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Poster Abstracts (Session 4)

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CCD Astrometry and Photometry of Visual Double Stars VI. Northern Hipparcos Wide Pairs Measured in the Years 2003–2005

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The relative positions of the Hipparcos visual double star components are currently known with a precision around fifty mas. Modern CCD astrometric observations of these objects achieve an accuracy of their angular separation between 10 and 20 mas per observation. New CCD measurements have been obtained at Kryonerion Observatory in the north hemisphere. They provide current relative positions of visual double stars, which are at least twice as accurate as the ones provided by Hipparcos. The new measurements will permit us to extract the physical pairs from the sample, and the double stars, which have components of common origin. Final statistics of these systems will improve our understanding of stellar formation and evolution rates, of wide binaries in the solar neighborhood.

Eclipsing Binaries In Open Clusters

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Detached eclipsing binary stars are of fundamental importance in providing constraints on theoretical stellar models and the physics they contain. They have been used to calibrate theoretical models and to constrain the amount of convective core overshooting and mixing length used by the models. However, a major limitation in this work is that the age and chemical composition are not in general known for each eclipsing binary, allowing these quantities to be freely adjusted when comparing to theoretical models. I describe an observational program to study eclipsing binaries in a sample open clusters with a range of ages and chemical compositions. In this situation, theoretical predictions are required to simultaneously match the masses, radii and luminosities of the two eclipsing stars and the radiative properties of all the other stars in the cluster. These more detailed constraints mean that subtle physical phenomena, such as convective overshooting and mixing length, can be disentangled from the effects of age and metallicity. I present newly acquired light curves for several eclipsing binaries in the young open cluster NGC 7128. This will uniquely allow mass-radius and mass-luminosity plots to be constructed which contain many stars with the same age and metallicity but a wide range of masses. In addition, the age, chemical composition and distance of NGC 7128 can be obtained

without the complications inherent in the comparison of theoretical isochrones to the cluster main sequence in colour-magnitude diagrams.

A Hundred New Preliminary Orbits and Masses from Hipparcos, Ground-based Astrometry and Radial Velocities

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Stellar pairs with large magnitude difference and period of several decades are hard to investigate by spectroscopic, interferometric and visual methods. A combination of Hipparcos and ground-based astrometry (see Gontcharov & Kiyaeva, 2002 A&A, 391, 647) can help to derive orbits and masses for such astrometric binaries. A direct combination of the Hipparcos/Tycho data with 400 astrometric ground-based catalogues of the 20^{th} century (including all ground-based catalogues used for Tycho-2) reduced to the ICRF/Hipparcos system is used to detect the variations of transversal velocity with median precision of 1 mas/year, which corresponds to 0.5 km/s at 100 pc. The radial velocity variations are detected with a median precision of 0.7 km/s as a by-product of a new compilation of 500 sources of precise radial velocities (including WEB, Barbier-Brossat and Figon, Geneva-Copenhagen survey (2004 A&A, 418, 989) and CORAVEL K-M giants (2005 A&A, 430, 165)) reduced to a common new standard of 837 stars, the Pulkovo RAdial VELOcities catalogue of 35000 stars (PRAVELO, `www.geocities.com/orionspiral`). Similar precision allows us to use transversal and radial velocities together. However, the data are still rather heterogeneous and have small S/N ratio mainly because the accuracy of observations improved with time. Therefore, least square solution uncertainties show several minima. A new approach is developed to solve it. As a first result, preliminary orbits and component masses are calculated for 100 astrometric binaries with no previous orbit calculation and 20 binaries with known visual or spectroscopic orbit. Many new orbital pairs appear to be A, F, G stars with white dwarfs. The duplicity/multiplicity of many famous stars is discussed in detail, such as Polaris, Mizar and Arcturus.

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Procedure for the Classification of Eclipsing Binaries

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In this work we present a procedure for the automatic classification of eclipsing binaries. The procedure is based on the data from a new catalogue of 6330 eclipsing variable stars, compiled by the authors and representing the largest list of eclipsing binaries classified from observations. The procedure allows the classification of a given system basing on a set of observational parameters even if the set is incomplete. Results of an application of the procedure to a test sample of 1029 classified systems and to a sample of 5301 unclassified systems are discussed. The classified eclipsing binaries will be used for determination of astrophysical parameters of their components.

Frontiers of Transient Phenomena in X-ray Binaries and Cataclysmic Variables Investigated by a High-speed CCD Camera and an Automated Monitor Telescope

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We are developing two new systems of a high-speed CCD camera, and an automated monitor telescope. This camera using a frame transfer-type CCD enables us to take images each 27.3 msec at the highest speed. We try to investigate accretion and eruption phenomena around compact stars by optical light. The automated monitor system of X-ray binaries and cataclysmic variables we are developing is a small system of a 30-cm reflector, a CCD camera, and a computer. It is a cheap system, but can monitor more than 150 systems each night. It will reveal long-term light curve of programmed stars of those transient systems, and catch sudden outbursts/decays. We will be able to start follow-up observations best to clarify the mechanism of these activities, as early as possible.

We here report the current status of these projects, the target physics, and the future development.

Search for Binary Systems from the SDSS

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Some cool stars exhibiting a strong Hα emission line in their spectra are actually binary systems with an undiscovered component such as RS CVn types, AM Hers, symbiotic systems and so forth. We therefore have searched candidates of binary systems from the *Sloan Digital Sky Survey Fourth Data Release* (SDSS DR4) for the spectra showing strong Balmer emission lines in late-type stars cooler than K spectral type. These categoric stars include such as M, L, and cool C-types having a low effective temperature ($<$3,500 K), hence, in general, exhibiting absorption features of Balmer series. Of 23,936 sample classified as late-type in the SDSS DR4, we selected 312 stars satisfying our constraints on the flux of Hα emission line in the continuum removed spectra, greater than 20 times level compared with continuum removed one. By hand inspection of those spectra, we find four candidates of binary systems, presumably all cataclysmic variables: SDSS J012018.49$-$102536.1, J133336.22+491157.7, J152831.00+380305.8, and J215101.33+123739.9 including two previously identified ones. In order to confirm these objects as binary systems and to determine their variable types, we are planning to perform follow-up observations.

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Gaia Treatment of Astrometric Binaries with a Variable Component: VIM, VIMA, VIMO

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Gaia is an ESA project that will conduct a census of one thousand million stars in our Galaxy. Each target star will receive about 100 1-D high-precision astrometric measurements over a five-year period. The magnitude of the stars will be accurately estimated in the same time.

Among the huge quantity of stars observed by Gaia, some will be unresolved binaries hosting a photometric variable; since the astrometric abscissa and the total luminosity of these stars will be recorded simultaneously, three distinct models will be considered to describe these observations:

(a) the VIM model (VIM=Variability Induced Movers), is dedicated to binaries with components having fixed relative positions;
(b) the VIMA model introduces acceleration terms in order to describe a short part of an orbit;
(c) the VIMO model is used to derive the orbital parameters of binaries with orbital period up to about 10 years.

The VIM model was already used in the Hipparcos data reduction. Each astrometric measurement is fitted with a linear function of the parameters of the stars, and their derivation is therefore straightforward.

The VIMA model is more complicated. It includes a parameter $h = ((1+q)/q)10^{-0.4\mathrm{mC}}$, which is a function of the mass ratio of the system and of the magnitude of the non-variable component. When "h" is fixed, the model remains linear.

The VIMO model is still more complicated, since, additionally to h, it is necessary to fix P, e, T_0 and ω to obtain a linear system.

A method of computation was tried with simulated data, and its results look fairly good.

In conclusion, unresolved binaries with a variable component will receive accurate astrometric parameters in the final Gaia catalogue, and other properties of these systems will still be derived with the software that we are preparing.

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Using MECI to Mine Eclipsing Binaries from Photometric Exoplanet Surveys

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We describe the Method for Eclipsing Component Identification (MECI), which is an automated method for assigning the most likely absolute physical parameters to the components of an eclipsing binary. MECI is unique in that it requires only the photometric light curve and combined color of the eclipsing binaries. We have implemented this method using published theoretical isochrones and limb-darkening coefficients, and publicly released its source code. MECI lends itself to creating large catalogues through the systematic analyses of datasets consisting of photometric time series, such as those produced by OGLE, MACHO, HAT, and many others surveys. We will be presenting results of data mining the Trans-Atlantic Exoplanet Survey (TrES). This sort of mining technique may be used for both characterizing stellar populations and for discovering rare and interesting binary systems. Of particular interest are the lower main-sequence stars, for which models underestimate their sizes by as much as 20%. Progress in this area has been hampered by the small number of suitable M-dwarf binary systems with accurately determined stellar properties. Finding additional systems by mining Exoplanet Surveys may provide significant benefits for our understanding of such low-mass stars.

WIRE Satellite Light Curves of Bright Eclipsing Binary Stars

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We are undertaking a project to obtain extensive high-precision photometry of bright eclipsing binary stars using the star tracker aboard the WIRE satellite. Our immediate aim is to measure the masses and radii of our target systems to the highest possible accuracy.

The resulting physical properties will be excellent tests and calibrators of theoretical models, in particular because several of our targets have very low mass ratios. These data will also allow us to investigate the reliability of eclipsing binary light curve models and limb darkening coefficients, to see just how far such analyses can be pushed. We present a 29-day light curve (sampling rate 15 seconds, with coverage of 30% of each 90-minute Earth orbit of the satellite) of the totally-eclipsing binary ψ Centauri with point-to-point scatter of only 2 mmag.

We measure the relative radii of the stars to a precision of 0.2% (random error) from these data, and also find clear evidence for g-mode pulsations in the primary star with amplitudes of only 0.2 mmag. We have also obtained a 25-day light curve of AR Cassiopeiae which will allow us to accurately measure its apsidal motion and the relative radii of the components. In addition to six modulation at the rotational period of the primary star, and several oscillation modes with periods in the range 1–2 days.

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