COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 37 — January 1999 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Stellar Abstracts

GJ 2069A, A New M Dwarf Eclipsing Binary

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We have discovered a third detached M dwarf eclipsing binary system, for which we present an accurate radial velocity orbit and a preliminary light curve. From those data, we derive individual masses (0.433 and 0.397 $M_\odot$) with 0.4% accuracy, the most accurate to date for M dwarfs. Both stars are clearly sub-luminous for their mass, compared with solar metallicity stellar models or empirical mass-luminosity relations. Their spectral types are also later than expected. This indicates a metal-rich composition ($[M/H] \sim 0.5$). An infrared light curve and a more accurate trigonometric parallax would make this system a stringent test of our understanding of M dwarfs.

Accepted by A&A Letters

For preprints contact: delfosse@ll.iac.es

For preprints via ftp: anonymous ftp to laog.obs.ujf-grenoble.fr, cd toutlemonde/delfosse/pub, file eclipse.ps

Beryllium Abundances in Halo Stars from Keck/HIRES Observations

Ann Merchant Boesgaard[1], Constantine P. Deliyannis[2], Jeremy R. King[3], Sean G. Ryan[4], Steven S. Vogt[5] and Timothy C. Beers[6]

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We have determined the abundance of Be in stars with an array of metal abundances in order to enhance our understanding of the chemical evolution of the Galaxy, cosmic ray theory, and cosmology. Observations of the Be II resonance lines at $\lambda3130$ and $\lambda3131$ were made at the Keck telescope with the HIRES spectrometer at a resolution of 46,000 and signal-to-noise ratios of 60 - 110 (per pixel) typically. Our sample includes 22 halo dwarfs and five disk stars (including the Sun). We have taken special care in determining the stellar parameters for these stars in a consistent manner. The Be abundances were found 1) from the measured equivalent width of the relatively unblended Be II line at 3131.065 Å with an analysis that included 11 weak atomic and molecular lines near that wavelength and 2) from spectrum synthesis which included newly-derived enhanced O (relative to Fe) in the synthesis calculations. The two methods are in excellent agreement. We find straight-line fits between Be and Fe:

$$\log N(\mathrm{Be/H}) = 0.96\ (\pm 0.04)\ [\mathrm{Fe/H}]\ -10.59\ (\pm 0.03)$$

and between Be and O:

$$\log N(\mathrm{Be/H}) = 1.45\ (\pm 0.04)\ [\mathrm{O/H}]\ -10.69\ (\pm 0.04)$$

It seems that Be and Fe increase at the same rate during the course of the evolution of the Galaxy. But as O increases by a factor of 100, Be increases more rapidly, by a factor of 800. Traditional models where energetic cosmic rays interact with ambient CNO nuclei in the interstellar medium to produce Be, are consistent with this finding, as long as certain chemical evolution effects (such as mass outflow from the halo) are taken into account. However, models predicting a linear relationship between Be and O, such as those producing Be in the vicinity of Type II supernovae, are less consistent with our result. There is some evidence for an intrinsic spread in Be at a given [Fe/H] or [O/H]. There is currently no evidence of a primordial plateau level of Be down to log N(Be/H) = −13.5.

Accepted by AJ (to appear March 1999)

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Rotation Periods of Late-type Stars in the Young Open Cluster IC 2602

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We present the results of a monitoring campaign aimed at deriving rotation periods for a representative sample of stars in the young (30 Myr) open cluster IC 2602. Rotation periods were derived for 29 of 33 stars monitored. The periods derived range from 0.2d (one of the shortest known rotation periods of any single open cluster star) to about 10d (which is almost twice as long as the longest period previously known for a cluster of this age). We are able to confirm 8 previously known periods and derive 21 new ones, delineating the long period end of the distribution. Despite our sensitivity to longer periods, we do not detect any variables with periods longer than about 10d. The combination of these data with those for IC 2391, an almost identical cluster, leads to the following conclusions: 1) The fast rotators in a 30 Myr cluster are distributed across the entire $0.5 < B-V < 1.6$ color range. 2) 6 stars in our sample are slow rotators, with periods longer than 6d. 3) The amplitude of variability depends on both the color and the period. The dependence on the latter might be important in understanding the selection effects in the currently available rotation period database and in planning future observations. 4) The interpretation of these data in terms of theoretical models of rotating stars suggests both that disk-interaction is the norm rather than the exception in young stars and that disk-locking times range from zero to a few Myr.

Accepted by ApJ (to appear in vol. 516, May 1, 1999)

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For preprints via ftp or WWW: http://xxx.lanl.gov/abs/astro-ph/9812168

Lithium in the Low Mass Stars of the Coma Berenices Open Cluster

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I report Lithium abundances and radial velocities for 15 late F, G and K stars in the Coma Berenices open cluster. All the stars are proper motion members and the radial velocities enable us to confirm membership for 11 single stars and identify 3 SB1 systems and 1 short period SB2 system that are very probable cluster members. The pattern of Li abundances is similar to that in the Hyades with some evidence for higher Li abundances in Coma Ber for $T_{\rm eff} < 5700$ K. I argue that these data do not support standard models for Li depletion involving only convective mixing, because the Coma Ber stars have consistently determined lower metallicities and shallower convection zones than the Hyades and should have suffered a great deal less Li depletion than observed. Instead it seems that the Li abundances in these and other young clusters are primarily ranked according to their age rather than their metallicity. I propose a scenario whereby the extreme metallicity dependence of pre-main sequence Li depletion is tempered by a mechanism that severely inhibits convective mixing, that continued main sequence depletion occurs via non-standard mixing mechanisms and that any dependence of Li depletion on metallicity takes at least several hundred Myr to emerge.

Accepted by MNRAS

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Differential Rotation Models for Late-type Dwarfs and Giants

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A model for global circulation in outer stellar convection zones is applied to simulate the angular velocity dependence of differential rotation for two spectral classes, G2 and K5, of main-sequence dwarfs. Only the solar-type rotation laws with an increasing angular velocity from pole to equator and a relatively small rotation inhomogeneity in radius were found. Differential rotation for G2 is larger compared to K5, their angular velocities being equal. As the rotation period decreases from its solar value, the absolute value of the surface differential rotation decreases initially but changes to a slight increase for periods of several days. The meridional flow inside the convection zones is confined to thin boundary layers at the top and bottom with a typical velocity amplitude of about 10 m s^{-1}. Also a sequence of rotation laws for evolving $2.5M_\odot$ star is produced. The predicted differential rotation is solar-like in structure and super-solar in amplitude. A comparison with observations is made and implications for dynamo theory of stellar activity are briefly discussed.

Accepted by A&A

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Implications from EUV Observations for Coronal Heating of Active Stars

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Extreme Ultraviolet Explorer (EUVE) data of two active solar analogs, 47 Cas and EK Dra, were used to investigate flare statistics and the distribution of the flare occurrence rate in energy. The EUVE satellite observed each star for almost 7 days. Simultaneous spectral data from its spectrometers were used to derive temperature and abundance characteristics of their coronae. The emission models were derived from differential emission measure distributions by fitting optically thin thermal models to the spectra. The Deep Survey instrument photon lists were analyzed by applying different time binnings. A total of 28 flares were identified for further analysis. The timing study provided estimates for the total radiative energy loss of each flare. The differential distribution of flares in total X-ray energy is found to be a power-law ($\frac{\mathrm{d}N}{\mathrm{d}E} \propto E^{-\alpha}$), with $\alpha \approx 2.2 \pm 0.2$, valid in the energy range between $3 \times 10^{33} - 6 \times 10^{34}$ ergs. The power-law index is larger than for typical solar flares but similar to indices found recently for small-scale solar events. If the power-law continues to energies of moderate solar flares, then the total energy emitted by the ensemble of all flares may suffice to explain all of the observed flaring and 'quiescent' X-ray emissions of the two stars. A considerable portion, if not all, of the energy required to heat their coronae could thus be provided by flares.

Accepted by ApJ Letters

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or ftp://saturn.ethz.ch/pub/audard/implic99.ps (.gz)

Detection of a Strong Stellar Flare from EUVE J1438−432

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We present extreme ultraviolet (EUV) observations of a strong flare from EUVE J1438−432, a source serendipitously detected with the EUVE Right Angle Program. The flare was detected in the Lexan/B (100Å) band and showed a sixteen-fold increase over quiescent emission with a rise time of ∼10 ksec and a decay time of ∼40 ksec. Optical spectroscopy of objects within the EUVE pointing uncertainty circle revealed a pair of late-type stars (WT 486/487) both showing Balmer series in emission; either star is a good candidate for production of the flare. The peak luminosity of the flare is 5.7x10^{29} erg/s with a total energy of ∼5x10^{33} ergs. The flare energetics are about two orders of magnitude lower than the large EUV flare detected from AU Mic in 1992, but similar to other EUV-detected flares from late-type stars.

Accepted by AJ

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Solar Abstracts

Can Streamer Blobs prevent the Buildup of the Interplanetary Magnetic Field?

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Coronal mass ejections continuously drag closed magnetic field lines away from the Sun, adding new flux to the interplanetary magnetic field (IMF). We propose that the outward-moving blobs that have been observed in helmet streamers are evidence of ongoing, small-scale reconnection in streamer current sheets, which may play an important role in the prevention of an indefinite buildup of the IMF. Reconnection between two open field lines from both sides of a streamer current sheet creates a new closed field line, which becomes part of the helmet, and a disconnected field line, which moves outward. The blobs are formed by plasma from the streamer that is swept up in the trough of the outward moving field line. We show that this mechanism is supported by observations from SOHO/LASCO. Additionally, we propose a thorough statistical study to quantify the contribution of blob formation to the reduction of the IMF, and indicate how this mechanism may be verified by observations with SOHO/UVCS and the proposed NASA STEREO and ESA Polar Orbiter missions.

Accepted by ApJL

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Yohkoh Observations of the Neupert Effect

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A Neupert effect is a well-known observational aspect of dynamics of many solar flares during their impulsive phase. Imaging capabilities of the *Yohkoh* satellite provide a new perspective in an investigation of this effect. In this paper it has been shown that impulsive soft X–ray brightenings are a direct cause of some soft X–ray excess resulting as

the Neupert effect. An additional observational confirmation is presented that the impulsive phase of flares showing the Neupert effect is dominated by non-thermal electron beams. The importance of relatively soft (below 10 keV) non-thermal electrons in the production of soft X–ray brightenings is suggested.

Accepted by A&A (to appear in vol. 342, Feb. 1999)

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Explosive Events in the Solar Atmosphere

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Two examples of explosive events observed with SUMER in transition region spectral lines are reported here; one detected in C IV 1548 Å, in a region within the northern polar coronal hole, and the other in O VI 1032 Å, in an active region. The event measured in C IV lasted $\sim$ 3 min and extended approximately a region of 8 arc sec along the slit (N-S) and 8 arc sec in the E-W direction. Velocities reached around 150 km s^{-1} in the blue wing and 100 km s^{-1} in the red wing. The active region events were more energetic and in total lasted $\sim$ 6 min. At the point of maximum activity, a region of 8 arc sec along the slit is covered by one explosive event located in the northern section of the observed region, while in the southern section we observe two events very closely located and extended over a maximum of 14 arc sec along the slit. More precisely, in the northern section we have at least two consecutive events occurring in a short time interval ($\sim$ 12 min) separated by $\sim$ 3 arc sec. In the E-W direction the raster length covered by each of these events was approximately 4 arc sec. The explosive events seen in O VI showed a very complex structure of subsonic and supersonic velocity flows, both red-shifted and blue-shifted. The apparent maximum velocity reached in the blue wing was approximately 250 km s^{-1} and 215 km s^{-1} in the red wing.

Accepted by A&A

For preprints contact: epp@star.arm.ac.uk

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Ph.D. Thesis Abstract

Surface Inhomogeneities and Semi-Empirical Modeling of Metal-Poor Stellar Photospheres

Carlos Allende Prieto

Thesis work conducted at: Instituto de Astrofísica de Canarias, Spain

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Ph.D dissertation directed by: Ramón J. García López

Ph.D degree awarded: November 1998

The interpretation of detailed spectroscopic observations of late-type stars reveals inconsistencies, due likely to inadequacies of the underlying hypothesis. The high accuracy of the parallaxes measured by the *Hipparcos* satellite established a firm reference frame that is used here to test theoretical classical model atmospheres for these stars. Stellar gravities derived making use of the *Hipparcos* parallaxes and stellar evolution models are compared with spectroscopic (iron ionization equilibrium) gravities. Previously suspected errors in the ionization balance are clearly confirmed, pointing towards important departures from local thermodynamic equilibrium for low-gravity stars as a possible explanation.

We propose a method of semi-empirical modeling of stellar atmospheres, as an alternative to the use of flux-constant one-dimensional model atmospheres. The new method is carried out via an inversion procedure that uses normalized line profiles as input data. The algorithm assumes LTE, a steady state, plane-parallel, one-dimensional atmosphere, solid body rotation, hydrostatic equilibrium, and negligible magnetic field. The procedure is applied to the Sun, showing its effectiveness through comparison of its predictions with spatially resolved observations and absolute flux measurements. The application to other stars, in particular the metal-poor star *Groombridge* 1830, and the solar-like metallicity and active star ϵ Eridani, yields semi-empirical model photospheres that succeed in reproducing all the considered spectral features (not included in the inversion procedure).

The very high-resolution spectra of *Groombridge* 1830 and the extremely metal deficient sub-giant HD140283, acquired at the McDonald Observatory 2.7m telescope, allow us to detect line asymmetries that are interpreted as the signature of convective patterns that, at least in HD140283, appear significantly enhanced due to the low atmospheric opacity. Strong differences are observed between the line bisector of photospheric atomic lines and the Mg I b_1 and b_2 lines, in the spectrum of HD140283. The lower part of the line bisector of the strong magnesium features, whose cores are formed higher in the atmosphere than the photospheric lines, appear remarkably bent to the red. This is compatible with the high velocity redshifts observed in the spectral lines formed in the chromosphere, transition region, and corona of late-type stars.

It is shown how not only the line asymmetries, but the relative line shifts, can be used in the Sun and other stars to extract useful information about velocity fields and atmospheric inhomogeneities. We have traced the strengthening of the convective blue-shifts towards deeper layers in the solar photosphere. The cores of the strong solar lines appear to be almost free of net convective shifts, a property that might be used to separate the stellar radial velocity and the gravitational red-shift from the photospheric motions in solar-like stars.

Finally, a search for very metal-poor stars in the Galaxy was conducted from the Isaac Newton Telescope at the Roque de los Muchachos Observatory in La Palma. In parallel, we developed a new method of classification of stellar spectra based on artificial neural networks, demonstrating its abilities and advantages against previously used schemes. The acquired medium resolution spectra are shown to be useful for estimating the stellar metallicity and the B-V color. The survey has provided spectra for more than 1000 objects of which 709 have been identified as late-type stars. Almost every star in the sample is metal deficient compared to the Sun: 26 are of $[Fe/H] < -3$, 87 of $[Fe/H] < -2$ and 210 of $[Fe/H] < -1$.

Thesis-related Publications: ApJ, 484, 941; A&AS, 129, 41; ApJ, 502, 951; A&AS, 131, 431

Upcoming Meetings

Second "Three-Islands" Euroconference
on
STELLAR CLUSTERS AND ASSOCIATIONS:
CONVECTION, ROTATION, AND DYNAMOS
May 25 - 28, 1999
Mondello (Palermo), Sicily, Italy
Organized by Osservatorio Astronomico di Palermo (OAPA) with the partial support of the European Union (EU)

SCIENTIFIC ORGANIZING COMMITTEE (SOC)

K. Koyama (Japan), R. Jeffries (UK), J. Linsky (USA), J.-C. Mermilliod (Switzerland), T. Montmerle (France), R. Pallavicini (Italy, Chair), R. Rebolo (Spain), M. Rodono‘ (Italy), J. Schmitt (Germany), D. Soderblom (USA), J. Stauffer (USA), R. Stern (USA), K. Strassmeier (Austria).

LOCAL ORGANIZING COMMITTEE (LOC)

R. Pallavicini (Chair), F. Bocchino, F. Damiani, G. Micela, S. Sciortino, D. Randazzo (Secretary)

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

This is the first announcement of an Euroconference on cool stars in stellar clusters and associations (convection, rotation, and dynamos) to be held in Mondello, Palermo (Sicily, Italy) on May 25 - 28, 1999. The meeting is organized by the Osservatorio Astronomico di Palermo (OAPA) and is the second of three Euroconferences (which we named the "Three-Islands Euroconferences") supported by the European Community and dedicated to galactic open clusters and young stellar associations. The first was held in Los Cancajos, La Palma (Canary Islands, Spain) on May 11-15, 1998 and was organized by the Instituto de Astrofisica de Canarias; the third one will be held in Corse (France) in May 2000 and will be organized by the Service d'Astrophysique - CEN Saclay.

These Euroconferences are aimed at facilitating the coordination of European research and stimulating the training of young researchers in the very promising field of stellar clusters.

The rationale behind this second workshop is to bring together specialists working in areas related to research on stars of late spectral types (F to M) in open clusters and associations. The aim of the meeting is to review the current knowledge on these stars both on the observational and theoretical aspects. Emphasis will be given to new results in this field and to advances made since the workshop held in Palermo in May 1997 on a similar subject. The advantages offered by stellar clusters as laboratories where homogeneous populations of cool dwarfs of different ages can be studied will be stressed. Recent results on field stars, as well as on the physics of processes like convection, angular momentum evolution and magnetic field generation by dynamo action will be reviewed as well.

TOPICS

Topics that will be discussed at the meeting include:

- Hipparcos distances to open clusters
- Age determinations
- IMFs and mass segregation in clusters
- Internal structure and evolutionary models
- Convection and extra mixing mechanisms
- Dynamo mechanisms
- Advances in model atmospheres
- Elemental abundances and metallicities
- Lithium and Berillium depletion

- Rotation and angular momentum evolution

- Chromospheric, transition region and coronal activity

- New technologies and future prospects including large-scale surveys

In addition to invited papers and talks, contributed papers and posters can be presented. The SOC will select a limited number of contributions for oral presentation on the basis of the submitted abstracts.

LOCATION

The meeting will take place at the Hotel La Torre in Mondello, a small sea-side resort town about 5 km west of Palermo. We expect most participants to stay in this hotel. We have booked a block of single and double rooms at this hotel at a reduced fare. The cost per night with half-board (room + breakfast + lunch) will be LIT 150,000 per night per person in single room and LIT 120,000 per night per person in double room. At the current rate of exchange 1 US dollar is about 1,700 LIT.

Mondello is conveniently connected to Palermo by public transportation (city bus); however, we do not recommend to stay in Palermo since the commuting time may be as long as 30 to 60 minutes early in the morming due to traffic congestion, and the prices may be considerably higher. Moreover, the Hotel La Torre is right in the seashore, has a nice swimming pool and a beautiful view over the bay of Mondello, and offers both excellent facilities for the scientific sessions and a pleasent atmosphere for participants and accompanying persons alike. In Mondello there are plenty of seafood restaurants for those very few nights that will be left free of social events. Further information on the conference venue as well as about Palermo and Sicily in general will be provided in the second announcement. Hotel reservations will be handled by the LOC. A hotel reservation form will be attached to the second announcement.

REGISTRATION FEE

A registration fee of 250,000 Italian Lire (approximately 150 US dollars at the current rate of change) will be charged to all participants. This will include the use of the conference facilities, refreshments during the Workshop, attendance of the social events, and a copy of the Proceedings. Instructions on how to pay the registration fee prior to the conference (normally by credit card) will be given in the second announcement.

EUROPEAN UNION FUNDING

European Union (EU) funding is available to support participation of young astronomers from across the Community and the Associated States. Researchers aged 35 years or under in all cases, who are nationals of EU Member or Associated States (i.e. Norway, Liechtenstein and Iceland) can apply for partial or total EC funding. Particular emphasis will be made to support researchers whose place of work is in a less-favoured region of the EU or who work for industry, as well as female applicants. Application forms to request a grant will be distributed together with the second announcement.

PROCEEDINGS

The Proceedings of the conference will be published by a major international publisher (we are considering several offers at present). A call for abstracts of proposed contributions will be circulated with the second announcement together with instructions on how to prepare abstracts using a LaTeX template.

ADDITIONAL INFORMATION

If you are interested in receiving further announcements, please return by e-mail the attached pre-registration form to

workshop@oapa.astropa.unipa.it

by ***** February 1, 1999 *****

The second announcement will be circulated by mid February 1999. It will contain the scientific program with the list of invited speakers, more detailed information about the logistics, the social programme and the proceedings. It will also contain WWW addresses where additional information can be found. Hotel registration forms, a template LaTeX file for submitting abstracts, and application forms for EC funding will also be distributed with the second announcement as well as being available through the Web pages that will be set-up shortly at the home page of Osservatorio Astronomico di Palermo (URL address: http://www.astropa.unipa.it).

For any question you may contact any of the LOC members

by e-mail workshop@oapa.astropa.unipa.it or by fax: +39 - 091 - 233 444

or by phone: +39 - 091 - 233 251 (R. Pallavicini) +39 - 091 - 233 230 (S. Sciortino) +39 - 091 - 233 231 (G. Micela)

(note: the zero before the city code is mandatory !!!)

***** PLEASE, CIRCULATE THIS ANNOUNCEMENT AMONG COLLEAGUES *****

We are looking forward to seeing you in Mondello next May.

On behalf of the SOC and LOC,

with kind regards

Roberto Pallavicini

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****

CUT HERE AND RETURN TO

workshop@oapa.astropa.unipa.it

before February 1, 1998

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Please keep me on your mailing list for the Euroconference on STELLAR CLUSTERS AND ASSOCIATIONS: CONVECTION, ROTATION, AND DYNAMOS Mondello, Palermo (Sicily, Italy), May 25-28, 1999.

Family Name .....:

First Name ......:

Middle initials .:

Institution .....:

Full address ....:

State............:

Zip code.........:

Phone ....:

Fax ....:

e-mail ....:

The likelihood for my attendance is (check one):

very likely (more than 75likely (from 50possible (from 25unlikely (less than 25

I intend to present a paper (check one):

oral ..... Poster .....

Tentative title :

================== CUT HERE =====================================

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` .