COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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TABLE OF CONTENTS

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Stellar Abstracts

Fundamental Properties of Solar-like Oscillating Stars from Frequencies of Minimum Deltanu – II. Model Computations for Different Chemical Compositions and Mass

M. Yıldız[1], Z. Çelik Orhan[1] and C. Kayhan[1]

[1] Department of Astronomy and Space Sciences, Science Faculty, Ege University, 35100 Bornova, Izmir, Turkey

The large separations between the oscillation frequencies of solar-like stars are measures of stellar mean density. The separations have been thought to be mostly constant in the observed range of frequencies. However, detailed investigation shows that they are not constant, and their variations are not random but have very strong diagnostic potential for our understanding of stellar structure and evolution. In this regard, frequencies of the minimum large separation are very useful tools. From these frequencies, in addition to the large separation and frequency of maximum amplitude, Yıldız et al. recently have developed new methods to find almost all the fundamental stellar properties. In the present study, we aim to find metallicity and helium abundances from the frequencies, and generalize the relations given by Yıldız et al. for a wider stellar mass range and arbitrary metallicity (Z) and helium abundance (Y). We show that the effect of metallicity is significant for most of the fundamental parameters. For stellar mass, for example, the expression must be multiplied by $(Z/Z_\odot)^{0.12}$. For arbitrary helium abundance, $M \propto (Y/Y_\odot)^{0.25}$. Methods for determination of Z and Y from pure asteroseismic quantities are based on amplitudes (differences between maximum and minimum values of $\Delta\nu$) in the oscillatory component in the spacing of oscillation frequencies. Additionally, we demonstrate that the difference between the first maximum and the second minimum is very sensitive to Z. It also depends on ν_{min1}/ν_{max} and small separation between the frequencies. Such a dependence leads us to develop a method to find Z (and Y) from oscillation frequencies. The maximum difference between the estimated and model Z values is about 14 per cent. It is 10 per cent for Y.

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For preprints contact: zcelik87@gmail.com

The Flare-ona of EK Draconis

Thomas R. Ayres[1]

[1] CASA, 389-UCB, University of Colorado, Boulder, CO 80309 USA

EK Draconis (HD 129333: G1.5 V) is a well-known young (50 Myr) solar analog. In 2012, *Hubble Space Telescope* returned to EK Dra to follow up a far-ultraviolet (FUV) SNAPshot visit by Cosmic Origins Spectrograph (COS) two years earlier. The brief SNAP pointing had found surprisingly redshifted, impulsively variable subcoronal "hot-line" emission of Si IV 1400 Å ($T \sim 8 \times 10^4$ K). Serendipitously, the 2012 follow-on program witnessed one of the largest FUV flares ever recorded on a sunlike star, which again displayed strong redshifts (downflows) of 30–40 km s^{-1}, even after compensating for small systematics in the COS velocity scales, uncovered through a cross-calibration by Space Telescope Imaging Spectrograph (STIS). The (now reduced, but still substantial) ∼10 km s^{-1} hot-line redshifts outside the flaring interval did not vary with rotational phase, so cannot be caused by "Doppler Imaging" (bright surface patches near a receding limb). Density diagnostic O IV] 1400 Å multiplet line ratios of EK Dra suggest $n_{\rm e} \sim 10^{11}$ cm^{-3}, an order of magnitude larger than in low-activity solar twin α Centauri A, but typical of densities inferred in large stellar soft X-ray events. The self-similar FUV hot-line profiles between the flare decay and the subsequent more quiet periods, and the unchanging but high densities, reinforce a long-standing idea that the coronae of hyperactive dwarfs are flaring all the time, in a scale-free way; a *flare-ona* if you will. In this picture, the subsonic hot-line downflows probably are a byproduct of the post-flare cooling process, something like "coronal rain" on the Sun. All in all, the new STIS/COS program documents a complex, energetic, dynamic outer atmosphere of the young sunlike star.

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For preprints contact:Thomas.Ayres@Colorado.edu

For preprints via WWW: http://arxiv.org/abs/1505.02320

Three-dimensional Simulations of Near-surface Convection in Main-sequence Stars. III. The Structure of Small-scale Magnetic Flux Concentrations

Benjamin Beeck[1], **Manfred Schüssler**[1], **Robert H. Cameron**[1] **and Ansgar Reiner**[2]

[1] Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany
[2] Institut für Astrophysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

The convective envelopes of cool main-sequence stars harbour magnetic fields with a complex global and local structure. These fields affect the near-surface convection and the outer stellar atmospheres in many ways and are responsible for the observable magnetic activity of stars. Our aim is to understand the local structure in unipolar regions with moderate average magnetic flux density. These correspond to plage regions covering a substantial fraction of the surface of the Sun (and likely also the surface of other Sun-like stars) during periods of high magnetic activity. We analyse the results of 18 local-box magnetohydrodynamics simulations covering the upper layers of the convection zones and the photospheres of cool main-sequence stars of spectral types F to early M. The average vertical field in these simulations ranges from 20 to 500 G. We find a substantial variation of the properties of the surface magnetoconvection between main-sequence stars of different spectral types. As a consequence of a reduced efficiency of the convective collapse of flux tubes, M dwarfs lack bright magnetic structures in unipolar regions of moderate field strength. The spatial correlation between velocity and the magnetic field as well as the lifetime of magnetic structures and their sizes relative to the granules vary significantly along the model sequence of stellar types.

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For preprints contact: beeck@mps.mpg.de

Three-dimensional Simulations of Near-surface Convection in Main-sequence stars. IV. Effect of Small-scale Magnetic Flux Concentrations on Centre-to-limb Variation and Spectral Lines

Benjamin Beeck[1], **Manfred Schüssler**[1], **Robert H. Cameron**[1] **and Ansgar Reiner**[2]

[1] Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany
[2] Institut für Astrophysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Magnetic fields affect the local structure of the photosphere of stars. They can considerably influence the radiative properties near the optical surface, flow velocities, and the temperature and pressure profiles. This has an impact on observables such as limb darkening and spectral line profiles. We aim at understanding qualitatively the influence of small magnetic flux concentrations in unipolar plage regions on the centre-to-limb variation of the intensity and its contrast and on the shape of spectral line profiles in cool main-sequence stars. We analyse the bolometric and continuum intensity and its angular dependence of 24 radiative magnetohydrodynamic simulations of the near-surface layers of main-sequence stars with six different sets of stellar parameters (spectral types F to early M) and four different average magnetic field strengths (including the non-magnetic case). We also calculated disc-integrated profiles of three spectral lines. The small magnetic flux concentrations formed in the magnetic runs of simulations have a considerable impact on the intensity and its centre-to-limb variation. In some cases, the difference in limb darkening between magnetic and non-magnetic runs is larger than the difference between the spectral types. Spectral lines are not only broadened owing to the Zeeman effect, but are also strongly affected by the modified thermodynamical structure and flow patterns. This indirect magnetic impact on the line profiles is often bigger than that of the Zeeman effect. The effects of the magnetic field on the radiation leaving the star can be considerable and is not restricted to spectral line broadening and polarisation by the Zeeman effect. The inhomogeneous structure of the magnetic field on small length scales and its impact on (and spatial correlation with) the local thermodynamical structure and the flow field near the surface influence the measurement of the global field properties and stellar parameters. These effects need to be taken into account in the interpretation of observations.

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For preprints contact: beeck@mps.mpg.de

Low-Mass and Substellar Abstracts

The Number Fraction of Discs Around Brown Dwarfs in Orion OB1a and the 25 Orionis Group

Juan José Downes[1,2], Carlos Román-Zúñiga[1], Javier Ballesteros-Paredes[3], Cecilia Mateu[1,2], César Briceño[4], Jesús Hernández[2], Monika G. Petr-Gotzens[6], Nuria Calvet[5], Lee Hartmann[5], and Karina Mauco[3]

[1]Instituto de Astronomía, UNAM, Ensenada, C.P. 22860, Baja California, México
[2]Centro de Investigaciones de Astronomía, AP 264, Mérida 5101-A, Venezuela
[3]Centro de Radioastronomía y Astrofísica, UNAM. Apartado Postal 72-3 (Xangari), Morelia, Michoacán 58089, México
[4]Cerro Tololo Interamerican Observatory, Casilla 603, La Serena, Chile
[5]Department of Astronomy, University of Michigan, 825 Dennison Building, 500 Church Street, Ann Arbor, MI 48109, USA
[6]European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching bei München, Germany

We present a study of 15 new brown dwarfs belonging to the ∼7 Myr old 25 Orionis group and Orion OB1a sub-association with spectral types between M6 and M9 and estimated masses between $\sim$0.07 $M_\odot$ and $\sim$0.01 $M_\odot$. By comparing them through a Bayesian method with low mass stars ($0.8 \lesssim M/M_\odot \lesssim 0.1$) from previous works in the 25 Orionis group, we found statistically significant differences in the number fraction of classical T Tauri stars, weak T Tauri stars, class II, evolved discs and purely photospheric emitters at both sides of the sub-stellar mass limit. Particularly we found a fraction of $3.9^{+2.4}_{-1.6}$ % low mass stars classified as CTTS and class II or evolved discs, against a fraction of $33.3^{+10.8}_{-9.8}$ % in the sub-stellar mass domain. Our results support the suggested scenario in which the dissipation of discs is less efficient for decreasing mass of the central object.

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For preprints contact: jdownes@astrosen.unam.mx, jdownes@cida.ve

On the Environment Surrounding Close-in Exoplanets

A. A. Vidotto[1], R. Fares[2], M. Jardine[2], C. Moutou[3,4], J. F. Donati[5]

[1]Observatoire de Genève, Université de Genève, Chemin des Maillettes 51, Versoix, CH-1290, Switzerland
[2]SUPA, School of Physics and Astronomy, University of St. Andrews, North Haugh, St Andrews, KY16 9SS, UK
[3]Canada-France-Hawaii Telescope Corporation, CNRS, 65-1238 Mamalahoa Hwy, Kamuela HI 96743, USA
[4]Aix Marseille Université, CNRS, LAM (Laboratoire d'Astrophysique de Marseille) UMR 7326, 13388, Marseille, France
[5]LATT - CNRS/Université de Toulouse, 14 Av. E. Belin, Toulouse, F-31400, France

Exoplanets in extremely close-in orbits are immersed in a local interplanetary medium (i.e., the stellar wind) much denser than the local conditions encountered around the solar system planets. The environment surrounding these exoplanets also differs in terms of dynamics (slower stellar winds, but higher Keplerian velocities) and ambient magnetic fields (likely higher for host stars more active than the Sun). Here, we quantitatively investigate the nature of the interplanetary media surrounding the hot Jupiters HD46375b, HD73256b, HD102195b, HD130322b, HD179949b. We simulate the three-dimensional winds of their host stars, in which we directly incorporate their observed surface magnetic fields. With that, we derive mass-loss rates (1.9 to 8.0×10^{-13} $M_\odot$ yr^{-1}) and the wind properties at the position of the hot-Jupiters' orbits (temperature, velocity, magnetic field intensity and pressure). We show that these exoplanets' orbits are super-magnetosonic, indicating that bow shocks are formed surrounding these planets. Assuming planetary magnetic fields similar to Jupiter's, we estimate planetary magnetospheric sizes of 4.1 to 5.6 planetary radii. We also derive the exoplanetary radio emission released in the dissipation of the stellar wind energy. We find radio fluxes ranging from 0.02 to 0.13 mJy, which are challenging to be observed with present-day technology, but could be detectable with future higher sensitivity arrays (e.g., SKA). Radio emission from systems having closer hot-Jupiters, such as from τ Boo b or HD 189733b, or from nearby planetary systems orbiting young stars, are likely to have higher radio fluxes, presenting better prospects for detecting exoplanetary radio emission.

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For preprints contact: Aline.Vidotto@unige.ch

For preprints via WWW: http://arxiv.org/pdf/1503.05711.pdf

Stellar and Planetary Dynamos
26-29 May 2015; Göttingen Germany
http://www.dynamos2015.de

Triple Evolution & Dynamics in Stellar and Planetary Systems
31 May - 5 June 2015; Haifa, Israel
http://trendy-triple.weebly.com

Kepler/TESS Asteroseismic Science Consortium Workshop: Space Asteroseismology, the Next Generation
15 - 19 June 2015; Aarhus, Denmark
http://sac.au.dk/currently/the-kasc8tasc1-workshop

Horizontal Branch Stars and UV Radiation from Old Stellar Populations
22 June 2015; Tenerife, Canary Islands, Spain
http://eas.unige.ch/EWASS2015/session.jsp?id=Sp11

In the Spirit of Bernard Lyot 2015 - Direct Detection of Exoplanets and Circumstellar Disks
22 - 26 June 2015; Montreal, Quebec, Canada
http://craq-astro.ca/lyot2015/

From Super-Earths to Brown Dwarfs: Who's Who?
29 June - 3 July 2015; Paris, France
http://www.iap.fr/col2015/

The Stellar IMF at Low Masses: A Critical Look at Variations and Environmental Dependencies
29 June - 1 July 2015; StSci, Baltimore, MD USA
http://www.stsci.edu/institute/conference/stellar-imf/

Stellar End Products: The Low Mass-High Mass Connection
6 - 10 July 2015; ESO, Garching, Germany
http://www.eso.org/sci/meetings/2015/STEPS2015.html

Seventh Meeting on Hot Subdwarfs and Related Objects
19 - 24 July 2015; Oxford, England, UK
http://www.physics.ox.ac.uk/subdwarfs2015/index.asp

IAU XXIX General Assembly
2 - 13 August 2015; Honolulu, Hawaii USA
http://astronomy2015.org

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

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

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