HK 6: Nuclear Structure and Dynamics I

Time: Monday 14:00–16:00 Location: H-ZO 40

Invited Group Report HK 6.1 Mo 14:00 H-ZO 40
Shell Structure in Neutron-Rich Nuclei around Z=20 — •Bogdan Fornal — Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland

It has been proven that the idea of a shell structure may be considered as an essential concept in understanding the atomic nucleus. According to that picture, the nucleons in a nucleus occupy well defined orbitals what implies that they move in a well defined average potential. The non-uniformities of the quantum states distribution in energy form the shells separated by the energy gaps - complete filling of the shells in nuclei along the stability valley occurs at magic numbers of nucleons: 2, 8, 20, 28, 50, 82, and 126. Recent investigations have shown, however, that magic numbers are not as universal as one might think. Examples of structural changes in nuclei with large neutron excess include the appearance of energy gap at N=32. The existence of this energy gap around Z=20 arises from the sizable energy spacing between the neutron p3/2 orbital and the higher lying p1/2 and f5/2 states. The studies of the location of single-particle states in 49Ca also pointed to a 2-MeV energy spacing between the two higher lying neutron orbitals p1/2 and f5/2. Such a finding could possibly have pointed to the presence of another subshell closure associated with the filling of the p1/2 orbital, i.e., at N = 34. However, the structure of very neutron-rich nuclei around Z=20 appeared to be very hard to reach. In the presentation, the status and perspectives of experimental investigations of the shell structure in exotic nuclei from the vicinity of N=34 will be discussed.

Invited Group Report HK 6.2 Mo 14:30 H-ZO 40
Recent results on knockout reactions at relativistic energies in the psd shell — •Dolores Cortina-Gil — Universidad Santiago de Compostela

Large isospin variations in exotic nuclei are predicted to modify the nuclear mean-field picture together with the long and short-range correlations. The role of certain residual interactions becomes enhanced with proton-neutron asymmetry, in particular the monopole interaction that acts between proton-neutron spin-orbit partners. The combination of all these effects is at the origin of the observed change in traditional magic numbers. Recent studies of light neutron-rich isotopes near the neutron dripline have shown very exciting issues suggesting the collapse of the N=20 shell closure in favour of the appearance of new magic numbers at N=14,16. The study of nuclear structure in the vicinity of these new magic numbers represents a key issue for the understanding of the evolution of the shell structure with isospin.

Direct reactions are currently used to explore nuclear structure. These reactions, exciting a minimal number of degrees of freedom, are very precise probes of single-particle motion. Among them, the reaction channel involving the removal of a single nucleon, known as one-neutron nuclear knockout, is favoured because of its relatively high cross-section. Using the FRS at GSI, we have studied this reaction channel in several experiments to elucidate the wave function of exotic nuclei.

We will present in this talk few selected experimental examples corresponding to nuclear knockout of Z=6-13 n-rich exotic projectiles.

HK 6.3 Mo 15:00 H-ZO 40
Shell model description of negative parity intruder states in sd nuclei — •Mouna Bouhelal[1,2], Florent Haas[1], Etienne Caurier[1], and Frédéric Nowacki[1] — [1]IPHC, CNRS/IN2P3, Université de Strasbourg, F-67037 Strasbourg Cedex 2, France — [2]Département des Sciences de la Matière, Université de Tébessa, Tébessa 12002, Algérie

To describe in a consistent way the negative parity intruder states throughout the sd shell, a new interaction has been developed in the psdpf model space with a ^4He core. These 1 $\hbar\omega$ states result from the promotion of one nucleon from p to sd shell for nuclei close to ^{16}O or from sd to pf for nuclei close to ^{40}Ca. Our interaction is based on existing interactions for the major shells; however, to describe the 1 $\hbar\omega$ states the cross shell parts are essential. They have been adjusted through a fitting procedure involving the well known negative parity states of sd nuclei close to the stability line.

The obtained PSDPF interaction has then be used to calculate energy spectra and electromagnetic properties of nuclei throughout sd. As an example, we will present our results for isotopic chains of P and S isotopes with $N \sim Z-2$ to N=20 and compare them with experimental spectroscopic data

HK 6.4 Mo 15:15 H-ZO 40
Measurement of the one-neutron removal momentum distribution characterizes ^{24}O as a new doubly magic nucleus — •A. Prochazka for the s322-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — Justus-Liebig-Universität, Gießen, Germany

First results are reported on the momentum distribution after one-neutron removal from ^{24}O at 920 MeV/u. The investigated isotopes were produced by projectile fragmentation of a 1 GeV/u ^{48}Ca beam in a beryllium production target placed at the entrance of the FRagment Separator (FRS). They were separated and identified in-flight at the mid-focal plane of the separator, where a carbon reaction target was placed. Due to the high resolution of the FRS, operated in dispersion matched-mode, precise momentum measurements of secondary fragments could be performed. The secondary fragments produced in the C target were detected at the final achromatic focal plane of the FRS thus providing the measurements independently of the large momentum spread of the primary fragments. The ^{23}O momentum distribution in the projectile rest frame and the one-neutron removal cross section can be well explained by using an eikonal model with a nearly pure $2s_{1/2}$ occupation probability. This large s-wave probability indicates a spherical shell closure at N=16, thereby experimentally confirming earlier suggestions that ^{24}O is a new doubly magic nucleus.

HK 6.5 Mo 15:30 H-ZO 40
Benchmarking relativistic knock-out reactions with ^{48}Ca* — •Sabine Schwertel for the S277-Collaboration — E12 Physik Department, TU München, Garching

The evolution of shell structure in neutron rich nuclei far from the valley of stability is one of the most interesting topics in modern nuclear-structure research. Knockout experiments in combination with high resolution γ-spectroscopy can be used to probe single-particle states and to test theoretical predictions.

As part of a knock-out experiment on ^{56}Ti at the GSI FRS a reference experiment was performed with ^{48}Ca primary beam to establish the method. Several detectors (TPCs, MUSIC, TOF) provided a full identification of all incoming and outgoing fragments and the measurement of the momentum transfer in the knockout-reaction on an event-by-event basis. To tag reaction channels with excited residual nuclei, the Miniball spectrometer was used.

Momentum distributions and spectroscopic factors were determined for ^{47}K and ^{47}Ca. These are compared to shell model predictions as well as to values from transfer electron scattering experiments.
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HK 6.6 Mo 15:45 H-ZO 40
In-trap decay of ^{61}Mn and Coulomb excitation of ^{61}Mn/^{61}Fe — •Jarno Van de Walle for the IS468-Collaboration — ISOLDE CERN, Geneve, Switzerland

In an explorative experiment at REX-ISOLDE, the feasibility to produce a post-accelerated beam of neutron rich iron isotopes by means of in-trap decay of neutron rich manganese isotopes was investigated. Iron isotopes are not directly accessible from the primary target, due to their long diffusion time in the primary target. The available highly selective Resonance Ionization Laser Ion Source (RILIS) [1] was utilized to produce an intense and pure beam of ^{61}Mn (half-life = 670(40) ms) isotopes. This beam was injected in the REXTRAP [2] and the EBIS (Electron Beam Ion Source) [3], where the isotopes were trapped and charge bred over extended time periods, in order to obtain a significant amount of the β^- decay daughter ^{61}Fe (half life = 5.98(6) min).

In this contribution the proof of principle of this production method at REX-ISOLDE will be given, together with the first physics results on the Coulomb excitation of ^{61}Mn and ^{61}Fe and the technical difficulties that were encountered. Some other potential candidates for in-trap decay experiments will be given. This in-trap decay of radioactive isotopes provides potentially an alternative method to produce post-accelerated beams of elements which are difficult to extract from thick

ISOL targets at current and future facilities.

[1] V.N. Fedoseyev *et al.*, Hyp. Int. **127**, (200) 409.
[2] F. Ames *et al.*, Nucl. Instr. Meth. A **538**, (2005) 17.
[3] F. Wenander *et al.*, Nucl. Phys. A **701**, (2002) 528.