BALTIC ASTRONOMY Vol. 21, No. 1/2 (2012), ABSTRACTS

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The Asiago Astrophysical Observatory and the Recently Refurbished 1.22 m Galileo Telescope

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Abstract. A history of the 1.22 m Galileo telescope of the Asiago Astrophysical Observatory is described.

Key words: instrumentation: telescopes – history of astronomy

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Symbiotic Stars: Observations Confront Theory

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Abstract. In this paper, I present and discuss some recent observational results which may have important implications for our understanding of late phases of binary evolution.

Key words: stars: binaries: symbiotic – stars: fundamental parameters – stars: mass-loss

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The ANS Collaboration Monitoring Program

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Abstract. ANS Collaboration is a growing Italian network of small and medium size telescopes performing spectroscopy (low and medium resolution single dispersion, and Echelle high resolution modes) and $UBVR_CI_C$ CCD photometry of symbiotic stars and novae mainly, but with interest also on other types of objects like optical transients, eclipsing binaries, X-ray source counterparts and on-call follow-up observations of selected targets from some surveys like IPHAS or RAVE. In the present form ANS started operations in 2005, and at the time of writing has logged on symbiotic stars 14602 photometric runs and a rich ensemble of low and high resolution, absolutely fluxed spectra. The paper describes the internal organization, operation modes and procedures, and presents sample data and performance statistics.

Key words: stars: symbiotic binaries – stars: novae – photometry – spectroscopy

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Characterizing the Photometric Response of the ANS Collaboration Monitoring Program

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Abstract. The ANS Collaboration uses the $UBVR_{\rm C}I_{\rm C}$ filters from various commercial manufacturers (Omega Optical, Custom Scientific, Schuler, Optec, Astrodon) for its ongoing photometric monitoring of symbiotic stars. We measured their transmittance profiles over the range 2000 Å to 1.1 μm for various operating conditions, and we are monitoring their evolution over time. Their field performance in terms of color equations has been evaluated by analyzing the transformations from local to standard system of the 14602 observing runs so far collected on symbiotic stars with the ANS Collaboration telescopes. Ageing effects, red leaks and transmittance vs. angle of incidence are also evaluated.

Key words: stars: symbiotic binaries, novae – photometry

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The Search for Symbiotic Stars in the IPHAS Survey

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Abstract. We have started a project to search for symbiotic stars using the data from IPHAS, the Hα survey of the Northern Galactic plane. Candidates are selected from the IPHAS photometric catalogue based on their colors, combined with the information in the near-infrared from 2MASS. So far, follow-up spectroscopy allowed us to discover 14 new symbiotic stars, compared to the 10 systems previously known in the IPHAS survey area. Their general characteristics and the most notable cases are briefly presented. The spectroscopic campaign also allowed us to refine the selection criteria for symbiotic stars in IPHAS. Perspectives, which include the extension of the survey in the Southern Galactic plane and a portion of the bulge (VPHAS+), are discussed.

Key words: surveys – stars: binaries: symbiotic

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New Symbiotic Stars Monitored with the Hermes Spectrograph: a Case Study of Orbital Hα Modulation

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Abstract. We present new orbital elements for two symbiotic systems involving a giant of spectral type S, namely V420 Hya and ER Del. These orbital elements are compared with existing elements for S-type binaries and for symbiotic binaries with M-giant primaries. It is shown that among the S-type binaries, most of the short-period systems (with P in the range 300 – 1000 d) exhibit some kind of symbiotic activity (Hα emission, UV continuum, hard X-rays), but symbiotic systems are not restricted to the short-period systems. The complex and varying Hα profile of V420 Hya has been decomposed to several components (broad emission with $\sigma \sim 140$ km/s, narrow emission with $\sigma \sim 60$ km/s, and narrow absorption components). Their orbital modulation reveals that the broad emission is located close to the companion (under the hypothesis of a system with a mass ratio $M_g/M_c = 2$), and that this broad emission is mutilated by absorption from matter located along the line of sight and flowing towards the observer (faster than the giant) at all orbital phases.

Key words: stars: binaries, symbiotic

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Spectroscopic Observations of the Recurrent Symbiotic Nova V407 Cyg during 2001–2009

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Abstract. We analyze the results of our spectroscopic monitoring of V407 Cyg in 2001–2009. The slow decline in optical brightness connected with the evolution of a Z And-type outburst (maximum in 1998) was observed in 2001–2003. The system returned to quiescence in 2004, and its spectrum returned to nearly the same as in 1994. We estimated the hot component's temperature from the equivalent width of He II 4686 Å to be $\sim 63\,000$ K . During 2006–2007 there was no clear evidence of the hot component in the spectra. The equivalent width of Hα dropped to 5 Å (in 2007). This passive state was similar to previous passive states observed during 2006–2007 and in 1991.

Key words: stars: stars: binaries – stars: symbiotic: variables: Miras – individual (V407 Cyg)

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The X-ray Evolution of the Symbiotic Star V407 Cyg during its 2010 Outburst

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Abstract. We present a summary of *Swift* and *Suzaku* X-ray observations of the 2010 nova outburst of the symbiotic star, V407 Cyg. The *Suzaku* spectrum obtained on day 30 indicates the presence of the supersoft component from the white dwarf surface, as well as optically thin component from the shock between the nova ejecta and the Mira wind. The *Swift* observations then allow us to track the evolution of both components from day 4 to day 150. Most notable is the sudden brightening of the optically thin component around day 20. We identify this as the time when the blast wave reached the immediate vicinity of the photosphere of the Mira. We have developed a simpe model of the blast wave – wind interaction that can reproduce the gross features of the X-ray evolution of V407 Cyg. If the model is correct, the binary separation is likely to be larger than previously suggested and the mass-loss rate of the Mira is likely to be relatively low.

Key words: stars: symbiotic, white dwarfs – X-rays: stars

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High Energy Emission of Symbiotic Recurrent Novae: RS Oph and V407 Cyg

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Abstract. Recurrent novae occurring in symbiotic binaries are candidate sources of high energy photons, reaching GeV energies. Such emission is a consequence of particle acceleration leading to pion production. The shock between matter ejected by the white dwarf, undergoing a nova explosion, and the wind from the red giant companion are responsible for such a process, which mimics a supernova remnant but with much smaller energetic output and much shorter time scales. Inverse Compton can also be responsible for high energy emission. Recent examples are V407 Cyg, detected by Fermi, and RS Oph, which unfortunately exploded in 2006, before Fermi was launched.

Key words: stars: white dwarfs, novae, symbiotic stars, supernovae – X- and gamma-ray astronomy

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An Extremely Massive White Dwarf of the Symbiotic Classical Nova V407 Cyg as Suggested by the RS Oph and U Sco Models

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Abstract. We have analyzed the optical light curve of the symbiotic star V407 Cyg that underwent a classical nova outburst in 2010 March. Being guided by a supersoft X-ray phase observed during days 20–40 after the nova outburst, we are able to reproduce the light curve during a very early phase of the nova outburst. Our model consists of an outbursting white dwarf and an extended equatorial disk. An extremely massive white dwarf of 1.35–1.37 $M_\odot$ is suggested. The optical light curve is also consistent with a sharp drop 47 days after the outburst, which is the end of hydrogen shell-burning on the white dwarf. Although the extremely massive white dwarf is favourable to the interpretation that V407 Cyg is a recurrent nova, enrichment of heavy elements in the ejecta suggests that the white dwarf is eroded and, as a result, its mass is not increasing. Therefore, V407 Cyg may not explode as a Type Ia supernova even if it is a carbon-oxygen white dwarf.

Key words: binaries: symbiotic – novae, cataclysmic variables – stars: individual (RS Oph, U Sco, V407 Cyg) – white dwarfs

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Hydrodynamic Studies of the Evolution of Recurrent, Symbiotic and Dwarf Novae: the White Dwarf Components are Growing in Mass

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Abstract. Symbiotic binaries are systems containing white dwarfs (WDs) and red giants. Symbiotic novae are those systems in which thermonuclear eruptions occur on the WD components. These are to be distinguished from events driven by accretion disk instabilities analogous to dwarf novae eruptions in cataclysmic variable outbursts. Another class of symbiotic systems are those in which the WD is extremely luminous and it seems likely that quiescent nuclear burning is ongoing on the accreting WD. A fundamental question is the secular evolution of the WD. Do the repeated outbursts or quiescent burning in these accreting systems cause the WD to gain or lose mass? If it is gaining mass, can it eventually reach the Chandrasekhar Limit and become a supernova (a SN Ia if it can hide the hydrogen and helium in the system)? In order to better understand these systems, we have begun a new study of the evolution of Thermonuclear Runaways (TNRs) in the accreted envelopes of WDs using a variety of initial WD masses, luminosities and mass accretion rates. We use our 1-D hydro code, NOVA, which includes the new convective algorithm of Arnett, Meakin and Young, the Hix and Thielemann nuclear reaction solver, the Iliadis reaction rate library, the Timmes equation of state, and the OPAL opacities. We assume a solar composition (Lodders abundance distribution) and do not allow any mixing of accreted material with core material. This assumption strongly influences our results. We report here (1) that the WD grows in mass for all simulations so that 'steady burning' does not occur, and

(2) that only a small fraction of the accreted matter is ejected in some (but not all) simulations. We also find that the accreting systems, before thermonuclear runaway, are too cool to be seen in X-ray searches for SN Ia progenitors.

Key words: stars: white dwarfs, close binaries, dwarf novae, interiors, novae, cataclysmic variables, supernovae

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Mass Transfer in Mira-type Binaries

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Abstract. Detached, symbiotic binaries are generally assumed to interact via Bondi-Hoyle-Littleton (BHL) wind accretion. However, the accretion rates and outflow geometries that result from this mass-transfer mechanism cannot adequately explain the observations of the nearest and best studied symbiotic binary, Mira, or the formation of some post-AGB binaries, e.g. barium stars. We propose a new mass-transfer mode for Mira-type binaries, which we call 'wind Roche-lobe overflow' (WRLOF), and which we demonstrate with 3D hydrodynamic simulations. Importantly, we show that the circumstellar outflows which result from WRLOF tend to be highly aspherical and strongly focused towards the binary orbital plane. Furthermore, the subsequent mass-transfer rates are at least an order of magnitude greater than the analogous BHL values. We discuss the implications of these results for the shaping of bipolar (proto)-planetary nebulae and other related systems.

Key words: stars: binaries: symbiotic – accretion, accretion disks – hydrodynamics – stars: mass loss, winds, outflows

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Multiwavelength SED as a Tool in Understanding Outbursts of Symbiotic Binaries

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Abstract. Symbiotic binaries consist of a few sources of radiation contributing to spectral energy distribution (SED) from hard X-rays to radio wavelengths. To identify the basic physical processes forming the observed spectrum, we have to disentangle the composite SED into its individual components of radiation, i.e., to determine their physical parameters. Spectral disentangling of different objects at different stages of activity allows us to understand the mechanism of their outbursts. In this contribution I demonstrate the method of multiwavelength modeling SEDs on the example of two classical symbiotic stars, AG Dra and Z And.

Key words: stars: binaries: symbiotic – X-rays: binaries – stars: fundamental parameters

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Formation of Neutral Disk-like Zone around the Active Hot Stars in Symbiotic Binaries

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Abstract. In this contribution we present the ionization structure in the enhanced wind from the hot star in symbiotic binaries during active phases. Rotation of the hot star leads to the compression of the outflowing material towards its equatorial plane. As a result, a neutral disk-like zone around the active hot star near the orbital plane is created. We modeled the compression of the wind and calculated the neutral disk-like zone in the enhanced wind from the hot star using the equation of the photoionization equilibrium. The presence of such neutral disk-like zones was also suggested on the basis of the modeling the spectral energy distribution of symbiotic binaries. We confront the calculated ionization structures in the enhanced wind from the hot star with the observations. The calculated column density of the neutral hydrogen atoms in the neutral disk-like zone and the emission measure of the ionized part of the wind from the hot star are in a good agreement with the quantities derived from observations during active phases. The presence of such neutral disk-like zones is transient, being connected with the active phases of symbiotic binaries. During quiescent phases, such neutral disk-like zones cannot be created because of insufficient mass-loss rate from the hot star.

Key words: stars: binaries: symbiotic – stars: winds, outflows

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Mass Ejection from the Symbiotic Prototype Z And during its 2006 Outburst

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Abstract. High-resolution spectroscopic observations in the region of the Balmer Hα and Hγ lines of the symbiotic binary Z And were performed during its major eruption in 2006. The Hα line had additional satellite high-velocity components situated on either side of its central peak which indicated bipolar collimated outflow from the compact object. The Hγ line presented three components, consisting of a central narrow emission, a broad emission component with low intensity indicating an optically thin stellar wind with a velocity of about 500 km s^{-1} from the compact object and a blueshifted P Cyg absorption with a multi-component structure occupying a broad velocity range. These data are explained in light of a model where a disk-like envelope surrounding the accretion disk collimates the stellar wind on the compact object and gives rise to bipolar outflow. The mass-loss rate of the accretor was derived at several epochs after outburst. We conclude that the mass-loss rate has decreased probably from 4–5 $\times 10^{-7}\,(d/1.12\mathrm{kpc})^{3/2}\,M_\odot\,\mathrm{yr}^{-1}$ at the time of maximum light to about $2 \times 10^{-7}\,(d/1.12\mathrm{kpc})^{3/2}\,M_\odot\,\mathrm{yr}^{-1}$ in 2006 December.

Key words: stars: binaries: symbiotic – stars: activity, mass-loss, winds, outflows – stars: individual (Z And)

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RR Tel: Determination of Dust Properties during Minimum Obscuration

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Abstract. The ISO infrared spectra and the SAAO long-term *JHKL* photometry of RR Tel in the epochs during minimum obscuration are studied in order to construct a circumstellar dust model. The spectral energy distribution in the near- and the mid-IR spectral range (1–15 μm) was obtained for an epoch without the pronounced dust obscuration. The DUSTY code was used to solve the radiative transfer through the dust and to determine the circumstellar dust properties of the inner dust regions around the Mira component. Dust temperature, maximum grain size, dust density distribution, mass-loss rate, terminal wind velocity and optical depth are determined. The spectral energy distribution and the long-term *JHKL* photometry during an epoch of minimum obscuration show almost unattenuated stellar source and strong dust emission which cannot be explained by a single dust shell model. We propose a two-component model consisting of an optically thin circmustellar dust shell and optically thick dust outside the line of sight in some kind of a flattened geometry, which is responsible for most of the observed dust thermal emission.

Key words: stars: binaries: symbiotic – stars: circumstellar matter – stars: AGB and post-AGB – radiative transfer

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News from AG Draconis

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Abstract. AG Dra is a classical symbiotic star that undergoes major outbursts at intervals between 12–15 years. We present spectroscopic observations of four emission lines (Hα, Hβ, He II 4686 Å, Raman scattered O VI 6825 Å) before, during and after the major outburst that started in 2006. Interesting strengthenings of the emission lines took place in late 2005 and in early 2008. The latter was followed by a very deep minimum in the line strengths in 2008–2009.

Key words: stars: symbiotic – stars: individual (AG Dra) – spectroscopy: emission lines

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The Long-Term Spectroscopic Misadventures of AG Dra with a Nod toward V407 Cyg: Degenerates Behaving Badly

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Abstract. We present some results of an ongoing study of the long-term spectroscopic variations of AG Dra, a prototypical eruptive symbiotic system. We discuss the effects of the environment and orbital modulation in this system and some of the physical processes revealed by a comparison with the nova outburst of the symbiotic-like recurrent nova V407 Cyg 2010.

Key words: stars: symbiotic, individual (AG Dra, V407 Cyg) – stars: novae

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Symbiotic Nova PU Vul – 33 Years of Observations

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Abstract. We present *UBVRI* light curves of the symbiotic nova PU Vul after its outburst in 1978. Three observed eclipses of the hot component by the cool one were used to determine the ephemeris of the binary system as JD (Min I) = 2444550(15) + 4897(10) × E days. The 194-day shift of the secondary minimum from its expected positions in 2001 suggests the eccentricity of the binary orbit. Period analysis of the *VRI* photometry improved the pulsation period of the cool AGB variable in the system to P = 217.7 days. Pulsation of the cool component is detected only in the phases around the primary minimum, when the visible hemisphere of the AGB star is not influenced by the interaction with the hot component.

Key words: stars: binaries: symbiotic, novae, eclipsing, AGB – techniques: photometric

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A Composite Light Curve Model of the Symbiotic Nova PU Vul (1979)

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Abstract. PU Vul (1979) is a symbiotic nova that shows a long-lasting flat optical peak followed by a slow decline. We made a quasi-evolution model for outbursts on a 0.6 $M_\odot$ white dwarf consisting of a series of static solutions with optically-thin winds. Our theoretical models reproduce well the observed visual/UV light curves as well as the new estimates of the temperature and radius of the hot component. We also modeled the light curve of the 1980 and 1994 eclipses as the total eclipse occulted by a pulsating M-giant companion star. In the second eclipse, the visual magnitude is dominated by nebular emission which is possibly ejected from the hot component between 1990 to 2000. We have quantitatively estimated three components of emission, i.e., the white dwarf, companion and nebular, and made a composite light curve that represents well the evolution of the PU Vul outburst.

Key words: stats: symbiotic, novae, cataclysmic variables, white dwarfs, individual (PU Vul)

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Mass Transfer in Two Post-AGB Binaries with Dusty Disks

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Abstract. We present a time series of high-resolution spectra for two poorly studied candidate post-AGB stars surrounded by dusty disks, BD+46 442 and IRAS 19135+3937. We find that both stars show radial velocity variations with periods of 130–140 days. IRAS 19135+3937 has been previously classified as a semi-regular variable based on the light variations with a similar period, but our spectra reveal an evolved star which is too warm to be on the AGB. The variability of BD+46 442 has not been studied till now. The stars reveal a number of spectroscopic peculiarities that resemble features in the interactive binaries including the S-type Symbiotics. Namely, Hα profile alternates between a double-peak emission and a P Cyg profile, which correlates with the radial velocity phase. A weak asymmetry is tentatively detected in the cross-correlation function that moves in anti-phase with the main component. In addition, strong photospheric lines reveal a narrow central absorption. We conclude that these peculiarities are consistent with a picture where the observed post-AGB stars orbit a much fainter companion at a sub-AU separation and transfer mass on it. The companion is surrounded by an accretion disk, possibly with some kind of an outflow. The SED shows that whole system is surrounded by stable dusty disk as well. It remains to be seen with more observations how much of the line asymmetry could be due to the contribution of low-amplitude pulsations.

Key words: stars: AGB and post-AGB – binaries: spectroscopic

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Spectroscopic Monitoring of the Symbiotic Star BX Monocerotis

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Abstract. Low resolution optical spectra of the symbiotic star BX Monocerotis in the 3500–9000 Å range obtained during 1999–2010 are described. The spectrum of BX Mon at all phases is dominated by the cool component, with a red continuum and TiO absorption. Emission lines, predominantly due to H I, He I, He II, Fe II, Ca II and [O III] are seen superimposed on the spectrum of the M5 III star, with variable intensities. The observed variations in the spectra seem to be correlated with the orbital phases.

Key words: stars: binaries: symbiotic – stars: individual (BX Mon)

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Reconstructing Historical Light Curves of Symbiotic Stars and Novae

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Abstract. We reconstructed photometric histories of symbiotic stars and novae from direct inspection and measurement of photographic plates preserved at historical archives. We have completed the digging of the rich Asiago archive, and have started working on the Harvard plate stack, while other plate collections should be added soon. For homogeneity, we use the same $UBVR_{\rm C}I_{\rm C}$ photometric comparison sequences used in current CCD observations. This data harvest has permitted the discovery of past undetected outbursts and secular trends, or to derive previously unknown orbital periods and recurrence times, which are essential to constrain the nature of these capricious and variegated active binaries.

Key words: stars: binaries: symbiotic – stars: novae

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Abell-35 Phenomena in Symbiotic Stars: Discovery of 1.2 and 6.4 Day Periods in VV8 (V471 Per)

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Abstract. We have collected high precision optical photometry of VV8, so far 782 individual observing runs uniformly distributed over the period 2005–2011. This dataset allows us to refine the known long periodicity of VV8 to $P = 16.8$ yr, with peak-to-valley amplitudes of $\Delta B = 0.18$ and $\Delta V = 0.14$ mag. In addition, we have discovered two new periodicities: 6.431 d (total amplitude $\Delta B = \Delta V = \Delta I = 0.05$ mag) and 1.185 d ($\Delta B = 0.022$, $\Delta V = 0.018$, $\Delta I = 0.014$ mag). These two short periods are reminiscent of the Abell-35 phenomena displayed by binary nuclei of planetary nebulae that have gone through a common envelope phase. Twice the 6.431 d period would nicely correspond to the double-peaked light-curve that the G5 III star in VV8 would display if its Roche lobe would be ellipsoidally distorted.

Key words: planetary nebulae: central star – stars: symbiotic binaries

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Photometric Activity of the Symbiotic Star CH Cyg during 2008–2011

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Abstract. We present results of $UBVR_{\rm C}$ observations of the symbiotic star CH Cyg before and after optical and X-ray bursts in 2009 at various timescales. Rapid variability was found only during a strong burst ($U \sim 9.5$ mag) in 2009 October, while during the low state, prior to ($U \sim 11$ mag) and after ($U \sim 9.4$ mag) the burst rapid variability was not detected.

Key words: stars: binaries: symbiotic: individual (CH Cyg) – stars: flare, oscillations

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BF Cyg during its Current Outburst

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Abstract. We are intensively monitoring the current outburst on BF Cyg, both spectroscopically (high and low resolution modes) and photometrically (so far 450 BVR_CI_C measurements have been collected). The outburst is photometrically reminiscent of the major event BF Cyg experienced in 1890 when it rose by 4 mag in the blue. In this contribution we present the data and describe the plans to investigate this object.

Key words: stars: symbiotic binaries – individual (BF Cyg)

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Telescope and Researcher Potential of Turkey for Collaboration in CV Studies

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Abstract. Turkish astronomical community has witnessed the construction of several telescopes in the last 10 years. These telescopes and the potential of young researchers in the country motivated this poster presentation which aims to receive attention for collaboration in the field of cataclysmic variables and related objects.

Key words: stars: novae, cataclysmic variables – telescopes – techniques: photometric, spectroscopic

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Contribution of the Electron Scattering Process to the Broad Hα Wings

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Abstract. We modeled the extended wings of the O VI 1032, 1038 Å resonance lines and He II 1640 Å emission line in the spectra of Z And, AG Dra and V1016 Cyg by the electron scattering process. By this way we determined the electron temperature and the electron optical depth of the layer of electrons, through which the line photons are transferred in the direction of the observer. We derived an empirical relationship between the emission measure of the symbiotic nebula and the electron optical depth. This relationship allows us to distinguish the flux contribution in the broad Hα wings, which is due to the electron scattering and that produced by the Hα transition in the moving hydrogen plasma. For example, subtracting the electron scattering contribution from the Hα line profile leads to a reduction in the mass-loss rate by approximately 15 %.

Key words: stars: binaries: symbiotic – line: profiles – scattering

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SBS 0802+529: a New Variable Star from the Second Byurakan Survey

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Abstract. A new emission line star was discovered on the plates of the Second Byurakan Survey (SBS). The follow up spectroscopy demonstrated that the object had a spectrum dominated by a late-type giant star with superposed hydrogen emission lines. The object resembles a pulsating Mira, but the amplitude of variability and a rapid UV variability are quite unusual for a single star, and we tentatively classify the object as a symbiotic star.

Key words: stars: variables – stars: binaries: symbiotic

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On the Symbiotic X-ray Binary Nature of the Star CGCS 5926

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Abstract. We report on multiwavelength (from X-ray to optical) follow up observations of a carbon star CGCS 5926, motivated by the fact that it is positionally coincident with a faint X-ray source of the ROSAT catalog, thus suggesting its possible symbiotic X-ray binary (SyXB) nature. Our optical spectroscopy confirms that this is a carbon star of type C(6,2). This allows us to infer for CGCS 5926 a distance of ~ 5 kpc. $BVR_{\rm C}I_{\rm C}$ photometry of the star shows variability of ~ 0.3 mag with a periodicity of 151 days, which we interpret as due to radial pulsations. The source is not detected with the *Swift* satellite in X-rays down to a 0.3–10 keV luminosity of $\sim 3 \times 10^{32}$ erg s^{-1}. This nondetection is apparently in contrast with the ROSAT data; however, the present information does not rule out that CGCS 5926 can be a SyXB. This will be settled by more sensitive observations at high energies.

Key words: stars: carbon, AGB – stars: individual (CGCS 5926) – stars: oscillations