National Symposium on VHE Gamma Ray Astronomy 2013

Monday 25 November 2013 - Wednesday 27 November 2013

BARC TRAINING SCHOOL HOSTEL

Book of abstracts

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Gamma-ray Spectral Break in Blazars

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Blazars(BL Lacs and FSRQs) are the class of Active Galactic Nuclei with their relativistic jet pointed close to the line of sight of the observer. The gamma ray spectrum of FSRQ generally follows a broken power-law distribution rather than a simple power-law. In this talk I will discuss the possible scenarios under which such a spectrum can be obtained and the present demand for more detailed study at high energies in order to understand the particle acceleration mechanism and energetics of the source.

1

High Energy Studies Using Astrosat

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Astrosat, the first multi-wavelength Indian Astronomical Satellite, is scheduled to be launched in the next year. It has wide band X-ray spectroscopic capabilities and it is ideally suited for the study of high energy sources. It consists of three sensitive co-aligned X-ray detectors (Soft X-ray Telescope - SXT, Large Area Xenon-filled Proportional Counter - LAXPC and Cadmium Zinc Telluride Imager - CZTI) which provide good spectroscopic measurements whereas high time resolution observations, particularly in the hard X-rays, are done with LAXPC. The Ultra-violet Imaging Telescope (UVIT) provides simultaneous mulati-wavelength observations in the optical and the UV regions. I will describe the instrument characteristics of Astrosat and present the observation strategies planned for high energy sources.

2

MACE in an extragalactic point of view

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MACE is a a large area imaging cherenkov telescope being built at Hanle in India. The high altitude (~4300m) of the site together with the large dish area (21 m diameter) and new generation electronics make MACE a unique facility to detect the lowest part of the very high energy spectrum which is largely unexplored. In this talk, we will discuss the unique science that can be carried out from the MACE observations of extragalactic sources.

3

Charge pulse profile studies of MACE

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MACE is new generation imaging cherenkov telescope which will be placed at Hanle in India. The large area dish (21 meter diameter) and 1088 photo-multiplier tubes (PMTs) would make the telescope a leading instrument in its genre. The camera has 68 modules, while each module contains 16 PMTs. In this talk, we will present the charge pulse profile studies that have been carried out on a test set up of 4 modules using an artificial light source, mimicking an almost real situation.

4

Long-Term Monitoring of Blazars for Variability

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Accretion of matter on the black hole powers the relativistic jet, which dominates the emission at all wavelengths in blazars. The exact mechanisms responsible for the structure, origin, acceleration and collimation of the jet are not well understood. Since central engine is not resolvable by any existing telescope facility, variability in flux and polarization, understood to be caused by the central engine, is a useful tool to understand the structure and physical processes in AGNs. Blazars are best candidate for such study as they provide a probe to peep into innermost regions of the central engine. They show variability in their flux at all frequencies with time scales ranging from years to minutes. Jet emission is dominated by non-thermal radiation which is highly polarized and variable. We have a long-term monitoring program to observe blazars in optical beginning 1995. Variability in flux and polarization are studied to understand blazar properties. Here we will report long term study of the blazar S5 0716+71 carried out during last seven years or so with observations made from Mt. Abu Infrared Observatory using 1.2m and 0.5m telescopes mounted with optical CCDs and polarimeter. The light curves are constructed for all the nights observed for longer than 2 hours to explore intra-night behaviour. WE notice variations during a large number of nights showing very high duty cycle of variation. The present observations suggest that the blazar S5 0716+71 showed significant night-to-night variations with mild bluer when brighter trend which could be caused by variations in the Doppler factor. The interaction of shocks with local inhomogeneities in the jet appears to cause intra-night variations while micro-variations could be due to small scale perturbations intrinsic to the jet. Averaged magnitudes for nightly observations for all the nights are used to construct long-term night curves. These show many large flares interspersed with relatively quiet phases. We notice a mild decrease in mean brightness of the source with time. Optical linear polarization measurements made during December 2009 indicate significant variation in the degree of polarization for this source. Detailed results on the variability in flux and polarization along with overall behaviour of the blazar S5 0716+71 as well as some other results will be presented at the meeting.

5

Blazars help in constraining Extragalactic Background Light

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The extragalactic background light (EBL) contains all radiative energy release from nuclear and accretion processes in the Universe. The intensity and shape of the EBL is an important issue in high energy astrophysics providing unique information about the epochs of formation and and history of evolution of the galaxies. Observations of blazars at energies above 100 GeV provide important constraints on EBL intensity and spectrum. Attenuation of very high energy (VHE) gamma-rays by low energy EBL photons via pair production is expected to leave a unique energy and redshift dependent imprint on blazar spectra. Here, we use a homogeneous simple one zone emission models for few selected blazars to estimate their intrinsic VHE spectra using nearly simultaneous multi-wavelength data available from various observations. The predicted intrinsic VHE spectra are then compared with spectra observed by ground based Cherenkov telescopes to estimate the optical depth of VHE gamma-rays. We compare these opacities with those predicted by different EBL models in the literature. We will also discuss possible explanations for deviations observed in the opacities determined using the above two methods.

6

Production, testing and alignment of diamond turned metallic mirrors for the MACE γ-ray telescope.

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The 21m-diameter MACE (Major Atmospheric Cerenkov Experiment) telescope is being set up at Hanle, India (32.8deg N, 78.9degE, 4200m asl) to explore the γ-ray energy domain ~ 20 GeV - 5 TeV. The parabolic light collector of the telescope (f/1.2 system) will use 356 panels of size ~ 984mm x 984 mm with each panel consisting of 4 diamond turned spherical mirrors of size ~488mm x 488 mm. The mirror facet front surface is made up of a 5 mm thick Aluminum alloy plate (AI 6161 T6) and the facet back plate is made up of a 1 mm thick AI alloy. Sandwiched between these two plates is a 26 mm thick HEXEL Aluminum honeycomb panel (AIM composites UK). The diamond turned fabrication methodology has been preferred for these mirror facets in order to achieve excellent surface finish and accuracy which is unmatched by other traditional methods. On-site testing of these mirror facets is done by setting up a point source of light at the radius of curvature (ROC) of the facet, by putting a green diode laser based system along with a beam expander. The spot size of the reflected beam is monitored on a white screen, at the ROC. After the facet is accepted for use, a thin layer of SiO2 (100-150 nm) is deposited on the mirror surface for protection. Results obtained on about 1300 mirror facets manufactured and about 30 panels aligned so far, indicate that the facets have mean D80 of ~3.5mm for an on-axis parallel incident beam while as the panel has a D80 of ~7.5mm (where D80 is defined as the radius of the circle within which 80% of rays are captured) and a reflectivity of >80% in the wavelength range 300-650 nm. In this work we present the fabrication and the alignment methodology of these mirrors along with their measured characteristics such as spot size, ROC and reflectivity for the individual facets and roadibility and vibrations test results of the aligned panels.

7

Effects of Beyond Standard Model Physics on GRB Neutrinos

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The nondetection of neutrinos coming from Gamma Ray Bursts (GRBs) by the IceCube experiment has raised serious questions on our understanding of GRB's and the mechanism of neutrino flux production in them. Motivated by this and the need for a precise calculation for GRB neutrino flux, here we study the effects of beyond standard model physics on the GRB neutrino flux. In the internal shock model of GRB, high energy neutrinos are expected from muon, pion and kaon decays. Using the latest best fit neutrino oscillation parameters,
we compute the expected flux on earth for standard as well as non-standard oscillation scenarios. Among the non-standard scenarios, we consider neutrino decay, Pseudo-Dirac nature of neutrinos and presence of one eV scale light sterile neutrino. Incorporating other experimental bounds on these new physics scenarios, we show that neutrino decay scenario can significantly alter the neutrino flux on earth from the expected ones whereas the
corresponding changes for pseudo-dirac and sterile neutrino cases are moderate.

8

Understanding of Supernova Remnant 3C391(G31.9+0.0) in GeV Gamma Rays and X-Rays

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3C 391(G31.9+0.0) is a galactic mixed-morphology supernova remnant with coordinate 282.383(R.A.) and −0.923(Dec.). It has been observed in GeV γ-ray by Large Area Telescope(LAT) on board the Fermi satellite and detected with 13σ confidence. 3C 391 is an interesting source for studying hadronic origin of γ-rays as it is known to be interacting with intersteller molecular cloud. We have analysed four years(2008-2012) of Fermi-LAT data of 3C 391 in the energy range 200 MeV to 300 GeV. The spectrum is fitted with various models and the best fit values of the model parameters have been estimated. The results are in good agreement with that obtained from the two years analysis done by Fermi group. The values of spectral parameters are useful to identify the actual nature of γ-rays production mechanism in 3C 391. We will discuss these results and their interpretation using multi-wavelength data from X-rays and γ-rays.

9

Variation of secondary cosmic gamma ray flux during celestial event.

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Abstract

We observed variation of secondary cosmic gamma ray flux during celestial event transit of Venus June 6, 2012 at Udaipur. We collected data as a function of time using ground based NaI(Tl) scintillation detector. After analyzing collected data we observed variation in secondary cosmic gamma ray flux. On the June 6, 2012 during the transit of Venus we observed decrease in secondary cosmic gamma ray flux about 2 %.

Key Words: Transit of Venus, obstruction of radiation by Venus.

10

Optical characteristics of the 21m diameter MACE gamma-ray telescope

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The light collector of the 21 m diameter MACE telescope (f/1.2 design) will use 356 panels of 984 mm x 984 mm size on a Paraboloid basket with mirror panels of graded focal lengths in the range 25060- 26190mm. Each panel will be assembled with 4 diamond-turned spherical mirror facets of size 488 mm x 488 mm so that the resulting mirror panel thus formed behaves like an equivalent single large spherical mirror. Detailed ray-tracing simulations have been carried out to study the point spread function of the MACE light collector, both for an ideal design as well as for a realistic design. In the realistic design, apart from considering gravitational deflection of the basket, we have also considered realistic mirror facets with non negligible values of surface roughness and figure errors. The results of the simulation study suggest that, with a D80<7.5 mm for each mirror panel and by using the Active Mirror Alignment & Control System (AMACS) it is possible to achieve the desired PSF with an on-axis D80 of <22 mm over a zenith angle range of 0-60 deg (where D80 is defined as the diameter of the circle, with its centre at the image centroid, within which 80% of rays are focussed). Details of the methodology followed for simulating the realistic light collector design along with results obtained will be presented in this work.

11

Extensive air showers induced by primary gamma-rays with energies 100 - 1000 TeV

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A Monte-Carlo simulation study of EAS initiated by primary proton, iron
and gamma-ray is carried out, at ARGO-YBJ level. After proposing an unambiguous way of estimating lateral shower age parameter, some important correlations of the parameter with other EAS observables are studied for different primaries using the simulated data. The lateral distribution of electrons or shower age parameter is found steeper
for showers induced by primary gamma-rays than for EAS generated by primary hadrons. We realized that the parameter might be useful for selecting gamma-ray EAS from hadron induced EASs without muon information.

12

Observation of Crab nebula with HAGAR Telescope Array

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HAGAR is a system of seven Non-imaging Atmospheric Cherenkov Telescopes located at Hanle in the Ladakh region of Indian Himalayas. Since 2008 we have observed the Crab nebula to assess the performance of the HAGAR telescopes. The trigger threshold of the HAGAR telescope array is 218 GeV for near vertical sources like Crab. Based on about 100 hours of data, we report the detection of gamma rays from Crab nebula at a significance level of 15.2 sigma, corresponding to a time averaged flux of (2.21 +/- 0.29) x 10^-10 photons\cm\sec for energies above 218 GeV. We also perform a detailed study of possible systematic effects in analysis method which may influence the analysis of the data taken with the HAGAR telescopes.

13

Observation of Crab Pulsar with HAGAR Telescope Array

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We present on VHE gamma ray observations of the Crab Pulsar above 218 GeV carried out with the HAGAR array of atmospheric Cherenkov telescopes. HAGAR telescope array is an array of seven non-imaging telescopes, located at Hanle in the Ladakh region of Indian Himalayas. We have detected pulsed gamma rays from Crab pulsar data taken during October 2008 to January 2013. In this paper we present our results on the light curve in the VHE energy band and compare time averaged flux of gamma rays with other ground based detections in TeV energies.

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Gamma-ray Variability of VHE Blazar PKS 1222+216 With Fermi-LAT

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PKS 1222+216 is a Flat Spectrum Radio Quasar detected (FSRQ) at Very High Energy (VHE, E>100 GeV) by \emph{MAGIC} observatory on June 17, 2010 in close coincidence with a bright flare ($\sim 10^{-5} ph~cm^{-2}~s^{-1}$) observed by Large Area Telescope (LAT) on board \emph{Fermi} satellite. A similar γ-ray flare was observed by LAT during April 2010 with no VHE counterpart. We performed a detail analysis of these two brightest LAT flares in different energy bands with the shortest possible time binning allowed by the photon statistics. The sub-daily binned light-curves shows a variety of temporal characteristics and variability patterns. This includes asymmetric profile with a faster rise time at lower energies on sub-daily timescales, a superposition of many short uncorrelated flaring events giving rise to an apparently coherent longer-duration outburst, and some isolated outbursts unresolved down to the timescale of 6 hr. Further the time delay study of LAT light-curves during the June flare suggest a soft lag of approximately 6 hr. In this talk, I will discuss the implication of various timescales on the physical processes shaping the light-curves, location of emission region and physical condition of the blazar zone.

15

Estimation of the Extra Galactic Background Light using VHE Observations of HBLs

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The VHE spectral index of HBLs correlates strongly with the redshift whereas there is no such correlation in the X-ray or the GeV bands.
We use this to argue that while the intrinsic VHE indices are also un-correlated, this observed correlation arises from the fact that the TeV photons from the
source get attenuated by pair producing with the photons of the extragalactic background light (EBL). We show that this requires the local EBL spectrum to
have a form $\epsilon n(\epsilon) \sim k\, log(\epsilon/\epsilon_p)$ in the energy band 0.05-2.5 eV. Assuming no correlation uptill $1-\sigma$ for the
redshift range 0-0.3 allows us to
constrain the values of $ k = 8.6 \pm 1.2 \cdot 10^{-4} $ and $ \epsilon_p = 4.9 \pm 2.4 eV$. This is completely model independent estimate of
the EBL spectrum agrees extremely well with the current theoretical models, and is also consistent within the limits obtained through observations

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The progenitor model of cosmic rays and high energy gamma ray observations

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An intriguing feature about the primary energy spectrum of all particle cosmic rays is the slight bend of the spectrum at about 3 PeV, the so called knee of the spectrum, where the power law spectral index changes from about -2.7 to nearly -3.0. The knee is generally believed to be of astrophysical origin. There exist different explanations of the knee but none of these models are free from problems. In the past we tentatively proposed that the steepening of the energy spectrum of cosmic rays beyond the knee might be related with ZAMS mass distribution of progenitors of cosmic ray sources. Further developing the idea, here we demonstrated that the hypothesis works well for acceleration of dominant part of cosmic rays in a single class of extragalactic sources.

We have also examined the results of high energy gamma ray observations by different experiments to check the proposed model. Our contention is that the gamma ray results are inconsistent with the supernova remnant model of cosmic ray origin but are consistent with the expectations from the progenitor model.

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Arrival time intervals of Gamma-Ray Bursts detected by SWIFT-BAT

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The origin of gamma ray bursts (GRBs), the most luminous electro-magnetic phenomenon in the Universe (releasing an isotropic equivalent luminosity of up to 1054 ergs/s), is so far not clear despite numerous observations and theoretical efforts. GRBs are distributed isotropically across the sky and are occurred roughly one per day though the time of occurrence of GRBs is unpredictable. In this work the time sequence of SWIFT-BAT detected GRB arrival time intervals have been analyzed with the objective to check for any periodicity of the data. Presence of any chaotic feature in the time series has also been examined.

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On non-extensive nature of Crab pulsar spectrum

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Non extensive statistical physics has been applied to various problems in physics including astrophysics. In present studies we explore the possibility of using non extensive approach to explain the recently observed pulsed γ-ray from Crab pulsar above 100 GeV observed by VERITAS γ-ray telescope. Leffa et al (2012) have shown that crab pulsar spectrum arises due to the Maxwellian distributions of the velocities of electrons. But this does not explain the broken power law spectrum. We explore using non extensive form of Maxwellian distributions to possible explanation of both exponential cut off as well as broken power law.

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Study of correlated variability in B3 1708+433

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The radio source B3 1708+433 (z=1.027), also known as CGRaBS J1709+4318, is a flat spectrum radio quasar. This source was studied by MOJAVE collaboration using Very Long Baseline Interferometry (VLBI) and OVRO telescopes (15 GHz) at radio wavelengths. Fermi-LAT has detected gamma-ray flux from a source positionally consistent with this source. An attempt is made to study the correlated flux variability at radio and gamma ray energy bands. The presence or absence of correlation between these two bands could provide insight into blazar emission physics. A study is carried out using five year Fermi-LAT data and publicly available data from MOJAVE collaboration and OVRO telescope.

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GAMMA RAY ASTRONOMY - A HISTORICAL PERSPECTIVE

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Gamma Ray Astronomy has come a long way in the last forty plus years.
Various steps in this journey in both Indian and International l efforts
will be discussed.A bird's eye view of the present state of the field will also be presented. Very recent results from the study of The Crab, the astrophysical source which paved the way for all this progress, will be presented.

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Multiwavelength study of Mrk 501 during HAGAR observations

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Since the detection of VHE gamma-rays from Mrk 501, its broad band emission of radiation was mostly modeled using one zone emission scenario, which was quite effective in explaining the
the observed broad band emission to a large extent. But broad-band spectral and flux variability studies enabled by the multiwavelength campaigns carried out during the recent years revealed rather complex behavior of Mrk 501. The observed emission from Mrk 501 could be due to a complex superposition of multiple emission zones. Moreover new evidences of detection of very hard intrinsic gamma-ray spectra obtained from Fermi-LAT observations have challenged the theories about origin of VHE gamma-rays. Our studies based on Fermi-LAT data indicate the existence of two separate components in the spectrum, one for low energy gamma-rays and the other for high energy gamma-rays. Using multiwaveband data from several ground and space based instruments, in addition to HAGAR data, the spectral energy distribution of Mrk 501 is obtained for various flux states observed during 2011. In present work, this observed broadband spectral energy distribution is reproduced with a leptonic, multi-zone Synchrotron Self-Compton model.

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Recent TACTIC Observations of VHE Gamma-ray Sources

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We have observed five potential VHE gamma-ray sources for more than 700 hours using TACTIC gamma-ray telescope at Mt. Abu(24.6◦N, 72.7◦E, 1300m asl) Rajasthan during years 2011-13. These are: Crab nebula, Mrk421, Mrk501, 1ES1218+305 and IC310 for 282, 255, 117, 47 and 19 hours respectively. These observations were made after the upgrades of the TACTIC system for which the related Monte Carlo simulation studies show that its trigger threshold energy has reduced to about 870GeV from its earlier value of 1TeV. And experimentally we find that an hourly VHE gamma-ray detection rate from Crab nebula direction has increased to 14±0.8 from its earlier value of 8.27±0.88 photons before the upgrades. Preliminary data analysis of above mentioned sources shows a presence of VHE gamma-ray signal from Mrk 501 and Mrk 421 directions whereas from 1ES1218+305 and IC 310 directions we do not find any evidence for a statistically significant gamma -ray signal. In addition, we have also analyzed Crab nebula data recorded during January this year using disp methodology. Our preliminary results obtained using this different methodology show that it has a better quality factor for gamma/hadron segregation as compared to the standard Hillas shape and orientation parameters approach. Further, we also investigate state of these sources in lower energy bands like at FERMI (LAT) 30MeV-300GeV, Swift (XRT) 0.3-10keV and BAT(15-50KeV) energies, where the recorded data on various sources are freely available.

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Status of HAGAR Telescope Array

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High Altitude GAmma Ray (HAGAR) telescope array installed at Hanle in Himalayas has been collecting science data since Septemebre, 2008. In last five years, several sources including galactic objects like Crab nebula, Geminga pulsar, binary LSI+61 303, some of the pulsars detected by Fermi as well as extragalactic objects including Mrk 421, Mrk 501, 1ES2344+514, 3C454.3 etc have been observed with HAGAR. Crab nebula has been detected successfully and flux from Mrk 421 has been estimated in flare state during February, 2010 and its multiwaveband spectral energy distribution (SED) has been studied. Recently pulsations from Crab were detected at a significance level of 3.6
sigma. Also flux from Mrk 501 has been estimated in bright state and
multiwaveband SED has been modeled. Work on comparison of simulations with data is at advanced stage. Results from HAGAR will be summarised followed by discussion about future plans.

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Long term study of Mrk 421 using HAGAR telescope array

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The blazar, Mrk 421 (z = 0.031), is the first extragalactic source to be detected at gamma-ray energies of E > 500 GeV. Since detection by the Whipple Observatory in 1992, gamma-ray flux from this source is found to be highly variable. The Mrk 421 has been monitored extensively using the HAGAR telescope system during last five years, and more than 100 hours of data have been collected. Source was detected in high and moderate state of gamma ray flux activity during HAGAR observations. Two extreme bright flares from Mrk 421 were detected during 2010 and 2013 respectively. In addition to HAGAR observations, we have studied multiwaveband emission of this source during flaring and moderate flux states using multifrequency, multi-epoch data. Five year long observations will be presented in this work.

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Study of Faint Blazars with HAGAR

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The High Altitude GAmma Ray (HAGAR) telescope array is an array of Atmospheric Cherenkov Telescopes to detect VHE gamma-rays from the celestial sources. This array is located at Indian Astronomical Observatory (IAO), Hanle , in the Ladakh region of India, at an altitude of 4270 m. We use the wavefront sampling technique to detect gamma-rays. One of the major goals of this experiment is to study VHE gamma-rays from extragalactic sources, such as blazars. Using the HAGAR telescope system, we have observed several blazars over the five years of operation so far. Here we present details of our study of three relatively faint blazars, 1ES 2344+514, 1ES1218+304 and 3C 454.3. In Addition to this, we will also discuss multiwaveband flux variability of 3C 454.3 over the past five years in this work.

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Relativistic spectral emission lines from X-ray binaries

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High-energy gamma-ray photons from some of the X-ray binaries possibly originate from their jets. The formation of such a jet depends on the accretion process near the central black hole or neutron star, for example via an accretion disk. I will discuss how broad relativistic spectral emission lines observed in X-ray wavelengths from some of the X-ray binaries can be used as a tool to probe the portion of the accretion disk near the central object.

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Camera Calibration Box for the Prototype Large Size Telescope (LST)

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The calibration of the camera for the prototype Large Size Telescope (LST) is one of the most important aspects of the camera. In order to calibrate the camera, the absolute gain of the system has to be accurately determined. The precise measurement of the gain of each electronic channel for the camera of LST requires the development of a reliable calibration device. In this talk I will discuss the progress in building such a prototype system for the LST.

28

Comparison of HAGAR data with simulations

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Monte Carlo simulations have been carried out in order to understand performance of HAGAR telescope array. Large samples of extensive air showers initiated by gamma rays and various species of cosmic rays have been simulated using CORSIKA package. Cherenkov photon distribution generated by CORSIKA is processed using custom made software to model response of HAGAR telescope system. In present work, we give details of detector simulation program with particular emphasis on modeling of the response of coaxial cables. Further we compare various parameters from data recorded by HAGAR, including PMT rate bias curve, Cherenkov pulse shape and total charge in the pulse as well as various combinations of telescopes participating in trigger, with corresponding estimates fromsimulations. Good agreement is seen between observations and simulations. Details of this comparison will be presented.

29

Study of weather parameters at Mt. Abu Observatory

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We have been monitoring the weather parameters like temperature, solar irradiance, wind speed, rain, dust load etc. at the Mt. Abu site since 1999. Last year, we have installed a new weather station and continuing this study further. In addition, we have also experimentally measured the value of light of night sky background of (3.26 ± 0.47) x 1012 photons/cm2/sec/sr in the wavelength range from blue to red using a hand held sky quality meter. Further, we have also estimated the annual percentage of cloudless nights suitable for making VHE gamma-ray observations at the Mt. Abu observatory indicating more cloudy nights during last few years. Dust load studies are also being done. We find that dust loads are high in the range of 50-120 μg/m3 during the pre- monsoon period from March to July, whereas low values of less than 40 μg/m3 have been recorded during the post monsoon period from August to February. The maximum and the minimum temperatures recorded so far are 38.4° C (21st May, 2010) and −4.2° C (21st February, 2005), respectively. The highest solar irradiance recorded was 1367.7 Watts/meter2 on 24th June, 2007. The highest and the lowest rainfall recorded at the site were 2400 mm and around 480 mm during the years 2006 and 2002 respectively. Details of these results for various weather parameters at the TACTIC site between 1999 to 2013 will be presented in the symposium.

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Application of Random Forest method in gamma-hadron segregation using Markarian(Mrk) 421 and Crab Nebula data of 2005-2006 observed by the TACTIC telescope

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The sensitivity of Imaging Atmospheric Cherenkov Telescope is a direct function of how effective is the background rejection. Most of the methods for gamma hadron segregation devote considerable efforts in evolving a strategy to achieve this goal. We present a study of gamma-hadron segregation using the Random Forest method for extragalactic source Mrk 421 observed during December 07, 2005 to April 30, 2006, (~202 hrs) and Crab Nebula observed during Nov. 10, 2005 - Jan. 30, 2006 (~101 hrs) by the TACTIC telescope
Random Forest is a flexible multivariate selection method which combines 'Bagging' and 'Random Split Selection' to construct a large collection of decision trees and then combines them to construct a common classifier. In this work, it will be shown that Random Forest method reduces the background by a factor of ~2 compared to earlier studies. For Mrk 421, previous studies reported the signal detection at 11.49σ by conventional "dynamic supercut" method. Same data analyzed by the Random Forest method estimates the signal strength at 16.0σ, ~39% higher than reported by the conventional method. The analysis for Crab Nebula data resulted in an excess of 1139 events compared to 928 events obtained by dynamic supercut method. The signal strength for crab increased from 9.4σ to 13σ (~38% higher). Image parameter frac2 (ratio of the sum of two highest pixel signal to the sum of all the signal) turns out to be the most effective parameter for gamma-hadron segregation followed by the width parameter.
In addition to better background rejection capabilities compared to conventional method, this method has very conservative computational resources needs. The training of Random Forest with a total of 40,000 signal and background events each and the application of trained forest on 40,000 test events (a total of 1,20,000 events) on a modest dual core machine takes less than 3 minutes.
The improvement in signal strength, very conservative computational needs and extremely low training time makes Random Forest a potential method of choice for TACTIC data analysis.

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Extra-galactic VHE sky

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With the development of current generation ground-based imaging atmospheric Cherenkov telescopes, nearly fifty extra-galactic very high energy (VHE: E > 100 GeV) sources have been detected till date. The extra-galactic TeV catalog is teeming with blazars, which are active galactic nuclei whose jet is directed at us. VHE blazars are broken down into four sub-classes with the detection of 34 HBLs , 4 IBLs, and 4 LBLs, as well as 3 FSRQs. Additionally, there are radio and starburst galaxies albeit with smaller numbers. In this talk, the observational status of extra-galactic VHE sources will be presented.

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Survey of candidate sites for CTA in Ladakh

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Cherenkov Telescope Array (CTA) will consist of two arrays of Imaging Atmospheric Cherenkov Telescopes (IACTs), one each in southern and northern hemisphere. HIGRO collaboration had proposed few sites in LADAKH region as candidate sites for northern CTA observatory. The sites included the places like Likir, Upshi and 'Thangchung Gari'. The relevant details of the sites like geographical/atmospheric/meteorological conditions, accessibility, infrastructure, political and economical conditions, technical/scientific support, safety etc will be shared in the talk.

33

X-ray Flares from Young Stars

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X-ray variability is a characteristics of magnetically active stars. Long time scales variability may comprise modulation by rotating active regions (on the order of days) or even activity cycles (on the order of years), however, short time scales of variability (on the order of minutes to hours) are attributed to flares resulting from magnetic reconnection events. X-ray emission arises mostly from violent magnetic reconnection events during their pre main sequence (PMS) phase. Recent X-ray surveys of PMS stars give detailed insights into PMS magnetic flaring, and reveal that most events are similar to solar magnetic flaring with the enhanced X-ray luminosities of 103 -105 fold of intensity. However, numerous puzzles are present including the structure of X-ray emitting coronae and magnetospheres, and effects of stellar rotation. To investigate these issues in detail, we analyzed the X-ray data from XMM-Newton of seven intense X-ray flares observed from six stars LAV 796, LAV 1174, SHM2002 3734, 2MASS 02191082+5707324, V553 Car, V557 Car. These flares show a rapid rise (10-40 minutes) and a slow decay (20-90 minutes). The X-ray luminosities during the flares in the energy band 0.3-7.5 keV are in the range of 1029.9 to 1031.7 erg s-1. The strongest flare was observed with the ratio ~13, count rates at peak of the flare to the quiescent intensity. The maximum temperature during the flares has been found to be ~100 MK.
The physical parameters of the flaring structure, the peak density, pressure, and minimum magnetic field required to confine the plasma have been derived and the semi loop lengths for the flaring loops are estimated to be of the order of 1010 cm. Detailed results on the flaring activities of these stars and physical size and morphology of the loop structures involved in these stellar flares will be discussed at the meeting.

34

Efforts of Detection of ``Dark Matter'' And Its Implications For Physics & Astrophysics

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The concept of ``Dark Matter'' (DM) will be introduced first. The nature of DM in terms of Baryonic, Leptonic and exotic Super-symmetric ideas will be discussed. Key results on DM searches made through (i) Gamma Ray Telescopes, (ii) Neutrino Telescopes and (iii) Direct searches will be brought out. However no experimental details will be presented. Neither any technical discussions of theoretical nature will be made. On the other hand, the physical and cosmological implications of the results of the DM searches will be emphasized. The basic aim of the talk will be to cover a broad range of physics for an overall picture rather than nitty-gritties of specific experimental or theoretical aspects. In general, the talk will be directed towards serious research students and non-experts.

35

Monte Carlo simulation studies for upgraded TACTIC telescope

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A comprehensive data-base to simulate the response of the upgraded TACTIC telescope to atmospheric Cerenkov events produced by gamma-ray and hadron initiated extensive air showers has been studied through detailed Monte-Carlo simulation using the CORSIKA (version 6.90) code. For this purpose Cerenkov data has been generated for gamma (400GeV - 40.0TeV) and background noise proton (500GeV – 60.0TeV)/ helium (1.0TeV – 90.0TeV) progenitors. Five separate sets for each progenitor have been obtained by generating the events at 5, 15, 25, 35 and 45 degree zenith angles. For each energy primary and particle type, the images were selected randomly at 20 different locations within the distance of 300m from the telescope. With this configuration each shower forms 20 images on the ground plane. The total number of Cerenkov images for gamma- proton- and helium used in the simulations are ~33 million, ~46 million and ~33million respectively. With a value of 13pe single pixel threshold, the trigger efficiency, effective collection area (m2) and thus the differential rates corresponding to each energy value for all three progenitors has been obtained for the upgraded-TACTIC telescope. Also comprehensive simulation studies after folding in all the basic differences in the images of gamma-ray and hadron shower has been carried out to estimate the expected sensitivity of the telescope for point gamma-ray sources. The various image-parameter cuts for Length(L), Width(W), Size(S), Distance(D), Frac2(F2), Alpha and Asymmetry have been obtained to maximize the signal to noise ratio and thus obtaining the Image-Collection area. All the above results obtained will be discussed in the the symposium.

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Simulation Studies of MACE Gamma-ray Telescope

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We are setting up a Major Atmospheric Cerenkov Experiment(MACE) at Hanle (320 46', 780 57', 4.2km a.s.l) in Jammu and Kashmir, India. This wiill be a low threshold energy gamma-ray telescope based on imaging atmospheric Cerenkov technique. It would depoly a tesselated 21m diameter parabolic light collector with a focal length of 25m. Its imaging camera comprises 1088 photomultipler tubes with a uniforn pixel resolution of 0.120.. We are presently carring out Monte carlo simulation studies to understand MACE, by simulating extensive air showers using CORSIKA (v 6.970) simulation code for gamma-ray, proton, alpha and electron progenitors. Wherein we use QGSJET-III, FLUKA2008.3d and EGS4 packages for high energy, low energy and electromagnetic interactions respectively. The ray tracing, trigger configurations, Hillas parameterisation, image cuts optimisation for the gamma and hadron seperation and sensitivity calculations were implemented in a backend code. For trigger rates and threshold energy studies, samples of 1 million showers for each progenitor in the energy range 1GeV to 10TeV for vertical showers were generated. We obtain a trigger energy threshold of about 22 GeV for the Crab like spectrum for camera trigger multiplicity of 4 nearest neighbour pixels with single channel photoelectron threshold of 10 photoelectron. The sensitivity studies were also carried out with the sample containing 1.5 million gamma-ray, 4 million protons, 2 million alpha and 0.15 million electron air showers in the energy range of 70GeV to 10TeV, at zenith angle of 50. The Hillas cuts were optimised by maximising the square of significance obtained per unit time for Crab spectrum. Results obtained on threshold energy, trigger rates and sensitivity estimates of the MACE will be presented in the symposium.

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Performance evaluation of the 16 channel Camera Integrated Module for the MACE telescope.

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A large area imaging Cherenkov telescope MACE is being setup at Hanle, a high altitude astronomical site in North India. The telescope will deploy a 21m diameter tracking light collector with a 1088 photomultiplier tube based high resolution imaging camera at its focal plane. The camera has been designed as a modular structure of 68 Camera Integrated Modules, each of which houses 16 photomultipliers along with their data acquisition system. In the present study we have evaluated the performance of a Camera Integrated Module using an in-house developed test setup. Long term monitoring of various telemetry parameters of the system i.e. High Voltage, Discrimination Threshold, Anode Current, Single Channel rates, Power Supply status, Module Temperature etc. shows steady and consistent performance.

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Fermi blazars: optical - GeV connection

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The launch of Fermi-gamma ray space telescope has opened up the opportunity of studying high energy flux variation in AGN. Fermi has clearly shown that blazars can exhibit flux variations on timescales of even hours in the GeV range. Simultaneous flux density measurements of Fermi blazars at multiple wavelengths across the electromagnetic
spectrum enables one to put constraints on the high energy emission processes in these sources. It is very important to know if the flux variations shown by blazars at different frequencies are correlated. Such a study will help us to probe the important physical origin of the emission at various frequency bands including its location and physical mechanisms. Details of a systematic study carried out on the opitcal - GeV variability properties of a sample of Fermi blazars will be presented in this symposium.

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Evaluation of data quality recorded with the TACTIC telescope

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TACTIC (TeV Atmospheric Cherenkov Telescope with Imaging Camera) is deployed for regular observations on a number of potential gamma-ray sources. In order to ensure that recorded data is of high quality, data go through several data quality checks. Apart from using zenith angle dependence of prompt coincidence rate (PCR), we also make use of frequency distribution of arrival time differences of successive cosmic-ray events which is expected to be exponential. Recently, we introduced a new parameter which is a function of peak event rate and mean event rate obtained from above mentioned procedures. It is found that the new parameter is a better estimator of the quality of data than using PCR and time difference distribution separately. This parameter is tested for TACTIC data of 56 days in total consisting of different years and different sources. The details of data quality evaluations will be presented in the symposium.

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Observations of Mrk 501 and 1ES1218+304 using TACTIC during 2013

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We have observed two AGNs, 1ES 1218+304 (z = 0.182) and Markarian 501 (z=0.034) at VHE gamma- ray energy range with the TACTIC telescope located at Mt. Abu, Rajasthan. The observations were made during March 2013- May 2013 for both the sources.The total observation time for 1ES1218+304 is 55.6 hrs and 41.4 hrs for Mrk501. Preliminary results obtained on both AGNs will be presented in the symposium.

41

Galactic Very High Energy Sky

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Teraelectron (TeV or Very High Energy Gamma Ray) astronomy concerns the study of astrophysical sources of gamma-ray photons, with
energies in the range between ~30 GeV to ~30 TeV. The TeV range is one of the most recent windows of the electromagnetic spectrum to be opened for study, beginning with the identification of the first source, the Crab Nebula in 1989. The field of TeV Gamma-ray astronomy has produced many exciting results over the last decade. Both the source catalog and the range of astrophysical questions which can be addressed, continue to expand. In the present talk we will present discovery of new population of TeV sources with emphasis on galactic sources, for examples SNR, X-Ray binaries, Pulsars etc. There are presently ~80 known TeV sources within our Galaxy. The majority of these sources are identified during the H.E.S.S. survey of the inner Galaxy. Observation of the outer Galactic regions by VERITAS, MAGIC, Milagro and AGRO-YBJ have revealed less densely populated sky, but containing some unique objects of particular interest for TeV studies. Many Galactic TeV sources are extended, allowing detailed studies of source morphology and spatially resolved spectra, while others are time variable and/or periodic.

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VHE gamma-ray observations of Markarian 421 using TACTIC during 2012- 13

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We have observed blazar Markarian 421(z =0.03) in Very High Energy (VHE) gamma-ray range with the TACTIC telescope located at Mt. Abu, Rajasthan(24.6◦ N, 72.7◦ E, 1300m asl). The observations were made intracking mode of the telescope operation during January-May, 2013 for 136.5hours .Preliminary results obtained from Markarian 421 will be presented in the
symposium.

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Diffuse gamma-ray emission

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Observed diffuse gamma-ray emission has both galactic and extragalactic origin. Majority of the Galactic gamma-ray emission is diffuse in nature. The primary source of gamma-ray production in our galaxy is interactions between cosmic rays with interstellar matter and radiation. The derivation of the extragalactic diffuse emission (extragalactic gamma-ray background: EGRB) is based on detailed modeling of the bright foreground diffuse Galactic gamma-ray emission and the detected point sources. Observational gamma-ray astronomy got a massive boost after the launch of Fermi Gamma-ray Space Telescope (Fermi) on 11th June, 2008. Fermi with its much improved sensitivity and rapid scanning ability provides an excellent opportunity to study the gamma-ray Universe. The spectrum of the EGRB as measured by Fermi is consistent with a power law. Fermi measured EGRB spectrum is featureless, less intense, and softer than that derived from EGRET data. Origin of the extragalactic gamma-ray background (EGRB) is one of the fundamental unsolved problem in astrophysics. EGRB can arise from some diffuse processes like black hole evaporation, large scale structure formation, matter-antimatter annihilation, etc. Alternatively, due to the limited instrument sensitivity, unresolved sources from different source classes could be the major contributor to the observed EGRB. Here, I will concentrate on the unresolved point source contribution to the EGRB and the evolutionary properties of blazars.

44

SUMMARY OF RESULTS FROM THE FERMI SATELLITE

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FERMI is the a GeV gamma ray satellite that is currently orbiting Earth with a unique capability to provide fully sky observations every 3 hours. With its enhanced sensitivity and wide field-of-view, this telescope has revolutionised gamma-ray astronomy by providing for the first time an ability to monitor the activity state of numerous gamma-ray bright astrophysical sources as well as discover new classes of gamma-ray emitting point sources. It has also revealed the presence of previously unknown extended emission sources. The talk will briefly summarise these new findings.

45

Multi-wavelength Studies of Blazars: A Revolution due to HE/VHE Gamma-ray Astronomy

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Blazars is a subclass of radio-loud AGNs and one of the best targets for studying
in multi-wavelengths of the EM spectrum. These objects show variable flux, polarization
on all possible timescales and the emission being predominantly non-thermal. In the present
talk, I will report our some important results reported in series of papers in the different
bands of the EM spectrum. I will also mention how the new development and upcoming HE/VHE
gamm-ray facilities can put the impact on blazar astronomy.

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The Cherenkov Telescope Arrray Project

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Celestial Gamma-rays are seen as a powerful tool for, the study of cosmic ray sources in our galaxy and beyond as well as providing non-thermal view of the Universe. Recently, tremendous progress has been made in this regard using satellite-based detectors and ground-based Cherenkov telescope arrays.

The current generation of Cherenkov telescopes are mainly limited in their gamma-ray energy and flux reconstruction by uncertainties in the determination of atmospheric parameters. A group of institutes intends to design, construct and operate a next-generation facility called the Cherenkov Telescope Array (CTA) for ground-based very high energy gamma ray astronomy. It is planned to provide an order of magnitude improvement in the sensitivity compared to current instruments and enlarge the energy range, both towards lower and higher energies. The CTA facility will address astrophysical questions such as acceleration and propagation of high-energy particles in the Universe as well as issues of fundamental physics and cosmology. The CTA will be operated as an observatory open to scientific community, providing appropriate tools for data access as well as integration into the Virtual Observatory. It aims to provide high-precision data to the public, corrected offline before dissemination.

The CTA will consist of arrays of several tens of three classes of Imaging Atmospheric Cherenkov Telescopes (IACTs), of large, medium and small sizes covering an energy range from tens of GeV to hundreds of TeV surpassing existing instruments in sensitivity by an order of magnitude. Two such arrays of IACTs located at a Northern latitude and Southern latitude sites are planned for full sky coverage. The CTA Preparatory Phase started at the beginning of October 2010 and will end in June 2014. The construction phase is expected to begin in 2015 and last till 2020 with scope for first science as early as in 2016. The details of this project will be discussed in this talk.

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An update on the MACE gamma-ray telescope

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A 21m diameter imaging gamma-ray telescope, MACE (Major Atmospheric Cherenkov Experiment) is being setup jointly by BARC, IIA, TIFR and SINP at Hanle, a high altitude astronomical site in the Ladakh region of North India. When operational by early 2015 the MACE will be the largest gamma-ray telescope in the Northern hemisphere. Manufacturing of most of the mechanical components of the 150 tons structure has been completed and trial installation of the telescope is underway at Hyderabad. An update on the progress of the work related to the telescope at Hyderabad and Hanle will be presented.

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Possible Indian contributions to the CTA project

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Gamma Ray astronomy community in India has successfully operated imaging and wave-front sampling gamma-ray telescopes in the country for more than a decade. These indigenously developed telescopes have detected steady gamma-ray emissions from the Crab Nebula and a number of flaring episodes from extra-galactic objects. Work on the 21m diameter MACE gamma-ray telescope is also at an advanced stage and it is likely to be operational by early 2015. The indigenous capabilities developed for the manufacture and operation of these telescopes can be put to use for the CTA project. Some of the possible in-kind contributions to the CTA project will be discussed in the presentation.

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Radio Pulsars

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Pulsars are super dense, rapidly rotating neutron stars and are some of the most exotic objects in the Universe. In this talk, I will cover the basic ideas about pulsars, and describe how we infer the various properties of these stars, primarily from observations at radio wavelengths. I will also describe how we infer the locations of the radio emission regions in the magnetosphere, as well as the possible emission mechanisms. Lastly, I will cover the radio observations of the newly discovered set of gamma-ray pulsars and try to illustrate what we learn from a comparative study of radio and gamma-ray emission properties.

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Possible extraction of signal from galactic and extragalactic gamma-ray sources using fractal and wavelet approach.

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We present fractal and wavelet analysis approach to atmospheric Cerenkov light of extensive air showers at > 1TeV energies as recorded by the TACTIC telescope . Using a Monte-Carlo simulated data base of Cerenkov images recorded by the TACTIC, we show here that one of the parameter Wavelet dimension B6 provides excellent segregation of the gamma events from cosmic-ray proton events. We use these results to estimate significance values from various observations scans of Carb-on and Mrk421.

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GRAPES-3 Experiment

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The GRAPES-3 experiment located at Ooty, India is designed for precision study of cosmic ray energy spectrum and its nuclear composition in the energy range of ~10^13 eV to 10^16 eV. It comprises of an array of ~400 plastic scintillator detectors spread over an area of 20,000 m^2 and a large area (560 m^2) tracking muon detector. Independent recording of muon flux has further widen the scope to study phenomenon induced by solar flares and atmospheric effects. I will describe the existing experimental setup and the future upgrade plans. The current results from the experiment will be highlighted.

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Gamma Ray Astronomy : A Historical Perspective