HK 27: Nuclear Structure and Dynamics II

Time: Tuesday 14:00–16:00 Location: H-ZO 50

HK 27.1 Tu 14:00 H-ZO 50

Beyond the relativistic mean-field approximation: configuration mixing calculations — •Tamara Niksic[1], Dario Vretenar[1], and Peter Ring[2] — [1]Physics Department, University of Zagreb, Croatia — [2]Physics Department, Technical University Munich, Germany

The framework of relativistic self-consistent mean-field models is extended to include correlations related to the restoration of broken symmetries and to fluctuations of collective variables. The generator coordinate method is used to perform configuration mixing of angular-momentum and particle-number projected relativistic wave functions. Intrinsic wave functions are generated from the solutions of relativistic mean-field equations, with a constraint on the mass quadrupole moment. The model, currently restricted to axially symmetric shapes, employs a relativistic point-coupling (contact) nucleon-nucleon effective interaction in the particle-hole channel, and a density-independent δ-interaction in the pairing channel. Both global and spectroscopic properties of nuclei are discussed.

In addition, an implementation of the five-dimensional collective Hamiltonian for quadrupole vibrational and rotational degrees of freedom is developed. The parameters are determined by constrained self-consistent mean-field calculation for triaxial shapes. The model is applied to nuclei in the Z=60,62 and 64 with N∼90 region of the periodic chart.

HK 27.2 Tu 14:15 H-ZO 50

Pion production in neutrino-nucleus interactions — •Christophe Praet, Natalie Jachowicz, and Jan Ryckebusch — Ghent University, B-9000 Gent, Belgium

Understanding the process of one-pion production, one of the most prominent reactions at few-GeV energies, is essential for a proper analysis of oscillation experiments. In addition, important questions with regard to the axial sector of hadronic and nuclear physics ask for further investigations. We have developed a formalism to study Δ-mediated one-pion production in neutrino-nucleus interactions [1]. We assess ambiguities stemming from the Δ couplings and quantify the uncertainties in the axial form factors by comparing model predictions with bubble-chamber data. Nuclear effects are described in terms of the relativistic plane-wave impulse approximation using realistic bound-state wave functions. Medium modifications to the Δ mass and width are taken into account. We present various distributions, against Q^2, W and outgoing-lepton variables.

Recently, the process of coherent pion production from nuclei has attracted a lot of interest. We find that nuclear effects are large. We add two new features to the existing models. First, we go beyond the so-called *local approximation*, and take into account the full nuclear dynamics of the process. Second, the attenuation of the pion by the medium is computed by means of Glauber transparencies. We present pion distributions for a variety of target nuclei and neutrino energies.

[1] C. Praet, O. Lalakulich, N. Jachowicz and J. Ryckebusch, arXiv:0804.2750 [nucl-th].

HK 27.3 Tu 14:30 H-ZO 50

Self-consistent theory of charged current neutrino-nucleus reactions — •Nils Paar[1], Tomislav Marketin[1], Dario Vretenar[1], and Peter Ring[2] — [1]Physics Department, Faculty of Science, University of Zagreb, Croatia — [2]Physik-Department der Technischen Universitaet Muenchen, D-85748 Muenchen, Germany

A novel theoretial framework has been introduced for description of neutrino induced reactions with nuclei[1,2]. The properties of target nuclei are determined in a self-consistent way using relativistic mean-field framework based on effective Lagrangians with density dependent meson-nucleon vertex functions. The weak lepton-hadron interaction is expressed in the standard current-current form, the nuclear ground state is described in the relativistic Hartree-Bogoliubov model, and the relevant transitions to excited nuclear states are calculated in the proton-neutron relativistic quasiparticle random phase approximation[3]. This framework has been employed in studies of charged-current neutrino reactions involving nuclei of relevance for neutrino detectors, r-process nuclei, and neutrino-nucleus cross sections averaged over measured neutrino fluxes and supernova neutrino distributions.

[1] N. Paar et al., Phys. Rev. C 77, 024608 (2008).
[2] N. Paar et al., J. Phys. G 35, 014039 (2008).
[3] N. Paar, D. Vretenar, E. Khan, and G. Colo, Rep. Prog. Phys. 70, 691 (2007).

HK 27.4 Tu 14:45 H-ZO 50

Low-lying magnetic excitations of doubly-closed-shell nuclei and the nucleon-nucleon effective interaction — •Viviana De Donno[1], Giampaolo Co'[1], Chiara Maieron[1], Marta Anguiano[2], Antonio Miguel Lallena[2], and Miguel Moreno Torres[2] — [1]Dipartimento di Fisica, Università del Salento and INFN Sezione di Lecce, Via Arnesano, I-73100 Lecce, ITALY — [2]Departamento de Física Atómica, Molecular y Nuclear, Universidad de Granada, E-18071 Granada, SPAIN

The description of low-lying magnetic states of doubly-closed-shell nuclei puts severe constraints on the spin and tensor channels of the effective nucleon-nucleon interaction. A study of the low lying magnetic spectra of ^{12}C , ^{16}O , ^{40}Ca , ^{48}Ca and ^{208}Pb nuclei within the Random Phase Approximation (RPA) theory is presented. An investigation by using four phenomenological effective interactions comparing results for spectra and electron scattering form factors with experimental data is shown. Then self-consistent RPA calculations are presented to test the validity of the finite range D1 Gogny interaction. Particular attention has been paid to observe the sensitivity of the quantities studied to different interactions.

HK 27.5 Tu 15:00 H-ZO 50

Nuclear response using realistic interactions and extended RPA theories — •Panagiota Papakonstantinou, Anneke Günther, Heiko Hergert, Sabine Reinhardt, and Robert Roth — Institut für Kernphysik, T.U. Darmstadt, Germany

Realistic interactions, renormalized within the Unitary Correlation Operator Method, were employed recently in Second RPA (SRPA) calculations of nuclear response. Results will be presented and the main lessons learned will be discussed. In particular, our results, which represent a great improvement over our earlier RPA calculations, as well as physical arguments, suggest the prospect of describing nuclear collective excitations realistically and consistently using extended RPA (ERPA) theories, like SRPA, and renormalized interactions with good convergence properties.

Up to now, only two-body Hamiltonians have been considered and most of the results have been obtained using a softened Argonne V18 potential. Appropriate three-body terms can be included to improve the Hamiltonian. Prospects with chiral interactions will also be discussed. Further issues to be addressed are related to the ERPA method itself: The standard SRPA based on the quasi-boson approximation may not be the best RPA extension, as it suffers from intrinsic inconsistencies and instabilities.

HK 27.6 Tu 15:15 H-ZO 50

Chiral nuclear forces on the lattice — •Hermann Krebs — Universität Bonn, HISKP, Nussallee 14-16, 53115 Bonn

Nuclear lattice simulations based on effective field theory provide a powerful method to describe few- and many-body systems at low energy without losing connection to QCD. The lattice effective field theory approach addresses the few- and many-body problem in nuclear physics by applying non-perturbative lattice methods to low-energy nucleons and pions. The effective Lagrangian is formulated on a space-time lattice and the path integral is evaluated by Monte Carlo sampling. Pions and nucleons are treated as point-like particles on the lattice sites. By using hadronic degrees of freedom and concentrating on low-energy physics, it is possible to probe large volumes and greater number of nucleons than in lattice QCD. In my talk I will present our recent studies of the two nucleon system and neutron matter at subleading order. Accurate description of two-nucleon phase-shifts and ground state energy ratio of dilute neutron matter up to corrections of higher orders show that lattice effective field theory is a promising tool for quantitative studies of low-energy few- and many-body systems.

Invited Group Report HK 27.7 Tu 15:30 H-ZO 50

Modern Beyond Mean Field Theories — •J. Luis Egido and Tomás R. Rodríguez — Universidad Autónoma de Madrid, Madrid, Spain

In this talk we review the progress made in the last years in Beyond Mean Field Theories. After a pedagogical presentation of concepts, like spontaneous symmetry breaking, angular momentum -and particle number- projection as well as configuration mixing, several applications of the theory will be presented.

First we study the recently proposed shell closures at N=32 and N=34. We have calculated the excitation energy of the 2+ states in the Ca, Ti and Cr isotopes. Our results nicely follow the experimental trend in all three nuclides. In particular we predict a shell closure for N=32 but not for N=34.

In a second application the spherical to prolate deformed shape transition in the Neodymium isotopic chain is analyzed. Our results do not support the interpretation of 150Nd as a critical point nucleus and question the interpretation of shape changes as nuclear shape phase transitions.

As a third issue the pathological excitation energies of the 2+ states of the Cd isotopes close to the semimagical 130Cd is analyzed. We find that it can be explained by a very remarkable nuclear structure effect.

Finally, preliminary results of the first triaxial angular momentum projection with the finite range density dependent Gogny interaction will be presented. In all calculations the D1S parametrization of the Gogny force will be used.