COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

Coronal Versus Photospheric Abundances of Stars With Different Activity Levels

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We report a detailed analysis of the coronal abundance of 4 stars with varying levels of activity and with accurately known photospheric abundances. The coronal abundance is determined here using a line flux analysis and a full determination of the differential emission measure. Photospheric abundance values are taken from literature works. Previous coronal abundance determinations have generally been compared to solar photospheric abundances; from this a number of general properties have been inferred, such as the presence of a coronal metal depletion with an inverse First Ionization Potential correlated with activity level. Here we show that, when coronal abundances are compared with real photospheric values for the individual stars, the resulting pattern can be very different. Also, we present evidence that, in some cases, the coronal metal abundance may not be uniform in the corona; in particular it can vary with the temperature of the emitting plasma.

Accepted by A&A

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Ultra-high-precision Velocity Measurements of Oscillations in α Cen A

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We have made differential radial velocity measurements of the star α Cen A using two spectrographs, UVES and UCLES, both with iodine absorption cells for wavelength referencing. Stellar oscillations are clearly visible in the time series. After removing jumps and slow trends in the data, we show that the precision of the velocity measurements per minute of observing time is $0.42\,\mathrm{m\,s^{-1}}$ for UVES and $1.0\,\mathrm{m\,s^{-1}}$ for UCLES, while the noise level in the Fourier spectrum of the combined data is $1.9\,\mathrm{cm\,s^{-1}}$. As such, these observations represent the most precise velocities ever measured on any star apart from the Sun.

Accepted by ApJ Letters

For preprints via ftp or WWW: http://arXiv.org/abs/astro-ph/0311408

A Chandra Observation of M 67

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We present the results of a 47-ks Chandra-ACIS observation of the old open cluster M 67. We detected 25 proper-motion cluster members (including ten new sources) and 12 sources (all new) that we suspect to be members from their locations close to the main sequence ($1<B{-}V<1.7$). Of the detected members, 23 are binaries. Among the new sources that are members and probable members are four spectroscopic binaries with $P_{\rm orb}<12$ d, two contact binaries and two periodic photometric variables with $P_{\rm ph}<8.4$ d. Their X-rays are likely the result of coronal activity enhanced by tidally locked rapid rotation. The X-rays of the new source S 997, a blue straggler in a wide eccentric orbit, are puzzling. Spectral fits show that the X-rays of the brightest sources S 1063 (a binary with a sub-subgiant), S 1082 (a triple blue straggler with a close binary) and S 1040 (a circular binary of a giant and a cool white dwarf), are consistent with coronal emission. We detected a new bright source that must have brightened at least about ten times since the time of the ROSAT observations. It is not clear whether its faint blue optical counterpart belongs to M 67. We discuss the possibility that this source is a low-mass X-ray binary in quiescence, which would be the first of its kind in an open cluster. In addition to cluster members, we detected about 100 background sources, many of which we identify with faint objects in the ESO Imaging Survey.

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For preprints via ftp or WWW: http://arXiv.org/abs/astro-ph/0311138

Magnetic Topology and Surface Differential Rotation on the K1 Subgiant of the RS CVn System HR 1099

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We present here spectropolarimetric observations of the RS CVn system HR 1099 (V711 Tau) secured from 1998 February to 2002 January with the spectropolarimeter MuSiCoS at the Télescope Bernard Lyot (Observatoire du Pic du Midi, France). We apply Zeeman-Doppler Imaging and reconstruct surface brightness and magnetic surface topologies of the K1 primary subgiant of the system, at five different epochs. We confirm the presence of large, axisymmetric regions where the magnetic field is mainly azimuthal, providing further support to the hypothesis that dynamo processes may be distributed throughout the whole convective zone in this star.

We study the short-term evolution of surface structures from a comparison of our images with observations secured at close-by epochs by Donati et al. (2003a) at the Anglo-Australian Telescope. We conclude that the small-scale brightness and magnetic patterns undergo major changes within a timescale of 4 to 6 weeks, while the largest structures remain stable over several years.

We report the detection of a weak surface differential rotation (both from brightness and magnetic tracers) indicating that the equator rotates faster than the pole with a difference in rotation rate between the pole and the equator about 4 times smaller than that of the Sun. This result suggests that tidal forces also impact the global dynamic equilibrium of convective zones in cool active stars.

Accepted by MNRAS

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High Resolution Doppler Images of the Spotted Contact Binary AE Phe

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We present Doppler images of the short period (P = 0.362 d) W UMa binary AE Phe. In order to obtain the necessary S/N rati o and time resolution required to see individual starspot features in highly rotationally broadened profiles we use least squares deconvolution, which makes use of the information content of the several thousand lines in a typical échelle spectrum. This yields a single ro tation profile (free of sidelobes due to blending) per spectrum with a typical S/N ratio of several thousand.

We use radial velocity curves, generated from standard profile fitting techniques to measure velocity amplitudes and the mass ratio. Fail ure to model starspots with this method leads to a biased set of values, and we show that an imaging code is essential if accurate system parameters are to be derived.

Images are reconstructed from four nights of data which reveal starspots at most latitudes on both components of the common envelope syst em. Our model requires that the primary component be several hundred K cooler than the secondary in order to reproduce the profile depth changes with phase. In a two temperature imaging model we interpret this as being due to 27% greater, but unresolved, spot filling on the primary relative to the secondary component. The images reveal that dark spots are present on both stars at various latitudes and longitud es. Starspots are also found in the neck region of both components, which appear to be darker on the side of each star leading in rotation phase, particularly on the secondary component. We investigate the reproducibility of the images from night to night and conclude that t he starspots evolve significantly on very short timescales, of order one day. This is significantly faster than the week timescales found on active single stars and the Sun.

Accepted by MNRAS

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Deconvolution of High Resolution Spectra as a Signal to Noise Enhancement Method

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We demonstrate the use of Singular Value Decomposition as a method for deconvolving high resolution spectra of rapidly rotating stars. A convolution matrix can be built from the observed template spectrum of a slowly rotating star, with the same spectral type as the target. This can then be written in terms of a set of orthogonal basis vectors which can easily be inverted. The deconvolved stellar rotation prof ile or broadening function is thus similarly represented as a linear combination of basis vectors. By including only the required number o f vectors and rejecting higher order terms which only describe noise, we obtain a broadening function with greatly boosted S/N ratio as co mpared with a mean line in the target spectrum. The high S/N ratios allow localised line distortions due to starspots to be resolved. We d escribe the technique and demonstrate its application to the data sets of a rapidly rotating K3 and M1 dwarf.

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Infrared Properties of Solid Titanium Oxides: Exploring Potential Primary Dust Condensates

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We present optical constants and opacities of solid TiO_2, Ti_2O_3, magnesium and calcium titanates, largely based on laboratory measurements. These dust species deserve interest as potential primary condensates in oxygen-rich dusty environments. Of the three known solid TiO_2 phases, only one (rutile) has been extensively studied so far with respect to its mid-IR optical properties. We compare these with our measurements of the optical constants of anatase, brookite and $CaTiO_3$. Furthermore, for several Mg-Ti-oxides, powder transmission spectra are shown. While all known TiO_2 modifications have their strongest bands between 13 and and 13.5 μm (for spherical particles), $CaTiO_3$, $MgTiO_3$ and other Mg titanates have principal maxima of their absorption coefficients between 14 and 19 μm. This makes a spectroscopic identification of circumstellar Ti oxide particles rather difficult, because both the 13 and the 14–19 μm region are crowded by other features in the spectra of oxygen-rich circumstellar shells. The new sets of optical constants here presented have been made available for public access in the electronic database *http://www.astro.uni-jena.de*

Accepted by ApJS

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Solar Abstracts

Ideal Kink Instability of a Magnetic Loop Equilibrium

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The force-free coronal loop model by Titov & Démoulin (1999) is found to be unstable with respect to the ideal kink mode, which suggests this instability as a mechanism for the initiation of flares. The long-wavelength ($m = 1$) mode grows for average twists $\Phi \gtrsim 3.5\pi$ (at a loop aspect ratio of ≈ 5). The threshold of instability increases with

increasing major loop radius, primarily because the aspect ratio then also increases. Numerically obtained equilibria at subcritical twist are very close to the approximate analytical equilibrium; they do not show indications of sigmoidal shape. The growth of kink perturbations is eventually slowed down by the surrounding potential field, which varies only slowly with radius in the model. With this field a global eruption is not obtained in the ideal MHD limit. Kink perturbations with a rising loop apex lead to the formation of a vertical current sheet below the apex, which does not occur in the cylindrical approximation.

Accepted by A&A Letters

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Formation of Current Sheets and Sigmoidal Structure by the Kink Instability of a Magnetic Loop

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We study dynamical consequences of the kink instability of a twisted coronal flux rope, using the force-free coronal loop model by Titov & Démoulin (1999) as the initial condition in ideal-MHD simulations. When a critical value of the twist is exceeded, the long-wavelength ($m = 1$) kink mode develops. Analogous to the well-known cylindrical approximation, a helical current sheet is then formed at the interface with the surrounding medium. In contrast to the cylindrical case, upward-kinking loops form a second, vertical current sheet below the loop apex at the position of the hyperbolic flux tube (generalized X line) in the model. The current density is steepened in both sheets and eventually exceeds the current density in the loop (although the kink perturbation starts to saturate in our simulations without leading to a global eruption). The projection of the field lines that pass through the vertical current sheet shows an S shape whose sense agrees with the typical sense of transient sigmoidal (forward or reverse S-shaped) structures that brighten in soft X rays prior to coronal eruptions. The upward-kinked loop has the opposite S shape, leading to the conclusion that such sigmoids do not generally show the erupting loops themselves but indicate the formation of the vertical current sheet below them that is the central element of the standard flare model.

Accepted by A&A Letters

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For preprints via ftp or WWW: http://www.aip.de/~kli/Fd041.pdf

Numerical Simulation of the Three-Dimensional Structure and Dynamics of the Non-Magnetic Solar Chromosphere

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Three-dimensional numerical simulations with CO^{5}BOLD, a new radiation hydrodynamics code, result in a dynamic, thermally bifurcated model of the non-magnetic chromosphere of the quiet Sun. The 3-D model includes the middle and low chromosphere, the photosphere, and the top of the convection zone, where acoustic waves are excited by convective motions. While the waves propagate upwards, they steepen into shocks, dissipate, and deposit their mechanical energy as heat in the chromosphere. Our numerical simulations show for the first time a complex 3-D structure of the chromospheric layers, formed by the interaction of shock waves. Horizontal temperature cross-sections of the model chromosphere exhibit a network of hot filaments and enclosed cool regions. The horizontal pattern evolves on short time-scales of the order of typically 20 - 25 seconds, and has spatial scales comparable to those of the underlying granulation. The resulting thermal bifurcation, i.e., the co-existence of cold and hot regions, provides temperatures high enough to produce the observed chromospheric UV emission and – at the same time – temperatures

cold enough to allow the formation of molecules (e.g., carbon monoxide). Our 3-D model corroborates the finding by Carlsson & Stein (1994) that the chromospheric temperature rise of semi-empirical models does not necessarily imply an increase in the average gas temperature but can be explained by the presence of substantial spatial and temporal temperature inhomogeneities.

Accepted by A&A *For preprints contact*: wedemeyer@kis.uni-freiburg.de

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Bashful Ballerina: Southward Shifted Heliospheric Current Sheet

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It is known since long [*Rosenberg and Coleman*, 1969] that one of the two sectors of the interplanetary magnetic field (IMF) observed at the Earth's orbit dominates at high heliographic latitudes during solar minimum times, reflecting the poloidal structure of the global solar magnetic field at these times. Here we find that while this latitudinal variation of the dominant IMF sector around the solar equator is valid for both solar hemispheres during the last four solar minima covered by direct observations, it is systematically more strongly developed in the northern heliographic hemisphere. This implies that the average heliospheric current sheet is shifted or coned southward during solar minimum times, suggesting that the temporary southward shift of the heliosheet found earlier by Ulysses observations in 1995 is a persistent pattern. This also implies that the open solar magnetic field is north-south asymmetric at these times, suggesting that the solar dynamo has an asymmetric component. Accordingly, the Sun with the heliosheet is like a bashful ballerina who is repeatedly trying to push her excessively high flaring skirt downward. However, the effective shift at 1 AU is only a few degrees, allowing the Rosenberg-Coleman rule to be valid, on an average, in both hemispheres during solar minima.

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Solar Impulsive Soft X–ray Brightenings and Their Connection with Footpoint Hard X–ray Emission Sources **T. Mrozek[1], and M. Tomczak[1]**

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We have investigated 46 solar flares showing impulsive soft X–ray brightenings in footpoints. To obtain their main observational characteristics we used the *Yohkoh*/SXT images. The results are presented in the form of normalized histograms showing the distribution of the characteristics. For 18 flares it has been possible to make a quantitative comparison between the footpoint response in soft X–ray images and in hard X–ray images. The latter have been derived from the *Yohkoh*/HXT and reconstructed using the MEM procedure. The evident correlation between these two kinds of response, as well as between the deposited energies, strongly supports a common physical cause, namely non-thermal electron beams. We present evidence that in the impulsive phase the chromospheric evaporation is driven mainly by low-energy non-thermal electrons. We show that the low-energy cut-off energy in hard X–ray photon fluxes may vary from flare to flare and may even vary during a given flare. Accepted by A&A *For preprints contact*: mrozek@astro.uni.wroc.pl

DOT Tomography of the Solar Atmosphere
I. Telescope Summary and Program Definition

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The Dutch Open Telescope (DOT) on La Palma is an innovative optical solar telescope capable of reaching 0.2 arcsec angular resolution over extended durations. The DOT presently progresses from technology testbed to a stable science configuration providing multi-wavelength imaging and multi-camera speckle data acquisition for tomographic mapping of the solar atmosphere. Large-volume speckle processing will soon enable frequent usage and community-wide time allocation, in particular for tandem operation with other solar telescopes pursuing spectropolarimetry and EUV imaging. We summarize the DOT hardware and software in the context of this increasing availability and outline the corresponding "open-DOT" program.

Accepted by A&A

For preprints via WWW: http://dot.astro.uu.nl

DOT Tomography of the Solar Atmosphere II. Reversed Granulation in Ca II H

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High-quality simultaneous image sequences from the Dutch Open Telescope (DOT) in the G band and the Ca II H line are used to quantify the occurrence of reversed granulation as a constituent of the subsonic brightness pattern observed as a background to acoustic oscillations in the quiet-Sun internetwork atmosphere. In the middle photosphere reversed granulation constitutes a much larger part of this background than at the larger heights sampled by ultraviolet radiation. The anticorrelation with the underlying granulation reaches about 50% at a temporal delay of 2–3 min, and increases with spatial image smoothing to mesogranular resolution. We discuss the nature of reversed granulation in terms of convection reversal, gravity waves, acoustic waves, and intergranular magnetism, suggest that the internetwork background pattern is primarily a mixture of the first two ingredients, and speculate that it is also an inverse canopy mapper.

Accepted by A&A

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Low-Mass and Substellar Abstracts

Spectroscopic [Fe/H] for 98 Extra-solar Planet Host Stars: Exploring the Probability of Planet Formation

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In this paper we present stellar parameters and metallicities, obtained from a detailed spectroscopic analysis, for a large sample of 98 stars known to be orbited by planetary mass companions (almost all known targets), as well as for a volume-limited sample of 41 stars not known to host any planet. For most of the stars the stellar parameters are revised versions of the ones presented in our previous works. However, we also present parameters for 18 stars with planets not previously published, and a compilation of stellar parameters for the remaining 4 planet-hosts for which we could not obtain a spectrum. A comparison of our stellar parameters with values of $T_{\rm eff}$, $\log g$, and [Fe/H] available in the literature shows a remarkable agreement. In particular, our spectroscopic $\log g$ values are now very close to trigonometric $\log g$ estimates based on Hipparcos parallaxes. The derived [Fe/H] values are then used to confirm the previously known result that planets are more prevalent around metal-rich stars. Furthermore, we confirm that the frequency of planets is a strongly rising function of the stellar metallicity, at least for stars with [Fe/H]>0. While only about 3% of the solar metallicity stars in the CORALIE planet search sample were found to be orbited by a planet, this number increases to more than 25% for stars with [Fe/H] above +0.3. Curiously, our results also suggest that these percentages might remain relatively constant for values of [Fe/H] lower than about solar, increasing then linearly with the mass fraction of heavy elements. These results are discussed in the context of the theories of planetary formation.

Accepted by A&A

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JHK Magnitudes for L and T Dwarfs and Infrared Photometric Systems

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Near–infrared magnitudes have been published for L and T dwarfs using a variety of photometric systems. Currently, the data obtained with these systems cannot be accurately compared or combined as transformations based on the colors of hotter stars are not valid for L and T dwarfs. To address this problem, we have synthesized J, H, and K magnitudes for some of the common photometric systems and present transformation equations with respect to the most atmospheric–independent system, the Mauna Kea Observatory (MKO) filter set. If the spectral type of the dwarf is known, our transformations allow data to be converted between systems to 0.01 mag, which is better than the typical measurement uncertainty. Transforming on the basis of color alone is more difficult because of the degeneracy and intrinsic scatter in the near–infrared colors of L and T dwarfs; in this case J magnitudes can only be transformed to ≤ 0.05 mag and H and K to ≤ 0.02 mag.

Accepted by PASP (to appear Jan. 2004, v.116)

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Job Openings

Positions at the Integral Science Data Center (ISDC)
Versoix, Switzerland

Three openings are available at ISDC as follows: (i) a postdoctoral position, (ii) a senior visitor position, and (iii) a PhD student position. The ISDC is located about 10 km from Geneva. Prospective applicants should consult the Nov. 25 PDF file Job Announcement on the ISDC web page at http://isdc.unige.ch. Applications for the Postdoctoral position are due 10 Dec. 2003.

INTEGRAL Science Data Centre
Chemin d'Ecogia 16
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Switzerland
http://isdc.unige.ch/

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

`http://casa.colorado.edu/~skinners/coolnews.html .`

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