Status of Slovak high energy/nuclear theory and phenomenology

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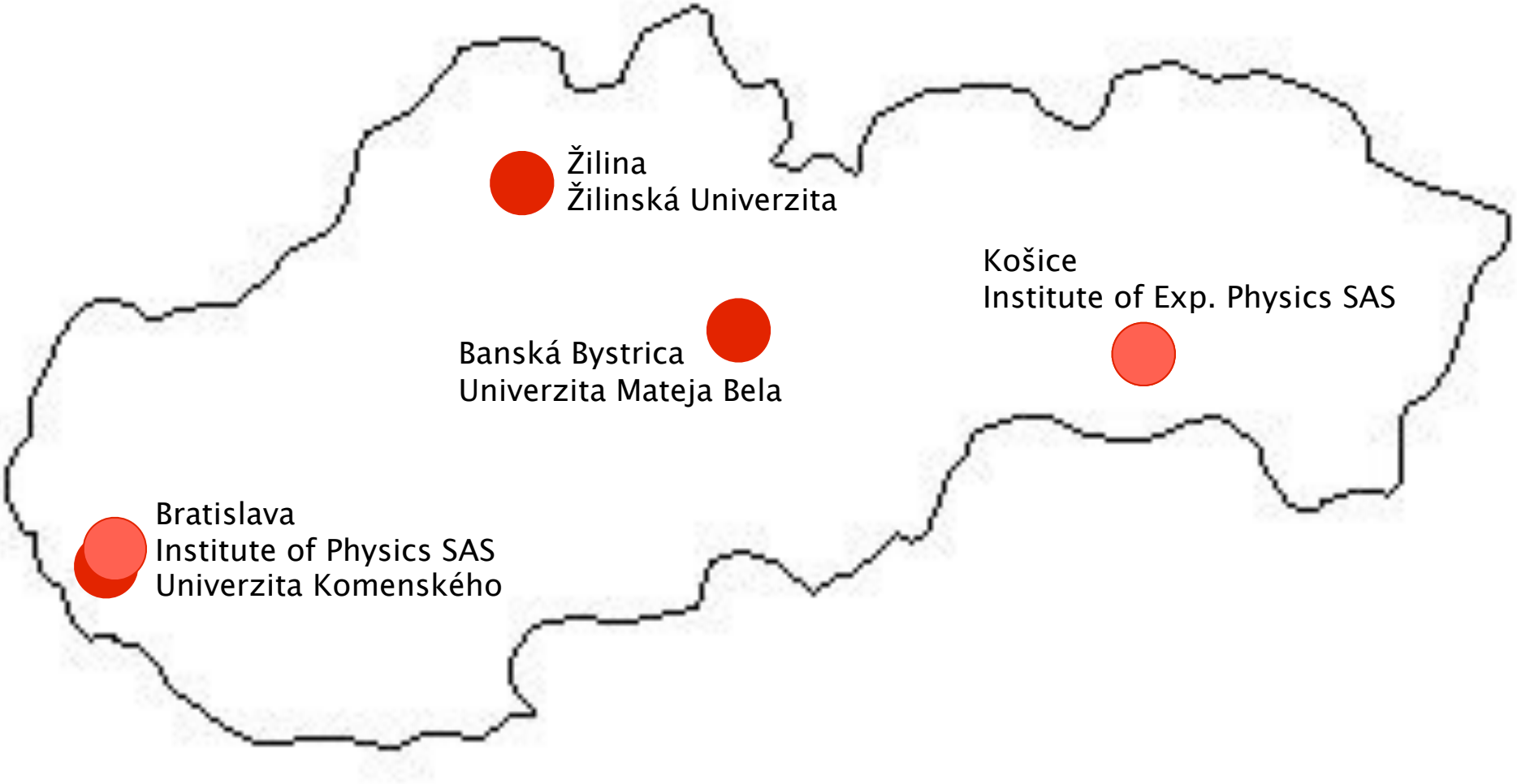
Institutions in Slovakia



Topic 1: Strongly interacting matter - overview of groups

- Štefan Olejník (Bratislava, Physics Institute SAS)
  Lattice QCD, confinement
- Štefan Gmuca, *Kristián Petrík* (Bratislava, Physics Institute SAS)
  Equation of State, consequences for compact stars
- Emil Běták (Bratislava, Physics Institute SAS)
  Compact star phenomenology with nuclear matter EoS
- Evgeni Kolomeitsev (Banská Bystrica, Univerzita Mateja Bela)
  Compact star properties, neutrino emission
- Peter Filip (Bratislava, Physics Institute SAS)
  Ultrarelativistic heavy ion phenomenology
- Boris Tomášik, Evgeni Kolomeitsev
  (Banská Bystrica, Univerzita Mateja Bela)
  Ivan Melo (Žilina, University of Žilina),
  Ultrarelativistic heavy ion phenomenology, hadron production

Investigation of the vacuum structure and mechanism of colour confinement in numerical simulations of lattice quantum chromodynamics

- Š. Olejník, Institute of Physics SAS, Bratislava, and collaborators.
- Numerical simulations of lattice quantum chromodynamics enable quantitative first-principle determination of properties of strongly interacting particles. They are also a valuable tool to investigate qualitatively the structure of the ground state of QCD, the mechanism of colour confinement, and the role of various gauge-field configurations for confinement and chiral symmetry breaking.
- Recent results in the qualitative direction:
  - Proposal of a model of the vacuum structure of gauge theories, common for Yang-Mills theories with SU(N) and G_2 gauge groups.
  - Verification of a specific prediction of the model, Casimir scaling of potentials between various colour sources.
  - An approximate form of the wave functional of the ground state of the Yang-Mills theory in 2+1 dimensions in temporal gauge:

$$\Psi_0[A] = \exp\left[-\tfrac{1}{2}\int d^2x d^2y\, B^a(x)\left(\frac{1}{\sqrt{-\mathcal{D}^2-\lambda_0+m^2}}\right)^{ab}_{xy} B^b(y)\right]$$

Compact stars

- Slovakia is member to the ESF RNP
  The new physics of compact stars - COMPSTAR
  (E. Kolomeitsev representative to Steering Committee)

Results:

- calculated the influence of Cooper pairing in superconductive matter of compact stars on neutrino emissivity
  (Kolomeitsev & Voskresensky - MEPhI Moscow)
- derived equation of state for nuclear matter fulfilling all known constraints from neutron stars and nuclear collision data
  (Kolomeitsev & Voskresensky - MEPhI Moscow)
- derived EoS with hyperons imposing constraints from DBHF description of hyperon-nucleon interaction
  (Gmuca, *Petrík*)
- masses and radii from EoS with and w/o hyperons calculated
  (Běták & Stuchlík - Silesian University)

High energy heavy ion phenomenology

- kinetic production of strangeness: kaons and the onset of deconfinement, new type of catalytic phi production (Tomášik, Kolomeitsev)
- fragmentation of the fireball at the phase transition and its signals (Tomášik, Melo, Gintner, *Bartoš* + international collaboration)
- hadron production and Monte Carlo modeling (Tomášik, Melo, *Mereš,* Černý, Balek)
- flow and flow anisotropies
  - influence of Au eccentricity on fluctuations of initial conditions (Filip)
  - influence of jet production at the LHC on elliptic flow (Tomášik)

Topic 2: Structure of hadrons and nuclei in reactions - groups

- Stanislav Dubnička, Cyril Adamuščín, Erik Bartoš, Andrej Liptaj (Bratislava, Physics Institute SAS)
  Anna Zuzana Dubničková (Bratislava, Comenius University)
  phenomenology of electroweak structure of hadrons

- Dalibor Krupa (Bratislava, Physics Institute SAS)
  properties of meson resonances via multi-channel scattering analysis, identification of quark/gluonic content

- Ján Nemčík (Košice, Institute of Experimental Physics SAS)
  nuclear effects in e+A, p(d)+A and A+B collisions

Analyticity in the phenomenology of electroweak structure of hadrons

Stanislav Dubnička and Anna Zuzana Dubničková group leaders

- about 3-4 young researchers
- Developed *Unitary & Analytic model of electroweak form-factors* unification of:
  - Vector meson dominance in e+e- annihilations
  - analyticity properties of form-factors in complex *t*-plane
  - correct asymptotic behaviour of the form-factors as predicted by the quark model of hadrons
- model applied sucessfully pseudoscalar meson nonet and $1/2^+$ baryon octet:
  - predicted total cross-section for $e^+e^- \rightarrow$ YYbar
  - better precision for muon anomalous magnetic moment
  - determined differences between neutral and charged rho family parameters
  - investigated see strange quark contribution to nucleon and kaon structure
  - first prediction of total cross-section for $e^+e^- \rightarrow$ ddbar
  - investigated polarization effects in $e^+e^- \rightarrow$ ppbar and $e^+e^- \rightarrow$ ddbar
  - etc.

Nuclear effects in e+A, p(d)+A and A+B collisions

Ján Nemčík, Košice, Institute of Experimental Physics

- Nuclear suppression at large x
  (prod. of hadrons, Drell-Yan, direct photons, heavy flavors …)
- Coherence phenomena at small x
  (gluon shadowing, CGC ...)
- Hadronization in nuclear matter
  (hadrons in DIS off nuclei, nucl. broadening, jet quenching …)
- Color transparency
  (production of hadrons, vector mesons ...)
- Cronin effect
- High-pT processes on nuclei
  (breakdown of QCD factorization ...)

Topic 3: Other high energy physics - overview of groups

- Ľubomír Martinovič (Bratislava, Physics Institute SAS)
  Quantum field theory in terms of light-front variables

- Mikuláš Gintner, Ivan Melo, Marián Janek
  (Žilina, University of Žilina)
  Strong electroweak symmetry breaking

- Fedor Šimkovic (Bratislava, Comenius University)
  Neutrino physics (separate talk)

Quantum field theory in terms of light-front variables

Ľubomír Martinovič, Bratislava, Institute of Physics

- spontaneous symmetry breaking in the LF formulation
  - found a mechanism based on shift operator that led to a infinite set of vacua represented by coherent states of antiperiodic boundary conditions
- A comparison of the LF and conventional (space-like) field theory at the level of exactly solvable models

Strong electroweak symmetry breaking

Mikuláš Gintner, Ivan Melo, Marián Janek (Žilina) + collaborators

- top-BESS (breaking electroweak symmetry strongly) model
  - $SU(2)_{L+R}$ resonance coupling only to the third generation
  - possible sizable signals at the LHC and in s-channel production processes at the ILC

Summary - theory and phenomenology

A small community with main contribution in strongly interacting matter studies and phenomenology of hadronic interactions.

Most contributions in phenomenology (hep-ph of nucl-th), some lattice theory.