



# Particle physics in Poland: BSM theory and cosmology

*Zygmunt Lalak*

*Institute of Theoretical Physics  
University of Warsaw*

*RECFA, Kraków, May 11th 2012*

# **OUTLINE:**

- **BSM TOPICS**
- **WHERE IN POLAND**
- **HUMAN RESOURCES**
- **BSM AND COSMOLOGY**  
**CENTERS IN POLAND**
- **SUMMARY**

# **Disclaimer**

- **Based on info from heads of chairs and divisions**
- **Data from web pages**
- **Papers and citations from InSPIRE database**
- **Fuzzy lines between**
  - **particle theory and formal QFT and mathematical physics**
  - **particle cosmology and cosmology/astrophysics**

# Beyond the SM

- ✓ electroweak breaking and nature of the Higgs sector: SUSY, composite higgs, higgs-less models, multi-higgs models, conformal models
- ✓ UV completion: strings, strongly coupled gauge sectors, extra dimensions (RS, deconstruction)
- ✓ dualities: AdS/CFT and its applications to nonequilibrium properties of strongly coupled plasma, relevant for the experimental RHIC/ LHC heavy-ion experiments
- ✓ NP in flavour physics, horizontal symmetries
- ✓ neutrino physics and model building
- ✓ cosmology: inflation and dark matter primordial fluctuations, dark energy

# Centers of BSM research in Poland

University of Szczecin



Warszawa

- University of Warsaw
- NCBJ

University of M.Curie-Skłodowska, Lublin

Świętokrzyska Academy, Kielce

University of Wrocław

University of Silesia, Katowice

Kraków  
Jagellonian University

# Human Resources (prof + assnt prof + PhD)

**University of Szczecin 2+2+2**



**University of Wrocław  
9+9+7**

**University of Silesia, Katowice  
3+2+6**

**Warszawa**

- University of Warsaw
- NCBJ

**14+11+24**

**University of M.Curie-Skłodowska, Lublin  
2+2+1**

**Świętokrzyska Academy, Kielce  
1+0+1**

**Kraków  
Jagellonian University  
3+3+5**

# BSM centers in Poland

## Warsaw University (UW) - Institute of Theoretical Physics

### Chair for Theory of Particles and Elementary Interactions: Prof. Stefan Pokorski

+ Professors: J. Bartelski, B. Grzadkowski, Z. Lalak, K. Meissner, M. Olechowski,  
W. Królikowski (emeritus), 1 ass. prof., 2 assnt prof., 3 post-docs, 15 PhD students

#### Topics:

**nonstandard, elementary and composite electroweak sectors,**  
**low energy supersymmetry, conformal symmetry, flavour physics,**  
**extra dimensions, string phenomenology, brane worlds, grand unification**  
**gauge and string/gravity dualities**  
**cosmology, loop quantum cosmology**  
**particle Dark Matter, collider phenomenology, NP in flavour physics**

**Papers (citations) 2007-2012: 192 (940)**

**Grants:** 3 grants from EC: networks „Unification in the LHC era”, „Universenet”  
TOK „Particles and cosmos” ~3 500 000 pln from EU  
10 grants from MNiSW/NCN ~3 500 000 pln

**Conferences** 6 intl Warsaw Workshops on Particle Cosmology,  
Planck 2007 and Planck 2012, String Phenomenology 2009,  
Scalars 2011, Stringtheory.pl 2011, 2012

# BSM centers in Poland

## Warsaw University (UW) - Institute of Theoretical Physics

### Chair for Theory of Strong and Electroweak Interactions: Prof. Maria Krawczyk

+ Professors: J. Kalinowski, P. Chankowski, S. Glazek , J. Namysłowski (emeritus),  
A. Szymacha (emeritus) + 1 ass. prof., 1 assnt prof., 7 PhD students

#### Topics:

**non-perturbative strong interactions,**  
**duality AdS/QCD,**  
**B- and K-decays, unitarity triangle**  
**EW precision observables,**  
**nonstandard Higgs setors (2 Higgs doublets),**  
**supersymmetry, neutrino physics,**  
**collider phenomenology, numerical tools**

**Papers (citations) 2007-2012: 80 (631)**

**Grants:** EU grants „FlaviaNet”, „HEPTOOLS” ~800 000 pln  
2 grants MNiSW/NCN ~ 500 000 pln

**Conferences** Planck 2007, Planck 2012, ILC-ECFA Workshop 2009,  
FlaviaNet Workshop 2009, Scalars 2011

# BSM centers in Poland

**Narodowe Centrum Badań Jądrowych (NCBJ)**  
- Division of Theoretical Physics

**BayesFITS Group: Prof. Leszek Roszkowski (U. of Sheffield and NCBJ since 2009)**

- + 4 assnt profs: P. Zalewski, M. Kazana, K. Kowalska, K. Nawrocki
- + Postdocs: S. Munir, E. Sessolo, S. Tsai
- + 1 PhD student

**Topics:**

search for new particles: supersymmetry in and Dark Matter in LHC data  
bayesian statistical methods

**Papers (citations) 2009-2012: 14 (186)**

**Grants: FNP (polish source) BayesFITS 2 000 000 pln 2011-2012**

# BSM centers in Poland

**Narodowe Centrum Badań Jądrowych (NCBJ)**  
- Division of Theoretical Physics

**String Theory Group: Dr Sc. Michał Spaliński**

+ 1 assnt prof.: M. Heller, 1 PhD student

**Topics:**

**string theory and its application to high energy physics**

**Papers (citations) 2007-2012: 15 (175)**

**Grants: NCN (polish source) ~ 15 000 pln/year**

**Conferences Stringtheory.pl 2011, 2012**

# BSM centers in Poland

**Jagiellonian University (UJ) Kraków - Institute of Physics**

**String Theory Group: Prof. Romuald Janik**

+ 1 assnt . prof. A. Wereszczyński, 3 PhD students

**Topics:**

**AdS/CFT correspondence in strongly coupled gauge theories**

**nonequilibrium properties of strongly coupled plasma**

**thermalization relevant for the experimental RHIC/LHC heavy-ion**

**exact results in N=4 Super-Yang-Mills theory**

**Papers (citations) 2007-2012: 30 (1000)**

**Grants: N N202 105136 (polish) String theory and the AdS/CFT correspondence  
POLONIUM 2008/9 Quark-gluon plasma and strings,  
2011/12 Gauge/gravity duality (pol-fr)**

**~ 40 000 pln/year**

**Conferences Stringtheory.pl 2011, 2012**

# BSM centers in Poland

**Jagiellonian University (UJ) Kraków - Institute of Physics**

**Division for Discrete Field Theory: Prof. Jacek Wosiek**

+ Professor A. Kotański + 2 assnt prof., 2 PhD students

**Topics:**

**non-perturbative methods for gauge theories,  
field theory on space-time lattices  
supersymmetric quantum mechanics  
black holes in high energy scattering**

**Papers (citations) 2007-2012: 48 (165)**

**Grants: MPD FNP/UE 250 000 euro  
MNiSW/NCN (polish source) ~20 000 pln/year**

# BSM centers in Poland

**University of Lublin (UMCS) - Institute of Physics, Institute of Informatics**

**Division for Complex Systems + Division for Theoretical Physics:**

**Prof. Wiesław A. Kamiński**

+ Dr Sc. Marek Rogatko, 2 assnt prof., 1 PhD student

**Topics:**

**Majorana neutrinos in SUSY models  
fermionic fields in curved backgrounds  
neutrino oscillations in strong gravitational fields**

**Papers (citations) 2007-2012: 9 (13)**

**Grants: Polish Astrophysics Net., 2 MNiSW/NCN grants, Pol-German Grant  
350 000 pln (polish sources) + 60 000 pln P-G  
~ 80 000 pln/year**

# BSM centers in Poland

**Silesian University (UŚ) - Institute of Physics**

**Division of Field Theory and Elementary Particles:**  
**Prof. Marek Zrałek**

+ Professors: H. Czyż, K. Kołodziej, 2 assnt prof., 6 PhD students

**Topics:**

**BSM in neutrino physics  
signatures of New Physics at colliders**

**Papers (citations) 2007-2012: 31 (317)**

**Conferences Ustroń Conferences 2007, 2009, 2011**

**Grants: 3 grants MNiSW/NCN ~ 435 000 pln**

**90 000 pln/year**

# BSM centers in Poland

**Jan Kochanowski University Kielce (JKU) - Institute of Physics**

**Department of Theoretical Physics: Prof. St. Mrówczyński**  
+ 1 PhD student

**Topics:**

**statistical field theory in high energy physics,  
physics of supersymmetric plasma systems**

**Papers (citations) 2007-2012: 4 (6)**

**Grants: 2 grants MNiSW/NCN                   ~50 000 pln/year**

# BSM centers in Poland

## University of Wrocław (UWr) - Institute for Theoretical Physics

**Division of Field Theory and Division of Neutrino Physics:**  
**Prof. Z. Haba and Prof. J. Sobczyk**

+ Dr Sc. S. Ciechanowicz, Dr Sc. D. Prorok, 4 assnt prof., 2 PhD students

### Topics:

**neutrino physics, nuclear effects, statistical methods, heavy ions,  
interference experiments**

**Papers (citations) 2007-2012: 30 (734)**

**Grants MNiSW/NCN ~420 000 pln, ~84 000 pln/year**

### Conferences

**Neutrino interactions: From theory to Monte Carlo simulations, 45th Karpacz  
Winter School in Theoretical Physics, Ladek-Zdroj, Poland, February 2-11, 2009.**

# BSM centers in Poland

**University of Wrocław (UWr) - Institute for Theoretical Physics**

**Division of Theory of Fundamental Interactions and Particles  
Elementary Interactions and Quantum Gravity:  
Prof. J. Kowalski-Glikman**

+ Professors: J. Lukierski, 1 ass. prof., 2 Dr Sc., 5 assnt prof., 5 PhD students

**Topics:**

**supersymmetry, conformal field theory, strings,  
quantum gravity, violation of Lorentz symmetry**

**Papers (citations) 2007-2012: 116 (954)**

**Grants MNiSW/NCN 3 grants, ~150 000 pln/year**

**Conferences Max Born Meetings 2009, 2011  
Stringtheory.pl 2011**

# BSM centers in Poland

## University of Szczecin (USz) - Institute of Physics

**Szczecin Cosmology Group: Prof. M. Dąbrowski**

+ ass. prof. J. Garecki, 2 assnt prof., 2 PhD students

### Topics:

**pre Big-Bang cosmology, string cosmology, dark energy (phantoms), observational cosmology, LSS, multiverses**

**Papers (citations) 2007-2012: 25 (340)**

**Grants MNiSW/NCN 3 grants, ~90 000 pln/year**

**Conferences GrassCosmoFun 2009**

# **BSM AND COSMO: SUMMARY**

- ▶ All important and hot topics are investigated in Poland
- ▶ Local highlights
  - Warsaw: SUSY, electroweak breaking, inflation, DM
  - Cracow: AdS/CFT
  - Katowice: BSM in neutrino physics
  - Wrocław: CFT, quantum gravity
- ▶ In total 34+28 staff and 46 PhD students
- ▶ 20 large international conferences
- ▶ over last 5 years 600 papers with 5736 citations
- ▶ Polish BSM active and productive (and inexpensive)

## **Problems**

- need to attract brilliant PhD students
- need for post-doc positions in research groups
- need for long-term stable funding for research groups