COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Editor's Note: Coolnews in PDF Format

Starting with issue No. 141 (Dec. 2007), I have added PDF to the choice of formats available for obtaining current and back issues of *Coolnews* on the newsletter web page at:

http://casa.colorado.edu/∼skinners/coolnews.html

Steve Skinner (ed.)

Constraining the Age-Activity Relation for Cool Stars: The SDSS DR5 Low-Mass Star Spectroscopic Sample

Andrew A. West[1], Suzanne L. Hawley[2], John J. Bochanski[2], Kevin R. Covey[3], I. Neill Reid[4], Saurav Dhital[5], Eric J. Hilton[2], and Michael Masuda[2]

[1] Dept. of Astronomy, 601 Campbell Hall, Univ. of California, Berkeley, CA 94720 USA
[2] Department of Astronomy, University of Washington, Box 351580, Seattle, WA 98195
[3] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge MA 02138
[4] Space Telescope Science Institute, 3700 San Martin Drive,Baltimore, MD 21218
[5] Department of Physics & Astronomy, Vanderbilt University, Nashville, TN 37235

We present a spectroscopic analysis of over 38,000 low-mass stars from the Sloan Digital Sky Survey (SDSS) Data Release 5 (DR5). Analysis of this unprecedentedly large sample confirms the previously detected decrease in the fraction of magnetically active stars (as traced by Hα emission) as a function of vertical distance from the Galactic Plane. The magnitude and slope of this effect varies as a function of spectral type. Using simple 1-D dynamical models, we demonstrate that the drop in activity fraction can be explained by thin disk dynamical heating and a rapid decrease in magnetic activity. The timescale for this rapid activity decrease changes according to the spectral type. By comparing our data to the simulations, we calibrate the age-activity relation at each M dwarf spectral type. We also present evidence for a possible decrease in the metallicity as a function of height above the Galactic Plane. In addition to our activity analysis, we provide line measurements, molecular band indices, colors, radial velocities, 3-D space motions and mean properties as a function of spectral type for the SDSS DR5 low-mass star sample.

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For preprints contact: awest@astro.berkeley.edu

For preprints via ftp or WWW: http://xxx.lanl.gov/abs/0712.1590

New Precision Orbits of Bright Double-Lined Spectroscopic Binaries. II. HR 2962, HD 214686, and 16 Psc

Jocelyn Tomkin[1] and Francis C. Fekel[2]

[1] Astronomy Department and McDonald Observatory, University of Texas, Austin, TX 78712
[2] Center of Excellence in Information Systems, Tennessee State University, Nashville, TN 37209

Radial velocities from the 2.1 m telescope at McDonald Observatory and the coudé feed telescope at KPNO are used to determine new spectroscopic orbits for the double-lined spectroscopic binaries HR 2962 (F5V), HD 214686 (F8IV) and 16 Psc (F6Vb vw). The new orbital dimensions ($a_1 \sin i$ and $a_2 \sin i$) and minimum masses ($m_1 \sin^3 i$ and $m_2 \sin^3 i$) have accuracies of 0.1 to 1 %. In the case of HD 214686, which has components of nearly the same mass ($m_1/m_2 = 1.0080 \pm 0.0013$), we confirm that the component labelled as the primary in previous spectroscopic studies of this system is the slightly more massive component. We find that in HR 2962 the primary is rotating much more rapidly than the pseudosynchronous rate, while the rotation of the secondary is slightly faster than pseudosynchronous; in HD 214686 the primary is rotating at the pseudosynchronous rate or perhaps slightly less, while the rotation of the secondary is pseudosynchronous; and in 16 Psc both components rotate somewhat more rapidly than the pseudosynchronous rates. The three systems, which are of naked-eye brightness, are good potential targets for resolution by modern optical interferometers and so are promising candidates for full determination of their orbits and associated precise masses and distances.

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For preprints contact: fekel@tsuniv.edu

X-Ray Flaring on the dMe Star, Ross 154

B. J. Wargelin[1], V. L. Kashyap[1], J. J. Drake[1], D. García-Alvarez[2] and P. W. Ratzlaff[1]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138
[2] Imperial College London, Blackett Laboratory, Prince Consort Rd, London, SW7 2AZ, UK

We present results from two *Chandra* imaging observations of Ross 154, a nearby flaring M dwarf star. During a 61-ks ACIS-S exposure, a very large flare occurred (the equivalent of a solar X3400 event, with $L_X = 1.8 \times 10^{30}$ ergs s^{-1}) in which the count rate increased by a factor of over 100. The early phase of the flare shows evidence for the Neupert effect, followed by a further rise and then a two-component exponential decay. A large flare was also observed at the end of a later 48-ks HRC-I observation. Emission from the non-flaring phases of both observations was analyzed for evidence of low level flaring. From these temporal studies we find that microflaring probably accounts for most of the 'quiescent' emission, and that, unlike for the Sun and the handful of other stars that have been studied, the distribution of flare intensities does not appear to follow a power-law with a single index. Analysis of the ACIS spectra, which was complicated by exclusion of the heavily piled-up source core, suggests that the quiescent Ne/O abundance ratio is enhanced by a factor of ∼2.5 compared to the commonly adopted solar abundance ratio, and that the Ne/O ratio and overall coronal metallicity during the flare appear to be enhanced relative to quiescent abundances. Based on the temperatures and emission measures derived from the spectral fits, we estimate the length scales and plasma densities in the flaring volume and also track the evolution of the flare in color-intensity space. Lastly, we searched for a stellar-wind charge-exchange X-ray halo around the star but without success; because of the relationship between mass-loss rate and the halo surface brightness, not even an upper limit on the stellar mass-loss rate can be determined.

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For preprints contact: bwargelin@cfa.harvard.edu

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Long-Term Magnetic Activity in Close Binary Systems. I. Patterns of Color Variations

Sergio Messina[1]

[1] INAF-Catania Astrophysical Observatory, via S. Sofia 78, I-95123 Catania, Italy

This is the first of a series of papers in which we present the results of a long-term photometric monitoring project carried out at Catania Astrophysical Observatory and aimed at studying magnetic activity in late-type components of close binary systems, its dependence on global stellar parameters, and its evolution on different time scales from days to years. In this first paper, we present the complete observations dataset and new results of an investigation on the origin of brightness and color variations observed in the following well-known magnetically active close binary stars: AR Psc, VY Ari, UX Ari, V711 Tau, EI Eri, V1149 Ori, DH Leo, HU Vir, RS CVn, V775 Her, AR Lac, SZ Psc, II Peg and BY Dra. About 38,000 high-precision photoelectric nightly observations in the U, B and V filters are analysed. Correlation and regression analyses of the V magnitude vs. U−B and B−V color variations are carried out and a comparison with model variations for a grid of active regions temperature and filling factor values is also performed. We find the existence of two different patterns of color variations. Eight stars in our sample: BY Dra, VY Ari, V775 Her, II Peg, V1149 Ori, HU Vir, EI Eri and DH Leo become redder when they get fainter, as it is expected from the presence of active regions consisting of cool spots. The other six stars show the opposite behaviour, i.e. they become bluer when they get fainter. For V711 Tau this behaviour could be explained by the increased relative U- and B- flux contribution by the earlier-type component of the binary system when the cooler component gets fainter. On the other hand, for AR Psc, UX Ari, RS CVn, SZ Psc and AR Lac the existence of hot photospheric faculae must be necessarily invoked. We also found that in single-lined and double-lined binary stars in which the fainter component is inactive or much less active the V magnitude is correlated to B−V and U−B color variations in more than 60% of observation seasons. The correlation is found in less than 40% of observation seasons when the fainter component has a non-negligible level of activity and/or hot faculae are present but they are either spatially or temporally uncorrelated to spots.

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Mass Outflow and Chromospheric Activity of Red Giant Stars in Globular Clusters I: M15

Sz. Meszaros[1] [2], A. K. Dupree[1] and A. Szentgyorgyi[1]

[1] Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138
[2] Department of Optics and Quantum Electronics, University of Szeged, 6701 Szeged, Hungary

High resolution spectra of 110 selected red giant stars in the globular cluster M15 (NGC 7078) were obtained with Hectochelle at the MMT telescope in 2005 May, 2006 May, and 2006 October. Echelle orders containing Hα and Ca H & K are used to identify emission and line asymmetries characterizing motions in the extended atmospheres. Emission in Hα is detected to a luminosity of $log(L/L_{\odot}) = 2.36$, in this very metal deficient cluster, comparable to other studies, suggesting that appearance of emission wings is independent of stellar metallicity. The faintest stars showing Hα emission appear to lie on the asymptotic giant branch (AGB) in M15. A line-bisector technique for Hα reveals outflowing velocities in all stars brighter than $log(L/L_{\odot}) = 2.5$, and this outflow velocity increases with stellar luminosity, indicating the mass outflow increases smoothly with luminosity. Many stars lying low on the AGB show exceptionally high outflow velocities (up to 10−15 km s^{-1}) and more velocity variability (up to 6−8 km s^{-1}), than red giant branch (RGB) stars of similar apparent magnitude. High velocities in M15 may be related to the low cluster metallicity. Dusty stars identified from *Spitzer* Space Telescope infrared photometry as AGB stars are confirmed as cluster members by radial velocity measurements, yet their Hα profiles are similar to those of RGB stars without dust. If substantial mass loss creates the circumstellar shell responsible for infrared emission, such mass loss must be episodic.

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For preprints contact: meszi@cfa.harvard.edu

Direct Detection of a Magnetic Field at the Surface of V390 Aur - An Effectively Single Active Giant

R. Konstantinova-Antova[1], M. Auriere[2], I. Kh. Iliev[1], R. Cabanac[2], J.-F. Donati[2], D. Mouillet[3], and P. Petit[2]

[1] Institute of Astronomy, Bulgarian Academy of Sciences, 72 Tsarigradsko shose, 1784 Sofia, Bulgaria
[2] Laboratoire d'Astrophysique de Toulouse-Tarbes, Université Paul Sabatier, CNRS, Observatoire Midi Pyrénés, 57 Avenue d'Azereix, 65008 Tarbes, France
[3] Laboratoire d'Astrophysique, Observatoire de Grenoble, BP 53, 38041 Grenoble Cedex 09, France

Aims: We have studied the active giant V390 Aur using spectropolarimetry to obtain direct and simultaneous measurements of the magnetic field and the activity indicators in order to infer the origin of the activity.
Methods: We used the new spectropolarimeter NARVAL at the Bernard Lyot Telescope (Observatoire du Pic du Midi, France) to obtain a series of Stokes I and Stokes V profiles. Using the LSD technique we were able to detect the Zeeman signature of the magnetic field in each of our 5 observations and to measure its longitudinal component. Using the wide wavelength range of the spectra we could monitor the CaII K&H and IR triplet, as well as the H_{α} lines which are activity indicators. The Stokes I LSD profiles enabled us to detect and measure the profiles of two weak stellar companions.
Results: From five observations obtained from November 2006 to March 2007, we deduce that the magnetic field has a complex structure which evolves with time and is reminiscent of a dynamo–induced magnetic field. The activity indicators also present day to day variations, but their behaviour does not completely follow the magnetic field variations, because their longitudinal component can cancel the contribution of complex magnetic features. There is a significant difference between the magnetic field observed on November 27, 2006 and on March 15, 2007, at the same rotational phase, but with an interval of 10 rotations. The behaviour of the activity indicators together with the measured enhanced magnetic field on March 15, 2007 support the idea of a change in the field topology.
Analysis (RV and EW) of the absorption components of the Stokes I LSD profile shows that the secondary of the visual wide orbit binary ADS 3812 is itself a spectroscopic binary, and suggests that the synchronization effect does not play role for V390 Aur (the primary), and that the giant should be considered as effectively single with regard to its fast rotation and activity.

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Prediction of Solar Cycle 24 and Beyond

K. M. Hiremath[1]

[1] Indian Institute of Astrophysics, Bangalore-560034, India

In the previous study (Hiremath, K. M., A&A, 452, 591, 2006), the solar cycle is modeled as a forced and damped harmonic oscillator and from all the 22 cycles (1755-1996), long-term amplitudes, frequencies, phases and decay factor are obtained. Using these physical parameters of the previous 22 solar cycles and by an *autoregressive model*, we predict the amplitude and period of the present cycle 23 and future fifteen solar cycles. The period of present solar cycle 23 is estimated to be 11.73 years and it is expected that onset of next sunspot activity cycle 24 might starts during the period 2008.57 ± 0.17 (*i.e.,* around May-Sept 2008). The predicted period and amplitude of the present cycle 23 are almost similar to the period and amplitude of the observed cycle. With these encouraging results, we also predict the profiles of future 15 solar cycles. Important predictions are : (i) the period and amplitude of the cycle 24 are 9.34 years and 110 ($\pm$11), (ii) the period and amplitude of the cycle 25 are 12.49 years and 110 ($\pm$ 11), (iii) during the cycles 26 (2030-2042 AD), 27 (2042-2054 AD), 34 (2118-2127 AD), 37 (2152-2163 AD) and 38 (2163-2176 AD), the sun might experience a very high sunspot activity, (iv) the sun might also experience a very low (around 60) sunspot activity during cycle 31 (2089-2100 AD) and, (v) length of the solar cycles vary from 8.65 yrs for the cycle 33 to maximum of 13.07 yrs for the cycle 35.

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For preprints contact: hiremath@iiap.res.in

The Nature of Running Penumbral Waves Revealed

D. Shaun Bloomfield[1], **Andreas Lagg**[1], **and Sami K. Solanki**[1]

[1]Max-Planck-Institut für Sonnensystemforschung, Max-Planck-Strasse 2, 37191 Katlenburg-Lindau, Germany

We seek to clarify the nature of running penumbral (RP) waves: are they chromospheric trans-sunspot waves or a visual pattern of upward-propagating waves? Full Stokes spectropolarimetric time series of the photospheric Si I λ10827 line and the chromospheric He I λ10830 multiplet were inverted using a Milne-Eddington atmosphere. Spatial pixels were paired between the outer umbral/inner penumbral photosphere and the penumbral chromosphere using inclinations retrieved by the inversion and the dual-height pairings of line-of-sight velocity time series were studied for signatures of wave propagation using a Fourier phase difference analysis. The dispersion relation for radiatively cooling acoustic waves, modified to incorporate an inclined propagation direction, fits well the observed phase differences between the pairs of photospheric and chromospheric pixels. We have thus demonstrated that RP waves are in effect low-β slow-mode waves propagating along the magnetic field.

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For preprints contact: shaun.bloomfield@tcd.ie (new email address)

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The Solar Chromosphere at High Resolution with IBIS. I. New Insights From the Ca II 854.2 nm Line

G. Cauzzi[1], K.P. Reardon[1], H. Uitenbroek[2], F. Cavallini[1], A. Falchi[1], R. Falciani[3], K. Janssen[1], T. Rimmele[2], A. Vecchio[1] and F. Wöger[2,4]

[1] INAF - Osservatorio Astrofisico di Arcetri, I-50125 Firenze, Italy
[2] National Solar Observatory, P.O. Box 62, Sunspot NM 88349, USA
[3] Dipartimento di Astronomia, Università di Firenze, I-50125 Firenze, Italy
[4] Kipenheuer Institute für Sonnenphysics, D-79104 Freiburg, Germany

Context. The chromosphere remains a poorly understood part of the solar atmosphere, as current modeling and observing capabilities are still ill-suited to investigate in depth its fully 3-dimensional nature. In particular, chromospheric observations that can preserve high spatial and temporal resolution while providing spectral information over extended fields of view are still very scarce.
Aims. In this paper, we seek to establish the suitability of imaging spectroscopy performed in the Ca II 854.2 nm line as a means to investigate the solar chromosphere at high resolution.
Methods. We utilize monochromatic images obtained with the Interferometric BIdimensional Spectrometer (IBIS) at multiple wavelengths within the Ca II 854.2 nm line and over several quiet areas. We analyze both the morphological properties derived from narrow-band monochromatic images and the average spectral properties of distinct solar features such as network points, internetwork areas and fibrils.
Results. The spectral properties derived over quiet-Sun targets are in full agreement with earlier results obtained with fixed-slit spectrographic observations, highlighting the reliability of the spectral information obtained with IBIS. Furthermore, the very narrowband IBIS imaging reveals with much clarity the dual nature of the Ca II 854.2 nm line: its outer wings gradually sample the solar photosphere, while the core is a purely chromospheric indicator. The latter displays a wealth of fine structures including bright points, akin to the Ca II H_{2V} and K_{2V} grains, as well as fibrils originating from even the smallest magnetic elements. The fibrils occupy a large fraction of the observed field of view even in the quiet regions, and clearly outline atmospheric volumes with different dynamical properties, strongly dependent on the local magnetic topology. This highlights the fact that 1-D models stratified along the vertical direction can provide only a very limited representation of the actual chromospheric physics.
Conclusions. Imaging spectroscopy in the Ca II 854.2 nm line currently represents one of the best observational tools to investigate the highly structured and highly dynamical chromospheric environment. A high performance instrument such as IBIS is crucial in order to achieve the necessary spectral purity and stability, spatial resolution, and temporal cadence.

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For preprints contact: gcauzzi@arcetri.astro.it

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Low-Mass and Substellar Abstracts

Four Faint T Dwarfs from the *UKIRT* Infrared Deep Sky Survey (UKIDSS) Southern Stripe

Kuenley Chiu[1], Michael C. Liu[2], Linhua Jiang[3], Katelyn N. Allers[2], Daniel P. Stark[4], Andrew Bunker[1,5], Xiaohui Fan[3], Karl Glazebrook[6], Trent J. Dupuy[2]

[1] School of Physics, University of Exeter, Stocker Road, Exeter EX4 4QL, UK email: chiu@astro.ex.ac.uk
[2] Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822
[3] Steward Observatory, University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721
[4] Department of Astronomy, California Institute of Technology, Mail Code 220-6, 1200 E. Calironia Blvd., Pasadena, CA 91125
[5] Anglo-Australian Observatory, Epping, NSW 1710, Australia
[6] Centre for Astrophysics and Supercomputing, Swinburne University of Technology, Hawthorn, Victoria 3122, Australia

We present the optical and near-infrared photometry and spectroscopy of four faint T dwarfs newly discovered from the UKIDSS first data release. The sample, drawn from an imaged area of ∼136 square degrees to a depth of $Y = 19.9$ (5σ, Vega), is located in the SDSS Southern Equatorial Stripe, a region of significant future deep imaging potential. We detail the selection and followup of these objects, three of which are spectroscopically confirmed brown dwarfs ranging from type T2.5 to T7.5, and one is photometrically identified as early T. Their magnitudes range from $Y = 19.01$ to 19.88 with derived distances from 34 to 98 pc, making these among the coldest and faintest brown dwarfs known. The sample brings the total number of T dwarfs found or confirmed by UKIDSS data in this region to nine, and we discuss the projected numbers of dwarfs in the future survey data. We estimate that ~ 240 early- and late-T dwarfs are discoverable in the UKIDSS LAS data, falling significantly short of published model projections and suggesting that IMFs and/or birthrates may be at the low end of possible models. Thus, deeper optical data has good potential to exploit the UKIDSS survey depth more fully, but may still find the potential Y dwarf sample to be extremely rare.

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Brown Dwarfs and Very Low Mass Stars in the Hyades Cluster : A Dynamically Evolved Mass Function.

J. Bouvier[1], T. Kendall[2], G. Meeus[3], L. Testi[4,5], E. Moraux[1], J.R. Stauffer[6], D. James[7], J.-C. Cuillandre[8], J. Irwin[9], M.J. McCaughrean[10], I. Baraffe[11], E. Bertin[12]

[1] Laboratoire d'Astrophysique de Grenoble, Observatoire de Grenoble, BP53, F-38041 Grenoble, France
[2] Centre for Astrophysics Research, University of Hertfordshire, College Lane, Hatfield AL10 9AB, UK
[3] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany
[4] Osservatorio Astrofisico di Arcetri, INAF, Largo E. Fermi 5, 50125 Firenze, Italy
[5] European Southern Observatory, Karl Schwarzschild Str. 2, 85748 Garching bei München, Germany
[6] Spitzer Science Center, California Institute of Technology, 1200 East California Boulevard, Pasadena, CA 91125, USA
[7] Department of Physics & Astronomy, Box 1807 Station B, Vanderbilt University, Nashville, TN 37235, USA
[8] CFHT Corporation, 65-1238 Mamalahoa Hwy, Kamuela, Hawaii 96743, USA
[9] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street MS-16, Cambridge, MA 02138, USA
[10] School of Physics, Stocker Road, Exeter, EX4 4QL, UK
[11] CRAL, Ecole Normale Supérieure, 46 allée d'Italie, 69364 Lyon Cedex 07, France
[12] Institut d'Astrophysique de Paris, 98bis bd Arago, 75014 Paris, France

We conducted a search for brown dwarfs (BDs) and very low mass (VLM) stars in the 625 Myr-old Hyades cluster in order to derive the cluster's mass function across the stellar-substellar boundary. We performed a deep (I=23, z=22.5) photometric survey over 16 sq.deg. around the cluster center, followed up with K-band photometry to measure the proper motion of candidate members, and optical and near-IR spectroscopy of probable BD and VLM members. We report the discovery of the first 2 brown dwarfs in the Hyades cluster. The 2 objects have a spectral type early-T and their optical and near-IR photometry as well as their proper motion are consistent with them being cluster members. According to models, their mass is 50 Jupiter masses at an age of 625 Myr. We also report the discovery of 3 new very low mass stellar members of the cluster, and confirm the membership of 16 others. We combine these results with a list of previously known cluster members to build the present-day mass function (PDMF) of the Hyades cluster from 50 Jupiter masses to 3Mo. We find the Hyades PDMF to be strongly deficient in very low mass objects and brown dwarfs compared to the IMF of younger open clusters such as the Pleiades. We interpret this deficiency as the result of dynamical evolution over the past few 100 Myr, i.e., the preferential evaporation of low mass cluster members due to weak gravitational encounters. We thus estimate that the Hyades cluster currently hosts about 10-15 brown dwarfs, while its initial substellar population may have amounted up to 150-200 members.

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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), substellar objects, 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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