C O N T E N T S

NUCLEAR PHYSICS

By using the Lindblad theory for open quantum systems, an analytical expression of the tunneling probability through a parabolic potential is obtained. The penetration probability depends on the environment coefficients and it increases with the dissipation and the temperature of the thermal bath.

The origin of strong M1 transitions in odd-odd *N=Z* nuclei is analyzed. The correlation between M1 transition strengths and the weight of the deuteron-like isoscalar *L=0, S=1* component for two nucleon configurations is found. The evolution of quasideuteron configurations in deformed nuclei is discussed.

High-spin states of the nucleus ^{88}Sr have been studied via the reaction ^{80}Se(^{11}B, *p2n*) at a beam energy of 45 MeV with the six-detector array OSIRIS CUBE. The level scheme of ^{88}Sr has been extended up to $E \approx 11$ MeV and $J = 17$. Mean lifetimes of three levels have been determined using the Doppler-shift-attenuation method. The shell model calculations in the configuration space $(0f_{5/2}, 1p_{3/2}, 1p_{1/2}, 0g_{9/2})$ for the protons and $(1p_{1/2}, 0g_{9/2}, 1d_{5/2})$ for the neutrons were performed. These calculations describe the high-spin level sequences linked by M1 transitions with strengths of $B(\text{M1}) \approx 0.3$ to 1.4 W.u. as multiplets of seniority $v = 4$ and 6 states including proton configurations and neutron-core excitations.

The comparative analysis of the experimental and microscopic elastic scattering angular distributions of ^{6,8}He on ^{4}He has been performed. The calculated angular distributions have been obtained employing a microscopic real optical potential (OP) based on (a) Tanihata and COSMA models for the density distributions of Helium isotopes, and (b) the M3Y. BDM3Y, DDM3Y Paris *NN*-effective interactions. The sensitivity of the calculated cross sections with respect to both density distributions and *NN*-effective interactions is discussed. Finally, it has been found that Tanihata's density distributions and the density dependent DDM3Y Paris *NN* effective interaction led to better agreement with the experimental data.

The low-energy level structure of ^{58}Cr has been studied following the beta decay of ^{58}V. This parent nuclide, along with eight additional neutron-rich nuclei, was produced by projectile fragmentation of a ^{70}Zn beam and implanted into a double-sided silicon strip detector (DSSD). Implants were identified based on ΔE-TOF information and correlated to beta decays in the DSSD. Beta-delayed gamma rays were monitored by an array of three Ge clover detectors and two high purity Ge detectors. The results from these observations will be discussed in light of the development of quadrupole collectivity in the even-even chromium isotopes toward the *N*=40 subshell closure.

Recent results indicate that in ^{152}Sm$_{90}$ a spherical excited configuration coexists with a deformed ground state configuration. Detailed knowledge of other $N = 90$ nuclei is important in studying the evolution of shape/phase coexistence along this isotonic chain. In the present study, low-lying states of ^{156}Dy$_{90}$ were populated in β decay and

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studied through γ-ray spectroscopy, permitting improved measurement of transition strengths important in the interpretation of the structure of ^{156}Dy.

The fine structure of ^{211}Po alpha decay is considered as a superasymmetric fission process. The occupation probabilities of the ground state and the excited states of the daughter ^{207}Pb are computed after the disintegration.

We have used the decay of ^{180m}Hf (t = 5.5 h) to obtain a very precise γ-ray calibration source in the 90 to 330 keV energy range. The decay of ^{180m}Hf to the ^{180}Hf ground state includes a cascade of three consecutive E2 γ-ray transitions of energies 332.3, 215.4 and 93.3-keV with no other feeding to the intermediate states. Since the total transition intensities must be the same, the relative γ-ray intensities emitted by the source are thus dependent only on the calculated E2 conversion coefficients. This provides a rather precise calibration standard.

The structure of Be and C isotopes is investigated using a microscopic model based on the molecular orbit (MO) picture. The low-lying states are characterized by several configurations of valence neutrons, which are constructed as combinations of three basic orbits. In ^{10}Be, all of the observed positive-parity bands and the negative-parity bands are described within the model, and the second 0^+ state has an enlargement of the α-α distance due to two-valence neutrons along the α-α axis (σ-orbit). The ^{12}Be nucleus is shown to exhibit similar characteristics, that the remarkable α clustering and the contribution of the spin-orbit interaction make the binding of the state with $(3/2^-_\pi)^2(1/2^+_\sigma)^2$ configuration properly stronger in comparison with the closed *p*-shell $(3/2^-_\pi)^2(1/2^+_\pi)^2$ configuration. Furthermore, the molecule-like structure of the C isotopes is investigated. The combination of the valence neutrons in the π- and the σ-orbit is promising to stabilize the linear-chain state against the breathing- and bending-modes, and it is found that the excited states of ^{16}C is one of the most promising candidates for such structure.

We propose a collective Hamiltonian which incorporates interactions capable of generating rotations in nuclei with the simultaneous presence of octupole and quadrupole deformations. It is demonstrated that the model formalism can reproduce the staggering effects observed in nuclear octupole bands. On this basis we propose that the interactions involved should provide a relevant tool to study collective phenomena in nuclei and other quantum mechanical systems with reflection asymmetric correlations.

Beta-decay properties of proton-rich nuclei in the mass region A ≈ 70 are studied within a selfconsistent framework based on a deformed HF + BCS + RPA calculation with density-dependent effective interactions of Skyrme type. We show results for ground state properties and for β^+-decay half-lives and Gamow-Teller strength distributions of two isotope chains (Se and Kr) approaching N = Z. We also discuss the sensitivity of the results to the nuclear shape.

In the framework of an European collaboration the next generation of large efficiency, high resolution spectrometers for nuclear spectroscopy is under development. The new spectrometers are large volume, segmented Ge-detectors featuring 3D position sensitivity in order to allow Gamma-Ray Tracking. That is, knowing the interaction positions and the energies released at each interaction, the track each gamma-ray follows during its scattering process inside the detector volume can be reconstructed on basis of the Compton-scattering formula. The resulting high add-back efficiency and effective granularity significantly improves peak-to-total ratio, efficiency, and Doppler-broadening of the spectrometer. In this contribution the status of the project concerning detector design and development of digital signal processing techniques to achieve an optimal 3D position sensitivity is presented.

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NUCLEAR ASTROPHYSICS

Recent achievements concerning *e.g.* the true half-rigid moment of inertia, and recent experimental level density data above 10-15 MeV have proved the need of additional work concerning parametrization of the nuclear level density for astrophysical applications. The various approaches developed for the energy-dependent level density parameter are reviewed. Finally the consistent description of all experimental data related to the nuclear level density is discussed.

In this work is presented a particular case of multivariate nonparametric analysis (Bayes) focused on EAS (Extensive Air Showers) muon arrival times measured with the Central Detector of the KASCADE experiment. The role of muon arrival times in primary mass discrimination is investigated.

Recent experiments support the existence of neutrino oscillations and by this imply that neutrinos have non vanishing masses. To explain the smallness of the neutrino masses we use a supersymmetric model. By including an additional $U(1)_x$ symmetry we were able to reconstruct the neutrino mass matrix for a given set of mixing angles and mass splittings in a unique way. The averaged Majorana neutrino mass comes out to be about 0.01-0.04 eV. This is a region which will be explored by the next generation of $0\nu\beta\beta$ decay experiments.

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