Astroparticle Physics in Poland

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Discovery of hypernucleus in 1952

Jerzy Pniewski & Marian Danysz
Astroparticle Physics in Poland

Several groups, 2-10 people each

- Cosmic rays
- Space weather
- Extraterrestrial neutrinos – talk by D.Kielczewska
- Gamma Ray Bursts

Fuzzy boundary between astronomy and particle physics ...
Satellite instruments for monitoring "space weather":
- solar activity
- magnetosphere
- radiation intensity

Regional Warning Center - [www.cbk.waw.pl/rwc1](http://www.cbk.waw.pl/rwc1)
Kielce - Świętokrzyska Academy

Institute of Physics

www.pu.kielce.pl/fiz

Collaboration: SINS Warsaw & INP Cracow

Stangelets:

- search for s. in CASTOR (CMS/LHC)
- study of muon bunches in CosmoLEP
- interpretation of strangelet candidates
- strangelets as source of UHE cosmic rays
- simulation of s. propagation through atmosphere
Jagiellonian University
Astronomical Observatory
www.oa.uj.edu.pl

• Theory of cosmic ray acceleration in interstellar turbulences and shock waves

Institute of Nuclear Physics
Polish Academy of Sciences
IFJ PAN - www.ifj.edu.pl

• Participation in the Pierre Auger Project
The Pierre Auger Project

A new cosmic ray observatory to study the highest energy cosmic rays

Explaining their origin is one of the most prominent problems in present-day astrophysics

Record: cosmic ray extensive air showers
Determine:
- cosmic ray energy spectrum
- arrival directions
- composition

Two large air shower detector systems, 3000 km² each:
- Mendoza, Argentina (construction underway)
- Utah or Colorado, USA (in planning)

Hybrid detection system → unprecedented accuracy of extensive air shower measurements

15 countries – 50 institutions
www.auger.org
Auger Construction Plan

Years 2000–2001: Engineering Array
32 prototype surface detector stations / 2 prototype fluorescence detectors

Year 2002–2003: Pre-production

Year 2003–2006: Full production and deployment

Auger already is the largest cosmic ray detection system in the world

Preliminary data analysis:
first science results expected in 2005
Construction of the Observatory:
provided parts for mechanical structure of the fluorescence detector telescopes

• Aperture box structure
• Mirror mounts
• External shutters
Improving fluorescence technique of shower detection

- refined the procedure of air shower energy determination (account of lateral spread of air showers)

- better account of atmospheric effects (atmospheric density profiles measured instead of a model, correction for multiple scattering of light)

Identification of photons in UHE cosmic rays

Study of the preshowering effect: photon conversion in geomagnetic field and subsequent air shower development

- developed a procedure to determine the fraction of photons in UHECR

- set the (preliminary) experimental upper limit on photon fraction in UHECR
University of Łódź

Department of Experimental Physics
kfd2.fic.uni.lodz.pl

Division of Cosmic Rays
• high energy cosmic rays (experiment Auger)
• gamma-ray astronomy (MAGIC)
• cosmic ray interactions in the atmosphere
  (experiment Pamir)

Division of High Energy Astrophysics
• models and mechanisms of X-ray and gamma-ray production
  in cosmic sources
• sources of high energy cosmic ray particles
• acceleration of particles and their propagation inside sources
• propagation of cosmic rays in the Galactic and intergalactic medium
Domestic experiments:
• Extensive Air Shower (EAS) detector: $E > 10^{15}$ eV
• Underground Muon Telescope: $E > 5$ GeV
• Roland Maze Project

International experiments:
• Kascade, Kascade Grande (Karlsruhe)
• Baksan (Kaukaz)
• EAS detection at Airbus A380 (College de France)

Theory, modelling:
• multiparticle production by cosmic rays
• cosmic rays and microwave background correlations
The Roland Maze Project: science + education

- Cosmic ray detectors distributed in schools
- 4 detectors per school
- Detector = 1m² of scintillator + PM
- GPS synchronisation (RMS=2ns)
- Local data preprocessing in schools
- Central data storage in the Institute
Gamma Ray Bursts (GRB)

- Short (0.01-100s) pulses of $\gamma$ rays from pointlike sources in the sky
- Extragalactic origin ($<13$ M ly, $z<4.6$)
- Huge energy: $10^{51}$ ergs
- Hypothesis (500 papers/year):
  - supernova collapsing to black hole
  - two neutron stars merging into black hole
  - creation of quark star
- Very frequent: 2-3/day (1-2/week detected by satellites)
- Information distributed to ground telescopes etc. via GRB Coordinate Network (GCN)
- So far:
  - ~3000 GRB detected by satellites
  - ~50 observed optically from ground after h or days
  - only 1 observed in real time (1 min after GRB)
„π of the Sky”

„Particle physics – like” way to search for GRB
- Continuous monitoring of all (>π) sky
- On-line data processing
- Multilevel trigger system

Participants:
- Sołtan Institute for Nuclear Studies, Warsaw/Świerk
- Center for Theoretical Physics, Polish Acad. of Sc.
- Institute of Experimental Physics, Warsaw Univ.
- Warsaw University of Technology

In collaboration with:
- Princeton University
- Astronomical Observatory of Warsaw Univ.
„π of the Sky” prototype

2 CCD cameras covering 33°×33°

Las Campanas Observatory, Chile

First results (7.2004-2.2005):
• 3 limits shortly after GRB
• 1st ever limit during GRB
• 1 candidate (not confirmed)

Brwinów, Poland
„π of the Sky” perspectives

2005 – 2×16 cameras to cover all sky
• grant application positively recommended

2006 – prototype of high sensitivity camera for next generation system (>100 cameras)
• plan to apply for EU FP7 grant

2007 – small systems at Greenland and Antarctica
• EoI submitted for International Polar Year

Proposal to establish
Laboratory for Astroparticle Apparatus
within Sołtan Institute of Nuclear Studies
Particle physics or Astronomy?

I predict – they will merge quite soon

- Particle physics came from space (cosmic rays)
- The Universe is full of powerful accelerators
- Particle physics is a key stone of cosmology
- Recently – also experimental technics become similar

CCD invention for astronomy was like wire chamber for particle physics.

Astronomy is now moving from single observations of individual objects to massive data acquisition from millions of objects.

All sky surveys, farms of robotic telescopes, etc ... "4π" detectors, huge data streams analysed online, multilevel trigger systems ...

all that we know so well ...
Nicolaus Copernicus
The first Polish expert on analysis of large data samples