**The Infrared Survey Facility: Past and Future**

**2 – 4 March 2016, SAAO**



SAAO Intranet

***WEDNESDAY 2 MARCH***

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| ***Registration*** | **09:30** |
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| ***Welcome***  Prof Patricia Whitelock (SAAO / UCT) | **10:00** |
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| ***Opening by the Deputy Chief Executive Officer (Astronomy) of the NRF***  Prof Nithaya Chetty | **10:05** |

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| ***CHAIR: Patricia Whitelock* *(SAAO / UCT)*** | |
| ***Review of Infrared Survey Facility since 2000, and plans for the future***  ***Takahiro Nagayama (Kagoshima Univ)*** | **10:20** |
| ***A survey of some Local Group galaxies***  ***John Menzies (SAAO)***  In this contribution I will describe a programme to search for and monitor long period variables in all Local Group galaxies accessible to the IRSF. Besides determining periods for the Mira variables discovered, we have shown that they satisfy a period-luminosity relation, which means they are useful for distance determination in the near infrared. A few Miras are brighter than expected, and are suspected of undergoing 'hot bottom burning' - using SALT, we have shown that this is true for one Mira in IC1613. | **10:50** |
| ***A very long term NIR variable star survey towards the LMC and SMC***  ***Yoshifusa Ita (Tohoku Univ)***  A very long term near-infrared variable star survey towards the Large and Small Magellanic Clouds was carried out using the 1.4m InfraRed Survey Facility at the South African Astronomical Observatory. This project was initiated in December 2000 in the LMC, and in July 2001 in the SMC. Since then an area of 3 square degrees along the bar in the LMC and an area of 1 square degree in the central part of the SMC have been repeatedly observed. Over more than 10 years we have observed the two survey areas about 100 and 140 times for the LMC and SMC, respectively. This is the world’s first and only survey that provides near-infrared time series data with such a long time baseline and on such a large scale. I will introduce the survey and talk about some tentative results from a study on R CrB stars using the data. | **11:20** |
| ***IRSF / SIRIUS survey of pulsating stars towards the bulge***  ***Noriyuki Matsunaga (Univ Tokyo)***  Pulsating variable stars, particularly Cepheids and Miras, are useful tracers because their distances and ages can be determined accurately. Infrared observations of these variable stars in the obscured regions can provide useful information about the hidden parts of the Galaxy. We have carried out a survey of variable stars towards the Galactic bulge, between −10 and +10 degrees in galactic longitude, using their IRSF 1.4m telescope and SIRIUS near-infrared camera between 2007 and 2012. We report new pulsating stars including classical Cepheids located behind the bulge. | **11:50** |
| ***Some problems of the obscuration and structure of the Galactic Bulge***  ***Michael Feast (SAAO)***  The interrelated problems of the structure of the Galactic Bulge and the foreground interstellar absorption will be discussed and current uncertainties emphasized. | **12:20** |
| ***12:50 – 13:50 LUNCH*** | |
| ***CHAIR: Noriyuki Matsunaga (Univ Tokyo)*** | |
| ***Galactic magnetic structure probed with polarimetry of Mira variables***  ***Tetsuya Nagata (Kyoto Univ)***  Analysis of the polarimetry data (Hatano et al 2013) for the Mira variables identified by Matsunaga et al (2009) in the central 20' x 30' region of the Galactic center reveal the magnetic field structure in the line of sight. Our first findings include its position angle change at the distance of ~6 kpc from us. | **13:50** |
| ***Research on the close binary frequency of Wolf-Rayet stars***  ***Hiroki Onozato (Tohoku Univ)***  The evolution of massive stars is highly affected by their mass loss. It has been considered that stellar winds driven by radiation pressure on the resonance absorption lines of heavy elements strip the hydrogen envelope. However, it turns out that the mass-loss rate for the winds is lower than previously thought. This raises a big question of how to produce Wolf-Rayet stars. One possible mechanism that solves this problem is binary Roche-lobe overflow. A high binary fraction of massive stars supports this mechanism. However, the research of the close binary fraction of Wolf-Rayet stars is not enough. Therefore, I try to find the close binary fraction of Wolf-Rayet stars by searching for eclipses using the Infrared Survey Facility. In this presentation, I report the initial result of this search. | **14:20** |
| ***Oh IRSF, You are my only hope! -- the case for near-IR monitoring of eta Carinae***  ***Kazunori Ishibashi (Nagoya Univ)***  With decommission of the Mk-II infrared photometer, IRSF/SIRIUS may be the sole instrument in the near infrared to monitor eta Carinae all year around. As eta Carinae undergoes a rapid change in its color (closely related to its known 5.5yr periodic change), it is never more critical to monitor the star. I will use our coordinated monitoring result as an example how crucial it was to obtain a few NIR data points in July - September 2014 and how it could help characterize the pattern of its rapid, cyclic changes in color (in turn, its apparent temperature in NIR). A possible physical implication by the changes will be discussed as well. | **14:50** |
| ***A multi-wavelength study of the supernova remnant IC443 with IRSF, AKARI, and Suzaku***  ***Takuma Kokusho (Nagoya Univ)***  We performed near-infrared (IR) line mapping of the supernova remnant IC443 with the narrow-band filters tuned for [FeII], Paβ, and H2. These line emissions are detected from a wide area of the observed region (30' x 35'), indicating that fast and slow shocks are propagating over the remnant. Combining these results with the IR and X-ray data obtained by the AKARI and Suzaku satellite, we discuss interactions between the shocks and the interstellar medium around IC443. | **15:20** |
| **15:50 – 16:20 BREAK** | |
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| ***CHAIR:******Tetsuya Nagata (Kyoto Univ)*** | |
| ***Near-IR Imaging Polarimetry toward the Vela C Molecular Cloud***  ***Takayoshi Kusune (Nagoya City Univ)***  We have made the near-infrared (JHKs) imaging polarimety toward the Vela C molecular cloud in order to reveal its magnetic field structure. We used the imaging polarimeter SIRPOL mounted on the IRSF 1.4 m telescope at the South African Astronomical Observatory. The polarization vector maps obtained show the magnetic fields of the Vela C as follows: (1) In the Centre-Ridge sub-region, which contains a compact HII region, the field is mostly perpendicular to the direction of the main filament elongation (2) In the South-Ridge, the field is mostly parallel to the filament elongation direction (3) In the South-Nest, with the network of overlapping filaments, its magnetic field appears to be disturbed. These results indicate that there is an association between the magnetic field configuration and the cloud structure. | **16:20** |
| ***First Infrared Circular Polarization Survey using IRSF/SIRPOL***  ***Jungmi Kwon (Univ Tokyo / JSPS)***  Polarimetry is a unique tool for studying the physical processes in the interstellar medium, including star-forming regions. Polarimetry of young stellar objects and their circumstellar structures provides very valuable information about the distribution of matter and the configuration of magnetic fields in their environments. However, only a few near-infrared circular polarization (CP) observations were reported so far (before our survey). We have conducted a systematic near-infrared CP survey in star-forming regions, covering high-mass, intermediate-mass, and low-mass young stellar objects. All the observations were made using the SIRPOL imaging polarimeter on the IRSF 1.4 m telescope at the SAAO. In this presentation, we mainly present the first CP survey results. The polarization patterns, extents, and maximum degrees of circular and linear polarizations are used to determine the prevalence and origin of CP in the star-forming regions. The results that we found are explained with a combination of circumstellar scattering and dichroic extinction mechanism generating the high degrees of CP in star forming regions. The universality of CP in star forming regions can also be linked with the origin of biological homochirality. We also present our very recent results for new targets in our on-going survey. | **16:50** |
| **END** | **17:20** |
| ***History and Tour of SAAO***  ***Ian Glass (SAAO)*** | **17:30** |
| **18:45 DRINKS AND DINNER** | |

***THURSDAY 3 MARCH***

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| ***Chair: Shazrene Mohamed (SAAO)*** | |
| ***Exploring the Kozai-Lidov mechanism in X-ray binaries***  ***Vanessa McBride (UCT, SAAO)*** | **09:00** |
| ***Dynamic modeling of massive X-ray and gamma-ray binaries and its implications for NIR observations***  ***Atsuo Okazaki (Hokkai-Gauken Univ)***  Massive binaries with compact objects are often high energy sources. In some systems, the high energy emission originates from the collision between the relativistic pulsar wind and the wind and/or circumstellar disk of a massive star. In other systems, the origin of high energy emission is accretion of the stellar wind and/or circumstellar-disk gas onto a neutron star or black hole. Because these circumstellar interactions are dynamic and complicated, almost the sole approach to understanding of their time-dependent behavior is to perform numerical simulations and compare the results with multi-wavelength observations, i.e., observations of radio, X-ray, and gamma-ray emission from the shocked pulsar wind or the vicinity of the compact object, and those of optical and infrared emission from the stellar wind and circumstellar disk.  In this talk, I first describe how the cicumstellar interaction occurs in massive X-ray and gamma-ray binaries, using the results from 3D SPH simulations. Then, assuming that the NIR emission from the circumstellar material is due to the free-free emission, and using the simulated distribution of density and temperature, I compute the NIR light curves for several objects visible from Sutherland [one X-ray binary (A 0535+262) and three gamma-ray binaries (PSR B1259-63, HESS J0632+057, and LS 5039)]. On the basis of these results, I discuss in which cases and how the NIR observations can be used as a probe of the circumstellar interaction in massive X-ray and gamma-ray binaries. | **09:30** |
| ***Study of the gamma-ray binaries via near-infrared photometric monitoring***  ***Yuki Moritani (Univ Tokyo/Kavli IPMU)***  Gamma-ray binaries are a subclass of X-ray binaries that emit the majority of the energy in the gamma-ray band. They are comprised of a compact object and a massive (>10 Msun) star with a circumstellar disk or strong stellar wind. Their emission, ranging from radio to TeV gamma-rays, show variations along with the orbital phase. Most of them have a wide and highly eccentric orbit, which makes interaction between two objects during one orbital cycle. The details of the interaction, however, are still under debate because (1) the nature of the compact object is unknown in most systems, and (2) complicated conditions (e.g. eccentric orbit, circumstellar disk) makes them difficult to understand even if the nature of the compact object is established. Therefore, there is also room to debate in associated mechanism of the particle acceleration and hence the high-energy emissions.  In order to look into variability in the NIR band, we have been carrying out IRSF monitoring of these enigmatic systems which are observable from the Sutherland observatory; PSR B1259-63, HESS J0632+057, LS 5039, and 1FGL J1018.6-5656. We covered the periastron passage of the former two systems (2010 Dec. and 2014 May for PSR B1259-63 and 2015 Dec. for HESS J0632+057), while the whole orbital phase is covered in LS 5039 and 1FGL J1018.6-5656. Some of our data are still under the analysis, but we show a few highlighted results of our monitoring in this presentation. LS 5039 showed no significant variability within the accuracy of 0.02 mag. The NIR flux of PSR B1259-63 increased around periastron. There seems a slight increase of the NIR flux in HESS J0632+057. | **10:00** |
| **10:30 – 11:00 BREAK** | |
| ***Chair: Kazunori Ishibashi (Nagoya Univ)*** | |
| ***Photometric and polarimetric variability in massive X-ray binaries***  ***Lee Townsend (UCT)***  I will review the SIRIUS observations of massive X-ray binaries made over the past 10 years. These observations focus on the Small Magellanic Cloud, which has a large population of neutron stars accreting from Be type companions. The long baseline over which these observations have been made will inform our ideas of how the decretion discs in these systems vary on the longest time scales and the affect this has on the accreting neutron stars. I will conclude by introducing an extension of this project which uses SIRPOL to measure the underlying polarised NIR emission from the same systems and, ultimately, to search for variability in this polarised emission. | **11:00** |
| ***An unusual nova possibly associated with the Sagittarius stream***  ***Elias Aydi (SAAO / UCT)***  This work addresses spectroscopic and photometric follow-up of the peculiar nova OGLE-2015-NOVA-01. The photometry shows a flat-topped light curve with quasi-periodic oscillations, then a smooth decline followed by two fainter recoveries in brightness. This decline was thought to be due to dust formation. IRSF data ruled out the possibility of dust formation. Spectroscopy with the Southern African Large Telescope shows first a classical nova with an Fe II or Fe IIb (broad) spectral type. After deriving the distances, the nova can possibly be associated to the Sagittarius Stream, If so it is the first nova to be detected from that, or from any dwarf spheroidal, galaxy. | **11:30** |
| ***Near-Infrared Imaging Polarimetry of NGC 1068***  ***Katsuhiro Murata (Nagoya Univ)***  We conducted NIR imaging polarimetry of NGC 1068, a nearby type 2 Seyfert galaxy, using IRSF/SIRPOL and detected linear polarization within 1.5 kpc from the galactic nucleus. We would like to show you the polarization map and discuss the origin of the polarization. | **12:00** |
| ***Deep NIR catalogue of the HI Zone of Avoidance galaxies***  ***Khaled Said (UCT)***  I will present the deep NIR catalogue of the HIZoA galaxies which will be used for investigation of matter distribution in the ZoA. Observations were conducted between 2006 and 2013 using the 1.4m IRSF telescope situated at the South African Astronomical Observatory site in Sutherland. Final data release, completeness and reliability for Tully -Fisher survey will be discussed. | **12:30** |
| **13:00 – 14:00 LUNCH** | |
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| ***Chair: Renée Kraan-Korteweg (UCT)*** | |
| ***Observing Transients from South Africa***  ***David Buckley (SAAO)***  In the realm of time variability studies of astrophysical phenomena, the study of transient  systems over all wavelengths is becoming a major endeavour globally, with many transient detection systems now operating, some focusing on specific classes (e.g. Supernovae, Gamma Ray Bursts).  High energy (X-ray and gamma-ray) satellite based instruments (e.g. Swift, Fermi, Integral, MAXI, ASTROSAT) continue to discover and observe a wide range of energetic transients associated with accretion onto dense objects. Over the last  decade or so, optical imaging surveys, like OGLE, CRTS, MASTER and ASAS-SN, have increased the rate of discoveries of many different types of optical transients, including CVs, SNe, GRB afterglows, eruptive variables and flaring blazars. The advent of faster, wider and deeper panchromatic imaging surveys of the sky by the likes of GAIA, PanSTARRs and LSST will result in unprecedented numbers of transient alerts (~10^6 per night!).  In South Africa there is an active and growing community of astronomers now involved in the study of transients, with several local facilities that are (or will be) also discovering them. This talk will describe some of this work, specifically in the context of a proposed large South African-led transient follow-up program on SALT, supported by other new facilities at SAAO, which will become operational during 2016. | **14:00** |
| ***ThunderKAT/MeerLICHT transients and the role of the IRSF in multi-wavelength follow-up***  ***Patrick Woudt (UCT)***  With the science commissioning of the MeerKAT AR1 and MeerLICHT scheduled for 2016, I will discuss the multi-wavelength follow up required for newly detected radio transients from MeerKAT. This includes optical and near-infrared photometry and spectroscopy to trace the photometric evolution of the transient and the spectroscopic classification. I will present some highlights of early results of coordinated KAT-7 and IRSF observations. | **14:30** |
| ***OISTER Observations of Gravitational Wave Sources***  ***Kaz Sekiguchi (NAOJ)***  We describe the planned optical and near-infrared observations of Gravitational Wave Sources (GWS) using telescopes of OISTER (Optical and Infrared Synergetic Telescope for Education and Research) program. OISTER is a collaboration of over 25 small to medium sized telescopes, the IRSF is one of them, mainly owned by Japanese Universities. Observing the GWS in optical and/or infrared electromagnetic domain(s) will help us identify the nature of GWS. | **15:00** |
| **15:30 – 16:00 BREAK** | |
| *Chair: Takahiro Nagayama (Kagoshima Univ)* | |
| ***Synergy between IRSF, AKARI and SPICA***  ***Hidehiro Kaneda (Nagoya Univ)***  I present the current status of our activities on the space IR missions, AKARI and SPICA, especially the mid-IR all-sky maps with AKARI and the mid-IR instrument on SPICA. In my presentation, I particularly focus on their synergy with IRSF in terms of both science and instrumentation. | **16:00** |
| ***The development of an optical and near-infrared spectrometer for the IRSF 1.4 m Telescope***  ***Akiko Tsuzuki (Nagoya Univ)***  We are developing a spectrometer for the IRSF 1.4m telescope. This spectrometer is designed to utilize photons effectively; it has a small number of optical surfaces to reduce reflection loss and continuously obtains a spectrum of 0.4—2.5 um range simultaneously. The instrument has optical and near-infrared (NIR) parts, and we are now developing the NIR part prior to the optical part. NIR photons from the telescope are dispersed by a prism made of sapphire and focus on an HgCdTe array detector in the NIR part. One of the features of this spectrometer is a NIR slit viewer. The detector for the slit viewer is an InGaAs array detector. In this talk, we present the current status of the development and expected performance of the instrument. | **16:20** |
| ***Exoplanet exploration with IRSF/SIRIUS and future plans***  ***Motohide Tamura (UTokyo/NINS Astrobiology Center/NINS NAOJ)***  IRSF/SIRIUS has played active roles in the studies of not only the Magellanic clouds but also exoplanets and star and planet formation. Its unique capability of sensitive JHKs simultaneous imaging with the dedicated telescope is used for the accurate (a few mmag) transit photometry of several exoplanets including super-earths and for the follow-up of several microlensing (ML) planets discovered by ML teams. I will summarize these results as well as some of the star formation results. Considering these past activities and trying to keep the current IRSF/SIRIUS availabilities, some Japanese teams are planning to build a 1-2 meter class telescope near IRSF and jointly operate these facilities. I will also introduce these future plans and hope to discuss these plans with both South African and Japanese researchers. | **16:40** |
| **END** | **17:10** |

***FRIDAY 4 MARCH***

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| ***Science Discussions***  The scientific meeting will be informal and we anticipate group discussions (possibly in parallel) on the following areas of mutual interest:  1 – Galactic structure (potentially extending to Local Group galaxies)  2 – Transients and high-energy binaries. | **09:30** |
| **13:00 – 14:00 LUNCH** | |
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**POSTERS**

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| ***Spectro/Photo/Polarimetric Survey Facility***  I propose a spectro/photo/polarimetric facility to search time-variation in the parameter space of coordinate (x,y), spectrum(λ) and polarization (σ). The telescope optics is "Cassegrain-type", consisting of four mirrors, that is, spherical 1ry, 2ry mirrors, and two mirror SAC (Spherical Aberration Corrector). It is capable of coverage of FoV of 8' with a resolution of 0.5". The telescope, together with the instrument, is on the Alt-Azimuth mount. I present the outline of the concept of SPSF (spectro/photo/polarimetric survey facility). | ***Shuji Sato***  ***(Nagoya Univ)*** |
| ***NIR variability around the periastron passages of the gamma-ray binary PSR B1259-63 /LS2883***  The observations using IRSF/SIRIUS and SIRPOL were performed for about a month covering the periastron passages in the 2010 and 2014 orbital cycles. Some observations in the quiescence were additionally carried out for calibration. The J-, H-, and Ks-band fluxes start to increase ~10 days before the periastron and reach a peak at ~15 days after the periastron. The maximum increase is about 0.1 magnitude. The timing when the flux starts differ between the bands, which results in the orbital changes in the color-magnitude diagrams. These behaviours are almost identical in the 2010 and 2014 periastron passages. In the circumstellar disk of Be stars, emission at different wavelengths is supposed to come from different radial regions. Our result suggests that the tidal force by the pulsar compresses the disk and causes the local density increase. | ***Akiko Kawachi (Tokai Univ)*** |
| ***High precision photometry of the gamma-ray binary HESS J0632+057 around the 2015 periastron passage***  HESS J0632+057 is a gamma-ray binary consisting of a Be star, MWC148, and a compact object of unknown nature. The X-ray and gamma-ray light curves are too puzzling for any simple interpretation to be applied. There are two outbursts in a single orbital cycle, one before the apastron and the other after it, and a dip in between. Around the periastron, on the other hand, the target is quiescent. The orbital period (~320d) determined from the X-ray light curves has an uncertainty of about a week, which results in a large uncertainty (~50d) in the date of current periastron passage. This causes a difficulty in discussing the orbital modulations in high-energy emission mechanisms. We have been monitoring HESS J0632+057 since 2010 using IRSF / SIRIUS and SIRPOL. Because of the observational conditions, the target was unable to be observed around the periastron passage until 2015. As long as the phases covered by our monitoring, there is no significant variation in the NIR magnitude. Recently, we have calculated the NIR variability of free-free emission from the Be disk, using the numerical simulation data of HESS J0632+057. The predicted light curves show a damping oscillation around periastron, with the amplitude (<0.1 mag) and pattern depending on the frequency and optical depth of each wave-band. Motivated by this, we observed the target for about 1month from 2015 December to 2016 January, considering the uncertainty in the date of periastron passage. In order to reduce the systematic errors, the target and reference stars were fixed on certain positions on the detector during the observations. We made multiple observations per night. The preliminary analysis shows small (~0.02 mag) periastron variations/oscillations in the J and H bands. The detailed results will be reported at the meeting. | ***Sho Chimasu***  ***(Tokai Univ)*** |
| ***Five years near-infrared monitoring of peculiar X-ray binary Cir X-1*** | ***Takahiro Nagayama***  ***(Kagoshima Univ)*** |
| ***Polarized Imaging Observations with the IRSF***  We will present polarized imaging that should be possible with the IRSF and complementary data sets from other facilities. | ***Lerothodi Leeuw***  ***(UNISA)*** |
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