

COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 143 — February 2008

Editor: Steve Skinner (coolnews@jila.colorado.edu)

TABLE OF CONTENTS

Stellar Abstracts	1
Solar Abstracts	4
Cross-Listed Abstracts	5
Job Opening	6
Abstract Guidelines	7

Stellar Abstracts

The Distribution of Stellar Mass in the Pleiades

Joseph M. Converse¹ and Steven W. Stahler²

¹ Dept. of Astronomy, 601 Campbell Hall, Univ. of California, Berkeley, CA 94720 USA

As part of an effort to understand the origin of open clusters, we present a statistical analysis of the currently observed Pleiades. Starting with a photometric catalog of the cluster, we employ a maximum likelihood technique to determine the mass distribution of its members, including single stars and both components of binary systems. We find that the overall binary fraction for unresolved pairs is 68%. Extrapolating to include resolved systems, this fraction climbs to about 76%, significantly higher than the accepted field-star result. Both figures are sensitive to the cluster age, for which we have used the currently favored value of 125 Myr. The primary and secondary masses within binaries are correlated, in the sense that their ratios are closer to unity than under the hypothesis of random pairing. We map out the spatial variation of the cluster's projected and three-dimensional mass and number densities. Finally, we revisit the issue of mass segregation in the Pleiades. We find unambiguous evidence of segregation, and introduce a new method for quantifying it.

Accepted by ApJ

For preprints contact: jconverse@astro.berkeley.edu

Oscillating K Giants with the WIRE Satellite: Determination of Their Asteroseismic Masses

D. Stello¹, H. Bruntt¹, H. Preston² and D. Buzasi²

¹ School of Physics, University of Sydney, 2006 NSW, Australia

² US Air Force Academy, Colorado Springs, CO 80840, USA

Mass estimates of K giants are generally very uncertain. Traditionally, stellar masses of single field stars are determined by comparing their location in the Hertzsprung-Russell diagram with stellar evolutionary models. Applying an additional method to determine the mass is therefore of significant interest for understanding stellar evolution. We present the time series analysis of 11 K giants recently observed with the WIRE satellite. With this comprehensive sample, we report the first confirmation that the characteristic acoustic frequency, ν_{max} , can be predicted for K giants by scaling from the solar acoustic cut-off frequency. We are further able to utilize our measurements of ν_{max} to determine an asteroseismic mass for each star with a lower uncertainty compared to the traditional method, for most stars in our sample. This indicates good prospects for the application of our method on the vast amounts of data that will soon come from the COROT and Kepler space missions.

Accepted by ApJL (in press)

For preprints contact: stello@physics.usyd.edu.au

Detection of ‘Parent’ Molecules from the Inner Wind of AGB Stars as Tracers of Non-equilibrium Chemistry

L. Decin^{1,2}, I. Cherchneff³, S. Hony^{4,1}, S. Dehaes¹, C. De Breuck⁵, K. M. Menten⁶

¹ Department of Physics and Astronomy, Institute for Astronomy, K.U.Leuven, Celestijnenlaan 200B, B-3001 Leuven, Belgium

² Sterrenkundig Instituut Anton Pannekoek, University of Amsterdam, Kruislaan 403 1098 Amsterdam, The Netherlands

³ Institut für Astronomie, ETH Hönggerberg, Wolfgang-Pauli-Strasse 16, 8093 Zürich, Switzerland

⁴ Laboratoire AIM, CEA/DSM - CNRS - Université Paris Diderot, DAPNIA/SAP, 91191 Gif sur Yvette, France

⁵ European Southern Observatory, Karl-Schwarzschild Strasse, D-85748 Garching bei München, Germany

⁶ MPI für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany

CONTEXT: Asymptotic Giant Branch (AGB) stars are typified by strong dust-driven, molecular outflows. For long, it was believed that the molecular content of the circumstellar envelope of AGB stars is primarily determined by the atmospheric C/O ratio. However, recent observations of molecules such as HCN, SiO, and SO reveal gas-phase abundances higher than predicted by thermodynamic equilibrium (TE) models. UV-photon initiated dissociation in the outer envelope or non-equilibrium formation by the effect of shocks in the inner envelope may be the origin of the anomalous abundances.

AIMS: We aim to detect (i) a group of ‘parent’ molecules (CO, SiO, HCN, CS), predicted by non-equilibrium studies to form with almost constant abundances independent of the C/O ratio and the stellar evolutionary stage on the Asymptotic Giant Branch (AGB), and (ii) the few molecules, such as SiS and SO, that are sensitive to the O- or C-rich nature of the star.

METHODS: Several low and high excitation rotational transitions of key molecules are observed at mm and sub-mm wavelengths with JCMT and APEX in four AGB stars: the oxygen-rich Mira WX Psc, the S star W Aql, and the two carbon stars V Cyg and II Lup. A critical density analysis is performed to determine the formation region of the high-excitation molecular lines.

RESULTS: We detect the four ‘parent’ molecules in all four objects, implying that, indeed, these chemical species form whatever the stage of evolution on the AGB. High-excitation lines of SiS are also detected in three stars with APEX, whereas SO is only detected in the oxygen-rich star WX Psc.

CONCLUSIONS: This is the first *multi-molecular* observational proof that periodically shocked layers above the photosphere of AGB stars show some *chemical homogeneity*, whatever the photospheric C/O ratio and stage of evolution of the star.

Accepted by A&A (in press)

For preprints contact: Leen.Decin@ster.kuleuven.be

Coronal Structure and Abundances in Young Fast Rotators

David García-Alvarez¹ Jeremy J. Drake², V.L. Kashyap², L. Lin², B. Ball²

¹ Imperial College London, Blackett Laboratory, Prince Consort Road, London SW7 2BZ, UK

² Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138

AB Dor, Speedy Mic and Rst 137B are in their early post-T Tauri evolutionary phase (≤ 100 Myr), at the age of fastest rotation in the life of late-type stars. They straddle the coronal saturation-supersaturation boundary first defined by young stars in open clusters. High resolution *Chandra* X-ray spectra have been analysed to study their coronal properties as a function of coronal activity parameters *Rossby number*, L_X/L_{bol} and a coronal temperature index. Plasma emission measure distributions as a function of temperature show broad peaks at $T \sim 10^7$ K. Differences between stars suggest that as supersaturation is reached the DEM slope below the temperature of peak DEM becomes shallower, while the DEM drop-off above this temperature becomes more pronounced. A larger sample comprising our three targets and 22 active stars studied in the recent literature reveals a general increase of plasma at $T > 10^7$ toward the saturated-supersaturated boundary but a decline beyond this among supersaturated stars. All three of the stars studied in detail here show lower coronal abundances of the low FIP elements Mg, Si and Fe, relative to the high FIP elements S, O and Ne, as compared to the solar mixture. The coronal Fe abundances of the stellar sample are inversely correlated with L_X/L_{bol} , declining slowly with rising L_X/L_{bol} , but with a much more sharp decline at $L_X/L_{bol} > 3 \times 10^{-4}$. For dwarfs the Fe abundance is also well-correlated with Rossby number. Coronal O abundances appear lower than photospheric expectations by up to ~ 0.2 dex, but with no obvious trends with activity indices. The coronal O/Fe ratios for dwarfs show a clear increase with decreasing Rossby number, apparently reaching saturation at $[O/Fe]=0.5$ at the coronal supersaturation boundary. Similar increases in O/Fe with increasing coronal temperature and L_X/L_{bol} are seen. The range in O/Fe variations attributable to outer atmosphere chemical fractionation in our sample is about a factor of 10.

Accepted by ApJ

For preprints contact: d.garcia-alvarez@imperial.ac.uk

A Coronal Explosion on the Flare Star CN Leonis

J.H.M.M. Schmitt¹, F. Reale², C. Liefke¹, U. Wolter¹, B. Fuhrmeister¹, A. Reiners³ and G. Peres²

¹ Hamburger Sternwarte, Gojenbergsweg 112, D-21029 Hamburg, Germany

² Dipartimento di Scienze Fisiche e Astronomiche, Università di Palermo, Piazza del Parlamento 1, I-90134 Palermo, Italy

³ Inst. f. Astrophysik, Universität Göttingen, 37077 Göttingen, Germany

We present simultaneous high-temporal and high-spectral resolution observations at optical and soft X-ray wavelengths of the nearby flare star CN Leo. During our observing campaign a major flare occurred, raising the star's instantaneous energy output by almost three orders of magnitude. The flare shows the often observed *impulsive behavior*, with a rapid rise and slow decay in the optical and a broad soft X-ray maximum about 200 seconds after the optical flare peak. However, in addition to this usually encountered flare phenomenology we find an extremely short ($\tau_{dec} \approx 2$ sec) soft X-ray peak, which is very likely of thermal, rather than non-thermal nature and temporally coincides with the optical flare peak. While at hard X-ray energies non-thermal bursts are routinely observed on the Sun at flare onset, thermal soft X-ray bursts on time scales of seconds have never been observed in a solar nor stellar context. Time-dependent, one-dimensional hydrodynamic modeling of this event requires an extremely short energy deposition time scale τ_{dep} of a few seconds to reconcile theory with observations, thus suggesting that we are witnessing the results of a coronal explosion on CN Leo. Thus the flare on CN Leo provides the opportunity to observationally study the physics of the long-sought "micro-flares" thought to be responsible for coronal heating.

Accepted by A&A

For preprints contact: jschmitt@hs.uni-hamburg.de

For preprints via ftp or WWW: <http://de.arxiv.org/abs/0801.3752>

Strong Horizontal Photospheric Magnetic Field in a Surface Dynamo Simulation

M. Schüssler¹ and A. Vögler²

¹ Max-Planck-Institut für Sonnensystemforschung, Max-Planck-Strasse 2, 37191 Katlenburg-Lindau, Germany

² Sterrekundig Instituut, Utrecht University, Postbus 80 000, 3508 TA Utrecht, The Netherlands

Observations with the Hinode spectro-polarimeter have revealed strong horizontal internetwork magnetic fields in the quiet solar photosphere. We aim at interpreting the observations by means of results from numerical simulations. Radiative MHD simulations of dynamo action by near-surface convection are analyzed with respect to the relation between vertical and horizontal magnetic field components. The dynamo-generated fields show a clear dominance of the horizontal field in the height range where the spectral lines used for the observations are formed. The ratio between the averaged horizontal and vertical field components is consistent with the values derived from the observations. This behavior results from the intermittent nature of the dynamo field with polarity mixing on small scales in the surface layers. Our results provide further evidence that local near-surface dynamo action contributes significantly to the solar internetwork fields.

Accepted by A&A

For preprints: <http://arxiv.org/abs/0801.1250v1>

Do Long-Lived Features Really Exist in the Solar Photosphere? II. Contrast of Time-Averaged Granulation Images

P.N. Brandt¹ and A.V. Getling²

¹ Kiepenheuer-Institut für Sonnenphysik, Schöneckstrasse 6, 79104 Freiburg, Germany

² Institute of Nuclear Physics, Lomonosov Moscow State University, 119991 Moscow, Russia

The decrease in the rms contrast of time-averaged images with the averaging time is compared between four datasets: (1) a series of solar granulation images recorded at La Palma in 1993; (2) a series of artificial granulation images obtained in numerical simulations by Rieutord et al. (2002); (3) a similar series computed by Steffen and his colleagues (see Wedemeyer et al., 2004); (4) a random field with some parameters typical of the granulation, constructed by Rast (2002). In addition, (5) a sequence of images was obtained from real granulation images using a temporal and spatial shuffling procedure, and the contrast of the average of n images from this sequence as a function of n is analysed. The series (1) of real granulation images exhibits a considerably slower contrast decrease than do both the series (3) of simulated granulation images and the series (4) of random fields. Starting from some relatively short averaging times t , the behaviour of the contrast in series (3) and (4) resembles the $t^{-1/2}$ statistical law, while the shuffled series (5) obeys the $n^{-1/2}$ law from $n = 2$ on. Series (2) demonstrates a peculiarly slow decline of contrast, which could be attributed to particular properties of the boundary conditions used in the simulations. Comparisons between the analysed contrast-variation laws indicate quite definitely that the brightness field of solar granulation contains a long-lived component, which could be associated with locally persistent dark intergranular holes and/or with the presence of quasi-regular structures. The suggestion that the random field (4) successfully reproduces the contrast-variation law for the real granulation (Rast, 2002) can be dismissed.

Accepted by Solar Physics

For preprints contact: A.Getling@mail.ru

Preprint available via arXiv [astro-ph] : <http://arxiv.org/abs/0802.0204>

Properties of High-degree Oscillation Modes of the Sun Observed with Hinode/SOT

U. Mitra-Kraev¹, A.G. Kosovichev² and T. Sekii³

¹ University of Sheffield, Department of Applied Mathematics, Hicks Building, Sheffield S3 7RH, UK

² W. W. Hansen Experimental Physics Laboratory, Stanford University, Stanford, CA 94305, USA

³ National Astronomical Observatory of Japan, Mitaka, Tokyo 181-8588, Japan

With the Solar Optical Telescope on Hinode, we investigate the basic properties of high-degree solar oscillations observed at two levels in the solar atmosphere, in the G-band (formed in the photosphere) and in the Ca II H line

(chromospheric emission). We analyzed the data by calculating the individual power spectra as well as the cross-spectral properties, i.e., coherence and phase shift. The observational properties are compared with a simple theoretical model, which includes the effects of correlated noise. The results reveal significant frequency shifts between the Ca II H and G-band spectra, in particular above the acoustic cut-off frequency for pseudo-modes. The cross-spectrum phase shows peaks associated with the acoustic oscillation (p-mode) lines, and begins to increase with frequency around the acoustic cut-off. However, we find no phase shift for the (surface gravity wave) f-mode. The observed properties for the p-modes are qualitatively reproduced in a simple model with a correlated background if the correlated noise level in the Ca II H data is higher than in the G-band data. These results suggest that multi-wavelength observations of solar oscillations, in combination with the traditional intensity-velocity observations, may help to determine the level of the correlated background noise and to determine the type of wave excitation sources on the Sun.

Accepted by A&A (Letter for Hinode Special Issue)

For preprints contact: u.mitrakraev@sheffield.ac.uk

For preprints via astro-ph: <http://xxx.lanl.gov/abs/0711.2210>

Cross-Listed Abstracts (Pre-Main Sequence Stars)

Editor's Note: The abstracts below are being cross-listed with the *Star Formation Newsletter*.

Discovery of a Bipolar X-ray Jet from the T Tauri Star DG Tau

Manuel Güdel^{1,2,3}, Stephen L. Skinner⁴, Marc Audard^{5,6}, Kevin R. Briggs¹ and Sylvie Cabrit⁷

¹ Paul Scherrer Institut, Würenlingen and Villigen, CH-5232 Villigen PSI, Switzerland

² Max-Planck-Institute for Astronomy, Königstuhl 17, D-69117 Heidelberg, Germany

³ Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands

⁴ CASA, UCB 389, University of Colorado, Boulder, CO 80309-0389, USA

⁵ ISDC, Chemin d'Ecogia 16, 1290 Versoix, Switzerland

⁶ Geneva Observatory, University of Geneva, Ch. des Maillettes 51, 1290 Sauverny, Switzerland

⁷ L'Observatoire de Paris, 61, avenue de l'Observatoire, 75014 Paris, France

We have obtained and analyzed Chandra ACIS-S observations of the strongly accreting classical T Tauri star DG Tau. Our principal goals are to map the immediate environment of the star to characterize possible extended X-rays formed in the jet, and to re-visit the anomalous, doubly absorbed X-ray spectrum of DG Tau itself. We combine our new ACIS-S data with a data set previously obtained. The data are superimposed to obtain flux and hardness images. Separate X-ray spectra are extracted for DG Tau and areas outside its point spread function. We detect a prominent X-ray jet at a position angle of PA \approx 225 deg (tentatively suggested by Güdel et al. 2005), coincident with the optical jet axis. We also identify a counter jet at PA = 45 deg. The X-ray jets are detected out to a distance of \approx 5" from the star, their sources being extended at the ACIS-S resolution. The jet spectra are soft, with a best-fit electron temperature of 3.4 MK. We find evidence for excess absorption of the counter jet. The spectrum of the DG Tau point source shows two components with largely different temperatures and absorption column densities. The similar temperatures and small absorbing gas columns of the jet sources and the soft component of the "stellar" source suggest that these sources are related, produced either by shocks or by magnetic heating in the jets. Cooling estimates suggest that the pressure in the hot gas contributes to jet expansion. The hard "stellar" component, on the other hand, is associated with a stellar corona or magnetosphere. The excessive photoelectric absorption of this component suggests the presence of dust-depleted accretion streams above coronal magnetic fields.

Accepted by A&A

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

For preprints via ftp or WWW: <http://www.astro.phys.ethz.ch/papers/guedel/papers.html>

Job Opening

**Tenure Track Assistant Professor
Solar Astrophysics
New Mexico State University
Las Cruces, NM**

The New Mexico State University (NMSU) Department of Astronomy invites applications for a tenure-track Assistant Professor position in Solar Astrophysics beginning August 2008. Applicants must have a Ph.D. in solar physics, astronomy, astrophysics, or a closely related field. The successful applicant will demonstrate a currently active solar observation/theory/ modeling program and the ability to participate in ongoing solar science studies at the national and international levels, including use of the in-development ATST and its science emphases (multi-layer polarimetry, magneto-convective processes, etc.). The successful candidate will ideally provide evidence of the ability to deliver high quality instruction at the graduate and undergraduate levels, the ability to secure sustained external research funding, and the ability to serve as a research advisor to MS and PhD students.

The Department hosts a wide range of astronomical investigations, which benefit from membership in the Astrophysical Research Consortium (ARC) and its Apache Point Observatory (APO) 3.5-meter telescope. The Department also operates its own 1-meter telescope at APO and is a member of the Sloan Digital Sky Survey II project. Additional Department information can be found at <http://astronomy.nmsu.edu>.

NMSU serves a diverse undergraduate and graduate population of 16,000 students. Located in Las Cruces (the state's second largest city), NMSU is within driving distance of: the National Solar Observatory, the NRAO Very Large Array, and Kitt Peak National Observatory.

To be considered for this position, send a cover letter, brief statements of research interests and plans (including any additional research expertise and interests) and teaching experience and philosophy, and a curriculum vitae to:

Chair, Faculty Search Committee Department of Astronomy New Mexico State University, MSC 4500 1320 Frenger St. Las Cruces, NM 88003-8001

Applicants should arrange for three confidential letters of recommendation to be sent to the same address. Review of completed applications will begin February 1st, 2008 and will continue until the position is filled or closed.

New Mexico State University is an EEO/AA Employer. Offer of employment contingent upon verification of individual's eligibility for employment in the United States.

Abstract Guidelines

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

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

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

<http://casa.colorado.edu/~skimmers/coolnews.html> .

*** Please send abstracts in the body of the message and *not* as attachments.***