IAU **Regional School on Astrophysical Data Reduction** IAU

9-13 June 2014 Central Department of Physics, Tribhuvan University, Kirtipur, Nepal

Report of

Regional School on Astrophysical Data Reduction

(RSADR2014)

9-13 June 2014

Central Department of Physics, Tribhuvan University, Kirtipur

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Institute of Science & Technology, Tribhuvan University

Project Leader: Prof. Dr. Binil Aryal, Head, CDP, TU, Kirtipur

Project Leader: Prof. Dr. Binil Aryal

Regional School on Astrophysical Data Reduction 9-13 July 2014, Kathmandu, Nepal (RSADR2014)

1 Summary

The Regional School on Astrophysical Data Reduction (RSADR2014) is successfully organized at the Central Department of Physics, Tribhuvan University during 9-13 June 2014. RSADR2014 achieved its goal by motivating more than 75 astrophysics graduates towards A&A research The importance of freely available database is strongly realized by the participants. Participants learned the process of data reduction skill, numerical simulations, calculations and effective plotting-skills using various software. The highlight of the school is that the participants put a joint effort and successfully analyzed and studied distribution of angular momentum vectors of 230 000 SDSS galaxies and obtained a result that supports hierarchy model (Peebles 1969). In addition, ten far infrared nebular region are studied in 60 and 100 micron maps. The dust color temperature and dust mass were calculated for all region. These original works remained highlight of the event. These results will be sent for the possible publication in the Journal soon. In the concluding session, project leader Prof. Dr. Binil Aryal acknowledges IAU and Govt. of Nepal for the constant help and strongly recommended to continue their helps to organize similar schools/workshops in the other parts of the nation in the future. Dr. Aryal highlighted the importance of IAU office of development for their program 'Astronomy for Universities and Research'.

2 Background

Tribhuvan University has been offered opportunity to carry out research work in A&A since 2006 at the Central Department of Physics (CDP), Kathmandu, Nepal. Till date 93 masters' thesis have been completed in the various areas of Astrophysics. About two dozen masters' theses are published in the Journals MNRAS, A&A, and Ap&SS. A few of masters' theses are published in the reputed Journals like MNRAS, A&A, Ap&SS, RAA and BASI. The research areas are galaxy evolution, dust structures around PNe, White Dwarfs and Pulsars, chirality of large scale structure, modeling galaxy rotation curve and observational work (16 inch Schmidt Telescope). Additional Information regarding publications, past and present on-going Ph.D. research and M.Sc. dissertation work are available in http://astronepal.webs.com. We also have a few experiences of collaborative work and organizing/hosting conferences in the various aspects of A&A in the past. Central Department of Physics have successfully organized International Conference on Astrophysics and Cosmology (ICAC2012) in Kirtipur, Kathmandu during March 19-21, 2012 under the leadership of Prof. Dr. Binil Aryal.

CDP has offered Ph.D. program in Astrophysics since 2010. At present, four students are involved in Ph.D. and 23 are doing work for their master's dissertation. The research areas are mainly galaxy evolution, ISM and dark energy. Additional Information is available in http://astronepal.webs.com. After completing masters' thesis, about 50% students go abroad (mostly USA) for the further study and research in A&A. The remaining students go to various colleges in Nepal to teach physics and astronomy at undergraduate level. They use to forget what they learned during masters' thesis because of their involvement in teaching. The aim of this school to group them and finally prepare them for Ph.D. project. In addition to these students, there are large number (more than 200) of masters' students majoring Astrophysics every year. Last year we had organized 4 days workshop NWAA2013 (For detail: http://www.astro4dev.org/category/tf1/nepal-workshop/). This workshop left a strong impact not only on participants, but also to the authorities of University as well as Government of Nepal. Because of the effective outcome of NWAA2013 (supported by IAU), recently our department has convinced Government of Nepal to support this particular area in the year 2014.

The Central Department of Physics have decided to organize a regional workshop on Astrophysical Data Reduction (RSADR2014 hereafter) in order to provide an extensive learning environment to the participants of Nepal

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Fig. 1 Opening Ceremony: The workshop is officially opened by the Dean of Institute of Science & Technology, Tribhuvan University *Prof. Chirika Shova Tamrakar*. There were seven invited guests including all faculty members of CDP.

Fig. 2 Participants and guests listening audio visual message from *Kevin Govender*, Director, IAU Office of Astronomy for Development during the opening ceremony. Full Text:

and neighboring countries. We will focus on database, data reduction and problem identification which is commonly used A&A research. Ultimately, a beginning of fruitful research collaboration is needed for the better future, in this region.

3 Opening Ceremony

The RSADR2014 is organized by the Central Department of Physics, Tribhuvan University in its premises at Kirtipur, Kathmandu during 9-13 June, 2014. RSADR2014 is officially opened by Mrs. Chirika Shova Tamrakar, Dean, Institute of Science & Technology, Tribhuvan University, Nepal. In that occasion, Assistant Dean Prof. Dr. Chet Raj Bhatta, Prof. Lok Narayan Jha, former Head of the Central Department of Physics, and Executive Director of Ministry of S&T Dr. Shobha Kanta Lammichhane addressed the participant. The physicists Prof. Sitaram Byhaut, Dr. Raju Khanal, Dr. Rajendra Parajuli, Dr. Ram Prasad Regmi, Dr. Balram Ghimire and Dr. Narayan Prasad Adhikari were present on the occasion. Prof. Binil Aryal welcomed the chief guest and guests. He presented souvenir to the guests. In the beginning, audio visual message from *Kevin Goverder*, Director, IAU Office of Astronomy for Development during the opening ceremony was displayed (Full text of his speech is given in the caption of Fig. 2). All the speakers advocated the importance of similar workshop in order to create environment for the better research work in the University. They all thanked the International Astronomical Union (IAU) for the 'Astronomy program for University Research'. All guests and participants acknowledged the contribution of IAU and wished that IAU will continue their supports to the University Research Program in the future. On that occasion, T-shirts (with IAU's official logo) and workshop key-rings are distributed to the guests as well as to all participants.

This event was supported by Tribhuvan University, B.P. Koirala Memorial Planetarium, Observatory and Science Museum Development Board, Ministry of Science, Technology & Environment, Govt. of Nepal & Institute of Science & Technology, Tribhuvan University, Kirtipur, Nepal, International Astronomical Union (IAU), Nepal Physical Society (NPS) and Astrophysics and Cosmology Research Group.

4 Objectives

Nepal is an underdeveloped country with very limited resources and infrastructure for the research work in A&A. We have been using freely available huge database, catalogs, software, virtual observatories that can be accessed through the internet for the masters' thesis and Ph.D. work in Nepal. Because of this, a good number of papers have been published in the international referred Journals. As an example, an important paper in galaxy orientation is recently published in MNRAS (Aryal et al. 2013).

The aim of this workshop is to form an active group who can have data reduction skill and carry out research works independently using freely available database in the field of A&A. In addition, our aim is to provide an opportunity to our graduates to interact with the similar level graduates of neighboring nations (India, Pakistan, China, Bangladesh, Vietnam, etc).

The objectives of RSADR2014 are as follows:

(1) The purpose of this regional school is to provide an opportunity to learn the data reduction skill to the graduate and Ph.D. students of Nepal and neighboring countries.

(2) A method of problem identification and solving procedure will be taught and discussed by the experts in the field.

(3) The purpose of this workshop is to bring together experienced as well as young astronomy graduates who are interested in working actively on various important aspects of A&A in this region (Nepal, India, Bangladesh, Pakistan and China).

(4) We intend to make a regional collaboration among students and faculties who are actively working in the field in this region of the world.

(5) To persuade the authorities in order to update Astronomy courses in the academic curriculum of colleges and universities.

5 Target Participants

Ph.D. and M.Sc. (Physics or Astrophysics Graduate) students of Nepal and neighboring countries are the target audience. There will be 100 participants, 2% participants will be reserved for neighboring nations. The selection criteria will be as follows:

(1) Participants should have masters degree in Physics or Astrophysics

(2) M.Phil and Ph.D. in Physics/Astrophysics are highly encouraged.

(3) Contributory participants (with oral/poster presentation) will be highly encouraged.

The lectures and tutorials will be arranged in such a way that the participants will have an opportunity to interact with the speakers who are both nationally and internationally leading experts in their field of research. In the theme session, there will be two talks delivered by invited speakers. SOC will decide and LOC will invite two speakers from aboard. The lectures will address major unsolved issues and current observational success in the field. Participants will be divided into 10 groups (ten in each group). An instructor will be assigned to each group. There will be 13 parallel working sessions. Instructors will be selected from the NWAA2013 participants and will be trained before the workshop. SOC will make selection criteria for this. Problems will be discussed in the theme session followed by tutorials and will be solved in the working session. Few important problems related to the photometry (eg, IRAS images: participants are asked to calculate the dust color temperature or mass of the dust in the far infrared maps) and spectrometry (eg., XMM Newton data: participants are asked to work on spectra and fit the spectra in a power law) will be taught. All participants will work on laptops with fast internet connection. In addition, necessary database and software will be provided to the participants. There will be contributory oral and poster presentations. The participants who are doing Ph.D. and masters dissertation will have opportunity to discuss their problems with the experts and participants.

2014	10:00-11:00	11:00-11:30	11:30-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-16:15	16:15-18:00
9 June	OPENING		TEA	BA	LUNCH	INSTALL	DATABASE	TEA	DATABASE
10 June	RK	TEA	IPN	IRAS		SDSS Tutorial			SDSS Tutorial
11 June	BA		MT1-3	SDSS		IRAS Tutorial			IRAS Tutorial
12 June	SA+SS		URK	NANTEN		NANTEN Tutorial			GRC
13 June	NA		MT4-5	NEWTON		NEWTON Tutorial			CLOSING

BA: Prof. Dr. Binil Aryal, Central Department of Physics, Tribhuvan University, Kirtipur
RK : Dr. Raju Khanal, Central Department of Physics, Tribhuvan University, Kirtipur
IPN: Dr. Ishwaree Pd Neupane, CERN, Switzerland
SA: Mr. Said Ally Mohamed, The Open University of Tanzania, Dar Es Salaam, Tanzania
SS: Mr. Srinivas Sashikanth, Hyderabad, India
MT: Minitalks (contribution from the participants)
URK: Prof. Uday Raj Khanal, Central Department of Physics, T.U., Kirtipur
NA: Dr. Narayan Pd Adhikari, Central Department of Physics, Tribhuvan University, Kirtipur

Fig. 3 Outline of the program.

Fig. 4 Prof. Aryal is delivering a talk entitled 'A&A Research at the Tribhuvan University, Nepal'.

6 Program

The program of the workshop is shown in Table 1. A brief description of the program is described below. There were 12 talks in the preliminarily session and 14 tutorials in the working session. Participants were divided into four groups during tutorial session. All participants have installed the data reduc6tion software ALADIN2.0, FITSVIEW4.0, MATLAB6.2, ORIGIN5.0 and ASTROLINUX2.0 in their Laptops.

There were ten tutors in order to help the speakers and instructors. All the participants worked on their laptops and tutors were running from one participants to another in order to check their software, commands, program and the procedure of data reduction.

We provided a set of already analyzed database (SDSS-optical/spectroscopic, IRAS-photometric, NANTEN-submm, GRC-Short Radio and XMM NEWTON-X-ray) to all participants and re-produced the results obtained in the previously published papers. For this, students leaned the technics of statistical data reduction, numerical simulation, data extraction from FITS images, calculations and so on.

7 Astrophysical Databases

In the pre- and post- lunch sessions, five databases have been extensively discussed, reduced and analyzed. These databases include (1) SDSS (Optical), (2) IRAS (Far Infrared), (3) NANTEN (sub-mm), (4) GRC (Radio), and (5) XMM NEWTON (X-ray).

7.1 Optical Database: SDSS

We have provided SDSS (seventh data release) database of merging binary cluster Abell 1775 to all participants. This dataset is already analyzed in the paper entitled *'Spatial orientation of angular momentum vector of galaxies in three merging binary clusters* (B. Aryal, R. R. Paudel, W. Saurer, Astrophysics & Space Science Journal (Springer), **337**, 313 2012). The participants re-produced the results that was presented in the paper.

We first briefly discuss the SDSS database. This database is free for all. One can do original research work and published results in the Journal using this database. The Sloan Digital Sky Survey or SDSS is a major multi-filter imaging and spectroscopic redshift survey using a dedicated 2.5-m wide-angle optical telescope at Apache Point Observatory in New Mexico, United States. The project was named after the Alfred P. Sloan Foundation, which contributed significant funding. Data collection began in 2000, and the final imaging data release covers over 35% of the sky, with photometric observations of around 500 million objects and spectra for more than 1 million objects. The main galaxy sample has a median redshift of $z = 0.1$; there are redshifts for luminous red galaxies as far as $z = 0.7$, and for quasars as far as $z = 5$; and the imaging survey has been involved in the detection of quasars beyond a redshift $z = 6$. Data release 8 (DR8), released in January 2011, includes all photometric observations taken with the SDSS imaging camera, covering 14,555 square degrees on the sky (just over 35% of the full sky). Data release 9 (DR9), released to the public on 31 July 2012, includes the first results from the Baryon Oscillation Spectroscopic Survey (BOSS) spectrograph, including over 800,000 new spectra. Over 500,000 of the new spectra are of objects in the Universe 7 billion years ago (roughly half the age of the universe). Data release 10 (DR10), released to the public on 31 July 2013, includes all data from previous releases, plus the first results from the APO Galactic Evolution Experiment (APOGEE) spectrograph, including over 57,000 high-resolution [infrared] spectra of stars in the Milky Way. DR10 also includes over 670,000 new BOSS spectra, of galaxies and quasars in the distant universe.

The Central Department of Physics has been using SDSS (DR7 & DR 9) spectroscopic as well as photometric data in order to study spatial orientation of spin vectors of galaxies in the clusters and Superclusters. About a dozen of papers are published in MNRAS, A&A, Ap&SS and BASI. Two Ph.D. project and about two dozen masters' thesis have been completed. Prof. Dr. Walter Saurer of Innsbruck University, Austria; Dr. W. Godlowski of Krakow Observatory, Poland and Prof. Dr. K. Odonari of KISO Observatory, Japan are our collaborators. The aim of this school is to share the methods through which we have been reducing SDSS data for the research. Following are the tutor of SDSS session.
(1) Shiv Narayan Yadav (Ph.D. student)
(2) Sunil Laudari (Researcher, NAST)
(3) Bhanu Bhakta Regmi (M.Sc.)
(4) Nirmal Baral (M.Sc.)
After learning simulation skill, thirty nine participants were involved in analyzing a huge database of 230,000 SDSS galaxies. They ran 21 simulations in 40 laptops and found expected isotropic distributions. The results were analysed with the observation and found that the results support hierarchy model (Peeble 1969).

7.2 Far Infrared Database: IRAS Maps

We have provided IRAS (Infrared Astronomical Satellite Survey) maps of NGC1514 in 60 and 100 micron wavelengths to all participants. This photometric database is already studied critically in the paper entitled *A giant dusty bipolar structure around the planetary nebula NGC 1514* (B. Aryal, C. Rajbahak & R. Weinberger, Monthly Notice of Royal Astronomical Society (MNRAS), **402**, 2, 1307, 2010) The participants re-produced the results that was presented in the paper.

We first briefly discuss the IRAS Survey maps. This database is free for all. The Infrared Astronomical Satellite (IRAS) was the first-ever space-based observatory to perform a survey of the entire sky at infrared wavelengths. Launched on January 25, 1983, its mission lasted ten months. The telescope was a joint project of the United States (NASA), the Netherlands (NIVR), and the United Kingdom (SERC). Over 250,000 infrared sources were observed at 12, 25, 60, and 100 micrometer wavelengths. Support for the processing and analysis of data from IRAS was contributed from the Infrared Processing and Analysis Center at the California Institute of Technology. Currently, IRSA at IPAC holds the IRAS archive. IRAS was the first observatory to perform an all-sky survey at infrared wavelengths. It mapped 96% of the sky four times, at 12, 25, 60 and 100 micrometres wavelengths, with resolutions ranging from 30 arcseconds at wavelength 12 micrometers to 2 arcminutes at wavelength 100 micrometers. It discovered about 350,000 sources, many of which are still awaiting identification. About 75,000 of those are believed to be starburst galaxies, still enduring their star-formation stage. Many other sources are normal stars with disks of dust around them,

Fig. 5 SDSS Tutorial session: Participants are extensively involved in the numerical simulation while analyzing a huge database of 230,000 SDSS galaxies that have redshift in the range 0.01 to 0.05.

possibly the early stage of a planetary system formation. New discoveries included a dust disk around Vega and the first images of the Milky Way Galaxy's core. IRAS's life, like that of most of infrared satellites that followed after, was limited by its cooling system. To effectively work in the infrared domain, the telescope must be cooled to cryogenic temperatures.

The Central Department of Physics has been using IRAS (mostly 60 and 100 micron) photometric data in order to study dust structure in the ISM. About half a dozen of papers are published in MNRAS, A&A, Ap&SS and BASI. Three Ph.D. projects and about two dozen masters' thesis have been completed. Prof. Dr. Ronald Weinberger of Innsbruck University, Austria; Prof. Dr. Noam Soker of University of Washington, Seattle, USA is our collaborators. The aim of this school is to share the methods through which we have been using IRAS maps in ALADIN software for the research. Following are the tutor of IRAS session:
(1) Madhu Sudhan Paudel (M.Sc.)
(2) Bhimsen Shrestha (M.Sc.)
(3) Devendra Upadhaya (M.Sc. Student)

7.3 Sub-mm Database: NANTEN

We have provided NANTEN2 database of star forming region NGC3603 to all participants. This spectroscopic dataset is already analyzed in the paper entitled *'Photon dominated regions in NGC 3603. [CI] and mid-J CO line emission'* (Rllig M., Kramer C., Rajbahak C., et al., Astronomy & Astrophysics Journal, **525**, 12, 2011). The participants re-produced the results that was already given or presented in the paper.

We first briefly describe the nature of NANTEN2 database. The NANTEN2 Observatory is a southern sky observatory in the Atacama Desert of northern Chile. It is located at an altitude of 4,865 m on Pampa la Bola next to Cerro Chajnantor. Operation started in 2006 May. The observatory is equipped with a millimeter and submillimeter wave telescope that is used for southern sky observations of atomic and molecular spectral lines in 110 GHz to 880 GHz range The NANTEN2 Observatory (NANTEN is Japanese word for southern sky) is a collaboration between research institutes in Japan, South Korea, Germany, Switzerland (ETH Zrich), University of

Fig. 6 IRAS Tutorial session: Participants were extensively involved in the photometric maps of 10 newly identified nebular region in 100 and 60 micron IRAS maps. Two non-nepalese participants (Said from Tanzania and Kristen from USA) are sharing their understandings.

New South Wales, and Chile. Equipped with a 4 m submillimeter telescope, NANTEN2 will be used to survey the southern sky in molecular and atomic spectral lines between 110 and 880 GHz (2.6 mm to 350 micron wave length). Star formation requires a cool and high-density interstellar medium (ISM) in which most of the hydrogen is in molecular form; therefore, studies of distribution and properties of molecular clouds are very important for understanding the star formation process. Emission from the tracer CO molecule has been widely used to estimate the distribution and amount of H2 in the Galaxy and other galaxies. Nevertheless, the CO lines in dwarf irregular galaxies are relatively weak, making the surveys of molecular clouds toward dwarf galaxies difficult. The science projects with NANTEN2 will focus on the study of the large scale distribution, structure, dynamics, and chemistry of the ISM in the Milky Way and nearby external galaxies. The most important diagnostics to determine physical parameters such as temperature, column density, and density in the mm and submm windows are: (1) Low-J CO, atomic carbon lines: large scale distribution of gas, (2) Mid-J CO lines, 13CO 8-7 (880 GHz) warm gas in dense cores. The main science goal for SMART at NANTEN2 is simultaneous large scale mapping in both atomic carbon lines (492 and 810 GHz) and CO 4-3/7-6 (460 and 806 GHz) of the southern Milky Way and selected nearby galaxies.

The Central Department of Physics has been using higher CO (J=12 to J=11) line data in order to study the PDR structure of the star forming region. We have studied various stars forming region of the molecular cloud NGC3603. Two papers are published in Ap&SS. About half a dozen masters' thesis have been completed.

7.4 Galaxy Rotation Curve: Radio

The rotation curve of a disc galaxy (also called a velocity curve) is a plot of the magnitude of the orbital velocities (i.e., the speeds) of visible stars or gas in that galaxy versus their radial distance from that galaxy's center, typically rendered graphically as a scatter plot. A general feature of the galaxy rotation curves that have been obtained through measurement to date is that the orbital speed of stars and gas is almost constant as far

Fig. 7 Participants are taking working lunch. Three participants are delivering their talks.

from the galactic centre as can be measured: that is, stars are observed to revolve around the centre of the galaxy at almost the same speed over a large range of distances from the centre of the galaxy. If disc galaxies had mass distributions similar to the observed distributions of stars and gas then the orbital speed would decline at increasing distances in the same way as do other systems with most of their mass in the centre, such as the Solar System or the moons of Jupiter. The rotation curves of Spiral galaxies are also known to be asymmetric. The observational data from each side of a galaxy are generally averaged. Therefore, only highly asymmetric cases are well known. But smaller asymmetries are also reported. RC asymmetry appears to be normal rather than exceptional. The galaxy rotation problem is the discrepancy between observed galaxy rotation curves and the theoretical prediction, assuming a centrally-dominated mass associated with the observed luminous material. When masses of galaxies are calculated solely from the luminosities and mass-to-light ratios in the disk, and if core portions of spiral galaxies are assumed to approximate to those of stars, the masses derived from the kinematics of the observed rotation and the law of gravity do not match.

The Central Department of Physics has been using following GRC data:
(1) A Large Survey for Very Low Surface Brightness Galaxies (James Marshall, Ph.D. 2004),
(2) High Resolution Optical Velocity Fields of Low Surface Brightness Galaxies and the Density Profiles of Dark Matter Halos, (Rachel Kuzio de Naray, Ph.D. 2007)
(3) Star Formation History of Low Surface Brightness Galaxies (Ji Hoon Kim, Ph.D. 2007).
(4) Rotation Curves of Spiral Galaxies, (Y.Sofue & V.Rubin 2001, ARAA 39, 137-174).
(5) Grand Rotation Curve and Dark Halo in the Milky Way Galaxy (Sofue, Y. 2012 PASJ 64, 75).
(6) Mass of the Galaxy Inferred from the Outer Rotation Curve (Honma, M., and Sofue, Y. 1996 PASJ Letters, 48, L103)

These data has been using to model galaxy rotation curves in order to find out the mass of the dark matter and the central black hole. One paper is published in A&A. About one dozen masters' thesis are completed. Prof. Dr. Uday Raj Khanal and Prof. Dr. Binil Aryal is working in this area. The aim of this school is to share the

methods through which we have been using GRC data. Following faculties will help the participant to learn the data analysis process.
(1) Binil Aryal (Prof., CDP, TU)
(2) Santosh Gaire (M.Sc.)

7.5 X-ray Database: XMM NEWTON

The XMM-Newton (X-ray Multi-Mirror Mission - Newton) is an orbiting X-ray observatory launched by ESA in December 1999 on an Ariane 5 rocket. It is named in honor of Sir Isaac Newton. Originally known as the High Throughput X-ray Spectroscopy Mission it was placed in a very eccentric 48 hour elliptical orbit at 40; at its apogee it is nearly 114,000 kilometres (71,000 mi) from Earth, while the perigee is only 7,000 kilometres (4,300 mi). The satellite weighs 3,800 kilograms (8,400 lb), is 10 metres (33 ft) long and 16 metres (52 ft) in span with its solar arrays deployed. It holds three X-ray telescopes, developed by Media Lario of Italy, each of which contains 58 Wolter-type concentric mirrors. The combined collecting area is 4,300 cm. The three European Photon Imaging Cameras (EPIC) are sensitive over the energy range 0.2 keV to 12 keV. Other instruments onboard are two reflection grating spectrometers which are sensitive below 2 keV, and a 30 centimetres (12 in) diameter Ritchey-Chretien optical/UV telescope. The mission was proposed in 1984 and approved in 1985; a project team was formed in 1993 and development work began in 1996. The satellite was constructed and tested from March 1997 to September 1999. Launched in Dec 1999, in-orbit commissioning started Jan 2000, and the first images were published Feb 2000. The original mission lifetime was two years, but it has now been extended for further observations until at least 2010, and again until 2012, and technically the observatory could operate until beyond 2018. Observations are managed and archived at the European Space Astronomy Centre (formerly known as VILSPA) at Villafranca, Spain. Until March 2012 the scientific data placed into the archive and distributed to observers were processed by the XMM-Newton Survey Science Centre led by the University of Leicester, England. After this date, responsibility for data processing transferred to the Science Operations Centre at ESAC. The European satellite XMM-Newton (X-ray Multi Mirror), built under contract to ESA by a consortium of 35 European companies with Astrium as prime contractor, by far excels its predecessor, the Astrium-built ROSAT satellite. The observational scope of XMM Newton includes the detection of X-ray emissions from Solar System objects, detailed studies of star-forming regions, investigation of the formation and evolution of galaxy clusters, the environment of supermassive black holes and the mapping of the mysterious "dark matter".

The XMM NEWTON data has been using to find new AGN candidates in the X-ray clusters. Two manuscripts are in the pipeline for the publication. Four masters' thesis is completed till date. We are in the process of collaboration with the Prof. Dr. Sandip Kumar Chakraborty, SNBose, India. The aim of this school is to share the methods through which we have been analyzing XMM NEWTON data. Following are the tutor of XMM NEWTON session.
(1) Binil Aryal (Prof., CDP, TU)
(2) Padam Ghimire (M.Sc.)

8 Special Talks

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Special Talk 1

Title: *A&A Research Activities in Nepal*
Speaker: **Prof. Dr. Binil Aryal**
Affiliation: Central Department of Physics, Tribhuvan University, Kirtipur, Nepal

Abstract: The research area includes modeling galaxy rotation curve for the dark energy/matter, spin vector orientation of galaxies in the clusters, interactions in the interstellar medium, structure formation and shaping mechanism, interaction between white dwarfs, pulsars, AGB stars and the ambient interstellar medium, chirality of large scale structure, search of new AGN candidates in X-ray region and observations using 16 inch telescopes. A brief discussion on galaxy orientation studies and the research related to the cosmological constant will be presented and discussed. There have been numerous galaxy orientation studies in the past, mostly to the end of verifying various galaxy cluster formation scenarios. The 'pancake model' predicts that the rotation axes of galaxies tend to lie within the cluster plane whereas the 'primordial vorticity model' says that the rotation axes of galaxies tend to be oriented perpendicular to the cluster plane. According to the 'hierarchy model' the directions of the rotation axes should be distributed randomly. Authors have drawn different conclusions regarding these scenarios: (1) no preferred alignment, (2) tend to orient parallel or perpendicular with respect to the cluster (or LSC) plane, (3) bimodal tendency (3) local anisotropy, (4) global anisotropy, etc. These results suggest different alignments of galaxies in clusters and superclusters. We have published more than two dozen papers in this area. A conclusion regarding the evolution of galaxies in the clusters and superclusters will be presented. The cosmological constant (?) is a parameter describing the energy density of the vacuum. A negative ? adds to the attractive gravity of matter whereas a positive ? resists the attractive gravity of matter due to its negative pressure. Two supernova cosmology projects converge on a common result: cosmos will expand forever at an accelerating rate, pushed on by dark energy (?). At present they derive and discuss an expression for

rotational velocity of a test particle in circular motion around the central mass in an asymptotically de Sitter space time. This expression is modeled and used to estimate the value of dark energy and mass (of dark matter) from the rotation curve of various nearby spiral galaxies.

Special Talk 2

Title: *Inflation and B-Mode Polarization in light of BICEP2*
Speaker: **Dr. Ishwaree Prasad Neupane**
Affiliation: CERN, Theory Department, CH-1211 Geneva 23, Switzerland

Abstract: On March 17, 2014 BICEP2 (Background Imaging of Cosmic Extragalactic Polarization) collaboration reported the detection of B-mode polarization of the CMB - a signal that might originate from gravitational waves (tensor fluctuations) created by cosmic inflation during the earliest moments in the evolution of the Universe. The major finding was that the ratio r of the amplitude of tensor perturbations (associated with gravitational waves) to the amplitude associated with scalar density fluctuations (reflected in the magnitude of CMB temperature fluctuations measured by experiments like COBE) is larger, r = 0.2 (+0.07-0.05) as compared with the bound r ¡ 0.11 found earlier by WMAP and Planck on a smaller angular scale. A direct implication of BICEP2 report is that the energy density during inflation is of order (1.1-1.2) 1016 GeV, the same scale where the fundamental forces of nature are conjectured to unify. If the BICEP2 result arises from solely primordial source, then it confirms the existence of gravitational waves, quantum effects of gravity and cosmic inflation. I will briefly review the experimental results and discuss in more details different models for inflation, where the value of r could possibly change between the high and low energies or between the smaller and larger angular scales of the sky. I conclude with my own claim that the true nature of gravity is five-dimensional and, if so, all inflationary parameters obtained using canonical four dimensional field theory estimates must include the contribution of high-energy semi-quantum curvature corrections in the 5D action. This helps to lower the level of tension between different sets of experimental bounds on B-mode polarization.

Special Talk 3

Title: *Plasma: The First State of Matter in Space Science*
Speaker: **Dr. Raju Khanal**
Affiliation: Central Department of Physics, Tribhuvan University, Kirtipur, Nepal

Abstract: Plasma, often called the "the fourth state of matter", is a collection of charged and neutral particles exhibiting collective behavior. It is almost non-existent in the earth, however as we move into the outer space it starts dominating over the other states of matter. The Big Bang was dominated by high-temperature plasma, and plasma continues today to comprise more than 99 percent of our visible universe. Basics of plasma physics, its occurrence and application will be discussed with emphasis on astrophysical plasmas.

Fig. 8 RSADR2014 Official Poster: This poster was distributed all around.

Special Talk 4

Title: *Role of Computational Physics in Space Science and Technology*
Speaker: **Dr. Narayan Pd Adhikari**
Affiliation: Central Department of Physics, Tribhuvan University, Kirtipur, Nepal

Abstract: We discuss the applications of computational physics in space science technology. The various computational techniques will be presented focusing mainly on designing hydrogen storage materials which can be used to store energy required to develop new materials in space technology. The use of graphene to store energy will be presented. A graphene may not be used to store energy (hydrogen) directly. However a metallic decorated graphene is a potential candidate to serve the purpose.

We present recent results to store hydrogen in various metals adsorbed graphene. Our results reveal that various metallic decorated graphenes can absorb hydrogen for potential use to store energy. They meet the criteria for materials to be used in energy storage set by Department of Energy. Such an energy storage system can be used in space technology.

Special Talk 5

Title: *An Analysis of Age Variations in the Stellar Populations of the Galaxy NGC300: A Study of Far Ultraviolet to Far Infrared Space*
Speaker: **Riwaj Pokhrel**
Affiliation: University of Massachusetts, USA

Abstract: I present the study of a close by ($\sim$ 2 Mpc) galaxy, NGC 300, at 18 different wavelengths from FUV to 160 microns at sub-galactic scale. For each sub-galactic grid (12" in our case), we build a spectral energy distribution (SED) and compare the observed SEDs with models generated from STARBURST99 code. All wavebands are convolved to the point spread function (PSF) of the 24 microns and the FUV image to study how variations in resolution infuence the modeling results. We find that the inter-arm regions of the galaxy are populated with older stellar populations. Observing such unusually red UV colors in the inter-arm region, as compared to the spiral arms, even after accounting for dust attenuation, suggests a complex mix of moderately aged stars and dust. As a result of this observation, we can call into question standard approaches to the dust attenuation correction that employ UV colors to gauge the amount of dust extinction present in a region, especially regions of low-star-formation, such as the inter-arm regions of a spiral galaxy.

Special Talk 6

Title: *Perturbation of FRW Space-time in Neuman-Penrose Formalism*
Speaker: **Prof. Dr. Uday Raj Khanal**
Affiliation: Central Department of Physics, Tribhuvan University, Kirtipur

Abstract: Jacobi polynomials appear to play a very important role in describing all the spin field (s = 0, 1/2, 1, 2) perturbation of the FRW spacetime. The formulation becomes very transparent when done in NP formalism. All the variables are separable, and the spatial eigenfuctions turn out to be Jacobian polynomials in different forms. In particular, the angular ones are expressible as spin weighted spherical harmonics which are just the spherical harmonics formed with Jacobi polynomials. The radial eigenfuctions are also Jacobi polynomials but with unconventional parameters. Various properties of these polynomials are used to describe the scalar, vector and tensor modes of the perturbation. The Green's function of the scalar perturbations and also its Lienard Wiecherte type potentials are derived, and are shown to reduce to the familiar ones in the limit to flat FRW case. Some of the components of the perturbed metric tensor h? have also been calculated.

Special Talk 7

Title: *CFD Techniques and their importance in studying compact dense objects*
Speaker: **Srinivas Sashikanth**
Affiliation: Hyderabad, India

Abstract: In this research work, binary star systems consisting of neutron stars are being studied and we are trying to employ CFD techniques to understand the various fluid accretion processes from the compact objects. Indeed this study can also be applied to accretion of matter from even more denser objects like supernovae. Many accretion processes can be understood with the help of the powerful CFD tools. The rate of accretion can also be directly proportional to the pressure and energy release inside the cores of the compact objects. Energy transport like convection and radiation play a vital role inside the core of a compact object. Hence CFD techniques can be employed to model the flow of fluid in the core and different layers till the surface. Recent discoveries suggest a Superfluid flow in the cores of compact objects giving rise to intense magnetic fields. Hence, CFD techniques can be utilized to model the magnetic field variations too.

Special Talk 8

Title: *Investigation of Quasi-Periodic Signals in X-ray Bursts from a Neutron Star using Fourier Analysis Technique*
Speaker: **Mr. Said Ally Mohamed**
Affiliation: P.O. Box 23409, The Open University of Tanzania, Kawawa Road, Kinondoni, Dar Es Salaam, Tanzania

Abstract: In this research work, binary star systems consisting of neutron stars are being studied and we are trying to employ CFD techniques to understand

9 Participants

There were 94 participants including six resource persons and ten instructors in the school. Six resource persons namely Prof. Uday Raj Khanal, Prof. Mukunda Mani Aryal, Prof. Binil Aryal, Dr. Raju Khanal, Dr. Narayan Prasad Adhikari of Central Department of Physics, Tribhuvan University, participated actively in the workshop.

Guest expert Dr. Ishwaree Prasad Neupane, Scientist, CERN, Theory Department, CH-1211 Geneva 23, Switzerland, and Riwaj Pokhrel of University of Massachusetts, USA delivered talks and chaired four sessions including two tutorial session. The instructors were Mr. Shiv Narayan Yadav, Mr. Sunil Laudari, Mr. Nirmal Baral, Mr. Bhanu Pd Regmi, Mr. Madhusudhan Paudel, Mr. Devendra Upadhayay, Mr. Bhimsen Shrestha, Mr. Sudhir Bhattarai, Mr. Santosh Gaire and Mr. Padam Ghimire. Nine of them are astronomy graduates who completed masters' dissertation under the supervision of Prof. Binil Aryal as research assistant. Mr. Shiv Narayan Yadav is the Ph.D. students working in the field of galaxy orientation. A complete list of participants and their affiliation is listed in the table 2. There were nine non-nepalese participants (two from USA, four from India, two from China and one from Tanzania). In addition, there were nine participants who came from outside the capital city, Kathmandu.

The Full form of the abbreviations given in Table 2 and 3 are as follows:
CDP: Central Department of Physics
TU: Tribhuvan University
GGIC: Golden Gate International College
PMC: Patan Multiple College
TIFR: Tata Institute of Fundamental Research

10 Contributory Talks

There were 5 contributory talks from the participants. A list of original contribution is as follows:

1. *A Study of Redshift Dependence in the Spatial Orientation of SDSS Galaxies* (Shiv Narayan Yadav)
2. *A Study of Spatial Orientation of u- Magnitude SDSS Galaxies* (Sunil Laudari)
3. *Systematic Search of Interacting Pulsar in the IRAS Maps* (Ajay Kumar Jha)
4. *Systematic Search of Interacting White Dwarf in the IRAS Maps* (Bhanu Bhakta Sapkota)
5. *Interaction Between Shocks Emitted from AGB Stars and ISM* (Devendra Upadhayay)

Non-nepalese participants visited Central Department of Physics and hold interactions with the faculties and the masters' students.

11 Project Outcome

Prime motive of RSADR2014 was to promote research activities in A&A research in Nepal by using freely available database. The target group was the graduate students of Tribhuvan University affiliated degree colleges

Fig. 9 Final Conference Poster (above) and the Banner (below).

of Nepal and Ph.D. students. We achieved following outcome at the end of the workshop:

1. Participants became familiar with the access of freely available database mainly SDSS, IRAS, NANTEN, GRC and XMM NEWTON. These database covers short radio wavelength to the hard X-ray.

2. Thirty nine participants worked on a huge database of more than 230,000 SDSS galaxies that have redshift in the range 0.01 to 0.05 and studied spatial orientation of angular momentum vectors of these galaxies and found that their results supports hierarchy model as suggested by Peebles (1969). They ran 21 simulations in 40 laptops to find expected isotropic distributions. This was a huge joint effort. As a project leader, Prof. Aryal announced that this result will be send for the possible publication in the Journal.

3. Forty two participants worked on IRAS maps of 10 new (not yet studied) nebular structures and calculated dust color temperature and dust mass profiles using 100 and 60 micron maps. They found that 4 structures are isolated and their mass exceeds Jeans mass, suggesting star forming region. Prof. Aryal announced that the result will be send for the possible publication in Journal.

4. Participants became familiar with the data reduction process, numerical simulation, plotting, statistics, etc using freely available software like IDL, AstroLinux and ALADIN. With the help of these software they

Table 1 List of RSADR2014 participants. The first column lists the name of the participants. The last column gives their affiliation.

S.N.	Name	Affiliation
1	Aatmaram Tiwari	Golden Gate Int. College, Kathmandu, Nepal
2	Ahmed Faiz Uddin	Cotton College, Assam, India
3	Ajay Paudel	CDP, Tribhuvan University, Kathmandu
4	Anil Ghimire	CDP, Tribhuvan University, Kathmandu
5	Baliyan Kiran Singh	Physical Research Laboratory, Ahmedabad, India
6	Bhandari Saurav Prasad	CDP, Tribhuvan University, Kathmandu, Nepal
7	Bhanu Bhakta Regmi	CDP, Tribhuvan University, Kathmandu, Nepal
8	Bharat Ghimire	St. Xavier's College, Kathmandu
9	Bhattarai Hemanta	Tribhuvan University, Kathmandu, Nepal
10	Bhattarai Puskar	St. Xaviers College, Kathmandu, Nepal
11	Bhattarai Sudhir	Golden Gate Int. College, Kathmandu, Nepal
12	Bhattari Prakash Raj	St. Xaviers College, Kathmandu, Nepal
13	Bhimsen Shrestha	Golden Gate Int. College, Kathmandu, Nepal
14	Bhupendra Karki	St. Xavier's College, Kathmandu
15	Bhusal Shampa	Golden Gate Int. College, Kathmandu, Nepal
16	Bimal Subedi	Golden Gate Int. College, Kathmandu, Nepal
17	Bishwash Sitaula	Golden Gate Int. College, Kathmandu, Nepal
18	Biswash Bhusal	St. Xavier's College, Kathmandu
19	Chandra Bahadur Baral	Golden Gate Int. College, Kathmandu, Nepal
20	Dhakal Saroj	CDP, Tribhuvan University, Kathmandu, Nepal
21	Dharma Raj Panthi	CDP, Tribhuvan University, Kathmandu
22	Dhungana Pradip	Tribhuvan University, Kathmandu, Nepal
23	Dhurba Xschetri	St. Xavier's College, Kathmandu
24	Dr. Balram Ghimire	CDP, Tribhuvan University, Kathmandu, Nepal
25	Dr. Binil Aryal	CDP, Tribhuvan University, Kathmandu, Nepal
26	Dr. Hari Lamichhannee	CDP, Tribhuvan University, Kathmandu, Nepal
27	Dr. Ishwaree Pd Neupane	CERN, Switzerland
28	Dr. Jeevan Jyoti Nakarmi	CDP, Tribhuvan University, Kathmandu, Nepal
29	Dr. Kabi Raj Bantawa	Trichandra College, Tribhuvan University, Nepal
30	Dr. Mukunda Mani Aryal	CDP, Tribhuvan University, Kathmandu, Nepal
31	Dr. Narayan Chapagain	Patan Multiple Campus, TU, Nepal
32	Dr. Narayan Prasad Adhikari	CDP, Tribhuvan University, Kathmandu, Nepal
33	Dr. Rajendra Parajuli	Amrit Science Campus, Lainchaur, Nepal
34	Dr. Raju Khanal	CDP, Tribhuvan University, Kathmandu, Nepal
35	Dr. Sanju Shrestha	CDP, Tribhuvan University, Kathmandu, Nepal
36	Dr. Sitaram Byhaut	CDP, Tribhuvan University, Kathmandu, Nepal
37	Dr. Uday Raj Khanal	CDP, Tribhuvan University, Kathmandu, Nepal
38	Dulal Rabindra	Tribhuvan University, Kathmandu, Nepal
39	Ganga Neupane	St. Xavier's College, Kathmandu
40	Hari Shankar Mallik	CDP, Tribhuvan University, Kathmandu, Nepal
41	Himal Achrya	CDP, Tribhuvan University, Kathmandu, Nepal
42	Iqbal Naseer	University of Kashmir Srinagar, India
43	Iswor Pd Koirala	CDP, Tribhuvan University, Kathmandu, Nepal
44	K.C. Buddhi Prakash	St. Xaviers College, Kathmandu, Nepal
45	Karan Bhatta	St. Xavier's College, Kathmandu
46	Karki Dev Bahadur	St. Xaviers College, Kathmandu, Nepal
47	Khairnar Rajendra	S.R.T.M. University, Nanded, India
48	Kishor Acharya	St. Xavier's College, Kathmandu
49	Lou Yu-Qing	Tsinghua University, Beijing, China
50	Lu Jufu	Xiamen University, China
51	Madhu Sudhan Paudel	CDP, Tribhuvan University, Kathmandu, Nepal
52	Manahari Upreti	Golden Gate Int. College, Kathmandu, Nepal
53	Manoj Basnet	Golden Gate Int. College, Kathmandu, Nepal
54	Miramonti Lino	Milano Univ. and INFN, Milano, Italy
55	Narayan K.D.	G.B Pant Engg. College, Uttarakhand, India
56	Nepal Samir	Golden Gate Int. College, Kathmandu, Nepal
57	Neupane Ishwaree Prasad	University of Cantubury, The Newzeland
58	Neupane Krishna Chandra	CDP, Tribhuvan University, Kathmandu, Nepal
59	Niraj Raj Karna	Golden Gate Int. College, Kathmandu, Nepal
60	Nirmal Baral	CDP, Tribhuvan University, Kathmandu, Nepal
61	Nisha Budhathoki	Golden Gate Int. College, Kathmandu, Nepal
62	Nurapati Pantha	CDP, Tribhuvan University, Kathmandu, Nepal
63	Ocean Shrestha	Golden Gate Int. College, Kathmandu, Nepal
64	Padam Ghimire	Nepal Engeneering College, Kathmandu, Nepal
65	Pandey Prakash	St. Xaviers College, Kathmandu, Nepal
66	Pandey Ramesh	Tribhuvan University, Kathmandu, Nepal
67	Panthi Dharma Raj	Tribhuvan University, Kathmandu, Nepal

Table 2 Continued from Table 1.

S.N.	Name	Affiliation
68	Patil Madhav K.	S.R.T.M. University, Nanded, India
69	Pokhrel Aawaz Raj	Bhudhanilkantha School, Kathmandu, Nepal
70	Pradip Dhungana	CDP, Tribhuvan University, Kathmandu
71	Pramod Kumar Thakur	CDP, Tribhuvan University, Kathmandu, Nepal
72	Prawesh Neupane	Golden Gate Int. College, Kathmandu, Nepal
73	Rajbahak Chandani	Tribhuvan University, Kathmandu, Nepal
74	Rajendra Prasad Koirala	CDP, Tribhuvan University, Kathmandu, Nepal
75	Rakesh Raushan	Golden Gate Int. College, Kathmandu, Nepal
76	Sahota Harpreet	Punjab Technical University, Jallandhar, India
77	Said Ally Mohammedy Masomaso	Open University of Tanzania, Tanzania
78	Santosh Gaire	Patan Multiple Campus, TU, Nepal
79	Shakya Nimesh Man	St Xaviers College, Kathmandu, Nepal
80	Shambhu K.C.	Amrit Science Campus, Lainchaur, Nepal
81	Shampa Bhusal	Golden Gate Int. College, Kathmandu, Nepal
82	Shrestha Utsav	Tribhuvan University, Kathmandu, Nepal
83	Srinivas Sashikanth	Hyderabad, India
84	Subedi Shiv Kumar	Tribhuvan University, Kathmandu, Nepal
85	Sugam Adhikari	St. Xavier's College, Kathmandu, Nepal
86	Sujan Budathoki	Patan Multiple Campus, TU, Nepal
87	Sunil Laudari	NAST, Lalitpur, Nepal
88	Thapaliya Tilak Ram	Tribhuvan Univ., Kathmandu, Nepal
89	Tika Ram Lamichanne	CDP, Tribhuvan University, Kathmandu, Nepal
90	Upadhyay Devendra Raj	CDP, Tribhuvan University, Kathmandu, Nepal
91	Vijaya Ghimire	Golden Gate Int. College, Kathmandu, Nepal
92	Yadav J.S.	TIFR, Mumbai, India
93	Yadav Shiv Narayan	CDP, Tribhuvan University, Kathmandu, Nepal
94	Zipffer Kriesten	Teaching Assistant at School for International Training, USA

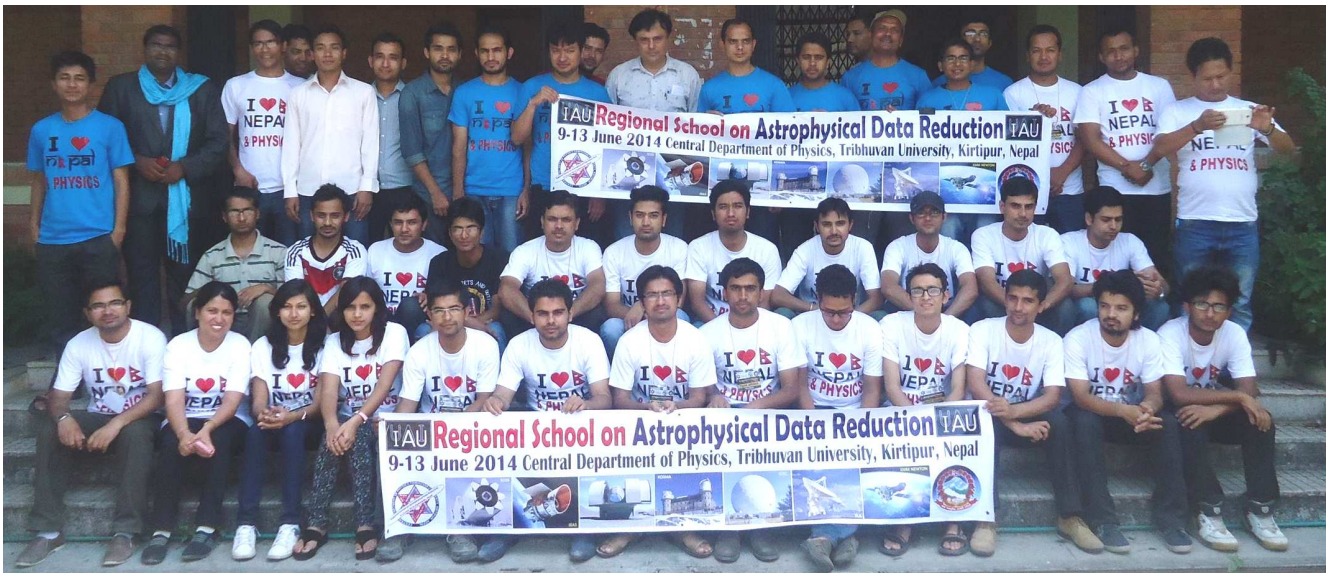

Fig. 10 Group photo session: Participants of RSADR2014 in front of Central Part of the Physics Department, Tribhuvan University, Kirtipur.

reproduced a few previous published results in the tutorial session.

5. Participants extended their programming skill what they have learned in the previous NWAA2013 workshop last year. They spent 2 full days learning programming in PYTHON using UBUNTU. They learned how to write program, how to use in-build programs and how to use available packages to solve specific problems.

6. Important software like Mathematica, Matlab and Origin were taught in detail. Home assignments and homework were given to the participants. Participants shared their understandings during tutorial session. The most important thing is that the participants new each other and the organizer hopes that

they will have a close contact for their future research work.

12 Conclusions and Recommendation

Regional School on Astrophysical Data Reduction (RSADR2014) is successfully organized at the Central Department of Physics, Tribhuvan University during 9-13 June 2014. RSADR2014 achieved its goal by motivating astrophysics graduates towards A&A research using freely available database. During the school, participants successfully studied a huge database of 230,000 SDSS galaxies and ten nebular region in 60 and 100 micron maps. These works remained highlight of the event because of its level (will be sent for the possible publications). In the concluding session, project leader Prof. Dr. Binil Aryal strongly recommended to organize similar event in the western and eastern region of Nepal. In addition, lecture series on A&A should be conducted in the colleges of small cities (e.g., Biratnagar, Bharatpur, Pokhara, etc) of Nepal. Dr. Aryal highlighted the importance of IAU office of development for Astronomy because of their program 'Astronomy for Universities and Research'.

13 Acknowledgement

As a project leader Dr. Aryal acknowledge B.P. Koirala Memorial Planetarium, Observatory and Science Museum Development Board, Ministry of Science, Technology & Environment, Govt. of Nepal; Institute of Science & Technology, Tribhuvan University, Kirtipur, Nepal; International Astronomical Union (IAU), Nepal Physical Society (NPS) and Astrophysics and Cosmology Research Group (ACRG), Golden Gate International College, Patan Multiple College and Amrit Science College for their significant support. Dr. Aryal is highly indebted to Kevin Goverder, Director, IAU Office of Astronomy for Development for their constant help, cooperation and timely suggestion. Dr. Aryal expresses sincere thanks to the faculties of Physics Department for their active participation during the workshop. Finally, Dr. Aryal highly appreciates effort made by instructors and participants, their hard work particularly for the tutorials in which their preparation, non-stop delivering skill and cooperative nature greatly helped the participants.

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