COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 132 — March 2007 Editor: Steve Skinner (coolnews@jila.colorado.edu)

TABLE OF CONTENTS

Stellar Abstracts

X-ray and Ultraviolet Spectroscopy of Intermediate Mass, First Crossing Giants

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Chandra X-ray Observatory, *Far-Ultraviolet Spectroscopic Explorer,* and *Hubble* Space Telescope Imaging Spectrograph jointly have obtained spectra of four intermediate mass giants ($\sim 3\mathcal{M}_{\odot}$) crossing the Hertzsprung gap for the first time; passing through a "rapid braking phase" analogous to, but much briefer than, the more gradual prolonged decay of magnetic activity experienced by single low mass stars like the Sun. All four giants display hot, dense coronal plasmas (6–30 MK, $\sim 10^{12}$ cm^{-3}), with near solar abundances. The ultraviolet spectra show a remarkable congruence of shapes of the 0.06–0.2 MK lines of Si IV, C IV, and N V, which further can be decomposed into narrow and broad Doppler components. The profile isomorphism extends to the yellow dwarf α^1 Cen (G2 V), utilized as a solar surrogate. The broad component fraction of the total increases with $L_{\rm X}/L_{\rm bol}$, and is suggestive of persistent "micro-flaring." Indeed, the most active of the targets, HR 9024 (G1 III), experienced a *macro* flare during the *Chandra* pointing, reaching a remarkable 100 MK. In pre-braking phase 31 Com (G0 III), and solar proxy α^1 Cen, emission levels in the 0.03–0.3 MK "transition zone" regime are very similar to those of the 1–10 MK corona; but in the three cooler giants, the hotter plasma is dominant. The high coronal densities of all four giants contrast to much lower values ($\sim 10^{10}$ cm^{-3}) at 0.15 MK from O IV line ratios, contrary to expectations for isobaric magnetic loops, but possibly analogous to the bimodal pressure behavior of certain solar impulsive flares.

Accepted by ApJ Supp.

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For preprints via anonymous ftp: casa.colorado.edu/pub/ayres/IntermedMass_Giants.pdf

α TrA Junior

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The "hybrid chromosphere" star α Trianguli Australis (K2 Ib-IIa) displays atypical coronal properties for its class: elevated soft X-ray emission, flare outbursts, and a super-hot ($T \sim 10$ MK) spectrum. The Wide Field and Planetary Camera 2 of Hubble Space Telescope now has found a faint object close to the red supergiant; $0\farcs4$ nearly due south and about 1% its intensity in the F160BW ultraviolet filter, consistent with a G0 dwarf. Potentially, the "young sun" companion to the massive primary could completely dominate the coronal luminosity. The X-ray centroid in a contemporaneous *Chandra* High Resolution Camera pointing is offset in the direction of the faint UV secondary; but measurements of the radio counterpart of a serendipitous X-ray source $12''$ south east of α TrA, obtained with the Australia Telescope Compact Array, suggest a conflicting offset.

Accepted by ApJ Letters

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Statistics of Superimposed Flares in the Taurus Molecular Cloud

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We investigate the statistics of stellar X-ray light curves from the XMM Extended Survey of the Taurus Molecular Cloud (XEST). To this end, the light curve is modeled as superimposed flares occurring at random times and with random amplitudes. The flare shape is estimated non-parametrically from the observations, while the flare amplitude distribution is modeled as a truncated power law, and the flare times are assumed as uniformly distributed. From these model assumptions, predictions on the binned counts are derived and compared with the observations. From a sample of 22 XEST observations matching the above model assumptions we find that the majority of cases have flare amplitude distributions with slopes steeper than two. This favours the role of small flares in coronal heating for 5 targets, of which, however, 4 are foreground or background main-sequence stars.

Accepted by A&A

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Editor's Note: XEST abstract.

The Narrowest M-dwarf Line Profiles and the Rotation-Activity Connection at Very Slow Rotation

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Context: The rotation-activity connection explains stellar activity in terms of rotation and convective overturn time. It is well established in stars of spectral types F–K as well as in M-type stars of young clusters, in which rotation is still very rapid even among M-dwarfs. The rotation-activity connection is not established in field M-dwarfs, because they rotate very slowly, and detecting rotation periods or rotational line broadening is a challenge. In field M-dwarfs, saturation sets in below $v_{\rm rot} = 5\,{\rm km\,s^{-1}}$, hence they are expected to populate the non-saturated part of the rotation-activity connection.
Aims: This work for the first time shows intrinsically resolved spectral lines of slowly rotating M-dwarfs and makes a first comparison to estimates of convective velocities. By measuring rotation velocities in a sample of mostly inactive M-dwarfs, the unsaturated part of the rotation-activity connection is followed into the regime of very low activity.
Methods: Spectra of ten M-dwarfs are taken at a resolving power of $R = 200\,000$ at the CES in the near infrared region where molecular FeH has strong absorption bands. The intrinsically very narrow lines are compared to model calculations of convective flows, and rotational broadening is measured.

Results: In one star, an upper limit of $v \sin i = 1\,\mathrm{km\,s^{-1}}$ was found, significant rotation was detected in the other nine objects. All inactive stars show rotation below or equal to $2\,\mathrm{km\,s^{-1}}$. In the two active stars AD Leo and YZ CMi, rotation velocities are found to be 40–50 % below the results from earlier studies.
Conclusions: The rotation activity connection holds in field early-M stars, too. Activity and rotation velocities of the sample stars are well in agreement with the relation found in earlier and younger stars. The intrinsic absorption profiles of molecular FeH lines are consistent with calculations from atomic Fe lines. Investigation of FeH line profiles is a very promising tool to measure convection patterns at the surfaces of M-stars.

Accepted by A&A

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For preprints via ftp or WWW: http://arxiv.org/abs/astro-ph/0702634

Solar Abstracts

A Solar Surface Dynamo

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Context: Observations indicate that the 'quiet' solar photosphere outside active regions contains considerable amounts of magnetic energy and magnetic flux, with mixed polarity on small scales. The origin of this flux is unclear. Aims: We test whether local dynamo action of the near-surface convection (granulation) can generate a significant contribution to the observed magnetic flux. Methods: We have carried out MHD simulations of solar surface convection, including the effects of strong stratification, compressibility, partial ionization, radiative transfer, as well as an open lower boundary. Results: Exponential growth of a weak magnetic seed field (with vanishing net flux through the computational box) is found in a simulation run with a magnetic Reynolds number of about 2600. The magnetic energy approaches saturation at a level of a few percent of the total kinetic energy of the convective motions. Near the visible solar surface, the (unsigned) magnetic flux density reaches at least a value of about 25 G. Conclusions: A realistic flow topology of stratified, compressible, non-helical surface convection without enforced recirculation is capable of turbulent local dynamo action near the solar surface.

Accepted by A&A Letters

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For preprints via WWW: http://arxiv.org/abs/astro-ph/0702681

Habitat of Early Life: Solar X-ray and UV Radiation at Earth's Surface 4–3.5 Billion Years Ago

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Solar X-ray and UV radiation (0.1–320 nm) received at Earth's surface is an important aspect of the circumstances under which life formed on Earth. The quantity that is received depends on two main variables: the emission of radiation by the young Sun and its extinction through absorption and scattering by the Earth's early atmosphere. The spectrum emitted by the Sun when life formed, between 4 and 3.5 Ga, was modeled here, including the effects of flares and activity cycles, using a solar-like star that has the same age now as the Sun had 4–3.5 Ga. Atmospheric extinction was calculated using the Beer-Lambert law, assuming several density profiles for the atmosphere of the Archean Earth. We found that almost all radiation with a wavelength shorter than 200 nm is attenuated effectively, even by very tenuous atmospheres. Longer-wavelength radiation is progressively less well attenuated, and its extinction is more sensitive to atmospheric composition. Minor atmospheric components, such as methane, ozone, water vapor, etc., have only negligible effects, but changes in CO_2 concentration can cause large differences in surface flux. Differences due

to variability in solar emission are small compared to this. In all cases surface radiation levels on the Archean Earth were several orders of magnitude higher in the 200–300 nm wavelength range than current levels in this range. That means that any form of life that might have been present at Earth's surface 4–3.5 Ga must have been exposed to much higher quantities of damaging radiation than at present.

Published by Journal of Geophysical Research - Planets (vol 112, E02008)

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For preprints via ftp or WWW: http://arxiv.org/abs/astro-ph/0702529

Atomic Data Abstracts

Ionization Rate Coefficients for the Elements Hydrogen through Zinc

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Aims. The interpretation of astrophysical spectra depends directly on a knowledge of the ionization state of the emitting plasma. This is determined, in part, from collisional ionization rate coefficients. The most recent assessments of these were performed by Arnaud and Rothenflug (1985) and Arnaud and Raymond (1992). Since their work, new laboratory measurements of ionization cross sections have become available as well as the Flexible Atomic Code (FAC) which enables theoretical calculations of these rates. Our goal is the provide a complete set of ionization rate coefficients for the elements hydrogen through zinc.
Methods. A scaling law, which assists the analysis of ionization cross sections and rate coefficients, has been developed following the approach of Burgess and Tully (1992). Essentially all available measured cross sections along each isoelectronic sequence have been examined and compared to cross sections calculated with the Flexible Atomic Code (FAC) and with other calculations. Two approaches has been taken to provide a complete set of ionization cross sections. In the first, fits to scaled measured ionization cross sections, particularly for neutral and singly ionized species, are performed. In the second, fits to scaled calculated direct ionization and excitation-autoionization cross sections are performed provide the remainder of the set. The fits to the cross sections are then integrated over a Maxwellian velocity distribution to derive ionization rate coefficients.
Results. A complete set of ground level ionization cross sections and rate coefficients has been developed through the combination of these two approaches. A tabulation of parameter fits to ground level ionization rate coefficients for all atoms and ions of the elements of H through Zn is provided.

Accepted by A&A

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Upcoming Meeting

2007 Gordon Research Conference on Origins of Solar Systems

8 - 13 July 2007

Mt. Holyoke College

South Hadley, MA

Registration is now open for the 2007 Gordon Research Conference on Origins of Solar Systems, to be held at Mt. Holyoke College in South Hadley, MA on 8-13 July 2007. This unique interdisciplinary meeting includes astronomers and astrophysicists interested in star and planet formation, planetary scientists and meteoriticists interested in the early history of the Solar System, and plasma and life scientists. This meeting is much broader than most conferences and many fruitful research collaborations have been initiated at Gordon conferences, encouraged by the relaxed pace of the meeting.

Information on the meeting, registration, etc. is available at

http://www.grc.org/programs.aspx?year=2007&program=origins

Speakers and discussion leaders include Yuri Aikawa, Sean Andrews, David Bennett, Ted Bergin, Martin Bizzarro, Alan Boss, Fred Ciesla, Harold Connolly, Marianna Cosarinsky, Andrew Davis, Suzan Edwards, Elise Furlan, Charles Gammie, Matthieu Gounelle, Lynne Hillenbrand, Rhian Jones, Scott Kenyon, Zoe Leinhardt, Doug Lin, James Lyons, Michael Meyer, Amaya Moro-Martin, Frank Podosek, Ken Rice, Scott Sandford, Sara Seager, Meenakshi Wadhwa, Dan Watson, Ed Young, and Michael Zolensky.

The Chair and Vice-Chair of the 2007 Origins of Solar Systems conference are Lee Hartmann (Michigan) and Sara Russell (Natural History Museum, London). Please contact us (lhartm@umich.edu, sara.russell@nhm.ac.uk) with any questions or suggestions.

Upcoming Meeting

5th Potsdam Thinkshop

Meridional Flow, Differential Rotation, Solar and Stellar Activity

24 - 29 June 2007

Potsdam, Germany

Dear colleagues,

The progress in helio- and asteroseismology as well as in the theory of hydromagnetic instabilities led to the idea of a conference on the connections between flows and fields. The fifth in a series of Potsdam ThinkShops will be dedicated to "Meridional flow, differential rotation, solar and stellar activity" and takes place in the Astrophysical Institute Potsdam (AIP), on June 24-29, 2007:

http://www.aip.de/thinkshop5/

A sequence of sessions is drafted below. If you are interested, we would like to encourage you to register for the Thinkshop at

http://www.aip.de/thinkshop5/registration.html

The following list of topics gives plenty of opportunities for discussing observational results versus theoretical models:

Session 1: Solar flow pattern : helioseismology : photospheric flows and fields : convection simulations

Session 2: Solar tachocline : geometry : stability : mixing

Session 3: Stellar differential rotation and meridional flow : photometry : spectroscopy : modeling

Session 4: Magnetic stability problems : flux-tube dynamics : magnetorotational instability : current-driven instabilities

Session 5: Ap stars : magnetic field configurations : element distribution : evolution to Ap stars

Session 6: Solar and stellar activity : spots : flip-flops : cycle statistics

Session 7: Dynamo theory : simulations : flux transport : activity forecast

We are looking forward seeing you at the 5th Potsdam ThinkShop in June.

On behalf of the SOC and the LOC, Sincerely,

Guenther Ruediger Klaus G. Strassmeier Alexander Kosovichev

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/~skinners/coolnews.html .`

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