IV Workshop Internacional IEA sobre “the structure and reactions of exotic nuclei.”

A estrutura e as reações de Núcleos Não Convencionais

Neste Workshop Internacional pretende-se reunir especialistas de renome no IEA para discutir os avanços recentes na fisica de núcleos ricos em nêutrons e prótons e analisar o papel destes sistemas fracamente ligados no processo de nucleossintese que envolve a captura lenta de nêutrons (slow nêutron capture, processo-s). A pesquisa mundial nesta área de física nuclear e’ intensa e ha inúmeros centros dedicados a ela. Ha também planos para construir novos centros de grande porte como o FRIB nos EUA, FAIR na Alemanha, e outros. Nestes centros pretende-se ampliar a capacidade de produzir tais núcleos instáveis para estudá-los através das suas reações com núcleos estáveis em energias que variam de baixos valores, próximas das barreiras Coulombianas, onde efeito de túnel e’ dominante, ate altos valores. O Workshop e’ organizado pelo “Grupo de Astrofísica Não Convencional” do IEA.

Mahir Hussein

Towards a more complete description deuteron-induced reactions

Deuteron-induced reactions are being used to produce medical radioisotopes [1] and as surrogates to other reactions (see review [2] and references therein), among recent applications. Although they have been studied for decades [3-6], their complexity continues to make their theoretical description challenging. The direct reaction mechanism is a major contributor to the reaction cross section due to the low binding energy of the deuteron. Competition between elastic breakup, absorption of only a neutron or a proton (stripping and inelastic breakup) and absorption of the deuteron must be taken into account to determine the formation

or not of a compound nucleus and its subsequent decay. The inelastic breakup reactions – those in which either only a neutron or a proton is absorbed – are particularly complex, as they form compound nuclei with a wide range of excitation energies and angular momenta. We present the results of a theoretical study of elastic and inelastic deuteron breakup for a large selection of targets at incident deuteron energies below 100 MeV. We use the zero-range post-form DWBA approximation to calculate the elastic breakup cross section [3,4] and its extension to absorption channels to calculate the inelastic breakup cross sections [5,6]. We look in detail at the extent to which our DWBA is capable of describing the inclusive breakup cross sections. We also discuss the regularities and ambiguities in our results, as well as the irregularities in the inelastic breakup energy and angular momentum distributions that complicate their substitution by a smooth distribution obtained from systematics.

References

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[5] A. Kasano and M. Ichimura, Phys. Lett. B115, 81 (1982).

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Brett V. Carlson

The neutron within the deuteron and neutron-induced reactions

Neutron induced reactions are of great relevance for nuclear astrophysics (I.e., r-processes), advanced fuel cycles, stockpile stewardship, and applications of nuclear science. However, it is quite difficult to perform direct measurements of neutron capture by nuclei. Moreover, theoretical models, mostly based on statistical theories often have difficulties reproducing experimental data. An alternative to direct experiments with free neutrons is the use of deuterons as a surrogate to induce neutron capture on a target. In this talk I will discuss benchmark calculations of (d,p) reactions and in particular I will discuss the reactions on 135Xe which has a neutron capture cross section of 6 million barns.

Carlos Bertulani

Study of the elastic breakup of weakly bound Lithium isotopes at near barrier energies

We have performed CDCC calculations for collisions of ^{6,7}Li projectiles on ^{59}Co, ^{144}Sm and ^{208}Pb targets at near-barrier energies, to assess the relative importance of the Coulomb and the nuclear couplings in the breakup of the two lithium isotopes, as well as the Coulomb-nuclear interference. We have also investigated scaling laws, expressing the dependence of the cross sections on the charge and the mass of the target. We explore the similarities and differences between the results for the two Lithium isotopes, both described as two-cluster nuclei, alpha plus deuteron or tritium. The relevance of the Coulomb dipole and quadrupole strengths at low energy for the two-cluster projectile is investigated in details.

Paulo R. S. Gomes

Microscopic description of elastic scattering with light exotic nuclei

The traditional CDCC method is extended to a microscopic variant, where the projectile is described by a many-body structure. This means that only neutron- and proton-target potentials are needed. The formalism has been first applied to the simple two-cluster 7Li projectile, and is now extended to three-cluster nuclei, such as 6He and 8B. The model provides an opportunity to investigate halo and breakup effects. Recent results, as well as future developments are presented.

Pierre Descouvemont

Studies of exotic nuclei and explosive stellar burning with fast RI beams at RIKEN RIBF

RIKEN RI Beam Factory (RIBF) is a new-generation facility for radioactive isotope (RI) beams based on the projectile-fragmentation and uranium in-flight fission as production using 345 MeV/nucleon heavy-ion primary beams. RIBF started its regular operation in 2007, and has provided beams of various nuclei very far from the stability valley with world highest intensities. Recent highlights of studies of nuclear structure and astrophysics will be presented. Hot topics include properties of light unbound nuclei, evolution of nuclear shell structure, and nuclear inputs to studies of r-process nucleosynthesis.

Tohru Motobayashi

The dipole response of exotic nuclei and the nuclear symmetry energy

Large efforts have been undertaken in the past years in order to develop the experimental tools for an investigation of giant resonances in unstable nuclei. Data are still scarce, but promising results have emerged, in particular concerning the dipole response of short-lived nuclei. The interest in studying the multipole response of exotic nuclei is on one hand the nuclear structure aspect concerned with the collective response of neutron-proton asymmetric nuclei, where a change is expected towards a softer response, including possibly new modes of excitation related to the excess nucleons and weak binding. On the other hand, the giant resonances, or the multipole response of heavy nuclei in general, can be related to nuclear matter properties. Measurements for neutron-proton asymmetric nuclei will be able to constrain parameters of the equation of state for asymmetric nuclear matter, as the giant monopole resonance energy for the incompressibility, and the dipole polarizability for the density dependence of the symmetry energy. I will discuss some recent experimental results and developments from the R3B experiment.

Thomas Aumann (TU Darmstadt)