COOLNEWS

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Stellar Abstracts

Multi-colour Light Variation of AGB Stars Observed with ISO

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New visual light curves and infrared multi-epoch photometry are presented for a sample of AGB-stars spectroscopically observed with ISO. While the ISO work is or will be presented elsewhere, the aim of this paper is to give an overview of the properties of the light change of the objects. This information is crucial for the interpretation of the valuable ISO material.
Using the University of Vienna Twin Automatic Photoelectric Telescope (APT) we monitored the stars of our sample in the photometric bands V and I_C. We present the light curve of each object and derive the parameters of the current light change, such as period(s) and amplitude. Furthermore we give $V-I_C$ colours and colour variations for these objects.
Our results allow us to derive some general results on semiregular and irregular variables. Only in less than 50% of the cases could we confirm the GCVS period. Moreover, we did not find any pronounced difference between SRb and Lb variables in the regularity of the light curve. The existence of rapid oscillations indicated by Hipparcos data could not be confirmed.
In addition to the visual light changes we present new near infrared photometry data. Although typically only few data points are available, they can be viewed relative to the better-monitored visual light curves providing information on possible phase shifts and differences in amplitude in different parts of the spectrum. Furthermore, multi-epoch photometry allows us to derive mean colours for these objects.

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Interferometric Astrometry with *Hubble Space Telescope* Fine Guidance Sensor 3: The Parallax of the Cataclysmic Variable TV Columbae

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TV Columbae (TV Col) is a 13th magnitude Intermediate Polar (IP) Cataclysmic Variable (CV), with multiple periods found in the light curves. Past estimates predicted a distance of 400 parsec to greater than 500 parsec. Recently completed Hubble Space Telescope (HST) Fine Guidance Sensor (FGS) interferometric observations allow us to determine the first trigonometric parallax to TV Col. This determination puts the distance of TV Col at 368^{-15}_{+17} parsecs.

CD-32 2376, a 10th magnitude Tycho Catalog star, is a reference star in the TV Col frame. We find a distance of 127.7^{-1}_{+1} parsecs.

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The Lithium Flash - Thermal Instabilities Generated by Lithium Burning in RGB Stars

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We present a scenario to explain the lithium-rich phase which occurs on the red giant branch at the so-called bump in the luminosity function. The high transport coefficients required to enhance the surface lithium abundance are obtained in the framework of rotation-induced mixing thanks to the impulse of the important nuclear energy released in a lithium burning shell. Under certain conditions a lithium flash is triggered off. The enhanced mass loss rate due to the temporary increase of the stellar luminosity naturally accounts for a dust shell formation.

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Microwave Plasma Emission of a Flare on AD Leo

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An intense radio flare on the dMe star AD Leo, observed with the Effelsberg radio telescope and spectrally resolved in a band of 480 MHz centred at 4.85 GHz is analysed. A lower limit of the brightness temperature of the totally right handed polarized emission is estimated as $T_{\rm b} \sim 5 \times 10^{10}$ K (with values $T_{\rm b} >\sim 3 \times 10^{13}$ K considered to be more probable), which requires a coherent radio emission process. In the interpretation we favour fundamental plasma radiation by mildly relativistic electrons trapped in a hot and dense coronal loop above electron cyclotron maser emission. This leads to densities and magnetic field strengths in the radio source of $n \sim 2 \times 10^{11}$ cm^{-3} and $B \sim 800$ G.

Quasi-periodic pulsations during the decay phase of the event suggest a loop radius of $r \sim 7 \times 10^8$ cm. A filamentary corona is implied in which the dense radio source is embedded in hot thin plasma with temperature $T \geq 2 \times 10^7$ K and density $n_{\rm ext} \leq 10^{-2} n$. Runaway acceleration by sub-Dreicer electric fields in a magnetic loop is found to supply a sufficient number of energetic electrons.

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For preprints via ftp or WWW: http://arXiv.org/abs/astro-ph/0106369

Spatially Resolved STIS Spectroscopy of α Orionis: Evidence for Non-radial Chromospheric Oscillation from Detailed Modeling

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Four spatially resolved near-UV raster scans across the chromospheric disk of α Ori, obtained with the Space Telescope Imaging Spectrograph on the *Hubble Space Telescope* reveal mean chromospheric infall from 1998 January to 1998 April, which reversed to upflow in deeper layers between 1998 September and 1999 March. In 1998 September we detect systematic reversals in the component maxima of four double-peaked emission lines of Si I (UV 1), Fe II (UV 36), Fe II (UV 61), and Al II] (UV 1), when scanning across the UV disk.

Detailed modeling of the Si I λ2516 resonance line with radiative transport calculations in spherical geometry constrain the mean radial velocity structure in the projected slit area (25 by 100 mas) for different aperture positions, observed off-limb to 157.5 mas. Hence we determine with semi-empirical models that these spatial reversals of emission line components correspond with average opposite flow velocities of $\sim$2 km s^{-1} across the chromospheric disk. We determine that the chromospheric velocity field can not be represented by a unique radial velocity structure across the stellar disk in order to match the observed peak ratios of this raster scan. These sub-sonic velocities indicate (local) non-radial movements of chromospheric fluid in confined regions during a chromospheric oscillation phase, which reverses from global contraction into expansion over this monitoring period of 15 months.

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Chemical Abundances from Inversions of Stellar Spectra: Analysis of Solar-Type Stars with Homogeneous and Static Model Atmospheres

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Spectra of late-type stars are usually analyzed with static model atmospheres in local thermodynamic equilibrium (LTE) and a homogeneous plane-parallel or spherically symmetric geometry. The energy balance requires particular attention, as two elements which are particularly difficult to model play an important role: line blanketing and convection. *Inversion* techniques are able to bypass the difficulties of a detailed description of the energy balance. Assuming that the atmosphere is in hydrostatic equilibrium and LTE, it is possible to constrain its structure from spectroscopic observations. Among the most serious approximations still implicit in the method is a static and homogeneous geometry. In this paper, we take advantage of a realistic three-dimensional radiative hydrodynamical simulation of the solar surface to check the systematic errors incurred by an inversion assuming a plane-parallel horizontally-homogeneous atmosphere. The thermal structure recovered resembles the spatial and time average of the three-dimensional atmosphere. Furthermore, the abundances retrieved are typically within *10 % (0.04 dex)* of the abundances used to construct the simulation. The application to a fairly complete dataset from the solar spectrum provides further confidence in previous analyses of the solar composition. There is only a narrow range of one-dimensional thermal structures able to fit the absorption lines in the spectrum of the Sun. With our carefully selected dataset, random errors are about a factor of two smaller than systematic errors. A small number of strong metal lines can provide very reliable results. We foresee no major difficulty in applying the technique to other similar stars, and obtaining similar accuracies, using spectra with $\lambda/\delta\lambda \sim 5 \times 10^4$ and a signal-to-noise ratio as low as 30.

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On the Dynamic Stability of Cool Supergiant Atmospheres

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We have developed a new formalism to compute the thermodynamic coefficient Γ_1 in the theory of stellar and atmospheric stability. We generalize the classical derivation of the first adiabatic index, which is based on the assumption of thermal ionization and equilibrium between gas and radiation temperature, towards an expression which incorporates photo-ionization due to radiation with a temperature $T_{\rm rad}$ different from the local kinetic gas temperature. Our formalism considers the important non-LTE conditions in the extended atmospheres of supergiant stars.

An application to the Kurucz grid of cool supergiant atmospheres demonstrates that models with $T_{\rm rad}{\simeq}T_{\rm eff}$ between 6500 K and 7500 K become most unstable against dynamic perturbations, according to Ledoux' stability integral $<\Gamma_1>$. This results from Γ_1 and $<\Gamma_1>$ acquiring very low values, below 4/3, throughout the entire stellar atmosphere, which causes very high gas compression ratios around these effective temperatures. Based on detailed NLTE-calculations, we discuss atmospheric instability of pulsating massive yellow supergiants, like the hypergiant ρ Cas (Ia$^+$), which exist in the extension of the Cepheid instability strip, near the Eddington luminosity limit.

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Study of FK Comae Berenices III. Photometry for the Years 1993–2001

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We present 8 years of previously unpublished photometric observations of FK Com together with the determination of the stability of the primary comparison star HD 117567. The observations have been carried out between 1993 and 2001 at four different observatories and they consist of 5157 data points in total: U(903), B(994), V(1643), R(166), $\rm I_c$(573), b(461) and y(417). We also analyse this new data together with the previously published photometric observations. The V magnitude shows variations with dominant periods of about 3, 6, 12, 14 and 31 years. The short-term light curve variations appear to be caused by rearrangement of approximately constant amount of cool spots. From the values for different colours obtained during the brightest season observed, corresponding to the supposedly unspotted surface, the spectral type of FK Com is determined to be G7 III.

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Long-Slit Observations of Extended C II λ1335 Emission around V854 Centauri and RY Sagittarii[1]

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We have obtained long-slit far-ultraviolet (1150–1730 Å) spectra of the R Coronae Borealis (RCB) stars V854 Cen and RY Sgr, near maximum light and pulsational phase zero, with the Space Telescope Imaging Spectrograph (STIS) on *Hubble Space Telescope* (*HST*). The far-UV spectrum of each star shows a photospheric continuum rising steeply toward longer wavelengths, and a prominent emission feature at C II λ1335. RY Sgr displays a second, but fainter, emission attributed to Cl I λ1351 (which is radiatively fluoresced by C II λ1335), but Cl I is weak or absent in V854 Cen. Most surprisingly, the C II emission of V854 Cen is significantly extended along the slit by $\pm 2\farcs5$, about 6×10^3 AU at the distance of the star. The C II feature of RY Sgr exhibits no such gross extension. Nevertheless, subtle broadenings of the C II emissions beyond the point response profile suggests inner clouds of radius $\sim 0\farcs1$ (250 AU) around both stars. V854 Cen is only the third RCB star after R CrB and UW Cen known to have a resolved shell.

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A *ROSAT* Medium Sensitivity Galactic Plane Survey $180° < l < 280°$

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We have performed a moderately deep soft X-ray (0.1–2 keV) survey of the Galactic Plane using pointed observations with the *ROSAT* Position Sensitive Proportional Counter (PSPC). The survey is more than an order of magnitude more sensitive than previous X-ray surveys near the galactic plane. The data consist of 9 fields each of $\approx$ 10 ks exposure, pointed at positions on or very close to the galactic plane ($|b| < 0.3°$) in the longitude range $180° < l < 280°$. This region has relatively low X-ray absorbing material out to distances of several hundred parsecs and presents fewer source-confusion problems than at other longitudes. The total sky area surveyed was 2.5 deg^2; this yielded 93 sources, 89 of which were detected in the 'hard' (0.4–2.0 keV) band. Nine sources were detected in both 'soft' (0.1–0.4 keV) and hard bands. In the hard band, the survey coverage is $\approx$ 90 per cent for sources brighter than 0.002 count s^{-1} ($\sim 2 \times 10^{-14}$ erg cm^{-2} s^{-1}), but falls steeply below this value, with the weakest sources being $\sim$ 0.001 count s^{-1}. The median limiting flux is $\approx$ 0.0013 count s^{-1} ($\sim 1.3 \times 10^{-14}$ erg cm^{-2} s^{-1}). There are 64 sources with hard-band count rates $>$ 0.002 count s^{-1}. We present the catalogue of X-ray sources and the number–flux relations ($\log N - \log S$). 18 sources have possible identifications from the SIMBAD database. We have searched the Tycho2 and USNO-A2.0 catalogues to find all possible optical counterparts brighter than $\sim$ 19th magnitude, and attempt to classify these on the basis of $\log(f_{\rm X}/f_{\rm opt})$ vs. optical colour diagrams and near-infrared photometry from the 2MASS Second Incremental Data Release. Hence, we have found the majority of these sources to be consistent with being late-type main-sequence stars, as previous studies have proposed from incompletely-identified surveys. Comparison of the measured number–flux relations with predictions of galactic (stellar) and extragalactic populations support the view that the population of young stars in the plane is denser than previously thought.

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Solar Abstracts

The Source Regions of Impulsive Solar Electron Events

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Low-energy (2 – 19 keV) impulsive electron events observed in interplanetary space have been traced back to the Sun, using their interplanetary type III radiation and metric/decimetric radio-spectrograms. For the first time we are able to study the highest frequencies and thus the radio signatures closest to the source region. All the selected impulsive solar electron events have been found to be associated with an interplanetary type III burst. This allows to time the particle events at the 2 MHz plasma level and identify the associated coronal radio emissions. Except for 5 out of 27 cases, the electron events were found to be associated with a coronal type III burst in the metric wavelength range. The start frequency yields a lower limit to the density in the acceleration region. We also search for narrowband spikes at the start of the type III bursts. In about half of the observed cases we find metric spikes or enhancements of type I bursts associated with the start of the electron event. If interpreted as the plasma emission of the acceleration process, the observed average frequency of spikes suggests a source density of the order of $3{\cdot}10^8$ cm^{-3} consistent with the energy cut-off observed.

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On the Reliability of Peak-flux Distributions, with an Application to Solar Flares

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Narrow-band radio spikes have been recorded during a solar flare with unprecedented resolution. This unique example allows us to study the effect of low resolution in previously published peak-flux distributions of radio spikes. We give a general, analytical expression for how an actual peak-flux distribution is changed in shape if the peaks are determined with low temporal and/or frequency resolution. It turns out that, generally, low resolution tends to cause an exponential behavior at large flux values if the actual distribution is of a power-law shape. The distribution may be severely altered if the burst-duration depends on the peak-flux. The derived expression is applicable also to peak-flux distributions derived at other wavelengths (e.g. soft and hard X-rays, EUV). We show that for the analyzed spike-event the resolution was sufficient for a reliable peak flux distribution. It can be fitted by generalized power-laws or by an exponential.

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The Forbidden Abundance of Oxygen in the Sun

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[1] McDonald Observatory and Dept. of Astronomy, RLM Hall, Univ. of Texas, Austin, TX 78712-1083 USA
[2] Uppsala Astronomical Observatory, Box 515, Uppsala 751-20, Sweden We reexamine closely the solar photospheric line at 6300 Å, which is attributed to a forbidden line of neutral oxygen, and is widely used in analyses of other

late-type stars. We use a three-dimensional time-dependent hydrodynamical model solar atmosphere which has been tested successfully against observed granulation patterns and an array of absorption lines. We show that the solar line is a blend with a Ni I line, as previously suggested but oftentimes neglected. Thanks to accurate atomic data on the [O I] and Ni I lines we are able to derive an accurate oxygen abundance for the Sun: $\log\epsilon(\mathrm{O}) = 8.69 \pm 0.05$ dex, a value at the lower end of the distribution of previously published abundances, but in good agreement with estimates for the local interstellar medium and hot stars in the solar neighborhood. We conclude by discussing the implication of the Ni I blend on oxygen abundances derived from the [O I] 6300 Å line in disk and halo stars.

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On the Nature of Magnetic Shadows in the Solar Chromosphere

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Recent multi-instrument spacecraft studies of the solar photosphere and chromosphere have uncovered a feature – a “magnetic shadow” – not previously discussed in the literature. A region of the mid-chromosphere neighboring, but not within, a network magnetic element exhibits a suppression of both the mean UV line/continuum intensity and the characteristic 3-minute oscillation which is clearly observed elsewhere in apparently similar inter-network regions. The clearest cases appear to occur rarely, and their properties stand in obvious contrast to the well-known “aureoles” of enhanced variability seen surrounding some plage regions. It is imperative to more clearly understand the nature of the shadow region; not least because the suppressed atmospheric heating within it has implications for heating processes elsewhere in the chromosphere that are dependent on, or at least related to, the 3-minute oscillation.

Based on the measured photospheric magnetic field, its upward extrapolation, and the appearance of spectral features formed above the mid-chromosphere, we suggest that a shadow occurs when magnetic structures, in a relatively weak background field, “close” locally within the chromosphere, suppressing the upward propagation of magneto-atmospheric waves into the chromosphere.

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Brown Dwarf Abstracts

The Orbit of the Brown Dwarf Binary Gl 569B

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We present photometric, astrometric and spectroscopic observations of the nearby (9.8 pc) low-mass binary Gl 569Bab (in turn being a companion to the early-M star Gl 569A), made with the Keck adaptive optics facility. Having observed Gl 569Bab since August 1999, we are able to see orbital motion and to determine the orbital parameters of the pair. We find the orbital period to be 892 ± 25 days, the semi-major axis to be 0.90 ± 0.02 AU, the eccentricity to be 0.32 ± 0.02 and the inclination of the system to be 34 ± 3 degrees (1-σ). The total mass is found to be $0.123^{+0.027}_{-0.022} M_\odot$ (3-σ). In addition, we have obtained low resolution ($R = 1500$–1700) near-infrared spectra of each of the components in the J- and K-bands. We determine the spectral types of the objects to be M8.5V (Gl 569Ba) and M9V (Gl 569Bb) with an uncertainty of half a subclass. We also present new J- and K-band photometry which allows us to accurately place the objects in the HR diagram. Most likely the binary system is comprised of two brown dwarfs with a mass ratio of 0.89 and with an age of approximately 300 Myr.

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Dust in Brown Dwarfs I. Dust Formation Under Turbulent Conditions on Microscopic Scales

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Dust formation in turbulent media is studied adopting the example of brown dwarf atmospheres. By combining asymptotic techniques and time-dependent, multi-dimensional numerical simulations, we show that acoustic waves originating from convective motions provide a mechanism to initiate dust nucleation in otherwise dust-hostile environments. The subsequently growing particles cause a radiative cooling strong enough to re-initiate efficient dust formation resulting in a strongly inhomogeneous distribution of dust in such environments. Recent observations bear indications for such cloudy dust distributions in brown dwarf atmospheres.

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Ph.D. Thesis Abstract

Activity Study of Single G and K Giants

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Ph.D degree awarded: May 2001

The magnetic activity in single late giants is a poorly studied problem. The reasons for magnetic activity in such evolved stars are still not clear. The aim of my research was to verify the existing hypotheses for magnetic activity in these stars and also to study their activity properties. 14 single giants with theoretical or observational evidences for activity - faster rotation, high Li abundance, CaII K&H emission cores, photometric variability due to spots, detected flares and other activity indicators, were selected. CaII K&H and H_α spectral study and UBV photometric measurements and patrol monitoring were carried out for these stars. Their evolutionary status was also studied. A determination of their situation in the H–R diagram was done on the basis of Hipparcos parallaxes. For more detail study of their evolutionary stage chemical abundances analysis was also carried out.

Nevertheless one should expect all these stars to be active, the study revealed that only 4 of them have evidences for activity and one more was suspected in activity. These are OP And, V390 Aur, HD112989 and HD145001. HD121107 was suspected in activity. The evolutionary status study found OP And and V390 Aur to be small–mass fairly evolved giants, while the rest 3 stars appeared intermediate–mass giants at different evolutionary stages. A difference in the activity level and behavior between low and intermediate mass single giants I studied was found - the last ones exhibited weaker activity properties.

The small number active single giants and their evolutionary status rise again the question about the conditions for dynamo action in these stars. In addition, the Li–rich single giants we studied exhibited no evidences for activity, nevertheless they have the same evolutionary stage like the known small-mass active single giants and, according to the theory the conditions in their convective envelopes should be similar. The absence of activity in the faster rotating well-mixed giant HD185958 also is in contradiction with the theoretical predictions. It seems, not every single giant become active and additional factors should play role for the activity and faster rotation in these stars.

Acknowledgements: I would like to thank all colleagues in Bulgaria and abroad who helped me with useful advices and discussions. Special thanks I express to Prof. J.R. De Medeiros for directing my attention to the intermediate–mass faster rotating single giants and for the useful e-mail discussions.

Dedication: The results of my PhD work are dedicated to the memory of my father, my uncle and to Prof. Vladimir Dermendjiev – an excellent astronomer and friend who left us a few months ago. Their selfless work has always been an example for me.

Thesis-related Publications: A&A, **347**, 550; IBVS No.4867 and others published in proceedings of IAU conferences.

JOB OPENING

Postdoctoral Position
Robotic Telescopes

Astrophysical Institute
Potsdam, Germany

We invite applications for a full-time postdoctoral research position at the Astrophysical Institute Potsdam (AIP) starting summer/fall 2001. The initial appointment is for two years with the possibility of an extension of one year. Salary is according to BAT IIa-O, i.e. approx. 3.100,– DM netto per month (13 times).

The AIP is a research foundation with a close link to the University of Potsdam and a member of the Wilhelm Gottfried Leibnitz Gesellschaft and carries out basic astronomical research in a variety of fields (see http://www.aip.de). The current opening is for an astronomer with strong interest in robotic telescopes, its software and hardware design, photometric instrumentation, and high-resolution spectroscopy.

The AIP is involved in the construction of a 1.2m robotic spectroscopic telescope for stellar activity monitoring on Tenerife and the applicant is to participate in its scientific use. A second telescope is now in the pre-design phase and the applicant will be initially in charge of its project management. Access to all ESO facilities, including the VLT, and later to the LBT is possible. Inhouse computing facilities include a 16 processor Hitachi SR800, a 4 processor Cray J90, an Alpha-Unix network, Suns, and many PC/Linux machines.

Please send your application to:

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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), brown dwarfs, 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` .