// COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

ROSAT All-sky Survey of W Ursae Majoris Stars and the Problem of Supersaturation

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From ROSAT all-sky survey (RASS) data we obtained X-ray fluxes for 57 W UMa type contact systems. In our sample we detected three stars which are the shortest period main sequence binaries ever found as X-ray sources. For sample stars with $(B-V)_0 < 0.6$ the normalized X-ray flux decreases with a decreasing color index but for $(B-V)_0 > 0.6$ a plateau is reached, similar to the saturation level observed for single, rapidly rotating stars. The X-ray flux of W UMa stars is about 4-5 times weaker than that of the fastest rotating single stars. Because early type, low activity variables have longer periods, an apparent period-activity relation is seen among our sample stars, while cool stars with $(B-V)_0 > 0.6$ and rotation periods between 0.23 and 0.45 days do not show any such relation.

The lower X-ray emission of the single, ultra fast rotators (UFRs) and W UMa stars is interpreted as the result of a decreased coronal filling factor. The physical mechanisms responsible for the decreased surface coverage differs for UFRs and W UMa systems. For UFRs we propose strong polar updrafts within a convection zone, driven by nonuniform heating from below. The updrafts should be accompanied by large scale poleward flows near the bottom of the convective layer and equatorward flows in the surface layers. The flows drag dynamo generated fields toward the poles and create a field-free equatorial region with a width depending on the stellar rotation rate. For W UMa stars we propose that a large scale horizontal flow embracing both stars will prevent the magnetic field from producing long-lived structures filled with hot X-ray emitting plasma. The decreased activity of the fastest rotating UFRs increases the angular momentum loss time scale of stars in a supersaturated state. Thus the existence of a period cutoff and a limiting mass of W UMa stars can be naturally explained.

Accepted by A & A

For preprints via WWW: http://www.astrouw.edu.pl/~kst/personal.html

The Radial Velocities of the RS CVn Star UX Ari. A Triple System With a Binary on the Same Line of Sight

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UX Ari belongs to the class of very active RS CVn stars and has recently been the target of surface (Doppler) imaging. Although this technique needs a quite accurate determination of the orbit (in order to have the correct period for phasing and the correct Doppler shift correction of the line profiles) we found only one, quite old orbit solution, which has subsequently been used by everyone.
We used published radial velocities (RVs), supplemented by a large number (124) of our own recent, high-accuracy RVs of both the primary (K0 IV) and the secondary (G5 V) to improve the orbit of UX Ari. In addition to the improved set of parameters, we found that the γ velocity of the system is systematically changing over time. It seems that UX Ari is a triple system. Actually, a third star is weakly present in the spectrum. While its RV is also changing, it is not a member of the system, but happens to be on the same line of sight.
Finally, conclusions about the physical parameters of the objects from the orbits are presented.

Accepted by A&A

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Convection in the Atmospheres and Envelopes of Turnoff and Giant Branch Stars of Globular Clusters

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We explore the dependence of T_{eff}s and colors of stellar models on the treatment of over–adiabatic convection, both in the atmosphere and in the interior. We compute main sequence, turnoff and subgiant models for low metallicity stars ($Z = 2 \times 10^{-4}$) using as boundary conditions two new sets of model atmospheres by the Wien group (Kupka 1996, Smalley & Kupka 1997, Heiter et al. 2001). In these models convection is treated either in the Mixing Length Theory (MLT) or in the Full Spectrum of Turbulence (FST) formulation.

We check the dependence of the T_{eff} location of the HR diagram both on the optical depth τ at which the atmospheric boundary conditions are fixed, and on the convective model adopted in the atmosphere and interior. Obviously, full selfconsistency of the result is obtained *only* if the treatment of convection is the same in the outer layers and in the interior. We show that it is not appropriate to use MLT convection in the atmosphere and FST in the interior; if we wish to test the effect of changing the l/H_p in the MLT, the atmospheric integration must be limited to $\tau = 1$.

We construct isochrones for ages of 10 Gyr and greater, and transform the theoretical T_{eff} and gravity values to the Johnson B and V magnitudes. The two sets of model atmospheres give small differences (up to ~ 0.03 mag) for the B-V color, a result of the different temperature stratification in the model atmosphere with FST convection treatment compared to that one based on MLT. The FST boundary conditions provide relative locations of turnoff and giant branch which differ from the MLT solutions, and are in better agreement with the HR diagram morphology of the Globular Cluster M92.

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EUVE Observations of Lambda Andromedae

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Extreme ultraviolet spectra ($\lambda\lambda$ 70−740) and light curves ($\lambda\lambda$ 75−175) of the spectroscopic binary system λ And (HD 222107), were obtained with the *Extreme Ultraviolet Explorer* satellite (EUVE) in 1997 July and August. Two flares were detected during the observations which spanned 15 days, or almost three-quarters of the orbital period of 20.5 days, with a total exposure time of 283 ks. The emission measure distribution (EMD) of λ And derived from a line-based analysis, shows an increasing slope with temperature at log T_e(K)=6.5–7.3 as well as a remarkable narrow enhancement or "bump" around log T_e(K)=6.9. Both flaring and quiescent EUVE spectra were obtained. During the flares small changes were detected in both the general slope of the EMD and the height of the bump, but the bump remained very stable in its temperature. Electron densities of log $N_e(cm^{-3}) \sim 12.3$ are indicated at temperatures of log T_e(K)=7 using Fe XXI and Fe XXII emission features, and those densities increase to log $N_e(cm^{-3}) \sim 12.9$ during flaring episodes.

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Solar Abstracts

Ion Cyclotron Diffusion of Velocity Distributions in the Extended Solar Corona

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The Ultraviolet Coronagraph Spectrometer (UVCS) aboard the *Solar and Heliospheric Observatory* (*SOHO*) has revealed strong kinetic anisotropies and extremely large perpendicular temperatures of heavy ions in the extended solar corona. These observations have revived interest in the idea that the high-speed solar wind is heated and accelerated by the dissipation of ion cyclotron resonant Alfvén waves. This process naturally produces departures from Maxwellian and bi-Maxwellian velocity distributions. Here it is argued that these departures must be taken into account in order to understand the resonant velocity-space diffusion, the wave damping, and the formation of ultraviolet emission lines. Time-dependent ion velocity distributions are computed for a fixed spectrum of waves in a homogeneous plasma, and the moments of the distributions are compared with simple bi-Maxwellian models. The existence of a boundary, in parallel velocity space, between resonance and nonresonance produces an effective saturation of the velocity-space diffusion that bi-Maxwellian models could not predict. The damping of an input wave spectrum is computed for a coronal population of 1000 ion species with the above saturation effect included. For realistic levels of fluctuation power, it is concluded that waves propagating solely from the coronal base would not be able to heat and accelerate the ions that have been observed to exhibit strong energization, and that local wave generation is required. Ultraviolet emission line profiles are computed for the derived non-Maxwellian distributions, and possible unique identifiers of the ion cyclotron resonance mechanism are noted.

Accepted by J. Geophys. Res.

For preprints contact: scranmer@cfa.harvard.edu

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A Second Substellar Companion in the Gliese 86 System. A Brown Dwarf in an Extrasolar Planetary System

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We report observations using the ESO adaptive optics system ADONIS of the known extrasolar planetary system Gliese 86. This star has a known 4 $\mathrm{M_{Jup}} \sin i$ planet in a 15.8 day orbit and exhibits an additional, large, long-period, radial velocity drift (Queloz et al. 2000). The coronographic images reveal a faint ($J = 14.7, H = 14.4, K = 13.7$) object at a projected distance of $r = 1.''72 \pm 0.''02$ and P.A.= $119 \pm 1°$. Gliese 86 and the discovered object share the same proper motion, as confirmed by independent measurements at three different epochs indicating that this system is gravitationally bound. From the infrared colors and magnitudes we infer an approximate spectral type for Gliese 86B at the transition from L to T dwarfs, also called "early T dwarf" assuming the classification by Leggett et al. (2000). Although present brown dwarf evolutionary models do not cover the mass and age range probed by this objects, an upper limit of the mass of about $\mathrm{M_{GJ86B}} \leq 70\ \mathrm{M_{Jup}}$ can be inferred from the models by Baraffe et al. (1998). Dusty model atmospheres appear not to be compatible with the IR colors.

Accepted by A&A Letters

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For preprints via WWW: http://www.ita.uni-heidelberg.de/~ sels/GL86/gliese86.html
or http://www.tls-tautenburg.de/research/tls-research/pub2001.html

Ph.D. Thesis Abstracts

An Infrared Coronagraphic Search for Substellar Companions

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Ph.D dissertation directed by: Eric E. Becklin

Ph.D degree awarded: Feb 2001

We present the results of a survey for the direct detection of substellar companions. We have used an infrared space-based coronagraph on the Near-InfraRed Camera and Multi-Object Spectrometer (NICMOS) on the Hubble Space Telescope (HST) to observe approximately 50 single stars with a median age of 0.15 Gyr, an average distance of 30 pc, and an average H-magnitude of 7 mag. The survey included stars ranging from spectral type A through M and concentrated on the cooler, lower-mass stars where the contrast ratio in luminosity would be lower. Included in the observations were several members of the very young (10–40 Myr) TW Hydrae and Tucanae Asoociations located 50 pc from the Earth. Substellar objects are predicted to be more luminous when younger, and therefore easier to detect.

The F160W filter ($1.4 - 1.8$ μm) and the coronagraph were used to search the region 0.4"– 4" around the primary stars. Our detection limit was improved by subtracting two images from the same orbit that were both centered on the star, but had a 29.9 degree difference in telescope orientation. Using independently determined ages and distances for the primaries, we can ascertain the masses of detected secondaries from their infrared magnitudes and theoretical evolutionary tracks. The lower mass limit of a detectable companion depends on the brightness and age of the target star as well as the angular separation between star and companion. For the median age of 0.15 Gyr, we were able to detect a 30 $M_{Jupiter}$ companion at separations between 15 and 200 AU. A 5 $M_{Jupiter}$ high mass planet could have been detected at 30 AU around 36% of our primaries. For several of our targets that were less than 30 Myr old, the lower mass limit was as low as a Jupiter mass, well into the high mass planet region.

We present results that include the detection of two low-mass stellar companions, two very likely brown dwarfs (located 100 AU and 180 AU from their primaries), and one possible brown dwarf binary (located 200 AU from their primary). We add these likely substellar companions to the very few already known. Our results are consistent with a flat (α=1) mass function seen in field stars and the Pleaides. We have detected a higher substellar binary frequency than other companion searches, especially radial velocity searches that display an apparent lack of brown dwarf companions. Therefore, we suggest the distribution of orbital separations of brown dwarf companions might be distinctly different from that of stellar companions.

Thesis-related Publications: ApJ 541 390 ; ApJ 512 L69

JOB OPENING

Postdoctoral Fellowship (Stellar Oscillations)
School of Physics
Univ. of Sydney (Australia)

REF NO: A06/001263
Closing Date: 15 March 2001

Applications are invited for a postdoctoral fellow to work with Dr Tim Bedding on stellar oscillations. The project is to detect and interpret oscillations in solar-like stars using ground-based telescopes and to participate in the development of the Danish-led space telescope MONS (Measuring Oscillations in Nearby Stars).

Candidates must possess a PhD in astronomy or equivalent, show proven research ability, evidence of the potential for further development and evidence of ability to work co-operatively with others. Experience in developing and using software for reduction of astronomical data is essential.

Experience in stellar spectroscopy and/or photometry, particularly observations and analysis of stellar oscillations, is desirable, as are familiarity with IDL and expertise in time series analysis using Fourier transforms and related methods.

The position is full-time fixed term for one year, subject to the completion of a probation period for new appointees. There is the possibility of further offers of employment up to 1.5 years, subject to funding and need.

Applicants are encouraged to contact Dr Tim Bedding on (02) 9351 2680, fax (02) 9351 7726 or e-mail:

bedding@physics.usyd.edu.au

before applying.

Remuneration Package: $42,567-57,767$ p.a. (which includes a base salary Level A $35,970-48,814$ p.a., leave loading and up to 17superannuation)

Applications (five copies) should quote the reference no. (A06/001263), address the selection criteria, and include a CV, a list of publications, and the names, addresses, e-mail, fax and phone number of three confidential referees. They should be sent to:

The Personnel Officer, College of Sciences and Technology Carslaw Building (F07) The University of Sydney, NSW, 2006 AUSTRALIA

Closing Date: 15/3/2001

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Abstracts dealing with cool pre-main-sequence (PMS) stars will generally not be included in *COOLNEWS*, since they are already covered by the *Star Formation Newsletter*. Exceptions to this rule will be considered if the subject matter is truly cross-disciplinary. If you wish to submit a cross-disciplinary abstract on PMS stars, then first submit it to the *Star Formation Newsletter*. After doing so, submit the abstract to *COOLNEWS* accompanied by a short e-mail stating that it has already been submitted to the *Star Formation Newsletter*, and summarizing why it will be of interest to the cool star/solar community at large.

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