News from the Society for Astronomical Sciences
Vol. 9 No. 3 (July, 2011)

Report from the 2011 Symposium

For three decades, the Society for Astronomical Sciences has supported small telescope science, encouraged amateur research, and facilitated pro-am collaboration. On May 24-26, more than one hundred participants in the 30th anniversary SAS Symposium heard presentations covering a wide range of astronomical topics, reaching from the laboratory to the distant cosmos.

A "family portrait" of 2009 TC3, at the SAS-2011 Symposium. Richard Kowalski (on left) discovered the asteroid while it was still in space, on a collision course with Earth. Dr. Peter Jenniskens (on right) organized an expedition that recovered fragments of the asteroid from the desert of northern Sudan. Dr. Jenniskens is holding a piece of the asteroid. Photo by Earl Wilson.

From Planets to Galaxies

Sky & Telescope Editor-in-Chief Bob Naeye opened the technical session with a review of the amateur contributions to exoplanet discovery and research through monitoring of transits and micro-lensing events.

R. Jay GaBany described his participation as an astro-imager in the search for evidence of galactic mergers. His exquisite deep images taken with his 24-inch telescope displayed the diverse patterns of star streams that can be left behind when a dwarf galaxy is disrupted and absorbed by a larger galaxy. He also noted that not all faint structures are evidence of galactic mergers: the faint "loop" structure near M-81 is actually foreground "galactic cirrus" in our own Milky Way masquerading as a faux tidal loop.

Education and Outreach

Several papers related to education and outreach were presented. Debra Ceravolo applied her expertise in the generation and perception of colors, to describe a new method of merging narrow-band (e.g. Hα) and broad-band (e.g. RGB) images into a natural-color image that displays enhanced detail without glaring false colors. She is a strong advocate of using "natural" colors, rather than the potentially-misleading false-color display of astronomical objects in education and public outreach.

Richard Berry presented his investigation of an imaginative challenge: "Can the proper motion of Barnard's Star be detected in a project lasting only a few nights? Astoundingly, the answer is "yes". He showed how precision of a few hundredths of an arc-second in relative astrometry can be achieved with a small telescope and CCD imager.

Robert Buchheim described his project to replicate Tycho's use of diurnal parallax to determine the distance to the Moon by using a DSLR camera and its standard lens. He then applied a 0.28-m (11-inch) telescope and CCD imager to determine the distance to an steroid, achieving respectable 15% accuracy.

Small-telescope science provides a wonderful adjunct to college classes, and not just for astronomy students. Doug Walker injected an astronomy project into his math class at Estrella College, giving his students a "hands-on" experience in conducting observations, making measurements, and applying mathematical analysis to their data. His students presented their project of measuring several visual binary stars, using both a reticle eyepiece and a CCD video camera. Their data will be submitted to the Journal of Double Star Observations for entry into the Washington Double Star Catalog.

While most small-telescope research is done with CCD imagers specially-designed for astronomy, the modern, inexpensive, commercial DSLR and "point and shoot" cameras have remarkable capabilities. John Hoot described the very advanced technology in these popular cameras, explaining how the advanced features can be used to conduct research and educational projects such as meteor parallax measurement, satellite tracking, and nova searches.

Optics, Instruments and Methods

Wide-field survey telescopes present unique challenges in optical design, but also offer the potential for making new kinds of observations. Peter Ceravolo explained his design of an instrument for detecting asteroid entry, which demands good image quality over a very large field of view. The keys to his optical system are its historical heritage (it is in some respects a folded, reflective version of a photographic lens), the importance of correct placement of the aperture stop (not at the primary optical element), and control of internal reflections (especially from the surface of the focal plane; front-illuminated CCDs are surprisingly reflective!)

Tom Smith presented a valuable description of the method for flat fielding CCD images that was developed for the AAVSO All-Sky Photometric Survey. This information will be useful to many small-telescope photometrists who want to ensure the highest quality and accuracy in their data. One surprisingly successful experiment was the use of Styrofoam insulation sheet as the reflective target. This material turns out to provide a wonderfully true white and Lambertian reflective surface.

Many variable star observers have struggled with determining their system's color transforms in order to achieve the best-possible consistency in CCD photometry. This struggle is partly mathematical, but mostly observational, since determining the transforms and second-order extinction requires observation of standard stars under near-photometric conditions on at least one or two nights per year (and these nights can be rare indeed for many backyard scientists). A new method of determining transforms and secondary extinction terms was explained by David Boyd. His method is less restrictive than previous approaches and offers great improvement in determining the night-to-night zero-points for asteroid lightcurves.

New Frontiers

Light pollution does not only impact astronomers. It has also been implicated in a variety of adverse ecological and physiological trends, including disruption of birds' migratory patterns and altering circadian rhythms. Unfortunately, as noted by Eric and Erin Craine, research into the effects of light-pollution is hampered by a paucity of quantitative data on sky brightness and its secular trends. They described their development of a portable light-monitor system and associated archive that can record both time-based and geographic variations in sky brightness. This system should be useful for both scientific investigations and policy assessments related to light control, such as demonstrating the impact of new property uses and assessing the light-control value of various regulatory regimes.

One of the difficult management challenges facing large professional observatories is the handling of transient "targets of opportunity" – should the telescope be diverted from an approved program in order to focus on a newly-discovered transient event? Private observatories can be supremely flexible in this regard. Near-Earth objects, supernovae, and other unpredictable events can be immediately put under intense, long-term observation on the owner's sole initiative. As Bob Koff described, opportunities abound for backyard scientists, as large surveys collect far more transient events than can possibly be studied by professional astronomers. He described the requirements for making credible observations of targets of opportunity along with sources of prompt notification of transients (one of the participants noted that "there's an 'app' for that!").

Automated and Robotic Telescopes

The very first robotic telescope may have been the pneumatically-operated mechanism that commanded multiple cameras to record a solar eclipse in 1901. Dr. Russ Genet described how this venerable heritage is being advanced, with progress on the development of low-cost, portable, meter-class telescopes for photometric and occultation studies.

Tom Smith and Tom Krajci presented a half-day workshop on various approaches (and potential pitfalls) in automating your observing equipment so that it robotically carries on observations and data collection, while the observer sleeps. Their lessons were useful for both "backyard" installations (such as Krajci's) and remotely-operated systems (such as Smith's).

Photometry

Jerry Horne discussed an interesting example of data mining in which he re-examined his own data from several years ago that happened to coincide with the Kepler field. He found one probable Cepheid variable and some interesting changes in several stars, between his data epoch and Kepler's recent lightcurves.

Gary Vander Haagen noted that "there are probably astrophysical processes that generate high-frequency brightness variability, but we don't know about them because we don't have the ability to monitor very fast fluctuations". He described how the silicon photomultiplier can provide the needed sensor, with some important advantages over the conventional photomultiplier. The Silicon PM is rugged, inexpensive, immune to magnetic fields, and only about 5X less sensitive that a conventional PMT. With appropriate filtering of the signal, it appears that most atmospheric scintillation noise can be removed from the data.

Eclipsing Binaries

Dr. Dirk Terrell presented a half-day class on eclipsing binary stars, covering their characteristics and their main observational features. He then presented an example of determining the properties of an eclipsing system by matching a theoretical lightcurve to observational data, using the PHOEBE code. Noting that many interesting systems are within the range of backyard scientists, Dr. Terrell concluded with a clear message: "You will be doing a service to science by taking the data, making the lightcurve, doing the analysis, and publishing your results."

Epsilon Aurigae's eclipse has generated many opportunities for small-telescope science, since it is far too bright for large observatories to deal with. Gary Cole presented new results from his ongoing campaign of polarimetric monitoring of the system throughout this eclipse. His data are of special value because his is one of only three known polarimetric data sets (one of which was largely clouded out during the critical period of third contact). His data show that the third-contact change in polarization during this eclipse is almost identical to the polarization observations made during the last eclipse – offering an important constraint for the theorists.

Spectroscopy
With the increasing availability of modest-cost, high-quality commercial spectroscopic instruments, amateur astronomers are contributing to several types of research activities. Olivier Thizy described the European scene in pro-am spectroscopic collaboration, which is both robust and energetic. He noted that one of the key elements to effective pro-am collaboration is for the professional astronomer to explain why the object/project is important and interesting. There are so many potential targets for small-telescope research that without such guidance, the amateur-research community might skim right over significant targets. He made particular note of the July 2011 periastron of delta-Scorpii, which should be a high-priority target for both photometric and spectroscopic observation. This system comprises a Be star with a companion in an eccentric orbit, and periastron may generate all sorts of interesting phenomena.

The “Be” stars are also the focus of California amateur Robert Gill, who described his home-made Littrow spectrograph. This inexpensive instrument should have sufficient resolving power to measure many of the features of the “Be” stars (e.g. high rotation speed of the circumstellar disk, and non-radial pulsations) with his 14-inch telescope.

Asteroids
Asteroids are an important area of solar system studies. A large majority of asteroid lightcurves are now generated by backyard scientists, and those lightcurves are being used for an expanding array of studies (including rotation period, shape modeling, and evidence of subtle non-gravitational forces). This emphasizes the need for an archive of asteroid photometric data. Brian Warner described the Asteroid Lightcurve Data Exchange Format (ALCDEF), and noted that the Minor Planet Center has agreed to host the archive, thereby ensuring its long-term survival and easy availability to current and future researchers. All asteroid photometrists were encouraged to submit their data to this archive.

Dr. Lance Benner described the current status and recent results of radar observations of near-Earth asteroids from Arecibo and Goldstone. There is important synergy between radar observations and optical lightcurve data to fully characterize these objects. He particularly highlighted the case of 2005 YU55, which will pass inside the Moon’s orbit this coming November, reaching 13th magnitude. The rotation period of this asteroid is currently unknown. Small-telescope photometrists were encouraged to put this event into their observing plans.

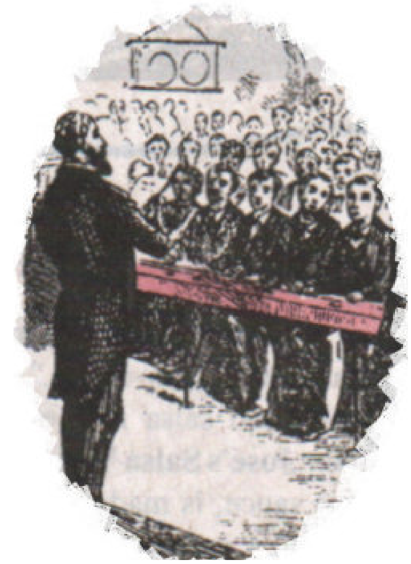
Richard Kowalski provided an overview of the Catalina Sky Survey and Catalina Real-time Transit Survey. The CSS is the most efficient search for near-Earth objects, having accounted for 65% of the NEO discoveries in 2010. One feature of the CSS is that its data are publicly available within minutes of each new discovery, which facilitates immediate follow-up and more detailed study by other observers, including amateur researchers. He noted that many of the supernovae that CSS discovers every night are in need of spectrographic follow-up, which might be within the range of some advanced amateur researchers. He also shared the story of his discovery of the Earth-impacting asteroid 2008 TC3, setting the stage for the after-dinner lecture.

The Symposium was capped by the Keynote lecture given by Dr. Peter Jenniskens, who described the observations of 2008 TC3’s atmospheric entry, and his subsequent expeditions to search for and recover samples of the asteroid from the strewn field in northern Sudan. This was a wonderful story that began in outer space, continued on the ground in an exotic locale, and is still ongoing in laboratories around the world to tease out the chemistry, petrology, and history of this remarkable object.

A Bright Future
Astronomy is special in many ways. One of the special features of our science is that making new discoveries and valuable observations is not solely the province of professional astronomers. As the presenters and audience at SAS demonstrated, “backyard scientists” with modest telescopes and diligent efforts are making important contributions to our understanding of the universe.

Videos of the technical paper presentations from the Symposium are available on the SAS website (www.SocAstroSci.org), along with links to the Proceedings.

The next SAS Symposium will be a joint meeting with the American Association of Variable Star Observers (AAVSO), to be held at Big Bear, CA, on May 22-23-24, 2012.



“... providing that the motion is under a constant force, the kinematics of the situation dictate that, as molecular friction resists the momentum of the sheer component, intolerable vectors develop in a semirigid medium ... and that, gentlemen, is how the cookie crumbles!”

SAS in *Sky & Telescope* and on YouTube:

Don’t overlook the video interview in which Robert Naeye (Editor in Chief of Sky & Tel) interviews Robert Stephens and Brian Warner about amateur research and SAS. It is at:

http://www.youtube.com/watch?v=A5mLjKrlk3g

SAS Election Results

The following candidates were approved by the Membership to serve as Directors from June 2, 2011 through June 1, 2014:

LeRoy Snyder
Robert Stephens
Robert Gill
Brian Warner
Jerry Foote
Dale Mais
Robert Buchheim

Congratulations to all of these SAS Committee members!

Workshops at 2011 SAS Symposium

There were about 50 participants in each of the Workshops at the 2011 SAS Symposium. The subjects this year were:

"Hands-on Analysis of Eclipsing Binary Light Curves", presented by Dirk Terrell.

"Developing and Using Your Remote Observatory", presented by Tom Krajci and Tom Smith.

There seems to be some interest in making the videos of these workshops available. The SAS Committee is deliberating about the issues, merits, and method of doing that. Look for more information in the future.

Observations Needed: δ-Scorpii

During the 2011 SAS Symposium, Olivier Thizy noted that the eccentric-orbit eclipsing system delta-Scorpii is predicted to pass through periastron in mid-2011. The timing of periastron is uncertain, so the time to begin your observations is *now*. Hopefully spectroscopic observations of the star during this year's periastron will provide a solid determination of the orbital period.

A discussion of the star, the observing campaign, and guidance on making spectroscopic observations can be found at http://www.stsci.de/convento/pdf/deltaSco2011.pdf.

This is a bright star. It varies between V≈ 2.4 to 1.6, so it is a fine target for small-telescope spectroscopy.

The 2011 SAS Symposium brought over one hundred people to Big Bear, CA to discuss recent astronomical research projects.

Correspondence:

Searching a Catalog of FITS Images

In the January 2011 Newsletter, we asked for ideas on "how to catalog and search an archive of FITS images, by their RA, Dec and time coordinates." This subject comes up when there is a call for "pre-discovery" images of a field, or "pre-recovery" images of a transient or moving object. For example, a soon-to-be-published paper describes the successful search for "pre-discovery" images of asteroid P/2010 A2, whose outburst was presumably caused by a collision in the asteroid belt (see David Jewitt, et al: "Pre-Discovery Observations of Disrupting Asteroid P/2010 A2", with preprint at http://arxiv.org/PS_cache/arxiv/pdf/1105/1105.3512v1.pdf).

Many astro-imagers and small-telescope researchers have huge collections of CCD images that could be valuable to such investigations, but the challenge of searching through them to find images that contain a specific position – or a specific moving object – can be painfully tedious.

Brian Warner reports that he has added a routine to the latest release of MPO Canopus that solves this challenge. The command UTILITIES | IMAGING PROCESSING | GET IMAGE INFO extracts the relevant information from one or more images in a folder, and creates a tab-delimited text file, with one row per image and columns containing:

parameter	*meaning*
Object	from OBJECT keyword in FITS header
JD	UT, mid-exposure
Date	UT, yyyy/mm/dd format
Time	UT, hh:mm:ss 24-hour format
Exp	exposure in seconds
ImageRA	RA of image center; Canopus adds this after an AutoMatch
ImageDec	Dec of image center; Canopus adds this after an AutoMatch
ObjectRA	RA of object; Connections adds this based on scope position
ObjectDec	Dec of object; Connections adds this based on scope position

The reported date/time are based on the Canopus configuration settings regarding header information, i.e. if the header time is start/middle/end and the UT Offset. In short, the date/time found here are the same as those used in the period search engine as the mid-exposure of the image.

The ObjectRA/Dec added by MPO Connections presume that the scope's position is that of the object. (We know that this is not always the case, depending on how your system operates.)

You might, for example, run this routine just before you archive a collection to DVD or backup drive. The text file containing the file header information can be concatenated onto an Excel spreadsheet, so that you will have a single file containing the parameters for every image in your archive. A simple "search" command can then find images that contain a desired RA/Dec location. A somewhat more complex command can find images that are near to a trajectory of interest.

If you use this method to (pre) discover something interesting, please send us a note – the inquiring minds of SAS members would like to know!

Small-Telescope Astronomical Science in the News
April – June 2011

compiled by Bob Buchheim

I continue to be impressed by the breadth of astronomical research that is being done with small telescopes (less than 1 meter aperture). The majority of the projects reported below could have been done by SAS members (indeed, some of you contributed to them). So, don't be discouraged by thinking that your equipment is too modest, or that your skill is too immature. There are targets within the range of almost any equipment. The best way to improve your skill is to exercise it, and stretch your limits. Remember Brian Warner's advice during the closing remarks of the 2010 SAS Symposium: "Do something with that telescope!"

If you have comments on any of the research projects noted below, or other suggestion, please do let me know (rbuchheim@earthlink.net). I would especially like to hear stories of how this column motivated you to attempt some observation, and what you learned (either positive or problematic).

SS Ari: a shallow-contact close binary system
by Liu L., Qian S.-B., et al
Astrophys Space Sci (2009) 321: 19-35
preprint at http://arxiv.org/abs/1103.2004v1

SS Ari is a 10th magnitude eclipsing binary star (W Uma type, although it may be barely overcontact) that has been noted for many years for its large O-C deviations (amounting to ± 1 hour, compared to a linear ephemeris). A great many times of minimum have been collected over the years, but they present a confusing picture of the orbit and orbital evolution. The present authors used a 60-cm (24-in) telescope to determine a complete R-band lightcurve and gather a couple of more times of minimum light. They then evaluated two possible models of the system using the WIlson-DeVinney code. In one model, the W Uma pair has a slightly eccentric orbit (so that some of the O-C variation is explained as apsidal motion), and the brighter star has a sizable dark spot. The O-C data compared to this model still shows a cyclic variation, which is most easily explained as being due to the light-time effect of a third body. However, This body would be about 8 solar masses in a ~87 year orbit. Unfortunately, despite quite a few careful studies over the years, no one has seen any photometric or spectroscopic evidence of this putative body; the authors note that his is hard to explain.

The second model (which they favor) assumes that the W Uma pair has settled into a circular orbit, and that some mechanism of angular momentum loss (e.g. stellar wind) is causing the period to change continuously. This model also displays a cyclic residual in the O-C curve, which can be explained as a light-time effect. In this case, however, the putative third body is only 0.3 solar masses (in a ~40 year orbit). It is not a surprise that such a small/faint body does not show up on photometric or spectroscopic data.

What to do now? Certainly small-telescope observers should continue to collect and publish times of minimum light (both primary and secondary minima). And perhaps a multi-band photometric study and an updated spectroscopic study (radial velocity and spectral types) would be useful to better understand this system.

High Fill-Out, Extreme Mass Ratio Overcontact Binary Systems. X. The new discovered binary XY Leonis Minoris
by Qian S.-B., Liu L., et al
preprint at http://arxiv.org/abs/1103.2006v1

Over the years, there have been a few serendipitous discoveries of new variable stars during asteroid lightcurve projects (e.g. when a chosen "comp star" is seen to vary in brightness). The star XY Leo was discovered by Bernasconi and Behrend in this way, and announced in 2003. It is a very short-period overcontact W Uma binary, with a period of about 10 hours.

The present authors report multi-color lightcurves (B, V, R, I) and times of minimum, all gathered with an 85-cm (33-in) telescope and CCD imager. They modeled this data with the Wilson-DeVinney code, to conclude that the mass ratio is q= 0.16 and that both stars have large dark spots. The analysis of the times of minimum indicates that the period is changing, at a constant rate that is consistent with typical expectations of such close pairs.

Asteroid lightcurve photometrists should take note of the discovery circumstances of this star. MPO Canopus includes a utility that will search your nightly images to identify candidate variable stars, so that you don't miss the chance to either (a) characterize variables that happen to be in the same field as your asteroid, or (b) announce our own discovery of a new variable star.

Period changes and four color light curves of the active overcontact binary V396 Monocerotis
by Liu L., Qian S.-B., et al
The Astronomical Journal, 141:44 (10pp), 2011 February
preprint at http://arxiv.org/abs/1103.2010v1

V396 Mon is a W Uma type contact binary. Qian has suggested that there is a relationship between mass ratio and period change in these systems, in which the period will gradually increase if q>0.4, whereas it will gradually decrease if q<0.4. The case of V396 Mon is of interest because its mass ratio is q= 0.40 ±0.002 – right on the cusp. The present authors report here on a multicolor photometric (B, V, R I) study done with an 85-cm (33-in) telescope and CCD imager; and an analysis of new and historic times of minimum.

They draw three conclusions. First, the cool spots on one or both stars are unstable, as evidenced by noticeable changes in the shape of the lightcurve over the past 10 years. Second, the O-C analysis of the times of minimum light appear to show both a secular decrease in period, and a cyclic component. The cyclic component could be due to magnetic effects (the Applegate effect) or light-time effect of a third body in the system. They prefer the third-body explanation, which implies a small ($M_3 \approx 0.3\ M_{sun}$) faint star in a ~42 year orbit (and which is conveniently unobservable, either photometrically or spectroscopically).

Third, and most importantly, they conclude that a radial-velocity study is badly needed, in order to pin down the parameters of this system: photometric-only solutions will always be subject to uncertainty caused by the changes in the lightcurve associated with the inconstant star-spots. Are any SAS spectroscopists up to this challenge? At V≈ 13, it might be a bit faint for small-telescope spectroscopists.

Reports from the WASP team: The following reports deriving from WASP photometry were disseminated in the past 3 months:

WASP-23b: a transiting hot Jupiter around a K dwarf and its Rossiter-McLaughlin effect
by Amaury H.M.J. Triaud, et al

WASP-23b was discovered: a gas giant a bit lighter and smaller than Jupiter, in a 3-day orbit around a K-dwarf star. The host star is 13th magnitude, and the combination of a low-luminosity star and a fairly large planet yields a healthy 1.7% brightness drop in the transit (Δm= 0.017). Subsequent spectroscopic follow-up with large telescopes was able to detect the Rossiter-McLaughlin effect, thereby providing constraints on the rotation period of the host star.

WASP-43b: The Closest-Orbiting Hot Jupiter
by Coel Hellier, et al
Astronomy & Astrophysics, April 15, 2011
preprint at http://arxiv.org/abs/1104.2823v1

If you have not recorded the transit of an exoplanet, this one might be a good target: the "hot Jupiter" orbits a 12th magnitude star every 19 hours, and its transit is relatively deep – about 0.02 magnitude. The star is located at RA= 10h19m38.01s, Dec = –09◦48′ 22.5″ (J2000).

WASP-35b, WASP-48b and WASP-51b: Two new planets and an independent discovery of HAT-P-30b.
by B.Enoch, et al
preprint at http://arxiv.org/abs/1104.2827v1

The WASP and HAT exoplanet searches use similar equipment, similar search and image processing methods, and are on the hunt for similar targets, so I guess it shouldn't be surprising that occasionally they will independently sweep up the same quarry. Well, it happened again: HAT gets the discovery credit, by virtue of primacy in publication; but WASP-51b is the same planet. Happily, the star and planet parameters derived independently by the two teams are essentially identical – a good test of the reliability of search methods and analyses used by these teams.

The possibility of determining open-cluster parameters from BVRI photometry
by H. Monteiro⋆ and W. S. Dias
accepted by *Astronomy & Astrophysics*
preprint at http://arxiv.org/abs/1103.3446v1

This isn't a report on small-telescope science, but it might be useful, and offer some encouragement, to those who have thought about doing photometric studies of open clusters. As the authors describe, the traditional approach to determining open cluster parameters (distance and age) involves first creating a color-color diagram in U-B vs. B-V to determine the interstellar reddening, and then finding a match between the color-magnitude diagram of the data (V vs. B-V color) and a calculated main-sequence isochrone. The practical problem with this approach is the need for U-band data, which is difficult and troublesome to get (and I suspect that very few backyard scientists even have a U-band filter!).

The breakthrough that the authors report is a method for using BVRI photometry to determine reliable cluster parameters. They demonstrate the accuracy of their method in two ways: (a) fitting "synthetic" data, and (b) applying it to real data from two open clusters. Their algorithm is able to quite nicely find the correct answers, in the case of the synthetic data. The results for the two real clusters is a good match to previous studies (which used the UBV method).

It appears that this method still requires very good data (photometric accuracy better than 0.01 mag), and quite deep data (down to Vmag ≈ 18 to 22, depending on the distance to the cluster) in order to give good results. And as the authors note, they still need to assess how robust the algorithm is to errors in cluster-membership assignment (i.e. field stars contaminating the data).

HATP-30b: A Transiting Hot Jupiter on a Highly Oblique Orbit
by John Asher Johnson, et al
preprint at: http://arxiv.org/abs/1103.3825v1

A planet has been discovered in orbit around a 10th magnitude star in Canis Minor. It is a "bloated Jupiter" (0.7 Jupiter masses, but 1.3 times Jupiter's diameter), whose transit depth is only 9 mmag (a bit less than 1% brightness drop). Spectroscopic study shows that the planet's orbit is significantly inclined to the spin axis of the star. There are a few other similarly inclined systems known, most of which (like this one) involve hot stars (Teff > 6250 K). Why hot stars and misaligned planetary orbits tend to go together is not known.

Supernova Discoveries 2010: Statistics and Trends
by Avishay Gal-Yam and P. A. Mazzali
preprint at http://arxiv.org/abs/1103.5165v1

So you'd like to discover a supernova, but you're worried that the professional surveys will sweep everything up before you can find it? Take heart – amateur supernova hunters haven't been pushed off the field yet. The authors examined all supernova discoveries reported in 2010. Of the 538 discoveries, 82 were made by amateurs (= 15% of the total). The amateur discoveries were at a mean magnitude of 16.7, and mean redshift z= 0.019. A sizable fraction (84%) of the amateur-reported discoveries earned spectroscopic follow-up by large telescope observatories.

Oddly, discoveries reported by the Catalina Real-Time Sky Survey (which was the most prolific discoverer, with 190 events to its credit) were far less likely to receive spectroscopic follow-up than were amateur discoveries. Only 35% of the CRTS discoveries were spectroscopically confirmed.

The Color-Period Diagram And Stellar Rotational Evolution - New Rotation Period Measurements In The Open Cluster M34

by Søren Meibom, et al

preprint at http://arxiv.org/abs/1103.5171v2

This study barely fits into my definition of "small telescope", since its photometric data comes from the 0.9-m (35-inch) WIYN telescope on Kitt Peak; but similar projects might be within the range of some SAS member's telescopes. Its key feature is the combination of rapid cadence and long-duration: 5 months of photometric monitoring of the cluster M34 (at between 1-hr to few-day intervals) to detect variability at a wide range of time scales. Typical photometric accuracy was .004 mag (1-σ). They detected periodic variability caused by stellar rotation (modulating star-spots) on about 120 stars (out of over 5600 stars monitored). This was then correlated with 4 years of spectroscopic (radial-velocity) monitoring of the cluster (done with a 3.5-m telescope).

Development of "color-period" diagrams for members of open clusters appears to be an important contribution to gyro-chronology (the observation that stellar spin slows down as the star ages). In particular, it appears that the spin deceleration changes at different stages of the star's evolution, and that the deceleration profile may depend on the star's mass.

SDSS J162520.29+120308.7 - A New SU Uma Star in the Period Gap

by A. Olech, et al

preprint at http://arxiv.org/abs/1103.5754v1

Note: The "et al" in the author list includes several respected backyard scientists: B. Staels in Belgium, S. Lowther in New Zealand, W. Stein in New Mexico, D. Boyd in UK, and R. Koff in Colorado; as well as Dr. Joe Patterson (founder of the Center for Backyard Astrophysics at Columbia Univ.) The telescopes used to gather photometric data were ranged from 25-cm (10-in) to 1-m (40-in), and all but two were 40-cm (16-in) or smaller. Photometry was unfiltered, to get the maximum possible SNR with short exposures on the ~13th magnitude target

This particular cataclysmic variable was of great interest because its orbital period falls in the "period gap" (between 2 and 3 hr) where such systems are rare. Photometric campaigns on systems within the gap (using small telescopes like those in this study) will help astronomers sort out the composition, evolution, and physics of these types of systems.

The data from this project clearly shows that the superhump period changes as the eruption progresses; but that the details present some problems for both of the best-regarded models for CV eruptions. Clearly, more data, on more systems is needed, and that suggests that more observers could be productively engaged in campaigns of the Center for Backyard Astrophysics. See http://cbastro.org/ for more opportunities.

The Eclipsing Cataclysmic Variables PHL 1445 and GALEX J003535.7+462353

by Wils, Patrick, Krajci, Tom, et al

IBVS No. 5982

preprint at http://arxiv.org/abs/1103.6021v1

Cataclysmic variables are binary stars with a complex interaction of primary star (a white dwarf), secondary (filling its Roche lobe), and accretion disk, that gives rise to several types of brightness fluctuations, and occasional outbursts (in which the brightness rises several magnitudes). Here, the authors report the discovery of two CVs that show eclipses, which should be useful in characterizing the features of the systems.

PHL 1445 has a very short period (76 minutes), and its eclipses are very deep – over 2 magnitudes. Measuring the eclipse times is a bit challenging, since the object is about 18th magnitude out-of-eclipse and nearly 20th magnitude at the depth of eclipse, and the eclipse duration is only about 6 minutes. Still, Krajci (good friend of the SAS) was able to make useful timing measurements with his 36-cm (14-in) schmidt-cassegrain telescope.

GALEXJ003535.7+462353 is a bit brighter – 16th magnitude in quiescence – and also shows eclipses with depth of nearly 2 magnitudes. It also appears to have fairly frequent outbursts.

The Orbital Period of the Eclipsing Dwarf Nova SDSS J081610.84+453010.2

Jeremy Shears, et al

preprint at http://arxiv.org/abs/11004.0104

Cataclysmic variable stars are the subjects of quite a few small-telescope studies each year (doubtless a consequence of the number of questions being greater than the number of large-telescopes available to deal with them). Here is a nice example of synergy between large and small telescope studies. This particular star is pretty faint (Sloan g ≈ 20). It was recognized as a CV by spectroscopy done with the 2.5m SDSS telescope. AAVSO added it to their database, and small-telescope users provided monitoring to detect outbursts (even 'not seen" reports are useful in this regard). The present paper reports on both quiescent photometry (provided by Dr. Arne Henden using the 1-m telescope at USNO Apache Point station) and time-series photometry during outburst provided by a half-dozen users with telescopes in the range 20-cm to 40-cm (8-in to 16-in).

This system provides special insight into the CV process because its stars eclipse each other (albeit in a shallow grazing eclipse). The orbital period is ~5 hours, and the ~0.5-mag deep primary eclipse lasts less than 11 minutes.

Key conclusions from this study include: (a) although not absolutely certain, it is most likely that it is the accretion disk that is being eclipsed, not the central white-dwarf star; (b) the accretion disk probably does not appear to change significantly in size between quiescence and outburst; (c) the system's brightness changes chaotically between eclipses, presumably due to rapid changes in the mass-transfer rate into the accretion disk or from the disk onto the white dwarf.

Superhumps and post-outburst rebrightening episodes in the AM CVn star SDSS J012940.05+384210.4

by Jeremy Shears,

preprint at http://arxiv.org/abs/1104.0107

Whereas most cataclysmic variable systems consist of a central white dwarf (surrounded by an accretion disk) and a less-evolved mass-losing star, the relatively rare AM CVn subset consists of two interacting white dwarf stars.

The system reported here was suspected of being an AM CVn, based on its SDSS spectrum, but very little else was known about it. When it was observed to be in outburst, the authors used telescopes ranging from 25-cm (10-in) to 40-cm (16-in) to conduct an unfiltered photometry study.

Unfortunately, the earliest phases of the outburst were missed – not an unusual problem, since the early portion of the outburst may last only a few days. In the case of this study, the authors were able to keep the star under observation and show that it had not yet faded to quiescence after 41 days, during which its fade was interrupted by a series of fairly violent re-brightenings. The rebrightening: phenomenon is rare, but not unprecedented.

Long-duration, rapid-cadence photometry is essential to unraveling the process of outburst in these systems. In one of the "rebrightening" events, the authors were able to detect quite rapid periodic cycles in the lightcurve (P≈38 min, amp ≈0.06 mag P-P), which are interpreted as being superhumps.

Fortnightly Fluctuations in the O-C Diagram of CS 1246
by B.N. Barlow, et al
Mon. Not. R. Astron. Soc. April 2011
preprint at http://arxiv.org/abs/1104.0666v1

CS 1246 is a "pulsating subluminous B" star – which presumably is a star that has evolved off of the main sequence, through the red-giant phase, and lost most or all of its hydrogen envelope (for reasons that are still not fully settled). Despite being quite common objects, few of them have been studied well, and there remain questions about their characteristics and life-cycle, in particular how important companions might be in helping to strip away their hydrogen envelopes.

The authors used the 0.41-m (16-in) PROMPT telescopes on Cerro Tololo to conduct a 14-month-long photometric study of this star (using unfiltered CCD images), to characterize its brightness fluctuations and look for variations in its pulsation period. The pulsation amplitude is only about 0.06 mag P-P, with a 6-minute period (hence requiring short exposure images – the authors used 30-sec exposures).

A couple of interesting discoveries came out of this photometric campaign. First, the amplitude of the pulsations is not constant, but changes quite significantly on a time-scale of several months (for unknown reasons). Second, when the pulsation times of peak brightness are plotted on an "observed minus calculated" (O-C) diagram, it shows that the period displays both a secular change (gradual decrease in period, amounting to a millisecond every couple of years), and a sinusoidal fluctuation (with period of 14.1 days). The two-week sinusoidal signal is presumed to be the light-time effect of a companion object. Unfortunately, the author's search for evidence of eclipses came up empty, and any search for spectral contamination by this (presumed) companion is complicated by the very high interstellar reddening in the direction of the target. The authors are arranging for spectroscopic radial-velocity follow-up, to confirm their interpretation of the two-week O-C cycle.

This study is a wonderful example of what can be done with a small telescope, given a long run of high-quality photometry, to learn more about a poorly-studied class of stars.

ASAS Light Curves of Intermediate Mass Eclipsing Binary Stars and the Parameters of HI Mon
by S. J. Williams, et al
preprint at http://arxiv.org/abs/1104.3166v1

The All-Sky Automated Survey (ASAS) uses 200 mm f/2.8 camera lenses and CCD imagers to maintain continuous V- and I-band photometric observation of northern and southern sky stars. ASAS data releases contain a wealth of time-series photometry of stars down to about magnitude 14. The authors of the present paper searched the ASAS Data Release 3 to identify intermediate-mass eclipsing systems. Photometric and spectroscopic characterization of these systems is expected to provide essential data to anchor the properties of intermediate-mass stars, especially their diameters and temperatures; it turns out that there are not very many stars with mass greater than 3 solar masses that have well-measured diameter.

This paper presents two key results. The first is a catalog of 56 relatively bright (<11th magnitude) systems that almost certainly are of intermediate mass (based on eclipse properties, and visual V-K colors). The second is an example of the sort of study that the authors plan for more of these systems. They combine multi-band photometric lightcurves and spectroscopic data (temperature and radial velocity) of the system HI Mon to develop a complete, high-accuracy model of the system.

This catalog might be of interest to those of you who want to try modeling of eclipsing binary systems (as described in the modeling workshop at SAS-2011).

Results of UBV Photoelectric Observations of Eclipsing Binary RY Sct
by M.I.Kumsiashvili, et al
preprint at http://arxiv.org/abs/1104.1532

RY Sct is an eclipsing binary with an associated nebula, and it offers a lesson that you should always save the raw data from your "completed" projects: you never know when that old data may serve a new purpose. These Georgian astronomers (from the Georgia in the former Soviet Union, not the one in southern USA) had done a photoelectric study of RY Sct a decade ago, using the Abastumani Observatory's 0.48-m (=19-in) reflector to determine that the system's mass ratio is q= 3.3. Subsequently, American studies suggested that one of the stars in this system was a Luminous Blue Variable (LBV), and that the nebula was created by an LBV-outburst, less than a couple of hundred years ago.

LBVs show a characteristic pattern of micro-variations after outburst. By re-examining their old data, the authors were able to detect these micro-variations (strengthening the LBV-outburst hypothesis).

The authors recommend a regular effort to determine times-of-minimum of the eclipsing pair. Considering the system's 11.1-day period, and the "microvariations", this may be trickier than it first sounds, but also may be well worth the effort. If strong mass flow is continuing in this system, then its effect should eventually be evident on the O-C diagram. And, as they note, you may be lucky enough to detect another outburst.

A Study Of Asteroid Pole-Latitude Distribution Based On An Extended Set Of Shape Models Derived By The Lightcurve Inversion Method
by J. Hanuˇs, J. Durech, M. Broˇz, B. D. Warner, F. Pilcher, R. Stephens, J. Oey, L. Bernasconi, S. Casulli, R. Behrend, D. Polishook, T. Henych, M. Lehk´y, F. Yoshida, and T. Ito
accepted by *Astronomy & Astrophysics*
preprint at http://arxiv.org/abs/1104.4114v1

I have included the full list of authors on this paper, because many of you will recognize some of them (including SAS leaders Brian Warner and Bob Stephens).

Small-telescope researchers are providing a wealth of high-quality of asteroid lightcurves. This data can be used to develop asteroid shape models (by lightcurve inversion), and to determine the orientation of the pole of the asteroid's spin-axis.

A breakthrough described in this paper is the ability to combine dense lightcurves (e.g. those provided by amateur astronomers) with sparse lightcurves (e.g. those gathered by surveys) into consolidated sets to derive asteroid shape and rotational parameters. In general, the dense lightcurves provide the rotational period and are the anchor on which to hang the sparse data points. The sparse data usually provides the necessary coverage of a longer set of apparitions.

This sort of study puts a spotlight on the value of the contributions of "backyard scientists" (who provide almost all of the dense lightcurves), and the importance of putting that data into the ALCDEF so that it is accessible to professional researchers. Of the hundreds of thousands of asteroids out there, we now have credible lightcurve-inversion shape models for about 200 – excellent progress, but clearly there is plenty of work to do. Creation of a good lightcurve inversion model requires a dozen or more "dense" lightcurves, from 3 or more apparitions. Keep observing, and recording those lightcurves, even if the period is already known!

The Z CamPaign: Year 1
by Mike Simonsen
JAAVSO Volume 39, 2011

Dwarf novae are a diverse family, one branch of which is the "Z Cam" stars. These are presumed to be binary systems with accretion disks feeding the mass-gaining star, and displaying pseudo-periodic eruptions (outbursts). The peculiarity of Z-Cam stars is that occasionally the system gets "stuck" halfway between outburst and quiescence, for intervals ranging from weeks to months. This characteristic might be indicating that the mass-transfer rate is high enough that sometimes the outburst can't "blow off" all of the excess mass. More data and in-depth studies are needed in order to better understand these systems; and the first step is to identify which stars are, indeed, genuine Z Cams. This is the primary purpose of the AAVSO's "A Cam-paign).

Both visual and CCD observers are needed to keep watch on the suspected Z Cam stars, so that lightcurves of sufficient length and quality will be able to distinguish the Z Cams (of which only 30-40 are currently known) from more typical eruptive variables. The list of targets can be found at https://sites.google.com/site/aavsocvsection/z-campaign/z-campaign-list-1. So far, the campaign has positively identified a dozen Z Cams, and has also gathered compelling evidence that several previously-suspected Z Cams are actually imposters.

WZ Cygni: a Marginal Contact Binary in a Triple System?
by Jae Woo Lee, et al
preprint at http://arxiv.org/abs/1104.3603v1

The authors conducted a multi-band (BVRI) lightcurve study of WZ Cyg, using a CCD and 61-cm (24-in) reflector. Their lightcurves were fit to the Wilson-DeVinney code, showing the system to be a non-contact binary, with mass ratio q= 0.6 ±0.04 and a large temperature difference between the two stars (1447K).

The century-long history of times of minimum displays strong evidence for mass transfer, and for a light-time effect that probably is due to an M-type star in a 48-yr orbit.

The triple system CG Aurigae
by M. Wolf, et al
New Astronomy 16 (2011) 402–404

One of the useful things that can be done with a small telescope and a CCD imager is to measure the time-of-minimum-light of an eclipsing binary. This task is tailor-made for backyard scientists, because it requires some diligence and a fair dedication of telescope time, but not a large aperture. Long-term records of t_{min} can be used to determine quite a bit about the star system, as is exemplified by this report. The authors used t_{min} data taken with telescopes in the range 20-cm to 40-cm (8-in to 16-in) aperture, to (a) demonstrate that the eclipsing pair has an eccentric orbit, (b) measure the apsidal motion rate, which includes a noticeable contribution from General Relativity, and (c) detect a cyclical variation in the observed-minus-calculated (O-C) curve that indicates the presence of a third body in a 1.9-yr orbit.

It is particularly impressive to see how the O-C data points, which at first appear to scatter randomly around the apsidal-motion prediction, map a nearly-perfect sinusoidal curve that gives the orbit of the third body.

The authors note that spectroscopic study of this system is badly needed – especially radial velocity curves. At mag 12, it may be a challenging object, but well worth the effort if your equipment can reach that deep.

The first spectroscopic and photometric solutions of the eclipsing binary, V335 Ser
by Z. Bozkurt
New Astronomy 16 (2011) 412–419

For those of you who attended Dr. Terrell's Workshop on "Eclipsing Binaries" at the 2011 SAS Symposium, here is a wonderful example of what can be done with photometry, radial velocity, and a modeling code. The author used a 48-cm (19-in) telescope and photoelectric photometer to measure the B- and V-band lightcurves, and a 1.5-m (60-in) telescope with echelle spectrograph to determine the radial-velocity curve of the system. The lightcurves show a slight eccentricity in the orbit, and (as in the preceding paper), an evaluation of the eclipse timing O-C curve enabled the author to accurately determine the apsidal rate. Having radial velocity data enabled the present author to go further, and use the apsidal motion to make some assessments of the internal structure of the stars.

Rotation periods of binary asteroids with large separations – Confronting the Escaping Ejecta Binaries model with observations
by D. Polishook, et al
Icarus 212 (2011) 167–174

This report barely fits into my definition of "small-telescope science", since about half of the lightcurve observations were made with a 0.46-m (18-in) telescope, and the other half used a 1-m (40-in) telescope. But since so many of you are interested in asteroid lightcurves, it seems important to include a summary of this study. Both telescopes used CCD differential photometry to prepare lightcurves of the target asteroids.

There are (at least) two competing notions of how widely-separated binary asteroids might form: the pair might be pieces left over from an impact (the "Escaping Ejecta Binary" model), or they may be remnants of a rubble-pile body that tore itself apart under the centrifugal stress of rapid rotation (the "rotational-fission" model). An earlier paper identified six asteroids that were known to be binaries, and whose wide separation suggested formation in a collision. The present paper describes lightcurve observations to determine the spin periods of four of these binary asteroids. Of these four, the authors conclude that 3 of them are spinning too rapidly (P≈ 2 to 4 hr) and are two small to be explained by the Escaping Ejecta model, and therefore are more probably the result of spin-up fission.

The status of a fifth binary asteroid [(17246) 2000 GL74] is uncertain. The authors were not able to get a good lightcurve, so its period is still uncertain. This one is crying out for attention, because a solidly-determined rotation period may be a valuable adjunct to this research.

Transit timing variation and activity in the WASP-10 planetary system
by G. Maciejewski, et al
Mon. Not. R. Astron. Soc. 411, 1204–1212 (2011)

A few years ago, many of us were astounded to find that the transits of exoplanets could be detected with CCDs and modest-size telescopes, using differential photometry of ~10 mmag precision. Here is the next step in the use of small telescopes to characterize these exoplanets. The authors report their project to obtain lightcurves of nine transits of WASP-10, using CCDs and telescopes of 60-cm and 80-cm (24-in and 31-in). They determined transit-time variations (analogous to “O-C” curves of eclipsing binary stars), and reach the provisional hypothesis that there is a second planet in the system, with mass about 10% of Jupiter’s, in a 5-day orbit. If there is indeed a second planet, and if it happens to transit the parent star, larger telescopes will be needed to detect the transit (estimated $\Delta m \approx 3$ mmag).

Campaign of sky brightness and extinction measurements using a portable CCD camera
by Fabio Falchi
Mon. Not. R. Astron. Soc. 412, 33–48 (2011)

At the 2011 SAS Symposium, Eric and Erin Craine noted that despite the importance of sky-brightness measurements (for astronomy, ecology, and policy assessment), there is darn little such data available. Here is a paper describing an instrument and program quite similar to the Craine’s. The present author mated a Starlite Xpress CCD to a photographic fish-eye lens to construct a portable sky-brightness meter. Because of his observing procedure, it also gives a measurement of the atmospheric extinction. His measurements were at several sites in Italy, and were almost entirely restricted to clear nights (since his primary interest was astronomical observatory sites).

His data quantifies an effect that many of you may recognize from experience. At a high mountain site, sky brightness is strongly affected by the conditions at lower-elevation distant urban centers: if there is high haze over the distant town, then light is scattered toward the mountain observatory, whereas a low-altitude cloud or fog layer traps the city light and results in nice dark sky on the mountain. Further, regardless of other conditions, the hours after midnight tend to be darker than earlier in the night.

It was also heartening to see that at a site for which he was able to collect a decades-long time sequences, the sky brightness stopped increasing sometime around 1998, despite continued dramatic growth in electricity consumption for public lighting after that date. This happy result appears to be a direct consequence of light-pollution regulations in the area, which prohibit upward-directed illumination.

Meteor showers of comet C/1917 F1 Mellish
by P. Vere, et al
Mon. Not. R. Astron. Soc. 412, 511–521 (2011)

The SonotaCo meteor video observation network (in Japan) creates a large and consistent database of meteor trajectories and inferred orbits. This is a fine example of the value of mating small-aperture wide-field video systems with sophisticated image analysis and data archive software.

The authors used the SonataCo database to assess the orbits of two weak meteor showers (the December Monocerotids and the November Orionids), and conclude that they are almost certainly both derived from C/1917 F1 Mellish. This assignment is justified by the similarity in all three orbits, and the nearly-identical physical properties of the two meteor streams.

Period Changes and Four-Color Light Curves of Active Contact Binary VW Bootis
by L. Liu, et al
The Astronomical Journal, 141:147 (14pp), 2011 May

VW Boo is a contact binary, which may be just entering the over-contact (common convective envelope) phase. It has therefore been a subject of a long-term monitoring project by Yunnan Observatory (China), using an 85-cm (33-in) telescope and CCD imager. The authors here report on recently-obtained BVRI lightcurves. Their lightcurves show some differences (in shape and relative amplitudes of the maxima) compared to lightcurves made 20 years ago, an apparent testament to either changing hot- and cool-spots, or rapid evolution of this system. Indeed, the present data shows slight but definite difference in the shape of the primary minimum, compared to a lightcurve made at Yunnan year earlier. A fit of the lightcurves to the Wilson-Devinney model yields a nice picture of a (barely) contact binary with a cool spot on the larger star.

A sixty-year history of times of minimum shows a definite secular decrease in the pair’s orbital period. The best recent CCD t_{min} data shows compelling evidence of a 25-year oscillation in the orbital period (with amplitude of $A_3 \approx$ 8.5 minutes). The cause of this oscillation cannot be established without a long-term study of the system’s radial velocity. The star is 10.5 mag. Are any SAS spectroscopists able to get a radial-velocity curve on such a system?

The Variability of Hα Equivalent Widths in Be Stars
by C. E. Jones, et al
The Astronomical Journal, 141:150 (9pp), 2011 May

There have been a couple of recent SAS reports about Be stars: Oliver Thizy described the small-telescope campaign to gather Be star spectra during the SAS-2010 symposium, and touched on it again at the SAS-2011 Symposium. There has also been an active discussion about the spectra of these stars on the Yahoo! group “spectra-l”.

Here is a “professional” look at Be star spectra, albeit one that sits right on the limit of my definition of “small-telescope science”. The authors used an echelle spectrograph on a 1-m (42-in) telescope to monitor the Hα line equivalent width of 56 Be stars over a 4-year period, hoping to identify observable features that correlate with the star’s variability. They note that a major source of error in determining the line’s equivalent width is the continuum normalization – a subject which Stan Gorodenski discussed in last quarter’s SAS Newsletter.

The Be stars show a wide array of variability in Hα line width, and ongoing monitoring (by both professional and amateur researchers) is needed to anchor models of these systems. As the authors note, their primary contribution in this paper is definition of a straightforward way to assess the confidence that a given EW-vs.-time plot indicates variability (as opposed to normal statistical scatter in the EW). It is probably worthwhile reading for anyone involved in, or planning to start, Be spectral studies.

Spectral Variability of LBV star V532 (Romano's star)
by O. N. Sholukhova, et al
preprint at http://arxiv.org/abs/1105.0123v1

The vast majority of variable stars that can be studied with small telescopes belong to our Milky Way galaxy. So it was an eye-opening surprise to me that backyard-scale telescopes can do CCD photometry on the brighter stars in nearby galaxies – witness the recent AAVSO project to re-measure the lightcurve of Cepheid M31-V1 in the Andromeda galaxy.

Here is another external-galaxy variable star study. The authors used archival (photographic!) data taken with 67-cm (26-in) and 50-cm (20-in) telescopes, and more recent CCD photometry taken with 1-m (40-in) and 60-cm (24-in) telescopes to map out the long-term light curve of the luminous blue variable star V532 in the galaxy M-33. The photometric data was than used to put spectroscopy (taken with much larger telescopes) into the context of the state of the star. The luminous blue variables have quite a few mysteries, partly because of their rarity, and partly because of sparse data. This particular star (like most other LBVs) varies dramatically in brightness (over 2 magnitudes in B-band). It changes color, being cooler when it is bright, and hotter when it is faint; this suggests that the total (bolometric) radiated intensity is nearly constant. The variability is very slow: the gradual change from faint/hot to bright/cool takes about 10 to 15 years (although there appear to be more rapid, smaller fluctuations, also). The spectroscopic study shows corresponding changes in the velocity of the solar wind.

This might be an interesting, exotic addition to your observing list. At B≈ 16.5 to 18, it may not be an extravagantly-difficult target for even backyard CCD photometry. And, of course, it's a grand excuse to take a few more shots of M-33! It is located at RA= 01 35 09.55, Dec= +30 41 57.4 (J2000), well away from the central region of the galaxy.

Observational Studies of Highly Evolved Cataclysmic Variables
by Helena Uthas (PhD Thesis)
preprint at http://arxiv.org/abs/1105.1164v1

This is only peripherally related to small-telescope science, although it does include a chunk of data for BW Scl gathered by the small telescopes of the Center for Backyard Astrophysics. I note it because quite a few SAS members are interested in cataclysmic variables, and this might be a nice overview of their physical and observational characteristics, and an example of recent academic research into these stars.

Spectral Evolution of the Unusual Slow Nova V5558 Sgr
by Jumpei Tanaka, et al
submitted to PASJ: Publ. Astron. Soc. Japan
preprint at http://arxiv.org/abs/1105.1614v1

Speaking of cataclysmic variables, here is a surprising (to me) report of small-telescope spectroscopy of a CV-gone-nova. According to the authors, different nova have been observed with different characteristic spectra types, but it's tough to be sure that any given nova is uniquely defined by its spectral type because most such spectra are snapshots in time. This paper reports an investigation of possible gradual evolution of the spectrum of the slow nova V5558 Sgr.

The authors used a 28-cm (11-in) telescope and a low-dispersion spectrograph ($\Delta\lambda/\lambda \approx$ 600, comparable to Shelyak "LISA" or SBIG "SGS" units). They found that the nova's spectrum gradually evolved as the nova brightened, faded, re-brightened, and finally continued its terminal decline. Not only do individual lines come and go (or grow and shrink) at different stages of the nova eruption, but their widths and shapes also change. In particular, they found that the spectrum changed from a "He/N" type into a "Fe II" type during the initial brightness rise.

A while ago, Dr. Arne Henden reminded the SAS of the need to keep all novae under photometric observation for at least a year after maximum brightness. This study seems to suggest that a comparable project of spectroscopic monitoring will also yield surprises.

The Stunted Outbursts of UU Aquarii Are Likely Mass-transfer Events
by R. Baptista, et al
Proceedings of the Physics of Accreting Compact Binaries
preprint at http://arxiv.org/abs/1105.1381v1

We learned from Dr. Dirk Terrell's workshop at the SAS-2011 Symposium that lightcurve analysis of an eclipsing binary system can be used to construct a "picture" of the relative sizes, shapes, and spots of the two stars. The authors of this paper take the concept a step (or two) further. Their target is the variable star UU Aqr – an eclipsing pair that displays frequent "SW Sex"nova-like outbursts. The system is presumed to include a bright accretion disk surrounding a white dwarf.

They collected dense B-band lightcurves of the system using a CCD and a 0.6-m (24-in) telescope on several nights during the course of an outburst.. These lightcurves were then "...analyzed with eclipse mapping techniques to solve for a map of the disc surface brightness ...". They were able to make "pictures" of the accretion disc, showing how it changes during the course of the outburst.

This star is fairly bright, and may be an interesting target for SAS photometrists.

Apsidal Motion of the Massive, Benchmark Eclipsing Binary V578 Mon
by E.V. Garcia, et al
preprint at http://arxiv.org/abs/1105.1387v2

V578 Mon is one of the few early B-type high-mass eclipsing binary systems (both stars are greater than 10 solar masses). It has an eccentric orbit, so that analysis of its apsidal motion can provide information about the stars' internal structure.

The authors used photoelectric photometry taken with two 16-in (40-cm) telescopes and one 50-cm (20-in) telescope to prepare UBV lightcurves of the system, and collected all available times of minimum.

One of the features of this particular analysis of an eclipsing system is that the authors point out that the eccentric orbit and apsidal motion will cause subtle changes in the lightcurves. This effect was incorporated into the lightcurve model, so that the photometry could be used to improve the values of the eccentricity and the apsidal period.

This is a pretty neat example of the variety of information that can be squeezed out of a photometric and modeling study of an eclipsing binary.

New β Cephei stars in the young open cluster NGC 637
by G. Handler and S. Meingast

submitted to Astronomy & Astrophysics
preprint at http://arxiv.org/abs/1105.3121v1

Many of you may know of the "VLT". It turns out that there is a diminutive system with the same acronym in lower case. The "vlt" is the "vienna little telescope". It is a 0.8-m (31-in) telescope located at the Institute of Astronomy of the University of Vienna.

The authors used CCD photometry to search for multi-mode pulsating variables the open cluster NGC 637. Multi-mode variables are potentially fruitful targets for asteroseismology studies to anchor models of stellar interiors; but doing so requires good estimates of stellar parameters such as luminosity, size, and metallicity. These can be problematic for isolated field stars. Groups of pulsators that are members of an open cluster (and hence of roughly equal distance, age, and composition) are particularly valuable.

By collecting 9 nights of data over about 3 months, the authors searched for variable stars in the cluster. They confirmed one previously-reported β-Cepheii pulsator, and found three new (and one additional possible) β-Cepheii pulsating variable stars. The authors note that their V-band (only) study has identified stars needing more study, and recommend the need for two follow-on projects. The first is multi-band photometry of these stars, with cadence that will reliably map the lightcurves, and project duration long enough to confidently minimize aliasing from the daily gaps in coverage. The goal of this study would be to map brightness and color changes, so that the different pulsation modes can be identified. The second project is spectroscopy to characterize the stars' Teff, composition, radial velocity and rotation rate, and possible binarity.

These projects might be within the range of SAS members. Beware, however, that the amplitudes of the lightcurves are pretty small. Typical fundamental-mode amplitudes are about 10 mmag, and the next-higher mode amplitude is about 5 mmag. You'll need to apply the same sort of diligence that you use to monitor an exoplanet transit (with the added complication of multi-color imaging).

All-sky video orbits of Lyrids 2009

by Juraj T´oth
submitted to Publications of the Astronomical Society of Japan
preprint at http://arxiv.org/abs/1106.0590v1

The authors report the first results of the Slovak Video Meteor Network. The heart of the network are two an intensified video cameras, providing an approximately 170° X 140° field of view. These are separated by 80km to provide good parallax measurements of meteors. They can detect meteors down to about magnitude 3.5. The video stream is processed by the widely-used SonotaCo "UFOCapture" software.

The first observing campaign was the 2009 Lyrid meteor shower. A total of 32 meteors were observed by both stations, of which 17 were Lyrids. The video observations provide a high-quality location of the shower's radiant, and 3-dimensional trajectory data for each meteor. The authors determined the implied pre-entry orbits, and found that their Lyrid orbit was consistent with previously-reported orbits (thereby lending confidence in their observation and data analysis procedure). They also report that the "beginning" and "terminal" heights of the Lyrid meteors seems to depend (weakly) on their brightness (hence the size of meteoroid).

Video observation of Geminids 2010 and Quadrantids 2011 by SVMN and CEMeNt.

by Juraj Tóth, et al
submitted to WGN The Journal of the IMO
preprint at http://arxiv.org/abs/1106.0595v1

Here is a report of observations of the Geminid and Quadrantid meteors, made by the Slovak Video Meteor Network (SVMN, see above), and the amateur wide field video stations of the Central European Meteor Network (CEMeNt). The CEMeNt systems are tiny-aperture, very wide-field (~80 deg) non-intensified video systems of several configurations, that can image meteors down to between magnitude 1.5 to 2.5. While this is not as "deep" as the SVMN, there are certainly advantages to having a more widely-spaced network of many stations to improve the trajectory assessment of meteors.

From the 44 Geminids observed, the authors were able to determine good-quality heliocentric orbits for 10; and from 100 Quadrantids, good orbits were found for 8.

This work suggests (to me) that there is room for more amateur-professional collaboration in meteor observations.

A Multicolour Photometric Study of the Neglected Eclipsing Binary FT Ursae Majoris

by Jin-Zhao Yuan
submitted to Research in Astron. Astrophys.
preprint at http://arxiv.org/abs/1106.1694v1

Here's a nice example of a photometric study of an eclipsing binary star. It also notes the danger of relying on "photometric mass ratios" in such studies. A previous analysis had used a "photometric" q=0.25; but subsequently, radial-velocity data indicated a more-likely q= 0.98. This justified a new analysis of this system.

The author used an 85-cm (33-in) telescope and CCD photometry in B- V- and R-bands to create a nearly-complete lightcurve of this star, and then applied the Wilson-DeVinney model to determine the system's properties by matching the lightcurve. The system is found to be a contact binary, with a large mass ratio (q=0.98 was fixed in their analysis) and an unusually small lightcurve amplitude (because of its orbital inclination of 62.8 degrees).

2MASS J01074282+4845188: a New Nova-Like Cataclysmic Star with a Deep Eclipse

by Dinko P. Dimitrova and Diana P. Kjurkchieva
preprint at http://arxiv.org/abs/1106.2115v1

The large wide-field surveys (for NEA's, for exoplanet transits, and other purposes) have released huge archives of photometric data and identification of variable objects that were outside the intended scope of their investigations. One suspects that there are all sorts of hidden gems in these databases, which could be polished by dedicated follow-up studies. Here is an example of such a follow-up effort.

This particular star was found by the TrES survey, which categorized it as an "ambiguous EB" with a short period (P≈ 0.19 d). The authors of the present report were searching for short-period eclipsing binaries, and so began a project of V- R- and I-band CCD photometry using a 60-cm (24-in) telescope. They discovered several interesting things. First, as a matter of book-keeping, the star identified by the TrES archive was not variable; a nearby – and fainter – star was the actual variable. Such things are probably not rare, considering the large pixel scale of many of the wide-field surveys. Second, there is significant brightness variation out-of-eclipse, including a pre-eclipse "hump" and significant color change during the eclipse. After excluding the eclipses and de-trending to eliminate shape effects, a periodogram of these out-of-eclipse shows "flickering". The authors note that all of this is typical of a nova-like cataclysmic variable.

A grism-spectrum study (done with a larger telescope) also showed characteristics of an SW Sex type cataclysmic variable.

Towards a Unified Definition of Solar Limb During Central Eclipses and Daily Transits
by Costantino Sigismondi, Richard Nugent, et al.
submitted to International Journal of Modern Physics D
preprint at http://arxiv.org/abs/1106.2197v1

Many SAS members are also participants in the IOTA's program of observing asteroid and lunar occultations; you will probably recognize Richard Nugent, who is a coauthor on this report. The greatest of the lunar occultations are the ones involving the Sun (aka solar eclipses). The subject here is the interpretation of the position and brightness distribution of the Sun's limb.

We loosely think of the solar limb as being the visible "edge" of the Sun, but of course that's a bit sloppy – there isn't really a sharp edge, and the observed limb position depends noticeably on the wavelength of observation, among other effects. The limb's image is smeared by turbulence in our own atmosphere, and we can't readily unravel the turbulent smearing because the true intensity profile is poorly known

The concept of the experiment reported here is to observe Bailey's beads with a video camera, and from the brightness vs. time profile, determine the solar limb intensity versus radial distance from the Sun. The intensity vs. time is, of course, affected by the exact shape of the lunar-limb valley that creates the "bead". Topographic data from the Japanese Kaguya lunar satellite gives very high-resolution profiles of the lunar limb, so that each individual bead can be used as a sort of "knife edge" that scans the solar limb. Since the knife edge is outside the Earth's atmosphere, the resulting brightness curve is not affected by local "seeing".

The report includes data and a sample limb-brightness curve derived from a single "bead" during the January, 2010 annular eclipse observed by Nugent from Uganda. The data seems to be very "clean", so this concept shows great promise. Future observations should be made at total eclipses (which are expected to provide improved signal-to-noise ratio), and preferably will use a camera with 12-bit output for improved resolution (rather than the 8-bit camera that was used for the data in this report).

Discovery and Mass Measurements of a Cold, 10-Earth Mass Planet and Its Host Star
by Y. Muraki, et al
preprint at http://arxiv.org/abs/1106.2160v1

Here is another remarkable discovery from observation of a "microlensing" event of a distant star. These are "remarkable" for several reasons. The very notion that gravitational (micro-) lensing from solar-mass objects is detectable still impresses me; that they can be accurately monitored with backyard-scale instruments is unexpected; and that exoplanets (and, sometimes, their moons) can be discovered and characterized this way is downright astounding.

The long list of authors on this paper includes several names that may be familiar to SAS members, including Berto Monard (of CBA), J. McCormick and D. Moorhouse (μFUN).

The particular object of this event turns out to be a 0.6-solar-mass star with a 10-Earth-mass planet orbiting at a distance of about 3.2 AU. The star+planet system lies about 3 kpc from Earth.

A special circumstance – of great benefit to microlensing studies – was that the EPOXI spacecraft was able to make a few measurements of the event, and thereby help to pin down the "microlensing parallax" effect. The authors suggest that future microlensing studies will benefit greatly from such opportunities, which sounds to me to be a really "out of this world" step in pro-am collaborations.

Dispatch from a Member

Fourth Observatory in 25 Years: Moving Toward the Ideal
by Dale E. Mais

Every time I have built an observatory, it was going to be the last time. Here I am again, for the fourth time, building an observatory and I will not say this is the last time. One thing for sure, it was easier building them when I was younger! I have learned over the years from my previous mistakes and have incorporated that learning into this observatory, again with modifications to account for the different weather conditions. All of the structures have had the same basic design, the walls height varied depending on local terrain, from 4 to 5 to now 7 feet, the roof angle has gone from 45 degree slop to a 30 degree slope. The same basic roll off design has served me very well. In the first three observatories there was always some calamity that befell the structure. In South Carolina where I built my first observatory and used it for 3 years, the observatory was destroyed by Hurricane Hugo in 1989, only 6 months after we had moved to Indiana. Now you might think that I dodged a bullet but not so fast. On the Memorial day weekend of 1989, shortly after building my second observatory in central Indiana, we were hit by a tornado. It tore the roof off, lifting it up and over the building. When we came out of the basement, you can imagine my horror to see the scope actually completely intact standing in the observatory but being drenched by rain! I rebuilt the roof of course, but still had not taken into account snow blizzard conditions and how snow can pile up inside a structure that by its nature cannot be completely sealed. Fortunately, during our 3 years in Indiana we never had a blizzard that tested this, and once again we were off, this time to southern California.

Snow blizzards were not a concern in California so I gave no thought to this issue. Because of the uneven terrain on which I was building, once I had a place carved out from the side of the hill, I was forced to raise the walls to 5 feet in order to accommodate the roll off rails. No problem, one remains flexible in this game. However, something even more hideous than snow storms was lurking about, wild fires. Over the years we had many of these and they resulted in a very light dusting of ash within the observatory. The one from which I never did completely recover from occurred in the big fires of late 2007. The dead space inside the observatory basically acts like an ash trap and when it was over everything, and I do mean everything had a one eighth inch covering of the ash. I never did fully recover from this mess. While I did my best to get things cleared off, I was interrupted by a job opportunity in the middle of 2008 (I had been laid off from my job of 15 years in early 2007). During late 2009, I completely disassembled the observatory and got it moved to our new place in Marcellus Michigan (lots of corn fields) and put it in storage. We finally got completely settled in during spring of 2010. It was time to build my fourth observatory.

By now I knew several things that I would need to deal with and technology was going to allow me to do other things I couldn't do before. I knew this time I would have to deal with the frequent snow storms. Also I knew because of a much windier area we lived in, I would need to have more protection. This led me to build the walls of the observatory at 7 feet for added protection. This led to two issues, one when I opened and closed the roof, and when the telescope is actually pointing to certain parts of the sky, something I didn't foresee, but more on this later. I also didn't want to sit in the observatory at night and fight very humid or very cold weather and certainly didn't want to deal with mosquitoes, so it was decided, to run everything from inside the house where I could access the observatory computers through a network line. Figure 1 shows progress in late spring during construction.

Figure 1

Figure 2 is a different angled shot. And yes, for those of you that didn't already know we live in a barn seen in the background.

Figure 2

Figure 3 shows initial assembly of the equipment. Before assembling everything, I took all equipment apart and completely cleaned it to get rid of all the ash from the fires in California, everything looked brand new. My setup is essentially as I had it in California except I upgraded to a 16 inch scope.

Figures 4 and 5 show essentially the completed observatory, both closed and opened. Notice in Figure 4 the arrows pointing to 2 boat winches. This was one of the issues alluded to above that created a problem with the 7 foot walls. I could no longer hand open the roof. I couldn't reach the beams above by hand like I did for the 4 and 5 foot versions. So I used a pole to push the roof. The problem was that the angle was relatively steep so a good portion of the force I was delivering was NOT going toward pushing the roof, but

Figure 3

rather lifting it (think in terms of vector forces). It was very difficult to move the roof so I purchased two hand boat winches and this completely solved the problem. The second issue with the 7 foot walls is pointed to by the yellow arrow in Figure 5.

Figure 4

Because I have a German equatorial mount, I did not have good access to the southern sky (yellow arrow points to southern side). At the last minute I had to modify this wall with a 2 foot hinged portion that hinges open allowing complete access to the south. Finally I had to deal with snow which I knew was going to be an issue when blowing. It didn't come to me until November of that year when snow could start coming anytime. The red arrow of Figure 5 points to the solution I used. It was an extension of the siding coming down from the mobile roof piece and overlapping about 8 inches with the side of the observatory. There is only a gap of about one fourth inch between these pieces and it essentially stops snow from meandering up and over those 8 inches and finding its way inside. All other small spaces were filled with spray insulation foam. This stuff works great as it expands into crevasses when it is sprayed into openings. This worked fine for our first winter. After we had a storm I went out to check and there was only a little snow around the door. Nowhere else had snow worked its way in.

Figure 5

Also in this same time frame, I rented a trencher and dug the trenches to lay the conduit for the power line and the network/wiring lines before the ground froze up. Figure 6 shows the completed assembly of scopes and instruments around the time that the network lines were being laid.

Figure 6

I allowed plenty of conductors through the conduit. I didn't know for sure how I would get things exactly connected to be able to control from inside the house. Then I discovered the web power switch shown in Figure 7. This device plugs into a power outlet in the observatory AND it interfaces with the rooter in the observatory. This allows me to see the power outlet from inside the house and turn on and off any of eight different devices with the click of the mouse. I can assign certain functions to any of the eight outlets. So as an example I can now with a mouse click turn on-off the thorium argon lamp, the slit illumination light etc. This solved a lot of issues for only $109! So now I still have all the conductors in the conduit I can use for other (unforeseen) devices/functions.


Figure 7

About 90% of things are done now and I have begun calibrations and alignments. I can tell you for sure, southwest Michigan is NOT southern California. We do not get that many good days at all and even a good night can turn bad fast because of the effect Lake Michigan has on the weather. I can see I will need to get a cloud detector to give me warnings at night when things are on auto-pilot.

It has been surprisingly more fun to build this than I thought it would, but I am eager to get to work with it .

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