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Poster Abstracts (Session 2)

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Activities and Achievements of the Double Star Committee of the French Astronomical Society

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Created in 1981 by Pierre DURAND with the support of Paul MULLER, the Double Star Committee constitutes ever since a forum of exchange of experiences and information in the field of double stars, particularly visual. The Committee relies on the advice of its scientific counsellors (in particular Pierre BACCHUS, Daniel BONNEAU, Paul COUTEAU and Jean DOMMANGET) to guide the work of its members. By fostering missions in observatories, it has stimulated the activities of observation and measurement of double stars. It has also encouraged the publication of measures (A&A and "Observations et Travaux") and raised up missions of verification of double star positions. Under its aegis, many series of measures of double stars made in particular with the 50-cm refractor at the Nice Observatory (either with a filar micrometer or with a CCD camera), were published. Uncertain positions of pairs have been checked and corrected. For the treatment of numerical images of double stars, software aiming in particular at the determination of position elements and the magnitude difference between components were tested and others created (e.g. REDUC and SURFACE). The spar plate double image micrometer of Lyot was developed and its fabrication raised up. Preliminary orbits of double stars have been calculated, as well. An amateur participates in the maintenance of the database of double star measures SiDoNie and pursues an historical research on the life and work of Robert JONCKHEERE. The Internet site of the Committee, created in 2005, informs laypersons as well as experienced amateurs (`http://saf.etoilesdoubles.free.fr`).

An Optical Search for Dwarf Novae in M22

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We report on the results of our 2004 monitoring program of M22, designed to search for CVs undergoing dwarf nova (DN) eruptions. We are interested to compare these globular cluster systems to similar ones in the field and determine if their different formation mechanisms result in different properties. We present a light curve for a CV candidate that went into outburst during May. Data were reduced using the ISIS image subtraction routine. Our ground-based results are consistent with previous HST measurements, and confirm the DN nature of the outburst. We also report on further attempts to apply the

ISIS software to look for additional outbursts of this object during 2004 as well as to identify other variable candidates in the core of M22.

An Investigation of the Small Eccentricity in the Spectroscopic Binary System ζ TrA

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The orbital eccentricity of the SB1 system ζ TrA (S.T. F9V, $P \sim 13$ d) was found by Skuljan *et al.* (2004) to be $e = 0.01398 \pm 0.00019$. Lucy (2005) devised a statistical test of the significance of this result based on the amplitude and phase of the third harmonic in the Fourier analysis of the radial velocity data, and concluded that the non-zero eccentricity measured does not arise from a slightly eccentric Keplerian orbit, but from proximity effects in the binary. He therefore believes a circular orbit should be assigned to this system. In this paper, we investigate one possible proximity effect, namely the tidal distortion of the primary star, such that the measured Doppler shift does not accurately indicate the centre of mass radial velocity of the star as a whole.

The code of Wilson & Devinney (2003) was used to model the tidal distortion of the measured radial velocities, assuming a range of possible secondary masses, corresponding to M dwarf companions. The result is that even for the lowest possible mass secondary of 0.09 $M_{\odot}$ with $\sin i = 1$ (this gives the greatest tidal distortion, as it is closest to the primary) there is no significant effect on the radial velocities (the differences are of order 1 m/s as a result of the tidal effects). Similar negligible tidal effects arise using a white-dwarf companion.

We note that the difference between a circular orbit and the observations amounts to as much as 140 m/s at some phases, which is essentially the amplitude of the second harmonic in the data. Our conclusion is that this strong and highly significant second harmonic is most probably the result of a small orbital eccentricity as reported by Skuljan *et al.* (2004). We note that the observed third harmonic according to Lucy (2005) has an amplitude of only 5.2 ± 2.0 m/s, which is just over twice the error bar of its measurement, and that the predicted third harmonic for an eccentric orbit is only 1.6 m/s.

Discovery of a New Dwarf Nova, TSS J022216.4+412259.9: WZ Sge-type Dwarf Novae Breaking the Shortest Superhump Period Record

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We report on the time-resolved CCD photometry of a newly discovered dwarf nova, TSS J022216.4+412259.9 during the outburst in the 2005 November-December. The best-estimated superhump period was 0.0554 days, which is the shortest superhump period among WZ Sge-type dwarf novae ever known. Double-peaked humps were also detected with a period of 0.05487 days in the early stage of the outburst. A rebrightening was exhibited after the end of the plateau phase. All of these observations indicate the WZ Sge nature of the system. We mainly discuss the rebrightening stage of the superoutburst, compared with other WZ Sge-type dwarf novae.

Periodic Perturbations of Relative Motion in the Multiple System ADS 15571.

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For the multiple system ADS 15571, it was calculated a preliminary orbit of the visible secondary component (around the primary) and periodic perturbations of its relative motion were investigated. ADS 15571 has been observed at Pulkovo with a 26-in refractor since 1960; it was observed for the first time in 1832 by O. Strueve. Treatment of astronegatives was made with the scanner UMAX (resolution 1200 dpi, transparency adapter). The accuracy of annual average relative positions amounts to $0''.0048$ in angular separation ρ and $0°.018$ in positional angle θ.

As known, the secondary component of visual double star ADS 15571 is a spectroscopic binary with a period of 1.1522 days (Sanford,1927). Study of more then 40-yrs set of photographic observations with the 26-in refractor shows that the system has more one component with a period of 23 years. I obtained an astrometric orbit of the photocenter based on the apparent motion ellipse and concluded that the detected periodic perturbations of relative motion are caused by the existence of a low-magnitude companion. Its minimum mass was estimated at 0.62 $M_{\odot}$.

Determination of the Orbits and Estimation of the Masses of ADS 7251 and ADS 5983 (δ Gem)

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The main purpose of our work was the investigation of the dynamics of two binaries; we also wish to define the masses of the components. After all the great interest was to search the existence a hidden mass or gravitational influence of probable dark satellites.

Our data have been founded on a homogeneous long-term series of photographic observations by means of Pulkovo observatory 65-cm refractor: 196 positions with m.e. $0''.004$ for ADS 7251 and 106 positions with m.e. $0''.020$ for δ Gem obtained in the years 1962-1996 and 1972-2006, respectively. All observations of δ Gem have been made with a diffraction grating because two its components have difference in magnitudes of about 5 mag.

For ADS 7251 the relative orbit, the total mass and the mass ratio have been obtained. Taking into account some contradictory data on masses and spectral classes of its components some discussion has been fulfilled. In the result of investigation of the individual motions of its components in the frame of reference stars the masses of A and B have been estimated. We were using different algorithms for the estimations of masses. As a result we have obtained the total mass and masses of components of ADS 7251. They are 0.56 and 0.54 $M_{\odot}$ for A and B respectively. The relative orbit for δ Gem has been obtained too, with a total mass of 2.5 $M_{\odot}$.

Any perturbations in the separation and position angles of ADS 7251 have not been discovered. The residuals in the motion of δ Gem are complicated character. In its separations a wave with a period of 6.1 year is revealed. The motion of a dark companion with mass about 0.2 $M_{\odot}$ is analysed, and some hypothesis on the other companion with a period about 1 year has been discussed.

Duplicity among Lambda Boo stars: The New Case of HD 204041

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The λ Boo stars are a fascinating class of stars: it is the only class of A-type stars with abundances lower than solar, in spite of the fact that they have the kinematical and photometric properties of Pop I stars. The most plausible theory, at present, to interpret this peculiar behaviour is based on the diffusion-accretion model proposed by Venn & Lambert (1990).

The key point of this model is the existence of a surrounding disk of dust and gas which would be the remnant of the star formation material and from which the — metal depleted — gas is accreted, the metals being incorporated into the dust.

The large variety of objects classified as λ Boo and the lack of any relation between their physical parameters and the measured abundance anomalies, coupled with the recent detection of bright companions near several λ Boo candidates (detected by ground-based speckle and our adaptive optics observations, as well as by the Hipparcos space experiment) prompted us to scrutinize all the high-resolution spectra we could obtain to search the objects that have composite spectra: a combination of two similar spectra which can be confused with that of a single metal poor star when analyzed by adopting their average T_{eff}, *log* g parameters.

The detection of duplicity is tricky because one of the characteristics of λ Boo stars is the mean-high v*sin*i which produces broad and shallow lines. We have developed a strategy to detect such composite spectra by selecting the spectral features which are more sensitive to duplicity. We apply this analysis to one more object: HD 204041, a "well known" λ Boo star which is shown to be a further member of the "composite spectra" class.

Four Massive O-type Eclipsing Binaries

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We have determined fundamental properties of four eclipsing massive O-type binaries. Three of these eclipsing binaries, namely FO15, CPD−59 2603 and CPD−59 2635 are members of the young open cluster Tr16 in the Carina Nebula. The fourth eclipsing binary, LS 1135, is located in the OB association Bochum 7. Light curves and radial velocities were analyzed with the Wilson-Devinney code. We find all four systems to be detached. The eclipsing binaries in the Carina Nebula have properties of stars which have recently arrived to ZAMS, as we find them to have smaller radii and luminosities than "normal" O-type stars. The properties of the components of LS 1135 correspond to "normal" massive stars.

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LIADA's Double Star Section: Studies of Visual Double Stars by Amateurs

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LIADA's Double Star Section has as its main goal to perform measures of relative astrometry of neglected and unconfirmed wide pairs, as well as to determine the astrophysical properties for their components and classify them, according to their nature, as physical, common origin, common proper motion or optical pairs.

$BVIJHK$ photometry, relative astrometry and kinematical data, in addition to other astrophysical parameters, were obtained from literature to characterize the components and the stellar systems. VizieR, Simbad, Aladin and the "services abstract" tools were used from the website of Centre de Données Stellaires de Strasbourg (CDS). USNO catalogs (USNO-B1.0 and UCAC-2) in addition to ESA catalogs (Tycho-2 and HIPPARCOS) were often used. Spectral types, luminosity classes, absolute magnitudes, and photometric distances were determined by using several tables, two colours and reduced proper motion diagrams. Astrophysical properties were corrected by reddening by using several maps.

CCD cameras, micrometric eyepieces, photographic plates from Digitalized Sky Survey (DSS) and other surveys were used to perform our astrometric measures.

According to their nature double stars are classified by using several professional criteria. Since 2001 LIADA has studied about 500 visual double stars, has discovered about 150 true binaries and several candidates to be white dwarfs, subdwarfs and nearby stars. Several orbits have been calculated.

Our results are published in national and international journals such as Journal of Double Star Observations (JDSO), in Information Circulars edited by Commision 26 of IAU and our measures were included in the WDS catalog. LIADA publishes a circular twice a year with our results.

Long-term Photometric Behaviour of the Symbiotic System AG Dra

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The general behaviour of the symbiotic system AG Dra was studied in the context of the long-term photometry and radial velocity analysis. The analysis of new and historical photometric data as well as radial velocities confirmed the continued presence of the second period, found by our previous analysis, which could be due to pulsation of the cool component of the AG Dra binary system. The discussion about very probable resonance of the orbital and pulsation periods as a general cause of the recurrence time of the active stages is also presented.

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J-, H-, and K-band Spectra of Three SU UMa-type Dwarf Novae

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We present the results of J-, H-, and K-band spectroscopy on three SU UMa-type dwarf novae with orbital periods of 1.33 ∼1.37 hr. We performed the SED fitting for the obtained spectra by assuming a power law distribution for the accretion disk and using template spectra of late-type dwarfs for secondary star.

ASAS 002511+1217.2 and EQ J183926+260409 are WZ Sge-type or WX Cet-type dwarf novae. We found strong water absorption features in their spectra, which are characteristic in late M- or L-type dwarfs. The SED fitting suggests that their secondary contributions to the overall SED are less than one third. We identified the secondary stars as M9 and L1 type dwarfs, which are rather less massive but still normal stars. The spectrum of SDSS J013701−091235 is dominated by the secondary component. Spectral features of this object are similar to those of an early M-type dwarf in spite of its short orbital period. The spectrum of SDSS0137 strongly suggests that the evolutionary path of this object is different from that of ordinary CVs, and this object is a candidate of EI Psc-like systems.

Long-Term Changes of the Supergiant in the X-Ray Binary Cyg X-1

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Both photometrical and spectral variations point to supergiant parameter changes on the time scale of tens of years. A 35-year long homogeneous photometric series of UBV observations acquired at SAI Crimean Laboratory was used. The object brightness was slowly increasing from 1985 to 1995, and then decreasing to a minimum reached in 2003. The brightness minima were observed in 1971 and in 2003–2005. The largest amplitude was seen in U band (ΔU=0.1). During the transition from the maximal (1995–1999) to the minimal (2003–2005) brightness, the X-ray activity increased. High-resolution spectra were obtained in 1997 at the Crimean Astrophysical Observatory (the 2.6-m telescope, resolution R=35000), and in 2003-2004 at the Peak Terskol Observatory (the 2-m telescope, R=13000) and BOAO (the 1.8-m telescope, R=30000). Comparison of the observed and non-LTE simulated photometrical variations and He I λ4713Å line profiles leads to the conclusion that the star radius has increased by about 1-4% from 1997 to 2003-2004 and the supergiant effective temperature decreased by 1300-2400K.

The work is partially supported by RFBR grant 04-02-16924.

Light Curves of Two Eclipsing Binary Systems, BL Eridani and GW Cephei

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We present light curves of two short period binary systems, BL Eridani and GW Cephei. BL Eridani was observed with VRI filters on 5 nights at Siding Spring Observatory (SSO) by a 50-cm wide-field robotic telescope equipped with a 2K CCD camera, which was developed by the Korea Astronomy and Space Science Institute (KASI), and Yonsei University Observatory (YUO). Two nights were observed at SSO by automatic operation mode, and three nights were observed by automatic remote observation mode from KASI in Korea. With light curves covering a full phase, five new times of minimum lights were determined. The magnitude difference between primary minimum and secondary minimum with V filter appeared as 0.25 magnitude, similar to the observation by Yamasaki (1998). The light curves were analyzed by mode 3 of WD binary code, and q-search method, which shows the best fit at q = 0.48 and i = 88°.7.

The short-period contact binary system GW Cephei was observed on 5 nights by the 61-cm telescope with a 2K CCD camera at Sobaeksan Optical Astronomy Observatory (SOAO) of KASI with standard BVR filters. Full light curves were obtained, and five new times of minimum light were determined. We analyzed period variation of this system with 96 times of minimum light including our observations, which shows systematic variations that can be interpreted as the light time effect by a third body with a minimum mass of 0.17 $M_{\odot}$. We assumed a cool spot on the surface of the massive secondary component responsible for the asymmetry of the light curves, and calculated photometric parameters of GW Cephei by WD code, which shows q = 2.59, and $i = 85°.4$, with a 16% fill-out factor.

The Magnetic Cataclysmic Variable Star AM Her

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In this study the cyclotron spectrum from the accretion column of the magnetic cataclysmic variable star AM Her is deduced and compared with the observed one. In addition, R-band light curves of the system obtained with 1.5-m Russian-Turkish telescope during the observing seasons 2004-2005, when the system was in its low state, are presented. During 3 observing nights, brightness variations most probably due to the stellar activity of the companion star were detected. The system was also observed with ROTSE IIId during April – July 2005, when the system passes from low to high state. Significant brightness variations, more than 1 mag, were also observed on two observing nights.

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Masses of Early-Type Contact Binary Systems

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In general, the mass ratio derived from photometric analyses, q(pe), agrees quite well with the value derived from double-line spectroscopic binary, q(sp), for wide pairs as well as for close pairs. Therefore one wishes that masses could be determined for single-line systems with the help of photometric mass ratio.

It is believed that the large masses determined for early type contact systems may be not reliable or quite wrong due to misleading photometric solution mass ratios. Of course this includes some of my old published papers as well. The appearance of continuous light variation of their light curves resembles a system with contact configuration. In general, the temperature difference between the components is relatively well determined from the differential depths of the eclipses. Most of these systems have large temperature differences. In mode 3 (most popular) contact configuration of W-D method automatically ends up with a very large temperature discontinuity at the interface. Even though some of our (with D. Q. Zhou of Peking University) model calculations on circulation in contact atmosphere did arrive at stable flow. (The mathematics just becomes too difficult to handle.) One can easily argue that such temperature discontinuity in a system cannot be stable. If one utilizes the mode 1 configuration of the W-D method, there would not be a temperature discontinuity at the interface but then the temperature difference derived would not agree with the differential depths of eclipses. The key problem comes from the fact that there is only very slight difference in the shape of the light curves between a contact system and a very close semidetached system. Essentially there is no inflection point in the contact light curve while there is a slight inflection point for the latter. Since we are dealing with O and early B stars there are serious stellar winds and wind-wind interaction to be considered. These could well smooth out the slight inflection point of a semidetacted light curve so as to mimic a contact light curve. It is suspected that this misleading configuration led to the wrong mass ratio and in turn resulted in very large masses. Therefore one should not trust the automatically arrived contact solution for these systems. One should limit the solution to semidetacted configure (mode 3 or 4 of the W-D method) for those systems. Therefore it is recommended that the observations of these systems should be re-analyzed. Since most of these system are single-line binaries one might be able to obtain more reasonable masses with reliable photometric mass ratios.

Optical Spectra of Ultra-Compact X-ray Binaries

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We present optical spectroscopy of several (candidate) ultra-compact X-ray binaries (UCXBs) obtained with the ESO VLT and Gemini-North telescopes. In only one of five observed UCXB candidates did we we find evidence for H in its spectrum (4U 1556−60). We find some spectra consistent with C/O discs and one consistent with a He/N accretion disc. We discuss the implications of our findings for our understanding of the formation of UCXBs and the Galactic population of UCXBs. At the moment all studied systems are consistent with having white dwarf donors, the majority being C/O rich.

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Eclipsing Binaries in Multiple Systems

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To undertake dynamical studies on stellar triple systems and to test stellar models for subsolar mass stars, a photometric and spectroscopic observational campaign of newly discovered HIPPARCOS eclipsing binaries has been realized since 1997 through a collaborative international effort.

The radial velocity measurements were carried out, from 1997 to 2005, at the Haute-Provence Observatory, France, with CORAVEL and ELODIE spectrographs. The photometric observations started through a collaborative international effort at various observatories: Cracow, Poland; Krioneri, Greece; and more recently Lvov, Ukraine and AUG and TUG, Turkey.

Starting with a sample of 50 candidate objects, we retained at the end 36 systems, including 24 new double-lined eclipsing binaries.

We found seven objects to be new spectroscopic triple systems and confirmed the presence of the spectroscopically visible third body in the next three other systems.

Two triple systems, CU Cam and CN Lyn show evident long-period variations of the third body radial velocity as well as changes of the center-of-mass velocity of eclipsing system (Table 1).

Table 1 : Orbital Elements of the CU Cam and CN Lyn Systems.

Name Comp	P	T_0(JD)	e	ω	V_0	K	q/f(m)	asini	$Msin^3i$	σ
	days	+2450000		^{o}	km s^{-1}	km s^{-1}	$M_\odot$	Gm	$M_\odot$	km s^{-1}
CU Cam long-period orbit										
A	2478	1711	0.0	-	-19.62	6.33	0.45	216	1.52	0.89
	±39	±30				±.26	±.07	±14	±.35	
B						14.14		482	0.68	0.58
						±1.9		±64	±.14	
CU Cam short-period orbit										
Aa	3.363767	2820.770	0.0	-	var	59.08	0.0719	2.733		0.53
	-	±.002				±.17	±.0006	±.008		
CN Lyn long-period orbit										
A	1625	1908	0.59	318.8	-16.38	3.98	0.491	71.57	0.10	-
	±35	±13	±.04	±2.5	±.08	±.17	±0.10	±4.3	±.01	
B						8.10		146	0.051	0.29
						±.19		±7	±.005	
CN Lyn short-period orbit										
Aa	1.955505	2308.110	0.0	-	var	111.40	0.985	2.996	1.155	0.78
	±.000006	±.001				±.21	±.003	±.006	±.004	
Ab						113.12		3.042	1.138	0.90
						±.21		±.006	±.004	

We present and discuss the results from short and long-period orbital solutions for these two triple systems.

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Orbit and Estimations of Masses of Components of ADS 14636 (61 Cygni) on the Basis of Photographic Observations at Pulkovo Observatory

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An investigation of the wide double star 61 Cyg was fulfilled by means of long-term series (40 years) of photographic observations of 26in refractor of Pulkovo observatory. The purposes of the investigation are

(*a*) determination of the pair's orbit and masses of its components, and
(*b*) detection of possible invisible satellites.

The two more long-term series of wide double stars – ADS 7251 (38 yr.) and ADS 14710 (23 yr.) – were used for control. Obtained photo-plates were measured by means of the automatic measurement machine "Fantazia" at Pulkovo Observatory.

Relative positions (distances between components and positional angles) were calculated for all pairs. The relative orbit of 61 Cyg was constructed and total mass of the pair was calculated by means of the Apparent Motion Parameters Method developed at Pulkovo Observatory.

These series were investigated by means of Scargle's and CLEAN methods to detect periodic deviations in orbital motion. The distant star ADS 14710 (π=0.0016) was used as a control star. Two peaks were detected in periodogram of X projection of components relative motion of 61 Cyg only. They correspond to periods of 6.4 and 11.2 years.

Investigation of the separate motion of each component of 61 Cyg relative to surrounded stars followed. The mass ratios and hence individual masses of its components were calculated. They are 0.74 ± 0.13 and $0.46 \pm 0.07 M_{\odot}$ for primary and secondary components respectively.

There is a small peak on periodogram of X projection of separate motion of 61 Cyg A. It corresponds to period of 6.2 years. We suppose that invisible satellites may be in 61 Cyg's system, but their mass does not exceed $0.01 M_{\odot}$.

Photometric Investigation of the Near-Contact Binary FR Ori

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An analysis of UBV photoelectric photometry for the eclipsing near-contact binary FR Ori using new observational data is presented. During four observational seasons 106.4 hours of observations were secured over 23 observational nights. The four new times of minima of the system FR Ori were determined from this photometric data. The analysis of the (O-C) diagram using method of weighted linear regression allowed us to state a new value of the orbital period of 0.883162859 day, and to construct new ephemerides for this eclipsing system. Detailed statistical analysis does not confirm the presence of intrinsic activity in this binary. The analysis of U, B and V light curves gave the geometrical and physical parameters of the system.

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Radial-Velocity Analysis of the Post-AGB Star, HD 101584

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This project concerns the analysis of the periodicity of the radial velocity of the peculiar emission-line supergiant star HD 101584 (F0 Ia), and also we propose a physical model to account for the observations.

From its peculiarities, HD 101584 is a star that is in the post-AGB phase. This study is considered as a key to clarify the multiple aspects related with the evolution of the circum-stellar layer associated with this star's last phase. The star shows many lines with P Cygni profiles, including Hα, Na D lines in the IR Ca triplet, indicating a mass outflow.

For HD 101584 we have performed a detailed study of its radial-velocity variations, using both emission and absorption lines over a wide range of wavelength. We have analyzed the variability and found a periodicity for all types of lines of 144 days, which must arise from the star's membership in a binary system. The data span a period of five consecutive years and were obtained using the 1-m telescope of Mt. John Observatory, in New Zealand, with the echelle and Hercules high resolution spectrographs and CCD camera.

HD 101584 is known to be an IRAS source, and our model suggests it is a proto-planetary nebula, probably with a bipolar outflow and surrounded by a dusty disk as part of a binary system. We have found no evidence for HD 101584 to contain a B9 star as found by Bakker *et al.* (1996). A low resolution IUE spectrum shows the absence of any strong UV continuum that would be expected for a B star to be in this system.

The BVRI Light Curves and Period Analysis of the Beta Lyrae System XX Leonis

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The contact eclipsing binary system XX Leonis (P = 0.97 days, sp A8) has been analysed using the PHOEBE programme, based on the Wilson-Devinney code. The *BVRI* light curves were obtained during spring 2006 using the 20-cm telescope and ST-7 CCD detector. The effective temperature of the primary component determined from the photometric analysis is T = (7889±61) K, the inclination of the orbit is i = (89.98±2.45) deg and the photometric mass ratio q = (0.41±0.01). Also the third body hypothesis was suggested, based on the period analysis using 57 minimum times and resulting the period of the third body p_3 = (52.96±0.01) yr, amplitude A = (0.057±0.029) d, and eccentricity e = (0.79±0.08), which gives the minimum mass $M_{3,\min}$ = (3.6±0.8) $M_\odot$.

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Photometric Study of the Short-Period W UMa System FZ Orionis

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W Ursae Majoris (W UMa) variables are the most extreme examples of tidally distorted stars in contact binaries in which both components fills or overfills their inner Lagrangian zero-velocity surfaces, known as Roche lobes. FZ Orionis, one of the prototypes of W UMa variables, is studied. Photoelectric B and V observations of this eclipsing binary system obtained from the Japal-Rangapur Observatory show period changes indicating cyclic process of mass transfer and mass loss from the system. The light curves are analyzed using the Wilson-Devinney method and the system parameters are derived. The evolutionary status of the system is discussed.

Photometric Analysis of the Eclipsing Binary DE Canis Venatici (RX J1326.9+4532)

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White dwarfs and red dwarfs represent two different evolutionary stages of low-mass stars. In our Galaxy, the low-mass stars form the most numerous group of objects. For members of binary systems among them, one can derive their physical parameters like mass and radius. In addition, they include valuable information about the mass distribution of our galaxy. Different evolution phases of the binary stars consisting of white dwarfs and red dwarfs are very important for the astronomy because they allow us to test the theories of the stellar evolution. In this study, a literature survey about the structure and evolution of these systems is done and theoretical and observational results for DE CVn are presented. After obtaining new light curves, we derived the geometrical and physical parameters of the eclipsing binary DE CVn, consisting of a white dwarf and a red dwarf. We also discuss the problems of both DE CVn and related systems. DE CVn was observed with 3 different telescopes and 2 different receivers through the Johnson B, V, R filters in 2002-2003. Since the clearest variations were seen in the B filter, the B light curve was analysed using the Wilson-Devinney method with Mode 2 designed to solve detached binaries. The mass ratio q=1.1 was found. The visual magnitude of the white dwarf is 13.04 mag. in 0.0 phase and orbital period of the system is 0.364077 days. The DE CVn system consists of a DA-DB white dwarf (He-WDs) and a M1-M2 red dwarf according to our solution. The system conforms to the classical cataclysmic-variable definitions, but the P-M and P-R relation of cataclysmic variables which results from the light curve differs from that obtained from Patterson's P-T relation (1984). The latter indicates a different spectral class for the red dwarf. It is not well known whether the second companion of the system is in post-evolution phase or is not conformed to standard ZAMS M-R relation.

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Parameters of the Two Helium-Rich Subdwarfs in the Short-Period Binary PG1544+488

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Helium-rich subdwarf B (He-sdB) stars form a small group of chemically peculiar, early-type, low-mass stellar remnants. They are thought to be formed either as a result of mergers of white dwarfs or by convective mixing of a helium white dwarf envelope after a late helium flash. PG1544+488 is the prototype of the He-sdB stars. It was serendipitously found to be a short-period binary ($P \sim 0.5$ day) comprising two helium-rich subdwarfs. Here we report physical parameters and orbital solution for the two helium-rich subdwarfs in PG1544+488 from optical spectra obtained over a period of three years. The physical parameters – effective temperature ($T_{\rm eff}$), surface gravity ($\log g$) and helium abundances by number ($n_{\rm He}$) – for both subdwarfs were measured by fitting the observed spectra with LTE models using a χ^2 minimization procedure. The orbital solutions were obtained using radial velocities measured from the optical spectra. We also briefly discuss the implications of the discovery that PG1544+488 is a binary on our current understanding of the evolution of helium-rich subdwarf B stars and the possibility of a third formation channel for these stars involving a common-envelope in a close binary.

This research is supported by the UK Particle Physics and Astronomy Research Council through grants PPA/G/S/2002/00546 and PPA/G/O/2003/00044 and by the Northern Ireland Department of Culture, Arts and Leisure (DCAL).

The Mass Excess in the Systems of Wide Visual Double Stars on the Basis of Apparent Motion Parameters Method, Hipparcos Parallax and WDS Data

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The formula for determination of the minimal value of the total mass of visual double star components is derived on the basis of the Apparent Motion Parameters method. To apply this formula, the trigonometric parallax p_t and the apparent motion parameters (distance ρ, position angle θ, apparent relative velocity μ and its direction ψ at a fixed epoch T_0, and also ρ_c – the radius of curvature of the observed short arc of the apparent motion near T_0) are to be known. We assume that Hipparcos parallax is determined with good precision. We selected 129 wide pairs ($\rho > 2''$, $p_{\rm t} > 0''.01$, observed arc is enough for $\rho_{\rm c}$ determination) from the WDS catalog for investigation. We conclude that for 13 stars the value of minimal mass $M_{\rm min}$ is more than may be expected from mass luminosity relation $M_{\rm SP-L}$. Possible explanations include invisible satellites or some peculiarities.

(a) Component separation is more than $2''$.
(b) Parallax from Hipparcos catalogue is more than $0''.01$.
(c) Observations cover the arc of about 10° to 30° so that at least the orbit curvature can be determined, although the orbit elements and masses can not be determined.

We discovered several stars for which the minimum mass is essentially more than the value determined on the basis of the mass-luminosity relation.

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Properties of the Cyg X-1 Optical Component

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We report the results of V1357 Cyg optical spectral observations carried on through 2003-2004. The comparison of observed and non-LTE model HI, HeI and MgII profiles is given. Tidal distortion of the Cyg X-1 optical component and its illumination by X-ray radiation of secondary one are taken into account. We set restrictions on the optical component main characteristics: $T_{\rm eff} = 30400 \pm 500$ K, $log\, g = 3.31 \pm 0.07$, and overabundance of He and Mg: [He/H] = 0.43 ± 0.06 dex, [Mg/H] = 0.4–0.6 dex. We also found overabundances of C, N, O, Al, Si, S, Fe and Zn in respect to solar abundance.

The chemical composition points to:

- a metallicity ([Fe/H] =0.34 dex) typical for young stars;
- affected by matter transformation in the reactions of CNO cycle at the main sequence stage ([N/C] = [N/O] = 0.7 dex);
- and by light elements burning ([Ne/H] = [Si/H] = 0.7 dex).

The work is partially supported by RFBR grant 04-02-16924.

The Double-Lined Spectroscopic Binary θ^1 Ori E: An Intermediate-Mass, Pre-Main Sequence System

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Theta[1] Ori E = ADS 4186 E = NSV 2291, the fifth brightest star in the Orion Trapezium, was reported to be a double-lined spectroscopic binary by Costero *et al.* 2006 (IAUC 8669). In this paper we present the derived orbital elements of the binary system and physical parameters of its members. The velocity curve of each component was derived from 61 echelle spectra in which the absorption systems are not blended. The radial velocities were obtained by cross-correlating these spectra with those of two reference stars with well-measured radial velocities, in the 5120 – 5515 Å spectral range.

The binary components are nearly identical, their composite spectral type being around G0IV. The Li I 6708Å absorption line is strong and the Ca II K line is in emission in both stars, indicative of their pre-main sequence evolutionary stage. The orbit is circular ($e < 10^{-3}$). The orbital period and systemic velocity are 9.896 ± 0.001 d and 32.4 ± 1.0 km/s. The semi-amplitude of both components is 85.7 ± 3.0 km/s.

From the published K magnitude for the object and a suitable pre-main sequence stellar evolution model, we find the bolometric luminosity, radius and mass of each component to be, respectively, 89, 8.4 and 4.0 (in solar units), if the stars are identical to each other. Based on the latter values, the orbital inclination is about 59°, while the minimum inclination for grazing eclipses to occur is 65°. Hence, no observable eclipses in this binary are expected.

An Astrometric Study of the Triple System ADS 9173

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The preliminary orbit of the wide pair ADS 9173 A-Bb is obtained by the Apparent Motion Parameters (AMP) method on the basis of Pulkovo 26-inch refractor uniform observations from 1982–2004, plus observations from the WDS catalog covering the period 1832–1980 and Hipparcos parallax. The spectroscopic orbit B-b is supplied by the elements i and Ω on the basis of deviations relative to the A-Bb orbit. The planes of the orbits are close to coplanarity. Pulkovo observations indicate perturbations with a period of more than 13 years. Probably the component A is also an astrometric binary.

The First Photometric Analysis of the Near-Contact Binary V370 Cygni

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The first complete CCD light curves of the near-contact eclipsing binary system V370 Cygni with an A0 primary have been obtained in the B, V, R and I filters during 5 consecutive nights in 2005 with the 122-cm telescope at the Kryoneri Station of the National Observatory of Athens. The light curves are analyzed with the PHOEBE version of the W-D program in order to determine the geometrical and physical parameters of the system. These parameters are used together with the available spectroscopic data to compute the absolute elements of the system in order to estimate its evolutionary status.

The Multiple System SZ Cam

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The multiple hierarchical system SZ Cam is one of the brightest members of the open cluster NGC 1502 and is the B component of visual double ADS 2984. It is composed of four components forming an SB2 eclipsing binary which is physically bound to an SB1 binary pair.

The system is solved using the method of spectra disentrangling. Hα line profiles of three components are obtained and spectroscopic orbit elements are redetermined.

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The Orbit of the Visual Binary ADS 8630

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We present a new orbit for the visual binary ADS 8630 = WDS12417-0127 = γ Vir. A series of new relative measurements, using the PISCO instrument on the 102-cm Zeiss telescope at Brera-Merate Observatory in speckle imaging mode, has been made. The PISCO observations cover an arc of 130 degrees and include the periastron passage of 2005. We discuss the possibility of a third body in the system.

The Remarkable Eclipsing Binary TW Draconis

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We analyzed new photometry of this well-known Algol-like eclipsing binary together with old photoelectric measurements, with the aim of better understanding of its orbital period changes and short-time light variations modulating the mean light curve. The analysis has been done by a new method based on the principal component analysis and robust regression. New spectroscopic observations and radial velocity curve are also presented, as well as the solution of the light curve of the system.

The Orbit of T Tauri South

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We report on previously unpublished diffraction-limited NIR observations of the young binary star T Tauri South. Orbital elements have been estimated by a least-squares fit to the relative positions. Although the parameters are not well constrained by the observations, we can derive a minimum system mass of about $3\,M_{\odot}$.

With the most recent astrometric measurements by Duchêne *et al.* (2006, A&A, astro-ph/0608018), hyperbolic (unbound) orbits can be excluded with high confidence. We conclude that T Tauri Sb is *not* in the process of being ejected from the system.

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U.S. Naval Observatory Double Star CD 2006.5

B.D. Mason and W.I. Hartkopf

U.S. Naval Observatory, Washington, DC, United States

The U.S. Naval Observatory has produced its second CDROM of double star catalogs. This successor to the 2001.0 CDROM includes the latest versions (30 June 2006) of four major double star catalogs maintained at the USNO:

- *Washington Double Star Catalog* (WDS),
- *Second Photometric Magnitude Difference Catalog*,
- *Fourth Catalog of Interferometric Measurements of Binary Stars*, and
- *Sixth Catalog of Orbits of Visual Binary Stars*.

Each of these catalogs had seen significant changes during the past six years; for example, the WDS has grown by over 150,000 measures and the number of systems in the Interferometric Catalog has nearly doubled. Other improvements include precise coordinates for the vast majority of systems, as well as new observing lists for tens of thousands of "neglected" doubles.

Also included on this CDROM is a *Catalog of Linear Elements* for several hundred optical pairs. These elements should prove useful for improving the components' proper motions, as well as providing scale calibration out to several tens of arcseconds.

As was done with its predecessor, the new CDROM will automatically be distributed free of charge to members of the double star community and to astronomy libraries. Others may receive a complementary copy upon request.

The Orbit and Properties of the Massive X-Ray Binary BD+60 73 = IGR J00370+6122

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Spectrograms of the blue and Hα regions of BD+60 73 obtained with the Cassegrain spectrograph on the David Dunlap Observatory 1.88-m telescope have been measured for radial velocities. These measures confirm that BD+60 73 is a single-line spectroscopic binary with the same period, 15.665 d, as the X-ray flux variations of IGR J00370+6122. The X-ray maxima occur at or just after the time of periastron passage. The orbital eccentricity, $e = 0.37$, and small $a \sin i$ are consistent with earlier suggestions that the X-ray flux variations are due to variations in the distance of the compact object from BD+60 73. Since $a \sin i$ is much less than the expected radius for a giant star, the orbital inclination must be low. Unless the optical companion has an unusually low mass for its spectral type, it seems more likely that the companion is a black hole rather than a neutron star, but this can only be resolved by further work on the properties of BD+60 73, since there are conflicting spectral classifications in the literature. The Hα line shows weak, variable emission, but we have insufficient data to test whether these variations are correlated with orbital phase. We note, as have other authors, that BD+60 73 is projected on the sky within the bounds of Cas OB5. However, the binary system has a radial velocity of approximately -40 km s^{-1} with respect to Cas OB5.

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