ApPEC Astroparticle Physics European Coordination

ASPERA

ApPEC Steering Committee & ASPERA Governing Board

Statement on the Future of Astroparticle Physics in Europe

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Astroparticle physics marks the intersection of astrophysics, particle physics and cosmology. It addresses fundamental questions concerning the nature of dark matter and dark energy, the physics of the Big Bang, the stability of protons, the properties of neutrinos and their role in cosmic evolution, the nature of the cosmic processes as viewed with gravitational waves and high energy messengers. During the past decade three related Nobel prizes have been awarded: solar and supernova neutrinos (2002), cosmic microwave background fluctuations (2006), and acceleration of the universe (2011), all of which demonstrate beyond doubt the relevance and vitality of astroparticle physics. Other spectacular successes have been the opening of two new windows to the universe: the low energy neutrino window and the window of high-energy gamma rays. Other aspects of astroparticle physics have progressed to levels of sensitivity which make analogous ground breaking discoveries in the near future likely.

In view of this remarkable progress and of the need for an increased coordination and networking on a global scale, the Scientific Advisory Committee was charged to update its 2008 European Strategy for Astroparticle Physics. The ApPEC Steering Committee and the ASPERA Governing Board, reflecting on the major issues, endorse the **European Roadmap for Astroparticle Physics, 2011 Edition,** and wish to make the following statement.

The current planning for astroparticle physics research includes medium scale projects, or upgrades at different stages of realization, large scale projects whose construction needs to start towards the middle of the current decade, and very large scale infrastructures being developed on a longer time scale.

The first category includes:

1. **Gravitational wave advanced detectors,** where a discovery in the next five years becomes highly probable and would open an entirely new window to the Universe.
2. **Dark matter searches,** where the WIMP dark matter hypothesis will be proven or disproven within the next 10 years. The dramatic progress of the noble liquid technology and the steady progress of bolometric techniques over the past 2-3 years demonstrate a high momentum which must be maintained. Ton scale experiments using xenon and lower total mass low-temperature crystals will start taking data by the middle of the decade. A program extending the target mass of noble liquids to several tons is envisaged.
3. **Neutrino property measurements,** where several experiments in Europe are either in the commissioning phase or in the final years of construction to search for neutrino-less double beta decay, and to measure the neutrino mass via single beta decay. The further road towards double beta experiments covering full mass range characteristic for the inverted mass hierarchy depends on the results of the present generation experiments.

4. **Underground laboratories**, where beyond the continuation of support to the **Gran Sasso** laboratory and the start of operations of the **Canfranc** laboratory, there is a unique window of opportunity to extend the present **Underground Laboratory of Modane.**

5. **Space-based detectors** using direct detection methods in order to get a better understanding on the composition and spectral features of cosmic rays.

The second category includes three high-energy and one low-energy neutrino astroparticle physics projects:

1. In the domain of TeV gamma-ray astrophysics the **Cherenkov Telescope Array (CTA)** is the worldwide priority project. It combines proven technological feasibility with a guaranteed scientific perspective. Its mode of operation and the wealth of data are similar to a large astronomy project. The ambitious time schedule for technical design and prototype development of CTA, as well as the selection of the site(s), is aiming at a start of construction before the middle of the decade.

2. The next generation **high-energy neutrino telescope** in the Mediterranean Sea (**KM3NeT**), an ESFRI project, must have sensitivity substantially larger than that of IceCube, the neutrino telescope operating in Antarctica. The KM3NeT collaboration produced a corresponding technical design report, funded by the EU Preparatory Phase program. The technology definition is in its final stages with prototype deployment within the next 2 years, and eventual access to deep-sea research.

3. Following the footsteps of the Pierre Auger Observatory in Argentina a global **next-generation ground-based observatory** is envisaged with a substantial contribution from Europe**.** The preparations include the development of new detection technologies, the search for appropriate sites, and the attraction of new partners.

4. The goals of a megaton-scale detector as addressed by the design studies **LAGUNA** range from **low-energy neutrino astrophysics** (e.g. supernova, solar, geo- and atmospheric neutrinos) to fundamental searches without accelerators (e.g. search for **proton decay**) and accelerator driven physics (e.g. **observation of CP-violation**). Due to its high cost, the program can be developed only in a global context; furthermore the timing of its realization depends strongly on whether the indications for the mixing parameter defined as θ_{13} were to be confirmed within the next one or two years, permitting a series of very exciting measurements for neutrino mass hierarchy and CP violation using CERN beams. LAGUNA is therefore clearly at the interface with the CERN European Strategy Update to be delivered early 2013, where it represents a high-priority astroparticle project.

The third category includes longer time scale projects in dark energy and gravitational wave domains. Astroparticle physicists play a major role in many international **Dark Energy programs,** such as the recently chosen Cosmic Vision ESA satellite **EUCLID** (2019) or the dominantly US-funded **LSST** observatory (2017), which would play a complementary role to EUCLID.

The path for research in gravitational waves beyond the advanced detectors foresees two projects of a very large scale: the Earth-bound **Einstein Telescope (ET)** and the space-bound **LISA** project. ET construction would start at the end of this decade, after the first detection of gravitational waves with the advanced detectors and following successful R&D. The LISA project, for which preparatory work in on-going, would eventually rely on the success of the technological mission LISA-Pathfinder.

ApPEC and ASPERA also recognise the importance of three transversal aspects. **Theoretical research** in the field of astroparticle physics would strongly benefit from a strengthened and more coordinated support**. Smaller projects and innovative R&D activities** are essential for the progress of the field and should also be supported in the framework of international co-operation, including common calls. Last but not least, most astroparticle observatories have developed strong **synergies with geo-sciences and environmental studies.** They provide state-of-the-art technologies and attractive infrastructures to the corresponding communities. The corresponding requirements should be taken into account in the planning phases.

In conclusion, ApPEC and ASPERA welcome the priorities defined by the scientific communities in the 2011 version of the Astroparticle Physics Roadmap. They accept the recommendations addressed to the governmental funding agencies with best endeavours to implement them. Co-operation is the only way to achieve the critical mass for projects which require budgets and personnel not available to a single agency. The Roadmap is also a timely input into the update of the European Strategy for Particle Physics launched by CERN Council.

European scientists have an exciting palette of opportunities for developing new technologies, for seeking international collaborations, and for reaching scientific breakthroughs. It is also important to seek a balance amongst funding large scale investment and innovative R&D activities, theoretical activities, large scale computing and services of astroparticle infrastructures to other larger communities, such as those in environmental and geo-sciences.

ApPEC is the Astroparticle Physics European Coordination. It was founded in 2001 when six European scientific agencies took the initiative to coordinate and encourage astroparticle physics in Europe. 11 countries are currently members of ApPEC.

ASPERA, the AStroParticle European Research Area is a network of European national funding agencies responsible for astroparticle physics. ASPERA is funded by the European Commission as an ERA-NET. ASPERA comprises currently 23 national funding agencies in 19 countries, and CERN European Organization.

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