# Abstracts of Papers and Posters Presented at the 102nd Annual Meeting of the AAVSO, Held in Woburn, Massachusetts, October 11–12, 2013

## Invited Guest Speaker

**Dr. George R. Ricker**
*Massacuhsetts Institute of Technology, Cambridge, Massachusetts*

## The Transiting Exoplanet Survey Satellite Mission

**Abstract** The Transiting Exoplanet Survey Satellite (TESS) will discover thousands of exoplanets in orbit around the brightest stars in the sky. In a two-year survey of the solar neighborhood, TESS will monitor more than 500,000 stars for temporary drops in brightness caused by planetary transits. This first-ever spaceborne all-sky transit survey will identify planets ranging from Earth-sized to gas giants, around a wide range of stellar types and orbital distances.

TESS stars will typically be 30 to 100 times brighter than those surveyed by the Kepler satellite; thus,TESS planets will be far easier to characterize with follow-up observations. For the first time it will be possible to study the masses, sizes, densities, orbits, and atmospheres of a large cohort of small planets, including a sample of rocky worlds in the habitable zones of their host stars. All of the half-million plus TESS targets will be observed at a rapid cadence (1 minute or less). Hence, the brighter TESS stars will potentially yield valuable asteroseismic information. TESS will provide prime exoplanet targets for characterization with the James Webb Space Telescope (JWST), as well as other large ground-based and space-based telescopes of the future.

TESS will serve as the "People's Telescope," with data releases every 4 months, inviting immediate community-wide efforts to study the new planets. The TESS legacy will be a catalog of the nearest and brightest main-sequence stars hosting transiting exoplanets, which will endure as the most favorable targets for detailed future investigations.

TESS has been selected by NASA for launch in 2017 as an Astrophysics Explorer mission.

## Paper Session: The Role of Amateur Astronomers in the Age of Large-Scale Surveys

## Invited Talk: Photometry of Bright Variable Stars with the BRITE Constellation Nano-Satellites: Opportunities for Amateur Astronomers

**Edward F. Guinan**
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**Abstract** The BRIght Target Explorer (BRITE) is a joint Austrian-Canadian-Polish Astronomy mission to carry out high precision photometry of bright (mv < 4 mag.) variable stars. BRITE consists of a "Constellation" of 20×20×20-cm nano-satellite cubes equipped with wide field (20×24 deg.) CCD cameras, control systems, solar panels, onboard computers, and so on. The first two (of up to six) satellites were successfully launched during February 2013. After post-launch commissioning, science operations commenced during October 2013. The primary goals are to carry out continuous multi-color (currently blue and red filters) high-precision millimag (mmag) photometry in particular locations in the sky. Typically these pointings will last for two to four months and secure simultaneous blue/red photometry of bright variable stars within the field. The first science pointing is centered on the Orion region.

Since most bright stars are intrinsically luminous, hot O/B stars, giants, and supergiants will be the most common targets. However, some bright eclipsing binaries (such as Algol, β Lyr, ε Aur) and a few chromospherically-active RS CVn stars (such as Capella) may be eventually be monitored. The BRITE-Constellation program of high precision, two-color photometry of bright stars offers a great opportunity to study a wide range of stellar astrophysical problems. Bright stars offer convenient laboratories to study many current and important problems in stellar astrophysics. These include probing stellar interiors and pulsation in pulsating stars, tests of stellar evolution, and structure for Cepheids and other luminous stars.

To scientifically enhance the BRITE science returns, the BRITE investigators are very interested in securing contemporaneous ground-based spectroscopy and standardized photometry of target stars. The BRITE Ground Based Observations Team is coordinating ground-based observing efforts for BRITE targets. The team helps coordinate collaborations with amateur and professional astronomers. The ground-based coordinators are Thomas Eversberg (thomas.eversberg@dlr.de) and, for spectroscopy, Contanze Zwintz (konstanze@ster.kuleuven.be). Detailed information about the BRITE Mission is provided at: www.brite-contellation.at.

## Using the Transient Surveys

**Arne A. Henden**
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**Abstract** We are starting the era of all-sky surveys. While some, like APASS, have specific goals in mind (sky calibration, exoplanets, asteroids, and so on), others have begun releasing real-time alerts of interesting objects. The easily available surveys with alerts will be discussed, along with the kind of objects they are detecting and some hints about how to make use of the transient information.

## Kepler and the RR Lyrae Stars

**Katrien Kolenberg**
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**Abstract** The spectacular data delivered by NASA's Kepler mission have not only boosted the discovery of planets orbiting other stars, but they have opened a window on the inner workings of the stars themselves. For the study of the RR Lyrae stars, Kepler has provided a breakthrough. To date, over fifty RR Lyrae stars are known in the Kepler field.

I will present some of the most interesting results on RR Lyrae stars obtained through Kepler so far. Though high-precision satellite data have led to new insights, amateur observations of these stars remain extremely valuable and can complement the space data.

## A Study of RR1 Light Curve Modulation in OGLE-III Bulge Time-Series

**Douglas L. Welch**
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**Abstract** We report the preliminary results of our study of lightcurve modulation in a sample of 493 RR1 variables from the OGLE-III survey of galactic bulge fields. Each object in this list has 1,500 or more I-band observations. We have located a "modulated-Blazhko" RR1 variable, OGLE-BLG-RRLYR-03825, which is similar in many respects to LS Her, a galactic field RR1 star. OGLE-BLG-RRLYR-03825's photometric period is 0.2774114 d and it has a Blazhko period of 16.469 d which is, itself, modulated with a period of 339.2 d.

Using an application of the "sequential CLEANest" method, we find that 169 of the 493 RR1 lightcurves examined show a detectable peak within the amplitude spectrum near 0.63 times the photometric period. Our finding extends the detection of such a period ratio in the four known RR1 stars in the Kepler field by Moskalik *et al.* (2012). We discuss how the appearance of this apparently new mode correlates with photometric (first overtone) period in this sample.

## Two Centuries of Observing R Coronae Borealis: What Will the Role of the AAVSO be in the Next Century?

**Geoffrey C. Clayton**
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**Abstract** R Coronae Borealis was found to be variable in the year 1783, and was one of the first variable stars to be identified. Its class, the R Coronae Borealis (RCB) stars, are rare hydrogen-deficient carbon-rich supergiants. RCB stars undergo massive declines of up to 8 mag due to the formation of carbon dust at irregular intervals. Their rarity may stem from the fact that they are in an extremely rapid phase of evolution or in an evolutionary phase that most stars do not undergo. Several evolutionary scenarios have been suggested to account for the RCB stars, including a merger of two white dwarfs (WDs) or a final helium shell flash in a PN central star. The large overabundance of the rare isotope oxygen-18 found in most of the RCB stars favors the WD merger scenario while the presence of lithium in the atmospheres of five of the RCB stars favors the FF scenario. In particular, the measured isotopic abundances imply that many, if not most, RCB stars are produced by WD mergers, which may be the low-mass counterparts of the more massive mergers thought to produce Type Ia supernovae. Understanding these enigmatic stars depends to a large extent on continuous monitoring to catch their irregular but rapid variations due to dust formation, their variations due to stellar pulsations, and longterm changes that may occur over centuries. The AAVSO has been instrumental in this monitoring for over a century, but how will this change in the era of all-sky surveys?

# General Paper Session

## Unpredictable LPVs: Stars Dropped from the *AAVSO Bulletin*

**Matthew R. Templeton**
**Elizabeth O. Waagen**
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**Abstract** A number of LPVs have been dropped from the *AAVSO Bulletin* over its history going all the way back to the days of Leon Campbell and Margaret Mayall. Many of these stars exhibit very interesting changes in behavior as recorded in their long-term visual light curves; they were dropped not for being uninteresting but simply for being too difficult to predict. We present highlights from this collection of stars and their light curves, with suggestions on what could be learned from both existing data and new observations.

## Aperture Fever and the Quality of AAVSO Visual Estimates: μ Cephei as an Example

**David G. Turner**
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**Abstract** At the limits of human vision the eye can reach precisions of 10% or better in brightness estimates for stars. So why did the quality of AAVSO visual estimates suddenly drop to 50% or worse for many stars following World War II? Possibly it is a consequence of viewing variable stars through ever-larger aperture instruments than was the case previously, a time when many variables were observed without optical aid. An example is provided by the bright red supergiant Cepheid variable μ Cephei, a star that has the potential to be a calibrating object for the extragalactic distance scale if its low-amplitude brightness variations are better defined. It appears to be a member of the open cluster Trumpler 37, so its distance and luminosity can be established provided one can pinpoint the amount of interstellar extinction between us and it. μ Cep appears to be a double-mode pulsator, as suggested previously in the literature, but with periods of roughly 700 and 1,000 days it is unexciting to observe and its red color presents a variety of calibration problems. Improving quality control for such variable stars is an issue important not only to the AAVSO, but also to science in general.

## The Eggen Card Project

**George Silvis**
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**Abstract** Olin Eggen, noted astronomer (1919–1998), left to us all his raw observation records recorded on 3×5 cards. The AAVSO has these cards on longterm loan from the Cerro Tololo Interamerican Observatory. This project is to make all these data available as an online resource. History and progress of the project will be presented. The 100,000 cards have been scanned and made into PDF files. The current phase of the project is to identify the star(s)

referenced on each card. This work is being done via crowdsourcing—you can help! Project details are available at: https://sites.google.com/site/eggencards/home. [*Ed note: see also Silvis' poster abstract, "Coding the Eggen Cards," in this issue.*]

## AAVSO Visual Sunspot Observations vs. SDO HMI Sunspot Catalog

**Rodney Howe**
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**Abstract** The most important issue with regard to using the SDO HMI data from the National Solar Observatory (NSO, http://www.nso.edu/staff/fwatson/STARA) is that their current model for creating sunspot counts does not split in groups and consequently does not provide a corresponding group count and Wolf number. As it is a different quantity, it cannot be mixed with the data from our sunspot networks. Although, for the AAVSO, with about seventy stations contributing each day, adding HMI sunspot data would hardly change the resulting index.

Perhaps the best use of HMI data is for external validation, by exploiting the fact that HMI provides a series that is rather close to the sunspot number and is acquired completely independently. So, it is unlikely to suffer from the same problems (jumps, biases) at the same time. This validation only works for rather short durations, as the lifetime of space instruments is limited and aging effects are often affecting the data over the mission. In addition, successive instruments have different properties: for example, the NSO model has not managed yet to reconcile the series from MDI and HMI. There is a ~10–15% jump.

The first challenge that should be addressed by AAVSO using HMI data is the splitting in groups and deriving group properties. Then, together with the sunspot counts and areas per group, a lot more analyses and diagnostics can be derived (such as the selective disappearance of the smallest sunspots?) that can help interpreting trends in the ratio SSN/other solar indices and many other solar effects.

## Identification of Cepheid Variables in ASAS Data (Poster abstract)

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**Abstract** Through studying the characteristics of Cepheid variables, we can further understand the nature and evolution of stars, as well as the scale of the Universe (through the famous Leavitt period-luminosity relationship). Classical Cepheid stars, or Type I Cepheids, are radially-pulsating supergiants. Type II Cepheids are older and have lower mass than Type I Cepheids. They are rarer, and existing classifications of these stars have been shown to be erroneous at unusually high rates. Computerized automatic classification programs sift through the data of large photometric surveys to produce a list of (what the program recognizes as) Cepheid star candidates. Unfortunately, this automatic classification of light curves has been demonstrated to be ambiguous. Therefore, it takes a human to further sift through the list in order to come up with a more accurate (and, as a result, a more useful) list of probable Cepheids. This study was based on a list of 3,548 Cepheid candidates in the ASAS data provided by Patrick Wils (through Dr. Doug Welch). Patrick Wils had previously examined eighty-four stars on the spreadsheet and positively identified only five of these stars as Cepheids. The methodology of the current study was to use known properties of Cepheids, including available infrared photometry (2MASS), proper motion (PPMXL), and X-Ray emission (ROTSE) data (for which we received helpful guidance from Sebastian Otero), to cull the list to the most likely Cepheids. The ASAS light curves of these candidates were investigated to determine whether the shapes were truly consistent with those of Cepheids. This poster will summarize the methodology used and give examples of how individual Cepheid candidates were evaluated. Candidates of interest are currently being crosschecked for any updated information on VSX, and the light curves more closely analyzed using VStar. Results concerning the misidentification of candidate Cepheids will be reported to VSX and summarized in *JAAVSO*.

## Identification of BY Draconis Variable Stars among ASAS Cepheid Candidates (Poster abstract)

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**Abstract** Cepheid variables are well-known to be important to astronomers, as their period-luminosity relationship (the Leavitt relationship) is used to determine the distances to galaxies. The unambiguous identification of newly discovered Cepheid variables in large photometric data sets is therefore of significance. A data set of 3,548 candidate Cepheid variable stars in the ASAS data was provided by Patrick Wils (through Dr. Doug Welch). A computer program had originally identified these candidates, however, Wils investigated a small subset of the data by hand and discovered that the vast majority of these stars were misidentified. The most common misidentification was of BY Draconis stars (rotating spotted K and M dwarfs). In a companion piece, Swenton and Larsen [see above] sought out the most likely Cepheid candidates in the data; the work discussed here is instead focused on looking at stars that had properties that were clearly different from Cepheids, more specifically properties likely to be seen in BY Dra stars. We are sorting the spreadsheet stars by characteristics in order to find as many BY Dra variables as possible (since they seem to be the most commonly misidentified stars). Resources for these characteristics include newly available infrared photometry (2MASS), proper motion (PPMXL), and X-Ray emission (ROTSE) data (for which we received helpful guidance from Sebastian Otero), as well as VSX information. The first 103 stars to be studied are those with the smallest range in magnitude (less than or equal to 0.1). An analysis of their light curves and other available data is being undertaken in order to determine whether or not they are indeed BY Dra-type variables. In doing so the goal is to be able to submit and publish the correct identifications for these stars to the International Variable Star Index (VSX) and *JAAVSO*.

## Summer Student Solar Observing Project Determining the Sunspot Number (Poster abstract)

**Brian Mason**

**Abstract** While modern telescopes and instruments generate much more astrophysical data, the Wolf Index (established 1848) provides a very long term measure of Solar activity through the Sunspot count. Interns from the USNO have, since at least 2005, contributed to the mean Wolf Index calculated by the American Association of Variable Star Observers.

## The DASCH Public Data Release (Poster abstract)

**Edward J. Los**
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**Abstract** The plate stacks of the Harvard College Observatory, one of the

original large scale sky surveys, contains an estimated 30–50 × $10^9$ star images spanning over 100 years. The Digital Access to a Sky Century @ Harvard (DASCH) is in the process of digitizing this archive and computing magnitudes for these images. This poster describes the public release of photometry data from approximately 29,000 scanned plates.

## Coding the Eggen Cards (Poster abstract)

**George Silvis**
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**Abstract** This poster presents a look at the Eggen Portal for accessing the Eggen cards, as well as a call for volunteers to help code the cards: 100,000 cards must be looked at and their star references identified and coded into the database for this to be a valuable resource. [*Ed. note: see also Silvis' talk abstract, "The Eggen Card Project," in this issue.*]