COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Stellar Abstracts

Excess Barium in a K Dwarf - White Dwarf Binary System

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We present spectroscopic evidence for an excess of the s-process element barium in the rapidly rotating K-dwarf component of the wide binary system 2RE J0357+283. The secondary star is a hot white dwarf (WD) and our result argues for a model where the K-star has accreted mass and angular momentum from the asymptotic giant branch progenitor of the WD and lends strong support to the wind-accretion hypothesis for barium giant formation. If our tentative detection of excess carbon can be confirmed, then we propose that 2RE J0357+283 is very similar to the two dwarf carbon star plus hot WD binary systems that have been found recently.

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ASCA and EUVE Observations of II Peg: Flaring and Quiescent Coronal Emission

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We have analyzed X-ray and EUV spectra of both the quiescent and flaring state of II Peg, obtained from observations with ASCA and EUVE. Coronal temperature structure and abundances have been derived from multi–temperature and differential emission measure (DEM) analyses of the spectra. The abundances are non–solar; in the case of ASCA for most elements (O, Ne, Mg, Si, S, Ar, Ca, Ni) we obtain abundances that are consistent with about 1/2–1/5 of the solar photospheric abundances of Anders and Grevesse (1989), but the Fe abundance is even lower, i.e. $0.1 \times$ solar. The multi-T and DEM fitting analysis shows that the quiescent EUVE and ASCA spectra can be described by two temperature components: 4 and 10 MK (EUVE), 10 and 20 MK (ASCA). The two flares detected by EUVE and ASCA show peak temperatures of 20 and $\gtrsim 35$ MK, respectively. The latter flare has a total energy (0.1–10 keV) of 2.7 10^{34} erg, a peak luminosity of 2.6 10^{30} erg/s and is classified as two– ribbon. There is evidence for an increase

of a factor ~ 4 of the iron abundance during the rise phase of the flare. Application of a cooling model yields a loop height of about 8 10^{10} cm and a plasma density of 8 10^{10} cm^{-3}.

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Constraints on Mass Loss from dMe Stars: Theory and Observations

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We show that the flux distribution of a wind from a cool star differs considerably from what is predicted by the theory for mass loss from hot stars. The differences are caused by the facts that 1) the mass loss rates are lower, resulting in smaller optical depths in the wind, and 2) for winds from cool stars the temperature of the wind is higher than the temperature of the star while for winds from hot stars the reverse holds. These differences result in substantial modifications of the flux distribution and imply that care must be exercised when applying the flux predictions by e.g. Wright and Barlow (1975) to winds from cool stars. By using observational constraints we show that the mass loss from cool dwarf stars equals at most 10^{-12} $M_\odot$/yr. This is a factor hundred lower than previous estimates. At this rate the mass loss from dMe stars is of little importance for the enrichment of the interstellar medium. By solving the radiative transfer equations for stellar winds from dMe stars, we show that the inferred power-law flux distributions, based on radio, *JCMT* and *IRAS* data, cannot be reconciled with the flux distributions from a stellar wind of 10^{-10} $M_\odot$/yr as was previously assumed. The maximum allowable mass loss rate is at most a few times 10^{-12} $M_\odot$/yr which implies that the fluxes observed with *JCMT*, *IRAS*, and in the future with *ISO*, require a different interpretation than free-free emission from a stellar wind.

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The Palomar/MSU Nearby Star Spectroscopic Survey II: The Southern M dwarfs and Investigation of Magnetic Activity

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Spectroscopic data for the southern stars ($\delta <$ -30°) in the PMSU survey are presented. The data were combined with the data from Paper I to obtain a list of all the magnetically active dMe stars in the survey. The incidence of activity increases monotonically toward later spectral type, reaching a level of 60% at spectral types > M5. This is not a selection effect, since the chromospheric activity level ($L_{H\alpha}/L_{bol}$) remains high throughout the spectral type range where the incidence is increasing. At very late types, there is evidence that the mean activity level drops in both chromospheric and coronal emission. The ratio between the chromospheric and coronal emission levels remains constant, indicating that the heating mechanism is not changing. There is little or no dependence of the chromospheric activity level on rotational velocity ($v\sin i$).

The color-magnitude diagrams in both M_V and M_K show strong evidence for a break between spectral types M3-M5, in both the dMe and dM stars. The dMe stars at earlier types than M3 are about 0.5 magnitudes brighter than dM stars of the same spectral type in both M_V and M_K. They also are slightly ($\lesssim$ 0.1 magnitude) redder. Both the Hyades and IC 2602 clusters show the same absolute magnitude effect for the early type dMe stars.

The Balmer decrement varies widely among the dMe field stars, in contrast to the Hyades stars. The photospheric TiO bands show detailed structure which depends on the chromospheric activity level of the star. These spectroscopic signatures will provide useful constraints on atmospheric models.

A rigorous maximum likelihood analysis of the kinematic properties of a complete subsample of the survey shows that the dMe stars are, as a whole, kinematically younger than the dM stars. Subsets of the dM sample also show that

the early type dM stars are younger than the late type dM stars, suggesting that the dMe phenomenon lasts longer in later type stars. This provides a natural explanation for the increase in the incidence of activity toward later spectral types.

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The Intrinsic Ly α to H α Ratio in M Dwarf Stars

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Using Ly α line profiles generated from a grid of M dwarf model atmospheres we calculate the attenuation factor [i.e. Ly α (obs)/ Ly α (intrin)] due to the interstellar medium as a function of hydrogen column density. Then using selected model atmospheres, attenuation factors were calculated for those M dwarfs with available Ly α observations. The prime motivation in this work has been to look afresh at the intrinsic Ly α to H α flux ratio, an important constraint in the radiative transfer modelling of M dwarfs. For those active dMe stars where both lines were observed, the intrinsic ratio is $\sim 3-5$ (with $\sim 50\%$ variation). The major uncertainty in this work has been the interstellar hydrogen column density, emphasizing the need for further work in this area and in particular an accurate model of its variation in all directions.

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Angular Size Measurements of 18 Mira Variable Stars at 2.2 μm

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We present angular size measurements of 18 oxygen-rich Mira variable stars. These data are part of a long term observational program using the Infrared Optical Telescope Array (IOTA) to characterize the observable behavior of these stars. Complementing the infrared angular size measurements, values for variable star phase, spectral type, bolometric flux and distance were established for stars in the sample; flux and distance led to values for effective temperature (T_{EFF}), and linear radius, respectively. We are able to define an effective temperature versus spectral type scale for Mira variables that we compare to the temperature scales for K and M giants and supergiants. T_{EFF}'s and linear radii for these stars are shown to lie between approximately 2100 and 3200 K, and 200 and 600 $R_\odot$, respectively. Relationships among the Mira variable parameters are explored for significant trends. Notably, the phase dependence of T_{EFF} is shown to follow simple expectations, and examination of the radius-T_{EFF} relationship yields a plausible description of the V and K band light curves of these stars. A simple examination of the oscillation mode of the stars in the sample does not strongly suggest either fundamental or first overtone oscillation as the primary mode of oscillation. This conclusion differs from that recently presented by Haniff et al. (1995), who argue that Mira variables are all first-overtone pulsators. We discuss some possible reasons for the different conclusions between the two studies.

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Library of High and Mid-resolution Spectra in the Ca II H & K, Hα, Hβ, Na I D_1, D_2, and He I D_3 Line Regions of F, G, K and M field stars

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In this work we present spectroscopic observations centered in the spectral lines most widely used as optical indicators of chromospheric activity (Hα, Hβ, Ca II H & K, and He I D_3) in a sample of F, G, K and M chromospherically inactive stars. The spectra have been obtained with the aim of providing a library of high and mid-resolution spectra to be used in the application of the spectral subtraction technique to obtain the active-chromosphere contribution to these lines in chromospherically active single and binary stars. This library can also be used for spectral classification purposes. A digital version with all the spectra is available via ftp and the World Wide Web (WWW) in both ASCII and FITS formats.

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The Relationship Between Lithium and Activity in Disk Population Main Sequence G and K Stars

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We present determinations of the lithium abundance (through observations of the Li I 6707.8 Å line) in a sample of main sequence stars with spectral types ranging from late F down to M0, selected from the sample of nearby stars which have been observed with the Einstein observatory. We show that lithium abundance is correlated with X-ray luminosity for the cooler stars in our sample ($4700 > T_{\rm eff} > 4000$), while no correlation is present for the hotter stars. However, the correlation is almost completely driven by a very small number of high lithium, high X-ray luminosity (and thus plausibly very young) cool dwarfs present in the sample. A number of high lithium K dwarfs are present in the survey, and their characteristics and likely age are discussed in detail.

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The ROSAT All-Sky Survey of Active Binary Coronae: III - Quiescent Coronal Properties For The BY Draconis-Type Binaries

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We present X-ray observations of 35 active late-type BY Draconis dwarf binary systems and 28 evolved binary systems, similar in nature to the RS Canum Venaticorum systems, obtained with the Position Sensitive Proportional Counter (PSPC) during the *ROSAT* All-Sky Survey phase of the mission. Of this sample, 52 targets were detected in exposures of roughly 600 seconds or less. When these new data are combined with the earlier results from Dempsey et al. (1993a), this survey represents the largest sample of active binary systems observed to date at any wavelength, including X-rays. We expand our investigation of how coronal properties (e.g. surface flux, luminosity, etc.) correlate with stellar parameters (e.g. rotation period, color, etc.) and confirm the conclusions of Dempsey et al. (1993a). Rotation period provides the best correlation with X-ray surface flux with $F_X \sim P_{rot}^{-0.59\pm0.10}$ for the entire sample. We find no evidence for a "basal" or nonmagnetic X-ray flux component. We model the low resolution pulse height spectra for 12 systems with two-temperature thermal plasmas. The derived temperatures for the BY Dra systems are identical to those previously derived for active evolved giants and subgiants in close binaries (Dempsey et al. 1993b). We also show that the dependance of temperature and emission measures on rotation period is the same for the dwarf, subgiant and giant binaries.

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Solar Abstracts

Fine Structure of the X-Ray and Radio Emissions of the Quiet Solar Corona

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Two deep soft X-ray exposures of a quiet region on the Sun were made with the SXT telescope on board the *Yohkoh* satellite on 20 Feb 1995. We report on the spatial X-ray fine structure. Regions of enhanced X-ray emission, more than two orders of magnitude fainter than previously reported X-ray bright points, are loosely associated with bipolar regions in the magnetic network. The power spectrum of quiet X-ray images at small spatial scales is similar to that of active regions, but exhibits a kink at a scale of $\approx 25,000$ km, possibly connected to the supergranular structure. The spatial X-ray structures in the time averaged image amount to an rms amplitude which is 6% of the mean value. The X-ray structures correlate with contemporaneous radio maps obtained by the VLA at wavelengths of 1.3, 2.0, and 3.6 cm. The amplitude of the brightness variations in the images increases with radio wavelength, i.e., with increasing height. The cross-correlation coefficient with the absolute magnetic field strength, however, generally decreases with height, consistent with the idea of bipolar regions in the network and of the magnetic field deviating from vertical in the upper chromosphere.

The X-ray observations require an enhanced pressure in the corona above the magnetic network, but suggest temperatures similar to intracellular regions. Model calculations show that, under a constant temperature, an rms density increase (relative to that in the cell interior) ranging from about 20% in the chromosphere to 60% in the low corona is sufficient to explain the observed average deviations due to the spatial structures in radio waves and soft X-rays, respectively.

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Announcements

Attention: MUSICOS Collaboration

Subject: Status and Use of ESA-MUSICOS Spectrometer at INT

Dear Colleagues:

I hope you had good holidays in all sites around the world! A copy of the MUSICOS spectrograph was integrated in the Solar System division in fall 1995, and tested in the lab at ESTEC. We brought the Dutch Sun via the fiber to the spectrometer. Solar observing, besides spectrograph performance evaluation, can serve to monitor the tiny variations due to oscillations or chromospheric activity. The ESA-MUSICOS spectrograph was then installed and commissioned successfully at the end of April 1996 on the 2.5 m Isaac Newton telescope at La Palma observatory. First light was obtained on first night. Specific MUSICOS echelle reduction routines have been developed in MIDAS and IRAF environments. Scientific results from this commissioning run include the assessment of the ESA-MUSICOS performances at INT (with R. Le Poole and H. Stempels), studies of wind and variability of hot stars (with J. de Jong), diffuse interstellar bands (with J. Cami, P. Sonnentrucker and P. Ehrenfreund), and the activity of the near break-up rotator FK Comae (with J. Oliveira and P. Gondoin). I thank C. Catala, J. Baudrand, E. Lesserteur (CNRS, F), T. Beaufort, T. Appourchaux, E. Houdebine, U. Telljohann (SO division), research students (L. Duvet, M. Gray, J. Oliveira, H. Stempels) for their contribution to the ESA-MUSICOS instrument, and the whole MUSICOS collaboration for their large instrumental, observational, data analysis and interpretation efforts. You can find by attached mail a copy of the master report written by Joana Oliveira on her research done with the ESA-MUSICOS spectrograph at INT.

We shall use the spectrograph at INT on 15-26 November as part of the next worldwide MUSICOS campaign on 15-30 November 1996 (information on MUSICOS96 homepage http://star-www.st-and.ac.uk/∼acc4/musicos96.html).

I wish also to call on you for proposing collaborative observations using the ESA-MUSICOS spectrometer at INT for 1997. UK and international deadline is end of September 1996 for applying for first semester 1997.

In addition we have also tested in June 1996 the possibility of using two transportable automatic telescopes for CCD photometry. We intend to support the MUSICOS96 campaign with these photometric observations as necessary. We have also developed a mode for remote control of the telescopes and CCD cameras.

Please contact me if you are interested by using these instruments and for further information.

Sincerely yours,

Bernard H. Foing

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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. The subject matter should pertain directly to cool stars (spectral types F,G,K, or M) or the sun. Both theoretical and observational abstracts are appropriate. Abstracts dealing with cool pre-main-sequence 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. 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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