



# Abstract Book

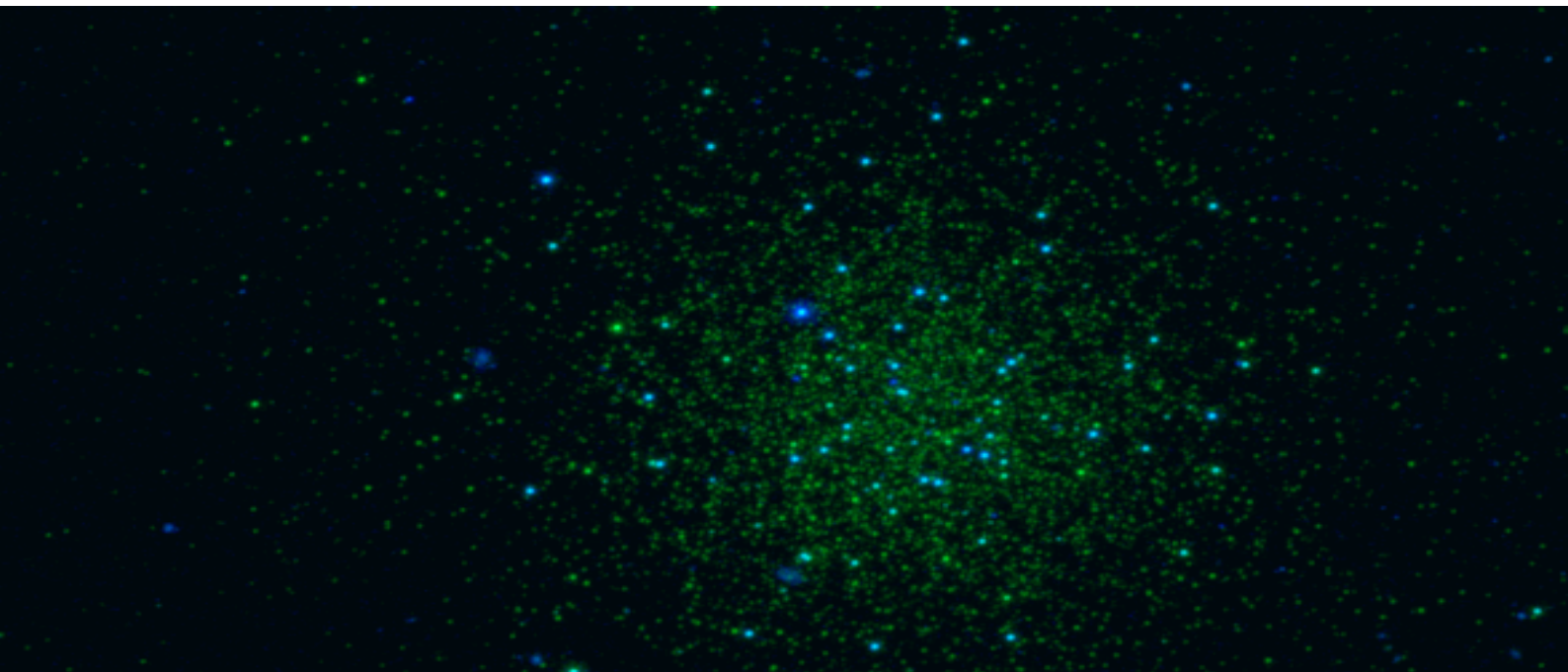
- UVIT: 5 years of operation

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*1 - 3 December, 2020*

All times are in Indian Standard Time (IST; UTC +5:30)

Indian Institute of Astrophysics



# December 1, 2020

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## **UVIT: from observations to science ready images**

Time : 10:45 – 11:15

Speaker : Swarna K Ghosh (TIFR, Mumbai, India)

Abstract : This talk will describe various processing steps involved in translating nearly raw (Level-1) data from observations carried out with UVIT to astronomical products ready for scientific research. The data products generated by this UVIT Level-2 Pipeline will also be presented. The Payload Operation Centre (POC) for UVIT at the IIA carries out these processing using an optimal set of selectable parameters (called 'default' setting) and selected products are sent to ISSDC/ISRO for their dissemination to PIs and archiving. Special situations/research areas which could benefit by exploring beyond the 'default' parameters will be commented upon.

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## **The UVIT FUV Light Curve of Hercules X-1**

Time : 11:15 – 11:45

Speaker : Denis Leahy (University of Calgary, Calgary, Canada)

Abstract : Hercules X-1 is a well studied X-ray binary with 1.7 day orbital period. It has a high orbital inclination, thus has eclipses of both the neutron star and A-type companion star. The neutron star is surrounded by a large accretion disk, which manifests itself in several ways, but primarily by the 35-day X-ray cycle. This is caused by the precession of the disk and changing obscuration of the central X-ray region on the neutron star. Here UVIT FUV observations of Her X-1 are modelled to learn about the geometry of the accretion disk.

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## **UV and X-ray Observations of Magnetic Cataclysmic Variables with the AstroSat**

Time : 11:45 – 12:15

Speaker : Kulinder Pal Singh (IISER, Mohali, India)

Abstract : Magnetic Cataclysmic Variables (MCVs) are short period (few hours) binary systems of a magnetic white dwarf accreting from an ordinary star filling its Roche Lobe. They come in two flavours – Polars with no accretion disk, and Intermediate Polars (IPs) with an accretion disk. Both types are prolific emitters

of UV and X-rays. We have observed several MCVs simultaneously with the UVIT, SXT and the LAXPC detectors aboard the AstroSat. I will present the results obtained from long UV and X-ray observations of two such systems : IGR J14536-5522 (a hard polar or a soft IP) and TX Col an IP, and our attempts to understand their UV to X-ray spectrum.

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**Peculiarities in the horizontal branch stars of globular cluster NGC 1851:  
Discovery of a Blue straggler companion to an EHB star**

Time : 12:15 – 12:35

Speaker : Gaurav Singh (ARIES, Nainital, India)

Abstract : We present a study of Far Ultraviolet (FUV) bright horizontal branch (HB) stars to understand the peculiarities seen in the HB sequence of the Globular Cluster NGC 1851, using UVIT along with other ground and space based multi-wavelength data. Optical and UV color magnitude diagrams are used to classify HB stars and their membership from HST and Gaia DR2 data. The Spectral energy distributions (SEDs) of the hot HB stars located from the core to tidal radii are constructed. The SEDs reveal that the HB stars near the G-jump show a decrease in the FUV flux when atmospheric models of cluster metallicity are used for fitting, but a better fit is found with higher metallicity models, as expected due to atmospheric diffusion. We report on four particularly interesting extreme HB (EHB) stars, two each in inner and outer regions.

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**The symbiotic nature of SU Lyn : Confirmation from UVIT Spectroscopy**

Time : 12:35 – 12:55

Speaker : Vipin Kumar (PRL, Ahmedabad, India)

Abstract : Symbiotic stars are a class of binary star systems consisting of a very hot compact white dwarf and very cool red giant star. SU Lyn, an ordinary late M-type giant star, has recently been proposed to be a symbiotic star based on its hard X-ray properties. This star does not show any high excitation emission lines typically seen in the low-resolution optical spectrum of symbiotic stars. We have used the ASTROSAT-UVIT facility to explore and confirm the proposed symbiotic nature of SU Lyn. Our Far-UV (1300-1800 angstroms) spectrum of SU Lyn, obtained with the ASTROSAT-UVIT instrument, shows emission lines of Si IV, C IV, O III, and N III in a spectrum typical of symbiotic stars. The UV spectrum, complemented by optical and NIR spectra, confirms the symbiotic nature of SU Lyn. The presence of emission lines in the low-resolution optical

spectrum has been the traditional way to identify and discover symbiotic stars. However, such a technique will fail in SU Lyn-type of symbiotics, thereby underestimating the census of symbiotic systems in the galaxy. These results are scientifically significant as they firmly establish the existence of non-burning symbiotics without prominent emission lines in optical regime (a new hidden class of symbiotic stars) with UV spectroscopy. Equally important is that these results demonstrate the spectroscopy capabilities of UVIT. To the best of our knowledge, this is the first result derived from the spectroscopic capability of UVIT in its five years of operation.

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### **UVIT view of star formation in extreme environments**

Time : 14:00 - 14:30

Speaker : Koshy George (Ludwig-Maximilians-University, Munich, Germany)

Abstract : The ultraviolet imaging data from UVIT onboard AstroSat had given valuable contribution in understanding star formation progression in diverse environments. We have been studying triggered star formation in jellyfish galaxies as part of the GASP survey for a statistically large sample of cluster galaxies undergoing ram-pressure stripping, with observations from radio to X-ray wavelengths. I will give a summary of results we obtained so far based on observations with UVIT over the last 5 years and discuss how the unique capability of UVIT opens up new avenues that was not possible before.

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### **Understanding Star formation in the Extended UV disks of Spiral Galaxies**

Time : 14:30 - 15:00

Speaker : Mousumi Das (IIA, Bangalore, India)

Abstract : Extended UV (XUV) galaxies are spirals which show filamentary or diffuse star formation in the outer parts of their optical disks. These regions have low stellar surface densities, low metal content and are adverse environments for star formation. Previous studies by GALEX found that surprisingly 30% of nearby spiral galaxies have XUV disks. The star formation in XUV disks could be driven by gas accretion from nearby interacting galaxies, gas infall from high velocity clouds or gas accreted from the intergalactic medium. They can be of two types, type~1 XUV disks have star formation that is linked to that in their main disk and are possibly linked to slow gas accretion. But in type~2 XUV disks the star formation is associated with a low surface brightness (LSB) disk and the star formation maybe triggered by rapid gas accretion. In

this study we first present a far-UV (FUV) study of the star-forming complexes (SFCs) in three nearby type~1 XUV galaxies using the UVIT. Two of them are isolated (NGC628, NGC6946), and one is interacting with distant companions (NGC5457). We compare the properties of the SFCs inside and outside the optical radius (R25). We find that the outer disk SFCs are at least ten times smaller in area than those in the inner disk. The SFR per unit area in both regions have similar mean values, but the outer SFCs have a much smaller range of SFRs and are metal-poor compared to the inner disk SFCs. Their structure suggests they formed due to local disk instabilities. The FUV emission is well correlated with the neutral hydrogen gas (HI) distribution and is detected within and near several HI holes over the disks. Our estimation of the instability Q parameter in the outer disks of the two isolated galaxies suggests that they are stable ( $Q > 1$ ). However, their FUV images indicate that there is ongoing star formation in these regions. This suggests that there may be some non-luminous mass or dark matter in their outer disks, increasing the disk surface density and supporting the formation of local gravitational instabilities. We then briefly compare the SFCs in these type~1 XUV disks with those in the type~2 XUV disk galaxy NGC 2090, which we have recently observed in FUV with the UVIT.

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### **Tracing young star-forming clumps in the nearby flocculent spiral galaxy NGC7793 with UVIT**

Time : 15:00 – 15:20

Speaker : Chayan Mondal (IIA, Bangalore, India)

Abstract : Spiral galaxies show recent star formation in their disk, specifically along the spiral arms. We studied a nearby flocculent spiral galaxy NGC7793 using the F148W and N242W band imaging data from the Ultra-Violet Imaging Telescope (UVIT). The estimated values of the disk scale-length in FUV ( $2.64 \pm 0.16$  kpc), NUV ( $2.21 \pm 0.21$  kpc), and optical (1.08 kpc) supports an inside-out growth scenario of the galaxy disk. Using UVIT FUV data, we identified 2046 young star-forming clumps in the galaxy and estimated their size, age, and mass. The identified clumps have radii between 12 - 70 pc, which is similar to the GMCs detected in the galaxy. We found the youngest star-forming clumps, with age  $< 10$  Myr, to distinctly trace the flocculent arms of the galaxy. The estimated masses of the clumps cover a range between  $10^3 - 10^6 M_{\odot}$ . The young star-forming regions in the galaxy are mostly found in regions with  $H\sim I$  column density greater than  $10^{21} \text{cm}^{-2}$ . We have also studied the nuclear star cluster of the galaxy and found that the cluster outskirts show more recent star formation than the inner part.

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**A UVIT and MUSE study of star formation and AGN activity in closely interacting galaxies**

Time : 15:20 - 15:40

Speaker : Jyoti Yadav (IIA, Bangalore, India)

Abstract : Interactions and mergers of gas rich galaxies can trigger star formation in their nuclear and disk regions, leading to starbursts and active galactic nuclear (AGN) activity. Galaxy mergers also lead to the formation of super-massive blackhole binaries that may start accreting gas and become single or dual AGN. The enhanced star formation will ultimately lead to bulge growth accompanied by starburst/AGN feedback activity. Apart from these effects, tidal dwarf galaxies may also form in the extended arms. These processes are all important for galaxy evolution and need to be understood in detail. Our study aims to understand these diverse processes using UV and optical observations of a sample of southern interacting galaxies for which we have obtained deep, near-IR observations using the SAAO. We use UVIT observations and MUSE archival data to find signatures of AGN activity and study its connection with the surrounding star formation. The UVIT images also show star formation in the tidal tails and is important for understanding tidal dwarf galaxy formation. The star formation is also visible in H $\alpha$  images obtained from MUSE. We present some preliminary results on the galaxy IC5110, whose BPT plot shows that it has a LINER like object but the MUSE data reveals that the emission is from a retired galaxy which has similar line ratios as those of a LINER, as well as a few other galaxies for which NIR, optical and UVIT data have been obtained.

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**The Sharpest Ultraviolet view of the star formation in an extreme environment of the nearest Jellyfish Galaxy IC 3418**

Time : 15:50 – 16:20

Speaker : Ananda Hota (UM-DAE CBS, Mumbai, India)

Abstract : We present the far ultraviolet imaging of the nearest Jellyfish or Fireball galaxy IC3418, in the Virgo cluster of galaxies, using Ultraviolet Imaging Telescope (UVIT) onboard the ASTROSAT satellite. The young star formation observed here in the 17 kpc long turbulent wake of IC3418, due to ram pressure stripping of cold gas surrounded by hot intra-cluster medium, is a unique laboratory that is unavailable in the Milkyway. We have tried to resolve star forming

clumps, seen compact to GALEX UV images, using better resolution available with the UVIT and incorporated UV-optical images from Hubble Space Telescope archive. For the first time, we resolve the compact star forming clumps into sub-clumps and subsequently into a dozen isolated stars. Many of them could be blue supergiant stars which are indeed cousins of SDSS J122952.66 +112227.8, the farthest star (16.5 Mpc) we had found earlier surrounding one of these compact clumps. We propose a new dynamical model in which the stripped gas may be developing vortex street where the vortices grow to compact star forming clumps due to self-gravity. Gravity winning over turbulent force with time or length along the trail can explain the puzzling trend of younger age of stars observed farther away from the parent galaxy.

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**The Ultraviolet Deep Imaging Survey of Galaxies in the Bootes Void I:  
catalog, color-magnitude relations and star-formation**

Time : 16:20 – 16:40

Speaker : Divya Pandey (National Institute of Technology, Rourkela, India)

Abstract : We present a catalog of galaxies present in the Bootes Void. Out of which, a few galaxies are newly detected in our FUV observation. We present UV, optical and NIR photometric properties along with star formation rates of these galaxies. The dependence of environment on the properties of galaxies is explored.

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# December 2, 2020

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## **A Trigonometric Algorithm for World Coordinate Solutions**

Time : 09:30 - 10:00

Speaker : Joseph Postma (University of Calgary, Calgary, Canada)

Abstract : The unique ultra-violet detection wavelengths of UVIT present difficulties for common World Coordinate Solution solvers. Out of a necessity to quickly solve World Coordinate Solutions for UVIT image data, a new algorithm was developed based on first-principles trigonometric relations such that coordinate triplets in an image may be quickly matched to coordinate triplets in a catalogue. The algorithm is generally applicable to all common scenarios of world coordinate solution solving.

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## **Multi-wavelength Spectroscopy with AstroSat**

Time : 10:00 – 10:30

Speaker : Gulab Dewangan (IUCAA, Pune, India)

Abstract : AstroSat carries four co-aligned payloads sensitive in the optical/UV and X-ray bands. The UVIT, SXT and LAXPC instruments are well suited for multi-wavelength timing and spectral studies of a variety of sources. Multi-wavelength spectral analysis requires treating the UVIT and X-ray data in the same way. We have performed calibration of UVIT gratings and generated spectral responses in a form similar to that used for X-ray data. Based on these results, we will present multi-wavelength spectral studies of a few sources using UVIT gratings and X-ray data from AstroSat. We will also present a few interesting results on multi-wavelength timing and UVIT imaging studies of active galaxies.

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## **Curvit: An open-source Python package to generate light curves from UVIT data**

Time : 10:30 – 10:50

Speaker : Prajwel Joseph (IIA, Bangalore, India)

Abstract : Curvit is an open-source Python package that facilitates the creation of light curves from the data collected by the Ultra-Violet Imaging Telescope (UVIT) onboard AstroSat, India's first multi-wavelength astronomical satellite. The input to Curvit is the calibrated events list generated by the UVIT-Payload



Operation Center (UVIT-POC) and made available to the principal investigators through the Indian Space Science Data Center. The features of Curvit include (i) automatically detecting sources and generating light curves for all the detected sources and (ii) custom generation of light curve for any particular source of interest. We present here the capabilities of Curvit and demonstrate its usability on the UVIT observations of the intermediate polar FO Aqr as an example.

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**AstroSat's contribution to the understanding of blue-stragglers,  
blue-lurkers and binaries in Open clusters**

Time : 10:50 – 11:10

Speaker : Vikrant Jadhav (IIA, IISc, Bangalore, India)

Abstract : Open clusters (OC) are the perfect place to study binary evolution as we know the distance, metallicity age of the stars and the dynamic interactions allow for binaries to evolve in isolation in contrast to globular clusters where binary systems are destroyed and reformed via collisions. Using Gaia DR2 membership and UVIT photometry, we created UV-optical CMDs of 6 open clusters. The evolved companion of binaries in these clusters helps in determining their formation scenario. Turnoff stars in NGC 2682 show systematic excess UV flux compared to other clusters. Blue stragglers and main sequence stars in old OC NGC 2682 show evidence of mass transfer. Similarly, OC King 2 has UV bright extreme horizontal/subdwarf B stars as companions to blue stragglers indicating past mass transfer. More than 100 stars in NGC 2477 will be useful to study extended turnoff stars and red clump.

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**Study of Galactic Structure Using UVIT/AstroSat Star Counts**

Time : 11:20 - 11:50

Speaker : Ananta Pradhan (National Institute of Technology, Rourkela, India)

Abstract : The structure of our Galaxy has been studied from ultraviolet (UV) star counts obtained from observations with the Ultra-Violet Imaging Telescope (UVIT) on board AstroSat satellite. The point sources are separated from the extra-galactic sources of UVIT using infrared (IR) color cut method. The observed UVIT star counts are validated with the simulations obtained from the Besançon model of stellar population synthesis towards several Galactic directions. We also estimated the scale length and scale height of the thick disc and the scale height of thin disc using the space density function and the exponential density law for the stars of intermediate Galactic latitudes.

## **Searching for LyC leakers with UVIT**

Time : 11:50 – 12:20

Speaker : Anne Verhamme (University of Geneva, Switzerland)

Abstract : We are testing a new indirect probe of LyC leakage from galaxies, using MgII, by correlating MUSE and UVIT FUV deep fields catalogues. I will present the motivations for this projects, the galaxy sample, and first results.

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## **Extended Ultra Violet Disk in Blue Compact Dwarfs**

Time : 12:20 – 12:40

Speaker : Anshuman Borgohain (Tezpur University, Assam, India)

Abstract : Extended Ultra Violet (XUV) disks, discovered in the recent past in nearby star forming galaxies has provided a new outlook as to how galaxy disks may have assembled over cosmic time. We present here a sample of low-mass and low-metallicity Blue Compact Dwarfs (BCDs), up to a redshift of  $\sim 24$ . We, for the first time, detect excess UV (XUV) emission around these BCDs from beyond the Local Volume. The detection of such XUV disks have become possible due to the deep and high-resolution FUV imaging by the Ultra-Violet Imaging Telescope (UVIT) on-board AstroSat. After correcting the observed light profiles for the UVIT PSF, we find that the intrinsic FUV exponential disks are shallower than their optical counterparts, which evidently confirm the presence of XUV disk around these dwarfs. Our analyses suggest that the FUV emission in these dwarfs extends as far as 2 - 3 times the observable optical disk. Implications of our findings are discussed in the light of the inside-out growth mode of galaxies and galaxy formation in general.

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## **Revealing Thermal Comptonization of accretion-disk photons in IC 4329A with AstroSat**

Time : 12:40 - 13:00

Speaker : Prakash Tripathi (IUCAA, Pune, India)

Abstract : The primary mechanism responsible for the X-ray emission from radio-quiet active galactic nuclei is believed to be the thermal Comptonization of optical/UV photons from an accretion disk in an optically thin hot corona. We examine this mechanism using five AstroSat observations of IC 4329A simultaneously in the ultraviolet, soft and hard X-ray bands. We derive intrinsic continuum UV flux after correcting for the contributions of the host galaxy,

numerous emission lines from the broad and narrow line regions, and internal and the Galactic reddening. The joint X-ray spectral analyses of five SXT and LAXPC spectra reveal a variable power-law and soft X-ray excess components, whereas the simultaneous UVIT observations unveil a variable intrinsic UV emission. The X-ray power-law steepens from  $\Gamma \sim 1.7$  to  $\Gamma \sim 1.9$  while the intrinsic UV flux increases by a factor of  $\sim$ , and the soft X-ray excess flux increases by a factor of  $\sim 3$ . We find that the intrinsic continuum photon flux from the accretion disk derived from the observed UV flux is about an order of magnitude larger than the intrinsic soft X-ray photon flux. We also find that the broadband X-ray photon flux is proportional to the intrinsic UV photon flux. These observations imply that the UV emission from the disk indeed acts as the primary seed photons for the Thermal Comptonization process. The X-ray spectral variability is either caused by cooling of the hot corona from a temperature of  $kTe \sim 40$  keV to  $\sim 32$  keV, at a constant optical depth, with the increasing UV flux or increasing optical depth of the corona, at a constant temperature, with increasing UV flux.

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### **An Astrosat study of UV and x-ray bright segments of the Cygnus SNR.**

Time : 14:00 – 14:30

Speaker : Firoza Sutaria (IIA, Bangalore, India)

Abstract : We present deep UV imaging and 0.3-10 keV spectra of a few, 28 arcmin diameter segments of the nearly 3 deg extent of the Cygnus loop. This isothermally expanding, x-ray, UV and optically bright,  $\sim 8000$  yr old SNR provides an excellent opportunity to study the propagation and the interaction of the supernova shock and its ejecta, as the blast wave propagates through the interstellar medium. The deep UVIT imaging (in multiple broad and narrow band FUV, and in some cases, NUV filters) allows us to trace emission regions in [CIV] (1550 °A), [HeII] (1640 °A) and [MgII] (2800 °A). In combination with the x-ray and archival Galex images, we map the physical and thermodynamic conditions within SNR, revealing signatures of supernova shock - ISM interaction.

## **UV study of the old open cluster NGC 188 using AstroSat**

Time : 14:30 – 14:50

Speaker : Sharmila Rani (IIA, Bangalore, India)

Abstract : We present the UV photometry of the old open cluster NGC188 obtained using images acquired with Ultraviolet Imaging telescope (UVIT) on board the ASTROSAT satellite, in two far-UV (FUV) and one near-UV (NUV) filters. UVIT data is utilised in combination with optical photometric data to construct the optical and UV colour-magnitude diagrams (CMDs). In the FUV images, we detect only hot and bright blue straggler stars (BSSs), one hot sub-dwarf, and one white dwarf (WD) candidate. In the NUV images, we detect members up to a faintness limit of  $\sim 22$  mag including 21 BSSs, 2 yellow straggler stars (YSSs), and one WD candidate. This study presents the first NUV-optical CMDs, and are overlaid with updated BaSTI-IAC isochrones and WD cooling sequence, which are found to fit well to the observed CMDs. We use spectral energy distribution (SED) fitting to estimate the effective temperatures, radii, and luminosities of the UV-bright stars. We find the cluster to have an HB population with three stars ( $T_{\text{eff}} = 4750\text{k}-21000\text{K}$ ). We also detect two yellow straggler stars, with one of them with UV excess connected to its binarity and X-ray emission.

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## **Testing the nature of the ULX by AstroSat: UV-X-ray variability in ultra-luminous X-ray source Holmberg~II X-1**

Time : 14:50 – 15:10

Speaker : Olag Pratim Bordoloi (Tezpur University, Assam, India)

Abstract : Despite the intensive studies of the ultraluminous X-ray sources (ULXs) in both X-rays and in optical, and many indirect arguments (relation to the youngest population, non-standard accretion disks), there are no strong and obvious evidences to distinguish among two competitive models of the ULXs: whether they contain stellar-mass or intermediate-mass black holes (IMBHs). What we know exactly is that the ULXs are close binary systems with massive donors (UV–optical spectral energy distributions hint at the two-component spectra: disk (or wind) and a donor). Recent data show that both UV and optical emissions may be reprocessed in strong heating by X-rays. To test the components of the ULX-binaries and the UV responses to the X-ray variability, we obtained simultaneous UV and X-ray observations of the highly variable ULX Holmberg-II X-1 with Astrosat - Indian multiwavelength space satellite. Our

observations with SXT and UVIT payloads onboard show possible correlation between UV and X-ray fluxes, which corresponds to a binary with the stellar-mass black hole and the supercritical accretion disk, rather than a binary with the IMBH.

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**A long term study of PKS 0208-512: resuming to its normal activity state after a prolonged stay at a very low-activity state**

Time : 15:10 – 15:30

Speaker : Krishna Mohana A (Manipal Centre for Natural Sciences, Manipal, India)

Abstract : Nearly two decades of  $\gamma$ -ray observation with EGRET and Fermi revealed the long-term low-activity state in blazar. PKS 0208-512 is one such source that shows at least an order of magnitude lower  $\gamma$ -ray flux level during the first 10 years of Fermi operation (2008-2018) compared to its average flux as observed by its predecessor EGRET during its first five years of observation (1991-1995). From the Fermi-LAT  $\gamma$ -ray lightcurve, a change in the baseline activity was noticed after April, 2018 and, a significant increment in the  $\gamma$ -ray flux was observed for next  $\sim 2$  years compared to the first  $\sim 10$  years. Also, the source flux did not come below the long-term average, as seen for the first decade of Fermi observation. After that, the source exhibited a very high  $\gamma$ -ray flux state for  $\sim 2$  months. During this time, the weekly averaged  $\gamma$ -ray flux of the source crossed EGRET average flux. We have observed the source through AstroSat during the long-term low-activity state and recent very high  $\gamma$ -ray flare period. Observation from UVIT plays a key role in understanding the source behavior as  $\gamma$ -ray emission is expected to be dominated by the inverse Comptonisation of accretion disk and/or BLR photons. In this work, we carried out a systematic multiband spectral study to understand the cause for the high  $\gamma$ -ray activity state after remaining for a prolonged low-activity state utilizing the observations from Fermi-LAT, SWIFT, AstroSat, SMARTS and CSS observatory, and other available archival data. The preliminary results of our study are presented here.

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**UV Imaging of Dual Cores in Late-stage Galaxy Mergers**

Time : 15:40 – 16:10

Speaker : Rubinur Khatun (NCRA-TIFR, Pune, India)

Abstract : It is now well established that mergers can trigger bursts of star-formation. Vigorous starbursts are found associated with the molecular gas

clumps in the central regions of galaxies. The UV images of interacting and merging galaxies suggest that spatially extended ( $>1$  kpc) star-formation and nuclear activity on scales  $<1$  kpc, each contributes approximately 50% to the total star-formation in the merging systems. We have carried out a pilot study of a sample of  $\sim 10$  dual nuclei galaxies with AstroSat Ultraviolet Imaging Telescope (UVIT). This sample includes the galaxy mergers or merger remnants that have both confirmed dual AGN and single AGN+star-forming nuclei. UVIT observations have revealed possible signatures AGN feedback in a number of our sample galaxies. I will present our initial results in this meeting.

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**Multiband studies on NGC 1275 and hotspot of Pictor A using AstroSat and other observatories**

Time : 16:10 – 16:30

Speaker : Sanna Gulati (Manipal Centre for Natural Sciences, Manipal, India)

Abstract : Misaligned active galaxies (MAGN) constitute a small fraction of sources detected by Fermi gamma-ray space telescope. They comprise of Fanaroff-Riley type 1 and 2 galaxies, steep spectrum radio quasars and compact steep spectrum radio sources. We have carried out a detailed study of two MAGNs utilising AstroSat and other observatories. While carrying out a decade-long study of one of the brightest FR I MAGN in gamma-rays, NGC 1275, we noticed a long-term multiband flux increase. Also, a significant shift of the synchrotron peak frequency was noticed during the AstroSat observing period when the source was in high gamma-ray activity state. We also carried out a detailed study of a nearby FR II radio galaxy, Pictor A, which exhibits a prominent north-western hotspot in IR, optical and X-ray bands. We detected the hotspot for the first time in both near-UV and far UV bands utilising observations from AstroSat-UVIT. Detailed findings of these two sources will be discussed.

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# December 3, 2020

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## **A First-look Astrosat/UVIT FUV Survey of the Small Magellanic Cloud (SMC)**

Time : 09:30 – 10:00

Speaker : David Thilker (John Hopkins University, USA)

**Abstract :** The Magellanic System is the closest laboratory to study stellar evolution at low metallicity. Numerous Astrosat/UVIT observations have been obtained for peripheral regions of the SMC, LMC, and in the Magellanic Bridge, but until now none have targeted brighter, more actively star-forming regions in the body of the SMC or within the  $Z \sim 1/7$  SMC Wing. Panoramic UVIT imaging of these areas is crucial because hot stars, such as traced by far-UV (FUV) imaging, drive the chemical and dynamical evolution of galaxies, and interstellar dust cycles. We are midway through conducting a first-look FUV.Silica (F172M) survey of the entire inner SMC and parts of the Wing, thus securing a long-needed  $\sim 1''$  resolution FUV imaging dataset for the benchmark low metallicity star-forming dwarf. By demonstrating instrument safety with the least sensitive FUV UVIT bandpass, our exploratory program should enable multi-filter UVIT observations similar to those obtained in peripheral regions of the galaxy, which are complete down to hot main sequence stars of intermediate spectral types, and also enable probing hot evolved objects for the first time. Even now with only FUV.Silica imaging, the Astrosat/UVIT FUV photometry, added to existing Swift/UVOT NUV coverage, and to ample ground-based new survey data, will yield unique information to identify and characterize the hottest early-type stars, hence constraining stellar and galaxy evolution and interstellar extinction. Herein we provide an overview of the ongoing first-look survey, and present results for one of the initial fields observed (out of 47 total). An analogous program on the Large Magellanic Cloud (LMC) has also recently been approved.

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## **Dorado and its member galaxies. A UVIT picture**

Time : 10:00 – 10:30

Speaker : Roberto Rampazzo (INAF Osservatorio Astronomico di Padova, Italy)

**Abstract :** Dorado is a nearby (17.69 Mpc), strongly evolving galaxy group in the Southern Hemisphere. We are investigating the star formation in the group sub-structures. FUV CaF2-1 UVIT-Astrosat images enrich our knowledge of the group provided by GALEX. In conjunction with deep optical wide-field,

narrow-band Halpa and 21-cm radio images we search for signatures of the interaction mechanisms looking in the FUV morphologies and derive the members star formation rate.

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### **M67: Discovering unknown systems with UVIT detection**

Time : 10:30 - 10:50

Speaker : Sindhu Pandey (ARIES, Nainital, India)

Abstract : M67 is an old open cluster of age 4 Gyr in our Galaxy. This is a well studied cluster with studies in multiwavelength bands from X-rays to IR. The cluster comprises of exotic stellar populations such as blue straggler stars (BSSs), yellow straggler stars and a few other exotic stars that defy standard single stellar evolutionary theory. We have detected and characterised BSS with low mass white dwarf (WD) companions, blue lurkers and several post mass transfer binaries in this cluster with UVIT. The BSSs and the post mass transfer systems with WD companions are formed through Case A/B mass transfer and are unlikely to show any chemical enhancement as the material they have accreted are not from AGB stars and hence not chemically processed. The multiwavelength spectral energy distributions covering 0.12 -11.5  $\mu\text{m}$  range, were found to require binary spectral fits for 5 BSSs, consisting of a cool (BSS) and a hot companion. The parameters (Luminosity, Temperature, Radius and Mass) of the hot companions suggest them to be WDs with mass in the range 0.2 - 0.35  $M(\text{sun})$  with  $T_{\text{eff}} \sim 11000 - 24000 \text{ K}$ .

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### **The First Extensive Exploration of UV-bright Stars in the Globular Cluster NGC 2808**

Time : 10:50 – 11:10

Speaker : Deepthi S. Prabhu (IIA, Bangalore, India)

Abstract : Globular clusters (GCs) are ideal laboratories to test our understanding of stellar evolution. Galactic GCs are known to host a few stars per cluster that are more than a magnitude brighter with respect to the horizontal branch (HB) in far-UV. These stars, known as UV-bright stars, can be in various stages of post-HB (pHB) evolution which are some of the least understood phases in the evolution of low-mass single stars. Owing to their relatively short lifetimes of about  $10^4$  to  $10^6$  yrs, the number of these type of stars observed per cluster is statistically low. However, such stars are speculated to be some of the significant contributors to the UV luminosity of old stellar populations like



GCs. In this work we identify and characterize the hot and luminous UV-bright members of the massive and dense GC NGC 2808 utilizing the excellent capabilities of the UV imaging telescope (UVIT) on board AstroSat. We constructed the UV and UV-optical color-magnitude diagrams (CMDs) by combining UVIT data with other multi-wavelength datasets. From the CMDs, we identified 34 UV-bright stars and derived the effective temperature, luminosity and radius of each star through its spectral energy distribution analysis for the first time. These stars were then placed on the H-R diagram, along with theoretical stellar evolutionary tracks to assess their evolutionary status. The models suggest that most of the stars are in the AGB-manqué phase and all, except three, have masses less than 0.53 solar masses. We also calculated the theoretically expected number of hot post-(early)-AGB stars in this cluster and found the range to match our observations. Seven UV-bright stars located in the outer region of the cluster, identified from the AstroSat/UVIT images, are ideal candidates for detailed follow-up spectroscopic studies.

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**The Carafe galaxy: A wet merger with a supermassive binary black hole precursor**

Time : 11:30 – 12:00

Speaker : Sundar M N (Jain (Deemed-to-be-University), Bangalore, India)

Abstract : As part of our multi-wavelength investigation of the footprints of the feedback mechanisms in the nearby active galaxies (Siding Spring Southern Seyfert Spectroscopic Snap-Shot Survey (S7)), we have studied the Carafe galaxy which is a merger remnant. It has been observed with the IFU on the Siding Spring 2.3m telescope, ATCA, Chandra and ASTROSAT. We present our preliminary results that concur with the hypothesis that this system has two accreting black holes.

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**UVIT study of UV bright stars in the globular cluster NGC 4147**

Time : 12:00 – 12:20

Speaker : Ranjan Kumar (National Institute of Technology, Rourkela, India)

Abstract : We study the ultraviolet properties of the halo globular cluster NGC 4147 using the three FUV filters of UVIT/AstroSat. We find 37 blue horizontal branch stars (BHBs) and one blue straggler star (BSs) using UV-optical color-magnitude diagrams (CMDs). Using UV-optical CMDs, we identify two sub-populations, BHB1 and BHB2, among the UV-bright BHBs in the cluster

with stars count ratio of 24:13 for BHB1 and BHB2. We see that more number of BHB1 are concentrated at the center than BHB2 stars. We also derive physical parameters of FUV bright BSs by fitting younger age BaSTI-IAC isochrones on optical and UV-optical CMDs.

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### **Study of AGN feedback in the active galaxy NGC 1566**

Time : 12:20 – 12:40

Speaker : Ananthamoorthy B (Manipal Centre for Natural Sciences, Manipal, India)

Abstract : Active Galactic Nuclei (AGN) and its jet can influence the star formation activities of the host galaxy via radiation energy or mechanical outflows, which may quench (negative AGN feedback) or enhance the star formation (positive AGN feedback). This feedback, in turn, can affect the activity of AGN. However, observational evidence for such feedback effects is very limited. The emission in the ultra-violet (UV) band of the electromagnetic spectrum is one of the direct tracers of recent star formation. We have initiated a study of AGN feedback in one of the active galaxies NGC 1566, utilizing high-resolution UV observation from UltraViolet Imaging Telescope (UVIT) onboard AstroSat. The preliminary findings of this study will be presented here.

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