Abstracts of Papers and Posters Presented at the 101st Annual Meeting of the American Association of Variable Star Observers, Held in Woburn, Massachusetts, November 1–3, 2012

Variability of Young Stars: the Importance of Keeping an Eye on Children

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Abstract I will review the state of our understanding of young stars with an emphasis on how and why they vary in brightness. The main causes of the variations will be reviewed, including the rotation of spotted weak-lined T Tauri stars, accretion onto classical T Tauri stars, the eruptive behavior of FUors, and the enigmatic variations of the UXors. The important role that amateurs have and will continue to play in these studies is highlighted. I will also discuss the latest results on two unusual young binaries, BM Orionis in the Trapezium asterism and KH 15D in NGC 2264.

Variable Stars in the Trapezium Region: the View From Ground and Space

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Abstract We present the results of our project to study variability among stars of the Trapezium Region of the Orion Nebula using both ground- and space-based observations. Continuous, broad-band optical photometry were collected over twenty-seven days using the orbiting MOST satellite in late 2010 and early 2011, while ground-based data were collected by AAVSO observers and the AAVSO's Bright Star Monitor telescope. Fifteen of thirty-seven stars showed clear evidence of variability of various types. The sample includes a dozen stars showing variability typical of YSOs, including T Tauri type and rotational variability; additionally, we found evidence of β Cephei pulsation in two stars, and we also obtained four full cycles of the primary target—the 6.5-day eclipsing binary BM Orionis. We show examples of the MOST and AAVSO light curves for these stars, what the results tell us about these stars, and what remains to be learned from these stars.

YSOs as Photometric Targets

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Abstract Young stellar object research is an active and growing field within astronomy, and YSOs are targets for both optical photometry and multiwavelength studies from ground and space. They vary due to a number of different physical processes; they are also often red objects in dust-rich environments, making their spectra complex. Understanding of their optical variations requires calibrated photometry in standardized filters. In this short talk, we cover the most straightforward ways to perform observations of these objects that yield scientifically useful data.

Working Together to Understand Novae

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Abstract In ancient times, people occasionally looked up to find a "nova," or new star, in the sky. With at least thirty-five per year in our galaxy, novae are the most common major stellar explosions. Although researchers now understand what causes a white dwarf to suddenly brighten into a nova, many puzzles remain, such as why novae appear to eject orders of magnitude more material than predicted by theory, and how a uniform eruption on a spherical white dwarf can expel matter in the form of jets, clumps, and rings. Coordinated observations at radio, optical, and X-ray wavelengths can answer these questions. I will describe how the AAVSO's new nova forum (http://www.aavso.org/forums/variable-stars/nova-project) is designed to enhance communication between amateur astronomers and professional astronomers who are using X-ray and newly upgraded radio telescopes to observe novae. Participants in the nova forum will have the opportunity to learn about novae, share their own expertise, and be a part of the process of scientific discovery.

Campaign of AAVSO Monitoring of the CH Cyg Symbiotic System in Support of Chandra and HST Observations

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Abstract CH Cyg is one of the most interesting interacting binaries in which

a compact object, a white dwarf or a neutron star, accretes from the wind of an evolved giant or supergiant. CH Cyg is a member of the symbiotic systems group, and at about 250pc it is one of the closest systems. Symbiotic systems are accreting binaries, which are likely progenitors of a fraction of Pre-Planetary and Planetary Nebulae, and of a fraction of SN type Ia (the cosmic distance scale indicators). We carried out Chandra and HST observations of CH Cyg in March 2012 as part of a follow-up investigation of the central region of CH Cyg and its precessing jet, including the multi-structures that were discovered in 2008. I will describe here the campaign of multi-wavelength observations, including photometry and spectroscopy, that were carried out by AAVSO members in support of the space-based observations.

2012: a Goldmine of Novae

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Abstract So far in 2012, sixteen objects have been at least initially classified as galactic novae. This total includes five confirmed novae in Sagittarius alone! This paper will discuss the observations for these objects that have been submitted to the AAVSO, with some thoughts about the future of nova discoveries and the role of amateurs.

Introducing Solar Observation to Elementary Students

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Abstract I will demonstrate the presentation I have developed for introducing solar observation to elementary students in Dartmouth, Massachusetts, and surrounding public schools. Copies of my program will be available for AAVSO members who would like to use it.

AAVSO Solar Observers Worldwide

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Abstract For visual solar observers there has been no biological change in the "detector" (human eye)—at century scales (eye + visual cortex) does not change much over time. Our capacity to "integrate" seeing distortions is not just simple averaging! The visual cortex plays an essential role, and until recently only the SDO-HMI (Solar Dynamics Observatory, Helioseismic and Magnetic

Imager) has had the capacity to detect the smallest sunspots, called pores. Prior to this the eye was superior to photography and CCD. Imaged data are not directly comparable or substitutable to counts by eye, as the effects of sensor/optical resolution and seeing will have a different influence on the resulting sunspot counts for images when compared to the human eye.

Also contributing to the complex task of counting sunspots is differentiating between a sunspot (which is usually defined as having a darker center (umbra) and lighter outer ring (penumbra)) and a pore, made even more complex by the conflicting definitions of the word "pore" in the solar context: "pore" can mean a small spot without penumbra or "pore" can mean a random intergranular blemish that is not a true sunspot. The overall agreement is that the smallest spot size is near 2,000 km or ~3 arc sec, (Loughhead, R. E. and Bray, R. J. 1961, *Australian J. Phys.*, **14**, 347). Sunspot size is dictated by granulation dynamics rather than spot size (cancellation of convective motion), and by the lifetime of the pore, which averages from 10 to 30 minutes.

There is no specific aperture required for AAVSO observers contributing sunspot observations. However, the detection of the smallest spots is influenced by the resolution of the telescope. Two factors to consider are the theoretical optical resolution (unobstructed aperture), Rayleigh criterion: theta = 138 / D(mm), and Dawes criterion: theta = 116 / D(mm) (http://www.telescope-optics.net/telescope_resolution.htm). However, seeing is variable with time; daytime range will be similar for all low-altitude sites, within the range of 1.5 to 3 arc sec, (typically = 2 arc sec equivalent diameter D = 45–90 mm, the typical solar scope = 70 mm aperture). Where large apertures are more affected by size of turbulent eddies ~8–12 cm, small-aperture telescopes reduce these differences, i.e. large aperture is not always beneficial.

Statistical Evidence for a Mid-Period Change in Daily Sunspot Group Counts from August 2011 through August 2012, and the Effect on Daily Relative Sunspot Numbers

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Abstract A combination of statistical counts modeling methods, time series analysis, and t-tests were applied to daily sunspot group counts data obtained from the American Association of Variable Star Observers (AAVSO) Solar Section. The data span the period from August 2011 through August 2012. The analysis investigates whether a statistically significant difference in daily sunspot group counts occurs between the first and second halves of this period. We show that a significant statistical difference exists between the two halves, and this difference also exists in the sunspot number. Also, the rate of change between daily sunspot group counts is shown to be stable between the two

periods. These results indicate that between the two periods, the sunspot group count averages and the corresponding sunspot numbers differ, and suggests the sunspot group counts submitted by AAVSO contributors are consistent between the two periods. The change between these time periods may give insight into an apparent bi-modal clustering of sunspots and sunspot groups during this twenty-forth cycle maximum.

Mentoring, a Shared Responsibility

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Abstract While the AAVSO has a variety of mentoring resources, including the Mentoring team supervised by Mike Simonsen, there is an enormous need for AAVSO participants to individually and actively mentor observers who have missed some of the basics of observing (visual or CCD), whether they are new or have been observing for a long time. Without this shared responsibility, by our silence we risk either losing new observers or enabling observers not following good procedures to contribute erroneous data. We will discuss some of the common mistakes that both visual and CCD observers make, how they can be detected, and how AAVSO members and observers can and should help those in need of mentoring.

66 Oph Decides to "Be"

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Abstract 66 Oph was first identified as a Be star by Merrill and Burwell (1933, *Contrib. Mt. Wilson Obs.*, No. 471, 1). Normally its spectrum exhibits pronounced Balmer line emission with some short-term variability. In the 1950s the emission disappeared and returned within a few years. When the emission started decreasing in 1993 and disappeared in 2009, Miroshnichenko *et al.* (2011, *Be Star Newsl.*, No. 40, 42.) predicted a similar recovery. Here we present the results to date of spectroscopic monitoring of 66 Oph through its "low" state and report that it appears to be on the verge of resuming an active Be status.

V439 Cygni: Insights into the Nature of an Exotic Variable Star

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Abstract V439 Cyg is a 12th magnitude irregular variable in the core of the very young cluster Berkeley 87 that has defied straightforward characterization in previous years. Prior to the last thirty years it was an irregular variable that displayed occasional erratic 0.5-magnitude flareups lasting several days. In 1959 it was classified as a late-type carbon star from an objective-prism survey, but a photometric study of the cluster in 1982 and an image-tube spectrum in 1983 revealed it to be a highly-reddened early-type star. Attempts to study the star spectroscopically have been hampered by its peculiar nature. The star always exhibits emission in the lower Balmer series hydrogen lines superposed on an almost featureless continuum. But the spectral veiling of V439 Cyg sometimes lifts, revealing characteristics of a very rapidly-rotating star that recently displays features of a nitrogen-enriched B0 dwarf. The star's light variability apparently ceased thirty years ago, yet it remains an exotic example of slightly evolved massive stars that display the effects of CNO-processed elements in stellar cores mixed into their surface layers. Is V439 Cyg an example of a merged binary?

Elizabeth Brown and Citizen Science in the Late 1800s (poster)

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Abstract While "Citizen Science" projects are sometimes thought of as a recent permutation of the professional-amateur relationship in science, the AAVSO is an example of an organization that has been encouraging such participation for over a century. Although the AAVSO's Solar Observing Program dates back only to 1944, AAVSO members had been submitting sunspot counts to other agencies long before this time. Other countries also have a long history of collecting valuable sunspot observations. For example, prior to the AAVSO's founding in 1911, British amateurs had been collecting solar data in organizations such as the British Astronomical Association (BAA) and Liverpool Astronomical Society (LAS) since the 1880s. British amateur astronomer Elizabeth Brown served as Solar Section Director of both the BAA and the LAS, and played an important role in promoting participation in citizen science projects, not only in solar observing, but in other astronomical and meteorological projects as well. This poster will summarize this work and

argue that Brown's contributions should be more widely known and studied in modern citizen science project circles.

APASS Data Product Developments

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Abstract Data Release 6 (DR6) of the AAVSO Photometric All-Sky Survey (APASS) was a significant milestone in the ambitious project to provide calibrated photometry for 10 < V < 17 over the entire sky in Johnson B and V and Sloan g',r',I', bandpasses. DR6 itself was a list of mean magnitudes and colors for about 42 million objects and sky coverage was approximately 95% complete. The photometric means database has now been supplemented by additional data products: an epoch photometry database and a publicly-accessible store of the dark-subtracted, flat-fielded images at the Canadian Astronomy Data Centre. In this talk, I will describe the processes and challenges of producing these new, useful resources and the contributions of numerous people to the success of this effort. As new data releases occur, the epoch photometry database—which contains data for all measured stars, not just variables—will be updated to include all newly available measurements. As of October 2012, 861,322,813 individual photometric measurements exist in the epoch photometry database. The breakdown of measurements per filter is: B 167,682,680; V 170,005,969; u 25,457; g 181,303,298; r 181,266,321; i 160,374,091; z 664,997. A VStar plug-in to access and analyse the APASS epoch photometry database will be demonstrated and future developments discussed.

The Case of the Tail Wagging the Dog: HD 189733—Evidence of Hot Jupiter Exoplanets Spinning-up Their Host Stars

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Abstract HD 189733A is an eighth mag K1.5V star that has attracted much attention because it hosts a short period, transiting, hot-Jupiter planet. This planet, HD 189733b, has one of the shortest known orbital periods (P = 2.22 days) and is only 0.031 AU from its host star. Because the system undergoes eclipses and is bright, HD 189733 has been extensively studied. The planet's atmosphere has been found to contain water vapor, methane, CO2, and sodium and possible haze. Spitzer IR observations indicate planet temperature, varying ~970 K to ~1,200 K over its surface (Tinetti (2007). Based on measurements

of the K-star's P(rot) from starspot modulations of ~11.95 d, strong coronal X-ray emission and chromospheric Ca II-HK emission indicate a young age of ~0.7 Gyr. But this apparent young age is discrepant with a much older age (> 4 Gyr) inferred from the star's very low Lithium abundance. However, the age of the HD 189733 system can be independently determined by the presence of a faint dM4 companion (HD 189733B) some 12" away. Our Age-Activity relations for this star (no detectable coronal X-ray emission and no H-alpha emission) indicate an age > 4 Gyr (and < 8 Gyr from kinematics and metallicity). This age should apply to its K star companion and its planet. The fast rotation and resultant high activity levels of the K star can best be explained from the increase in its (rotation) angular momentum (AM) from the orbital AM of the planet. This AM transfer occurs from tidal and magnetic interactions of the K star with its planet. Determining the possible decrease in the planet's orbital period is possible from studying the planet eclipse times (which can be done by AAVSO members with CCD photometry). We also discuss the properties of other related short-period exoplanet systems found by the Kepler Mission that show similar behavior—in that close-in hot Jupiter size planets appear to be physically interacting with their host stars. This work is supported by NSF/RUI grant AST-1009903.

An Overview of the Swinburne Online Astronomy Courses

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Abstract An overview of the online astronomy courses at Swinburne University of Technology is presented for the benefit of AAVSO members who might be interested in the courses or programs. The decision to take the online Master's degree in astronomy at Swinburne was a natural evolution from being interested in astronomy at an early age, being an amateur astronomer all my life, and being a variable star observer and member of the AAVSO for the past several decades. This presentation provides an overview of the program and examples of the course materials, assignments, and projects that may provide some idea of the commitment and expectations for AAVSO members considering the program.