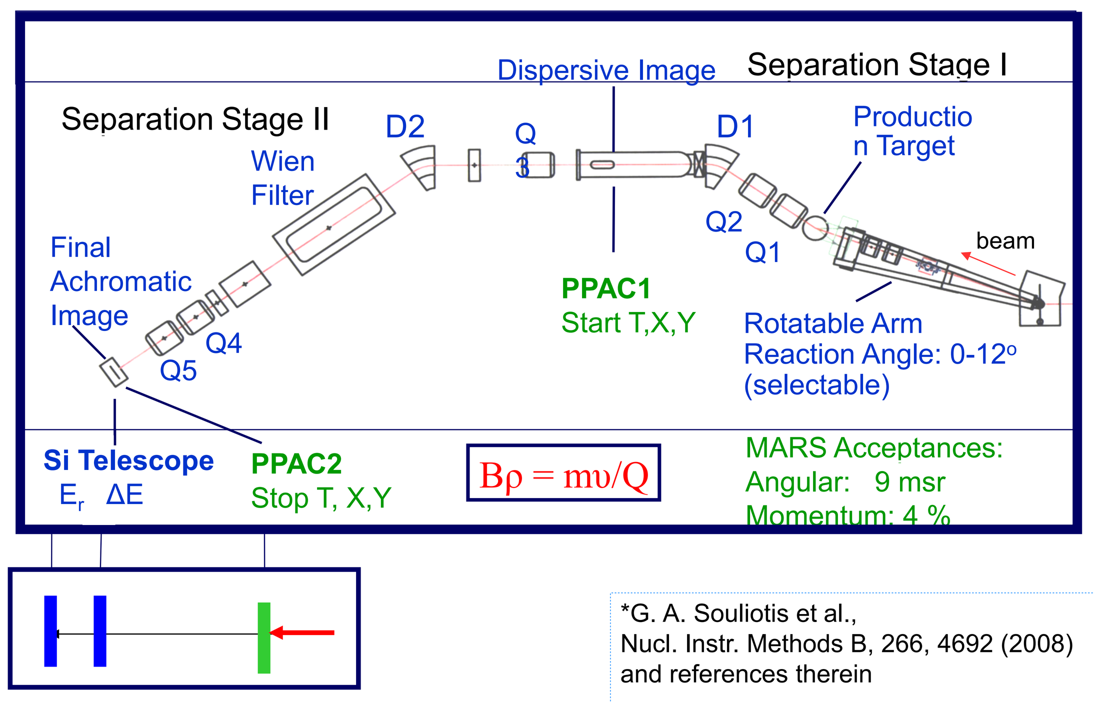
Presenting author email: gkakonst@chem.uoa.gr



Abstract

We present an investigation of the mass-asymmetric collision of a ^{86}Kr beam with a ^{27}Al target at an incident energy of 15 MeV/nucleon. The primary goal is to characterize the mass, angular, and momentum distributions of projectile-like fragments emerging from this reaction. The experimental data utilized here were acquired with the MARS spectrometer at the Texas A&M University Cyclotron Institute during earlier work by our group. These data are compared with theoretical predictions from two approaches: the phenomenological Deep-Inelastic Transfer (DIT) model, that describes the reaction dynamics, and the microscopic Constrained Molecular Dynamics (CoMD) model. In both cases, the statistical decay code GEMINI is employed to describe the de-excitation of primary fragments. A comparison between the measured observables and the model outcomes offers meaningful insight into the contributing reaction mechanisms. The DIT model successfully captures the multinucleon transfer (MNT) processes. The CoMD model, while also reproducing the MNT features, additionally accounts for an incomplete fusion component in this light target. It is worth noting that the MNT mechanism is responsible for generating neutron-rich nuclides in this mass region. We anticipate that the study of this mass-asymmetric system will enhance our understanding of heavy-ion reaction mechanisms below the Fermi energy regime (15–35 MeV/nucleon).

MARS Recoil Separator for Rare Isotope Studies: Cyclotron Institute, Texas A&M University*



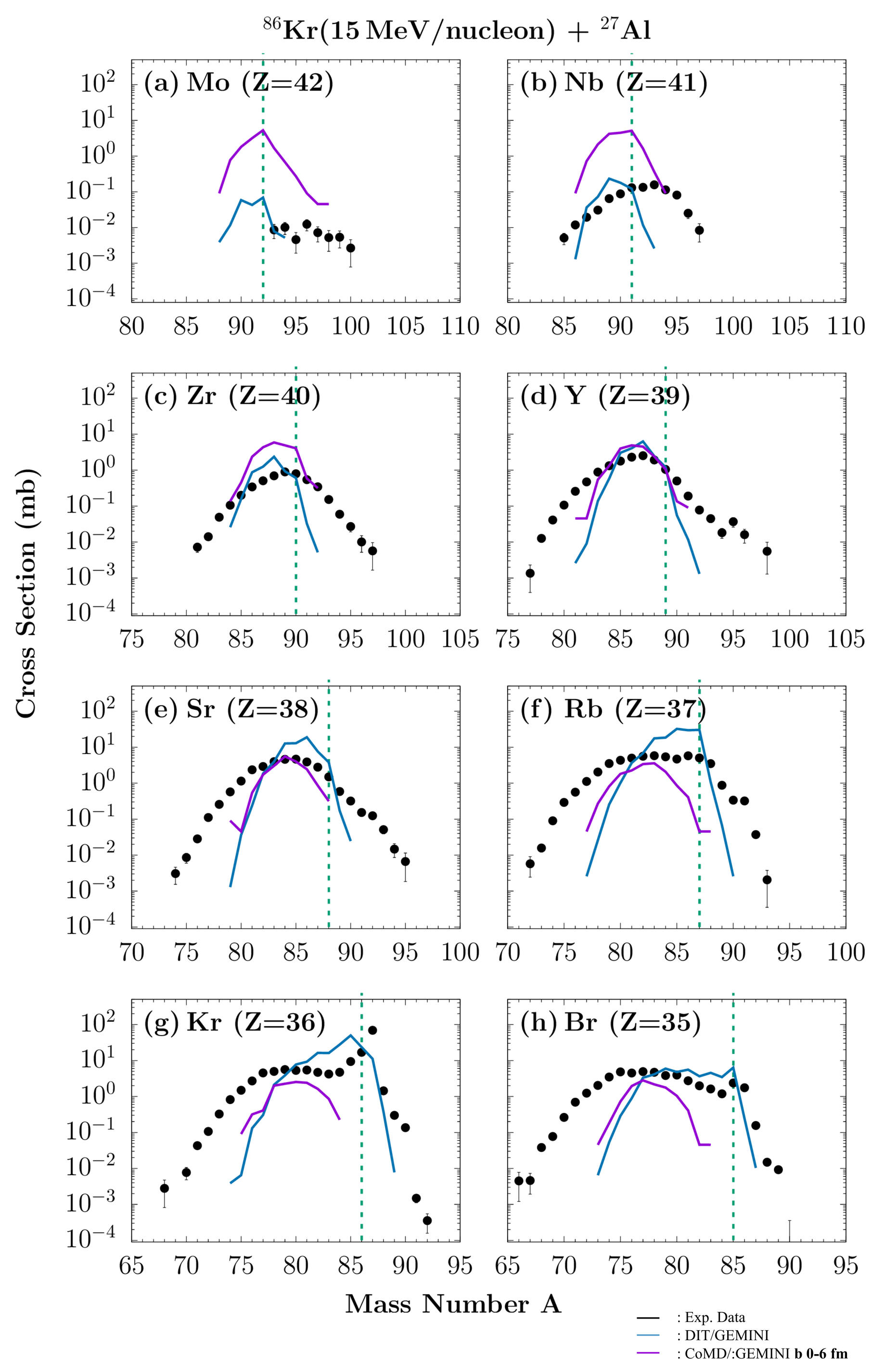
*G. A. Souliotis et al., Nucl. Instr. Methods B, 266, 4692 (2008) and references therein

Introduction

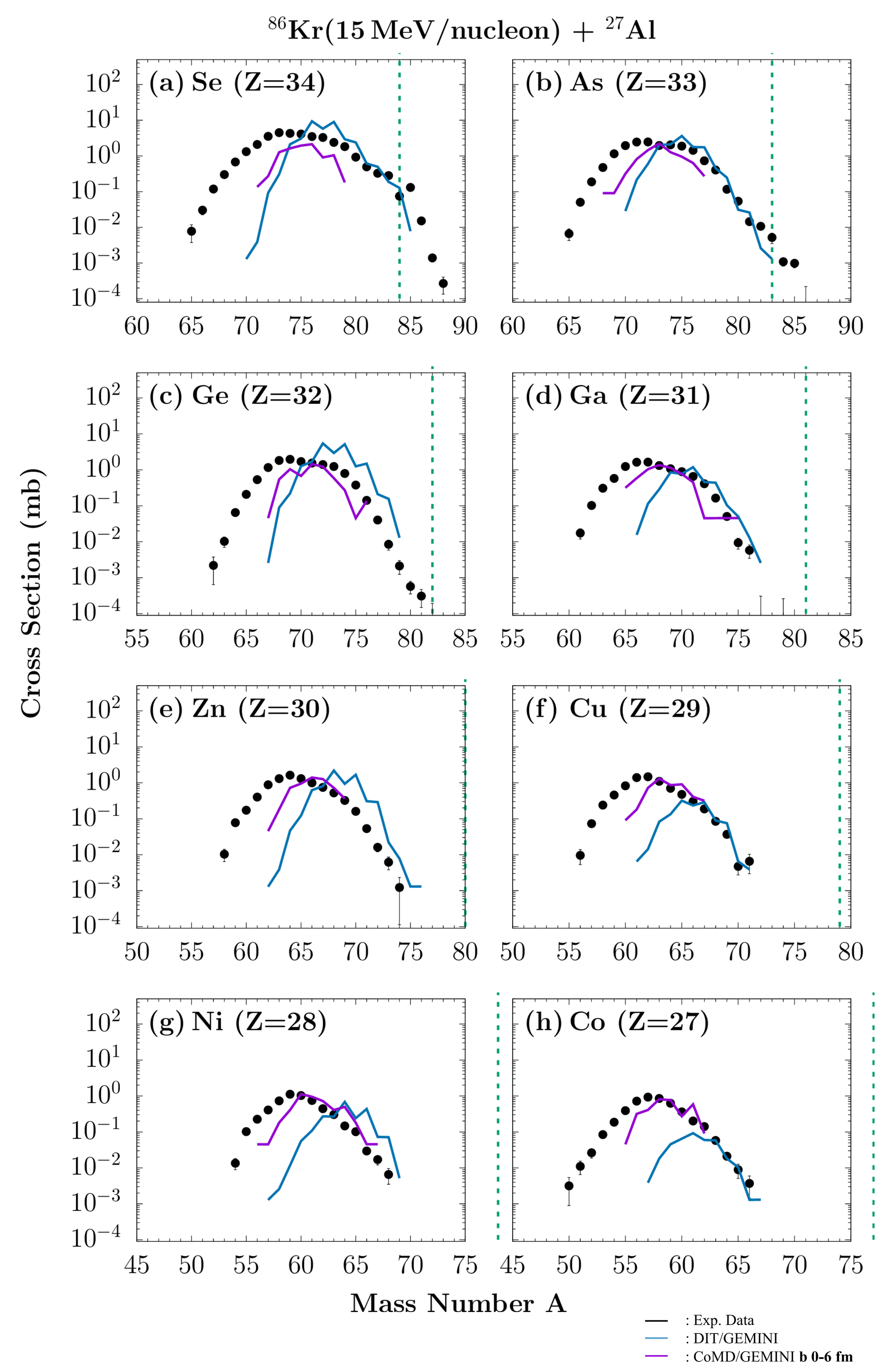
In this work we compare experimental data from the reaction ^{86}Kr and ^{27}Al at 15 Mev/nucleon [1] with theoretical calculations from DIT (GEMINI) [2] and CoMD (GEMINI) [3,4].

- The multinucleon transfer mechanism predominates during peripheral reactions leading to the production of neutron rich isotopes, related to the nucleosynthetic processes, such as the rapid neutron capture process (r-process), which is responsible for the production of approximately half of the atomic nuclei heavier than iron [5-9].
- Comparing the DIT and the CoMD models at the neutron deficient region we observe the inability of the DIT model to reproduce well the experimental data indicating the presence of incomplete fusion mechanism.
- We have separated the theoretical calculations of CoMD into two groups. The upper two figures show the results for central events (b:0-6 fm) where incomplete fusion predominates, while the lower two figures show the results for more peripheral events (b:6-12 fm), where MNT predominates.

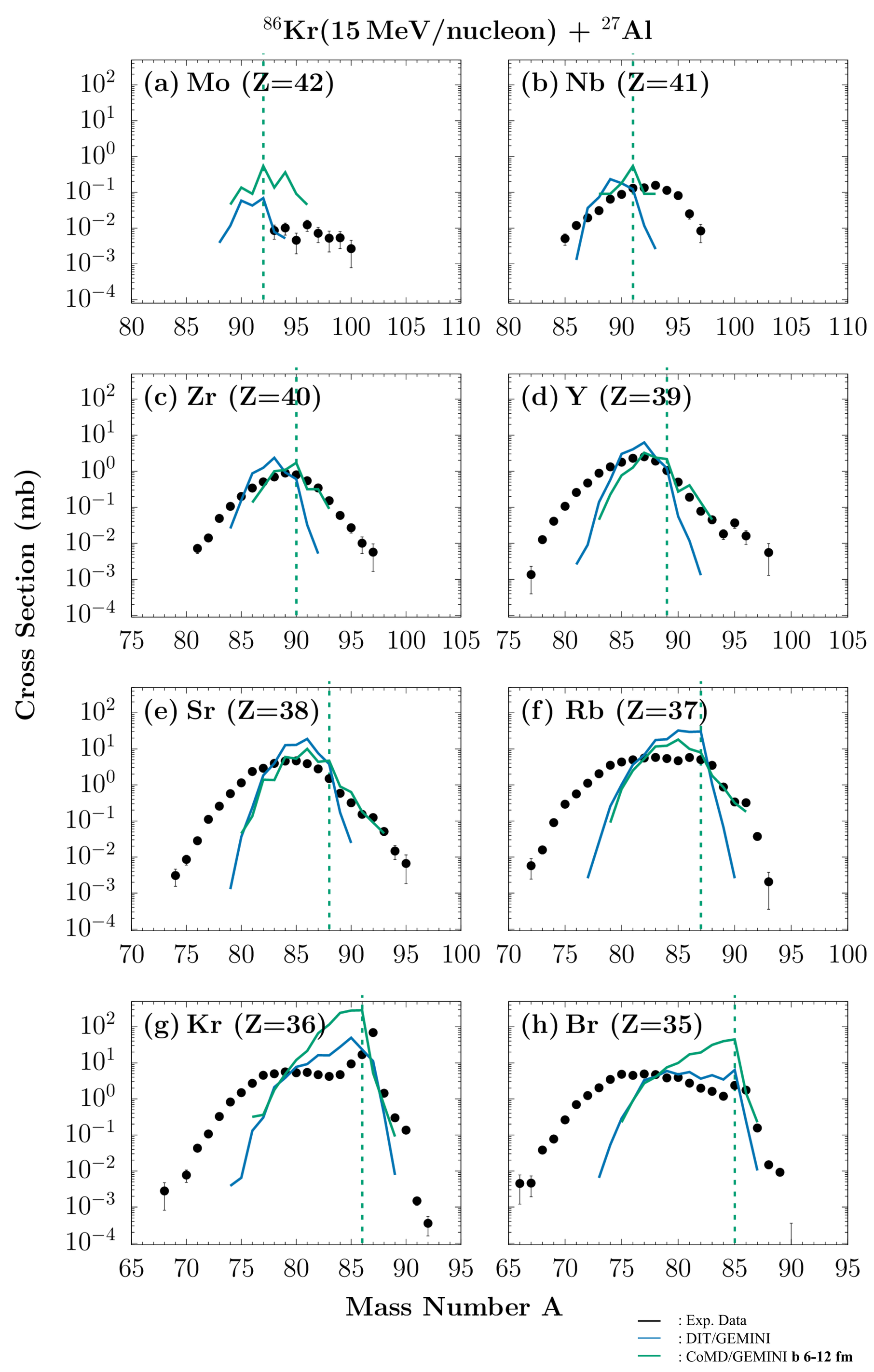
Mass Distributions Z=42 to Z=35



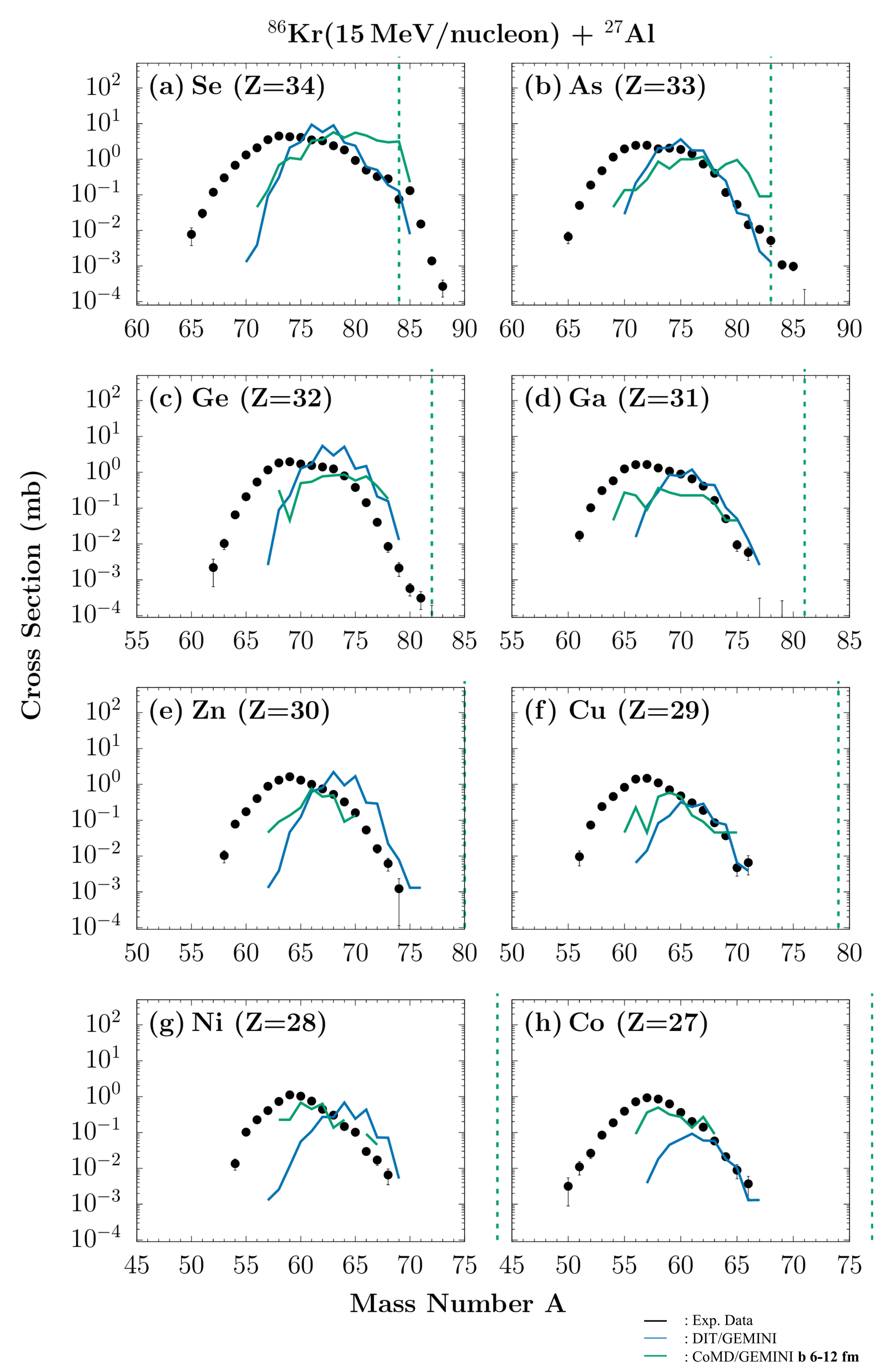
Mass Distributions Z=34 to Z=27



Mass Distributions Z=42 to Z=35



Mass Distributions Z=34 to Z=27



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Future Work

- Increase of our statistics.
- Study the angular, momentum and excitation energy distributions of various channels of this reaction.