

"INTER-LONGITUDE ASTRONOMY" (ILA) PROJECT: CURRENT HIGHLIGHTS AND PERSPECTIVES.

I. MAGNETIC VS. NON-MAGNETIC INTERACTING BINARY STARS

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ABSTRACT. We present a review of highlights of our photometric and photo-polarimetric monitoring and mathematical modeling of interacting binary stars of different types: classical, asynchronous, intermediate polars with 25 timescales corresponding to different physical mechanisms and their combinations (part "Polar"); negative and positive superhumpers in nova-like and dwarf novae stars ("Superhumper"); symbiotic ("Symbiosis"); eclipsing variables with and without evidence for a current mass transfer ("Eclipser") with a special emphasis on systems with a direct impact of the stream into the gainor star's atmosphere, which we propose to call "Impactors", or V361 Lyr-type stars. Other parts of the ILA project are "Stellar Bell" (pul-

sating variables of different types and periods - M, SR, RV Tau, RR Lyr, Delta Sct) and "New Variable".

Key words: Variable stars: cataclysmic, pulsating, eclipsing, interacting binary

The monitoring of the first star of our sample AM Her was initiated by Prof. V.P. Tsessevich (1907-1983). More than 300 papers were published, with a total number of studied variable stars exceeding 1400. The previous review of the "Inter-Longitude Astronomy" ("ILA") campaign was published by Andronov et al. (2003). For the CCD observations, we mainly use the BVRI calibration of A.Henden.

The "top of the top" of the recent highlights are:

- **TT Ari** (nova-like superhumper): discoveries of a back switch between the states of positive and negative superhumps (Andronov et al., 1999, 2005a); of a "loop" at the "Period of Quasi-Periodic Oscillations (QPO) brightness", contrary to a previous suggestion on dependence of characteristics of superhumps and QPOs on brightness (Kim et al., 2009); of drastic brightness variations up to 2 mag during a prolonged exotic "low luminosity state" started in October, 2009 and continued for one year, finished just before final version of this paper, passing through stages (with increasing luminosity) of positive superhumps, double wave of positive superhumps; negative superhumps.
- **DO Dra** (an "outbursting intermediate polar" or a "magnetic dwarf nova"): discoveries of the new type of variability "Transient Periodic Oscillations" (TPO), which are interpreted by model of plasma blobs spiralling down to the magnetic white dwarf; correlation of the decay rate and outburst brightness; out-of-outburst luminosity variations (Andronov et al., 2008);
- **V1432 Aql** (asynchronous polar): discovery of a third type of eclipses in the system, self-consistent model for the arc-shaped accretion structure (Andronov and Baklanov, 2007); determination of the most accurate value of the synchronization time of 96.5 ± 1.5 years (Andronov and Baklanov, 2006) in an excellent agreement with former theoretical prediction for another system AM Her with similar physical parameters (Andronov, 1987ab);
- **AM Her** (synchronous polar): Discovery of two-component nature of the "shot noise" with characteristic time-scales of 9.8 and 170 sec based on the 24117 seconds of CHANDRA observations, which justifies the "Z-pinch"-type magneto-hydrodynamic instability in falling plasma blobs "spaghetti" (Andronov et al., 2003, 2005b). More detailed self-review was published by Andronov (2008);
- **BY Cam** (asynchronous polar): detailed study of previously discovered switching of accretion from pole to pole with a phase of spin-orbital beat; correlation between the color index and brightness, which is an agreement with a cyclotron emission of the accretion column (Andronov et al., 2008); detection of drastic changes of the amplitude of variations of polarization which may be explained by variations of the accretion structure dependent on periodically changing angle between the line of centers and the magnetic axis (Breus et al., 2007);
- **Intermediate polars** (BG CMi, MU Cam =1RXS J062518.2+733433, FO Aqr, AO Psc, 1RXS J063631.9 +353537, 1RXS J070407.9 +262501, 1RXS J180340.0 +401214, 1RXS J192626.8 +132153, 1RXS J213344.1 +510725, PQ Gem, V405 Aqr): study of the rotational evolution of magnetic white dwarfs in these systems based on long-term monitoring; some systems exhibit acceleration (Andronov, Ostrova and Burwitz, 2005) or deceleration (Kim et al., 2005) of rotational acceleration (i.e. negative or positive d^2P/dt^2), for interpretation of which a model of precession was proposed (Andronov, 2005); the statistical dependence of phases of spin pulses on orbital phase was detected in MU Cam, indicating modulation of the accretion structure with a periodically changing angle between the magnetic axis and the line of centers (Kim et al., 2005);
- **OT J071126.0+440405** (synchronous polar with 3 types of eclipses): discovery of 3 distinctly separate luminosity states based on 100+ nights of mono and multi-color observations; determination with best accuracy of the parameters of the light curve; elaboration of self-consistent theoretical model for structure of the system, which is dependent on luminosity (i.e. the accretion rate);
- **Eclipsing nova-like variables** (DW UMa, BH Lyn, PX And, other SW Sex stars): besides superhumps and QPOs, they exhibit an ultra-violet excess (seen in the U-B color index) at the eclipse (e.g. Andronov et al., 2001), indicating an extended hot emission region (like an accretion disk corona) and thus a physical unreliability of thin disk models;
- **Positive vs. Negative Superhumps** in non-eclipsing Nova-Like variables: besides a large international campaign on TT Ari, we arrange occasional campaigns for V603 Aql. In 2004 the system was found to exhibit either positive superhump with a period 0.14813(10), or the statistically significant waves with 3^d9 , 1^d4 , 0^d135 , which may be interpreted as the negative superhump-orbital, the beat periods (negative superhump - positive superhump) and the negative superhump with low amplitude, respectively (Andronov et al., 2005c). Similarly to TT Ari, another star MV Lyr showed dependence of colors of variations with time scale - the most "blue" spectral energy distribution correspond to the quasi-periodic oscillations (QPO), the most "red" is time-averaged emission and the negative superhumps are intermediate in color temperature (Andronov and Antoniuk 2005). Using advanced methods for mathematic modeling of multi-component signals, from the observations obtained during 6 nights following "the king of superoutbursts" in WZ Sge, we succeeded to detect not only a orbital variability

with prominent eclipses of the accretion disk, but also “early superhumps”, which have become dominating only two weeks later (Andronov et al., 2002).

- **Symbiotic stars:** photographic photometry and time series analysis was made for dozens stars during an international campaign initiated by Hric and Skopal (1989). For recent studies of these stars, we use different methods: periodogram, wavelet, scalegram analysis and global (polynomial + trigonometric polynomial fits) and local (running parabolae, running sine fits), see e.g. Andronov and Chinarova (2003).
- **New Eclipsing and Pulsating variables:** from the database of BV Hipparcos-Tycho observations, we have found 863 new variables (Andronov et al., 1999), the majority of which are eclipsing or pulsating variables. For such a study, we have used trigonometric polynomial fits of 1, 2, 3 orders and than specially developed algorithms of “EAC” (“EA catcher”, which is effective for noisy observations not only of the EA-type systems, but also for the types EB and EW) and “RR Catcher” (Andronov, Cuypers and Piquard, 2010). More than fifty new variable stars were discovered, studied and classified by N.Virgina. From those, 27 discoveries were reported separately in this volume (Virgina, 2010b). It should be noted that, from this sample, 10 systems (i.e. $\sim 37\%$) exhibit statistically significant difference between the brightness at maxima arguing for a presence of spots.
- **VSX J052807.9+725606:** discovery of large asymmetry of the newly detected variable (Virgina, 2010a, Virgina and Andronov, 2010) with an amplitude increasing towards shorter wavelengths, which were interpreted in terms of the model proposed for V361 Lyr (Andronov and Richter, 1987), i.e. an extremely bright hot spot caused by a direct impact of an accretion stream from the donor to the accretor’s atmosphere at a pre-contact stage; this allows to propose a new class of “Impactors”.

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