TAUP 2011

5–9 September 2011

München, Germany

Abstract Booklet

Topics in Astroparticle and Underground Physics

Times and Rooms for Parallel Workshop Sessions

		Room			
		Festsaal	Millerzimmer	Clubraum 1	Clubraum 3
Mon	14:30–16:10	Dark Matter W1	Astro Messengers W1	2 Beta/Nu Mass W1	Low-E Neutrinos W1
	16:50–18:30	Dark Matter W2	Astro Messengers W2	Nu Oscillations W1	Cosmology W1
Tue	14:30–16:10	Dark Matter W3	Astro Messengers W3	2 Beta/Nu Mass W2	Low-E Neutrinos W2
	16:50–18:30	Dark Matter W4	Astro Messengers W4	Nu Oscillations W2	Cosmology W2
Wed	14:30–16:10	Dark Matter W5	Astro Messengers W5	2 Beta/Nu Mass W3	Low-E Neutrinos W3
	16:50–18:30	Dark Matter W6	Astro Messengers W6	Nu Oscillations W3	Cosmology W3
Thu	14:30–16:10	Dark Matter W7	Astro Messengers W7	2 Beta/Nu Mass W4	Grav Waves W1
	16:50–18:30	Dark Matter W8	Low-E Neutrinos W4	2 Beta/Nu Mass W5	Grav Waves W2

Contents

PLENARY SESSIONS **5**

Cosmology and Dark Matter I 5
Cosmology and Dark Matter II 5
Direct Dark Matter Searches I 6
Direct Dark Matter Searches II 6
Neutrinos I 7
Neutrinos II 7
Astrophysical Messengers I 7
Astrophysical Messengers II 8
Astrophysical Messengers III 8
Astrophysical Messengers IV 9
Concluding Session 10

PARALLEL SESSIONS **11**

Dark Matter W1
Searches with neutrinos and gamma rays . . 11
Dark Matter W2
Directional and indirect + $0\nu\beta\beta$ experiments 12
Dark Matter W3
Direct detection and light WIMPs 13
Dark Matter W4
Searches with charged cosmic rays 14
Dark Matter W5
Direct detection with bolometers 15
Dark Matter W6
Direct Detection: Bubbles, NaI and CsI . . . 16
Dark Matter W7
Model building; Collider searches 17
Dark Matter W8
Direct detection: Liquid noble gases 18
Cosmology W1 19
Cosmology W2 20
Cosmology W3 21
Double Beta Decay and Neutrino Mass W1 22
Double Beta Decay and Neutrino Mass W2 22
Double Beta Decay and Neutrino Mass W3 23
Double Beta Decay and Neutrino Mass W4 24
Double Beta Decay and Neutrino Mass W5 25
Neutrino Oscillations W1 26
Neutrino Oscillations W2 27
Neutrino Oscillations W3 28
Low-Energy Neutrinos W1 29
Low-Energy Neutrinos W2 30
Low-Energy Neutrinos W3 31
Low-Energy Neutrinos W4 32
Gravitational Waves W1 33
Gravitational Waves W2 34
Astrophysical Messengers W1 – Cosmic rays . . . 35
Astrophysical Messengers W2 – Cosmic rays . . . 36
Astrophysical Messengers W3 36
Astrophysical Messengers W4 37
Astrophysical Messengers W5 38
Astrophysical Messengers W6 – Gamma-Rays . . 39
Astrophysical Messengers W7 – Gamma-Rays . . 40

POSTER SESSION **41**

AUTHOR INDEX **46**

PLENARY SESSIONS

Room: Festsaal

Mon **Cosmology and Dark Matter I**

Room: Festsaal Chair: Georg Raffelt

09:00 **CMB and Planck (25+10′)**

Francois Bouchet (IAP Paris)

The Planck satellite's primary objective is to provide a definitive mapping of the cosmic microwave background (CMB) temperature anisotropies and a first detailed mapping of their polarisation, which requires exquisite control of all other sources of fluctuations, instrumental or astrophysical. Planck has successfully completed the acquisition of the data of the nominal mission and the instrumental teams are working toward releasing preliminary science results as soon as they are obtained, in particular regarding the CMB astrophysical foregrounds, with a goal to deliver the first cosmological data and analyses at the expected date. I will review the project status, it's current results, and expectations.

09:35 **Precision cosmology as a particle physics laboratory (25+10′)**

Yvonne Wong (RWTH Aachen)

I review how precision data from observations of the cosmic microwave background anisotropies and the large scale structure distribution can be used to probe fundamental physics. Some examples are the absolute neutrino mass scale and non-standard neutrino interactions. I also discuss the sensitivities and discovery potential of future surveys.

10:10 **Alternatives to WIMPs and alternative uses of WIMP detectors (25+10′)**

Maxim Pospelov (Univ. of Victoria and Perimeter Institute)

Although perfectly motivated, WIMP dark matter candidates do not exhaust even a small fraction of dark matter particle mass/couplings. Over the years, a number of appealing alternatives has been developed by the theory community. These include superweakly interacting particles such as sterile neutrinos, and hidden vectors and scalars; supercold dark matter such as axions, as well as even more exotic possibilities. After reviewing a fraction of these ideas, I will concentrate on alternative uses of WIMP dark matter detectors and show how their results can be interpreted as constraints on properties of super-WIMPs, solar axions and solar neutrinos.

Cosmology and Dark Matter II *Mon*

Room: Festsaal Chair: Takaaki Kajita

Status of indirect detection (25+10′) *11:15*

Pasquale Serpico (LAPTh)

I will review the status of indirect detection of dark matter (charged cosmic rays, gamma rays, neutrinos, cosmology), which remains a cornerstone for the dark matter particle identification program. I will stress the importance of accounting for astrophysical backgrounds, especially when moving from setting constraints in parameter space to the more challenging ambition of detection. I will argue that, barring some exception, we are close to the limits of blind searches for indirect dark matter evidence due to systematic limitations to our understanding of astrophysical backgrounds. Guidance from collider/direct detection is needed to perform a much more fruitful "a priori" search for correlated signatures in many indirect channels.

Antimatter in space (25+10′) *11:50*

Bruna Bertucci (Università degli Studi di Perugia and INFN)

The search for anti-nuclei, as proof of anti-matter on a cosmological scale, and the precise measurement of light anti-matter, as smoking gun of Dark Matter annihilations in the galaxy, have been the driving motivations for a rich experimental program devoted to the quest of the faint anti-matter signals in the Cosmic Rays. Along several decades, in fact, this research has been deeply connected to the understanding of the CR sources, their acceleration and propagation through the galaxy: light anti-matter is routinely produced in the interactions of primary CR in the interstellar medium and a clear signature of exotic primary components must rely on the correct description of the background coming from ordinary sources. Space is the ideal environment where to carry these studies due to the lack of atmospheric backgrounds and long exposure times, the impressive results from PAMELA and FERMI space experiments have puzzled the scientific community and triggered a lively debate. PAMELA will soon arrive to the end of its mission, but a new experiment – AMS-02 – is promising new precision measurements for the next decade. On May 19, 2011 the AMS-02 experiment started his operation on board of the International Space Station, following a 51.7° inclined orbit at 390 km from the earth surface. AMS-02 is a large acceptance magnetic spectrometer conceived for the search of anti-matter as well as for the precise measurement of the cosmic ray flux components and energy spectra in the GV-TV rigidity range. Nine layers of silicon microstrip detectors constitute the core of the spectrometer, allowing the simultaneous measurement of the charge magnitude and sign of impinging particles and reconstructing their rigidity up to the TV. A 3D imaging calorimeter, with a depth of 17 radiation lengths, and a TRD detector allow an accurate measurement of the electron and positron components and an effective rejection of the proton background. Velocity measurement and redundant measurements of the charge magnitude are performed by the four scintillator planes constituting the Time of Flight system and a Ring Imaging Cherenkov detector. During the first three months of data taking, 4×10^9 triggers have been recorded by AMS-02, for a downlinked data sample of $\approx$ 35 TB. In this contribution, after a

review of the actual measurements of anti-matter in space, we will report on the flight operations of AMS-02 and its perspectives for physics measurements.

12:25 **Status of deep underground laboratories (25+10′)**

Nigel Smith (SNOLAB)

Several of the major questions studied in contemporary astro-particle and sub-atomic physics are performed through weak interaction studies or rare event searches that require the ultra-quiet environment afforded by deep underground facilities, where the cosmic radiation induced backgrounds in the detection systems are reduced to a manageable level. This talk will provide a review of the status of, and future plans for, deep underground facilities around the world, highlighting the expansions to available laboratory experimental space that have recently occurred, or are planned in the near future. Additionally, major facilities that will be hosted in these laboratories will be outlined.

Tue Direct Dark Matter Searches I

Room: Festsaal Chair: Alessandro Bottino

09:00 **Direct WIMP searches and theoretical scenarios (25+10′)**

Carlos Muñoz (Universidad Autónoma Madrid UAM & Instituto de Fisica Teorica UAM/CSIC)

Theoretical models and WIMP candidates for dark matter will be discussed in the light of recent experimental results.

09:35 **Status of XENON100 (20+10′)**

Rafael Lang (Purdue University)

XENON100 is a two-phase time projection chamber with a 62 kg liquid xenon target to search for Dark Matter interactions. Both scintillation and ionization signals are recorded to allow interaction vertex reconstruction in three dimensions. Fiducialization of the target volume results in the lowest background level of any Dark Matter search running. In a 48kg fiducial target and 100 days of live time, no evidence for Dark Matter is found. This allows to place some of the strongest limits on Dark Matter interactions. The XENON100 detector is presented together with latest results from the search for Dark Matter.

10:05 **Dark matter search with CDMS and SuperCDMS (20+10′)**

Wolfgang Rau (Queen's University)

The CDMS experiment operated cryogenic Ge and Si detectors for several years in a well shielded underground environment searching for signals from Weakly Interacting Massive dark matter Particles (WIMPs). Due to the low background and excellent background discrimination power, CDMS has provided the best sensitivity for WIMP-nucleon interactions for most of the past decade. New detectors with larger mass and further improved background discrimination, developed for the successor experiment SuperCDMS, are currently being studied; WIMP search measurements are foreseen to resume later this year. We will discuss the results from CDMS, in particular the constraints on low mass WIMPs recently proposed to explain results from other dark matter experiments, and present the status of SuperCDMS.

Direct Dark Matter Searches II *Tue*

Room: Festsaal Chair: Lothar Oberauer

11:00 **Latest results from the CRESST dark matter search (20+10′)**

Federica Petricca (MPI für Physik)

The CRESST-II experiment is searching for Dark Matter particles in the form of WIMPs via their elastic scattering off nuclei in a target material. The CRESST target consists of scintillating $CaWO_4$ crystals which are operated as cryogenic calorimeters. For each interaction a phonon signal in the target crystal and the scintillation light produced are measured. In the talk we present the latest results of the experiment, obtained from a net exposure of 734 kg days acquired with 9 detectors between July 2009 and January 2011. The data has shown a considerable number of oxygen recoil candidates in our signal region which is difficult to explain by known backgrounds. We discuss the significance of this excess of events over the known backgrounds and the compatibility with a WIMP signal.

11:30 **CoGENT and COUPP (20+10′)**

Juan Collar (University of Chicago)

Recent results from CoGeNT will be discussed. Sources of uncertainty affecting searches in principle sensitive to low mass WIMPs will be considered, in particular any irreducible surface event contamination in CoGeNT PPCs and those arising from quenching factor and the possibility of channeling in NaI[Tl]. Preliminary results from a measurement of ion channeling in NaI[Tl] at energies relevant for dark matter searches will be presented, concluding with an overview of the present landscape of experimental constraints and anomalies affecting searches for few-GeV WIMPs. The status of COUPP will be briefly discussed, and plans for both CoGeNT and COUPP will be mentioned.

12:00 **EDELWEISS status report (20+10′)**

Eric Armengaud (IRFU/SPP)

The EDELWEISS-II experiment, operated at the Frejus laboratory in a low-background environment, uses cryogenic germanium detectors to look for WIMPs. We present the results of a WIMP search carried out recently with ten so-called InterDigit detectors. This technology enables a high level of gamma radioactivity rejection within a controled fiducial volume. A cross-section of 4.4×10^{-8} pb could be excluded for a WIMP mass of 85 GeV. We also present the status of the EDELWEISS-III project, which will operate 40 newly-designed FID detectors in an upgraded installation to improve significantly the sensitivity to low WIMP scattering cross-sections.

12:30 **DAMA/LIBRA results and perspectives (20+10′)**

Antonella Incicchitti (INFN Roma)

The DAMA/LIBRA set-up (about 250 kg highly radiopure NaI(Tl)) is running at the Gran Sasso National Laboratory of the INFN. The results obtained in 6 annual cycles have been already released; the cumulative exposure with the former DAMA/NaI data is 1.17 ton $\times$ yr, corresponding to 13 annual cycles. The data further confirm the model independent evidence for the presence of Dark Matter particles in the galactic halo on the basis of the Dark Matter annual modulation signature (8.9 σ C.L.). A further annual cycle has been collected before the new upgrading performed at the end of 2010. The set-up has now started the data taking and optimizations in this new configuration. Results and perspectives will be summarized.

Wed Neutrinos I

Room: Festsaal Chair: Thierry Lasserre

09:00 **Direct neutrino mass determination: Status and prospects (25+10′)**

Volker Hannen (Münster University)

The scale of neutrino masses is of strong interest to the fields of particle physics and cosmology. Although many insights about the properties of neutrinos are coming from neutrino oscillation experiments, we are still missing important information about the possible Majorana nature of neutrinos and about their absolute mass scale. While searches for neutrino-less double beta decay probe whether the neutrino is actually a Majorana particle and, in that case, determine an effective mass, kinematic methods, as applied in MARE, KATRIN and in the recently proposed Project 8 experiment, allow for a model-independent extraction of the electron neutrino mass. The talk will provide an overview of status and sensitivities of direct neutrino mass experiments currently under construction.

09:35 **Double beta decay (25+10′)**

Bernhard Schwingenheuer (MPI für Kernphysik)

The search for neutrinoless double beta decay is the most sensitive experimental probe to decide whether neutrinos are their own anti-particles. This decay changes the lepton number by 2 units. In the next years several new experiments using different isotopes and techniques will start taking data. The prospects of these approaches and the current status of nuclear matrix element calculations are reviewed.

10:10 **Long-baseline experiments (25+10′)**

Takeshi Nakadaira (IPNS/KEK)

Long baseline neutrino experiments are designed to complete the knowledge on 3-flavor neutrino mixing by measuring the flavor change of accelerator-produced neutrinos. The current status of the measurement of the neutrino mixing angles by running experiments are reviewed. The recent progress in the θ_{13} measurements is reported. The future plans which will search the CP violation in the neutrino sector are also discussed.

Neutrinos II *Wed*

Room: Festsaal Chair: Yoichiro Suzuki

Short baseline: Status and prospects (25+10′) *11:15*

Bonnie Fleming (Yale University)

Neutrinos have offered many unexpected surprises since their proposed existence almost 80 years ago. Recent results from the MiniBooNE short baseline experiment, re-analysis of short baseline reactor experiment and calibration data offer puzzling results which could suggest a new sterile neutrino. A number of future possible experiments using radioactive sources, and particle accelerators have been suggested as ways to address these anomalies. The short baseline results as well as prospects to address them in the future will be presented.

Neutrino oscillations with reactor neutrinos (25+10′) *11:50*

Manfred Lindner (Max-Planck-Institut für Kernphysik)

The status of reactor neutrino experiments to determine θ_{13} will be reviewed. The potential and uncertainties of the measurement as well as possible interpretations for standard and non-standard results will be discussed.

Neutrinos: Phenomenology and interpretation (25+10′) *12:25*

Eligio Lisi (INFN Bari)

The current phenomenology of neutrino masses and mixings will be reviewed, with emphasis on the standard three-neutrino framework and on the mixing angle θ_{13}. Anomalous results, which could be interpreted in terms of nonstandard neutrino properties or states, will also be briefly discussed.

Astrophysical Messengers I *Thu*

Room: Festsaal Chair: David Sinclair

Novel results on low energy neutrino physics (25+10′) *09:00*

Gianpaolo Bellini (Università and INFN Milano)

The study of low energy neutrinos from Sun and Earth have produced recently new insights in the neutrino physics. New measurements of the solar fluxes from ^{7}Be and ^{8}B, the first determination of neutrino flux from pep and the study of the day/night effect at low energy have been provided by Borexino. Their impact on the MSW-LMA model in vacuum and transition regions, and on the global fit with only solar, without antineutrino data, are discussed. Implemented analyses of geoneutrinos are also presented in addition to new results, if any, from SuperK, SNO, Kamland. A campaign of data taking in Borexino with artificial sources has been proposed to check the possible existence of a sterile neutrino.

09:35 **Diffuse supernova neutrino background (DSNB) (25+10′)**

John Beacom (Ohio State University)

The diffuse supernova neutrino background (DSNB) is the weak glow of MeV neutrinos and antineutrinos from distant core-collapse supernovae. The DSNB has not been detected yet, but the Super-Kamiokande (SK) 2003 upper limit on the electron antineutrino flux is close to predictions, now quite precise, based on astrophysical data. If SK is modified with dissolved gadolinium to reduce detector backgrounds, then it should detect the DSNB at a rate of a few events per year, providing a new probe of supernova neutrino emission and the cosmic core-collapse rate. Neutrino astronomy, while uniquely powerful, has proven extremely difficult – only the Sun and the nearby Supernova 1987A have been detected to date – so the promise of detecting new sources soon is exciting indeed.

10:10 **Future underground large detectors: Prospects and physics case (25+10′)**

Kate Scholberg (Duke University)

A new generation of large underground detectors is being planned to further investigate neutrino mass and mixing and to search for possible CP violation that may provide a hint to the origin of our asymmetric universe. Such detectors would also investigate neutrinos in nature - from the earth's crust to supernovae. The physics case for such a program is presented and plans for detectors worldwide are summarized.

Thu Astrophysical Messengers II

Room: Festsaal Chair: Christian Spiering

11:15 **Sources of highest energy cosmic rays and neutrinos (25+10′)**

Eli Waxmann (Weizmann Institute)

The construction of large-volume detectors of high energy, $>$1 TeV, neutrinos is mainly driven by the search for extra galactic neutrino sources. The existence of such sources is implied by the observations of ultrahigh energy, $> 10^{19}$ eV, cosmic rays (UHECRs), the origin of which is still a mystery. The detection of extra galactic neutrinos will allow one to identify the sources of ultrahigh energy cosmic rays and to resolve open questions related to the underlying physics of models of high energy astrophysical sources. Moreover, such detection may allow one to test for neutrino properties (e.g., flavor oscillations and coupling to gravity) with an accuracy many orders of magnitude better than is currently possible. I will discuss the constraints imposed by current cosmic-ray observations on the properties of the (yet unknown) sources of UHECRs, the implications of AUGER CR observations and of Fermi high energy gamma-ray observations to the expected extra galactic neutrino signal, the open questions that neutrino detection may help addressing, and the current state of the experimental efforts.

Cosmic rays at the highest energies (25+10′) *11:50*

Angela Olinto (University of Chicago)

After a century of observations, we still don't know the origin of cosmic rays. I will review the current state of cosmic ray observations at the highest energies, and their implications for proposed acceleration models and secondary astroparticle fluxes. Possible sources have narrowed down with the confirmation of a GZK-like spectral feature. The anisotropy observed by the Pierre Auger Observatory may signal the dawn of particle astronomy raising hopes for high energy neutrino observations. However, composition related measurements point to a different interpretation. A clear resolution of this mystery calls for much larger statistics than the reach of current observatories.

High energy neutrino astronomy (25+10′) *12:25*

Teresa Montaruli (University of Wisconsin – Madison)

It is an exciting time for neutrino astronomy now that the first cubic-kilometer detector (IceCube) has been completed at the South Pole and the first underwater detector is running in its complete configuration (ANTARES). The discovery of high energy astrophysical neutrinos may come any time now. The status of experimental results and how they constrain models is illustrated. Some of them, for instance the fireball model for gamma-ray bursts, may be severely constrained in a few years unless neutrinos will be revealed. In both case, our view of the highest energy universe will probably change and we will have a more complete picture than what we have now when all information come from photon astronomy. A view of the experimental future of this science will be also provided.

Astrophysical Messengers III *Fri*

Room: Festsaal Chair: Barbara De Lotto

09:00 **Underground research laboratories and deep mines as a window into subsurface microbiology (25+10′)**

Barbara Sherwood Lollar (University of Toronto)

Chemolithotrophic communities, or microbes drawing their energy for life from geologically produced chemical species rather than from photosynthesis, were discovered in the late 1970s at the mid-ocean ridge hydrothermal vents. This discovery sparked a revolution in our understanding of the range of possible mechanisms for sustaining life and hence in our concept of where on this planet life could be found. Since that time, our understanding that life is not simply a thin veneer on the earth's surface but may permeate deep into the subsurface of this planet has evolved rapidly. Serpentinization of ultramafic rocks and alteration of basaltic ocean floor have been invoked as key mechanisms by which geochemical processes of water-rock interaction may provide energy and reducing power for chemoautotrophic microbial communities on the seafloor. In continental settings, H_2-utilizing chemoautotrophic microbial communities have been identified in volcanic hot springs, and research in groundwater aquifers suggests that H_2-fueled autotrophic microbial ecosystems might be widespread in continental flood basalts. A major gap remains in our understanding of life in

the deep, but not so hot, biosphere. Investigations, particularly in the continental or terrestrial deep subsurface, are recognizing that chemosynthetic communities are not restricted to the high temperature hydrothermal vents and springs, but can be sustained under lower temperature regimes by similar types of water-rock reactions, albeit at slower rates. The implications of this conceptual evolution are profound, as it suggests much larger volumes of the Earth's subsurface may be habitable. Taking advantage of deep boreholes, subsurface mines and deep research laboratories worldwide, researchers in geology, geochemistry, hydrogeology, microbiology and genomics are mobilizing to explore Earth's "Inner Space". The presentation will highlight work at underground sites in 2–3 billion year old Precambrian Shield rocks in South Africa, Canada and Finland where isotope geochemistry has identified large accumulations of free H_2 gas, methane and higher hydrocarbons dissolved in saline fracture waters with residence times on the order of millions of years. Within these fracture waters, a low biomass chemolithotrophic microbial community couples H_2 consumption to sulfate-reduction to eke out an existence at maintenance levels in an exotic outpost of life far from the photosphere.

09:35 **Gamma rays: Review of observations (25+10′)**

David Paneque (MPI für Physik)

Our knowledge of the gamma-ray sky has dramatically changed due to the advent of the new Imaging Atmospheric Cherenkov Telescopes (HESS, MAGIC and VERITAS) and satellite-borne instruments (AGILE and Fermi). These facilities boosted the number of gamma-ray sources by one order of magnitude in the last 6 years, providing us with about 2000 sources detected above 100 MeV (from space) and about 100 sources detected above 100 GeV (from the ground). In this talk I will review some of the most exciting observations from this rapidly evolving field, and I will briefly report about the planned facilities for the coming years.

10:10 **Gamma-rays: Physics interpretation (25+10′)**

Felix Aharonian (DIAS Dublin)

I will discuss the theoretical implications of the recent gamma-ray observations in the high and very high energy regimes in the context of origin of cosmic rays, physics and astrophysics of relativistic outflows (pulsar winds and AGN jets), as well as cosmological issues related to the extragalactic radiation and magnetic fields.

Fri Astrophysical Messengers IV

Room: Festsaal Chair: Eugenio Coccia

11:15 **Astronomy and astrophysics with gravitational waves in the advanced detector era (25+10′)**

Alan Weinstein (Caltech)

With the advanced gravitational wave detectors coming on line in the next 5 years, we expect to make the first detections of gravitational waves from astrophysical sources, and study the properties of the waves themselves as tests of General Relativity. In addition, these gravitational waves will be powerful tools for the study of their astrophysical sources and source populations. They carry information that is quite complementary to what can be learned from electromagnetic or neutrino observations, probing the central gravitational engines that power the electromagnetic emissions. Preparations are being made to enable near-simultaneous observations of both gravitational wave and electromagnetic observations of transient sources, using low-latency search pipelines and rapid sky localization. We will review the many opportunities for multi-messenger astronomy and astrophysics with gravitational waves enabled by the advanced detectors, and the preparations that are being made to quickly and fully exploit them.

Gravitational waves: Current and future experimental overview (25+10′) *11:50*

Kazuaki Kuroda (ICRR Tokyo)

First generation detectors for gravitational waves, LIGO, Virgo with GEO have recently collected astrophysically interesting data with a sensitivity ranging up to a few tens Mpc for coalescences of compact binary stars. However, no traces of gravitational waves have been detected, yet. This negative result gives the upper limit of occurrence rate of several kinds of gravitational wave events in the Universe. In order to obtain positive result, Advanced LIGO started to be installed utilizing the vacuum facility of the initial LIGO and also the advanced Virgo is ready to be built after the present Virgo. During the observation gap in this construction period, GEO will be operated for targeting higher frequency sources as "AstroWatch", which is upgraded by introducing vacuum squeezed light with refined mirror suspension system (GEOHF). These advanced detectors of laser interferometer are the so-called second generation ones. There is a broad improvement in sensitivity of about a factor of 10. The limits to sensitivity are quantum noise and thermal noise. Below 100 Hz, the sensitivity is limited by quantum noise arising from the fluctuation of photon recoil pressure, which is the result of higher laser power to reduce photon shot noise at higher frequencies. In the critical mid band, thermal noise limited the sensitivity of the best observation frequencies of the first generation detectors. One method to reduce thermal noise is cooling the temperature of mirror with its suspension system. The other method is to widen the beam size on the mirror. In any case, other thermal noise has to be reduced less than the limit of the quantum noise. Although the Advanced LIGO and Advanced Virgo adopt the widened beam size, the cryogenics is applied to LCGT project that has been recently funded to construct in Japan. These second generation detectors will begin observation in 2015–2017 and certainly detect gravitational wave events. In order to open gravitational wave astronomy, these detectors need to be operated in a network to cover the whole sky. The most important item is the positioning accuracy to make useful the collaboration with optical and electromagnetic wave telescopes. At least three detectors are needed to position on the sky and the longer the baseline, the better accuracy is obtained. In addition to the above second generation detectors, there are two planned projects; LIGO-Australia and LIGO-IndIGO. The former project is primarily pursued at this stage by IndIGO and ACIGA collaborations with LIGO partnership. The planned site is in Western Australia, which would be the first southern hemisphere location to augment the

observation network. These ground-based gravitational wave detectors can detect events in the frequency band around 100 Hz. The main frequency band of black hole coalescence is lower than 10 Hz and there are many sources of frequencies of mHz region apart from black holes. In order to observe these gravitational wave sources, space-based laser interferometers are planned and developed. LISA is the joint project of NASA and ESA to fulfill the requirement to achieve the detection of such lower frequency events with higher sensitivity. However, there are uncertainties about the scope of NASA contributions to several large missions, including LISA. Currently, a redesign of LISA is going on, focusing on the worst case of an ESA-led mission. And by using several ideas on transfer, orbit and mission design, most of the original objectives can be retained, while considerably reducing mass and cost. LISA Pathfinder is almost complete and aims to a launch in 2 years from now. DECIGO is the Japanese space mission to cover the frequency gap (100 mHz–10 Hz) between the LISA and the second generation detectors. The Path Finder of DECIGO is waiting a fund for launch within a few years. The effort to realize the detection in frequencies at around 10 Hz is being pursued by European researchers as the Einstein Telescope (ET) project. The working group of ET finished its design study this spring and has been made public. It adopts cryogenics in an underground facility with 10 km scale baseline length of laser interferometer. This third generation detector will drastically expand both the observation volume in the Universe and the observation frequency band. Finally, the projects for gravitational wave detectors who make up the Gravitational Wave International Committee (GWIC) have chances to prepare and study to realize an international collaboration for observation network considering possible collaboration with wider optical and/or electromagnetic and/or astro-particle observations.

Concluding Session *Fri*

Room: Festsaal Chair: Eugenio Coccia

Visions and outlook (25+10′) *12:25*

Hitoshi Murayama (IPMU Tokyo)

PARALLEL SESSIONS

Dark Matter – Candidates and Searches

Convened by
- Jean-Côme Lanfranchi (Technische Universität München)
- Teresa Marrodán Undagoitia (University of Zurich)
- Torsten Bringmann (Universität Hamburg)

Mon **Dark Matter W1**
Searches with neutrinos and gamma rays

Room: Festsaal Chair: Pasquale Serpico

14:30 **Conservative upper limits on WIMP annihilation cross section from Fermi-LAT γ-rays (15+5′)**

Fiorenza Donato (Torino University)

The spectrum of an isotropic extragalactic gamma-ray background (EGB) has been measured by the Fermi-LAT telescope at high latitudes. Two new models for the EGB are derived from the subtraction of unresolved point sources and extragalactic diffuse processes, which could explain from 30% to 70% of the Fermi-LAT EGB. Within the hypothesis that the two residual EGBs are entirely due to the annihilation of dark matter (DM) particles in the Galactic halo, we obtain stringent upper limits on their annihilation cross section. Severe bounds on a possible Sommerfeld enhancement are set as well. Finally, we consider models for DM annihilation depending on the inverse of the velocity and associate the EGBs to photons arising from the annihilation of DM in primordial halos.

14:50 **Spectral cutoffs in indirect dark matter searches (15+5′)**

Christoph Weniger (MPI für Physik, München)

Indirect searches for dark matter annihilation or decay products in the cosmic-ray spectrum are plagued by the question of how to disentangle a dark matter signal from the omnipresent astrophysical background. One of the practically background-free 'smoking gun' signatures for dark matter would be the observation of a sharp cutoff in the gamma-ray energy spectrum. Such a feature is generically produced in many dark matter models by internal Bremsstrahlung, and it can be treated in a similar manner as the traditionally looked-for gamma-ray lines. In this talk, we will discuss prospects for seeing such features with present and future gamma-ray telescopes. We will concentrate on Air Cherenkov Telescopes and comment on the Fermi LAT.

15:10 **Determining WIMP properties with neutrinos in IceCube/DeepCore (15+5′)**

Chitta Ranjan Das (Centro de Física Teórica de Partículas)

Cosmological and astrophysical observations provide increasing evidence of the existence of dark matter in our Universe. One of the favored candidates is a weakly interacting massive particle (WIMP). WIMP particles can be captured by the Sun, accumulate in the core, annihilate, and produce high energy neutrinos either directly or by subsequent decays of SM particles. These neutrinos can be a striking dark matter signature in IceCube/DeepCore neutrino telescope. We investigate the prospects for indirect WIMP dark matter detection in IceCube/DeepCore and its capabilities to determine some dark matter properties, as mass, cross section and the branching ratios of the various annihilation channels.

Downward going tau neutrinos and dark matter (15+5′) *15:30*

Viviana Niro (University of Torino and INFN/Torino)

We discuss the possibility of detecting Dark Matter using the downward going tau neutrinos in Cherenkov detectors. We include in our analysis the problem of misidentified muons and electrons and show how this technical limitation influences the Dark Matter discovery potential with downward going tau neutrinos. Considering different Dark Matter masses and annihilation channels, we calculate the limits on the Dark Matter flux from the Sun that could be set by future Cherenkov detectors with specific detection efficiencies.

Indirect searches for gravitino dark matter (15+5′) *15:50*

Michael Grefe (DESY)

The gravitino in models with a small R-parity violation is a well-motivated dark matter candidate that is leading to a cosmological scenario consistent with big bang nucleosynthesis and thermal leptogenesis. Its lifetime is sufficiently long since its decays are suppressed by the Planck-scale as well as the small R-parity violating parameter. We want to discuss the signals in different cosmic ray species coming from the decay of gravitino dark matter, namely gamma rays, positrons, antiprotons, antideuterons and neutrinos. Comparison to cosmic ray data can be used to constrain the parameters of the model and to predict fluxes for other cosmic ray channels.

Mon **Dark Matter W2**
Directional and indirect + $0\nu\beta\beta$ experiments

Room: Festsaal Chair: Elisa Resconi

16:50 **Searches for dark matter with the IceCube detector (12+3′)**

Matthias Danninger (Stockholm University)

Construction of the IceCube neutrino observatory was recently completed, including the full DeepCore sub-array, a low-energy extension of the IceCube neutrino observatory. We present recent results from the searches of dark matter candidates with IceCube, performed with the 22-and 40-string configurations using the Sun and the Galactic Center and Halo as possible dark matter sources. We also report on the search for dark matter annihilations with the IceCube neutrino detector in the 79-string configuration. Furthermore, a formalism for quickly and directly comparing event-level IceCube data with arbitrary annihilation spectra in detailed model scans is presented. We show an application of this formalism to both model exclusion and parameter estimation in models of supersymmetry.

17:05 **Indirect search for dark matter with the ANTARES neutrino telescope (12+3′)**

Vincent Bertin (CPPM)

The ANTARES Collaboration is operating the largest water Cherenkov neutrino telescope in the Northern hemisphere installed in the Mediterranean Sea offshore France. One major goal of ANTARES is the search for neutrinos produced in self-annihilation of Dark Matter particles, for instance in the direction of the Sun or the Galactic Centre. First results on the search for Dark Matter annihilations in the Sun with the data recorded in 2007 and 2008 are presented, as well as sensitivity studies on Dark Matter searches with the full ANTARES detector and the future large undersea cubic-kilometre neutrino telescope studied by the KM3NeT consortium. A comparison with respect to predictions on neutrino fluxes from Dark Matter annihilations in the framework of CMSSM and UED models will be presented.

17:20 **Recent progress from the DMTPC directional dark matter search (12+3′)**

Asher Kaboth (MIT)

The DMTPC directional dark matter detection experiment is a low-pressure CF_4 gas time projection chamber, instrumented with charge and scintillation photon readout. This detector design strategy emphasizes reconstruction of WIMP-induced nuclear recoil tracks, in order to determine the direction of incident dark matter particles. Directional detection has the potential to make a definitive observation of dark matter using the unique angular signature of the dark matter wind, which is distinct from all known backgrounds. This talk will review the experimental technique and current status of DMTPC.

17:35 **NEWAGE – Direction-sensitive dark matter search experiment (12+3′)**

Kiseki Nakamura (Kyoto University)

NEWAGE is a direction-sensitive WIMP (weakly interacting massive particle) search experiment using a gaseous detector. Our 3-dimensional tracking device is based on a micro-patterned gaseous detector (MPGD). After our first underground measurement at Kamioka [PLB 686 (2010) 11], we made several detector updates to improve the sensitivities. One of the main improvements was lowering the energy threshold by decreasing the gas pressure. Energy threshold of a direction-sensitive gaseous detector is limited by the track length. With lower pressure gas, track length will be longer and energy threshold will be lower. We optimized the detector operation with CF_4 gas at 76 torr, which is one half of the previous pressure. We report on the detector performance and the result of underground measurements.

17:50 **Directional detection of dark matter with MIMAC (12+3′)**

Julien Billard (LPSC Grenoble)

Directional detection of galactic Dark Matter is a promising search strategy to identify genuine WIMP events amongst background ones. Indeed, using a dedicated statistical analysis, data of forthcoming directional detectors could lead either to a competitive exclusion or to a conclusive discovery, depending on the value of the WIMP-nucleon cross section. Constraints on both the WIMP properties and the WIMP velocity distribution may also be deduced. MIMAC is a project of directional detection of Dark Matter using a matrix of micro-tpc chambers with a 3D reconstruction of recoil tracks thanks to the use of pixelized micromegas. I will then present several aspects of the MIMAC project: phenomenological studies, 3D track reconstruction analysis and some experimental results.

18:05 **Dark matter sensitivities of the MAJORANA DEMONSTRATOR (12+3′)**

Graham Giovanetti (UNC-Chapel Hill, TUNL)

The MAJORANA DEMONSTRATOR is an array of natural and enriched high purity germanium detectors that will search for the neutrinoless double-beta decay of Germanium-76 and perform a search for WIMPs with masses below 10 GeV. To achieve a background rate in the neutrinoless double-beta decay region of interest of 1 count/keV/t/y, the DEMONSTRATOR utilizes a number of background reduction strategies, including a time-correlated event cut for ^{68}Ge that requires a sub-keV energy threshold. This low energy threshold allows the DEMONSTRATOR to extend its physics reach to include a search for light WIMPs. I will discuss the detector systems and data analysis techniques required to achieve sub-keV thresholds as well as present the projected dark matter sensitivities of the MAJORANA DEMONSTRATOR.

Tue **Dark Matter W3**
Direct detection and light WIMPs

Room: Festsaal Chair: Klaus Eitel

14:30 **CoGeNT-4: Prospects for an expanded search for light-mass WIMPs (12+3′)**

John Orrell (Pacific Northwest National Laboratory)

The CoGeNT experiment located at the Soudan Underground Laboratory has reported an excess of events below an electron scattering equivalent of 1 keV. This result may be interpreted alternatively as either an unidentified background contribution or a signature of light-mass (5–10 GeV/c^2) weakly interacting massive particle (WIMP) dark matter. The initial CoGeNT results were produced using a single 440 gram high-purity germanium radiation detector operated at liquid nitrogen temperature. To further test these unexpected results, an expanded CoGeNT-4 experimental design is under development. The shield design concept is presented and the science impact of a four-detector experiment is explored.

14:45 **Construction and commissioning of the China Jinping underground laboratory and the CDEX-TEXONO experiment (12+3′)**

Henry Wong (Academia Sinica)

Tsinghua University collaborating with the Ertan Hydropower Development Company of China began construction of the China Jinping Underground Laboratory (CJPL) in July 2009. CJPL is located in a traffic tunnel with about 2400 m of rock overburden and low ambient radioactivity background. CJPL was inaugurated on Dec. 12, 2010. The Phase-I laboratory has about 4000 m^3 of space. As the first experiment project, the CDEX-TEXONO collaboration will perform a direct dark matter search with sub-keV PCGe detector array, starting from kg-scale experiment with projected upgrades to ton-scale target in the future. Two detectors with 20 g and 1000 g target mass are currently data taking at CJPL. The status and latest results will be presented.

15:00 **An ionisation-only analysis of XENON10 data (12+3′)**

Peter Sorensen (Lawrence Livermore National Laboratory)

I will discuss a novel analysis technique applicable to liquid xenon detectors, in which only the ionisation signal is used. Despite the resulting loss of incident particle type discrimination, the results obtained from application to 12.5 live days of dark matter search obtained by the XENON10 experiment explores interesting regions of parameter space. The motivation for the technique is an increased sensitivity to light mass WIMPs, and the XENON10 result offers the best sensitivity in the 5–10 GeV particle mass range. The technique is expected to be applicable to larger xenon detectors such as XENON100 and LUX, with a commensurate increase in sensitivity.

15:15 **Likelihood approach to XENON dark matter results (12+3′)**

Eilam Gross (Weizmann Institute of Science)

Many experiments that aim at the direct detection of Dark Matter are able to distinguish a dominant background from the expected feeble signals, based on some measured discrimination parameter. We develop a statistical model for such experiments using the Profile Likelihood ratio as a test statistic in a frequentist approach. We take data from calibrations as control measurements for signal and background. Systematic detector uncertainties, such as uncertainties in the energy scale, as well as astrophysical uncertainties, are included in the model. The statistical model can be used to either set an exclusion limit or to make a discovery claim, and the results are derived with a proper treatment of statistical and systematic uncertainties. We apply the model to the XENON100 experiment.

15:30 **Bayes and present dark matter direct search status (12+3′)**

Chiara Arina (RWTH Aachen)

Recently there has been a huge activity in the dark matter direct detection field, with the report of an excess from CoGeNT and CRESST, the two events in the CDMS-II along with the annual modulated signal of DAMA/Libra and the strong exclusion bound from XENON100. We analyse these results within the framework of Bayesian inference. Indeed Bayesian methods are well suited for marginalizing over the experimental systematics and the background. We present the result for spin-independent interaction on nucleus with particular attention to the low dark matter mass region and the compatibility between experiments. In the same vein we also investigate the impact of astrophysical uncertainties on the WIMP preferred parameter space within the class of isotropic dark matter velocity distribution.

15:45 **Light neutralino dark matter (12+3′)**

Nicolao Fornengo (University of Torino and INFN/Torino)

We examine the status of light neutralinos in an effective MSSM at the electroweak scale. We discuss these models in the light of dark matter direct detection and show that they fit quite well the DAMA/LIBRA annual modulation data, together with the preliminary results of CDMS, CoGeNT and CRESST, should these data, which hint at excesses of events over the expected backgrounds, be interpreted as authentic signals of dark matter. The analysis is implemented by the new measurements at the Tevatron, B-factories and LHC which might potentially provide significant constraints on the MSSM model. We examine in detail all these new data and show that the neutralino mass has a lower bound of 7-8 GeV, with interesting correlations with the other parameters of the model.

Tue **Dark Matter W4**
Searches with charged cosmic rays

Room: Festsaal Chair: Dieter Horns

16:50 **Discriminating dark matter in cosmic rays: The role of electron dipole anisotropy (15+5′)**

Enrico Borriello (DESY & University of Naples)

Indirect searches of particle Dark Matter (DM) with high energy Cosmic Rays (CR) are affected by large uncertainties, coming both from the DM side and from poor understanding of the astrophysical backgrounds. I will discuss such uncertainties in the light of the well known experimental data provided by PAMELA, Fermi and HESS. I will also show that, on the contrary, the DM intrinsic degree of anisotropy in the arrival directions of high energy CR electrons and positrons does not suffer from these unknowns and can therefore be used as a tool to distinguish Dark Matter from astrophysical contributions to the electron and positron Cosmic Ray fluxes.

17:10 **Galactic synchrotron emission from astrophysical electrons (15+5′)**

Roberto Alfredo Lineros Rodriguez (IFIC, U. Valencia/CSIC)

The interaction between the galactic magnetic field and the non-thermal population of electrons is responsible for a large part of the radio sky from 10 MHz up to several GHz. This population is mostly composed of electrons with primary and secondary origin. Cosmic ray propagation models describe their evolution in space and energy, and allow to study the impact on the radio sky in intensity and morphology at different frequencies. We consider different propagation models and test their compatibility with available radio maps. We find models highly consistent with B/C data, the local electron flux and synchrotron emission observations. The resulting constraints on propagation models would significantly improve indirect dark matter searches in these channels and in antiprotons.

17:30 **Dark matter synchrotron emission and radio observations (15+5′)**

Marco Taoso (IFIC Valencia)

We compute the synchrotron emission induced by electrons produced by DM annihilations in galactic and extragalactic DM halos. The signal is compared with observations in a large range of frequencies, ranging from tens of MHz up to few hundreds of GHz. We set constraints on the DM mass and annihilation cross-section and highlight the impact of astrophysical uncertainties.

17:50 **Antiproton constraints on light dark matter candidates (15+5′)**

Julien Lavalle (IFT-Madrid, UAM/CSIC)

I will discuss the cosmic-ray antiproton constraints on light dark matter candidates, showing that they can be very strong if dark matter annihilates into quarks or into singlet-like (pseudo-)scalar particles.

18:10 **Electroweak lights from DM annihilations (15+5′)**

Andrea De Simone (EPFL)

The energy spectra of Standard Model particles originated from dark matter annihilations can be significantly altered by the inclusion of electroweak gauge boson radiation from the final state. A situation where this effect is particularly important is when a Majorana dark matter particle annihilates into two light fermions. This process is in p-wave and hence suppressed by the small value of the relative velocity of the annihilating particles. The inclusion of electroweak radiation eludes this suppression and opens up a potentially sizeable s-wave contribution to the annihilation cross section. I will describe this effect in detail and discuss its impact on the fluxes of stable particles resulting from the dark matter annihilations, which are relevant for dark matter indirect searches. I will also comment on the effective field theory approach, pointing out that the opening of the s-wave is missed at the level of dimension-six operators and only encoded by higher orders.

Wed **Dark Matter W5**
Direct detection with bolometers

Room: Festsaal Chair: Laura Baudis

14:30 **Background discrimination in new iZIP detectors at SuperCDMS (12+3′)**

Silvia Scorza (Southern Methodist University)

The SuperCDMS is a direct dark matter search experiment in the Soudan Underground Laboratory (Minnesota, USA). Cryogenic germanium detectors are used to identify eventual rare nuclear recoils induced by elastic scattering of WIMPs from our Galactic halo. The detectors measure phonon and ionization signals, simultaneously allowing an event by event discrimination between the electronic recoils, tracers of electromagnetic background, and the nuclear ones originated by neutrons and WIMPs.To further increase the discrimination background power, novel detectors with a special interleaved electrode scheme have been tested and installed. I will present the background rejection performances achieved, giving the resulting improvement in the sensitivity of the experiment for spin-independent WIMPs.

14:45 **Backgrounds of the EDELWEISS-II dark matter experiment (12+3′)**

Pia Loaiza (Laboratoire Souterrain de Modane)

The EDELWEISS-II dark matter experiment searches for WIMP interactions using cryogenic germanium detectors. The potential sources of background in the WIMP search region has been investigated using calibration data, measured background outside the nuclear-recoil band and Monte Carlo simulations. Three potential sources were considered: gamma-rays, surface events and neutron scattering. We present the studies leading to the background estimates for the WIMP search using a 4 kg array of Ge detectors with interleaved electrodes, with emphasis on surface events and gamma rays

15:00 **Neutron background simulation for the CRESST-II experiment (12+3′)**

Stephan Scholl (Kepler Center for Astro and Particle Physics, Physikalisches Institut der Universität Tübingen)

Neutron induced nuclear recoils provide an important background for all direct dark matter searches. If events are observed experimentally in the region of interest, the question arises if these can be explained by neutrons. The results of a GEANT4 simulation of the known neutron sources for the CRESST-II experiment are presented in this work. Apart from the experimental total rate of nuclear recoils, two independent checks with the predicted results from the simulation are made: The multi-detector module approach of the CRESST-II experiment allows the comparison of the observed multiplicities of detector hit events to the simulated ones. Additionally, the agreement of distribution of events in the plane of deposited energy and light yield to simulated results is tested.

15:15 **Scintillating bolometers for fast neutron spectroscopy in rare events searches (12+3′)**

Maria Martinez (IAS Orsay)

Neutrons are a relevant background in rare events physics. Detectors based on fast neutron-induced nuclear reactions are commonly used for fast neutron spectroscopy. In this subject, scintillating bolometers provide an excellent energy resolution and particle discrimination by the simultaneous measurement of the heat and emitted light. Our group has constructed several ^{6}Li and ^{10}B based massive scintillating bolometers [LiF, $Li_6Eu(BO_3)_3$, $Li_6Gd(BO_3)_3$], with energy resolutions ranging from 16 to 200 keV. First results of a 32 g ^{6}LiF scintillating bolometer enriched at 95% in ^{6}Li operated at 20 mK are presented. The use of this material in a multi-target cryogenic dark matter experiment, like EURECA, would allow monitoring the neutron flux incident in the detector during the data-taking.

15:30 **Dark matter search with 1 ton of cryogenic detectors: EURECA (12+3′)**

Gilles Gerbier (CEA Saclay - IRFU/SPP)

EURECA (European Underground Rare Event Calorimeter Array) is the European tonne-scale, cryogenic dark matter search project. It is based on cryogenic technology with powerful event type recognition through phonon-ionisation (EDELWEISS) and phonon-scintillation (CRESST/ROSEBUD) detection. The aim is to explore scalar cross sections down to the 10^{-46} cm^2 region. A major advantage of EURECA is its multi-element dark matter target, a key component for WIMP identification. We report on the current status of the design of the experiment, its future prospects and the collaborative work with a similar project in the US led by the SuperCDMS collaboration.

15:45 **Measurements of muon-induced neutrons in the LSM underground laboratory (12+3′)**

Klaus Eitel (Karlsruhe Institute of Technology)

Muon-induced neutron background is a prime factor potentially limiting the sensitivity of rare event searches, especially Dark Matter experiments. Despite its importance there is yet a rather limited data base on neutron yields per incident muon as a function of the overburden in underground labs. The EDELWEISS experiment in the LSM lab at 4800 mwe overburden consists of an array of Ge bolometers surrounded by 100 m^2 of modular plastic scintillator with an additional 1-ton Gd-loaded liquid scintillator for moderating and capturing neutrons. This setup allows to unambiguously identify muon-induced neutrons in situ of a Dark Matter experiment. We present results based on data collected over more than 2 years. Implications for EDELWEISS and the planned EURECA project will be discussed.

Wed **Dark Matter W6**
Direct Detection: Bubbles, NaI and CsI

Room: Festsaal Chair: Josef Jochum

16:50 **Recent results from the SIMPLE dark matter search (12+3′)**

Miguel Felizardo da Costa (Instituto Tecnológico e Nuclear)

We present the results of the recent Phase II SIMPLE search effort, comprising two stages each of ∼14 kg d exposure of 15 Superheated Droplet Detectors with ∼0.2 kg active mass and recoil energy threshold of 8 keV. In the second stage, the neutron shielding was increased to reduce the on-detector rate to ∼0.25 evt/kg d. Combined with an improved nucleation efficiency and analysis of the detector pressure evolution during the measurements, the results yield improved results in the phase space of both spin dependent and spin independent WIMP interactions.

17:05 **Searching for dark matter with COUPP (12+3′)**

Hugh Lippincott (Fermilab)

COUPP is an experimental campaign with the goal of detecting dark matter in the form of Weakly Interacting Massive Particles (WIMPs) using continuously sensitive bubble chambers, operated under mildly superheated conditions. Recoils of dark matter particles off the target nuclei in the chamber would produce single, isolated bubbles, which are detectable both optically and acoustically. Under normal operating conditions, the detector has an energy threshold for nuclear recoils of approximately 10 keV but is insensitive to electron recoils, which typically constitute the background in dark matter searches. Nuclear recoils can be discriminated from alpha decays in the target liquid with the acoustic signal produced by the bubbles, which show excess power at high frequencies for alpha events.

17:20 **Spin-dependent dark matter searches with PICASSO (12+3′)**

Viktor Zacek (Université de Montréal)

PICASSO at SNOLAB searches for spin-dependent WIMP interactions on 19-F using the superheated droplet technique. This technique is based on the bubble chamber principle, where phase transitions in superheated liquids can be triggered by WIMP induced nuclear recoils. The physics of the detection process allows a highly efficient suppression of backgrounds from cosmic muons, gamma- and beta-rays. In this talk we will discuss recent progress in PICASSO and its present sensitivity for spin-dependent WIMP searches. We will also describe an important new background suppression mechanism, which allows also a powerful discrimination of alpha particle induced events. Finally we will discuss future, larger scale applications of this technique at the scale of 100 kg and more.

Recent result from KIMS (12+3′) *17:35*

Sun Kee Kim (Seoul National University)

The KIMS collaboration has carried out an experimental search for Weakly Interacting Massive Parricle using CsI(Tl) crystal detectors at Yangyang underground laboratory. We present recent KIMS result with 100 kg CsI(Tl) crystal array.

Update on the ANAIS experiment and first results at the new Canfranc Underground Laboratory Facilities with the ANAIS-0 prototype (12+3′) *17:50*

Clara Cuesta (University of Zaragoza)

ANAIS (Annual modulation with NaI Scintillators) is a project aiming to set up, at the new facilities of the Canfranc Underground Laboratory a large scale NaI(Tl) experiment to explore the DAMA/LIBRA annual modulation positive result using the same target and technique. For this purpose, new ultrapure NaI(Tl) detectors are being developed: NaI powder is being purified in order to reduce K-40 bulk content and Ultra Low Background photomultipliers are being tested. In the meanwhile, a 9.6 kg NaI(Tl) crystal (ANAIS 0 prototype) has been installed at the new LSC facilities. The background model at low and high energy for this prototype will be presented and compared to the available experimental data. Different event populations contributing to the low energy spectrum will be analysed.

DM-Ice: A direct detection experiment for dark matter at the South Pole (12+3′) *18:05*

Reina Maruyama (University of Wisconsin)

DM-Ice, a direct detection dark matter experiment to be deployed at the South Pole, will be described. This experiment will use roughly 250 kg of low-background NaI detectors to search for the DAMA/LIBRA annual modulation in the southern hemisphere where many of the environmental backgrounds associated with seasonal variations present in experiments in the northern hemisphere are either reversed in phase or absent altogether. A 15-kg prototype was deployed in December 2010 at the South Pole at the depth of ∼2200 m.w.e. as a feasibility study: it is now taking data. I will report on the status of the prototype and the plans for the full-scale experiment.

Technical aspects in dark matter investigations (12+3′) *18:20*

Riccardo Cerulli (INFN-LNGS)

Some technical aspects in Dark Matter investigations will be discussed both on the experimental and the theoretical sides. Some implications will be presented.

Thu **Dark Matter W7**
Model building; Collider searches

Room: Festsaal Chair: Nicolao Fornengo

14:30 **Light neutralino in the MSSM: A playground for dark matter, flavor physics and collider experiments (15+5′)**

Toshihiko Ota (Max-Planck-Institut für Physik)

We investigate the constraints to the light neutralino dark matter scenario in the minimal supersymmetric standard model from available experimental observations such as decays of B and K meson, relic dark matter abundance, and the search for neutralino and Higgs production at colliders. We find that two regions of the MSSM parameter space fulfill all the constraints: a fine-tuned strip with large tan beta where the lightest neutralino can be as light as 8 GeV, and a low tan beta region providing a neutralino mass larger than 16 GeV. The large tan beta strip, which can be compatible with recently reported signals from direct detection experiments, can be fully tested by some low-energy observables and Higgs bosons searches at the LHC within the upcoming months.

14:50 **Combined LEP/Tevatron/XENON100 analysis to determine the nature of DM (15+5′)**

Yann Mambrini (LPT Orsay, Universite Paris XI)

We will present how one can exclude light leptophylic (hadrophobic) and heavy hadrophylic (leptophobic) dark matter by combining the recent Tevatron/LEP and XENON analysis.

15:10 **keV sterile neutrino dark matter and neutrino model building (15+5′)**

Alexander Merle (Royal Institute of Technology (KTH))

When thinking about dark matter, one always has the typical WIMP with a mass of a few 100 GeV in mind. In this talk, we will argue that another valid possibility is to have sterile neutrinos at the keV scale ("warm dark matter"), which can yield the correct dark matter abundance when, e.g., produced non-thermally. The crucial advantage of this framework is that we need some type of right-handed neutrino to explain neutrino masses, which suggests an interesting connection of the Dark Matter problem to particle physics model building. We will explain these connections and present the most interesting models on the market.

15:30 **Direct detection of hot dark matter including light sterile neutrinos (15+5′)**

Zhi-zhong Xing (Institute of High Energy Physics)

The relic neutrinos of the big bang, whose masses lie in the sub-eV range, may constitute hot dark matter in the Universe. Although their temperature is extremely low today, they can be detected by means of the thresholdless reaction $\nu_e + {}^3\mathrm{H} \to {}^3\mathrm{He} + e$. If sub-eV sterile neutrinos exist, they can also leave a distinct imprint on the electron energy spectrum in this capture process. We examine possible signals of hot active and sterile neutrino dark matter against the corresponding beta-decay background. We also look at the possibility of capturing hot antineutrino dark matter on EC-decaying ^{163}Ho nuclei in a calorimetric experiment. This kind of direct detection of hot dark matter might be feasible in the future. [Y. F. Li and Z.-Z. Xing, Phys. Lett. B **692** (2010) 261; **698** (2011) 430]

15:50 **Accurate estimate of the relic density and the kinetic decoupling in non-thermal dark matter models (15+5′)**

Giorgio Arcadi (S.I.S.S.A.)

We reconsider non thermal dark matter production mechanisms in a systematic way, focusing on scenarios with long-lived states decaying into DM. We analyze the connection of these scenarios with anomalies in cosmic rays detected by Pamela and Fermi and then, concentrating on Supersymmetry, we study the impact of non-thermal production into LHC phenomenology. We finally examine a rather predictive model, the G2-MSSM, also relaxing some of the standard assumptions usually implemented in the solution of the Boltzmann equation for the dark matter component. As a byproduct we develop here a formalism to compute the kinetic decoupling temperature in case of coannihilating particles, which can be applied also to other particle physics frameworks, also within standard cosmological scenarios.

Thu **Dark Matter W8**
Direct detection: Liquid noble gases

Room: Festsaal Chair: Gilles Gerbier

16:50 **The XMASS 800kg experiment (12+3′)**

Jing Liu (Institute for the Physics and Mathematics of the Universe, University of Tokyo)

The XMASS 800 kg detector, aiming primarily at direct dark matter search, is currently under commissioning at the Kamioka Underground Observatory, Japan. The construction and performance of the detector are briefly reviewed.

17:05 **Dark matter search at SNOLAB with DEAP-3600 (12+3′)**

Mark Boulay (Queen's University)

The DEAP-3600 experiment will search for dark matter particle interactions on liquid argon at SNOLAB, located 2 km underground in Sudbury, Canada. The detector is currently under construction, and will contain a 3600 kg liquid argon target in an acrylic sphere surrounded by photomultiplier tubes for detection of scintillation light, with a target sensitivity to spin-independent scattering on nucleons of 10^{-46} cm^2. Significant background reduction studies, including pulse-shape discrimination of beta/gamma events, and studies of radon and surface contamination reduction have been carried out with a prototype liquid argon detector at SNOLAB. The status of the experiment and of background reduction studies will be presented.

17:20 **Status of the LUX dark matter search (12+3′)**

Carter Hall (University of Maryland)

At 350 kg of target material, the LUX experiment is expected to be one of the most sensitive dark matter searches ever performed. LUX is a dual-phase liquid xenon TPC, and it is designed to detect WIMP dark matter through its interactions with the atomic nuclei in the sensitive volume. Radioactive backgrounds are suppressed by passive and active shielding, by nuclear recoil discrimination, and by a careful materials screening program. LUX is currently being commissioned in a surface facility at the Sanford Lab in Lead, South Dakota (formerly the Homestake mine), and it is on track to be installed underground in December of 2011. We review here the construction of the detector, the current status of the commissioning operations, and the projected sensitivity and of the final experiment.

17:35 **Recent progress from the MiniCLEAN dark matter experiment (12+3′)**

Jocelyn Monroe (MIT)

The MiniCLEAN dark matter direct detection experiment is a single-phase liquid argon detector, instrumented with photomultiplier tubes to observe scintillation light from a 150 kg fiducial mass. This detector design strategy emphasizes scalability to target masses of order 10 tons or more. The projected light yield is > 5 photo-electrons per keV, which allows pulse shape discrimination to separate the electron background from a WIMP-induced nuclear recoil signal. MiniCLEAN is also designed for a liquid neon target which, in the event of a positive signal in argon, will enable an independent verification of backgrounds and provide a unique test of the expected A2 dependence of the WIMP interaction rate. This talk will review the experimental technique and current status of MiniCLEAN.

17:50 **Measurements of the low-energy response of liquid xenon (12+3′)**

Aaron Manalaysay (University of Zurich)

The field of dark matter detection has seen important contributions in recent years from experiments using liquid xenon. These searches usually focus on detecting an excess rate of nuclear recoils, as generic expectations about WIMP properties predict these as their dominant interaction mode. However, signals from electronic recoils can also be considered for an examination if one is to perform a fully model-independent search, as has been emphasized by the DAMA collaboration. Liquid xenon is expected to have sensitivity for electronic recoils down to sub-keV energies, but no calibration has been made for energies below 9.4 keV. I present a recent calibration of a small liquid xenon chamber using low-angle Compton scatters at energies never before calibrated, and discuss results.

18:05 **Study of nuclear recoils in liquid argon (12+3′)**

Christian Regenfus (University of Zürich/CERN)

In the framework of direct dark matter detection with cryogenic liquid argon targets we are setting up a neutron scattering experiment in our laboratory at CERN. Monoenergetic neutrons from dd-fusion are collimated onto a small liquid argon cell and tagged by organic scintillators. Presently the cell is operated in single-phase mode (zero electric field) to study scintillation yields of nuclear recoils as well as light pulse shapes. At a later stage we plan to add an electric field and to extract the ionisation charge (dual phase) to determine field and energy dependences in liquid argon of both, the light and the charge yields, at working points relevant for dark matter searches. The experimental setup and first results will be presented and discussed.

18:20 **DARWIN: dark matter WIMP search with noble liquids (12+3′)**

Laura Baudis (University of Zurich)

DARWIN (DARk matter WImp search with Noble liquids) is a design study towards the realization of a ton to multi-ton scale dark matter facility in Europe, based on the liquid argon and liquid xenon time projection chamber technique. Approved by ASPERA in late 2009, DARWIN brings together several European and US groups working on the existing XENON, WARP and ArDM experiments with the goal of providing a technical design report for the realization of the facility in three years from now. I will present the status and goals of DARWIN, as well as initial results from R&D studies.

Cosmology

Convened by
- Jochen Weller (Ludwig-Maximilians-Universität München)
- Steen Hannestad (University of Aarhus)

Mon Cosmology W1

Room: Clubraum 3 Chair: Yvonne Wong

16:50 Constraints on small-scale cosmological perturbations from gamma-ray searches for dark matter (15+5′)

Pat Scott (McGill University)

Events like inflation can produce large density perturbations on very small scales in the Early Universe. Probes of small scales are therefore useful for discriminating between inflationary models. The only such constraint presently comes from non-observation of primordial black holes (PBHs), associated with the largest perturbations. Moderate-amplitude perturbations can collapse shortly after equality to form ultracompact minihalos (UCMHs) of dark matter, in far greater abundance than PBHs. If dark matter self-annihilates, UCMHs become excellent targets for indirect detection. I will describe the gamma-ray fluxes expected from UCMHs, the prospect of observing them with gamma-ray telescopes, and limits upon the primordial power spectrum derived from their non-observation by Fermi.

17:10 Cosmological constraints on the number of neutrino species (15+5′)

Jan Hamann (Aarhus University)

The presence of light particles beyond the standard model's three neutrino species can profoundly impact the physics of decoupling and primordial nucleosynthesis. I will review the observational signatures of extra light species, present constraints from recent data, and discuss the implications of possible sterile neutrinos with O(eV)-masses for cosmology.

17:30 Constraining the cosmic radiation density due to lepton number with BBN (15+5′)

Sergio Pastor (IFIC Valencia)

We have determined the BBN constraints on primordial neutrino-antineutrino asymmetries, with a careful treatment of the dynamics of flavor neutrino oscillations, collisions and pair processes. The allowed regions on both the total neutrino asymmetry and the electron neutrino asymmetry at the onset of BBN are obtained taking into account the time evolution of neutrino distributions and the most recent determinations of primordial ^{4}He mass fraction and ^{2}H/H density ratio, which plays a relevant role. These bounds fix the maximum contribution of neutrinos with primordial asymmetries to the radiation content of the universe (to be measured by the Planck satellite) as a function of the mixing parameter θ_{13}, with a global upper bound $N_{\rm eff} < 3.4$. [Analysis published in JCAP **03** (2011) 035]

17:50 Estimating the tensor-to-scalar ratio and the effect of residual foreground contamination (15+5′)

Yabebal Fantaye (SISSA)

We consider cosmic microwave background suborbital experiments designed to search for inflationary gravitational waves, and investigate the impact of residual foregrounds that remain in the final estimated maps. We characterize the error covariance due to subtracted foregrounds, and find it to be subdominant compared to instrumental noise and sample variance in our simulated data analysis. We model the unsubtracted residual foreground using a two-parameter power law model and show that marginalization over these parameters is effective in eliminating a bias due to excess foreground power at low ℓ. We conclude that, at least in the suborbital experimental setups we have simulated, foreground errors are not the main treat for these experiments to reach their target sensitivity.

18:10 Foreground fNL (15+5′)

Alessandro Renzi (SISSA)

We study the astrophysical foreground emissions in the context of the effort for constraining the Cosmic Microwave Background (CMB) anisotropy non-Gaussianity (NG). We parametrize the NG signal by an equivalent fNL evaluated through the Komatsu-Spergel-Wandelt (KSW, `arXiv:astro-ph/0305189`) estimator and induced by the known Galactic and extra-Galactic foreground emissions. We conduct our study in the harmonic as well as space domains, by selecting suitable intervals of angular scales and emission intensities. We investigate the effect of spatially varying spectral indices of the Galactic emissions. Finally, focusing on the diffuse Galactic emissions, we construct masks where the available sky area is characterized by a foreground induced spurious NG signal which is not cosmologically relevant.

Tue Cosmology W2

Room: Clubraum 3 Chair: Steen Hannestad

16:50 Results from optical followup program of SPT clusters (15+5′)

Shantanu Desai (Exc. Cluster Universe/LMU München)

The South Pole Telescope (SPT) is a 10m mm wave telescope located at the South Pole and is expected to complete a 3-band survey of 2500 sq. deg by end of 2011. The main goal of this survey is to detect galaxy clusters using Sunyaev-Zeldovich effect and use these clusters for a variety of cosmological studies such as dark energy equation of state, primordial non-gaussianity and since 2005 we have initiated an optical and near-IR followup progam to image high significance SPT clusters to measure the photometric redshift and estimate the false contamination rate of clusters. We will present details of this optical followup campaign and highlight some important implications of these observations for fundamental physics.

17:10 Status and perspectives of the CAST experiment (15+5′)

Biljana Lakic (Rudjer Boskovic Institute)

CERN Axion Solar Telescope (CAST) is currently the most sensitive axion helioscope designed to search for axions produced by the Primakoff process in the solar core. CAST is using a Large Hadron Collider (LHC) test magnet where axions could be converted into X-rays with energies up to 10 keV. During the phase I, the experiment operated with vacuum inside the magnet bores and covered axion masses up to 0.02 eV. In the phase II, the magnet bores are filled with a buffer gas (first ^{4}He and later ^{3}He) at various densities in order to extend the sensitivity to higher axion masses (up to $\sim$1 eV). So far, no evidence of axion signal has been found and CAST set the most restrictive experimental limit on the axion-photon coupling constant over a broad range of axion masses. The latest CAST results with ^{3}He data and future plans will be presented.

17:30 Cosmological constraints on thermal relic axions and axion-like particles (15+5′)

Davide Cadamuro (MPI für Physik)

Cosmological precision data can be used to set very strict constraints on Axions and Axion-like particles produced thermally in the big bang. We briefly review the known bounds and propose two new constraints for Axions and ALPs decaying in the early universe, based upon the concomitant dilution of baryon and neutrino densities, using WMAP7 and other cosmological data.

17:50 First second of lepton asymmetries (15+5′)

Maik Stuke (University of Bielefeld)

We study the influence of lepton asymmetries l on the evolution of the early Universe. l is poorly constrained by observations and might be orders of magnitudes larger than the observed baryon asymmetry. We find that large lepton asymmetries can influence the dynamics of the QCD phase transition significantly. The cosmic trajectory in the μ_B–T–phase diagram of strongly interacting matter becomes a function of l. The latter might trigger the order of the cosmic transition. Furthermore a large lepton flavour asymmetry changes the number of helicity degrees of freedom of all particles in equilibrium g_* significantly and thus changes the relic abundance of a given WIMP candidate.

18:10 Effect of massive neutrinos in the nonlinear regime (15+5′)

Daniel Boriero (UNICAMP / RWTH Aachen)

The distribution of matter in small scales, subject to nonlinear effects, will be much better known in the next few years through upcoming surveys. To accomplish the measurement of parameters such as the neutrino mass the theoretical preciseness must evolve accordingly. We present some improvements in theoretical prediction for the matter power spectrum taking in account the effect of massive neutrinos in the nonlinear regime. The method used was a modified version of Halofit calibrated over NBody simulation with massive neutrinos. The results so far differ a great deal from the linear regime and slightly from previous calibration of Halofit.

Wed Cosmology W3

Room: Clubraum 3 Chair: Jochen Weller

16:50 Dark energy physics expectations at DES (15+5′)

Marcelle Soares-Santos (Fermi National Accelerator Lab.)

Giving rise to a new and exciting research field, observations of the last ten years established dark energy as a component of unknown nature responsible for the accelerated expansion of the Universe. A powerful experimental approach to this problem is the study of complementary cosmological probes in large optical galaxy surveys. For such a study, the Sloan Digital Sky Survey (SDSS) is the state of the art data set to be surpassed only by the next generation of experiments such as the upcoming Dark Energy Survey (DES). In this talk we review the four fundamental probes to be explored by DES – galaxy clusters, weak lensing, large scale structure and supernova – and report on the status of the experiment which will be commissioned in the Fall of 2011.

17:10 Reconstructing the equation of state and density parameter for dark energy from combined analysis of recent SNe Ia, OHD and BAO data (15+5′)

Debasish Majumdar (Saha Inst. of Nuclear Physics, Kolkata)

We adopt a model independent method to reconstruct the dark energy equation of state by analyzing 5 sets of SNe Ia data along with Baryon Acoustic Oscillation (BAO) and Observational Hubble Data (OHD). The SNe Ia data sets include the most recent UNION2 data and other data compilations from the year 2007 to the present. We assume a closed form parametrization of the luminosity distance in terms of redshift and perform a χ^2 analysis of the observational data. The matter density at the present epoch Ω_m^0 is also taken to be a parameter in the analysis and its best-fit values are obtained for each of the data sets. We found a strong dependence of dark energy equation of state on the matter density in the present and earlier epoch. From the analysis, we also predict the lower limit of matter density parameter at an earlier epoch within 1σ confidence level for a flat FRW universe. The dark energy equation of state appears to be a slow varying function of z. The variation of dark energy density parameter and the matter density parameter are also shown along with their 1σ variations.

17:30 21 cm cosmology and dark energy (15+5′)

Reza Ansari (LAL – Univ. Paris Sud)

3D mapping of matter distribution in the universe through the 21 cm radio emission of atomic hydrogen is a complementary approach to optical surveys for the study of the Large Scale Structures, in particular for measuring the BAO (Baryon Acoustic Oscillation) scale up to redshifts z=3 and constrain dark energy. We propose an instrument to carry such a survey through intensity mapping, without detecting individual galaxies. An R&D effort (electronics, antenna/feeds, software, ...), initiated in 2007, is being carried by an international team (France, USA, Canada, China), to design a multi-beam (100–1000 beams), large field of view (10–100 sq. deg) and large bandwidth (100 MHz) instrument suited for 21 cm intensity mapping at $z = 1$ (`http://bao.lal.in2p3.fr/21cm/`).

17:50 Coupled quintessence through dark energy density (15+5′)

Laura Lopez Honorez (Université Libre de Bruxelles)

I will present a coupled quintessence model in which the interaction with the dark matter sector depends on some power of the dark energy density. Such a coupling can naturally arise from a field dependent mass term for the dark matter field. I will show in which cases the dynamical analysis of this system possesses a late time accelerated attractor and present the results of a fit to Supernovae Ia, Cosmic Microwave Background and Baryon Acoustic Oscillation data sets. Constraints arising from weak equivalence principle violation arguments will also be discussed. [`arXiv:1009.5263`]

18:10 Measuring dark energy parameters and choosing theoretical models (15+5′)

Sidney Bludman (Universidad de Chile)

All recent supernova, CMB, baryon acoustic oscillation, galaxy clustering and gravitational weak lensing observations of the cosmological expansion are consistent with a static fine-tuned cosmological constant Λ, but also may admit a dynamic mechanism, either material Dark Energy or low-curvature modifications of Einstein gravity (Dark Gravity). Trying to interpret the cosmological constant as material vacuum energy leads inevitably to the Cosmological Constant Problem: Why is it so tiny compared with observed material vacuum energy fluctuations? This problem is avoided if Λ is interpreted as a classical fine-tuned intrinsic curvature of space-time. Cosmological Coincidence remains: Why do we live at such a late time that material energy density has diluted down to $\sim \Lambda/2$?

Double Beta Decay and Neutrino Mass

Convened by
- Martin Hirsch (IFIC/CSIC – University of Valencia)
- Andrea Giuliani (CNRS Orsay)

Mon Double Beta Decay and Neutrino Mass W1

Room: Clubraum 1 Chair: Giorgio Gratta

14:30 **Results of the NEMO-3 experiment (15+5′)**

Laurent Simard (LAL, Université Paris-Sud 11)

The NEMO-3 detector searches for the neutrinoless double beta; the observation of this process, beyond the Standard Model, would prove that the neutrino is a Majorana particle. The NEMO-3 detector is a tracko-calo low-background detector: electron trajectories are reconstructed, then their energies are arrival times are measured. It has taken data between 2003 and 2011. Preliminary results for the neutrinoless double beta decay of ^{82}Se and ^{100}Mo will be given. Results concerning the allowed process in the standard model, which is the double beta decay with 2-neutrino emission, will also be given for the different isotopes (^{100}Mo, ^{82}Se, ^{130}Te, ^{116}Cd, ^{96}Zr, ^{150}Nd, ^{48}Ca).

14:50 **CUORICINO: Final results (15+5′)**

Sergio Di Domizio (Università and INFN Genova)

CUORICINO, the predecessor experiment of CUORE, was operated in Gran Sasso National Laboratories in Italy and demonstrated the CUORE feasibility. The CUORICINO detector was an array of large cubic TeO_2 crystals summing up to the total mass of 40 kg. CUORICINO stopped the data taking in middle 2008. In this talk we will present the Cuoricino detector performances and experimental final results in DBD, on ground and excited states of Te-130 and on Te-120, together with the total data analysis that is of fundamental interest in the prediction of the expected CUORE-0 and CUORE background.

15:10 **Project 8: Measuring neutrino masses using radio-frequency techniques (15+5′)**

Joseph Formaggio (Massachusetts Institute of Technology)

Although the neutrino mass affects the spectral shape of tritium beta decay electrons, no experiment has yet observed this distortion. The Project 8 Experiment proposes to measure that spectral distortion in a novel way: through coherent cyclotron emission of the beta electrons confined in a magnetic field. The relativistic frequency shift of emitted radiation depends on the total energy of the electron and may provide greater resolution than other techniques. This presentation covers the status of a prototype to demonstrate single-electron detection at energies near the tritium endpoint, 18.6 keV, through cyclotron emission. Results from the prototype experiment are expected to be of value in estimating the scale and sensitivity of a neutrino mass experiment based on this technique.

15:30 **The MAJORANA DEMONSTRATOR: A search for neutrinoless double-beta decay of Germanium 76 (15+5′)**

John Wilkerson (University of North Carolina)

The observation of neutrinoless double-beta decay would show that neutrinos are Majorana particles and provide information on the absolute scale of neutrino mass. Attaining sensitivities for neutrino masses in the inverted hierarchy region requires large, tonne scale detectors with extremely low backgrounds, $\lesssim 10^{-4}$ counts/(keV kg yr) in the region of interest. The MAJORANA collaboration is constructing the DEMONSTRATOR to show the feasibility for a future tonne scale experiment. It consists of 40 kg of p-type point contact germanium detectors, at least half of which will be enriched to 86% in ^{76}Ge that are placed into two Cu cryostats fabricated out of ultra-low activity Cu that has been electroformed underground. The cryostats will be surrounded by a graded compact shield.

15:50 **Status report of the GERDA experiment (15+5′)**

Carla Maria Cattadori (INFN)

The GERDA experiment, designed to search for neutrinoless double beta decay of Ge-76, started the technical runs in 2010, with a pilot string of 3 non-enriched Ge detector. In this talk we will report the results on background characterization, from the first year of data taking, as well as the forthcoming phase I physics program which foresee the deployment of the enriched germanium detectors. Finally, the status of the GERDA phase II preparation, and of the related R&D will be summarized.

Tue Double Beta Decay and Neutrino Mass W2

Room: Clubraum 1 Chair: Stefan Schönert

14:30 **LUCIFER: A scintillating bolometer array for the search of neutrinoless double beta decay (15+5′)**

Laura Cardani (Università Roma “la Sapienza”)

Neutrinoless Double Beta Decay (0νDBD) is the most promising process to understand the nature of the neutrino (Dirac or Majorana). The goal of the LUCIFER project, financed by a ERC-AdG, is the study of the ^{82}Se 0νDBD through an array of ZnSe scintillating bolometers. A high sensitivity on this rare decay will be achieved through the simultaneous read-out of the heat and light signals. This will provide a background discrimination, and it will allow to reach a level of $<$0.001 counts/kg/keV/year. In addition, a large source mass will be achieved through the enrichment of Se into ^{82}Se. The feasibility of the isotopic enrichment as well as the growth of radio-pure ZnSe crystals will be discussed in this talk. The recent results of the R&D on ZnSe crystals will also be presented.

14:50 **SuperNEMO double beta decay experiment (15+5′)**

Alexander Barabash (Inst. of Theor. and Exp. Physics)

Main objective of SuperNEMO experiment is search for neutrinoless double beta decay of ^{82}Se with sensitivity $\approx (1-2)\times 10^{26}$yr that corresponds to sensitivity to effective Majorana neutrino mass $\approx$ 0.05–0.1 eV. The detector will consist of 20 independent modules surrounded with passive shield and placed deeply underground (Frejus Underground Laboratory, 4800 mwe). In present time Collaboration has started creation of installation the Demonstrator which to be the first module of SuperNEMO and it is intended for studying and optimization of all characteristics of the detector. Besides, on installation the Demonstrator is supposed to investigate 7 kg of ^{82}Se with sensitivity 6.5×10^{24} yr ($\approx$ 0.2–0.6 eV). The present status of SuperNEMO program and plans for the future are discussed.

15:10 **Implications of finite one-loop corrections on see-saw neutrino masses (15+5′)**

Diego Aristizabal (Universite de Liege)

In the standard seesaw model, finite corrections to the neutrino mass matrix arise from one-loop self-energy diagrams mediated by a heavy neutrino. In this talk I will discuss the impact that these corrections may have on the different low-energy neutrino observables paying special attention to their dependence with the seesaw model parameters. It will be shown that sizable deviations from the tribimaximal mixing pattern can be obtained when these corrections are taken into account.

15:30 **Study of ^{48}Ca double beta decay by CANDLES (15+5′)**

Izumi Ogawa (University of Fukui)

CANDLES is the project to search for double beta decay (DBD) of ^{48}Ca by using CaF_2 scintillators. The Q-value of ^{48}Ca, which is the highest (4.27 MeV) among potential DBD nuclei, is far above energies of γ-rays from natural radioactivities (maximum 2.615 MeV from ^{208}Tl decay), therefore we can naturally expect small backgrounds in the energy region we are interested in. We have constructed the prototype detector, CANDLES III in our laboratory (Osaka U.) at sea level and studied the basic performance of the system, including the light collection, position reconstruction and background rejection. After R&D study we moved the detector system to new experimental room at Kamioka underground laboratory. Present status of the CANDLES III detector will be presented

15:50 **CUORE detector: An update (15+5′)**

Paolo Gorla (INFN – Roma Tor Vergata)

CUORE is a bolometric detector composed of 988 TeO_2 crystals, with a total mass of about 200 kg of Te-130, currently under construction at the Gran Sasso National Laboratories in Italy. It will probe the neutrinoless double beta decay (0nuDBD) of Te-130, a tool to test the neutrino nature and mass at the level relevant for exploring the inverted neutrino mass hierarchy. On the road towards CUORE, the first tower (CUORE-0) will be assembled and operated in near future. Detailed information on this detector and on the expected performance will be given. We will then discuss the status of the CUORE experiment, including a discussion of CUORE critical points, the recent R&D efforts and its sensitivity.

Double Beta Decay and Neutrino Mass W3 *Wed*

Room: Clubraum 1 Chair: Alexander Barabash

14:30 **Status of calculations of the nuclear matrix elements for double beta decay (15+5′)**

Vadim Rodin (Universität Tübingen)

The present status of calculations of the nuclear matrix elements for neutrinoless double beta decay is reviewed. Advantages and disadvantages of different nuclear structure models used for the calculations are discussed in detail. A proposal of a direct measurement of the Fermi matrix element for neutrinoless double beta decay is briefly presented.

14:50 **Nuclear matrix elements for double beta processes (15+5′)**

Jouni Suhonen (University of Jyväskylä)

Two-neutrino and neutrinoless double beta decays to ground states and various excited states (0^+, 2^+) are recently studied in the framework of a higher QRPA theory. Different characteristics of the ground-state and excited-state decays are analysed in terms of decompositions of the associated nuclear matrix elements (NMEs). Special interest is directed to seldom discussed nuclei for the double beta minus decays and to nuclei that are double positron/electron-capture candidates. The most intriguing resonant neutrinoless double electron capture is discussed for several potential cases. For the neutrinoless decays the short-range correlations and other relevant effects are included in the formalism. [Submitted to Nucl. Phys. A and Phys. Lett. B for publ.]

15:10 **Magnetic tracking detector DCBA/MTD for neutrinoless double beta decay experiments (15+5′)**

Nobuhiro Ishihara (KEK)

Magnetic tracking detector is in progress at KEK for neutrinoless double beta decay experiments. Drift Chamber Beta-ray Analyzer (DCBA) is an R&D program. A prototype called DCBA-T2 has been constructed and operated. The obtained energy resolution is about 150 keV (FWHM) at 980 keV. Its engineering run has been made with a source of natural Mo. So far we have obtained 20 candidates of two-neutrino double beta decay from Mo-100 of 0.036 mol, and 39 events of the decay from Bi-214 to Po-214. Another prototype DCBA-T3 is now under construction. Its energy resolution is expected to be less than 100 keV (FWHM). On the basis of DCBA-T2&T3, we have designed a future project temporarily called Magnetic Tracking Detector (MTD). One module of MTD will be able to accommodate decay source of 32 kg.

15:30 **Discovering neutrinoless double beta decay with NEXT100 detector (15+5′)**

Francesc Monrabal Capilla (IFIC)

NEXT is a neutrinoless double beta decay experiment, based on a 100 kg high pressure gas xenon. It is now completing the final stages of R&D and will start construction next year. We plan to start data taking at the Canfranc laboratory in 2014. NEXT proposes a novel detection technique called SOFT (Separated Optimized Function TPC).That concept optimizes the measurement of the topological signature of the event. This result in a powerful background rejection, which, combined with a carefully screened radiopure detector will allow NEXT to be competitive with existing proposals for next-generation neutrinoless double-beta decay experiments. First prototypes have been operating successfully in different laboratories giving first results on energy resolution. Results give a resolution of 1% @ Qbb.

15:50 **The Enriched Xenon Observatory (EXO) double beta decay experiment: Status and early results (15+5′)**

Phillip Barbeau (Stanford University)

The EXO experimental program is aimed at searching for neutrinoless double beta decay of Xe-136. Observation of this decay would establish the Majorana nature of the neutrino and set the absolute mass scale of neutrinos. The EXO-200 detector contains 200 kg of xenon enriched to 80% in Xe-136 in an ultra-low background TPC. The detector is currently operational at the WIPP site and was commissioned with natural xenon to study its performance; preparations for physics runs are underway. Preliminary results from the EXO-200 experiment will be presented and its science program illustrated. The collaboration is performing R&D to realize a background-free search for which the double beta decay daughter nucleus is also detected. The prospects for a ton scale experiment are also discussed.

Thu Double Beta Decay and Neutrino Mass W4

Room: Clubraum 1 Chair: Jouni Suhonen

14:30 **Relic antineutrino capture on ^{163}Ho decaying nuclei (15+5′)**

Marco Vignati (Sapienza, Università di Roma and INFN)

The electron capture decay of the isotope ^{163}Ho has been proposed since a long time as a candidate for measuring the electron neutrino mass and recently the interest on this idea has been renewed. We note that a direct observation of the cosmic antineutrino background could be made using a target made of this isotope. We further discuss the requirements for an experiment aiming to obtain this result.

14:50 **Low energy signatures of the TeV scale see-saw mechanism (15+5′)**

Emiliano Molinaro (CFTP – IST)

We study a type I see-saw scenario where the right-handed (RH) neutrinos, responsible for the light neutrino mass generation, lie at the electroweak scale. Under certain conditions, the strength of the charged and neutral current weak interactions of the Standard Model particles with the heavy RH neutrinos can be large enough to allow the production of the latter at the LHC. We show that all present experimental constraints on this scenario still allow (i) for an enhancement of the rate of neutrinoless double beta decay and and (ii) for the predicted mu to e+gamma decay rate to be within the sensitivity range of the MEG experiment.

15:10 **Recent progress of the COBRA experiment (15+5′)**

Christian Oldorf (Universität Hamburg)

The COBRA experiment uses CdZnTe semiconductor detectors to search for neutrinoless double beta decays. The main focus is on the isotope Cd-116, with a decay energy of 2809 keV well above the highest naturally occurring gamma lines. Also ^{130}Te and ^{106}Cd, a double β^+ emitter, are under investigation. An overview of the recent improvements of the COBRA low-background setup at the LNGS underground laboratory is given, including first results obtained with new FADC readout electronics which allows background reduction by pulse-shape analysis. Furthermore studies on detector characterization, the use of liquid scintillator for background suppression and Monte-Carlo simulations of the shielding are presented. Finally, concepts for a large-scale setup will be shown.

15:30 **Searches for neutrinoless resonant 2e captures at LNGS (15+5′)**

Vladimir Tretyak (Inst. for Nuclear Research, Kyiv, Ukraine)

Searches for neutrinoless resonant double electron captures ($0\nu 2e$) are considered now as possible alternative for $0\nu 2\beta^-$ decays in testing the non-zero Majorana neutrino mass. Series of experiments was performed at LNGS to search for $0\nu 2e$ processes in ^{96}Ru, ^{106}Cd, ^{136}Ce, ^{156}Dy, ^{180}W, ^{190}Pt by ultra-low background HP Ge gamma spectrometry, and with $ZnWO_4$ and enriched $^{106}CdWO_4$ crystal scintillators. New $T_{1/2}$ limits on these processes were established, many of them obtained at the first time or more stringent than those known previously. In particular, $T_{1/2}$ limits for ^{96}Ru are on the level of 10^{19} yr, and for ^{106}Cd on the level of 10^{20} yr.

15:50 **Neutrinoless double beta decay with SNO+ (15+5′)**

Jeffrey Hartnell (University of Sussex)

SNO+ will perform a sensitive search for neutrinoless double beta decay using 800 tons of Nd-doped liquid scintillator. Conversion of the SNO detector to SNO+ is proceeding well: a short light-water phase will begin next year followed by physics runs with scintillator in early 2013. Doping the LAB liquid scintillator at around 0.1% by mass with Nd allows a ton-scale experiment to be performed,

probing down to the 100 meV neutrino mass scale and beyond. The first phase will be with natural-Nd but enrichment for a second phase is a strong possibility.

Thu Double Beta Decay and Neutrino Mass W5

Room: Clubraum 1 Chair: Oliviero Cremonesi

16:50 **Experiment TGV-2: Search for double beta decay of ^{106}Cd (15+5′)**

Nikolay Rukhadze (Joint Institute for Nuclear Research)

Search for ECEC decay of ^{106}Cd was performed at LSM (France, 4800 mwe) using the spectrometer TGV-2. The basic detection cell is a sandwich-like pair of face-to-face planar type detectors (20.4 cm$^2\times$0.6 cm) with foils of enriched ^{106}Cd placed between them. The coincidences between two X-rays of Pd ($\sim$21 keV) detected in neighboring detectors were analyzed to search for 2ν ECEC decay of ^{106}Cd. A small increase in the number of X(Pd)-X(Pd) events above background was obtained in TGV-2 experiment lasted 12900 h. This may point to the presence of the 2ν ECEC decay of ^{106}Cd at the level of $T_{1/2} \approx 4.5 \times 10^{20}$ yr (at 77% CL). New limit (at 90% CL) on 0ν ECEC resonant decay of ^{106}Cd to 2741 keV excited state of ^{106}Pd, $T_{1/2} \geq 1.8 \times 10^{20}$ yr was obtained. A new measurement of ^{106}Cd is in preparation.

17:10 **Search for double beta decay of cadmium 106 by using isotopically enriched cadmium tungstate crystal scintillator (15+5′)**

Fedor Danevich (Inst. for Nuclear Research, Kyiv, Ukraine)

An experiment to search for double beta processes in ^{106}Cd was carried out over 6549 h in the DAMA R&D set-up at the Gran Sasso Laboratory with the help of enriched in 106-Cd (66%) cadmium tungstate ($^{106}CdWO_4$) crystal scintillator (mass 215 g). New limits on different modes and channels of double beta decay of ^{106}Cd have been established on the level of $10^{19}-10^{21}$yr. A possible resonant enhancement of the neutrinoless double electron capture is estimated in the framework of the QRPA approach. Sensitivity of the experiment can be improved by placing the $^{106}CdWO_4$ crystal scintillator inside the ultra-low background set-up with four 225cm^3 HP Ge detectors to use both coincidence and anti-coincidence information.

17:30 **Leptogenesis and neutrino phenomenology with $\mu\tau$ symmetric four zero Yukawa textures (15+5′)**

Probir Roy (Saha Institute of Nuclear Physics)

Allowed four zero neutrino Yukawa textures in a specified weak basis, combined with $\mu\tau$ symmetry and type-I seesaw, yield a highly constrained and predictive scheme. Oscillation data as well as the cosmological bound on the neutrino mass sum and the requirement of the generation of the right baryon asymmetry via leptogenesis severely restrict the parameter space of the scheme resulting in the prediction of neutrino masses and their Majorana phases within definite ranges. Interesting rates emerge for $0\nu\beta\beta$ decay and laboratory CP violation.

17:50 **AMoRE experiment: A search for neutrinoless double beta decay of ^{100}Mo isotope with $^{40}Ca^{100}MoO_4$ cryogenic scintillation detector (15+5′)**

Vasily Kornoukhov (ITEP)

AMoRE (Advanced Mo based Rare process Experiment) collaboration will use calcium molybdate crystals as cryogenic scintillation detector in a search for neutrinoless DBD of ^{100}Mo isotope. Two detection mechanisms, phonons and light, will be used for the active rejection of backgrounds. A FWHM resolution of 0.2% in the phonon channel has been achieved with a 0.5 cm^3 crystal. Several 0.55 kg $^{40}Ca^{100}MoO_4$ crystals have been produced from enriched ^{100}Mo and ^{48}Ca depleted materials. The light yield of these crystals has been shown to be comparable with reference $CaMoO_4$ scintillators for temperatures ranging down to 8 K. The content of dangerous radioisotopes in the crystals is under measurement. The projected sensitivity of the experiment for a 250 kg-years data-taking period is 3×10^{26} years.

18:10 **Status of the KamLAND-Zen experiment (15+5′)**

Alexandre Kozlov (Tokyo university, IPMU)

The talk will be focused on preparations towards the KamLAND-Zen experiment. KamLAND-Zen physics goals and future plans will be also discussed. Currently we hope to begin the double-beta decay experiment using Xenon-136 within the next several month. Work to load a liquid scintillator containing Xenon-136 into a small central balloon is scheduled to summer of 2011.

Neutrino Oscillations

Convened by
- Tobias Lachenmaier (Universität Tübingen)
- Fumihiko Suekane (Tohoku University)

Mon Neutrino Oscillations W1

Room: Clubraum 1 Chair: Karsten Heeger

16:50 **Status of the NOνA experiment (15+5′)**

Brian Rebel (Fermilab)

The long-baseline NOνA experiment is designed to observe appearance of electron neutrinos in a beam of muon neutrinos. If the mixing angle between the first and third neutrino mass eigenstates, θ_{13}, is large enough, NOνA will measure θ_{13} as well as the neutrino mass hierarchy. It will also provide information about the CP-violating phase, δ. This talk will outline the physics goals of the experiment and the current status of the design and construction of its near and far detectors. This talk will also present data from the prototype near detector (NDOS), located on the surface at Fermilab. The NDOS began data taking in 2010, and it observes an off-axis neutrino beam from the NuMI beamline and an on-axis neutrino beam from the Booster beam line.

17:10 **ICARUS and status of liquid argon technology (15+5′)**

Alessandro Menegolli (University and INFN of Pavia)

ICARUS T600 is the largest liquid Argon Time Projection Chamber (LAr TPC) detector ever built, consisting of about 600 tons of LAr mass. It operates underground at the LNGS laboratory in Gran Sasso. It has been smoothly running since summer 2010, collecting data with the CNGS beam and with cosmics. Liquid Argon TPCs are indeed "electronic bubble chambers", providing a completely uniform imaging calorimetry with unprecedented accuracy on such massive volumes. ICARUS T600 is internationally considered as a milestone towards the realization of the next generation of massive detectors ($\sim$ tens of ktons) for neutrino and rare event physics. Results will be presented on the data collected so far with the detector at LNGS.

17:30 **Neutrino oscillations, energy-momentum conservation and entanglement. (12+3′)**

Evgeny Akhmedov (MPI für Kernphysik, Heidelberg)

There is an intricate relationship between neutrino oscillations and energy-momentum conservation. On the one hand, conservation of energy and momentum is an exact law of nature; on the other hand, exact energy and momentum conservation in neutrino production and detection processes would apparently destroy coherence of the emitted or absorbed neutrino states and therefore wash out the oscillations. This dichotomy led to a significant confusion in the literature. I will discuss whether entanglement of neutrinos and recoil particles often invoked for "saving" the conservation laws in neutrino oscillations is indeed relevant to this process, as well as a number of other subtle issues related to conservation of energy and momentum in neutrino oscillations.

17:45 **Optimization of a low energy neutrino factory (12+3′)**

Srubabati Goswami (Physical Research Laboratory)

We discuss the optimization of the energy and baseline for a low energy neutrino factory, in order to determine the mass ordering, θ_{13}, CP violation, and the deviation of θ_{23} from maximality. While we perform a general scan over the baselines and parent muon energies, we specifically show a comparison between the baselines of 1300 km and 2540 km, which have recently been of considerable interest: while the former is expected to have a higher sensitivity to θ_{13}, the latter would be remarkably better at determining the mass ordering. We demonstrate the strong dependence of the optimal values of energy and baseline on the actual value of the CP phase.

18:00 **The Nucifer experiment: Non proliferation with reactor antineutrinos (12+3′)**

Andi Sebastian Cucoanes (CEA Saclay)

In nuclear reactors, antineutrinos are generated in the decay chains of the of the fission products. In consequence, a survey of the neutrino flux close to a reactor provides information related to the uranium and plutonium content of the core. This application arouses the IAEA's interest in using antineutrino detectors as a potential safeguard tool. After a brief review of the existing projects in this field, we present the Nucifer experiment, under development at CEA-Saclay and IN2P3, France. The design of this new neutrino detector has been focused on safety, size reduction, reliability and high detection efficiency ($\sim$50%) with a good background rejection. The Nucifer detector is going to be deployed at the CEA-OSIRIS research reactor. First antineutrino event is expected by end 2011.

18:15 **Status of the DANSS project – solid scintillator detector of the reactor antineutrino (12+3′)**

Viacheslav Egorov (Joint Institute for Nuclear Research)

The construction of the 1 m^3 detector of the reactor antineutrinos is described. It will consist of 2500 independent cells $\approx 4 \times 1 \times 100$ cm^3 bars made of polystyrene-based scintillator covered with thin Gd-containing and light-reflecting layer. We estimate the Inversed Beta-Decay registration efficiency as 73%, and expect that, being placed at 10 m distance from the 3 GWth reactor unit #4 of the Kalinin NPP (Russia), the spectrometer would detect about 10000 IBD-events per day. It is planned to be put in operation in 2013 and after measurements at 10, 13 and 18 m distances allow to confirm or to disprove the short-baseline sterile neutrino oscillation hypothesis.

18:30 **The NA61/SHINE hadron production experiment for T2K: Update and recent results (12+3′)**

Sébastien Murphy (University of Geneva)

The NA61/SHINE experiment provides the hadron production cross sections of 30 GeV protons on carbon for the T2K experiment. There are several new results: recently published pion cross-sections with 2007 data; preliminary charged kaon cross-sections with 2007 data; possibly neutral kaon and lambda cross-sections with 2007 and 2009 data; new results and new methodology for the extraction of production results from the long target (replica of T2K). There will be a report on the 2009 and 2010 data taking which will multiply statistics both thin and long target by factor 20. So far most experiments (e.g., SPY and HARP) have done measurements on thin targets but have had no long target data, or difficulty exploiting the long target data.

Tue Neutrino Oscillations W2

Room: Clubraum 1 Chair: Franz von Feilitzsch

16:50 **The Double Chooz experiment (15+5′)**

Patrick Pfahler (Technische Universität München)

Double Chooz is a reactor antineutrino experiment that is currently under construction at the commercial nuclear power plant (NPP) of Chooz in northern France. The experiment aims for the revelation of the last unknown mixing angle θ_{13} as a part of the neutrino mixing matrix or the improvement of the upper limit for $\sin^2(2\theta_{13})$ which is currently ≤ 0.14 (90%CL). A newly developed gadolinium-loaded liquid scintillator allows the detection of an electron-anti-neutrinos ($\bar{\nu}_e$) using the distinct pattern of inverse beta decay ($\bar{\nu}_e + p \rightarrow e^+ + n$). Double Chooz uses two identical detectors which is reducing systematic uncertainties and will allow, after a data taking phase of 4 years, an measurement of $\sin^2(2\theta_{13})$ down to ≤ 0.03 (90%CL). The first (far) detector has successfully been filled in winter of 2010. The commissioning of the second (near) detector is expected 1.5 years later and will provide the maximum sensitivity for the experiment.

17:10 **First data with the Daya Bay antineutrino detectors (15+5′)**

Karsten Heeger (University of Wisconsin)

The Daya Bay reactor neutrino experiment is designed to measure the last unknown neutrino mixing angle θ_{13} with a sensitivity of $\sin^2(2\theta_{13}) < 0.01$. The experiment will use eight identical liquid scintillator detectors with 20-ton target mass installed at three underground sites to measure the flux and spectrum of reactor antineutrinos from the Daya Bay nuclear power plant and search for subdominant neutrino oscillation. Two of the eight antineutrino detectors have been completed and are installed in the Daya Bay near site. Data taking with these detectors will begin in summer 2011. We will describe the design, construction, and performance of the first two Daya Bay antineutrino detectors.

17:30 **First data with the Daya Bay muon detectors (12+3′)**

Zhimin Wang (Institute of High Energy Physics)

The Daya Bay reactor neutrino experiment is designed to measure the last unknown neutrino mixing angle θ_{13} with a sensitivity of $\sin^2(2\theta_{13})$ less than 0.01 through a measurement of the relative rates and energy spectra of reactor neutrinos at different baselines. Three experimental halls will be installed with 8 identical antineutrino detectors (ADs). The first hall, Daya Bay near site, will come on line in this summer, which has 98m rock overburden $\sim$ 360 m away from reactors. 2 ADs will be installed in a water pool with at least 2.5m water shielding. The water pool is divided into inner/outer parts to serve as two layers' Cherenkov detector. RPC covers the water pool for multiple Muon tagging. We will describe the design, construct and performance of Daya Bay Muon detector.

17:45 **The reactor antineutrino anomaly (15+5′)**

Thierry Lasserre (Saclay)

New reactor antineutrino spectra have been provided for ^{235}U, ^{239}Pu, ^{241}Pu and ^{238}U, increasing the mean flux by 3%. Our new synthesis of published experiments at reactor-detector distances 1.5 eV^2 (99%) and $\sin^2(2\theta_{\text{new}}) = 0.14(0.1)$ (95%). Constraints on the θ_{13} neutrino mixing angle are revised.

18:05 **Short-baseline neutrino oscillations with Borexino (12+3′)**

Aldo Ianni (INFN LNGS)

Recent experimental results suggest that the standard 3 flavor scenario with oscillations might be insufficient, and that new physics might be needed to explain the data. Several possibilities are being investigated, including the existence of sterile neutrino components, of non standard interactions or even CPT violation. The Borexino experiment might be an ideal place to test these ideas. By means of powerful neutrino and/or anti-neutrino sources, oscillations in the L/E$\approx$1 range can be probed precisely and neatly. We will show the sensitivity of such an experiment and the medium-term future perspectives.

18:20 **Ga source experiment for detection of short baseline neutrino oscillations (12+3′)**

Valery Gorbachev (INR RAS)

The status of the feasibility studies for the proposed Ga source experiment to search for possible electron neutrino transitions into sterile states is reported. The advantages of the proposed technique will be presented. The proposed experiment has the potential to detect neutrino oscillation transitions with mass-squared difference $\Delta m^2 > 0.5$ eV^2 with a sensitivity to disappearance of electron neutrinos of a few percent.

Wed Neutrino Oscillations W3

Room: Clubraum 1 Chair: André Rubbia

16:50 T2K: New physics results (15+5′)

Shoei Nakayama (Kamioka Observatory, ICRR, Univ. Tokyo)

The T2K experiment is designed to probe the θ_{13} neutrino mixing parameter by looking for the appearance of ν_e in a pure ν_μ beam and to precisely measure atmospheric Δm^2 and θ_{23} parameters. A neutrino beam produced at J-PARC, Japan, is aimed at 2.5° off-axis angle to the SuperKamiokande far neutrino detector, 295 km away. The narrow energy neutrino beam peaked at about 600 MeV is optimized to maximize the probability of oscillation at the atmospheric Δm^2. The neutrino beam is monitored by a complex of neutrino near detectors at 280 m from the production target. T2K has successfully operated since January 2010. Data taking has been presently paused due to the recent earthquake in Japan. Results on measurements of ν_e appearance and ν_μ disappearance will be presented in this talk.

17:10 Latest neutrino oscillation results from MINOS (15+5′)

Donna Naples (University of Pittsburgh)

MINOS, the Main Injection Neutrino Oscillation Search, is a two detector long baseline neutrino oscillation experiment. Since 2005 we have collected more than 12×10^{20} protons on target (POTs), including 8×10^{20} POTs and 2.5×10^{20} POTs in dedicated neutrino and anti-neutrino running respectively. I will present the $\bar{\nu}_\mu$ charged current disappearance analysis where we have the worlds best measurement on $\Delta\overline{m^2}$, and the electron-neutrino appearance analysis where we have placed the worlds best limit on $\sin^2(2\theta_{13})$.

17:30 Updated results of the OPERA long baseline neutrino experiment (15+5′)

Artem Chukanov (JINR, Dubna)

The OPERA neutrino detector is built in the Gran Sasso Laboratory 730 km away from CERN, along the CNGS neutrino beam. OPERA is designed to detect muon-neutrino to tau-neutrino oscillations in direct appearance mode. The hybrid apparatus consists of an emulsion/lead target complemented by electronic detectors. The experimental setup and ancillary facilities used to extract data recorded in the emulsion are described, with the special procedures used to locate the interactions vertices and detect short decay topologies. OPERA is taking data since 2008. A first nu-tau interaction candidate was already published in 2010. An improved analysis scheme associated with a more detailed simulation has been developed and new results with increased statistics will be presented.

Laguna: Future Megaton Detectors in Europe (12+3′) *17:50*

Thomas Patzak (University Paris Diderot)

The FP7 Design Study LAGUNA (Large Apparatus studying Grand Unification and Neutrino Astrophysics) supports studies of European research infrastructures in deep underground cavities able to host a very large multipurpose next-generation neutrino observatory dedicated to nucleon decay, neutrinos from supernovae, solar and atmospheric neutrinos, as well as neutrinos from a future Super-Beam or β-Beam to measure the mixing angle θ_{13}, the CP violating phase δ and the mass hierarchy.

MicroBooNE: Searching for new physics in the neutrino sector with a 100-ton-scale liquid argon TPC (12+3′) *18:05*

Georgia Karagiorgi (Columbia University)

This talk introduces the MicroBooNE experiment, a 170 ton liquid argon TPC which is currently in construction in the Booster Neutrino Beamline (BNB) at Fermilab, and its physics goals. The talk focuses on MicroBooNE's sensitivity to interpretations of the low energy excess observed by the MiniBooNE experiment, which remains unexplained, as well as its sensitivity to light sterile neutrino oscillations, both as a single detector and in combination with a second, kiloton-scale liquid argon TPC in the Fermilab BNB.

Reviewing the status of neutrino NSI with quark parameters (12+3′) *18:20*

Francisco Javier Escrihuela (IFIC – CSIC/Valencia U.)

The search for new interactions of neutrinos beyond those of the standard model may help to elucidate the mechanism responsible for neutrino masses. In order to grant the relevance that it deserves, here we will see a review of neutrino NSI with quark parameters using the most recent solar, reactor, accelerator and atmospheric data.

Low-Energy Neutrinos (Geo, Solar, Supernova)

Convened by
- Amol Dighe (TIFR Mumbai)
- Mark Chen (Queen's University)
- Michael Wurm (Universität Hamburg)

Mon Low-Energy Neutrinos W1

Room: Clubraum 3 Chair: Walter Potzel

14:30 **Testing the sterile neutrino hypothesis at the solar sector (15+5′)**

Antonio Palazzo (TU München)

Non-negligible mixing among active neutrinos and new sterile species has been put forward as a possible solution of old and new neutrino data anomalies. Such a hypothesis can be tested looking at various neutrino data sets. Here we investigate the imprints of sterile neutrinos on the solar sector data, showing that they can provide very stringent constraints on such exotic particles.

14:50 **Precision measurement of the ^{7}Be solar neutrino flux and its day-night asymmetry with Borexino (15+5′)**

Barbara Caccianiga (INFN Milano)

We present the most recent results published by Borexino, the only experiment able to detect in real-time solar neutrinos below 1 MeV. We measure the flux of ^{7}Be solar neutrinos with a total error below 5% and its day-night asymmetry with an error of $\approx$1%. Compared with the latest SSM predictions our measurement rejects the no-oscillation hypothesis at 4.9σ and provides a precise measurement of the survival probability in the vacuum dominated oscillation regime. We find a ^{7}Be day-night asymmetry consistent with zero within the error. We show that this result alone is able of rejecting the LOW solution at more than 8.5σ. Combined with the other solar neutrino data it isolates the LMA-MSW solution at $\Delta\chi^2 > 190$ without using KamLAND anti-neutrino data.

15:10 **Final results from the Sudbury Neutrino Observatory (15+5′)**

Nikolai Tolich (University of Washington)

The Sudbury Neutrino Observatory (SNO) was designed to solve the so-called solar neutrino anomaly by measuring the total flux of active neutrinos from the Sun. By measuring the number of neutrinos detected as the electron type, SNO was able to measure neutrino oscillation parameters. By making precise measurements of both the solar neutrino oscillation parameters and the flux of neutrinos from 8B decay in the Sun, the SNO collaboration could shed light on some remaining mysteries about neutrino oscillations and solar fusion. I will present the results of this final reanalysis of the SNO data.

15:30 **Scintillator phase of the SNO+ experiment (15+5′)**

Valentina Lozza (TU Dresden)

The SNO+ experiment is the follow up of the SNO experiment, replacing the heavy water volume with about 1000 tons of liquid scintillator (LAB) in order to shift the sensitive threshold to the low energy range. The 6000 m.w.e. natural rock shielding, and the use of ultra-clean materials makes the detector suitable for neutrinos studies. The main physical goals are the detection of pep and CNO solar neutrinos, geo-neutrinos, the possible observation of neutrinos from supernova and the study of reactor oscillations. Complementing this neutrino program, SNO+ will also search for ^{150}Nd (5.6% abundance) neutrinoless double beta decay, loading the liquid scintillator with 0.1% natural Neodymium. After a review of the general SNO+ setup, the physics of the solar neutrino phase will be presented.

15:50 **Measuring the pep and CNO neutrinos with Borexino (12+3′)**

Richard Saldanha (Princeton University)

Borexino is a low-background liquid scintillator detector, designed to measure the flux of sub-MeV solar neutrinos. The collaboration is currently working on determining the rates of the CNO and pep solar neutrinos. Knowledge of the CNO neutrino rate is critical to addressing the Solar Metallicity Problem, while the pep neutrinos are an excellent probe of the vacuum-matter transition region in the LMA-MSW solution. The main challenge for these measurements is the characterization and removal of cosmogenic and radiogenic background. I will present the current status of the pep and CNO neutrino analyses, discussing the recent purification campaign as well as several data analysis techniques that have been developed to significantly reduce the cosmogenic ^{11}C background.

16:05 **A step toward CNO solar neutrinos detection in liquid scintillators (12+3′)**

Francesco Villante (Università dell' Aquila and INFN-LNGS)

The detection of CNO solar neutrinos in ultrapure liquid scintillator detectors is limited by the background produced by Bismuth-210 nuclei that undergo beta-decay to Polonium-210 with a lifetime of about 7 days. Polonium-210 nuclei are unstable and decay with a lifetime equal to about 200 days emitting alpha-particles that can be also detected. We propose to determine the Bi-210 background by looking at the time evolution of alpha-decay rate of Po-210. A sufficient accuracy can be obtained in a relatively short time. As an example, if the initial Po-210 event rate is 2000cpd/100 ton or lower, a Borexino-like detector could start discerning CNO neutrino signal from Bi-210 background in about 1 yr.

Tue **Low-Energy Neutrinos W2**

Room: Clubraum 3 Chair: Aldo Ianni

14:30 **Towards a refined reference Earth model for geo-neutrinos (15+5′)**

Fabio Mantovani (INFN Ferrara)

Geo-neutrino data from KamLAND and Borexino provide insights into Earth's energetics and radiogenic heat production. In 2013, SNO+ will begin to collect data; the era of the exploration of our planet through geo-neutrinos is open. One aim is to discriminate among models for the bulk composition of the Earth, which are based on cosmochemical arguments and geochemical and geophysical observations. In order to determine the U and Th concentration of the deep Earth with geo-neutrinos, the regional crustal contribution to the geo-neutrino flux needs to be determined from detailed geological studies. We are developing an improved reference model for the crust and lithospheric mantle using new compilations of geochemical data for sediments, oceanic and continental crust. The expected geo-neutrino signal and its uncertainties have been calculated for detectors at several locations.

14:50 **Low energy neutrino physics at KamLAND (15+5′)**

Hiroko Watanabe (Tohoky University)

The KamLAND experiment has many scientific motivations of low energy neutrino physics. I will present recent results of KamLAND neutrino analysis such as supernova relic neutrino limits, geo neutrinos and solar neutrinos, etc.

15:10 **Antineutrino studies with Borexino detector (15+5′)**

Oleg Smirnov (Joint Institute for Nuclear Research)

Spectral contributions corresponding to two known anti-neutrino sources were observed by Borexino: $\bar{\nu}_e$ produced in nuclear reactors and geo-neutrinos. Presence of geo-neutrino signal is confirmed at 99.997% c.l. and 99.6% c.l. is reported for exclusion of no-oscillations hypothesis for the reactor neutrino on the average base of 1000 km. An upper limit of 3 TW at 90% c.l. has been established for the power of hypothetical geo-reactor. A sensitive search for other possible anti-neutrino sources has been performed, including the search for solar anti-neutrinos and other, unspecified and model-independent $\bar{\nu}_e$ fluxes. New data have been accumulated by Borexino since the last release, their impact on the geo-neutrino and reactor antineutrino studies will be discussed.

15:30 **Final results of neutrino-electron scattering cross-section measurements and constraints on new physics (12+3′)**

Henry Wong (Academia Sinica)

The antineutrino-electron elastic scattering cross-section was measured with a CsI(Tl) scintillating crystal array having a total mass of 187 kg. The detector was exposed to an average reactor neutrino flux of 6.4×10^{12} cm^{-2} s^{-1} at the Kuo-Sheng Nuclear Power Station in Taiwan. We will present final resuls with 29882/7369 kg-days of Reactor ON/OFF data, on the cross-section and the standard electroweak parameters, weak mixing angle and $(g_V\ ,g_A)$ measurements, the test on charged-current neutral-neutral interference, as well as limits on neutrino magnetic moments and charge radius squared. We will also present constraints on NSI and Unparticle Physics (UP) in antineutrino-electron interaction channel based on this data set as well as our previos data sets with ULE-HP Ge detectors.

15:45 **Neutrino electromagnetic properties and new bounds on neutrino magnetic moments (12+3′)**

Alexander Studenikin (Moscow State Univ. & JINR Dubna)

A short review on neutrino electromagnetic properties is presented. In particular, developments in studies, both theoretical and experimental, of neutrino magnetic moments are discussed. The recent claim that through an enhancement of the neutrino magnetic moment scattering cross section, due to atomic ionization effects in Ge detectors, there is a significant improvement of the best upper limit for the neutrino magnetic moment is critically analyzed.

16:00 **Detecting extragalactic supernova neutrinos in the ice of the South Pole (12+3′)**

Marek Kowalski (University of Bonn)

With current neutrino detectors and a rate of 2 galactic SNe per century, awaiting the next SN discovery requires patience. The perspective changes instantly, once the sensitivity of neutrino detectors reaches a scale allowing the detection of SNe in neighboring galaxies. A low-energy neutrino detector of 10 Mton mass would deliver several SN detections per year, thereby opening enormous new scientific opportunities. In this talk we describe the motivation, along with detector concepts, that utilize the clear ice at the South Pole and have the potential to reach the required sensitivity in a cost effective manner. This work is part of a set of R&D studies done in conjunction with PINGU (Phased IceCube Next Generation Upgrade), an upgrade to IceCube that will be proposed in the near future.

Wed Low-Energy Neutrinos W3

Room: Clubraum 3 Chair: Michael Wurm

14:30 Site selection for the new generation of giant neutrino detectors (15+5′)

Wladyslaw Henryk Trzaska (University of Jyväskylä)

SuperK is one of the most successful experiments of modern physics. Its success was possible thanks to the large mass. To go even further one needs an order of magnitude improvement either in size or through improved detection techniques. LAGUNA offers a realistic path towards that goal. The recently completed Design Study has investigated 7 potential sites and 3 detector options: GLACIER, LENA, and MEMPHYS. The project has now entered the second phase where it will determine the full cost of construction, commissioning and long-term operation of the infrastructure, and assess the use of CERN beams for long baseline neutrino physics. The talk will summarize the findings of the Design Study concerning the advantages of each site and discuss the main physics arguments favoring each selection

14:50 Future neutrino physics with LENA (Low Energy Neutrino Astronomy) (15+5′)

Jürgen Winter (TUM)

Taking advantage of the high potential of liquid-scintillator detectors (LSDs), the proposed LENA detector hopes to follow in the footsteps of the Borexino and KamLAND experiments. LSDs feature low-energy threshold, good energy resolution, and efficient background discrimination. LENA's large mass of 50 kt allows for high-statistic measurements of astrophysical and terrestrial low-energy neutrino sources such as the Sun, galactic Supernovae, and the interior of our Earth. Moreover, the observation of the Diffuse Supernova Background (DSNB) and νs from Dark Matter annihilation seem feasible. New limits might be put on the lifetime of the $K^+\bar{\nu}$ proton decay channel. As shown in simulations, LENA has remarkable prospects concerning long-baseline neutrino oscillation experiments.

15:10 The Memphys experiment (15+5′)

Thomas Patzak (University Paris Diderot)

MEMPHYS is a proposed 0.5 Mton scale Water Cherenkov experiment to be performed deep underground. Possible sites are under study in the European FP7 design studis LAGUNA and LAGUNA-LBNO. Memphys is a very large multipurpose next- generation neutrino observatory dedicated to nucleon decay, neutrinos from supernovæ, solar and atmospheric neutrinos, as well as neutrinos from a future Super-Beam or β-Beam to measure the mixing angle θ_{13}, the CP violating phase δ and the mass hierarchy. A small-scale prototype, Memphyno, has been constructed with the purpose of serving as a test bench for new photodetection and data acquisition solutions, such as grouped readout systems. The physics potential of the 500 k ton water Cherenkov detector will be demonstrated.

15:30 Towards GLACIER, a giant liquid argon TPC detector (15+5′)

André Rubbia (ETH Zürich)

GLACIER is a proposed giant liquid argon multipurpose next-generation neutrino observatory at the 100 kton scale, dedicated to long baseline neutrino studies for the neutrino mass hierarchy determination and mixing angle θ_{13} and CP violating phase δ measurements, to nucleon decay searches and to known and unknown astrophysical neutrino detection. It is one of the three detector options considered in the European FP7 design studies LAGUNA and LAGUNA-LBNO. A very attractive feature is the ability to measure interactions with very high precision and granularity thanks to the charge imaging technology. Technical developments have been proposed to reach the required mass scale. Several detector prototypes have been assembled and operated. We will report on the physics potential of such an observatory and describe the current state of the project.

15:50 Measuring the central temperature of the Sun through the regeneration of ^{7}Be neutrinos in the Earth (12+3′)

Ara Ioannisian (Yerevan Physics Institute)

The solar neutrino's ^{7}Be line ($E_\nu = 0.862$ MeV) has a width of an order of the temperature in the center of the Sun (approx. 1keV).The regeneration of the electron neutrinos from remote structures of the Earth is suppressed due to the averaging of the effect over the width of the ^{7}Be line (oscillation dyeing effect). We discuss a possibility of measuring the width of the beryllium neutrino's line at large liquid scintillator detector (LENA) by measuring the regenerated neutrino flux.

16:05 Potential of the Andes underground laboratory for neutrino geophysics and astrophysics (12+3′)

Renata Zukanovich Funchal (Universidade de São Paulo)

Recently the construction of an underground laboratory inside the Agua Negra tunnel in the Andes between Argentina and Chile has been proposed. If constructed, it will be the first under ground laboratory for particle physics and astrophysics in the Southern Hemisphere. In this talk we will discuss the potential advantages of a neutrino detector placed in this laboratory to contribute to geophysics by measuring geoneutrinos and to astrophysics by measuring neutrinos coming from Galactic core collapse supernova.

Thu **Low-Energy Neutrinos W4**

Room: Millerzimmer Chair: Amol Dighe

16:50 **Development of InP solid state detector and liquid scintillator contaning metal complex for measurement of pp/^{7}Be solar neutrinos and neutrinoless double beta decay (15+5′)**

Yoshiyuki Fukuda (Miyagi University of Education)

A large volume radiation detector using a semi-insulating Indium Phosphide (InP) photodiode has been developed for measurement of pp/^{7}Be solar neutrinos. This detector was designed to measure both electron emitted from neutrino capture of ^{115}In and scintillation light from liquid xenon interacted by gammas emitted by the excited state of ^{115}Sn. For another possibility for the observation of pp/^{7}Be and the neutrinoless double beta decay experiment, we have also developed an organic liquid scintillator which contains 8-quinolinolate indium and zirconium complex, respectively. Here we report the performance of InP detector and the gamma-ray induced luminescence of liquid scintillator with metal complexes.

17:10 **The detection of supernova neutrinos (15+5′)**

Kate Scholberg (Duke University)

When a massive star collapses at the end of its life, nearly all of the gravitational binding energy of the resulting remnant is released in the form of neutrinos. The burst of neutrinos from a Galactic core collapse supernova will be detected in neutrino detectors worldwide. This talk will cover supernova neutrino detection techniques in general, current supernova neutrino detectors, prospects for specific future experiments, and outstanding questions for experimentalists and theorists to address in order to get the most from the next Galactic supernova burst.

17:30 **New possibilities in supernova accretion phase from dense matter effect (15+5′)**

Sovan Chakraborty (II. Institute for Theoretical Physics, Hamburg University)

The accretion phase in Supernova (SN) emits large neutrino (nu) fluxes with distinct flavor hierarchy, offering the best detection opportunity of flavor oscillations. We study the possibility of SN neutrino oscillations in the accretion phase, using recent neutrino radiation hydrodynamics simulation. In contrast to what expected with only nu-nu interactions, the multi-angle effects associated with the dense ordinary matter suppress the collective oscillations in the accretion phase for a typical iron core SN. This suppression of oscillation implies the negligible role of flavor evolutions in neutrino heating and explosion dynamics. Moreover accretion phase signal from a galactic SN, with MSW in SN mantle and Earth matter, can reveal neutrino mass hierarchy, in the large θ_{13} limit.

Sterile neutrinos in supernovae (15+5′) *17:50*

Irene Tamborra (Max Planck Institute for Physics)

Motivated by the recent hints for sterile neutrinos coming from reactor anomalies and cosmology, we discuss active-sterile conversions in supernovae. By including the feedback effect on the electron abundance due to neutrino oscillations, we study the impact of sterile neutrinos on both the oscillated neutrino fluxes and the rapid neutron capture process.

Possible trace of neutrino non-standard interactions in the supernova (15+5′) *18:10*

João Pulido (CFTP, IST Universidade Técnica de Lisboa)

Neutrino non-standard interactions (NSI), previously introduced for the sun, are studied in the supernova context. The decay into antineutrinos, which has been shown to be implied by dense matter, cannot be seen experimentally, owing to the smallness of the antineutrino production probability. The effect that may be visible and providing a clear indication of NSI is the possible appearance of a significant electron neutrino event rate in the low energy range below 0.8 MeV.

Search for supernova relic neutrinos at Super-Kamiokande (15+5′) *18:30*

Kirk Bays (University of California, Irvine)

The diffuse supernova relic neutrino signal has never been observed. Currently the world's best upper flux limit comes from a search for inverse beta decay of anti-neutrinos in the Super-Kamiokande (SK) detector. A new SK study utilizes a novel method of spallation tagging, improved event selection, and an expanded data set to lower the analysis energy threshold and improve overall accuracy. Full results of this new study (including a combined upper flux limit of 2.6–2.8 ν_e events cm^{-2} s^{-1} , E_ν >17.3 MeV) will be presented, as well as a short update on the research and development of using Gadolinium for neutron tagging.

Gravitational Waves

Convened by
- Eugenio Coccia (University of Rome Tor Vergata and INFN)
- Szabolcs Marka (Columbia University)

Thu Gravitational Waves W1

Room: Clubraum 3 Chair: Eugenio Coccia

14:30 **Past and future in the quest for gravitational wave transients (20+5′)**

Laura Cadonati (University of Massachusetts Amherst)

According to the Theory of General Relativity and current astrophysical understanding, the detection of gravitational wave transients will provide new insights on some of the most mysterious astrophysical objects and events, such as neutron stars, black holes and core-collapse supernovae, with potential cosmological implications. This talk will review recent efforts in the quest for gravitational wave transients with LIGO and Virgo data, and give an outlook on future searches and detection potential in the approaching Advanced LIGO/Virgo era and beyond, in the context of a new multi-messenger astrophysics where combined input from electromagnetic, gravitational and particle signatures will yield a new, more complete understanding of the Universe.

14:55 **Gravitational wave transients state-of-the-arts: Detection confidence and signal reconstruction (20+5′)**

Giovanni Andrea Prodi (University of Trento and INFN)

Making a convincing case for the first detection of transient signals is a primary goal of gravitational wave searches. Subsequent detections will rely on the reconstructed signal properties to impact gravitational wave astronomy. This talk will review recent progress in assessing the confidence of candidate events in searches for gravitational wave transients by the LIGO-Virgo network of detectors. We will review how the searches take advantage of general signal properties and reconstruct specific signal characteristics. In particular, we will present a case study provided by a blind challenge conducted during the most recent joint LIGO-Virgo science run.

15:20 **Current status of LCGT project (20+5′)**

Shinji Miyoki (Inst. for Cosmic Ray Research, Univ. Tokyo)

Large-scale Cryogenic Gravitational wave Telescope (LCGT) project has started in 2010 in Japan not only for direct gravitational wave (GW) detection but also forming a GW detection network with Advanced LIGO, Advanced VIRGO, GEO-HF and Australian group detector. LCGT takes two characteristic adoptions to obtain the targeted strain sensitivity of $3 \times 10^{-24}[1/rhz]$ around 100 Hz. One is underground construction for stable detector operation. The other is usage of cryogenic mirrors and cryogenic mirror suspension system to reduce thermal noises. We will present detail designs of LCGT tunnel, vacuum, seismic noise isolator, mirror and length control scheme, digital system, cryostat and cryogenic suspension.

15:45 **Electromagnetic follow-up of gravitational wave transient signal candidates (20+5′)**

Marica Branchesi (Univ. Urbino/INFN Sezione di Firenze)

Pioneering efforts aiming at the development of multimessenger gravitational wave (GW) and electromagnetic (EM) astronomy have been made. An EM follow-up program of candidate GW events has been performed during the recent LIGO/Virgo runs. It involved ground-based and space EM facilities observing the sky at optical, X-ray and radio wavelengths. The joint GW/EM observation study requires the development of specific image analysis procedures able to discriminate the possible EM counterpart of GW triggers from contaminant events. An overview of the EM follow-up program and the image analysis procedures is presented. The current follow-up procedures represent a milestone towards the forthcoming advanced GW detector era, for which there will be a significant increase of the observational reach.

Thu **Gravitational Waves W2**

Room: Clubraum 3 Chair: Szabolcs Marka

16:50 **Gravitational wave tricks for multi-messenger astronomy (15+5′)**

Bruce Allen (MPI for Gravitational Physics, Hannover)

It is well-known that combining observations from the next generation of gravitational wave detectors with data from more conventional electromagnetic and neutrino detectors will yield new science. What is not so well known is that some of the data analysis methods and instrumentation developed for gravitational wave detection can also be profitably applied to electromagnetic data. I discuss the current status of these topics, along with some possible new opportunities for the future.

17:10 **First Joint analysis between GW and HEN using LIGO/Virgo-ANTARES data (15+5′)**

Irene Di Palma (Max Planck Institut, AEI)

Multi-messenger astronomy is entering an exciting period with the recent development of experimental techniques that have opened new windows of observation of the cosmic radiation in all its components. Cataclysmic cosmic events can be plausible sources of both Gravitational Waves (GWs) and High Energy Neutrinos (HENs). Such messengers could reveal new, hidden sources that are not observed by conventional photon astronomy. Requiring consistency between GW and HEN detection channels shall enable new searches and a detection will yield significant additional information about the common source. A neutrino telescope such as ANTARES can determine accurately the time and direction of high energy neutrino events. A network of gravitational wave detectors such as LIGO and Virgo can also provide timing/directional information for gravitational wave bursts. By combining the information from these totally independent detectors, one can search for cosmic events that may arrive from common astrophysical sources. I will talk about the first joint analysis between GW and HENs using LIGO-Virgo and ANTARES data.

17:30 **Searches for gravitational wave signals form rotating neutron stars (15+5′)**

Andrzej Krolak (Institute of Mathematics, Polish Academy of Sciences)

The LIGO Scientific Collaboration and Virgo Collaboration carry out searches in LIGO and Virgo data for periodic gravitational waves originating from rotating neutron stars. There are several types of analyses: targeted searches for known pulsars, for which precise ephemerides from radio or X-ray observations are used in matched filters, directed searches for known stars of unknown spin frequency or for new unknown sources at specific locations, such as near the galactic center or in globular clusters, all-sky searches for unknown neutron stars, including stars in binary systems. Most of these searches are computationally bound, requiring tradeoffs in sensitivity to achieve large parameter space coverage. We present the status of these searches.

17:50 **The Einstein Telescope: A third generation gravitational wave observatory (15+5′)**

Harald Lück (Max-Planck-Institut für Gravitationsphysik)

With the worldwide network of gravitational wave (GW) detectors currently being upgraded from the initial (first) to the advanced (second) generation, the direct detection of GWs is expected to happen within the next five years. Moving from the detection of GWs to an era of routine GW observation requires yet another large step in sensitivity improvement. The Einstein Telescope (ET) is a pan-European project for building an underground third generation GW observatory at a depth of about 100–200 m in a seismically quiet location. The conceptual design study just concluded within the 7th Framework Programme of the EU foresees a triangular detector arrangement with a side length of 10km. This talk will present the major scientific goals of ET and technical challenges in reaching the sensitivity.

18:10 **Vibrational excitation induced by electron beam and cosmic rays in normal and superconductive aluminum bars (12+3′)**

Francesco Ronga (INFN)

We report new measurements of the acoustic excitation of an Al5056 superconductive bar when hit by an electron beam, in a previously unexplored temperature range, down to 0.35 K. These data, analyzed together with previous results of the RAP experiment obtained for T>0.54 K, show a vibrational response enhanced by a factor $\sim$4.9 with respect to that measured in the normal state. This enhancement explains the anomalous large signals due to cosmic rays previously detected in the NAUTILUS gravitational wave detector.

18:25 **A laser gyroscope system to detect the gravito-magnetic effect on Earth (12+3′)**

Angela D. V. Di Virgilio (INFN-Pisa)

We propose an under-ground based experiment to detect the general relativistic effects due both to the curvature of space-time around the Earth (de Sitter effect) and to the rotation of the planet (dragging of the inertial frames or Lense-Thirring effect) by an off-line comparison between IERS measurement of the Earth rotation vector and the corresponding measurements obtained by a three-axial laser detector of rotation. The detector is realized by six or more large ring-lasers arranged along three orthogonal axes. To get a 1% sensitivity for the measurement of the Lense-Thirring drag in 2 years of integration time, square rings of 6 m side, shot noise limited with a sensitivity of 6 prad/s/$\sqrt{\text{Hz}}$ are required. LNGS is a suitable location, and G-GranSasso the project name.

Astrophysical Messengers (Neutrinos, Gamma-Rays, Cosmic Rays)

Convened by
- Robert Wagner (MPI für Physik, München)
- Michael Kachelriess (University of Trondheim)
- Marek Kowalski (University of Bonn)

Mon Astrophysical Messengers W1 – Cosmic rays

Room: Millerzimmer Chair: Pierre Sokolsky

14:30 Anisotropy studies with the Pierre Auger Observatory (15+5′)

Carla Macolino (LPNHE, Paris)

We report recent results from the Pierre Auger Observatory about the anisotropy of ultra-high energy cosmic ray arrival directions. We present the results on the search for a dipolar anisotropy at the EeV energy scale. Both the phase and the amplitude measurements of the first harmonic modulation in the right-ascension distribution are discussed. For cosmic rays with energies above 55 EeV, we present an update on the search for correlations between their arrival directions and the positions of active galactic nuclei from the Véron-Cetty and Véron catalog. Finally, we also discuss the results of correlation analyses applied to other populations of extragalactic objects.

14:50 The nuclear mass composition of UHECR with the Pierre Auger Observatory (15+5′)

Lorenzo Cazon Boado (LIP)

The Fluorescence Detector of the Pierre Auger Observatory measures the atmospheric depth X_{max} where the longitudinal profile of the UHECR (Ultra High Energy Cosmic Ray) induced electromagnetic cascade reaches its maximum. This is sensitive to the nuclear mass composition of the cosmic rays. Due to its hybrid design, the Pierre Auger Observatory also provides independent experimental observables for the study of the nuclear mass composition coming from the Surface Detector. We present X_{max} distributions and an update of the average and RMS values in different energy bins and compare them to the predictions for different nuclear masses and hadronic models. We also present the results of the composition sensitive parameters derived from the ground level component.

15:10 Determination of hadronic interaction characteristics with the Pierre Auger Observatory (15+5′)

Ralf Ulrich (Karlsruhe Institute of Technology)

The Pierre Auger Observatory measures extensive air showers (EAS) up to the highest energies. One of the biggest challenges in current data analyses is to interpret these data in terms of the primary mass composition. Due to the insufficient constraint of interactions in EAS this is afflicted with large uncertainties. On the other hand, this high sensitivity of EAS to interaction features can be exploited to determine or constrain properties of interactions up to $\sqrt{s}$ of 450 TeV. We demonstrate how specific EAS observations are suited for this task and thus may contribute to limit the uncertainties in the interpretation of air showers. These are the estimation of the muon number at ground level and the study of the hadronic cross-section for particle production via EAS fluctuations.

15:30 Search for the nuclei sources in the ultra-high energy cosmic ray data (15+5′)

Dmitri Semikoz (APC)

We propose a new method to search for heavy nuclei sources, on top of background, in the Ultra-High Energy Cosmic Ray data. We apply this method to the 69 events recently published by the Pierre Auger Collaboration and find a tail of events for which it reconstructs the source at a few degrees from the Virgo galaxy cluster. The probability to have such a cluster of events in some random background is about 0.7%. The probability to reconstruct the source at less than 10 degrees from M87 in a data set already containing such a cluster of events is about 0.4%. This may be a hint at the Virgo cluster as a bright ultra-high energy nuclei source. We investigate the ability of current and future experiments to validate or rule out this possibility.

15:50 Enhancements to the Southern Pierre Auger Observatory (15+5′)

Hans Klages (KIT Karlsruhe)

The southern Pierre Auger Observatory detects cosmic rays above 3×10^{18} eV since 2004, exploiting a hybrid air shower detection technique, with 1600 water Cherenkov detectors and 24 air fluorescence telescopes on a 3000 km^2 site. As low energy enhancement to the observatory three additional telescopes with elevated field of view were built (HEAT). In the field of view of HEAT the density of the detector array was raised by additional water tanks on an area of about 20 km^2. This setup enables unbiased hybrid data taking above 10^{17} eV. The infill area is being equipped with large underground muon detectors (AMIGA). A prototype array of radio antenna stations (AERA), working at 30 to 80 MHz, was installed in the infill. Properties and status of AERA, AMIGA and HEAT will be presented.

Mon Astrophysical Messengers W2 – Cosmic rays

Room: Millerzimmer Chair: Sebastian Böser

16:50 Recent results from Telescope Array (15+5′)

Daisuke Ikeda (Institute for Cosmic Ray Research, University of Tokyo)

The Telescope Array (TA) experiment, located in the West Desert of Utah, is the largest ultra-high energy cosmic ray (UHECR) observatory in the Northern Hemisphere. The TA detector consists of three Fluorescence Detectors (FDs) and an array of 507 scintillation surface detectors (SDs). The SDs deployed on a square grid of 1.2 km spacing and cover a total area of ≈ 700 km^2. Three FD stations are located on the periphery of the SD array. The observation started in November 2007 for FD and in March 2008 for SD. Here we present the preliminary results of energy spectra, mass composition, photon search and anisotropy search of UHECRs from the TA three-year operation.

17:10 Lorentz invariance violation and chemical composition of ultra high energy cosmic rays (15+5′)

Luca Maccione (DESY)

Motivated by experimental indications of a significant presence of heavy nuclei in the cosmic ray flux at ultra-high energies ($\gtrsim 10^{19}$eV), we consider the effects of Planck scale suppressed Lorentz Invariance Violation (LIV) on the propagation of cosmic ray nuclei. In particular we focus on LIV effects on the photodisintegration of nuclei onto the background radiation fields. After a general discussion of the formalism, we present constraints on LIV attainable with present data and an outlook of possible future improvements.

17:30 Future projects at Telescope Array (15+5′)

Pierre Sokolsky (University of Utah)

Future projects and extensions of the Telescope Array will be presented. These include the TALE detector, a Cherenkov array and prototype detectors for sensing cosmic rays using bistatic radar.

17:50 Cosmic ray anisotropies observed by the ARGO-YBJ experiment (15+5′)

Giuseppe Di Sciascio (INFN Sezione Roma Tor Vergata)

The ARGO-YBJ experiment, located at the Yangbajing Cosmic Ray Laboratory (Tibet, 4300 m asl, 606 g cm^{-2}), is an EAS-array exploiting the full coverage approach at high altitude. We analyzed the data taken since November 2007 looking for anisotropies in the arrival directions of cosmic rays on different angular scales. The results of the analysis are reported and compared with other experiments.

The JEM-EUSO mission (15+5′) *18:10*

Marco Ricci (INFN Laboratori Nazionali Frascati)

The Extreme Universe Space Observatory on Japanese Experiment Module (JEM-EUSO) is a science mission planned to be launched around the end of 2016 to the International Space Station (ISS) to investigate the nature and origin of Extreme Energy Cosmic Rays (EECR) beyond energy $E > 5 \times 10^{19}$eV. JEM-EUSO is a wide-angle telescope (60 degrees full field of view) and consists of high-transmittance Fresnel lenses 2.5 m in diameter, an advanced photo-sensitive detector at the focal surface and a suitable electronics. An infrared camera and a LIDAR system will also be used to monitor the Earth's atmosphere and provide significant information on cloud coverage. The present status of advancement of the mission will be reported.

UHECR spectra composition and maps by lightest nuclei from nearest universe (15+5′) *18:30*

Daniele Fargion (Physics Department and INFN)

UHECR should open a new astronomy window because of rigidity and nearby GZK Universe space. However the earlier 2007 AUGER correlation with the super- galactic plane faded away in 2010. UHECR composition (nuclei) was already on 2007 and it is contradiction with directionality (proton). Since 2007, Cen A is the only nearby (4 Mpc) source where UHECR events are clustering (15–20%). Virgo events are absent. We tried to solve these puzzles assuming UHECR as He like nuclei arriving from nerest Universe and maybe even galactic sources. UHECR secondaries at half energy should also crowd along UHECR tail. GZK neutrino may rise by nuclei fragmentation at tens-hundred TeVs in Icecube and few UHE tau neutrino at PeVs in nearest upward Tau airshower in fluorescence Auger-TA telescopes.

Astrophysical Messengers W3 *Tue*

Room: Millerzimmer Chair: Hans Klages

Density imaging of volcanoes with atmospheric muons (15+5′) *14:30*

Felix Fehr (LPC Clermont-Ferrand)

A Collaboration between volcanologists, astroparticle- and particle physicists, TOMUVOL, has been formed in 2009 to study tomographic muon imaging of volcanoes with high-resolution tracking detectors. Presently TOMUVOL is operating a muon telescope based based on Glass Resistive Plate Chambers (GRPCs) at the flank of the Puy de Dôme, an inactive volcanic dome situated in the Massif Central (south-central France). This contribution presents the geophysical motivations for muon imaging as well as the results after several months of data taking at the Puy de Dôme including measurements of the horizontal muon flux and first radiographic images.

14:50 **Main results of the PAMELA space experiment after 5 years in orbit (15+5′)**

Marco Ricci (INFN Laboratori Nazionali Frascati)

After five years of data taking in space, the experiment PAMELA is showing very interesting features in cosmic rays, namely in the fluxes of protons, heliums, electrons, that could have significant implications on the production, acceleration and propagation of cosmic rays in the galaxy. In addition, PAMELA measurements of cosmic antiproton and positron fluxes are setting strong constraints to the nature of Dark Matter. PAMELA is also measuring the radiation environment around the Earth, and has recently discovered an antiproton radiation belt. The study of particles related to the Solar activity is part of the scientific program of PAMELA too, providing important improvements in the comprehension of the solar modulation mechanisms. In this talk PAMELA main results will be reviewed.

15:10 **Restrictions on cosmogenic neutrinos and UHECR from Fermi 3 years data (15+5′)**

Oleg Kalashev (Institute for Nuclear Research RAS)

Ultra-high energy cosmic ray protons accelerated in astrophysical objects produce secondary electromagnetic cascades during propagation in the cosmic microwave and infrared backgrounds. Those cascades contribute to the GeV-TeV diffuse photon flux, measured by Fermi LAT experiment. Recent studies of 3 years of Fermi LAT data have shown that diffuse gamma-ray background at $E > 10$ GeV is about factor of 2 smaller then original one year data. This affects both models of UHECR and secondary cosmogenic neutrino fluxes. We show the allowed range of cosmogenic neutrino fluxes scanning over unknown UHECR parameters such as injected proton maximum energy and power law index, evolution of sources, systematic shift of UHECR energy scale.

15:30 **The first year IceCube-DeepCore results (15+5′)**

Chang Hyon Ha (Penn State University)

The IceCube Neutrino Observatory includes a tightly spaced inner array in the deepest ice, called DeepCore, which gives access to low-energy neutrinos with a sizable surrounding cosmic ray muon veto. Designed to be sensitive to neutrinos at energies well below 1 TeV, DeepCore will be used to study diverse physics involving neutrinos, including Dark Matter, atmospheric neutrinos and their oscillations. The first year of DeepCore physics data-taking has been completed, and the performance of the detector and the first IceCube observation of atmospheric neutrino-induced cascades are presented.

15:50 **Recent results of the ANTARES neutrino telescope (15+5′)**

Juan Jose Hernandez-Rey (IFIC-Inst. de Fisica Corpuscular)

The ANTARES deep-sea neutrino telescope, located in the Mediterranean Sea, is sensitive to upgoing neutrinos from potential extraterrestrial sources in the TeV to PeV energy regime. Muon tracks and showers are reconstructed using the recorded arrival time and number of Cherenkov photons detected using an array of photomultipliers distributed along a total of 12 lines anchored to the seabed at a depth of 2475 m. The telescope is operating since 2008. In this contribution, the status of the detector and data taking will be given together with recent physics results on the search for point sources of neutrinos, the indirect search for dark matter and the use of the telescope in conjunction with other astrophysical devices, such as optical, gamma, cosmic ray and gravitational detectors.

Astrophysical Messengers W4

Tue

Room: Millerzimmer Chair: Marco Roncadelli

16:50 **Neutrino spectra and flavor composition on the Hillas plot (15+5′)**

Walter Winter (Universität Würzburg)

We describe energy-dependent neutrino fluxes and flavor ratios of neutrinos produced in cosmic accelerators over 20x24 orders of magnitude in R and B, which are the parameters of the Hillas plot. For this approach, we use a self-consistent model where neutrinos are produced by photohadronic interactions between protons and synchrotron photons from co-accelerated electrons. We especially emphasize magnetic field and flavor effects in the neutrino production chains, including the most relevant neutrino production modes. We also illustrate how the energy-dependent flavor composition can be used to measure physics beyond the Standard Model, and we demonstrate what regions of the Hillas plane can be best probed by existing data, such as IC-40 or Auger.

17:10 **Classifying and probing flavor transition mechanisms of astrophysical high energy neutrinos (15+5′)**

Kwang-Chang Lai (Chang Gung University)

The flavor ratio of astrophysical neutrinos observed on the Earth depends on both the initial flavor ratio at the source and flavor transitions taking place during propagations of these neutrinos. We propose a model independent parametrization which is very convenient for classifying flavor transition models. A few flavor transition models are employed to test our parametrization. We also demonstrate how one can constrain paprameters of the above parametrization by discriminating flavors in the neutrino telescope.

17:30 **UHECRs and multiple shock acceleration in active galactic nuclei (15+5′)**

Athina Meli (University of Liege)

Sequences of consecutive mild relativistic oblique shock features, have been theorized and eventually observed in many AGN jets. Here we use by analogy the Comptonisation effect and we propose a scenario of a single injection of particles which are accelerated consecutively by several oblique (conical) shocks along the axis of an AGN jet. We use detailed Monte Carlo simulations calculating particle spectra while monitoring the efficiency of the acceleration. Among other we find that the first shock of a sequence of relativistic conical shocks, establishes a power-law spectrum with $\sim E^{-2.7}$.

The following consecutive shocks push the spectrum up in energy to the UHECR energy regime rendering flatter distributions with steep cut-offs by leaving a depletion at low energies.

17:50 **Estimating the significance of a signal in a multi-dimensional search (15+5′)**

Ofer Vitells (Weizmann Institute of Science)

In experiments that are aimed at detecting astrophysical sources such as neutrino telescopes, one usually performs a search over a continuous parameter space. Correctly estimating the p-value of a given observation thus requires repeated simulations of the entire search, a procedure that may be prohibitively expansive in terms of CPU resources. Recent results from the theory of random fields provide powerful tools which may be used to alleviate this difficulty, in a wide range of applications. We review those results and discuss their implementation, with a detailed example applied for neutrino point source analysis in the IceCube experiment.

18:10 **A new interpretation of the high energy atmospheric muon charge ratio (15+5′)**

Maximiliano Sioli (Bologna University and INFN)

Recently new experimental measurements of the atmospheric muon charge ratio have been provided up to 10 TeV in the vertical direction. We present a new way to interpret these data and discuss the relation with the atmospheric neutrino flux in the TeV region.

Wed Astrophysical Messengers W5

Room: Millerzimmer Chair: Nepomuk Otte

14:30 **Results from high-energy neutrino searches from gamma-ray bursts with IceCube (15+5′)**

Nathan Whitehorn (University of Wisconsin – Madison)

IceCube, a cubic kilometer neutrino detector located in glacial ice at the South Pole, has recently become the first neutrino telescope with a sensitivity below the TeV-PeV neutrino flux predicted from gamma-ray bursts if GRBs are responsible for the observed extragalactic cosmic-ray flux. As these neutrinos are expected on fairly general principles on the assumption of high magnetic fields during cosmic ray acceleration, our results will now begin to directly constrain the possibility of proton acceleration in these sources. New results from searches for this flux using the first 59 strings of IceCube will be presented, as well as implications of this result for cosmic-ray acceleration in GRBs and prospects for the future.

14:50 **The KM3NeT project (15+5′)**

Simone Biagi (Bologna University and INFN)

The KM3NeT consortium has been carrying on R&D activities towards the construction of a km^3 scale deep sea neutrino telescope to detect high-energy astrophysical neutrinos. It will complement the IceCube detector, already in operation at South Pole, and will have the Galactic center and most of the Galactic plane in its field of view. Recently a technical design report has been published which contains the general description of the KM3NeT deep sea research infrastructure. The KM3NeT research facility will represent also a multidisciplinary marine and Earth science observatory, hosting a network of nodes for long term continuous monitoring of the deep sea environment. The objectives, status and plans of the KM3NeT project will be presented.

15:10 **Recent results from IceCube on high-energy neutrinos and cosmic rays (15+5′)**

Sebastian Böser (Universität Bonn)

The IceCube observatory with its in-ice detector IceCube and air-shower array IceTop has been completed in January 2011. It now comprises 5484 optical modules and encompasses an instrumented volume of $\sim$1 km^3. Already with the data accumulated during construction, a number of important physics results have been achieved, including new limits on high-energy neutrino point sources, transient neutrino sources and the diffuse flux of high-energy neutrinos. Using the abundant muons from atmospheric neutrinos, also anisotropy in the arrival direction of cosmic rays has been observed. From the IceTop array the spectrum of cosmic rays and the composition in the energy region of the knee and above has been measured. I will present these results together with an outlook on possible future extensions.

15:30 **The Askaryan radio array (15+5′)**

Kael Hanson (Universite Libre de Bruxelles)

We are developing an antenna array to be installed in boreholes extending 200 m below the ice surface at the geographic South Pole. ARA will cover a fiducial area of 150 sq. km, chosen to ensure the detection of the flux of neutrinos guaranteed by observations of the GZK cutoff by HiRes and the Pierre Auger Observatory. The first components of ARA were installed during the austral summer of 2010–2011. After three years of operation, the full array sensitivity will exceed that of any other instrument in the 0.1–10 EeV energy range by an order of magnitude. The primary goal of the ARA experiment is to establish the absolute cosmogenic neutrino flux through a modest number of events. This talk will describe the array, its science goals, and give the current status of the project.

15:50 **GRBs and ultra-high-energy cosmic rays (15+5′)**

Martin Pohl (Universität Potsdam / DESY)

GRBs are a potential source of ultra-high-energy cosmic rays, although reproducing the observed flux at GZK energies requires a relatively efficiency in accelerating and releasing particles. If that were the case, GRBs in the Galaxy should account for intermittent contributions to sub-ankle cosmic-rays. Using a Monte-Carlo method and assuming a source population similar to that of long GRB, we derive constraints arising from intermittency. It is shown that the composition and anisotropy at 10^{18}eV are difficult to reproduce and require that either the particle mean free path is unusually small of the composition is heavier than suggested by recent Auger data. Therefore, it is highly desirable to reduce the systematic uncertainty in the experimental derivation of the UHECR composition.

Wed Astrophysical Messengers W6 – Gamma-Rays

Room: Millerzimmer Chair: Dieter Horns

16:50 Highlights from the ARGO-YBJ experiment (15+5′)

Ivan De Mitri (Università del Salento and INFN)

Very high energy gamma ray astronomy and cosmic ray physics in the 10^{12}–10^{15} eV primary energy range is among the main scientific goals of ARGO-YBJ. The detector, located in the Cosmic Ray Observatory of Yangbajing (Tibet, China) at 4300m a.s.l., is a full coverage Extensive Air Shower array consisting of a carpet of Resistive Plate Chambers (RPC) of about 6000 m^2. The apparatus layout, performance and location ensure a low energy threshold and a full sky coverage for gamma observation, while the hadronic component of the cosmic ray flux can be studied in deep detail in an energy window marked by the transition from direct to indirect measurements. Important information on hadronic physics at these energies can also be obtained. We will report on the main results so far obtained.

17:10 The HAWC observatory (15+5′)

Andreas Tepe (Georgia Institute of Technology)

The High Altitude Water Cherenkov (HAWC) Detector is a new instrument for high energy gamma-ray observation of the sky. HAWC, the successor of Milagro, is currently under construction in Mexico at Sierra Negra at an altitude of 4100 m (MSL). Due to its higher altitude, extended surface area and improved design, the sensitivity of HAWC is about 15 times higher than that of Milagro. The main features of HAWC are its high duty cycle, a wide field of view and a large effective area. HAWC will study galactic cosmic ray accelerators, active galactic nuclei and the diffuse gamma-ray sky. The large duty cycle and wide field of view make HAWC an ideal detector to the search for transient sources like GRBs. HAWCś two DAQ systems, the main DAQ and the scaler DAQ are well suited for GRB searches.

17:30 Cosmic rays, gamma rays and synchrotron radiation from the Milky Way (15+5′)

Elena Orlando (HEPL/KIPAC Stanford University)

Galactic cosmic rays (CRs), interstellar gamma-ray emission and synchrotron radiation are related topics. CR electrons propagate in the Galaxy and interact with the interstellar medium, producing inverse Compton emission measured in gamma rays and synchrotron emission measured in radio. I present an overview of the latest results with Fermi on the gamma-ray diffuse emission induced by CR protons, nuclei and electrons. I then focus on complementary studies of the synchrotron emission. Relevant observables include spectral indices, their variations and radio maps. We use synchrotron radiation to constrain the low-energy interstellar CR electron spectrum, models of propagation of CRs, and magnetic fields. Surveys over a wide range of radio frequencies are used, including polarization data.

17:50 Importance of axion-like particles for very-high-energy astrophysics (15+5′)

Marco Roncadelli (INFN Pavia)

Many extensions of the Standard Model predict the existence of axion-like particles (ALPs), which are very light spin-zero bosons with a two-photon coupling. We show that photon-ALP oscillations occurring in large-scale magnetic fields can produce harder photon spectra of very-high energy blazars. This effect is detecteble with the CTA and with the HAWC water Cherenkov gamma-ray observatory, and possibly with the currently operating Imaging Atmospheric Cherenkov Telescopes. Moreover, we show that the a new interpretation of the blazars detected so far above 100 GeV arises, according to which the large spread in the values of the observed spectral index is mainly due to the wide spread in the source distances rather than to large variations of their internal physical properties.

18:10 Constraints on the intergalactic magnetic field from gamma-ray observations of TeV blazars (15+5′)

Sergey Ostapchenko (Norwegian University for Science and Technology)

We discuss different approaches to infer the properties of the intergalactic magnetic field (IGMF) from gamma-ray observations of blazars. In particular, we investigate constraints on the IGMF properties, resulting from studies of TeV blazars by IACTs and Fermi-LAT and demonstrate that the non-observation of certain sources by Fermi-LAT indicates that a relatively strong magnetic field fills more than 60% of space, favoring the primordial IGMF origin.

Thu Astrophysical Messengers W7 – Gamma-Rays

Room: Millerzimmer Chair: Robert Wagner

14:30 The MAGIC telescopes: performance, results and future perspectives (15+5′)

Barbara De Lotto (University of Udine & INFN)

The MAGIC Cherenkov telescopes are operating in stereoscopic mode since almost two years. The improvements due to the stereoscopic upgrade, an overview on the physics results and the plans for the forthcoming upgrade will be presented.

14:50 The Crab pulsar above 100 GeV (12+3′)

Nepomuk Otte (University of California Santa Cruz)

It has been long thought that gamma-ray emission from pulsars cuts off sharply above a few GeV and that no emission would be observable above 100 GeV. With the VERITAS array of four imaging atmospheric Cherenkov telescopes we conducted a deep observation of the Crab pulsar and detected significant pulsed emission above 100 GeV. We discuss the detection and put it into context with present theoretical interpretation.

15:05 Observations of the Crab pulsar above 25 GeV with the MAGIC telescope (12+3′)

Stefan Klepser (IFAE, Barcelona)

The emission mechanism of pulsars is not fully understood yet, although the discovery of the first pulsar was more than 40 years ago. There were two major theoretical models which explain the pulsation, namely, the Polar Cap model and the Outer Gap model. The detection of the Crab pulsar above 25 GeV by MAGIC in 2008 excluded the Polar Cap model. The exponential cutoff spectra of many gamma-ray pulsars measured by Fermi-LAT since 2008 also excluded the Polar Cap model and supported the Outer Gap model. However, comparison of the energy spectrum of the Crab pulsar in Fermi-LAT energies (100 MeV to a few tens of GeV) and that in MAGIC energies (25 GeV to above100 GeV) revealed that the spectrum does not roll off as fast as the exponential cutoff above 25 GeV but that it extends following a power law, i.e. even Outer Gap model is not valid for the Crab pulsar. Here we would like to present the results of MAGIC observations of the Crab pulsar in the last three years. Observations were performed in two different modes, mono-mode with a threshold of 25 GeV and stereo-mode with a threshold of 50 GeV.

15:20 Very high energy optical depth of the universe (15+5′)

Dieter Horns (Universität Hamburg)

At sufficiently large energies, the Universe becomes optically thick due to pair production processes with the background photon field. We have investigated the transition from optically thin to the expected optically thick regime using all available spectral data points from very high energy emitting blazars at red-shifts from 0.004 to 0.536. We have carried out an unbiased search to find the transition under the assumption of a minimum background photon field. Using this guaranteed background radiation field, we have found with 3 st.deviations indications that the Universe appears less opticall thick than expected. We rule out systematic effects related to instruments or data selection by carrying out a mock-analysis on a null-sample of Galactic sources.

15:40 Prospects for a dark matter annihilation signal towards the Sagittarius dwarf galaxy with ground based Cherenkov telescopes (15+5′)

Aion Viana (CEA Saclay)

Dwarf galaxies are widely believed to be among the best targets for indirect dark matter (DM) searches using high-energy gamma rays; and indeed gamma-ray emission from these objects has long been a subject of detailed study for ground-based atmospheric Cherenkov telescopes. Here, we update current exclusion limits obtained on the Sagittarius dwarf galaxy, in light of recent realistic DM halo models. The limits are extrapolated to the sensitivities of future Cherenkov Telescope Arrays. For 200 h of observation time, the sensitivity reaches 10^{-25} cm^{3}s^{-1}. Possible astrophysical backgrounds from gamma-ray sources are studied. It is shown that the background from millisecond pulsars in a globular cluster contained within Sagittarius may limit the sensitivity to DM annihilation.

16:00 Searching for primordial black holes with the VERITAS gamma-ray experiment (15+5′)

Gordana Tešić (McGill University)

VERITAS is an array of four 12 m Cherenkov gamma-ray telescopes located in southern Arizona. It detects very-high-energy (VHE) gamma rays with energies between 100 GeV and 30 TeV, which originate from non-thermal processes in various astrophysical environments. VHE gamma rays could also be produced by evaporating primordial black holes (PBHs). Setting a limit on PBHs is important for cosmology, particle physics and quantum gravity. According to some theoretical models, PBHs evaporate and could produce bursts of VHE gamma rays detectable with VERITAS. We present the results from a search in the VERITAS data sample for evidence of gamma-ray bursts due to evaporating PBHs. A new constraint on the number density of PBHs is derived by comparing the VERITAS data with the model prediction.

POSTER SESSION

Venue: Courtyard Chair: Béla Majorovits

Tuesday, 6 Sept. 2011, 18:30–20:00

Drinks and snacks will be served.

Dark Matter

P1 **Principal properties of the velocity distribution of dark matter particles on the outskirts of the Solar System**

Anton Baushev (DESY, Zeuthen)

The velocity distribution of the dark matter particles on the outskirts of the Solar System remains unclear. We show that under very common assumptions it should be highly anisotropic and have a sharp maximum near $\upsilon \approx 500$ km/s. The distribution is totally different from the Maxwell one. We analyze the influence of the distribution function on the results of dark matter detection experiments. It is found that the direct detection signal should differ noticeably from the one calculated from the Maxwell distribution with $\langle \upsilon \rangle \approx 220$ km/s, which is conventional for direct detection experiments. Moreover, the sharp distinction from the Maxwell distribution can be very essential to the observations of dark matter annihilation.

P2 **A Phase III SIMPLE measurement?**

Tom Girard (Centro de Fisica Nuclear, Univ. de Lisboa)

Current plans of the SIMPLE project include a Phase III measurement based on a new device under development the past two years which contains a large superheated liquid droplet within a gel-sheathed vessel (effectively a bubble chamber). Apart from a change in refrigerant and improvements in the instrumentation, the experiment is to be re-shielded to provide an additional factor 10^4 in neutron suppression. I briefly describe the chamber and its instrumentation, the projected run configuration, and expected results.

P3 **Search for hidden baryons through scintillation**

Marc Moniez (IN2P3-CNRS)

We propose a new way to search for (hidden) cool molecular hydrogen H_2 in the Galaxy through diffractive and refractive effects: in favorable cases the light of a background star can be subject to stochastic fluctuations of the order of a few percent at a characteristic time scale of a few minutes. We tested the concept by observing stars in SMC and through nebulae with the NTT telescope. One star showed fluctuations compatible with a scintillation effect through a turbulent structure in B68 nebula. We could establish upper limits on the contribution of gas clumpuscules to the Galactic halo. We show that monitoring a few 10^6 star $\times$ hour with a > 4 m telescope and a fast readout camera should allow one to seriously constrain the contribution of turbulent molecular gas to the Galactic mass.

P4 **EDELWEISS detectors: From R&D to dark matter search**

Claudia Nones (CEA/IRFU/SPP)

Cryogenic Ge detectors used within the EDELWEISS experiment are subject to constant improvement with respect to the rejection capabilities against non WIMP interactions. These are driven by the performances obtained at a given step. A summary of the ionisation electrodes “InterDigit” detector evolution will be given with new possible solutions to improve the heat channel, with the ultimate goal of defining a building piece for the EURECA detector array.

P5 **Dark matter stability from non-Abelian discrete flavor symmetries**

Eduardo Peinado (IFIC Universidad de Valencia/CSIC)

The existence of non-baryonic Dark Matter (DM) is well established by cosmological and astrophysical probes. However, despite the great experimental efort over many years, its nature still remains elusive. Elucidating the long-standing puzzle of the nature of dark matter constitutes one of the most important challenges of modern cosmology and particle physics. We suggest that the same non-abelian discrete flavor symmetry which accounts for the observed pattern of neutrino oscillations, spontaneously breaks to a Z2 subgroup which renders DM stable. The simplest scheme leads to a scalar doublet DM potentially detectable in nuclear recoil experiments, inverse neutrino mass hierarchy, hence a neutrinoless double beta decay rate accessible to upcoming searches, while the reactor angle is zero.

P6 **Limits on inelastic dark matter from the CRESST experiment**

Jens Schmaler (Max-Planck-Institut für Physik)

The standard assumption of direct searches for WIMP Dark Matter is that the WIMPs scatter elastically off the nuclei in a target material. The corresponding nuclear recoils are then potentially detectable. In the recent past, an alternative idea has been frequently discussed, according to which the scattering process is inelastic. This kinematic modification affects the sensitivity of direct search experiments such that a signal may be detectable in experiments with heavy targets, while light target materials can make an experiment completely insensitive to inelastic Dark Matter interactions. This effect is particularly interesting, since it could possibly reconcile the long-standing signal claim of the DAMA/LIBRA collaboration with the null-results of other experiments. The CRESST Dark Matter search with $CaWO_4$ as a target material is highly sensitive to the scenario of inelastic DM because of the heavy tungsten nuclei. Based on the data obtained in the latest experimental run, we present exclusion limits for this model. We find that these limits rule out the complete parameter space compatible with the signal in DAMA/LIBRA under the standard astrophysical assumptions and when no ion channeling is assumed.

P7 **Determining WIMP properties with non-negligible background events**

Chung-Lin Shan (Department of Physics, National Cheng Kung University)

In this poster, I present effects on the determination of WIMP properties caused by a small, but non-negligible fraction of residue background events, which pass all discrimination criteria and then mix with other real WIMP-induced events in data sets. Corrections of the reconstructed WIMP properties as well as a possible check for the purity/availability of the analyzed data sets will also be discussed.

P8 **Supersymmetric left-right models and low energy phenomenology**

Avelino Vicente (Universität Würzburg)

The see-saw mechanism is the most popular explanation for the smallness of neutrino masses. However, its high scale implies that only indirect signals at low energies are reachable, lepton flavor violation in SUSY models being the best example. In this poster I will discuss lepton flavor violating signatures and dark matter phenomenology in the context of a SUSY left-right model that naturally incorporates the seesaw mechanism. This non-minimal embedding of the seesaw leads to observable LFV effects in the right sleptons sector, contrary to minimal seesaw models where these are found to be totally negligible. Moreover, the deformation of the low energy spectrum leads to some other interesting differences. In particular, dark matter relic density might clearly depart from the standard picture.

Astrophysical Messengers

P9 **Underground cosmic-ray experiment EMMA**

Timo Enqvist (University of Oulu)

EMMA (Experiment with MultiMuon Array) is a dedicated underground cosmic-ray experiment at the shallow depth of 75 metres in the Pyhäsalmi mine, Finland, aiming at the composition analysis in the knee region. The array will consists of nine detector stations of 15 square metres each. It measures the muon multiplicity, its lateral density distribution and the arrival angle of an air shower. CORSIKA simulations predict that the lateral density distributions for muons of energy of 50 GeV or more are sensitive to the energy and mass of the primary cosmic-ray particle. Moreover, these distributions are nearly model independent at the knee region. Two-third of the array has now been completed. First results measured with the partial array will be presented with comparison to model predictions.

P10 **Neutrinos from gamma-ray bursts in the Fermi era**

Svenja Hümmer (Universität Würzburg)

We reanalyse the well known Waxman-Bahcall gamma-ray burst flux applying a detailed photohadronics treatment and allowing for magnetic field and flavor effects. We investigate the consequences the results have on diffuse fluxes using a Monte Carlo simulation, and we study the connection to the gamma-ray counterpart in the era of Fermi. In addition, we comment on the properties of those gamma-ray bursts which may dominate the prompt neutrino flux, and on the interpretation of recent IceCube results.

P11 **Plasma influence on neutrino electromagnetic properties**

Alexey Lokhov (Department of Theoretical Physics, Moscow State University)

We discuss recently discovered phenomena connected with neutrino possessing non-zero magnetic moment and thus interacting electromagnetically. We exactly account for dense plasma presence (which is typical situation for neutron stars, for instance) while studying neutrino emitting electromagnetic radiation via the spin-light mechanism.

P12 **On the mass composition of primary cosmic rays in the energy region 10^{15}–10^{16} eV**

Yury Novoseltsev (Institute for Nuclear Research of RAS)

A new analysis of high multiplicity muon events ($n_\mu > 114$) collected at the Baksan underground scintillation telescope is presented. Within the framework of three components (protons, helium and heavy nuclei), the mass composition in the region $10^{15} - 10^{16}$ eV has been defined. Our analysis shows that the mass composition becomes more heavy $\approx \ln(A)$ increases from 1.85 (at $E = 10^{14}$ eV) to 1.98.

P13 **Ultrahigh-energy cosmic ray spectrum from near AGN**

Olga Shustova (Skobeltsyn Research Institute of Nuclear Physics)

The origin of the UHECR sources is one of the main open problems in modern CR astrophysics. It is well known that the composition of CR nuclei is strongly distorted at extremely high energies due to their interaction with background photons. We analyze the propagation of protons and heavy nuclei from active galactic nuclei which are located around us within 40 Mpc, assuming that intensity and abundance of CR particles coincide for all sources. So the power index γ_0 of the initial spectrum is the only parameter relevant. We calculate the UHECR spectra at different γ_0 and compare our results with experimental data.

P14 **Analysis of inclined air showers and search for ultra-high energy neutrinos and photons with the Pierre Auger Observatory.**

Ines Valino Rielo (University of Santiago de Compostela)

The Pierre Auger Observatory distinguishes itself by being well suited to detect showers arriving at the ground with zenith angles up to 90 deg, and provides a unique tool to search for primary photons and neutrinos in ultra-high energy (UHE) cosmic rays. We present the cosmic-ray energy spectrum above 4 EeV obtained from a dedicated analysis of inclined air showers with zenith angles larger than 60 deg. This analysis also leads to a measurement of

the muon content in inclined showers relative to the model predictions. We also present the latest results on the search for UHE neutrinos and photons, reporting updated upper limits on neutrino and photon fluxes in the sub-EeV range and above.

Neutrino Properties

P15 Identification of neutrons produced from neutrino interactions with water and its physics application at Super-Kamiokande IV

Shaomin Chen (Tsinghua University)

With the electronics upgrade in 2008, the fourth phase of Super-Kamiokande (SK-IV) is now capable of indentifying thermal neutrons from neutrino interactions with water. A detailed study has been conducted in determining the relevant efficiency and background probability. This poster will present an analysis of neutron yield and neutron multiplicity in atmospheric neutrino data, together with a preliminary result of background study for supernova relic neutrino (SRN) detection from SK-IV data sample. Also discussed are prospects of future SRN searches and possible improvement of background rejection for proton decay searches with neutron identification – potentially gadolinium-enhanced – in SK-IV and beyond.

P16 Hunt for θ_{13} with LENA

Kai Loo (University of Jyväskylä, Department of Physics)

In a hunt for missing neutrino mixing angle θ_{13} the reactor neutrino experiments are moving towards the data-taking phase. The possible small effect of θ_{13} can be complementarily probed using artificially made source of mono-chromatic neutrinos with low energies originated from electron captures. The small energies and cross sections, and expected tiny effect of θ_{13} give a support to the use of large liquid scintillation detector. In this poster, the estimated sensitivities for measurement of mixing angle θ_{13} is presented in context of LENA. Event rates for analysis are calculated by using low-energy electron neutrinos originated from so far the best source candidates ^{51}Cr and ^{75}Se. The search for possible sterile flavors of neutrinos is also discussed.

P17 Large extra dimensions and the reactor antineutrino anomaly

Hiroshi Nunokawa (Dep. of Physics, Pontificia Univ. Catolica do Rio de Janeiro (PUC-Rio))

Recently, there has been a reevaluation of the reactor antineutrino spectra which increased the mean flux by 3%. The analysis of the former reactor antineutrino experiments with the new spectra revealed a 2.2σ deviation from the consolidated 3 neutrino framework. Together with gallium solar neutrino calibration experiments, this deviation is around 3σ. We show that in the context of a model with large extra dimensions the mixing between active neutrinos and sterile KK modes could be responsible for this anomaly.

P18 The ultimate Borexino impact in the global analysis of neutrino data

Alessandra Carlotta Re (Università degli Studi and INFN di Milano)

The Borexino collaboration has recently published the most precise, direct measurement of ^{7}Be solar neutrino rate and the exclusion of a significant day-night asymmetry. These results, combined with the other solar neutrino data, isolate for the first time the Large Mixing Angle solution at $\Delta\chi^2 > 190$ (2 d.o.f.) without relying on the antineutrino results. I present a phenomenological analysis of neutrino data (the most up-todate from solar, reactor, atmospheric and accelerator experiments) within the standard scenario of three non-sterile and mixed neutrinos. The aim is to study the implications of Borexino results in neutrino physics and solar interior astrophysics.

P19 Phenomenology of neutrino oscillations at the neutrino factory

Jian Tang (TPII, ITPA, Würzburg University)

We consider the prospects for a neutrino factory to measure mixing angles, the CP violating phase and mass square differences by detect wrong-sign muons arising from electron-(anti)neutrino to muon-(anti)neutrino through neutrino oscillations. First, we study physics with near detectors and consider the systematics treatment including cross section errors, flux errors, and background uncertainties. Second, we perform the baseline and energy optimization of the Neutrino Factory including the latest simulation results on the magnetized iron detector (MIND). We also consider the impact of tau decays, generated by appearance from electron or muon neutrinos. Third, effects of one additional massive sterile neutrino are discussed in the context of a combined short and long baseline setup. It is found that near detectors can provide the expected sensitivity at the LSND-motivated Δm^2_{41}-range, while some sensitivity can also be obtained in the region of the atmospheric mass splitting induced by the sterile neutrino from the long baselines.

Cosmology

P20 Thermal axion production in the primordial quark-gluon plasma

Peter Graf (Max-Planck-Institute for Physics)

We calculate the rate for thermal production of axions via scattering of quarks and gluons in the primordial quark-gluon plasma. To obtain a finite result in a gauge-invariant way that is consistent to leading order in the strong gauge coupling, we use systematic field theoretical methods such as hard thermal loop resummation and the Braaten-Yuan prescription. The thermally produced yield, the decoupling temperature, and the density parameter are computed for axions with a mass below 10 meV. In this regime, with a Peccei-Quinn scale above 6×10^8 GeV, the associated axion population can still be relativistic today and can coexist with the axion cold dark matter condensate.

P21 **Polytropic and Chaplygin f(T)-gravity models**

Kayoomars Karami (Department of Physics, University of Kurdistan)

We reconstruct the different f(T)-gravity models corresponding to a set of dark energy scenarios containing the polytropic, the standard Chaplygin, the generalized Chaplygin and the modified Chaplygin gas models. We also derive the equation of state parameter of the selected f(T)-gravity models and obtain the necessary conditions for crossing the phantom-divide line.

P22 **Temperature dependent resolution of cosmological scalar field**

Murli Manohar Verma (Department of Physics, Lucknow University)

We discuss the cosmological scalar field which at present reveals itself in form of matter and radiation etc. as the special forms of quantized equation of state, whose manifestation is temperature dependent. This is presented in a three-phase scenario of the evolution of the universe. In phase one and three , the cosmological constant does not interact with the background and so remains a true constant, while in the intermediate phase two, it interacts and loses its strength thereby indicating a possible solution to the cosmological constant problem. We show that such a mechanism is consistent with present observations, in form of arc-like pattern on CMBR, as well as the logical theoretical two-component structure of the relativistic tachyonic scalar field.

P23 **The meV frontier of axion physics**

Javier Redondo (MPP Munich)

The cooling speed of white dwarfs suggests a possible new energy-loss channel, consistent with axions if their Yukawa coupling to electrons is $g \approx 10^{-13}$ corresponding to a mass of a few meV. In this case axions provide less than 0.1% of the cosmic cold dark matter, whereas core-collapse supernovae release a large fraction of their energy in the form of axions. We estimate the diffuse supernova axion background (DSAB) from all past supernovae, consisting of 30 MeV-range axions with a radiation density comparable to the extra-galactic background light. The DSAB would be extremely challenging to detect, but axions with white-dwarf inspired parameters may be accessible in a next or next-to-next generation axion helioscope.

P24 **Galaxy population of SPT-SZ selected galaxy clusters.**

Alfredo Zenteno (Universitäts-Sternwarte München)

By detecting clusters of galaxies by mean of the Sunyaev-Zeldovich effect on the cosmic microwave background, the South Pole Telescope team has been contructing a sample of hundreds of clusters. One of the characteristics of such a sample is that the selection function is nearly redshift independent, allowing us to study evolutionary effect on the galaxy population. With that goal we study optical properties of the galaxy population by constructing the luminosity function, the radial profile, the Halo Occupation number and the blue fraction for those SPT-SZ selected galaxy clusters. We will present an analysis of a sample of 250 clusters, from the latest published SPT results, where the optical followup is complete.

Low-Background Techniques

Time variation of the neutron background rate measured in the Gran Sasso underground laboratory. *P25*

Gianmarco Bruno (INFN-LNGS and University of L'Aquila)

Some of the most sensitive detectors presently running are placed in the INFN Gran Sasso National Laboratory, probing low background regions never studied before. Experiments searching for rare events, like double beta decay or dark matter interactions require accurate knowledge of the background conditions in which they operate, especially concerning neutrons. Thanks to its large cross-section and high energy released for neutron capture processes, gadolinium has been widely adopted to detect neutrons in the presence of strong gamma background. One ton of Gd-loaded liquid scintillator has been employed to set-up a detector to study the temporal evolution of the neutron field in the Gran Sasso Laboratory. We present in this work the first data obtained and their possible interpretation.

Rare event searches based on Micromegas detectors *P26*

Theopisti Dafni (Universidad de Zaragoza)

Micromegas are being used or considered as readout of TPCs in the field of Rare Event searches (dark matter, axions or double beta decay). Several prototypes and setups based on Micromegas have been developed in order to improve different features. A low background level is one of the most important objectives pursued with one of the prototypes, placing it inside different configuration shielding and operating it underground. In addition, pressure chambers are being operated with Micromegas, registering the energy and the track of each event, which will improve further discrimination techniques, leading to better sensitivity. Gas mixtures or operation pressure studies, have been also done. Description of the setups, as well as first data taken is presented together future prospects.

LArGe – R&D for active background suppression in GERDA *P27*

Mark Heisel (Max-Planck-Institut für Kernphysik)

LArGe is a GERDA low-background test facility to study novel background suppression methods for future application in GERDA. Similar to GERDA, LArGe operates bare germanium detectors in liquid argon (1 m^3), which in addition is instrumented with photomultipliers to detect argon scintillation light. The light is used to effectively suppress background events. The suppression efficiency was studied in combination with a pulse shape discrimination (PSD) technique for various sources, which represent characteristic backgrounds to GERDA. Suppression factors of a few times 10^3 have been achieved. First background data of LArGe (without PSD) yield a background index at the level of the GERDA phase I design goal. As a result, the development of an active liquid argon veto in GERDA is pursued.

P28 **Maintaining cleanliness in liquid noble gases**

Kai Martens (IPMU, The University of Tokyo)

To maintain viability of the massive liquid argon and liquid xenon detectors called for in the next round of underground experiments, contaminants will have to be removed continually from the liquid in the detector. An elegant way of doing this is by means of electron as well as hole currents sweeping the liquid and attaching to the contaminants that can then be drifted out of a properly designed primary bulk liquid circulation system to be concentrated in a smaller secondary circulation system for further treatment. We will be discussing electro-formed Cu structures for charge injection into the liquid by field emission, which is suitable for both, electron and hole injection.

P29 **The MGDO software libraries for Ge neutrinoless double beta decay experiments**

Luciano Pandola (INFN-LNGS)

The GERDA and Majorana experiments will search for neutrinoless double beta decay of Ge-76 using Germanium detectors enriched in the isotope of interest. While the experiments differ for several design concepts, they have many aspects in common, including analysis tools. In this contribution a new joint software library called MGDO (Majorana-Gerda Data Object) is described. MGDO contains a set of generic interfaces and data objects to encapsulate, store and manage physical quantities of interest, including waveforms, run and event level information. The existence of standardized interfaces and containers eases the exchange and the cross-comparison of simulation output and experimental data.

P30 **Measurement of the differential neutron flux inside a lead shielding in a cryogenic experiment**

Jorge Puimedon (University of Zaragoza)

The ROSEBUD collaboration measured the differential flux of neutrons inside a shielding of lead irradiated with a source of ^{252}Cf using two scintillating bolometers of LiF and Al_2O_3 at 20 mK. We compare an unfolding method using a three parameter model for the fast component of the neutron flux with a multigroup method in which the energy interval of interest is divided in groups. Some issues regarding the neutron monitoring with LiF or Al_2O_3 in a cryogenic experiment searching for dark matter WIMPs are discussed.

P31 **Tools for advanced data analysis in the GERDA neutrinoless double beta decay experiment**

Paolo Zavarise (L'Aquila University – INFN LNGS)

The GERDA experiment at the Gran Sasso Laboratory will look for neutrinoless double beta decay in Ge-76 by using enriched germanium detectors. In order to minimize the background it is necessary to use advanced techniques for data analysis, including pulse shape discrimination and time correlation with muon veto events. In this contribution the original software tools developed for the GERDA data analysis will be described. A few real-life examples based on the GERDA commissioning data will be presented. The applications will include both the analysis framework GELATIO and the correlated SQL database, which allows the direct management of the event information and the data quality control.

Author Index

Aharonian, Felix, 9
Akhmedov, Evgeny, 26
Allen, Bruce, 34
Ansari, Reza, 21
Arcadi, Giorgio, 17
Arina, Chiara, 13
Aristizabal, Diego, 23
Armengaud, Eric, 6

Böser, Sebastian, 36, 38
Barabash, Alexander, 23
Barbeau, Phillip, 24
Baudis, Laura, 15, 18
Baushev, Anton, 41
Bays, Kirk, 32
Beacom, John, 8
Bellini, Gianpaolo, 7
Bertin, Vincent, 12
Bertucci, Bruna, 5
Biagi, Simone, 38
Billard, Julien, 12
Bludman, Sidney, 21
Boriero, Daniel, 20
Borriello, Enrico, 14
Bottino, Alessandro, 6
Bouchet, Francois, 5
Boulay, Mark, 18
Branchesi, Marica, 33
Bringmann, Torsten, 11
Bruno, Gianmarco, 44

Caccianiga, Barbara, 29
Cadamuro, Davide, 20
Cadonati, Laura, 33
Cardani, Laura, 22
Cattadori, Carla Maria, 22
Cazon Boado, Lorenzo, 35
Cerulli, Riccardo, 16
Chakraborty, Sovan, 32
Chen, Mark, 29
Chen, Shaomin, 43
Chukanov, Artem, 28
Coccia, Eugenio, 9, 10, 33
Collar, Juan, 6
Cremonesi, Oliviero, 25
Cucoanes, Andi Sebastian, 26
Cuesta, Clara, 16

Dafni, Theopisti, 44
Danevich, Fedor, 25
Danninger, Matthias, 12
Das, Chitta Ranjan, 11
De Lotto, Barbara, 8, 40
De Mitri, Ivan, 39
De Simone, Andrea, 14
Desai, Shantanu, 20
Di Domizio, Sergio, 22
Di Palma, Irene, 34
Di Sciascio, Giuseppe, 36
Di Virgilio, Angela D. V., 34
Dighe, Amol, 29, 32
Donato, Fiorenza, 11

Egorov, Viacheslav, 26
Eitel, Klaus, 13, 15
Enqvist, Timo, 42
Escrihuela, Francisco Javier, 28

Fantaye, Yabebal, 19
Fargion, Daniele, 36
Fehr, Felix, 36
Felizardo da Costa, Miguel, 16
Fleming, Bonnie, 7
Formaggio, Joseph, 22
Fornengo, Nicolao, 13, 17
Fukuda, Yoshiyuki, 32

Gerbier, Gilles, 15, 18
Giovanetti, Graham, 12
Girard, Tom, 41
Giuliani, Andrea, 22
Gorbachev, Valery, 27
Gorla, Paolo, 23
Goswami, Srubabati, 26
Graf, Peter, 43
Gratta, Giorgio, 22
Grefe, Michael, 11
Gross, Eilam, 13

Hümmer, Svenja, 42
Ha, Chang Hyon, 37
Hall, Carter, 18
Hamann, Jan, 19
Hannen, Volker, 7
Hannestad, Steen, 19, 20
Hanson, Kael, 38
Hartnell, Jeffrey, 24
Heeger, Karsten, 26, 27
Heisel, Mark, 44
Hernandez-Rey, Juan Jose, 37
Hirsch, Martin, 22
Horns, Dieter, 14, 39, 40

Ianni, Aldo, 27, 30
Ikeda, Daisuke, 36
Incicchitti, Antonella, 7
Ioannisian, Ara, 31
Ishihara, Nobuhiro, 23

Jochum, Josef, 16

Kaboth, Asher, 12
Kachelriess, Michael, 35
Kajita, Takaaki, 5
Kalashev, Oleg, 37
Karagiorgi, Georgia, 28
Karami, Kayoomars, 44
Kim, Sun Kee, 16
Klages, Hans, 35, 36
Klepser, Stefan, 40
Kornoukhov, Vasily, 25
Kowalski, Marek, 30, 35
Kozlov, Alexandre, 25
Krolak, Andrzej, 34
Kuroda, Kazuaki, 9

Lück, Harald, 34
Lachenmaier, Tobias, 26
Lai, Kwang-Chang, 37
Lakic, Biljana, 20
Lanfranchi, Jean-Côme, 11
Lang, Rafael, 6
Lasserre, Thierry, 7, 27
Lavalle, Julien, 14
Lindner, Manfred, 7
Lineros Rodriguez, Roberto Alfredo, 14
Lippincott, Hugh, 16
Lisi, Eligio, 7
Liu, Jing, 18
Loaiza, Pia, 15
Lokhov, Alexey, 42
Loo, Kai, 43
Lopez Honorez, Laura, 21
Lozza, Valentina, 29

Maccione, Luca, 36
Macolino, Carla, 35
Majorovits, Béla, 41
Majumdar, Debasish, 21
Mambrini, Yann, 17
Manalaysay, Aaron, 18
Manohar Verma, Murli, 44
Mantovani, Fabio, 30
Marka, Szabolcs, 33, 34
Marrodán Undagoitia, Teresa, 11
Martens, Kai, 45
Martinez, Maria, 15
Maruyama, Reina, 16
Meli, Athina, 37
Menegolli, Alessandro, 26
Merle, Alexander, 17
Miyoki, Shinji, 33
Molinaro, Emiliano, 24
Moniez, Marc, 41
Monrabal Capilla, Francesc, 24
Monroe, Jocelyn, 18
Montaruli, Teresa, 8
Muñoz, Carlos, 6
Murayama, Hitoshi, 10
Murphy, Sébastien, 27

Nakadaira, Takeshi, 7
Nakamura, Kiseki, 12
Nakayama, Shoei, 28

Naples, Donna, 28
Niro, Viviana, 11
Nones, Claudia, 41
Novoseltsev, Yury, 42
Nunokawa, Hiroshi, 43

Oberauer, Lothar, 6
Ogawa, Izumi, 23
Oldorf, Christian, 24
Olinto, Angela, 8
Orlando, Elena, 39
Orrell, John, 13
Ostapchenko, Sergey, 39
Ota, Toshihiko, 17
Otte, Nepomuk, 38, 40

Palazzo, Antonio, 29
Pandola, Luciano, 45
Paneque, David, 9
Pastor, Sergio, 19
Patzak, Thomas, 28, 31
Peinado, Eduardo, 41
Petricca, Federica, 6
Pfahler, Patrick, 27
Pohl, Martin, 38
Pospelov, Maxim, 5
Potzel, Walter, 29
Prodi, Giovanni Andrea, 33
Puimedon, Jorge, 45
Pulido, João, 32

Raffelt, Georg, 5
Rau, Wolfgang, 6
Re, Alessandra Carlotta, 43
Rebel, Brian, 26
Redondo, Javier, 44
Regenfus, Christian, 18
Renzi, Alessandro, 19
Resconi, Elisa, 12
Ricci, Marco, 36, 37
Rodin, Vadim, 23
Roncadelli, Marco, 37, 39
Ronga, Francesco, 34
Roy, Probir, 25
Rubbia, André, 28, 31
Rukhadze, Nikolay, 25

Saldanha, Richard, 29
Schmaler, Jens, 41
Schönert, Stefan, 22
Scholberg, Kate, 8, 32
Scholl, Stephan, 15
Schwingenheuer, Bernhard, 7
Scorza, Silvia, 15
Scott, Pat, 19
Semikoz, Dmitri, 35
Serpico, Pasquale, 5, 11
Shan, Chung-Lin, 42
Sherwood Lollar, Barbara, 8
Shustova, Olga, 42
Simard, Laurent, 22
Sinclair, David, 7
Sioli, Maximiliano, 38
Smirnov, Oleg, 30
Smith, Nigel, 6
Soares-Santos, Marcelle, 21
Sokolsky, Pierre, 35, 36
Sorensen, Peter, 13
Spiering, Christian, 8
Studenikin, Alexander, 30
Stuke, Maik, 20
Suekane, Fumihiko, 26
Suhonen, Jouni, 23, 24
Suzuki, Yoichiro, 7

Tamborra, Irene, 32
Tang, Jian, 43
Taoso, Marco, 14
Tepe, Andreas, 39
Tešić, Gordana, 40
Tolich, Nikolai, 29
Tretyak, Vladimir, 24
Trzaska, Wladyslaw Henryk, 31

Ulrich, Ralf, 35

Valino Rielo, Ines, 42
Viana, Aion, 40
Vicente, Avelino, 42
Vignati, Marco, 24
Villante, Francesco, 29
Vitells, Ofer, 38
von Feilitzsch, Franz, 27

Wagner, Robert, 35, 40
Wang, Zhimin, 27
Watanabe, Hiroko, 30
Waxmann, Eli, 8
Weinstein, Alan, 9
Weller, Jochen, 19, 21
Weniger, Christoph, 11
Whitehorn, Nathan, 38
Wilkerson, John, 22
Winter, Jürgen, 31
Winter, Walter, 37
Wong, Henry, 13, 30
Wong, Yvonne, 5, 19
Wurm, Michael, 29, 31

Xing, Zhi-zhong, 17

Zacek, Viktor, 16
Zavarise, Paolo, 45
Zenteno, Alfredo, 44
Zukanovich Funchal, Renata, 31