// COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 35 — November 1998 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Deep ROSAT HRI Observations of the Pleiades

G. Micela[1], S. Sciortino[1], F. R. Harnden Jr.[2], V. Kashyap[2], R. Rosner[3], C.F. Prosser[4], F. Damiani[1], J. Stauffer[2], and J.-P. Caillault[5]

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In a deep X-ray survey of the Pleiades open cluster, we use the ROSAT High Resolution Imager to explore a region of the cluster formerly surveyed with the PSPC. These new observations substantially improve upon both the sensitivity and the spatial resolution for this region of the Pleiades, allowing us to detect 18 cluster members not detected before and 16 members not included in the catalogs used in previous surveys. The high sensitivity of the present observations permits us to obtain more stringent upper limits for 72 additional members and also provides sufficient numbers of stars to enable us to explore the dependence of L_x on stellar rotation for the slow rotators of the Pleiades. Using the new high sensitivity X-ray observations and the recent rotational measurements we discuss the activity-rotation relationship in the Pleiades solar type stars.

We also present new photometric observations of optical counterparts of a number of X-ray sources detected in previous surveys but not yet identified.

Accepted by A&A

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Evidence for Large-scale, Global Mass Inflow and Flaring on the Late-type Fast Rotator BD+22°4409

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We present new results from high-resolution spectroscopic observations of the late-type fast rotator BD+22°4409, revealing interesting aspects about its magnetic activity that have not been considered before. Analysis of the extremely variable and rotationally broadened chromospheric Hα emission profile provides clear evidence for an intense and continuous downflow of absorbing material. A high level of activity was also exhibited in the form of two consecutive flares that lasted for almost five hours. The decay of the second flare was accompanied by a dramatic absorption in the blue half of the Hα profile that is attributed to the development of cool flare loops. The observed circulation of material and the presence of magnetic loops in connection to the chromospheric flare suggest plasma is being effectively transferred between the chromosphere and corona.

As opposed to similar active and fast rotators, direct evidence of cool prominence clouds has not been found in this star. The results provide strong support for recent theoretical studies by van den Oord et al. (1997). In that work it was concluded that such prominences are only stable at some distance from the star in the equatorial plane. Unstable material would be expected to flow towards the poles along magnetic lines. The inclination of BD+22°4409, $i \simeq 50°$, favours the detection of such flow as an asymmetry in chromospheric line profiles. However, it could make clouds undetectable if they can never be seen in projection on the disk.

Accepted by A&A

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Li I Enhancement During a Long-duration Stellar Flare

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We report the possible detection of a Li I λ6708 Å line enhancement during an unusual long-duration optical flare in the recently discovered, X-ray/EUV selected, chromospherically active binary 2RE J0743+224. The Li I equivalent width (EW) variations follow the temporal evolution of the flare and large changes are observed in the intensity of the line. The maximum Li I enhancement (40% in EW) occurs just after the maximum chromospheric emission observed in the flare. A significant increase of the ^{6}Li/^{7}Li isotopic ratio is also detected. No significant simultaneous variations are detected in other photospheric lines. Neither line blends nor starspots seem to be the primary cause of the observed Li I line variation. From all this we suggest that this Li I enhancement is produced by spallation reactions during the flare.

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The Nearby Low-Mass Visual Binary Wolf 424

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We present new measurements of the relative positions of the components of the low-mass visual binary Wolf 424 (M5.5Ve) made with the Fine Guidance Sensors on the Hubble Space Telescope. Previous analyses of the astrometric orbit of this system indicated that the components have substellar masses (Heintz 1972, 1989; Schultz et al. 1998), raising considerable interest as the first candidate brown dwarfs to have their masses measured dynamically. These studies relied partly on visual and photographic measurements, which are affected by systematic errors in the angular separation and have thus biased those solutions.

Our new orbital solution using only the position angles of the early measurements together with all available modern high-resolution observations including our own shows that the component masses are clearly above the substellar limit ($M_A = 0.143 \pm 0.011$ M$_\odot$, $M_B = 0.131 \pm 0.010$ M$_\odot$), and thus they are *not* brown dwarfs. Recent evolutionary models for low-mass stars show good agreement with the location of Wolf 424 A and B in the mass-luminosity diagram in the K band.

In addition, we show that while the secondary appears to have normal colors compared to similar M dwarfs, the primary star is fainter than expected at optical wavelengths (B, V), possibly due to significant spot coverage. This is consistent with the strong flaring activity displayed by the system.

Accepted by AJ (to appear January 1999)

For preprints via ftp: ftp://cfa0.harvard.edu/outgoing/torres/w424/

EUVE Photometry of RS CVn Systems: Four Flaring Megaseconds

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We present an analysis of 12.2 Megaseconds of *Extreme Ultraviolet Explorer* (EUVE) photometry of 16 RS CVn systems (including four flaring Megaseconds). Our study attempts a systematic categorization of stellar coronal emission in RS CVn binary systems. The temporal resolution of the EUVE satellite and opportunity for long observations enables us to study separately the quiescent and flaring states of RS CVn systems. Thirty out of thirty-one observations are statistically variable. We examine light curves, characterizing both phase-dependent variations, and large- and small-scale flaring. There is evidence for small-scale stochastic variability on the one short-period ($P_{orb} < 1$ day) system in our sample (ER Vul), which we interpret as small-scale flaring. CF Tuc is the only system for which phase-dependent variations over multiple orbital periods are seen. We analyze 30 flares on 9 systems, fitting rise and decay times. Several flares have durations > 0.5 P_{orb}, and thus cannot originate from compact emission regions close to the stellar surfaces. Many flares have unusual flare morphologies, with rise times comparable to or greater than the decay time, and emission plateaus. In addition, 8 flares have decay phases which are fit better by a broken power-law than a single power-law. The decay times for the second power-law are statistically different than the single decay times, and are correlated with the flare rise times. This observed connection points to the potential importance of the change in decay rate as a means of examining the physical processes operating during the flare. The distribution of orbital phase of flare onsets on V711 Tau (HR 1099), the best studied RS CVn in our sample, is consistent with a Poisson distribution which is random in time. In two systems that are partially eclipsing (CF Tuc and ER Vul), we find no evidence for an eclipse in the light curve, indicating that the emission region is large compared to the stellar radius. We parameterize the distribution of flare energies as a power-law, finding a cut-off energy of $\approx 10^{33}$ ergs and a slope of -0.6. Flare energy increases with flare duration as E $\propto \Delta t^{1.42}$, confirming the long-duration nature of high-energy flares on RS CVn systems. The integrated flare luminosity depends on the quiescent luminosity as $L_{flare} \propto L_{quiescent}^{1.05}$. Flare frequencies range from 0.1 day^{-1} to 1.5 day^{-1}. For observations not affected by the Dead Spot on the Deep Survey detector, 40% of the observed time was spent in a flaring state, indicating that flaring is a "normal" state for the coronae of these systems. We note the presence of a quasi-periodicity in EUVE photometric data on the order of one day, which is not corrected for in the standard reduction and analysis software.

Accepted by ApJ

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Solar Abstracts

Heating Events in the Quiet Solar Corona: Multiwavelength Correlations

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Coronal, transition region and chromospheric lines and centimeter radio emission of the quiet Sun have been simultaneously observed by SoHO and the VLA. The corona above the magnetic network has a higher pressure and is more variable than above the interior of supergranular cells. The Fourier transform in time is found to have steeper spectra in the corona and upper chromosphere than in the transition region.

The temporal sequence of brightenings has been determined by cross-correlations of identical picture elements in different emissions. The method allows to study statistically the faintest fluctuations in the corona and relate them to the layers below. The cross-correlations yield that *(i)* the first emissions to peak in time are O V and He I originating in the transition region and the upper chromosphere, respectively. *(ii)* The coronal line of Fe XII lags by about 5 minutes and Fe IX/X peaks a further half a minute later in the average, latest of all emissions. The interpretation of these lags follows readily from analogy with regular flares in active regions, where O V and He I correlate closely with hard X-rays emitted by beam electrons impinging into the chromosphere. The coronal iron lines are then emitted by the evaporating plasma expanding into the corona and cooling by conducting part of the energy to increase the emission in Fe IX. *(iii)* The radio emission peaks before the coronal emission measure, similar to the Neupert effect in flares, but shows considerable variation relative to O V. It is proposed that there are two emission processes at work radiating both thermal emission and non-thermal gyrosynchrotron emission at various fluxes. These statistical results show that the coronal heating events follow the properties of regular solar flares and thus may be interpreted as microflares or nanoflares.

Accepted by A&A

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Analytical Results in a Cellular Automaton Model of Solar Flare Occurrence

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Methods of the branching theory are applied to the Macpherson–MacKinnon (1997) cellular automation model for the occurrence of solar flares. The distribution of flare energies is shown to be a power law with the slope $\alpha = 3/2$ independent of dimensionality D of the model and in nice agreement with observations, arguing in favor of the model. An expression for the upper energy cut-off and a condition for the average flare size to become infinite are derived for an arbitrary D as well, providing an opportunity for comparing the analytical and numerical results.

Accepted by A&A

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Analysis of Transition-Region Emission Line Profiles from Full-Disk Scans of the Sun using the SUMER instrument on SOHO

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We examine statistical properties of line profiles seen in full disk observations with the UV spectrograph SUMER on board SOHO. In the SUMER data archive, full disk data with complete spectral information are available only for wavelength regions including the He I (584 Å), Ne VIII (770 Å), C III (977 Å) and C IV (1548 Å) emission lines. In this

paper we will concentrate on C IV and Ne VIII. Collectively these data provide us with the unique opportunity to study the properties of line profiles in the lower and upper solar transition-region beyond what could be achieved with earlier instruments. In particular these data reveal the center-to-limb behavior of line shifts and line widths for the first time in a statistically meaningful way.

For C IV these data show the well known redshift of the transition-region lines in the quiet Sun and a clear correlation of the Doppler shift and the non-thermal broadening to the intensity as a characteristic of the network structure. This correlation is not found in the coronal holes. No indications for the network can be found in Ne VIII. For Ne VIII we find a center-to-limb variation of the line shift opposite to C IV, which leads to the conclusion that Ne VIII must be blueshifted at disk center. This also shows the need for a re-measurement of the wavelength of Ne VIII in the laboratory. The center-to-limb variation of the line width leads to the conclusion that the non-resolved motions are not isotropic with a preference for the vertical component. Both lines show a clear signal for an outflow in the polar coronal holes. We discuss the implications of these and other observations for models of the transition-region and corona. The line shift behavior of Ne VIII and other lines from the upper transition-region deserves deeper investigation and probably has pivotal importance in our understanding of the solar transition-region. We are pursuing such work.

Accepted by ApJ

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Brown Dwarf Abstracts

Discovery of a Very Low-Mass Binary with HST/NICMOS

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Hubble Space Telescope NICMOS observations are presented of six brown dwarf candidates in the Pleiades open cluster. One of them, namely CFHT-Pl-18, is clearly resolved as a binary with an angular separation of 0".33. The very low density of contaminating background stars in our images and the photometry of the components support that this system is a physical binary rather than a chance projection. All the available photometric and spectroscopic data indicate that the CFHT-Pl-18 system is likely a member of the Pleiades cluster, but a final confirmation will have to wait until lithium can be detected. Assuming cluster membership, we compare our NICMOS photometry with evolutionary models, and find that the inclusion of the effects of dust grains is necessary for fitting the data. We estimate that the masses of the components are about 0.045 $M_\odot$ and 0.035 $M_\odot$. The binary system has a projected separation of 42 AU (for a distance of 125 pc) that is common among stellar binaries.

Accepted by ApJ Letters

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Job Announcement

Postdoctoral Position
Osservatorio Astronomico di Palermo G.S. Vaiana

The Observatory has open a temporary position at the PostDoc level, for research on the stellar coronal component of the X-ray sky based on the analyses of ROSAT, AXAF and XMM data.

Detailed information on application procedure can be found at

http://www.astropa.unipa.it/

Applications have to be sent by registered mail by Nov. 8 1998 to:

Director of Osservatorio Astronomico di Palermo G.S. Vaiana
Piazza del Parlamento 1
90134 Palermo, Italy

Upcoming Meetings

THE ELEVENTH CAMBRIDGE WORKSHOP ON COOL STARS, STELLAR SYSTEMS, AND THE SUN

Challenges for the New Millennium

Puerto de la Cruz, Tenerife (Spain)
4 - 8 October 1999

***** First Announcement *****

This is the first announcement for the 11$^{\text{th}}$ Cool Stars Workshop to be held in the town of Puerto de la Cruz (Tenerife, Spain) on October 1999. The meeting is organized by the Instituto de Astrofísica de Canarias (IAC), which hosts the two international observatories located in the Canary Islands (Roque de los Muchachos at La Palma and Teide at Tenerife).

I. Rationale

The Cool Stars Workshops are designed to provide a regular forum where members of the solar and stellar communities can gather to discuss new observations and theoretical models and, in particular, to attempt to correlate the very detailed observations we have for the Sun with the vast, but less detailed database of observations of more distant stars. Cool Stars 11 will continue that tradition. We expect this to be a very lively meeting, with about 300 participants. The emphasis will be on identifying the challenges and unsolved problems in the physics of late-type stars for the future. Note that this will be the last Cool Stars Workshop of the millennium and it will be a good opportunity to review some of the fields frequently considered in these workshops.

II. Scientific Programming and Scheduling

The meeting will be divided into morning and afternoon sessions.

Five of these time slots will be arranged as plenary morning sessions with a sequence of talks devoted to a particular topic. The five selected topics are:

- Advances in Solar Physics
- The Formation of Stars and Planets
- Chemical Abundances as Diagnostics of Stellar Structure
- Unsolved Problems in Stellar Activity
- Impact of Space Missions and Very Large telescopes on Cool Stars

Invited reviews, invited and contributed talks, and posters will be presented. The organising committee will select contributions for oral or poster presentation from the applications.

Two afternoon time slots will be arranged as parallel discussion sessions. The spirit of the these discussion sessions will be the same as for the last three Cool Stars Workshops, with a moderator to organise the session and keep it moving, a panel of "experts" to raise questions and suggest answers, and frequent opportunities for contributions from the audience. During each time slot, there will be two concurrent discussion sessions.

Two of the discussion topics will be:

- Magnetic Fields in Cool Stars

- Ages, Distances, and the Initial Mass Functions of Stellar Clusters

We invite the potential attendees of the meeting to propose topics to be covered in the two remaining discussion sessions.

III. Scientific Organising Committee (SOC)

Thomas R. Ayres	(USA)
Annie Baglin	(France)
Suchitra Balachandran	(USA)
Jean-Pierre Caillault	(USA)
Pierre Demarque	(USA)
Andrea Dupree	(USA)
Ramón J. García López	(Spain, **Chair**)
Bengt Gustafsson	(Sweden)
Carole Jordan	(UK)
David L. Lambert	(USA)
Jeffrey L. Linsky	(USA)
Benjamin Montesinos	(Spain)
Robert W. Noyes	(USA)
Roberto Pallavicini	(Italy)
Rafael Rebolo	(Spain,**Chair**)
Teodoro Roca Cortés	(Spain)
Juergen H.M.M. Schmitt	(Germany)
Klaus Strassmeier	(Austria)
John Stauffer	(USA)
Alan M. Title	(USA)
Manuel Vázquez	(Spain)
Jean-Paul Zahn	(France)

Local Organising Committee (LOC)

Ramón J. García López, Rafael Rebolo, Victor Sánchez Bejar, and María Rosa Zapatero Osorio.

Event Co-ordinator: Monica Murphy
Secretary: Beatriz Mederos

IV. Location

The meeting will take place in the conference center adjacent to the Casino Taoro in Puerto de la Cruz. We expect most participants to stay in the hotels close to the conference center. Puerto de la Cruz is a seaside resort within a 30 minutes drive of La Laguna (University town hosting the IAC's headquarters) and Santa Cruz (largest city in Tenerife, population $\sim 250,000$), and only 20 minutes from the North airport.

Tenerife is regularly connected to 16 foreign airports and has direct charter flights from/to more than 112 foreign cities. There are daily flights between Tenerife and Madrid, and also direct connections with other Spanish and European cities. Daily flights are also available for different American locations and Madrid, which are easily linked to Tenerife via Iberia or other Spanish regular airlines.

V. Schedule

This is the first announcement of the meeting. If you wish to receive further announcements, please return the attached questionaire ***BY E-MAIL***. The second announcement will be sent in February 1999. It will contain a preliminary scientific programme with the list of invited speakers, more detailed information about the logistics, publication of proceedings, and the social programme.

Further information may be obtained through our WWW site. You are welcome to contact any member of the LOC by e-mail, fax, or phone, for any enquiry.

e-mail: cs11@iac.es

Phone: 34-922-605200

Fax: 34-922-605373

WWW: http://www.iac.es/cs11/cs11.html

Postal: Cool Stars 11 Workshop,
Instituto de Astrofísica de Canarias,
E-38200 La Laguna, Tenerife, Spain

It is possible to make a preliminary registration through the WWW, or by sending the document below by e-mail.

CUT HERE AND RETURN TO cs11@iac.es

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Please keep me on your mailing list for the
ELEVENTH CAMBRIDGE WORKSHOP ON
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to be held on October 1999.

Name ....:

Institute ..:

Address ......:

Phone ....:

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e-mail ....:

The likelihood for my attendance is (check one):

$> 75\%$:

$25\% - 75\%$:

$< 25\%$:

I would like to give a presentation:
Oral ....:
Poster ....:
Tentative title ..:

This information is for planning purposes only. In the second announcement we will ask for definitive titles and abstracts.

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, or M) 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

`http://casa.colorado.edu/~skinners/coolnews.html` .