GSI Helmholtzzentrum für Schwerionenforschung GmbH
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2nd Workshop on Inelastic Reaction Isotope Separator for Heavy Elements

IRiS HEAVY ELEMENTS

General Info

• Workshop Goal

The unique opportunity exists to build a new separator dedicated to the isolation of heavy element isotopes produced in multi-nucleon transfer reaction. This device, named **IRiS** (**I**nelastic **R**eaction **i**sotope **S**eparator for Heavy Elements), will be set up at the GSI in Darmstadt in a collaborative effort headed by the Institut für Kernchemie at the Johannes Gutenberg-University Mainz, the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt, and the Helmholtz Institute Mainz.

During the first IRiS Workshop held earlier this year, an international collaboration was established, which pursues the IRiS construction. Two promising separator designs were discussed and are currently being considered in more detail: a solenoid-based design and one based on a combination of a dipole and magnetic multipoles. The next step approaching the design of IRiS was divided into the following modules: *solenoid-based design, Quadrupoles(multipoles)+Dipols (QD) design, detection system, products collection, and reaction properties.* For every module a working group was established.

• Scope

The main focus of the IRiS Fall 2010 Workshop is:

- Status reports from the working groups.
- To discuss the optimal design solution of IRiS. A desired outcome of this discussion will be the choice "Solenoid design" vs. "QD design".
- Related technical and scientific questions.

• Scientific Background

The question of the possible production of very heavy elements in nuclear transfer reactions was carefully studied in the 1970's and 1980's. Numerous neutron-rich isotopes of transuranium elements were synthesized, but the search for superheavy elements produced in such reactions has reached the limits of contemporary detection capabilities. Therefore, these studies were almost completely abandoned and for the following 30 years, the focus was shifted to nuclear fusion reactions. During this time novel, highly efficient techniques were introduced, which allowed for the detection of a large number of new isotopes synthesized in fusion reactions. Among others, advances in detection techniques lead us to reconsidering the potential of multi-nucleon transfer reactions once again.

Theoretical calculations published in last years predict favorable cross sections for multi-nucleon transfer reactions, opening the possibility to study yet unknown isotopes of very-neutron-rich transuranium isotopes. These new isotopes can be produced exclusively in transfer reactions. Study of neutron-rich transuranium isotopes will bring new insight into:

- r-process systematics
- Spontaneous fission systematics and the influence of the shell closures
- Spontaneous fission of ^{264}Fm, which could undergo symmetrical decay to form two nuclei of the doubly magic ^{132}Sn
- Testing the robustness of the deformed N=152 and N=162 shell closures with increasing distance from Z=100 and Z=108
- Exploring potential newly appearing shell closures
- Possibility of beta-delayed decay

• Technical Background

A design of IRiS is a challenging task, especially because of large angular spread of reaction products. Two promising separator designs are currently being considered in more detail: a solenoid-based design and one based on a combination of a dipole and magnetic multipoles. Both options exhibit advantages and disadvantages, which have to be contemplated carefully. Generally, IRiS should allow for:

- Good separation of the transfer reaction products from the primary beam and from elastically scattered particles
- Large angular acceptance
- High overall efficiency (> 10%)
- Separated products must be delivered to the detection system in the form suitable for their further investigation
- Use of actinide targets
- Design reactions: various projectiles (^{22}Ne, ^{40}Ar, ^{48}Ca, ^{136}Xe, and ^{238}U) on actinide targets (^{238}U, ^{248}Cm, or ^{254}Es), and ^{136}Xe+^{208}Pb. Energies typically 100-110% of the Coulomb barrier.
- Optionally a spectrometer mode, in which products are detected on-line in a detector setup inside the separator.

• Topics

The following topics will be presented and discussed, and we kindly ask for submission of contributions to these topics:

- Status report of the working groups.
- Especially important will be reports from the solenoid-based design" and "Quadrupoles(multipoles)+Dipols (QD) design" as the workshop should lead to a decision which of these two designs will be chosen for IRiS

In addition, some time will be allotted to the following topics:

- Status and design of existing transfer product separators, spectrometers, and other relevant tools
- Status of current experimental knowledge in this area
- Advances in theoretical understanding of the multi-nucleon transfer reactions
- Discussion of important scientific topics, which could be resolved with help of the transfer reactions