COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

Velocity Observations of Multiple Mode AGB Variable Stars

Kenneth H. Hinkle[1], Thomas Lebzelter[2], Richard R. Joyce[1], and Francis C. Fekel[3]

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Numerous infrared spectroscopic observations were obtained of nine AGB field M giants that have multiple periods of light variability. Each star has a short period of several months, which is typical of low amplitude pulsation for stars on the AGB, as well as a long period of 1–3 years, which is significantly longer than the predicted fundamental-mode pulsations for these stars. The location of these stars in the AGB period-luminosity relation is discussed. For six of the nine giants we found radial-velocity periods that confirm the long-period light variability. Although we considered the possibility that the velocity variations result from orbital motion, we conclude that the long-period velocity changes in most, if not all of the sample stars, likely result from a currently unknown type of pulsation rather than duplicity.

Accepted by AJ

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3 Ms in the Life of Beta Ceti: Sustained Flare Activity on a Clump Giant Detected by the *Extreme Ultraviolet Explorer*

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A 34 day *Extreme Ultraviolet Explorer* (*EUVE*) pointing on the "clump" giant β Ceti (HD 4128: K0 III) recorded a series of striking coronal flare events, reminiscent of a singular outburst seen previously from μ Velorum (HD 93497: G6 III + dF). The recent flaring episode contrasts with a more placid behavior in a 6 day *EUVE* observation of β Cet six years earlier. The average 70–180 Å Deep Survey count rate in the new observation is twice as high, and the 75–150 Å spectrum displays a distinct hardening. The discovery of sustained flare activity on β Cet raises the

possibility that such episodes are more common than suspected among the core helium burning giants, and sharpens the puzzle of the survival of magnetic activity beyond helium flash.

Accepted by ApJ Letters (November 2001 issue)

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For preprints via anonymous ftp: **casa.colorado.edu/pub/ayres/bet_cet.pdf**

Spectral Analysis of Water Vapour in Cool Stars

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M dwarf spectra, at wavelengths beyond 1.35 μm, are dominated by water vapour yet terrestrial water vapour makes it notoriously difficult to make accurate measurement from ground-based observations. We have used the short wavelength spectrometer on the Infrared Space Observatory at four wavelength settings to cover the 2.5–3.0 μm region for a range of M stars. The observations show a good match with previous ground-based observations and with synthetic spectra based on the Partridge & Schwenke (1997) linelist though not with the SCAN (Jorgënsen et al. 2001) line list. We used a least-squared minimisation technique to systematically find best fit parameters for the sample of stars. The temperatures that we find indicate a relatively hot temperature scale for M dwarfs. We consider that this discrepancy could be a consequence of problems with the Partridge & Schwenke linelist which leads to synthetic spectra predicting water bands which are too strong for a given temperature. Such problems need to be solved in the next generation of water vapour line lists which will extend the calculation of water vapour to higher energy levels with the good convergence necessary for reliable modelling of hot water vapour. Then water bands can assume their natural role as the primary tool for the spectroscopic analysis of M dwarfs.

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Stellar Differential Rotation from Direct Starspot Tracking

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On the Sun, the rotation periods of individual sunspots not only trace the latitude dependence of the surface rotation rate, but also provide clues as to the amount of subsurface fluid shear. In this paper we present the first measurements of stellar differential rotation made by tracking the rotation of individual starspots with sizes comparable to the largest sunspots. To achieve this we re-analyse four sequences of densely-sampled, high signal-to-noise echelle spectra of AB Doradus spanning several stellar rotations in 1996 December. Using spectral subtraction, least-squares deconvolution and matched-filter analysis, we demonstrate that it is possible to measure directly the velocity amplitudes and rotation periods of large numbers of individual starspots at low to intermediate latitude. We derive values for the equatorial rotation rate and the magnitude of the surface differential rotation, both of which are in excellent agreement with those obtained by cross-correlation of Doppler images derived a year earlier in 1995 December, and with a re-analysis of the 1996 data by the entropy-landscape method. The differences between the rotation rates of individual spots and the fitted differential rotation law are substantially greater than the observational errors. The smaller spots show a greater scatter about the mean relation than the larger ones, which suggests that buffeting by turbulent supergranular flows could be responsible.

Accepted by MNRAS

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or http://arXiv.org/abs/astro-ph/0111050

Doin' the Twist: Secular Changes in the Surface Differential Rotation on AB Doradus

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We present measurements of the rotation rates of individual starspots on the rapidly rotating young K0 dwarf AB Doradus, at six epochs between 1988 December and 1996 December. The equatorial rotation period of the star decreased from 0.5137 to 0.5129 days between 1988 December and 1992 January. It then increased steadily, attaining a value of 0.5133 days by 1996 December. The latitude dependence of the rotation rate mirrored the changes in the equatorial rotation rate. The beat period between the equatorial and polar rotation periods dropped from 140 days to 70 days initially, then rose steadily. The most rigid rotation, in 1988 December, occurred when the starspot coverage was at a maximum. The time-dependent part of the differential rotation is found to have $\Delta\Omega/\Omega \simeq 0.004$, which should alter the oblateness of the star enough to explain the period changes observed in several close binaries via the Applegate mechanism.

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Latitude Distribution of Star-spots on He 699

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In this paper, the latitude distribution of star-spots are analysed on the rapidly rotating G dwarf He 699. An image was reconstructed from data taken with the William Herschel Telescope on La Palma on 2000 October 08. The predominant magnetic field structure is a decentred polar spot at high latitude, with smaller low latitude features also present. This result was verified by independent reconstructions using even numbered and odd numbered spectra. This work confirms and extends that of Barnes et al.(2001,MNRAS,326,1057) and provides further evidence that there is a correlation between the presence of low latitude features and the amplitude of the photometric lightcurve. It is also a further step in the search for activity cycles on young G dwarfs.

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Absolute Dimensions of the M-type Eclipsing Binary YY Geminorum (Castor C): A Challenge to Evolutionary Models in the Lower Main-Sequence

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We present new spectroscopic observations of the detached late-type double-lined eclipsing binary YY Gem (P = 0.814 days), a member of the Castor sextuple system and one of the benchmarks for the comparison between observations and stellar evolution theory in the lower main-sequence. In addition, we have re-analyzed existing light curves in several passbands using modern techniques that account for the conspicuous presence of spots. This, combined with the spectroscopy, has yielded a very precise determination of the absolute dimensions of the components, which are virtually identical to each other. We obtain for the mean mass, radius, and effective temperature the values $M = 0.5992 \pm 0.0047$ $M_\odot$, $R = 0.6191 \pm 0.0057$ $R_\odot$, and $T_{\rm eff} = 3820 \pm 100$ K. Both the mass and the radius determinations are good to better than 1%, which in the case of the radius represents a fourfold improvement over previous results and significantly enhances the value of this quantity for testing the models. We discuss the importance of

systematic effects in these measurements by comparison with another high-precision determination of the mass by Ségransan et al. (2000). A re-analysis of the Hipparcos transit data for Castor AB that accounts for the relative motion of the pair in its 467 yr-period orbit has yielded an improved parallax for the system of 66.90 ± 0.63 mas. With this, we have estimated the age (∼370 Myr) and metal abundance ([Fe/H] ∼ 0.0) of YY Gem from isochrone fits to Castor A and B under the assumption of a common origin. This, along with the other physical properties, allows for an unusually stringent test of the models for low-mass stars. We have compared the observations of YY Gem with a large number of recent theoretical calculations, and we show that all models underestimate the radius by up to 20%, and most overestimate the effective temperature by 150 K or more. Both of these trends are confirmed by observations of another similar system in the Hyades cluster (V818 Tau). Consequently, theoretical ages for relatively low-mass objects such as T Tauri stars derived by placing them on the H-R diagram may be considerably biased. If the radius is used directly as a measure of evolution, ages could be underestimated by as much as a factor of 10 in this mass regime. In view of these discrepancies, absolute ages from essentially all current models for the lower main sequence must be viewed with at least some measure of skepticism. Finally, we derive a new and very accurate ephemeris based on all available times of eclipse, and we lay to rest previous claims of sudden changes in the orbital period of the binary, which we show to be spurious.

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For preprints via ftp or WWW: http://xxx.lanl.gov/abs/astro-ph/0111167

The Tidal Effects on the Lithium Abundance of Binary Systems with Giant Component

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We analyze the behavior of lithium abundance as a function of effective temperature, projected rotational velocity, orbital period and eccentricity for a sample of 68 binary systems with giant component and orbital period ranging from about 10 to 6400 days. For these binary systems the Li abundances show a gradual decrease with temperature, paralleling the well established result for single giants. We have also observed a dependence of lithium content on rotation. Binary systems with moderate to high rotation present also moderate to high Li content. This study shows also that synchronized binary systems with giant component seems to retain more of their original lithium than the unsynchronized systems. For orbital periods lower than 100 to 250 days, lithium depleted stars seems to be unusual. The suggestion is made that there is an 'inhibited zone' in which synchronized binary systems with giant component having lithium abundance lower than a threshold level should be unusual.

Accepted by A&A

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On X-ray Variability in ROSAT-PSPC Observations of F7-K2 stars

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We have analyzed the X-ray variability of dF7-dK2 stars in the solar neighborhood detected with the pointed ROSAT-PSPC observations. Our data base is the sample of all stars listed in the CNS3 catalog (Gliese & Jahreiβ 1991) having a B-V color between 0.5 and 0.9; it includes 70 pointed observations of 40 distinct stars or multiple systems. We have applied the unbinned Kolmogorov-Smirnov test on all X-ray photon time series of our sample: only 10 observations relative to 8 distinct stars are variable at a confidence level greater than 99% and 4 of them belong to multiple systems. For the subsample of 9 stars observed both at the beginning and at the end of the mission, we can study the variability on time scale of years and compare amplitude variations at short and long time scales. Our analysis suggests hat, for these stars, the X-ray variability is more likely on longer time scale. All the stars variable on long time scale, and not on short time scale, are relatively quiet and similar to the Sun, suggesting that the variations may be due to cycles. The comparison of our results with those previously obtained for dM stars shows that the amplitude of variability of

X-ray emission from dF7-dK2 stars is smaller than that observed in dM stars.

Accepted by A&A

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The Böhm – Vitense Gap: The Role of Turbulent Convection

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"Böhm–Vitense Gaps", discontinuities in the color distribution of A-F type stars along the main–sequence, have been traditionally attributed to the abrupt onset of strong convection ($8000\ K \geq T_{\rm eff} \geq 6400\ K$) in stellar atmospheres and envelopes. Using the Full Spectrum Turbulence (FST) model to describe convective transport (Canuto, Goldman & Mazzitelli), both in the interior and in the atmosphere, yields a *very sharp* transition between structures which are convective only in the surface layers, and structures which show a well developped convection also in the interior. This produces a sudden change in the $T_{\rm eff}$ of stars, around $T_{\rm eff} \simeq 6800$K. Using numerical simulations we show that this feature produces a stellar depletion which is consistent with the gap at $0.33 \leq$ B–V ≤ 0.38. The standard Mixing Length Theory does not show this behavior. Consequently, this particular gap is a '$T_{\rm eff}$' gap, and not a 'color' gap. In fact, it is also present in the V–I color distribution of the Hyades stars.

Accepted by ApJ

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Solar Abstracts

Avalanche Models for Solar Flares

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This paper is a pedagogical introduction to avalanche models of solar flares, including a comprehensive review of recent modeling efforts and directions. This class of flare model is built on a recent paradigm in statistical physics, known as self-organized criticality. The basic idea is that flares are the result of an "avalanche" of small-scale magnetic reconnection events cascading through a highly stressed coronal magnetic structure, driven to a critical state by random photospheric motions of its magnetic footpoints. Such models thus provide a natural and convenient computational framework to examine Parker's hypothesis of coronal heating by nanoflares.

Accepted by SolP [Invited Review]

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Energy Distribution of Micro-events in the Quiet Solar Corona

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Recent imaging observations of EUV line emissions have shown evidence for frequent flare-like events in a majority of the pixels in quiet regions of the solar corona. The changes in coronal emission measure indicate impulsive heating of new material to coronal temperatures. These heating or evaporation events are candidate signatures of "nanoflares" or "microflares" proposed to interpret the high temperature as well as the very existence of the corona. The energy distribution of these micro-events reported in the literature differ widely, and so do the estimates of their total energy input into the corona. Here we analyze the assumptions of the different methods, compare them by using the same data set and discuss their results.

We also estimate the different forms of energy input and output, keeping in mind that the observed brightenings are most likely secondary phenomena. A rough estimate of the energy input observed by EIT on the SoHO satellite is of the order of 10% of the total radiative output in the same region. It is considerably smaller for the two reported TRACE observations. The discrepancy can be explained by flare selection and different thresholds for flare detection. There is agreement on the slope and the absolute value of the distribution if the same methods are used and a numerical error is corrected. The extrapolation of the power law to unobserved energies that are many orders of magnitude smaller remains questionable. Nevertheless, these micro-events and unresolved smaller events are currently the best source of information on the heating process of the corona.

Accepted by ApJ

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Geometrical Effects in Avalanche Models of Solar Flares: Implications for Coronal Heating

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Observational inferences of the power-law frequency distribution of energy release by solar flares, and in particular its logarithmic slope α_E depend critically on the geometrical relationship assumed to relate the observed emitting area A and the underlying emitting volume V. Recent results on the fractal nature of avalanches in self-organized critical models for solar flares indicate that this relationship is a power-law $V \propto A^{\gamma}$ with index $\gamma = 1.41(\pm 0.04)$. We show that, when proper account is made for the fractal geometry of the flaring volume, hitherto discrepant observational inferences of α_E are brought in much closer agreement. The resulting values of α_E lie tantalizingly close, but still below the critical value $\alpha_E = 2.0$ beyond which Parker's conjecture of coronal heating by nanoflares is tenable.

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Sub-Stellar Abstracts

Evolutionary Models for Very-low-mass Stars and Brown Dwarfs with Dusty Atmospheres

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We analyse pre-Main Sequence evolutionary tracks for low mass stars with masses $m \leq 1.4\,\mathrm{M}_{\odot}$ based on the Baraffe et al. (1998) input physics. We also extend the recent Chabrier et al. (2000) evolutionary models based on dusty atmosphere to young brown dwarfs down to one mass of Jupiter. We analyse current theoretical uncertainties due to molecular line lists, convection and initial conditions. Simple tests on initial conditions show the high uncertainties of models at ages $\lesssim$ 1 Myr. We find a significant sensitivity of atmosphere profiles to the treatment of convection at low gravity and $T_{\rm eff} < 4000$ K, whereas it vanishes as gravity increases. This effect adds another source of uncertainty on evolutionary tracks at very early phases. We show that at low surface gravity (log $g \lesssim 3.5$,) the common picture of

vertical Hayashi lines with constant $T_{\rm eff}$ is oversimplified. The effect of a variation of initial deuterium abundance is studied. We compare our models with evolutionary tracks available in the literature and discuss the main differences. We finally analyse to which extent current observations of young systems provide a good test for pre-Main Sequence tracks.

Accepted by A&A

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Detection of an Extrasolar Planet Atmosphere

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We report high precision spectrophotometric observations of four planetary transits of HD 209458, in the region of the sodium resonance doublet at 589.3 nm. We find that the photometric dimming during transit in a bandpass centered on the sodium feature is deeper by $(2.32 \pm 0.57) \times 10^{-4}$ relative to simultaneous observations of the transit in adjacent bands. We interpret this additional dimming as absorption from sodium in the planetary atmosphere, as recently predicted from several theoretical modeling efforts. Our model for a cloudless planetary atmosphere with a solar abundance of sodium in atomic form predicts more sodium absorption than we observe. There are several possibilities that may account for this reduced amplitude, including reaction of atomic sodium into molecular gases and/or condensates, photoionization of sodium by the stellar flux, a low primordial abundance of sodium, or the presence of clouds high in the atmosphere.

Accepted by ApJ

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JOB OPENING

Postdoctoral Position
Marie Curie Fellowship
Osservatorio Astronomico di Palermo - Giuseppe S. Vaiana
Palermo, Italy

Closing Date: 15 January 2002

Osservatorio Astronomico di Palermo (OAPA) Giuseppe S. Vaiana expects to appoint one fellow in the area of X-ray Astrophysics under the European Commission's Marie Curie Development Host Fellowship Scheme in one of the following areas:

- Analysis and interpretation of X-ray observations. The successfull candidate is expected to partecipate to the analysis of new XMM/Newton and/or Chandra observations of star forming regions and stellar open clusters, as part of the program of the OAPA on the study of the evolution of stellar coronal emission and stellar populations.
- Low temperature spectroscopic X-ray detectors for laboratory and astrophysical plasmas The succesfull candidate is expected to participate in the development, testing and optimization of cryogenic detectors at the X-ray Astronomy Calibration and testing (XACT) facility of OAPA.

The fellowship will start before the end of July 2002.

Candidates should have a PhD in a relevant field or at least four years of full-time research experience at postgraduate level other than doctoral studies, and the ability to work in a team.

The applicant must be national of a Member State of the European Community (other than Italy) or an Associated State, or otherwise residing in the Community for at least the last five years. The fellow must be of age 35 years or less (allowance is made for time actually served in compulsory military or civil service and for childcare with a maximum of 2 years per child). Candidates should not have been resident in Italy for more than 12 months in the two years prior to selection. Gross salary, including all compulsory deductions under italian legislation, is fixed at 3813 Euro per month plus a mobility allowance for the duration of the contract, which is expected to last for 24 months. Female candidates are explicitly encouraged to apply.

Applications, including CV, publication list, description of applicant's research interests/program (all documents above should be signed by the candidate), documents certifying the doctoral degree or a four years of full time research experience and two letters of recommendations should arrive by 15 January 2002 at:

Osservatorio Astronomico di Palermo
Marie Curie Fellowship Selection
Piazza del Parlamento 1
I-90134 Palermo, Italy

For further information contact:
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JOB OPENING

Postdoctoral Position
Stellar Astrophysics
Paul Scherrer Institute, Switzerland

We invite applications for a postdoctoral research position in stellar astrophysics, starting in summer or fall 2002. This position is initially awarded for up to three years, with the possibility of extension. We are particularly looking for candidates with a background in one or more of the following fields: (i) star formation and young stars, observations and/or theory; (ii) magnetic activity/coronal physics of young and active stars (X-rays, radio); or (iii) theory of coronal plasmas. Candidates with expertise in related fields of stellar astronomy (any observational wavelength regime) are also invited to apply.

The successful candidate has a doctoral degree and will work in a joint team of astronomers from PSI and ETH Zurich. This team has a strong background and interest in high-energy astrophysics, X-ray and radio astronomy, magnetically active and young stars, plasma physics, and solar physics. The institutes are/were involved in the development of the XMM-Newton, Hessi, and Integral missions. We offer extensive collaborations within ongoing XMM-Newton guaranteed/open time and Chandra GO projects, and within our stellar VLA/VLBA/VLBI campaigns. The candidate is expected to develop further vigorous research activities. Office space and computing facilities will be provided by both PSI and ETH.

Please send CV, publication list, and a short description of research interests plans, and arrange for two letters of recommendation sent directly to us. Applications are requested by 1 February 2002 but will continue to be considered thereafter until the position is filled. For questions, please send e-mail to Dr. M. Güdel (guedel@astro.phys.ethz.ch).

Human Resources, Ref. Code 1513
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Abstract Guidelines

Abstracts for *COOLNEWS* are solicited for papers that have been recently accepted by or submitted to refereed journals, and for recent Ph.D. theses. Abstracts for conference proceedings articles are *not* posted in *COOLNEWS*. The subject matter should pertain directly to cool stars (spectral types F,G,K,M or L), substellar objects, or the sun. Both theoretical and observational abstracts are appropriate.

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.

A monthly call for abstracts will be issued and abstracts received by the last day of the month will usually appear in the following month's newsletter. Announcements of general interest to the cool star and solar communities may also be submitted for posting in the newsletter. These might include (but are not restricted to) the following: (i) *Job Openings* directed toward cool star or solar researchers, (ii) announcements of *Upcoming Meetings*, (iii) announcements of *Upcoming Observing Campaigns* for which participation is solicited from the community at large, (iv) reviews of *New Books*, and (v) *General Announcements* that provide or request research-related information. Please send all correspondence to the editor at coolnews@jila.colorado.edu. Abstract templates and back issues can be obtained from the COOLNEWS Web-page at

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