Preface

The XXI International Workshop on Nuclear Theory was held at Gjuletchitsa resort in Rila Mountains, Bulgaria, from 10^{th} to 15^{th} June, 2002. It was attended by about 50 participants from 12 countries: Bulgaria, France, Germany, Greece, Italy, Poland, Romania, Russia, Slovakia, Spain, Switzerland, USA. The Workshop is an annual event organized by the Laboratory of Nuclear Theory in the Institute of Nuclear Research and Nuclear Energy (INRNE, Sofia) of the Bulgarian Academy of Sciences. This year it was partly sponsored by the Committee on the Use of Atomic Energy for Peaceful Purposes and by the Bulgarian Nuclear Society.

The main topics were:
• nucleon-nucleon correlation effects on nuclear structure and reactions;
• algebraic methods in nuclear theory;
• density functional theory for many-fermion systems;
• exotic nuclei.

Prof. D. Day reviewed new results obtained by the traditional experimental methods used to extract neutron electromagnetic form factors G_E^n. Details of an experiment performed at Jefferson Lab were presented comparing the modern data set to the theory. Lecture of Prof. I. Sick was devoted to inclusive electron-nucleus scattering. In an attempt to answear to various open questions, he discussed new L/T-separations in the quasi-elastic region. Results of theoretical calculations that include an exact treatment of both initial (bound) and final (continuum) state and that take into account the contribution of meson exchange currents were presented. Prof. V. Zelevinsky gave a short review of new approaches to the description of many-body systems with strong interaction between constituents. Strong interactions bring in *many-body quantum chaos* which has specific features and manifestations. The paradoxical idea of "regularities of chaos" leads to new interpretations of various nuclear phenomena. The examples of new understanding include: statistical enhancement of weak perturbations, analysis of experimental data with poor resolution, thermodynamics and equlibrium in a small closed system, theory of strength functions and spreading widths, exponential convergence of eigenvalues in large-scale shell model calcu-

lations, predominance of ground state spin zero, new theoretical approximations based on chaoticity, dynamics and statistics of unstable or loosely bound states. Lecture given by Prof. K. Kubodera was focussed on the nuclear responses to electroweak probes in terms of effective field theory (EFT), the approach has been scoring impressive success for certain classes of nuclear phenomena. He focussed on calculations of the ν-d reaction cross sections, which are crucial in interpreting the neutrino oscillation experiment. Dr. S. Dimitrova discussed an approach to realistic nuclear shell model based on the density matrix renormalization group method. Dr. Garistov reported new results on phenomenological description of the yrast lines. He analysed the collective structure of the 0^+ states in terms of phonon excitations for a great amount of nuclei. Dr. E. Stoimenova talked about new ideas in estimating the activity concentrations of difficult-to-measure nuclides.

Lecture of Prof. G. Co' was devoted to short range correlations in finite nuclear systems. Form factors of discrete nuclear excitations were evaluated and inclusive excitations in the quasi-elastic region as well as the nucleon photoemission were analyzed. Prof. V. Karmanov presented calculations of three-boson relativistic bound states with zero-range interaction. He showed that for minimal relativistic model in the framework of the Light-Front Dynamics the three-body binding energy is finite due to relativistic repulsion, and the Thomas collapse is consequently avoided. Current issues in electromagnetic knockout reactions were reviewed by Prof. C. Giusti. Attention was given to final-state interactions, one-body and two-body currents, and different types of correlations in the overlap functions. The role and relevance of the different contributions was also discussed in comparison with experimental data. Lecture by Prof. J. Gómez-Camacho was devoted to continuum discretization by the THO method and its application to the scattering of weakly bound nuclei. The continuum discretization procedure provides a basis of transformed harmonic oscillator wave functions to accomplish the necessary calculations. Appropriate convergence of the elastic and breakup cross sections with increasing dimension of the basis was reported. Preliminary calculations including the effect of long range dipole Coulomb forces have also been presented. Lecture "Centauro And Strange Object Research in Nucleus-Nucleus Collisions at LHC" was presented by Dr. E. Gładysz-Dziaduś on behalf of the CASTOR group. The motivation to study the very forward phase space in nucleus-nucleus collisions at the LHC stems from the potentially very rich field of new phenomena to be produced in an environment of very high baryochemical potential. It was argued that such a study will provide important information for understanding of a QGP state at relatively low temperatures. Prof. M. Stoitsov made a systematic study of deformed nuclei at the drip lines and beyond. An improved prescription for choosing a THO basis for use in configuration-space Hartree-Fock-Bogoliubov (HFB) calculations was given. The calculations using the Skyrme Force SkLY4 and volume pair-

ing for all even-even nuclei from proton drip-line to neutron drip-line having proton numbers $Z = 4, 6, 8, ..., 108$ were carried out. He stated that there exist numerous particle-bound even-even nuclei (i.e., nuclei with negative Fermi energies) that have negative two-proton or two-neutron separation energies. In his contribution Dr. M. Gaidarov presented y-scaling analysis of the deuteron within the light-front dynamics method. The concept of relativistic scaling is applied to describe the most recent data from inclusive electron-deuteron scattering at large momentum transfer. Calculated asymptotic scaling function $f(y)$ of the deuteron using its relationship with the nucleon momentum distribution was presented. The one-dimensional harmonic oscillator in a box problem was considered to introduce a mixed-mode shell-model scheme in the talk given by Dr. V. Gueorguiev. The method is applied to nuclear physics by combining traditional spherical states, which yield a diagonal representation of the usual single-particle interaction, with collective SU(3) configurations that track deformation.

Prof. N. Van Giai reviewed the last results on microscopic treatment of continuum effects in neutron-rich nuclei. On the basis of the continuum-HFB solution one can build the continuum-QRPA approach which provides a consistent description of the excitations. The continuum-QRPA response function can be calculated. The results obtained for low-lying excitations and giant resonances in neutron-rich oxygen isotopes were presented and discussed. The interaction of light heavy ions, such as ^{12}C and ^{16}O, with nuclei yielding a considerable production of intermediate mass fragments was discussed in the lecture given by Prof. E. Gadioli. He demonstrated that a satisfactory explanation of the energy and of the angular dependence of their spectra can be obtained on the basis of the Boltzmann Master Equation theory assuming that they are produced by nucleon coalescence during the cascade of nucleon-nucleon interactions by which the excited composite nuclei (produced both in complete fusion of the two ions and in incomplete fusions of participant break-up fragments) reach the statistical equilibrium. Dr. E. Běták contributed by reviewing pre-equilibrium complex particle emission. He considered the processes and interplays of the competing mechanisms of pre-equilibrium cluster formation and emission, namely the coalescence, pick-up and knock-out. Nuclear structure in the dinuclear model was presented by Prof. W. Scheid. He investigated whether hyperdeformed nuclei can be interpreted as dinuclear cluster configurations. The calculated parity splitting and electric dipole, quadrupole and octupole transition moments observed in alternating parity bands in actinide nuclei are in agreement with experimental data. Prof. Ch. Stoyanov talked about the structure of low-lying excited states in even-even $N = 84$ nuclei as an example of interplay between collective and noncollective modes. In his talk Dr. N. Minkov referred to description of alternating parity bands in a quadrupole-octupole rotation model (QORM). He suggested that the QORM approach could provide a relevant handle in the study

of various complex shape phenomena along the whole nuclear chart including its near drip lines region as well as of the shape properties of other quantum mechanical system. Experimental results on beta decay of ^{100}In was discussed in the talk presented by A. Blazhev.

The quantum groups approach to nuclear spectra was considered by Prof. D. Bonatsos. He demonstrated how quantum algebras (quantum groups), which are nonlinear generalizations of the usual Lie algebras, can be used for constructing nuclear Hamiltonians which, in addition to the deformed symmetry $su_q(2)$, also obey the usual su(2) symmetry underlying physical angular momentum. Prof. A. Raduta offered an unified description of three positive and three negative parity interacting bands. Applications are made to ^{158}Gd, ^{172}Yb, ^{218}Ra, ^{226}Ra, ^{232}Th, ^{238}U, ^{238}Pu. New signatures for octupole deformation manifested in excited bands were pointed out. Dr. J. Dukelsky presented applications of generalized Richardson-Gaudin models to boson systems with repulsive pairing interactions. The model displays a quantum phase transition to a state in which only the two lowest single boson levels are macroscopically occupied. In her lecture Dr. A. Georgieva studied deformations of the boson and fermion representations of sp(4) and sp(4,R). She analyzed the boson and the fermion realization of the compact sp(4) and noncompact sp(4,R) with a view towards future applications in nuclear physics. Dr. R. Pavlov presented new results on hyperfine electron-nuclear interactions in the terms of density functional and of density matrix methods.

The participants had an opportunity to conquer attractive high mountains spots in the Rila Mountains. They also visited the famous Rila Monastery – symbol of the Bulgarian Christianity – situated in the heart of the Mountains.

The next XXII Workshop on Nuclear Theory is planned to be held in June 2003.

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