// COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Introducing COOLNEWS!!!

Welcome to the first issue of what I hope will become a prosperous monthly newsletter devoted to cool stars and the sun. We are starting off with a good show of interest as evidenced by the 24 abstracts (20 stellar + 4 solar) in this issue. I sincerely thank those of you who took the time to send in your recent results. The long-term survival of this newsletter obviously depends on the willingness of the cool star and solar communities to send in research abstracts, and I strongly encourage you to do so. You will be rewarded for the few minutes of time that it takes to send in your abstract by rapid and broad circulation of your research results – we already have more than 600 subscribers and the list is still growing! Although we did receive four interesting solar abstracts this month, I hope that we will see more participation from the solar community in the future as the newsletter becomes more widely known. We know you are out there solar physicists...so let us know what you are up to! I would like to thank two people who made contributions that enabled me to put together this first issue in a relatively short amount of time. Bo Reipurth contributed some of his existing Latex macros and Roberto Pallavicini added many names of cool star researchers (mainly in Europe) to my original mailing list. I am planning to set COOLNEWS up on the World-Wide-Web but this has not been done yet. So now on with our first issue, which I hope you will enjoy and find useful in your research.
Sincerely, Steve Skinner

An X-ray Survey of the Open Cluster NGC 6475 (M7) with ROSAT

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A ROSAT X-ray survey, with complimentary optical photometry, of the open cluster NGC 6475 has enabled the detection of $\sim$ 50 late-F to K0 and $\sim$ 70 K/M dwarf new candidate members, providing the first reliable detection of low-mass stars in this low galactic latitude, 220 Myr-old cluster. The X-ray observations reported here have a typical limiting sensitivity of $L_X \simeq 10^{29}$ erg/s. The detection frequency of early-type cluster members is consistent with the hypothesis that the X-ray emitting early-type stars are binary systems with an unseen, low-mass secondary producing the X-rays. The ratio between X-ray and bolometric luminosity among NGC 6475 members saturates at a spectral-type/color which is intermediate between that in much younger and in much older clusters, consistent with rotational spindown of solar-type stars upon their arrival on the ZAMS. The upper envelope of X-ray luminosity as a function of spectral-type is comparable to that of the Pleiades, with the observed spread in X-ray luminosity among low-mass members being likely due to the presence of binaries and relatively rapid rotators. However, the list of X-ray selected candidate members is likely biased against low-mass, slowly rotating single stars. While some preliminary spectroscopic information is given in an appendix, further spectroscopic observations of the new candidate members will aid in interpreting the coronal activity among solar-type NGC 6475 members and their relation to similar stars in older and younger open clusters.

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HD 121447: An ellipsoidal-variable barium star?

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Orbital elements are derived from CORAVEL measurements for the coolest known barium star HD 121447 (K7IIIBa5). The orbital period of $P_{\rm orb} = 185.7$ d is the second shortest among barium stars. A photometric monitoring reveals small amplitude variations with a period $P_{\rm orb}/2$. The phase of the variations and the stability of the color indices are compatible with the system being an ellipsoidal variable. If the red giant is located on the first giant branch, the analysis of the light curve and the orbital elements yield the following parameters for the system: $1.5 \le M_1$ (M$_\odot$) ≤ 1.7, $0.5 \le M_2$ (M$_\odot$) ≤ 0.7, $68° \ge i \ge 48°$, $53 \le R_1$ (R$_\odot$) ≤ 61, $173 \le A$ (R$_\odot$) ≤ 184, and $-2.2 \ge M_{\rm bol,1} \ge -2.4$ (where the indices 1 and 2 stand for the giant and the companion, respectively). The mass of the invisible companion is compatible with a white dwarf. Possible binary scenarios for this system are briefly discussed. In particular, the short orbital period of this barium star makes it hardly possible for the AGB progenitor of the current white dwarf to fit in the system without having filled its Roche lobe. Wind accretion in a detached system can thus not account for the chemical peculiarities exhibited by HD 121447. Another peculiarity of this system is the absence of synchronization between the giant rotation and the orbital motion, although the orbit has been circularized by dissipative processes.

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New X-ray sources detected among mild barium and S stars

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We report on the detection by ROSAT of X-rays from the mild barium star HD 165141 (K0III/IIBa1) and from the S stars HD 35155 (S4,1) and HR 363 (S3/2). For the S stars, the X-ray flux is attributed to the accretion of the red-giant wind by the white dwarf companion. The strong variability observed in the X- and UV fluxes on time scales of both hours and months may be due to irregularities in the accretion rate, or to variable obscuration by cool gas present in the system. In the case of HD 35155, the absence of ROSAT detection at the phase where eclipses are observed in the UV and optical domains suggests that part of the X-ray variability may be associated with eclipses of the compact companion.

HD 165141 is more puzzling since this star seems to share the properties of RS CVn and barium systems. The properties of the X-rays emitted by this system are typical of RS CVn systems, as is the photometric period of 35 d and the rapid rotation. However, the rapid rotation does not seem to be due to synchronism with the orbital period, as is usually the case for RS CVn systems. The companion appears to be a hot white dwarf rather than a main sequence star, with a long orbital period ($\sim$ 5200 d), more typical of barium than of RS CVn systems. These conflicting properties could be explained if this particular barium star formed on the giant branch, accreting not only mass but also spin angular momentum.

The two giants HR 5692 (G8IIIBa0.3) and HR 6468 (G8IIIBa0.6) appear to be coronal X-ray sources. The barium nature of these stars is questioned, given their small Ba indices and their normal DDO photometric indices. Moreover, since HR 6468 is a radial-velocity standard star, it is likely not a binary star as required for barium stars.

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A catalogue of associations between IRAS sources and S stars

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Cross identifications between the *General Catalogue of Galactic S Stars* (GCGSS), the IRAS *Point Source Catalogue* (PSC), and the *Guide Star Catalogue* (GSC) are presented. The purpose of the present catalogue is (i) to provide a clean sample of S stars with far-IR data, and (ii) to provide accurate GSC positions for S stars, superseding those listed in the GCGSS. The IRAS colour-colour diagram and the galactic distribution of S stars associated with an IRAS source are presented. Several S stars having extended images in at least one IRAS band have also been identified.

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Coronal X-Ray Emission of Cool Stars in Relation to Chromospheric Activity and Magnetic Cycles

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We study the relationship between the coronal X-ray emission of single, main-sequence F-K stars and the characteristics of their magnetic cycles. We use X-ray data primarily from the ROSAT all-sky survey (RASS) as well as data acquired by us in the ROSAT pointed program, and the published data of the Mt. Wilson CaII H+K monitoring program. According to their CaII H+K long-term variability characteristics, we divide the stars into three groups: non-variable,

regular variable and irregular (chaotic) variable stars. We show that the regular and the irregular stars differ mainly in their Rossby-numbers (Ro): regular stars have almost always $Ro < 1$ whereas the irregular group is characterized by $Ro > 1$; further, the X-ray surface flux distributions differ significantly between these three groups. We discuss to what extent stars exhibiting constant Ca II fluxes can be considered "Maunder minimum" stars, and demonstrate – in a statistical sense – that cyclic chromospheric activity also implies cyclic coronal activity. From a reanalysis of the flux-flux relation between the calcium excess flux density ($\Delta F_{\rm Ca}$) and $F_{\rm X}$, we find different relations between the regular and the constant stars on one hand and the irregular stars on the other hand. Performing regression analysis in the form of a power law, the coefficient κ is derived to be $\kappa \approx 1$ for constant and regular stars whereas $\kappa \approx 2$ for the more active irregular stars. We discuss our findings in the context of a transition from a nonlinear to a linear dynamo regime when going from irregular to regular stars.

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Rotational periods and starspot activity of young solar-type dwarfs in the open cluster IC4665

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We present the results of a V-band photometric monitoring survey of 15 late-type dwarfs in the young open cluster IC 4665. Low-amplitude periodic light variations are found for 8 stars and ascribed to the modulation by starspots that cover typically a few percent of the stellar disk. Periods range from 0.6 to 3.7d, translating to equatorial velocities between 13 and 93 km s^{-1}. That no period longer than 4d was detected suggests a relative paucity of extremely slow rotators ($V_{\rm eq} << 10$ km s^{-1}) among late-type dwarfs in IC 4665. The fractional number of slow rotators in IC 4665 is similar to that of the Alpha Per cluster, suggesting that IC 4665 is close in age to Alpha Per ($\sim$ 50 Myr).

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Observation and modelling of main sequence star chromospheres IV. The chromospheric contribution to Li I lines in active dwarfs

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In magnetically active stars, non-thermal heating and magnetic fields result in inhomogeneous outer atmospheres (plages) and photospheres (dark and bright spots). So as to gauge the importance of these phenomena on "normal photospheric lines", we investigate the influence of the chromosphere on the Lithium I lines in M dwarfs. We choose this element because Li I 6708Å is often used as an age indicator.

Solving the NLTE-radiation transfer problem for a grid of model atmospheres that mimic the effect of magnetic activity (from basal to saturated chromospheres), we show that the Lithium lines are in fact activity sensitive. This dependence commences at rather high activity levels, i.e. when H_α goes into emission. As in the solar case, this chromospheric plage effect weakens the line equivalent widths and may cancel the photospheric spot effect on disc integrated measurements.

The ionisation balance and line formation remain photoionisation controlled throughout the known pressure range in M star chromospheres. Changes in the line profiles and equivalent widths are due to the non-photospheric UV continuum that further ionises neutral lithium and depletes the line optical depths, whereas in solar plages collisional ionisation is the driving mechanism. In K dwarfs, both would compete to yield a similar effect. Therefore, great care must be exercised in the use of Li 6708Å in both abundance and age calculations for active stars. We found that the 6708Å to 6104Å line ratio is less sensitive to magnetic activity than the line equivalent widths and should be a better age indicator.

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Observation and modelling of main sequence star chromospheres V. Ultra-Violet excess emission in active M dwarfs

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The variation in the continuum intensity (50-5000nm) of late-type M dwarfs is investigated via two grids of model atmospheres with different temperature minima. It is shown that the (E)UV intensity is mostly dependent on the transition region pressure, although the temperature minimum also plays an important role. We also observe a significant *frequency redistribution* of the photospheric flux when changing the minimum temperature, and a black-body type of emission from the lower chromosphere.We examine the formation of the continuum and point out that, although some differences appear for very low or very high activity levels, in general the global picture is much alike the Sun. We show that the UV continua are very good diagnostics of cool dwarf atmospheres, from the temperature minimum to the transition region. Our calculations give a good overview of the domains where physical parameters and spectral signatures are most likely observed.

We compute the UBV(RIJKL)$_J$ broad band fluxes for our models and conclude that the chromospheric contribution should be detectable in the U band and possibly also in the B band. We compare our calculations to recent high resolution observations for selected stars in a narrow spectral range ((R-I)$_K$=0.875±0.05); we show that Hα line profiles behave as expected, with a tight correlation between the line width and equivalent width. Hα emission line stars show an excess in U-B color but not in B-V. They are also more luminous than their less active absorption line counterparts, which indicates that active dwarfs have not yet reached the main sequence and are intermediate between T Tauri stars and main sequence stars. The anomalously large proportion of active stars towards late spectral types is attributed to the very slow contraction phase for low mass stars.

We calculate the fluxes in the Extreme Ultraviolet Explorer Sn/SiO band (500-740Å) and show that they are compatible with observed upper limits. We further compare our results for the upper activity range to pre-main sequence models and observations. They strongly support the case for a chromospheric contribution to Hα and the blue/UV excess for those objects (T Tauris, naked T Tauris, YSOs).

An important conclusion is that at high pressures, corresponding to active dMe stellar atmospheres, the chromosphere becomes a very efficient radiator at continuum wavelengths. From log(M)∼-5 (column mass), radiative losses in the continuum rise exponentially and faster than in hydrogen spectral lines because of their larger optical depths. As a consequence, H I spectral lines have a small or negligible contribution to the total H I (lines and continua) and white light radiative budget.

We show that the hydrogen series dominate the radiative cooling in spectral lines (from 40% to 90%) for Hα emission line stars. The cooling in the (E)UV continuum overwhelms the total radiative budget and is much larger than that in outstanding chromospheric and transition region lines (e.g. Ca II, Mg II, H I Lyman and Balmer). We propose this as a possible contribution for the apparent saturation observed in some spectral lines, therefore questioning the suggestion of saturation in magnetic activity levels.

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Corona(e) of AR Lac: I. The Temperature and Abundance Distribution

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X-ray spectra of the RS CVn binary, AR Lac, obtained from simultaneous observations with the *ROSAT* PSPC and the *ASCA* SIS and GIS detectors have been analyzed to study the coronal temperature and abundance distribution. The spectra were jointly fit with plasma emission models to the following possible temperature distributions: (a) one with discrete multi-temperature emission components, (b) a continuous emission measure with a power-law dependence on temperature, and (c) a continuous emission distribution parameterized by the sum of a 6th order Chebyshev polynomial. We find: (i) solar abundance plasma models with either discrete or continuous emission measure (CEM) distributions are rejected, (ii) the best fit is obtained with a two-temperature, 2T, plasma emission model with an under-abundance of the elements O, Mg, Si, S, Ar, Ca and Fe by a factor of 3 – 4 relative to the solar photospheric values, and (iii) the best-fit CEM distribution also has similarly reduced abundances, but fits the data less well than the 2T model. These results are confirmed even when the Fe L region, which is subject to uncertainties in the atomic physics, is excluded from the fit. We consider optical depth effects as unlikely to be the explanation for the observed weakness of the line complexes relative to the continuum. Analysis of the spectral data during the primary and secondary eclipses show that the emission measure of the high temperature component in the 2T models appears to be more affected by the primary eclipse than the low temperature component, suggesting that part of the former is concentrated in structures that are spatially more compact.

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The Corona of AR LAC: II. The Spatial Structure

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The X-ray lightcurves in the 0.4–1.5 keV and 2–7 keV bands of the RS CVn binary AR Lac observed on 1993 June 1 to 3 over one full orbital cycle with the *ASCA* satellite have been used to map the spatial structure of AR Lac's coronae. We find that (i) both stars are X-ray active, (ii) X-ray emission is concentrated on the sides of the stars facing each other, (iii) there are compact and well localized regions of enhanced X-ray emission with heights much smaller than the stellar radii, as well as extended regions with dimensions similar to or greater then the radii of the underlying stars which may be structures that interconnect the two stars, (iv) the corona of the K-type secondary star appears to be hotter than the corona of the G-type primary star, and (v) about 50% of the X-ray emission is unmodulated and could come from either an extended halo region, or from the poles of the larger K star, or from other symmetric or uneclipsed structures in the orbital plane. We compare the coronal structures inferred from the *ASCA* observations with those inferred using the same technique from an *EXOSAT* observation of AR Lac made in 1984, and find that there are substantial differences between the coronal structures at these two epochs. We have derived rough physical parameters for the corona of AR Lac using the information on the spatial sizes of its components together with information about its emission measure and temperature obtained from a simple spectral analysis of the *ASCA* data. The electron densities inferred for the spatially resolved emission regions are similar to the range of values observed in the solar corona above active regions, viz. 10^9–10^{10} cm^{-3}, while the estimated temperatures of these regions are similar to those found in solar flares ($T \geq 1$ keV).

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Lithium abundance in the Globular Cluster NGC 6397

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We present high resolution observations (FWHM=15 km s^{-1}) of the lithium region in 6 stars belonging to the old

globular cluster NGC6397. Three stars are located at the turn-off with T_{eff} on the Spite *plateau*. All three show the lithium line. Of the three other stars (all of which have evolved from the main sequence) two show depleted lithium and the third, most luminous one, has only an upper limit.

Abundances are derived by using model atmospheres generated with the Atlas 9 code (Kurucz 1993) with α enhancement and no-overshooting. The average lithium abundance of the three turnoff stars is 2.28±0.10. For one of these we confirm the detection of Molaro and Pasquini (1994). This value is fully consistent with the Li *plateau* of field population II stars, obtained with the same set of models.

Thus, the present results confirm that this 14 Gyrs old globular cluster and the field population II share the same lithium abundance. Furthermore, within the errors, no spread is observed in the Li abundance of the turnoff stars. As NGC6397 is one of the oldest clusters known, the observed Li abundance strongly supports a cosmological origin for lithium, leaving little room for alternative sources.

In two subgiants with T_{eff} ~5100 K and ~5600 K that are respectively 2 and 0.5 magnitudes brighter than turnoff, we have measured Li abundance of 1.81 and 1.2. However, for the cooler and most luminous star of the sample only an upper limit could be derived. This drop in Li abundance is not predicted by any of the existing models.

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Trigonometric Parallaxes and the HR Diagram at the Bottom of the Main Sequence

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The final results of a parallax program carried out with the 1.5m telescope on Palomar Mountain are presented. Astrometry has been obtained for 34 Very Low-Mass (VLM) stars, one white dwarf and a serendipitously discovered proper motion star. Sixteen of these stars stars have new (or improved) parallaxes and proper motions, and a further eighteen have proper motions alone. Common proper motions have also been determined for two VLM binary systems; GD 165AB and TVLM 513-42404AB. The latest atmospheric and interior models for low-mass stars are combined to produce isochrones in the *observational* M_I:I–K plane. Remarkable agreement is seen between both the solar metallicity and low metallicity models, and the observed low-mass sequences.

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Mass-luminosity Relation of Low Mass Stars

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The data on dynamic masses and multicolor photometry of 53 M-type components of binary/multiple systems was collected. Critical evaluation of late type stars bolometric correction scales have been performed. Our refined and reduced data is compared with published empirical and theoretical mass-luminosity relations. Our data does not exclude the existence of a step-like feature at $M_V = 12^m$. The best agreement between observations and theoretical models is found for recent calculations of D'Antona & Mazzitelli (1994) with Alexander opacities. We conclude that present-day knowledge of the mass-luminosity relation at faintest magnitudes is not sufficient for making definite conclusions on the initial mass function of low mass stars.

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Goddard High Resolution Spectrograph Observations of Procyon and HR 1099

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Goddard High Resolution Spectrograph (GHRS) observations have revealed the presence of broad wings in the transition region lines of AU Mic and Capella (Linsky & Wood 1994, ApJ, 430, 342; Linsky et al. 1995, ApJ, 442, 381). These authors proposed that these wings are signatures of microflares in the transition regions of these stars, and that the solar analog for this phenomenon might be the "transition region explosive events" discussed by Dere, Bartoe, & Brueckner (1989, Sol. Phys., 123, 41). We have analyzed GHRS observations of Procyon (F5 IV-V) and HR 1099 (K1 IV + G5 IV) to search for broad wings in the UV emission lines of these stars. We find that the transition region lines of HR 1099, which are emitted almost entirely by the K1 star, do indeed have broad wings that are even more prominent than those of AU Mic and Capella. This is consistent with the association of the broad wings with microflaring since HR 1099 is a very active binary system. In contrast, the transition region lines of Procyon, a relatively inactive star, do not show evidence for broad wings, with the possible exception of N V λ1239. However, Procyon's lines do appear to have excess emission in their blue wings.

Linsky et al. (1995) found no evidence for broad wings in Capella's chromospheric lines, but we find that the Mg II resonance lines of HR 1099 do have broad wings. The striking resemblance between HR 1099's Mg II and C IV lines suggests that the Mg II line profiles may be regulated by turbulent processes similar to those that control the transition region line profiles. If this is the case, microflaring may be occurring in the K1 star's chromosphere as well as in its transition region. However, radiative transfer calculations suggest that the broad wings of the Mg II lines can also result from normal chromospheric opacity effects rather than pure turbulence. The prominence of broad wings in the transition region and perhaps even chromospheric lines of active stars suggests that microflaring is very prevalent in the outer atmospheres of active stars.

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Quiescent Non-thermal Radio Emission From Stellar Systems

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Non-thermal radio emission has been detected from dMe stars, RS CVn binaries and W T Tauri stars. Polarization and intensity measurements of the quiescent (i.e. non-flaring) emission indicate that the emission is gyrosynchrotron emission from mildly relativistic electrons spiralling in a magnetic field. A three-dimensional dipole magnetic field model for the stellar field is presented and the quiescent gyrosynchrotron emission from such a model is calculated and compared with observations. The model can account for many phenomenological features of quiescent emission. Quantitative comparisons of model results with observations indicate that the electron distribution in the emission region may be a magnetically mirroring distribution.

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Formation of lithium lines in very cool dwarfs

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We present LTE and NLTE results on the formation of Li I lines (λ6103, λ6708, and λ8126) in the atmospheres of solar metallicity dwarfs with effective temperatures in the range 5500 K to 2000 K. NLTE effects are governed by overionization of Li and by the interlocking effects of energy levels. For stars with $T_{eff} \geq 4000$ K, we confirm previous findings by Magazzù et al. (1992). NLTE corrections can lower the LTE Li abundances derived from strong Li lines by up to 0.5 dex.

Our computations using model atmospheres with T_{eff} between 3000 K and 2000 K show that prominent Li I lines are formed. We give a set of line profiles, which support the feasability of the Li test for brown dwarfs. The ionization-dissociation equilibrium for Li species was carefully considered. NLTE effects on the Li I lines of very cool dwarfs are found to be small, implying corrections to the LTE Li abundances lower than 0.1 dex. Several numerical tests have been carried out to estimate the effects of chromosphere-like structures on the formation of LiI lines. Our preliminary results suggest that in the presence of very strong chromospheres, the line strengths are reduced.

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Theoretical LTE & non-LTE curves of growth for Li I lines in G-M dwarfs and subgiants

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Detailed simultaneous radiative transfer-statistical equilibrium calculations have been performed for lithium in atmospheres of solar metallicity G-M dwarfs and subgiants. Model atmospheres of stars with $3500 \leq T_{eff} \leq 6000$ K, $3.5 \leq \log g \leq 4.5$ have been considered. The behaviour of individual lithium levels populations, source functions and curves of growth for the lithium doublet at λ670.8 nm and two subordinate lines of astrophysical interest (λ610.3 nm and λ812.6 nm) are discussed. The computed LTE and non-LTE curves of growth are given in tabular form.

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On the quiet state periodic light variation of the flare star EV Lac

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The analysis of a homogeneous set of photometric UBV data of the flare star EV Lac for the time interval between July 1972 and October 1976 indicates that EV Lac exhibits intervals of periodic light variations with amplitudes up to 0.1 magnitude and period of $4^{d}.376$. The duration of these active periods are of the order of one or two months and are separated by calm periods of about the same duration. All the photometrically active periods coincide with periods of relatively high flare activity. The phasing of the light minima are in good agreement with the phasing of the flare frequency for the time interval 1973–1976. These results are in favour of a starspot modulated light variation model of the star which rotates with a period of $4^{d}.376$.

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A Consistent Explanation for $^{12}C/^{13}C$, ^{7}Li and ^{3}He Anomalies in Red Giant Stars

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The observations of carbon isotopic ratios in evolved stars suggest that non standard mixing is acting in low mass stars as they are ascending the red giant branch. We propose a simple consistent mechanism, based on the most recent

developments in the description of rotation-induced mixing by Zahn (1992), which simultaneously accounts for the low $^{12}C/^{13}C$ ratios in globular cluster and field Pop II giants and for the lithium abundances in metal-poor giant stars. It also leads to the destruction of ^{3}He produced on the main sequence in low mass stars. This should both naturally account for the recent measurements of ^{3}He/H in galactic HII regions and allow for high values of ^{3}He observed in some planetary nebulae.

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Cross-correlation radial velocity measurements of chromospherically active binaries

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We present observational radial velocity curves for 12 chromospherically active binary systems and indivudual measurements for a further 5 systems. These binaries are LX Per, V471 Tau, EI Eri, OU Gem, GK Hya, TY Pyx, Z Her, MM Her, V772 Her, ER Vul, BD-004234, MY Cyg, AR Lac, KZ And, RT And, SZ Psc and EZ Peg. Six of our target binaries do not agree with published ephemerides or orbital parameters. We also present a rigorous derivation of the resolution limit for binary star cross-correlation radial velocities. Using synthetic spectral data we investigate the errors induced by rotational broadening, signal-to-noise ratio, spectral-type mismatch and luminosity ratio.

A & A (in press)

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Solar Abstracts

Yohkoh Soft X-ray Spectroscopic Observations of the Bright Loop-top Kernels of Solar Flares

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Observations of solar flares by the Soft X-ray Telescope (SXT) on board *Yohkoh* frequently show strongly enhanced brightenings near the tops of the magnetic loops containing hot plasma. The *Yohkoh* Bragg Crystal Spectrometer (BCS) cannot normally make observations of these loop-top sources in the absence of contamination by the legs and the feet of the loops since it has no spatial resolution. We have overcome this limitation by using the solar limb as an occulting edge in a sequence of similar flares that occurred over an interval of $\sim$ 10 hr near the west limb on 1992 November 24. The progressive occultation by the limb restricts the line of sight to higher and higher altitudes during this sequence, with the final event showing only a compact source of the type often found at loop tops. BCS observations in Fe XXV, Ca XIX, and S XV show that electron temperatures and nonthermal velocities in these compact sources are similar to those quantities determined for disk flares in previous studies. As with disk flares, the nonthermal line broadening persists late into the decay phase of the flaring isolated loop tops. Our results favor mechanisms for nonthermal-velocity generation which are either independent of height or place the source near the apex of the flaring loop. In addition, there may be a temporal relationship between the hard X-ray emission and the nonthermal velocity, which suggests a possible association between the primary energy release of the flare, the nonthermal velocity generation mechanism, and the loop top.

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The Ultraviolet Spectrum of a 3B Class Flare Observed with SOLSTICE

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An observation of the ultraviolet spectrum (1200 to 1800 Å) during the impulsive phase of a very extended 3B-X3 class solar flare on 1992 February 27 has been obtained with the Solar-Stellar Irradiance Comparison Experiment (SOLSTICE). Our observation is combined with ground based Hα, magnetogram, and microwave observations as well as hard X-ray measurements from the Ulysses spacecraft. This flare shows a dramatic enhancement of lines formed in the solar transition region. The full disk irradiance (i.e. the *Sun as a star*) of the resonance lines of C IV and Si IV increased by a factor of 15-17 during the impulsive phase of the flare. These flux enhancements are comparable with those during stellar flares. By taking into account the emitting area we infer that the radiance of this flare increased by a factor of 20,000 or more relative to the non-flaring background. Such enhancement far exceeds previous published values (e.g., OSO 8, Skylab, and SMM) and indicates that many observations were affected by limited dynamical range. Thus, the SOLSTICE observation may be the first measurement of the true UV enhancement during very bright solar flares.

In addition to C IV and Si IV, the the Si III multiplet near 1295 Å also shows remarkable enhancement. Most other allowed lines such as C II, Si III(1206) , N V, and He II show moderate enhancements. The weakest enhancement of all is the H I Lyman-α, for which the irradiance increases only 10%. Some of the differences between the various enhancements may be due to the observations timing since the scanning spectrometer observes different spectral features with up to 4 minutes time difference. Other differences due to line formation processes are being investigated but are consistent with density effects in the line emission calculations. During the flare the strong transition region lines are systematically redshifted by 50 km s^{-1}.

The observed Lyman-α is consistent with current models, and even the large intensities of C IV and Si IV could be explained by a rapid increase in the electron density of the plasma at transition region temperatures.

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Turbulent and Chaotic Dynamics Underlying Solar Magnetic Variability

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We examine the temporal scaling properties of solar magnetic activity on time scales from days to decades. Because of more than 63,000 usable data points, we concentrate on the daily International Sunspot Number. Some results have been checked with other data sets, primarily the 10.7 cm microwave flux with about 16,000 data points. Such time series provide a measure whose scaling and intermittency properties are analyzed.

By means of correlation analysis and both Fourier and wavelet spectral analysis, we distinguish two regimes of temporal behavior of the magnetic variability. The scaling of the time series is analyzed in terms of multiplicative cascade processes which prove to be invariant over more than two decades of scale from about 2 years down to about 2 days or less. We interpret this result to indicate generic turbulent structuring of the magnetic fields as they rise through the convection zone. We find that a low-dimensional, chaotic behavior in the sunspot number operates entirely at time scales longer than a transition threshold scale of about 8 years. Magnetic variability on time scales between 2 years and 8 years apparently requires handling by direct simulation.

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The Role of Loop Footpoints Rotation in Single Loop Flares

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We suppose that relative rotational momentum of loop footpoints is one of the important reasons for single loop flares. The relative rotation of loop footpoints necessarily causes the existence of a nonrotating normal plane (NNP) with zero rotational momentum. The location of this NNP depends on the relative rotation of the footpoints. The centrifugal force, which is one of the compensating factors against the magnetic Lorentz force, is very small near the NNP; therefore the pinch instability is more probable in this area. Choosing a typical geometry for this area, we use MHD equations to find self-consistent expressions and a set of equations governing behaviour of all physical quantities. Numerical simulations have revealed that under the determined conditions for the initial azimuthal velocity and current, a pinch instability takes place. The most important parameters of the problem are the plasma parameter β ($\beta = 4\pi p_{00}/{b_{\phi 0}}^2$, where p_{00} and $b_{\phi 0}$ are the initial values of the pressure and the longitudinal component of the magnetic field, respectively), and the ratio of the initial values of longitudinal and poloidal components of the magnetic field - B_1. Thus, calculations show that the critical pinch time increases with the increase of B_1 and decreases with the increase of plasma parameter β. So the most effective flares are probable for the highest loops with strong currents. For $B_1 = 10$ and $\beta = 0.01$ the critical pinch time is $\approx$2.5 seconds and the critical twist angle for the magnetic field is $\approx 2\pi$. Geometrical analysis shows that the present model can explain single loop flares taking place on different parts of the loop. The location of the flare depends on the relative rotational momentum of loop footpoints. If the footpoints have equal rotating momenta then the flare is located on the top of the loop. In all other cases the flare is located close to the footpoint with lower rotating momentum.

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Utrecht Lecture Notes

Lecture Notes on Radiative Transfer in Stellar Atmospheres

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These lecture notes represent the current version of the Utrecht third-year astronomy course on stellar atmospheres. The main topic treated in this 30-hour course is the classical theory of radiative transfer for explaining stellar spectra. They emphasize NLTE line formation and represent a middle road between Mihalas' "Stellar Atmospheres" (graduate level and up) and the books by Novotny and Böhm-Vitense (undergraduate).

I make these lecture notes available on WWW in the hope that colleagues and students elsewhere may profit from them, and, if so, that they will send me corrections and additions.

My WWW homepage (http://www.fys.ruu.nl/˜rutten) specifies how to obtain the lecture notes in the form of a 6.5 Mbyte binary file, and how to expand this into printable PostScript files (120 Mbyte in total).

For information contact: rutten@fys.ruu.nl

Upcoming Meetings

Röntgenstrahlung from the Universe
September 25 - 29, 1995 – Würzburg, Germany
Contact: Conference Secretariat (xray-conf@mpe-garching.mpg.de)

9th Cambridge Workshop - Cool Stars, Stellar Systems, & the Sun
October 3 - 6, 1995 – Florence,Italy
Contact: R. Pallavicini (cs9@arcetri.astro.it)

Stellar Surface Structure (IAU Symp. 176)
October 9 - 13, 1995 – Vienna, Austria
Contact: K. Strassmeier (iau@astro.ast.univie.ac.at) or
J. Linsky (jlinsky@jila.colorado.edu)

Recent Developments on Binary Star Research
October 26 - November 1, 1995 – Lopburi, Thailand
Contact: K. Leung (kleung@unlinfo.unl.edu) or
B. Soonthornthum (boonraks@cmu.chiangmai.ac.th)

Colliding Winds in Binary Stars
November 21 - 24, 1995 – La Plata, Argentina
Contact: V. Niemela (winds@fcaglp.fcaglp.unlp.edu.ar)

X-ray Imaging and Spectroscopy of Cosmic Hot Plasmas
March 11 - 14, 1996 – Tokyo, Japan
Contact: F. Makino (ascasymp@astro.isas.ac.jp)

The Carbon Star Phenomenon (IAU Symp. 177)
May 27 - 31, 1996 – Antalya, Turkey
Contact: R. Wing (wing.1@osu.edu)

Stellar Ecology: Celebration of the 65th Birthday of Icko Iben, Jr.
June 23 - 29, 1996 – Elba, Italy
Contact: R. Rood (rtr@ninkasi.astro.virginia.edu)

Herbig-Haro Flows and the Birth of Low Mass Stars
September 1996 – Grenoble, France
Contact: C. Bertout (bertout@gag.observ-gr.fr)

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. The subject matter should pertain directly to cool stars (spectral types F,G,K, or M) or the sun. Both theoretical and observational abstracts are appropriate. Abstracts dealing with cool pre-main-sequence stars will generally not be included in *COOLNEWS*, since they are already covered by the *Star Formation Newsletter*. Exceptions to this rule will only be considered if the subject matter is truly cross-disciplinary. 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, and (iv) *General Announcements* that provide or request research-related information. Requests for abstract templates and all other correspondence should be sent to the editor at coolnews@jila.colorado.edu .