HK 6: Structure and Dynamics of Nuclei 1

Time: Monday 14:30–16:30 Location: T/HS2

Group Report HK 6.1 Mon 14:30 T/HS2

Investigation of mass-dependent prompt fission γ-ray emission — •Stephan Oberstedt[1], Angelique Gatera[1], Matthieu Lebois[2], Andreas Oberstedt[3], and Jonathan Wilson[2] — [1]European Commission, DG Joint Research Centre IRMM — [2]Institut de Physique Nucléaire Orsay, F-91406 Orsay — [3]Fundamental Fysik, Chalmers Tekniska Högskola, S-41296 Göteborg

In recent years we conducted a systematic investigation of fission-fragment de-excitation through prompt neutron and γ-ray emission. For the latter we were able to obtain spectral data for thermal-neutron induced fission on ^{235}U [1] and ^{241}Pu [2] with unprecedented accuracy. The recently installed neutron source LICORNE [3], where neutrons are produced in inverse kinematics, enables us to explore prompt de-excitation also for fast-neutron induced fission and on non-fissile targets. In a next step we started studying the spectral changes as a function of mass and total kinetic energy using the spontaneous fission of ^{252}Cf. By tagging on isomeric γ-decay we are exploring the possibility to identify very neutron-rich isotopes. First results and the new hybrid array, GLANDIS, consisting of $CeBr_3$ and HPGe detectors, is being presented.

[1] A. Oberstedt et al., Phys. Rev. C87, 051602(R), 2013 [2] S. Oberstedt et al., Phys. Rev. C90, 024618, 2014 [3] M. Lebois et al., Nucl. Instr. Meth. A735 (2014) 145-151

HK 6.2 Mon 15:00 T/HS2

A VUV detection system for the direct identification of the fluorescence radiation of ^{229m}Th * — •Benedict Seiferle, Lars v.d. Wense, and Peter G. Thirolf — LMU Munich

In the whole landscape of atomic nuclei, ^{229}Th has the lowest transition energy to its first excited state. The transition energy was indirectly measured to be 7.8(5) eV, which corresponds to ≈160 nm and conceptionally allows to get optical access to the transition. This talk will report on a VUV detection system that aims on the direct detection of the fluorescence radiation of ^{229m}Th. The setup consists of two annular parabolic mirrors (made of MgF_2-coated aluminum) and a phosphorous screen behind a CsI-coated MCP, monitored by a CCD camera. $^{229(m)}$Th will be populated via the α decay of ^{233}U. Therefore a ^{233}U α-recoil source is placed in a buffer-gas stopping cell, where a continuous ion beam is produced by a subsequent RFQ. By using a quadrupole mass separator, $^{229(m)}$Th ions are then separated from other short lived daughter nuclei. The $^{229(m)}$Th ions are collected on a point-like micro electrode (50 μm in diameter) that is placed in the focal spot of the annular parabolic mirror (f=10 mm) which collimates the fluorescence radiation. The parallelized light is then focused by a second annular parabolic mirror (f=2 mm) onto the MCP. To get a high signal to noise ratio, it is important to achieve a small focal spot size on the MCP. Since the optical axis is blocked by the collection electrode, also the alignment of the optics poses a special challenge. The alignment method as well as results from first test measurements will be presented. *Supported by the DFG Grant TH956/3-1

HK 6.3 Mon 15:15 T/HS2

The nuclear isomer transition in Thorium-229: Search for the VUV photon — •Simon Stellmer[1], Matthias Schreitl[1], Koji Yoshimura[2], and Thorsten Schumm[1] — [1]Atominstitut /TU Wien and VCQ, Vienna, Austria — [2]Okayama University, Japan

The isotope ^{229}Th is believed to possess a low-lying nuclear excitation, at an energy of about 7.8(5) eV [1], corresponding to a wavelength of 160(10) nm. Convincing direct evidence of the existence of this state, for instance by observation of its excitation or decay, is still pending.

Optical excitation of the isomer state is an exceptional challenge, as the required wavelength is not known, the transition is believed to be extremely narrow, and the choice of suitable lasers is limited. Instead, we use synchrotron radiation at 29 keV to populate the second excited state, which then decays into the desired isomer state. This state proceeds further into the ground state under emission of the much sought-after VUV photon. This photon is detected in a spectrometer.

The measurements are performed at the SPring-8 facility in Japan; we will report on the latest status of the experiment.

[1] Beck *et al.*, Phys. Rev. Lett. **98**, 142501 (2007).

HK 6.4 Mon 15:30 T/HS2

The new Bucharest multi-detector setup for γ-ray spectroscopy studies — •Sorin Pascu — National Institute for Physics and Nuclear Engineering, Bucharest, Romania

The ROmanian array for SPectroscopy in HEavy ion REactions (ROSPHERE) is a new 4π high-resolution γ-ray detector array which was installed at the Bucharest 9 MV tandem accelerator. The setup consists of up to 25 detectors and it is typically used in a mixed combination of high-purity Ge detectors and fast $LaBr_3$:Ce scintillation detectors. The total efficiency of the array is close to 3%, balanced between the two type of detectors when used in the usual configuration with 14 HPGe ($\epsilon \simeq$1.1%) and 11 $LaBr_3$:Ce detectors ($\epsilon \simeq$1.8%). The multi-detector setup can be coupled with a state of the art plunger device allowing for lifetime measurements by employing the Recoil Distance Doppler Shift (RDDS) or in-beam Fast Electronic Scintillation Timing (FEST) technique. Two recent experiments illustrating the methods are presented.

HK 6.5 Mon 15:45 T/HS2

Time-dependent nuclear excitation dynamics in coherent gamma-ray fields — •Adriana Pálffy and Hans A. Weidenmüller — Max-Planck-Institut für Kernphysik, Heidelberg

Recent experimental developments in laser physics hold promise to advance the new field of laser-induced nuclear reactions beyond known territory. At the Extreme Light Infrastructure (ELI), efforts are under way to generate multi-MeV zeptosecond coherent laser pulses. Consecutive absorption of many MeV-gamma rays would lead to the formation of a compound nucleus with excitation energy several hundreds MeV above yrast in a so-far totally unexplored parameter regime [1].

We have considered the laser-nucleus interaction in the quasiadiabatic regime, in which the nucleus (almost) attains statistical equilibrium between two subsequent photon absorption processes. The dynamics is described by means of a system of time-dependent master equations that account for the excitation and neutron decay of a chain of nuclei, with the rates involved depending on the total and partial nuclear level densities [2]. Our quantitative estimates predict the excitation path and range of nuclei reached by neutron decay and provide relevant information for the layout of future experiments.

[1] A. Pálffy and H. A. Weidenmüller, Phys. Rev. Lett. 112, 192502 (2014).

[2] A. Pálffy and H. A. Weidenmüller, Nucl. Phys. A 917, 15 (2013).

HK 6.6 Mon 16:00 T/HS2

New excited states in *sd*-shell nucleus ^{33}P — •B. Fu, P. Reiter, K. Arnswald, H. Hess, R. Hirsch, L. Lewandowski, D. Schneiders, M. Seidlitz, B. Siebeck, T. Steinbach, A. Vogt, A. Wendt, and K. Wolf — Institut für Kernphysik, Universität zu Köln

Isospin-symmetry breaking in nuclear physics is mainly described by Mirror-Energy Differences (MED) for mirror nuclei or Triplet-Energy Differences (TED) for isobaric triplets. Modified USD-calculations [1] successfully reproduce MED for T = 1, 3/2, 2 *sd*-shell nuclei. Refined tests of theory are given by lifetime measurements in order to deduce transition-strength values. In order to study the mirror pair ^{33}Ar and ^{33}P, the fusion-evaporation reaction ^{13}C + ^{26}Mg at 46 MeV was measured at the Cologne tandem accelerator and the HORUS spectrometer employing the Doppler-Shift-Attenuation-Method (DSAM). First results yielded new γ-ray transitions in ^{33}P and ^{33}S. The level scheme of ^{33}P was extended up to excitation energies of 10 MeV. Spins and parities of the new levels were determined exploiting $\gamma\gamma$-angular correlations. Together with values from the proton-rich $T_z = -3/2$ partner, the levels are compared to shell model calculations, describing excitation energies of *sd* -shell mirror pairs.

[1] A. Wendt et al.; Phys. Rev. C 90 (2014) 054301

HK 6.7 Mon 16:15 T/HS2

Study of the background observed with PreSPEC — •Giulia Guastalla[1], Magdalena Górska[1], Jürgen Gerl[1], Ivan Kojuharov[1], Norbert Pietralla[2], Stephane Pietri[1], Damian Ralet[1], and Hans Jürgen Wollersheim[1] — [1]GSI, Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt, Germany — [2]Technische Universität Darmstadt, D-64289 Darmstadt, Germany

Relativistic rare isotope beams allow investigation of unexplored regions of exotic nuclei, however the large amount of background radiation present in such measurements is a great challenge for the analysis process. Even after a detailed analysis and the application of strict conditions, a large component of the background can remain in the γ-ray energy spectra and often hamper the observation of the γ-transition under study. Hence, a dedicated and detailed analysis has been performed in order to better disentangle several components of the background that affects γ-ray energy spectra, and understand their nature and origin. Analyzing the correlations between more than 20 observables provided the by PreSPEC setup, different classes of background events were identified and characterized. This information will help to reduce the presence of background events and, therefore, facilitate and improve the study of new phenomena in fast-beam experiments on exotic nuclei at FAIR.