APS April Meeting 2010
Washington, DC
http://www.aps.org/meetings/april/index.cfm
Fermi Observations of Gamma-ray Pulsars

LUCAS GUILLEMOT, Max-Planck-Institut für Radioastronomie — A year and a half after Fermi was launched, the number of known gamma-ray pulsars has increased dramatically. For the first time, a sizeable population of pulsars has been discovered in gamma-ray data alone. For the first time, millisecond pulsars have been confirmed as powerful sources of gamma-ray emission, and a whole population of these objects is seen with the LAT. The remaining gamma-ray pulsars are young pulsars, discovered via an efficient collaboration with radio and X-ray telescopes. It is now clear that a large fraction of the nearby energetic pulsars are gamma-ray emitters, whose luminosity growth is driven by the down energy losses in core-collapse supernovae or newly born black holes. By taking into account only radiative and supergravity corrections, it is well known that the tensor to scalar ratio \( r = 0.963 \pm 0.014 \) is found by WMAP5. In the absence of this soft term, and by taking into account only radiative and supergravity corrections, it is well known that the tensor to scalar ratio \( r \) is quite small in these models, taking on values \( r \geq 0.985 \). This same soft term has previously been shown to play a key role in resolving the MSSM \( \mu \) problem. The tensor to scalar ratio \( r \) is quite small in these models, taking on values \( r \leq 10^{-5} \) in the WMAP5 2\( \sigma \) range of \( n_s \).

Implications of Fermi Observations for Gamma-Ray Pulsar Emission Models

MATTHEW BARING, Rice University — Pulsars are powerful sources of radiation across the electromagnetic spectrum. This review will highlight some recent theoretical insights into non-thermal, magnetospheric pulsar gamma-ray radiation. These advances have been driven by the huge data infusion provided by NASA’s Fermi mission, launched in mid-2008. The LAT instrument on Fermi has afforded the discrimination between polar cap and slot gap/outer gap acceleration zones in young and middle-aged pulsars. Altitude discernment using the highest energy pulsar photons will be addressed, as well as inferences of the primary radiation mechanism in the LAT band using phase-resolved spectroscopy, connecting to both polar cap/slot gap and outer gap scenarios. Focuses on curvature radiation and pair creation will be included, as well as population trends that may afford probes of the magnetospheric accelerating potential. While the Vela pulsar serves as a principal test case, the geometrical and emission model interpretation of Fermi LAT results for several other young pulsars will also be discussed. An additional brief focus will be the implications of Fermi observations for millisecond pulsars.

Particle acceleration in pulsar magnetospheres

ANATOLY SPITKOVSKY, Princeton University — Fermi Telescope has dramatically expanded the sample of gamma-ray pulsars. The quality of pulsar light curves and spectra is exceptional, and allows a direct study of the magnetospheric processes that lead to the emission of gamma-rays. I will review the theoretical understanding of pulsar magnetospheres and discuss how gamma-ray light curves and spectra can be used to determine the location of the emitting zones and the geometry of magnetic field. It is now clear that the emission is coming from the outer magnetosphere, where the deviations from dipolar field geometry due to plasma currents must be taken into account. I will discuss the modeling of gamma-ray light curves in plasma-filled (force-free) magnetospheres. The double-peaked nature of the gamma-ray light curves observed by Fermi tells us that the accelerating regions are related to the location of strong currents sheets in plasma-filled magnetosphere. Plasma physics and particle acceleration in these current sheets needs to be understood, and will be strongly constrained by modeling of the phase-resolved spectra from Fermi. Gamma rays carry a significant fraction of spin down energy in pulsars; thus, Fermi observations are probing the heart of the electromagnetic pulsar machine.

Numerical Cosmology: Building a Dynamical Universe

DAVID GARRISON, UH Clear Lake — In this talk, I discuss an often over-looked aspect of most cosmological models, dynamical interactions caused by gravitational waves. Did gravitational waves interacting with the primordial plasma field result in a chaotic system? What impact would such a system have on cosmic structure formation? I begin by reviewing our current state of knowledge involving gravitational waves in the early universe. Then, I review work done to understand the physics of turbulent plasmas. Finally, I show the results of computer simulations of gravitational wave/plasma interactions in the early universe. This work seeks to explain what role gravitational waves played in the early universe when interacting with the primordial plasma field, primordial seed magnetic fields and cold dark matter.

Extending the validity of Lagrangian Perturbation Theory

SHARVARI NADKARNI-GHOSH, Dept. of Physics, Cornell University, DAVID CHERNOFF, Dept. of Astronomy, Cornell University — Lagrangian Perturbation Theory (LPT) has been widely used to model the non-linear growth of large-scale structure analytically. However, it is known that the Lagrangian series fails to converge when applied to spherical voids. The work to be presented discusses the convergence properties for homogeneous spherical top-hats with arbitrary initial density and velocity perturbations. For this special class of problems, we derive the time of validity of the series and demonstrate how to extend the range of validity. The conclusion is that LPT should be viewed as a finite difference approximation, which, similar to the Euler-Poisson system can diverge prior to shell crossings and it requires a time-step condition to assure stability and yield convergent results.

Supersymmetric Hybrid Inflation Redux

MANSOOR UR REHMAN, QAISAR SHAFI, JOSHUA R. WICKMAN, Bartol Research Institute, Department of Physics and Astronomy, University of Delaware — We discuss the important role played during inflation by one of the soft supersymmetry breaking terms in the inflationary potential of supersymmetric hybrid inflation models. With minimal Kahler potential, the tensor to scalar ratio \( r = 0.963 \pm 0.014 \) is found by WMAP5. In the absence of this soft term, and by taking into account only radiative and supergravity corrections, it is well known that the tensor to scalar ratio \( r \) is quite small in these models, taking on values \( r \leq 10^{-5} \) in the WMAP5 2\( \sigma \) range of \( n_s \).

Astrophysical Searches for Extra Spatial Dimensions

MICHAEL KAVIC, The College of New Jersey, JOHN SIMONETTI, DJORJDE MIÑIC, Virginia Tech — Extra spatial dimensions have been employed in theoretical physics for quite some time now. Earth-bound experimental tests for the existence of extra spatial dimensions are currently limited. Astrophysical tests are also possible. I will review some of the basic conceptual ideas that underlie the theories. Then I will discuss some astrophysical observations that could test for the existence of extra spatial dimensions.
9:18AM A13.00005 Cosmological Constraints on Moduli from Cosmic Strings, ERAY SABANCILAR, Tufts Institute of Cosmology, Tufts University. Cosmological constraints on moduli, whose coupling to matter is stronger than Planck mass suppressed coupling, are derived. In particular, moduli are considered to be produced by oscillating loops of cosmic strings and constraints are obtained from their effects on big bang nucleosynthesis and their contribution to diffuse gamma ray background and dark matter. Large volume and warped Type-IIB flux compactifications are taken as examples where strongly coupled moduli are present. Finally, the constraints on cosmic string tension, modulus mass and modulus coupling constant are obtained and it is shown that the constraints are relaxed significantly when the coupling constant is large enough. In addition, the effect of thermal production of moduli is considered and the corresponding constraints are derived.

9:30AM A13.00006 Combining Shear Statistics to Constrain Cosmological Parameters, SEDONA PRICE, California Institute of Technology, JASON RHODES, JOEL BERGE, Jet Propulsion Laboratory/California Institute of Technology, RICHARD ELLIS, California Institute of Technology. Weak gravitational lensing causes shear in the images of distant galaxies. Shear statistics can be measured from high-quality astronomical images and then fit to theoretical expectations. Thus constraints can be made on dark matter structures and on dark energy. Code to measure the two-point correlation function (2PCF) including tomography (redshift information) is modified and developed. Code to measure the signal-to-noise peak counts is adopted. The 2PCF and peak counts are measured on a shear catalog derived from the Hubble Space Telescope COSMOS survey. Constraints on cosmological parameters are then derived from the measured 2PCF and from the peak counts. These constraints are combined to break the degeneracy between the matter mass density ($\Omega_m$) and the amplitude of density fluctuations ($\sigma_8$), making the overall set of constraints tighter.

9:42AM A13.00007 Testing General Relativity on Cosmological Scales with Weak Gravitational Lensing, ALI VANDERVELD, Caltech/JPL. Weak gravitational lensing is a powerful probe of modifications of General Relativity on cosmological scales, since such modifications can affect both how matter produces gravitational potential wells and how photons move within these wells. We will discuss alternative theories of gravitation and how we may constrain such theories using weak lensing observables, including those that could be obtained with the balloon-borne High Altitude Lensing Observatory (HALO). I will also discuss the "parametrized-post-Friedmannian" approach for obtaining model-independent constraints, in which new parameters are introduced to characterize the departure from General Relativity on large scales.

9:54AM A13.00008 Cosmological Tests of General Relativity with tomographic surveys, ALESSANDRA SILVESTRI, MIT, Kavli Institute for Astrophysics and Space Research, GONGBO ZHAO, ICG Portsmouth, UK, LEVON POGOSIAN, Simon Fraser University, Canada, JOEL ZYLBERBERG, University of California, Berkeley. Future cosmological surveys, combining galaxy counts and weak lensing measurements, will map the evolution of matter perturbations and gravitational potentials from the matter dominated epoch until today. In addition to tightening the constraints on allowed expansion histories, the combination of these measurements will test the relationships between matter overdensities, local curvature, and the Newtonian potential. These relation- ships can be modi?ed in alternative theories of gravity and by exotic forms of Dark Energy. I will present a study of the potential of upcoming and future tomographic surveys, such as DES and LSST, with the aid of CMB and supernovae data, to detect departures from the growth of perturbations expected within General Relativity with a cosmological constant.

10:06AM A13.00009 Parameter Estimation Forecasts in Cosmology, RAHUL BISWAS. In the current era of precision cosmology, new extremely well planned observational missions are being designed to study cosmology to unprecedented detail. Such missions will not only allow us to constrain the free parameters in the standard model of cosmology, but also to test the possible departures in this model. In order to optimize the scientific impact of these surveys, it is therefore essential to forecast the constraints from these surveys, and also study different ways in which this data can be used to study cosmology. We discuss forecasts, in particular those pertaining to dark energy studies from the planned surveys.

Saturday, February 13, 2010 10:45AM - 12:33PM

10:45AM B3.00001 European Strategy for Astroparticle Physics, STAVROS KATSANEVAS, IN2P3/CNRS. Astroparticle Physics emerged worldwide, in the last 20 years, from a field of charismatic pioneers transgressing disciplinary frontiers using risky and innovative detection techniques to a full blown global science activity involving many hundreds of researchers and hundred million or billion dollar scale projects. I will report on the recent effort to develop a strategic vision, roadmap and action plan for this field in Europe, performed under the auspices of ApPeC (Astroparticle Physics European Coordination) and in the context of the European Union program ASPERA. I will describe the many links that tie the proposed large observatories to the corresponding US and more generally worldwide infrastructures, as well as the efforts to a global coordination in progress.

11:21AM B3.00002 Report from the Particle Astrophysics Scientific Assessment Group, STEVE RITZ, SCIPP, University of California - Santa Cruz. No abstract available.

11:57AM B3.00003 Japanese Programs in Astro-Particle Physics, HITOSHI MURAYAMA, Institute for the Physics and Mathematics of the Universe, University of Tokyo. No abstract available.

10:45AM B13.00001 Detecting Gravitational Waves with Pulsar Timing Arrays, LARRY PRICE, XAVIER SIEMENS, JOLIEN CREIGHTON, PENG YU, University of Wisconsin - Milwaukee. Long-term high-precision astronomical timing observations of a network of pulsars, a pulsar timing array, open a portal on low frequency gravitational waves. In this talk I’ll discuss progress on efforts to detect both a stochastic background of gravitational radiation and gravitational waves from un-modeled bursts of gravitational waves using a pulsar timing array. I’ll also address prospects for stochastic backgrounds of gravitational waves from cosmological sources in the pulsar timing band.

10:57AM B13.00002 First search for gravitational waves from the youngest known neutron star, BENJAMIN OWEN, Penn State, LIGO SCIENTIFIC COLLABORATION. We present preliminary results of a search for continuous gravitational waves from the central compact object in supernova remnant Cassiopeia A. The object is the youngest suspected neutron star in the Galaxy. Its position and barycentric timing correction are precisely known, but no pulses are observed. Thus the search, of data from a twelve-day period of LIGO’s fifth science run, covers the three-dimensional space of frequencies and first and second time derivatives. Preliminary upper limits on gravitational wave emission beat the indirect limit inferred from the age of the object over the frequency band 100–300 Hz.
11:09AM B13.00003 Gravitational Waves and SGR Bursts, LEO SINGER, California Institute of Technology, LIGO SCIENTIFIC COLLABORATION, VIRGO COLLABORATION — Soft gamma repeaters (SGRs) are nearby, they burst repeatedly and sometimes spectacularly, and their burst emission mechanism may involve neutron star crust fractures and excitation of non-radial modes which could emit gravitational waves (GW). We present recent searches for GW associated with SGR bursts, including a new individual burst search of SGR events which occurred between 2006 November and 2009 June. The search examines burst events from six magnetar sources, including one (SGR 0501+4516) which is likely less than 1 kpc from Earth, and uses data from five GW detectors. Due to the proximity of SGR 0501+4516 we are able to probe GW energies more than an order of magnitude lower than previous SGR GW searches. We present results from GW searches and discuss the emerging astrophysical context.

11:21AM B13.00004 Searches for coalescence of binary systems in LIGO and Virgo data1, GABRIELA GONZALEZ, Louisiana State University, LIGO SCIENTIFIC COLLABORATION AND THE VIRGO COLLABORATION — We present the latest results from the searches for gravitational waves from the coalescence of binary systems of neutron stars and black holes in LIGO and Virgo data. These searches are done with a variety of methods, all using optimal filtering of waveform templates. We present results on data from the Fifth Science Run LIGO run S5 from Nov 2005 to Oct 2007, which was joint with Virgo’s first Science Run VSR1 from May to Oct 2007. We also show how these methods are being applied in the current LIGO S6/Virgo VSR2 data-taking run started in July 2009.

11:33AM B13.00005 Distinguishing Compact White-dwarf Binary Systems - An application of GW color magnitude diagram for LISA, RAVI KUMAR KOPPARAPU, Pennsylvania State University — The population of Double white dwarf (DWD) and neutron star-white dwarf (NSWD) binaries in our Galaxy are considered to be some of the most promising gravitational-wave (GW) sources for LISA. Electromagnetic observations have already discovered several of these white-dwarf binary systems in various phases of their evolution, in LISA’s band of detection. Here we illustrate a GW equivalent of a color-magnitude diagram (CMD), assuming non-zero temperature white-dwarf donors, and propose boundaries for both inspiralling and mass-transferring systems in the CMD. Depending upon the precision with which LISA can measure the frequency evolution (f) of a white-dwarf binary system we show that one can distinguish between a DWD and a NSWD system, and possibly the composition of the donor white dwarf, using CMD. We assess the limits and applicability of our theoretical boundaries with respect to observations and find that a measurement of f by LISA at high frequencies (log(f) ≥ 2) would likely distinguish between DWD/NSWD binary. For low-frequency sources, GW observations alone would unlikely tell us about the binary components, without the help of electromagnetic observations.

11:45AM B13.00006 ABSTRACT WITHDRAWN —

11:57AM B13.00007 Extracting accretion disk radii from LISA observations of accreting binary star systems, SHANE LARSON, Utah State University — LISA will be sensitive to a wide range of ultra-compact binary star systems in the Milky Way. A handful of these binaries will be verification binaries — systems which can be seen electromagnetically, and individually resolved and characterized in the LISA data stream. This multi-messenger characterization of these systems provides a useful synergy of observing capabilities that can be exploited to recover detailed information about the underlying astrophysical processes in the binary. This poster discusses how simultaneous photon and EM observations can be used to study mass transferring system and characterize parameters such as the mass transfer rate and radius of accretion disks around the primary.

12:09PM B13.00008 Seeking optical counterparts to gravitational wave event candidates, JONAH KANNER, University of Maryland, LIGO SCIENTIFIC COLLABORATION, VIRGO COLLABORATION — Large, kilometer scale gravitational wave (GW) detectors are now operating in the U.S. and Europe. Potential GW sources include compact object mergers, supernovae, and other energetic astrophysical events. Many such sources of gravitational waves would also be expected to emit electromagnetic radiation promptly and/or as a fading afterglow. The on-going search effort can be aided by the use of wide-field optical telescopes promptly imaging sky regions associated with gravitational wave signal candidates. Capturing the image of the optical counterpart to a GW emitting event would yield valuable astrophysical information, and could help confirm a GW signal candidate as a real event. This talk will discuss the methods and status of the effort to capture and interpret relevant image data.

Saturday, February 13, 2010 1:30PM - 3:06PM —
Session D1 DAP DPF: Inflation — Marriott Ballroom Salon 2

1:30PM D1.00001 Eternal Inflation: Is Our Universe Part of a Multiverse?, ALAN GUTH, Massachusetts Institute of Technology — No abstract available.

2:06PM D1.00002 Inflation Confronts Observations, WILL KINNEY, University at Buffalo, SUNY — No abstract available.

2:42PM D1.00003 Inflation as a Probe of Fundamental Physics, LIAM MCALLISTER, Cornell University — No abstract available.

Saturday, February 13, 2010 1:30PM - 3:06PM —
Session D13 DAP: Ground-based and Space-based Instruments and Techniques — Washington 6

1:30PM D13.00001 Current Status of QUIET, COLIN BISCHOFF, University of Chicago, QUIET COLLABORATION — QUIET (the Q/U Imaging Experiment) is designed to measure the Cosmic Microwave Background polarization on large angular scales using sensitive HEMT-based polarimeters. The experiment targets the signature on the CMB of gravitational waves generated during inflation, known as B-mode polarization. Observations were made from October 2008 through May 2009 using a 19-element 40 GHz instrument coupled to a 1.4 meter telescope located at the Chajnantor Observatory in Chile. Observations with a 90-element 90 GHz instrument on the same telescope are ongoing. We describe the status of analysis of the 40 GHz data and the current 90 GHz observations. At both frequencies, we target four patches totaling ~1000 square degrees and chosen to have low foreground contamination. The current phase of QUIET will provide precise measurements of the E-mode polarization power spectrum and improve upper limits on B-modes for angular scales up to ℓ = 1000. Meanwhile, planning is underway for the second phase of QUIET, which will increase the number of detector by an order of magnitude to reach the level of sensitivity necessary to detect B-mode polarization.

1:30PM D13.00002 Current Status of QUIET, COLIN BISCHOFF, University of Chicago, QUIET COLLABORATION — QUIET (the Q/U Imaging Experiment) is designed to measure the Cosmic Microwave Background polarization on large angular scales using sensitive HEMT-based polarimeters. The experiment targets the signature on the CMB of gravitational waves generated during inflation, known as B-mode polarization. Observations were made from October 2008 through May 2009 using a 19-element 40 GHz instrument coupled to a 1.4 meter telescope located at the Chajnantor Observatory in Chile. Observations with a 90-element 90 GHz instrument on the same telescope are ongoing. We describe the status of analysis of the 40 GHz data and the current 90 GHz observations. At both frequencies, we target four patches totaling ~1000 square degrees and chosen to have low foreground contamination. The current phase of QUIET will provide precise measurements of the E-mode polarization power spectrum and improve upper limits on B-modes for angular scales up to ℓ = 1000. Meanwhile, planning is underway for the second phase of QUIET, which will increase the number of detector by an order of magnitude to reach the level of sensitivity necessary to detect B-mode polarization.
1:14PM D13.00002 The Science and Design of the AGIS Observatory, MARTIN SCHROEDTER, Iowa State University, AGIS COLLABORATION — The AGIS observatory is a next-generation array of imaging atmospheric Cherenkov telescopes (IACTs) for gamma-ray astronomy between 100 GeV and 100 TeV. The AGIS observatory is the next logical step in high energy gamma-ray astronomy, offering improved angular resolution and sensitivity compared to FERMI, and overlapping the high energy end of FERMI’s sensitivity band. The baseline AGIS observatory will employ an array of 36 Schwarzschild-Couder IACTs in combination with a highly pixelated (0.05° diameter) camera. The instrument is designed to provide milliradian sensitivity over a wide (8° diameter) field of view, allowing both deep studies of faint point sources as well as efficient mapping of the Galactic plane and extended sources. I will describe science drivers behind the AGIS observatory and the design and status of the project.

1:54PM D13.00003 Toward Supernova Observations with the Micro-X High-Resolution Microcalorimeter X-ray Imaging Rocket1, ENECTALI FIGUEROA-FELICIANO, Massachusetts Institute of Technology, MICRO-X COLLABORATION — The Micro-X High-Resolution Microcalorimeter X-ray Imaging Rocket is a sounding rocket payload which will observe extended astrophysical X-ray sources with a focal plane array of transition-edge sensitive microcalorimeters. An energy resolution of 2–4 eV over the 0.2–3.0 keV band, coupled with a ~ 300 cm² conical approximation Wolter-I mirror, will make high energy resolution imaging of extended sources possible. Puppis A, a bright supernova remnant, will be the first target. The line-dominated expected spectrum of the recently discovered “silicon knot” of Puppis A will provide a wealth of new information. Highly resolved Doppler shifts and broadening of emission lines will map out the dynamical structure of the ejecta. The ionization state of the plasma across the knot and between elements will be analyzed with the benefit of fewer model degeneracies. Additionally, estimates of elemental abundances in the remnant will be refined, and the spatial variations of enrichment across the knot will be mapped. The first flight is scheduled for January 2011. We will give an overview of the science goals and an update on our current progress.

1 We would like to gratefully acknowledge support from NASA Grant NNX07AK52G S05.

2:06PM D13.00004 A tunable laser system for precision wavelength calibration of spectra, CLAIRE CRAMER, Harvard University — We present a novel laser-based wavelength calibration technique that improves the precision of astronomical spectroscopy, and solves a calibration problem inherent to multi-object spectroscopy. We have tested a prototype with the Hectochelle spectrograph at the MMT 6.5 m telescope. The Hectochelle is a high-dispersion, fiber-fed, multi-object spectrograph capable of recording up to 240 spectra simultaneously with a resolving power of 40000. The standard wavelength calibration method uses of spectra from Th hollow-cathode lamps shining directly onto the fiber. The difference in light path between calibration and science light as well as the uneven distribution of spectral lines are believed to introduce errors of up to several hundred m/s in the wavelength scale. Our tunable laser wavelength calibrator is bright enough for use with a dome screen, allowing the calibration light path to better match the science light path. Further, the laser is tuned in regular steps across a spectral order, creating a comb of evenly-spaced lines on the detector. Using the solar spectrum, we demonstrate that our system records the same spectrum in every fiber, we show that laser wavelength calibration brings radial velocity uncertainties down below 100 m/s. We also present results from studies of globular clusters, and explain how the calibration technique can aid in stellar age determinations, studies of young stars, and searches for dark matter clumping in the galactic halo.

2:20PM D13.00005 Photoelectron Track Length Distributions in CH$_{3}$OCH$_{3}$ and Ne:CO$_{2}$:NO:CH$_{3}$, ZACHARY PRIESKORN, University of Iowa, JOANNE HILL, NASA GSFC USRA, PHILIP KAARET, University of Iowa, JOEL BLACK, NASA GSFC Rockwell Scientific — We have measured the photoelectron track length distribution in 190 Torr CH$_{3}$OCH$_{3}$ and 400 Torr Ne:CO$_{2}$:NO:CH$_{3}$, partial pressures 300:80:20 Torr, using a Time Projection Chamber Polarimeter (TPC) and Negative Ion TPC Polarimeter (NITPC) respectively. The measurements were made at the Brookhaven National Laboratory National Synchrotron Light Source. Track length means range from 150 microns at 2.5 keV to 700 microns at 7 keV. The track length mean vs energy was found to fit a powerlaw as reported in future TPC’s and NITPC’s. The difference in light path between calibration and science light as well as the uneven distribution of spectral lines are believed to introduce errors of up to several hundred m/s in the wavelength scale. Our tunable laser wavelength calibrator is bright enough for use with a dome screen, allowing the calibration light path to better match the science light path. Further, the laser is tuned in regular steps across a spectral order, creating a comb of evenly-spaced lines on the detector. Using the solar spectrum, we demonstrate that our system records the same spectrum in every fiber, we show that laser wavelength calibration brings radial velocity uncertainties down below 100 m/s. We also present results from studies of globular clusters, and explain how the calibration technique can aid in stellar age determinations, studies of young stars, and searches for dark matter clumping in the galactic halo.

2:18PM D13.00006 Database and Library Development of Organic Species using Gas Chromatography and Mass Spectral Measurements in Support of the Mars Science Laboratory, Raul Garcia, Howard University, Paul Mahaffy, NASA Goddard Space Flight Center, Prabhakar Misra, Howard University — Our work involves the development of an organic compounds database that will allow us to determine which compounds are found here on Earth and which are inadvertently detected in the Mars soil and gaseous samples as impurities. It will be used for the Sample Analysis at Mars (SAM) instrument analysis in the Mars Science Laboratory (MSL) rover scheduled for launch in 2011. In order to develop a comprehensive target database, we utilize the NIST Mass Spectral Library, Automated Mass Spectral Deconvolution and Identification System (AMDIS) and Ion Fingerprint Deconvolution (IFD) software to analyze the GC-MS data. We have analyzed data from commercial samples, such as paint and polymers, which have not been implemented into the rover and are now analyzing actual data from pyrolyzation on the rover. We have successfully developed an initial target compound database that will aid SAM in determining whether the components being analyzed come from Mars or are contaminants from either the rover itself or the Earth environment and are continuing to make improvements and adding data to the target contaminants database.

2:30PM D13.00007 Database and Library Development of Organic Species using Gas Chromatography and Mass Spectral Measurements in Support of the Mars Science Laboratory, RAUL GARCIA, Howard University, PAUL MAHAFFY, NASA Goddard Space Flight Center, Prabhakar Misra, Howard University — Our work involves the development of an organic compounds database that will allow us to determine which compounds are found here on Earth and which are inadvertently detected in the Mars soil and gaseous samples as impurities. It will be used for the Sample Analysis at Mars (SAM) instrument analysis in the Mars Science Laboratory (MSL) rover scheduled for launch in 2011. In order to develop a comprehensive target database, we utilize the NIST Mass Spectral Library, Automated Mass Spectral Deconvolution and Identification System (AMDIS) and Ion Fingerprint Deconvolution (IFD) software to analyze the GC-MS data. We have analyzed data from commercial samples, such as paint and polymers, which have not been implemented into the rover and are now analyzing actual data from pyrolyzation on the rover. We have successfully developed an initial target compound database that will aid SAM in determining whether the components being analyzed come from Mars or are contaminants from either the rover itself or the Earth environment and are continuing to make improvements and adding data to the target contaminants database.

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2:42PM D13.00007 Non-Linear Simulation for the Disturbance of Electronic Systems in Low Earth Orbits by High Energy Electrons, WILLIAM ATKINSON, The Boeing Company/Dept. of Electro-Optics — A Simulator is presented that models the disturbance of electrical circuits by high energy electrons trapped in earth’s radiation belts; the model components are a module computing the rate given the altitude and time of the year, and the sunspot number, a module that models the interaction of the electrons with the materials of the electrical component, and a module that computes the charge and the magnitude of electrical field in the insulating materials as a function of time. The Adamec-Calderwood equation is used to model the relationship between the electrical conductivity of dielectric materials and the electric field intensity, making the charging/discharging equations highly non-linear. The non-linearity of the charging equations becomes especially pronounced in magnetic storms during intense solar flares. The results show that the electric field intensity can approach the dielectric breakdown strength in materials commonly used as dielectrics in space-based systems and that the fields can be sustained at high levels for as long as an hour.

2:54PM D13.00008 Speed Kills: Highly Relativistic Spaceflight Would be Fatal for People and Instruments, WILLIAM EDELSTEIN, Johns Hopkins School of Medicine, ARTHUR EDELSTEIN, University of California, San Francisco — Stories, books and movies about space travel often describe journeys at near-light velocities. Such high speed is desirable, as the resulting relativistic time dilation reduces the duration of the trip, at least for the travelers, so that they can cover interstellar distances in a reasonable amount of time (by their own clocks) and live long enough to reach their destination. The relativistic rocket equation shows the enormous difficulty of achieving such velocities. As spaceship velocities approach the speed of light, interstellar hydrogen, although only present on average at a density of about 2 atoms per cm$^3$, impinges on the spacecraft and turns into intense radiation (Purcell, 1963) that would quickly kill passengers and destroy instrumentation. In addition, the energy loss of ionizing radiation passing through the ship’s hull represents an increasing heat load which necessitates large expenditures of energy to cool the ship. Preventing this irradiation by the use of material or electromagnetic shields is a daunting and, as far as we know, unsolvable problem. The presence of interstellar hydrogen is yet another formidable obstacle to interstellar travel.
9:06AM G3.00002 Multiwavelength observations of Fermi blazars, ERIN WELLS BONNING, Yale University — Multiwavelength observations of blazars have entered a new era with the launch and successful operation of the Fermi Gamma-ray Space Telescope. With concurrent monitoring programs spanning decades of energies from radio through gamma-rays, the characteristic double-peak spectral energy distribution (SED) of blazars can be observed evolving on timescales from days to months (and ultimately to years). The low energy peak of the SED is well understood as synchrotron emission from electrons accelerated in a relativistic jet; however, the source of the high-energy emission is as yet poorly understood with multiple models often able to fit a given single-epoch SED. With both spectral and time-variability information available for a large number of sources, physical models for gamma-ray emission can be more effectively constrained. I will discuss recent and ongoing observations of blazars with Fermi, associated multiwavelength campaigns, and theoretical implications of these observations.

9:42AM G3.00003 TeV Observation of Extragalactic Gamma-Ray Sources, NEPOMUK OTTE, University of California, Santa Cruz — The recent years have brought incredible progress observing the gamma-ray sky above 100 GeV. One of the reasons is that Cherenkov telescopes such as H.E.S.S., MAGIC, and VERITAS have come online with ten times higher sensitivity in comparison to their predecessors and with an expanded energy range. These improvements resulted in a jump in the number of detected extragalactic sources, which now also includes two starburst galaxies, the first non-blazars in the extragalactic VHE sky. Furthermore, variability can and has been observed down to timescales of a few minutes in the some of the strongest sources. Correlation studies with other wavelengths have continued to prove to be a powerful tool and in some cases provided interesting constraints on the origin of the gamma-rays and their emission mechanisms. Gamma-rays from extragalactic objects also provide insight into some questions in cosmology. I will review the recent progress that has been made by observations of the extragalactic sky with imaging atmospheric Cherenkov telescopes.

Session G13 DAP DPF: Astrophysical Searches for Dark Matter and New Physics

Sunday, February 14, 2010 8:30AM - 10:18AM

8:30AM G13.00001 Untangling Galactic History in Action Space, ROBYN SANDERSON, JOHN BOCHANSKI, MIT, ANDREW WEST, Boston University, ADAM BURGASSER, UCSD, JAMES BINNEY, Rudolph Peierls Center for Theoretical Physics, Oxford University — Action-angle variables provide an instructive alternative viewpoint for studying the dynamical properties of objects in our Galaxy. Using a numerical method that constructs actions in an axisymmetric potential fit to the rotation curve of the Milky Way, we determine the locations in action space of two samples of stars from the SDSS survey for which complete six-dimensional phase space information is available: a small sample of ultra-cool dwarfs thought to include a large proportion of halo stars, and a large sample of M dwarfs that includes both disk and halo stars. We use this technique to examine the orbits of halo stars, compare the dynamical properties of the Milky Way thin and thick disks, and search for moving groups. We also demonstrate how observational errors and selection functions may be projected into action space, and forecast the performance of our method for next-generation astrometric surveys.

8:42AM G13.00002 Gravitational Rotation Curves for the THINGS Survey, JAMES O'BRIEN, University of Connecticut — The use of Galactic Rotation Curves has long been thought to provide evidence for the existence of Dark Matter. Although dark matter is currently the commonly accepted solution to the discrepancies found in galactic rotation curves between observation and theory, numerous dark matter alternative theories are beginning to emerge as possible solutions as well, in part because the galactic halos used in dark matter fits involve one or two extra external free parameters per galaxy. Among these alternative theories, the Conformal Gravity theory first presented by Weyl and recently advanced by Mannheim and Kazanas presents a renormalizable, fourth order theory, which does not assume the existence of dark matter, nor is inferred as an ad hoc addition to standard gravity. Moreover, Conformal Gravity can serve to define the rotation curves of spiral and dwarf galaxies with no external free parameters, thus eliminating the ambiguity of the current dark matter halo mass models. The THINGS survey is a recent sample of 18 galaxies, consisting of both dwarf and spiral galaxies, at distances between 2 and 15 Mpc. We thus apply the conformal theory to the THINGS data to produce rotation curves that fit the data with very high accuracy without the need for dark matter. The results yield rotation curves, which being parameter free, are strikingly more convincing than those of the standard gravity with dark matter.

8:54AM G13.00003 A Generalized Secondary Infall Model, PHILLIP ZUKIN, EDMUND BERTSCHINGER, MIT — The inner slope of a dark matter halo's density profile affects our understanding of galaxy formation and evolution and has implications for dark matter direct detection. While simulations seem to predict a cuspy steep inner slope, observations suggest flat cored-like profiles. This discrepancy is known as the Cusp Core problem. We attempt to shed light on the problem, through analytic means, by generalizing the self-similar secondary infall model to include angular momentum. In our model, each halo is represented by a two parameter family of solutions. One parameter describes the initial mass perturbation and the other defines how a given shell is torqued through evolution. We show how the inner slope varies with parameters.

9:06AM G13.00004 Using anisotropy to identify a dark matter signal in diffuse gamma-ray emission with Fermi, JENNIFER SIEGAL-GASKINS, CCAPP, Ohio State University, VASILIKI PAVLIDOU, BRANDON HENSLEY, Caltech — Dark matter annihilation in Galactic substructure will produce diffuse gamma-ray emission of remarkably constant intensity across the sky, making it difficult to disentangle this Galactic dark matter signal from the extragalactic gamma-ray background. Recent studies have considered the angular power spectrum of the diffuse emission from various extragalactic source classes and from Galactic dark matter. I'll discuss these results and show how the energy dependence of anisotropies in the total measured diffuse emission could be used to confidently identify a signal from dark matter in Fermi data. Finally, I'll present new results demonstrating how anisotropy analysis could extend the capabilities of current indirect dark matter searches.
9:18AM G13.00005 Probing the Dark Matter-Galaxy Formation Connection with Lyman Alpha Emitting Galaxies. ERIC GAWISER, Rutgers University, MUSYC COLLABORATION. We will describe how our understanding of cosmological structure formation is used to probe the dark matter properties of high-redshift galaxies and to identify their present-day descendants. Samples of 261 and 162 Lyman Alpha Emitting (LAE) galaxies at redshifts z = 2.1 and z = 3.1, respectively, were discovered in deep narrow-band imaging of the MUSYC survey. The LAEs exhibit a moderate clustering bias of b = 1.8 + 0.3, which implies median dark matter halo masses of 10^{11} M☉. The evolution of dark matter halo mass with redshift predicts that these LAEs evolve into typical present-day galaxies like the Milky Way, whereas other high-redshift galaxy populations, including Lyman Break Galaxies and Active Galactic Nuclei, typically evolve into more massive galaxies. Hence these Lyman Alpha Emitting galaxies represent our first direct knowledge of the progenitors of galaxies like the Milky Way seen when the universe was only 2-3 Gyr in age. I will also describe how these galaxies will be used by HETDEX and LSST to probe cosmological parameters including the dark energy equation-of-state and neutrino masses.


1 We gratefully acknowledge research grants from NSF, DOE, and NASA.

9:30AM G13.00006 Morphological Tests of the Pulsar and Dark Matter Interpretations of the WMAP Haze. J. PATRICK HARDING, University of Maryland. The WMAP Haze is an excess in microwave emission coming from the center of the Milky Way galaxy. In the case of synchrotron emission models of the Haze, we present tests for the source of radiating high-energy electrons/positrons. We explore several models in the case of a pulsar population or dark matter coannihilation as the source. These morphological signatures of these models are small behind the WMAP Galactic mask, but are testable and constrain the source models. In particular, a zero central density Galactic pulsar population model is in tension with the observed WMAP Haze. The Planck observatory's greater sensitivity and expected smaller Galactic mask should potentially provide a robust signature of the WMAP Haze as either a pulsar population or the dark matter.

9:42AM G13.00007 Verification of Indirect Indications of the Nature of Dark Matter. KEVORK ABAZAJIAN, University of Maryland. Several observations have drawn considerable interest as potential indications for indirect signatures of the nature of dark matter. Radio synchrotron towards the galactic center, the "WMAP haze," high-energy cosmic ray electron/positron observations, as well as the behavior of dark matter in small scale structure, are potential signals for properties of the dark matter. I will discuss how current and future observations will test the dark matter interpretation of these signals.

9:54AM G13.00008 Luke-warm dark matter: Bose-condensation of ultra-light particles. MIHAI BONDARESCU, University of Mississippi, ANDREW LUNDGREN, Syracuse University, RUZANDRA BONDARESCU, Penn State University, JAYASHREE BALAKRISHNA, Harris Stowe State University. We discuss the thermal evolution and Bose condensation of ultra-light dark matter particles with Compton wavelength of galactic scales. Agglomerations of these particles form stable halo structures and naturally exhibit no small scale structure. They are supported against gravitational collapse by Heisenberg's uncertainty principle similar to boson stars. We find that these ultra-light scalars Bose condense at high temperatures. The condensate has a very high critical temperature allowing us to treat the ground state and excited states separately. The particles in excited states are ultra-relativistic and act like radiation, while the bosons in the ground state have the same effect on the universe as pressureless matter. We then solve the Friedman-Klein-Gordon equations and study the cosmological evolution of this scalar field.

10:06AM G13.00009 Particle Production and Big Rip Singularities. JASON BATES, Wake Forest University. In 1929, Edwin Hubble found that objects in our Universe generally recede from us at a rate proportional to their distance, suggesting that the Universe as a whole is expanding. More recently, astronomers have observed that this expansion is accelerating. According to Einstein's theory of gravity, all normal matter in the Universe should act to slow the rate of expansion, so there must be something new which is causing this acceleration. Cosmologists call this "Dark Energy." One of the possibilities for dark energy leads to a Universe which expands to an infinite size in a finite amount of time. This scenario is called a "Big Rip," because near the end of time this expansion overcomes all other forces in the Universe - even atoms are ripped apart. However, Quantum Mechanics predicts that as the Universe expands particles will be created. If enough particles are created, this process could slow or even halt the expansion, and the "Big Rip" might be avoided. Using numerical methods, we considered the quantum effects for massive and massless scalar fields, and found that while at late times quantum effects do grow large, they do not become comparable to the dark energy until very near the singularity when the curvature of the Universe approaches the Planck scale.

Sunday, February 14, 2010 10:45AM - 12:33PM –
Session H3 DAP GPAP: Magnetoplasmas in Astrophysical Jets, Lobes, and in the Laboratory
Thurgood Marshall South

10:45AM H3.00001 Global Structures of Radio Galaxies – Theory and Simulations Meet Observations. HUI LI, Los Alamos National Laboratory. X-ray and radio observations of galaxy clusters have revealed a wealth of structure in their hot halos associated with extragalactic radio sources. Structures in the form of large scale cavities and weak shocks provide a reliable gauge of the mechanical output of extragalactic radio jets launched by AGNs. The energies involved range between 10^{57} to 10^{62} ergs. Furthermore, the morphology and properties of cavities have given strong constraints on the nature of AGN outflows, especially on large scales. We will present 3-D magnetohydrodynamic (MHD) simulations to study these large scale structures of radio galaxies, emphasizing the roles of magnetic fields and kinetic energy flow. The important effects of background environment on the radio galaxies will be discussed. In addition, we will present self-consistent cosmological MHD simulations of cluster formation with AGN feedback, emphasizing the important role of magnetic fields in carrying the AGN energy and in the cavity formation. Such simulations are compared with cluster radio halo and relic observations, as well as extensive Faraday rotation measurements. These results are shedding light on the origin and energetics of the cluster-wide magnetic fields. We demonstrate that the intracluster medium turbulence can be excited and sustained by the frequent mergers during the cluster formation. This turbulence then excites a small-scale dynamo process that transports, spreads, and amplifies the fields originated from the radio jet/lobe system. This process could be the primary process of populating the whole cluster with magnetic fields at observed levels.

1 Supported by LDRD program at LANL and DOE/OFES.
11:21AM H3.00002 Exploring how astrophysical jets work using laboratory plasma jets1, PAUL BELLAN, Caltech — Astrophysical jets occur in numerous contexts where there is accretion (e.g., stellar formation, black holes) and are presumed to be driven by magnetohydrodynamic (MHD) forces. This talk describes a laboratory plasma experiment that simulates the essential features of astrophysical jets. The geometry is arranged so the laboratory jets are unaffected by walls and the experimental time scale is such that frozen-in magnetic flux, the condition for ideal MHD, is reasonably approximated. The lab jets evolve through a sequence of reproducible stages consisting of formation, collimation, kink instability, and at sufficiently high electric current, detachment. Diagnostics include imaging at > 1 million frames per second, magnetic probing, spectroscopy, and laser interferometry. The collimated nature of both these jets and of arched plasma-filled flux tubes in a related solar corona loop simulation experiment suggest that collimation is a ubiquitous property of magnetic flux tubes conducting axial electric currents. This realization has motivated a collimation mechanism whereby the accumulation of convected, frozen-in toroidal magnetic flux near the jet tip increases the toroidal magnetic flux density near the tip. Since magnetic flux density is magnetic field strength, this flux pile-up corresponds to an increase of the toroidal field near the tip. Increase of toroidal field increases the MHD pinch force thereby collimating the jet. The model additionally shows that plasma-filled coronal loops can be considered as resulting from two counter-propagating jets colliding head-on; color-coded images of two colliding lab jets confirm this postulate. The experiments have also motivated development of a dusty-plasma dynamo mechanism suitable for driving actual astrophysical jets. This mechanism involves dust grains having a charge to mass ratio so small that their cyclotron frequency becomes comparable to the Kepler frequency. The resulting collisionless orbits spiral across magnetic field lines towards the central object and the accumulation of charged dust grains creates a radial electromagnetic force appropriate for driving an astrophysical jet. These spiral orbits are not described by MHD but instead result from conservation of canonical angular momentum in combined gravitational and magnetic fields.

1Supported by USDOE, NSF, and AFOSR.

11:57AM H3.00003 Extended Lobes as Sources of High Energy Particles and Radiation, LUKasz STAWARZ, KIPAC, Stanford University — Extended lobes in radio galaxies and quasars are one of the largest structures in the Universe, in many cases reaching enormous sizes of a few billion parsecs (∼ 10^25 cm). These are formed by relativistic jets emanating from the closest vicinities of supermassive black holes in the centers of active galaxies, and interacting with the ambient intergalactic medium. The physical conditions in extended lobes are hardly known, although it is established that the lobes are filled with ionized, highly magnetized, and rarefied plasma extracted predominantly from the surrounding medium of supermassive black holes. Presence of magnetic turbulence and extended shock waves in the lobes ensures efficient acceleration of plasma particles up to the very high, ultrarelativistic energies. Such energies are not, and will not be accessible in our laboratories even in a near future. In this talk I will summarize present understanding of the lobes’ structure and evolution, and I will also review the recently discussed ideas and models regarding particle acceleration and generation of high-energy radiation therein. Finally, I will also discuss the current status and prospects of high-energy observations of these extreme structures, focusing especially on the X-ray and γ-ray domains.


10:45AM H13.00001 Observation of UHE Cosmic Rays from a Balloon-borne Neutrino Telescope, STEPHEN HOOVER, UCLA, ANITA COLLABORATION — The ANtarctic Impulsive Transient Antenna (ANITA) is a balloon-borne array of radio antennas designed to detect coherent radio Cherenkov radiation from ultra-high energy (UHE) neutrino-induced particle showers in the Antarctic ice sheet. The first flight of ANITA has produced limits on the UHE neutrino flux, and analysis of data from the second flight is underway. I will describe the neutrino search in ANITA-1 data and concurrent observations of geosynchrotron radio emissions from UHE cosmic ray extensive air showers.

10:57AM H13.00002 The Nature of Horizontally Polarized Events in ANITA 1: MC Simulations, ERIC GRASHORN, Center for Cosmology and AstroParticle Physics, Ohio State University, ANTARCTIC IMPULSIVE TRANSIENT ARRAY (ANITA) COLLABORATION — The ANITA (ANtarctic Impulsive Transient Antenna) experiment is a balloon-borne, broadband antenna array flown over the Antarctic continent. It is designed to detect radio Cherenkov emission from UHE astrophysical neutrinos (E > 10^18 eV) interactions in the ice below. ANITA 1 completed a 35 day flight during the Austral summer of 2006-2007, observing a number of horizontally polarized events, which could be caused by radio emission from downward going cosmic rays reflecting off the ice. A detailed simulation was written to calculate ANITA’s sensitivity to reflected cosmic ray radio signals.

10:09AM H13.00003 The Search for Ultra High-Energy Neutrinos With The ANITA Experiment1, ABIGAIL GOODHUE VIEREGG, UCLA Dept. of Physics and Astronomy — The ANITA (ANtarctic Impulsive Transient Antenna) experiment is an innovative balloon-borne radio telescope, designed to detect coherent Cherenkov emission from cosmicmenic ultra-high-energy neutrinos with energy greater than 10^{18} eV. The second flight of the ANITA experiment launched on 21 December 2008, and collected data for 30 days. This large data set allows for the most sensitive investigation into the exciting GZK (Greisin-Zatsepin-Kuzmin) neutrino flux regime to date. I will present the status of the first pass analysis of the ANITA-II data set including calibration, analysis methods, and background rejection techniques.

1Supported by NASA, Dept. of Energy, and NSF.

11:21AM H13.00004 The Sensitivity of the ANITA Experiment to Magnetic Monopoles1, MILES DETRIXHE, University of Kansas, ANITA COLLABORATION — The ANITA (Antarctic Impulsive Transient Antenna) experiment is a balloon-borne antenna array designed to detect Cherenkov radiation produced by ultra-high energy neutrino interactions with the Antarctic ice. Magnetic monopoles are hypothetical particles that also produce Cherenkov radiation in the radio regime. The first ANITA flight in 2006-07 illustrated the extreme sensitivity of ANITA to relativistic magnetic monopoles. The second flight (2008-09) flew with much more live time. I will discuss the potential ANITA’s second flight has for detecting ultra-relativistic magnetic monopoles and a method for doing so.

1This research was supported by NASA Award Number NNX08AD99G.

11:33AM H13.00005 Upper limit on the diffuse flux of UHE tau neutrinos, CLAUDIA FRACCHIOLLA, Colorado State University — The Pierre Auger Observatory is a cosmic ray hybrid detector located in the province of Mendoza in Argentina. Due to its design characteristics it allows us to study fundamental particle interactions at energies well beyond those available at colliders. The Auger Observatory is not only sensitive to high energy cosmic rays, but also to ultra-high energy neutrinos with energies above 10^{19} eV (1EeV). Neutrinos are the perfect messengers from out of space, neutrally charged and interact only weakly, they can travel long distances without interacting. Therefore they can provide us information that other particles, especially charged particles, are not able to. In this talk I will present the evaluation of the sensitivity of Auger to the so-called “Earth-skimming” events, the procedure to discriminate them from background, and the upper limit on the diffuse flux of tau neutrinos obtained at EeV energies from Auger data.
11:45AM H13.00006 The Extreme Universe Space Observatory on the Japanese Experiment Module (JEM-EUSO), YOSHIYUKI TAKAHASHI, Dept. of Physics, The University of Alabama in Huntsville, MARK CHRISTL, VP-62, NASA Marshall Space Flight Center, JEM-EUSO COLLABORATION — The JEM-EUSO mission will explore the nature and physical processes of the highest energy particles. This international mission will be carried out aboard the ISS looking down on Earth’s dark sky to observe the extensive air showers produced through the interaction of extreme high energy particles in the atmosphere. The science program and technical advances in the instrument design continue to evolve. An update of the mission status will be presented.

11:57AM H13.00007 Probing Dark Matter with Neutrinos, INA SARCEVIC, University of Arizona — We evaluate the neutrino and muon flux from annihilation of the dark matter in the core of the Sun, in the core of the Earth, from the Galactic Center and from cosmic diffuse neutrinos produced in dark matter annihilation in the halos. We consider model-independent direct neutrino production and secondary neutrino production from the decay of taus produced in the annihilation of dark matter. We illustrate how muon energy distribution from dark matter annihilation has a very different shape than muon flux from atmospheric neutrinos. We consider both the upward muon flux, when muons are created in the rock below the detector, and the contained flux when muons are created in the (ice) detector. We comment on neutrino flavor dependence and their detection.

12:09PM H13.00008 Neutrinos in Hot and Dense Media, SAMINA MASOOD, Univ of Houston Clear Lake — We reinvestigate the modifications in the properties of neutrinos in hot and dense media. The change in properties depends on the type of neutrinos. Massless neutrinos of the standard model acquire Dirac type of temperature and density dependent selfmass in hot and dense media. Dirac neutrinos exhibit the refractive energy and higher value of the magnetic moment in hot and dense media. The transition magnetic moment of Majorana neutrino is modiﬁed differently in hot and dense media. We contrast these effects in detail.

12:21PM H13.00009 Search Capability for $\eta \rightarrow \nu_e,\bar{\nu}_e,\tau$ Decays in Cubic Kilometer Neutrino Detectors, ALI FAZELEY, RATHNAYAKA GUNASINGHA1, RICHARD IMLAY, SAMVEL TER-ANTONYAN, XIANWU XU, Southern University. We investigate the discovery potential of cubic kilometer neutrino observatories such as IceCube to set stringent limits on the forbidden decays $\eta \rightarrow \nu_e,\bar{\nu}_e,\tau$. The signatures for these decays are cascade events resulting from the charged-current reactions of $\nu_e,\bar{\nu}_e,\nu_\tau,\bar{\nu}_\tau$ on nuclei in such detectors. Background cascade events are mainly due to $\nu_e$'s from atmospheric $\mu$, $K^+$, and $K^0_L$ decays and to a lesser extent from atmospheric $\nu_\mu$ neutral current interactions with nuclei. A direct upper limit for the branching ratio $\eta \rightarrow \nu_e,\bar{\nu}_e,\tau$ of $5.0 \times 10^{-4}$ at 90% CL can be achieved.

1Present address: Duke University

Sunday, February 14, 2010 3:30PM - 5:18PM

Session K3 DNP DAP: Nucleosynthesis in Stellar Explosions Thurgood Marshall South

3:30PM K3.00001 Advances in the Modeling of Type Ia Supernovae, ALAN CALDER, Stony Brook University — Type Ia supernovae are bright stellar explosions distinguished by a lack of hydrogen features in the observed spectra. These events produce and disseminate heavy elements and are noted for properties of their light curves that allow the standardization of events and subsequent use as cosmological distance indicators. The explosion mechanism, however, remains incompletely understood. I will present an overview of the physics of these events and competing explosion models. Many models invoke a deflagration born near the center of a white dwarf that has gained mass from a stellar companion. I will present simulations of this single-degenerate scenario in which the deflagration transitions to a detonation and describe the dependence of explosion yield on properties of the white dwarf and conditions under which the transition to detonation occurs.

1This work was supported by NASA through grant NNX09AD19G and by the DOE through grants DE-FG02-07ER41516 and DE-FG02-87ER40317.

4:06PM K3.00002 Nucleosynthesis in the Classical Nova Outburst, SUMNER STARRFIELD, Arizona State University — Classical Novae are the consequences of the accretion of hydrogen-rich material onto white dwarfs in close binary stellar systems. They are the third largest stellar explosions that occur in a galaxy after Gamma-ray Bursts and Supernovae but are far more common. They are well studied in the Solar neighborhood and in nearby galaxies so that a large number now have measured chemical abundances of their ejected gases. Of importance to this meeting, our simulations show that the temperatures reached in the explosions sample the same conditions realized in terrestrial laboratory measurements; therefore, no extrapolations are necessary. As a result, we have been doing new calculations that test the effects of new reaction rates on predictions of the observed properties of the outburst. We will show the results of these simulations and, in addition, the effects of including reaction rates that were not previously included in the calculations. We will also show how the evolution and properties of the explosion depend on the initial assumed composition of the accreting material and the characteristics of the white dwarf. Finally, the connection with Supernovae of Type Ia, the explosions currently being used the study the evolution of the universe, is that they are thought to be the consequences of the accretion of helium rich material onto a white dwarf. The results of new simulations of these events will be presented.

1We gratefully acknowledge support from NASA, NSF, and the DOE.

4:42PM K3.00003 New Hydrodynamical Models of Type I X-Ray Bursts, JORDI JOSE, Univeritat Politecnica de Catalunya — Type I X-ray bursts constitute the most frequent type of stellar explosion in the Galaxy (and the third most energetic event after supernovae and nova outbursts). They take place in the H/He-rich envelopes accreted onto neutron stars in binary systems. In this talk, I will present new hydrodynamic models (1D) of type I X-ray bursts, from the onset of accretion up to the explosion stage, with special emphasis on their gross observational properties (light curves, recurrence time between bursts) and their associated nucleosynthesis. In particular, I will focus on the impact of the chemical composition of the accreted material on burst properties. The impact of nuclear uncertainties on the final nucleosynthetic yields will be discussed as well.
3:30PM K13.00001 High Energy Radiation from Black Holes in Gamma Ray Bursts — Charles Dermer, Naval Research Laboratory, Govind Menon, Troy University, Soebur Razzaque, Justin Finke. Gamma ray bursts are sources of broadband radio-through-gamma radiation that are thought to occur during the formation of black holes from stellar core collapse or compact-object coalescence. Theoretically, they are expected to have jet-like structures that are powered by high Lorentz factors, which is consistent with the presence of large jet bulk Lorentz factors. The presence of solar gamma rays provides evidence that black holes can exist in our galaxy. The interaction of these jets with the surrounding medium produces gamma rays, X-rays, and high-energy gamma rays, which can be detected by satellites. The gamma-ray emission from black holes in gamma ray bursts provides important insights into the physics of these objects and their environment.

3:42PM K13.00002 Hadronic interpretation of high energy radiation from Fermi LAT GRBs — Soebur Razzaque, U.S. Naval Research Lab, Charles Dermer, Justin Finke. Data collected with the Fermi large area telescope (LAT) from gamma-ray bursts (GRBs) challenge our understanding of the high energy radiation mechanisms from ultra-relativistic jets. Delayed onset of GeV emission extending to well after the decay of keV-MeV emission, large fluences in high energy components and large jet bulk Lorentz factors are common features in Fermi LAT GRBs and require consistent theoretical explanation. GRBs have long been considered as candidates of ultra-high energy cosmic rays (UHECRs). We investigate ion acceleration in GRB jets, and the high energy signatures of their hadronic and electromagnetic interactions. We show that the acceleration of slowly cooling ions compared to rapidly cooling electrons in the GRB shocks can explain delayed onset of 100 MeV radiation and extended GeV emission.

3:54PM K13.00003 Probing the Association of Gravitational-Wave and Gamma-Ray Bursts with LIGO and Virgo — Laura Cadonati, University of Massachusetts, Amherst, LIGO Scientific Collaboration, Virgo Collaboration. Gamma-ray bursts (GRBs) are the most energetic cosmic events, with emission ranging from gamma rays to radio waves. The Fermi Gamma-ray Large Area Space Telescope (LAT) has detected gamma-ray bursts, and the Pierre Auger Observatory (PAO) has observed high-energy cosmic rays (HECRs). Combining gravitational waves with electromagnetic and neutrino observations will enable the extraction of scientific insight that was hidden from us before. We present the results of a search for gravitational wave burst associated with 137 GRBs detected during the fifth LIGO Science run and the first Virgo science run. We discuss the astrophysical interpretation and implication of these results for future investigations of GRBs and gravitational wave bursts.

4:06PM K13.00004 Astrophysically Triggered Searches for Gravitational Waves — Zsuza Marka, Columbia University, LIGO Scientific Collaboration, Virgo Collaboration. Many expected sources of gravitational waves are observable in more traditional channels, such as gamma rays, X-rays, optical, radio, or neutrino emission. Some of these channels are already being used in searches for gravitational waves with the LIGO-GEO600-Virgo interferometer network, and others are currently being incorporated into new or planned searches. Astrophysical targets include gamma-ray bursts, soft-gamma repeaters, supernovae, and glitcheing pulsars. The observation of electromagnetic or neutrino emission simultaneously with gravitational waves could be crucial for the first direct detection of gravitational waves. Information on the progenitor, such as trigger time, direction, and expected frequency range, can enhance our ability to identify gravitational wave signatures with amplitude close to the noise floor of the detector. Furthermore, combining gravitational waves with electromagnetic or neutrino observations will enable the extraction of scientific insight that was hidden from us before. We will discuss the status for astrophysically triggered searches with the LIGO-GEO600-Virgo network and the science goals and outlook for the second and third generation gravitational wave detector era.

4:18PM K13.00005 Final Results of the All-sky Search for Gravitational-wave Bursts in the First Joint LIGO-GEO-Virgo Run — Amber Stuver, LIGO Livingston Observatory, LIGO Scientific Collaboration, Virgo Collaboration. The LIGO-GEO-Virgo network of gravitational-wave detectors collected data of unprecedented sensitivity in their 2005-2007 science runs and have produced the most sensitive all-sky burst search to date. Using data from these runs, we describe the search for bursts: short-duration gravitational-wave signals with unknown or poorly modeled waveforms. Such signals may accompany astrophysical events like core-collapse supernovae, and the merger phase of coalescing binary compact stars. 387 days of data were collected when at least 2 of the 4 LIGO/Virgo detectors were in operation and four different analysis algorithms were applied to these data in the frequency band of 50 - 6000 Hz. In this talk, we will discuss the search algorithms used, their combined results and their astrophysical interpretation.

4:30PM K13.00006 Frequency stabilization of a laser used to measure Plank scale indeterminacy — Robert Lanza, Aaron Chou, Young-Kee Kim. The University of Chicago and Fermilab — Macroscopic effects of spacetime quantization due to the holographic principle will soon be tested using precision power recycled interferometers at Fermilab. The relative transverse position of two objects is predicted to experience a quantum blurring, resulting from the overall reduction in the number of spacetime degrees of freedom set by holographic entropy bounds. This blurring is manifested in a spectrally flat noise signal in relative phase measurements made in large Michelson interferometers. In the proposed experiment, the holographic noise levels are amplified to a detectable level using ~40 m interferometer arms, in which the beams are recycled using cavity mirrors. The frequency of the laser must be sufficiently stable before injection into the long, narrow bandwidth cavity arms of the interferometer. We present here studies of the shorter, wider bandwidth cavities which we are developing to pre-stabilize the laser frequency. This technology will also be applied to a Fermilab cavity-enhanced search for axions created from a laser beam.

Monday, February 15, 2010 10:45AM - 12:33PM — Session P13 DAP: UHECR Detection and Results — Washington 6

10:45AM P13.00001 Observations vs. Simulations of Golden Hybrid Events at the Pierre Auger Observatory — Jeff Allen, New York University, Pierre Auger Collaboration. The hybrid detection method employed by the Pierre Auger Observatory, detecting the longitudinal development with the Fluoresence Detector (FD) and the ground particle signal with the Surface Detector (SD), places strong constraints on individual detected air showers. The event-by-event basis. The comparison of the simulated and measured events provides a direct test for air shower simulations and the high energy hadronic event generators upon which they depend. The nature of the discrepancies seen in this comparison can provide guidance as to the primary cosmic ray composition, overall energy calibration, and hadronic interactions beyond the reach of accelerator experiments.
regardless of nucleus type. Energy reconstruction for the primary nuclei within an air shower array experiments such as IceTop. Results are obtained using CORSIKA EAS simulations taking into account the detector response.


A multi-parameter event-by-event primary energy reconstruction method is presented for the Telescope Array experiment. We developed an analysis technique based solely on the data, using parameterizations similar to those used in the AGASA experiment. We calculated the aperture of the detector by making a detailed Monte Carlo simulation of the experiment, and tested it by comparing distributions of kinematical and dynamical quantities with the data. The methods will be described and the results presented.

The Telescope Array (TA) is the largest ultra-high energy cosmic ray (UHECR) observatory in the Northern Hemisphere. TA observes cosmic rays with two principal components: Optical detectors use nitrogen fluorescence to observe the longitudinal development of cosmic ray extensive air showers (EAS) in the atmosphere, while an array of scintillator counters captures the lateral cross sections of EAS at ground-level. While both methods of observation independently yield important information about the energy, composition, and arrival directions of UHECR, far better data resolution can be achieved by utilizing hybrid observation. We will present the results of a simulation study of TA hybrid efficiency and data resolution.

The evolution with energy of the average value of $X_{\text{max}}$, the slant depth at which extensive air showers induced by cosmic rays reach maximum development, is of importance for cosmic ray physics but also opens a new research window with impact on astrophysics, cosmology, particle and possibly fundamental physics. The Pierre Auger Observatory has been used for photon searches of unprecedented sensitivity. The current status of this search will be reported, including experimental limits at EeV.

We present the latest measurements of these quantities and discuss briefly their interpretation in terms of the cosmic ray mass composition.

The Pierre Auger Observatory is a cosmic ray detector designed to measure the flux, the energy spectrum, and the mass composition of ultra-high energy cosmic rays. In this talk, we describe the measurement of $X_{\text{max}}$, the slant depth at which extensive air showers induced by cosmic rays reach maximum development. The evolution with energy of the average value of $X_{\text{max}}$ and its fluctuations are two observables sensitive to the mass composition of cosmic rays. We present the latest measurements of these quantities and discuss briefly their interpretation in terms of the cosmic ray mass composition.

The Earth’s upper atmosphere is constantly bombarded by rain of charged particles known as primary cosmic rays. These primary cosmic rays will collide with the atmospheric molecules and create extensive secondary particles which shower downward to the surface of the Earth. In recent years, a few studies have been done regarding to the applications of the cosmic ray measurements and the correlations between the Earth’s climate conditions and the cosmic ray fluxes [1,2,3]. Most of the particles, which reach to the surface of the Earth, are muons together with a small percentage of electrons, gammas, neutrons, etc. At Georgia State University, multiple cosmic ray particle detectors have been constructed to measure the fluxes and energy distributions of the secondary cosmic ray particles. In this presentation, we will briefly describe these prototype detectors and show the preliminary test results. Reference: [1] K.Borozdin, G.Hogan, C.Morris, W.Priedhorsky, A.Saunders, L.Shultz, M.Teasdale, Nature, Vol.422, 277 (2003). [2] L.V. Egorova, V. Ya Vovk, O.A. Troshichev, Journal of Atmospheric and Terrestrial Physics 62, 955-966 (2000). [3] Henrik Svensmark, Phy. Rev. Lett. 81, 5027 (1998).

10:57AM P13.00002 Measurement of the longitudinal profile of extensive air showers with the Pierre Auger Observatory . FLORIN IONITA, University of Chicago, THE PIERRE AUGER OBSERVATORY COLLABORATION — The Pierre Auger Observatory is a cosmic ray detector designed to measure the flux, the energy spectrum, and the mass composition of ultra-high energy cosmic rays. In this talk, we describe the measurement of $X_{\text{max}}$, the slant depth at which extensive air showers induced by cosmic rays reach maximum development. The evolution with energy of the average value of $X_{\text{max}}$ and its fluctuations are two observables sensitive to the mass composition of cosmic rays. We present the latest measurements of these quantities and discuss briefly their interpretation in terms of the cosmic ray mass composition.

11:09AM P13.00003 Measurement of the Flux of Ultra-High Energy Cosmic Rays at the Pierre Auger Observatory . SEGEV BENZVI, University of Wisconsin - Madison, PIERRE AUGER COLLABORATION — The energy spectrum of cosmic rays above $10^{18}$ eV has been measured with unprecedented statistics at the Pierre Auger Observatory. From air shower measurements made using the fluorescence telescopes and the surface detector array at the Auger site, we report three measurements of the energy spectrum: using downgoing events observed with the surface array; using nearly horizontal showers observed with the surface array; and using showers observed with the fluorescence telescopes and surface array in combination. These three techniques use partly independent data sets with different systematic uncertainties, providing useful checks of the spectrum measurement. The observed spectra agree within systematic uncertainties, and indicate a hardening of the spectral index near $10^{18.6} \text{ eV}$ and a significant suppression of the flux above $10^{19.5} \text{ eV}$. We will describe the systematic uncertainties of the reported fluxes, and discuss the astrophysical implications of these measurements.

11:21AM P13.00004 Ultra-high energy photon studies with the Pierre Auger Observatory . VIVIANA SCHERINI, Louisiana State University, PIERRE AUGER COLLABORATION — While the most likely candidates for cosmic rays above $10^{18}$ eV are protons and nuclei, many of the scenarios of cosmic ray origin also predict a photon component. Detection of this component is of importance for cosmic ray physics but also opens a new research window with impact on astrophysics, cosmology, particle and possibly fundamental physics. The Pierre Auger Observatory has been used for photon searches of unprecedented sensitivity. The current status of this search will be reported, including experimental limits at EeV.

11:33AM P13.00005 Hybrid Observation with the Telescope Array Observatory . BENJAMIN STOKES, DMITRI IVANOV, Rutgers University, GORDON THOMSON, University of Utah, TELESCOPE ARRAY COLLABORATION — The Telescope Array (TA) is the largest ultra-high energy cosmic ray (UHECR) observatory in the Northern Hemisphere. TA observes cosmic rays with two principal components: Optical detectors use nitrogen fluorescence to observe the longitudinal development of cosmic ray extensive air showers (EAS) in the atmosphere, while an array of scintillator counters captures the lateral cross sections of EAS at ground-level. While both methods of observation independently yield important information about the energy, composition, and arrival directions of UHECR, far better data resolution can be achieved by utilizing hybrid observation. We will present the results of a simulation study of TA hybrid efficiency and data resolution.

11:45AM P13.00006 Measurement of the Flux of Ultrahigh Energy Cosmic Rays by the Surface Detector of the Telescope Array Experiment . GORDON THOMSON, University of Utah, DMITRI IVANOV, BENJAMIN STOKES, Rutgers University, TELESCOPE ARRAY COLLABORATION — We have measured the flux of ultrahigh energy cosmic rays using the surface detector of the Telescope Array experiment. We developed an analysis technique based solely on the data, using parameterizations similar to those used in the AGASA experiment. We calculated the aperture of the detector by making a detailed Monte Carlo simulation of the experiment, and tested it by comparing distributions of kinematical and dynamical quantities with the data. The methods will be described and the results presented.

11:57AM P13.00007 Measurement of the UHECR Flux by the Telescope Array Fluorescence Detectors . SEAN STRATTON, LAUREN SCOTT, The Telescope Array Collaboration, THE TELESCOPE ARRAY COLLABORATION — The Telescope Array (TA), the first dedicated Northern Hemisphere “hybrid” ultrahigh energy cosmic ray (UHECR) detector, is online in Millard Country, Utah. The three Fluorescence Detector sites (FD) located at Black Rock Mesa, Long Ridge and Middle Drum have been taking data since November 2007. By measuring the characteristics of UHECR-induced extensive air showers using the FD, we can measure the energies, composition and arrival directions of the highest-energy cosmic rays. We will show data from the experiment, comparisons with simulated data from our full detector Monte Carlo simulation program, and our measurement of the UHECR energy spectrum.

12:09PM P13.00008 Multi-spectra Cosmic Ray Flux Measurement . XIAOCHUN HE, MATHES DAYANANDA, Georgia State University — The Earth’s upper atmosphere is constantly bombarded by rain of charged particles known as primary cosmic rays. These primary cosmic rays will collide with the atmospheric molecules and create extensive secondary particles which shower downward to the surface of the Earth. In recent years, a few studies have been done regarding to the applications of the cosmic ray measurements and the correlations between the Earth’s climate conditions and the cosmic ray fluxes [1,2,3]. Most of the particles, which reach to the surface of the Earth, are muons together with a small percentage of electrons, gammas, neutrons, etc. At Georgia State University, multiple cosmic ray particle detectors have been constructed to measure the fluxes and energy distributions of the secondary cosmic ray particles. In this presentation, we will briefly describe these prototype detectors and show the preliminary test results. Reference: [1] K.Borozdin, G.Hogan, C.Morris, W.Priedhorsky, A.Saunders, L.Shultz, M.Teasdale, Nature, Vol.422, 277 (2003). [2] L.V. Egorova, V. Ya Vovk, O.A. Troshichev, Journal of Atmospheric and Terrestrial Physics 62, 955-966 (2000). [3] Henrik Svensmark, Phy. Rev. Lett. 81, 5027 (1998).

12:21PM P13.00009 A Primary Energy Reconstruction Method for Air Shower Array Experiments . SEAVEL TER-ANTONYAN, ALI FAZELY, Southern University — A multi-parameter event-by-event primary energy reconstruction method is presented for the air shower array experiments such as IceTop. Results are obtained using CORSIKA EAS simulations taking into account the detector response and shower reconstruction uncertainties. Energy reconstruction for the primary nuclei within 10 – 12% in the energy region of $E > 10P_{\text{EeV}}$ are achievable, regardless of nucleus type.

Monday, February 15, 2010 1:30PM - 3:18PM _
Session Q1 DAP DPF: Dark Matter in the Universe Marriott Ballroom Salon 2

1:30PM P10.00001 Dark Matter Observed in the Universe . MARLA GEHA, Astronomy Department Yale University — No abstract available.
2:06PM Q1.00002 Indirect Detection and Theoretical Models, DOUGLAS FINKBEINER, Harvard CfA — Gamma-ray, cosmic-ray, and microwave observations all have the potential to reveal signals from annihilating or decaying WIMP dark matter. These astrophysical tests of dark matter are known as “indirect detection,” in contrast to the direct detection of WIMP-nucleon scattering in cryogenic detectors. I will review the latest measurements from PAMELA, FERMI, and other projects, and discuss the possibility that the observations could already contain signals from dark matter. I will then present a variety of theoretical models that are compatible with these observations, and propose criteria which must be fulfilled before detection of dark matter can be claimed. Provocative statements will be made.

2:42PM Q1.00003 Recent Results on Dark Matter Searches with Fermi, SIMONA MURGIA1, SLAC-KIPAC — The Fermi Large Area Telescope (LAT) has been successfully launched from Cape Canaveral on 11 June 2008. It is exploring the gamma ray sky in the energy range from 20 MeV to over 300 GeV with unprecedented sensitivity. One of the most exciting science questions that the Fermi LAT will address is the nature of dark matter. Several theoretical models have been proposed that predict the existence of Weakly Interacting Massive Particles (WIMPs) that are excellent dark matter candidates. The Fermi LAT investigates the existence of WIMPs indirectly, primarily through their annihilation or decay into photons and into electrons and positrons. I will present recent results on these searches.

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1:30PM Q13.00001 The TeV Gamma-Ray Sky Observed by Milagro, BRENDA DINGUS, Los Alamos National Laboratory, MILAGRO COLLABORATION — Milagro has performed the deepest survey of the Northern Hemisphere TeV gamma-ray sky. The observatory is sensitive to gamma rays from below 1 TeV to greater than 100 TeV. The analysis technique weights events by the ratio of the probability that the detected event is due to a gamma ray or a background hadronic cosmic ray. The hadronic cosmic ray background produces penetrating particles in the extensive air showers that are less prevalent in the gamma ray initiated showers. Two different sets of weights were selected to search for gamma-ray sources with spectra extending to the highest energies and to search for gamma-ray sources in which spectra cut off at a few TeV. In this talk we will present the location and flux of the sources detected for each of these two spectral assumptions. Most of the strongly detected Milagro sources are coincident with high luminosity pulsars detected at lower energies by the Fermi satellite.

1:42PM Q13.00002 Energy spectrum of Galactic gamma-ray sources detected by Milagro, ANDREW SMITH, University of Maryland, MILAGRO COLLABORATION — The Milagro Gamma-Ray Observatory has detected numerous sources of VHE gamma-rays with a median energy above 10 TeV. The large collection area, high duty cycle and large aperture give Milagro unprecedented sensitivity particularly at E = 30 -100 TeV. In this energy regime, the contribution from inverse-Compton scattering of accelerated electrons is expected to attenuate, so the highest energy events are likely due to hadronic interactions. Gamma-ray sources with spectra that extend to 100 TeV without cutting off are therefore strong candidates for acceleration sites for Galactic cosmic rays. I will present the spectra from 5-100 TeV for all the high significance gamma-ray sources detected by Milagro.

1:54PM Q13.00003 Physics with the HAWC Gamma-Ray Observatory, JORDAN GOODMAN, University of Maryland, HAWC COLLABORATION — The High Altitude Water Cherenkov (HAWC) gamma-ray observatory will be a wide field of view, continuously operated, TeV gamma-ray observatory. HAWC is a natural extension of Milagro, which has demonstrated the ability to detect, at TeV energies many of the galactic sources which have been observed by the Fermi LAT in the GeV energy range. Since Milagro was a first generation detector constructed in a preexisting reservoir at a relatively low elevation (2640m), what Fermi was able to see in several months took Milagro near seven years to see. HAWC will be constructed as a joint Mexican-US collaboration on the Sierra Negra Mountain in Mexico at an elevation of 4100m. The design of HAWC was optimized using the lessons learned from Milagro and will be 15 times more sensitive than Milagro when completed. This improvement in sensitivity will allow HAWC to measure or constrain the TeV spectra of most of the Fermi discovered GeV sources. In addition, above 100 GeV HAWC will be more sensitive than the Fermi and be the only ground-based instrument capable of detecting prompt emission from gamma-ray bursts in this energy regime. This talk will present the physics capabilities of HAWC as well as its status.

2:06PM Q13.00004 Constraining the Propagation of Galactic Cosmic Rays Using Measurements of the Composition and Energy Spectra of Dominantly Secondary Isotopes, KELLY LAVE, Washington University, MARK WIEDENBECK, JPL/Caltech, ALAN CUMMINGS, ANDREW DAVIS, RICHARD LESKE, RICHARD MEWALDT, EDWARD STONE, Caltech, W. ROBERT BINNS, MARTIN ISRAEL, LAUREN SCOTT1, Washington University, ERIC CHRISTIAN, GEORGIA DE NOLFO, TYCHO VON ROSENVINGE, NASA GSFC, ACE/CRS COLLABORATION — Using measurements from the Cosmic Ray Isotope Spectrometer (CRIS) on-board the Advanced Composition Explorer (ACE), we report isotopic abundances and energy spectra for dominantly secondary isotopes, produced by interstellar fragmentation of heavier species, in the energy range of 50-500 MeV/nucleon. We also consider secondary-to-primary ratios that are fit using a simple leaky box model of cosmic ray transport in the Galaxy combined with a spherically symmetric solar modulation model. CRIS measurements reported here include data from two consecutive solar minima, between 1997-1998 and 2008-2009, when the solar magnetic field was of opposite polarity. These results are used to constrain the propagation of cosmic rays in the Galaxy, as well as better understand how the effects of gradient and curvature drifts in the interplanetary magnetic field change over the solar cycle.

2:18PM Q13.00005 On the positron fraction and models of cosmic ray propagation1, RAMANATH COWSIK, BENJAMIN BURCH, Washington University in St. Louis — The recent observations of the positron fraction in cosmic rays by PAMELA has created much excitement because of its possible connection with annihilation or decay of dark matter in the Galaxy, or with a variety of astrophysical processes taking place in nearby pulsars or supernova explosions. The PAMELA instrument measured a positron fraction of ~0.0673 at ~1.64 GeV, which decreases to ~0.0483 at ~6.83 GeV, and thereupon increases monotonically, reaching a value of ~0.137 at mean energy of 82.55 GeV. It is this monotonic increase that has been called anomalous, as it does not conform to the predictions of the leaky box model with the residence time of cosmic rays decreasing with increasing energy. Accordingly the possibility of the reacceleration of positrons in the cosmic ray sources, and the effects of inhomogeneous distribution of cosmic ray sources about the solar system, have been discussed. Detailed comments on these suggestions may be found in Ahlers et al. and in Mertsch et al.. We wish to point out here that very general arguments based on cosmic-ray propagation models indicate that the positron fraction should increase at high energies, and asymptotically reach a value of ~0.6 at the highest energies. Furthermore, we show that these observations support the nested leaky-box models for cosmic ray propagation.

1Funding provided by the McDonnell Center for the Space Sciences, Washington University in St. Louis.
2:30PM Q13.00006 A Method for Constraining Galactic Magnetic Field Models Using Data from the Pierre Auger Observatory, MICHAEL SUTHERLAND, The Ohio State University, THE PIERRE AUGER COLLABORATION — Ultra-high energy cosmic rays are deflected by magnetic fields during propagation from their extra-galactic sources. However, these fields are poorly understood. We present a method for constraining the parameter space of galactic magnetic field models by comparing test statistics between backscattered data and isotropic expectations for assumed source and cosmic ray composition hypotheses. Different galactic magnetic field models are scanned using data from the Pierre Auger Observatory under various assumed source and composition hypotheses.

2:42PM Q13.00007 Cross-Correlation of UHECRs with the Local Matter Distribution, CRAIG LARGE, New York University, PIERRE AUGER COLLABORATION — The cross-correlation of UHECR arrival directions with the local matter distribution is a powerful tool for analyzing the anisotropy of cosmic ray events. Because the nearby matter distribution is known to high resolution from the 2 MASS Redshift Survey, the fractional fluctuations in the cross-correlation are reduced by the factor \( \sim \left( \frac{n \cdot N}{n} \right)^{-2} \), where \( n \) is the number of UHECR events and \( N \) the number of galaxies, as compared to \( \sim n^{-1} \) for UHECR auto-correlations. The observed cross-correlation between UHECRs detected with the Pierre Auger Observatory and 2MRS galaxies is incompatible with the UHECRs coming from an isotropic distribution, and compatible with their sources being associated with galaxies. The dependence of the significance of the correlation on the energy threshold of the UHECRs and on the depth of the galaxy sample carries important information, which can be interpreted by simulations with mock UHECR catalogs.

2:54PM Q13.00008 Search for nearby extragalactic sources of the highest energy cosmic rays, MIGUEL MOSTAFÁ, Colorado State University, PIERRE AUGER COLLABORATION — We update the analysis of the correlation between the arrival directions of the highest energy cosmic rays \((E > 57\, \text{EeV})\) observed with the Pierre Auger Southern Observatory and the positions of nearby extragalactic objects.

Monday, February 15, 2010 3:30PM - 5:18PM — Session S1 DPF DAP: Dark Matter in the Laboratory Marriott Ballroom Salon 2

3:30PM S1.00001 Results from the Cryogenic Dark Matter Search Experiment, ANGELA REISSETTER\(^3\), University of Minnesota and St. Olaf College — The Cryogenic Dark Matter Search (CDMS-II and SuperCDMS) uses high-purity Ge crystals operated at 40mK to look for WIMPs, a leading dark matter candidate. The CDMS experiment is housed in the Soudan Underground Laboratory in Soudan, MN, and the collaboration has published world-leading limits on WIMP-nucleon cross sections. The CDMS-II detectors, 1-cm thick crystals, use ionization and phonon signals to distinguish bulk nuclear recoils (caused by WIMPs) from electron recoils and from surface events caused by electromagnetic backgrounds. I will report on recent results from the operation of 5 towers of detectors (6 detectors per tower) for 612.13 kg-days of exposure, during what was the final run of CDMS-II. I will also address the progress in R&D work on the next generation of CDMS Ge detectors, and the status of the first run of SuperCDMS, a run including 6 SuperCDMS 1-inch thick Ge detectors with newly developed phonon sensors.

\(^3\)for the CDMS collaboration

4:06PM S1.00002 Searching for WIMPs in the Galactic Halo: Scaling Up with Liquid Xenon Detectors, DAN AKERIB, Department of Physics, Case Western Reserve University — No abstract available.

4:42PM S1.00003 Missing energy based searches at colliders: gateway to dark matter in the lab?, SARAH ENO, University of Maryland — The results from cosmology experiments on the properties of the particles that make up the observed dark matter in the universe are consistent with its having a mass on order the weak scale \( (\mathcal{O}(100\, \text{GeV}/c^2)) \) and weak couplings. Many models of new physics that contain such a particle, such as supersymmetry or universal extra dimensions, predict its copious production at the Large Hadron Collider, either directly or via the decays of other new particles. Events containing these particles would show an apparent momentum imbalance in the plane transverse to the beam direction (missing transverse energy). In this talk, I report on the status of searches by the ATLAS and CMS collaborations for an excess of such events beyond the expectations from production of known particles.


3:30PM S3.00001 Observational Constraints on Cosmic Ray Acceleration in Supernova Remnants, JOHN P. HUGHES, Rutgers University — Over the past few years, observations in the X-ray and gamma-ray bands, coupled with theoretical investigations, have led to important new insights into the process of particle acceleration at high speed shocks in supernova remnants. In this presentation I will review results largely from the X-ray band that reveal the presence of shock-accelerated relativistic electrons and amplified magnetic fields at these shock fronts. Evidence for shock-accelerated protons, although less direct, appears in the form of modifications to the dynamical evolution of young remnants, particularly SN1006 and the Tycho supernova remnant. As time permits, I will examine other observational topics bearing on the small-scale angular structure and temporal variations in the X-ray synchrotron emission, and particle acceleration at the reverse shocks of remnants.

4:06PM S3.00002 Gamma-Ray Emission from Supernova Remnants, STEFAN FUNK, Stanford University — The last few years have brought significant advances in our understanding of acceleration processes at work in shell-type as well as in plerionic Supernova remnants through observations from X-rays to VHE Gamma-rays. Unprecedented morphological studies of gamma-ray emission from shell-type Supernova remnants show a striking correlation to X-ray emission. Gamma-ray energy spectra of up to 100 TeV confirm particle acceleration up to the “knee” in the cosmic ray spectrum at 1 PeV in these objects. All these measurements can now be complemented with data from the recently-launched Fermi-LAT, operating in the energy range between 20 MeV and 300 GeV. Fermi-LAT data will constrain gamma-ray emission models and allow studies of the parent population accelerated in these objects. I will review the current observational status of gamma-ray emission in supernova remnants.
4:42PM S3.00003 Supernova Remnants as Probes of Type Ia Nucleosynthesis , CARLES BADENES, Weizmann Institute of Science and Tel-Aviv University — I will review our present understanding of Type Ia Supernovae (SN), with an emphasis on the open questions about the explosion mechanism and the identification of their elusive progenitors. The study of nearby supernova remnants (SNRs) originated by Type Ia SNe has the potential to shed new light onto these long-standing open questions. SNRs in our Galaxy and the Magellanic Clouds are much closer than the extragalactic SNe that are discovered by the hundreds every year, which means that we can study the composition of the ejected material in much greater detail. We can also examine the structure of the ambient medium and the stellar populations around Type Ia SNRs and put constraints on the mass-loss rates and properties of their progenitors. I will conclude with some thoughts about the future of X-ray observations of SNRs.


3:30PM S13.00001 Search for Long-lived particles in cosmic rays , MARIO CAMUYRANO, MARK ADAMS, University of Illinois at Chicago — High energy cosmic ray air showers are capable of producing massive particles, such as those predicted in SUSY models. A search was carried out for long-lived charged particles that can be observed as a second component in the decay spectrum of stopped cosmic ray muons. Using plastic scintillation counters from a QuarkNet cosmic ray large array project, decays were studied as a function of the number of muons detected in the shower.

3:42PM S13.00002 Radar Detection of ultra high energy cosmic rays , ABAZ KRYEMADHI, Messiah College, Grantham PA, USA, MICHAEL BAKUNOV, University of Niżnja Novgorod, Niżnja Novgorod Russia, ALEX MASLOV, Tucson AZ USA, ALINA NOVOKOVSKAYA, University of Niżnja Novgorod, Niżnja Novgorod Russia — We revisit the radar echo technique as an approach to detect ultra high energy cosmic rays (UHECR). The UHECR extensive air showers produce disk-like ionization fronts propagating with a relativistic speed and creating fast decaying plasma. We study the reflection of a radio wave, such as the one from a radar transmitter or commercial radio and TV station, from the ionization front. The reflected wave will be frequency up-shifted due to relativistic Doppler effect. The amplitude of the reflected wave depends strongly on the velocity of the front, and density and collision frequency of the plasma behind it. The returned power will be shown for typical extensive air shower parameters.

3:54PM S13.00003 Status and prospects of the AMBER experiment for detecting ultrahigh energy cosmic ray air showers through molecular bremsstrahlung , P.S. ALLISON, X. GAO, P.W. GORHAM, J. KENNEDY, L. MACCHIARULO, C. MIKI, L.L. RUCKMAN, G.S. VARNER, University of Hawaii-Manoa, J.I. BEATTY, J. DAVIS, E.W. GRASHORN, N. GRIFFITH, J. MAYER, C. MORRIS, Ohio State University — The Air-shower Molecular Bremsstrahlung Radiometer (AMBER) is a novel experiment intended to open a new detection mechanism for ultrahigh energy cosmic ray showers motivated by laboratory and accelerator experiments which show evidence of partially coherent emission in the microwave region from an electromagnetic cascade. This would allow the longitudinal measurement of an air shower in a similar manner to a nitrogen fluorescence detector, but with a much higher duty cycle and without uncertainty due to variable atmospheric attenuation. Prototype detectors are being developed by the Ohio State University and the University of Hawaii-Manoa for deployment at the Pierre Auger Observatory in Mendoza, Argentina to confirm and calibrate the emission by using the surface and fluorescence detectors to trigger directly on cosmic ray air showers.

4:06PM S13.00004 The MIDAS experiment: Microwave Detection of Air Showers , PEDRO FACAL, MARTINA BOHACOVA, MARIA MONASOR, PAOLO PRIVITERA, LUIS C. REYES, CRISTOPHER WILLIAMS, University of Chicago — Recent measurements suggest that extensive air showers initiated by high energy cosmic rays (above 1 EeV) emit signals in the microwave band of the EM spectrum caused by the collisions of the free-electrons with the atmospheric neutral molecules in the plasma produced by the passage of the shower. Such emission is isotropic and could allow the detection of air showers with 100% duty cycle and a calorimetric-like energy measurement - a significant improvement over current detection techniques. We have built a MIDAS prototype, which consists of a 4.5 m diameter antenna with a cluster of 35 feed-horns in the 4 GHz range, covering a 10° × 10° field of view, with self-triggering capability. The details of the prototype and first results will be presented.

4:18PM S13.00005 Measurement of absolute fluorescence yield in air by AIRFLY , MARTINA BOHACOVA, University of Chicago, CARLOS HOJVAT, FREDERICK KUEHN, Fermilab, PEDRO FACAL, MARIA MONASOR, PAOLO PRIVITERA, CRISTOPHER WILLIAMS, University of Chicago, AIRFLY COLLABORATION — Fluorescence detection of UHECR air showers is a widely used technique. Precise knowledge of the air fluorescence yield in dependence on the atmospheric conditions in the region of production propagates into the primary cosmic ray energy reconstruction. Relative measurements, such as dependence on pressure, temperature, humidity, energy of the secondary particles and nitrogen emission spectrum have already been studied in the previous measurement campaigns of the experiment AIRFLY. A precise measurement of the absolute fluorescence yield of the 337 nm line - the most prominent line in the nitrogen spectrum - has been recently performed at the Fermilab MTest beam facility. The experimental method and first results are presented.

4:30PM S13.00006 Upgrades to the LIDAR atmospheric monitoring detectors for the Pierre Auger Observatory1 , MARIA BECKER, University of Nebraska, THE PIERRE AUGER COLLABORATION — The LIDAR (Light Detection and Ranging) systems at the Pierre Auger Cosmic Ray Observatory are being upgraded with near-field detectors to improve atmospheric measurements within the first kilometer in front of each LIDAR station. The upgrades have involved designing, simulating, constructing, and installing new LIDAR telescopes, which use small spherical mirrors and photomultiplier tubes to collect and measure back-scattered laser light. Data collected by the near-field detectors will provide a more complete atmospheric density profile between detected air showers and the fluorescence detectors (FDs), resulting in a more accurate calibration of the energy measurements of primary cosmic rays as determined by the FDs. The near-field LIDAR detector design and preliminary results of data analysis will be presented.

4:42PM S13.00007 Enhancements of the Southern Pierre Auger Observatory , RALF ULRICH, Pennsylvania State University, PIERRE AUGER COLLABORATION — The southern Pierre Auger observatory in Argentina takes data routinely now, and the first physics results have been obtained and published. The successful operation of the experiment is soon going to be enhanced by the low energy extension HEAT and the muon detector system AMIGA. Both of these extensions individually have a large potential to answer further questions for example concerning the high energy galactic cosmic ray component and the transition from galactic to extragalactic cosmic rays.

4:54PM S13.00008 The Pierre Auger Northern Observatory , GREGORY SNOW, University of Nebraska, THE PIERRE AUGER COLLABORATION — The Pierre Auger collaboration plans to build the northern part of the Observatory in southeast Colorado. Results from the southern section of the Auger Observatory, which was completed in 2008, imply a scientific imperative to create a much larger acceptance for the extremely rare cosmic rays of energy above a few times 1019 eV. The plan for Auger North is to cover an area greater than 20,000 km2, seven times the area of Auger South in Argentina. The motivation for Auger North and the status of preparations will be presented including: R&D work at the Colorado site on a small surface detector array; atmospheric monitoring measurements; R&D on new electronics and communications equipment; and outreach and relations with the local community.
11:21AM X3.00002 Composition Studies of the Highest Energy Cosmic Rays with the High Resolution Fly’s Eye Observatory . JOHN BELZ, University of Utah — The existence of a strong break at $6 \times 10^{19}$ eV in the cosmic ray energy spectrum may be most simply explained by the Greisen-Zatsepin-Kuzmin (GZK) mechanism of interactions with the cosmic microwave background (CMB), provided the highest energy particles observed are both protons and extragalactic in origin. Mass studies of cosmic rays can test both of these conditions, by observing a transition from a heavy galactic to light extragalactic composition and the persistence of the light composition at the highest energies. Air fluorescence observatories such as the High Resolution Fly’s Eye (HiRes) probe primary cosmic ray composition by studying of the shape of cosmic-ray induced extensive airshowers. The average depth of airshower maximum $X_{\text{max}}$ depends logarithmically on the primary energy and atomic mass, and the elongation rate, $d<\text{X}_{\text{max}}>/d\log E$, will be constant for unchanged primary compositions. Further, shower-to-shower fluctuations in $X_{\text{max}}$ will be smaller in airshowers induced by heavy nuclei due to averaging effects. We report the results of composition studies of ultra-high energy cosmic rays observed by the stereoscopic HiRes observatory, for particles with energies above 1.6 EeV. The mean shower maximum, elongation rate, and fluctuations observed by HiRes are all consistent with a predominantly protonic composition when interpreted via the QGSJET01 and QGSJET-II high energy hadronic interaction models. The HiRes data thus supports the CMB-interaction explanation of the end of the energy spectrum and severely constrains models in which the galactic-to-extragalactic transition occurs above $10^{18}$ eV.

11:57AM X3.00003 Ultra-High Energy Cosmic Ray Origin and Model Building in Light of new data1. GUENTER SIGL, University of Hamburg — Ultra-high energy cosmic ray detection recently made a considerable leap forward due to results of the world’s current largest cosmic ray detector, the Pierre Auger Observatory in Argentina, and also due to new data from the Northern hemisphere, such as from the High Resolution Fly’s Eye. As often the case when science enters new sensitivity regimes, the emerging picture also holds some surprises. For example, there is a significant correlation of highest energy events with the large scale galaxy structure on the Southern hemisphere but at the same time considerable deflection by cosmic magnetic fields would be expected if many of these events are heavy nuclei, as hinted to by the data. We will discuss how this and other open questions may be addressed by theoretical models for the origin of the most energetic particles in Nature.

1The Collaborative Research Center 676 funded by Deutsche Forschungsgemeinschaft is acknowledged for support.

Tuesday, February 16, 2010 10:45AM - 12:21PM —

10:45AM X3.00001 Observations of Ultra-High Energy Cosmic Rays by the Pierre Auger Observatory , RALF ULRICH, Penn State University — No abstract available.

10:45AM X3.00002 Composition Studies of the Highest Energy Cosmic Rays with the High Resolution Fly’s Eye Observatory . JOHN BELZ, University of Utah — The existence of a strong break at $6 \times 10^{19}$ eV in the cosmic ray energy spectrum may be most simply explained by the Greisen-Zatsepin-Kuzmin (GZK) mechanism of interactions with the cosmic microwave background (CMB), provided the highest energy particles observed are both protons and extragalactic in origin. Mass studies of cosmic rays can test both of these conditions, by observing a transition from a heavy galactic to light extragalactic composition and the persistence of the light composition at the highest energies. Air fluorescence observatories such as the High Resolution Fly’s Eye (HiRes) probe primary cosmic ray composition by studying of the shape of cosmic-ray induced extensive airshowers. The average depth of airshower maximum $X_{\text{max}}$ depends logarithmically on the primary energy and atomic mass, and the elongation rate, $d<\text{X}_{\text{max}}>/d\log E$, will be constant for unchanged primary compositions. Further, shower-to-shower fluctuations in $X_{\text{max}}$ will be smaller in airshowers induced by heavy nuclei due to averaging effects. We report the results of composition studies of ultra-high energy cosmic rays observed by the stereoscopic HiRes observatory, for particles with energies above 1.6 EeV. The mean shower maximum, elongation rate, and fluctuations observed by HiRes are all consistent with a predominantly protonic composition when interpreted via the QGSJET01 and QGSJET-II high energy hadronic interaction models. The HiRes data thus supports the CMB-interaction explanation of the end of the energy spectrum and severely constrains models in which the galactic-to-extragalactic transition occurs above $10^{18}$ eV.

11:57AM X3.00003 Ultra-High Energy Cosmic Ray Origin and Model Building in Light of new data1. GUENTER SIGL, University of Hamburg — Ultra-high energy cosmic ray detection recently made a considerable leap forward due to results of the world’s current largest cosmic ray detector, the Pierre Auger Observatory in Argentina, and also due to new data from the Northern hemisphere, such as from the High Resolution Fly’s Eye. As often the case when science enters new sensitivity regimes, the emerging picture also holds some surprises. For example, there is a significant correlation of highest energy events with the large scale galaxy structure on the Southern hemisphere but at the same time considerable deflection by cosmic magnetic fields would be expected if many of these events are heavy nuclei, as hinted to by the data. We will discuss how this and other open questions may be addressed by theoretical models for the origin of the most energetic particles in Nature.

1The Collaborative Research Center 676 funded by Deutsche Forschungsgemeinschaft is acknowledged for support.

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10:45AM X3.00001 Plasma Regimes in the Surroundings of Black Holes, Composite Magnetic Field Structures and Associated Radiation Processes* . B. COPPI, MIT — In the close vicinity of Binary Black Holes the existence of three characteristic plasma regions is envisioned. The intermediate of these regions exhibits three physical regimes that differ both for the magnetic field structure and the spectrum of the emitted radiation, with jets and High Frequency Periodic Oscillations (HFQPOs) produced in two of these regimes. The excitation of radial localized density spirals co-rotating with the plasma, at a distance related to the radius of the marginally stable orbit is proposed as the explanation for the HFQPOs of non-thermal X-ray emission characterizing the relevant regime. The theory of the composite plasma disk structures[1] and of the relevant magnetic field configurations that can surround black holes is presented, consistently with recent experimental observations indicating that highly coherent magnetic field configurations exist in the core of these structures. The radial gradient of the rotation frequency and the vertical gradient of the plasma pressure are the excitation factors for spirals as well as for axisymmetric modes. These can produce vertical flows of thermal energy and particles in opposing directions that can be connected to the winds emanating from disks in Active Galactic Nuclei (AGNs). *Sponsored in part by the U.S. Department of Energy. [1] B. Coppi Pl. Phys. Cont. Fus. 51 (2009).

10:57AM X3.00002 Plasma Regions and Regimes Near Black Holes and High Frequency QPOs1. P. REBUSCO, B. COPPI, MIT, M. BURSA, C.U. — Tri-dimensional, tightly wound spirals [1] are considered that co-rotate with the magnetized plasma disk structure surrounding a black hole at a radial distance that is related to the radius of the marginally stable orbit. These modes can be excited under the combined effects of the differential rotation and the vertical gradients of the plasma density and temperature. The spirals are localized over radial widths that defines one of the regions surrounding a black hole and have frequencies that are multiples of the plasma rotation frequency. The high toroidal number $m_p$ modes are considered to decay into $m_p = 2$ and $m_p = 3$ modes. The observed twin peak non-thermal spectra of High Frequency QPOs are associated with the excitations of these modes, with the $3:2$ ratio. The modulation of the observed radiation associated with general relativistic effects is analyzed, considering different emission processes. These are connected to strong variations of the plasma collisionality parameters corresponding to a local rarefaction and heating, due to the considered spirals.


1Sponsored in part by the U.S. DOE and the Pappalardo Fellowship program.

11:09AM X3.00003 3D accretion disks: investigation of global transient dynamics , PAOLA REBUSCO, B. COPPI, ORKAN UMURHAN, Queen Mary - London, WLODEK KLUZNIAK, Zielona Gora University, ODED REGEV, Technion/Columbia University — Accretion disks are both important and ubiquitous astrophysical objects. In this work we considered the approximate nonlinear dynamics of a disturbed hydrodynamical viscous thin disk with vertical structure. By means of an asymptotic expansion we find the temporal evolution of global non-axisymmetric perturbations. While in the first order all the variables decay, in the second order the perturbed density and vertical velocity display a strong transient growth. As these perturbations grow they wind and display successive radial peaks and troughs. We argue that these transient non-axisymmetric structures may be a critical element for a new alternative picture of development of turbulence in non-magnetized astrophysical disks.
11:21AM X13.00004 Poynting Robertson Battery and the Chiral Magnetic Fields of AGN Jets , DEMOSTHENES KAZANAS, NASA/GSFC, IOANNIS CONTOPOULOS, Academy of Athens, Athens Greece, DIMITRIS CHRISTODOULOU, Math Methods, Bedford MA, DENISE GABUZZA, University of Cork, Ireland — The origin of cosmic magnetic (B) fields remains an open question. It is generally believed that very weak primordial B fields are amplified by dynamo processes, but it appears unlikely that the amplification proceeds fast enough to account for the fields presently found in galaxies and galaxy clusters. In an alternative scenario, cosmic B fields are generated near the inner edges of accretion disks in active galactic nuclei (AGNs) by azimuthal electric currents due to the difference between the plasma electron and ion velocities that arises when the electrons are retarded by interactions with photons. While dynamo processes show no preference for the polarity of the (presumably random) seed field that they amplify, this alternative mechanism uniquely relates the polarity of the poloidal B field to the angular velocity of the accretion disk, resulting in a unique direction for the toroidal B field induced by disk rotation. Observations of the toroidal fields of 29 AGN jets revealed by parsec-scale Faraday rotation measurements show a clear asymmetry that is consistent with this model, with the probability that this asymmetry came about by chance being less than 1%. This lends support to the hypothesis that the universe is seeded by B fields that are generated in AGNs via this mechanism and subsequently injected into intergalactic space by the jet outflows.

11:33AM X13.00005 Fermi-LAT Observations of the Core of Centaurus A . JUSTIN FINKE1, U.S. Naval Research Laboratory, FERMI LARGE AREA TELESCOPE COLLABORATION — The nearby radio galaxy Centaurus A has been detected by the Large Area Telescope (LAT) onboard the Fermi Gamma-Ray Space Telescope. Here we report on the LAT detection of the Cen A core integrated over 10 months. Contamination from the gamma-ray emission of the giant radio lobes has been accounted for and subtracted. The flux level and spectral index observed by the LAT is consistent with that found by EGRET. The core observations are complemented by a variety of contemporaneous and archival data to create a spectral energy distribution (SED). The SED is fit with a single zone synchrotron self-Compton model, which is not able to account for the non-simultaneous very high energy emission observed from Cen A by HESS in 2004–2008. These results have implications for possible emission mechanisms and for blazar/radio galaxy unification.

11:45AM X13.00006 TANAMI: High Resolution Physics of AGN in the Multiwavelength Era , ROOPESH OJHA, NVI/USNO, MATTHIAS KADLER, Dr. Karl Remeis-Sternwarte, Bamberg. TANAMI COLLABORATION — Near simultaneous, multiwavelength observations of AGN are essential to discriminate between competing theoretical blazar emission models. Milliarcsecond resolution observations using Very Long Baseline Interferometry are the only way to spatially resolve the sub-parsec scale regions where the high-energy (and much of the lower energy) radiation originates. The TANAMI (Tracking AGN with Austral Milliarcsecond Interferometry) and associated programs provide comprehensive radio monitoring of extragalactic gamma-ray sources south of declination −30 degrees. We describe the TANAMI program, present results and place them in the context of observations across the electromagnetic spectrum.

11:57AM X13.00007 Nonthermal Filaments in CAS A: Testing Plasma Turbulence , MAXIM LYTIKOV, Purdue University — Young supernova remnants are prime candidates for CR acceleration up to the “knee” energies. In addition, they often show thin non-thermal X-ray filaments associated with the forward shock. We use 1 Msec Chandra observation of Cassiopeia A to study the spectral evolution across the X-ray filaments and to determine the properties of the plasma turbulence. Using advection-diffusion modeling of synchrotron emission, we find magnetic field, diffusion strength and the plasma turbulence level in the shocked plasma. This provides an important observational test of the CR acceleration models.

12:09PM X13.00008 A small magnetic inclination model for the paucity of accreting millisecond X-ray pulsars1 , STRATOS BOUTLOUKOS, University of Maryland, FREDERICK LAMB, KA HO LO, ROBERT CHAMBERLAIN, University of Illinois, M. COLEMAN MILLER, University of Maryland — Given their status as progenitors of rotation-powered millisecond radio pulsars, it is somewhat surprising that accretion-powered millisecond X-ray pulsars are so rare, and that all current examples are transient sources. We show that this and other phenomenology can be explained by a model in which the magnetic poles are close to one or both rotational poles. Accreting gas is therefore channeled close to the rotational poles, leading to oscillations that have low amplitudes, are nearly sinusoidal, and can exhibit large phase variations. We present general relativistic ray-tracing computations and population studies using such a model and compare the results with observations.

1 Tuesday, February 16, 2010 1:30PM - 3:18PM –
Session Y1 DPF DAP: Neutrino Astrophysics Marriott Ballroom Salon 2

1 Supported by NASA grant NAG 5-12030, NSF grant AST0709015, funds of the Fortner Endowed Chair, and NSF grant AST0708424.

1:30PM Y1.00001 Results from the ANITA search for Ultra-High Energy Neutrinos and Cosmic Rays using the Radio detection technique1, DAVID SALTZBERG, University of California, Los Angeles — ANITA is a balloon-borne radio telescope flown on Long Duration Balloons in Antarctica. The payload looks for Ultra-high energy cosmic neutrinos striking the ice via their emission of radio-Cherenkov radiation. I will present the results of our neutrino searches in the data from ANITA’s two full flights. In a different polarization, ANITA observes the radio emission of extensive air showers via their radio emission in the atmosphere below the payload. I will present evidence for these events being induced by cosmic rays and discuss their properties.

1 Supported by NASA, DOE, and NSF. Presented for the ANITA collaboration.

2:06PM Y1.00002 Cosmic Rays and Neutrinos above $10^{21}$ eV - the NuMoon experiment with WSRT and LOFAR , HEINO FALCKE, Radboud University, Nijmegen & ASTRON, Dwingeloo — Ultra-High Energy Cosmic Ray particles (UHECR) are known to reach energies at least up to $10^{20}$ eV, providing potential insight into physics that cannot be studied by current or upcoming particle accelerators. However, these particles are extremely rare and large natural detector volumes are needed to detect them. Here radio detection techniques provide interesting possibilities. Geosynchrotron radiation in the Earth’s atmosphere or radio Cherenkov (Askaryan) emission in solid media make it possible to observe radio waves from showers induced by UHECRs and neutrinos. In the NuMoon project we have used the Westerbork Synthesis Radio Telescope (WSRT) to monitor the lunar surface for an aggregate observing time of 46 hours at a frequency around 150 MHz. This has allowed us to improve current limits for the cosmic neutrino flux above $4\times10^{22}$ eV by almost an order of magnitude, bringing it into an astrophysically interesting regime. In the future we will be using the new LOFAR interferometer to lower this neutrino limit further by at least one to two orders of magnitude. In addition we will place further constraints on UHECR beyond the Greisen-Zatsepin-Kuzmin (GZK) cut-off ($\sim10^{20}$ eV) and detect air showers from cosmic rays at lower energies around $10^{18}$ eV.
Supernova neutrinos are of interest for a number of reasons. A future detection will provide a rare opportunity to obtain information about the supernova core, and perhaps also about the hydrodynamics of the explosion and/or the properties of the neutrinos themselves. In addition to traditional supernovae, MeV scale neutrinos also originate from sources such as black-hole accretion disk supernova, gamma ray bursts and compact object mergers. Astrophysically produced MeV scale neutrinos exhibit a rich variety of behavior. Neutrino flavor transformation in all these environments is affected by a changing stellar and neutrino density profile, and new flavor transformation behavior of neutrinos recently has been discovered. Neutrinos from these environments play a crucial role in element synthesis. I will review some recent developments in these areas.