Society for Astronomical Sciences

News from the Society for Astronomical Sciences

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Jeff Hopkins Honored with ASP Amateur Achievement Award

The Astronomical Society of the Pacific (ASP) has announced the recipients of its 2012 awards for excellence in astronomy research and education. Long-time SAS member Jeff Hopkins was awarded the Amateur Achievement Award.

The Amateur Achievement Award recognizes significant observational or technical achievements by an amateur astronomer. Jeffery Hopkins exemplifies a level of long-term dedication and commitment in the very best tradition of amateur astronomers contributing to professional science. He has a long record of achievement in precision photoelectric photometry and recently in high-resolution spectroscopy. He has co-authored dozens of research papers that have appeared in such publications as Astronomy and Astrophysics, the Astrophysical Journal, Astrophysics and Space Science, and the Publications of the Astronomical Society of the Pacific and has published five astronomical related books the most recent being Small Telescope Astronomical Spectroscopy. He has participated in numerous observing campaigns, including studies of Epsilon Aurigae, comets, eclipsing binaries, and RS CVn stars. Amateur photometry and spectroscopy requires a high level of precision, often without access to professional resources, and Hopkins' work, going back several decades, has significantly helped to lower the barriers between amateur and professional astronomers.

Congratulations, Jeff!

Ms. Sobel's keynote lecture included a reading (with her brother Steve) of the scene in her play that imagines the discussion between Rheticus and Copernicus about the astonishing theory that removed the Earth from the center of the universe.

Report from the Joint SAS - AAVSO 2012 Symposium

The 2012 Symposium on Telescope Science – a joint meeting of the Society for Astronomical Sciences and the American Association of Variable Star Observers – provided a wonderful view of the breadth and depth of small-telescope astronomical science. Technical papers were presented on Pro-Am collaborations, Solar system Research, Variable Stars, Discovery Campaigns, Spectroscopy, and a variety of Special Projects. These all had in common the importance of data that was gathered by amateur-class telescopes. The presenters were a mix of professional astronomers, "backyard scientists", and students. Presented talks were augmented by quite a few poster-papers (most of which are summarized in the published Proceedings)

There were 146 people registered for the Symposium, which was held as usual at the Northwoods Resort in Big Bear CA. The international participation was impressive -- attendees came from the USA, Canada, United Kingdom, Belgium, Spain, Uruguay, Argentina, and New Zealand. In addition to the formal sessions, participants made good use of the hallways, lobbies, and late-night gatherings as productive opportunities for networking, planning new projects, and getting re-acquainted with old friends.

The complete Proceedings and videos of most of the Presentations will soon be available for download on the SAS website (www.SocAstroSci.org).

The Symposium schedule included two half-day educational workshops: "Spectroscopy for Small Telescopes" was presented by Dr. John Martin, and "Photometry with VPHOT" was presented by Dr. Aaron Price.

These were very popular – roughly 60 participants in each – reflecting the enthusiasm of non-professional researchers for education in new techniques and training to improving their skills in creating and interpreting astronomical data.

The final highlight of the Symposium was the keynote lecture by Ms. Dava Sobel, the award-winning author of LONGITUDE, GALILEO'S DAUGHTER, and A MORE PERFECT HEAVEN.

Workshop DVDs Available

The Workshop on "Small-Telescope Spectroscopy", presented by Dr. John C. Martin at the 2012 SAS Symposium, is now available on DVD. The lecture (audio and all slides) is contained in three "WMV" files, which should be compatible with any PC with modern software.

DVDs of the workshops from the 2011 Symposium ("Eclipsing Binary Stars", by Dr. Dirk Terrell, and "Robotic Observatories" by Tom Smith and Tom Krajci) can also be ordered. Pricing is:

$3 per Workshop for registered participants (if you registered for the workshop but were unable to attend, this is your price).

$53 per Workshop for people who weren't registered.

To order a Workshop DVD, send an e-mail to Bob Buchheim at Bob@RKBuchheim.org, and be sure to say whether you were registered for the Workshop. Checks should be made out to "SAS".

Videos of SAS-2012 Technical Papers on the SAS website

Those of you who attended the 2012 Symposium will remember that the A/V team were pretty frantic and stressed out during the hour before the start of proceedings on Day 1. We won't go into the gory details, but by last-minute swapping of computers the team was able to get the meeting started on schedule, with excellent projection quality for the audience.

The recording quality, however, was a casualty of the "Day 1" computer issues. We will post the Technical Presentation videos from both days on the SAS website for the benefit of those of you who weren't able to attend the Symposium, but we apologize to both the Presenters and the on-line audience for the low quality of the recordings on Day 1. Happily, the problems were resolved overnight and the quality of the Day 2 recordings are what we had been striving for.

For Your Viewing Enjoyment

You may remember the article about the Pro-Am spectroscopic campaign on the Wolf-Rayet star WR-140 (see Sky & Tel "Stellar Winds above Atlantic Clouds"). This was a really fabulous example of what amateur spectroscopy and professional astronomers can do together, and resulted in several peer-reviewed papers describing new results related to the stellar winds.

A very interesting "first person" description of this experience, presented by Dr. Thomas Eversberg, is available for viewing at http://www.iac.es/info.php?op1=23&op2=119&op3=41&y=2012&lang=en&id=429 (Leige Conference on Massive Stars, 2010). It is particularly interesting to see the breadth, skill, and dynamism of the European amateur spectroscopy community, which seems to be more active than the American amateur-science community. (or Google "Spectroscopic Madness - The ProAm WR 140 campaign")

Spectroscopy Projects for Small Telescopes and Pro-Am Collaborations

by Olivier Thizy

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Editor's note: This article is an edited version of some advice that Olivier posted on the spectro-l Yahoo! group on May 29, 2012. It is a nice list of projects that are within the capabilities of "backyard scientists".

In response to some questions that I have received, here is a short compilation of spectroscopy projects for small-telescope research, and pro/am collaborations that do (or could) benefit from amateur scientists. There are quite a few more-or-less active collaborations with professional astronomers taking advantage of our spectroscopic capabilities.

I have divided the list of suggested projects into "high resolution" and "low resolution categories. "High resolution" projects can be pursued with equipment such as the Lhires III with 2400 lines/mm grating, the SBIG SGS using the 1200 lines/mm grating or the eShel with a 1200 lines/mm grating.. "Low resolution" projects can be pursued with systems such as the LISA or Lhires III spectrographs with 150 lines/mm grating.

"High resolution" projects

Be stars: A Be star is a B-type star with prominent hydrogen emission lines in its spectrum (which is unusual: most stars show only absorption lines). The star's emission lines can change, and even disappear/reappear from time to time; and the cause of these changes is not well understood. Therefore, it is important to monitor Be stars on a regular basis, to provide a database against which theories can be tested. This is a long term project. The "Be Star Spectra" (BeSS) web page and database at

http://basebe.obspm.fr/basebe/

is a central archive for the observed spectra, most of which have been gathered by small-telescope researchers. (*Ed. note: For more information on the BeSS, see Olivier's paper from SAS-2011, and the associated video, both of which are freely available on the SAS website*).

It will require about 10 years of data for the observations to be statistically valid. Some articles are already being published using data from BeSS database for some specific stars. It is hard to know in advance which star will be the most interesting, but the early publications using BeSS data does show the interest in this database and the associated amateur work.

If you do not know what to do, simply look at ARASBeAm web site and select a visible target in red or yellow status: http://arasbeal.free.fr Just record & reduce your spectra and upload them in BeSS!

The Be stars program is well structured with a group of administrators who are willing to help you to improve the quality of your spectra. This practical education will be useful for any other type of spectroscopic projects that you might pursue.

delta Sco: Delta Scorpii is a binary star in an eccentric orbit. The system was in periastron last summer but it is important to continue to follow it through the complete period. The last period (2000-2011) was very interesting and we think the next one will be as well.

Here also, it is simple to participate: simply upload your spectra into BeSS but also send your data to Ernst Pollmann who is linked to the professional astronomers who are interested in that star.

Herbig Ae/Be stars: These are young (pre-main-sequence) stars which may display both photometric variability and spectroscopic changes. They are interesting to monitor with short exposure time series.

The professional team is currently adding this category of stars (Herbig stars) in the BeSS database. You can already see in the query pages of the BeSS database a few references to these Herbig stars, but for now there are only 2 of these stars in the database for testing purposes. In the near future, the full catalogue of Herbig stars will be available. So you will be able to upload your Herbig spectra into BeSS.

VV Cep: This star is a binary with a very long period which deserves continuous monitoring (one spectrum every month or every two weeks, for example). When the system approaches periastron, the observation cadence should of course be adjusted.

Ernst Pollmann (see his contact information on BeSS) is the person to contact if you have spectra of this star. You can also disseminate your spectra on the ARAS forum!

P Cygni: This is a LBV star (Luminous Blue Variable) with strong wind and matter ejection. It is a rare type of star (along with eta Carinae in the southern hemisphere) and should be continuously monitored in high resolution. A recent publication was made possible by the help of several amateurs, and there is more to learn from this star... until it explodes! ☺)

Spectra can be sent to Ernst Pollmann and disseminated on the ARAS forum, at

http://www.spectro-aras.com/forum

zeta Oph: This is a pulsating variable star which has been the subject of recent work by Ernst Pollmann.

Do short exposure time series over several nights and send your spectra to Ernst who is studying this star at the moment.

epsilon Aurigae: The current transit is over and we'll have to wait about 35 years for the next one, but it is important to continue to monitor epsilon Aurigae to understand its out-of-eclipse behavior. There are short term fluctuations that still require observation and data so that they can be fully understood. Take regular spectra, disseminate them on the ARAS forum, and send reduced FITS/BeSS files to Robin Leadbeater who is working with the professionals (e.g. Dr. Bob Stencel) on this object.

Wolf Rayet stars: Some of these stars are binaries and very interesting to monitor when close to periastron. The most famous case is WR140, which reached periastron in 2009. I do not think there are any active campaigns at the moment but I would recommend taking regular spectra once or twice a year to be ready for next periastron campaign! Disseminate your results on ARAS forum so we will know you will be interested in a future campaign for those stars.

Ed. note: Robin Leadbeater noted that The Convento group is planning a campaign on WR134, WR135 during 2013.

http://www.stsci.de/wr134/index.htm

The requirements are quite challenging unless you have a large aperture but now is the time to try to see what you can do.

Exoplanets: OK, this is definitively an eShel project as it does require very accurate Radial Velocity measurements. And it will be very challenging. But there are several exoplanets to monitor that are within reach of our amateur telescopes.

If you are willing to invest a significant amount of telescope time with an eShel and if you are very meticulous, contact me in private and I will connect you with the professional team on exoplanets!

"Low Resolution" projects

Be Stars: I noted these as targets for "high resolution" spectroscopy, but a lot of Be stars are only accessible in low resolution with our amateur-size telescopes. Some of these stars don't even have a single spectrum in BeSS database yet - so be the first one to add it!

A very interesting project is to do a complete survey of B/Be stars in an open cluster and do some statistics on the results. If someone has telescope time with low resolution spectrograph, contact me in private to help you find some targets and put you in contact with a professional astronomer interested in such observations. Of course, publish your data for known Be stars on BeSS database!

Symbiotic Stars: These are ideal targets for a LISA spectrograph. Monitor them through the complete cycle and look specifically when an outburst occurs (announced through AAVSO alerts for example). See François Teyssier's web site at

http://www.astronomie-amateur.fr/

for a list of these stars.

Disseminate your spectra on the ARAS forum so you can be integrated in specific pro/am campaigns:

Cataclysmic Variables: These interesting objects are also good (albeit challenging) targets for spectroscopy. Some data and project results can be found on François Teyssier's web site at

http://www.astronomie-amateur.fr/

(*Ed. note: Francois' site is in French, but the photometric and spectroscopic graphs are easily understood*).

Novae: More and more novae are within reach of the LISA spectrograph. Follow UAI alerts through AAVSO or the Spectro-L discussion group. Dr. Arne Henden has advised that photometric monitoring of novae should be continued for at least a year after outburst (because surprising variations are observed); and monitoring for as long as possible with spectroscopy would doubtless be valuable.

Supernovae Here also, more and more targets are within reach of our telescopes and spectrographs. For bright supernovae, try to monitor them as long as possible and disseminate your results on the ARAS forum. This should help to create over time a stronger pro/am link for those targets.

Micro quasars: This project was recently discussed at La Rochelle. A reasonable size telescope and a LISA should allow some monitoring that would help the professionals get more data on those mysterious objects.

Katherine Blundell from University of Oxford (UK) will welcome amateur spectroscopists with reasonable size telescope and spectrograph with resolving power R between 1000 and 5000 to join the Global Jet Watch project and contribute to microquasar monitoring, specially SS433. A web site & a newsletter for the project will be setup in august and a database is being created to store Global Jet Watch project spectra including amateur spectra; discussion are on-going to extend that database to cataclysmic variables, symbiotic stars, novae... Katherine can be reached at: Katherine.Blundell@astro.ox.ac.uk

Comets: There is no official campaign on those objects but I would recommend taking spectra of bright comets and disseminating them on the ARAS forum. A professional astronomer would certainly be interested some day as we do see regular publication of papers that include data from amateur spectra.

Images of the 2012 Symposium

Here are some views of the 2012 Joint Symposium of the Society for Astronomical Sciences and American Association of Variable Star Observers.

The conference room: well-filled, but still comfortable and nicely appointed. Photo by Earl Wilson.

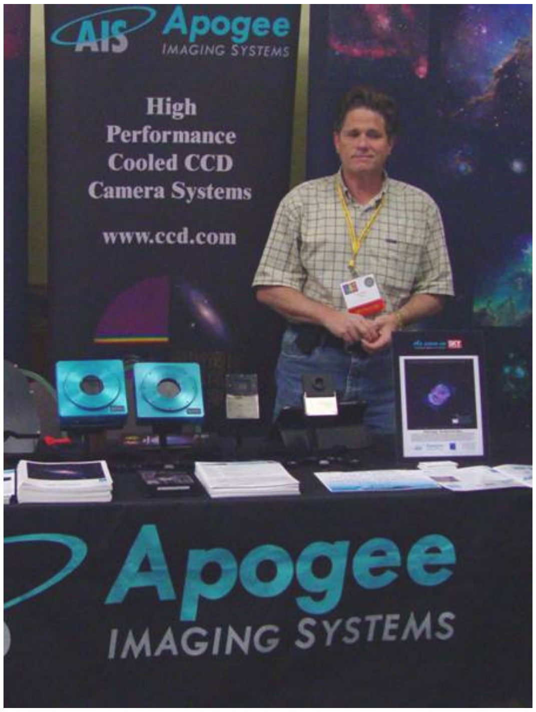
The Registration Committee: (left to right) Cindy Foote, Margaret Miller, Loraine Moon. Photo by Earl Wilson.

The crescent Moon (just a couple of days after the annular eclipse) and Venus made a pretty pair in the evening twilight. Photo by Bob Stephens.

Bob Gill, Dale Mais, and --- reached the front of the long line of fans having books signed by the author (Dava Sobel, seated). Photo by Bob Stephens

Doug Walker (l) introducing Elise Sparks (c) and Kodiak Darling (r) who presented their spectroscopic analysis of Algol.

Bob Denny explained the capabilities and benefits of DC3 Dreams software. DC3 Dreams is a valued Sponsor of the SAS Symposium. Photo by Earl Wilson.



Tim Puckett gave a Technical Paper on Supernova Hunting, and also represented Apogee Imaging Systems, displaying their line of advanced imaging equipment. Apogee is a valued Sponsor of the SAS Symposium. Photo by Earl Wilson.

Lee Snyder (SAS President) wouldn't tell us how old he was, but he did admit that when he was born, the Dead Sea was only sick. Photo by Bob Stephens

Tom Field describes the RSPEC software. Photo by Earl Wilson.

Rick Hedrick, founder of Plane Wave Instruments, displayed some of their top-end products: the 24-inch CDK, on an Ascension 200HR mount. Plane Wave Instruments is a valued Sponsor of the SAS Symposium. Photo by Earl Wilson.

Networking before dinner. Photo by Bob Stephens

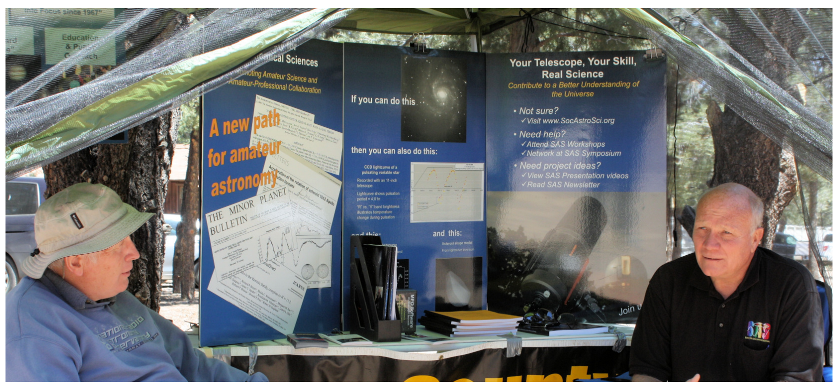
John Menke (at the podium) describes his medium-resolution spectrograph. Photo by Bob Stephens

The whole gang gathered for the traditional group picture. Photo by Bob Stephens.

One of the technical papers described the successful AAVSO-organized effort to gather a modern lightcurve of Hubble's first Cepheid variable in M31. Yes, indeed, a backyard telescope can see and measure the lightcurve of a single star in a nearby galaxy!

Here are some of the people who contributed observations: (left to right) Richard Sabo, Bill Goff, Arne Henden, Robert Buchheim, Michael Cook, Gary Walker, and Steve Smith.

The following project participants are absent from picture: Gergana Belcheva, Tim Crawford, Shawn Dvorak, Barabara Harris, and Mathew Templeton. Photo by Michael Cook.



Dale Mais (r) and Gary Cole (l) are shown here sitting in the SAS booth at RTMC, chatting about small-telescope science. The booth (shared with Orange County Astronomers) was a good opportunity to introduce visitors at RTMC to opportunities for research by amateur astronomers. Photo by Bob Buchheim

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Small-Telescope Astronomical Science in the News

April - June 2012

compiled by Bob Buchheim

A couple of months ago, I served as a Judge at the Orange County (CA) Science and Engineering Fair. The experience gave me a renewed optimism about the younger generation: there are some very bright kids out there! I was a bit disappointed to see only one astronomy project, and that one a poorly-conceived effort. Such a shame, considering the wide array of astronomical projects that are well within reach of bright high school students with backyard-size telescopes. On the other hand, aerodynamics, fluid dynamics, civil engineering, and life-sciences were well-represented by top-notch efforts. I encourage you to invest some effort encouraging, motivating, and offering advice to science-oriented youngsters. It might change their lives, and yours!

This quarter's review of recent small-telescope science results might give you some ideas for astronomy projects that are appropriate for Science Fair entries, or for your own research program. Papers summarized below identify several stellar systems that are in need of photometric or spectroscopic data and that are within the range of "backyard scale" equipment.

The KELT-South Telescope
by Joshua Pepper, et al
Publ. Astro. Soc. Pacific, v. 124, p 230 (Mar 2012)

A couple of years ago at the SAS Symposium, Bob Stephens pointed out that if you are starting a challenging project, the first thing to work out is a snappy acronym. Here's one: KELT stands for Kilo-degree Extremely Little Telescope.

The concept is to feed an Apogee Alta CCD with a Mamiya 80 mm f-1.9 camera lens, mount the pair on a Paramount ME, and control them with fully-automatic scripts. The system records almost a thousand square degrees (nominally a 26 X 26 deg FOV) and with its less-than-two-inch aperture provides ~5 mmag photometry of stars to 11th magnitude. Like other similar systems, its primary goal is detection of exoplanet transits, but naturally it also does quite a job on variable stars of all varieties.

At first, this sounds like a fun "backyard" project. Certainly the equipment requirements aren't beyond reach. The challenge seems to lie in the data processing. There are thousands of stars per image, a hundred or more images per night, a variety of systematic and random effects to be assessed during image processing, and a wide array of photometric-phasing parameters to apply to each star. This is not a programming chore for the faint-hearted! But the author's initial examples of variable star lightcurves are very impressive.

Astronomical Sky Quality Near Eureka, in the Canadian High Arctic
by Eric Steinbring, et al
Publ. Astro. Soc. Pacific, v. 124, p 230 (Mar 2012)

Another useful employment for small-aperture CCD imaging is site characterization. in this case the authors established a fish-eye (almost "all-sky") lens and CCD combination and set it to staring at Polaris for an extended season that include two complete north-polar nights.

Some results were to be expected – it gets darn cold up there (-40C ... brrr), and it's very dark (aside from aurora). It turns out to also be clear most of the time, and winds are not a serious problem.

The authors show their lightcurve of Polaris, which is in itself pretty interesting considering the modest equipment used to gather it – it clearly shows the 28 mmag brightness variation with a period of 4 days.

HS 2325 +8205 – An Ideal Laboratory for Accretion Disk Physics
by S. Pyrzas, et al
Publ Astro. Soc. Pacific, v124, p.204 (Mar 2012)

Here is a productive collaboration between small-telescope backyard scientists, and large-telescope professional astronomers. The "et al" in the author list includes several names that you may recognize: D. Boyd, I. Miller, and G. Poyner, (from the British Astronomical Association's Variable Star Section), S. Brady (AAVSO) and B. Staels (CBA Flanders).

The "small telescope" team used 11- to 14-inch (28- to 36-cm) telescopes for photometric monitoring (mostly unfiltered) to characterize the outburst cadence of this star. The "large telescope" team used 1.2m to 2.5m telescopes to create (a) accurate photometric eclipse lightcurves and (b) high-resolution spectroscopy.

This effort confirms that HS 2325+8205 is a cataclysmic variable with frequent outbursts (brightening by nearly 2 magnitudes, every couple of weeks); and that it is an eclipsing system. The short outburst cycle suggests that it might be a Z-Cam type star; if so, it is only the third known eclipsing Z-Cam, which will make further characterization (e.g. rapid-cadence eclipse lightcurves) extremely valuable. In addition, its brightness and far-north location make it an easy target for small telescopes located in the northern hemisphere.

The Photometric Period and Variability of the Cataclysmic Variable V849 Herculis (PG 1633+115)
by F.A. Ringwald, et al
New Astronomy 17 (2012) 570–575

The authors used a 16-in (41-cm) telescope to conduct "clear" C-filter time-series photometry of this system over almost three months. It is not bright (nominally 15th magnitude), but by combining their almost-nightly data with longer-term AAVSO data (both V-band CCD and visual estimates), they were able to see a couple of interesting features. First, the system is almost certainly a nova-like variable, whose usually-continuous outburst state is punctuated by "low states" during which the mass-transfer between the two stars presumably slows, or maybe stops. In the "low state", the star is roughly 0.5 magnitude fainter than normal. Second, the low-states occur at roughly 12.5-day intervals, although the phenomenon may not be truly periodic, and its quasi-periodicity is poorly constrained. Third, the star displays a brightness lightcurve with period of about 3.4 hours; it is not clear if this represents the orbital period, a "superhump" period, or something else.

The authors end with a strong plea for continued photometric monitoring of this system, to determine if the 12.5-day "quasi-period" of low-states is real (and whether it might be truly periodic); to better characterize the overall variation of the system; and to gather longer time-series with which to study the nature of the 3.4-hour fluctuations. Spectroscopy would be valuable, too, but at 15th magnitude it is probably well out of the range of most SAS observers.

HS Hydrae About To Turn Off Its Eclipses
by P. Zasche and A. Paschke
Astronomy & Astrophysics 542, L23 (2012)

Here is a story of how the modeling of an eclipsing binary system can discover a surprising bit of orbital dynamics. HY Hyd is a bright (mag 8) eclipsing-binary system with period P≈1.6 d. It has a long history of study (lightcurves and times of minimum light). The authors re-examined the historical lightcurves – mostly made with small telescopes – and noted that the eclipses have become progressively shallower over the past 50 years. In 1964, the depth of the eclipse was about ΔV≈0.4 mag. In 2008, ASAS data showed that the eclipse depth was only ΔV≈0.05 mag (and lightcurves from intermediate epochs show a consistent trend of reduced eclipse depth). Modeling shows that eclipse depth is most sensitive to the inclination of the binary's orbital plane. The implication of this change, in the binary-star models, is that the orbit inclination has changed from i≈89 deg in 1964 to i≈75 deg in 2008. Assuming that the modeling is reliable, the authors predict that eclipses will cease in about 2022 (although the slight brightness variation caused by the elliptical shape of the stars will still remain).

What is going on? The authors' hypothesis is that a third body in the system (in a 190-hr orbit) is tugging on the orbit of the close pair, causing their orbital plane to precess in a ~600-yr cycle.

Assuming that the system is, indeed, changing this rapidly, the authors issue an urgent call to gather more lightcurves and radial velocity data over the next decade. Ideally, the RV observations should be "matched" to lightcurves at the same epoch so that the system's evolution can be followed. At magnitude 8, this might be a feasible target/project for some SAS spectroscopists. There are only a handful of systems that have displayed a similar effect, so this is a chance to contribute data on a rare type of object.

Long-term Photometric Monitoring of RR Lyrae Stars in Messier 3
by J. Jurcsik, et al
Monthly Notices of the Royal Astronomical Society
Volume 419, Issue 3, pages 2173–2194, January 2012

A few years ago I saw a time-lapse movie of images of a globular cluster, where the many periodic variable stars made the cluster seem to "sparkle". Was that M3? I don't remember ...

The key observational contribution reported in this paper is a collection of photometry of M3, made mostly with a 60-cm (24-in) telescope. This collection fills in a long gap in the century-long record of photometry of RR Lyrae stars in this globular cluster.

These data are important because they contribute to the characterization of RR Lyrae pulsation periods and lightcurve shapes. The simplest expectation is that as a star evolves across the instability strip, it will either expand or contract (slowly), and this will be manifested as slight changes in pulsation period. Alas, things aren't nearly that simple: overlaid on this stately "evolutionary" change are a variety of short-duration sporadic period and lightcurve changes. The hope is that with a long-enough time base of a sufficient number of stars, the evolutionary change can be seen as a sort of "smoothed average" over the other changes; and the other changes can be understood. The present (110-year) time base appears to be not long enough for these purposes, but it also suggests that occasional intensive observation campaigns of this cluster are useful.

Photometry of Meteorites
by P. Beck
Icarus v. 218 (2012) 364–377

Here is a laboratory experiment that may interest those of you who have made "phase curves" of asteroids. The authors report their measurements of the bi-directional reflectance of meteorite samples, which might be considered a sort of "ground truth" of our telescopic measurements of asteroid phase curves. If life were simple, this sort of experiment would make it possible to use the Hapke reflectance model to "invert" photometric phase curves and solve for the surface properties of the asteroid. Alas, life isn't that simple: even with good laboratory data the Hapke model is underdetermined and there are strong correlations between multiple parameters.

Nevertheless, the laboratory data does show similar trends to asteroid observations. All of their samples (lunar breccia, several chondrites and Howardite–Eucrite–Diogenite meteorites) displayed slightly redder color when observed at large phase angles. This has been observed in asteroid photometry, and may be an important clue because the standard Hapke reflection model does not predict color change with phase angle. (The authors hypothesize that it is related to micro-roughness on the 100-nanometer scale, that is not included in Hapke's model). Their measurements validate long-quoted relationship between opposition surge and reflectivity/albedo: lower reflectance correlates with more pronounced opposition surge. Their spectra also illustrate why visible-wavelength spectroscopy doesn't do a good job of distinguishing asteroid types: the first really significant absorption band is centered at a wavelength of about 0.9μm.

Measuring and Mapping the Night Sky Brightness of Perth, Western Australia
by James D. Biggs, et al
Monthly Notices of the Royal Astronomical Society, V 421, Issue 2, p 1450–1464, April 2012

At the 2012 SAS Symposium, Eric Crane described his project of mapping night-sky illumination in southern Arizona, whose goals are to define a "baseline" against which to compare future measurements, and to provide a means for establishing and assuring conformance to light-control regimes. Here is a similar project, examining the region of Perth, Australia. The authors include a nice section discussing the adverse effects of light pollution and light trespass, which goes far beyond the chauvinistic interests of astronomers. For example, many plants require darkness night, in order to achieve optimal photosynthetic performance during the daytime. And a credible estimate is that worldwide, it costs about $2.3B per year to *create* light pollution.

The authors used hand-held light meters to conduct a ground-level (only) survey of zenith night-sky brightness around Perth. In comparison with Crane's survey, the Perth survey did not include aerial reconnaissance, and seems to be a sparser irregular matrix of data points. The measurements are then correlated with LandSat imagery to note the relationship between sky brightness and land use.

Not surprisingly, land use correlates strongly with night-sky brightness: forest and agriculture land has darker skies than industrial areas, and you really don't want your observatory to be next to an airport! And, at least for an isolated city like Perth, the sky brightness decreases fairly rapidly as you move outside of the city boundary.

Variable Stars in the Globular Cluster M14
by Kyle E. Conroy
Journal of the Southeastern Association for Research in Astronomy, Vol 5, 20
preprint at arXiv:1205.2814v1

The authors report on the results of CCD photometric monitoring of M14 using a 90-cm (35-in) and a 60-cm (24-in) telescope. They used an image-subtraction algorithm to identify variable stars and create useful lightcurves despite the cluttered field. M14 is a rich source of variables: the authors identify over a hundred variable stars, predominantly RR Lyrae's. However, since this project spanned only a couple of months the authors acknowledge that they are probably missing a population of long-period variables.

Photometric Lightcurve and Rotation Period of Himalia (Jupiter VI)
by Frederick Pilcher, et al
Icarus v 219 (2012) 741–742

Many of you will probably recognize lead author Fred Pilcher, a photometrist with a long record of asteroid lightcurve projects. (It is pretty neat that an amateur astronomer is lead author on a paper in Icarus!)

Here, he reports on the determination of the rotation period of Jupiter's irregular satellite Himalia. Surprisingly (to me), despite at least 50 years worth of opportunities and several spacecraft missions to Jupiter, this is only the second attempt to determine the rotation period of Himalia; and it is probably the first to determine the correct rotation period (P≈7.78 hr, with amplitude Δm≈0.2 mag).

Data were gathered using a 36-cm (14-in) schmidt-cass telescope and CCD; and confirmed with a CCD lightcurve made using a 1.2-m (48-in) telescope. It is impressive to see that the small-telescope data set is only slightly more "noisy", and provides quite comparable information as the large-telescope data set.

This may be a fruitful niche for more small-telescope photometrists – measurement of irregular satellite lightcurves seems to be a neglected topic, and all of the same techniques that are applied to asteroids can be applied.

A Photometric Study of the Neglected Eclipsing Binaries: V405 Cep, V948 Her, KR Mon and UZ Sge
by A. Liakos and P. Niarchos
New Astronomy v.17 (2012) 634–639

The authors report multi-band time-series photometry of four eclipsing binary stars, taken with a 40-cm (16-in) telescope and CCD. They gathered complete lightcurves, showing both primary and secondary eclipses and color-changes during eclipse; and the applied the PHOEBE code to create models of the systems, using much the same techniques that Dr. Terrell explained in his Workshop at the SAS-2011 Symposium.

They made an interesting additional step in the analysis of several of these stars: after a reliable system model was established, they created a time-series data set of the difference between "observed" and "calculated" brightness, and subjected it to a Fourier analysis in search of additional periodicity. For three of the stars, nothing significant was found (at the 4-sigma level). For UZ Sge, they discovered two periodic signals, with the dominant period P≈ 2 hr, which they attribute to δ-Scuti type pulsations in the primary star.

For all of these stars, spectroscopic study is still needed, to confirm their spectral types, and to get some radial velocity data so that absolute stellar parameters (radii, separation and luminosity) can be reliably determined.

[*Ed. note: Hidden in the paper is something that is either scary or complimentary, depending on how you look at it, namely: our papers presented at SAS do, indeed get noticed by the research community. A couple of years ago I presented a lightcurve and analysis of UZ Sge at SAS, which was found and referenced by the present authors. Happily, their data and model are consistent with mine. RKB*]

Constraints on the Optical Precursor to the Naked-eye Burst GRB080319B from "Pi of the Sky" Observations
by L. W. Piotrowski
Astronomy & Astrophysics v.540, L8 (2012)

Here's a unique "small-telescope" application to high-energy cosmology that might be food for thought to those who are doing other wide-field imaging activities. The idea goes like this: it is now well-accepted that gamma-ray bursts can have optical counterparts (optical transients that occur simultaneously with the gamma-ray burst); many of these have been detected and measured. It is also not unusual for gamma-ray bursts to have been preceded by a "precursor" gamma-ray transient; but so far nobody has seen the optical transient that corresponds to the precursor. Different models make different predictions about the characteristics of an optical precursor, and disagree on whether such an optical precursor might exist. Most optical observations are "follow-up", in which a telescope is rapidly slewed to the gamma-ray burst location after the burst is detected. This method naturally precludes any chance of detecting optical transients prior to the gamma ray burst.

Enter the "Pi of the Sky": a set of wide-field-of-view cameras that monitor most of the sky in a rapid cycle. The data can then be examined after a gamma-ray burst, to see if by chance there was a precursor optical transient at the burst's location. So far, no detections; although the opportunities have been pretty tightly constrained in both time and brightness.

If you are doing a project that entails wide-field monitoring (e.g. nova patrol), it might be worthwhile to see if you can adjust your cadence and data analysis to include a search for gamma-ray burst optical counterparts, and optical precursors.

Biperiodic Orbital Period Modulation of the W UMa Binary System CK Bootis
by Alexandru Pop a and Ca˘lin Vamos
New Astronomy v.17 (2012) 667–672

One of the fundamental observations can be made with small telescopes is the time of minimum light of eclipsing binary stars. Quite a wealth of information can be inferred from such timings, including evidence of changing orbital period, evidence for (invisibly-faint) companions, and evidence for magnetic activity in one or both stars.

This paper presents an evaluation of about 30 years worth of eclipse timings of this W UMa type contact binary system, and highlights the difficulty of unraveling what is going on. In particular, it is difficult to convincingly distinguish between the light-time effect of a third (and possibly fourth) body versus the effect of magnetic cycles of one (or possibly both) stars of the binary pair. In the case of CK Boo, there are almost certainly two periodicities in the O-C diagram, but the time span of times-of-minimum measurements encompasses barely 1.5 periods of the putative longer period, so continued measurements are needed for this star – which is well within reach of small telescopes – to provide a basis for understanding its O-C cycles.

Speckle Interferometry at the U.S. Naval Observatory. XVIII
by Brian D. Mason, et al
The Astronomical Journal, 143:124 (6pp), 2012 May

The measurement of visual double stars is a fruitful application of a modest-aperture telescope in a light-polluted urban observatory. The USNO uses a vintage 26-in refractor for CCD astrometry of double stars (I wonder if Mr. Biden thinks of it as his "backyard telescope", since it is on the grounds of the Vice President's mansion?)

The observing and data reduction method is in the transition region between "lucky imaging" and "speckle interferometry". A large number of short-exposure images are taken of each target (as in "lucky imaging"), and the image analysis uses "speckle imaging" methods; but the separations of almost all pairs reported here are wide enough that the isoplanaticity criterion of speckle-imaging isn't met. In this paper, the reported separations range from ρ≈0.5 arc-sec to ρ≈72 arc-sec, with typical accuracy of about 1% in separation, and 1° in position angle – i.e. better than backyard double-star observers might do, but not extravagantly so. And of course double-star measurement is an ongoing need, as exemplified by the fact that for some of the pairs reported here, the most recent previous measurement was over 50 years ago. Ongoing observations are needed to confirm linear motion, verify or determine orbits, and (in some cases) determine if the pair even exists. Some results of each type are noted here.

An Extensive Photometric Study of the Recently Discovered Intermediate Polar V515 And (XSS J00564+4548)
by V. P. Kozhevnikov
Monthly Notices of the Royal Astronomical Society
V. 422, Issue 2, pages 1518–1526, May 2012

This work reports the result of unfiltered photometry of this cataclysmic variable, done with a 70-cm (28-in) telescope and a two-channel photometer. The two-channel photometry enables simultaneous measurement of two stars, on a very rapid cadence of about 8 seconds per data point. The result is quite nice resolution of the many brightness variations that the system displays.

Particularly noted is the clear "two-period" modulation in the lightcurve ($P_1 \approx 7.77$ min and $P_2 \approx 8.13$ min). The lightcurve of P1 is a slow rise and rapid drop; and it is stable over the duration of observations. These characteristics prompt the identification of P1 as the spin period of the white dwarf. The shape of the lightcurve of P2 changes significantly over time, from sort of "sinusoidal" to something that looks almost like an eclipsing binary. It is identified as the orbital sideband (relative to the white dwarf spin "carrier" frequency). The amplitudes of both of these lightcurves are about 0.02 mag. From these identifications, the orbital period of the companion star is derived to be $P_{orb} \approx 2.6$ hr.

The authors note that the shape – and changes – in the lightcurve of P2 are probably telling us something important about the accretion disk, the mass flow, and/or the magnetic activity of this system; but there is no clear winner among several models.

Power and Duration of Impact Flashes on the Moon: Implication for the Cause of Radiation
by S. Bouley, et al
Icarus v. 218 (2012) 115–124

At SAS-2012, Brian Cudnick gave us an overview of the ALPO/NASA lunar-impact monitoring program, which primarily depends on small telescopes equipped with video cameras. It is clear that when a meteoroid hits the lunar surface, some of its kinetic energy is converted into an optical flash; but the details of that conversion are poorly understood. The authors here describe a model in which the flash is predominately thermal emission from the small cloud of molten silicates formed at the impact site. This model is used to explain some statistical trends that have been inferred, particularly that flash brightness and duration are correlated, and that Leonid flashes tend to be shorter than others (at comparable brightness).

The implications of this model are that (a) using higher frame-rate sensors should result in more detections, (b) using sensors that are sensitive to near-infrared should result in more detections, and (c) multi-spectral observations would be very useful in better characterizing the flash-generating process.

Binary Asteroid Population. 2. Anisotropic Distribution of Orbit Poles of Small, Inner Main-Belt Binaries
by P. Pravec et al
Icarus v. 218 (2012) 125–143

The "et al" in the author list includes quite a few people who many of you will recognize: Alan Harris and Dirk Terrell (SAS Advisors), Bob Stephens and Brian Warner (SAS Committee), Donald Pray, David Higgins, William Cooney, Ron Durkey, Ron Dyvig, and Jim Brinsfield. The majority of the observations were made with backyard-class telescopes and CCDs.

The idea of this study is to use mutual events of binary asteroids to help pin down the orbital pole of the binary asteroid system. If you observe eclipse or occultation signatures in an asteroid lightcurve, that gives you strong evidence that it is a binary asteroid, but it doesn't tell you anything about the plane of the orbit of the pair. Fast forward to the next apparition. If you observe eclipse/occultation signatures again, then that does help determine the pole of the orbit of the binary pair, and the constraint can be quite tight. In an extreme example, if you observe mutual events at every apparition, then the two asteroids almost certainly orbit each other in the plane of the ecliptic (± a small angle that depends on their sizes and separation).

The authors began with 18 asteroids that had displayed mutual events in their lightcurves, and re-observed them at a subsequent apparition. Remarkably, 15 of them showed mutual events at the second apparition. This is strong evidence that all of these pairs orbit each other in planes that are close to the plane of the ecliptic or close to the plane of their heliocentric orbit; and by inference it is expected that the majority of binary asteroids should have orbital planes close to the ecliptic (±30 degrees or so) – they are definitely not randomly oriented (even after some tricky observational selection effects are accounted for).

Why are things aligned this way? There are two competing hypotheses. One is that the YORP effect simultaneously orients an asteroid's spin axis toward the pole of the ecliptic, and increases its spin rate. Then when it spins so rapidly that it fissions or sheds some mass (which becomes the secondary), naturally the binary orbit will be aligned with the original spin axis. The second hypothesis is that the YORP's principal effect is to speed up the asteroid's spin (regardless of the pole of the spin axis), and then after the fission or mass-shedding event, continues to re-orient the orbital pole of the pair until it preferentially lines up with the pole of the ecliptic. At this point it is not clear which hypothesis is the best (both can work)

A BVR$_C$I$_C$ Survey of W Ursae Majoris Binaries
by Dirk Terrell, John Gross, and Walter R. Cooney, Jr
The Astronomical Journal, 143:99 (7pp), 2012 April

Many of you may remember the SAS-2011 Workshop o Eclipsing Binaries, during which SAS Advisor Dr. Terrell explained how to use multi-color lightcurves to create a surprisingly-accurate model of the binary system. He is the lead author of this paper that describes a robotic survey for W UMa (overcontact) binary stars using a 35-cm (14-in) telescope and B-V-R-I filtered CCD imager.

For the best accuracy, the model lightcurve model should be matched not to the "observed" lightcurves, but to the "de-reddened" lightcurves, from which the effects of interstellar absorption have been removed. This paper discusses the difficulty of using observations to infer the effect of interstellar absorption. The authors describe two independent approaches: one based on differential-color in the photometric data, the other based on the density of HI between us and the star. They recommend reasonable confidence in situations where both reddening estimates give equivalent results; and head-scratching if the two give significantly different reddening estimates. By selecting 100 systems from their survey that have both excellent lightcurves and consistent reddening estimates, they provide a population of well-characterized overcontact binaries that will be useful for comparison of data with stellar models.

They also point out a couple of systems that warrant additional observation (photometric and spectroscopic). V1044 Her is affected by very discordant reddening estimates; which might be telling us that there is something odd about the system (high solar activity increasing its B-band brightness?) V532 Cas is given consistent reddening estimates by the two methods, but it is significantly bluer and has a significantly shorter period than is predicted by standard binary-evolution model. (Why? Maybe it isn't really a W UMa system, or maybe it has a blue companion star). These two stars, and their siblings, can be fruitful targets for small-telescope photometry and spectroscopy.

Physical parameters of Some Close Binaries: ET Boo, V1123 Tau, V1191 Cyg, V1073 Cyg and V357 Peg
by F. Ekmekçi
New Astronomy v.17 (2012) 603–609

Multi-color lightcurves of an eclipsing binary system can be used to create quite accurate and precise models of the system, but the resulting model is "relative" in the sense that scaling the star sizes, separations, and the distance to Earth by any arbitrary factor will yield an identical lightcurve. In order to determine the absolute values of stellar parameters (in km), it is necessary to have both a lightcurve and a radial velocity curve. I've been surprised by the number of systems that have radial velocity data (mostly courtesy of Rucinski's series of publications), but no good lightcurves. In this report, the authors use their own multi-band CCD photometry, taken with a 40–cm (16-in) telescope, in combination with Rucinski's radial velocity curves, to remedy this lack for five short-period eclipsing binary systems.

The authors acknowledge that there is some disagreement in the literature regarding ET Boo, and that their data and model doesn't settle the issue: the secondary star might be an F8IV (subgiant) or an F8V (main sequence) star. The difference implies very different evolution paths for this system. They recommend that some high-resolution spectra could settle the issue.

V1073 Cyg is also a bit controversial: different studies have reported different lightcurve shapes, some with and some without an O'Connell effect. The authors seem to accept that the lightcurve is, indeed, fluctuating. Although they don't make a recommendation, it sounds as if a campaign of regular observation (of both lightcurves and times of minimum light) for several years might be worthwhile, to characterize the variations in this system.

Absolute Dimensions of Solar-Type Eclipsing Binaries: EF Aquarii: A G0 Test for Stellar Evolution Models
by J. Vos, et al
Astronomy & Astrophysics v.540, A64 (2012)

Here is an interesting example of the level of detailed work that can be done with modest telescopes. The authors used a 50-cm (20-in) telescope to determine uvby lightcurves of this eclipsing binary system; and a 1.2-m (48-in) telescope to gather high-resolution spectra (R = 85,000). The spectra were used to determine the spectral types, temperatures, radial velocity, and metallicity of the two stars. The photometry was combined with radial velocity curves to determine the absolute stellar parameters. The entire project used observations gathered over an eight year span, although most of the relevant information could have been gathered in a month or so of unrestricted telescope time.

One thing that the long period of data-gathering made possible was observation of slight fluctuations in the spectra, radial velocity, and lightcurve, all of which are consistent with star-spot type activity (which was most apparent in the Ca II line, and is probably mostly in the secondary star).

The authors believe that they have determined the stellar parameters to within a few percent, which makes this a good data set to compare with stellar evolution models. The comparison highlights some discrepancies: the secondary star is significantly cooler and larger than models predict, and models suggest significantly different ages for the two stars (in contrast to the expectation that they are coeval). The authors suggest that these discrepancies are due to stellar magnetic activity, and that corresponding changes may be needed in stellar models.

The Historical Light Curve of the Symbiotic Star AG Draconis: Intense, Magnetically Induced Cyclic Activity
by Liliana Formiggini*, Elia M. Leibowitz
Monthly Notices of the Royal Astronomical Society
v.422, Issue 3, pages 2648–2655, May 2012

Here is an interesting application of a rich history of photographic and visual observations of a variable star. The authors examined the Harvard patrol photographic plates and the AAVSO's database of visual observations, and used the data from several photoelectric photometry campaigns to both (1) add lightcurve data and (2) "bridge" the visual and photographic observations to put them on the same baseline – thus achieving a 120-year record – and analyzed the implications for the activity of this system.

Qualitatively, the lightcurve shows the system's long intervals of quiescence, punctuated by outbursts during which it brightens by > 1 magnitude.

Statistical analysis of the lightcurve (using several different methods, to tease out the maximum information and to protect against artifacts introduced by analysis methods), shows several clear periodicities. Porb≈ 550 d is recognized in both the lightcurve and other data as the orbital period of the two stars involved in the system. A longer cycle, P≈ 1160 d is interpreted as being the rotation period of the cooler star (which makes the system non-synchronous).

There is also a pseudo-period of ~5300 days between outbursts, which is interpreted as being analogous to the Sun's activity cycle.

Continued photometric and spectroscopic monitoring – for a long time – will be needed to test this interpretation against new data.

Simultaneous B'V'R' Monitoring of Bl Lacertae Object S5 0716+714 And Detection of Inter-Band Time Delay
by Jianghua Wu, et al
The Astronomical Journal, 143:108 (12pp), 2012 May

Blazars and BL Lac objects are active galactic nuclei that display remarkably large and rapid brightness fluctuations – up to a couple of tenths of a magnitude per hour in some events – and also color changes on a similar time scale. There have been various attempts to study both the color vs. brightness trend and the time-delay between brightness changes in different colors (in order to characterize the activity of the central engine); and some controversy about the nature of these trends. Most previous studies have been hampered by the fact that multi-band photometry was "quasi-simultaneous", meaning that it was the sort that you get if you cycle your filter wheel continuously, taking an image in B, then one in V, then one in R, etc. You can map out a lightcurve in each color, but the data points aren't really simultaneous and if the source fluctuations have power at frequencies higher than your sampling frequency, then the correlations can be spurious.

The authors here use an interesting photometric instrument: A 60/90-cm (24/35-in) telescope with an objective prism, and a CCD with a multi-bandpass spectral filter. The objective prism spreads the star-light into a spectrum, and the multi-band filter passes only light centered on the B, V, and R-bands. In this way, each object becomes three dots on the focal plane (one for each color). The brightness of the target and comp stars can thus be measured simultaneously in all three bands.

The authors see pretty clear evidence for a "bluer-when-brighter" chromatism in their target BL Lac object, and tantalizing evidence that the longer-wavelength lightcurve fluctuations (e.g. R) are delayed as long as 30 minutes compared to shorter-wavelength (e.g. B) lightcurve. Their monitoring only covered a span of 9 nights. Hopefully, continued monitoring over much longer time spans can confirm and extend their conclusions.

First Detailed Analysis of Multiple System V2083 Cyg
by P. Zasche, et al
Monthly Notices of the Royal Astronomical Society
v. 421, Issue 2, pages 1196–1200, April 2012

The subject of this project has been recognized as a visual binary since 1904, and the primary was discovered to be an eclipsing binary by Hipparcos photometry (and confirmed by superWASP). The system is, therefore, probably a hierarchical system made of a close pair (eclipsing pair, period P≈1.5 d), orbited by a third star (P≈ several hundred years). The authors made BVRI photometric lightcurves using a 34-cm = (13-inch) telescope and CCD. These lightcurves of the eclipsing pair are, of course, contaminated by significant amount of "third light" (since the visual-binary third component separation is less than 1 arc-sec). They then used a 2-m telescope to gather a handful of radial velocity data points. This yielded a good RV curve for the eclipsing pair. They tried to get RV data for the third (visual binary) star also, but acknowledge that that data is uncertain.

Modeling followed an interesting procedure, making use of the unique array of information: photometry and radial velocity of the eclipsing pair, a preliminary orbit for the visual binary, and spectral types for the stars involved. Beginning with a standard approach, they fixed the primary temperature based on spectral type and iterated to the best fit with the PHOEBE code ... but the resulting solution was not consistent with independently-estimated mass and luminosity of stars 2 and 3. So, the second analysis path was to map the best-fit chi-squared versus T1 (primary star temperature) – i.e. follow a routine that was very similar to "q-search" that is often done to estimate the mass ratio, but in this case using it to refine the estimate of the primary star's temperature.

The net result appears to be a good model of the eclipsing pair (both are main-sequence stars), and a refinement of the orbital period of the visual binary (P≈ 177 yr). But the authors note that the implied brightness and spectral type of the visual secondary are inconsistent with it being on the main-sequence; it is therefore conceivable that it is actually a close pair. This would make V2083 a hierarchical quadruple system.

An Archaean Heavy Bombardment from a Destabilized Extension of the Asteroid Belt
by William F. Bottke, et al
Nature, v. 485, 3 May 2012, p 78

This paper is primarily describing a new insight into the theory of solar system formation, but it has a partly-hidden connection to small-telescope science.

The subject of the research is the period of the Late Heavy Bombardment (LHB), during which many of the giant impacts in the inner solar system occurred (e.g. formation of the lunar basins). The current thinking is that after the formation of the large bodies was pretty well completed, a transient orbital resonance between Jupiter and Saturn caused great disruption in the inner asteroid belt, sending a huge population of rocks careening around the inner solar system. But what was the source reservoir of these impactors, and how long did the LHB last? Two papers (this one and a related geological one in the same issue of *Nature*) address these questions and find compelling geological and astronomical observable evidence of these destructive events.

Most old impact craters on Earth have been wiped away by the tectonic and erosive activity on our planet's surface, so we can't find the impact sites. But it turns out that the impact effects – in the form of layers of spherules representing the "rain" of condensing rock vapor blasted out by the impact – are being found and characterized. They show that the LHB lasted longer than had been previously estimated.

Bottke et al's simulations show that the source reservoir of the impactors was a now-defunct inner ring of the asteroid belt. Most of these objects are, of course, gone now. But, it turns out that there is a remnant population of objects in the right orbits, namely the Hungaria asteroids. They are the small-telescope connection to this study: Brian Warner et al's project to characterize them is an important data source referenced in this paper.

Discovery of a Wolf–Rayet Star Through Detection of its Photometric Variability
by Colin Littlefield, et al
The Astronomical Journal, 143:136 (6pp), 2012 June

Here are two unusual things: a WR star discovered with a 28-cm (11-in) telescope, and a paper in AJ whose lead author is a law student.

The story began with photometric monitoring of a cataclysmic variable, and the observation that one of the field stars showed unusual low-amplitude variability. Step two was using a Star Analyzer grism – on the same 28-cm telescope – to get a low-resolution spectrum. Quoting from the Notre Dame press release: "Littlefield said, 'The spectrum showed unmistakable signs of the high temperatures and strange chemical composition unique to Wolf-Rayet stars, enough evidence to get professional astronomers with big telescopes excited.'"

The excitement garnered time on the 9.2-m (360-in) Hobbey-Eberly Telescope for a high-resolution spectrum, and ultraviolet spectroscopy on the Large Binocular Telescope. These confirmed that the star is a Wolf-Rayet star, a relatively rare very heavy evolved star that is presumably destined for eventual death as a type Ib/c supernova.

The moral of the story seems clear: when you run across something odd in one of your images, it is probably worthwhile getting some additional – supplementary – data to track down what you've found.

Video Observation of the Leonids 2001 Activity
by Chilong LIN, et al
Publ. Astron. Soc. Japan 64, 6, 2012 February 25

This research is a candidate for the "smallest aperture" award: it reports the results of video meteor observations, made with a 3.5mm (0.14-in) f/1.4 lens to achieve a wide-field video record of the peak of the 2001 Leonid meteor shower. Visual review of the resulting video identified over 3700 meteors in about 4 hours. The video-analysis software LiMovie (originally developed for occultation analyses) was used to determine the brightness of the meteors. The authors note that the math underlying LiMovie is designed to allow it to make good estimates of the brightness of saturated stars, which was valuable for this project. Field stars were used to determine the "video brightness to visual magnitude" conversion line. With this conversion, the absolute magnitude of each meteor was calculated. The shower's population index was found to be r = 2.01±0.05, which is consistent with most (but not all) previous studies.

If you are a video meteor observer, it is worthwhile reading this entire report, which describes some innovative ways of using video records and geometric arguments to translate ZHR into number density and mass flux estimates for a meteor shower.

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