ASPERA

Workshop ASPERA:

The Synergies between Environmental Sciences and Astroparticle Physics

1 – 2 December 2010

Salle de Conférences - Palais de la découverte, Paris

Programme and Abstracts

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From the Geosphere to the Cosmos : ASPERA Workshop / Programme

Salle de Conférences - Palais de la découverte / Paris

Wednesday 01 December 2010

13:30-14:00	**Registration**	
14:00-14:20	**ASPERA : Introduction to the workshop** *B. Revaz (Univ. of Geneva); T.Berghöfer (BMBF/PT-DESY)*	
14:20-14:50	Atmospheric physics at Auger *B. Keilhauer (KIT)*	Chairman: A.Watson Univ. of Leeds
14:50-15:20	Cosmic rays and climatology *U. Baltensperger (PSI)*	
15:20-15:50	Correlation of ultra-high energy cosmic rays with lightning *P. Krehbiel (New Mexico Tech)*	
15:50-16:20	Marine sciences at Antares *P. Coyle (CNRS)*	
16:20-16:50	Coffee Break	
16:50-17:20	Geoneutrino physics and nuclear activities monitoring *D. Lhuillier (CEA-Saclay)*	Chairman: A.Ferrer MICINN
17:20-17:50	Bioacoustics and geophysics at NEMO *G. Riccobene (LNS-INFN Catania)*	
17:50-18:20	Muon radiography applied to volcanology *J. Marteau (CNRS)*	
18:20-18:50	Cosmic ray-produced radionuclides in Earth sciences *T. Dunai (Univ. of Cologne)*	

19:00-20:00	Welcome Cocktail - Salle des planètes

Thursday 02 December 2010

09:00-09:30	ARGO-YBJ:A straightforward approach for space weather forecasting *Z. Cao (IHEP)*	chairman: S.Katsanevas CNRS
09:30-10:00	Environmental sciences in glacial ice *B. Price (UC Berkeley)*	
10:00-10:30	Gravitational wave antennas and seismology *P. Lognonné (IPG Paris)*	
10:30-11:00	Coffee break	
11:00-11:40	ApP and associated sciences at LNGS *L. Votano (LNGS)*	Chairman: B.Saghai CEA-Saclay
11:40-12:20	ApP and associated sciences at LSM F. Piquemal (LSM)	
12:20-12:50	Laguna, a design study for a Large Apparatus for the search for Grand Unification and Neutrino Astronomy *F. von Feilitzsch (TUM)*	
13:00-14:00	Lunch	
14:00-14:30	CTA, associated sciences and energy considerations *S. Nolan (Univ. of Durham)*	Chairman: M.Bourquin Univ. of Geneva
14:30-15:00	AGILE: terrestrial gamma-ray flashes as powerful particle accelerators *M. Tavani (INAF and Univ. of Rome)*	
15:00-15:30	BAIKAL: an underwater laboratory for ApP and environmental studies N. Budnev (Irkutsk State Univ.)	
15:30-16:30	Discussion: Interdisciplinary research and mutual enrichment *E. Coccia (Convener), T. Dunai, S. Katsanevas, B. Price, A. Watson*	
16h30-17:00	Refreshments	

CV&Abstracts:

Atmospheric Physics at the Pierre Auger Observatory

Bianca Keilhauer :
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Karlsruhe Institute of Technology KIT / Institute for Nuclear Physics

Curriculum Vitae :
Member of the Pierre Auger Collaboration since 2001, Bianca Keilhauer is co-Task Leader for Atmospheric Monitoring since 2008. She is also member of the (K)CETA – (KIT) Centrum Elementarteilchen- und Astroteilchenphysik and of the AIRFLY Collaboration since 2004. Bianca Keilhauer was involved in the KIT Young Investigator Network YIN 2008. She did several short-term research stays in Malargüe – Argentina, Rome – Italy, Chicago – USA, Krakow – Poland.

Abstract:
The Pierre Auger Observatory detects high-energy cosmic rays with energies above some 1017 eV. It is designed as a hybrid detector measuring charged particles of initiated extensive air showers at ground in combination with observations of fluorescence emissions induced by extensive air showers on its development through the atmosphere.

For the reconstruction of extensive air showers, the atmospheric conditions at the site of the observatory have to be known quite well. This is particularly true for reconstructions based on data obtained by the fluorescence technique. For these data not only the weather conditions near ground are relevant, most important are altitude-dependent atmospheric profiles.

Thus, the Pierre Auger Observatory has set up a dedicated atmospheric monitoring programme at the site of the observatory in the province Mendoza, Argentina. For measuring state variables like pressure, temperature and humidity, a set of ground-based weather stations is installed in addition to a facility for launching meteorological radio soundings. For determining the optical properties of the atmosphere, several instruments are located at the site. The Observatory operates a Central Laser Facility, lidar stations, cloud monitors, Aerosol Phase Function monitors, and a Horizontal Attenuation Monitor and a Photometric Robotic Atmospheric Monitor telescopes. A subset of these instruments is running a rapid atmospheric monitoring programme in addition to the characterisation of the atmospheric properties on fixed timescales. The programme serves for increasing the accuracy of air shower reconstruction of very high-energy showers or further showers of particular interest. Recently, activities about applying satellite data about cloud coverage to derive local cloud information have started as well as applying Global Data Assimilation System data for state variables to the air shower reconstruction algorithm.

All these activities aim primarily for a high-quality reconstruction of air showers. Further interests are beyond the scope of cosmic ray investigations, in the field of atmospheric science. Local measurements can be used for determining the accuracy of global model data at the site of the Observatory or can serve for dedicated studies of local conditions in the Pampa Amarilla, Argentina.

Cosmic Rays and Climatology: The CLOUD Project at CERN

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Paul Scherrer Institute, 5232 Villigen, Switzerland and the CLOUD Consortium

Curriculum Vitae :

Urs Baltensperger is head of the laboratory of chemistry at the Paul Scherrer Institute, Villigen, Switzerland, and professor at ETH Zürich. He is also President of the Commission for Atmospheric Chemistry and Physics of the Swiss Academy of Natural Sciences. His main scientific interest is on physical and chemical aerosol characterization, and effects on climate and heterogeneous chemistry. He has published more than 200 peer-reviewed papers.

Abstract :

CLOUD is an acronym for Cosmics Leaving OUtdoor Droplets. The scientific objective of CLOUD is to investigate the influence of galactic cosmic rays (GCRs) on ions, aerosols, cloud condensation nuclei (CCN) and clouds, with the CLOUD facility at CERN, and thereby to assess the significance of a possible "solar indirect" contribution to climate change.

Aerosols and clouds are recognised as representing the largest uncertainty in the current understanding of climate change. The Intergovernmental Panel on Climate Change (IPCC) estimates that changes of solar irradiance ("direct solar forcing") have made only a small (7%) contribution to the observed warming. However, large uncertainties remain on other solar-related contributions, such as the effects of changes of GCR on aerosols and clouds. There are several plausible mechanisms that could link GCR flux and cloud properties. A leading candidate is the 'ion–aerosol clear-air mechanism', in which atmospheric ions created by GCRs act as nuclei for the formation of atmospheric particles. The nucleation of new nanometer-sized aerosol particles is observed frequently, and in many parts of the atmosphere, and is thought to be a major source of cloud-condensation nuclei (CCN) — particles large enough for cloud droplets to form around them.

To investigate the involved processes, a large aerosol chamber has been established in the beamline T11 at the CERN Proton Synchrotron accelerator, within which the atmosphere is recreated from ultra-pure air with added water vapour and trace gases under study. The chamber is equipped with a wide range of sensitive instruments to analyse their contents. The accelerator provides an adjustable and precisely measurable beam of "cosmic rays" that closely matches natural cosmic rays in ionisation density, uniformity and intensity, spanning the atmospheric range from ground level to the maximum around 15 km altitude. First results will be presented, which give new insight on the first step in the overall hypothesis of an influence of cosmic rays on clouds, i.e., ion-mediated nucleation of aerosol particles in the atmosphere.

For more information on the CLOUD project:
http://www.unifrankfurt.de/english/research/inter_projects/clouditn/index.html/

Lightning Studies at Pierre Auger Observatory

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New Mexico Tech, Socorro, New Mexico 87801 USA

Curriculum Vitae :

Education:

1963	S.B., Electrical Engineering, MIT
1966	S.M., Electrical Engineering, MIT
1981	Ph.D., Physics, Univ. of Manchester Inst. of Science and Technology

Appointments:

2004-	Professor of Physics (semi-retired)
1989-1992	Chairman and Professor, Electrical Engineering
1987-2004	Professor of Physics
1985-1987	Assoc. Professor of Physics
1966-2004	Research Engineer/Physicist, R&ED Division, NM Tech

Abstract

An initial set of two Lightning Mapping Array (LMA) stations has been set up at the Pierre Auger Cosmic Ray Observatory to begin studying the possible effects of high energy cosmic rays on the initiation of lightning and electrical discharges in thunderstorms. In this presentation I will describe the ability of VHF time-of-arrival mapping systems to provide 3-dimensional images of lightning inside storms and the proposed methodology of using the joint LMA and cosmic ray data to study lightning initiation questions. I will also discuss how a full LMA network could be set up at Pierre Auger and how it would be beneficial both to operational issues and scientific studies of the Observatory.

For examples of online real time lightning mapping data, see http://lightning.nmt.edu/oklma and http://branch.nsstc.nasa.gov/PUBLIC/NALMA/.

For a detailed description of the LMA system, see Thomas et al.,

Accuracy of the Lightning Mapping Array, J. Geophys. Res. 109, D14207,

doi:10.1029/2004/, 2004.

Selected Publications:

Krehbiel, P.R., Riousset, J.A., V.P. Pasko, R.J. Thomas, W. Rison, M.A. Stanley, and H.E. Edens, Upward Electrical Discharges from Thunderstorms, Nature Geoscience, doi:10.1038/ngeo162 April, 2008.

Thomas, R.J., P.R. Krehbiel, W. Rison, H.E. Edens, G.D. Aulich, W.P. Winn, S.R. McNutt, G. Tytgat, and E. Clark, Electrical Activity During the 2006 Mount St. Augustine Volcanic Eruptions, Science, 315, 1097; DOI:10.1126/science.1136091, 2007.

Marshall, T.C., M. Stolzenburg, C.R. Maggio, L.M. Coleman, P.R. Krehbiel, T. Hamlin, R.J. Thomas, and W. Rison, Observed electric fields associated with lightning initiation, Geophys. Res. Letts., 32, L03813, doi:10.1029/2004GL021802, 2005.

Rust, W.D., D.R. MacGorman, E.C. Bruning, S.A.Weiss, P.R. Krehbiel, R.J. Thomas, W. Rison, T. Hamlin, and J. Harlin, Inverted-polarity electrical structures in thunderstorms in the Severe Thunderstorm Electrification and Precipitation Study (STEPS), Atmos. Res., doi:10.1016/j.atmosres.2004.11.029, 2005.

Marine sciences at Antares

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CNRS

The completion of the ANTARES high-energy neutrino telescope in the deep Mediterranean Sea has enabled a large program of synergetic research in the fields of Earth and Sea sciences. Located at a depth of 2475m, 42km from the town of Toulon in the South of France, ANTARES provides an unique infrastructure for the deployment of real-time, high-bandwidth, high-power sensors at this extreme location. In the presentation, the results from a variety of instruments connected to ANTARES will be described; including seismographs, acoustic hydrophones, sensors for oceanographic parameters (sea currents, oxygen, temperature etc) and video cameras for studies of bioluminscence. The long-term measurements provided by these instruments already provide data of interest to a wide field of sciences including biology, environmental sciences, geology, geophysics and oceanography. Deep sea observatories such as ANTARES, and in the future KM3NeT, have the potential to play a key role in the assessment of global warming,climate change and geo-hazards.

Muon radiography applied to volcanology

Jacques MARTEAU
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CNRS

Curriculum Vitae :

Dr. J.Marteau is researcher in the fields of high energy physics and transverse applications in tomography imaging, currently involved in two large experimental programmes focused on the neutrino oscillations physics (OPERA and T2K), in the phenomenological theory of neutrino-matter interactions, in liquid argon TPC readout R&D and in muon tomography applied to geosciences (volcanology and geological inner structures characterization).

Permanent position (assistant professor) in the Université Claude Bernard Lyon-I

Research fields : high energy physics, experimental neutrino physics, neutrino-matter interactions theory, cosmic rays physics

Collaborations : OPERA (Oscillation Project with Emulsion tRacking Apparatus : experiment between CERN and the underground Gran Sasso laboratory) since 2000.

1st direct observation of neutrino oscillations candidate in 2009

Data acquisition project leader since 2002.

Member of the Executive committee of the collaboration.

T2K (Tokai to Kamiokande, Japan) since 2008.

Conception and production of a near detector to monitor the beam asymmetry

Instrumentation R&D : opto-electronics readout chains, scintillator detectors, large volume liquid argon TPC, development of large scale distributed data acquisition systems over Ethernet

2 patents deposited in the field of Ethernet-Based DAQ system (2003, 2008)

Transverse activities : medical imaging (micro-TEP developments)

muon tomography applied to geosciences (since 2008) : first observations on the Etna and La Soufrière de Guadeloupe in 2010

Abstract:

The interest of muon tomography for Earth Sciences purposes soon arose after the discovery of cosmic rays when it was realised that muons of cosmic origin are able to cross hundredths of meters, and even kilometres, of rock with an attenuation mainly related to the amount of matter encountered along their trajectory. Up to now, muon imaging has been performed according to a radiography concept where the opacity of geological structures is deduced by comparing the flux of muons crossing the geological target to the incident flux measured at the surface of the Earth in open sky condition. The opacity is converted into density integrated along the trajectories. Further improvements of the method are necessary to actually perform 3D tomography imaging and imply to combine a set of radiographies as done in medical 3D X-ray computed tomography.

A review of the methodology will be presented focusing on the DIAPHANE project in the Lesser Antilles (Soufrière of Guadeloupe and Soufrière Hills of Montserrat). Lesser Antilles is a subduction volcanic arc within which a dozen of either potentially or presently active volcanoes are located in populated areas and therefore require careful monitoring. The aim of muon tomography is to provide a complementary tool to evaluate the present state of the volcano within its eruption cycle, estimate its evolution in the near future, and quantify the associated risk for surrounding inhabitants. Collaborations with INGV on the Etna and with Swisstopo on the Mont-Terri project will be detailed as well. The first results and density profiles obtained with the method are presented and commented.

Bibliography:

- "*Muon tomography : plans for observations in the Lessers Antilles*", D.Gibert et al, E.P.S. 62 (2010) 153-165.
- "*The MU-RAY project: Summary*", F. Beauducel et al, Earth Planets and Space 62 (2010) 141-151.
- "*Geophysical muon imaging: feasibility and limits*", N. Lesparre et al, Geophysical Journal International (2010) 181, 1-14.
- "*Design and Operation of a Field Telescope for Cosmic Ray Geophysical Tomography*" N. Lesparre et al, submitted to NIM A.

Bioacoustics and Geophysics at NEMO

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LNS-INFN, Catania

Curriculum Vitae :

1995-1997	Member of the INFN-ALaDiN Collaboration (Nuclear Physiscs)
from 1999	Member of the INFN-NEMO Collabration (Astroparticle Physiscs)
from 2001	Responsible of the NEMO-OnDE experiment (Astroparticle Physiscs, Bioacoustics)
from 2002	Member of the INFN-ANTARES Collaboration (Astroparticle Physiscs)
from 2006	Member of the European KM3NeT Consortium (Astroparticle Physiscs)
from 2007	Member of the ESONeT Network of Excellence – EMSO (Earth and Sea science)
from 2008	INFN responsible for the LIDO Demo-Mission of ESONeT NoE (Multidisciplinary)
form 2008	INFN responsible for the “Test Site” Call of ESONeT NoE (Multidisciplinary)
from 2010	PI of the SMO Project – Funded by the Italian Ministry of Research and University (Multidisciplinary)

Author and Co-author of more than 100 scientific publications
Referee of the Astro-Particle Physics Journal

Abstract:

The NEutrino Mediterranean Observatory (NEMO) project, funded by INFN and part of the KM3NeT Consortium, is an R&D activity towards the construction of the Mediterranean km3-scale high energy neutrino detector. INFN, in collaboration with INGV, has built and operated since 2005 the NEMOSN1(Submarine Network 1) Test-Site, located in the Ionian Sea at about 2100 m w.d., 25 km off the harbor of Catania, Sicily. NEMO-SN1 is a prototype of cabled multidisciplinary deep-sea observatory, and one of the operative nodes of the incoming European large-scale research infrastructure EMSO (European Multidisciplinary Seafloor Observatory). The observatory ran in realtime several sensors that produced valuable information both for HE neutrino telescopes and Earth and Sea Sciences.

NEMO-Phase 1, the main experiment carried out at the Test-Site, consisted in the operation of a prototypal module of a HE neutrino detector, whose successful operations validated innovative technologies for KM3NeT and allowed measurement of cosmic muon flux at large depth. Passive acoustic transducers were installed onboard the NEMO-Ocean Noise Detection Experiment (OvDE) in collaboration with CIBRA-University of Pavia (Italy), to perform real-time monitoring of acoustic noise in deep-sea, as input for studies on acoustic neutrino detection. OvDE measured acoustic noise spectrum and its correlations with environmental conditions, human activities and with the presence of marine mammals in the region. Since first recordings, in fact, OvDE discovered biological sounds revealing marine mammals passing or living in the area. The detection of sperm whales was an especially exciting find. Biologists knew that whales travel through the whole Mediterranean, the recordings provided evidence for record numbers of transiting whales and for a prolonged presence of them in the waters of Eastern Sicily. New analyses were developed to detect the marine mammals’ acoustic signatures, to locate and track them. This provides new data about migration, group behaviour, and seasonal activity. All these are information relevant for marine biologists and for the conservation of the species, considered endangered and poorly known in the area.

The SN1 observatory was also deployed at the Test-Site to monitor geophysical (mainly seismic activity) and oceanographic parameters. The Western Ionian Sea is a well known seismogenic– tsunamigenic area, close to the Mt. Etna volcano. The site is also crucial for the water circulation of the entire Mediterranean Sea. High-quality seismic data were acquired: both continuous low frequency noise and earthquakes were observed. Moreover, very interesting signals connected to the different phases of Mt. Etna activity, like degassing, and seismic swarms occurred during its vigorous eruptions, were recorded. Thanks to excellent signal-to-noise ratio, SN1 recorded both local, regional and teleseismic events. At the level of local seismicity, about 30% of the recorded events were not reported on seismic bulletins.

The infrastructures conceived and tested at the NEMO-SN1 Test Site has been an important step towards the construction of deep-sea observatories incorporating HE cosmic neutrinos detectors, and sensors for Earth and Sea Science. A larger-scale improved observatory will be soon installed in Capo Passero (3500 m w.d., 100 km offshore East-Sicily) a candidate site for KM3NeT.

Geo-neutrino Physics and Nuclear Activities Monitoring

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CEA - Saclay

Curriculum Vitae :
Since 1997: Permanent position at the Nuclear Physics department of CEA Saclay.

1997-2005 : Study of the quark structure of the nucleon and test of the Standard Model of electroweak interactions at low energy, using high precision measurement of parity violation in the scattering of few GeV electrons off hydrogen and helium targets. HAPPEx experiments at Jefferson Laboratory (Virginia) and E158 experiment at SLAC (California).

2005-2010: Detection of reactor antineutrinos. Search for a non-vanishing value of the θ13 neutrino mixing angle in the Double Chooz experiment (Ardennes, France). Development of the small ($1m^3$ target size) neutrino detector Nucifer for surveillance of nuclear reactor in the context of the nonproliferation of nuclear weapons.

Abstract:
Neutrinos are the most abundant matter particles in the Universe. Thoroughly investigated in basic science, the neutrino field is now delivering first applications in the fields of nuclear reactor monitoring and study of geo-neutrinos.

Nuclear reactors provide energy from the fission of uranium and plutonium isotopes. Because of the neutron excess of such heavy nuclei the fission products are neutron-rich, unstable nuclei that decay toward the valley of stability following β^- decay chains. With an approximate energy of 200 MeV/fission and 6 neutrinos/fission, 3 GW of thermal power correspond to 10^{21} neutrinos/s. Such a large flux compensates for the tiny interaction cross-section and this triggered the interest of neutrino physicists since the earliest stages, in the 50's. The idea of reactor monitoring emerged after gathering enough nuclear data on the mass distributions and beta spectra of fission products [1]. It turns out that for the same released thermal power, ^{239}Pu fissions produce 60% less detected neutrino than ^{235}U fissions. Based on this sensitivity to the ^{239}Pu content of a reactor, the IAEA is currently investigating the potentiality of neutrinos as a novel safeguards tool [2]. This technology offers unique features of non-intrusive, continuous, remote controlled and tamper resistant measurements. The detector is to be installed in a basement room less than 30m from the core with a global footprint of 3x3 m. In normal operation a reactor burns ^{235}U and accumulate ^{239}Pu leading to a constant decrease of the detected neutrino flux. We'll present the existing data [3] validating this scheme as well as the ongoing worldwide program aiming at developing efficient detection techniques within the IAEA specifications. Detection with liquid scintillators will be highlighted [4] as the most efficient approach so far.

Another remote place to be spied out by neutrinos is the Earth's interior. Geo-neutrinos are electron anti-neutrinos produced in β decays of ^{40}K and of several nuclides in the chains of long-lived radioactive isotopes ^{238}U and ^{232}Th, which are naturally present in the Earth. Measuring the flux and spectrum of geo-neutrinos is a way to assess more quantitatively the radiogenic contribution to the total heat balance of the Earth. These pieces of information, in turn, are critical in understanding complex processes such as the generation of the Earth's magnetic field, mantle convection, and plate tectonics. We'll discuss the first signals of geo-neutrinos associated with the ^{238}U and ^{232}Th chains as measured by the Kamland [5] and Borexino experiments. Perspectives of complementary measurements, with larger detectors and different locations aiming at disentangling the contributions from the upper Earth layers and from the mantle will be presented.

References:
[1] L. A. Mikaelyan, "Neutrino Laboratory in the Atomic Plant " in *Proc. Inter. Conf. "Neutrino-77"*, vol.2, Moscow, 1977, pp. 383-387.
[2] "Final Report: Focused Workshop on Antineutrino Detection for safeguards Applications", report of IAEA Workshop, IAEA Headquarters, Vienna, Austria, Oct. 2008.
[3] « Experimental results from an antineutrino detector for cooperative monitoring of nuclear reactors. », N.S. Bowden *et al.*, Nucl. Instrum. Meth. A572:985-998, 2007.
[4] Reactor Neutrino Detection for Non Proliferation with the NUCIFER Experiment, A. Porta et al., IEEE proceedings 10.1109/ANIMMA.2009.5503653.
[5] "Precision Measurement of Neutrino Oscillation Parameters with KamLAND", KamLAND Collaboration, Phys. Rev. Lett. 100:221803, 2008.

Cosmic ray-produced radionuclides in Earth Sciences

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Earth Sciences, Universität zu Köln

Curriculum Vitae :

Professor for Geology, head of CologneAMS, the new national facility dedicated for the analysis of in-situ produced cosmogenic nuclides. Research interests include the methodological development of cosmogenic nuclides for Earth Surface Sciences and their application to pertinent research questions in landscape evolution, paleoseismology and climate research. Coordinator of CRONUS-EU (FP6, MC-RTN), permanent member of the steering committee of CRONUS-Earth (NSF, USA).

Abstract:

Over the last decade in-situ produced cosmogenic nuclides have become an essential tool for Earth surface sciences; changing it from being a largely qualitative to a quantitative branch of sciences. These cosmognic nuclides are produced in near-surface rocks by secondary cosmic ray neutrons and muons from the atmospheric reaction cascade. In-situ cosmogenic nuclides allow determining surface exposure ages of rocks, e. g., to date glacial advances or retreats, lava flows, earthquake recurrence rates, as well as constraining modes of soil production. Since nuclide production decreases quickly with depth in a rock, cosmogenic nuclides also allow measuring erosion rates, either locally or as catchment wide averages. The application of cosmogenic nuclides have allowed to quantitatively address, for the first time, a wide range of long-standing first-order problems in geomorphology, paleoglaciology, paleoclimatology, volcanology, paleoseismology and related fields.

The methodology is continuously refined, recently by the two international research consortia CRONUS-EU and CRONUS-Earth (Stuart and Dunai, 2009; Phillips 2009). Aim is to increase the accuracy of ages obtained, crucial to test e.g. climate models, and develop new nuclides as tools for Earth Sciences. From the work of these consortia it emerged that a detailed survey of the secondary neutron energy spectrum is required to close the remaining gaps in our understanding and fully benefit of pertinent newly derived reaction cross section data.

Stuart, F. M. and Dunai, T. J., 2009. Advances in cosmogenic isotope research from CRONUS-EU. Quaternary Geochronology 4, 435.

Phillips, FM, 2009. The CRONUS-Earth Project: Current results and future plans, Geochim. Cosmochim. Acta, 73, A1025.

ARGO-YBJ/LHAASO:A Straightforward Approach for Space Weather Forecasting

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Institute of High Energy Physics, Beijing, 100049, China

Curriculum Vitae :

Education:

1990 to 1994	Institute of High Energy Physics, Beijing, China Graduated with a Ph. Doctor degree in physics.

Research Experiences:

Apr. 2004 to now	Professor, Institute of High Energy Physics, China
Feb. 2003 to March 2009	Associate Research Professor, University of Utah
Feb. 1998 to Feb. 2003	Research Associate, University of Utah
Oct. 1994 to Jan. 1998	Research Associate, University of Oregon
Jan. 1994 to Sept. 1994	Research Associate, Institute of High Energy Physics, Beijing, China
Fall 1992	Visiting scholar, Institute of Cosmic Ray, University of Tokyo, Tokyo, Japan

Abstract:
The ARGO-YBJ experiment and the future project LHAASO at Tibet site are dedicated to gamma ray astronomy above 1TeV and cosmic ray physics above 10TeV up to 1EeV. In many ways, the two experiments will conduct researches associated with the environment issues from the Qing-Zang plateau to the space between the Sun and the Earth. In this talk, I will present a monitoring of the interplanetary magnetic field (IMF) by using the very energetic cosmic rays and the shadow of the sun in the rays. If there were interplanetary coronal mass ejections (ICME, magnetic cloud) toward the earth, the IMF passed by the cosmic rays is enhanced and induces unexpected displacements and deductions of the sun shadow observed by using the ground based experiments. Since the rays are propagating with a speed of light which is much faster than ICME, one can foresee a magnetic storm on the earth before it arrives. This is demonstrated using the ARGO-YBJ data. Forecasting of such space storms using the LHAASO detector in the future is simulated using historic data recorded at space ship at Lagrangian point. More environment related researches using the ARGO-YBJ experiment and LHAASO prototype experiment at Tibet site are also presented in this talk.

Environmental Sciences in Glacial Ice

Buford Price and Ryan Bay
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Univ. of Berkeley

Abstract:

In 1999 Price led an international consortium that proposed to the U.S. NSF to create a Science and Technology Center called DeepIce. Astroparticle physicists within AMANDA (the forerunner of IceCube) were to collaborate with environmental scientists on projects that exploited the special features of glacial ice at or near the South Pole. The institutions included 24 from U.S. and 11 from other countries. Although they reached the final round in the competition, they were not funded. Nevertheless, many of the ideas they generated have led to important advances in glaciology, climate research, volcanology, propagation of acoustic and radio waves in ice, and extremophile biology.

One important spinoff of the brainstorming sessions of DeepIce members was the optical dust-logger, which reads out concentrations of dust particles and volcanic ash down a several-thousand-meter borehole in one day with a depth resolution of ~1 mm. Dust logs in Antarctic and Greenland ice revealed an apparent causal relationship between abrupt climate changes and faint volcanic fallout layers. By the end of 2010 Ryan Bay will have mapped particles down to depths of 2450 m in nine hot-water boreholes drilled during IceCube construction. These images have permitted reconstructions of dust and paleowind records of unparalleled quality, and reveal a complex pattern of glacial flow from more than one upstream source. The detailed characterization of South Pole ice made possible by IceCube has made the site a leading candidate for the next deep U.S. ice core project. After discovering a thick layer of high dust concentration at ~2100 m corresponding to ~65,000 years ago, IceCube elected to concentrate optical modules deeper, where the dust concentration is extremely low, in order to create a volume of ice capable of recording neutrinos down to a few GeV in energy.

There is much uncertainty and concern about the stability of large ice sheets; at the same time, the potential impacts of shearing have long been a concern for IceCube. Thermistors and microinclinometers installed in IceCube show that South Pole ice undergoes rigid-body flow at depths shallower than ~2450 m, below which shear flow is being detected at rates of order 0.1 degree per year. For the first time, the shear strain rate of a large volume of ice can be studied in three dimensions as a function of stress, impurity content and temperature down to -35°C.

In discussions among DeepIce participants about possible life in subglacial lakes, Price worked out a quantitative model, later confirmed by others, of how microbes less than several microns in size could live in liquid veins at triple junctions of ice grains. The ecology of microbes in ice is now an active field. For example, excesses of gases such as methane and nitrous oxide at several depths in ice have been shown to be the products of metabolism by microbes living in ice. A quantitative analysis of the concentrations of the gases and of the microbes enables one to calculate the average metabolic rate as a function of temperature.

Using autofluorescence techniques and flow cytometry, the Berkeley group has discovered that the dominant microbial taxa in glacial ice at several sites are submicron-size cyanobacteria whose fluorophors are chlorophyll and phycoerythrin. Their sources are wind-transport from shallow Arctic and Antarctic ocean waters onto the growing icepack. The group speculates that one can trace mutations of cyanobacteria over more than 106 generations in the ocean by analyzing changes in their genomes as a function of depth in glacial ice.

The completion of IceCube in January 2011 will provide new opportunities in particle astrophysics that exploit the IceCube hot-water drill and the ability to reject backgrounds of charged particles within the IceCube volume. Examples include a proposed search for new supernovae extending to a distance of 10 Mpc using a large array of PMTs in ice; flavor oscillations of neutrinos produced in Earth's atmosphere; and a search for the dark matter wind.

Gravitational wave antennas and seismology

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Institut de Physique du Globe de Paris et Université paris Diderot, France

Curriculum Vitae :
Philippe Lognonné is Professor of Geophysics at University of Paris Diderot and leader of the Planetary and Space geophysics of IPGP –Sorbonne Paris Cité. He was Principal Investigator of several attempts to deploy Mars or Moon seismic experiments (Mars96, NetLander, Humboldt-ExoMars) and has contributed to recent re-analysis of the Apollo Seismic experiment and to the design of new generation earth gravity mission concept using the LISA technology (e.g. Licody).

Abstract :
Since the mid 60th, synergies and links between gravitational wave antenna and seismology have been developed. The amplitudes of the free oscillations of the Earth have been for example used to provide the first observational limit on the cosmic flux of gravitational waves (Weber, 1967). The Apollo 17 mission deployed also a gravimeter on the Moon in December 1972, which primary goal was the detection of gravitational waves (Weber, 1971). Due to a misfunction, this instrument was not able to provide data with sufficient sensitivity, but it nevertheless operated as low gain seismometer and detected Moon quakes and meteorites impacts.

We review in this presentation the sensitivity of the seismological sensors and compare them to those requested for gravitational wave antenna. This allow us to point out synergies, either in term of concept cross-fertilisations (e.g. using a LISA based Space system in earth's orbit for detecting very low amplitude Earth's normal modes) or in term of common development requested to increase furthermore the performances of future instruments. We also review the present knowledge of the seismic noise of the Earth and Moon as well as the techniques able to process and therefore to model and numerically compensate this noise from gravitational waves detectors. We conclude by presenting some perspectives, both in term of geophysical observation on the existing and future gravitational waves or on fundamental physics observation on the existing and future Earth's and Moon geophysical instruments.

ApP and associated sciences at LNGS

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Curriculum Vitae :
Lucia Votano became staff research scientist in 1975 at the ENEA Frascati Laboratory and in 1976 at the INFN Frascati National Laboratory (LNF). Senior Researcher in 1988 and Research Director of INFN (Istituto Nazionale di Fisica Nucleare) in 2000, Lucia Votano is Director of the Gran Sasso National Laboratory of INFN, the world's largest underground laboratory for astroparticle physics, since September 2009.

As an experimental particle and astroparticle physicist, she has been active at LNF, CERN, DESY and Gran Sasso Laboratory (LNGS), performing physics studies as well as constructing and running large detector systems and acting as the leader of a LNF group of physicists, engineers and technicians. LV is presently active in the field of experimental astroparticle physics for the neutrino oscillation search with the OPERA experiment in the CNGS beam from CERN to Gran Sasso.

Formerly:
Member of INFN GR II (Astroparticle Physics) Scientific Committee.
Responsible of the Scientific Information Service of LNF.
Director of the Research Division of the LNF for two mandates up to 2004,
Member of the Peer Review Committee of ApPec and of the ASPERA Roadmap Committee.
Presently member of the ASPERA SAC.

Abstract:
The Gran sasso National Laboratory of INFN is a research infrastructure mainly devoted to astroparticle and neutrino physics. It offers the most advanced underground Laboratory in terms of dimensions, complexity and completeness of infrastructures. The laboratory hosts also experiment aimed to study cosmogenic and primordial radionuclides, and experiments of geophysical interest as well.

Borexino is a solar neutrino detector located at LNGS. The main goal is the detection of the monochromatic neutrinos that are emitted in the decay of 7Be in the sun. However the intrinsic radioactivity achieved in the detector is much lower than expected which resulted in a broadening of the scientific program. The detector is very competitive for the observations of anti-neutrinos of geophysical origin. Geo-neutrinos are the ideal messengers of information about the earth interior composition. By measuring their flux and spectrum, it’s possible to assess the radiogenic contribution to the total eat balance of the Earth.

The LNGS hosts an ultra low background counting facility STELLA (Subterranean Low Level Assay): a service infrastructure devoted to highly sensitive radio purity measurements and material screening for the experiments installed at the LNGS. Its main core is the pool of 10 high purity Germanium (HPGe) detectors used for gamma spectroscopy. Gamma spectroscopy performed in a deep underground laboratory using ultra low background equipment gives the unique opportunity of having almost background free measurements. This is very helpful for example when measuring tiny objects with small amounts of radioactivity.

Within the framework of the scientific program ERMES (Environmental Radioactivity Monitoring for Earth Sciences) radon (222Rn) radiocarbon (14C) and tritium (3H) have been monitored in the groundwater inside the LNGS and different chemical, physical and fluid dynamical characteristics of groundwater have been detected. The uranium groundwater monitoring started on June 2008 with the aim of better defining the 222Rn groundwater transport processes through the cataclastic rocks as well as to check its contribution to the neutron background at the LNGS. Measurements evidence anomalies related to a preparation phase of the seismic swarm, which occurred near L’Aquila, Italy, from October 2008 to April 2009. Furthermore, high precision 14C measurements have been performed and ERMES extended the present maximum dating limit from 58,000 BP to 62,000 BP (5 mL, 3 days counting).

Finally LNGS hosts since several years an interferometric station with two geodetic extensometers. Both instruments are unequal-arm Michelson interferometers, using a 90 m long measurement arm and a <40 cm long reference arm, sharing the same stabilized HeNe laser source. The results of the analysis of the data produced by the interferometers before and after the occurrence of the April 2009 earthquake will be presented.

ApP and associated sciences at LSM: Laboratoire Souterrain de Modane

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Modane Underground Laboratory CNRS

Curriculum Vitae :

Researcher at CNRS on neutrino physics at Centre d'Etude Nucléaire de Bordeaux-Gradignan and Laboratoire Souterrain de Modane. I work in the NEMO3 and SuperNEMO project to look for neutrinoless doublebeta decay using tracko-calo technique. As Director of Modane Underground Laboratory, I am involved in the project of extension of the laboratory and on the development of its scientific program, in particular interdisciplinary activities requiring low radioactivity techniques or deep underground infrastructure.

Education: 1994: PhD in Particle Physics (University of Strasbourg, France)

Research:

1994 – 2002 :	NEMO2 et NEMO3 experiments.
2002 – 2003 :	Invited professor at Tohoku University (Sendai, Japan), KamLAND experiment. l'expérience KamLAND de mesure des oscillations de neutrino venant des réacteurs
2004 – 2010 :	NEMO 3 experiment Spokeperson of SuperNEMO project
2007 – 2010 :	Director of LSM.

Abstract:
The Laboratoire Souterrain de Modane (Modane Underground Laboratory, LSM) is the deepest in Europe and the second deepest in the world. With the cosmic radiation flux being reduced by a factor of 2 000 000, this platform provides exceptional conditions for the research of very rare physics phenomena and the measurement of very weak levels of radioactivity.

For many years the LSM has been a multidisciplinary infrastructure using the gamma-ray spectrometer developed to select ultra low radioactive materials for the fundamental physics experiments. A multitude of uses were found (still under investigation), including environmental research (oceanography, glaciology, climatology, paleoenvironment, hydrology, sedimentary transfer, etc.) and environmental observation (environmental monitoring, origin of pollution). Expertises were also developed by using natural or artificial radioactivity as a tracer.

The LSM also serves as a laboratory of reference for the international norm JEDEC (determines the reliability of electronics when exposed to radiation) and hosts laboratory or industrial microelectronic bench tests in order to characterize the effects of natural radioactivity on electrical circuits.

Laguna, a design study for a Large Apparatus for the search for Grand Unification and Neutrino Astronomy

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Curriculum Vitae :

Prof. em. at the Technische Universität München.

1977 PHD at the Technische Universität München

1978-1980 Institut Laue Langevin in Grenoble, search for neutrino oscillations, measurement of the reactor neutrino spectrum

1981-1987 Neutrino experiments at the nuclear power plant Gösgen (Switzerland) and Bugey (France).

1990- 2010 measurement of the solar neutrino spectrum with the experiments Gallex, GNO, and Borexino, performed in the Gran Sasso underground Laboratory (Italy)

1995-2010 experiments to search for Dark Matter with the experiment CRESST at the Gran Sasso underground laboratory in Italy.

2002 – 2010 Member of the collaboration DOUBLE CHOOZ to investigate neutrino oscillations at the reactor Chooz in France.

1994 – 2010 chair of the institute for experimental Physics and astroparticle physics at the TUM

1995-2006 spokesman of the special research centre for astroparticle physics in Munich.

2004-2008 chair of the Governing Board of the European “Integrated Large Infrastructure for Astro Particle Science” ILIAS.

1995 to 2009 member of the referee board of APpEC – Aspera and co-author of the European road map for Astroparticle Physics.

Abstract:

Laguna is an EU funded design study for the construction of a European Large Infrastructure for the search for grand unification in particle physics and a new observatory for neutrino astronomy. Seven sites in Europe have been investigated for the possibility to construct the large infrastructure in a deep underground location. For this three different suggested detectors based on water Cherenkov light, a liquid argon drift chamber and a liquid scintilator with total masses between 50-600 KT of detector material where considered.

In this contribution the status of the design study is reported and the scientific program discussed.

In this presentation special emphasis will be given to the proposal of LENA, a large (50KT) scitillatior detector which is focusing to low energy neutrino spectroscopy. This will include neutrinos originating from the sun, supernova explosions, and the interior of the earth as well as from an accelerator produced neutrino beam. In addition the sensitivity of this detector to a possible decay of protons will be presented.

CTA, associated sciences and energy considerations

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Abstract:
In this talk I introduce the Cherenkov Telescope Array (CTA) project and will discuss in detail the work of the Atmospheric Monitoring and Calibration Working Group (ATAC) of the CTA project which incorporates both astroparticle and atmospheric physicists. I will address the detailed atmospheric simulations undertaken by the working group, which utilize a database of existing Radiosonde and Lidar data to model the performance of candidate telescope arrays under differing atmospheric conditions utilizing Monte Carlo simulations of the atmosphere, the development of the extensive air showers and the telescope optics and electronics. This discussion will highlight the need for precise measurements of the atmospheric transmission profile, and leads directly to the significant ongoing efforts in the development of Raman Lidars for CTA. I will highlight this work, and the constraints the operation of the telescope array puts upon the use of such systems.

Terrestrial Gamma-Ray Flashes as powerful particle accelerators

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INAF, and University of Rome "Tor Vergata"

Abstract:
Terrestrial gamma-ray flashes (TGFs) are sudden (a few millisecond) bursts of energy associated with lightning in powerful thunderstorms.
TGFs are very energetic, and are characterized by a spectrum reaching energies up to 100 MeV. We will summarize the current satellite observations, and will focus on the results obtained by the AGILE satellite, a high-energy astrophysics mission operating in an equatorial orbit since mid-2007.

AGILE has been detecting hundreds of TGFs in about 3 years of operations, and substantially improved the high-energy detection of these impulsive phenomena. Contrary to previous expectations and current theoretical models, AGILE discovered substantial TGF emission well above 10 MeV.

A distinct power-law spectral component is detected up to 100 MeV with far-reaching consequences. Very efficient particle acceleration occurs in TGFs using potential differences of the order of the maximum values (hundreds of MegaVolts) that can be established in cloud-to-ground and inter-cloud discharges. We will discuss the relevance of these observations for theoretical studies of particle acceleration and atmospheric and climate studies. TGFs copiously produce accelerated electrons (and possibly positrons) that radiate an intense gamma-ray spectrum. Neutrons are also produced by photonuclear reactions in the atmosphere. We will discuss the atmospheric propagation properties of the particle/radiation output of TGFs and discuss their implications.

Baikal Underwater Neutrino Telescope NT-200 --- an Underwater Laboratory for Astroparticle Physics and Environmental Studies

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Abstract:
Lake Baikal in Siberia is one of the most unusual lakes in the world. It is the world's largest reservoir of fresh surface water and home to several hundred endemic species; and at the same time Baikal is a home for the first underwater neutrino telescope NT200. For this neutrino telescope, a number of methods and instruments were designed to study different processes in the Baikal ecosystem. Now the hundreds of optical, acoustic and other sensors allow one to realize a long-term 3D monitoring of the various water parameters like water temperature, inherent optical properties, intensity of water luminescence etc., as well as processes like sedimentation, deep water renewal etc. in Lake Baikal. In cooperation with eg. EAWAG (Switzerland) and the Limnological Institute SB RAS, a number of new phenomena were discovered and studied, like luminescence of Baikal water, coastal downwelling along the steep lake shores, appearance of "foreshocks" in electric Earth fields before big magnitude Earthquakes in the Baikal rift zone.

We review the present status of the Baikal Neutrino Telescope infrastructure facilities for interdisciplinary environmental studies and the most interesting limnology results, which were obtained in the framework of the project. We will underline our interest to broaden the scientific objectives with new collaborators, by e.g. using the potential to include new measurement subsystems, distributed over km-scales with full online environmental monitoring capability.