News from the Society for Astronomical Sciences

Vol. 9 No. 4 (October, 2011)

SAS at PATS-2011

The Society for Astronomical Sciences had a productive presence at this year's Pacific Astronomy and Telescope Show.

Our booth display, designed to encourage curiosity and interest in small-telescope science, seemed to generate a nice response. Quite a few visitors engaged us in long conversations about projects, equipment, and the research contributions that are made by backyard scientists. We didn't keep count, but at least a hundred people picked up SAS brochures.

Also at PATS, Brian Warner presented a lecture on "Measuring the Universe", which focused specifically on finding variable stars, and determining their lightcurves. About 40 people attended the lecture, and at least half of them accepted free copies of MPO Canopus, to facilitate their own entry into "backyard science".

If you are giving a lecture or participating in a conference, and would like some SAS brochures to hand out, or the 3-poster SAS display, contact Bob Buchheim.

Gene Lucas (left) explains the value of small-telescope science to a visitor at the SAS booth during PATS-2011. Photo by Bob Buchheim.

Call for Observations of Zeta Aurigae Eclipse

Here is a project that will build on your experience with Epsilon Aurigae, and enable you to contribute to the study of a stellar atmosphere.

Zeta Aurigae (= TYC 2899-2236) is a 3.7-mag star, located a bit less than 3 degrees from Epsilon Aurigae. It is a binary system: the primary component is a K giant star, and the secondary star is a very hot, blue, and much smaller B5 star. The two form an eclipsing binary pair with a (reportedly) eccentric orbit. The orbital period is 972 days (approximately 2.66 yr), making these eclipses 10 times less rare than the 9890 day cycle for Epsilon Aur. Primary eclipses occur when the B-star is eclipsed by the (much larger) K-star. The depth of the primary eclipse is strongly dependent on the band that you observe in. The V-band depth is about 0.15 mag, and the eclipse is much deeper in B and U than it is in V or R. The secondary eclipse (when the blue star transits in front of the red star) is shallower – less than 0.1 mag – and apparently is poorly characterized.

Observations of this system before, during, and after the October/November 2011 primary eclipse are needed – most particularly during the ingress and egress stages, where the hot star acts as a probe for the extended atmosphere of the super giant. Observations are probably going to be attempted with CHARA during these phases.

Photometric coverage of the ingress and egress phases, especially in U and B bands, will be helpful to define the time of eclipse and search for related shorter-term variations. Investigators are especially interested in Blue and Ultraviolet photometry to precisely define the ingress and egress phase timing. Precise V band photometry will also be helpful in this regard.

Spectroscopic observers will see the biggest changes at the shortest wavelengths.

Spectra will almost certainly be interesting, but will probably need to extend deep into the blue/violet to show eclipse effects (which of course will be difficult with standard CCDs). This makes it a challenging set of observations, but the SAS membership has demonstrated that they enjoy a challenge.

You may ask, "Why should small-telescope scientists observe and monitor this system?" Dr. Robert Stencel offered several reasons to put this system high on your observing schedule:

• It will be undergoing its primary eclipse. This is an opportunity to get dense photometric and spectroscopic coverage under favorable observing conditions.

• As with many bright stars, large observatories cannot easily get time to conduct these observations. Thus, it is likely that investigation of this object must depend on backyard scientists and their modest telescopes.

• Spectra spanning the time before, through, and after the eclipse will be most interesting.

• This is an exploratory project. Even if observations are ambiguous this time around, the results will prove valuable to plan for future observing campaigns.

Happily, this eclipse comes at a good time. It is well placed for Northern hemisphere observing, in a good position for late night or early morning observing. For those observers that have been monitoring epsilon Aurigae, here is a very near neighbor that needs your attention!

The current prediction for first contact is 29 October 2011, with mid-eclipse on 19 November 2011. You should plan on concentrated observing (nightly time-series photometry of spectroscopy) beginning in mid-October (i.e. "right now"), and continue through at least 17 December 2011.

Jeff Hopkins provided the following estimates of the eclipse phenomena, based on his observations of the 1985 eclipse:

Ingress duration ~ 4 days
Totality duration ~ 36 days
Egress duration ~ 4 days
Eclipse duration ~ 44 days

Jeff has prepared a Zeta Aur campaign website, at:

http://www.hposoft.com/EAur09/zeta%20Aurigae/zeta.html

Refer to Jeff's website for the most current information and updates.

A 1996 Astrophysical Journal Paper on this system by Philip Bennett, et al can be found at:

http://www.hposoft.com/EAur09/zeta%20Aurigae/Doc/1996BE.PDF

Dr. Bennett offers the following advice: "I am very pleased to see the attention you and your fellow observers are devoting to this interesting and useful binary system.

"I am particularly interested in spectra. The best region is in the blue-violet-near UV (3200-4250 Å). Shorter wavelengths are more useful, but also more difficult to observe. It is probably impossible for most amateurs to observe below 3500 Å because regular optical glass absorbs strongly at wavelengths shorter than this (special optics made of fused silica optics are needed).

"The key times to observe are nightly for the 2 weeks prior to the start of eclipse, during total eclipse, and for the 2 weeks following emergence from eclipse. Spectroscopic signatures of the supergiant's atmosphere remain visible for ±2 weeks from total eclipse.

"If any of you are able to observe in the blue-violet-near UV on a regular basis, I would be *very* interested in hearing from you directly."

"New Look" of the Journal for Occultation Astronomy

One of the most active and important research areas for small (and very small) telescopes is the timing and recording of stellar occultations by solar system objects (mostly asteroids). The International Occultation Timing Association (IOTA) is the coordinating body for these activities.

The IOTA's publication (formerly "Occultation Newsletter") has been dramatically upgraded in the past year, taking on a new title ("Journal for Occultation Astronomy"), a new production arrangement (the IOTA European Section is now accepting contributions and handling the preparation of the Journal) and an energetic Editor-in-Chief (Hans-J. Bode). Mr. Bode and his many helpers and contributors are to be congratulated on bringing this new vision to fruition. The past few issues have included excellent "how to" explanations of equipment and data reduction methods, and reports of occultation observations.

Mr. Bode notes in an editorial that there is an important opportunity for collaboration between occultation timing and asteroid lightcurve photometry: the photometry provides information about aspect ratio and shape of the object (but is agnostic regarding the object's actual size) while the occultation timing can provide calibration of the physical size of the asteroid. He strongly encourages asteroid photometrists (i.e. many SAS members) to specifically attempt lightcurves of occultation targets, either shortly before or after the occultation. There have been a few recent research articles published that combine lightcurve, shape-modeling, and occultation results, and they have been pretty remarkable in terms of consistency,

A melancholy astronomer observes a foggy dusk at Cerro Tololo.
Photo by Bob Stephens.

quality, and teamwork.

On a vaguely related subject, sometime in the past couple of years I heard a talk that included the quip that "If we keep treating Pluto like an asteroid, pretty soon it will start acting like one!" (Alas, I can't remember who to credit that quip to). In keeping with this prediction, Pluto has been the subject of occultation observations just like other asteroids. In the July-Sept 2011 issue of the Journal for Occultation Astronomy, longtime SAS member John Menke and his wife Meg report their successful observation of Pluto's May 22, 2011 occultation of a 14th magnitude star. Not surprisingly considering the star's faintness, the data is noisy, but the occultation is definitely visible in their lightcurve. Congratulations, John and Meg!

(221149) Cindyfoote

Asteroid 2005 TG61 was discovered on 2005 Oct. 3 by the Catalina Sky Survey. The IAU has now approved its entry into the catalog of numbered and named asteroids, with the moniker (221149) Cindyfoote. It is named in honor of SAS' own Cindy N. Foote.

She obtained her first telescope on a dare with her husband, Jerry. Within 4 years, she became one of the leading amateur astronomers in the field of exoplanet observing. She has been co-author on at least four papers on exoplanets in professional journals.

Congratulations to our newest "rock star"!

Small-Telescope Astronomical Science in the News July – September 2011

compiled by Bob Buchheim

A while ago, I was chatting with a professional astronomer (who will remain anonymous here because our conversation wasn't intended to be "on the record"). I asked him if there was any prospect of re-invigorating the American Astronomical Society's Working Group on Professional-Amateur Cooperation. His response was, "Well, no, there's nothing much going on in WGPAC. But ask yourself: Is there really any need for such a group, when amateur astronomers are now being published in NATURE?"

Good point. Although most of us won't reach that high a level in our backyard research, there are some SAS members who have indeed been co-authors on papers in Nature and other prestigious journals. And as you've seen in the past few issues of the SAS Newsletter, amateur and small-telescope research is both productive and wide-ranging.

Regarding NATURE – well, it happened again this quarter: two articles in the same issue featured observations of Saturn made by amateur astronomers with small telescopes.

Deep Winds Beneath Saturn's Upper Clouds From a Seasonal Long-Lived Planetary-Scale Storm
by A. Sanchez-Lavega, et al
Nature vol 475, p. 71 (7 July 2011)

The list of co-authors on this paper includes respected amateur astronomer Don Parker, and the International Outer Planet Watch Team (an eclectic mix of amateur observers and professors). I didn't recognize the names of any SAS members; if any of you are involved in IOPW, please let me know.

The subject of this paper is the "great white spot" that developed into a major storm on Saturn, beginning in early December 2010. It appears that amateur observations provided the first detection of the infant spot. Almost simultaneously, the Radio Plasma Wave Science instrument on the Cassini spacecraft (in orbit around Saturn) began singing its report of major electrical discharge activity – the signature of lightning in this massive "thunderhead". Continuous observation of the evolution of the storm head by both ground- and space-based instruments has provided a wealth of data. The major result reported here is use of this data to anchor models of the upwelling and the zonal winds at depth in Saturn's atmosphere.

A Giant Thunderstorm On Saturn
by G. Fischer, et al
Nature, vol 465 p. 75 (7 July 2011)

The list of co-authors on this paper includes Anthony Wesley (an Australian amateur astronomer) and Christopher Go (an amateur observer in the Philippines). Although the primary thrust of this article is on the radio-frequency characteristics of the storm, the article is highlighted by outstanding images taken by these two observers. Mr. Go used an 11-inch Schmidt-Cass, and Mr. Wesley used a 16-inch Newtonian to record the visual evolution of the storm as it rose, grew, spread and was sheared by Saturn's strong winds.

Philippine amateur astronomer, "backyard scientist", winner of the ALPO's Walter H. Haas Award in 2008, and co-author on recent *Nature* paper on Saturn's storm, Christopher Go is shown here with his C-11 telescope and AP mount.

Absolute photometry of small main-belt asteroids in 2007–2009
by V. Chiorny, et al.
Planetary and Space Science, v. 59, p. 1482–1489 (2011)

The “et al” in the author listing includes several members and friends of SAS, and others whom many of you will recognize: Bob Stephens, Petr Pravec, Don Pray, Russell Durkee, and Ron Dyvig. All of the telescopes used for this CCD photometry project (including the “professional” observatories) were modest, ranging from 35-cm (14-in) to 70-cm (28-in).

The authors determined lightcurve parameters (period and absolute brightness, color index) for 11 small main-belt asteroids. These are then combined with (assumed) albedo values to estimate the sizes of these objects.

The excellent quality of these lightcurves is a testament of the capabilities of modern “amateur” researchers – very clean lightcurves, with excellent consistency across multiple observatories.

Lunar Eclipse of June, 15, 2011: Three-color umbra surface photometry
by Oleg S. Ugolnikov, et al
preprint at
http://arxiv.org/ftp/arxiv/papers/1106/1106.6178.pdf

We all know that the brightness and color of the fully-eclipsed Moon is affected by the conditions in the Earth’s atmosphere – the scattering and refraction that redirects incident sunlight and sends it toward the Moon. Here is a quantitative study of lunar umbral brightness. The authors used two CCD systems, with three narrow spectral filters (two in the visual range, one in the near-IR) to image the Moon during the June 15, 2011 total eclipse. They calibrated the brightness by imaging reference stars, and also the un-eclipsed lunar surface. This enabled them to make maps of the ratio of “eclipsed” to “non-eclipsed” lunar surface brightness. The near-infrared data showed a definite asymmetry, with the eastern umbra being much darker than the western, and containing particularly dark regions. These dark areas turn out to correspond to Sunlight that passed through the troposphere over the (heavily polluted) region of eastern China. So, it turns out that brightness maps of lunar eclipses can provide a method of inferring not just the global-average conditions of our atmosphere, but also the conditions of specific regions around the Earth’s limb as seen from the Moon.

New Cataclysmic Variable 1RXS J073346.0+261933 in Gemini
by D. V. Denisenko, et al
preprint at
http://arxiv.org/ftp/arxiv/papers/1107/1107.1415.pdf

Here is a clever piece of detective work by a group of Russian astronomers. One of them had been searching the digitized Palomar Observatory Sky Survey images for counterparts of bright but hitherto unidentified ROSAT x-ray sources when he noted that the subject star had varied by at least 2.5 magnitudes between two plates. This prompted a search of other databases for more observations (the Catalina Real-Time Survey, 2MASS, and SDSS were particularly valuable), a brief run of spectroscopy on a large telescope, and a campaign of photometric observations of this star using a 30-cm (12-inch) telescope. The star is tentatively characterized as a magnetic (polar) CV.

The primary goal of the small-telescope part of the study was to catch the star in outburst, so that rapid-cadence photometry could be done. This goal was successful, with an outburst being recognized in February, 2011. The lightcurve indicates a period of 3.20 h (or possibly 3.35 h).

There is a curiosity in the archival CRTS and NEAT data: the lightcurve looks a lot like an eclipsing system, with an approximately 940-d period. The authors acknowledge their befuddlement over this signal, and encourage ongoing observations. (Alas, in quiescence the star is about mag 18 out-of-eclipse, and as faint as mag 21 at the bottom of primary eclipse).

Delta Scorpii 2011 Periastron: Worldwide Observational Campaign and Preliminary Photometric Analysis
by Costantino Sigismondi
preprint at
http://arxiv.org/PS_cache/arxiv/pdf/1107/1107.1107v1.pdf

Like epsilon Aurigae, δ-Sco is an eclipsing binary that is currently undergoing an important event (periastron), needing continuous photometric and spectroscopic observation, but is far too bright for most professional observatories to deal with (it is roughly mag 1.6). There is a very active amateur spectroscopic campaign underway.

In the present paper the author describes his combined digital-imaging and visual observation method and results. The star is particularly challenging because (especially for those of us in mid-northern latitudes) it never gets very high in the sky, and the nearest good comp stars are 10 degrees from the target – implying wide field imaging, relatively large air mass, and an ever-present risk of inconstant atmospheric conditions. The author found that digital imagery could provide excellent precision, but that visual (naked eye) estimation was a useful discipline to protect against spurious digital results that were corrupted by atmospheric problems.

He also mentions a new (to me) method of photometric reduction of his digital images that may be of interest to those of you who use DSLRs for photometry. He found that in many cases, normal “aperture photometry” gave poor, inconsistent results that were apparently related to haze and sky glow. So instead of summing ADUs over a measuring aperture, he used only the G-band mask pixels, and used the three brightest pixels (only) as the measure of star brightness.

Marginally Low Mass Ratio Close Binary System V1191 Cyg
by B. Usas, et al
preprint at
http://arxiv.org/PS_cache/arxiv/pdf/1107/1107.0277v1.pdf

Very close binary systems evolve in a complex way, with the stars changing in size due to their individual evolution, while exchanging mass and energy due to their mutual interaction. The authors of this paper used a 40-cm (16-in) telescope to gather B-, V- and R-band lightcurves and times of minima. They entered their data and published radial velocity data into the PHOEBE code to determine a model of the system. Their results show a pretty extreme mass ratio ($q \approx 0.1$). Their times of minima (compared to historical data) show a rapid change in period, which is presumably related to rapid mass-transfer. Their lightcurves also seem to display evidence of stellar activity, and small changes in the shape of the lightcurve since the last previous study

The Patterns of High-Level Magnetic Activity Occurring on the Surface of V1285 Aql: The OPEA Model of Flare and DFT Models of Stellar Spots
by H.A. Dal and S. Evren
Pub. Astro. Society of the Pacific, v 123, p 659 (2011 June)

V1285 is a 10th magnitude red star (B-V ≈1.5). In 1970 it was discovered to display a very high level of flare activity, although there have been inconsistent reports about the statistics of the flare characteristics, and the out-of-flare photometric variations.

The authors used a high-speed photoelectric photometer on a 48-cm (19-in) telescope to monitor U-band brightness in an effort to see and characterize flares (time resolution of about 10 sec). Over the course of 32 nights, they observed 83 flares (!). Typical U-band amplitude of flares was 0.2 to 0.5 magnitudes, and flare durations range from about 1 min to 25 min.

The authors used the same telescope to conduct a B-V-R band search for out-of-flare photometric variations. They appear to have found a robust nearly-sinusoidal signal with period ≈3.1 days and amplitude ≈0.02 mag. They interpret this as being the rotational period of the star (modulated by dark/cool spots), although they note that a previous study inferred a ≈2.2 day photometric period.

It sounds like additional long-term photometric (and maybe low-resolution spectroscopic?) monitoring of this star would be useful and fruitful.

Planetary Construction Zones in Occultation: Eclipses by Circumsecondary and Circumplanetary Disks and a Candidate Eclipse of a Pre-main Sequence Star in Sco-Cen
by Eric E. Mamajek, et al
preprint at:
http://arxiv.org/PS_cache/arxiv/pdf/1108/1108.4070v1.pdf

The authors report an intriguing discovery from the SuperWASP and ASAS photometry of a 12th magnitude star (GSC 7807-0004) located in the Scorpius-Centaurus association. They find a huge (delta-mag = 3 mag) asymmetric drop in brightness during a ~54 day period in mid-2007 which they identify as the eclipse of a probable circumplanetary disk in orbit around a (putative) planet or sub-stellar companion to the observable star. The eclipse has some similarities to the asymmetric eclipses observed in EE Cep.

Based on the available data, the authors conclude that the orbital period must be greater than 850 days. The photometry contains barely-detectible hints of a secondary eclipse in 2001. If this is, indeed, a secondary eclipse, then the period is 6.12 years.

This sounds like a potentially fruitful target for photometric monitoring. If/when the next eclipse is detected, an intense campaign analogous to that on ε-Aur might be valuable. If you are situated so that you can conveniently reach declination -40 deg, you may want to add this onto your observing list.

A Study of Asteroid Pole-Latitude Distribution Based on an Extended Set of Shape Models Derived by the Lightcurve Inversion Method
by J. Hanus, et al
Astronomy & Astrophysics, v 530, article A134 (2011)

The "et al" in the author's list includes two good friends of the SAS – Brian Warner and Robert Stephens – and two more names that many of you will recognize: Fredrick Pilcher and Raoul Behrend. Well done, gentlemen!

This paper reports on two advances. The first is analytical. Lightcurves can be divided into "dense" lightcurves (with many data points gathered during a single rotation – the kind made by most backyard scientists, and the most reliable in terms of determining an asteroid's rotation period), and "sparse' lightcurves (typified by survey data, which might gather only a few – or even just one – data point per asteroid rotation, but may observe several apparitions, providing a wide span of time). The analytical community has found ways to take advantage of the "spares" lightcurves, combining them with "dense" lightcurves, to create excellent shape models and rotation vectors.

The second advance reported here relates to characterizing asteroid families and populations. The authors report new shape and rotation axis solutions for 80 asteroids. Of these, 16 were determined using *only* sparse lightcurve sets. The data shows a compelling tendency for the spin axes of small bodies to be normal to the ecliptic, with a small preference for prograde rotation and an almost complete lack of small bodies having spin vectors close to the ecliptic plane. In contrast, larger bodies seem to have spin axes distributed almost uniformly over the celestial sphere.

Those of you who gather asteroid lightcurves probably already know that it is valuable to gather a complete, dense lightcurve even if the rotation period of the asteroid is already well-known. Lightcurve-inversion algorithms can determine remarkably-good models of the shape of an asteroid, but they require lightcurves from different aspect angles as the input data; and this usually means gathering lightcurves from several different apparitions. Lightcurve inversion can also give a quite accurate estimate of the asteroid's pole of rotation, which may not be as picturesque as a shape model, but is at least as important from the standpoint of science and understanding of the evolution of asteroid families.

It is also important that you make your lightcurve data available to researchers doing studies like this – so please provide your data to the ALCDEF database. See the April 2011 SAS Newsletter (v.9 no.2) for details, or go to the ALCDEF page at the Minor Planet Center.

V2368 Ophiuchi: an eclipsing and double-lined spectroscopic binary used as a photometric comparison star for U Ophiuchi
by P. Harmanec, et al
Astronomy & Astrophysics, v 531, article A49 (2011)

This study had two objectives. The first was to gather time-series photometry from several small telescopes (ranging from 40 cm (=16-in) to 85 cm (=33-in) to create a lightcurve of this suspected eclipsing-binary, thereby determining its period and providing a basis for correcting observations of U Oph that had used it as a comp star. The result was pretty interesting. The star has a period of P≈ 38.3 d, and a very eccentric orbit; the secondary eclipse occurs at orbital phase φ≈ -0.2. The eclipses are about 0.2 mag deep in V-band.

The second objective was to gather a radial-velocity curve (using telescopes in the 1- to 2-meter range). This was also successful, enabling the authors to make a first-cut model of the system. However, they note that their resulting model does not agree with stellar evolution predictions (in terms of sizes, colors and temperatures of the stars), so it appears that there may still be more to learn here.

SDSS J162520.29+120308.7 – a new SU Ursae Majoris star in the period gap

by A. Olech, et al

Astronomy & Astrophysics, v. 532, article A64 (2011)

The "et al" in the author list includes several "backyard scientists" who will be familiar to many of you (B. Staels, S. Lowther, D. Boyd, R. Koff) as well as Dr. Joe Patterson from the Center for Backyard Astrophysics.

The star is a cataclysmic variable: a white dwarf paired with a main-sequence star that is shedding material into an accretion disk. Occasional outbursts (probably related to instability in the accretion disk) can increase the brightness by several magnitudes, and complex, very-rapid brightness fluctuations are observed during outburst. This particular star is an SU UMa type – the orbital period is short – less than 2.5 hours – and the system undergoes two types of outbursts ("normal" and "superoutburst").

The orbital period of the pair appears to be a critical parameter in the theory of evolution of these pairs, and in the phenomenon of cataclysmic variability. In particular, there is a "gap" in the observed orbital periods of CV's: the CV (or dwarf nova) phenomenon is rarely observed in systems with periods between 2 and 3 hours (longer or shorter periods both display cataclysmic variability, albeit with somewhat different physics involved). CV's that are passing through this "period gap" are therefore of special interest as tests of the theories of these systems.

The investigators here combined data from the Catalina Real-Time Transient Survey with a worldwide campaign that used a variety of telescopes, all but two of which were 40-cm (16-in) or less aperture, to compile a detailed lightcurve of the July 2010 superoutburst. The unfiltered photometry shows the evolution of superhumps, with their period and amplitude gradually changing as the outburst progresses. Because of the completeness of the lightcurve, the small-telescope photometric data enabled an O-C ("observed minus calculated") analysis that showed how the period of the superhumps (and their amplitude) changes in a complex way throughout the outburst.

The researchers conducted a follow-up study after the outburst had completed, to examine its photometric activity during quiescence, and attempt to detect the signature of its orbital period. This study was done with a 60-cm (24-in) and a 1-m (40-in) telescope, for which the then-18.5 magnitude star was a challenging target. Despite the target's faintness at quiescence (about 18.5 mag), continued brightness fluctuations were observed, but the orbital signature was not detected.

Superhumps and grazing eclipses in the dwarf nova BG Arietis

by Jeremy Shears, David Boyd, Tut Campbell, Franz-Josef Hambsch, Enrique de Miguel, Ian Miller, Etienne Morelle, George Roberts, Richard Sabo and Bart Staels

Accepted for publication in the Journal of the British Astronomical Association

preprint at:

http://arxiv.org/PS_cache/arxiv/pdf/1109/1109.4133.pdf

I've listed the complete author list, because you may recognize many of them as well-respected amateur scientists, and members or friends of the SAS. Together, they used telescopes in the range of 20-cm to 43-cm (8-in to 17-in) aperture and CCDs to provide quite complete descriptions of the 2009 and 2010 outbursts of this cataclysmic variable (which, like the target of the preceding paper, is of the SU UMa type). These systems display a variety of photometric variabilities, on fairly quick time-scales (a few hours to a few minutes).

During both episodes they detected shallow eclipses, Δm ≈ 0.06 to 0.13 mag, that are apparently grazing eclipses of the accretion disk.

In the 2009 outburst, the system rapidly brightened by over 5 magnitudes, and showed clear signatures of "superhumps" – periodic brightness oscillations with period of 2 hr and amplitude as high as 0.36 mag (p-p) at the beginning of the outburst. Interestingly, the superhump period appears to have changed noticeably during the fading phase of the outburst.

The more complete photometric coverage of the 2010 outburst shows what appears to be a "precursor" burst lasting about a day, followed by a more-or-less normal superoutburst. During the precursor outburst, there was no periodic brightness signal. Superhumps gradually developed during the first three days of the subsequent superoutburst.

This star deserves ongoing monitoring. The authors note that the interval between the 2009 and 2010 outbursts was 15 months; and the next previous known outburst (in 2007) occurred 30 months earlier. This suggests the possibility of a rough periodicity of 15 months between outbursts (and by implication, one "missed" outburst in 2008).

New Earth-based absolute photometry of the Moon

by Yu. I. Velikodsky, et al.

Icarus, vol 214, p 30-45 (2011)

Remember John Hoot's talks from the SAS Symposium a few years ago, about using a commercial DSLR for photometry? This idea (although not credited to John) has now appeared in a major journal.

The albedo and phase function of the Moon's reflected light is important for a variety of reasons; and you might think that it is well-understood. These are very difficult measurements to make, because of the huge dynamic range involved (e.g. comparing sunlight to moonlight, or moonlight to starlight, to fine accuracy), and other effects, but it is important to know these observational properties of the lunar surface in order to calibrate or independently verify Earth- and space-based measurements. It turns out that there are several independent data sets of lunar photometry, which disagree by up to 20 – 30%.

The authors here developed a method to use a 15-cm (6-in) refractor and a Canon DSLR (EOS 300D) to observe both the Moon and the Sun (through a 5-mm sub-aperture plus neutral-density filter), to determine the Moon's albedo and phase function in the camera's three spectral bands. They create maps of lunar albedo (which naturally differs according to the terrain) as well as a detailed phase curve down to about 2 degrees phase; and they discuss the reasons for differences between their results and various previous investigations.

One aspect of this paper that may be of particular value to backyard scientists is their efforts to characterize the properties of the Canon DSLR camera. They found that dark current was negligible for exposures up to 30s; they provide detailed spectral-response curves for the R, G, and B pixels; and they did a careful study of the camera's photometric non- linearity. They found that the camera is very nonlinear if the signal is greater than 3000 ADU; but that it is linear to within about 2% below this signal. They also found that the camera's pre-programmed exposure intervals are somewhat unreliable – a 20-sec exposure is not exactly twice as long as a 10-sec exposure, for example. Therefore, it is dangerous to inter-compare data taken with different exposure durations; and if you are going to do so, you probably need to characterize your camera's exposure non-linearity.

A clear night on Cerro Tololo. Photo by Bob Stephens.

Radar and photometric observations and shape modeling of contact binary near-Earth Asteroid (8567) 1996 HW1

by Christopher Magre, et al.

Icarus, vol 214, p 210-227 (2011)

The "et al" in the list of authors includes amateur astronomers Donald Pray and David Higgins, and SAS' good friend Lance Benner (from JPL).

The authors report on an (apparently successful) effort to combine radar and lightcurve data, to establish the shape, rotation axis, and other physical properties of this asteroid. It appears to be a "bifurcated" object, possibly a contact-binary, with two well-defined lobes in contact, and a fairly high level of internal porosity. The great number of independent parameters in such a model-fitting procedure makes it a mathematically challenging project. The authors found it necessary to include some "eyeball" judgment of the significance of some data, as well as subjective assessment of the physical plausibility of certain combinations of parameters in their fitting procedure. Although the end result is an excellent match to the data, and the authors could find no evidence for ambiguity in the solution, they note that it is difficult to prove that the derived shape model is unique.

The authors note that the asteroid's orbit precludes getting any more radar observations during this century; but that additional lightcurve observations can be used to refine (or refute) the present model of this asteroid. The upcoming apparition in October-December 2011, when the asteroid will reach magnitude ≈ 16.3, is critical, since it is the last good lightcurve opportunity until 2046. If your equipment can reach this deep, please put this asteroid on your observing list. (Details are given in the Minor Planet Bulletin, Vol. 38 No. 4, Oct-Dec 2011, p. 228).

A Comprehensive study of six Algol type binaries

by A. Liakos, et al.

New Astronomy, v. 16, p. 530-538 (2011)

Small-telescope researchers have a long history of monitoring eclipsing binaries to determine the times of minimum light; and such timings can be combined into an O-C curve that describes how the pair's orbital period changes on time scales of decades (or longer). The modern amateur astronomer can also conduct photometric study to map the complete lightcurve of an eclipsing binary pair; and (as Dr. Terrell explained at his SAS-2011 Workshop) these lightcurves can be transformed into quite accurate models of the shape, separation, and relative temperatures of the two stars.

The present study is an investigation of combining these two aspects of eclipsing binaries. The authors selected six pairs that have shown "interesting" changes in their O-C curves, prepared full lightcurves and then modeled the systems with particular attention to the (possible) contribution of third light. Complete multi-color lightcurves (BVRI) were constructed from CCD observations that used a 20-cm (8-in) and a 40-cm (16-in) telescope. Part of the impetus for this effort was the possibility that it might help distinguish between the several possible causes of O-C variation (third body light-time effect, mass transfer, mass loss, magnetic activity, and others). In addition, a couple of the systems were suspected of containing a pulsating variable star as one of the pair, so the authors searched for evidence of such regular pulsations. As it turned out, no evidence for pulsations was found in any of the systems studied.

Lightcurve modeling was done with PHOEBE (the same program as Dr. Terrell described in his Workshop), and q-search was used to estimate a photometric mass ratio (since no radial velocity data was available for any of the targets).

For FG Gem, the lightcurve model predicts a semi-detached system, with a third component contributing 4.8% of system luminosity. The O-C analysis implies a third body, in a 16.9-year orbit, having a mass of 0.82 solar masses, which – if it is main-sequence star – would contribute 4.8% of the system luminosity: that is, perfect consistency between the lightcurve and O-C analyses. Neat! Similar consistency was found in the case of UU Leo (in which case the third body contributes 11% of system luminosity, in both the O-C and lightcurve models). Hence, these two are almost certainly triple-star systems.

In the cases of CF Tau, DP Cep, and AW Vul, the lightcurve model and O-C analysis both indicated third bodies, but they were not as nicely consistent with each other.

For AL Gem, there was a complete disagreement: between the two analyses: the lightcurve model was best fit with a 12.5% third-light, while the O-C analysis indicated a third body of such small mass that it would contribute only 0.2% of system luminosity. So, something else is probably going on in this system.

The detached eclipsing binary TX Her revisited
by A. Erdem, et al
New Astronomy, v. 16, p. 498-502 (2011)

Here is a nice example of the great power of combined lightcurve, radial velocity, and O-C analysis of an eclipsing binary system. The authors used a 40-cm (16-in) telescope and CCD to determine the complete BVRI lightcurve. Radial velocity data was available (from other studies), so the combined lightcurve + radial velocity were modeled with the Wilson-DeVinney code. The system turns out to be a detached system with period P≈ 2.06 d. The lightcurve analysis does not indicate any noticeable "third light" contribution.

An O-C analysis (from over a century of timings!) gives compelling evidence for a small body in a ≈51.9-yr eccentric orbit around the main pair. This body is small enough that (assuming it is a main-sequence star) it will make negligible contribution to the system's luminosity. So, the lightcurve and the O-C analyses are consistent in this regard.

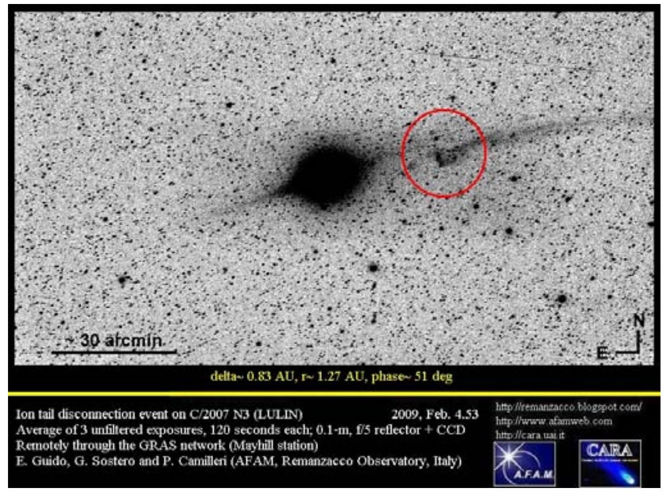
A Disconnection Event of Comet Lulin
by SHI Jian-chun, et al
Chinese Astronomy and Astrophysics, v. 35, p. 295-303 (2011)

A stereotypical comet image displays the nucleus with a dust tail and a plasma tail streaming out from it. In a disconnection event, the plasma tail breaks apart from the nucleus and moves away (roughly in the anti-solar direction). There are several competing theories about the cause of these disconnection events, but most invoke some sort of interacting with the solar wind (and of course, there is no guarantee that there is a single explanation for all such disconnection events).

The authors used a 16-cm (6-in) telescope and ASA 1600 film (!) to photograph the comet; and then digitally processed the images to separate the R and B images and study the disconnection event. They find evidence of two separate disconnection events on consecutive days (Feb 3 and Feb 4, 2009), and their measurements show that the disconnected tail accelerates away from the comet's nucleus (a≈ several m/s^2).

They then evaluate the state of the solar wind at the time of the disconnection event, as recorded by the STEREO-A spacecraft. This shows that the density and speed of the solar wind was essentially stable – it wasn't creating any significant buffeting or pressure changes on the comet at the time of the disconnection event. There was, however, a series of 3 coronal mass ejections that were timed just about right to "hit" the comet at the onset of the disconnection event. Although somewhat circumstantial, the authors prefer this explanation for the observed disconnection event.

This makes me wonder if it might be fruitful for someone to undertake a project of time-series imagery of the next bright comet, and correlate the images with space weather data on the state of the solar wind and CME's.



Comet Lulin's Feb 2009 disconnection event, imaged by E. Guido et al (source: http://www.spaceweather.com/comets/lulin/04feb09/Ernesto-Guido-Giovanni-Sostero-a-Paul-Camilleri1.jpg)

Optical Variability and Colour Behaviour of 3C 345
by Jianghua Wu, et al
accepted by Mon. Not. Royal Astro. Soc.
preprint at
http://arxiv.org/PS_cache/arxiv/pdf/1108/1108.1020v1.pdf

Several months ago, the AAVSO sent an alert requesting photometry of Quasars 3C 273 and 3C 279, to support a study of the varying spectral-energy distribution of these objects. Those of you who participated in that project may be particularly interested in this paper. The authors used a 60/90-cm (24/35-in) telescope for CCD photometry of the quasar 3C 345 over a long observing interval, to characterize the quasar's brightness and color changes. The quasar is nominally about 16th magnitude, but displays significant brightness changes on all time scales. They observed two "intra-day optical variations", in which it changed by several tenths of a magnitude in just a couple of hours. They also saw longer-term brightness changes in which it changed by more than a full magnitude, over a few months.

They followed the object in 5 different color-bands, that are much narrower than the Johnson-Cousins or SDSS filter bandwidths: the BATC filter set ranges from near-UV 4200 Å to near-IR 9173 Å. This multi-color data enabled the authors to investigate the color-variability of the quasar. Previous investigations have given varying results in this regard, some observers finding a "bluer while brighter" trend, while others seeing the opposite – "redder when brighter." It turns out that both may be correct. The present authors suggest that the chromaticity is expected to depend on the specific spectral bands and colors used. if the bands are at short optical wavelength (e.g. UBV), then the brightness is dominated by "less variable emission features" and a "redder-while-brighter" chromaticity is expected. But if the color is based on longer wavelengths (e.g. VRI), then the "non-thermal continuum" dominates the signal, and a "bluer when brighter" chromaticity is expected. These trends are, indeed, what the authors find.

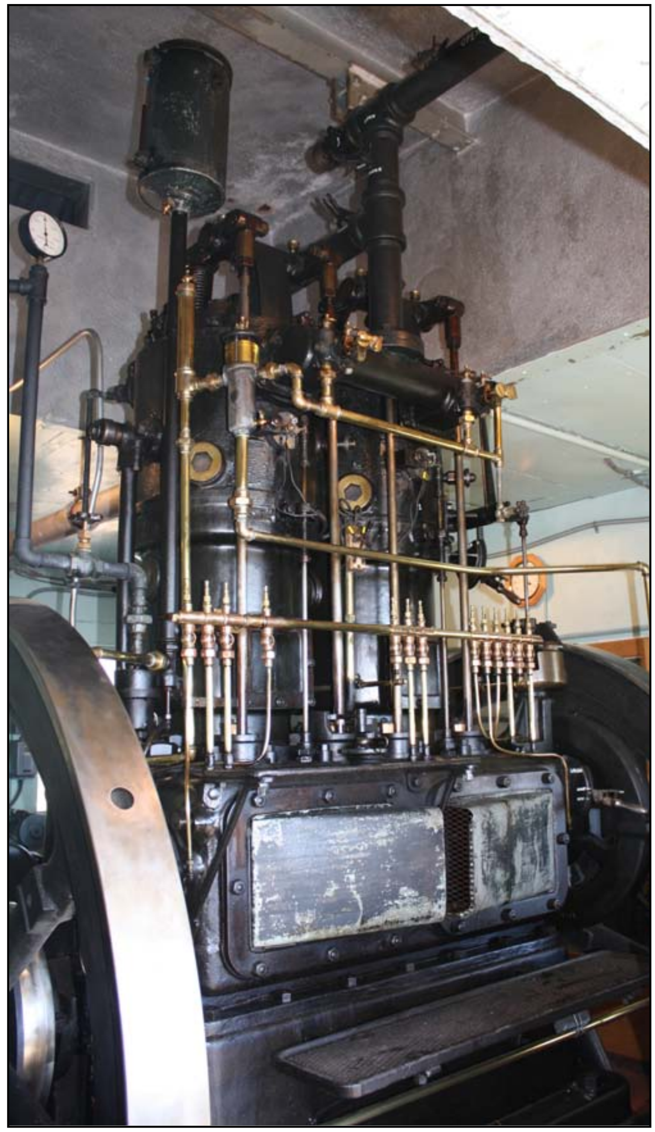
The present study encompassed 53 nights over a 4-year period, so that are huge gaps in their data that leave room for all sorts of object activity in between the data points. Further, the large error-bars on their color data suggest that a replication of this study might be a worthwhile endeavor. Such a replication might be within the range of some SAS photometrists. Imagine, for example, a multi-year project of nightly multi-color time-series photometry (say, u-g-r-i-z or B-V-R-I) to map "intra-night optical variations", secular brightness changes, and the color changes corresponding to both of these effects.

A new flare star member candidate in the Pleiades cluster
by M. Moualla, et al
Astron. Nachr. / AN 999, No. 88, p. 789 – 795 (2011)
preprint at:
http://arxiv.org/PS_cache/arxiv/pdf/1108/1108.6278v1.pdf

This paper reports on a project to monitor a field adjacent to the Pleiades, searching for new low-mass members. In the process, the authors swept up a previously-unrecognized flare star that is most likely a member of the Pleiades cluster. In the course of their survey, two different telescopes were used for CCD imaging: a 25-cm (10-in) and a 60-cm (24-in). Images and photometry were mostly in R-band, with exposures generally 60- or 90-sec.

Their “flare star” is normally about V≈17.3. On one night, their time-series photometry showed the star constant at its normal brightness for a few hours, then suddenly spiking by about one magnitude, and fading over the next half-hour to return to its normal brightness. The rise is incredibly rapid – about 2 minutes from “normal” to “peak brightness” – and after peaking the star began an immediate (roughly exponential) fade lasting a bit less than an hour. There might have been a slight, short “negative flare” (fade) just before the main flare, but it only lasts one or two images, so its statistical significance is only 2.6σ.

The authors observed this field for 132 hours, and saw just the one flare, so there is no data on the probability of witnessing a repeat performance – but it is probably within reach of some of you, and would be quite an interesting event to record. Is any one up to the challenge?



How do you provide electrical power for your remote observatory? When Mt Wilson Observatory was first built, electrical power was provided by a great bank of batteries, and they were charged by this wonderful two-piston motor-generator. The effluent flow from its open-cycle water-cooling system was fed into the observatory’s only hot shower! Photo by Bob Buchheim.

Brian Warner had a large and engaged audience for the "Measuring the Universe" seminar at PATS-2011.

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