HK 12: Kernphysik / Spektroskopie

Zeit: Dienstag 14:15–16:30 Raum: D

HK 12.1 Di 14:15 D

Suche nach skalarer Wechselwirkung mit dem WITCH Experiment: Prinzip und Stand des Experiments — •Marcus Beck[1], Peter Friedag[1], Christian Weinheimer[1], Sam Coeck[2], Mustapha Herbane[2], Valentin Kozlov[2], Ilya Kraev[2], Nathal Severijns[2], Michael Tandecki[2], Pierre Delahaye[3], Alexander Herlert[3] und Frederick Wenander[3] — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Deutschland — [2]Instituut voor Kern- en Stralingsfysica, Katholieke Universiteit Leuven, Belgien — [3]CERN, Schweiz

Das WITCH Experiment misst das Rückstossspektrum der Tochterionen nach Kern-Betazerfall. Aus diesem Spektrum lässt sich die Elektron-Neutrino Winkelkorrelation bestimmen, die aufgrund einer eventuell vorhandenen skalaren oder tensoriellen Wechselwirkung von der V-A Form des Standardmodelles abweichen kann. Der Aufbau ist an ISOLDE/CERN durchgeführt worden und besteht im Wesentlichen aus zwei Penningfallen zur Speicherung der radioaktiven Mutterionen, sowie einem anschliessenden MAC-E Filter zur Bestimmung der Energie der Tochterionen. Im Herbst 2006 wurde ein erstes Rückstossspektrum gemessen. Die Analyse der Daten und Probleme ist in vollem Gang. In diesem Vortrag werden Prinzip und Stand des Projektes beschrieben.

HK 12.2 Di 14:30 D

Mass measurements on superallowed β-emitters using Ramsey's excitation method at ISOLTRAP — •Sebastian George for the ISOLTRAP-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — GSI, 64291 Darmstadt, Germany

The Penning trap mass spectrometer ISOLTRAP, installed at the ISOLDE/CERN facility, is dedicated to high-precision mass measurements on short-lived radionuclides. One of the very active fields, where mass values with uncertainties at the level of 10^{-8} and even below are required, is the test of the electroweak part of the Standard Model. Here, the conserved-vector-current (CVC) hypothesis postulates that the vector-current part of the weak interaction is unaffected by the strong interaction. Thus, the decay strength of all superallowed $0^+ \rightarrow 0^+$ β-decays is independent of the nuclei except for theoretical corrections. The 12 best known superallowed Fermi-type β-decays ranging from ^{10}C to ^{74}Rb yield an average Ft value of Ft = 3072.7 (0.8)s [1], which confirms the CVC hypothesis at a level of $3 \cdot 10^{-4}$. Now the masses of a few more candidates for further tests have been measured, two of them at ISOLTRAP, with a novel technique in Penning trap mass spectrometry: Time separated oscillating fields, known as the Ramsey method and recognized with the Nobel prize in 1989, were used for the excitation of the stored ions' motion to determine the masses of ^{26}Al and ^{38}Ca. The method as well as the results will be presented.

[1] J.C. Hardy and I.S. Towner, Phys. Rev. Lett. 94, 092502 (2005).

HK 12.3 Di 14:45 D

Recent high-accuracy mass measurements with ISOLTRAP — •M. Kowalska[1], D. Beck[2], K. Blaum[1,2], M. Breitenfeldt[3], S. George[1], F. Herfurt[2], A. Herlert[4], A. Kellerbauer[5], H.-J. Kluge[2], D. Neidherr[1], L. Schweikhard[3], C. Yazidjian[2], D. Lunney[6], R. Savreux[2], and S. Schwarz[7] — [1]Institut für Physik, Universität Mainz, Germany — [2]GSI, Darmstadt, Germany — [3]Institut für Physik, Universität Greifswald, Germany — [4]CERN, Geneva, Switzerland — [5]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [6]CSNSM, Orsay, France — [7]NSCL, MSU, East-Lansing, USA

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 in the order of 10^{-8} provide new data for tests of nuclear and astrophysical models. The 2006 results include masses of neutron-rich Ag, Mn, and Fe nuclei. Since Fe isotopes are not accessible directly at ISOLDE, we studied them with the in-trap decay method. In the talk we will present the physics interest of the above investigations, the experimental technique and setup, as well as the results and their implications.

HK 12.4 Di 15:00 D

Bindungsenergie-Systematik für 0^+, T=1 und 1^+, 2^+ und 3^+, T=0 Zustände von Nukliden mit N=Z und A=4n+2 von ^{14}N bis ^{38}K — •Friedrich Everling — NC State University, Raleigh, und TUNL, Durham, NC, USA (frühere Zugehörigkeit, jetzt Ringheide 24 f, 21149 Hamburg)

Die Bindungsenergien werden hier in der Form $-B^*$+(9,5 MeV) als Funktion der Massenzahl A aufgetragen, wobei B^* die Bindungsenergie des Grundzustandes und der Anregungszustände bedeutet. Vier Diagramme zeigen alle 0^+, T=1 und 1^+, 2^+ und 3^+, T=0 Zustände und solche ohne Spin-Bestimmung. Die Verbindungen der Punkte ergeben nahezu geradlinige Verläufe und fast parallelogrammförmige Figuren, wenn komplementäre Niveaus und Bezugspunkte hinzugefügt werden. Nach dieser Systematik, die von relativ reinen Unterschalenzuständen ausgeht, ist der Energiegewinn beim Hinzufügen von 2 Protonen und 2 Neutronen in die $1d_{5/2}$ Unterschale unabhängig davon, wie viele Nukleonen sich schon in den Unterschalen $1d_{5/2}$ und $1d_{3/2}$ befinden. Er ist aber größer, wenn die $2s_{1/2}$ Unterschale mit 2 oder 4 Nukleonen besetzt ist. Von den 99 verwendeten Kernzuständen haben 65 einen bekannten Spin. Die verbleibenden 34 bestehen aus 4 komplementären Niveaus und 15 Bezugspunkten, von denen allein 9 bei ^{22}Na auftreten, weil es als Rumpf den anormalen Grundzustand von ^{20}Ne hat (siehe Zitat unten). Bei 15 Niveaus fehlt die Bestimmung des Spins noch. Eine Tabelle gibt insgesamt 39 wünschenswerte experimentelle Klarstellungen an. Die Untersuchung ist im Einklang mit derjenigen für die Nuklide mit N=Z und A=4n (J. Phys. Soc. Jpn. **75**, No.12, 2006).

HK 12.5 Di 15:15 D

Search for E0 Transitions in Mg Isotopes around the Island of Inversion* — •W. Schwerdtfeger[1,3], V. Bildstein[2,3], D. Habs[1,3], T. Kröll[2,3], R. Krücken[2,3], T. Morgan[1,3], O. Schaile[1,3], M. Sewtz[1,3], P. Thirolf[1,3], and K. Wimmer[1,3] for the IS414-Collaboration — [1]Department für Physik, LMU München — [2]E12, TU München — [3]Maier-Leibnitz-Laboratorium, Garching

Around the island of inversion a coexistence of spherical and deformed 0^+ states in neutron rich Mg nuclei is predicted. Resulting from a fast timing experiment on ^{30}Mg at ISOLDE the 1789 keV state is expected to be a candidate for the deformed 0^+ state with a potentially strong E0 decay branch to the spherical 0^+ ground state. Two different estimates for $\rho^2(E0)$ can be derived (i) from the measured deformation of the 0_1^+ state in ^{32}Mg taken as an estimate for the deformation of the 0_2^+ state in ^{30}Mg and (ii) from the $A^{-2/3}$ scaling based on the known value in ^{24}Mg, resulting in $\rho^2(E0) \sim 0.02 - 0.26$. In a first experiment using a Mini-Orange spectrometer a limit for the E0 strength $\rho^2(E0) \leq 0.26$ (absolute intensity $\leq 0.1\%$) could be derived. An improved experiment was done measuring E0 decay in coincidence with β-decay. An improvement by a factor of 12 for the peak-to-background ratio was reached allowing for a reduced limit of $\rho^2(E0) \leq 0.08$ (absolute intensity $\leq 0.03\%$). However the electron spectrum still contains a sizable amount of background electrons. GEANT4 simulations have been performed in order to design a new target chamber, reducing background from Compton scattering and pair creation.

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HK 12.6 Di 15:30 D

First measurement of the spin/parity and magnetic moment neutron-rich ^{33}Mg using β-NMR — D. Yordanov[1], •M. Kowalska[2], K. Blaum[2,3], K. Flanagan[1], P. Lievens[4], R. Neugart[2], and G. Neyens[1] — [1]Instituut voor Kern- en Stralingsfysica, K.U. Leuven, Belgium — [2]Institut für Physik, Universität Mainz, Germany — [3]GSI, Darmstadt, Germany — [4]Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U. Leuven, Belgium

The well-established shell model fails in some more exotic parts of the nuclear landscape where the shell gaps and magic numbers seem different than closer to stability. One of such regions is the "island of inversion" located around Z = 10-12 and the N = 20 magic number, characterised by ground-state deformations which are surprisingly large for closed-shell nuclei. With our β-NMR spectroscopy setup, located at ISOLDE/CERN, in 2006 we continued our recent studies of the "island of inversion". By optically pumping ^{33}Mg$^+$ ions with UV laser light and by using the hyperfine interaction of the nucleus with atomic electrons or external magnetic fields, we have determined the hyperfine structure and the Larmor frequency of the ^{33}Mg nucleus.

This allowed to measure for the first time the ground-state spin and magnetic moment of ^{33}Mg. The latter was found to have a negative sign, consistent with a large 2p2h component of the ground state wave function and corresponding to a negative parity. In the talk we will present the physics motivation of our studies, the experimental technique, as well as the results and their interpretation in the context of the shell model. (Supported by BMBF, FWO and EU)

HK 12.7 Di 15:45 D

First Tests of a new Setup for Transfer Experiments @ REX-ISOLDE — •Vinzenz Bildstein[1], Roman Gernhäuser[1], Thosten Kröll[1], Reiner Krücken[1], Riccardo Raabe[2], and Piet Van Duppen[2] for the MINIBALL-Collaboration — [1]Physik-Department E12, TU München, Germany — [2]Instituut voor Kern- en Stralingsfysica, Katholieke Universiteit Leuven, Belgium

Transfer reactions yield important spectroscopic information about isotopes, including spin and parity assignments to nuclear levels and spectroscopic factors. The corresponding information is still lacking for many nuclei far from stability, e.g. in the region of the "island of inversion" [1].

A previous experiment [2], studying the d(^{30}Mg, ^{31}Mg)p reaction with MINIBALL at REX-ISOLDE, has shown the need to cover an extended angular range in order to unambiguously determine the transferred angular momentum. Therefor a new setup for transfer experiments in inverse kinematics at REX-ISOLDE was designed which consists of two segmented annular detectors and a barrel of position sensitive strip detectors.

The status and the results of first tests of this new setup as well as simulations will be presented.

[1] C. Thibault et al., Phys. Rev. C 12, 644 (1975)

[2] M. Pantea, PhD Thesis, TU Darmstadt, Germany (2005)

*supported by BMBF 06MT190 and 06MT238

HK 12.8 Di 16:00 D

Magnetic Quadrupole Modes in Selfconjugate sd-Shell Nuclei from Electron Scattering at 180° — •Maksym Chernykh[1], Natalya Goncharova[2], Peter von Neumann-Cosel[1], Natalya Pronkina[2], and Achim Richter[1] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Germany — [2]Institute of Nuclear Physics, Moscow State University, Russia

Magnetic quadrupole modes in the selfconjugate nuclei ^{24}Mg, ^{28}Si and ^{32}S have been studied in 180° electron scattering at the S-DALINAC. The experimental form factors and B(M2) strength distributions are compared to particle-core shell-model calculations which provide a satisfactory description of the experimentally observed fragmentation. The role of orbital contributions (the so-called "twist mode") and of a quenching of the spin response are investigated.

HK 12.9 Di 16:15 D

Lifetime and g-factor measurements on Coulomb excited ^{36}S beams$^+$ — Stefan Schielke[1], Karl-Heinz Speidel[1], •Jörg Leske[1,2], Norbert Pietralla[2], Tan Ahn[2], Alin Costin[2], Oscar Zell[3], Shadow JQ Robinson[4], Alberto Escuderos[5], Yitzhak Sharon[5], Larry Zamick[5], and Jean Gerber[6] — [1]University of Bonn — [2]TU Darmstadt — [3]University of Cologne — [4]University of Southern Indiana, USA — [5]Rutgers University, USA — [6]IReS, Strasbourg

In view of recent studies on Ar- [1] and Ca- [2] isotopes indicating significant cross-shell neutron excitations at the $N = 20$ shell gap causing appropriate nucleon configurations in the nuclear wave functions, the g factor of the 2_1^+ state in semi-magic ^{36}S has been determined for the first time. In addition, the lifetimes of the 2_1^+ and 3_1^- states were redetermined with higher precision, and the g factor of $^{40}Ar(2_1^+)$ was remeasured. Projectile Coulomb excitation and α transfer reaction in inverse kinematics were combined with transient fields in gadolinium. ^{36}S beams were provided by the Cologne tandem accelerator. The de-excitation γ rays were detected with NaI(Tl) scintillators in coincidence with forward scattered carbon ions using a multilayered target with a thin carbon layer. The experimental data are compared with results from large scale shell model calculations. $^+$ supported by the BMBF and the DFG

[1] K.-H. Speidel et al., Phys. Lett. B 632 (2006) 207

[2] S. Schielke et al., Phys. Lett. B 571 (2003) 29