THE HENRYK NIEWODNICZAŃSKI
INSTITUTE OF NUCLEAR PHYSICS
POLISH ACADEMY OF SCIENCES

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For MPD IB

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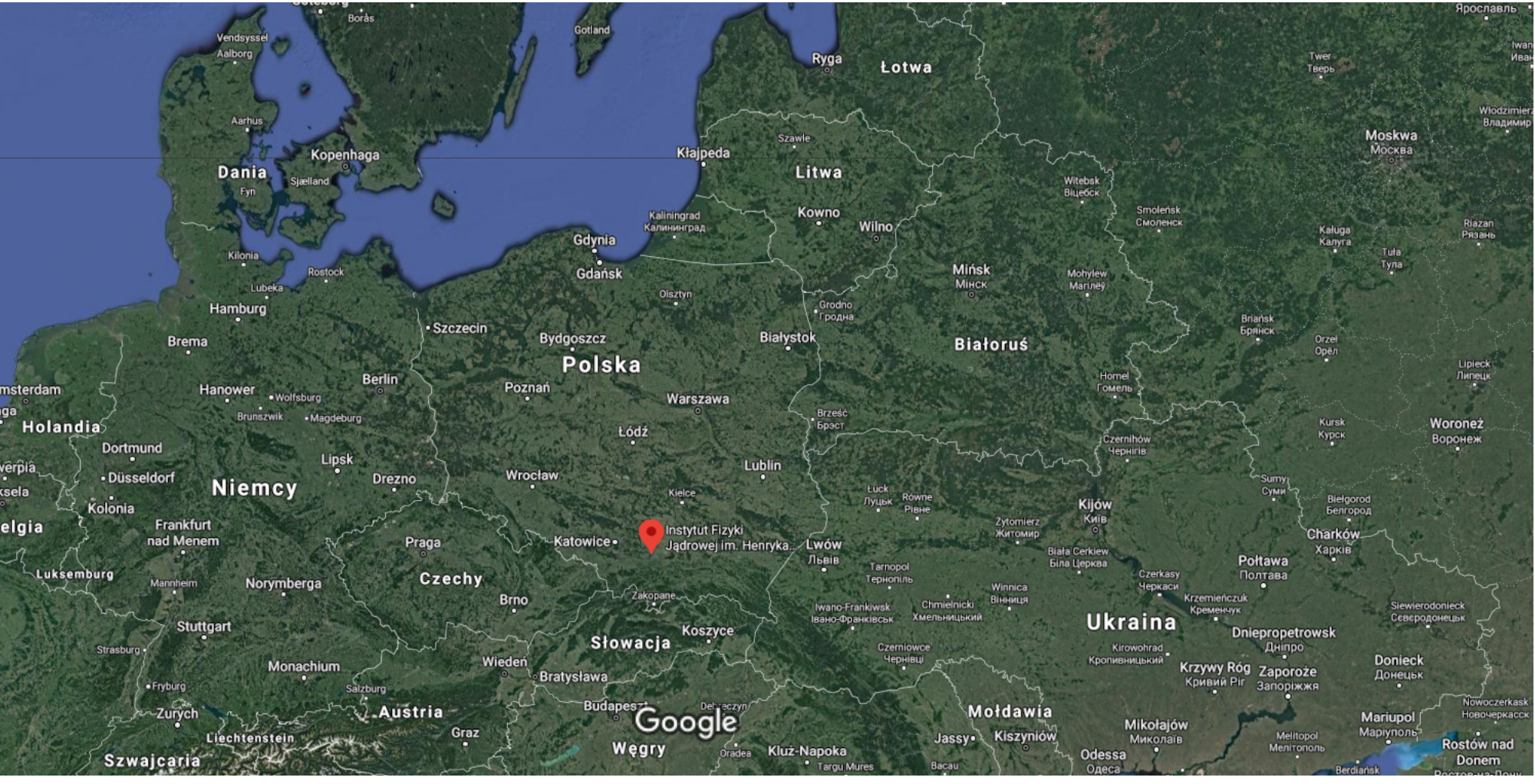
Instytut Fizyki Jądrowej im. Henryka Niewodniczańskiego Polskiej Akademii Nauk



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General information

- **established in 1955**,
- **the largest institute of the Polish Academy of Sciences:** (> 550 employees)
  a) 33 full professors,
  b) 82 associate professors,
  c) 104 PhD associates,
  d) and a team of over 120 highly qualified engineers and technicians.
- since 2014 rated the **A+ category** in the group of science and engineering,
- status of the **Leading National Research Centre (KNOW)** for the years 2012-2017,
- 2017: prestigious distinction of **"HR Excellence in Research"** by the European Commission,
- many projects and undertakings of the Institute are also included in the **Polish Map of Research Infrastructure**,
- **National Centre for Hadron Radiotherapy-Cyclotron Centre Bronowice**

The key activity

- basic and applied research in the field of physics and related sciences:

  a) **particle physics and astrophysics**,

  b) **nuclear physics and strong interaction physics**,

  c) **condensed matter physics** (including nano-materials),

  d) **interdisciplinary and applied research**, which involves applications of physics in medicine, biology, dosimetry, environmental protection, nuclear geophysics, radiochemistry, high-temperature plasma diagnostics, the study of complex systems, such as the human brain, financial market or linguistics.

The key activity

large-scale experiments carried out through global research collaborations

- main projects: **ALICE, ATLAS, LHCb** contributing to their construction, development and maintenance,
- other projects:
  a) European Laser on Free Electrons (**E-XFEL, DESY**, Hamburg),
  b) European Spallation Source (**ESS, Lund**, Sweden),
  c) Système de Production d'Ions Radioactifs Accélérés en Ligne (**SPIRAL2, GANIL**, Caen, France),
  d) Facility for Antiproton and Ion Research (**FAIR**, Darmstadt),
  e) Cherenkov Telescope Array (**CTA**),
  f) Pierre Auger Observatory (Argentina),
  g) International Thermonuclear Experimental Reactor (**ITER**, Cadarache, France),
  h) Belle2 experiment (**KEK**, Tsukuba, Japan)

Publications and other things

- the average yearly publication yield of IFJ PAN includes over **600 scientific papers** in high-impact international journals,
- over **100 monographs**, reports and conference contributions,
- holding international and national **scientific conferences** every year and a large number of weekly **seminars and occasional meetings**,
- 2019: Krakow School of **Interdisciplinary PhD Studies** (KISD),
- four nationally **accredited laboratories** offer certified measurements of radioactivity and spectra of radiation isotopes in environmental and materials samples, regular dosimetry services evaluating individual occupational and environmental exposure of workers to radiation, routine calibration of all electronic radiometers which measure the activity of gamma-, alpha- and beta-ray sources

IFJ involvement in MPD

Group makeup and past experiences of the group:

Currently 4 people - all employees of the INP PAS in Krakow:
one full proffesor, two associate proffesors, one dr hab.

Number of published papers	citations/paper (avg)	h
293	22.9	41
436	105	111
54	37.6	21
23	27	11

from:

- **Division of Nuclear Physics and Strong Interactions** and **Department of Ultra-relativistic Nuclear Physics and Hadron**,
- **Division of Nuclear Physics and Strong Interactions** and **Department of Theory of Strong Interactions and Multi-Body Systems**
- **Division of Theoretical Physics** and **Department of Theory of Structure of Matter**
- **Division of Particle Physics and Astrophysics** and **Department of Cosmic Rays and Neutrinos**

IFJ involvement in MPD

Specializations:

- **Theoretical physics:**
  a) dynamics of multi-body systems,
  b) gluon and photon physics,
  c) quark-gluon plasma physics,
  d) interactions of light mesons at low energies (up to a few GeV),
  e) decay of heavy mesons,
  f) cosmic ray physics,
  g) the equation of state of dense nuclear matter in compact stars and heavy ion collisions,
  h) bayesian methods for astronomy and astrophysics,
  i) numerical relativity

- **Experimental physics:**
  a) heavy ion physics,
  b) electromagnetic effects in nucleus-nucleus collisions,
  c) correlations and fluctuations,
  d) baryon number transport,
  e) nuclear reactions

Past experiences and main achievements:

- many years of work for the WASA-at-COSY and PANDA projects,
- studies of strong interaction with antiprotons,
- analyses of exclusive photoproduction of J/ψ in $p - p$ and $p - \bar{p}$ scattering,
- a large contribution to the work on evidence for a new resonance from polarized neutron-proton scattering,
- works on ABC effect in basic double-pionic fusion,
- membership in collaborations:
  a) NA49 collab. since 1996: calibration, simulation, data analysis,
  b) ALICE collab since 1995; calibration, simulation, data analysis,
  c) leadership of IFJ PAN group in the NA61/SHINE collab. since 2016,
- introduction of a polar approach to the worldwide methodology of describing resonances (changes even in PDF tables),
- determining the parameters of several basic and difficult to parameterize meson resonances (e.g. $f_0(500)$),
- development of unitary and universal methods of describing meson FSI,

Past experiences and main achievements:

- experimental and phenomenological studies of electromagnetic effects in heavy ion collisions (leadership of this program in NA61/SHINE),
- coordination of "CP Task Force" in NA61/SHINE - intermittency studies,
- scientific supervision of studies of correlations/fluctuations using Strongly Intensive (SI) quantities in ALICE,
- new phenomenological program for studies of the transport of baryon number with a new model (GEM),
- development of compact star equations of state and estimation of physical properties of neutron stars (particularly for the mass-twin scenario),
- application of Bayesian inference for model parameter estimations exploiting multi-messenger astronomy observations,
- studies of ultra-high-energy cosmic rays generated from compact stars as well as near the Sun

IFJ involvement in MPD

- FOR SEVERAL MONTHS NOW AND IN THE FOLLOWING WEEKS AND MONTHS: participation in seminars (active and passive) and in conferences,
- NEXT: preparation of simulations, theoretical and detector consultancy, analysis of the first data, i.e. their processing and phenomenological analysis, i.e. creating theoretical models and drawing conclusions about e.g. the spectrum of resonances and others,
- construction of unitary amplitudes of FSI and analysis of their analytical structure in the complex momentum or energy space. Searching for standard (existing) resonances and for exotic ones (with standard and exotic quantum numbers, i.e. non-two or three-quark states),
- intermittency studies, studies of electromagnetic effects in heavy ion collisions, simulations of heavy ion collisions, data analysis, detector design and construction, simulations of experimental setups and detectors,
- works for MCORD - with detectors and with analyses of the data

IFJ involvement in MPD

Group resources and future plan and contribution to MPD: In the first two years, on average, each group member will spend about 15-20Financial resources: we will rely on a Polish grant for which the entire NICA-pl group will apply. Preparations for the application are advanced and several very reputable institutions and universities in Poland are participating in it. Later (in more or less 2 years), participation in the project will concern the analysis of the first data, i.e. their processing and phenomenological analysis, i.e. creating theoretical models and drawing conclusions about e.g. the spectrum of resonances and others. For example, model and unitary amplitudes of interactions in final states will be determined and their analytical structure in the space of complex momentum or energy will be analyzed. Standard (existing) resonances will be found and exotic ones will be sought - with exotic quantum numbers, i.e. non-two or three-quark states. Other planned works: intermittency studies, studies of electromagnetic effects in heavy ion collisions, simulations of heavy ion collisions, data analysis, detector design and construction, simulations of experimental setups and detectors, works for MCORD - with detectors and with analyses of the data.