INSTYTUT FIZYKI JĄDROWEJ
im. HENRYKA NIEWODNICZAŃSKIEGO
HENRYK NIEWODNICZAŃSKI
INSTITUTE OF NUCLEAR PHYSICS

INP--1580

ZAKŁAD FIZYKI TEORETYCZNEJ
DEPARTMENT OF THEORETICAL PHYSICS

SPRAWOZDANIE ROCZNE
ANNUAL REPORT

1991

Radzikowskiego 152, 31-342 Kraków, POLAND

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1. FOREWORD

The research done at the Department of Theoretical Physics of the H. Niewodniczański Institute of Nuclear Physics concerns various theoretical problems of low, medium and high energy nuclear physics, elementary particle physics, astrophysics, general physics and mathematical physics. Both formal problems as well as the more phenomenologically oriented ones are being considered. Phenomenological research is closely linked with experimental program in elementary particle and nuclear physics in various laboratories in the world. This includes elaboration of predictions for experiments which will be performed at HERA, SSC and LHC colliders. Department of Theoretical Physics actively collaborates with other Departments of our Institute as well as with other institutes in Poland and abroad.

The research program is now formally divided into three main topics:

(1) - the role of the Galilean relativity principle in quantum mechanics,

(2) - dense and/or hot hadronic matter,

(3) - structure of hadrons studied in particle and nuclear interactions.

These are three approved proposals by the Scientific Research Committee within the new system of the scientific research finance policy in Poland. The details of the results obtained in various fields are summarised in the abstracts presented below.

Besides pure research our Department is actively engaged in the graduate and undergraduate teaching program. During 1991 one PhD and one Msc theses have been completed. At present we have three PhD students who should finish their theses during the forthcoming year. Also the lectures for graduate students at the Institute are read by the members of the Department.

Head of Theory Department

prof. dr hab. Jan Kwieciński

1. WPROWADZENIE

Badania prowadzone w Zakładzie Fizyki Teoretycznej Instytutu Fizyki Jądrowej im. H. Niewodniczańskiego dotyczą różnych problemów teoretycznych fizyki jądrowej niskich, średnich i wysokich energii, astrofizyki, fizyki ogólnej i fizyki matematycznej. Podejmowane są zarówno formalne problemy teoretyczne jak też zagadnienia o charakterze fenomenologicznym. Badania fenomenologiczne pozostają w ścisłym związku z programami eksperymentalnymi fizyki cząstek elementarnych i fizyki jądrowej różnych laboratoriów w świecie. Badania te obejmują m.in. opracowanie przewidywań teoretycznych dla eksperymentów, które będą prowadzone na akceleratorach HERA, SSC i LHC.

Zakład Fizyki Teoretycznej aktywnie współpracuje z innymi Zakładami naszego Instytutu oraz z różnymi Instytutami w Polsce i w innych krajach

Obecnie program badawczy jest formalnie podzielony na trzy następujące tematy:

1. Rola zasady względności Galileusza w mechanice kwantowej,
2. Gęsta i/lub gorąca materia hadronowa,
3. Struktura hadronów i oddziaływania cząstek jąder atomowych.

Powyższe trzy tematy są to tematy projektów badawczych zatwierdzonych do realizacji przez Komitet Badań Naukowych w ramach nowego systemu finansowania prac badawczych w Polsce. Szczegóły dotyczące wyników uzyskanych w różnych dziedzinach są przedstawione w streszczeniach.

Oprócz prowadzenia prac badawczych nasz Zakład jest również zaangażowany w działalność dydaktyczną i w kształcenie młodej kadry naukowej.

W 1991r. wykonana została w Zakładzie jedna praca magisterska i jedna praca doktorska. Obecnie w Zakładzie wykonuje pracę doktorską trzech doktorantów.

Pracownicy Zakładu prowadzą też wykłady dla studentów Studium Doktoranckiego IFJ.

Kierownik Zakładu Fizyki Teoretycznej

prof. dr hab. Jan Kwieciński

2. PRACOWNICY - STAFF

Lista stałych pracowników - Permanent staff

mgr Piotr *BOCHNACKI*

dr Wojciech *BRONIOWSKI*

dr Marcin *CERKASKI*

dr Piotr *CZERSKI*

prof.dr hab. Wiesław *CZYŻ* *

dr Wojciech *FLORKOWSKI*

dr Krzysztof *GOLEC-BIERNAT*

dr Andrzej *HORZELA*

mgr Robert *KAMIŃSKI*

prof. dr hab. Edward *KAPUŚCIK*

dr hab. Marek *KUTSCHERA*

prof. dr hab. Jan *KWIECIŃSKI* Head of Department

dr hab. Leonard *LEŚNIAK*

dr hab. Andrzej *MALECKI*

mgr inż. Ewa *PAGACZEWSKA* Secretary

dr hab. Marek *PLOSZAJCZAK*

mgr Stanisław *ZUBIK*

dr hab. Piotr *ŻENCZYKOWSKI*

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* also at the Institute of Physics, Jagellonian University, Chairman of the Scientific Council of the Institute of Physics, Jagellonian University, Chairman of the Scientific Council of Nicolas Copernicus Astronomical Center

Doktoranci - Graduate students

mgr Piotr *BOŻEK*

mgr Piotr *KAMIŃSKI*

mgr Andrzej *KOTLORZ*

mgr Dorota *STRÓZIK-KOTLORZ*

3. GOŚCIE ZAGRANICZNI - VISITING SCIENTISTS

A. FAESSLER

- Department of Theoretical Physics, University of Tübingen, Tübingen, Germany, April 1991

F. GRÜMER

- Department of Theoretical Physics, Ruhr-Universität Bochum, Bochum, Germany, March 1991

R.C. HWA

- Institute of Theoretical Science, University of Oregon, Eugene, U.S.A., June 1991

J.-P. MAILLET

- Division de Physique Théorique, Institut de Physique Nucléaire, Orsay, France, June/July 1991

A.D. MARTIN

- Department of Physics, University of Durham, Durham, England, June 1991

H. MÜTHER

- Department of Theoretical Physics, University of Tübingen, Tübingen, Germany, June 1991

4. KOMUNIKATY - ABSTRACTS

Collective Modes in a Slab of Interacting Nuclear Matter

W.M. ALBERICO [1], *P. CZERSKI, V.R. MANFREDI* [2], *A. MOLINARI* [1]

[1] Dipartimento di Fisica Teorica, Universita di Torino, Italy

[2] Dipartimento di Fisica, Universita di Padova, Italy

We study the properties of a slab of nuclear matter. The behaviour with the slab thickness of the particle density, kinetic energy density and surface tension are given in the non-interacting case, together with the slab free response to an external field. Next we introduce a zero-range isovector interaction among the nucleons and analyse the slab collective excitation. For moderate momenta hard and soft modes are found, which exhaust most of the excitation strength. Their position and splitting energy favourably compares with the splitted giant dipole resonance experimentally seen in deformed nuclei [1].

Quantum Tunnelling in the Periodically Driven SU(2) Model

R. ARVIEU [2], *P. KAMIŃSKI* [1], *M. PLOSZAJCZAK* [1]

[1] INP Cracow and GANIL, France

[2] Institut des Sciences Nucleáires, 53 Avenue des Martyrs, F-38026 Grenoble Cedex, France

The tunnelling rate is investigated in the quantum and classical limits using an exactly soluble, periodically driven SU(2) model [2]. The tunnelling rate is obtained by solving the time-dependent Schrödinger equation and projecting the exact wave-function on the space of coherent states using the Husimi distribution. The oscillatory and coherent tunnelling of the wave-function between two Hartree-Fock minima is observed. The driving plays an important role increasing the tunnelling rate by orders of magnitude as compared to

...iclassical results. This is due to the dominant role of excited states in the dri... ...tunnelling.

Phase Space Structure of Simple Nuclear Models

R. ARVIEU [1], *P. ROZMEJ* [2], *M. PLOSZAJCZAK* [3]

[1] Institut des Sciences Nucléaires, 53 Avenue des Martyrs, F-38026 Grenoble Cedex

[2] Department of Theoretical Physics, Institute of Physics,

Maria Curie-Sklodowska University, 20-031 Lublin, Poland

[3] INP Cracow and GANIL, France

...present a schematic description of the eight dimensional phase space of a nucle... ...harmonic oscillator with a simple spin orbit term [3]. Ordered traject... ...identified as well as chaotic ones with dimensions $D = 4,5$. Prolate and obl... ...are considered. Moreover we discuss in details the phase space features of the S... ...Lipkin model using the Husimi distributions to exhibit the classical prope... ...quantum solutions of the Lipkin model. Properties of Husimi distributions ... ...number of particles are exhibited and new scaling properties are found in the ...

Shadowing in Inelastic Lepton - Deuteron Scattering

B. BADELEK [1], *J. KWIECIŃSKI*

[1] Institute of Experimental Physics, Warsaw University

Warsaw, Poland

...ing in inelastic lepton-deuteron scattering was analysed using the doubl... ...formalism where shadowing was related to inclusive diffractive processes. ... ...tor meson and parton contributions were considered for low and high Q^2 ...

including QCD corrections with parton recombination for high Q^2. These Q^2 values were chosen to correspond to existing experimental data and to the possible HERA measurements. Detailed discussion of various shadowing mechanisms is given. As expected the shadowing effects were found to be very small, less than 2% or so, in agreement with the recent precise measurements performed by the New Muon Collaboration [5].

Parton Distributions and Deep Inelastic Processes at Small x

B. BADELEK [1], *K. CHARCHULA* [1,2], *K. GOLEC-BIERNAT, M. KRAWCZYK* [3], *J. KWIECIŃSKI, A.D. MARTIN* [4], *D. STRÓZIK-KOTLORZ, P.J. SUTTON* [4]

[1] Institute of Experimental Physics, Warsaw University, Warsaw, Poland

[2] Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

[3] Institute of Theoretical Physics, Warsaw University, Warsaw, Poland

[4] Department of Physics, University of Durham, Durham, United Kingdom

The measurements at the ISR, CERN and Tevatron colliders were used to determine the values of the central eikonal and hence to estimate the energy dependence of the semi-hard component of the cross-section for proton - antiproton scattering. It was compared with QCD expectations obtained from gluon distributions which incorporate both singular small x behaviour and shadowing corrections. The expectations for the asymptotic form of the total pp cross section were discussed with the emphasis given to the effects of gluon saturation [32].

The very small x behaviour of the gluon distribution in a proton was analysed by solving the Lipatov equation without [42] and with shadowing effects [31,33]. The emergence of an $x^{-\lambda}$ behaviour *and* the eventual taming of this behaviour by shadowing term was found. This dynamically-generated gluon distribution was compared with (i) the results of a recent next-to-leading order QCD structure function analysis which incorporated both a singular $x^{-1/2}$ behaviour and shadowing corrections, and (ii) the double logarithm approximation. The semiclassical approximation of the Lipatov equation was formulated in order to compare with earlier analyses based on this approximation.

In [4] the physics of of deep inelastic processes in the region of small x was reviewed. The theoretical concepts concerning the Regge limit of deep inelastic scattering were summarized and the recent theoretical results on the small x limit of parton distributions in perturbative QCD were discussed. Presently available experimental data on the free and bound nucleon structure functions at small x were reviewed in detail and their theoretical interpretations (including low x, low Q^2 region) were discussed. QCD predictions for the deep inelastic scattering structure functions F_2 and F_L in the small x ($10^{-5} < x < 10^{-2}$) and moderately large Q^2 region relevant for HERA ($Q^2 \sim 10$ GeV^2) were given.

Convective Stability of Hot Matter in Ultrarelativistic Heavy-Ion Collisions

G. BAYM [1], *W. FLORKOWSKI* [2,3], *B. L. FRIMAN* [3,4], *P. V. RUUSKANEN* [5]

[1] Department of Physics, University of Illinois at Urbana-Champaign, USA

[2] INP Cracow, Poland

[3] Gesellschaft für Schwerionenforschung, Darmstadt, Germany

[4] Institut für Kernphysik, Technische Hochschule Darmstadt, Germany

[5] Department of Physics, University of Jyväskylä, Finland

The convective stability of strongly interacting matter undergoing hydrodynamic flow in ultrarelativistic heavy-ion collisions is studied in both the quark-gluon plasma and hadron gas phases. We find that this stability depends on the form of the initial conditions assumed for the hydrodynamic flow. In the case of the initial conditions corresponding to partial transparency the flow of the quark-gluon plasma is stable whereas the flow of the hadron gas is convectively unstable. The timescale for hydrodynamic oscillations around the (stable or unstable) equilibrium state is found to be larger than the expected lifetime of the system, suggesting that the flow in either case is very close to neutral convective equilibrium.

Galilean Covariance in Classical and Quantum Mechanics

P. BOCHNACKI, A. HORZELA, E. KAPUŚCIK [1], *J. KEMPCZYŃSKI* [2]

[1] JINR Dubna and INP Cracow, Poland

[2] INP Cracow, Poland

We formulated a Galilean covariant approach to classical mechanics. In this scheme constitutive relations defining forces are rejected as breaking the covariance principle. The acting forces are determined in fully covariant way from some sets of fundamental differential equations which may be defined for any particular problem. The analysis of the covariance principle and transformation laws shows that the total energy of interacting particle has to transform under Galilean transformations differently from the kinetic energy. The suitable transformation laws are found exactly for harmonic and damped oscillators and for anharmonic oscillator in the framework of perturbation theory [21]. The covariant introduction of forces plays also a crucial role in Galilean covariant formulation of quantum mechanics. We solve this problem treating quantum forces as independently quantized observables and constructing wave functions as functions depending on more variables than it is assumed in the standard approach [22,24].

Detailed analysis of the meaning of nonrelativistic transformation laws for the momentum and the kinetic energy leaded us to the formulation of the concept of Galilean mass, in general different from the inertial mass [23,30]. This idea applied to many body systems in the scheme exhibiting the Galilean covariance of the formalism gives the possibility of their alternative description in which particles forming the system have individual kinematics but are deprived from individual dynamics. Dynamics exists only for a system as a whole and we consider this fact to be a classical prototype of the "confinement" being the phenomenon of non-dynamical origin independent from any particular model of interaction [6,27].

Intermittency and Clustering in the One-Dimensional Lattice Gas Model

P. BOŻEK [1], *Z. BURDA* [2], *J. JURKIEWICZ* [2], *M. PLOSZAJCZAK* [1]

[1] INP Cracow and GANIL, France

[2] Jagellonian Unversity, Cracow, Poland

The generating functions of the scaled factorial moments of the distribution of the particles and links in the one-dimensional statistical model for variable bin size have been constructed [7]. The results show an intermittent like behaviour, in spite of the fact that the model does not exhibit any scaling behaviour and has a very small correlation range. The intermittency signal for the particles and links was compared and the possible influence of the clustering in the cold hadronization on the size of the fluctuations was disscussed.

Finite-Size Effect in the Intermittency Analysis of the Fragment Size Correlations

P. BOŻEK [1], *M.PLOSZAJCZAK* [1], *A.TUCHOLSKI* [2]

[1] INP Cracow and GANIL, France

[2] Institute of Nuclear Studies, Świerk, Poland

The influence of the finite size effect on the fragment correlations in the nuclear multifragmentation was studied using the method of the scaled factorial moments. The correlations in the fragments were calculated analytically for the one-dimensional percolation model and for a statistical model of the fragmentation process [8], which for a certain value of a tuning parameter yields the power-law behaviour of the fragment size distribution. It was shown that the statistical models of this type contain only repulsive correlations due to the conservation laws. The comparison of the results with the those obtained in the non-critical one-dimensional percolation and with the numerical results obtained for the three-dimensional percolation at around the critical point was made. In the two latter models there are some attractive correlations which were also seen in the experimental results on the nuclear multifragmentation. The analytical solutions allow to identify the origin of the repulsive correlations (the mass conservation) and of the attractive ones (the perimeter links).

Intermitttency in Ultrarelativistic Nuclear Collisions

P. BOŻEK [1], *M. PLOSZAJCZAK* [1]

[1] INP Cracow and GANIL, France

The effect of nonstatistical fluctuations in ultrarelativistic collisions has been analysed. Arguments are given to show that it is a nonlinear effect going beyond the simple nucleon-nucleon superposition models. This effect may have strong implications on our understanding of the collision dynamics. To describe the effect the model of the spatio-temporal intermittency in the interaction region was developed [9]. This model can explain the impact parameter and the projectile and/or target mass dependence of the strength of the fluctuations. The behaviour of the self-similar structures during the hydrodynamical evolution has been studied as well as the possibility of the detection of the spatio-temporal intermittency in the Bose-Einstein correlations. The implications of correlated emission on the Bose-Einstein measurements have been analysed.

Finite-Size Scaling, Finite-Size Effects and the Dimensional Projection

P. BOŻEK [1], *M. PLOSZAJCZAK* [1]

[1] INP Cracow and GANIL, France

The implications of the scale-invariant multiparticle distributions have been studied. This description was compared with the predictions of $\alpha-$model. The two approaches were shown to be largely equivalent [10]. This includes the case of the weak and strong intermittency and similar behaviour for the scaled factorial moments as well as the scaled factorial correlators. It was also shown that the dimensional projection does not alter this similarity and, moreover, it explains an experimentally observed difference between the slopes of the factorial moments and the factorial correlators.

A quantitative method to analyse the projected one-dimensional data on the scaled factorial moments was proposed. The dimensional projection is known to destroy the intermittent behaviour. Till now there was no clear method to deal with this effect other than to go to the full dimensional analysis. We have proposed the finite-size scaling analysis of the scaled factorial moment data [11]. This analysis allows to extract the scaling indices of the underlying higher-dimensional scale-invariant distributions. Moreover, it exhibits the change of the effective transverse size involved in the dimensional projection with transverse momentum cuts applied to the data. It is the only way of deconvolution of the dimensional projection if the intermittency phenomenon takes place in a space inaccessible experimentally in its "full-dimensional form", as the rapidity impact-parameter space.

The detailed implications of the presence of a finite size in the system have also been adressed. In fact, the presence of such a finite-size changes already the full-dimensional correlations. This effect was studied on the example of the critical system in two-dimensions [12]. Two systems have been studied: one system consisted of an infinite plane and the second of an infinitely long strip with the finite width. The correlations in the two systems were related by the conformal symmetry. The second system behaves in the projected one-dimensional analysis as an effectively one-dimensional system on distances of the order of the induced correlation range. Possible implications of this effect on the observation of the intermittency signal were disscussed.

Electromagnetic Polarizabilities of the Nucleon

W. BRONIOWSKI

Recently electromagnetic polarizabilities of the nucleon have been remeasured. We have analyzed these polarizabilities in chiral soliton models of the nucleon, with emphasis on the splitting between the neutron and proton polarizabilities. One can show, using general arguments, that the neutron should have a bigger electric polarizability than the proton. This is directly related to the charge density profile. Our model calculation confirms these predictions. The calculations are done using semiclassical linear response theory in a system of mesons and quarks [13].

Quarks with a Pion Condensate as a New Phase of Matter

W. BRONIOWSKI, A. KOTLORZ, M. KUTSCHERA

It is argued that the chirally broken quark matter is the ground state of baryon matter at densities of the order of a few nuclear densities. Properties of this new phase of matter are studied in the framework of the sigma model with quark and meson degrees of freedom. Existence of this phase is a general feature of models based on chiral dynamics, such as the sigma model. Phenomenological consequences on the physics of dense matter are discussed, in particular we describe interesting magnetic properties of the phase [14,34].

Final State Interaction of Nucleons in Knock-Out Reactions

F. CANNATA [1], J.-P. DEDONDER [2], L. LEŚNIAK

[1] Dipartimento di Fisica and INFN Bologna, Italy

[2] Division de Physique Théorique, Institut de Physique Nucléaire, Orsay and Laboratoire de Physique Nucléaire, Université Paris 7, Paris, France

Electromagnetic knock-out of nucleons from nuclei is a valuable source of information on the nucleon propagation in nuclear matter. The transition form factor for a nucleon going from an initial bound state to a final scattering state is calculated. We discuss an efficient method leading to an evaluation of the final state interaction effects at high energies of outgoing nucleons. This method is based on the fact that a convergence of the partial wave expansion series for the difference between the exact form factor and the plane wave approximation to it is faster than a convergence of the standard partial wave expansion series [15].

Two and Three-Channel Models of the $f_0(975)$ Meson

F. CANNATA [1], *J.-P. DEDONDER* [2], *L. LEŚNIAK*

[1] Dipartimento di Fisica and INFN Bologna, Italy

[2] Division de Physique Théorique, Institut de Physique Nucléaire, Orsay

and Laboratoire de Physique Nucléaire, Université Paris 7, Paris, France

A separable potential formalism is used to study $K\bar{K}$ threshold effects. In addition to the $\pi\pi$ and $K\bar{K}$ channels, a third channel with heavy constituents is introduced to simulate the role of additional channels in building up the $f_0(975)$ meson, assuming, in general, no direct interaction in the $K\bar{K}$ channel. As a consequence, the coupling between the exotic channel and the $K\bar{K}$ channel is rather large. One can reduce further the three-channel problem to an effective two-channel problem where the $f_0(975)$ meson behaves as if it were a $K\bar{K}$ molecule bound by the coupling to the exotic channel. This is also supported by the fact that a single pole only, in the complex $K\bar{K}$ momentum plane, is associated to the $f_0(975)$ meson. Various physical observables, like the decay branching ratio and the $K\bar{K}$ scattering length, are then discussed in this effective two-channel framework [16,17].

Symmetry Transformations of Nonstandard Irreducible Characters of Groups Sp(2N), S0(2N + 1) and their Applications

M. CERKASKI

Using some symmetries of the irreducible character functions of groups G(k) = SP(2N) S0(2N), S0(2N + 1) we establish a new and very simple algorithm for the transformation of the nonstandard characters of these groups. This strongly simplified a calculation of branching rules for the group reductions $U(k) \searrow G(k)$ frequently used in theoretical physics. This method has been tested in a number of numerical calculations.

Nuclear Collective Motion within the 0(N - 1) Invariant Dynamics

M. CERKASKI, I.N. MIKHAILOV [1]

[1] Laboratory for Theoretical Physics, JINR, Dubna

Assuming 0(N - 1) symmetry for an interaction term in the N-body Hamiltonian we find closed subsystem equations of motion. Forming the model in a geometrical way we show that nucleons move along the trajectories determined by the time dependent harmonic potential being a function of the collective variables. A class of stationary solutions which generalize the families of the S-Riemann ellipsoids leads to the cranking model with selfconsistency relations generated by the 0(n - 1) scalar part of the potential. We pursue this investigation studying a problem of general classification of stationary solutions for this model and preparing the computer program calculating selfconsistent nuclear collective bands.

Production of Hard Photons in Electron-Positron Annihilation into Hadrons †

W. CZYŻ [1], *A. DYREK* [2]

[1] also at Institute of Physics, Jagellonian University

Reymonta 4, 30-059 Kraków, Poland

[2] Institute of Physics, Jagellonian University

Reymonta 4, 30-059 Kraków, Poland

Frequency of emission of prompt, hard photons radiated by the fast-moving quarks (antiquarks) in e^-e^+ annihilation into hadrons is estimated for the string model. The diffrential probability of emission of such photons is obtained from a sum rule which takes for the initial state of the emitter a classical trajectory. It is found that the string models are

† Supported in part by the Polish Ministry of Education, Grant DNS-P-04/215/90-2 and BN No 2-00054-91-01.

quite effective in production of hard photons (i.e., photons whose energies are substantial fractions of energies of the initial e^+e^- pair) associated with production of hadrons. For 100 GeV e^+e^- initial energy the frequency of emission, ν, of 10 GeV $< \hbar\omega <$ 40 GeV photons is estimated to be $10^{-4} < \nu < 10^{-3}$ [18].

Splitting of the Different Parity States and Quantum Tunnelling in the SU(2) Model

S. DROŻDŻ [1], *P. KAMIŃSKI* [1,2], *M. PLOSZAJCZAK* [1,2]

[1] INP Cracow

[2] GANIL, France

The splitting of different parity states in various models with the SU(2) symmetry has been calculated using different approximate schemes and then compared to the exact results. In case of the strong coupling between shells, i.e. for large potential barriers in the semiclassical limit, the time dependent Hartree-Fock approximation (TDHF) in the imaginary time yields very good results. Simultanously, the nonadiabatic effects are important. The overlap of the single-particle Hartree-Fock (SPHF) excited state and the TDHF state can be a measure of the adiabaticity. One cannot use the cranking approximation when this overlap is large and comparable with the overlap of the SPHF for the ground state and the TDHF state. This situation happens for all SU(2) models containing the p^4 terms in the classical limit. For these models,one observes a remarkable difference in the behaviour of the energy splitting of parity dublets as a function of the strength of the two-body interaction for even and odd number of particles. The TDHF approximation always reproduces the results for the even number of particles. The semiclassical calculation of splitting for the odd number of particles requires an introduction of the additional term to the semiclassical action. This effect seems to be closely related to the Berry's phase and related anomalies.

Properties of G Moments

W. FLORKOWSKI

We investigated the general features of the G_q moments in the case where they are applied in the analysis of the fluctuations of the rapidity distributions. In particular their dependence on the statistical background was clarified.

Shadowing at HERA

K. GOLEC-BIERNAT

We study the possibility to see shadowing effects in the electron-proton collisions at HERA. The data which are not available yet are generated from the KMRS parton distributions and the Altarelli-Parisi equations with nonlinear shadowing terms of the "hot-spots" type. A global fit to the data is performed with the help of conventional input parton distributions and linear Altarelli-Parisi equations. Preliminary results show that the shadowing effects in the data can be explained in the conventional way provided the experimental errors are not smaller than 10%.

Relativistic Effects in Decay Channels of Scalar Mesons

R. KAMIŃSKI, L. LEŚNIAK, J.-P. MAILLET [1]

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Orsay, France

A separable potential formalism is formulated and used to describe the properties of scalar, isospin zero mesons including $f_0(975)$ and $f_0(1400)$. Relativistic propagators in both $\pi\pi$ and $K\bar{K}$ channels are used. Rank two separable potentials are chosen in the $\pi\pi$ channel and a rank one potential in the $K\bar{K}$ channel. Parameters of the potentials will be fixed by comparison with experimental data. Preliminary results indicate a large influence of the relativistic effects on values of the $\pi\pi$ interaction strengths and range parameters. Important relativistic effects are also found in the $K\bar{K}$ channel if the $K\bar{K}$ interaction form factor has a short range character. They grow with increasing $K\bar{K}$ effective mass.

Quantum Tunnelling in the SU(2) Model with Quasi-Periodic and Random Driving

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Quantum evolution of the wave-packets in the time-dependent SU(2) (TDSU(2)) spin system is investigated for different kinds of driving in the quantum and classical limits. The tunnelling between the two degenerate Hartree-Fock minima is studied by solving the Schrödinger equation and using the Husimi distribution formalism. The considerable enhancement of the tunnelling rate due to the driving is observed. Depending on the type of driving , the evolution can be either periodic and coherent (the time-periodic driving) or irregular (the random series of pulses). The relation between the structure of the classical phase-space and the character of quantum tunnelling was found. If the classical trajectories are regular then one observes the periodic and coherent tunnelling of the initial wave-packet between minima of the classical potential. Its rate is large due to the presence of the irregular structures in the classical phase-space at higher energies. On the contrary, when the classical trajectories are chaotic at all energies, the wave tunnelling is irregular. The initial wave-packet easily goes through the barrier, but then it rapidly spreads over all the available phase-space and does not return to the state close to the initial condition. For the random driving force, the diffusive character of the energy growth in time was found. In the limit of a small particle number, the time-scale of the evolution is much shorter. In this case the simple four-level model explains qualitatively the mechanism of the driven fast tunnelling.

Properties of Classical Electrodynamics

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A non-standard formulation of classical electrodynamics is proposed. In this scheme the electromagnetic fields $\vec{D}$ and $\vec{H}$ as well as polarization $\vec{P}$ and magnetization $\vec{M}$ vectors must be distributions while the electromagnetic fields $\vec{E}$ and $\vec{B}$ are test functions. The mathematically precise description of all these quantities gives the possibility of avoiding the troubles of the conventional electrodynamics connected to the problem of the distribution-valued sources, like for example the point charge [25].

Unknown Aspects of Relativity

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We have continued our research generalizing ideas of conventional relativity theory. In [28] we have proposed a generalization of the Einstein equivalence principle valid not only for gravitation but for all fundamental interactions. The principle is based on the concept of full symmetry between space-time and boundary conditions dependence of the fields which opens more freedom for the transformation of the physical quantities. Applying the idea of treating transformation laws as one of the most important fundamentals of any physical theory we have considered the possibility to define a new class of mathematical objects and to introduce them into the general relativity. These objects have not geometrical meaning, generalize the concept of the affine connection and enables us to replace the metric tensor and the affine connection by the unified mathematical structure [26]. We have reanalized the Einstein radiolocation method and have described the synchronization procedure in the case when light moving nonuniformly is used for the clock synchronization. It has been shown that a relativity theory with both an invariant acceleration and an invariant velocity of light is possible [20,29].

Polarized Phases of Dense Matter and Magnetic Fields of Neutron Stars

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Possible mechanisms of a spontaneous spin polarization in the dense baryon matter of the neutron star core are discussed. It is shown that protons in the core of the neutron star are likely to be polarized. The quark core if present can be also magnetized due to ordering of quarks spins in the pion-condensed phase of a chirally broken quark matter. This model accounts for a recent evidence that decay of magnetic field occurs only for neutron stars which accreted matter in their evolution [35,36].

Nuclear and Partonic Dynamics in High Energy Elastic Nucleus-Nucleus Scattering

A. MALECKI

A hybrid description of diffraction which combines a geometrical modelling of multiple scattering with many-channel effects resulting from intrinsic dynamics on the nuclear and subnuclear level is presented. The application to ^4He - ^4He elastic scattering is satisfactory. Our analysis suggests that, at large momentum transfers, the parton constituents of nucleons immersed in nuclei are deconfined [39].

Inelastic Diffraction and Equivalence of States

A. MALECKI

A new approach to diffraction, based on the concept of equivalent states, is applied to the inclusive inelastic scattering. Differences from the classical description of Good and Walker are pointed out [38].

Intermittency in Nuclear Multifragmentation

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The fluctuations of the fragment size distribution in a percolation model and in nuclear multifragmentation following the breakup of high-energy nuclei in the nuclear emulsion have been studied using the method of scaled factorial moments [40]. An intermittent pattern of fluctuations has been found in the data as well as in the percolation lattice calculations. This feature is a consequence of both a self-similarity in the fragment size distribution and a random character for the scaling law. These fluctuations are, in general, well described by a percolation model. The multifractal dimensions are calculated and their relevance to the study of possible critical behaviour has been pointed out.

On the Nuclear Incompressibility Modulus

St. ZUBIK

Until quite lately, almost the whole existing experimental evidence for the giant quadrupole (GQR) and monopole (GMR) isoscalar resonances has been provided by the electron and hadron probes, as the (e, e'), (p, p'), (d, d'), (α, α') inelastic scattering experiments. Now, due to the coincidence experiment (e, e' n) performed on ^{116}Sn [a] and ^{208}Pb [b] nuclei a new evidence for these resonances exists.

In the case of ^{208}Pb nucleus, the results of the (e, e' n) experiment are in a resonable agreement with the hadronic one, whereas in the case of ^{116}Sn they disagree remarkably with the already existing evidence [c].

Especially important is the difference in the GMR resonance energy E_{br} because of its connection with the nuclear incompressibility modulus K_A:

$$K_A = \frac{m}{\hbar^2} < r^2 > E_{br}^2,$$

where m is the nuclear mass and $< r^2 >$ is the experimental root-mean-square radius. If one calculates K_A for $E_{br} = 15.7$ MeV taken from the (α, α') experiment [c], one gets $K_A = 126.7$ MeV and for $E_{br} = 17.9$ MeV obtained from (e, e' n) experiment, one gets $K_A = 164$ MeV.

Before a new experimental (e, e' n) evidence will be available for other nuclei, we can try to see whether the value $K_A = 164$ MeV is acceptable in our semiclassical model calculations, based on the Navier-Stokes hydrodynamical equations of motion of the viscous and compressive liquid drop.

When we increase the K_A value from 126.7 MeV to 164 MeV, then our model calculations for ^{116}Sn give a satisfactory agreement for the new GMR and GQR experimental data.

Moreover, if we perform calculations for ^{208}Pb using the same value $K_A = 164$ MeV, which is greater than the value 143 MeV, previously inferred from the hadronic data, we again get an agreement with experiment. In the earlier calculations,with the lower ascribed values of K_A, we could not fit properly the widths of the monopole resonances for all the nuclei from ^{90}Zr to ^{208}Pb for which the breathing mode resonance energy has been known.

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[b] - G.O. Bolme et al., Phys. Rev. Lett. **61** (1988) 1081

[c] - M.M. Sharma et al., Phys. Rev. **C38** (1988) 2562

Baryon Semileptonic Decays

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We discuss small contributions to baryon semileptonic decays which provide corrections to the simplest SU(3)-symmetric formulas. In particular, we consider

1. - SU(3) symmetry breaking resulting from the wave function deformations due to s-u,d quark mass difference and
2. - the effects of the configuration mixing of S^2_M and S^2_S states, originating from QCD hyperfine interactions. Both effects are treated in combination with form factor suppression effect which is operative if three-momentum transfer between initial and final hadron is nonzero. Our estimates are performed in the framework of the hadronic oscillator quark model. While the inclusion of s-u,d quark mass difference leads to unacceptable g_A/g_v ratio for the $\Lambda \to pe\nu$ semileptonic decay, the corrections due to configuration mixing do not lead to disagreement with the data. Better measurements of the $\Xi \to ne\nu$ and $\Xi \to \Lambda e\nu$ are needed if the choice is to be made between the standard SU(3)-symmetric parametrization and the pattern of SU(3) breaking resulting from configuration mixing [43].

Weak Radiative Hyperon Decays

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Weak radiative hyperon decays (WRHD) are studied in an approach which combines the idea of vector-meson dominance with requirements of $SU(6)_W$ symmetry connecting vector- and pseudoscalar -meson weak couplings to hyperons. In such an approach the data on nonleptonic hyperon decays determine the parity conserving WRHD amplitudes completely and suffice to fix two of three parameters needed to describe the parity violating amplitudes. The parity-conserving amplitudes are obtained from those of nonleptonic hyperon decays in two ways:

1. - in the pole model and
2. - by assuming that the parity-conserving part of the weak Hamiltonian transforms as λ_7. Both are considered since, although the two frameworks are theoretically close, their numerical predictions are fairly different. The only parameter that cannot be fixed from nonleptonic hyperon decays and which is needed for the description of parity-violating amplitudes is determined from fits to all the branching ratios and asymmetries of WRHD measured so far. The fits strongly favour a substantial positive asymmetry for the $\Xi^- \to \Sigma^-\gamma$ decay. The best fit ($\chi^2/NDF = 7.9/7$) is obtained with $H_w^{p.c.}$ transforming as λ_7 and photon -baryon coupling determined by experimental values of baryon magnetic moments. The corresponding asymmetry parameter is then predicted to be $\alpha = +0.6$ [44,45].

Weak Nonleptonic Hyperon Decays

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The influence of hadronic-loop effects on the SU(3) structure of the soft- pion contribution to the S-wave weak nonleptonic hyperon decays is studied in the framework of the Unitarized Quark Model. The effects considered originate from the interference of strong and weak amplitudes of the P-wave hyperon decays. When the baryon-pole model is used to describe the latter it is found that the quark sea generated by hadronic loops renormalizes the sizes of the two independent SU(3) amplitudes away from their naive quark model ratio of f/d = -1 to f/d = -1.6. This is in remarkably good agreement with the phenomenological estimate of the soft-pion contribution performed by Pham who, after subtracting the terms violating the modified Lee-Sugawara relation, obtained $(f/d)_{soft-pion} = -1.5$ [46].

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P. BOŻEK - graduate student

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W. BRONIOWSKI

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2. *RPA in Quark Meson Systems*, University of Bochum, Bochum, Germany, May 1991,
3. *Dense Quark Matter and Pion Condensates*, Workshop on Nucleon Structure and Nucleon Resonances, Institute of Nuclear Theory, Seattle, August 1991.

M. CERKASKI

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2. *Collective Nuclear Dynamics within O(N-1) Invariant Approach*, ZIBJ, Dubna, kwiecień 1991,
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P. CZERSKI

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[illegible]RING - [illegible]-Universität, Bochum, Germany

[illegible] Dependence of the NFL Model, Zakład IV IFJ, March 1991.

[illegible]SSLER - [illegible] of Tübingen, Germany

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[illegible]RÜMER - Ruhr-Universität, Bochum, Germany

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[illegible]ELLER - [illegible] of Physics, Jagellonian University, Cracow

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M. JEŻABEK - Zakład V IFJ

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P. KAMIŃSKI - graduate student

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M. KUTSCHERA

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2. *Parton Distributions at Small x*, XXVI Rencontre de Moriond, Les Arcs, France, March 1991,
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L. LEŚNIAK

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2. *Mezony skalarne i efekty progowe $K\bar{K}$*, Środowiskowe Seminarium Fizyki Jądrowej i Jej Zastosowań, Instytut Fizyki UJ, maj 1991,

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2. *Nieelastyczna dyfrakcja jądrowa*, Zakład IV IFJ, listopad 1991.

A. D. MARTIN - University of Durham, Durham, England

1. *Parton Distributions and Small x*, XXXI Zakopane School of Theoretical Physics, Zakopane, czerwiec 1991.

H. MÜTHER - University of Tübingen, Tübingen, Germany

1. *Mesons and Nucleons in a Nuclear Medium*, XXXI Zakopane School of Theoretical Physics, Zakopane, czerwiec 1991.

M. A. NOWAK - Institute of Physics, Jagellonian University, Cracow

1. *Model próżni instantonowej dla QCD*, Zakład IV IFJ, luty 1991.

M. PLOSZAJCZAK

1. *Fractal Structures in Nature*, GANIL, Caen, France, February 1991,

2. *Phase-Transitions and Critical Phenomena in Heavy-Ion Collisions*, GANIL, Caen, France, March 1991,
3. *Non-Statistical Fluctuations in Heavy-Ion Collisions*, IPN-Orsay, France, March 1991,
4. *Intermittency and Fluctuations in Heavy-Ion Collisions* , Laboratoire National Saturne, Gif-sur Yvette, France, March 1991,
5. *The Volume Conserving Pairing (special seminar devoted to the memory of Professor Z. Bochnacki)*, Jagellonian University, Cracow, Poland, April 1991,
6. *Intermittency in Heavy-Ion Collisions*, 29th Spring School of Nuclear Physics, Holzhau, Germany, April 1991,
7. *Intermittency in Ultrarelativistic Collisions*, GSI-Darmstadt Workshop, Darmstadt, Germany, May 1991,
8. *Kinetic Theories for Heavy-Ion Collisions* (Table Ronde), Orsay, France, May 1991,
9. *Fluctuations in Nuclear Collisions*, Giens, France, May 1991,
10. *Exclusive Analysis of the Fluctuations in the Heavy-Ion Collisions*, Int. Conf. on Heavy-Ion Collisions, Kanazawa, Japan, June 1991,
11. *Critical Phenomena in Nuclear Collisions*, HMI-Berlin, Germany, June 1991,
12. *Intermittency in the Particle Production and in the Nuclear Fragmentation*, Tours, France, August 1991,
13. *Non-Statistical Fluctuations in Fragmentation Process*, Grenoble, France, November 1991.

A. RADOSZ - Wydział Fizyki Politechniki Wrocławskiej, Wrocław

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D. STRÓZIK-KOTLORZ - graduate student

1. *Parton Distributions in the Small x Region within LLx Approximation*, QCD Workshop, University of Lund, Lund, Sweden, May 1991.

P. ŻENCZYKOWSKI

1. ***Weak Radiative Hyperon Decays and Vector-Meson Dominance***, contributing talk, HADRON-91 Conference, University of Maryland, College Park, Maryland, USA, August 1991.

6. HABILITACJE - HABILITATIONS

Marek *KUTSCHERA* - O chiralnych modelach gęstej materii i jej własnościach magnetycznych, 13 maja 1991

7. PRACE DOKTORSKIE - Ph.D. THESES

Dorota *STRÓZIK-KOTLORZ* - QCD Analysis of Parton Distribution Functions in the Small x Region, 3 września 1991, promotor - prof. dr hab. J. Kwieciński

8. WYKLADY - LECTURES

I WYKLADY I ĆWICZENIA DLA STUDENTÓW FIZYKI I MATEMATYKI ORAZ PRACOWNIKÓW NAUKOWYCH

1. prof. J. Kwieciński - ***Introduction to Nuclear and Elementary Particle Physics***, lectures for undergraduate physics students at the Cracow Pedagogical University,
2. prof. J. Kwieciński - ***Deep Inelastic Processes***, series of lectures delivered at the Institute of Nuclear Physics in Jülich, Germany, June 1991,
3. dr hab. M. Płoszajczak - wyklady indywidualne: Table Ronde na temat jądrowej fragmentacji (Febr. 1991) GANIL, Caen, France; IPN-Orsay, Paris, France,

March 1991; CEN-Saclay, Paris, France, April 1991; IPN-Grenoble, France, October 1991; IPN-CNRS, Univ. Nantes, France, November 1991.

4. dr hab. P. Żenczykowski - ***Subatomic Physics***, lectures for undergraduate students of physics, University of Guelph, Guelph, Canada, Winter 1991,

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[5] B. Badelek, J. Kwieciński: *Shadowing in Inelastic Lepton-Deuteron Scattering*, preprint Warsaw Univ. **IFD/3/91** (1991); to be published in Nucl. Phys.B

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