News from the Society for Astronomical Sciences

Vol. 10 No. 2 (April, 2012)

SAS and AAVSO: together again for 2012 Symposium

The 2012 Symposium promises to be a path-breaking gathering, a joint meeting of the Society for Astronomical Sciences and the American Association of Variable Star Observers. The paper presentations have been selected, the poster papers accepted, the workshops prepared, and the Sponsors and Vendors are bringing their latest offerings to display. Everything is ready for the annual gathering in Big Bear, CA by the gang of astronomers who are leading the way in small-telescope science. (We've even warned the "Teddy Bear" to be prepared for the breakfast crowd).

The planned agenda of activities is listed on the SAS website.

Tuesday, May 22 features two half-day technical workshops, described in more detail below. In the morning, Dr. John C. Martin will teach "Small-Telescope Spectroscopy", and in the afternoon Dr. Aaron Price will teach "Photometry Analysis with VPHOT".

Technical papers and posters will be presented on Wednesday May 23 and Thursday May 24. An AAVSO member's meeting will be held on Wdnesday evening.

Thursday evening is highlighted by the annual banquet, and our keynote speaker, Ms. Dava Sobel.

Registration information for the Symposium and the Workshops is available on the SAS website (www.SocAstroSci.org).

If you haven't registered yet, we suggest that you move fast: spaces are filling up at a rapid pace.

2012 Keynote Speaker: Ms. Dava Sobel

The Program Committee is delighted to announce that our keynote speaker will be Ms. Dava Sobel. Ms. Sobel is a former New York Times science reporter, and is the author of *Longitude*, *Galileo's Daughter*, *The Planets*, and *A More Perfect Heaven*.

In her forty years as a science journalist she has written for many magazines, including Audubon, Discover, Life and The New Yorker, served as a contributing editor to Harvard Magazine and Omni, and co-authored five books, including *Is Anyone Out There?* with astronomer Frank Drake.

Ms. Sobel received the 2001 Individual Public Service Award from the National Science Board "for fostering awareness of science and technology among broad segments of the general public." Also in 2001, the Boston Museum of Science gave her its prestigious Bradford Washburn Award for her "outstanding contribution toward public understanding of science, appreciation of its fascination, and the vital role it plays in all our lives." In October 2004, in London, Ms. Sobel received the Harrison Medal from the Worshipful Company of Clockmakers, in recognition of her contribution to increasing awareness of the science of horology by the general public, through her writing and lecturing. In 2008 the Astronomical Society of the Pacific gave her its Klumpke-Roberts Award for "increasing the public understanding and appreciation of astronomy."

She will be available to sign your copies of her books after the lecture.

Photo by Libi Pedder

Tim Puckett is selected for 2012 Chambliss Award

The American Astronomical Society has awarded Tim Puckett the 2012 Chambliss Award for achievement in astronomical research made by an amateur. This is in recognition of his Puckett Observatory supernova search program that has discovered more than 200 supernovae.

Many of you also know Tim as the representative of Apogee Instruments, who has participated in recent Symposia as part of Apogee's sponsorship of SAS.

Congratulations to Tim for this wonderful recognition of his 15 years of dedication to the search for supernovae!

SAS-2012 Photometry and Spectroscopy Workshops

The SAS-2012 Symposium will feature two half-day workshops, to help participants learn new skills and become familiar with the tools and procedures of astronomical Spectroscopy and Photometry. The workshops will be held on Tuesday, May 22, 2012. Dr. Martin's Spectroscopy workshop will be held in the morning, and Dr. Price's Photometry workshop will be held in the afternoon. Check the SAS website Registration page for details on how to register for these workshops.

"Spectroscopy with Small Telescopes" workshop will be presented by Dr. John C. Martin.

The field of spectroscopy is a new frontier now available for amateur astronomers to explore. In the right context, it is no more complex than the long practiced methods of photometry. There are also a wide variety of projects better suited for small telescopes over large telescopes. In this workshop, Dr. Martin will be sharing his expertise with spectroscopy and small telescopes to give the participants a basic working knowledge (independent of any particular hardware or software setup) of how spectrographs work, how to optimize their efficiency on a small telescope, and how to reduce and analyze the data that they produce. He will also discuss projects for those who have the equipment as well as databases of spectroscopic data that are publicly available for data mining.

Dr. Martin is an Assistant Professor of Astronomy-Physics at the University of Illinois Springfield where he is also the director of a community-supported research observatory. He earned his PhD from Case Western Reserve University and has research interests in spectroscopy, the evolution of massive and hot stars, and small telescopes. His most recently published work has used the Hubble Space Telescope and Gemini South Telescope to observe the massive star Eta Carinae. He is also the recipient of a National Science Foundation grant to study the variability of massive stars and supernova imposters in the local group of galaxies.

"Using the Photometry Analysis Package VPHOT" workshop will be presented by Dr. Aaron Price.

VPHOT is AAVSO's on-line photometry analysis software, which is freely available to all AAVSO members. It has an intuitive interface on the surface, yet behind the scenes it has a powerful photometry algorithm designed by Dr. Arne Henden. It performs aperture photometry, searches for new variable stars across the full field, gives a wide variety of diagnostic plots, and writes standard output files ready for direct submission to the AAVSO. It will work on your own images, or images taken through AAVSOnet, the AAVSO network of robotic telescopes. It can be used for any variable object, including minor planets.

This demonstration will walk the audience through the most common uses of the software and will come with a printed tutorial handout. VPhot is available for free to AAVSO members and was originally written by Geir Klingenberg.

Dr. Price is the Assistant Director of the AAVSO. He has a BS in astronomy and a Ph.D. in STEM Education from Tufts University. He is active in the astronomy outreach community as a U.S. committee member for the International Year of Astronomy and creator of the Slacker Astronomy podcast.

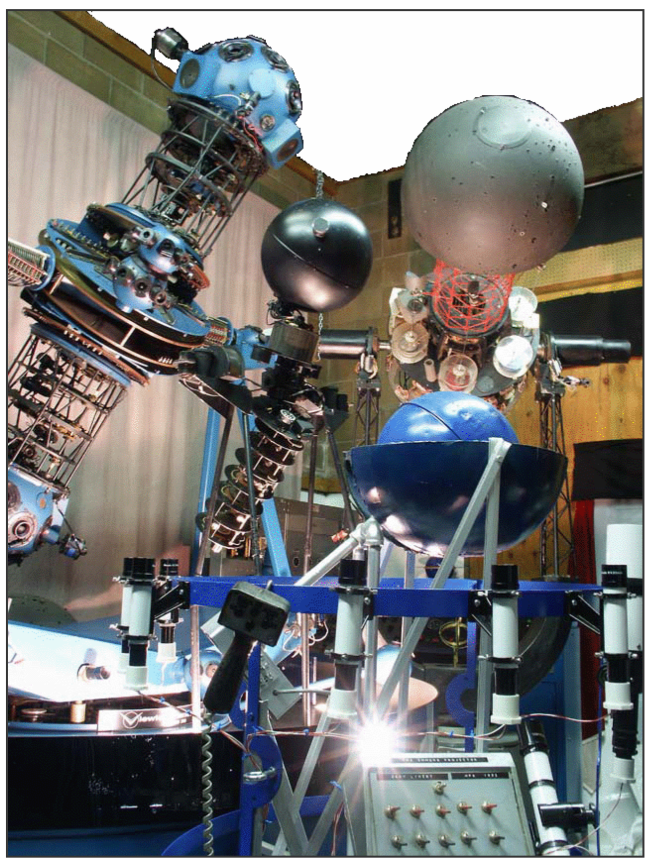
Something to See While You're at Big Bear

The universe is filled with strange objects and wonderful phenomena: exoplanets, cataclysmic variable stars, binary asteroids and black holes (all of which are likely to play supporting roles in the SAS Symposium). But there is nothing in the natural world that is as remarkable as the ability of the human mind to conceive of new ways to invest your energy, money, and time on planet Earth.

Here is something that is just too extraordinarily weird and wonderful to miss out on: a collection of old planetarium projectors and other scientific, astronomical, and historical ... uhm ... treasures.

Your editors are grateful to Gene Lucas for bringing to our attention the "Planetarium Projector and Science Museum" in Big Bear City. This is apparently one of Big Bear's better-kept secrets (that is to say that despite spending quite a bit of time up there, we had never heard of it, nor ever imagined anything like it).

If you would like to learn more about this collection, point your browser toward
http://planetariummuseum.org/index.html



Technical Note:

Mid-Eclipse Brightening During Eclipses of Binaries

by Lee Snyder
President and Co-Chair SAS

When an increase in the brightness of the light curve occurs during an eclipse it only becomes apparent when the magnitude is plotted versus the phase of the curve. The brightening occurs only during an eclipse of the system, hence the descriptive expression Eclipse Brightening. A good example of the brightening is shown in Figure 1.

The eclipse brightening was addressed in a paper published in the SAS Proceedings, May 2008. At that time, eleven binaries with eclipse brightening features were located in the literature and seven discovered in unpublished light curve data. These eighteen eclipsing binaries were used then to analyze and apply the refracted electromagnetic radiation "prism effect", illustrated in Figure 2, as the most probable explanation for the brightening feature.

Two other phenomena have been suggested as possible causes: gravitational lensing and microlensing. Both of these cause magnitude brightening, but both require large distances – on the order of several parsecs – between the objects to create the effect. We can therefore rule them out as the cause of the brightening occurring in eclipsing binaries, because of the close proximity of the two stars. This article therefore will only concentrate on the "prism effect" explanation.

The 2008 SAS paper listed eighteen binary systems displaying the brightening feature. This list and some information about each system is repeated in Table 1. I have added two columns to this Table, "Spectral Types" (A – B) and "Prism Effect Thru SP Type" to help identify physical properties of the stars that might be related to the eclipse brightening.

When all the factors are considered eclipsing brightening occurs in all types of binary systems, and it is observed in all spectral bands (U B V and R). I have not found any light curve constructed using the I filter with the brightening feature. The brightening occurs during

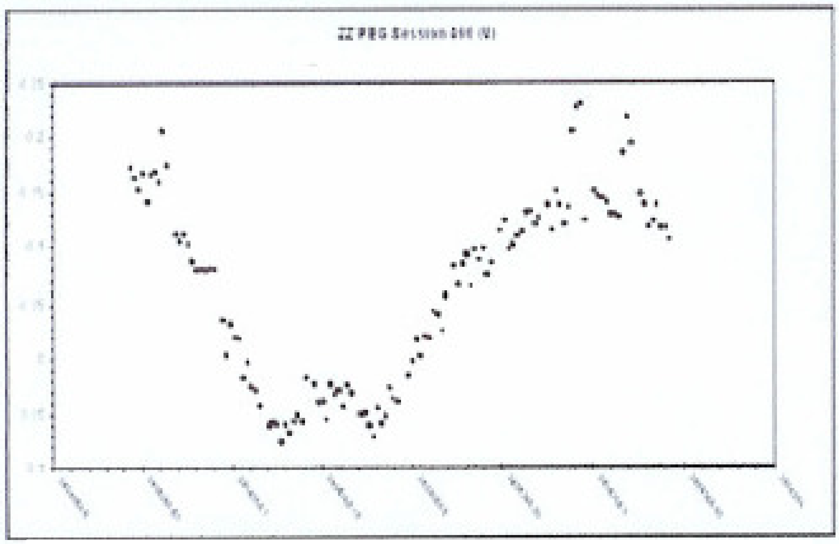


Figure 1: Example of mid-eclipse brightening, from data acquired by J. Lapham, ZZ Pegasii October 21, 2007

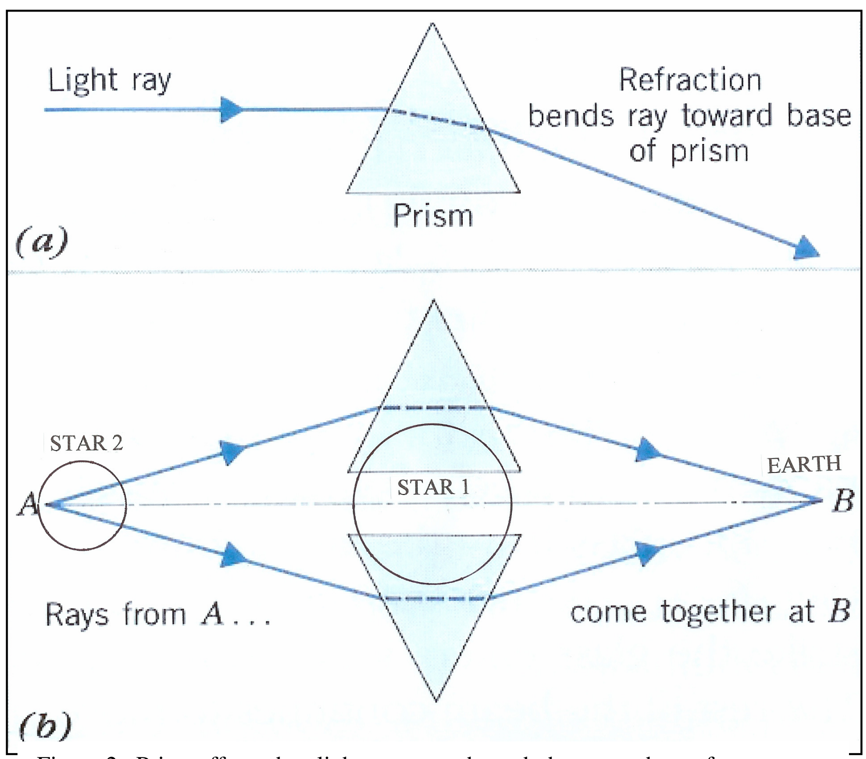


Figure 2: Prism effect when light rays pass through the atmosphere of a star. Rays are refracted and refocused. Modified drawing from Zelllk 1991.

Table 1: Systems displaying the mid-eclipse brightening effect

Binary System	Filter Used	Binary Type	Amplitude of Brightening (mag)	Brightening in Pri. or Sec. Eclipse	Brightening Occurred at Mid-Eclipse?	Spectral Types (SP) (A-B)	Prism Effect Occurred Thru Atmosphere of SP Type
RT AND	B	SD		SEC	N	F8V+KOIV	F8V
V417 AQL	U	OC		PRI	N	G2V+	
EPSILONAURIGA	V	D	2.2	SEC	N		
SZ CAM	V	D		SEC	N	BOII-III+B1	BOII
V382 CYG	V	OC	0.025	SEC	Y	O7.5+O9	O7.5
V739 CYG	B	OC		SEC	N		
AK HER	V	EW		SEC	Y	F2+F7	F2
HS HER	V	OC		SEC	Y	B6III+A4	B6III
AR LAC	V	D		SEC	Y	G5IV+KOIV	G5IV
RV OPH	B	SD		PRI	Y	A0+G5:	G5:
BM ORI	V	SD		PRI	N	B2V+A5:	A5:
BB PEG	R	OC		PRI	N	F8+	
EE PEG	B	D		SEC	N	A3V+F4:	A3V
ZZ PEG	V	OC	0.06	SEC	Y	A2:+K1:	A2:
V432 PER	V	SD		SEC	Y	K3+GI	K3
ZETA PHE	B	D		SEC	N	B7:+A0:	B7:
AW UMA	V	C	0.02	SEC	N	F0+F2	FO
TY UMA	V	OC		PRI	N	FO:+F7	F7

both primary and secondary eclipse and it does not always occur precisely at mid-eclipse.

I added the spectral types of each binary star to determine if the atmosphere of the star which eclipses and acts as a lens, refracting the electromagnetic radiation of the eclipsed star, might be an important parameter of this phenomenon. The brightening only occurs during total eclipse, and it is conceivable that the "lensed" radiation might be affected differently by radiative versus convective stars. The temperature demarcation between radiative and convective stars is ~ 7200ºK, therefore the spectral type delimit is ~ F0. For radiative stars most of the incident energy from the companion star is re-radiated. For convective stars approximately half of the incident energy is redistributed and maintained around the star. It could therefore be a possibility that the atmosphere of one type of star would affect the prism – and hence the brightening effect – differently than the other type. However, as shown in Table 1, the spectral type had no apparent influence on the existence of the brightening effect since it is observed with rays passing thru the atmosphere of both early and late spectral types.

The brightening is observed in all binary types, in all filters used, during both primary and secondary eclipses, at any time during the eclipse; and the spectral types of the stars seems to be unimportant. The one factor that has to be present is for the eclipse to be total (although it is curious that the "brightening bump does not always occur at precisely mid-eclipse).

I Kudzej, of the Humenne People Observatory in Czechoslovakia, has used the coefficients of refraction mathematically to compute the rays in the atmosphere of the eclipsing star. He determined that the refracted rays form a ring which at the moment of total eclipse generates an additional radiation in the form of a bump in the light curve.

In conclusion it can be assumed that eclipse brightening happens in every eclipsing binary system when a nearly-central total eclipse occurs. Due to the focusing aspect of the prism effect the heliocentric location of your equipment would be critical in determining the brightening results in the obtained light curve. It is there when all the agents are present. If and when you acquire a lightcurve that shows the mid-eclipse brightening, please share your data with the author.

For the references to Table 1 and this article contact the author at

committee@socastrosci.org

A piece of astronomical history:

Once upon a time, the Paris Observatory and Greenwich competed for ownership of the Prime Meridian. You can still find emblems of the meridian line extended throughout the streets of Paris, such as this one embedded in a sidewalk ("Arago" was the name of the Paris Observatory director). The next time you are in Paris, search out and follow them like you are a character in a Dan Brown novel. Alas, the French did not realize how the economic forces were stacked against them, and London eventually got the Prime Meridian. Photo & caption © Bob Stephens.

Technical Note:

Lunar Impact Monitoring 2012: The ALPO-LMIS and the upcoming LADEE mission

by Brian Cudnik
ALPO Lunar Meteoritic Impact Search Coordinator

For over twelve years, amateur and professional astronomers have been monitoring the moon regularly for the tell-tale point-like flashes of impacting meteoroids. This endeavor started with my own visual sighting of a lunar Leonid meteor impacting the dark hemisphere of the waxing gibbous Moon on 18 November 1999 (UT). Soon after that, six additional impact observations were reported, bringing the total number of scientifically confirmed lunar Leonid meteors to seven. Although my observation was made visually with a 14-inch f/11 Cassegrain at 98X, the others were recorded by video. Since then, the Association of Lunar and Planetary Observers (ALPO) has established the Lunar Meteoritic Impact Search (LMIS) section, for which I have served as coordinator since early 2000. We have logged nearly 100 lunar meteor impact candidates.

Unlike atmospheric meteors, which take up to several seconds to burn up in Earth's atmosphere and take on the appearance of "shooting" or "falling" stars, lunar meteoroids produce a very quick flash as they smash into the lunar surface, unhindered by any atmosphere. The energy of a lunar meteor is dispersed in a matter of milliseconds, compared to seconds for the average terrestrial meteor. This makes monitoring the moon visually for lunar meteor activities a severe challenge visually but it can be done if steps are taken to ensure alertness at the eyepiece.

Just like on Earth, the frequency of occurrence of lunar meteors goes up and down with the occurrence of the annual meteor showers. Although the Leonids provided the ideal combination of high numbers and high impact velocity, the high numbers lasted only a few years centered on 1999, and they have since returned to their normal levels of ZHR ≈ 20. The Perseids and the Geminids, the two best annual meteor showers in the northern hemisphere, now provide the best opportunities to observe lunar meteor o,[acts – when the moon is favorably placed.

ALPO-LMIS has worked with two moon missions that impacted our satellite, the SMART probe which impacted the moon in September 2006; and the LCROSS satellite pair which impacted the polar region of the moon in October 2009. No definitive impact phenomena (flash and / or plume) was seen in either mission, with one exception in 2006 (this is highlighted on the ALPO-LMIS webpage in the archives). Another opportunity to work with a lunar mission has presented itself. This is with a mission called LADEE ("Lah-Dee", not "Lay-Dee"), which stands for Lunar Atmosphere and Dust Environment Explorer. I am working with Brian Day of NASA Ames Research Center in California to coordinate a global network of amateur astronomers to observe the Moon during the August 2013 Perseid annual shower, to look for impact flashes that can be correlated to increases in the dust environment of low lunar orbit.

LADEE is scheduled to launch in May 2013 from Wallops Flight Facility, Wallops Island, Virginia atop a Minotaur V launch vehicle. The spacecraft will take 30 days to travel to the moon, 30 days for checkout, and 100 days for science operation which includes the time of the Perseid maximum. The objective of the mission is to orbit the moon to characterize the atmosphere and lunar dust environment.

For more information about the Lunar Meteoritic Impact Search section, visit

www.alpoastronomy.org/lunarupload/lunimpacts.htm.

For more information about the LADEE mission, visit

http://www.nasa.gov/mission_pages/LADEE/main/

LADEE Propulsion System
James Bell examines the integrated propulsion system for LADEE, the Lunar Atmosphere and Dust Environment Explorer in a cleanroom at NASA's Ames Research Center. The propulsion system was developed by Space Systems/Loral for the Ames-managed mission. The LADEE spacecraft primary structure can be seen in the background to the left. LADEE will gather detailed information about conditions near the lunar surface and environmental influences on lunar dust. A thorough understanding of these influences will help researchers predict how future lunar exploration may shape the moon's environment and how the environment may affect future explorers. It also will help scientists understand other planetary bodies with exospheres, or very thin atmospheres, like the moon. Photo Credit: NASA Ames Research Center / Dominic Hart

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Small-Telescope Astronomical Science in the News
January - March 2012

compiled by Bob Buchheim

One of the foundational themes of the Society for Astronomical Sciences is that astronomical research is not the sole province of giant telescopes. A variety of topics can be effectively investigated with small telescopes and modest instrumentation that are well within the reach of backyard scientists and college observatories. Indeed, there are some projects where the much-needed data can only be gathered by small telescopes, because the targets are bright and the projects require extended observing runs. This quarter's perusal of research publications that are based on observations with telescopes smaller than one meter aperture (mostly less than half-meter) touches on asteroids, binary *and variable stars, and distant galaxies. There is a whole universe out there, awaiting study with your small telescope!*

Binary Asteroid Population. 2. Anisotropic Distribution of Orbit Poles of Small, Inner Main-Belt Binaries.
by Pravec, P., et al
Icarus v.218 (2012)

The "et al" in the author list includes some well-respected professional astronomers with expertise in asteroids who are good friends of the SAS (P. Pravec, A. Harris, D. Terrell) as well as quite a few amateur-astronomer researchers whom you may recognize: Don Pray, David Higgins, Ron Durkee, Robert Stephens, Ron Dyvig, Brian Warner, and Jim Brinsfield.

This work is an impressive "next step" in the interpretation of asteroid lightcurves. Amateur researchers are now providing high-quality lightcurves (with dense photometric time series, complete coverage of the entire rotation period, and differential photometry errors of just a few hundredths of a magnitude), which can provide excellent determination of the asteroid's rotation period and phase curve parameters (H, G).

These lightcurves may also contain "oddities", brief dips of a tenth of a magnitude or so, that do not repeat with the asteroid's rotation period, but which do repeat at their own characteristic period – and some of these represent mutual events (eclipses, transits, occultations) of two bodies in a binary asteroid system. Seeing just one or two such "oddities" in the lightcurve of a single apparition is, well, odd and interesting, but not diagnostic of a binary asteroid. If the oddity is seen on multiple apparitions, and the properties of the brightness dip (timing, duration, etc.) are consistent between two or more apparitions, then it not only offers compelling evidence of the binary nature of the asteroid, but also enables the analyst to make good estimates of the orbital elements of the binary system. High-quality lightcurves can contain evidence of the rotation periods of both asteroids (they may not be synchronous), and even hints of a third body in the system.

From a scientific standpoint, the key conclusions of this report are that lightcurves can, indeed, be used to verify the suspected binary-asteroid characterization; and that – importantly – the orbital planes of these binary asteroid systems all lie quite close to the plane of the ecliptic. This provides an observational constraint on theories of the formation and evolution of binary-asteroid systems.

From a backyard-scientist perspective, I infer these important lessons: (1) do strive for excellent differential-photometry accuracy, so that the detailed shape of the lightcurve is observed; (2) do place your lightcurve data into ALCDEF, so that it can be combined with data from other apparitions, and (3) don't blithely delete or censor data just because it "doesn't fit" with the expected lightcurve.

Modern Observations of Hubble's First-discovered Cepheid in M31
by M. Templeton, A. Henden, W. Goss, S. Smith, R. Sabo, G. Walker, R. Buchheim, G. Belcheva, T. Crawford, M. Cook, S. Dvorak, B. Harris
Publ Astron. Soc. Pacific, v. 123, n. 910 (Dec 2011) p. 1374

I've listed all of the authors, since many of you will recognize some (or all) of them.

You all remember the history story: Dr. Edwin Hubble used the largest telescopes in the world (the Mt. Wilson 60- and 100-inch) to measure the lightcurves of Cepheid variables in external galaxies, and used this data to prove that they were, indeed, distant "island universes". At the 2009 SAS Symposium, Dr. Arne Henden mentioned an interesting comparison of technologies. Dr. Hubble's "detector" was a glass photographic plate, with quantum efficiency of about 2%. Today's amateur CCD has quantum efficiency about 30 times higher, which suggests that a much smaller telescope (say, 60/sqrt(30) ≈ 11 inches) might be able to make comparable measurements.

Indeed, the 11 observers who participated in the project, some with quite modest telescopes, were able to map the lightcurve of Hubble's first Cepheid in M31, something which was last done over 50 years ago.

There are several important aspects of this project, but perhaps the most compelling is that today's "backyard scientist" is capable of quite remarkable observations and measurements, which have essential value to astronomy.

Absolute photometry of small main-belt asteroids in 2007–2009
by V. Chiorny, A. Gala´d, P. Pravec, P. Kuˇsnira´k, K. Hornoch, ˇS. Gajdoˇs, L. Kornoˇs, J. Vila´ gi, M. Husa´ rik, Z. Kaˇnuchova´, Z. Kriˇsandova´, D. Higgins, D.P. Pray, R. Durkee, R. Dyvig, V. Reddy, J. Oey, F. Marchis, R.D. Stephens
Planetary and Space Science 59 (2011) 1482–1489

I've listed all of the authors of this paper, because many of you will recognize some of them – amateur astronomers with impressive records of contributing observations in support of solar system science. This paper reports on asteroid lightcurves made with modest telescopes, in the range 0.35 to 0.7m (14 to 28 in), with a couple of special features. First the photometric data is of extraordinarily high quality (careful processing, excellent SNR, typical photometric accuracy better than 0.03 mag). Second, the observations include filtered (B, V and/or R-band) data so that the asteroid's color index is well-determined. Third, all data was reduced to absolute photometry on the Johnson-Cousins system using Landolt standard stars. Fourth, all lightcurves were extrapolated (using H-G formalism) to determine the absolute magnitude of the asteroid (H_V)

The net result of this degree of care is that lightcurves from multiple observatories can be combined with virtually no discordant "steps" in the curves, and the combination of color and absolute magnitude provides the basis for estimating the size of each asteroid in addition to its rotation period.

Photometric Analysis of 8 Newly Discovered Short-Period Eclipsing Binaries at Astronomical Observatory at Kolonica Saddle
by Š. Parimucha, et al
New Astronomy 17 (2012) 93–100

It appears that there are a great many variable stars still awaiting discovery. The authors report 8 newly-noticed short-period eclipsing binaries that fortuitously are located in the same FOV as one of their target stars (in their ongoing study of eclipsing binaries and cataclysmic variables). All of these have periods in the range 0.3 to 1 day, which means that a single night of time-series photometry will show that they are variable (and in several cases, a single night can map the complete lightcurve). They mostly have peak-to-peak lightcurve amplitudes of several tenths of a magnitude. Some of them are of special interest because of their asymmetric lightcurves (presumably caused by star-spots).

Although the authors offer models of the systems based on the PHOEBE (Wilson-Devinney) code, their data is V-band only. It is probably worthwhile to do follow-up observation of these stars in two or three colors, to better anchor the lightcurves, and to search for changes in the star-spot characteristics. The authors note that one of their finds may also need consistent time-of-minimum monitoring to investigate the possibility of period change due to mass transfer.

The Algol System SZ Herculis: Physical Nature and Orbital Behavior
by Jae Woo Lee, et al
Astronomical Journal, 143:34 (8pp), 2012 February

Here is a good example of the remarkable depth of understanding of an eclipsing binary system that can be garnered by multi-color CCD photometry with a small telescope. The authors used a 61-cm (24-in) telescope to map the complete lightcurve of SZ Her in B, V, R and I-bands. The lightcurves are classical "Algol"-type, with a deep primary and shallow secondary eclipse; and pronounced changes in the depths of the eclipses in different colors. As you go from blue (B-band) to red and near-IR (R- and I-band), the primary eclipse becomes shallower, and the secondary becomes deeper, indicating a significant temperature difference between the two stars.

Modeling with the Wilson-Devinney code shows the (expected) semi-detached configuration.

The author's analysis of over a century of eclipse timings yields an interesting complication: the O-C (observed minus calculated) plot is best fit by a solution that uses the light-time effect of two companions in distant orbit around the eclipsing pair, with these companions almost in a 2:1 orbital resonance (orbital periods ≈ 42.5 y and 85.8 y). This makes SZ Her a quadruple system. The masses of these purported distant companions are small (about 0.2 solar masses, each) so they are expected to be faint and red, resulting in negligible contribution to the system's light and hence no chance of detecting them spectroscopically. However, the authors do point out that they might be far enough from the primary pair that it might be possible to detect them in deep-infrared (K-band) speckle imaging.

Plus, it is clearly useful to maintain a program of measurement of the times of minimum light, which over the next several decades could lend confidence to (or refute) the "quadruple" system hypothesis.

Close Binary System GO Cyg
by B. Ulas, et al
New Astronomy 17 (2012) 296–302

GO Cyg is a near-contact binary system. It has a long history of photometric study (beginning with (Payne-Gaposchkin in 1935), and at least one confusing feature: some lightcurves were reported to show an asymmetry in the secondary eclipse, while others (including these authors') do not. The history of times of minimum light have historically been interpreted as indicating mass-transfer (a parabolic O-C curve), but could as well be fit with a half-cycle of a sinusoid (a light-time effect). The work here reports a nice multi-color CCD photometric study using a 40-cm (16-in) telescope. These results are nicely fit by a PHOEBE model of a near-contact binary system in which the primary component fills its Roche lobe, and the secondary component is close to its Roche lobe. The authors are convinced that their new times of minimum light demonstrate that the O-C curve is, indeed sinusoidal, but with only a few data points the distinction between sinusoid vs. parabola is probably not unimpeachable.

A very interesting aspect of their work, however, is that they did a complete re-analysis of all the historical lightcurves, using the modern PHOEBE code (and using their own parameters as the starting point for the optimization). They see no firm evidence for asymmetry in any of the lightcurves, hence no need to invoke star-spots on any of them. But they do find evidence for a definite (gradual) decrease in the period over the past 50 years – presumably reflecting mass transfer between the two components.

The Statistical Analyses of Flares Detected in B Band Photometry of UV Ceti Type Stars
by H.A. Dal and S. Evren
New Astronomy 17 (2012) 399–410

The authors used a 48-cm (19-in) telescope and a two-channel photoelectric photometer in a project to monitor and characterize flare activity on 4 UV Ceti-type stars. Several useful and (to me) surprising features were observed. First, the flare activity of these stars was pretty dramatic – AD Leo showing an average rate of nearly 1 flare per hour. Second, the size and speed of some flares is pretty astounding. A couple of lightcurve examples show flares that rose by a half-magnitude or more in only a couple of minutes.

"Fast" flares are characterized by a sawtooth lightcurve: a very rapid rise, followed by a more gradual decline ($t_{decline}/t_{rise} > 3.5$). "Slow" flares have more symmetrical lightcurves with the rise and fall times being more nearly equal. This is presumably (in the opinion of the authors) indicating that there are two different driving mechanisms, most likely a thermal mechanism for the "slow" flares and a non-thermal mechanism for the "fast" flares.

Statistical analysis of the duration and intensity of individual flares indicate that for each star there is a pretty definite maximum-possible flare energy; but that this plateau energy is a characteristic of the individual star, not a constant across all stars.

The Slowly Declining Type Ia Supernova 2008fv and the Near-Infrared Second Maximum
by I. Biscardi, et al
Astronomy & Astrophysics 537, A57 (2012)

This supernova was a grand highlight for small telescope research. It was discovered by Japanese amateur Koichi Itagaki in the barred spiral galaxy NGC 3147. The authors of the present paper then gathered an impressive multi-band lightcurve: they used a 72-cm (28-in) telescope and CCD photometry in B-, V-, R-, and I-bands, and a 108-cm (42-in) telescope with mercury-cadmium-telluride infrared detector array in the J-, H-, and K-bands.

Their data shows nicely how this pretty-normal type Ia supernova displays quite different lightcurves in the visible versus the infrared bands. In B-, V-, and R-bands, the lightcurve is a clean rise-and-fall. In the far infrared, however, it displays a secondary maximum at about 30 days after the B-band brightness maximum. The near-infrared I-band shows intermediate character, with a hint of a (small) secondary brightness bump at this time.

Unfortunately, no spectroscopic follow-up was done on this particular event. The authors point out that there are a variety of correlations between visible and IR lightcurve shapes, the brightness decay time, the peak amplitude, and (presumably) properties of the progenitor star and the nature of the explosion. Continued efforts to record multi-band photometry of supernovae will be valuable in unraveling all of this, and can be done with modest telescopes.

Using Sparse Photometric Data Sets for Asteroid Lightcurve Studies
by Brian D. Warner and Alan W. Harris
Icarus 216 (2011) 610–624

Most of you will recognize the authors – Brian Warner is a leader of the SAS, and Dr. Harris is one of the SAS Advisors. Congratulations to Brian (the "amateur") on being the lead author of this paper!

A sort of "back to the future" trend may soon become apparent in the asteroid lightcurves gathered by professional observatories/programs. A few decades ago, it was an exhausting effort to create an asteroid lightcurve using photoelectric photometers, climbing up the ladder to center the target, down the ladder to read and record the photomultiplier's signal, then back up the ladder to center the compstar, etc. Not surprisingly, many studies from that era yielded relatively sparse data sets, with fewer than a dozen data points per night and often large gaps between observing nights. A fair percentage of their derived rotation periods were later shown to have been mistaken – sometimes by a little, sometimes by a lot. Then, the era of amateur CCD photometry of asteroids led to a dramatic improvement in the density of the data (e.g. a data point every few minutes, continuously all night, for several consecutive nights), the completeness of the rotational coverage, and the overall reliability of the derived periods.

Soon, however, we'll see the first streams of data from survey programs (e.g. pan-STARRS) that will be characterized by high photometric accuracy but – an echo of the old days – sparse data, with gaps of hours or possibly days between adjacent data points.

This paper addresses the question, "how reliable will the rotation periods be, that are derived from such data?" It turns out that sparse data sets are subject to a variety of effects that can confuse a period-finding algorithm. Things are best if the lightcurve amplitude is large, and the true period is long enough (but not too long); but even under good conditions there is a substantial risk of "finding" a rotation period that is significantly different from the "true" period. Interestingly, if you are willing to accept as valid a derived period that is ½ or 2X the "true" period, that doesn't dramatically reduce the probability of deriving a deviant period.

The authors propose two important conclusions. First, that effective collaboration between the "large-telescope sparse-data surveys" and the "small-telescope dense-data dedicated asteroid lightcurve projects" is needed in order to take advantage of the unique value of each type of observing strategy. In particular, just a night or two of "dense" data can clarify the jumble of data points from a "sparse" data set, turning the combination into a complete and long-baseline phased lightcurve. Second, an effort should be made to apply the many under-utilized meter-class telescopes to dedicated asteroid photometry projects, to augment the data stream coming from the deep surveys.

Asteroid Rotation Periods from the Palomar Transient Factory Survey
by D. Polishook, et al
preprint at http://arxiv.org/pdf/1201.1930.pdf

Apropos of the preceding article, a paper will soon appear in the *Monthly Notices of the Royal Astronomical Society* describing the use of data from the 1.2-m (48-in) Palomar Transient Factory (PTF) to determine asteroid lightcurve periods. While PTF's principal targets are outside the solar system (supernovae and novae), their sensitive CCD's sweep up quite a few asteroids. And as it turns out there are PTF data sets in which the same field of view was imaged a dozen or so times per night, for up to 4 consecutive nights. This cadence is sufficiently high to provide good-quality lightcurves, and the large aperture enables accurate photometry on quite faint asteroids (down to about R-mag ≈19).

The authors found over 600 asteroids in their data set, and report reliable periods (with very reasonable lightcurve shapes) for 88 of these asteroids. In keeping with the conclusions of Warner & Harris (above), these "reliable" periods come from a subset of the observed objects that is characterized by relatively large amplitudes, good signal levels, and periods in the range P≈ 3 to 11 hours, which provides for good sampling of the lightcurve with the observing cadence that was available. Some objects that appear to show consistent brightness trends (but not a complete lightcurve cycle) were characterized by "minimum plausible" periods. The authors were also frank about showing that they found a number of objects that could not be assigned reliable periods (U≈1 at best).

So, here is practical confirmation of one of Warner & Harris' conclusions – a meter-class telescope can make an enormous contribution to asteroid studies!

Spin Vector and Shape of (6070) Rheinland and Their Implications
by David Vokrouhlicky et al
Astronomical Journal, 142:159 (8pp), 2011 November

The authors report on a project to combine and interpret several years of lightcurves, most of which were gathered by CCD photometry on small telescopes in the 40-cm (16-in) to 80-cm range (32-in). The "et al" in the author list includes some names that may be familiar to many of you: Josef Durech, David Polishook, Petr Pravec,

6070 Rheinland is one of a pair of asteroids whose orbital elements are virtually identical, strongly suggesting that they have a common origin (e.g. by fission or spin-ejection of a surface boulder). Analysis of the orbital elements suggested a likelihood that Rheinland should be a retrograde rotator. Analysis of the asteroid by lightcurve inversion provided a very precise rotation period (P≈4.3 hr), and an impressive shape model. The pole solution is not well constrained, but does indicate a retrograde rotation as expected.

Additional lightcurves from future apparitions are needed in order to further constrain the rotational state, and confirm the shape model of this asteroid. The next good opportunity will be in late 2013.

Unfortunately, its orbital partner is too small, and hence too faint, to be a lightcurve target for small telescopes.

A Petal of the Sunflower: Photometry of the Stellar Tidal Stream in the Halo of Messier 63 (NGC 5055)
by Taylor S. Chonis et al

The “et al” in the author list includes R. Jay Gabany, who described his experiences with very-deep galaxy imaging at SAS-2011, and Ray Gralak. Both of these gentlemen used relatively small telescopes to not only reveal the complex pattern of faint debris which is identified as the evidence of a relatively recent “minor merger”, but also to provide multi-band photometric data that facilitated distinguishing the tidal tail from the “normal” galactic glow. Doing this is both a great service to cosmology and a tour-de-force of astro-imaging. In the case of Gralak, using a 16-cm (6-in) telescope, it entailed gathering almost 32 hours of imagery (in C, R, G, B bands). Gabany, using a 50-cm (20-in) telescope collected 11 hours of imagery. This was augmented by an additional 11 hr of imagery in B and R bands from the 80-cm (32-in) telescope at McDonald Observatory.

Image processing for surface photometry of the faint tidal tails is a delicate and critical aspect of this study. Some features of the tidal tails are only 10 ADU above the background, which amounts to about 2300 ADU per pixel – those tail structures are faint, indeed! Nevertheless, the authors are able to measure definite color differences between the tidal streams and the extended disk of the host galaxy. The detailed shape of the tidal stream is consistent with the hypothesis of it being the result of the disruption and merger with the host galaxy.

This is a remarkable example of how the capabilities of small-telescope astroimaging can be stretched, to not only make beautiful artwork, but also to compare cosmological theory to observations.

New BV $(RI)_C$ Photometry for Praesepe: Further Tests of Broadband Photometric Consistency
by Michael D. Joner, et al
Astronomical Journal, 142:161 (6pp), 2011 November

Those of you who do multi-band photometry (and who understand and use transforms to put your photometry onto the standard Johnson-Cousins system), probably make occasional checks of the stability of your transforms. Things do change, after all – coatings degrade, dust accumulates on optics, and who knows what little demons lurk inside CCD sensors and their electronics – so it is prudent to check every now and then. The professionals do that, too, but at a level of precision that is probably beyond most of us. Here is a report on a series of tests made using the 0.5-m (20-in) telescope of the South African Astronomical Observatory and a photometer with a long heritage of precision stellar photometry. The authors tested the consistency between the SAAO system, the Johnson-Cousins system, and Landolt standards, for several widely-used fields, including Praesepe (the “Beehive” cluster). From the standpoint of most of us, this is a simple confirmation that the standard fields, magnitudes, and color indices that we’ve been using are confirmed. At the level of precision that some professional studies utilize (which the authors refer to as “FM” quality – “few millimags”), there are a few discrepancies between the zero-points of various systems (although not Landolt).

Radar and Optical Observations and Physical Modeling of Triple Near-Earth Asteroid (136617) 1994 CC
by Marina Brozovic, et al
Icarus 216 (2011) 241–256

Here’s a report that shows the valuable synergy between small-telescope, large-telescope, and radar observations of near-Earth asteroids. The “et al” in the author list includes two names that many of you will recognize: Lance Benner (a good friend of the SAS), and Petr Pravec.

This little rock was observed with the 41-cm (16-in) PROMPT telescopes, which generated nice lightcurves a couple of weeks prior to its close flyby of Earth. The lightcurves show a rotation period of $P \approx 2.4$ hr, amplitude $\Delta m \approx 0.1$ mag, and generally tight fits to a low-order Fourier model. On one night, a portion of the night’s lightcurve falls noticeably below the fourier model, providing a tempting hint of an unusual fade in brightness, but insufficient by itself to declare that a “mutual event” in a binary system was observed. Note that the “PROMPT” telescopes have an eclectic set of filters, so the lightcurve represents a mix of photometric R-band, astro-imager’s Red filter, and unfiltered observations.

The 5-m (200-in) Hale telescope was used to collect spectroscopy of the asteroid and a set of solar-analog stars. In this way, the spectral reflectance profile of the asteroid was created, showing the asteroid’s surface to be similar to an LL-type ordinary chondrite meteorite.

Radar observations were done at both Arecibo and Goldstone. Doppler imagery shows that the asteroid’s main body is low-aspect-ratio (consistent with the low delta-mag lightcurve); and it also discovered two small satellites accompanying the main body.

The radar shape model of the main body shows a nearly round body, but with a pronounced equatorial bulge running completely around it. (I think we’ve seen that weird shape before on other asteroids ...). Happily, when this shape model is used to “predict” the optical lightcurve, the results match the observed lightcurve nicely.

Of the two little satellites, one is in synchronous rotation, but the other (more distant one) appears to not have synchronized its orbit with its rotation period.

There are several morals to this story, but I’ll harp on only one: when you see those calls in the *Minor Planet bulletin* for optical observations of near-Earth asteroids (both for pre-approach astrometry and for lightcurve photometry), heed them! Your data can be an important contribution to the investigation of these objects.

Photometry of Variable Stars From Dome A, Antarctica
Lingzhi Wang, et al
Astronomical Journal, 142:155 (13pp), 2011 November

Oh, boy: if you think it’s cold at your observatory, imagine working at the south pole! Of course, in addition to a very cool site, you get a single “night” that is about 4 months of uninterrupted darkness, so you can do really neat variable-star lightcurves – which is what the authors report here.

The instrument used was “CSTAR” (the Chinese Small Telescope Array), consisting of four 14.5-cm (5.7-in) schmidt-cass ‘scopes with CCDs. The telescopes are fixed, aimed near the south celestial pole. Each telescope has a different filter (Sloan g, r, i and clear). For the observing season being reported, only one of the instruments provided useful data (in Sloan “i”); the authors don’t elaborate on their technical difficulties, but I suspect that the Antarctic environment is at least as challenging to precision instruments as outer space is (maybe worse, in some ways).

Of the 100,000 stars (to mag 20) that were observed in their ~4.5-degree FOV, the authors performed differential time-series photometry on the brightest 10,000 (down to about mag 14.5), with internal precision of better than 1 mmag. They found 154 periodic variables, of which several appear to be transit-type lightcurves.

This catalog of variable stars will probably find a variety uses, due to its unique observing cadence, excellent precision, and (when upcoming seasons succeed with the other filters) multi-band data.

Infrared Studies of Epsilon Aurigae in Eclipse
by Robert E. Stencel, et al
Astronomical Journal, 142:174 (9pp), 2011 November

This isn't really "small telescope science", since it reports on infrared observations made with large professional ground-based facilities and satellite observatories. I note it because Dr. Stencel includes the generous acknowledgement that "We are fortunate to have well-determined optical light curves, due to the International Campaign organized by Jeffrey Hopkins ... which has provided thousands of UBVRIJH measurements since 2006 and earlier." This is a well-earned compliment to Jeff and the many contributors to the photometric study of ε-Aur, and hopefully will be an encouragement to other amateur astronomers to put some of their telescope time to the service of science.

Both Dr. Stencel and Jeff Hopkins are good friends of the SAS.

CAMS: Cameras for Allsky Meteor Surveillance to Establish Minor Meteor Showers
by P. Jenniskens, et al
Icarus 216 (2011) 40–61

Most of you will remember Dr. Jenniskens, who was the keynote speaker at SAS-2011. He showed us a few pictures of the CAMS setup during his talk. In this paper, he presents the initial results from them.

Each CAMS system comprises an array of 20 WATEC low-light-level (non-intensified) cameras with FOV of 22 X 30 degrees (each), aligned so that together they cover the entire sky from zenith down to 30 degrees above the horizon. There are 3 CAMS systems, providing a baseline for triangulation of meteor trajectories.

The core of the data analysis is the MeteorScan software, which may be familiar to those of you using all-sky cameras to search for (and triangulate) fireballs.

In recognition that there hasn't been much written to explain the process (mathematical and procedural) for translating video observations of a meteor into its real-world trajectory and then into orbital elements, this paper gives a complete description of the methods used with CAMS. This might be valuable to those of you who are thinking about participating in a fireball-detection network.

The primary purpose of the CAMS project was to detect and verify suspected-but-unconfirmed meteor showers (which has value to a variety of subjects ranging from solar system evolution to spacecraft risk assessment). In this, it appears to be a smashing success. During the first month of operation CAMS was able to determine almost 2200 meteor orbits, and confirm several "suspected" showers. This is a great start for the project. Dr. Jenniskens has hopes to deploy similar systems in the southern hemisphere, and to adapt the concept to include spectroscopy.

Absolute Properties of the Highly Eccentric, Solar-Type Eclipsing Binary HD 74057
by James R. Sowell, et al
Astronomical Journal, 143:5 (8pp), 2012 January

We hear it said that "ongoing surveys will find a great many interesting stars that are worthy of detailed follow-up projects". Here's an example. The authors note that HD 74057 was an "undistinguished seventh magnitude ... star ... until Davies (2006) examined the data from an automated survey for variable stars and discovered it to be an eclipsing binary" – one whose period was about 1 month. This makes it a challenging photometric project to map the lightcurve.

The authors devoted 167 nights on an 80-cm (31-in) telescope, over two separate apparitions to capture a good map of its out-of-eclipse photometric variability, as well as both the primary and secondary eclipses. They found that the period is P= 31.2 d, the pair is on a very eccentric orbit (ε=0.47) so that the eclipses are of unequal duration (5.5 h for one, and 13.5 h for the other).

The out-of-eclipse photometry showed periodic variability (about 0.01 mag) with a period of 8.5 days, which is attributed to a star's rotation period (modulated by star spots).

This small-telescope photometry was augmented with large-telescope spectroscopy, which enabled them to determine the radial velocity profile, and hence determine a complete solution of the system (orbital parameters, sizes and relative luminosity of the stars). In contrast to most shorter-period eclipsing binaries, these two stars appear to not have synchronized their orbital and rotational periods.

There are probably several messages here, but one of them is surely that small-telescope photometrists should take a look at the survey results occasionally: there are probably more interesting gems like this can benefit from long-duration precise photometric study. (And the existence of a good lightcurve might make it easier to get time allocated for the needed spectroscopic study).

Is KR Cygni a triple star system?
by Esin Sipahi
New Astronomy 17 (2012) 383–387

Here is a nicely-described multi-band (UBVR) photometric study of KR Cyg, made using a 48-cm (19-in) telescope and 3-channel photometer. The system is shown to be a near-contact binary, with a surprisingly large temperature difference between the two stars.

The approximately 75-year history of eclipse timings gives a hint of a sinusoidal variation in the O-C ("observed minus calculated") curve, which is emphasized by the author's recent timings. This could be due to a third body in a ~75-yr orbit. Indeed, the photometric solution using PHOEBE does give a noticeable third-light contribution, which (if real) would be a ~0.5 solar mass star.

The photometric period of the cataclysmic variable HV Andromedae
by Gerald D. Rude II and F.A. Ringwald
New Astronomy 17 (2012) 442–445

On the basis of some old photometric, polarimetric, and spectroscopic data, this star had been suspected of being an anomalously short-period cataclysmic variable (with period in the "period gap" of P≈2 to 3 hr). The authors used a 40-cm (16-in) telescope to gather four consecutive nights of differential CCD photometry ("clear" filter) to test this suspicion.

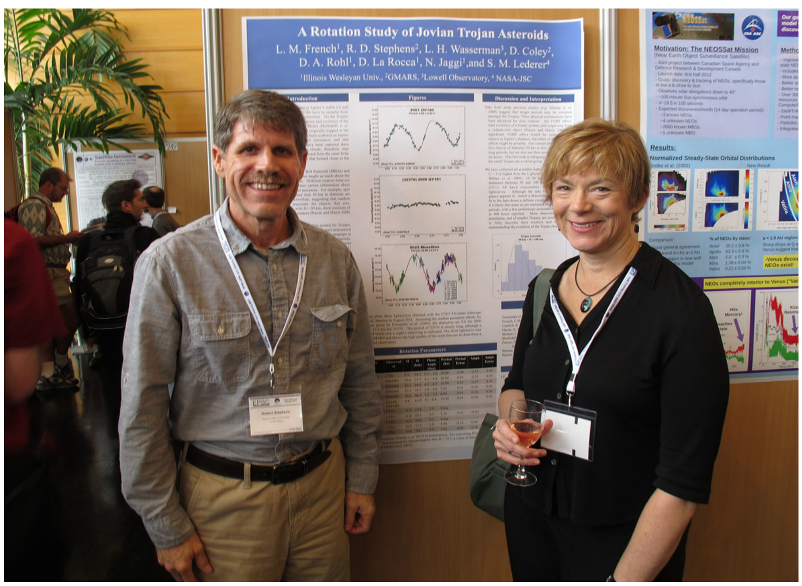
With 2-minute exposures they were able to get very clean lightcurves showing a definite sawtooth-shaped signal, with period P≈3.368 hr. While this could conceivably be the orbital period, the sawtooth shape makes it more likely that it represents a superhump period, representing either (a) eccentricity in the accretion disk, and consequent "sloshing" of disk material, or (b) bending waves in the accretion disk.

They note that if further study can detect the actual orbital period, then that will help to decide which effect is causing these superhumps.

Care and Feeding of Frogs
by Margaret Pan and Eugene Chiang
Astronomical Journal, 143:9, 2012 January

Editor's note: This paper has nothing to do with small-telescope science, but it reminded me of how much I enjoyed Dr. Virginia Trimble's annual review of astrophysics in the Publications of the Astronomical Society of the Pacific. She always included a collection of infelicitous translations, oddly-worded conclusions (or conclusions that applied only to odd worlds), and titles that brought a smile to one's face. This paper is my nomination for the "strangest astronomy title of the year". If you would like to nominate a different title, send your candidates to the Newsletter editors. There are no rules in this contest. There are also no prizes.

The subject of this paper is the subtle "propeller" features that have been observed in Saturn's A-ring. The authors describe a candidate model for how they are formed, and why they are fairly long-lived phenomena. A tiny moonlet embedded in the particulate field of the ring causes a gap (a low-density region) to form; and the gravitational interaction between the moonlet and the material just outside of the gap causes the moonlet to follow a racetrack orbit in which it oscillates toward one end, and then the other end, of the gap. This motion was christened by the authors a "frog libration". Hence the title.



Dr. Linda French (lead investigator, Illinois Weslyan Univ.) and SAS Treasurer Bob Stephens (co-author) presented a poster paper "A Rotation Study of Jovian Trojan Asteroids" at the European Planetary Science Congress (EPSC) and the Division of Planetary Sciences (DPS) in Nantes, France in October, 2011. Note that astronomy conferences in France include wine (which, judging from the college experiences of your editor, does not always go well with equations).

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2012 SAS/AAVSO Joint Meeting Schedule

Wednesday 5/23

Coffee/Registration		***0800***	***0830***	
Welcome	***Lee Snyder and Arne Henden***	***0830***	***0900***	
Pro-Am Collaborations				
Bill Goff	Photometry of Hubble's First Cepheid in the Andromeda Galaxy, M31	0900	0920	
Joe Patterson	The Tortured Accretion Disk of BK Lyncis	0920	0940	
Bruce Gary	Photometric Monitoring of YY Gem	0940	1000	
Deidre Hunter	The Lowell Amateur Research Initiative	1000	1020	
Coffee Break		***1020***	***1040***	***20 MINUTES***
Solar System Research				
Brian Cudnik	Lunar Meteor Impacts	1040	1100	
Maurice Clark	Shape Modeling of Three Asteroids	1100	1120	
Eduardo Alvarez	Diurnal parallax determinations of asteroid distance	1120	1140	
Alan W. Harris	On the maximum amplitude of harmonics of an asteroid lightcurve	1140	1200	
Lunch		***1200***	***1340***	***100 MINUTES***
Variable Stars				
David Boyd	PV Cephei and Gyulbudaghian's Variable Nebula	1340	1400	
David Turner	Why Visual Observations of Mu Cephei are Important	1400	1420	
Josch Hambsh	Remote Observations of Variable Stars	1420	1440	
Enrique de Miguel	ER UMa: A Dwarf Nova with Surprises	1440	1500	
Coffee		***1500***	***1520***	***20 MINUTES***
Campaign Champions				
Tim Puckett	Supernova Searching	1520	1540	
Jeffrey Hopkins	Small Telescope Spectroscopy of epsilon Aurigae	1540	1600	
Sponsor Infomercials		***1600***	***1700***	
AAVSO Membership Meeting		***1900***	***2100***	

Thursday 5/24

Coffee		***0800***	***0840***	
Spectroscopy and Such				
John Menke	Observations Using a Medium Resolution Home-built Fast Spectrograph	0840	0900	
Stan Gorodenski	High Resolution Spectroscopy for the Amateur	0900	0920	
John Beaver	Extremely Low-Cost Point-Source Spectrophotometry (ELCPSS)	0920	0940	
Doug Walker	Low Resolution Spectroscopy of the Eclipsing Binary Star Algol	0940	1000	
Kevin B. Alton	A Fresh Look at the Algol-like Eclipsing Binary AO Ser	1000	1020	
Coffee		***1020***	***1040***	***20 MINUTES***
Special Projects I				
Eric Crane	The Light at Night Mapping Project	1040	1100	
Russ Genet	CCD Double Star Observations	1100	1120	
Wayne Green	Imaging Pipeline Processing using Python plus PyRAF	1120	1140	
Gary Vander Haagen	High Speed Photometry	1140	1200	
Group Photo / Lunch		***1200***	***1400***	***2 HOURS***
Special Projects II				
Richard Stanton	Photo Counting - One More Time	1400	1420	
Tom Kaye	Tracking Bolides, 3D Visualization and Data	1420	1440	
John E. Hoot	DSLR and CCD Occultation Methods	1440	1500	
Good Night, and Good Luck		***1520***	***1530***	
Dinner		***1730***		
Banquet Speaker	***Dava Sobel***	***1900***	***2000***	

POSTERS/PAPERS WITHOUT PRESENTATION

Jerry Horne	A Single-beam Polarimeter
John Menke	Design, Construction, and Testing a Home-built Fast f3.5 Spectrograph
John Beaver	VARMiNT: A Virtual Astronomical Research Machine in No Time
Robert K. Buchheim	The Confusing Case of 16666 Liroma
Bob Gill	Solar Rotation
Erin Craine	Student Project and Curriculum Based on Light at Night Data Collection
Robert Gill	Enhancing Education with an iPad and Telescope
Wayne Green	An Amateur Dual Imaging Littrow Spectrograph
Wayne Green	Adding High Precision Encoders to a Circa 1890's Telescope
Arne Henden	New Formulation of the Astrodon B filter
Arne Henden	Current Variable Stars of Interest

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