Joe Philip Ninan

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EDUCATION

Currently pursuing Int. M.Sc.-PhD (in Physics) on Star Formation at Tata Institute of Fundamental Research (TIFR), Mumbai.
PhD Thesis: *Episodic Accretion and Outflows in Young Stellar Objects & Near Infrared Instrumentation*
Expected date of submission : 12 August 2016

Course	Year	Institute	Marks
M.Sc. (Physics)	2012	TIFR, Mumbai	72.7 %
B.Sc. (PME)*	2010	Christ College, Bangalore	95.2 %
XIIth	2007	St Johns H.S.S., Eraviperoor	95.7 %
Xth	2005	St Johns H.S.S., Eraviperoor	92.5 %

**PME* stands for Physics, Mathematics and Electronics triple main B.Sc.

HONORS AND AWARDS

Ratanbai Jerajani award for best seminar in the area of Astronomy and Astrophysics at TIFR (2013).

JRF CSIR/UGC Junior Research Fellowship by Council of Scientific & Industrial Research (CSIR), India (2012).

1st Rank in B.Sc. (Gold Medal) (2010).

KVPY Fellow Kishore Vaigyanik Protsahan Yojana, DST, Govt. of India. (2009).

NIUS Fellow National Initiative on Undergraduate Science, HBCSE - TIFR, India (2008).

RESEARCH INTERESTS

- Star Formation.
- Protoplanetary Discs, Episodic Accretion & Outflows from young stars.
- Astronomical Instrumentation.
- Astronomical data analysis and software design.

OBSERVING EXPERIENCES

- Optical Imaging and Spectroscopy (> 175 nights on 2-m HCT & IGO telescope, India)
- High Resolution Spectroscopy (using 11-m SALT, South Africa)
- Near-Infrared Imaging and Spectroscopy (> 60 nights on 2-m HCT & IGO telescope, India)
- Radio Interferometry Observation (using GMRT, India)
- Sub-millimeter Heterodyne Observation (using APEX, Chile)

SUCCESSFUL PROPOSALS

- PI of long-term *MFES* program proposals for 2-m HCT and IGO Telescopes. (Optical & NIR)
- Co-I of proposals for 11-m SALT Telescope. (optical)
- PI of two proposals for APEX, Chile. (sub-millimeter)
- PI and Co-I of proposals for GMRT, India (radio)
- Co-I of proposals for 1.3-m ARIES Telescope (optical)

TEACHING EXPERIENCES

- Teaching Assistant for Electrodynamics course by Prof. Sudip Bhattacharyya for TIFR Graduate students. (2013)

PUBLIC OUTREACH

- Chai & Why, TIFR Outreach Talk on 'The eight wanderers of the Solar System', Ruparel College, Mumbai. (21^{st} June, 2015)
- Astronomy Outreach talk at St. Johns H.S.S. Eraviperoor, Kerala (December, 2013)
- Setting up telescopes during transits and other outreach events for TIFR Open Day (2011-2015).

TALKS, CONFERENCES, SCHOOLS & VISITS

- Talk on 'Constraining the episodic outflow mechanism and outburst period of young stellar objects', IUCAA, Pune, India (27^{th} July, 2016)
- Talk on 'Understanding the episodic accretion mechanisms in young stellar objects & Near Infrared Instrumentation', NCRA-TIFR, Pune, India (25^{th} July, 2016)
- ASET Colloquium on 'Ground-based Infrared Astronomy Activities at TIFR and Future Plans', TIFR, Mumbai (8^{th} July, 2016).
- Talk on 'Supervised and Unsupervised machine learning using scikit-python', Big Data, pre-ASI Workshop at 34th ASI, Kashmir University (9^{th} May, 2016).
- 34^{th} ASI, Kashmir University, Srinagar, 2016. Poster:'Hierarchical Bayesian model to constrain rate of rare episodic outbursts', (May, 2016).
- Talk on 'Episodic high velocity outflows from an outbursting YSO: V899 Mon', Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, Russia, (24^{th} March, 2016)
- 'Episodic accretion outbursts in protoplanetary discs and outflows', IISc Bangalore, Astro Seminar Talk, (10^{th} November, 2015)
- CLOUDY Workshop, IUCAA, Pune, India (September, 2015)
- SALT Science 2015 Conference, South Africa. Poster on "SALT-HRS results showing structures in outflows during outburst" on June, 2015.
- Visited Max Planck Institute for Astronomy, Heidelberg, Germany in March 2015. Gave a talk on our results from V899 Mon in understanding FUors accretion in Planet and Star Formation group meeting.
- 45^{th} Saas-Fee Course, 2015 From Protoplanetary Disks to Planet Formation, Switzerland.(Poster: Understanding Disc Accretion from FUors/EXors), (March, 2015)
- 33^{rd} ASI, NCRA-TIFR, Pune, 2015 (Poster: V899 Mon (IRAS06068-0641) : Understanding FUors/EXors Phenomenon.)
- International workshop on "Current trends in Near Infrared Astronomy in India", Hyderabad, 2014. (Gave Talk on: FU Ori Type Outburst Sources in Young Low Mass Stars)
- 32^{nd} ASI, IISER Mohali, 2014. (Gave talk on : Episodic accretion events from a young stellar object IRAS 06068-0641. Also presented a poster on : TIRSPEC, TIFR Near Infrared Spectrometer and Imager).

- Python Programming in Astronomy, IUCAA, Pune, 2014. (Gave talk on "Astropy - FITS, WCS and Cosmology" and conducted hands-on sessions).
- IRC Workshop on Variable Sources in Astronomy, Thiruvalla, 2014 (Gave talk on: How to acheive 1% photometry).
- 4^{th} IIA - PennState Astrostatistics School, VBO, IIA, Kavalur, 2013.
- Radio Astronomy School NCRA TIFR, Pune, 2013.
- Workshop on Research in Astronomy : Opportunities and Challenges, Thiruvalla, 2013. (Gave talk on "Outburst sources in YSOs")
- 31^{st} ASI, Trivandrum, 2013. (Gave talk on : Constraining models of accretion outbursts in low-mass YSOs).
- Sokendai Asian Winter School on Exoplanets, NAOJ, Mitaka, Japan, December 2012.
- ASTROCHEM 2012, Kolkata, 2012. (Poster on : Second outburst phase of a young eruptive star V1647 Orionis (McNeil's Nebula)).
- Winter School on Astronomical and Cosmological Surveys, TIFR, Mumbai, 2012
- 27^{th} ASI, IIA, Bangalore, 2009. Poster on : Color method to study temperature distribution around Wolf-Rayet Stars.
- Asian Science Camp, Tsukuba, Japan, August, 2009. (Represented India as a team)

PUBLICATIONS

In Referred Journals

Primary Five Publications

1. 'Episodic High Velocity Outflows from V899 Mon: A Constraint On The Outflow Mechanisms', **Ninan J.P.**, Ojha D.K. & Philip N. S., 2016a, ApJ 825, 65
2. 'V899 Mon: An Outbursting Protostar With Peculiar Light Curve And Its Transition Phases', **Ninan J.P.**, Ojha D.K., et al., 2015, ApJ, 815, 4
3. 'TIRSPEC: TIFR Near Infrared Spectrometer and Imager', **Ninan J.P.**, Ojha D.K., et al., 2014, Journal of Astronomical Instrumentation, 03, 1450006
4. 'Re-appearance of McNeil's nebula (V1647 Orionis) and its outburst environment', **Ninan J.P.**, Ojha D.K. et al., 2013, ApJ, 778, 116
5. 'A Bayesian Model for Constraining the FU Ori Outburst Frequency', **Ninan J.P.**, Ojha D.K. & Hillenbrand L. A., 2016b, (submitted in ApJ)

Other Refereed Publications

6. 'Near-Infrared Imaging of Barred Halo Dominated Low Surface Brightness Galaxies', Honey M., Das M., **Ninan J.P.**, et al., 2016, MNRAS, 461
7. 'Star formation activity in the neighbourhood of W-R 1503-160L star in the mid-infrared bubble N46', Dewangan L., Baug T., et al., 2016, ApJ (accepted) arXiv:1605.02211
8. 'Optical and NIR observations of the nearby type Ia supernova SN 2014J', Srivastav S., **Ninan J.P.**, et al., 2016, MNRAS, 457, 1000
9. 'A multi-wavelength study of star formation activity in the S235 complex', Dewangan L., Ojha D. K., et al., 2016, ApJ, 819, 66
10. 'Sh2-138: Physical environment around a small cluster of massive stars', Baug T., Ojha D. K., et al. 2015, MNRAS, 454(4): 4335-4356
11. 'Large-Scale Mapping of the Massive Star-Forming Region RCW38 in the [CII] and PAH Emission.', Kaneda, H. et al., 2013, A&A, 556
12. 'TIRCAM2: The TIFR Near Infrared Imaging Camera', Naik M. B. et al., BASI, 2012
13. 'Near-infrared Spectral library using TIRSPEC', Baug T., **Ninan J.P.**, et al., 2016 (to be submitted)
14. 'Star formation around Galactic bubble N37: Evidence of cloud-cloud collision' Baug T., Dewangan L., Ojha D.K., **Ninan J.P.**, et al., 2016 (to be submitted)

In Conference Proceedings

1. 'Probing the Structure and Kinematics of Outflows in Episodic Accretion of YSOs', **Ninan, J.P.**, Ojha, D.K., et al., SALT Science Conference 2015, SSC2015, PoS, 069
2. 'Second outburst phase of a young eruptive star V1647 Orionis (McNeils nebula)', **Ninan, J.P.**, Ojha, D.K., et al., Astrochem2012, 1543, 1, 184-186, 2013, AIP Publishing.
3. 'Constraining models of accretion outbursts in low-mass YSOs' **Ninan, J.P.**, Ojha, D.K., et al., 2013, ASI Conference Series, 9, 78.
4. 'The outburst and nature of young eruptive low mass stars in dark clouds', **Ninan J.P.**, Ojha D.K. et al.,ASI Conference Series, 2012, Vol. 4, pp 1-8.
5. 'Post-outburst phase of LDN 1415 nebula (IRAS 04376+5413)', Pawade V. S. et al., ASI Conference Series, 2010, Vol. 1, pp 243-244

6. 'Second outburst phase of McNeil's nebula (V1647 Orionis)', Kaurav, S. S. et al., ASI Conference Series, 2010, Vol. 1, pp 237-238
7. 'ccdproc: CCD data reduction software', Craig, M. W., et al., Astrophysics Source Code Library, record ascl:1510.007, 2015

Telegrams

1. 'Optical and NIR observations of SN 2014J', Srivastav S., **Ninan J.P.**, et al., ATel #5876, 2014.
2. 'Dust formation in Nova Cephei 2013', **Ninan, J.P.**, Ojha, D.K. et al., ATel #5269, 2013.
3. 'V1647 Orionis', **Ninan J.P.**, Ojha D.K. et al., CBET #3164, 2012.
4. 'Slow dimming in the brightness of V1647 Orionis', **Ninan J.P.**, Ojha D.K. et al., ATel #4237, 2012.

SOFTWARE CONTRIBUTIONS TO ASTRONOMY COMMUNITY

TIRSPEC Pipeline
Developed Near-Infrared spectroscopy and photometry data reduction pipeline for TIFR Near-Infrared Imager and Spectrometer (TIRSPEC) camera. `https://indiajoe.github.io/TIRSPEC/`

Optical Spectro-Photometry Pipeline
Developed Multi Instrument Optical spectroscopy and photometry data reduction pipeline. It currently supports HFOSC instrument on 2-m HCT, as well as IFOSC instrument on 2-m IGO telescope. More instrument support to be added soon. `https://indiajoe.github.io/OpticalPhotoSpecPipeline/`

SALT-HRS
Python tool to reduce SALT Telescope's High Resolution Spectrograph (HRS) data. `https://github.com/indiajoe/SALTHRS`

HandyTools4Astronomers
Collection of various scripts and small tools for Astronomers. `https://indiajoe.github.io/HandyTools4Astronomers/`

ArXivSorter
Tool build on Machine learning algorithm to rank and sort daily arXiv papers based on subject interest. `https://github.com/indiajoe/ArXivSorter`

Other Contributions
astropy : Feature to load multi-aperture daophot files.
specutils : Feature to load IRAF Equispec spectrum.
ccdproc : Function to combine images under memory constraint.
Also contributed to **findutils** (11 yr old bug in parsing long arguments to *find* and *xargs* Linux commands), **PyRAF** (special character parsing in filename completion), **TIFR FIR balloon-borne 100 cm telescope pipeline** and also to **JWST** data cube manipulation toolkit.

Github
Various other projects : `https://github.com/indiajoe?tab=repositories`

COMPUTATIONAL SKILLS

- Languages: Python, BASH, IRAF CL, Fortran, C, C++, Perl, Matlab, IDL
- Version control: Git, Hg
- Server maintenance experience: TIFR IR Group's Owncloud Cloud data storage server, Wiki Server, GitLab Internal Code Hosting Server.
- Contribution to Porteus-ATMA astronomy oriented GNU/Linux distribution.

PAST INSTRUMENTATION & RESEARCH PROJECTS

INSTRUMENTATION PROJECTS 2012-

Ground based projects:

TIFR Near Infrared Spectrometer and Imager (TIRSPEC)

During my PhD program at TIFR, I led the development, installation, calibration and upgrades of TIFR Near Infrared Spectrometer and Imager (TIRSPEC) at TIFR IR lab, which we installed on the side port of 2 meter Himalayan Chandra Telescope (HCT), Hanle, Ladakh, India. I developed various algorithms for troubleshooting and optimising the optics as well as the data acquisition mode of HAWAII-I PACE array used in TIRSPEC. This array compared to modern H1RG and H2RG arrays does not have any reference pixels and has many poorly understood anomalies like the reset anomaly, strong persistence, and fringes. I could demonstrate the non-thermal origin of the reset anomaly in these arrays, which enabled us to significantly improve the effective readout noise of the array. I developed fully automated procedures to characterise and correct the non-linearity, subarray readout capability for fast readout, gain variations, fringes, cosmic ray hit events, enhanced dynamic range, etc. of the instrument. I also did extensive optics study on symmetric out-off focus measurements and wavefront modelling to improve and troubleshoot the star profile structure. This was crucial to obtain the atmospheric seeing limited profile which improved the faint source detection sensitivity of the instrument. Accurate field of view distortions were also measured and constrained to improve the photometry quality of the instrument. After obtaining the first light on telescope on 21^{st} June 2013, we had a few serious mechanical issues due to lower boiling point temperature of liquid N_2 at the 4500 m amsl high altitude observatory. By manually controlling the motor movements using custom written codes, I could troubleshoot the possible internal mechanism failure from the hall effect sensor output readings. After developing the strategy for repair at Mumbai, we went to remote Hanle site in September 2013, and repaired the instrument by setting up a temporary clean room. Our hypothesis was proven correct after opening and inspection of the dewar. During my initial engineering run observations, 10 arcsec slits were found to be inadequate for optimal sky removal. After analysing the instrumental constraints from the optics design, 50 arcsec slit was found to be ideal for observations. Along with two IR lab engineers, I went for a third upgrade mission to Hanle in May 2014, and upgraded the slits to 50 arcsec slits. In this mission, I could also solve another filter wheel slipping issue which was noticed during some nights of engineering observation runs. We also fixed a few other issues with calibration mirror movement stage, etc. in the third mission. Using the data from the initial engineering run I also did extensive site calibration studies of NIR sky at Hanle, which was crucial for both designing the strategy for optimal NIR observations as well as for future mega telescope projects planned at Hanle. These calibrations of the instrument as well as Hanle site are published in the instrumentation paper (Ninan et al., 2014). TIRSPEC is now released to public from 1^{st} May 2014. I also developed and released a pipeline for data reduction of this instrument. I later used this instrument extensively for the NIR monitoring of my outburst sources. TIRSPEC is also now heavily used by other astronomers using HCT. I am also currently taking care of the constant maintenance checks and optimisation for the operation as well as data reduction of the ongoing observations by the community.

TIFR-ARIES Near-Infrared Spectrometer (TANSPEC)

I was actively involved in the TIFR-ARIES Near-Infrared Spectrometer (TANSPEC) project for the 3.6-m Devasthal Optical Telescope (DOT), Nainital, India, from the design phase. Based on my experience with TIRSPEC, I could contribute in the mechanical design decisions of the wheel mechanisms, requirement of separate focussing stage in the spectrograph detector array, etc. I contributed in reducing the background significantly from the central black hole in the DOT's secondary mirror by using an Offner relay and blackening the footprint of the hole on the re-imaged secondary mirror of Offner relay. I also contributed in developing a more realistic optical components' tolerance estimation by incorporating correlated lens shifts in Monte Carlo simulation. One of the unique capabilities of TANSPEC is its ability to simultaneously cover the wide wavelength range from Optical to NIR. In order to achieve that, parallactic angle tracking by the telescope is crucial, else the diffraction in atmosphere will throw the short wavelength light outside the narrow slit.

During the preliminary and critical design review meetings, I developed off-axis active parallactic angle tracking algorithm as well as optimal autoguider filter response for achieving this capability on DOT. Currently, the fabrication of TANSPEC hardware is going on and in parallel I am working on the various software and interface aspects of the TANSPEC instrument.

TIFR Near-Infrared Imaging Camera -II (TIRCAM2)

I led the detector calibration and optimal data acquisition procedure for the Aladdin III Quadrant 512×512 InSb array based TIRCAM2 near-infrared imaging camera. InSb array is sensitive upto 5 μm. This puts a much stronger requirement to optimise the data in high background radiation regime. I developed optimal procedures from observations using 2-m IGO telescope and currently 3.6-m DOT in order to observe upto L' band (3.6 μm). We obtained the first L' band observations using TIRCAM2 from the IGO. This is the only imaging camera available in the country which can observe upto L' band in NIR (Naik et al. 2012). TIRCAM2 is currently mounted on the primary port of 3.6-m DOT.

Space based projects:
TIFR 100 cm FIR Balloon-borne Telescope

TIFR 100 cm Far-Infrared Balloon-borne Telescope was mostly observed in the sky chopped mode. However, more sensitive observations can be done in the fast spectral scan mode where sky chopping is not done. I developed a wavelet based signal processing step for the un-chopped signal from the optical photo diodes on the balloon-borne telescope. This, for the first time enabled us to generate optical maps of the scanned region, which we could then use to improve the telescope aspect and pointing. This was crucial for aligning and doing correlation studies using our FIR maps generated with other shorter wavelength maps of the region taken from different telescopes (Kaneda et al. 2013).

IRSIS and UVIT

Infrared Spectroscopic Imaging Survey (IRSIS) payload for an Indian small satellite is being developed, designed and fabricated by the IR astronomy group at TIFR. Using my experience in detector optimisation and characterisation, I developed a procedure for optimal readout and processing of the H2RG detector array used in IRSIS. I have also contributed in troubleshooting of the mirror holder stress pattern which was slightly deforming the primary mirror of IRSIS resulting in astigmatism aberration.

For the UltraViolet Imaging Telescope (UVIT) instrument onboard AstroSat, when the initial first light was obtained, we had to combine the UV readouts using the drifts obtained from the visible channel. I developed a procedure to estimate the achieved star profile width by simultaneously incorporating all the faint stars in the 2D field.

SCIENCE PROJECTS 2012-
Episodic accretion and outflow phenomena in YSOs

As part of my PhD program at TIFR under my thesis advisor Prof. D.K. Ojha, I studied outburst phenomenon in young stellar objects (YSOs) caused by the episodic accretion events in protoplanetary discs. I did multi-wavelength (optical, near-infrared, far-infrared and radio) long term monitoring studies (a total of $\sim$ 175 nights) on a sample of these objects to constrain various stellar and circumstellar properties. Among this sample of outbursts, in our study of V1647 Ori, for the first time in this family of objects, I detected short time-scale episodic outflows. From the time-scales V1647 Ori spent in the intermediate quiescent phase between its two outbursts, I could also constrain and rule out certain basic disk instability models of this outburst phenomenon (Ninan et al. 2013). From my study of another peculiar outburst source, V899 Mon, I could monitor the transition of the

source from the first outburst to the quiescence and its return to a second outburst. This enabled me to simultaneously track the corresponding evolution in the accretion and outflow at various phases of this transition. For instance, from the evolution of outflow line profiles in our multi-epoch spectra I could detect heavy, high velocity outflows just before the source transitioned to quiescence state. After attaining quiescence the strength of the outflow dropped below our detection limit. Hence, we reported the first direct detection of overall correlation of the outflows with accretion, and at the same time I could also detect independent short term fluctuations in both outflow strength and velocity, indicating a more complex relation (Ninan et al. 2015). My high resolution spectroscopic observations using the HRS instrument on 11-m SALT telescope showed sudden changes in the high velocity components of outflow by large factors, which are difficult to explain by the magnetically driven steady disc winds or radiatively accelerated models of stellar winds. I could constrain the outflow mechanism based these results from the multi-epoch high resolution spectra of heavily accreting YSOs (Ninan et al. 2016a). Results from these three papers strongly argued for mechanisms which can temporarily pause magnetospheric accretion, without requiring the disc surface density to drop below a critical value (as required by various instability models) as well as magnetic instability driven outflows from magnetosphere. I have also developed a hierarchical Bayesian model to incorporate all the photometric observations of star forming regions to estimate these episodic accretion outburst frequency. This model for the first time enables us to quantitatively analyse variations in the outburst phenomena across various age clusters of YSOs (Ninan et al. 2016b).

FIR 158 μm [C II] line mapping of massive star forming regions 2013-

Using a Fabry-Perot Spectrometer on TIFR Balloon borne 100 cm FIR telescope, we have mapped wide area 158 μm [C II] line emission from nearby massive star forming regions. I developed a pipeline which models the line emission profiles from the raster scan data and generates line strength and continuum flux maps of the region. Using these maps we studied and modelled the star forming regions by correlating with other emissions from Polycyclic Aromatic Hydrocarbons (PAH) and continuum to understand the importance of various heating and cooling mechanisms.

Crater study using Chandryan TMC data 2009

To estimate the age of surfaces on moon, a crater distribution study was done by automatically identifying craters and their radii in ISRO's Chandryan Terrain Mapping Camera (TMC) data. This work was done under Dr. B. S. Shylaja, JNP, Bangalore.

Study of Solar wind using Interplanetary Scintillations December 2008

As part of NIUS Astronomy Nurture Program, I did a project on study of solar wind using Interplanetary Scintillations, from Ooty Radio telescope, under Prof. P. Manoharan, in December 2008.