COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 17 — March 1997 Editor: Steve Skinner (coolnews@jila.colorado.edu)

TABLE OF CONTENTS

Stellar Abstracts

Doppler Imaging of AB Doradus Using the Li I 6708 line.

G.A.J. Hussain[1], Y.C. Unruh[1] and A. Collier Cameron[1]

[1] School of Physics and Astronomy, University of St.Andrews, North Haugh, St.Andrews KY16 9SS

We present maximum entropy reconstructions of the stellar surface of the K0 dwarf AB Doradus using observations obtained in November 1993. Doppler images are produced using the Li I 6708 Å line and compared to images produced using Ca I and Fe I lines. A Li abundance of log N(Li) = 2.9 ± 0.3 is measured using LTE profile synthesis. By assessing how enhanced spot Li abundances affect fits between synthetic reconstructions and the observed data, we conclude that the presence of starspots is unlikely to lead to an overestimation of the photospheric Li abundance. Moreover, Li abundances in starspots do not appear to be enhanced with respect to the photospheric level. The equivalent width measurements for the Li I 6708 Å line are strengthened by the presence of starspots. This effect is probably due to their lower effective temperatures. Because the spots were widely distributed in longitude at the time of observation, the extent to which the Li I line equivalent width is modulated as the star rotates is diluted.

Accepted by MNRAS

For preprints contact: gajh@st-and.ac.uk

For preprints via ftp or WWW: http://star-www.st-and.ac.uk/astronomy/preprints/lithium_abs.html

Activity–Related Radial Velocity Variation in Cool Stars

Steven H. Saar[1] and Robert A. Donahue[1,2]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138 USA
[2] Mount Wilson Institute, 740 Holladay Road, Pasadena, CA 91106 USA

Planets have been detected orbiting several solar-type stars using high-precision radial velocity ($v_{\rm r}$) measurements. While changes in $v_{\rm r}$ can be measured with an accuracy of a few m s^{-1}, there has been relatively little study of how other astrophysical processes, such as magnetic activity, may effect the observed velocities. In this paper, we use published data and simple models to explore the contributions to $v_{\rm r}$ from two activity-related sources, starspots and convective inhomogeneities, as these features rotate across the disk and evolve in time.

Radial velocity perturbations due to both of these sources increase with rotation and the level of surface activity. Our models indicate that for solar-age G stars, the amplitude of perturbations due to spots is $A_{\rm S}\lesssim 5$ m s^{-1}, increasing to $A_{\rm S} \sim 30$ to 50 m s^{-1} for Hyades-age G stars. If $f_{\rm S}$ is the starspot area coverage, we find $A_{\rm S} \propto {f_{\rm S}}^{0.9} v \sin i$. The effects of convective inhomogeneities (as observed in line bisector variations) appear to depend on both rotation and spectral type. Young (active) F and G dwarfs can have convective $v_{\rm r}$ perturbations with amplitudes $A_{\rm C}\gtrsim$ 50 m s^{-1}, while $v_{\rm r}$ amplitudes are reduced for stars with lower $v \sin i$ and cooler $T_{\rm eff}$. We show that $v_{\rm r}$ data from the literature display similar trends with $v \sin i$ and $T_{\rm eff}$. $A_{\rm S}$ and $A_{\rm C}$ will be strongest at or near timescales related to magnetic activity variations: rotation, active region growth and decay, and activity cycles. Thus, knowledge of these timescales and typical $A_{\rm S}$ and $A_{\rm C}$ values are important in searching for extra-solar planets, especially those around younger, more active stars or those with small $v_{\rm r}$ reflex amplitudes (i.e., $\lesssim$20 m s^{-1}). We discuss implications of our results for current planet detections and planet search strategies.

Accepted by ApJ

For preprints contact: saar@cfa.harvard.edu

For preprints via ftp or WWW: http://www.mtwilson.edu/Services/Professional/Preprints/HK_Project/ADelV.ps or http://cfa-www.harvard.edu/~donahue/Preprints/ADelV.ps

An X-ray Survey of the Young Open Cluster NGC 2516

R. D. Jeffries[1], M. R. Thurston[2] and J. P. Pye[3]

[1] Department of Physics, Keele University, Keele, Staffordshire, ST5 5BG, UK
[2] School of Physics and Space Research, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK
[3] Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH, UK

We present an analysis of a 60 ks *ROSAT* X-ray observation of the Galactic open cluster NGC 2516, which has an age of about 110 Myr and a less than solar metallicity. 159 X-ray sources (0.5-2.0 keV) are found in the central portion of the position sensitive proportional counter together with 6 soft X-ray sources (0.1-0.4 keV). From the literature, we have constructed a uniform catalogue of photometrically selected cluster candidates. 65 of the X-ray sources are identified with photometric members of NGC 2516 and 25 X-ray sources are identified with probable cluster non-members or stars with no photometric measurements with which to assess cluster membership. The X-ray luminosity threshold is approximately 10^{29} erg s^{-1} and X-ray upper limits are determined for a further 136 possible cluster members. X-ray emission is observed across the Hertzsprung-Russell diagram, from spectral types of B2Ve to the early K-stars which define the faintness limit of our optical catalogue. At least 73 X-ray sources have no plausible counterpart brighter than V=15. Some may be foreground or background stars, 10-15 are probably extragalactic, but the majority are likely to be lower mass stars in the cluster. Three of the soft X-ray sources are probable hot white dwarfs in binary systems with late-type stars. One of these may be in the cluster, the other two are foreground objects.

X-ray emission from the hottest star in the cluster is attributed to a shocked stellar wind. 20 percent of late B and A-type stars are detected which is consistent with the X-ray emission being due to unresolved late-type companions. At least 4 out of the 6 magnetic, chemically peculiar stars are X-ray sources. We conclude that this is probably intrinsic, although an explanation involving binary companions cannot be entirely ruled out. Many F, G and K-stars are detected, presumably as a result of dynamo-generated coronal activity. The peak level of X-ray activity is reached among the late G-stars, which have an X-ray to bolometric flux ratio of 10^{-3}. This suggests that these stars have not yet spun down below the empirical X-ray saturation rotation speed of 10-20 km s^{-1}. Interpretation of the late-type star X-ray luminosity functions is hampered by the fact that there are likely to be contaminating field stars among the X-ray upper limits.

The U-B, B-V colour-colour diagram for X-ray selected cluster members reveals an ultraviolet excess among the F and G-stars of NGC 2516, which is best explained by a less than solar metallicity, [Fe/H]$= -0.32 \pm 0.06$. Comparison with younger and older clusters shows that the late-type stars in NGC 2516 do not simply obey the widely accepted

rotation-activity-age paradigm. We suggest a modification to the paradigm which explains the observations in terms of the different convection zone properties that late-type stars of differing metallicities have at the same colour or mass.

Accepted by MNRAS

For preprints contact: rdj@astro.keele.ac.uk

For preprints via ftp or WWW: http://www.astro.keele.ac.uk

Spectral Evidence for Dust in Late-type M Dwarfs

Hugh R.A. Jones[1,2] and Takashi Tsuji[1]

[1] Institute of Astronomy, University of Tokyo, 2-21-1 Osawa, Mitaka 181, Tokyo, Japan
[2] Astrophysics Group, Liverpool John Moores University, Byrom St, Liverpool L3 3AF, UK

We draw attention to the 0.65–0.75 μm region of the spectra of late-type M dwarfs where we find that the TiO molecular absorption bands decrease rather than increase in strength toward later spectral types. This decrease is not expected from synthetic spectra unless the effects of dust formation are included. It thus seems that a substantial part of the long-standing discrepancies between late-type M dwarf models and observations arises from dust as recently proposed by Tsuji, Ohnaka & Aoki.

Accepted by ApJL

For preprints contact: hjones@mtk.ioa.s.u-tokyo.ac.jp

For preprints via anonymous ftp: staru1.livjm.ac.uk/pub/hraj/preprints/dust/

Alignment of Rotational Axes in Asynchronous Late-type Binaries

R. Glebocki[1], A. Stawikowski[2]

[1] Instute of Theoretical Physics and Astrophysics, University of Gdansk, ul. Wita Stwosza 57, 80-952 Gdansk, Poland
[2] N. Copernicus Astronomical Center, ul. Rabianska 8, 87-100 Torun, Poland.

41 RS CVn and BY Dra type binaries with reliable orbital and physical parameters have been found to rotate asynchronously with the orbital revolution. For this sample inclinations of the rotational axes, $i_{\rm r}$, of the primaries and the orbital inclinations, $i_{\rm o}$, are independently determined to test the alignment between the equatorial and the orbital planes. The observed difference Δi=$|i_{\rm o}$ - $i_{\rm r}|$ measures a deviation from coplanarity of these planes. It turns out that most asynchronous systems prove to be misaligned, especially when the influence of the position angle is taken into account. Thus, the generally accepted assumption that rotational axes are perpendicular to orbital planes is not valid for asynchronous RS CVn and BY Dra type binaries. The influence of the position angle of the observer on the derived values of Δi can be studied only by statistical methods. The distribution of the observed Δi is compared wih the expected values of $\Delta i^{\rm e}$ for three cases: a) the rotational axes are randomly inclined to the orbital planes, b) the rotational axes are perpendicular to the orbital planes, c) the distribution of the true values of $\Delta i_{\rm t}$ is Gaussian around an assumed discrete value. The best fit to our observed sample of asynchronous binaries is obtained for the case a), while for the synchronous RS CVn and BY Dra type binaries the rotational axes are perpendicular to their orbital planes.

Submitted to A&A

For preprints contact: fizrg@halina.univ.gda.pl

Wavelet Analysis of Stellar Differential Rotation I. The Sun

A. Hempelmann[1] and R.A. Donahue [2,3]

[1] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany
[2] Mount Wilson Institute, 740 Holladay Road, Pasadena, CA 91106, U.S.A.
[3] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 15, Cambridge, MA 02138, U.S.A.

A key mystery in stellar magnetohydrodynamics is knowledge of stellar differential rotation. At present, the only practical method for detecting the presence of surface differential rotation for slowly-rotating stars is through the

indirect measurement of the stellar butterfly diagram: i.e., the change of rotation period determined from light modulation caused by the change in mean latitude of stellar surface inhomogeneities, correlated with the phase of the stellar activity cycle. However, finding the correct period is hampered by stellar active region evolution which introduces variability in the amplitude and phase of the modulation. We demonstrate that time-frequency analysis using the wavelet transform is possibly a suitable method for monitoring the stellar butterfly diagram. Wavelet analysis of disk-integrated solar Ca II K line core emission measures shows nearly the correct pattern of the solar surface differential rotation when viewed as a star. This technique can therefore be applied to long-term measurements of stellar activity.

Accepted by A&A

For preprints contact: ahempelmann@aip.de

For preprints via ftp or WWW: http://cfa-www.harvard.edu/~donahue/Preprints/Wavesun.ps

The [Fe/H] Distribution of a Volume Limited Sample of Solar-type Stars and its Implications for Galactic Chemical Evolution

Fabio Favata[1], G. Micela[2] and S. Sciortino[2]

[1] Astrophysics Division – ESA/ESTEC, Postbus 299, 2200 AG Noordwijk, The Netherlands
[2] Istituto e Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134 Palermo, Italy

We present [Fe/H] determinations for a volume-limited sample of G and K dwarfs from the Gliese catalog of nearby stars. The [Fe/H] values were determined from the Fe I lines present in $\simeq 40$ Å wide high resolution ($R \geq 50\,000$) spectra taken around the Li I 6707.8 Å line, through an equivalent width analysis based on the latest Kurucz model atmospheres.

The resulting abundance distribution, corrected for disk heating effects, is compared to recent models of galactic chemical evolution. The surprising result is that, while the abundance distribution of solar-type dwarfs hotter than $\simeq 5100$ K and the derived chemical evolution parameters (in particular the rate of Fe enrichment and the abundance spread at a given age) are compatible with previous determinations of the same quantities, dwarfs cooler than 5100 K show a lack of metal-poor ([Fe/H ≤ -0.4) objects, implying chemical evolution parameters (using the same model) not compatible with the ones derived for the hotter stars. Possible explanations for this fact are discussed, critically considering possible biases present in the parent sample, as well as each of the assumptions made in the chemical evolution model and in particular the assumption that the birth rate will be constant with time and independent of stellar mass.

Accepted by A&A

For preprints contact: fabio.favata@astro.estec.esa.nl

Are Coronae of Magnetically Active Stars Heated by Flares?

Manuel Güdel[1]

[1]Paul Scherrer Institut, Würenlingen und Villigen, CH-5232 Villigen PSI, Switzerland

Coronal flares are promising candidates as agents for plasma heating in quiescent coronae of magnetically active stars. This paper confronts recently reconstructed coronal emission measure distributions of solar-like stars with results from a statistical, hydrodynamical approach to flare simulations. The time evolution of a statistical set of flare energy release events, distributed in total energy as a power-law as observed in the Sun or in active stars, is simulated in a family of magnetically rigid loops. The resulting time-averaged emission measure distribution is double-peaked with the hotter peak due to the cooling plasma of energetic flares in the larger loops, while the cooler peak can be understood as a dispersion effect of a "quiescent", isothermal plasma induced by the large number of low-energy flares (microflares). The intervening minimum occurs around 10 MK and can be explained as due to the combined effects of the flare decay of energetic flares, the power-law increase of the flare frequency toward low-energy flares, and a nearly exponential dependence between flare peak emission measure and simultaneous temperature in a given loop. The required simulation flare frequency decreases with decreasing average coronal temperature, in agreement with the observation that the average coronal temperature is correlated with magnetic activity indicators.

Accepted by ApJ

For preprints contact: guedel@astro.phys.ethz.ch

For preprints via ftp or WWW: ftp://www.psi.ch/pub/incoming/guedel ; filename: flareheat.ps

Radio and EUV observations of CF Tucanae

A. G. Gunn[1,3], V. Migenes[2,5], J. G. Doyle[1], R. E. Spencer[3] and M. Mathioudakis[4]

[1] Armagh Observatory, College Hill, Armagh, BT61 9DG, N. Ireland
[2] ATNF, P. O. Box 76, Epping, NSW 2121, Australia
[3] NRAL, Jodrell Bank, Lower Withington, Cheshire, SK11 9DG, UK
[4] Department of Pure & Applied Physics, Queen's University of Belfast, Belfast, BT7 1NN, N. Ireland
[5] VSOP Project, National Astronomical Observatory, Osawa 2-21-1, Mitaka, Tokyo 181, Japan

We present contemporaneous EUV and radio observations obtained for the totally eclipsing chromospherically active RS CVn-type binary CF Tucanae. Observations were made with the ATNF Compact Array at 6 cm and 3.6 cm over one complete orbital cycle of the system and with the EUVE Deep Survey/Spectrometer telescope over five orbital cycles. We obtained a strong detection of the source (1.9 mJy at 6 cm and 1.1 mJy at 3.6 cm) in the radio. Both EUV and radio flux levels appear to show a clear modulation at the orbital period with a maximum at phase 0.5 which indicates the existence of an intra-binary region of activity. This has important consequences for the details of coronal formation and field interaction in active close binary stars. We interpret the EUV emission as an isotropically radiating thermal source; on the other hand the radio emission shows evidence of intrinsic gyromagnetic directivity. We also demonstrate that contemporaneous EUV and radio observations are not sufficient to determine the characteristics of the gyroemission electron population.

Accepted by MNRAS

For preprints contact: agg@jb.man.ac.uk

For preprints via ftp or WWW: http://star.arm.ac.uk/∼ambn/preprints.html

An Exceptional X-ray Flare on the dMe Star EQ1839.6+8002

H. C. Pan[1], C. Jordan[1], K. Makishima[2], R. A. Stern[3], K. Hayashida[4] and M. Inda-Koide[5]

[1] Department of Physics (Theoretical Physics), University of Oxford, 1 Keble Road, Oxford OX1 3NP, UK
[2] Department of Physics, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan 113
[3] Lockheed Martin Solar and Astrophysics Laboratory, 3251 Hanover Street, Palo Alto, CA 94304, USA
[4] Department of Earth and Space Science, Osaka University, 1-1 Machikaneyama, Toyonaka, Osaka, Japan 560
[5] Department of Electronics and Information, Toyama University, 3190 Gofuku, Toyama, Japan 930

A large impulsive flare was detected serendipitously during observations of the radio galaxy 3C390.3 made with the *Ginga* satellite on 1991 February 14, between 22:30-23:00 (UT). The dMe Star EQ1839.6+8002 is the most likely source of this flare. The rise of the flare was observed and the spectra obtained are of sufficient quality to determine the temperature and emission measure as a function of time. The flare is exceptional in its high peak temperature ($T_{\rm e} \sim 10^8$ K) and emission measure ($\sim 9 \times 10^{53}$ cm^{-3}), the largest recorded for a flare on a dMe star, and comparable with those for flares in RS CVn systems. The normalized X-ray luminosity is also very large ($L_{\rm X}/L_{\rm bol} \sim 0.25$). The flare geometry and plasma parameters are derived by making various assumptions concerning the dominant terms in the internal energy equation, which takes account of a varying mass *and* volume. The initial heating appears to be proportional to the gas pressure. At the peak $T_{\rm e}$ the electron density is $\sim 1.7 \times 10^{12}$ cm^{-3}, and the hot plasma has a length $\sim 10^{10}$ cm. The flare plasma then cools initially by 'evaporative conduction'. Two alternative simple models are made of the flare decay beyond this time (cooling with constant mass or constant volume). Both require continued heating, and the latter gives results similar to those expected in quasi-static conditions. The evolution of the flare temperature and density broadly resembles that predicted by numerical simulations. Observations with the *Einstein* IPC, the *EXOSAT* LE and the *ROSAT* PSPC instruments show flaring and quiescent properties similar to those of the flare stars discussed by Pallavicini et al. (1990).

Accepted by MNRAS

For preprints contact: cj@astro.ox.ac.uk

The Extremely Active Single Giant 1E1751+7046 = ET Draconis: Revised Properties and a Reevaluation of its Evolutionary Status

Carol W. Ambruster[1], **Francis C. Fekel**[2] **Edward F. Guinan**[3] **and Bruce J. Hrivnak**[4]

[1] Dept. of Astronomy and Astrophysics, Villanova University, Villanova, PA 19085 USA
[2] Center for Automated Space Science and Center of Excellence in Information Systems, Tennessee State University, Nashville, TN 37203
[3] Dept. of Astronomy and Astrophysics, Villanova University, Villanova, PA 19085 USA
[4] Dept. of Physics and Astronomy, Valparaiso University, Valparaiso, IN 46383 USA

New spectroscopic observations have resulted in significant revisions to several of the originally published properties of the X-ray bright, chromospherically active star 1E1751+7046: the spectral classification has been revised from K5 IV to K0 III, $v \sin i$ from 30-40 km s^{-1} to 23 km s^{-1}, and the reported non-detection of the Li I 6707 Å line to a significant log ϵ(Li) = 1.8. Chromospheric and transition-region surface fluxes from *IUE* observations and the coronal surface flux from earlier *EINSTEIN* data are close to saturation levels, and comparable only to very active binaries, pre-main sequence stars, and FK Comae itself. *IUE* observations also recorded a flare. Fifteen new radial velocity measurements show no evidence for a companion, and are consistent with Intermediate or Young Disk membership. On the other hand, we show the star to be located about 250 pc above the galactic plane, suggesting an Intermediate or Old Disk object. The new spectral class (T$_{eff}$) and limits on the luminosity indicate that 1E1751+7046 is a low-mass star on its first ascent of the giant branch. Photometry from the Four College Consortium Automatic Photometry Telescope is consistent with the recently published photometric period of 13.98 days, and the light curve is well fit by a model consisting of two large spots at latitudes of $\sim 30^o$ and $\sim 50^o$. There are currently only two possible evolutionary scenarios for this anomalous star: a) coalescence from a progenitor W UMa-type contact binary; or b) the dredge-up of both angular momentum and nuclear processed material in a low mass ($\sim 1 - 2.5$ M$_\odot$) giant. A space motion, obtainable once a parallax and proper motion are available from HIPPARCOS, may resolve the age (Old Disk - Young Disk) uncertainty: Young Disk motions would favor the angular momentum transfer scenario. There is no current theory that can account for the observed lithium abundance.

Accepted by ApJ (to appear 1997 April 20)

For preprints contact: ca@ast.vill.edu

Solar Abstracts

Kinetic Electrons in High-Speed Solar Wind Streams: Formation of High-Energy Tails

Øystein Lie-Svendsen[1], **Viggo H. Hansteen**[2] **and Egil Leer**[2]

[1] Norwegian Defence Research Establishment, div. for electronics, P.O. Box 25, N–2007 Kjeller, Norway
[2] Institute of Theoretical Astrophysics, Univ. of Oslo, P.O. Box 1029, Blindern, N–0315 Oslo, Norway

We study the evolution of the electron velocity distribution function in high-speed solar wind streams, from the collision-dominated corona and into the collisionless interplanetary space. The model we employ solves the kinetic transport equation with the Fokker-Planck collision operator to describe Coulomb collisions between electrons. We use a test particle approach, where test electrons are injected into a prescribed solar wind background. The density, temperature and electric field associated with the background are computed from fluid models. The test electrons are in thermal equilibrium with the background at the base of the corona, and we study the evolution of the velocity distribution of the test electrons as a function of altitude. We find that velocity filtration, due to the energy dependence of the Coulomb cross section, is a small effect, and is not capable of producing significant beams in the distribution or a temperature moment that increases with altitude. The distribution function is mainly determined by the electric field and the expanding geometry, and consists of an almost isotropic, static core which is bound in the electrostatic potential, and a beam-like high-energy tail which escapes. The trapped electrons contribute significantly to the even moments of of the distribution function, but almost nothing to the odd moments; the drift speed and energy flux moments are carried solely by the tail. In order to describe the high-speed solar wind observed near 0.3 AU by the Helios spacecraft, we use a multi-fluid model where ions are heated preferentially. The resulting test electron

distribution at 0.3 AU, in this background, is in very good agreement with distributions observed by the Helios spacecraft.

Accepted by JGR

For preprints contact: Oystein.Lie-Svendsen@ffi.no

The Role of Helium in the Outer Solar Atmosphere

Viggo H. Hansteen[1], Egil Leer[1,2] and Thomas E. Holzer[2]

[1] Institute of Theoretical Astrophysics, University of Oslo, P.O. Box 1029, Blindern, 0315 Oslo, Norway
[2] High Altitude Observatory, National Center for Atmospheric Research, P.O. Box 3000, Boulder CO 80307-3000, USA

We construct models of the outer solar atmosphere comprising the region from the mid chromosphere and into the solar wind in order to study the force and energy balance in models with a significant helium abundance. The corona is created by dissipation of an energy flux from the Sun. The energy flux is lost as radiation from the top of the chromosphere and as gravitational and kinetic solar wind energy flux. We find that in models with significant ion heating of the extended corona most of the energy flux is lost in the solar wind. The ion temperatures are higher than the electron temperature in these models, and the α-particle temperature is much higher than the proton temperature, so there is energy transfer from the α-fluid to the protons and electrons, but this energy exchange between the different species is relatively small. To a fairly good approximation we can say that the energy flux deposited in the protons and α-particles is lost as kinetic and gravitational energy flux in the proton and α-particle flow. How this energy flux is divided between gravitational and kinetic energy flux (i.e. how large are the particle fluxes and flow speeds) depends upon details of the heating process. We also find that mixing processes in the chromosphere play an important role in determining the coronal helium abundance and the relative solar wind proton and α-particle fluxes. Roughly speaking we find that the relative α-particle and proton fluxes are set by the degree of chromospheric mixing while the speeds are set by the details of the coronal heating process.

Accepted by ApJ

For preprints contact: Viggo.Hansteen@astro.uio.no

Signatures of Acoustic and Magnetic Waves in Solar and Stellar Coronae

Øivind Wikstøl[1], Philip G. Judge[2] and Viggo H. Hansteen[1]

[1] Institute of Theoretical Astrophysics, University of Oslo, P.O. Box 1029, Blindern, 0315 Oslo, Norway
[2] High Altitude Observatory, National Center for Atmospheric Research, P.O. Box 3000, Boulder CO 80307-3000, USA

Time-dependent dynamical calculations of the radiating gas in solar coronal flux tubes are used to identify features in UV spectral line profiles that can reveal the direction in which energy flows through the solar transition region. The profile features survive spatial and temporal averaging through non-linear dependencies of line emission coefficients on thermal properties of the plasma that are correlated with fluid velocities. This approach could naturally be applied to stellar and other unresolved sources, as well as the solar atmosphere. It can be regarded as a new angle of attack on the long standing problem of determining coronal heating mechanisms. The approach requires low noise data of high spectral resolution. It can therefore take advantage of some unique properties of the SUMER instrument on SOHO. We make specific predictions for SUMER data that can in principle test whether energy propagates upwards or downwards in coronal flux tubes, thus allowing one to discriminate between competing theories of coronal heating. We are acquiring SUMER data in an attempt to do this.

Accepted by ApJ

For preprints contact: Viggo.Hansteen@astro.uio.no

An Upper Bound to the Solar Oblateness

Rozelot, Jean-Pierre [1] and Rösch, Jean [2]

[1] OCA – CERGA, Avenue Copernic, 06 130, Grasse, France
[2] Observatoire Midi-Pyrénées, 65 200 Bagères de Bigorre, France

From a great number of already available data and from our own observations at the Pic du Midi Observatory, we deduced an upper bound of the quadrupole moment of the Sun J2. This determination yields a maximum value of the solar oblateness of 22 arc ms. This upper limit is not contradictory with the theory of the general relativity. On the same way, we were able to determine a mean value of J2, leading to a mean value of the solar oblateness of 13.1 $\pm$ 4.1 arc ms. That would mean, within the errors bars, that the Sun may carry a slight gravitational moment. It is suspected that the solar oblateness may be time dependent: the amplitude of the modulation may vary from 6 to 19 arc ms, the first value being the lowest one compatible with a pure rotation.

Accepted by Solar Physics

For preprints contact: rozelot@obs-azur.fr

The Polar Solar Wind: A Linear, Force-Free Field, 3-D MHD Model

Yu.V. Pisanko[1]

[1] Institute of Applied Geophysics, Rostokinskaya st.9, Moscow 129128, Russia

A 3-D analytical discontinuous solution of the MHD equations for the polar solar wind near the Sun has been obtained. The relativistic description is used of the solar rotation influence on the polar solar wind. Explicit expressions for the flow velocity, density, pressure, magnetic field and electric current are presented. The model predicts the existence of the double electric layer at the heliocentric distance of 2.6 solar radii and the system of field-aligned electric currents in the polar corona similar to the magnetospheric case. The pressure, density, velocity and magnetic field of the polar solar wind depend on all three spatial coordinates; the radial component of the magnetic field which does not depend on heliolatitude and heliolongitude is the only exception. Amplitudes of heliolongitudinal variations decrease toward the pole. Nonradial components of the magnetic field and corresponding nonradial components of the flow velocity are in phase. The radial component of the flow velocity shows an additional acceleration above the double electric layer: velocities of $700 \div 800$ km/s observed by the ULYSSES spacecraft are predicted at heliocentric distances of about 30 solar radii in this model.

Accepted by Solar Physics

For preprints contact: geophys@sovam.com

Ph.D. Thesis Abstract

Ca II Lines in the Solar Atmosphere

Andrew H. Rowe

Thesis work conducted at: Dept. of Physics (Theoretical Physics), University of Oxford, UK

Current address: Oxford Molecular Ltd, The Medawar Centre, Oxford Science Park, Oxford OX4 4GA, UK

E-mail: arowe@oxmol.co.uk

D.Phil dissertation directed by: Prof. Carole Jordan

D.Phil degree awarded: February 1997

This thesis is a study of the Ca II lines in different regions of the solar atmosphere. The work was motivated by the identification of Ca II high n lines in the HRTS spectra of sunspot and plage regions, which have not previously been modelled. A new model Ca II atom, consisting of all the levels up to 10f, is constructed to allow lines from these high n levels to be modelled. The MULTI computer code is used to solve the radiative transfer in existing models of the chromosphere between the photosphere and transition region in sunspot, plage and quiet regions of the Sun. Following comparisons of the observations and calculations, a new model for the sunspot atmosphere is proposed, which accounts better for the Ca II high n lines seen. In addition, the predicted H & K line profiles by this sunspot model are in closer agreement with the observations than those predicted by previous models. In the quiet Sun it is found that the line-profiles calculated using the VAL3C model are consistent with the observations. However, existing plage models do not accurately predict the observed high n emission line fluxes, which demonstrates the potential of these lines as chromospheric diagnostics. Changes to the exisiting plage models to improve the agreement between the calculations and observations are suggested. The importance of photoionisation from the Ca II 3d states by H Ly α is investigated and found to be important in the formation of the high n lines. Photoionisation by H Ly α is also found to significantly affect the H & K line-profiles in the sunspot, demonstrating that this process must be included in the calculations when the H & K lines are used to model the chromospheres of magnetically active stars.

Ph.D. Thesis Abstract

Coronal and Transition Region Structure in the RS CVn Binaries V711 Tau, AR Lac and II Peg

Neil Griffiths

Thesis work conducted at: Dept. of Physics (Theoretical Physics), University of Oxford, UK

Current address: Space Science Lab, University of California, Berkeley, CA 94720, USA

E-mail: neilg@ssl.berkeley.edu

D.Phil dissertation directed by: Prof. Carole Jordan

D.Phil degree awarded: November 1996

This thesis is a study of the transition regions and coronae in the RS CVn binaries V711 Tau, AR Lac and II Peg. A variety of archival data have been analysed and modelled to improve our understanding of the outer atmospheres of these stars. Emission measure distributions have been determined for the transition region of each system. The lower transition region ($3.8 < \log T_e < 5.3$) has been studied using emission line fluxes from IUE and the GHRS. Emission measure distributions for the upper transition region ($6.1 < \log T_e < 7.4$) have been determined using line fluxes from the Extreme Ultraviolet Explorer (EUVE). Electron densities of $\sim 10^{11.5}\,\mathrm{cm}^{-3}$ and $\sim 10^{11.0}\,\mathrm{cm}^{-3}$ have been determined at $\log T_e = 4.7$ and $\log T_e = 7.0$ respectively, using the density sensitive Si III] 1892Å and Fe XXI 128.7Å lines. The emission measure distributions from the EUVE spectra are compared to those resulting from a variety of low resolution X-ray spectra, including a re-analysis of EXOSAT spectra. The observed emission measure distributions are compared with those from theoretical models that assume an energy balance between radiation and conduction, adopting spherically symmetric, plane parallel and magnetic loop geometries. By considering particle escape temperatures and model electron densities, it is concluded that spherically symmetric models cannot account satisfactorily for the observations. However, more realistic models can be made in terms of magnetic loops. These reproduce the observed emission measure distributions and electron densities using two families of loops. The hotter loops have peak temperatures of $\log T_e \sim 7.35$ and a height $\sim 0.05 R_\star$, whereas the cooler loops have peak temperatures of $\log T_e \sim 6.9$ and a height $\sim 0.15 R_\star$. The loop models are discussed in terms of possible heating mechanisms and the magnetic fields required. The area coverage of the loops on the surface of the star is compared to the cool spot areas determined from photometry and Doppler Imaging techniques, and the loops are compared to the predictions of loop scaling laws.

Ph.D. Thesis Abstract

Models of the Transition Regions and Coronae of Late-Type Stars

Despina A. Philippides

Thesis work conducted at: Dept. of Physics (Theoretical Physics), University of Oxford, UK

Current address: The LEK Partnership, The Adelphi Building, 1-11 John Adam Street, London WC2N 6BW, UK

D.Phil dissertation directed by: Prof. Carole Jordan

D.Phil degree awarded: October 1996

This thesis examines the structure and heating requirements of the outer atmospheres (the lower transition region, upper transition region and corona) of the five dwarfs ξ^1 Ori (G0V), ϵ Eri (K2V), ξ Boo A (G8V), α Cen A (G2V) and α Cen B (K0V), and the sub-giant Procyon (F5 IV-V).

Alternative fits to X-ray spectra of ten late-type dwarfs from ROSAT are made using the latest available versions of the radiative power loss codes of Raymond and Smith, Landini and Monsignori Fossi, and Mewe *et al.* Differences between these codes are found to arise from the choice of atomic physics and the number of transitions included. The resulting coronal temperatures and emission measures are found to follow correlations proposed by Montesinos & Jordan (1993, MNRAS, **264**, 900).

The lower transition region is modelled using observations made with the *International Ultraviolet Explorer* and up-to-date atomic data. Models of the upper transition region and corona are derived assuming a balance between the radiative and conductive losses. Wave pressure is included in these models for the first time. Recent observations with the *Extreme Ultraviolet Explorer* aid the choice of starting parameters. The calculations are acrried out in plane parallel and spherically symmetric geometries. The models of the lower and upper transition region are then combined; the spherically symmetric models of the upper transition region fit more smoothly on to those of the lower transition region than do the plane parallel models. The new model of Procyon and the new measurements of N_e resolve a previous discrepancy which led to suggestions that emission in the transition region is restricted in area.

The heating requirements are examined. In the five dwarfs, but not in Procyon, the conductive fluxes at the base of the upper transition region are found to exceed the radiative energy losses for the layers immediately below. In Procyon, it is shown that acoustic wave heating is a viable mechanism for heating the lower transition region and corona, while the correlation of coronal properties with the dynamo Rossby number suggest that magnetic heating models are more likely for the five dwarfs.

Upcoming Meetings

THE SECOND ANNUAL LOWELL OBSERVATORY FALL WORKSHOP

Solar Analogs: Characteristics and Optimum Candidates

Lowell Observatory, Flagstaff, Arizona, USA
October 5-7, 1997
Jeffrey C. Hall, G. Wesley Lockwood (Lowell),
and Richard R. Radick (NOAO/Sac Peak), SOC

http://www.lowell.edu/users/jch/workshop/analogs.html

FIRST ANNOUNCEMENT and CALL FOR PAPERS

We announce the Second Lowell Observatory Fall Workshop, which will focus on solar-analogous stars and the selection of optimum solar analog candidates. Different workers have searched for solar analogs using many different procedures and criteria, resulting in a long and at times vitriolic debate in the literature. Because of the continuing efforts today to understand the so-called "solar-stellar connection," we feel the time is ripe for a thorough examination of this issue. The goal of this workshop is to identify the very best solar-analogous stars, on the basis of as broad a set of solar and stellar characteristics as possible.

After an opening reception on the evening of Sunday the 5th, we will begin on Monday by examining how we should best define solar-analogous stars. This will include examination of the stellar parameters that may be used as bases for comparison with the Sun, and their relative importance in making solar comparisons. Invited speakers will be asked to present their opinions in a set of oral sessions, and ample time for questioning and discussions will be provided. A concurrent, 2-day display session will supplement these talks. The current slate of invited speakers includes Sallie L. Baliunas, Karen L. Harvey, Edward F. Guinan, and Mark S. Giampapa.

On Tuesday the 7th we will go into real "workshop mode." After an opening panel discussion, we will break into small discussion groups, each with the task of debating the merits of specific groups of candidate stars. The SOC will do the groundwork for this, providing all attendees with star lists, relevant references, and essential results from the literature. We will conclude with a plenary session, with the goal of developing a concrete list of the best solar-analogous stars available. No tentative conclusions! – as a result of this "working day" we want a list in each attendee's hand that will represent real progress in this important area of inquiry. Current members of our panel include Thomas R. Ayres, Robert F. Garrison, and Richard A. Wade.

We invite all interested parties to visit our meeting Web site at http://www.lowell.edu/users/jch/workshop/analogs.html. You will find complete meeting details, as well as an on-line registration form. Registration is limited due to the size of our meeting facilities. Please register early! We have booked blocks of hotel rooms at two Flagstaff hotels; these rooms are first-come first-served as well.

You are invited to submit a contributed display on any of the relevant topics: the Sun, the Stars, the Solar-Stellar Connection, and Solar Analogs. We encourage the presentation of specific data that may be of aid during the Tuesday working sessions. Extra time will be allotted to display sessions on Monday to allow close perusal of the posters.

The registration fee of $70 will cover all your meeting materials, attendance at the opening reception, refreshment breaks on both days, catered lunches on both days, a catered dinner at our dark-sky site at Anderson Mesa (6 air miles SE of Flagstaff) on Monday night (including tours and demonstrations of our facilities by Lowell staff members), and a copy of the proceedings.

If you have questions or wish further information, please contact Jeffrey Hall at jch@lowell.edu; there is also an email response link to the same address at the meeting Web site.

Job Announcement

Associate Professor in Astronomy

University of Oulu, Finland
Faculty of Science

Applications are invited for the tenured position of Associate Professor in Astronomy, from candidates with research and teaching proficiency in astronomy. Emphasis is placed on scientific excellence. The duties include research, and both undergraduate and postgraduate teaching. The teaching language is mainly Finnish but English is also allowed.

The annual salary will be within the range of 190'000 - 230'000 FIM, depending on qualifications and experience.

For informal information contact Professor Ilkka Tuominen, Astronomy Division (telephone 358 8 553 1930, e-mail Ilkka.Tuominen@Oulu.Fi, or Chief Administrator, Ms. Kaisa Ala, Faculty of Science (telephone 358 8 5531051, telefax 358 8 5531060, e-mail Kaisa.Ala@Oulu.Fi), address P.O. Box 333, 90571 Oulu, Finland.

Details for making applications are available from the Registrar, at the address below (telephone 358 8 5534108, telefax 358 8 371158).

Applications, including the documents required according to the application instructions, should be received no later than 24 March 1997 at the University of Oulu, Registrar's Office, P.O Box 191, 90101 Oulu, Finland.

Editors Note: 1 $U.S. $\approx$ 4.95 FIM as of Feb. '97.

Job Announcement

Postdoctoral Positions
Centre for Astrophysics, University of Porto, Portugal

CAUP accepts candidates for **two post-doctoral positions in Stellar Astrophysics**, namely in areas of stellar evolution and activity, circumstellar medium and young objects, astro-tomography and inversion techniques, helio and astero-seismology. Priority will be given to candidates with experience in multi-wavelength observations.

The positions are for one year with possible extension up to three years, and are expected to start in:

- June 97 - deadline for applications is the **20th of February**
- December 97 - deadline for applications is the **22nd of May**

Applicants should forward curriculum vitae, list of publications, a brief description of past experience and of research interests and plans as well as the name/address of three referees.

Inquiries about the positions and CAUP can be directed to

Prof M.T.V.T. Lago (mtlago@astro.up.pt)
Centro de Astrofísica - UP
Rua do Campo Alegre 823
P-4150 Porto, PORTUGAL.

For more information see also http://www.astro.up.pt/

Hipparcos Results Press Release

ROYAL ASTRONOMICAL SOCIETY PRESS NOTICE

EMBARGOED For release 1 p.m. GMT, Friday 14th February 1997

Ref. PN 97/06 Issued by: Dr Jacqueline Mitton RAS Public Relations Officer Phone: Cambridge ((0)1223) 564914 FAX: Cambridge ((0)1223) 572892 E-mail: jmitton@ast.cam.ac.uk

EARLY RESULTS FROM HIPPARCOS DATA

Astronomers attending a Royal Astronomical Discussion Meeting in London today will get the first tantalizing glimpse of the kind of significant results being extracted from the Hipparcos satellite's harvest of data. Scientists working on the data emphasise that the discussions today revolve around their earliest and most preliminary findings, but highlights emerging already include:

* Cepheid variable stars appear to be more luminous and distant than previously thought. Since these stars are used to gauge the distances to other galaxies, this implies that the universe may be larger than previous estimates by about 10 per cent. The result also implies that the oldest known stars are no more than 11 billion years old, consistent with an age for the universe a whole of perhaps 12 billion years.

* Previous estimates that our own Galaxy is 8 to 10 billion years old, based on the rate at which white dwarf stars gradually cool down, are confirmed as reliable by completely independent Hipparcos observations of white dwarfs.

* The nearby Pleiades star cluster, whose distance is used as a stepping stone for determing the distance to much more remote clusters in our Galaxy and to galaxies beyond our own, appears to be nearer than previously thought - at about 360 light years rather than 400, implying, curiously, that the Pleiades stars are intrinsically fainter than typical stars with comparable colours in the solar neighbourhood.

* A picture of stellar movements in our local part of the Galaxy allows a clear recognition of the very old stars, dating from the time when the Galaxy had not collapsed to its present disk-like shape, which are travelling through space in a completely different way from the Sun and its cohort.

* With the real intrinsic brightness of 40,000 stars measured by Hipparcos, far more giant and supergiant stars are being identified for certain on the basis of their luminosity where previously their detection relied on interpreting their spectra correctly. These identifications will help astrophysicists understand these stars and their spectra better.

* Work is well under way that will give important new insights into the nearest star cluster to the Sun, the Hyades. Careful analysis of which stars belong to the cluster, where they are positioned in relation to each other, and how they are moving, is going to result in a re-evaluation of the cluster's distance. This distance is of crucial importance because it calibrates most other methods used for finding the distances to more remote objects.

The flood of new data available to astronomers from ESA's Hipparcos stems from its ability to detect any apparent change in the position of a star with an accuracy equivalent to measuring from Earth the height of a child standing on the Moon. This made it possible to determine the positions, distances and real movements of large numbers of stars with unprecedented precision. The full data will be published in June 1997, when it will be available to any astronomers who wish to use it. Until then, early access to the data is being restricted to the research groups involved in carrying out the Hipparcos mission.

The organizers of the RAS Discussion Meeting are Prof. Michael A. C. Perryman (ESTEC/Leiden Observatory) and Dr Floor van Leeuwen (Royal Greenwich Observatory, Cambridge)

Contacts for contributions referred to above

Prof. Michael A. C. Perryman (ESTEC/Leiden Observatory) phone +31 71 565 3615; e-mail mperryma@astro.estec.esa.nl presents Review of the mission and The Hyades as seen by Hipparcos

Dr Floor van Leeuwen, (RGO, Cambridge) phone 01223 374765; e-mail fvl@ast.cam.ac.uk The distance to the Pleiades

Dr Dafydd Wyn Evans (RGO, Cambridge) phone 01223 374000; e-mail dwe@ast.cam.ac.uk Stars in the solar neighbourhood

Prof. Michael Feast, University of Cape Town phone +27 21 650 2396; e-mail mwf@uctvax.uct.ac.za Cepheid and Mira variable stars and the distance scale

Prof. James Binney, University of Oxford phone 01865 727650; j.binney@astro.ox.ac.uk Spectral classifications and distances for stars within 80 pc of the Sun

Dr Martin Barstow (University of Leicester) phone 0116-252-3492; e-mail mab@star.le.ac.uk The white dwarf temperature scale and mass-radius relation

Editor's Note: The full text of the above press release is available on the Web at

`http://www.ras.org.uk/ras/press/press.htm`

See also the related article on page 1064 of the 21 Feb '97 issue of *Science*.

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 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, (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` .