HK 51: Structure and Dynamics of Nuclei IX

Time: Wednesday 16:00–17:30 Location: HK-H7

Group Report HK 51.1 Wed 16:00 HK-H7

Studying Exotic Nuclei with the FRS Ion Catcher — •Sönke Beck for the FRS Ion Catcher-Collaboration — Justus-Liebig-Universität, Gießen, Germany — GSI, Darmstadt, Germany

At the FRS at GSI, exotic nuclei are produced at relativistic velocities by projectile fragmentation or fission. With the FRS Ion Catcher (FRS-IC) experiment they can be slowed down and thermalized in a cryogenic stopping cell (CSC), which in addition contains a ^{252}Cf spontaneous fission source. Their mass and abundance can be measured using a multiple-reflection time-of-flight mass-spectrometer (MR-TOF-MS). The MR-TOF-MS has single-ion sensitivity and features resolving powers of up to one million, or broadband measurements, like covering more than 20 mass units with mass resolving powers exceeding 250 000 in a measurement time of about 10 ms. Thus, very low yields can be handled and masses of nuclei from different production mechanisms can be measured accurately.

High-accuracy mass measurements at the borders of the known nuclear landscape were performed, including neutron-deficient light lanthanides close to the proton drip line and neutron rich nuclei around the $N = 126$ shell closure. Masses of nuclei close to the $N = Z$ line shed light on nuclear structure, for instance the proton-neutron interaction. From the ^{252}Cf internal source, masses and yields of spontaneous fission products can be obtained. Further upgrades will allow studying multi nucleon transfer reactions, and the masses of the respective neutron-rich products can improve nuclear astrophysics r-process calculations. Recent results will be discussed, concluded by an outlook.

HK 51.2 Wed 16:30 HK-H7

Fission isomer studies with the FRS — •Jianwei Zhao[1], Timo Dickel[1,2], Moritz P. Reiter[3], Peter G. Thirolf[4], Michiharu Wada[5], Nazarena Tortorelli[4,1], and Ziga Brencic[6] for the S530-Collaboration — [1]GSI, Darmstadt, Germany — [2]JLU Gießen, Gießen, Germany — [3]University of Edinburgh, Edinburgh, UK — [4]LMU Munich, Munich, Germany — [5]Wako Nuclear Science Center, Saitama, Japan — [6]University of Ljubljana, Ljubljana, Slovenia

Multi-humped fission barriers as they occur in the actinide region give rise to isomeric fission. Such barrier shapes can be described as the result of superimposing microscopic shell corrections to the macroscopic liquid drop barrier. A whole 'island' of fission isomers has been identified in the actinide region (Z = 92 - 97, N = 141- 151) with presently 35 experimentally observed fission isomers. Half-lives range from 5 ps to 14 ms. We will present the results of fission isomer studies with the FRS at GSI. For the first time, the fragmentation of 1 GeV/u ^{238}U projectiles, instead of so-far used light-particle induced reactions, was employed to study fission isomers. The projectile fragmentation gives access to isotopes hard or impossible to reach by light particle reactions and the in-flight separation with FRS allows studying fission isomers with short half-lives. Most importantly, it provides beam with a high purity and with the event-by-event identification. Two detection methods were used to cover fission isomers with half-lives in the range of about 50 ns to 50 ms: beam implantation in a fast plastic scintillator and in a cryogenic stopping cell at the FRS Ion Catcher.

HK 51.3 Wed 16:45 HK-H7

Towards solving the puzzle of high temperature light (anti)-nuclei production in ultra-relativistic heavy ion collisions — •Tim Neidig[1], Carsten Greiner[1], Kai Gallmeister[2], Volodymyr Vovchenko[3], and Marcus Bleicher[1] — [1]Institut for Theoretical Physics, Frankfurt am Main, Germany — [2]nstitut for Theoretical Physics, Gießen, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley, USA

The creation of loosely bound objects in heavy ion collisions, e.g. light clusters, near the phase transition temperature (T ˜ 155 MeV) has been a puzzling observation that seems to be at odds with Big Bang nucleosynthesis suggesting that deuterons and other clusters are formed only below a temperature T ˜ 0.1-1 MeV. We showed that the light cluster abundancies in heavy ion reactions stay approximately constant from chemical freeze-out to kinetic freeze-out. To this aim we develop an extensive network of coupled reaction rate equations including stable hadrons and hadronic resonances to describe the temporal evolution of the abundancies of light (anti-)(hyper-)nuclei in the late hadronic environment of an ultrarelativistic heavy ion collision. However, because of the partial chemical equilibrium of the stable hadrons, including the nucleon feeding from resonances, the abundancies of the light nuclei stay nearly constant during the evolution and cooling of the hadronic phase and are in excellent agreement with those measured by ALICE at LHC.

HK 51.4 Wed 17:00 HK-H7

Coalescence in Monte Carlo generators and implications for cosmic ray studies — •Maximilian Horst — Technical University Munich

Coalescence is one of the main models used to describe the formation of light (anti)nuclei. It is based on the hypothesis that two nucleons close in phase space can coalesce and form a nucleus. Coalescence has been successfully tested in hadron collisions at colliders, from small (pp collisions) to large systems (Au-Au collisions). However, in Monte Carlo simulations (anti)nuclear production is not described by event generators. A possible solution is given by the implementation of coalescence afterburners, which can describe nuclear production on an event-by-event basis. This idea would find application in astroparticle studies, allowing for the description of (anti)nuclear fluxes in cosmic rays, which are crucial for indirect Dark Matter searches. In this presentation, the implementation of event-by-event coalescence afterburners will be discussed, focusing on different approaches and on the comparison with the experimental results for different collision systems.

HK 51.5 Wed 17:15 HK-H7

The PUMA Experiment: Investigating Short-lived Nuclei with Antiprotons — •Alexander Schmidt, Alexandre Obertelli, and Frank Wienholtz — Technische Universität Darmstadt

The antiProton Unstable Matter Annihilation (PUMA) experiment is a nuclear physics experiment at CERN which will provide the ratio of protons to neutrons in the tail of the nucleon density distributions to constrain nuclear structure theories. To determine this ratio, the interaction of antiprotons and nuclei at low relative energies is used. Following the captures of the antiproton by the nucleus (formation of antiprotonic atom), the antiproton cascades towards the nucleus and eventually annihilates with a nucleon. This annihilation conserves the total charge, so that the annihilated nucleon can be identified by detecting all charged pions produced in the annihilation. The process takes place at larger radii than usual nuclear reactions (e.g. nucleon removal reactions), making this method unique for nuclei with a high neutron-to-proton asymmetry, i.e. short-lived nuclei close to the driplines, halo nuclei and nuclei with a thick neutron skin. As there is no joint facility for antiprotons and short-lived nuclei available, a transportable experimental setup is needed to bring antiprotons from ELENA/CERN to the nuclei at ISOLDE/CERN.

This talk will give an overview over the fundamental physics, the experimental setup and technique as well as the current status of the experiment.