NASSP OT1 Course Student Projects

– 2012 –

Writing a SALT Observing Proposal

Dr David Buckley

SALT
OT1 Course Lecturer
(dibnob@saao.ac.za)

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Summary
These projects are expected to take ~3 – 4 weeks to complete, with a completion deadline on midnight (00:00 SAST) on **Monday 14 May 2012**, just as if you were submitting a real proposal for telescope time (***there will be severe mark penalties for late submissions!***). Three components of the project will be marked, which in totality will comprise 35% of the mark for the OT1 (optical/IR) course, comprising:

1. Written component (50% of project), consisting of:
   a. *Literature study*. A general description of the observational topic in context with our current understandings and the specific SALT observing proposal. References should be given to any relevant published papers that you have consulted on the topic. Maximum of 4 x A4 pages, including figures.

   b. *Scientific Justification*. This should be a maximum of 2 A4 pages (font size ≥ 10 point) including figures, diagrams, tables, etc. It should consist of:
      i. a brief summary of the science being attempted (i.e. summarizing 1 a.) and its importance
      ii. a description of the instrument configuration(s) to be used
      iii. a brief discussion on the technical feasibility (e.g. in terms of instrument capability, requested exposure time, total amount of observing time being requested, signal-to-noise needs, etc.).

      This will be submitted as a PDF file during the PIPT proposal submission process.

   c. Summary of the proposed observations. A description and reasoning for the instrument mode choice and details of the instrument configuration(s) (e.g. filter or grating choice). This may refer to results using the SALT instrument simulation tools (e.g. for S/N or exposure time calculations), with extracts of results from these tools.

   d. A list or table of the objects to be observed. The list of target names, their positions, brightness and any other relevant information, plus their visibilities (e.g. as obtained from the SALT visibility tool) and finding charts for all of the targets.

2. Submitted SALT Proposal (25%)

On completing the SALT PIPT proposal form, this will be submitted to a pseudo-database, over the internet (by clicking the "submission" button). If successful (email will confirm this), an XML proposal file will be created automatically. You have the option of checking and changing this and resubmitting it before the submission deadline.

The final version of the submitted proposal will be assessed in terms of:

- how well it matches the proposal requirements
- how logical and efficient is the observing plan
- how complete is the observing plan (i.e. is there anything missing?)
- any errors in the proposal (e.g. objects not observable)

3. Project Presentation (25%)

Sometime in the week beginning of 14 May (exact date and venue to be confirmed), all students are to make a short presentation to the class on their observing proposals. This will be the in the form of a PowerPoint (or similar) presentation last 15 minutes, with 5 mins for questions. The venue will be the SAAO Auditorium.

Keep your presentation to the point, covering all the aspects of what, why and how you are proposing to observe. Make sure your presentation slides are visible and that any supporting graphics relevant. Practice delivering your talk (even to a imaginary audience!) and try to face the audience as much as possible, not the screen!

The 2012 Projects

The following pages include the titles and descriptions of the projects that are offered in 2012, together with the relevant project proposers name, email address and the number of students assigned. There are 11 project themes, covering a range of modern astronomical observational topics, all of which can be addressed by SALT. ***The last page lists which students have been assigned to which proposal and/or proposal option (some projects have different options within them).***

These projects are meant to be independently carried out with minimal contact with the proposers. However, if you get stuck or need some clarification, you can always email the proposers for assistance and advice. There will be at least two tutorials on using the PIPT (Principal Investigator Proposal Tool) and instrument simulation tools, which will be required in order to submit your final proposal.

Please note, however, that emails asking for help should not be sent at the last minute nor should you expect the recipients to write the proposal for you. They are there as a last resort when you can't progress further on your own. If there are questions that arise, ask them sooner than later, since there's no guarantee of a quick answer, particularly if people are away.

One word of advice: don't leave it until the last minute to try to complete your projects and submit your proposals!

Marking of the project will be done as follows:

1. written component: by the project proposer and myself
2. PIPT component: by the project proposer and myself
3. talk: by the project proposer, Drs Whitelock, van der Heyden and myself

NASSP OT1 PROJECT DESCRIPTIONS

#1: Star formation in starburst galaxies (3 students)

Dr Petri Väisänen, SAAO
(petri@saao.ac.za)

Starburst galaxies are sites of extreme star formation (SF). SF rate is elevated by factors of 5-100 compared to more quiescent star forming galaxies such as the Milky Way. Starbursts are often, but not always, related to interactions of galaxies. In this proposal we will study how the SF rate depends on the interaction stage of the galaxy, and what other characteristics of the galaxy would correlate with the strength, age and history of SF.

We propose to obtain spectroscopy of a sample of strong SF galaxies, at various ranges of interaction and isolation. We will need to cover approximately the spectral range encompassing the main star-formation lines from [OII]3726Å to Hα (6563Å). From these data we will measure:
A. strengths of emission lines to estimate derive extinction, SF-rate and age of starburst;
B. line ratios to derive the mechanisms responsible for ionizing the gas;
C. fit models of stellar population to the full spectrum to derive ages of the underlying stellar population.

We will use one or two slit positions through the target systems, along the major axes of the one or two galaxies in question. It is important to acquire high-signal to noise (>30) even in the outer regions of the galaxies for stellar population modelling.

Tasks:
1. In the science justification expand on the case above, explaining especially how the immediate objectives A,B,C above would be done.
2. Choose the appropriate instrument
3. Choose the appropriate instrument configuration
4. Choose an appropriate observing strategy by taking care to satisfy the scientific needs described in the program above.
3. Select *2 galaxies* from the target options most suitable for *one* of the following options:
   a) observations in the period March-June
   b) observations in the period Jul-Oct
   c) observations in the period Nov-Feb.
5. Use PIPT to fill out the observations specifications as you have determined them.

Target options: select the *two* galaxies with *different* interaction stage from the following list:
NGC470, NGC660, NGC1022, NGC1068, NGC1222, NGC1482, IRAS04296+2923, NGC3885, NGC4038/39, NGC5073, NGC5597, NGC600, NGC6181, NGC6835, NGC7479, NGC7714

Use the Extragalactic Database NED at http://nedwww.ipac.caltech.edu/ to find the coordinates and approximate brightnesses and images of the targets.

*Science background *starting points* & references:*
Kennicutt, Robert C., Jr.: *Star Formation in Galaxies Along the Hubble Sequence*
http://arxiv.org/abs/astro-ph/9807187 or http://adsabs.harvard.edu/abs/1998ARA%26A..36..189K

Angel R. Lopez-Sanchez, Cesar Esteban: *Interactions and star formation activity in Wolf-Rayet galaxies*
http://arxiv.org/abs/0704.2846

Angel R. Lopez-Sanchez, Cesar Esteban: *Massive star formation in Wolf-Rayet galaxies: II. Optical spectroscopy results,* http://arxiv.org/abs/0910.1578 (2009A&A...508..615L)

Hints: 1.) Consider galaxy *surface brighnesses* rather than integrated brightness when doing the observation simulations 2.) Don't get side-tracked by the "Wolf-Rayet" nature of the latter two papers, they are just one type of strongly SF galaxies.]

#2: Secondary Radial Velocity Curve of the Polar V895 Cen (1 student)

Dr David Buckley, SAAO
(dibnob@saao.ac.za)

The eclipsing polar V895 Cen shows evidence of its secondary star both in photometry and spectroscopy, the latter by the presence of absorption lines of sodium and titanium oxide, seen in the red part of the spectrum.

The aim is to determine the orbital radial velocity curve of the secondary star by looking for changes in the spectral line positions over the orbital cycle, in particular the sodium (NaI) absorption doublet at 818.5 and 819.7 nm and the CaII near IR emission triplet.

Tasks:

1. Review our current understanding of this system and identify the spectral lines and their wavelengths that can be used for these observations.
2. Choose the appropriate instrument and configurations for the observations to observe both the NaI and CaII lines at the highest resolution.
3. Choose a range of potential observing windows with SALT which when combined will cover the entire orbit.
4. Write an observing proposal with the PIPT and submit it.

Hints:

1. The long orbital period (4.75 hours) will mean that a number of SALT tracks will be needed.
2. Check the SALT visibility and calculate the *orbital phase coverage* for the tracks based on the published *orbital eclipse ephemeris*.
3. Use the instrument simulators to estimate the exposure time assuming a S/N of ~10 is required per exposure.

Useful references:

Stobie et al. (1996), *Monthly Notices of the Royal Astronomical Society*, **283**, L127.
Warner, B. (1995), *Cataclysmic Variable Stars*, Cambridge University Press.

#3: Cyclotron Spectroscopy of Polars (2 students)

Dr Stephen Potter, SAAO
(sbp@saao.ac.za)

Polars (also known as AM Herculis systems) are binary stars consisting of a highly magnetic (20-200 MG) white dwarf accreting from a red dwarf companion star. The spin period is synchronized to the orbital period of the system, which falls in the range ~80 to ~500 minutes. Most of a polars luminosity (in the form of X-ray and optical cyclotron emission) arises from the hot accretion spots (shocks), situated near the magnetic poles of the white dwarf.

The aim of this project is to investigate the physical environment of the accretion shocks in polars. Parameters such as the magnetic field strength at the shock, the density and temperature profile of the shock and its shape, size and location on the surface of the white dwarf.

In order to achieve this, low resolution (covering as much wavelength range as possible) phase resolved spectroscopy is required with a minimum of 20 spectra covering 1 complete orbit. This project is best suited for highly polarized polars.

Tasks:

1. Select an object from a list of known polars and choose any *one* of the following options:
    a. The shortest period system
    b. A high magnetic field system
2. Review what is already known about the chosen object.
3. Select the most appropriate instrument and configuration and date to undertake these observations.
4. Write an observing proposal and submit it.

Hints:
A list of the currently known polars can be obtained from: http://www.arm.ac.uk/~gar/research/polar.html
Spectra may need to be taken on different nights, depending on the orbital period and the SALT visibility.
You will need to know the *orbital ephemeris* of the selected polar in order to calculate the orbital phase coverage for a given observing window.

Useful references:
Cropper, M. (1990), Space Sci. Reviews, **54**, 195.
Warner, B. (1990), *Cataclysmic Variable Stars*, Cambridge University Press.

#4: Doppler Tomography of Polars (2 students)

Dr Stephen Potter, SAAO
(sbp@saao.ac.za)

Polars (also known as AM Herculis systems) are binary stars consisting of a highly magnetic (20-200 MG) white dwarf accreting from a red dwarf companion star. The spin period is synchronized to the orbital period of the system, which falls in the range ~80 to ~500 minutes. Most of a polar's luminosity (in the form of X-ray and optical cyclotron emission) arises from the hot accretion spots (shocks), situated near the magnetic poles of the white dwarf.

The aim of this project is to make use of the radial velocity variations in the emission lines of polars. The variations arise as a result of the Doppler effect as the various emission regions (e.g. the secondary star and the accretion stream) orbit around the system's center of mass. Techniques such as Doppler tomography can be used to extract the velocity information to produce velocity maps of the emission regions in these systems.

In order to achieve this, high resolution, phase resolved spectroscopy of the HeII (4686) emission line is required with a minimum of 20 spectra covering one complete orbit. This project is best suited for high inclination polars.

Tasks:
1. Select *one* object from a list of known polars and choose *one* of the following options:
    a. The longest period system
    b. A known one-pole accreting system
2. Review what is already known about the chosen object
3. Select the most appropriate instrument and configuration and date to undertake these observations
4. Write an observing proposal and submit it

Hints:
A list of the currently known polars can be obtained from: http://www.arm.ac.uk/~gar/research/polar.html
Spectra may need to be taken on different nights, depending on the orbital period and the SALT visibility.
You will need to know the *orbital ephemeris* of the selected polar in order to calculate the orbital phase coverage for a given observing window.

Useful references:
Cropper, M. (1990), Space Sci. Reviews, **54**, 195.
Warner, B. (1995), *Cataclysmic Variable Stars*, Cambridge University Press.

#5: Wavelength Dependency of Spin Modulations in Intermediate Polars (2 student)

Dr David Buckley, SAAO
(dibnob@saao.ac.za)

Intermediate Polars (IPs, sometimes also referred to as DQ Herculis stars) are binary stars consisting of a moderately strong magnetic field white dwarf accreting gas from a red dwarf companion star. Unlike their "cousins", the Polars, IPs are thought to have weaker field strengths, which is why their spin and orbital are not synchronized, as in Polars. Orbital periods are typically 2-4 hours and spin periods typically 10-30 min.

Little is known about the wavelength dependency of the light modulation in IPs on the spin period, thought to arise from varying aspects of the extended accretion regions. Most IPs are thought to be accreting from a disk of material orbiting the white dwarf, while some are probably diskless systems, where accretion occurs directly into the magnetosphere with the flow then channeled along field lines.

The observing program aims to look at how the amplitude of the light variations caused by the spinning white dwarf changes with wavelength in the visible spectral region. Amplitude measurements at ~5 wavelengths spanning the entire visible spectrum are required. To resolve these variations will require both short exposures and good S/N.

Tasks:

1. Review what is known about the reasons for the spin periods detected in IPs
2. Decide which is the most appropriate SALT instrument to use for these observations, bearing in mind the constraints.
3. Write an observing proposal to study the wavelength behaviour of the spin period in a selection of IPs, chosen to be one of *any* of the following:
    a. a potential discless accretor
    b. a hard X-ray IP discovered by the INTEGRAL satellite

Hints:

Check out Koji Mukai's Intermediate Polar website: http://asd.gsfc.nasa.gov/Koji.Mukai/iphome/iphome.html
Use SIMBAD to find out about the selected objects (http://simbad.u-strasbg.fr/simbad/)

Potential useful references:

Hellier, C. (2001), *Cataclysmic Variable Stars: How & Why they Vary*, Springer.
Patterson, J (1994), Publications of the Astronomical Society of the Pacific, **106**, 209

#6: Planetary Nebulae in the area of CMa dwarf galaxy (3 students)

Dr Alexei Kniazev, SAAO
(akniazev@saao.ac.za)

Planetary Nebulae (PNe) can be detected out to quite large distances from their strong emission lines. The emission lines are narrow, making PNe ideal kinematic probes of a galaxy's gravitational potential. The emission lines can also provide nebular abundances, which can be related to those of the progenitor star, allowing the use of PN as chemical probes of galaxies. Since PNe arise in the common low-intermediate mass stars, they provide a representative tracer of the progenitor stars in a galaxy.

The aim of this project would be to observe with SALT and analyse spectral data for some PNe are located in the area covered by dwarf galaxy in the Canis Major constellation (CMa dwarf). Your goals are: (1) to get the map of studied PNe in the one of strongest emission lines to estimate its size, to calculate radial velocities (2), to estimate extinction (3), to calculate chemical abundances (4) of some elements like oxygen (O), neon (Ne), and sulphur (S).

Tasks:

1. Choose the appropriate instrument.

2. Choose the appropriate settings for the instrument taking care to satisfy the scientific needs described above.
3. Select three targets, either:
   a. ESO 428-5, PN ARO 235 & ESO 427-19, or
   b. ESO 427-30, PN ARO 538, PK 244-06 2, or
   c. PN G236.0-10.6, PN ARO 536, ESO 367- 1
4. Using SIMBAD database http://simbad.u-strasbg.fr/simbad/, review in short form what is already known about chosen objects.
5. Estimate needed exposure times with your settings for your targets.
6. Use PIPT to fill out the observations specifications as you have determined them and submit the proposal.

Additional questions you HAVE TO answer:
1. What is the Canis Major Dwarf Galaxy? Is it a real galaxy?
2. Is it true that you will need to cover spectral region 3700-6800 A to detect all lines of your interest?
3. Which main emission lines in the covered spectral region will you need to detect to estimate the extinction?
4. Which main emission lines in the spectral region covered will you need to detect to calculate the abundance of one the following elements? Select one elements from: Oxygen, Neon, Sulphur

Potentially useful advice and background reference(s):
1. Please, start your background reading for the Canis Major Dwarf Galaxy with Martin et al., 2004, MNRAS, 348, pp. 12-23
2. To review the current state of Canis Major Dwarf Galaxy see Mateu et al., 2009, AJ, 137, 4412
3. To read about observations of Planetary Nebulae with SALT, see Kniazev et al., 2008, SALT spectrophotometry of PNe in Sgr dwarf galaxy, 2008, MNRAS, 388, 1667
4. SALT, current status: http://www.salt.ac.za/fileadmin/files/observing/2012-1Phase1.pdf

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#7: Probing the Atmosphere of Pluto through an Occultation Observation (1 student)

Dr Amanda Gulbis, SAAO
(amanda@saao.ac.za)

For this exercise we must go back in time. On 14 June 2007, Pluto was predicted to “occult” a bright (V ~ 16) star at ~01:28 UTC and we want to observe the occultation from SALT.

Previous observations of stellar occultations by Pluto have shown that between 1988 and 2002 Pluto’s atmospheric pressure increased drastically (Elliot *et al*. 2003; Sicardy *et al*. 2003). More recent data (Young *et al*. 2008; Elliot *et al*. 2007) indicate a general stability between 2002 and 2006 and have revealed interesting features like waves in Pluto’s atmosphere (Person *et al.* 2008). Some models predict that the pressure might continue to increase, but those models are largely dependent on unknown parameters. This is mainly a seasonal effect predicted by Hansen and Paige (1996), which dominates the vapor-pressure equilibrium between the primarily N_2 atmosphere and the surface ice. As Pluto recedes from its 1989 perihelion, deeper into the outer solar system, we anticipate its atmosphere will collapse back into ice sometime between now and the year 2020.

We plan to create a light curve during the predicted occultation time using SALT images of the candidate star and a comparison. To allow calibration, we request a sufficient amount of time to image the star and Pluto when they are well separated before and after the event. These proposed occultation measurements take place in the context of the *New Horizons* space mission, launched in 2006 and scheduled to fly by Pluto in 2015. The recent discovery of Pluto’s smaller moons, Nix, Hydra, and P4, suggest the possibility that the Pluto system may possess tenuous rings created from Kuiper Belt debris that may also be detectable via this stellar occultation observation.

Tasks:
1. Review our knowledge about Pluto, the stellar occultation method, what data are expected to be obtained, and how the data can be used to learn more about Pluto.
2. Select an appropriate SALT instrument and configurations to optimize the observations.

3. Use the PIPT to write a SALT observing proposal for the occultation event and submit it. Be sure to justify your proposed times and types of observations.

Hints:
See webpages http://occult.mit.edu/research/occultations/Pluto/P468/index.html and http://www.lesia.obspm.fr/perso/bruno-sicardy/14_jun_07/index.html for independent predictions of the occultation path.

References (available upon request)*:*

Elliot, J.L. *et al.* 2003, Nature, 424, 165-168
Elliot, J.L. *et al*. 2007, Astronomical Journal, 134, 1-13
Hansen and Page 1996, Icarus 120, 247-265
Person, M.J. *et al.* 2008, Astronomical Journal, 136, 1510-1518.
Sicardy, B. *et al*. 2003, Nature, 424, 168
Young, E.F. *et al*. 2008, Astronomical Journal, 136, 1757-1769

#8: Exploring the surfaces of irregular Jovian satellites (1 student)

Dr Amanda Gulbis, SAAO
(amanda@saao.ac.za)

The giant planets each retain an entourage of satellites – Jupiter has the most, with 63 confirmed moons. In addition to the large and well-known moons, there are also dozens of smaller satellites. The smaller moons located farther from the planets are typically on more eccentric orbits and are collectively called "irregular satellites". These objects range in size from a few hundred kilometers in diameter to less than ten kilometers and many are on retrograde orbits. Their orbits suggest they were captured early in Solar System history, after which some were disrupted into satellite families. The study of the irregular satellites thus provides the potential for greatly increasing our knowledge about the conditions and starting material in this region of the Solar System. However, the relationships between irregular satellites and other objects in the Solar System (such as asteroids, Trojans, and Kuiper Belt objects) are currently very poorly constrained, as are their source regions (Jewitt and Sheppard 2005).

Although these objects are distant and faint, we can employ the same techniques that we use on the closer and brighter asteroids: compositional studies via spectroscopy. Very little spectral information exists for the irregular satellites. Jarvis *et al.* (2000) obtained spectra of Jupiter's moon Himalia, although they have relatively high uncertainties. For other satellites of the giant planets, some broadband colors have been measured that suggest that irregular satellites fall in the C, P, and D asteroid spectral classes (Grav *et al.* 2004; Vilas *et al*. 2006). These classes are associated with primitive, organic-rich bodies. The presence of ice and other volatiles has been inferred in the spectra of Saturnian irregulars (and observed on Phoebe), but has not been detected on other objects.

Low-resolution SALT data in the UV-visible-NIR spectral region provides an opportunity to characterize Jupiter's irregular satellite populations. The visible data can be used for classification in terms of asteroid spectral classes and for comparison with broadband colors of other groups of objects in the Solar System. The UV and NIR data can be used to detect specific surface features. For example, absorptions near 0.7 µm and shortward of 0.4-0.5 µm (the "UV dropoff") are correlated with the presence and amount of hydrated minerals (Rivkin *et al.* 2002; Vilas 1995). A signal-to-noise ratio (SNR) of > 10 per resolution element is required in order to achieve these goals. A higher SNR, which is achievable for brighter targets, could reveal new features.

Tasks:
1. Select *one* group of irregular Jovian satellites to study (e.g. Himalia, Carme, Ananke, Pasiphaë).
2. Review the known information about the chosen irregular satellites and how the proposed measurements can increase our knowledge base.
3. Select the appropriate observing times, instrument, configuration, and exposure times required to reach the scientific goals.
4. Use the PIPT to create and submit a proposal for observing the irregular satellites.

Potentially useful background reference(s):

Grav, T., *et al*. 2003, Icarus, 166, 33
Jarvis, K.S. *et al.* 2000, Icarus, 145, 445
Jewitt, D. & Sheppard, S. 2005, Space Science Reviews, 116, 441
Rivkin, A. S. *et al.* 2002, in Asteroids III, University of Arizona Press, p. 235
Vilas, F. 1995, Icarus, 115, 217
Vilas, F. *et al.* 2006, Icarus, 180, 453

#9: Star Formation histories in Lenticular galaxies (2 students)

Dr Sudhanshu Barway, SAAO
(barway@saao.ac.za)

We propose to obtain long-slit spectroscopy with the RSS spectrograph at SALT of Lenticular (S0) galaxies with an intriguing diversity in structure and stellar content. S0 galaxies play a central role for our understanding of galaxy formation and evolution, since they incorporate attributes of both elliptical and spiral galaxies. However, despite this complex multi-component nature (Barway et al. 2009; 2007, Lisker et al. 2006), they are usually not analyzed separately from elliptical galaxies, treating them both in a simplified way as early-type galaxies. A detailed study of individual lenticular galaxies indicates that the situation is more complex. It has been suggested (van den Bergh 1994) that there are different, but overlapping, sub-populations amongst the lenticulars. The two main components of lenticulars, the bulge and the disc may have their own different and possibly independent formation histories. Observationally, the discs seem to be younger than the bulges in both spiral and lenticular galaxies (Peletier & Balcells 1996), with the age difference between the two components larger in lenticulars (Bothun & Gregg 1990). Bars in lenticular galaxies are also of interest in many studies as they provide a clue about the evolutionary history of these galaxies.

In this proposal, we want to trace the evolutionary history in the light of structure formation of the universe, and therefore propose to obtain long-slit spectroscopy of S0 galaxies which span a large range in luminosity (includes giant as well as dwarf S0s (dS0s)) and environment. This kinematic data will allow us to place the galaxies on fundamental scaling relations (Kormendy relation, Fundamental Plane etc.) and a comparison with semi-analytic models with star formation histories will allow us to evaluate the formation processes of S0 galaxies.

Tasks:

1. Choose one of a, b or c as targets (one S0 and one dS0) for proposed observations:
    a. NGC 6861 and ESO 294- G 010, or
    b. NGC 5102 and ESO 482- G 031
2. Choose the appropriate instrument.
3. Choose the appropriate instrument configurations for the observations.
4. Estimate the optimal observing period for your object.
5. Estimate exposure times needed with your settings for your targets.
6. Use the PIPT to fill out the observations specifications as you have determined them and submit the proposal.

Hint:
Resolution of about R ~2000 and 3640-6765 Å range is sufficient to model the absorption and emission features in the spectra of S0 and dS0 galaxies.

References:

Aguerri et al. 2009, A&A, 494, 891
Barway et al. 2007, ApJ, 661, L37
Barway et al. 2009, MNRAS, 394, 1991
Lisker et al. 2006, AJ, 132, 497
Peletier & Balcells 1996, AJ, 111, 2238
Bothun et al. 1990, ApJ, 350, 73
van den Bergh S. 1994, AJ, 107, 153

#10: Optical properties of H I shells in the Magellanic Clouds (2 students)

Dr Sudhanshu Barway, SAAO
(barway@saao.ac.za)

The Small Magellanic Cloud (SMC) is an irregular dwarf galaxy that is in orbit around the Milky Way galaxy and only visible only from the southern hemisphere. It is roughly 60 kpc distant, making it an excellent source to study the interstellar matter (ISM) and star formation in nearby galaxies. High-resolution neutral hydrogen (H I) maps of the SMC have revealed a complex system of more than 500 'holes' surrounded by shells of higher density. Such shells are common in gas-rich galaxies, and have been catalogued in the Milky Way as well as in several nearby spirals and irregulars and the Large Magellanic Cloud (LMC). There are over 500 shells and supershells in the SMC, five times more than found in the much more massive LMC. The rich population of apparently (dynamically) young shells in the SMC provides us with an excellent statistical sample to readdress some of the basic questions related to the origin and evolution of shells and supershells in gas-rich galaxies which probably pointing towards a recent global burst of star formation in the SMC.

The Large Magellanic Cloud (LMC), at distance of 50 kpc, is also an excellent object to study supergiant shells. Because of its proximity, it is possible to study in detail the physical structure of supergiant shells, and it is also possible to resolve their underlying stellar content in order to determine their formation mechanism. Nine supergiant shells (SGS) have been optically identified in the LMC. Among the nine supergiant shells of the LMC, LMC 2 has been extensively studied because it appears to have the most coherent shell structure and has the highest X-ray surface brightness of all known LMC supergiant shells. LMC 4 is also of special interest because it is the largest. The Hα shell, LMC 4, consists of diffuse filaments and bright H II regions and coincides with a remarkable HI hole. To date various formation mechanisms for LMC 2 and LMC 4 have been suggested and are still under discussion.

We propose to study photometric properties of these supergiant shells in the SMC and LMC with SALT. We will obtain mosaic images of SMC, LMC 2 and LMC 4 in various bands available with SALT to get colors and hence information on star formation of these H I shells. Assuming that the observed H I structures in the SMC and LMC are driven by star formation, we would expect to find some correlation between the occurrence and properties of shells and massive star formation activity. Further we will use these observations with the multi-band data (such as radio) available in literature to investigate the nature of HI shells with the help of VO tools.

Tasks:

1. Choose *one* of the following targets options:
   a. SMC
   b. LMC 2
2. Identify the super shells for your object from archive images.
3. Choose the suitable instrument, filter set and settings for the instrument.
4. Estimate the optimal observing period for your object.
5. Estimate needed exposure times in various bands to reach appropriate S/N.
6. Estimate the number of pointings to obtain an entire mosaic of your object with your settings.
7. Use PIPT tool to fill out the observing specifications that you have determined.

Hint:
The size of the SMC, LMC 2 and LMC 4 is larger than the FOV of SALT, but use only *one* pointing for the present proposal.

References:
Hatzidimitriou, D. et al. 2005, MNRAS, 360, 1171
Points, S. D. et al. 1999, ApJ, 518, 298
Yamaguchi, R. et al. 2001, ApJ, 553, 185

11: Planetary Nebula Haloes (1 student)

Dr Brent Miszalski, SAAO/SALT
(brent@saao.ac.za)

Planetary Nebulae (PNe) are the ejected atmospheres of Sun-like stars near the end of their lives, lit up by their hot inert cores. Many PNe have haloes, extremely faint ionised shells of gas up to 10^3-10^4 times fainter than the object we normally see as the PN (Corradi et al. 2003). A small fraction show arcs or rings in their haloes (Corradi et al. 2004), however the spacing timescales of these structures cannot be explained by stellar pulsations (too short) or thermal pulses (too long). These rings are likely due to a binary central star (Mauron & Huggins 2006).

The aim of this project is to observe arcs or rings in the faint haloes of a planetary nebula and measure the separation between rings. This separation can be used with other information to estimate the properties of the binary central star.

Tasks:

1. Select *one* object from a list of known PNe with rings in their haloes from Corradi et al. (2004) and review our current knowledge of the PN.
2. Select the most appropriate instrument, instrument configuration and date to take deep narrowband Halpha images of the halo.
3. Calculate the surface brightness of the inner nebula and use this to estimate the brightness of the halo.
4. Demonstrate that you will be able to see rings in the haloes in your observations.
5. Write an observing proposal and submit it

Hints:

* The surface brightness depends on the Halpha flux and angular diameter of a PN. Catalogues of both may be accessed with http://vizier.u-strasbg.fr/viz-bin/VizieR-4
* You may need the velocity width of the Halpha emission line. Assume 20 km/s for the expansion velocity of the nebula.
* The visibility of the arcs will depend on the signal-to-noise of the Halpha emission from the halo and the instrument resolution (influenced by the seeing). You may wish to retrieve a Hubble image from http://hla.stsci.edu/hlaview.html and smooth it to match the expected observing conditions.

Useful references:

Balick & Frank, ARA&A, 40, 439, (shapes of planetary nebulae)
Corradi et al. 2003, MNRAS, 340, 417, (compilation of haloes)
Corradi et al. 2004, A&A, 417, 637, (rings in haloes, http://arxiv.org/abs/astro-ph/0401056)
De Marco O., 2009, PASP, 121, 316, (binary central stars) http://arxiv.org/abs/0902.1137
Mauron & Huggins, 2006, A&A, 452, 257, http://arxiv.org/abs/astro-ph/0602623

Project Assignments:

OT1 Student#	Surname	First Name	Campus ID	Project #	Option
1	Abo El Hassan,	Sheref	ABLSHE002	1	3a
2	Amin,	Mahmud	AMNMAH001	1	3b
3	Antel,	Claire	ANTCLA002	1	3c
4	Ikechukwu Patrick,	Affadi	IKCAFF001	2	
5	Kudoda,	Ayman	KDDAYM001	3	1a
6	Legodi,	Letjatji	LGDLET001	3	1b
7	Mampofu,	Vuyani	MMPVUY001	4	1a
8	Matshawule,	Siyambonga	MTSSIY009	4	1b
9	Mzazi,	Phumlani	MZZPHU002	5	3a
10	Namumba,	Brenda	NMMBRE001	5	3b
11	Ntamehlo,	Luvo	NTMLUV001	6	3a
12	Paulse,	Oscar	PLSOSC001	6	3b
13	Radovanovic,	Lidija	RDVLID001	6	3c
14	Rae,	Stephen	RXXSTE009	7	
15	Rafieferantsoa,	Mika	RFFMIK001	8	
16	Sorgho,	Amidou	SRGAMI001	9	1a
17	Steward,	Louise	STWLOU002	9	1b
18	Tapsoba,	Wendyam	TPSWEN001	10	1a
19	Thabethe,	Kulunga	THBKUL001	10	1b
20	Tsibeb,	Edmund	TSBEDM001	11	