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Cover picture: Kevin Govender is awarded the prestigious Edinburgh Medal, jointly with the IAU, see page 5.

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News Note: Gravitational Waves Detected

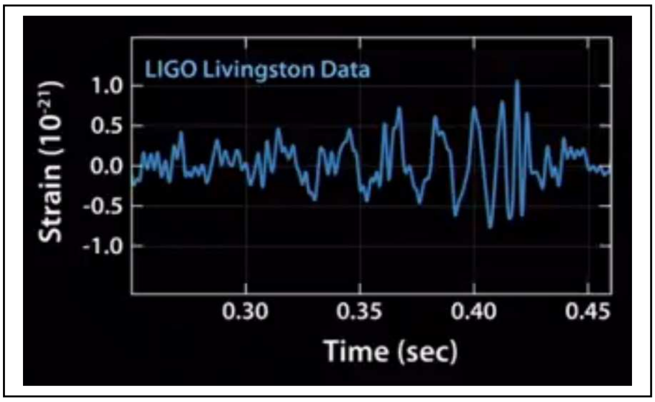
In a news conference given at the National Science Foundation in Washington DC on 11 February it was announced that Gravitational Waves had been detected for the first time. These had been predicted by Einstein just 100 years ago as a consequence of General Relativity, in papers published by the Prussian Academy of Sciences in Berlin but he had recognized that they would be extremely feeble and difficult to observe.

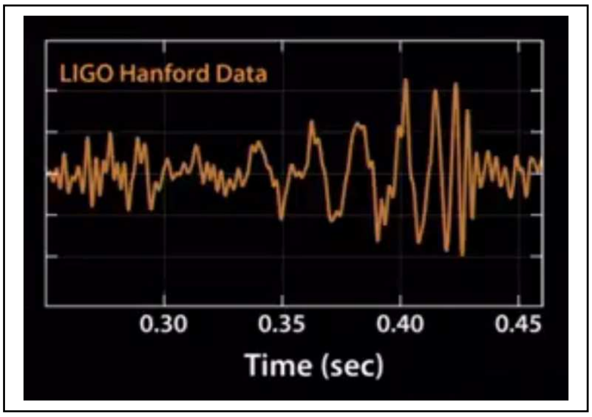
As early as 1969, Joseph Weber had claimed to have detected them, but his results could not be reproduced. However, in the 1980s a team led by Rainer Weiss of MIT started to develop laser interferometric instruments of ever-increasing sensitivity that they hoped would solve the problem. The scale of the distortion in space-time that had been predicted was about one part in 10^{21}.The latest instrument, based in Hanford, Washington, called Advanced LIGO (Laser Interferometer Gravitational-Wave Observatory), was ready for initial trials late last year. A second detector is in Livingstone, Louisiana.

The definitive paper appeared in Physical Review Letters for 12 February 2016, under the name BP Abbott et al, where “al” denotes a huge number of co-authors. On 4 September, 2015 they detected an unambiguous oscillatory stretching event which they were able to interpret as arising from the death-spiral as two orbiting black holes of 29 and 36 solar masses collapsed into one to form an even more massive black hole. Their distance could be estimated by modeling the observations as 410 Mpc or about 1 230 million light years. The energy released in the process corresponded to a phenomenal 3 solar masses (from $E = mc^2$).

Gravitational waves cannot be emitted by symmetrical rotating or expanding objects but require elements of asymmetry together with acceleration. That is why collapsing binary black holes are ideal sources. In principal a rotating neutron star with a mountain or other irregularity could also emit gravitational waves.

The effect of gravitational waves can very easily be imitated by earth tremors. For this reason, the detectors had to be isolated to a phenomenal degree from the earth's surface. The second detector at the other side of the USA was able to confirm the event seen in the first, with a few milliseconds delay. Apart from confirming the reality of the event, it was possible to get a rough idea of the source's direction in space. When more LIGO-type detectors become available it will be possible to pinpoint the direction more closely.





Ideally, they should be installed in space, though even then there are many possible causes of spurious signals.

So far no further results have been published by the LIGO group but it can be expected that there will be more detections as the sensitivity is improved and more instruments come into use.

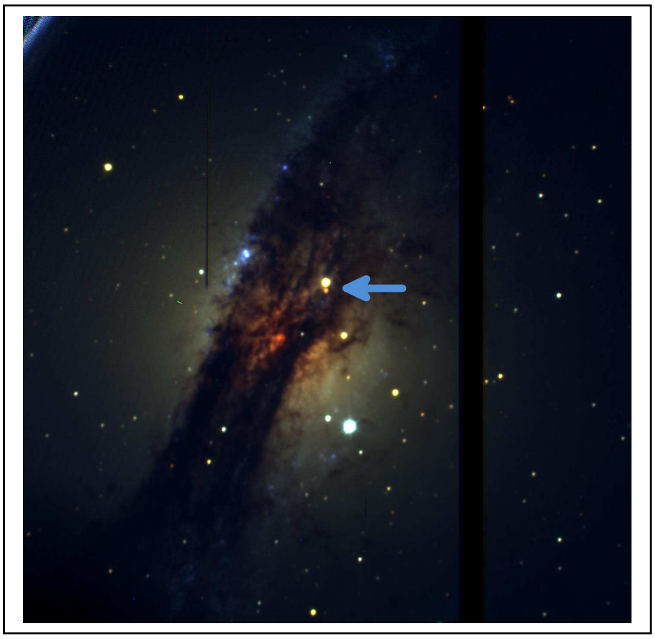
Gravitational waves offer a special advantage over electromagnetic radiations in that they are not affected by intervening matter such as dust or large galaxies. [See also “Tailpiece”, p.45]

News Note: Supernova in NGC5128

During the ongoing Backyard Observatory Supernova Search (BOSS), one of its members, Peter Marples, discovered a possible bright supernova, using data from Loganholme Observatory, Queensland, Australia

NGC5128 is one of the brightest galaxies in the sky and is a peculiar elliptical with a prominent dust lane running across it. It has an active nucleus and prominent radio jets.

The accompanying photograph was obtained in just a few seconds by the SALT telescope and is a composite of three images taken in the u’, g’, and r’ bands. The arrow shows the 14th mag supernova just below a bright foreground star. The red colour of the supernova indicates that it is in or behind the dust disc. The observers were Thea Koen (SALT Operator) and Eric Depagne (SALT Astronomer).



It is believed that the first spectra taken of it were by the SALT telescope in Sutherland. Preliminary indications are that it is a Type II Supernova, according to Steve Crawford (SAAO)

NGC5128 previously hosted the supernova 1986G.

Fig 1: *The supernova in NGC 5128 is red and just below a bright star.*

News Note: Zone of Avoidance Radio Survey

One of the bugbears faced by astronomers interested in studying the distribution of galaxies over the whole sky is the Milky Way – our own galaxy! Unfortunately it hides a large part of the distant universe behind its gas, dust and stars. The part of the sky obscured in this way is known as the Zone of Avoidance. For many years there have been indications of substantial numbers of galaxies hidden from us in this region, including those contributing to a hypothesized "Great Attractor" that affects the gravitational field felt by nearby galaxies.

The results of a hydrogen 21-cm line survey of the region $212° < \ell < 36°$ and Galactic latitudes $|b| < 5°$ (which means from 148° along the plane to one side of the Centre to 36° on the other and from 5° below the plane to 5° above it) have been published in the *Astronomical Journal* for 9 Feb 2016 (also available at arXiv:1602.02922v2 [astro-ph.GA]). The title of the study is "The Parkes HI Zone of Avoidance Survey", with lead author L. Stavely-Smith (University of Western Australia). Co-authors include Renée Kaan-Korteweg (UCT) and Anya Schröder (SAAO) as well as others from Australia, the USA and the Netherlands.

Prof Kraan-Korteweg and her group have been studying this region for a number of years in the visible and infrared regions. Though many of the 883 objects in the new survey have already been detected, only a small proportion have optical redshift measurements.

"Merging the new catalogue with a similarly-conducted northern extension, large-scale structures are delineated, including those within the Puppis and Great Attractor regions, and the Local Void. Several newly-identified structures are revealed for the first time. Three new galaxy concentrations (NW1, NW2 and NW3) are key in confirming the diagonal crossing of the Great Attractor Wall between the Norma cluster and the CIZA J1324.7-5736 cluster. Further contributors to the general mass overdensity in that area are two new clusters (CW1 and CW2) in the nearer Centaurus Wall, one of which forms part of the striking180° (100h $^{-1}$ Mpc) long filament that dominates the southern sky at velocities of 3000 km s^{-1} and the suggestion of a further wall at the Great Attractor distance at slightly higher longitudes”.

News Note: The 2016 Edinburgh Medal awarded jointly to Kevin Govender and the IAU

The medal will be jointly awarded to Kevin Govender from IAU’s Office of Astronomy for Development and the International Astronomical Union (IAU) on Wednesday 30 March at the 2016 Edinburgh International Science Festival, to recognise their wide-reaching contribution to science.

It is awarded jointly for the creation and practical establishment of the Office of Astronomy for Development, which integrates the pursuit of scientific knowledge with social development for and with those most in need. Under the pioneering stewardship of Kevin Govender, the Office of Astronomy for Development, hosted at the South African Astronomical Observatory in partnership with the National Research Foundation and the South African Department of Science and Technology, has successfully harnessed astronomy in the service of global education and capacity building.

The Edinburgh Medal is a prestigious award given each year to men and women of science and technology whose professional achievements are judged to have made a significant contribution to the understanding and well-being of humanity. The 2016 Edinburgh International Science Festival will run from 26 March to 10 April.

Upon hearing the news, the director of SA Astronomical Observatory, Professor Ted Williams said, "Kevin Govender has been the driving force behind the spectacular success of the IAU Office of Astronomy for Development. His passion and boundless energy for using astronomy to promote a better world for everyone inspire all who meet him. The South

African Astronomical Observatory is proud to both host the Office of Astronomy for Development and to claim Kevin as one of our illustrious associates."

Kevin Govender and President of the IAU, Silvia Torres Peimbert, will be presented with the Edinburgh Medal at the Chambers of the City of Edinburgh Council on Wednesday 30 March. They will give the Edinburgh Medal Address: Astronomy for a Better World as part of the 2016 Edinburgh International Science Festival, in the presence of Lord (Martin) Rees, the UK Astronomer Royal.

On behalf of the IAU, its President Silvia Torres Peimbert commented that she was delighted that the work of the IAU in the field of development has been recognised by the award of this medal. Astronomy is an exciting and stimulating pursuit and has a large part to play in inspiring the next generation of scientists from developing countries

Prof. Nithaya Chetty, CEO of the NRF's Astronomy sub-Agency said, "This is a significant achievement for Kevin Govender and the IAU-OAD, and we feel very proud that Kevin has been recognised in this way. It is also timely, as we have just gone through a review of the OAD less than a year ago which highlighted the excellent achievements of the Office of Astronomy for Development (OAD) since its inception in 2010. IAU and NRF/DST subsequently renewed the Agreement to co-host OAD at SAAO in Cape Town for another six years until 2021. As a part of the Review, DST agreed to fund an additional post within OAD at the level of a PhD (Astronomy), while IAU had agreed to appoint an international fund-raiser. The future looks very bright indeed, as the joint principals for the OAD have continued to express strong support and confidence in the work of the OAD. OAD is an important gateway for South Africa's astronomical developmental goals in Africa and broadly in the world, and I would like to see the good offices of the OAD being much better utilised by us in South Africa to advance Astronomy internationally".

Editor's note*: Kevin is in outstanding company, previous winners include: 1989 Professor Abdus Salam, 1998 Sir David Attenborough,
1999 Professor Jocelyn Bell Burnell and in 2013 Professor Peter Higgs/CERN.*

News Note: SKA SA-led Infra SA Consortium receives more than R40 million in European Union Horizon 2020 funding

A Square Kilometre Array South Africa (SKA SA)-led consortium has received €2,251,920 (more than R40,3 million) from the European Union Horizon 2020 Funding to undertake the detailed design of the SKA1_MID infrastructure and power elements in South Africa. The announcement, which was made yesterday in Manchester in the UK, will see a total award amount of €5M by the European Union's Research and Innovation programme Horizon 2020.

The funding will enable activity across the Infrastructure SKA (IN_SKA) programme, including work at the SKA Global Headquarters in the UK and also within the two teams responsible for delivering the SKA's infrastructure design: Infrastructure Australia, led by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) in partnership with Aurecon Australasia, and Infrastructure South Africa, led by SKA South Africa. This includes the design of the SKA1_MID power network, roads, buildings, antenna foundations, water and sanitation, site monitoring, security, communications and vehicles.

The Consortium is led by Tracy Cheetham, General Manager: Site Operations and Infrastructure at SKA SA, and comprises of SKA SA staff members, young graduate professionals, retired engineers from the South African Institute for Civil Engineering (SAICE) Development Projects and South African industry partners.

This includes 11 SKA SA engineers / project managers appointed by SKA SA, three young graduate engineers from SAICE and one SKA SA young graduate professional. The SKA SA team and young graduates are mentored and supported by six retired engineers appointed by the SKA SA through SAICE Development Projects.

"We are extremely pleased and excited to receive this funding to take forward the detailed design of the SKA1_MID infrastructure and power on behalf of the SKAO. It is also a very good opportunity to involve experts and retired engineers, as well as to provide an opportunity to young engineering professionals to hone their skills on a project of this magnitude, which is directly in line with SKA SA's vision of developing science and engineering capacity in South Africa. The SKA SA infrastructure team has excelled and we are all very proud of their achievements, hard work and commitment in an effort to realising the first phase of the SKA in South Africa," says Cheetham.

The South African industry partners are in the process of being appointed for Stage 2 to assist with the detailed design of the SKA1_MID antenna foundations and the construction of an antenna foundation prototype on site and to undertake the detailed design of the building and power facility upgrades required for SKA1_MID.

The main deliverables for Stage 2 include capital, operations and maintenance cost plan updates; a topographical survey of the SKA1_MID site; a geotechnical and geohydrological investigation of the SKA1_MID site; road maintenance usage reports; Radio Frequency Interference control plans for infrastructure and power sub-elements; a Power Analysis report; antenna foundation prototype and detailed design; detailed design reports of all infrastructure and power sub-elements; a suite of management plans; and a Critical Design Review.

The detailed design commenced in April 2015 and is expected to be completed in April 2017.

PSR J1723-2837: Intensive photometric study captured unique events.

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Abstract: PSR J1723-2837, a 1.86 millisecond pulsar (MSP) is one of the growing populations of MSP pulsars with a non-degenerative companion star of mass 0.2 – 0.4 M⊙, also known as Redbacks (RBs), in a ~15 hour orbital period. The presented paper reports on photometric results obtained on the ~16 magnitude companion to PSR J1723-2837. The optical light curve of the companion was intensively monitored for a period of one year.

A steady state was identified, dominated by ellipsoidal variation, a common signature to a number of RBs followed by a transitional period of asymmetric phase luminosity during 2014. Most unexpectedly was the development of a presumably asynchronous rotating spot in 2015 which was observed until the end of 2015 when observations ceased.

1 Introduction

PSR J1723-2837 is an eclipsing, 1.86 MSP in an almost circular ~14.8 hour orbit, about a companion star (J17232318-2837571) of spectral type G5 that was identified using Infrared, optical, ultraviolet and spectrophotometry in previous studies [Crawford, 2013]. X-Ray emission was also detected from PSR J1723–2837 and is presumably a candidate for a radio pulsar/X-ray binary transition object [Bogdanov, 2014].

PSR J1723-2837 is likely a RB system with a heavy companion mass range of 0.4 to 0.7 M⊙ and an orbital inclination angle range of between 30° and

41°, assuming a pulsar mass range of 1.4−2.0 M⊙ [Crawford, 2013], [Roberts, 2012].

Time series photometry on RBs and Black Widows (BW), similar to RBs but with a lighter companion star, M <<0.1 M⊙, are generally time constrained where vital information is recovered, for example identifying the associated companion, revealing light curve properties, Spectral analyses, etc. J1723-2837 has an optical companion of ~16mag allowing favourable photometric opportunities for even small telescopes. In this context, the focus of this study was to monitor the light curve behaviour over a period of one year.

The source of optical emission from BWs and RBs are produced by the companion star. Due to the gravitational pull of the MSP, the companion star becomes tidally distorted. The apparent geometry as seen from Earth is constantly changing while orbiting because the companion is tidally locked to the MSP. This in turn produces ellipsoidal variations in the light curve with two peaks ($4\pi\cdot\phi$). The maximum light received is when the maximum areas are exposed, i.e. when we see the side of the star at ϕ = 0.0 and ϕ = 0.5. Minimums are expected at ϕ = 0.25 and ϕ =0.75 at inferior/superior conjunction when viewing the smaller surfaces and where the effects of gravity and limb darkening also contributes to the weaker flux received.

Irrespective of the ellipsoidal variation, the majority of BWs shows a single-peak ($2\pi\cdot\phi$) optical light curve [e.g., Stappers et al. 2001], with the peak around ϕ = 0.75. This is believe to be a consequence of the heating of the companion star surface, due to irradiation of relativistic photons and/or high energy particles from the MSP [Breton et al. 2013].

Examples of RBs with single-peak light curves [Salvetti et al. 2015] are: PSR J1023+0038 [Thorstensen & Armstrong 2005], J2215+5135 [Schroeder & Halpern 2014], J2339−0533 [Romani & Shaw 2011], and J1227−4853 [Bassa et al. 2014], while examples of RBs with double-peaked light curves are: PSR J1628−3205 [Li et al. 2014], J1816+4510 [Kaplan et al. 2012] and J2129−0428 [Hui et al. 2015].

2 Observations

2.1 Statistics

Observational period: 3 August 2014 – 16 October 2015
Observational nights: 67
Total observational time: ~260 hours
Total number of photometric measurements: 2000+.

A graphical representation of observations made was presented in Figure 1 showing consecutive groups ranging from GR1 to GR14. A summary of the groups can also be found in Table 2.

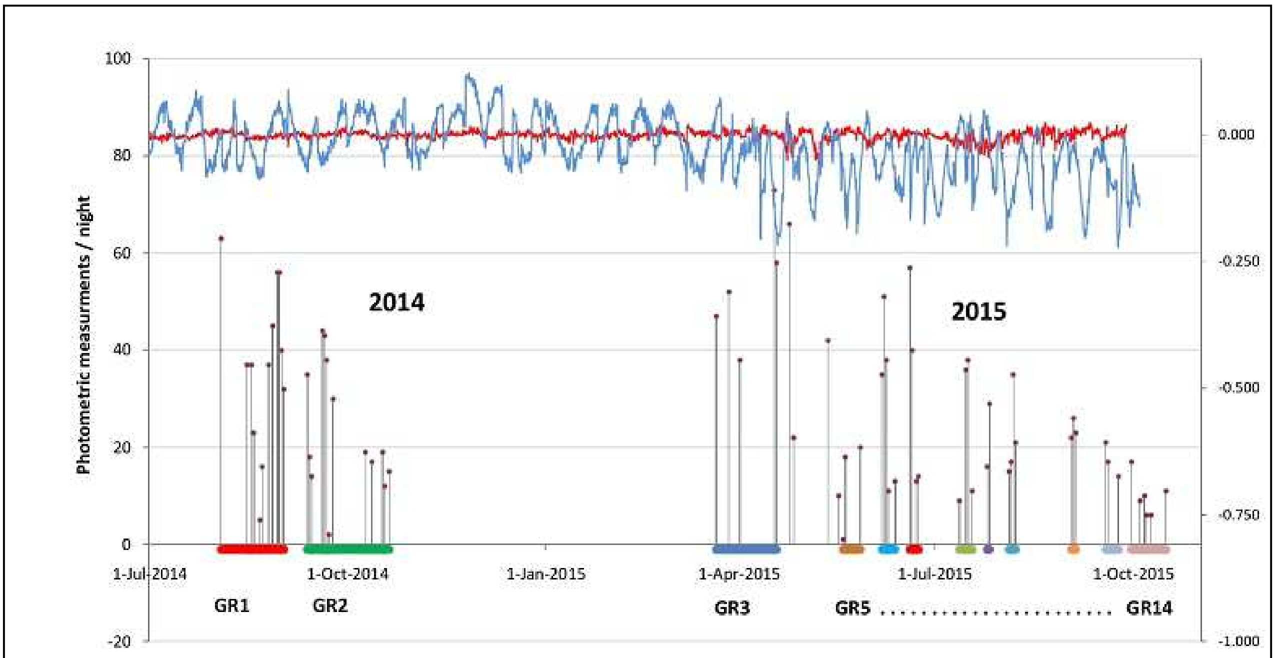

Figure 1. *Graphical representation of observations made for this report. The blue and red curve shows a series plot of all photometric data for J1723-2837 and a close-by comparison star respectively (not plotted to time). The Stem plot shows the distribution, number of photometric measurements and how the data was grouped.*

2.2 Observations and data analysis

All observations were obtained from the authors site (International observatory code 641 – Overberg, South Africa) with a 30 cm SCT and ST9e CCD (512x512) cooled to -15 °C. The site experiences minimal light pollution and has seeing with FWHM normally between 2 to 3 arcsec, occasionally reaching < 2 and >3 arcsec. No light filters were used. Light exposures were all 300 seconds in 2014 and were increased to 600 seconds during 2015. The increased integration time resulted in marginal improvement with negligible effect overall. J1723-2837 was located and identified from coordinates and an image by the WIYN 0.9-m telescope [Crawford, 2013].

Photometric measurements for J1723-2837 in this report are based on differential (V-C) magnitudes, computed with Muniwin 2.0.17, a public photometric program. A set of six comparison stars in the FOV were cautiously selected to compute a virtual comparison star (C) for the V-C computation. A comparison star was plotted in a number of figures in this report and was selected as a variable from the group of six (comparison) stars. A standard deviation of 0.009 mag was calculated for the comparison star with no long term deviations. A Lomb-Scargle analysis on the comparison star showed good distribution of energy in the frequency range. The possible effect of mass extinction due to unfiltered images was extensively investigated and found to be negligible on the results reported in this article.

Timing for CCD images was derived from PC time, synchronized to an international time server with additional spot checks against a GPS Master clock. The camera software converts PC system time to mid-exposure time in UT. Muniwin performs heliocentric correction on UT. All photometric measurements in this report referred to heliocentric time.

2.3 Conventions

Magnitude scale: Phase plots were expressed in flux and is related to magnitude with the relationship; Flux = -(V-C) + offset, where V-C is the differential photometric magnitude and offset was calculated as the mean value of the ellipsoidal signal in order to bring the signal to centre zero. Therefore, more positive flux corresponds to brightening of an object where flux in the negative direction means dimming of the object.

Phases of the companion star: Phase orientation was adopted to be consistent with the radio ephemeris for PSR J1723-2837 [Crawford et al. 2013, Tab. 3] with primary intervals:

ϕ = 0.00: The time of ascending node (MJD 55425.320466), the epoch of phase zero. The companion is approaching us with maximum velocity according to **Doppler measurements [Crawford et al. 2013].**

ϕ = 0.25: This interval encompasses the inferior conjunction where the pulsar is behind its companion and where radio eclipses were observed from the pulsar [Crawford et al. 2013].

ϕ = 0.50: Viewing the companion from the long-axis side (same as ϕ = 0.00). **This is also the trailing (receding) side of the companion.**

ϕ = 0.75: The pulsar is between the companion and earth. Irradiation from pulsar heat is expected to play an important role at this orientation.

The period for the phase plots included the 1st and 2nd orbital period derivate and phases (ϕ_t) were calculated for mid-times of exposures with the relation,

$$\phi_t = \left(T_{asc} \cdot f_b\right) + \left(T_{epoch} \cdot \dot{f}_b\right) + \left(\frac{T_{epoch}^2 \cdot \ddot{f}_b}{2}\right)$$

Where T_{asc} is the time interval starting at the time of ascending node (MJD 55425.320466) and T_{epoch} is the time interval starting at the time of

Epoch (MJD 55667). Orbital derivatives were selected from Table 1. All observational times were Heliocentric corrected.

3 Results

3.1 Ellipsoidal variation – (Group 1 & 3)

The companion to J1723-2837 shows a double peaked light curve signal dominated by ellipsoidal variations of 0.108 magnitudes. A nominal light curve (Figure 2- left) was defined based on data consistently stable, following the ellipsoidal patterns based on 17 observational nights consisting of groups 1 and 3.

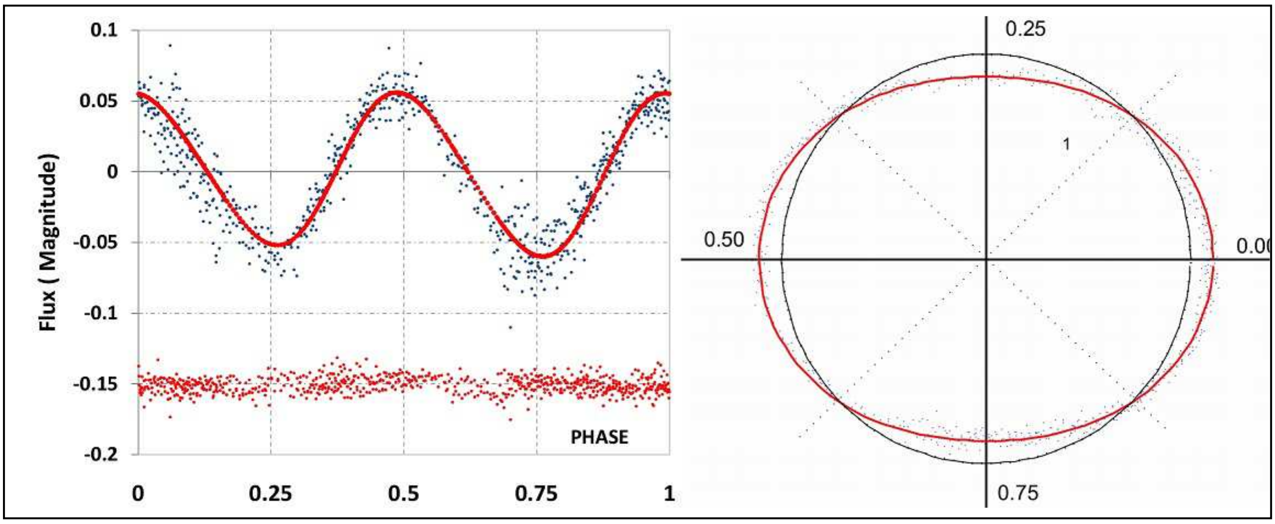

Figure 2. (Groups 1 & 3) Folded phase plots for J1723-2837 and comparison star (red dots below). The red curve represents the nominal ellipsoidal signal. The ellipse on the right represents the same nominal light curve as a polar plot. (A radius magnitude of one unit was added for demonstration purposes)

Evidently from the phase plot is the unequal minima at ϕ = 0.25 and ϕ = 0.75. Phase = 0.75 is slightly dimmer compare to ϕ = 0.25. This occurrence was also observed in other RB studies. e.g.: PSR J1628−3205 [Li et al. 2014], J2129−0428 [Hui et al. 2015], J1824-2452H [Pallanca et al. 2010]. Apart from this, the data shows an overall good symmetry as presented with the polar phase plot in the right panel, Figure 2 (red ellipse). Although relatively small, minor variations were seen in the data during this period particularly from ϕ = 0.75 to ϕ = 0.25. The data from group 1 matched the data from group 3 excellently, confirming observations to be consistent beween 2014 and 2015 with no measurable change in magnitude.

3.2 Asymmetric maximum – (Group 2)

During September 2014, a sudden increase in luminosity was observed in the ϕ = 0.5 region of ~0.04 mag as shown here in Figure 3. This episode was observed until the 20 October, 2014 when observations were stopped due to low altitude angles.

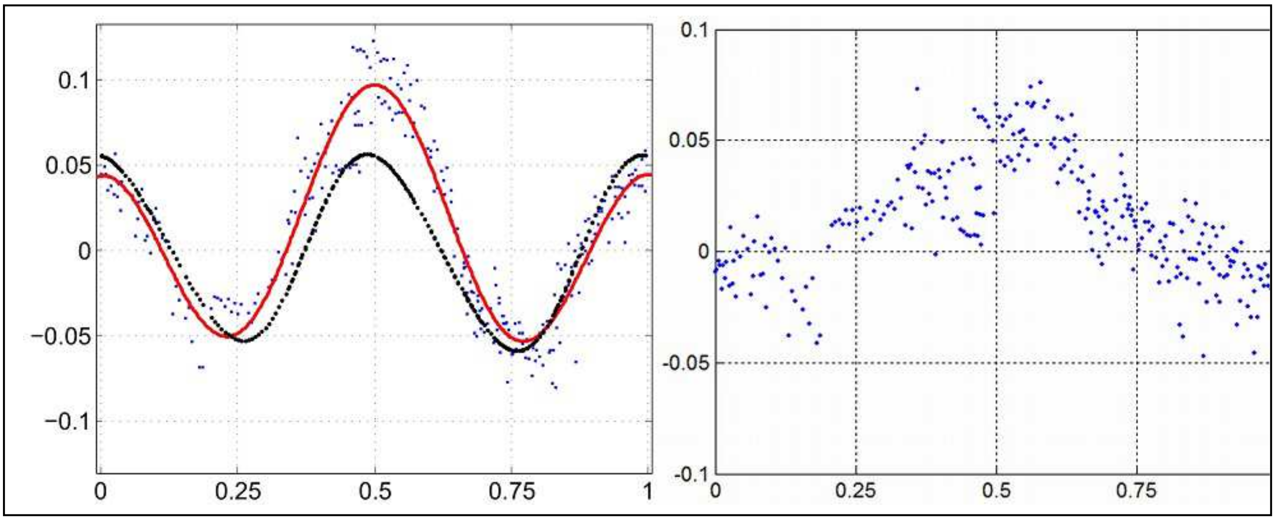

Figure 3**.** *(Group 2) The red curve fitted to the data shows the deviation from the nominal signal plotted in black, during the mentioned period. The plot on the right shows the differences between the two signals.*

3.3 Photometric dips (Groups 5 to 14)

Observations made from May 2015 to October 2015 revealed another episode of large variations as shown in Figure 4.

The data was analysed by first removing the nominal ellipsoidal signal. The resulting signal was still heavily convolved in both phase and amplitude, evident from phase diagrams and Fourier analyses. However, by carefully dividing the data in smaller consecutive groups (GR 5 - GR 14) consisting of observations closely spaced, resolved events are seen as dips in the light curve data. See Figures 7 to 16 at the end.

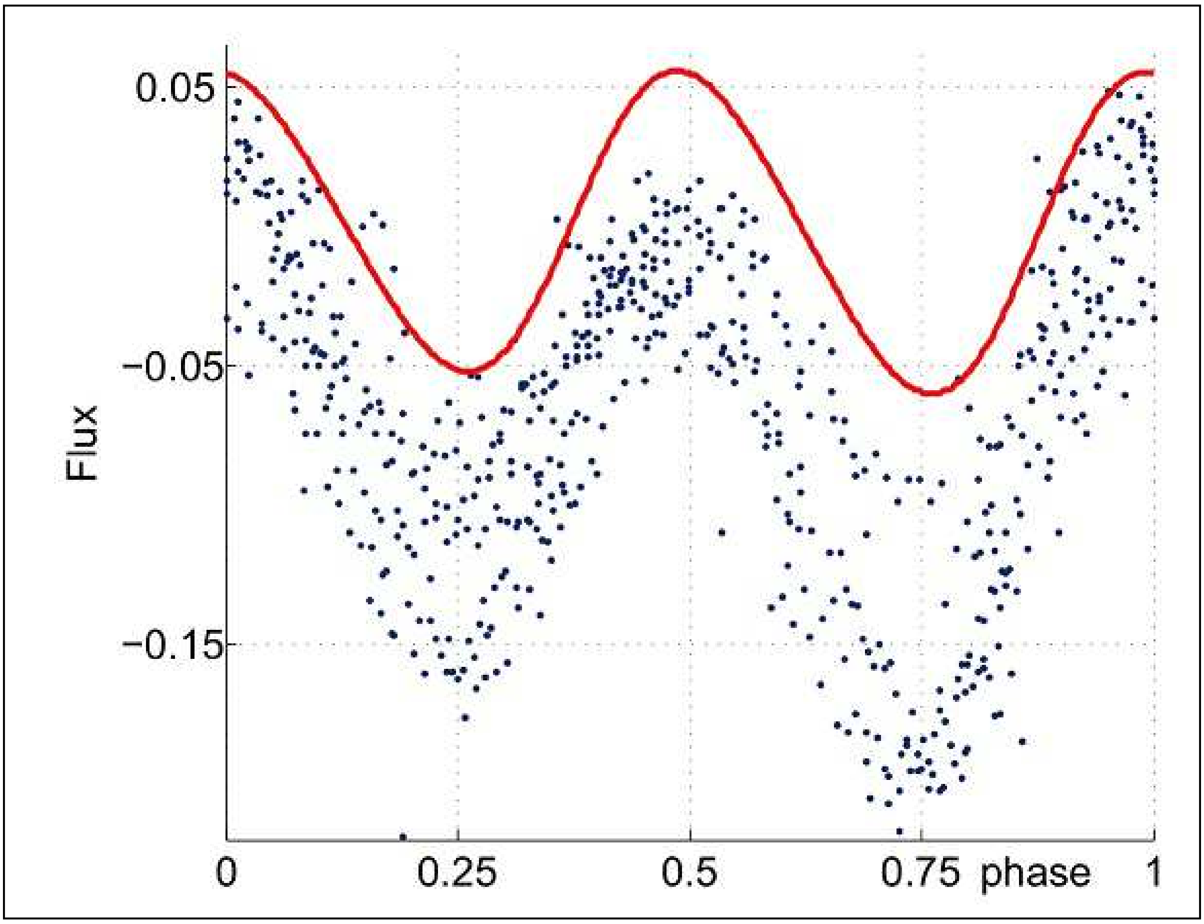

Figure 4*. (Groups 5 to 14) Data captured during May 2015 to October 2015 shown here with blue dots and a nominal ellipsoidal signal plotted in red.*

From the observed ellipsoidal variation we believed that the companion star is tidally locked to the NS or least geometrically fixed. In this case, the companion star co-rotates (geometrically) with the rotating frame induced by orbital rotation and we can therefore describe longitudinal events on the star in terms of phase measurements.

In this context, the first observed dip (GR 5) is coincident with ϕ ~ 0.75 which can be related to a position on the star, for instance a cold spot on the surface at that particular longitudinal position. All consecutive dips or cold spots were measured in this fashion including phase error estimations

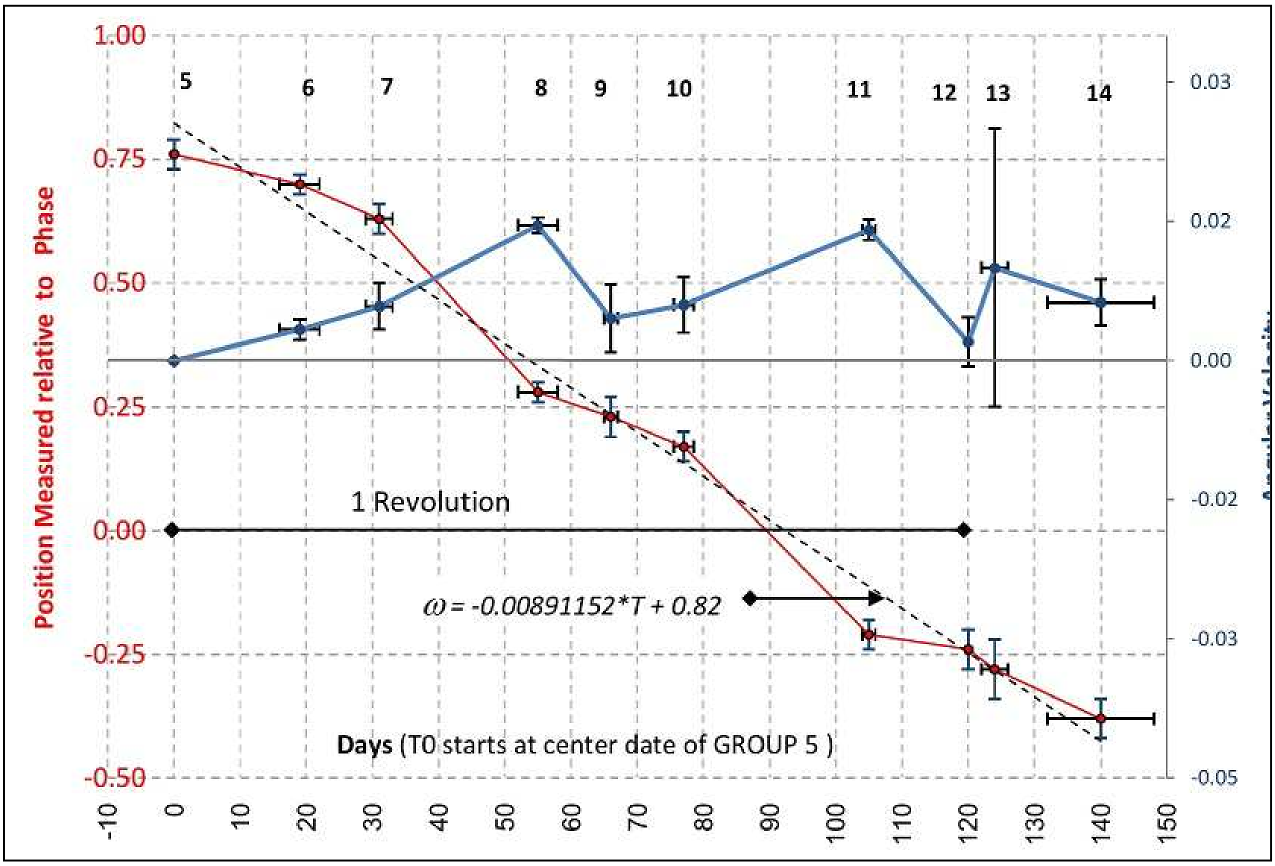

Figure 5: *The red dots represent the measured longitudinal positions from Group 5 to 14. Horizontal error bars indicate the corresponding group period. For vertical bar estimations, see figures 7-16. Blue dots represent the corresponding angular velocity. Velocity vertical error bars were derived from the phase errors. Note that phase -0.25 is the same as phase 0.75.*

Most notable in this arrangement is the shifting of phase in one direction at a near constant rate which strongly relates to the effect of angular rotation. In this scenario we can imagine a rotating star with a single spot observed at different times. In support of this idea, the shape and size of the dip remain reasonably constant throughout the full period. From the spot movement we calculated an average rate $\omega = d\varphi/dt$ of 0.008911/day (see dotted line) indicating a rotation period of 112 days while the true period for one revolution took approximately 120 days. The discrepancy lies in the small deviations from the mean, probably caused by brief periods of deceleration and acceleration in angular rotation. A second curve, although very crude, shows this effect as an angular velocity $\omega = d\varphi/dt$ between consecutive spots. Remarkable is the steady increase in velocity from the start at ϕ ~ 0.75. e.g. a spin-up scenario. Similarly, there may have been brief periods of deceleration and acceleration in the region at ϕ ~ 0.25 and again at ϕ ~ 0.75.

From the onset of this episode, the companion star suddenly dropped 0.05 magnitudes in luminosity in contrast to a stable period since 2014. The dip sizes covered approximately 60% of the phase and slightly increased after 120 days. (see Table 2).

Two minor disturbances were also detected which may be additional cold spots or merely distortion of main spot. These minor events lag the main spot respectively by 0.28 and 0.60 in phase. Although this observation may be important, the effect on the presented phase position measurements was negligible. For completeness, Figure 6 was created to illustrate the effect of the first event.

4 Discussion

J1723-2837 is one of the heaviest RBs and closest to Earth with an optical companion of ~16mag allowing favourable photometric opportunities. The companion star was observed for more than 260 hours in its ~15 hour orbit for a period of one year. Detailed attention was given to the integrity of the data.

The companion star shows a very distinct double peak light curve signal dominated by ellipsoidal variations. A nominal light curve with good precision was established therefore providing a free parameter value for further modelling. No irradiation was observed at ϕ = 0.75, in fact it was shown that the phase at 0.75 measured slightly dimmer compare to the phase at 0.25. The weaker flux at phase 0.75 is often explained as a contribution to the effects of gravity and limb darkening. Interestingly, it seems so far from available data that all of the heavier RB companions (Mc > ~0.2M) shows a double peak light curve with absence of irradiation while the ligter systems and BWs show strong irradiation induces curves.

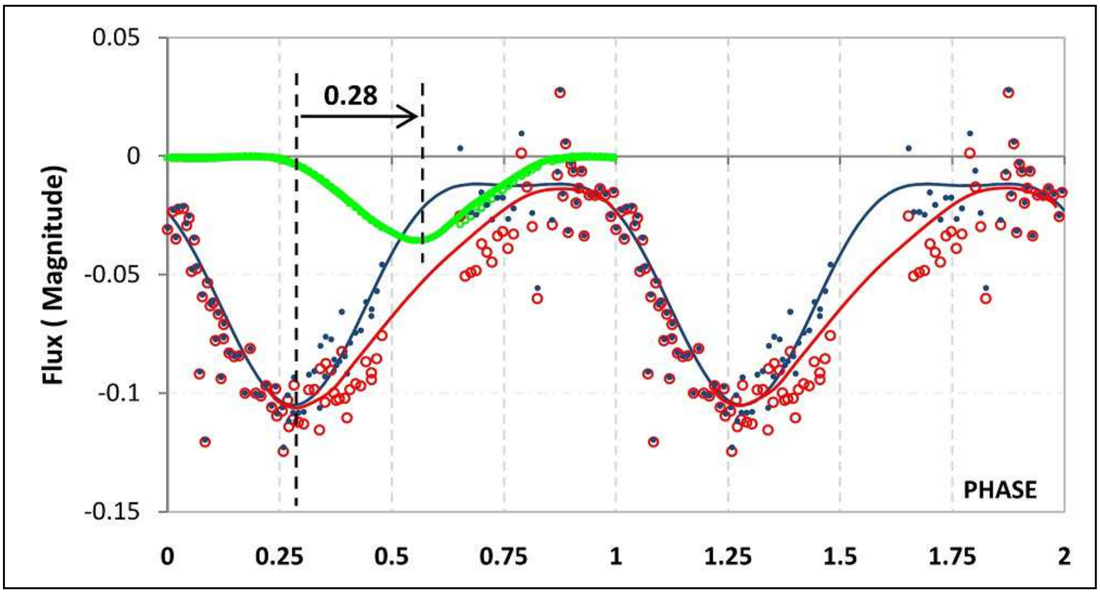

Figure 6*: Data from GROUP 8: The measured data (red dots) shows a slightly asymmetrical dip. Assuming a second minor dip (green curve) was responsible for the deformation and applying this (inverted) to the data we see a reasonable symmetrical correction as illustrated with the blue dots.*

During September 2014, a sudden increase in luminosity was observed in the $\phi = 0.5$ region, proceeding for more than two months. Asymmetric peaks, particularly, $\phi_{0.5} > \phi_{0.0}$ is not an uncommon manifestation and were observed in a number of RBs. We noticed that J1723-2837 changes from $\phi_{0.5} \approx \phi_{0.0}$ to $\phi_{0.5} > \phi_{0.0}$ and back to $\phi_{0.5} \approx \phi_{0.0}$.

Most unexpectedly was the development of a presumably asynchronous rotating spot in 2015 which was observed until the end of 2015 when observations ceased. Spots have not been observed in MSP companions to date nor is there evidence for angular rotation. However, they may have been missed up to now because of insufficiently continuous observations.

Magnetic activity is a likely candidate when it comes to explaining star spots, however it will be exciting, though unique, if J1723-2837 showed signs of reverse flow of accreting material through the L1 point. In this scenario an influx of cooler material from a previous accreting phase will cause the star to contract and spin up to conserve angular momentum while keeping the filling factor well below the Roche overflow limit for a period of time. Occasionally, larger clumps of in-falling material will produce a cold spot before contracting and starts to rotate.

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Acknowledgement: I would like to thank Dr. John Antoniadis from the Dunlap Institute for Astronomy and Astrophysics, University of Toronto, for his friendly support and helpful discussions.

Additional tables and plots

Table 1. Parameters for PSR J1723−2837 [Crawford et al. 2013].

Parameter	**Value**
Right ascension (J2000)	17:23:23.1856(8)
Declination (J2000)	−28:37:57.17(11)
Spin frequency, f (s^{-1})	538.870683485(3)
Timing epoch (MJD)	55667
Time of ascending node, T_{asc} (MJD)	55425.320466(2)
Projected semi-major axis, x (s) [a]	1.225807(9)
Orbital frequency, f_b (s^{-1})	$1.88062856(2) \times 10^{-5}$
Orbital frequency derivative, $\dot{f}_b$ (s^{-2})	$1.24(4) \times 10^{-18}$
Orbital frequency second derivative, , $\ddot{f}_b$ (s^{-3})	$-2.6(3) \times 10^{-26}$
Spin period, P (ms)	1.855732795728(8)
Orbital period, Pb (d)	0.615436473(8)
Companion mass range ($M_\odot$)[d] 0.4−0.7	0.4−0.7
Orbital inclination angle range (degrees)[d]	30−41
Distance, d (kpc) [f]	0.75(10)

$a_x = a \sin i/c$ where a is the semi-major axis and i is the orbital inclination angle.

Table 2: A summary of the groups

GROUP	ACTIVITY	DATE	Observational Time window in days	DATA SETS (Night of observations)
1	**STABLE PERIOD** Ellipsoidal variation *(see figure 2)*	3 Aug – 1 Sep 2014	29	1-12 (12)
2	**UNSTABLE** Increase in flux at ϕ = 0.5 *(see figure 3)*	12 Sep – 20 Oct 2014	38	13-25 (13)
BELOW NIGHT HORIZON				
3	**STABLE PERIOD** Ellipsoidal variation *(see figure 2)*	21 Mar – 18 Apr 2015	28	26-30 (5)
4	**UNSTABLE** Drop in flux Dips in Light Curve *(See figures 4 and 7–16)*			
5		19 May – 27 May 2015	8	35-37 (3)
6		06 Jun – 12 Jun 2015	6	38-42 (5)
7		19 Jun – 23 Jun 2015	4	43-46 (4)
8		12 Jul – 18 Jul 2015	6	47-50 (4)

9		25 Jul – 26 Jul 2015	1	51-52 (2)
10		04 Aug – 07 Aug 2015	4	53-56 (4)
11		02 Sep – 04 Sep 2015	2	57-59 (3)
12		18 Sep – 18 Sep 2015	1	60 (1)
13		19 Sep – 24 Sep 2015	6	61-62 (2)
14		30 Sep – 16 Oct 2015	17	63-68(6)

Table 3: Additional data on the observed dips.

GROUP	CENTRE DATE	Acc Days	Phase	Magnitde (Flat top)	Size (factor)
GRP 5	21-May-15	0.00	**0.76**	-0.050	1.20
GRP 6	9-Jun-15	19.00	0.70	-0.030	1.20
GRP 7	21-Jun-15	31.00	0.63	-0.030	1.20
GRP 8	15-Jul-15	55.00	0.28	-0.015	1.20
GRP 9	26-Jul-15	66.00	0.23	0.010	1.00
GRP 10	6-Aug-15	77.00	0.17	-0.025	1.10
GRP 11	3-Sep-15	105.00	-0.21	-0.035	1.10
GRP 12	18-Sep-15	120.00	**-0.24**	-0.025	1.50
GRP 13	22-Sep-15	124.00	-0.28	-0.050	1.40
GRP 14	8-Oct-15	140.00	-0.38	-0.050	1.50

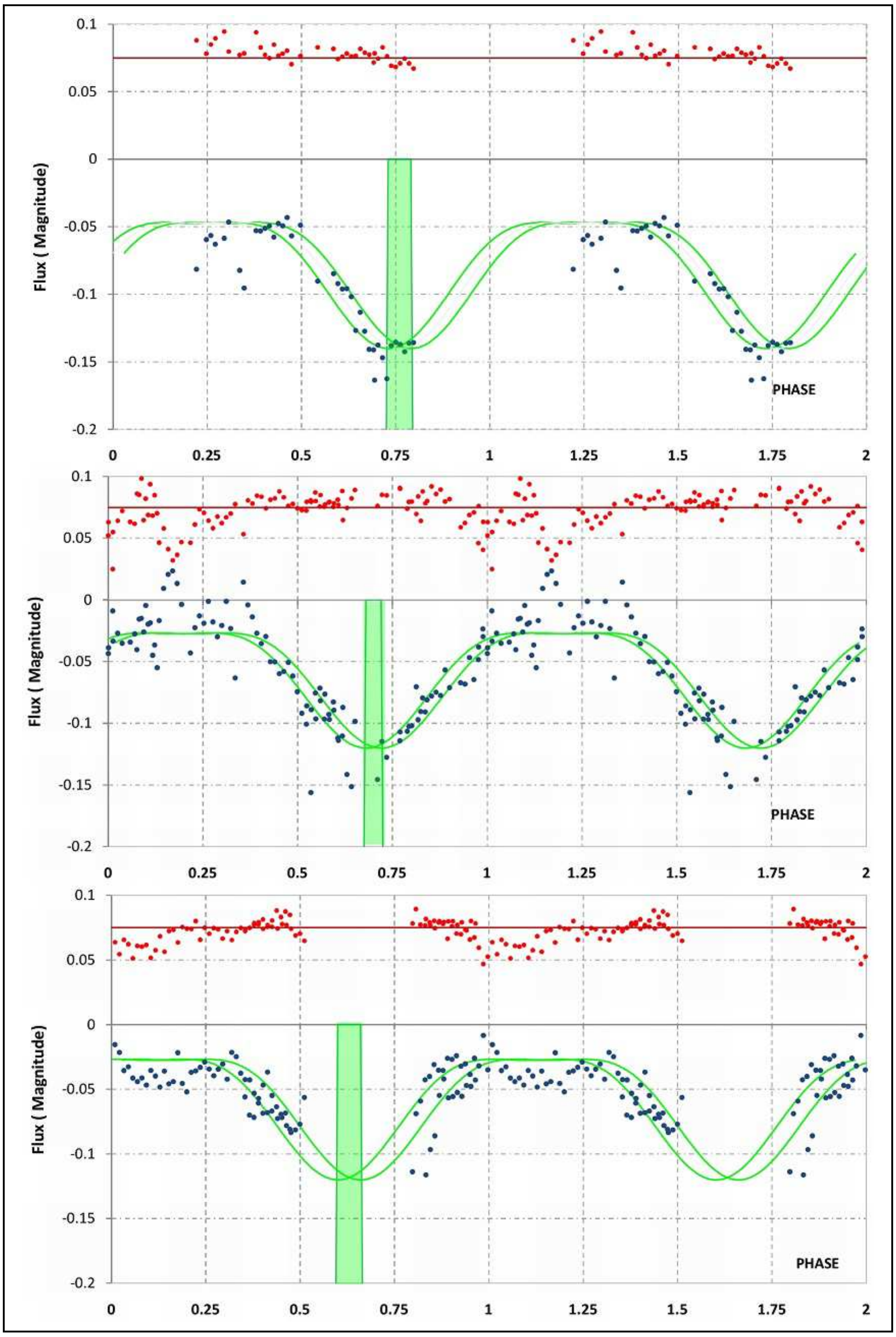

Figure 7, 8 & 9**:** *Folded light curve phase plots for J1723-2837 and the comparison star plotted on the same scale. From top to bottom are groups 5,6 & 7. Blue dots = J1723-2837. Red dots = comparison star. Green curves are nominal dip profiles to estimate the longitudinal centers. The green bars represent the centers of the dips while the widths of the bars are error estimates.*

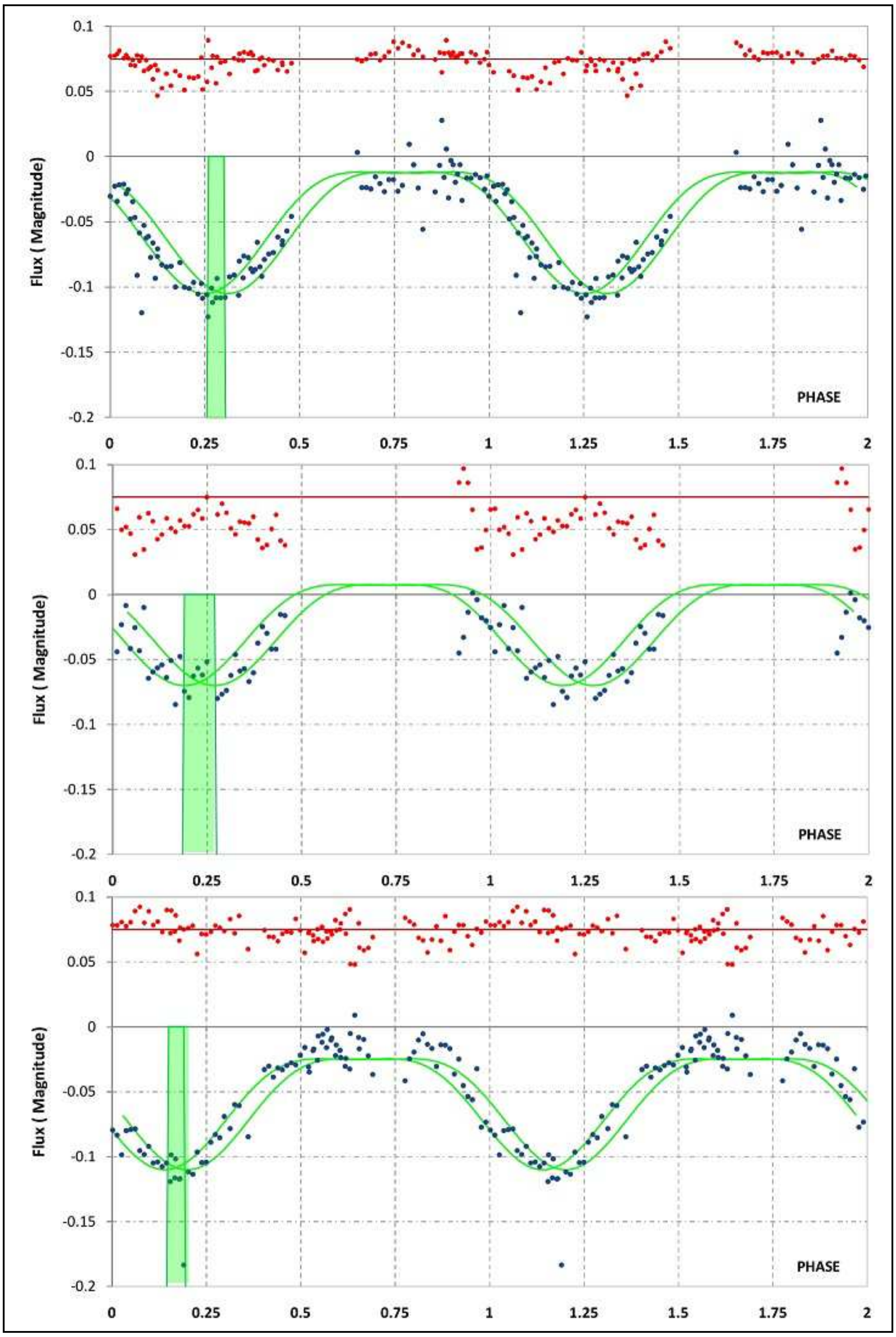

Figure 10, 11 & 12: *Folded light curve phase plots for J1723-2837 and the comparison star plotted on the same scale. From top to bottom are groups 8,9 & 10. Blue dots = J1723-2837. Red dots = comparison star. Green curves are nominal dip profiles to estimate the longitudinal centers. The green bars represent the centers of the dips while the widths of the bars are error estimates.*

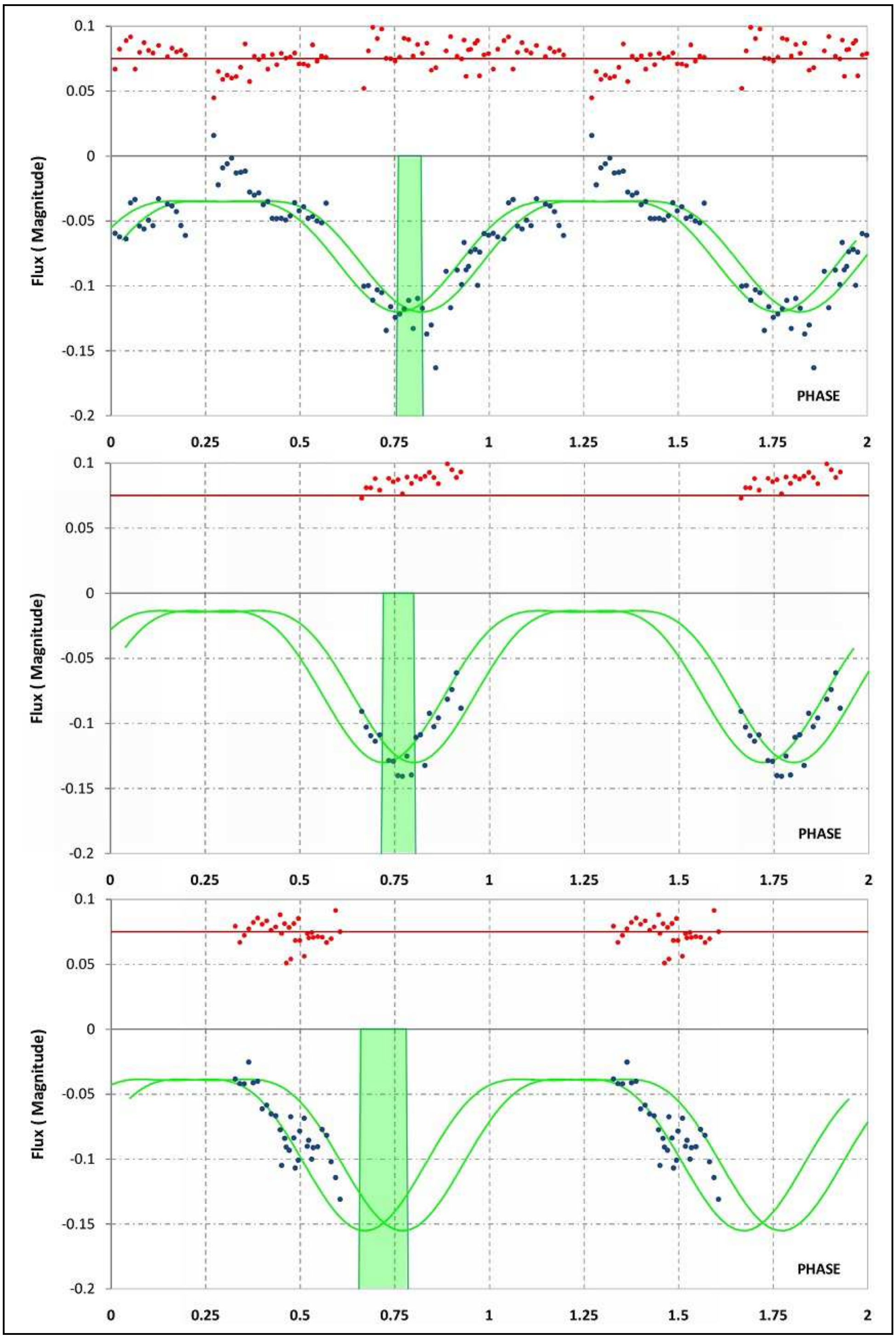

Figure 13, 14 & 15*: Folded light curve phase plots for J1723-2837 and the comparison star plotted on the same scale. From top to bottom are groups 11,12 & 13. Blue dots = J1723-2837. Red dots = comparison star. Green curves are nominal dip profiles to estimate the longitudinal centers. The green bars represent the centers of the dips while the widths of the bars are error estimates.*

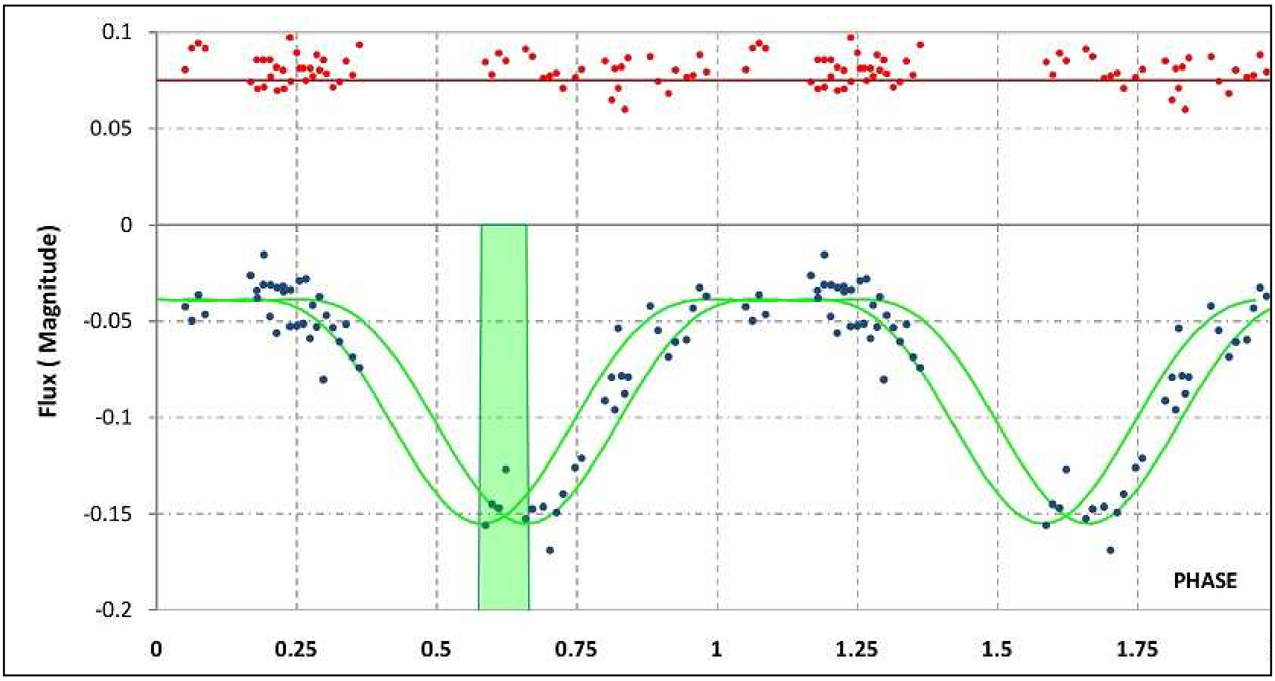

Figure 16 (GROUP 14)***:*** *Folded light curve phase plot for J1723-2837 and the comparison star plotted on the same scale. Blue dots = J1723-2837. Red dots = comparison star. Green curves are nominal dip profiles to estimate the longitudinal centers. The green bars represent the centers of the dips while the widths of the bars are error estimates.*

Sky Delights: A Crab named Cancer

Magda Streicher

The Cancer constellation has always interested me, not only because it is my "so-called" zodiacal, but also because the position of the constellation does represent a story regarding the position of the stars

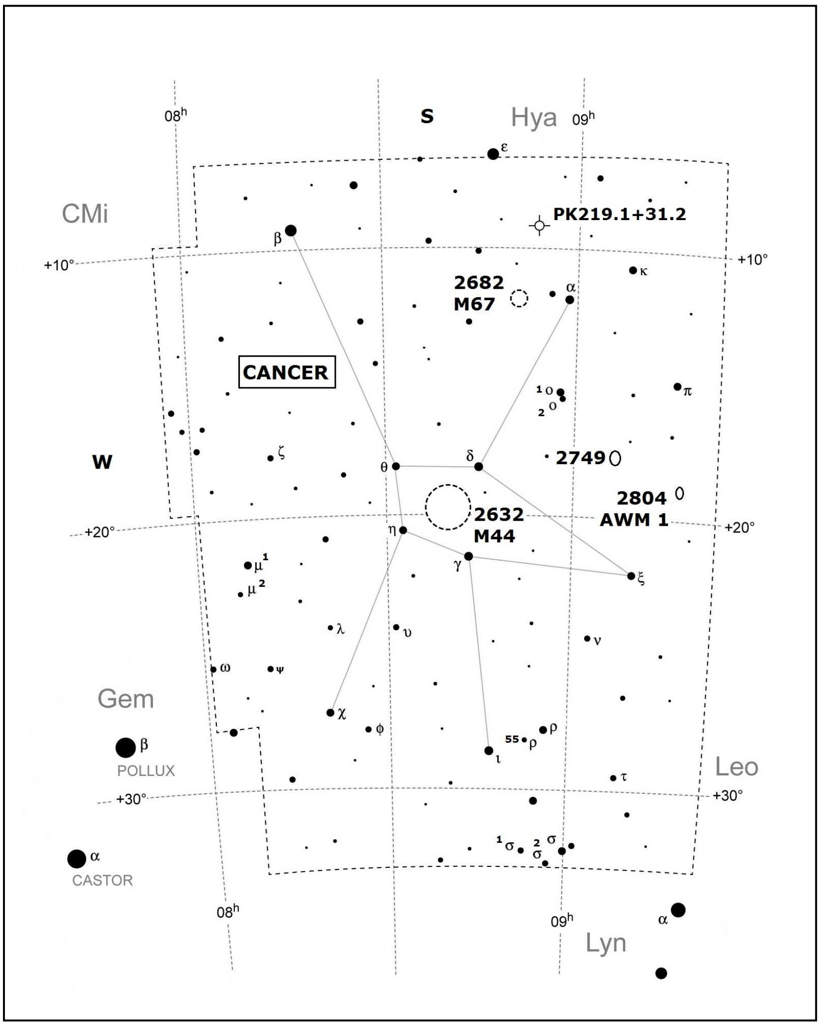

Fig 1. *Cancer Sky Map.*

The constellation was also known at some point as the Tortoise of Babylonia and was represented as such there and also in Egypt in 4000 BCE. An illuminated astronomical manuscript from the 12th century shows a "water beetle". In the *Albumasar* of 1489 it is a large crayfish, and in the 17th century it was seen as a lobster (*Star-Names and their Meanings*, R.H. Allen).

The Sun is in Cancer from middle July to early August; however, the solstice which was formerly here and gave the name to the tropic is now about 33 degrees westward near eta Geminorum. It is an ancient constellation with no stars brighter than magnitude 3.5, and regarded as the faintest of the 12 zodiacal constellations and the fourth smallest in the zodiac. Be that as it may, in a favourable, dark, star-laden night sky the image is outstanding, with the crab's faint little body marked, of course, by the well-known star cluster Messier 44.

In the southern part of the constellation a very faint planetary nebula, **PK 219.1+31.2**, (also known as **Abel 31**) is situated 2 degrees north of the constellation Hydra. Yes, sometimes we do get tired of observing all the faint objects, but in a favourable dark starry-sky it is rewarding to search them out. The planetary, however, is a large see-through glow, making it even more difficult to spot amongst faint stars. Perhaps a double star magnitude 7.5 and 8 a half a degree south of it can show the way with the very faint galaxy IC 523 situated 20' north-west. What can we expect to see? Well, first the round, large glow is somewhat irregular with no brightening towards the centre. The sad part is that you have to have at least a 12-inch telescope, and certainly the darkest star-filled night.

There is, however, light at the end of the tunnel with magnificent open clusters about further north. Only 1.8 degrees west of alpha Cancri is the star cluster **NGC 2682**, better known as Messier 67. The grouping is beautiful, with a brightness of 5.6, and sits in the shadow of the better known Crab cluster further south. The grouping can be seen through small telescopes as a mass of at least 100 stars. With larger telescopes it is a beautiful, rich swarm of various magnitude stars very irregular in shape.

Fig 2. *M 67, an open cluster (Dale Liebenberg)*

On the north-eastern edge an outstanding 7.8 star can be seen. However, the cluster contains plenty of yellow-coloured stars, which confirms that it is a very old cluster, more or less 4 billion years old, with a distance around 3 000 light years away and well above the plane of the Milky Way. Plenty of star strings splash out with a few dark lanes in between. The western side of the cluster contains fewer stars, with a somewhat broken-down impression.

Gottfried Koehler was the first to see M67 before Charles Messier independently rediscovered it in April 1780. But the cluster is famous for a good reason. “Robert Zimmerman wrote to determine the environment in which our Sun’s birthplace would be, is like a mote of dust that has been tossed into a pile of dirt. Despite these challenges astronomers are beginning to pin down a few key facts about the womb that produced our Sun. These parameters are even pointing to this open star cluster M67 as a place where the Sun might have been born. Though there are arguments *Bengt Gustafsson of the University of Uppsala Sweden* notes the possibility could be appealing.”

Astronomers have however found a planetary system of distant stars that in significant respects reminds them of the Sun's family of planets. One such is the planetary system, 55 Cancri, much like the Sun in age and size. It has a newly detected planet that resembles Jupiter in mass and, of greater importance, has an orbit almost the same as that of our planet Jupiter. In the dynamics of the solar system, Jupiter is pivotal in setting up conditions conducive to life on Earth. It is not inconceivable, astronomers say that somewhere between the Jupiter-class planet and its star orbits an Earth-like planet (NASA).

The constellation Cancer is mostly popular and best known for the bright cluster **NGC 2632**, also known as the Praesepe or Beehive, or best to call it Messier 44. The Greek astronomer Hipparcos listed M44 in his 2nd-century BC celestial catalogue as a little cloud. This cluster can be described in so many ways and is situated between the four feet of the crab and made up of several hundred stars, about 500 light years away. The middle area is relatively dense in starlight in which some double stars stand out. The grouping is best seen using a low-power eyepiece. M44 is probably two distinct clusters colliding with each other, indicating that its core is older than its surroundings according to researchers at the University of Leicester and Queen's University, Belfast. Also discovered is that the Beehive members will fly apart during the next ten million years or so (*Leicester-Belfast*).

Fig 3. *M44 (APOD, NASA)*

But not only is M44 a famous and well-known cluster; it also hosts a few galaxies (NGC 2647, NGC 2624 and IC 2390) in its midst. If you are really up to it, try to search for them – but no one would blame you if you didn't see your way clear to accepting the challenge.

The late Scott Houston made mention of the Beehive group of galaxies in his Deep Sky Wonders article in the March 1988 issue of *Sky and Telescope* magazine, page 340. "He was able to see a few through a 16-inch, and later in his 25-inch telescopes. However, you need a good star map to pinpoint the galaxies among the stars of M44. This bright star grouping is easily seen in a triangle with delta and gamma Cancri. The stars gamma and delta Cancri are named Asellus borealis and Asellus australis, with delta, an K-class star and at a distance of 160 light years and gamma, an A-class 280 light years distant.

Slightly further west a mass of galaxies can be searched out, but be aware: most of them vary from magnitude 12 to 14.5. A close pair of galaxies, IC 2422 and IC 2423, situated 3.5 degrees east of M44 is three billion light years away from us and house a pair of super massive black holes at its centres.

But the grouping that I want to discuss is east of M44: a group of seven galaxies in a 40’ field of view with **NGC 2749** the brightest. Since galaxies are called faint fuzzies, do not expect to find it without any effort. NGC 2749 is a round haze and the largest of the three, with a relatively bright core. NGC 2751 is towards the south and NGC 2752 north, both separate from NGC 2749 by less than 5’.

Another very interesting group of galaxies is situated 3 degrees north-east with the dominant magnitude 12.3 elliptical member **NGC 2804**. This group is also known as the AWM 1 Galaxy group. In 1977 this group caught the attention of Yerkes Observatory astronomers Elise Albert, Richard White and William Morgan during a search for giant elliptical galaxies that reside outside their usual environment. AWM is the first entry in a short list of 7 galaxy groups meeting the necessary criteria. AWM 1 contains about a dozen galaxies. NGC 2804 is the northern-most, with NGC 2809 more or less in the heart of the group 10’ south. NGC 2807 is situated only 3’ south of NGC 2809, but NGC 2806 could not be found. John Louis Dreyer, compiler of the NGC, logged NGC 2806 in 1876 using Lord Rosse’s 72-inch speculum metal reflector while making measurements of stars close to the galaxies. At this position, however, is a magnitude 15 star.

The most northern crab foot, so to speak, is indicated by the magnitude 4 iota Cancri 1. The primary magnitude 4.2 is yellow in colour with the magnitude 6.6 secondary slightly blue. The separation is 3.5” in a position angle of 307 degrees. It is a beautiful colourful pair easily seen in small amateur telescopes. The companion iota Cancri 2 is also a double star with spectra of KO and AB. Although the pair has magnitudes of 6 and 6.5, the separation is only 1.4” in position angle 3.16 degrees.

The crab constellation is surrounded by more galaxies than can be counted, but it stands on its little crab feet to show the observer a thing or two, so don’t let the crab scare you.

OBJECT	**TYPE**	**RA**	**DEC**	**MAG**	**SIZE**
PK 219.1+ 31.2	Planetary Nebula	08h54m.2	+08° 55′.3	12	980″
NGC 2682 Messier 67	Open Cluster	08h50m.4	+11° 49′.0	6.9	29′
NGC 2632 Messier 44	Open Cluster	08h40m.1	+19° 59′.0	3.1	95′
NGC 2749	Galaxy	09h05m.4	+18° 19′.0	11.8	1.8′x1. 7′
AWM 1 NGC 2804	Galaxy Group Galaxy	09h17m.2 09h16m.8	+20°02.8 +20° 11′.8	14 13.8	Field 15′ 2.2′x2′

On the Bookshelf

The aim here to try to get readers to share their experience of "good reads" of popular science writing by some of the world's leading scientists. These are not reviews, just comments and pointers to enjoyable and informative writing.

1 Seven Brief Lessons in Physics

This is a short little book, beautifully written by Carlo Rovelli, a theoretical physicist who has made significant contributions to the physics of space and time. He has worked in Italy and the US, and is currently directing the quantum gravity research group of the Centre de Physique Théorique in Marseille, France. Seven Brief Lessons on Physics was an instant number one bestseller in Italy and has been translated into twenty-four languages.

These lessons were written for those who know little or nothing about modern science. Together they provide a rapid overview of the most fascinating aspects of the great revolution that has occurred in physics in the twentieth century, and of the questions and mysteries which this revolution has opened up. Because science shows us how to better understand the world, but it also reveals to us just how vast is the extent of what is still not known.

The first lesson is dedicated to Albert Einstein's general theory of relativity, 'the most beautiful of theories'. The second to quantum mechanics, where the most baffling aspects of modern physics lurk. The third is dedicated to the cosmos: the architecture of the universe which we inhabit; the fourth to its elementary particles. The fifth deals with quantum gravity: the attempts which are underway to construct a synthesis of the major discoveries of the twentieth century. The sixth is on probability and the heat of black holes. The final section of the book returns to ourselves, and asks how it is possible to think about our existence in the light of the strange world described by physics.

It is available as an e-Book and as a hardback for under R200 - well worth it!

Case Rijsdijk

Book Review: Lost in the Stars: A. W. Roberts at the Crossroads of Mission, Science, and Race in South Africa 1883–1938

I.S. Glass

Author: Keith Snedegar

Lexington Books, Lanham, MD, USA

First edition 2015. ISBN 978-0-7391-9624-3 (Hard cover) 978-0-7391-9625-0 (electronic), pp xii+189

This is the biography of a remarkable person who achieved fame in both the scientific and the political life of South Africa. AW Roberts, though he came from a relatively poor Scottish family, was bright and received a good education. He grew up a liberal Presbyterian and was to spend most of his life educating, Europeanizing, and championing the rights of "native" South Africans. In middle age he came to represent their interests to a politically conservative regime that could not accept the direct involvement of black people.

He was a pioneer of serious amateur astronomy in South Africa and carved out an enviable reputation in the field of variable star studies, earning the respect of specialists in Europe and the United States of America. He published nearly a hundred papers in scientific journals. The book conveys how difficult it was to do work of this kind from the isolated and austere institution of Lovedale. However, he received encouragement from David

Gill, JKE Halm and Robert Innes at the Royal Observatory, Cape of Good Hope.

Lovedale was then the leading institution in black education. It attracted the young, bright and well-connected. Many of those who passed through his and its hands came later in life to occupy leading roles in national black intellectual movements. Amongst them was for example the pioneering black academic, ZK Matthews, the grandfather of the present Minister of Education, Naledi Pandor. It is interesting that he had to deal with the same problems that are encountered in country schools today, such as a tendency to "equate rote memory with learning". In 1925 there were student riots over food quality, with extensive damage to the facilities. Roberts, though something of a disciplinarian, was in favour of leniency towards the perpetrators. Because he was a lay teacher and a scientist, he was often regarded with suspicion by the missionaries who controlled the institution. Compared to these, he was liberal in his attitudes and opinions, though not irreligious.

Roberts was openly in favor of the franchise for blacks on the same basis as for whites, a very radical position for the time.

He received considerable recognition for his variable star work and was one of the founder members of the BAA in 1890. In 1896, he became a Fellow of the Royal Society of Edinburgh. He was recognized in South Africa by the award in 1899 of an honorary doctorate by the University of the Cape of Good Hope. His influence grew during these years and he was a founder member of S2A3 – the South African Association for the Advancement of Science. The Cape Astronomical Association was formed in (1912) with Roberts as one of the founder members. This later developed into ASSA.

Roberts became well-known in political circles both through his membership of educational committees and his activity in the South African Association for the Advancement of Science.

In 1920 he was appointed a member of the Native Affairs Commission, intended as an official channel of communication between the then government and the “native” population. He often found himself at odds with the other members, who tended to be much more conservative than him. Unfortunately, as time went on and governments changed, communication tended to flow in only one direction and he found himself having to justify the government’s unpalatable policies, particularly in land ownership matters. He was appointed a senator by JC Smuts, an amateur scientist himself, to be one of four who were intended to represent the interests of the non-white races. He was regarded as having their interests at heart in a sober and level-headed (i.e. politically acceptable) way. Not unexpectedly, he tended to become more conservative as he aged although even then he sometimes stood on the toes of those who had championed his appointment. Today however he would be regarded as patronizing.

By 1920 or so, Roberts’s observing became very sporadic and he ceased to work up his light curves for publication. Snedegar suggests that this was partly due to shyness on account of his lack of theoretical competence. The book lists the stars that Roberts observed, comprising miras, semi-regulars, Algol-type and classical cepheid variables, with a smattering of rarer types and stars found to be constant. As MNASSA readers will know, his observational notes found a final resting place at Boyden Observatory and have been digitized by ASSA members Brian Fraser and Tim Cooper.

Snedegar’s study is a *tour de force* of research into the political and scientific background of the South Africa in which Roberts lived and made his mark. For my own part I found it hard to put down, opening as it did for me many aspects of the scientific and political life that prevailed a century ago.

Colloquia and Seminars

These form an important part of a research facility, often as a sort of pre-publication discussion or a discussion of an individual’s current research, and as such it is virtually impossible to “publish” this material. However by recording the topics discussed in the form below does indicate to those, who are unable to attend, what current trends are and who has visited to do research: it keeps everyone ‘in the loop’ so to speak

Also included in this section are the colloquia/seminars at the SAAO, UWC and the Astrophysics, Cosmology and Gravity Centre at UCT, ACGC. Also included are the SAAO Astro-coffees which are 15-20min informal discussions on just about any topic including but not limited to: recent astro-ph papers, seminal/classic publications, education/outreach ideas and initiatives, preliminary results, student progress reports, conference/workshop feedback and skills-transfer.

UCT

Title: Extreme Astrophysics with a Robotic Radio Telescope
Speaker: Rob Fender (Oxford and UCT)
Date: 21 January
Time: 13h00
Venue: Astro Seminar Room R W James Building

Abstract: Over the past three years we have used a large fraction of time on the AMI-LA radio telescope array, operating at 15 GHz and located in Cambridge, UK, to conduct an intensive radio transients programme. As part of this programme we have fully automated the response of the telescope so that it responds directly to Swift burst alerts with no human intervention, providing the world's first robotic response by a radio telescope array. The programme was initially designed to focus on GRBs, an area in which it has been extremely successful, providing a very-early-time detection of reverse shocks and doubling the global rate of GRB radio detections. Robotic responses have also been made to bright bursts from flare stars and nearby black holes, providing the earliest-time radio detection of such events. The programme has been further broadened out to provide high-cadence long-term monitoring of other radio transients, including very exciting results on compact objects, supernovae and tidal disruption events. In this talk I shall present a summary of this highly successful programme, some of the science highlights from the past three years, and discuss how equivalent programmes in the SKA era might operate.

SAAO

Title: Revealing the binary interaction in the puzzling gamma-ray binary HESS J0632+057
Speaker: Yuki Moritani (Kavli IPMU, Japan)
Date: 4 February
Time: 11h00 – 12h00
Venue: 1896 Building

Abstract: The gamma-ray binaries, a relatively newly identified subclass of X-ray binaries, show variable emissions in a wide range of energy bands, from radio to the TeV gamma-rays. Currently, 5 systems are classified as gamma-ray binaries, among which 4 systems have the compact object of unknown nature, whilst their optical counterparts are well-known as massive stars (M > 10 M_sun) with circumstellar disks or strong stellar winds. Despite plenty of both theoretical and observational studies, the nature of the compact object is still under discussion for four systems. Hence themechanisms for particle acceleration and very high-energy emissions are still one of the big challenges of the this field. We have monitored gamma-ray binaries to probe the nature of the compact object and detailed binary interaction, focusing on the role of the massive star in the interaction. In particular, I'll show some results of our monitoring about HESS J0632+057 in the seminar. This system exhibits puzzling X-ray and gamma-ray light curves – during one orbital cycle, there are two outbursts apart from periastron and a “dip” around apastron. This makes it more difficult to study the system based on a simple model. Our optical spectroscopic monitoring, however, gives evidence that the compact object is a pulsar.

Title: Flare stars across the H-R diagram
Speaker: Luis Balona
Date: 11 February
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: Stars cooler than F5 have convective envelopes. Such stars develop surface magnetic fields due to dynamo action. This, in turn, allows starspots to develop and re-connection of magnetic field lines releases energy in the form of flares. On the other hand, stars hotter than F5 have radiative envelopes and magnetic fields are thought to be absent. Such stars do not have starspots nor flares. While this is our current understanding, high-precision photometric observations of A and B stars from the Kepler satellite show light variations which are most easily interpreted as starspots. Furthermore, flares are seen in many A stars. These flares cannot be attributed to a proposed cool companion. In this talk I present a summary of our current view of magnetic fields, spots and flares on stars and demonstrate that this view needs to be modified. Furthermore, I argue that far from being an attribute of mostly K and M stars, flare stars are a common property of all stars across the H-R diagram.

Astro-Coffee

Title: Fundamental limits of direction dependent calibration
Speaker: Dr Stefan Wijnholds ASTRON, R&D Department
Date: 28 January
Time: 13h00
Venue: 2nd floor auditorium SKA office, Pinelands

Abstract**:** Direction dependent (DD) calibration plays a crucial role in the data reduction process of modern radio interferometers and is essential to achieve high dynamic range imaging results. With modern algorithms being capable of estimating DD gains for hundreds of directions, one may get the impression that DD effects can be properly dealt with. In this talk, I will discuss fundamental limits of DD calibration imposed by the mathematics of the problem as well as by availability of radio astronomical calibration sources. Based on these considerations, I show that proper instrument design remains essential to achieve the envisaged performance of modern radio interferometers.

Title: Dying young and frustrated? A low radio frequency view of 'young' radio galaxies

Speaker: Joe Callingham (University of Sydney)
Date: 3 February
Time: 13h00
Venue: 2nd floor auditorium SKA office, Pinelands

Abstract: Gigahertz-peaked spectrum (GPS) and compact steep spectrum (CSS) sources sources have been hypothesised to represent an early stage of radio galaxy evolution. However, such an interpretation is contentious as it is possible that these sources are not young but are confined to a small spatial scales due to a high density medium. One of the main reasons there has not been resolution between these two competing hypotheses is because the absorption mechanism responsible for the turnover in their radio spectra still ambiguous since the spectra of these sources below the turnover has not been well enough sampled to date.

The Murchison Widefield Array (MWA) has conducted an all-sky survey at low radio frequencies (73 to 230 MHz). This survey provides an unparalleled number of GPS and CSS sources with broad spectral coverage below the turnover. In this talk I will outline the survey, present results of spectral modelling of these sources and discuss the impact such a frequency domain has on our understanding of the absorption mechanism. In particular, I will highlight the modelling of an extreme GPS source that has the steepest known slope below the turnover and smallest spectral width of any known GPS source. I will demonstrate that the MWA all-sky survey has identified a large population of GPS sources that have ceased activity, and will show that a portion of the ultra-steep spectrum source population will be composed of GPS sources in a relic phase. Finally, I will conclude on what impact MeerKAT and the MIGHTEE Survey will have on understanding these sources.

UWC

Title: Planck probes the standard model(s)
Speaker: Prof. Andrew Jaffe (Imperial)
Date**:** 5 February
Time**:** 14h00
Venue: New Physics Building, UWC

Abstract: The recent results from the Planck Satellite, combined with other astrophysical data, allow us to build a remarkable and simple description of the history and contents of the Universe. I will give an overview of these results and their implications for the Lambda Cold Dark Matter standard model of cosmology, including a discussion of more esoteric extensions such as the possibility of non-trivial large-scale geometry or topology. I will also briefly discuss recent observations of CMB polarization from Polarbear (as a team member) and BICEP2 (as an outsider), and their implications for these models when combined with polarisation data from Planck. The standard cosmological model is, however, not complete, nor are the current data completely consistent between different experiments, even those using the same underlying data. I will also highlight some of these inconsistencies and whether they can be explained by statistical flukes, systematic errors in the analyses of the various datasets, or whether new physics beyond the standard models of cosmology and particle physics might be required.

Editor's Note: This seminar was also presented as an ACGC seminar on 16 February

Title: Observing the reservoir for star formation
Speaker: Dr. Natasha Maddox (ASTRON)
Date: 12 February
Time: 14h00
Venue: New Physics Building, UWC

Abstract: While the star formation density over cosmic time is well studied, very little is known about neutral hydrogen, the fuel for star formation, over the same epoch. I'll give an overview of current observations, look ahead to upcoming surveys in the era of the SKA, and motivate why these efforts are essential for a complete picture of galaxy formation and evolution.

ACGC (Joint UCT/UWC seminar)

Title: Is dark matter self-annihilation causing the excess gamma rays from the Galactic Centre?
Speaker: Dr Chris Gordon (University of Canterbury, NZ)
Date: 26 January
Time: 12h00
Venue: MAM-202 Maths Building, UCT

Abstract: Recently excess GeV gamma rays have been observed coming from the Galactic Center by the Fermi large area telescope. The three main candidates are an unresolved population of millisecond pulsars, cosmic-rays interacting with the interstellar medium, and dark matter self-annihilation. I will discuss the evidence for and against these three possibilities.

Title: From colliding black holes to gravitational waves
Speaker: Dr Bishop Mongwane (UCT)
Date**:** 23 February
Time**:** 12h00
Venue**:** MAM-110 Maths Building, UCT

Abstract: In this informal talk, I will spend +/- 30 minutes to summarize the mathematics of binary black hole collision from a numerical relativity viewpoint and then we can spend the remaining time discussing the LIGO discovery and implications for cosmology and modified gravity.

AIMS

Title: Weak Lensing analysis with Bayesian Hierarchical Modelling
Speaker: Prof. Andrew Jaffe (Imperial)
Date**:** 1 February
Time**:** 12h00
Venue**:** Upstairs Hall, AIMS

Abstract: We develop a Bayesian hierarchical modelling approach for cosmic shear power spectrum inference, jointly sampling from the posterior distribution of the cosmic shear field and its (tomographic) power spectra. I will review the cosmological uses of weak lensing as a probe of large-scale structure and as a way of measuring cosmological parameters, and apply the tools of Bayesian hierarchical modelling to the problem.

Inference of the shear power spectrum is a powerful intermediate product for a cosmic shear analysis, since it requires very few model assumptions and can be used to perform inference on a wide range of cosmological models {**a posteriori**} without loss of information. We show that joint posterior for the shear map and power spectrum can be sampled effectively by Gibbs sampling, iteratively drawing samples from the map and power spectrum, each conditional on the other. This approach neatly

circumvents difficulties associated with complicated survey geometry and masks that plague frequentist power spectrum estimators, since the power spectrum inference provides prior information about the field in masked regions at every sampling step. We demonstrate this approach for inference of tomographic shear E-mode, B-mode and EB-cr oss power spectra from a simulated galaxy shear catalogue with a number of important features; galaxies distributed on the sky and in redshift with photometric redshift uncertainties, realistic random ellipticity noise for every galaxy and a complicated survey mask. The obtained posterior distributions for the tomographic power spectrum coefficients recover the underlying simulated power spectra for both E- and B-modes.

Largely based on arXiv:1505.07840

Tailpiece: Einstein would not have been surprised!

Suddenly Einstein … handed me a cable that he took from the window-sill with the words, "This may interest you." It was Eddington's cable with the results of the famous eclipse expedition. Full of enthusiasm, I exclaimed, "How wonderful! This is almost the value you calculated!" Quite unperturbed, he remarked, "I knew that the theory is correct. Did you doubt it?" I answered, "No, of course not. But what would you have said if there had been no confirmation like this?" He replied, "Da könnt' mir halt der liebe Gott leid tun. Die Theorie stimmt doch" ("I would have had to pity our dear God. The theory is correct all the same"). Here he said, as he often did, "God" instead of "Nature."« – Ilse Rosenthal-Schneider: *Reality and scientific truth. Discussions with Einstein, von Laue and Planck*. Detroit: Wayne State UP, 1980, p.74.

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