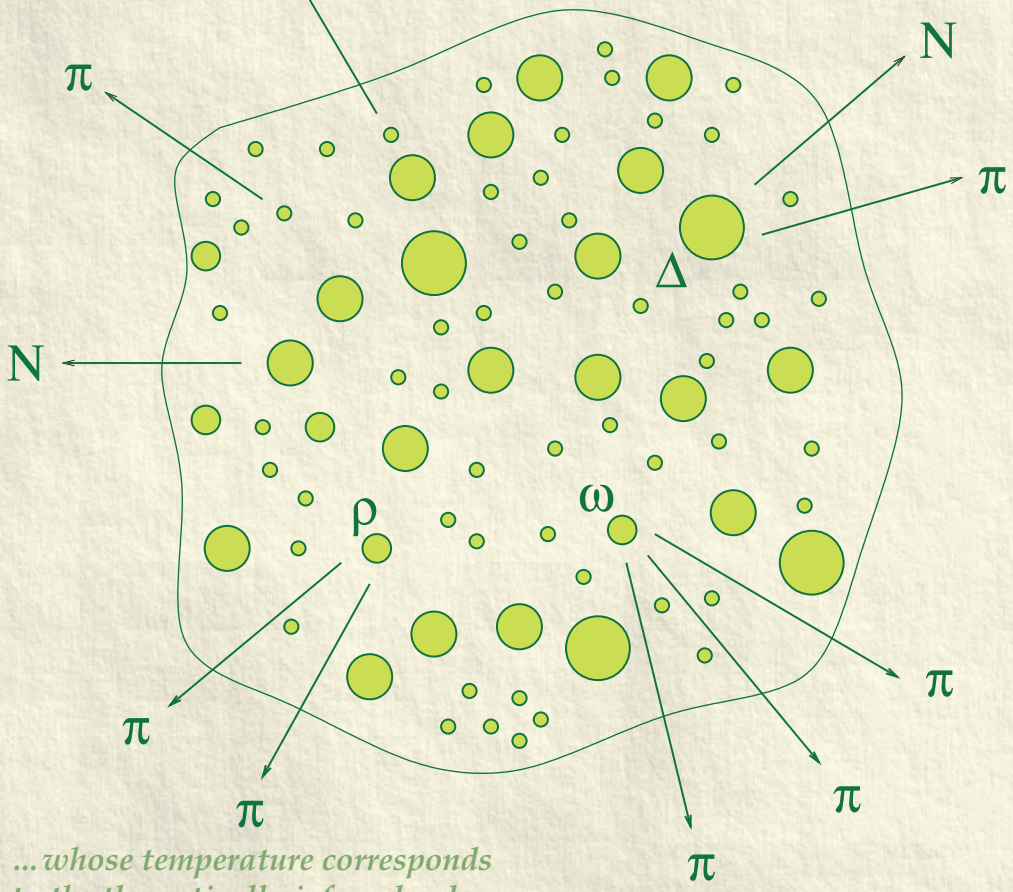
The Henryk Niewodniczański
Institute of Nuclear Physics
Kraków, Poland

At the final stage
of ultra-relativistic heavy-ion collisions,
a hadron gas is formed,...



...whose temperature corresponds
to the theoretically inferred value
for the phase transition
to the quark-gluon plasma.

Annual Report 2001

ISSN 1425-3763

Report No 1901

PRINTED BY
THE HENRYK NIEWODNICZAŃSKI INSTITUTE OF NUCLEAR PHYSICS

e-mail: Wojciech.Zajac@ifj.edu.pl or Maria.Krygowska-Doniec@ifj.edu.pl

Front cover:

At the final stage of ultra-relativistic heavy-ion collisions, delivered by the Relativistic Heavy Ion Collider at the Brookhaven National Laboratory, a hadron gas is formed whose temperature corresponds to the theoretically inferred value for the phase transition to the quark-gluon plasma. The measured ratios of the hadron multiplicities and the hadron transverse-momentum spectra are very well reproduced in the model which assumes local thermal equilibrium and includes the contributions from the decyas of all hadron resonances (W. Broniowski and W. Florkowski, Phys. Rev. Lett. **87** (2001) 272302).

Opracowanie i skład komputerowy: SEKCJA WYDAWNICTW DZIAŁU INFORMACJI NAUKOWEJ IFJ

druk: Drukania SKRYPT tel. 0 503 792 402

DIRECTORATE:

General Director: ***Professor Andrzej Budzanowski***
Deputy Directors: *Professor Roman Hołyński*
Dr Maria Pollak-Stachurowa
Professor Jan Styczeń

SCIENTIFIC COUNCIL:

Chairman: *Professor Krzysztof Rybicki*
Honorary Chairman: *Professor Andrzej Hrynkiewicz*
Secretary: *Halina Szymańska, M.A.*
tel.: (48) (12) 637 02 22 ext. 301
fax: (48) (12) 637 54 41
e-mail: rada@ifj.edu.pl

A. REPRESENTATIVES OF THE SCIENTIFIC STAFF:

Jerzy Bartke, Prof.
Rafał Broda, Prof.
Andrzej Budzanowski, Prof.
Stanisław Drożdż, Prof.
Andrzej Eskreys, Prof.
Roman Hołyński, Prof.
Stanisław Jadach, Prof.
Marek Jeżabek, Prof.
Marek Kutschera, Prof.
Jan Kwieciński, Prof.
Leonard Leśniak, Prof.
Piotr Malecki, Prof.
Maria Massalska-Arodź, Assoc. Prof.
Krzysztof Parliński, Prof.
Jan Styczeń, Prof.
Antoni Szczurek, Assoc. Prof.
Jacek Turnau, Prof.
Tadeusz Wasiutyński, Assoc. Prof.
Henryk Wilczyński, Assoc. Prof.
Barbara Wosiek, Prof.
Wojciech Zając, Ph.D.
Piotr Zieliński, Assoc. Prof.

B. REPRESENTATIVES OF TECHNICAL PERSONNEL:

Edmund Bakewicz, M.Sc., E.E.
Joanna Bogacz, M.Sc.
Barbara Brzezicka, M.Sc.
Bronisław Czech, M.Sc., E.E.
Jerzy Halik, M.Sc., M.E.
Zbigniew Król, M.Sc., M.E.
Stanisław Maranda
Zbigniew Natkaniec, M.Sc., E.E.
Elżbieta Ryba, M.Sc., E.E.
Piotr Skóra, M.Sc, E.E.
Józefa Turzańska
Mirosław Zięblíński, M.Sc., E.E.

C. MEMBERS OF THE SCIENTIFIC COUNCIL FROM OUTSIDE THE INSTITUTE:

Tomir Coghen, Prof. – *Professor Emeritus*
Danuta Kisielewska, Prof. – *University of Mining and Metallurgy, Kraków*
Michał Turała, Prof. – *CERN, Geneva*
Kacper Zalewski, Prof. – *Jagiellonian University, Kraków*

CONTENTS:

Overview

Thanks to the hard work and creativity of our scientific and technical staff, year 2001 was concluded with many exciting and promising research results. Their highlights are:

The Belle experiment, running at KEKB at the High Energy Accelerator Research Organization in Tsukuba (Japan), observed the time-dependent CP violation in a neutral B-meson system. The CP violation prameter $sin(2\phi_1)$ was measured to be $0.99\pm0.14\pm0.06$. The work of the Cracow group concentrated mainly on the silicon vertex detector and on the analysis of the underlying physics.

New results were obtained in the field of multiparticle production in heavy-ion collisions using the PHOBOS detector installed at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. The pseudorapidity densities of charged particles in Au + Au collisions measured near midrapidity show an approximately logarithmic evolution over a broad range of collision energies. The measurements of antiparticle-to-particle ratios allow an estimate of the baryochemical potential, showing a closer but not yet complete approach to the baryon-free regime potential at RHIC energies.

An excellent fit to the transverse momentum spectra of $p, \overline{p}, \pi^+, \pi^-$ and K^-,K^+ up to 1.5 GeV/c within the thermal model was obtained at $\sqrt{s}_{NN} = 130$ GeV, indicating the validity of the thermal model with expansion.

Two large experiments, H1 and ZEUS, both with strong INP participation, continued their studies of *e-p* collisions at the HERA accelerator at DESY. For the project of the HERA collider upgrade, the Cracow ZEUS team built and installed most parts of the new luminosity detector, while the Cracow H1 group contributed to the design and development of the new software for data acquisition and on-line reconstruction.

Preparations for future large experiments, ALICE, ATLAS and LHCB, at the *p-p* and *A-A* Large Hadron Collider at CERN, have continued, with strong human and financial involvement on our part. The experiments will continue the search for new particles (Higgs, super-particles) and the so-called New Physics phenomena (supersymmetry, quark-gluon plasma, CP violation) in the TeV energy range.

The theoretical research was devoted to precision tests of the Standard Model, as well as to the search for a more complete theory of fundamental particles in close relation to the current and future high-energy experiments.

In the field of nuclear structure, an outstanding result was the identification of the 10^+ state in ^{206}Hg and the measurement of its decay probability. This allowed the determination of the core charge polarization value of $e_P = 0.60$e. As a consequence, a rule was confirmed that the electrical quadrupole moment induced in the core has the proportionality factor of 0.6 for protons and 0.9 for neutrons.

An interesting result was the proof that the constituent quark approach is broader than hadron-level local effective theory permits. This was shown by studying the theory of weak radiative hyperon decays. B into π^+, π^- and KK^- pairs.

In the physics of condensed matter, using the PAC method it was shown experimentally for the first time, that the test radioactive atoms $^{111}In/^{111}Cd$ can jump between two sublattices of the intermetallic alloys of $Hf\ Al_2$.

In cooperation with the Silesian University we investigated the magnetic properties of hemin, a blood cell component. It was found that the external magnetic field of about 5T increases the content of low-spin iron complex in the blood.

Applying from calculations the first principles to the example of the $FeBO_3$ crystal it was shown that magnetic interaction could have a huge influence on phonon frequencies, contrary to the generally accepted opinion that magnetic interaction is too weak to influence phonons.

In collaboration with KAERI (Korea), a new type of thermoluminescent detectors resistive to high temperatures was found which allows annealing at large exposure.

The 48 MeV proton beam was succesfully extracted beam from our AIC-144 cyclotron. The dosimeter calibration laboratory obtained formal accreditation.

The Marian Mięsowicz award of the Polish Academy of Arts and Sciences went to dr K. Golec-Biernat for his work on saturation effects in DIS at low Q^2.

Dr M. Kmiecik was awarded the Henryk Niewodniczański prize for her outstanding work on transitions between various Jacobi shapes at high angular momentum rotation of ^{46}Ti nuclei.

534 papers of which 318 in journals listed by the Philadelphia Institute of Science Information were published at our Institute. The Institute hosted eight international and three national scientific conferences. We participated in one FW4 and seven FW5 UE programmes.

We also completed a large renovation effort aimed at preparing new facilities at at the main campus of the Institute for our high energy departments.

Eleven scientists got their PhD degrees, five completed their habilitations and one got the title of a full professor.

Two distinguished scientists were awarded the title of a Honorary Professor of the Henryk Niewodniczański Institute of Nuclear Physics, namely Professor Bernard Haas (IRS, Strasbourg) and Professor Bernard Hyams (CERN).

Last but not least, let me take this opportunity to extend my sincere thank-you to my colleagues and co-workers at the Institute for their great involvement and effort which helped us to achieve all the excellent results in 2001.

Professor Andrzej Budzanowski
Director of the Institute