COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 53 — June 2000 Editor: Steve Skinner (coolnews@jila.colorado.edu)

TABLE OF CONTENTS

Stellar Abstracts

Rotation and Activity in the Solar-Type Stars of NGC 2547

R. D. Jeffries[1], E. J. Totten[1], D. J. James[2,3]

1 Department of Physics, Keele University, Keele, Staffordshire, ST5 5BG, UK
2 School of Physics and Astronomy, University of St Andrews, North Haugh, St Andrews, Fife, KY16 9SS, UK
3 Observatoire de Genève, Chemin de Maillettes 51, CH-1290, Sauverny, Switzerland

We present high resolution spectroscopy of a sample of 24 solar-type stars in the young (15-40 Myr), open cluster, NGC 2547. We use our spectra to confirm cluster membership in 23 of these stars, determine projected equatorial velocities and chromospheric activity, and to search for the presence of accretion discs. We have found examples of both fast ($vsini > 50\,\mathrm{km\,s^{-1}}$) and slow ($vsini < 10\,\mathrm{km\,s^{-1}}$) rotators, but find no evidence for active accretion in any of the sample. The distribution of projected rotation velocities is indistinguishable from the slightly older IC 2391 and IC 2602 clusters, implying similar initial angular momentum distributions and circumstellar disc lifetimes. The presence of very slow rotators indicates that either long (10-40 Myr) disc lifetimes or internal differential rotation are needed, or that NGC 2547 (and IC 2391/2602) were born with more slowly rotating stars than are presently seen in even younger clusters and associations. The solar-type stars in NGC 2547 follow a similar rotation-activity relationship to that seen in older clusters. X-ray activity increases until a saturation level is reached for $vsini > 15-20\,\mathrm{km\,s^{-1}}$. We are unable to explain why this saturation level, of $\log(L_{\rm x}/L_{\rm bol}) \simeq -3.3$, is a factor of two lower than in other clusters, but rule out anomalously slow rotation rates or uncertainties in X-ray flux calculations.

Accepted by MNRAS

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

For preprints via WWW: http://www.astro.keele.ac.uk/∼rdj/

AR Lacertae: Hα Chromospheric Emission and Radial Velocities from Long-term Optical Spectroscopy

A. Frasca[1], G. Marino[2], S. Catalano[1], E. Marilli[1]

[1] Osservatorio Astrofisico di Catania, Via S. Sofia, 78 – I-95125 Catania, Italy
[2] Istituto di Astronomia, Università di Catania, Via S. Sofia, 78 – I–95125 Catania, Italy

We present here the results of spectroscopic studies in the Hα region of the active eclipsing binary AR Lac (G2IV+K0IV) obtained at Catania Astrophysical Observatory in 1989, 1990, 1994, 1996 and 1997. Accurate measurements of radial velocities by using the cross-correlation method have been made and a new orbital solution has been derived. The equivalent width of the Hα emission core has been measured by subtraction of spectra synthesised from standard non-active stars of spectral types similar to those of the two components. We find chromospheric emission from both components in most of the spectra. No rotational modulation of the Hα emission is apparent. The absorption excess observed near and during primary minima in 1997 is interpreted as the effect of a prominence-like structure anchored between the leading and the trailing hemisphere of the cool component. This interpretation is fully compatible with the radial velocities of the Hα emission peaks in the subtracted spectra.

The observation of a Hα flare in 1989 on the cool star is also reported and an estimate of the size of the magnetic structure involved in the event is proposed.

Accepted by A&A

For preprints contact: afr@sunct.ct.astro.it

For preprints via ftp: ftp sunct.ct.astro.it; login: anonymous; cd pub/frasca/arlac; bin; get 8726.ps.gz

Circumstellar Dust Shells Around Long-period Variables VIII. CO Infrared Line Profiles from Dynamical Models for C-stars

J.M. Winters[1,2], J.J. Keady[3], A. Gauger[4], and P.V. Sada[5]

[1] Max–Planck–Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[2] Technische Universität Berlin, Institut für Astronomie und Astrophysik, PN 8-1, Hardenbergstr. 36, D-10623 Berlin, Germany
[3] Los Alamos National Laboratory, Theoretical Division, Group T–4, MS B268, Los Alamos, NM 87545, USA
[4] Fachhochschule Fulda, Marquardstr. 35, D-36039 Fulda, Germany
[5] Universidad de Monterrey, Departamento de Física y Matemáticas, Av. Moromes Prieto 4500 Pte., Garza García, N.L., 66238 México

We present simplified non-LTE radiative transfer calculations for CO (v 0-1) fundamental and (v 0-2) overtone lines, using the structure of dynamical models for dust shells around carbon-rich long-period variables, which result from a consistent treatment of hydro- and thermodynamics, radiative transfer, chemistry and carbon grain formation.

Owing to the saturation of the fundamental band absorption cores the most useful information is provided by the P-Cygni emission component, which can be used to constrain the dust optical depth in the 5 μm region. The first overtone lines clearly reflect the shocked, layered structure of the inner shell region by showing a multi-component structure of the profiles. At least the lines of higher rotational excitation ($J_l > 10$) are not saturated even for mass loss rates of the order of $10^{-5} M_\odot \mathrm{yr}^{-1}$ and thus can be used to constrain the mass loss rate. Furthermore, the dynamics of the dust formation process is reflected in the temporal evolution of the synthetic CO first overtone line profiles resulting from the models. The formation of a new dust layer in the inner shell region leads to a secondary (low velocity) absorption component which evolves on the time scale of a dust formation event, usually longer than the pulsation period of the star.

The synthetic overtone line profiles calculated on the basis of one dust shell model resemble the time variations of corresponding lines in the observed high resolution CO line spectra of the carbon-Mira IRC +10216, which thereby are interpreted as the result of a dust formation event taking place on a time scale of $\approx$ 10 yr corresponding to 6 pulsation periods of the star. However, the calculated fundamental line absorption cores are broader than observed and the first overtone line strengths are too high, indicating that the density and thus probably the mass loss rate of the model is too high by a factor of about 3 and should be closer to the value of $1\,10^{-5}\,M_\odot \mathrm{yr}^{-1}$ given for IRC +10216 in the literature.

Accepted by A&A

For preprints contact: jwinters@mpifr-bonn.mpg.de

Interferometric Astrometry of the Low-mass Binary Gl 791.2 (=3D HU Del) Using *Hubble Space Telescope* Fine Guidance Sensor 3: Parallax and Component Masses

G. Fritz Benedict[1], Barbara E. McArthur[1], Otto G. Franz[2], Lawrence H. Wasserman[2], and Todd J. Henry[3]

[1] McDonald Observatory, University of Texas, Austin, TX 78712

[2] Lowell Observatory, 1400 West Mars Hill Rd., Flagstaff, AZ 86001

[3] Department of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218

With fourteen epochs of fringe tracking data spanning 1.7y from Fine Guidance Sensor 3 we have obtained a parallax ($\pi_{abs} = 3D113.1 \pm 0.3$ mas) and perturbation orbit for Gl 791.2A. Contemporaneous fringe scanning observations yield only three clear detections of the secondary on both interferometer axes. They provide a mean component magnitude difference, $\Delta V = 3D3.27 \pm 0.10$. The period (P =3D 1.4731 yr) from the perturbation orbit and the semi-major axis (a =3D 0.963 ± 0.007 AU) from the measured component separations with our parallax provide a total system mass $\mathcal{M}_A + \mathcal{M}_B = 3D0.412 \pm 0.009\mathcal{M}_\odot$. Component masses are $\mathcal{M}_A = 3D0.286 \pm 0.006M_\odot$ and $\mathcal{M}_B = 3D0.126 \pm 0.003\mathcal{M}_\odot$. Gl 791.2A and B are placed in a sparsely populated region of the lower main sequence mass-luminosity relation where they help *define* the relation because the masses have been determined to high accuracy, with errors of only 2%.

Accepted by AJ

For preprints contact: fritz@astro.utexas.edu

For preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0005026

The Atmosphere of Mira Variables: A View with the Hubble Space Telescope

Donald G. Luttermoser[1]

[1] Department of Physics and Astronomy, East Tennessee State University, Box 70652, Johnson City, TN 37614

Ultraviolet spectra obtained with Hubble Space Telescope (HST) of two Mira-type variable stars, R Leo and R Hya, are presented, along with analysis providing information on their outer atmospheres. These high-dispersion spectra were taken with the Goddard High Resolution Spectrograph (HRS) in two spectral regions: 2320 Å – 2368 Å to record the C II] (UV0.01) multiplet and 2785 Å – 2835 Å to obtain the Mg II h & k lines. The R Hya spectrum was obtained at visual light phase 0.26 and shows a Mg II spectrum that is very clean, showing clear evidence for the overlying circumstellar absorption from Fe I (UV3) and Mn II (UV1) over the k line. The fluoresced Fe I (UV44) feature at 2824 Å is plainly visible in this spectrum, whereas past IUE observations of Miras at high dispersion were unable to record this feature. Remarkably, the newly identified fluoresced Fe I (UV45) feature near 2807 Å is seen in this spectrum. Until now, this line has only been seen in cool carbon stars with HST/HRS. This line is pumped by the thin C II] (UV0.01) emission line at 2325.5 Å. Two of the strongest C II] (UV0.01) lines near 2325 Å are plainly seen in this spectrum. This region of the spectrum, however, is dominated by the Si II] (UV0.01) line near 2335 Å, in contrast to that observed in the carbon stars and the non-Mira oxygen-rich red giant stars. Very weak Mg II lines are seen in the R Leo spectrum at phase 0.12. At this phase, these lines are typically absent in IUE spectra. Velocity shifts of emission features in the UV spectra of Miras are consistent with previously published hydrodynamic models of these stars. These velocities indicate, however, that the C II] (UV0.01) emission lines are not formed in the same atmospheric layers as the Mg II emission. The electron density deduced from the C II] (UV0.01) multiplet is $\sim 10^9$ cm^{-3}. Finally, the temperature-density structure of the semiregular variable carbon stars is similar to the oxygen-rich Mira variables – both are hydrodynamic in nature, however, the carbon stars macroscopic velocity fields are not identical to the Mira stars in the atmosphere layers between the Mg II emission region and the circumstellar shell.

Accepted by ApJ (to appear 20 June 2000)

For preprints contact: lutter@etsu.edu

The Lithium Isotope Ratio in the Metal-poor Halo Star G271-162 from VLT/UVES Observations

P.E. Nissen[1], M. Asplund[2], V. Hill[3], and S. D'Odorico[3]

[1] Institute of Physics and Astronomy, University of Aarhus, DK–8000 Aarhus C, Denmark
[2] Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden
[3] European Southern Observatory, Karl-Schwarzschild Str. 2, D–85748 Garching b. München, Germany

A high resolution ($\lambda/\Delta\lambda \simeq 110\,000$), very high S/N (≥ 600) spectrum of the metal-poor turnoff star G 271-162 has been obtained in connection with the commissioning of UVES at VLT/Kueyen. Using both 1D hydrostatic and 3D hydrodynamical model atmospheres, the lithium isotope ratio has been estimated from the Li I 670.8 nm line by means of spectral synthesis. The necessary stellar line broadening (1D: macroturbulence + rotation, 3D: rotation) has been determined from unblended K I, Ca I and Fe I lines. The 3D line profiles agree very well with the observed profiles, including the characteristic line asymmetries. Both the 1D and 3D analyses reveal a possible detection of ^{6}Li in G 271-162, ^{6}Li/^{7}Li$= 0.02 \pm 0.01$ (1σ). It is discussed if the smaller amount of ^{6}Li in G 271-162 than in the similar halo star HD 84937 could be due to differences in stellar mass and/or metallicity or whether it may reflect an intrinsic scatter of ^{6}Li/^{7}Li in the ISM at a given metallicity.

Accepted by A&A (to appear in A&A, 357, L49)

For preprints contact: pen@ifa.au.dk

For preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0004251

The Effects of Numerical Resolution on Hydrodynamical Surface Convection Simulations and Spectral Line Formation

M. Asplund[1,2], H.-G. Ludwig[3,4], Å. Nordlund[3] and R.F. Stein[5]

[1] NORDITA, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark
[2] present address: Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden
[3] Astronomical Observatory, NBIfAFG, Juliane Maries Vej 30, DK-2100 Copenhagen Ø, Denmark
[4] present address: ENS-CRAL, 46 allée d'Italie, F-69364 Lyon Cedex 07, France
[5] Dept. of Physics and Astronomy, Michigan State University, East Lansing, MI 48823, USA

The computationally demanding nature of radiative-hydrodynamical simulations of stellar surface convection warrants an investigation of the sensitivity of the convective structure and spectral synthesis to the numerical resolution and dimension of the simulations, which is presented here.

With too coarse a resolution the predicted spectral lines tend to be too narrow, reflecting insufficient Doppler broadening from the convective motions, while at the currently highest affordable resolution the line shapes have converged essentially perfectly to the observed profiles. Similar conclusions are drawn from the line asymmetries and shifts. Due to the robustness of the pressure and temperature structures with respect to the numerical resolution, strong Fe lines with pronounced damping wings and H I lines are essentially immune to resolution effects, and can therefore be used for improved $T_{\rm eff}$ and $\log g$ determinations even at very modest resolutions. In terms of abundances, weak Fe I and Fe II lines show a very small dependence ($\simeq 0.02$ dex) while for intermediate strong lines with significant non-thermal broadening the sensitivity increases (≤ 0.10 dex).

Problems arise when using 2D convection simulations to describe an inherent 3D phenomenon, which translates to inaccurate atmospheric velocity fields and temperature and pressure structures. In 2D the theoretical line profiles tend to be too shallow and broad compared with the 3D calculations and observations, in particular for intermediate strong lines. In terms of abundances, the 2D results are systematically about 0.1 dex lower than for the 3D case for Fe I lines. Furthermore, the predicted line asymmetries and shifts are much inferior in 2D with discrepancies amounting to $\sim 200\,{\rm m\,s^{-1}}$. Given these shortcomings and computing time considerations it is better to use 3D simulations of even modest resolution than high-resolution 2D simulations.

Accepted by A&A

For preprints contact: martin@astro.uu.se

For preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0005319

Magnetic Cycle of LQ Hydrae: Observational Indications and Dynamo Model

L.L. Kitchatinov[1,2], **M. Jardine**[1] **and J.-F. Donati**[3]

[1] School of Physics and Astronomy, University of St. Andrews, North Haugh, St Andrews KY16 9SS, Scotland
[2] Institute for Solar–Terrestrial Physics, P.O. Box 4026, Irkutsk, 664033, Russia
[3] Laboratoire d'Astrophysique, Observatoire Midi-Pyrénées, F-31400 Toulouse, France

We present a model for the differential rotation and dynamo activity of the young rapidly-rotating K0 dwarf LQ Hya ($P_{\rm rot} = 1.6$ days). As might be expected from observations of the similar rapid rotator AB Dor, the predicted differential rotation is small ($\simeq 0.8$ per cent) but extremely efficient in generating magnetic fields. The dynamo, which is of a distributed type, produces a globally axisymmetric field with radial and azimuthal components that are of the same magnitude and display a phase-lag in their evolution of about $\pi/2$. This is consistent with the long-term Zeeman-Doppler imaging study by Donati (1999). The latitudinal distribution of flux is, however, a little different from that observed and the cycle period of 3.2 years is somewhat shorter than suggested by the observations.

Accepted by MNRAS

For preprints contact: kit@iszf.irk.ru

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

Magnetic Field Escape from a Stellar Convection Zone and the Dynamo-cycle Period

L.L. Kitchatinov[1,2], **M.V. Mazur**[2] **and M. Jardine**[1]

[1] School of Physics and Astronomy, University of St Andrews, St Andrews, Fife, KY16 9SS, Scotland
[2] Institute for Solar-Terrestrial Physics, P.O. Box 4026, Irkutsk, 664033, Russia

Traditionally, dynamo theories have predicted periods for stellar activity cycles that are much shorter than is observed. We argue that this problem can be solved by allowing for the non-free escape of magnetic fields through the surface boundary. New boundary conditions are suggested that largely reduce magnetic flux escape from the dynamo region compared to the traditional vacuum conditions. The effect of the new conditions is checked with a solar-type dynamo model in a spherical shell. The dynamo incorporates the helioseismologically-detected rotation law and prescribes all the key parameters in accord with the convection zone structure models. The cycle period increases by an order of magnitude and the critical dynamo number decreases in about the same proportion when the new boundary conditions are implemented. The observed 22-year period of the solar cycle can be reproduced. Also the ratio of toroidal-to-poloidal magnetic field is brought closer to observations in this way. Based on our dynamo model, an interpretation can be offered for the empirical relation between activity cycle period and rotation rate of the slowly rotating solar-type stars.

Accepted by A&A

For preprints contact: kit@iszf.irk.ru

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

Removal of the Calcium Underabundance in Cool Metal Rich Galactic Disk Dwarfs

Patrik Thorén[1]

[1] Uppsala Astronomical Observatory, Box 515, S-751 20, Uppsala, Sweden

An apparent Ca underabundance for cool metal rich disk dwarfs was derived by Feltzing & Gustafsson (1998, *A&AS* **129**, 237). This was suggested to be a NLTE effect, following the prediction by Drake (1991, *MNRAS* **251**, 369). New NLTE calculations with MARCS atmospheres and opacities (Thorén, P.: 2000, *A&A, in preparation*) show that deviations from LTE are very small and can *not* explain the underabundance. It is shown that the underabundance was primarily due to erroneously calculated atomic line broadening parameters (van der Waals broadening). Part of the underabundance was also due to the decision not to change photometrically determined stellar parameters to satisfy the Fe I excitation balance.

Accepted by A&A Letters

For preprints contact: patrik.thoren@astro.uu.se

A Model of Slingshot Prominences in Rapidly-rotating Stars

J. M. Ferreira [1,2,3]

[1] School of Physics & Astronomy, University of St. Andrews, St. Andrews, Fife KY16 9SS, Scotland
[2] Universidade dos Açores, Terceira, Açores, Portugal
[3] Centro de Astrofísica da Universidade do Porto, R. das Estrelas, 4150 Porto, Portugal

We study the stability of an equilibrium model of prominences in rapidly-rotating stars. A prominence is represented by an axisymmetric equatorial current sheet embedded in a massless and perfectly conducting coronal plasma. There is an equilibrium between gravity, centrifugal force and Lorentz force acting on the prominence. The energy method of Bernstein *et al (1958), in the form presented by Lepeltier & Aly (1996), is used to derive sufficient stability conditions. Using existing observational values for the masses, dimensions and coronal locations of the prominences, we find that surface fields of a few hundred gauss are required to hold them in a stable equilibrium. The free magnetic energy present in stable equilibrium models is sufficient to feed medium sized flares but probably not the very energetic ones.*

We discuss the question of what makes stellar prominences so different from their solar counterparts and what allows them to be detected. We also examine the role of the co-rotation radius in their formation.

Accepted by MNRAS

For preprints contact: miguelf@angra.uac.pt

Two K Giants with Super-meteoritic Lithium Abundances: HDE 233517 and HD 9746

Suchitra C. Balachandran[1], Frank C. Fekel[2], Gregory W. Henry[2] and Han Uitelbroek[3]

[1] Department of Astronomy, University of Maryland, College Park MD, 20742
[2] Center of Excellence in Information Systems, Tennessee State University, 330 10th Avenue North, Nashville TN 37203
[3] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138

Two unusual Li-rich K giants, HDE 233517 and HD 9746, have been studied. Optical spectroscopy and photometry have been obtained to determine the fundamental parameters of HDE 233517, a single K2 III with an extremely large infrared-excess. The spectra yield T_{eff} = 4475 K, log g = 2.25, [Fe/H] = −0.37, v sin i = 17.6 km s^{-1}, and a non-LTE log $\epsilon(^7\mathrm{Li})$ = 4.22. Photometric observations reveal low-amplitude light variability with a period of 47.9 days. Combined with other parameters, this results in a minimum radius of 16.7 $R_\odot$ and minimum distance of 617 pc. Comparison of spectra obtained in 1994 and 1996 show profile variations in Hα and the Na D lines indicative of changing mass loss. Optical spectra of HD 9746, a chromospherically-active giant, were analyzed. The T_{eff} = 4400 K and revised *Hipparcos*-based gravity of log g = 2.30 lead to a non-LTE log $\epsilon(^7\mathrm{Li})$ = 3.75. The Li abundances in both stars are super-meteoritic.

By the inclusion and exclusion of ^{6}Li in the syntheses, we show that consistent ^{7}Li abundances are obtained only when ^{6}Li is absent in the synthetic fit. This provides evidence for fresh ^{7}Li production and excludes both preservation of primordial Li and planetary accretion as viable scenarios for the formation of Li-rich giants. Both stars lie in close proximity to the red-giant luminosity bump supporting the hypothesis that ^{7}Li production is caused by the same mixing mechanism that later results in CN processing and lowers the ^{12}C/^{13}C ratio to non-standard values.

Accepted by ApJ

For preprints contact: suchitra@astro.umd.edu

For preprints via ftp : anonftp to ftp.astro.umd.edu; cd /pub/suchitra/HDE233517; get all files

Chemical Composition of Evolved Stars in the Open Cluster M 67

G. Tautvaišienė[1], B. Edvardsson[2], I. Tuominen[3] and I. Ilyin[3]

[1] Institute of Theoretical Physics and Astronomy, Goštauto 12, Vilnius 2600, Lithuania
[2] Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden
[3] Astronomy Division, Dept. of Physical Sciences, University of Oulu, P.O. Box 300, 90401, Oulu, Finland

High-resolution spectra of six core helium-burning ‘clump’ stars and three giants in the open cluster M 67 have been

obtained with the SOFIN spectrograph on the Nordic Optical Telescope to investigate abundances of up to 25 chemical elements. Abundances of carbon were studied using the C_2 Swan (0,1) band head at 5635.5 Å. The wavelength interval 7980–8130 Å with strong CN features was analysed in order to determine nitrogen abundances and $^{12}C/^{13}C$ isotope ratios. The oxygen abundances were determined from the [O I] line at 6300 Å.

The overall metallicity of the cluster stars was found to be close to solar ([Fe/H]$=-0.03 \pm 0.03$). Compared with the Sun and other dwarf stars of the Galactic disk, as well as with dwarf stars of M 67 itself, abundances in the investigated stars suggest that carbon is depleted by about 0.2 dex, nitrogen is enhanced by about 0.2 dex and oxygen is unaltered. Among other mixing-sensitive chemical elements an overabundance of sodium may be suspected. The mean C/N and $^{12}C/^{13}C$ ratios are lowered to the values of 1.7 ± 0.2 and 24 ± 4 in the giants and to the values of 1.4 ± 0.2 and 16 ± 4 in the clump stars. These results suggest that extra mixing of CN-cycled material to the stellar surface takes place after the He-core flash. Abundances of heavy chemical elements in all nine stars were found to be almost identical and close to solar.

Accepted by A&A

For preprints via anonymous ftp: ftp ftp.astro.uu.se , directory: pub/articles/atmos/P140 ; also as astro-ph/0006001

Photometric Variability in a Sample of 187 G and K Giants

Gregory W. Henry,[1] Francis C. Fekel,[1] Stephen M. Henry,[1] and Douglas S. Hall[2]

[1] Center of Excellence in Information Systems, Tennessee State University, Nashville, TN 37203 USA
[2] Dyer Observatory, Vanderbilt University, Nashville, TN 37203 USA

We have used three automatic photoelectric telescopes to obtain photometric observations of 187 G, K, and a few M0 field giants. We find low-amplitude photometric variability on time scales of days to weeks on both sides of the coronal dividing line (CDL) in a total of 81 or 43% of the 187 giants. About one-third of the variables have amplitudes greater than 0.01 mag in V. In our sample the percentage of variable giants is a minimum for late-G spectral classes and increases for earlier and later classes; all K5 and M0 giants are variable. We also obtained high-resolution, red-wavelength spectroscopic observations of 147 of the giants, which we used to determine spectral classifications, $v \sin i$ values, and radial velocities. We acquired additional high-resolution, blue-wavelength spectra of 48 of the giants, which we used to determine chromospheric emission fluxes. We analyzed the photometric and spectroscopic observations to identify the cause(s) of photometric variability in our sample of giants. We show that the light variations in the vast majority of G and K giant variables cannot be due to rotation. For giants on the cool side of the CDL, we find that the variability mechanism is radial pulsation. Thus, the variability mechanism operating in M giants extends into the K giants up to about spectral class K2. On the hot side of the CDL, the variability mechanism is most likely non-radial, g-mode pulsation.

Accepted by ApJ Supp.

For preprints via WWW: http://schwab.tsuniv.edu/papers/apjs/gkgiants/preprint.ps

The INT Search for Metal-Poor Stars. Spectroscopic Observations and Classification via Artificial Neural Networks

Carlos Allende Prieto[1], Rafael Rebolo[1], Ramón J. García López[1], Miguel Serra-Ricart[1], Timothy C. Beers[2], Silvia Rossi[3], Piercarlo Bonifacio[4] and Paolo Molaro[4]

[1] Instituto de Astrofísica de Canarias, E-38200, La Laguna, Tenerife, SPAIN
[2] Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA
[3] Instituto Astronômico e Geofísico, Universidade de São Paulo, Av. Miguel Stefano 4200, 04301-908, São Paulo SP, BRAZIL
[4] Osservatorio Astronomico di Trieste, Via Tiepolo 11, I-34131, Trieste, ITALY

With the dual aims of enlarging the list of extremely metal-poor stars identified in the Galaxy, and boosting the numbers of moderately metal-deficient stars in directions that sample the rotational properties of the thick disk, we have used the 2.5m Isaac Newton Telescope and the Intermediate Dispersion Spectrograph to carry out a survey of brighter (primarily northern hemisphere) metal-poor candidates selected from the HK objective-prism/interference-filter survey of Beers and collaborators. Over the course of only three observing runs (15 nights) we have obtained medium-resolution ($\lambda/\delta\lambda \simeq 2000$) spectra for 1203 objects ($V \simeq 11 - 15$). Spectral absorption-line indices and radial

velocities have been measured for all of the candidates. Metallicities, quantified by [Fe/H], and intrinsic $(B-V)_0$ colors have been estimated for 731 stars with effective temperatures cooler than roughly 6500 K, making use of artificial neural networks (ANNs), trained with spectral indices. We show that this method performs as well as a previously explored Ca II K calibration technique, yet it presents some practical advantages. Among the candidates in our sample, we identify 195 stars with $[\mathrm{Fe/H}] \leq -1.0$, 67 stars with $[\mathrm{Fe/H}] \leq -2.0$, and 12 new stars with $[\mathrm{Fe/H}] \leq -3.0$. Although the *effective yield* of metal-poor stars in our sample is not as large as previous HK survey follow-up programs, the *rate* of discovery per unit of telescope time is quite high.

Further development of the ANN technique, with the networks being fed the entire spectrum, rather than just the spectral indices, holds the promise to produce fast, accurate, multi-dimensional spectral classifications (with the associated physical parameter estimates), as is required to process the large data flow provided by present and future instrumentation.

Accepted by AJ

For preprints contact: callende@astro.as.utexas.edu

For preprints via ftp or WWW: http://hebe.as.utexas.edu

Solar Abstracts

Line Formation in Solar Granulation: I. Fe Line Shapes, Shifts and Asymmetries

M. Asplund[1,2], Å. Nordlund[3], R. Trampedach[4], C. Allende Prieto[5], and R.F. Stein[4]

[1] NORDITA, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark
[2] present address: Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden
[3] Astronomical Observatory, NBIfAFG, Juliane Maries Vej 30, DK-2100 Copenhagen Ø, Denmark
[4] Dept. of Physics and Astronomy, Michigan State University, East Lansing, MI 48823, USA
[5] McDonald Observatory and Department of Astronomy, University of Texas, Austin, TX 78712-1083, USA

Realistic ab-initio 3D, radiative-hydrodynamical convection simulations of the solar granulation have been applied to Fe I and Fe II line formation. In contrast to classical analyses based on hydrostatic 1D model atmospheres the procedure contains no adjustable free parameters but the treatment of the numerical viscosity in the construction of the 3D, time-dependent, inhomogeneous model atmosphere and the elemental abundance in the 3D spectral synthesis. However, the numerical viscosity is introduced purely for numerical stability purposes and is determined from standard hydrodynamical test cases with no adjustments allowed to improve the agreement with the observational constraints from the solar granulation.

The non-thermal line broadening is mainly provided by the Doppler shifts arising from the convective flows in the solar photosphere and the solar oscillations. The almost perfect agreement between the predicted temporally and spatially averaged line profiles for weak Fe lines with the observed profiles and the absence of trends in derived abundances with line strengths, seem to imply that the micro- and macroturbulence concepts are obsolete in these 3D analyses. Furthermore, the theoretical line asymmetries and shifts show a very satisfactory agreement with observations with an accuracy of typically $50-100\,\mathrm{m\,s^{-1}}$ on an absolute velocity scale. The remaining minor discrepancies point to how the convection simulations can be refined further.

Accepted by A&A

For preprints contact: martin@astro.uu.se

For preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0005320

Line Formation in Solar Granulation: II. The Photospheric Fe Abundance

M. Asplund[1,2], Å. Nordlund[3], R. Trampedach[4], and R.F. Stein[4]

[1] NORDITA, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark
[2] present address: Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden
[3] Astronomical Observatory, NBIfAFG, Juliane Maries Vej 30, DK-2100 Copenhagen Ø, Denmark
[4] Dept. of Physics and Astronomy, Michigan State University, East Lansing, MI 48823, USA

The solar photospheric Fe abundance has been determined using realistic ab initio 3D, time-dependent, hydrodynamical model atmospheres. The study is based on the excellent agreement between the predicted and observed line profiles directly rather than equivalent width, since the intrinsic Doppler broadening from the convective motions and oscillations provide the necessary non-thermal broadening. Thus, three of the four hotly debated parameters (equivalent widths, microturbulence and damping enhancement factors) in the center of the recent solar Fe abundance dispute regarding Fe I lines no longer enter the analysis, leaving the transition probabilities as the main uncertainty. Both Fe I (using the samples of lines of both the Oxford and Kiel studies) and Fe II lines have been investigated, which give consistent results: $\log \epsilon_{\rm FeI} = 7.44 \pm 0.05$ and $\log \epsilon_{\rm FeII} = 7.45 \pm 0.10$. Also the wings of strong Fe I lines return consistent abundances, $\log \epsilon_{\rm FeII} = 7.42 \pm 0.03$, but due to the uncertainties inherent in analyses of strong lines we give this determination lower weight than the results from weak and intermediate strong lines. In view of the recent slight downward revision of the meteoritic Fe abundance $\log \epsilon_{\rm Fe} = 7.46 \pm 0.01$, the agreement between the meteoritic and photospheric values is very good, thus appearingly settling the debate over the photospheric Fe abundance from Fe I lines.

Accepted by A&A

For preprints contact: martin@astro.uu.se

For preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0005321

Line Formation in Solar Granulation: III. The Photospheric Si and Meteoritic Fe Abundances

M. Asplund[1,2]

[1] NORDITA, Blegdamsvej 17, DK-2100 Copenhagen Ø, Denmark

[2] present address: Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden

Using realistic hydrodynamical simulations of the solar surface convection as 3D, time-dependent, inhomogeneous model atmospheres, the solar photospheric Si abundance has been determined to be $\log \epsilon_{\rm Si} = 7.51 \pm 0.04$. This constitutes a difference of 0.04 dex compared with previous estimates based on the 1D Holweger-Müller (1974) model, of which half is attributable to the adopted model atmosphere and the remaining part to the improved quantum mechanical broadening treatment. As a consequence, all meteoritic abundances should be adjusted downwards by the same amount. In particular the meteoritic Fe abundance will be $\log \epsilon_{\rm Fe} = 7.46 \pm 0.01$, in good agreement with the recently determined photospheric Fe abundance (Asplund et al. 2000b). The existing uncertainties unfortunately prevent an observational confirmation of the postulated effects of elemental migration of metals in the Sun.

Accepted by A&A

For preprints contact: martin@astro.uu.se

For preprints via WWW: http://xxx.lanl.gov/abs/astro-ph/0005322

Brown Dwarf Abstracts

Evolutionary Models for Very-low-mass Stars and Brown Dwarfs With Dusty Atmospheres

G. Chabrier[1], **I. Baraffe**[1], **F. Allard**[1] **and P. Hauschildt**[2]

[1] Ecole Normale Supérieure de Lyon, C.R.A.L. (UMR 5574 CNRS), F-69364 Lyon Cedex 07, France

[2] Dept. of Physics and Astronomy and Center for Simulational Physics, University of Georgia Athens, GA 30602-2451

We present evolutionary calculations for very-low-mass stars and brown dwarfs based on synthetic spectra and non-grey atmosphere models which include dust formation and opacity, i.e. objects with $T_{\rm eff} \lesssim 2800$ K. The interior of the most massive brown dwarfs is shown to develop a conductive core after ~ 2 Gyr which slows down their cooling. Comparison is made in optical and infrared color-magnitude diagrams with recent late-M and L-dwarf observations. The saturation in optical colors and the very red near-infrared colors of these objects are well explained by the onset of dust formation in the atmosphere. Comparison of the faintest presently observed L-dwarfs with these dusty evolutionary models suggests that dynamical processes such as turbulent diffusion and gravitational settling are taking place near the photosphere. As the effective temperature decreases below $T_{\rm eff} \approx 1300 - 1400$ K, the colors of these

objects move to very blue near-infrared colors, a consequence of the ongoing methane absorption in the infrared. We suggest the possibility of a brown dwarf dearth in J, H, K color-magnitude diagrams around this temperature.

Accepted by ApJ

For preprints contact: ibaraffe@ens-lyon.fr

For preprints via WWW: http://babbage.sissa.it/astro-ph/0005557

A Candidate Substellar Companion to HR 7329

P.J. Lowrance[1], G. Schneider[2], J.D. Kirkpatrick[3], E.E. Becklin[1], A. J. Weinberger[1], B. Zuckerman[1], P. Plait[4], E. Malmuth[5], S. Heap[6], A. Schultz[7], B. A. Smith[8], R. J. Terrile[9] and D. C. Hines[3]

[1]University of California Los Angeles, Los Angeles, CA
[2]University of Arizona, Tucson, AZ
[3]Infrared Processing and Analysis Center, California Institute of Technology, Pasadena, CA
[4]Advanced Computer Concepts, Inc, Goddard Space Flight Center, Greenbelt, MD
[5]Raytheon ITSS, Goddard Space Flight Center, Greenbelt, MD
[6]NASA, Goddard Space Flight Center, Greenbelt, MD
[7]Computer Sciences Corporation, Baltimore, MD
[8]Institute for Astronomy, University of Hawaii, Honolulu, HI
[9]Jet Propulsion Laboratory, Pasadena, CA

We present the discovery of a candidate substellar companion from a survey of nearby, young stars with the NICMOS coronagraph on the Hubble Space Telescope. The H$\approx$12 mag object was discovered approximately 4" from the young A0V star HR 7329. Using follow-up spectroscopy from STIS, we derive a spectral type between M7V and M8V with an effective temperature of $\sim$ 2600 K. We estimate that the probability of a chance alignment with a foreground dwarf star of this nature is $\sim 10^{-8}$ and therefore suggest the object (HR 7329B) is physically associated with HR 7329 with a projected separation of 200 AU. Current brown dwarf cooling models indicate a mass of less than 50 Jupiter masses for HR 7329B based on age estimates of $\leq$ 30 Myr for HR7329A.

Accepted by ApJ

For preprints contact: lowrance@astro.ucla.edu

For preprints via ftp or WWW: http://www.astro.ucla.edu/~lowrance or http://xxx.lanl.gov/abs/astro-ph/0005047

MEETING ANNOUNCEMENT

Stellar Coronae in the *Chandra* and *XMM-Newton* Era

June 25 to 29, 2001
Noordwijk, The Netherlands
Organized by the
European Space Technology and Research Center

Results from earlier generations of X-ray and EUV observatories (Einstein, EXOSAT, ROSAT, ASCA, EUVE) over the past two decades have opened up the field of stellar coronae, while solar observations have greatly advanced our view of the only stellar corona that we can study with spatial resolution. However, the observational advances and discoveries have left many open questions regarding the nature of stellar outer atmospheres. Fundamental issues such as coronal heating, the spatial distribution of stellar coronal plasma, and the nature and presence of elemental fractionation and abundance anomalies, remain outstanding problems. Much also remains to be explored concerning the existence and role of hot stellar coronae in the broader context of the HR diagram, in star formation and in other areas of astronomy.

Thanks to their high sensitivity and spectral resolution, the data obtained by the Chandra and XMM-Newton missions are providing a new look at the coronae of stars. At the same time, the spectacular successes of the SoHO and TRACE missions are providing the most detailed spatial and spectral views ever obtained of the solar corona. The aim of this conference is to provide a timely forum for a detailed discussion of the impact of the new generation of data on coronal astronomy at large, bringing together observers and theoreticians, as well as experts in other disciplines of relevance, such as stellar structure and star formation.

A list of topics which will be addressed at the meeting is:

- the solar corona in the stellar context
- coronal heating mechanisms (quiescent and flaring)
- structuring of stellar coronae: size, density, location, filling factor
- flares and their contribution to the understanding of coronae in general
- stellar and solar coronal abundances
- impact of coronal phenomena on our understanding of internal stellar structure, star formation mechanisms and on other fields of astronomy

Scientific Organizing Committee: F. Favata (ESA/ESTEC – chair), J. Drake (Harvard-Smithsonian Center for Astrophysics – co-chair), M. Guedel (Paul Scherrer Institute), J. Klimchuk (US Naval Research Laboratory), J. M. Laming (US Naval Research Laboratory), G. Micela (Osservatorio Astronomico di Palermo), J. Schmitt (Universität Hamburg), S.M. White (University of Maryland)

Logistics The conference will take place in the Conference Center of the European Space Research and Technology Center (ESTEC) in Noordwijk, The Netherlands. A first announcement will be circulated in late 2000, including a call for papers, details about registration and a preliminary program with a list of invited speakers.

Further Information Please contact: Fabio Favata (`ffavata@astro.estec.esa.nl`) for any additional information.

Abstract Guidelines

Abstracts for *COOLNEWS* are solicited for papers that have been recently accepted by or submitted to refereed journals, and for recent Ph.D. theses. Abstracts for conference proceedings articles are *not* posted in *COOLNEWS*. The subject matter should pertain directly to cool stars (spectral types F,G,K,M or L), brown dwarfs, or the sun. Both theoretical and observational abstracts are appropriate.

Abstracts dealing with cool pre-main-sequence (PMS) stars will generally not be included in *COOLNEWS*, since they are already covered by the *Star Formation Newsletter*. Exceptions to this rule will be considered if the subject matter is truly cross-disciplinary. If you wish to submit a cross-disciplinary abstract on PMS stars, then first submit it to the *Star Formation Newsletter*. After doing so, submit the abstract to *COOLNEWS* accompanied by a short e-mail stating that it has already been submitted to the *Star Formation Newsletter*, and summarizing why it will be of interest to the cool star/solar community at large.

A monthly call for abstracts will be issued and abstracts received by the last day of the month will usually appear in the following month's newsletter. Announcements of general interest to the cool star and solar communities may also be submitted for posting in the newsletter. These might include (but are not restricted to) the following: (i) *Job Openings* directed toward cool star or solar researchers, (ii) announcements of *Upcoming Meetings*, (iii) announcements of *Upcoming Observing Campaigns* for which participation is solicited from the community at large, (iv) reviews of *New Books*, and (v) *General Announcements* that provide or request research-related information. Please send all correspondence to the editor at coolnews@jila.colorado.edu. Abstract templates and back issues can be obtained from the COOLNEWS Web-page at

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