HK 72: Nuclear Structure and Dynamics II

Time: Thursday 16:30–19:00 Location: H-ZO 50

Group Report HK 72.1 Th 16:30 H-ZO 50

^{14}C Dating Beta Decay with Chiral Effective Field Theory — •Jeremy Holt, Norbert Kaiser, and Wolfram Weise — Technische Universität München, München, Germany

The anomalously long beta-decay lifetime of ^{14}C, which is essential for the science of radiocarbon dating, has long been a challenge for nuclear structure theory. Here we present a shell model calculation of this decay, treating the initial and final nuclear states as two p-holes in an ^{16}O core. Employing the low-momentum nucleon-nucleon (NN) interaction V_{low-k} only, we find that the Gamow-Teller transition matrix element is too large to describe the known lifetime of ^{14}C. As a novel approach to this problem, we invoke the chiral three-nucleon force (3NF) at leading order and derive from it a density-dependent in-medium NN interaction. After including these in-medium contributions, we find that the Gamow-Teller matrix element vanishes at a nuclear density close to that of saturated nuclear matter. The genuine short-range part of the 3NF is identified as the most important contribution leading to the observed suppression, and we find that although individual terms arising from the long- and medium-range parts of the chiral 3NF can be large, they significantly cancel. Work supported in part by BMBF, GSI, and by the DFG cluster of excellence: Origin and Structure of the Universe.

HK 72.2 Th 17:00 H-ZO 50

Quasi-free Scattering in Inverse Kinematics with the Proton-Dripline Nucleus ^{17}Ne — •Felix Wamers for the LAND-S318-Collaboration — Gesellschaft für Schwerionenforschung, 64291 Darmstadt, Germany

^{17}Ne is a proton-dripline nucleus that has raised special interest in nuclear structure physics in recent years. It has a half life of 109.2 ms and a low two-proton separation energy of 950 keV. It's a (^{15}O-p-p) 3-body borromean system, i.e. all its 2-body subsystems (p-p, ^{16}F-p) are unbound. ^{17}Ne is considered to be a potential 2-proton-halo nucleus, yet lacking final and concluding experimental evidence about its structure.
The S318-LAND collaboration has studied reactions of 500 AMeV ^{17}Ne secondary beams at GSI. One focus was put on employing quasi-free scattering in inverse kinematics at these relativistic energies. In other words, the ^{17}Ne(p,2p)^{16}F $\rightarrow$ ^{15}O+p proton knockout reaction on hydrogen atoms in a paraffin (CH_2) target was studied with a kinematically complete measurement. Recoil protons have been detected with Si-Strip detectors and the surrounding 4 π NaI spectrometer "Crystal Ball".
In a preliminary analysis, events with ^{17}Ne and ^{15}O in initial and final state, respectively, together with 2 coincident protons in the Crystal Ball have been observed. Angular and energy correlations of these scattered protons have been obtained and will be discussed.

HK 72.3 Th 17:15 H-ZO 50

Isospin symmetry in the A=12 system using both beta decay and M1 gamma decays — •martin alcorta[1] and the 12c-kvi collaboration[2] for the MAGISOL-Collaboration — [1]Instituto de Estructura de la Materia, CSIC, Madrid, Spain — [2]KVI Rijksuniversiteit Groningen, Zernikelaan 25 9747 AA Groningen, the Netherlands

The A=12 isobars provide an excellent system for testing isospin symmetry. The Gamow-Teller strength to states in ^{12}C populated in the β decays of ^{12}B and ^{12}N can be directly compared. By using the parallels between the Gamow-Teller operator and the operator for M1 γ transitions this isospin symmetry can also be tested in the T_3=0 member of this isospin triplet.

We have precisely measured the branching ratios to unbound states in ^{12}C populated in the β decay of both ^{12}B and ^{12}N by implanting these nuclei in a segmented Si detector at KVI, Groningen. By studying the ^{10}B(^{3}He,p$\alpha\alpha\alpha$) reaction in complete kinematics we were able to observe M1 γ decay of the 15.11 MeV T=1 IAS of the ^{12}B and ^{12}N ground states to the same unbound states populated in the β decays. This allows us to improve the values of the overall branching ratios of the γ decay of the T=1 15.11 MeV state. The results from these two experiments gives us a complete picture of branching ratios of the decay from the A=12 isospin triplet leading to an improved test of the isospin symmetry. In this contribution we will present our results on the γ branching intensities from the 15.11 MeV state and the β decay transition rates of ^{12}B and ^{12}N and compare these to state-of-the-art calculations.

HK 72.4 Th 17:30 H-ZO 50

Reaction study of ^{11}Li on ^{208}Pb target at energies close the Coulomb barrier — •mario cubero[1], maria jose borge[1], olof tengblad[1], martin alcorta[1], miguel madurga[1], joaquin camacho[2], ismael martel[3], and pat walden[4] — [1]Instituto de Estructura de la Materia, Madrid, Spain — [2]Departamento de Física Atómica, Molecular y Nuclear, Universidad de Sevilla, Sevilla, Spain — [3]Departamento de Física Aplicada, Universidad de Huelva, Huelva, Spain — [4]TRI-University Meson Facilities, University of British Columbia, Vancouver Canadá

In the past 20 years there has been interest among the nuclear physics community to study the exotic properties observed in halo nuclei such as ^{11}Li. Recent theoretical calculations predicted a deviation of the elastic cross section from the standard Rutherford formula, expected due to the dipole structure formed by the ^{9}Li core and the halo neutrons when passing near the strong Coulomb produced by the Pb target. To explore this effect, the scattering and breakup reactions of the two-neutron halo nucleus ^{11}Li were measured at ISACII-TRIUMF. Data was obtained at energies around, below and above the Coulomb barrier, 2.7MeV/u. We used a set of four telescopes with PAD silicon detectors behind in order to clearly identified all fragments in the full detection angles covering 10-140 degree.In this contribution we will present the analysis of the ^{9}Li scattering data that it is needed to understand the effect on the ^{11}Li cross sections. We will also present preliminary results of the ^{11}Li scattering.

HK 72.5 Th 17:45 H-ZO 50

Microscopic study of Neon isotopes, including the two-proton halo ^{17}Ne — •Thomas Neff and Hans Feldmeier — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Fermionic Molecular Dynamics (FMD) is a many-body approach that uses Gaussian wave-packets localized in phase-space as single-particle states. The wave-packet basis is very flexible and includes harmonic oscillator and localized cluster states. The width of the wave-packets is a variational parameter which helps to describe extended nuclear halos. The intrinsic many-body basis states are projected on parity, angular momentum and linear momentum. The Hamiltonian is finally diagonalized in a set of many-body states. In this talk I will present calculations for the Neon isotopes $^{17-22}$Ne. The calculated charge radii describe very well recent experimental results from the COLLAPS collaboration. The calculations show that ^{17}Ne (^{18}Ne) can be considered as ^{15}O (^{16}O) plus two protons in either s^2 or d^2 configurations. In ^{17}Ne we find an extended s^2-component with about 40% contribution explaining the very large charge radius. In ^{18}Ne the s^2-component is only 15% corresponding to a smaller radius. In ^{19,20}Ne again very large charge radii are observed which are due to the admixture of ^{3}He and ^{4}He cluster configurations into the ground states.

[1] W. Geithner, T. Neff, et al., accecpted for publication in Phys. Rev. Lett.

HK 72.6 Th 18:00 H-ZO 50

One-nucleon knockout reactions from proton-rich carbon isotopes — •Vasily Volkov for the S341-Collaboration — Institut für Kernphysik, Technische Universität Darmstadt, Germany

We present selected results of one-nucleon knockout reactions from relativistic proton-rich carbon beams performed at the fragment separator FRS at GSI within experiment S341. Beams of ^{9,10,11,12}C were produced in fragmentation reactions. The secondary beam impinged on a beryllium target at the second focus (S2) of the FRS. To maximize transmission, the reaction residues were measured at the third focus (S3) of the FRS. We will show preliminary cross sections for one-nucleon removal reactions. We aim at a quantitative understanding of absolute spectroscopic factors that appear to be quenched for deeply bound nucleons [1-3].

[1] B. A. Brown et al., Phys. Rev. C 65, 061601 (R) (2002)
[2] A. Gade et al., Phys. Rev. Lett. 93, 042501 (2004)
[3] A. Gade et al., Phys. Rev. C 77, 044306 (2008)
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PIET.

HK 72.7 Th 18:15 H-ZO 50

Two-nucleon removal cross sections from ^{11}C — •Matthias Holl for the S341-Collaboration — Institut für Kernphysik, Technische Universität Darmstadt, Germany

The removal of two well-bound nucleons has been identified as a direct reaction process [1,2]. We report on preliminary results obtained at GSI's fragment separator FRS for the two-nucleon removal reactions from relativitstic radioactive ^{11}C. The FRS was operated in a high-acceptance mode with the reaction residues being detected at the third focus (S3) of the FRS.

[1] D. Bazin et al., Phys. Rev. Lett. 91, 012501 (2003)

[2] J. A. Tostevin, B. A. Brown, Phys. Rev. C 74, 064604 (2006)

Work supported in part by GSI Research and Development Contract DA PIET.

HK 72.8 Th 18:30 H-ZO 50

Study of 15F energy levels — •Florence de Grancey and François de Oliveira — GANIL, CEA/DSM-CNRS/IN2P3, Caen, France

Energy levels of ^{15}F have been studied by resonant elastic scattering in inverse kinematic. A 84MeV ^{14}O radioactive ions beam was produced by SPIRAL facility with an intensity of 10^5 particles per second and was sent onto a thick 150 um polypropylene target. Energy calibration was obtained using resonances from resonant elastic scattering measurement of ^{14}N stable beam.

The two lowest resonances in ^{15}F were seen at 1.35 MeV and 2.78 MeV resonant energies, consistent with previous measurements. Moreover, a destructive resonance has been measured at an resonant energy of 4.78 MeV, which correspond to the second excited. Its total width has been estimated at 80keV. At this energy, this state is located 160 keV below 13N+2p threshold, opening the channel for diproton decay.

Several events of diproton decay coming from this second excited state have been observed and interpreted as sequential decay via a virtual state in ^{14}O. Experimental width for this diproton emission has been estimated at 12eV.

Analysis is still in progress.

HK 72.9 Th 18:45 H-ZO 50

Importance-Truncated No-Core Shell Model for Ab-Initio Nuclear Structure Calculations — •Robert Roth — Institut für Kernphysik, Tech. Univ. Darmstadt, Darmstadt, Germany

Ab-initio methods for the solution of the nuclear many-body problem play a crucial role for the development of a consistent QCD-based theory of nuclear structure and reactions. Many of the established ab-initio methods, like the no-core shell model (NCSM), are limited to light nuclei or very small $N_{\max}\hbar\Omega$, simply because the model spaces become prohibitively large. In this talk an adaptive importance-truncation scheme is presented, which employs an a priori selection of the important basis states via perturbation theory and thus reduces the model-space dimension to a tractable size. The major elements and properties of this importance-truncated no-core shell model (IT-NCSM) are discussed. Results for ground and excited states of closed and open-shell nuclei up to mass $A \approx 40$ are presented and compared to full NCSM calculations. The properties of the IT-NCSM are contrasted with those of coupled-cluster approaches. An outlook to reaction calculations using IT-NCSM wave functions is given.