Allegato n. 1

CONCORSO PER TITOLI ED ESAMI PER UN POSTO PER IL PROFILO PROFESSIONALE DI TECNOLOGO DI III LIVELLO PROFESSIONALE CON CONTRATTO DI LAVORO A TEMPO INDETERMINATO PRESSO LA SEZIONE DI ROMA TOR VERGATA
BANDO N. 23671/2021

PROVA ORALE – TESTO N. 1

1. Si discuta l'utilizzo di software di simulazione per la progettazione di un rivelatore di particelle per un esperimento spaziale
2. Usando il numero N scelto precedentemente e l'offset (O): 7, si ottiene il numero M=(N+O) mod 10. Si discuta, con particolare riguardo al proprio contributo personale, la pubblicazione numero M (contando dall'alto) dell'elenco dei prodotti, lavori a stampa, progetti ed elaborati tecnici allegato alla domanda concorsuale
3. Si descriva un pacchetto software di propria scelta per l'analisi dati, illustrandone le caratteristiche e gli usi principali
4. Leggere e tradurre

Scientific issues

Large-scale multi-messenger infrastructures

To improve understanding of our Universe, APPEC identified as a very high priority those research infrastructures that exploit all confirmed high-energy 'messengers' (cosmic particles that can provide vital insights into the Universe and how it functions). These messengers include gamma rays, neutrinos, cosmic rays and gravitational waves. European coordination is essential to ensuring timely implementation of such infrastructures and enabling Europe to retain its scientific leadership in this field.

1. High-energy gamma rays

Through the use of ground-based gamma-ray telescopes (e.g. HESS and MAGIC) and key participation in satellite missions such as Fermi, Europe has played a leading and pioneering role in establishing high-energy gamma rays as an ideal messenger to enable exploration of the extreme Universe – as demonstrated by the astonishing number of gamma-ray sources discovered in recent years. The next-generation European-led, ESFRI-listed global project will be the Cherenkov Telescope Array (CTA), which has excellent discovery potential ranging from astrophysics to fundamental physics. The CTA is expected to start full operation as an observatory in 2023.

APPEC fully supports the CTA collaboration in order to secure the funding for its timely, cost-effective realisation and the subsequent long-term operation of this observatory covering both northern and southern hemispheres.

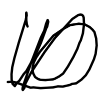
2. High-energy neutrinos

IceCube's first observation of PeV-scale cosmic neutrinos in 2013 has opened an entirely new window onto our Universe: neutrino astronomy. As well as presenting the opportunity to resolve neutrinos' mass hierarchy by studying atmospheric neutrinos, this led ESFRI to include KM3NeT 2.0 in its 2016 roadmap, with operation anticipated to commence in 2020. Within the Global Neutrino Network (GNN), the IceCube, KM3NeT and Baikal-GVD collaborations already join forces to provide a network of large-volume detectors viewing both northern and southern hemispheres and to exploit efficiently the full discovery potential inherent in neutrino astronomy.

For the northern hemisphere (including Baikal GVD), APPEC strongly endorses the KM3NeT collaboration's ambitions to realise, by 2020: (i) a large-volume telescope with optimal angular resolution for high-energy neutrino astronomy; and (ii) a dedicated detector optimised for low-energy neutrinos, primarily aiming to resolve the neutrino mass hierarchy. For the southern hemisphere, APPEC looks forward to a positive decision in the US regarding IceCube-Gen2.

3. High-energy cosmic rays

The Pierre Auger Observatory is the world's largest, most sensitive ground-based air-shower detector. Understanding the evident flux suppression observed at the highest energies requires good mass resolution of primary cosmic rays: are they predominantly light nuclei (protons) or heavy nuclei (like iron)? This is the missing key to deciding whether the observed cut-off is due to particles being limited in energy because of interactions with the CMB, or to cosmic accelerators 'running out of steam' to accelerate particles. The Auger collaboration will install additional particle detectors (AugerPrime) to measure simultaneously the electron and muon content of air showers, in order to help determine the mass of primary cosmic rays. This upgrade will also deepen understanding of hadronic showers and interactions at centre-of-mass energies above those accessible at the LHC.



APPEC strongly supports the Auger collaboration's installation of AugerPrime by 2019. At the same time, APPEC urges the community to continue R&D on alternative technologies that are cost-effective and provide a 100% (day and night) duty cycle so that, ultimately, the full sky can be observed using very large observatories.

Allegato n. 2

CONCORSO PER TITOLI ED ESAMI PER UN POSTO PER IL PROFILO PROFESSIONALE DI TECNOLOGO DI III LIVELLO PROFESSIONALE CON CONTRATTO DI LAVORO A TEMPO INDETERMINATO PRESSO LA SEZIONE DI ROMA TOR VERGATA
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PROVA ORALE – TESTO N. 2

1. Si presentino le funzionalità ritenute necessarie per un programma software per l’acquisizione dati per un rivelatore di particelle per un esperimento spaziale
2. Usando il numero N scelto precedentemente e l’offset (O): 2, si ottiene il numero M=(N+O) mod 10. Si discuta, con particolare riguardo al proprio contributo personale, la pubblicazione numero M (contando dall'alto) dell'elenco dei prodotti, lavori a stampa, progetti ed elaborati tecnici allegato alla domanda concorsuale
3. Si discutano le differenze tra due sistemi operativi di propria scelta
4. Leggere e tradurre

4. Gravitational waves

The first direct observations of gravitational waves by the LIGO-Virgo consortium have revealed a scientific treasure trove. Multi-solar-mass black holes coalescing within seconds into one larger black hole and simultaneously radiating the equivalent of a few solar masses of energy as gravitational waves are now an established fact; they also provide unprecedented tests of General Relativity. Another new, revolutionary window onto our Universe has therefore now opened: gravitational-wave astronomy. In this field, the laboratories that host gravitational-wave antennas play a crucial role by developing new technologies to increase detection efficiencies further. The incredibly high precision in monitoring free-falling objects in space recently achieved by ESA's LISA Pathfinder mission is an important step towards complementary (low-frequency) space-based gravitational-wave astronomy.

With its global partners and in consultation with the Gravitational Wave International Committee (GWIC), APPEC will define timelines for upgrades of existing as well as next-generation ground-based interferometers. APPEC strongly supports further actions strengthening the collaboration between gravitational-wave laboratories. It also strongly supports Europe's next-generation ground-based interferometer, the Einstein Telescope (ET) project, in developing the required technology and acquiring ESFRI status. In the field of space-based interferometry, APPEC strongly supports the European LISA proposal.

Medium-scale Dark Matter and neutrino experiments

APPEC considers as its core assets the diverse, often ultra-precise and invariably ingenious suite of medium-scale laboratory experiments targeted at the discovery of extremely rare processes. These include experiments to detect the scattering of Dark Matter particles and neutrinoless double-beta decay, and direct measurement of neutrino mass using single-beta decay. Collectively, these searches must be pursued to the level of discovery, unless prevented by an irreducible background or an unrealistically high demand for capital investment.

5. Dark Matter

Elucidating the nature of Dark Matter is a key priority at the leading tip of astroparticle physics. Among the plethora of subatomic particles proposed to explain the Dark Matter content of our Universe, one category stands out: the Weakly Interacting Massive Particle (WIMP). WIMPs arise naturally, for instance, in supersymmetric extensions of the Standard Model of particle physics. Many experiments located in deep-underground laboratories are searching for WIMP interactions. For masses in excess of a few GeV, the best sensitivity to WIMPs is reached with detectors that use ultra-pure liquid noble-gas targets; such detectors include XENON1T (using 3.5 tons of xenon) and DEAP (using 3.6 tons of argon), which both started operating in 2016. Their sensitivity can be further enhanced by increasing the target mass. A suite of smaller-scale experiments is exploring, in particular, low-mass WIMPs and other Dark Matter hypotheses such as those based on dark photons and axions.

APPEC encourages the continuation of a diverse and vibrant programme (including experiments as well as detector R&D) searching for WIMPs and non-WIMP Dark Matter. With its global partners, APPEC aims to converge around 2019 on a strategy aimed at realising worldwide at least one 'ultimate' Dark Matter detector based on xenon (in the order of 50 tons) and one based on argon (in the order of 300 tons), as advocated respectively by DARWIN and Argo.

Allegato n. 3

CONCORSO PER TITOLI ED ESAMI PER UN POSTO PER IL PROFILO PROFESSIONALE DI TECNOLOGO DI III LIVELLO PROFESSIONALE CON CONTRATTO DI LAVORO A TEMPO INDETERMINATO PRESSO LA SEZIONE DI ROMA TOR VERGATA
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PROVA ORALE – TESTO N. 3

1. Si discuta una procedura di calibrazione di un rivelatore di particelle per un esperimento spaziale e le problematiche software a questa collegate
2. Usando il numero N scelto precedentemente e l'offset (O): 5, si ottiene il numero M=(N+O) mod 10. Si discuta, con particolare riguardo al proprio contributo personale, la pubblicazione numero M (contando dall'alto) dell'elenco dei prodotti, lavori a stampa, progetti ed elaborati tecnici allegato alla domanda concorsuale
3. Si descriva un pacchetto software di grafica scientifica di propria scelta per l'analisi dati, illustrandone le caratteristiche e gli usi principali
4. Leggere e tradurre

6. Neutrino mass and nature

Despite all previous efforts, some of the neutrino's very fundamental characteristics remain unknown. Notably, these include neutrino mass and whether the neutrino is its own anti-particle or not (in other words, whether it is a Majorana-type particle or a Dirac-type particle). Both of these issues can be explored by studying the beta decay of selected isotopes. Single-beta decay allows direct kinematical inference of neutrino mass; first results from the world-leading KATRIN experiment in Germany are eagerly awaited. The double-beta decay of, for instance, germanium, tellurium or xenon, meanwhile, is used to probe physics beyond the Standard Model in a unique way by searching for decays without neutrinos. This process is only allowed if neutrinos are Majorana-type particles and its observation would not only reveal the neutrino's nature and pinpoint its mass but also demonstrate violation of lepton number. Among the various experiments worldwide searching for neutrinoless double-beta decay, European experiments such as GERDA (focusing on germanium), CUORE (tellurium) and NEXT (xenon) are some of the most competitive.

APPEC strongly supports the present range of direct neutrino-mass measurements and searches for neutrinoless double-beta decay. Guided by the results of experiments currently in operation and in consultation with its global partners, APPEC intends to converge on a roadmap for the next generation of experiments into neutrino mass and nature by 2020.

Synergies with astronomy, particle physics and cosmology

To shed light on neutrino mixing and the neutrino mass hierarchy, APPEC is a long-term proponent of experiments using natural neutrinos from the Sun and from Earth's atmosphere as well as neutrinos from nuclear reactors and accelerators. Recognising the increasingly interdisciplinary reach of astroparticle physics, APPEC has broadened the scope of its roadmap to include explicitly two topics referred to in its 2008 science vison: the CMB and Dark Energy. These are flourishing fields of research, as demonstrated by Nobel Prizes awarded in 2006 and 2011. They not only complement core astroparticle physics topics but also yield stringent constraints on neutrino masses and on the role of neutrinos in the early Universe. So far in these recommendations, the focus has been on projects primarily funded by European astroparticle physics agencies. By contrast, for the three topics addressed in this subsection, the main funding is likely to come from US and Asian agencies or from the European particle physics and astronomy communities.

7. Neutrino mixing and mass hierarchy

Neutrino oscillation – implying neutrino mixing and thus the existence of non-zero neutrino masses – was discovered by experiments with solar and atmospheric neutrinos and rewarded with Nobel Prizes in 2002 and 2015. For precise determination of the intricacies of neutrino mixing – including the much-anticipated violation of matter/anti-matter symmetry in the neutrino sector, and the neutrino mass hierarchy – dedicated accelerator neutrino beams and neutrinos from nuclear reactors are ideal. With the Double Chooz concept, the Borexino liquid scintillator and the ICARUS liquid-argon time-projection-chamber technologies, Europe was a pioneer in this field and large-scale facilities are now envisaged in the US (the DUNE long-baseline neutrino experiment) and Asia (the JUNO reactor neutrino experiment); DUNE emerged after the first of a series of global neutrino physics strategy meetings co-initiated by APPEC in 2014. Together with the Hyper-Kamiokande proposal

Allegato n. 4

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PROVA ORALE – TESTO N. 4

1. Si discutano le caratteristiche richieste ad un software di simulazione utilizzato nell’analisi dati di un esperimento nello spazio
2. Usando il numero N scelto precedentemente e l’offset (O): 1, si ottiene il numero M=(N+O) mod 10. Si discuta, con particolare riguardo al proprio contributo personale, la pubblicazione numero M (contando dall'alto) dell'elenco dei prodotti, lavori a stampa, progetti ed elaborati tecnici allegato alla domanda concorsuale
3. Si descriva un sistema operativo di propria scelta, illustrandone le caratteristiche, procedure di installazione ed usi principali
4. Leggere e tradurre

in Japan, DUNE and JUNO define the future of this field. Both DUNE and Hyper-Kamiokande will also incorporate unsurpassed and complementary sensitivities for low-energy cosmic messengers (e.g. supernova neutrinos) and for the much-sought-after proton decay.

From a scientific perspective and as part of a global strategy, APPEC strongly endorses European participation in DUNE and Hyper-Kamiokande experiments – exploiting long-baseline neutrino beam facilities – as well as in the JUNO nuclear reactor neutrino experiment.

8. Cosmic microwave background (CMB)

ESA's Planck satellite mission gave Europe a major role in space-based experiments in this field, while the US leads the way in ground-based experiments. Apart from better precision, the next generation of experiments primarily aims at trying to identify the tell-tale sign of cosmic inflation: the imprint of primordial gravitational waves on CMB polarisation modes.

APPEC strongly endorses a European-led satellite mission (such as COrE) to map the CMB from space. APPEC will encourage detector R&D towards a next-generation ground-based experiment complementary to initiatives in the US. APPEC continues to contribute to global coordination of this field following the Florence CMB Workshop series that started in 2015.

9. Dark Energy

Together with Dark Matter, Dark Energy – the hypothetical form of energy behind the Universe's accelerated expansion – constitutes the least-understood component of the cosmos. It is studied via large galaxy-survey campaigns (both satellite-based and ground-based) that combine spectroscopic, photometric and weak-lensing techniques to reconstruct the growth of cosmic structures.

APPEC supports the forthcoming ESA Euclid satellite mission, which will establish clear European leadership in space-based Dark Energy research. Because of their complementarity to Euclid, APPEC encourages continued European participation in the US-led DESI and LSST ground-based research projects. To benefit fully from the combined power of satellite-based and ground-based experiments, the exchange of data is essential.

Foundations

Underpinning, driving and facilitating the experiments summarised above are vibrant programmes in theoretical physics, cutting-edge detector R&D and efforts to provide the necessary computing resources. APPEC has every intention of continuing to support and stimulate all of these activities in whatever way it can. In addition, APPEC recognises the uniqueness of the infrastructures provided by Europe's deep-underground laboratories. Without these, key APPEC research objectives would become impossible to achieve.

10. Astroparticle theory

Astroparticle physics research is a concerted effort between theory and experiment. As well as inspiring a vast spectrum of experiments, unified theories of fundamental interactions are indispensable to the analysis and interpretation of experimental data. Many European institutes recognise the exciting challenges presented by astroparticle physics and, accordingly, are expanding their activities in the field of theory.

Allegato n. 5

CONCORSO PER TITOLI ED ESAMI PER UN POSTO PER IL PROFILO PROFESSIONALE DI TECNOLOGO DI III LIVELLO PROFESSIONALE CON CONTRATTO DI LAVORO A TEMPO INDETERMINATO PRESSO LA SEZIONE DI ROMA TOR VERGATA
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PROVA ORALE – TESTO N. 5

1. Si discuta la progettazione di un programma software per l'analisi dati raccolti da un esperimento spaziale
2. Usando il numero N scelto precedentemente e l'offset (O): 8, si ottiene il numero M=(N+O) mod 10. Si discuta, con particolare riguardo al proprio contributo personale, la pubblicazione numero M (contando dall'alto) dell'elenco dei prodotti, lavori a stampa, progetti ed elaborati tecnici allegato alla domanda concorsuale
3. Si descrivano vantaggi e svantaggi di un linguaggio di programmazione object oriented di propria scelta
4. Leggere e tradurre

APPEC supports an ambitious theory programme in the field of astroparticle physics, with special attention focused on adjacent disciplines such as particle physics, astronomy and cosmology. APPEC encourages the establishment of a centre for astroparticle physics theory in one of its member countries.

11. Detector R&D

Frontier experiments in the field of astroparticle physics rely on innovative particle detection technologies and instrumentation that are rarely available as off-the-shelf products. Occasionally, new technologies even open up entirely new detection concepts or industrial applications. With activities in many European institutes, detector R&D constitutes a cornerstone of the astroparticle physics community.

APPEC stimulates and supports a range of detector R&D projects through targeted common calls and technology fora that bring scientists and industries together. APPEC encourages consortia to apply for EU (technology) grants such as those achieved by SENSE for low-level light-sensor technologies. APPEC welcomes the ATTRACT initiative, which aims to accelerate development of particle-radiation detector and imaging technologies for the science community and for the wider market.

12. Computing and data policies

To date, the computing needs of the European astroparticle physics community have been modest and could be accommodated by the Worldwide LHC Computer Grid. However, several of the future large observatories dedicated to multi-messenger studies of our Universe will require massive computing resources for data simulation, template matching and data analysis/storage. In parallel, awareness is growing that much can be gained by the sharing of 'big data' and best practice between experiments and communities.

APPEC requests all relevant experiments to have their computing requirements scrutinised. APPEC will engage with the particle physics and astronomy communities (e.g. within the context of EU-T0) to secure for the future a balance between available European computing resources and needs. Furthermore, APPEC encourages the use of data format standards to facilitate data access between experiments. APPEC supports the transition to Open Access publication strategies and encourages the making of data publicly available (as 'open data') to foster 'citizen science', for example.

13. Unique infrastructures: deep-underground laboratories

Shielded by thousands of metres of rock, deep-underground laboratories host a diverse suite of extremely low-background experiments that are often unique. These facilities also provide a platform for multidisciplinary collaboration.

With a view to maintaining a good match between available capacity and planned activities, APPEC fosters continued support for and cooperation between underground laboratories – as advocated, for example, by the DULIA (Deep Underground Laboratory Integrated Activity) initiative.

Allegato n. 6

CONCORSO PER TITOLI ED ESAMI PER UN POSTO PER IL PROFILO PROFESSIONALE DI TECNOLOGO DI III LIVELLO PROFESSIONALE CON CONTRATTO DI LAVORO A TEMPO INDETERMINATO PRESSO LA SEZIONE DI ROMA TOR VERGATA
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PROVA ORALE – TESTO N. 6

1. Si discuta un modello per la condivisione dei dati di un esperimento spaziale e le problematiche software ad esso collegate
2. Usando il numero N scelto precedentemente e l'offset (O): 3, si ottiene il numero M=(N+O) mod 10. Si discuta, con particolare riguardo al proprio contributo personale, la pubblicazione numero M (contando dall'alto) dell'elenco dei prodotti, lavori a stampa, progetti ed elaborati tecnici allegato alla domanda concorsuale
3. Si illustri i passi e gli strumenti necessari per creare un programma, facendo riferimento a un linguaggio e un ambiente di programmazione di propria scelta
4. Leggere e tradurre

Organisational issues

As a ‘big science’ research field, astroparticle physics critically relies on large infrastructures that require large investments. This makes collaboration – national, European and even global – absolutely essential. Similarly, as an interdisciplinary field, astroparticle physics not only naturally interacts closely with the astronomy and particle physics communities but also offers opportunities to other fields of research and industry.

14. European Commission
European astroparticle physics successfully contributes to the Commission’s aim of strengthening the excellence and attractiveness of European research and innovation, and Europe’s economic and industrial competitiveness. The present APPEC consortium is building on the past success of the EU-supported ASPERA project, while ESFRI status and EU structural and regional funding play an increasingly important role in the realisation of our large research infrastructures. ERC grants often drive original ideas that would otherwise be difficult to pursue. Importantly, astroparticle physics technology has already demonstrated that it can have innovative commercial applications.

APPEC will continue to work with the European Commission in order to strengthen the EU’s ability to capitalise on astroparticle physics technologies and ideas, as well as to make optimal use of the opportunities that already exist within various EU programmes in terms of advancing science and generating economic value.

15. European collaboration and coordination
The roadmap presented in this document is the result of an intense process that culminated in the Town Meeting of the European astroparticle physics community which took place in Paris in April 2016. Prominent flagship astroparticle physics infrastructures (e.g. the CTA and KM3NeT ESFRI projects and the future ET project) require capital investments that surpass the capabilities of a single European country.

APPEC will explore ways of aligning the realistically available funding in Europe to maintain the excellent discovery potential of European scientists. Project governance, management, computing needs and running costs all require serious attention.

16. Global collaboration and coordination
Some research directions warrant a global strategy. In some cases, this may be due to substantial capital requirements or running expenses (e.g. for multi-messenger facilities); in others, it may be because of the advantages in pursuing complementary technologies (e.g. for next-generation Dark Matter searches and the measurement of neutrino properties). In some instances, cooperation between different observatories working as a single interconnected network can lead to much better precision or much deeper understanding (e.g. in the field of gravitational-wave detection or, ultimately, all multi-messenger observatories).

APPEC will continue to seek collaboration and coordination with its partners worldwide – scientists and funding agencies – to advance the design, construction, sustainable exploitation (including computing needs) and governance of the next-generation world-class large research infrastructures required to achieve the scientific discoveries of which we all dream.