HK 75: Anwendungen kernphysikalischer Methoden

Zeit: Donnerstag 16:45–19:00 Raum: HSZ-204

Gruppenbericht HK 75.1 Do 16:45 HSZ-204

The TRAKULA joint research project — •Roland Beyer for the TRAKULA-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

TRAKULA is a BMBF joint research project in the framework "Energie 2020+" that aims for precise measurements of nuclear data relevant for nuclear transmutation technologies. The collaboration consists of the University of Cologne, the Technical University Dresden, the Johannes-Gutenberg University Mainz, the Technical University Munich, the Physikalisch-Technische Bundesanstalt Braunschweig, and the Helmholtz-Zentrum Dresden-Rossendorf. The topics covered are the production and experimental use of fast neutrons to study nuclear reactions, the spectroscopy with photon beams in the MeV range, the development of a high resolution Compton camera, the measurement of low radioactivities including accelerator mass spectroscopy, and the production of homogeneous thin actinide targets for neutron-induced fission measurements. Graduate seminars have been organized to maintain competencies in the field of nuclear safety and radiation research. All topics are connected to each other by their application to nuclear transmutation and nuclear waste management. The progress of the various topics will be explained and results will be presented. Experiments at the neutron-time-of-flight facility nELBE and measurements of fast neutron induced reactions will be discussed in detail. TRAKULA is supported by the German Federal Ministry of Education and Research (Contract 02NUK13A).

Gruppenbericht HK 75.2 Do 17:15 HSZ-204

Positron Annihilation Spectroscopy at a Superconducting Electron Accelerator — •Andreas Wagner[1], Wolfgang Anwand[1], Maik Butterling[1], Thomas E. Cowan[1,2], Fine Fiedler[1], Fabian Fritz[1,2], Marco Jungmann[3], Mathias Kempe[1,2], and Reinhard Krause-Rehberg[3] — [1]Inst. für Strahlenphysik, Helmholtz-Zentrum Dresden-Rossendorf, D-01328 Dresden — [2]Inst. für Kern- und Teilchenphysik, Technische Univ. Dresden, D-01069 Dresden — [3]Inst. für Physik, Martin-Luther Univ., D-06099 Halle

High-power superconducting linear electron accelerators allow producing a variety of secondary beams. At the Helmholtz-Zentrum Dresden-Rossendorf a 40 MeV superconducting electron accelerator is operated at beam currents up to 1.6 mA in continous-wave mode delivering neutrons from photo-production off lead, tunable coherent laser light from free-electron lasers, intense Bremsstrahlung for nuclear (astro-) physics, and positrons from pair production. New developments now enable for the first time positron annihilation lifetime experiments in bulk materials, fluids, gases and organic tissue. A 3-D tomographic annihilation lifetime imaging systems has been developped for new classes of experiments for quantitative and qualitative crystal-defect characterizations, chemsitry of positronium in insulators and porous materials. Some recent applications will be presented.

HK 75.3 Do 17:45 HSZ-204

PGAA experiments close to detection limits — •Petra Kudejova[1], Anne Houben[2], Ivo Tomandl[3], Ladislav Viererbl[4], and Zsolt Revay[1] — [1]Technische Universität München, Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II), Garching, Germany — [2]Max-Planck-Institut fuer Plasmaphysik, Garching, Germany — [3]Nuclear Physics Institute, Academy of Science CR, Czech Republic — [4]Research Centre Rez Ltd., Nuclear Research Institute Rez plc, Czech Republic

The ultimate detection limits (DL) of the Prompt Gamma Activation Analysis (PGAA) method depend strongly on the amount and matrix of the measured sample as well as on the background signal contribution to the signal coming from the sample itself.

We have performed few experiments close to the detection limits for given elements at the high-flux-PGAA facility at FRM II in Garching. One of the most important elements which can be determined by the PGAA technique is Hydrogen. Hydrogen impurities in Silicon as well as Hydrogen implantation in Beryllium crystals were measured and analysed. Concerning Silicon, which appears frequently in the nature and so in the PGAA samples, we could determine 3 ppm Hydrogen in the crystals. Another experiment testing the limits of the PGAA facility at FRM II was performed in a frame of a Transmutation detectors (TMD) proposal. In this presentation, the experiments and the results will be discussed and possible ways how to improve the detection limits will be proposed.

HK 75.4 Do 18:00 HSZ-204

Hints of supernova debris deposition on the lunar surface: ^{60}Fe and ^{53}Mn measurements by means of accelerator mass spectrometry — •Leticia Fimiani[1], Thomas Faestermann[1], José Manuel Gómez Guzmán[1], Karin Hain[1], Gregory Herzog[2], Gunther Korschinek[1], Bret Ligon[2], Peter Ludwig[1], Jisun Park[2], and Georg Rugel[3] — [1]Physik Department, Technische Universität München, Garching, Germany — [2]Department of Chemistry and Chemical Biology, Rutgers University, Piscataway, NJ, USA — [3]Forschungszentrum Dresden Rossendorf, Dresden, Germany

The enhanced concentration of ^{60}Fe in a deep ocean ferro-manganese crust about (2.1±0.4) Myr old (Fitoussi *et al.*, PRL 101, 121101 (2008)), suggests that one or more supernova (SN) explosions occurred in the vicinity of the Solar System. That observation was only possible with the ultra sensitive Accelerator Mass Spectrometry (AMS) technique at the Maier-Leibnitz-Laboratorium in Munich, where we are able to measure concentrations of ^{60}Fe/Fe down to a level of 10^{-16}. Because of its lacking atmosphere and negligible sedimentation rate, the Lunar surface is an excellent quantitative reservoir for SN debris. We searched for live ^{60}Fe and ^{53}Mn in samples from 3 Apollo missions. ^{53}Mn is, similar as ^{26}Al and ^{60}Fe, a tool to trace nucleosynthesis activities. It is formed primarily during the explosive silicon-burning of the inner shells of SNe via ^{53}Fe which β-decays to ^{53}Mn with an 8.51 min half-life. Samples where we found an enhanced ^{60}Fe concentration showed also an enhancement of ^{53}Mn. If confirmed, this could be the first detection of live ^{53}Mn originating from nucleosynthesis.

HK 75.5 Do 18:15 HSZ-204

Search for supernova produced ^{60}Fe in Earth's microfossil record — •Peter Ludwig[1], Shawn Bishop[1], Ramon Egli[2], Valentyna Chernenko[1], Thomas Faestermann[1], Leticia Fimiani[1], Jose Gomez[1], Karin Hain[1], and Gunther Korschinek[1] — [1]Physik Department, Technische Universität München, Garching — [2]Central Institute for Meteorology and Geodynamics, Vienna

The detection of supernova debris on Earth can be achieved by use of accelerator mass spectrometry (AMS) to search for radionuclides like ^{60}Fe. This long-lived isotope ($T_{1/2}$ = 2.6 Myr) is produced in massive stars and is expected to be present in the debris of type II supernovae. The discovery of ^{60}Fe in a ferromanganese crust from the Pacific ocean (Knie et al., 2004) was interpreted as the input of a supernova explosion about 2.2 Myr ago. Currently, several projects are aiming for the confirmation of the signature of ^{60}Fe in terrestrial and lunar samples. In this talk, the search for this ^{60}Fe signature in Earth's microfossil record will be presented. The sample material for this study is marine sediment from the eastern equatorial Pacific. A specific kind of secondary (formed in situ) magnetite mineral contained in the sample material are magnetofossils, which are the remains of magnetotactic bacteria, which are the target for extraction. The chemical extraction technique used to produce AMS samples has been characterized using newly developed magnetic analysis methods and has been shown to be extremely selective towards secondary magnetite. The AMS samples produced in this way are uniquely suited for the search for supernova ^{60}Fe. Preliminary AMS results will be presented.

HK 75.6 Do 18:30 HSZ-204

Funktionsnachweis eines Messsystems zur Bestimmung der Tritiumkonzentration in Wasser mittels Verstärkerfolie und Photodioden — •Manuel Klein — Karlsruher Insitut für Technologie, Institut für experimentelle Kernphysik

Das KArlsruher TRItium Neutrino-Experiment KATRIN untersucht spektroskopisch das Elektronenspektrum des Tritium β-Zerfalls $^3\mathrm{H} \rightarrow {}^3\mathrm{He} + \mathrm{e}^- + \nu_\mathrm{e}$ nahe dem kinematischen Endpunkt von 18.6 keV. Mit einer fensterlosen molekularen gasförmigen Tritiumquelle hoher Luminosität und einem hochauflösenden elektrostatischen Filter von bisher unerreichter Energieauflösung ΔE = 1 eV wird KATRIN eine modellunabhängige Bestimmung der Neutrinomasse mit einer erwarteten Sensitivität von 0.2 eV (90 % CL) ermöglichen. Wichtig für eine derart präzise Massenbestimmung ist die Stabilität der Quelle be-

züglich ihrer β-Aktivität, um die Nachweisgrenze für den Wert der Neutrinomasse zu erreichen. Das dazu notwendige aktive Pumpen geschieht mit wassergekühlten Turbomolekularpumpen, durch deren Metallwände Tritium in den Kühlwasserkreislauf permetieren kann. Um dort die Tritiumkonzentration zu überwachen, wird ein kostengünstiges Messsystem benötigt. Das Experiment TrAMPeL (Tritium Activity Monitoring with Photodiodes in Liquids) soll den Funktionsnachweis für ein Messverfahren erbringen, das mithilfe gängiger Verstärkerfolien aus der Medizintechnik und Photodioden die Bremsstrahlung von β-Zerfallselektronen in Wasser registriert. Dieser Vortrag präsentiert Konzeptionierung und Konstruktion einer solchen Messzelle, sowie die Ergebnisse der mit ihr angefertigten Messreihe.

HK 75.7 Do 18:45 HSZ-204

Tritium Measurement in Water using Bremsstrahlung X-Rays and a Silicon Drift Detector — •Simon Niemes — Karlsruhe Institut of Technology, Institute for Technical Physics - Tritium Laboratory, Karlsruhe, Germany

Applications like future fusion plants or scientific experiments like KATRIN need a closed tritium infrastructure to cycle and handle tritium safely. At some process stages tritiated water (HTO) is generated, making measuring the tritium content in HTO vital for process control, accountancy and safety.

There are several methods used to measure HTO, primarily Liquid Scintillation Counting (LSC). A new technique promising fast, inline and wasteless measurement compared to LSC is the Beta Induced X-ray Spectroscopy (BIXS). The principle of BIXS is detecting the bremsstrahlung spectrum from the decelerated decay electrons in water and calibrate it to known concentrations.

A novel approach utilizing a Silicon Drift Detector (SDD) to measure the emitted X-ray spectrum has several advantages over other detector types like scintillation counters. A SDD is a semiconductor detector with very low noise and good energy resolution, suitable for detecting the low intensity, low energy signal from BIXS.

In this talk an overview of the experimental setup and detector will be given and first results will be presented.