COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 31 — June & July 1998 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Stellar Abstracts

Spectroscopic Evidence for Non-Uniform Starspot Properties on II Peg

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We present spectroscopic evidence for multiple spot temperatures on the RS CVn star II Pegasi (HD 224085). We model the strengths of the 7055 Å and 8860 Å TiO absorption bands in the spectrum of II Peg using weighted sums of inactive comparison spectra: a K star to represent the non-spotted photosphere and an M star to represent the spots. The best fit yields independent measurements of the starspot filling factor (f_S) and mean spot temperature ($\langle T_S \rangle$) averaged over the visible hemisphere of the star. During 3/4 of a rotation of II Peg in late 1996, we measure a constant $f_S \approx 55 \pm 5\%$. However, $\langle T_S \rangle$ varies from 3350±60 K to 3550±70 K. We compute $\langle T_S \rangle$ for two simple models: (1) a star with two distinct spot temperatures, and (2) a star with different umbral/penumbral area ratios. The changing $\langle T_S \rangle$ correlates with emission strengths of Hα and the Ca II infrared triplet, in the sense that cooler $\langle T_S \rangle$ accompanies weaker emission. We explore possible implications of these results for the physical properties of the spots on II Peg and for stellar surface structure in general.

Accepted by ApJ Letters

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ISO-SWS spectra of the C-rich AGB Star R Scl and Dynamical Model Atmospheres

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We have monitored the spectral variations of the carbon rich AGB star R Scl in the $2-45\,\mu$m range using the ISO-SWS instrument. We have also computed hydrostatic and hydrodynamic model atmospheres and corresponding synthetic spectra representative for two phases of R Scl. There is good qualitative agreement between observations and models in the near IR. This demonstrates the theoretical progress and the potential of analysing carbon star spectra with self-consistent dynamical models.

Accepted by A&A Letters

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Brown Dwarfs and Very Low-mass Stars in the Pleiades Cluster: A Deep Wide-field Imaging Survey

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We have performed a deep, wide-field imaging survey of the Pleiades cluster (Melotte 22) in the R and I-bands to search for very low-mass stars and brown dwarfs. The survey extends over ~2.5 square degrees around the cluster's center down to a ~90% completeness limit of R~23 and I~22. We find 26 objects whose location in the (I, R-I) color–magnitude diagram is consistent with them being Pleiades members. Of these, 17 have extremely red (R-I) colors and low I luminosity, which make them prime brown dwarf candidates. We present the luminosity function of the Pleiades cluster down to $M_I \sim 15$. Using current-generation theoretical models, we compute the mass of the brown dwarf candidates which is found to range from the hydrogen-burning limit down to about $0.045 M_{\odot}$. Based on these results, a preliminary estimate of the Pleiades mass function is presented. While the stellar portion of the Pleiades mass function is well approximated by the log-normal IMF of Miller & Scalo (1979), the substellar part of it is found to be slightly higher than predicted by Miller & Scalo's IMF. In a log-log plot, the IMF is found to be still rising in the substellar domain, with a slope consistent with $dN/dM \sim M^{-0.6}$ if a power-law functional form is assumed. We estimate a total of about 250 objects below the hydrogen burning mass limit in the Pleiades which nevertheless make up only a few per cent of the mass of the cluster.

Accepted by A&A

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Extrasolar Giant Planets Under Strong Stellar Irradiation

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We investigate irradiation of extrasolar giant planets [EGPs] by treating the radiative transfer in detail, so that the flux from the parent star interacts with all relevant depths of the planetary atmosphere with no need for a pre-assumed albedo. Rayleigh scattering (in dust-free models) increases the EGP's flux by orders of magnitude shortward of the Ca II H&K doublet (3930 Å) and the spectral features of the parent star are exactly reflected. The inclusion of dust increases the reflected flux in the blue. In the optical and near-IR the thermal absorption of the planet takes over,

but the absorption features are changed by the irradiation.

Accepted by ApJL

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New Insights Into The Large 1992 July 15-17 Flare On AU Mic: The First Detection Of Post-Eruptive Energy Release On a Red Dwarf Star

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Extreme Ultraviolet Explorer (EUVE) observations of the long-duration 1992 July 15-17 flaring event on the red dwarf star AU Mic are discussed. The flare was detected in the EUVE Deep Survey (DS) Lexan/B band (65-190 Å) and comprised a large first impulsive event corresponding to an increase in the extreme ultraviolet (EUV) emission by a factor of 15 relative to quiescence, followed by a slow exponential decay interspersed with another smaller impulsive event and further decay. As observed in the EUV, the flare lasted for more than half a day. A similar exponential decay of the flux in the Fe XVIII 93.9 Å line was detected in the EUVE short wavelength (SW) spectrometer following the first powerful impulsive phase. The flare decay in the 65-190 Å band and in the Fe XVIII line during this prolonged event lasted a factor of 10 or more longer than would have been the case had the plasma cooling been due only to radiative losses at typical flare plasma densities. An analysis of the simultaneous DS Lexan/B data and the Fe XVIII line flux has allowed us to determine the approximate temporal behaviour of the flaring plasma temperature ($d \log T/dt \approx -0.5$ per day) and of the emission measure of the EUV source. The total energy emitted in the 1–2000 Å range during the 12 hours or so of the flaring event was 3×10^{35} ergs. Solar analogues of processes providing similar long-duration soft X-ray radiation are discussed: (1) a coronal mass ejection (CME); (2) a system of giant post-flare arches, which can form in powerful solar flares after a CME; (3) typical soft X-ray flaring loops. A general expression describing the energy balance in the EUV source is derived for both CME's and giant arch systems. As a result, we conclude that the long duration EUV emission in the AU Mic flare most resembles the solar scenario of emission from a system of giant coronal arches forming after a CME. Such a system on AU Mic would have a size of 1-2 stellar radii, and would be energized by reconnection in a vertical current sheet. In this picture, a substantial part of the radiative loss is compensated for by additional post-flare energy input, in a similar way as is thought to take place in the post-eruptive phases of the most powerful solar flares. Apparently, we are faced here with a new kind of surface activity on late-type stars which is intermediate between impulsive flares on red dwarf stars and the long-duration, powerful events seen on subgiant components of the RS CVn binaries.

Accepted by ApJ

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Near–Infrared Classification Spectroscopy: H–band Spectra of Fundamental MK Standards

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We present a catalogue of H–band spectra for 85 stars of approximately solar abundance observed at a resolving power of 3000 with the KPNO Mayall 4m FTS. The atlas covers spectral types O7–M5 and luminosity classes I-V as defined on the MK system. We identify both atomic and molecular indices and line–ratios which are temperature and luminosity sensitive allowing spectral classification to be carried out in the H–band. The line ratios permit spectral classification in the presence of continuum excess emission, which is commonly found in pre–main sequence and evolved stars. We demonstrate that with spectra of $R = 1000$ obtained at $SNR > 50$ it is possible to derive spectral types within ± 2 subclasses for late–type stars. These data are available electronically through the Astronomical Data Center in addition to being served on the World–Wide–Web.

Accepted by ApJ. To appear in volume 580 (Nov. 20, 1998).

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For preprints via WWW: http://nimbus.as.arizona.edu:8000/ mmeyer/origins/preprint.html
Data will be available through the ADC and WWW: http://donald.phast.umass.edu

Solar Abstracts

Flows in Sunspot Plumes Detected with the Solar and Heliospheric Observatory

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Bright extreme-UV sunspot plumes have been observed in eight out of 11 different sunspot regions with the Coronal Diagnostic Spectrometer on *Solar and Heliospheric Observatory*. From wavelength shifts we derive the line-of-sight velocity, relative to the average velocity in the rastered area, 120"x 120". In sunspot plumes we find that the motion is directed away from the observer and increases with increasing line formation temperature, reaches a maximum between 15 and 41 km s^{-1} close to log T $\approx$ 5.5, then decreases abruptly. The flow field in the corona is not well correlated with the flow in the transition region and we discuss briefly the implication of this finding.

Accepted by ApJ Letters

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The Effect of Curvature on Flux-Rope Models of Coronal Mass Ejections

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The large scale curvature of a flux rope can help propel it outwards from the Sun. Here we extend previous two-dimensional flux-rope models of coronal mass ejections to include the curvature force. To obtain analytical results we assume axial symmetry and model the flux rope as a torus which encircles the Sun. Initially, the flux rope is suspended in the corona by a balance between magnetic tension, compression, and curvature forces, but this balance is lost if the photospheric sources of the coronal field slowly decay with time. The evolution of the system shows catastrophic behavior as occurred in previous models, but, unlike the previous models, flux-ropes with large radii are more likely to erupt than ones with small radii. The maximum total magnetic energy which can be stored before equilibrium is lost is 1.53 times the energy of the potential field, and this value is less than the limiting value of 1.662 for the fully opened field. As a consequence, the loss of ideal-MHD equilibrium which occurs in the model cannot completely open the magnetic field. However, the loss of equilibrium does lead to the sudden formation of a current sheet, and if rapid reconnection occurs in this sheet, then the flux rope can escape from the Sun. We also find that the field can gradually become opened without suffering any loss of equilibrium if the photospheric field strength falls below a critical value. This behavior is analogous to the opening of a spherically symmetric arcade in response to a finite amount of shear.

Accepted by ApJ

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OPTICAL/IR INTERFEROMETRY WORKSHOP
Lowell Observatory, Flagstaff, AZ
4 - 9 October 1998

We announce the Optical/IR Interferometry Workshop, to be held October 4-9 at the campus of the Lowell Observatory in Flagstaff, Arizona, presented by CHARA, Lowell Observatory, NASA, NRL, SAO, UC Berkeley, and USNO, and sponsored by NASA, NSF, and ONR. This will be an interdisciplinary school covering all aspects of optical and IR interferometry, from acquisition of fringes to analysis of reduced data, and will be highly useful to anyone interested in astrometry or determination of fundamental parameters of cool stars. Oral presentations by the foremost researchers in the field will be supplemented by in-depth tours of the Navy Prototype Optical Interferometer and by real-time demonstrations of NPOI data acquisition, reduction and analysis. Applications of modern interferometry to the study of stellar atmospheres and evolution will be specifically addressed in the science sessions. All results and classes will be summarized in a detailed Proceedings volume. This five-day school, to be hosted in the pleasant October climate of northern Arizona, will be an invaluable opportunity for anyone planning to work with the latest generation of optical and IR interferometers. There will be no registration fee for this conference. Attendees need cover only their travel, lodging, and lunches. The conference will provide twice-daily coffee breaks, hotel shuttle, an opening reception, and a banquet at no charge. Sightseeing excursions will be available on Sunday, October 4, the day before the workshop sessions begin. We invite all interested scientists and students to visit the meeting Web site at

http://www.lowell.edu/research/infr

Here you can read more details about the meeting and register on-line.

For futher information about the meeting schedule and local arrangements, please contact Jeffrey Hall (Lowell, jch@lowell.edu). For questions regarding the science program and possible travel support, please contact Ken Johnston (USNO, kjohnston@spica.usno.navy.mil).

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

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