HK 32 Kernphysik/Spektroskopie

Zeit: Dienstag 16:30–19:00 Raum: TU MA005

Gruppenbericht HK 32.1 Di 16:30 TU MA005

ATRAP - on the way to trapped Antihydrogen — •Dieter Grzonka for the ATRAP collaboration — Institut für Kernphysik, Forschungszentrum Jülich, 52425Jülich, Germany

The ATRAP experiment at the CERN antiproton decelerator AD aims for a test of the CPT invariance by a comparison of the hydrogen to antihydrogen atom spectroscopy. The antihydrogen production is routinely operated at ATRAP [1] in a nested Penning trap configuration, a stack of ring electrodes capturing the charged particles in axial direction within a uniform magnetic solenoid field for the radial confinement. Detailed studies have been performed in order to improve the production efficiency of useful antihydrogen. High precision measurements of atomic transitions requires trapped cold antihydrogen in the ground state. The trapping of neutral antihydrogen atoms should work via the force on the magnetic moment in a magnetic field gradient. To ensure a high antihydrogen trapping efficiency a magnetic trap has to be superimposed on the nested Penning trap. A basic question in such a configuration is the possibility to keep the antiproton and positron clouds in the stabilizing solenoid field which is strongly distorted by the field of the magnetic trap.

Studies on the antihydrogen production and first trapping tests of charged particles within a combined magnetic/Penning trap will be presented.

* Supported by FZ-Jülich and BMBF.

[1] G. Gabrielse et al., PRL 89, 213401 (2002), PRL 89, 233401 (2002), PRL 93, 073401 (2004), P. Oxley et al., Phys. Lett. B595, 60 (2004).

Gruppenbericht HK 32.2 Di 17:00 TU MA005

Recent mass measurements with ISOLTRAP — •Alexander Herlert for the ISOLTRAP collaboration — Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, 17487 Greifswald, Germany — CERN, Physics Department, 1211 Geneva 23, Switzerland

The Penning trap mass spectrometer ISOLTRAP at ISOLDE/CERN is devoted to accurate mass measurements of short-lived nuclides. Recent mass measurements with a relative mass uncertainty of only 1×10^{-8} provide new data for tests of nuclear and astrophysical models as well as new input for fundamental tests of the weak interaction. Examples are the mass determination of ^{22}Mg, where the comparative half-life of the superallowed beta decay has been obtained for a further test of the conserved-vector-current hypothesis and the unitarity of the Cabibbo-Kobayashi-Maskawa matrix [1], and the mass measurement of ^{35}K, which allows a stringent test of the quadratic form of the isobaric multiplet mass equation for isospin quartets.

In addition to the mass measurements a new experimental technique has been tested, where for the first time the daughter ion of a beta-decaying nuclide was stored after the decay in a Penning trap and investigated for mass determination. This in-trap decay mass spectrometry as demonstrated for $^{37}\mathrm{K} \rightarrow {}^{37}\mathrm{Ar}$ offers a new approach to obtain nuclides that are not delivered from a radioactive ion-beam facility. A summary of all recent mass measurements as well as the status of ISOLTRAP will be presented.

[1] M. Mukherjee et al., Phys Rev. Lett. 93, 150801 (2004)

HK 32.3 Di 17:30 TU MA005

Proton Induced Fragmentation of Ni, Nb, and Au Nuclei — •Borys Piskor-Ignatowicz for the PISA collaboration — Institut für Kernphysik, Forschungszentrum Jülich, D-52425 Jülich, Germany — M. Smoluchowski Institute of Physics, Jagellonian University, Reymonta 4, 30059 Kraków, Poland

The double differential cross sections $d\sigma/dEd\Omega$ for proton induced fragmentation of Ni, Nb, and Au nuclei have been measured by the PISA (Proton Induced SpAllation) collaboration. Thin ($\sim 300\ \mu$g/cm^2), self-supporting targets have been irradiated by 1.2, 1.9 and 2.5 GeV internal proton beam of the COSY accelerator of the Forschungszentrum Jülich. Reaction products were registered by Bragg curve detectors, cooled silicon detectors and phoswich detectors. The apparatus enabled to identify the charge and mass of light charged particles (H and He ions) as well as intermediate mass fragments up to Z=6. Heavier ejectiles (with Z < 14) were only Z - identified. Preliminary analysis of the data shows that two contributions can be observed for all scattering angles and all observed reaction products: one of them seems to correspond to evaporation of particles from excited remnant nucleus of the fast intranuclear cascade of nucleon-nucleon collisions whereas another one is connected with isotropic emission of fragments from the fast, hot source which is significantly smaller than the target nucleus. The latter mechanism becomes increasingly more important for heavier reaction products. The quantitative analysis of the data is expected to give more detailed information on the reaction mechanism, especially as a function of the target mass and incident proton energy.

HK 32.4 Di 17:45 TU MA005

Binary fission-fragment yields from the reaction 251Cf(nth, f) — •S. Oberstedt[1], E. Birgersson[1,2], A. Oberstedt[2], F.-J Hambsch[1], D. Rochman[3], and I. Tsekhanovitsch[4] — [1]EC-JRC Institute for Reference Materials and Measurements, B-2440 Geel — [2]Dept. of Natural Sciences, Örebro University, SE-70182 Örebro — [3]Los Alamos National Laboratory, Los Alamos, New Mexico 87545 — [4]Institut Laue-Langevin, F-38042 Grenoble Cedex

The interpretation of fission-fragment properties in terms of so-called fission modes has been successfully applied to describe mass yield and total kinetic energy distributions as a function of incident neutron energy. There, the asymmetric standard I (S1) and standard II (S2) modes as well as the symmetric superlong (SL) mode have been used. In the case of spontaneous fission of 252Cf the number of traditional fission modes is not sufficient to properly describe the experimental fission-fragment distributions. Additional theoretically obtained fission modes have to be included into the analysis to improve the description of the data. In order to achieve experimental confirmation of the number of fission modes, neutron-induced fission of 252Cf*, using 251Cf as target material, has been investigated at thermal excitation, using the recoil mass-separator LOHENGRIN of the ILL, Grenoble. Light post-neutron fission-fragment kinetic energy distributions were measured for A = 80 to 124 for the first time ever, and relative emission yields together with mean kinetic energies as a function of A have been determined. Data analysis and final experimental results will be presented.

HK 32.5 Di 18:00 TU MA005

New results on the neutron-induced fission cross-section of 231Pa — •A. Oberstedt[1], S. Oberstedt[2], F.-J. Hambsch[2], V. Fritsch[2], G. Vladuca[3], and A. Tudora[3] — [1]Dept. of Natural Sciences, Örebro University, SE-70182 Örebro — [2]EC-JRC Institute for Reference Materials and Measurements, B-2440 Geel — [3]Faculty of Physics, Bucharest University, RO-76900 Bucharest

Our studies of neutron-induced reactions for advanced nuclear applications have recently been extended to the nuclide 231Pa. In accordance with the heavier isotope 233Pa, which we reported about previously, 231Pa is supposed to play an important role for future reactors involving the thorium-uranium fuel cycle. Thus, 231Pa belongs to the isotopes that were pointed out by the IAEA to be investigated with highest priority. Although the neutron-induced fission cross-section has been measured before, the compiled experimental results as well as data in existing evaluated data files exhibit quite some differences. For this reason we have performed new experiments with a quasi mono-energetic neutron beam, provided by the Van de Graaff accelerator at IRMM. The first results, covering the neutron energy range from 0.8 to 3.5 MeV, will be presented.

HK 32.6 Di 18:15 TU MA005

Bremsstrahlung emission in the α decay of ^{210}Po — •Hans Boie, Vinzenz Bildstein, Frank Köck, Martin Lauer, Oliver Niedermaier, Heiko Scheit, and Dirk Schwalm — MPI für Kernphysik, Heidelberg

The emission of bremsstrahlung in the α decay of a nucleus has attracted strong theoretical interest recently (e.g. [1,2]). The emission of bremsstrahlung is usually well described by a semi-classical treatment. However, in an α decay the α particle is tunneling through the Coulomb barrier of the nucleus, a process which can only be understood quantum-mechanically. The proposed semi-classical and quantum-mechanical models differ considerably, but, due to poor statistics, the data available so far [3] do not allow to distinguish between these models.

Therefore, a new experiment has been conceived at the MPI-K Heidelberg, measuring the emission probability of bremsstahlung in the α

decay of ^{210}Po [4]. For the production run two new α sources with improved energy resolution were used. After about 280 days of data taking the experiment has now been completed. The experimental setup, the status of the analysis and preliminary results will be presented.

[1] T. Papenbrock and G. F. Bertsch, Phys. Rev. Lett. **80**, 4141 (1998).
[2] M.I. Dyakonov, Phys. Rev. C **60**, 037602-1 (1999).
[3] J. Kasagi et. al., Phys. Rev. Lett. **79**, 371 (1997).
[4] H. Boie et. al., DPG Frühjahrstagung 2002, Vortrag HK 45.6

HK 32.7 Di 18:30 TU MA005

Bimodality and charge (mass) splitting in fission of actinides — •A.V. Andreev[1,2], G.G. Adamian[2,3], N.V. Antonenko[1,2], S.P. Ivanova[2], and W. Scheid[1] — [1]Institut für Theoretische Physik der Universität Giessen — [2]Joint Institut for Nuclear Research, Dubna, Russia — [3]Institute of Nuclear Physics, Tashkent, Uzbekistan

Fission of actinides is described within the scission-point model. Scission configurations are interpreted as dinuclear systems (DNS). The potential energy surfaces of scission configurations are analyzed as functions of deformations of the DNS fragments by considering mass and charge asymmetries as independent variables. It is demonstrated that bimodality in fission of actinides at fixed mass splitting is related to different charge splittings. Experiments are suggested to prove this interpretation of bimodality.

HK 32.8 Di 18:45 TU MA005

Mass Measurements of Radionuclides around the Proton Shell Closure $Z = 82$ — •C. Weber[1,2], G. Audi[3], D. Beck[1], K. Blaum[1,2], G. Bollen[4], F. Herfurth[1], H.-J. Kluge[1], D. Lunney[3], and S. Schwarz[4] for the ISOLTRAP collaboration — [1]GSI, D - 64291 Darmstadt — [2]University of Mainz, D - 55099 Mainz — [3]CSNSM, F - 91405 Orsay — [4]NSCL, Michigan State University, USA

The Penning trap mass spectrometer ISOLTRAP allows for the precise mass determination of exotic nuclides far from stability with uncertainties $\delta m/m$ of about 10^{-8}. The mass of an ion stored in a strong magnetic field is determined by a measurement of its cyclotron frequency. In this contribution recent results from mass measurements of heavy radionuclides around the proton shell closure $Z = 82$ are presented. Since the mass represents one of the most basic nuclear properties, precise systematic studies allow to conclude on the resulting size and shape of a given nuclide, as it manifests itself *e.g.* in the appearance of shape coexistence. With the advent of high-precision mass measurements using the ISOLTRAP spectrometer, in some cases requiring isomeric resolution, it is possible to see a structure in the neutron pairing energy and to examine the relationship between masses and radii for correlations.