COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

Stellar Abstracts

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

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We present a catalog of J–band spectra for 88 fundamental MK standard stars observed at a resolving power of $R \sim 3000$. This contribution serves as a companion atlas to the K–band spectra published by Wallace and Hinkle (1997) and the H–band atlas of Meyer et al. (1998). We report data from 7400–9550 cm^{-1} (1.05–1.34 μm) for stars of spectral types O7–M6 and luminosity classes I–V as defined in the MK system. In reducing these data, special care has been taken to remove time–variable telluric features of water vapor. We identify atomic and molecular indices which are both temperature and luminosity sensitive that aid in the classification of stellar spectra in the J–band. In addition to being useful in the classification of late–type stars, the J–band contains several features of interest in the study of early–type stellar photospheres. These data are available electronically for anonymous FTP in addition to being served on the World Wide Web.

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For preprints via WWW: http://gould.as.arizona.edu/origins/preprint.html

Data available through the WWW: http://www.noao.edu/archives.html

Infrared Spectroscopy of Symbiotic Stars: I. Orbits for Well-known S-type Systems

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First results are reported for a program of monitoring symbiotic-star velocities in the 1.6 μm region with infrared-array technology. Infrared radial velocities have been used to determine single-lined spectroscopic orbits for six well-known symbiotic stars, EG And, T CrB, CI Cyg, BX Mon, RS Oph, and AG Peg. The new orbits are in general agreement with previous orbits derived from optical velocities. From the combined optical and infrared velocities improved orbital elements for the six systems have been determined. Each of the orbital periods has been determined solely from the radial-velocity data. With the addition of our new velocities the orbital period of BX Mon has been revised to 1259 d, a 10% decrease from the previously reported result.

Accepted by AJ

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Studying the Pulsation of Mira Variables in the Ultraviolet

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We present results from an empirical study of the Mg II h & k emission lines of selected Mira variable stars, using spectra from the *International Ultraviolet Explorer* (IUE). The stars all exhibit similar Mg II behavior during the course of their pulsation cycles. The Mg II flux always peaks after optical maximum near pulsation phase $\phi = 0.2 - 0.5$, although the Mg II flux can vary greatly from one cycle to the next. The lines are highly blueshifted, with the magnitude of the blueshift decreasing with phase. The widths of the Mg II lines are also phase-dependent, decreasing from about 70 km s^{-1} to 40 km s^{-1} between $\phi = 0.2$ and $\phi = 0.6$. We also study other UV emission lines apparent in the IUE spectra, most of them Fe II lines. These lines are much narrower and not nearly as blueshifted as the Mg II lines. They exhibit the same phase-dependent flux behavior as Mg II, but they do not show similar velocity or width variations.

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Optical, X-ray and Radio Observations of HD 61396: A Probable New RS CVn-type Binary

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We have carried out BVR photometric and H_α spectroscopic observations of the star HD 61396 during 1998 March 20 to 1999 April 3. We have discovered regular optical photometric variability from this star, with an inferred period of 31.95±0.10 days, and an amplitude of ~0.18 mag. A possible period of 35.34±0.12 days, as determined with *Hipparcos*, cannot be completely ruled out. However, modeling of its photometric light curve with two circular spots indicates that 5–21% of the stellar surface is covered by dark starspots which are cooler by ~830 K compared to the surrounding photosphere, and produce the observed rotational modulation of the optical flux. Optical spectroscopy reveals a variable H_α emission feature, indicating that it is an unusually active star.

In addition, we have analysed archival X-ray data of HD 61396, obtained from serendipitous observations with the

ROSAT X-ray observatory, and we also discuss the radio properties of this star, based both on published Green Bank and unpublished VLA observations. The strong photometric variability and H_α emission, the relatively hard X-ray spectrum, and the high X-ray and radio luminosities imply that HD 61396 is most likely to be a member of the RS CVn class of evolved active binary stars. Its X-ray and radio luminosities place it among the five most luminous active binaries detected so far.

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The Corona of the dMe Flare Star AD Leo

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We have systematically studied the X-ray emission (both the quiescent component and the flares) of the dM3e star AD Leo, analyzing the existing observations from the *Einstein* IPC, ROSAT PSPC and ASCA SIS instruments. Using a consistent method which explicitly considers the possibility of sustained heating we have analyzed the six flares which have sufficient statistics, deriving constraints on the physical parameters of the flaring regions. In all cases the flaring loops are likely compact ($L \simeq 0.3\ R_*$), and confined to a rather narrow range of sizes, incompatible with the large ($L \geq R_*$) tenuous loops claimed by previous analyses of flares on AD Leo and other similar stars. The flaring loops appear to have a larger cross section ($\beta = r/L \simeq 0.3$) than customarily assumed (e.g. $\beta \simeq 0.1$). All flares show evidence of significant heating during the decay phase. Although the derived peak pressures are high (up to $P \simeq 10^4$ dyne cm^{-2}) with a peak temperature of $\simeq 50$ MK, the magnetic fields required to confine such loops and to produce the observed flare luminosity are relatively modest ($B \simeq 1$–2 kG) and fully compatible with the photospheric magnetic fields measured in several flare stars. If the narrow range of loop sizes obtained is extrapolated to the quiescent structures responsible for the active corona, the latter can be naturally scaled up from the solar case through a modest (a factor of 10) increase in pressure in otherwise solar-like active structures with a small surface filling factor ($\simeq 5\%$). The quiescent component of the corona shows no evidence for abundance peculiarities with respect to the photosphere, and the quiescent coronal luminosity is remarkably constant (with variations of less than a factor of 2) across the almost 20 yr span of the observations discussed here.

Accepted by A&A

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Solar Abstracts

On the Inference of Differential Emission Measures Using Diagnostic Line Ratios

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Spectroscopic diagnosis of hot optically thin plasmas can be used to infer valuable information about the temperature structure of the emitting plasma volume, through the emission measure differential in T_e, DEM(T_e). However, the uncertainties in atomic parameters (required to model the plasma emission) make such inferences intractable. We demonstrate that it is possible, and relatively straightforward, to implement a formalism and infer DEM(T_e) in a way such that atomic uncertainties are treated explicitly. Indeed, we show that a hybrid line-ratio emission measure method is robust when “standard” inversion methods will fail to produce consistent results.

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Magnetic Reconnection as the Cause of a Photospheric Canceling Feature and Mass Flows in a Filament

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Magnetic reconnection in the temperature minimum region of the solar photosphere can account for the canceling magnetic features on the Sun. Litvinenko (1999a) showed that a reconnection model explains the quiet-Sun features with the magnetic flux cancelation rate of order 10^{17} Mx hr^{-1}. In this paper the model is applied to cancelation in solar active regions, which is characterized by a much larger rate of cancelation $\geq 10^{19}$ Mx hr^{-1}. In particular, the evolution of a photospheric canceling feature observed in an active region on July 2, 1994 is studied. The theoretical predictions are demonstrated to be in reasonable agreement with the measured speed of approaching magnetic fragments, the magnetic field in the fragments, and the flux cancelation rate, deduced from the combined Big Bear Hα time-lapse images and videomagnetograms calibrated against the daily NSO/Kitt Peak magnetogram. Of particular interest is the prediction that photospheric reconnection should lead to a significant upward mass flux and the formation of a solar filament. Hα observations indeed showed a filament that had one of its ends spatially superposed with the canceling feature.

Accepted by Solar Physics

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The Minimum Bandwidth of Narrowband Spikes in Solar Flare Decimetric Radio Waves

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The minimum and the mean bandwidth of individual narrowband spikes in two events in decimetric radio waves is determined by means of multi-resolution analysis. Spikes of a few tens of millisecond duration occur at decimetric/microwave wavelength in the particle acceleration phase of solar flares. A first method determines the dominant spike bandwidth scale based on their scalegram, the mean squared wavelet coefficient at each frequency scale. This allows to measure the scale bandwidth independently of heuristic spike selection criteria, e.g. manual selection. The major drawback is a low resolution in the bandwidth. To overcome this uncertainty, a feature detection algorithm and a criterion for spike shape in the time-frequency plane is applied to locate the spikes. In that case, the bandwidth is measured by fitting an assumed spike profile into the denoised data. The smallest FWHM bandwidth of spikes was found at 0.17% and 0.41% of the center frequency in the two events. Knowing the shortest relevant bandwidth of spikes, the slope of the Fourier power spectrum of this two events was determined and no resemblance to a Kolmogorov spectrum detected. Additionally the correlation between spike peak flux and bandwidth was examined.

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Variations of Solar Coronal Hole Area and Terrestrial Lower Tropospheric Air Temperature from 1979 to mid-1998: Astronomical Forcings of Change in Earth's Climate?

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The temperature anomaly of the terrestrial lower troposphere, inferred from the Microwave Sounding Unit (MSU) radiometers, is found to be inversely correlated with the area of the Sun covered by coronal holes. The correlation between the monthly time series of global tropospheric temperature anomaly and total coronal hole area from January 1979 to April 1998 has a Pearson coefficient of -0.46, which is different from zero at a 95% confidence level. Physical

reasonings for the explained and unexplained parts of the correlation are discussed. The coronal hole area is a physical proxy for both the global-scale, 22-yr geometrical and shorter-term, dynamical components of the cosmic ray modulation, as well as the corpuscular emission of the Sun. Other solar parameters that may indicate a solar radiative effect on climate are also evaluated. It is concluded that variable fluxes either of solar charged particles or cosmic rays modulated by the solar wind, or both, may influence the terrestrial tropospheric temperature on timescale of months to years.

Accepted by New Astronomy

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A Brightening Coronal Loop Observed by TRACE: I. Morphology and Evolution

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We analyze the transient brightening of a solar coronal loop observed, at high time cadence (30 sec) and spatial resolution (0.5" pixel size), with TRACE in the 171 Å band on June 26, 1998. The loop, located in AR 8253, is $\approx 10^{10}$ cm long and inclined with respect to the vertical to the solar surface. Its geometry and shape do not change significantly during the brightening, which lasts for ~ 2 hours and is preceded by highly dynamic events in nearby and perhaps interacting loops. The loop footpoints brighten first; after ~ 10 min, moving brightness fronts rise initially from the northern footpoint, and after further ~ 7 min from the southern one, at an apparent speed ~ 100 km/s, the whole loop becoming clearly visible afterwards. During the rising phase the loop evolves coherently as a single magnetic tube. The brightness profile is asymmetric with respect to the loop apex at all times; the brightness contrast between the footpoints and the apex decreases with time from a ratio of ~ 10 to ~ 3. After the loop has become all visible, the several parallel filaments which form it follow an independent evolution. Assuming a plasma temperature of ≈ 1 MK, we infer a plasma density of $\sim 6 \times 10^8$ cm^{-3} and a pressure of ~ 0.2 dyne cm^{-2} close to the loop apex at the luminosity maximum. A companion paper is devoted to modeling the rising phase of this event.

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A Brightening Coronal Loop Observed by TRACE: II. Loop Modeling and Constraints on Heating

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This is the second of two papers dedicated to the brightening of a coronal loop observed by TRACE on 26 June 1998; it aims at hydrodynamic modeling the brightening. Since the loop geometry is practically unchanged during the brightening, the evolution of the plasma confined in the loop is described with a one-dimensional hydrodynamic time-dependent numerical model and from the results the emission along the loop in the TRACE 171 Å band is synthesized. The information from Paper I is used to derive the geometry and the initial configuration of the loop, as well as for comparison with the results of the model. The modeling is focused to determine the amount, spatial distribution and evolution of the heating deposited in the loop to make the modelled evolution close to that observed with TRACE. We find that, in order to match the observed evolution and distribution of the brightness along the loop, the heating has to be non-symmetrical in the loop, in particular deposited between the apex and one footpoint (3×10^9 cm from the southern footpoint). A reasonable match with observations is obtained by assuming that the heating is switched on abruptly and then kept constant for the whole rising phase. An even better match is obtained with the heating high and constant for 100 s and then decaying exponentially with an e-folding time of 300 s. We discuss the resulting physical scenario: a bright irregular structure close to the loop in the TRACE images may be a tracer of the heating release.

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TRACE-derived Temperature and Emission Measure Profiles Along Long-lived Coronal Loops: The Role of Filamentation.

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In a recent letter (ApJ 517, L155) Lenz et al. have shown the evidence of uniform temperature along steady long coronal loops observed by TRACE in two different passbands (171 Å and 195 Å filters). We propose that such an evidence can be explained by the sub-arcsecond structuring of the loops across the magnetic field lines. In this perspective, we present a model of a bundle of six thin parallel hydrostatic filaments with temperature stratification dictated by detailed energy balance and with temperatures at their apex ranging between 0.8 and 5 MK. If analyzed as a single loop, the bundle would appear isothermal along most of its length.

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Coronal Sources Of The Fast Solar Wind

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The present spectroscopic study of the ultraviolet coronal emission in a polar hole, detected on April 6–9, 1996 with the Ultraviolet Coronagraph Spectrometer aboard the SOHO spacecraft, identifies the inter–plume lanes and background coronal hole regions as the channels where the fast solar wind is preferentially accelerated. In inter–plume lanes, at heliocentric distance 1.7 $R_{\odot}$, the corona expands at a rate between 105 km s^{-1} and 150 km s^{-1}, that is, much faster than in plumes where the outflow velocity is between 0 km s^{-1} and 65 km s^{-1}. The wind velocity is inferred from the Doppler dimming of the O VI $\lambda\lambda$ 1032, 1037 Å lines, within a range of values, whose lower and upper limit corresponds to anisotropic and isotropic velocity distribution of the oxygen coronal ions, respectively.

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An Extrasolar Giant Planet in an Earth-like Orbit. Precise Radial Velocities of the Young Star ι Horologii = HR 810

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We present 5 1/2 years of radial velocity (RV) monitoring with the ESO CES of the young (ZAMS) G0V star ι Hor. We find a Keplerian signal with a period of 320.1 d indicative of an orbiting planet with minimum mass $m \sin i = 2.26\ \mathrm{M_{Jup}}$. With an eccentricity of 0.161 and a semi-major axis of 0.925 AU this object moves in the most Earth-like orbit found so far among extrasolar planets. ι Hor is the youngest star with a known planet. In addition to the planetary signal we find an excess RV scatter of 27.0 $\mathrm{ms^{-1}}$ rms exceeding our measurement precision of 17.4 $\mathrm{ms^{-1}}$ and probably due to stellar activity.

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On the Possibility of Ground-based Direct Imaging Detection of Extra-solar Planets: The Case of TWA-7

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We show that *ground-based* direct imaging detection of extra-solar planets is possible with current technology. As an example, we present evidence for a possible planetary companion to the young T Tauri star 1RXSJ104230.3−334014 (=TWA-7), discovered by ROSAT as a member of the nearby TW Hya association. In an HST NICMOS F160W image, an object is detected that is more than 9 mag fainter than TWA-7, located $2.445 \pm 0.035''$ south-east at a position angle of $142.24 \pm 1.34°$. One year later using the ESO-NTT with the SHARP speckle camera, we obtained H- and K-band detections of this faint object at a separation of $2.536 \pm 0.077''$ and a position angle of $139.3 \pm 2.1°$. Given the known proper motion of TWA-7, the pair may form a proper motion pair. If the faint object orbits TWA-7, then its apparent magnitudes of H=16.42 ± 0.11 and K=16.34 ± 0.15 mag yield absolute magnitudes consistent with a $\sim 10^{6.5}$ yr old $\sim 3\ \mathrm{M_{jup}}$ mass object according to the non-gray theory by Burrows et al. (1997). At $\sim$ 55 pc, the angular separation of $\sim 2.5''$ corresponds to $\sim$ 138 AU, clearly within typical disk sizes. However, position angles and separations are slightly more consistent with a background object than with a companion.

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New Book

SOLAR AND STELLAR MAGNETIC ACTIVITY

by Carolus J. Schrijver and Cornelis Zwaan

Publisher: Cambridge University Press (http://www.cup.org)
Publication Date: January 2000
Price: $80.00 (hardback; ISBN 0 521 58286 5)
Contains: 400 pages, 108 figures, 18 tables.

Chapters: 1. Introduction: solar features and terminology; 2. Stellar structure; 3. Solar differential rotation and meridional flow; 4. Solar magnetic structure; 5. Solar magnetic configurations; 6. Global properties of the solar magnetic field; 7. The solar dynamo; 8. The solar outer atmosphere; 9. Stellar outer atmospheres; 10. Mechanisms of atmospheric heating; 11. Activity and stellar properties; 12. Stellar magnetic phenomena; 13. Activity and rotation on evolutionary time scales; 14. Activity in binary stars; 15. Propositions on stellar dynamos.

This monograph is the first comprehensive review and synthesis of our understanding of the origin, evolution, and effects of magnetic fields in stars that, like the Sun, have convective envelopes immediately below their photospheres. Our aim is to relate the magnetohydrodynamic processes in the various domains of stellar atmospheres to processes in the interior. We do so by exploiting the complementarity of solar studies, with their wealth of observational detail, and stellar studies, which allow us to study the evolutionary history of activity and the dependence of activity on fundamental parameters such as stellar mass, age, and chemical composition. We focus on observational studies and their immediate interpretation, in which results from theoretical studies and numerical simulations are included.

This book is intended for astrophysicists who are seeking an introduction to the physics of magnetic activity of the Sun and of other cool stars, and for students at the graduate level. The topics include a variety of specialties, such as radiative transfer, convective simulations, dynamo theory, outer-atmospheric heating, stellar winds, and angular momentum loss.

Submitted by:

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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

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