Astroparticle physics, gravitation and cosmology

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Topics to be considered

Astroparticles in Europe

- ApPEC = Astroparticle Physics European Coordination
  - Body of funding agencies and ministries, since 2001
- ASPERA Eranet – EU funding July 2006 – July 2012
  - Network of funding agencies – CERN is a member
  - Funding for the organisation of the field
  - Distributed Joint Secretariat, Governing Board
  - Virtual common pot for financing of R&D = now 3rd call for proposals
- ApPEC – CERN workplan for the update of the European Strategy
- ApPEC-ASPERA *Astroparticles roadmap* presented 21-22/11/11 in Paris – www.aspera-eu.org

European strategy update

- APP field evolved a lot since previous European Strategy document
- 2009 census: ~ 3000 FTE in Europe, ~ 200 universities
- 2010: CERN scientific enlargement – CERN can participate to experiments outside Geneva lab

- **Proposal for the strategy update**:
- start from ApPEC/ASPERA roadmap – written by Scientific Advisory Committee
- Ask comments/input from community – ASPERA newsletter, particle physics channels, ..

Astroparticle and particle physics

- complementarity and interference with collider based HEP
- Need for dedicated infrastructure, eg deep underground labs
- APP shares with particle physics
  - Theory support
  - R&D for new detectors, test beams, …
  - Large computing systems for data management and simulation, GRID, high bandwidth networks, …

common research topics

- Complementary effort to understand
  - SUSY/neutrino related to dark matter
  - Axions and strong CP problem
  - Neutrino properties : global fit & beyond SM
  - Dark energy, gravitation and beyond SM
  - Anti-matter

Subjects: high energy universe

- origin of high-energy cosmic rays? multi-messenger approach
- Charged cosmic rays
  - Space based (primary CR) and ground based (atmospheric air shower) – AMS, AUGER in data taking phase
  - Search for sources of HE cosmic rays
  - CR composition & energy spectrum
  - Anti-matter , indirect dark matter search
  - New physics at energies beyond LHC
  - need improved knowledge of interaction models – eg forward physics @ LHC

Subjects: high energy universe

- Gamma-ray astrophysics : MeV - 100TeV
  - Space based (eg Fermi) and ground based (eg HESS, CTA)
  - Study of AGN and GRB, indirect dark matter search, ..

➔ CTA strongly pushed by the community ←

- High-energy neutrinos: GeV-PeV
  - Few large operational detectors: ANTARES, IceCube, Baikal
  - Understand cosmic acceleration: objects, hadronic component, ..
  - indirect dark matter search
  - SN neutrinos – SNEWS

➔ No source identified yet: Sensitivity problem←

➔ Projects more connected with astrophysics ←

Subjects: dark matter & neutrino properties

- Direct Dark matter experiments
  - Complementary to indirect searches and searches at LHC
  - WIMPs, axions
  - Many experiments spread over world
  - Many different techniques

  ➔ Physics goals strongly connected with particle physics🡐

- measurement of neutrino mass
- Neutrinoless double beta decay

  ➔ Physics goals strongly connected with particle physics🡐

Subjects: large underground detectors

- Proton decay
- SN, solar and atmospheric neutrinos
- Neutrino oscillations @ reactors
- Long baseline neutrino experiments and neutrino beam

➔**LAGUNA-LBNO on CERN to XX neutrino beam**

➔ **Physics goals strongly connected with particle physics**🡐

Cosmology and gravitation

- Dark energy
  - High statistics surveys of galaxies and SNIa by astronomical observatories – ground and space based
  - Support to cosmological modelling : expansion rate, structure formation, general relativity, modified gravity …
  - Access to data on CMB, DES …
  - Huge effort – EUCLID ESA mission = European leadership

➔ Physics goals connected with particle physics🡐

- Gravitational waves
  - Advanced LIGO+VIRGO+GEOHF probe 250Mpc
  - Signals of matter under extreme density – signals from very early universe
  - Test of fundamental laws (eg equivalence principle, Lorentz invariance, …)

➔ Physics goals connected with particle physics (common quantum standard model including gravity is missing)🡐