COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 169 — August - Sept. 2010 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Stellar Abstracts

Metal-Rich M-dwarf Planet Hosts: Metallicities with K-Band Spectra

Bárbara Rojas-Ayala[1], Kevin R. Covey[1,2], Philip S. Muirhead[1] and James P. Lloyd[1]

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A metal-rich environment facilitates planet formation, making metal- rich stars the most favorable targets for surveys seeking to detect new exoplanets. Using this advantage to identify likely low-mass planet hosts, however, has been difcult: until now methods to determine M-dwarf metallicities required observationally expensive data (such as parallaxes and high-resolution spectra) and were limited to a few bright cool stars. We have obtained moderate (R$\sim$2700) resolution K-band spectra of 17 M-dwarfs with metallicity estimates derived from their FGK companions. Analysis of these spectra, and inspection of theoretical synthetic spectra, reveals that an M-dwarf s metallicity can be inferred from the strength of its Na I doublet (2.206 μm and 2.209 μm) and Ca I triplet (2.261 μm, 2.263 μm, and 2.265 μm) absorption lines. We use these features, and a temperature- sensitive water index, to construct an empirical metallicity indicator applicable for M-dwarfs with near-solar metallicities (-0.5<[Fe/H]< +0.5). This indicator has an accuracy of $\pm$0.15 dex, comparable to that of existing techniques for estimating M-dwarf metallicities, but is more observationally accessible, requiring only a moderate resolution K-band spectrum. Applying this method to eight known M- dwarf planet hosts, we estimate metallicities ([Fe/H]) in excess of the mean metallicity of M-dwarfs in the solar neighborhood, consistent with the metallicity distribution of FGK planet hosts.

and the name of journal, for example: Published in ApJL

For preprints contact: babs@astro.cornell.edu

For preprints via ftp or WWW: http://adsabs.harvard.edu/abs/2010ApJ...720L.113R

XMM-Newton Observations of HD189733 During Planetary Transits

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We report on two XMM-Newton observations of the planetary host star HD189733. The system has a close in planet and it can potentially affect the coronal structure via interactions with the magnetosphere. We have obtained X-ray spectra and light curves from EPIC and RGS on board XMM-Newton which we have analyzed and interpreted. We reduced X-ray data from primary transit and secondary eclipse occurred in April 17th 2007 and May 18th 2009, respectively. In the April 2007 observation only variability due to weak flares is recognized. In 2009 HD189733 exhibited a X-ray flux always larger than in the 2007 observation. The average flux in 2009 was higher than in 2007 observation by a factor of 45%. During the 2009 secondary eclipse we observed a softening of the X-ray spectrum significant at level of $\sim 3\sigma$. Further, we observed the most intense flare recorded at either epochs. This flare occurred 3 ks after the end of the eclipse. The flare decay shows several minor ignitions perhaps linked to the main event and hinting for secondary loops that emit triggered by the main loop. Magneto-Hydro-Dynamical (MHD) simulations show that the magnetic interaction between planet and star enhances the density and the magnetic field in a region comprised between the planet and the star because of their relative orbital/rotation motion. X-ray observations and model predictions are globally found in agreement, despite the quite simple MHD model and the lack of precise estimate of parameters including the alignment and the intensity of stellar and planetary magnetic fields. Future observations should confirm or disprove this hypothesis, by determining whether flares are systematically recurring in the light curve at the same planetary phase.

Accepted by ApJ

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Probing the Mass-loss History of AGB and Red Supergiant Stars from CO Rotational Line Profiles
II. CO Line Survey of Evolved Stars: Derivation of Mass-loss Rate Formulae

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We aim to (1) set up simple and general analytical expressions to estimate mass-loss rates of evolved stars, and (2) from those calculate estimates for the mass-loss rates of asymptotic giant branch (AGB), red supergiant (RSG), and yellow hypergiant stars in our galactic sample. Rotationally excited lines of CO are a very robust diagnostic in the study of circumstellar envelopes (CSEs). When sampling different layers of the CSE, observations of these molecular lines lead to detailed profiles of kinetic temperature, expansion velocity, and density. A state-of-the-art, nonlocal thermal equilibrium, and co-moving frame radiative transfer code that predicts CO line intensities in the CSEs of late-type stars is used in deriving relations between stellar and molecular-line parameters, on the one hand, and mass-loss rate, on the other. We present analytical expressions for estimating the mass-loss rates of evolved stellar objects for 8 rotational transitions of the CO molecule, apply them to our extensive CO data set covering 47 stars, and compare our results to those of previous studies. Our expressions account for line saturation and resolving of the envelope, thereby allowing accurate determination of very high mass-loss rates. We argue that, for estimates based on a single rotational line, the CO(2-1) transition provides the most reliable mass-loss rate. The mass-loss rates calculated for the

AGB stars range from $4x10^{-8}$ Msun/yr up to $8x10^{-5}$ Msun/yr. For RSGs they reach values between $2x10^{-7}$ Msun/yr and $3x10^{-4}$ Msun/yr. The estimates for the set of CO transitions allow time variability to be identified in the mass-loss rate. Possible mass-loss-rate variability is traced for 7 of the sample stars. We find a clear relation between the pulsation periods of the AGB stars and their derived mass-loss rates, with a levelling off at approx. $3x10^{-5}$ Msun/yr for periods exceeding 850 days.

Accepted by A&A

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On Detectability of Zeeman Broadening in Optical Spectra of F- and G-Dwarfs

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We investigate the detectability of Zeeman broadening in optical Stokes I spectra of slowly rotating sun-like stars. To this end, we apply the LTE spectral line inversion package `SPINOR` to very-high quality CES data and explore how fit quality depends on the average magnetic field, Bf. One-component (OC) and two-component (TC) models are adopted. In OC models, the entire surface is assumed to be magnetic. Under this assumption, we determine formal 3σ upper limits on the average magnetic field of 200 G for the Sun, and 150 G for 61 Vir (G6V). Evidence for an average magnetic field of ~ 500 G is found for 59 Vir (G0V), and of ~ 1000 G for HD 68456 (F6V). A distinction between magnetic and non-magnetic regions is made in TC models, while assuming a homogeneous distribution of both components. In our TC inversions of 59 Vir, we investigate three cases: both components have equal temperatures; warm magnetic regions; cool magnetic regions. Our TC model with equal temperatures does not yield significant improvement over OC inversions for 59 Vir. The resulting Bf values are consistent for both. Fit quality is significantly improved, however, by using two components of different temperatures. The inversions for 59 Vir that assume different temperatures for the two components yield results consistent with $0-450$ G at the formal 3σ confidence level. We thus find a model dependence of our analysis and demonstrate that the influence of an additional temperature component can dominate over the Zeeman broadening signature, at least in optical data. Previous comparable analyses that neglected effects due to multiple temperature components may be prone to the same ambiguities.

Accepted by A&A

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For preprints via WWW: http://arxiv.org/abs/1008.2213

Low-Mass and Substellar Abstracts

Large-amplitude Photometric Variability of the Candidate Protoplanet TMR-1C

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In their *HST*/NICMOS observations, Terebey et al. 1998 (T98) detected a candidate protoplanet, TMR-1C, that lies at a separation of about 10″ (∼1000 AU) from the Class I protobinary TMR-1 (IRAS 04361+2547) located in the Taurus molecular cloud. A narrow filament-like structure was observed extending south-east from the central proto-binary system towards TMR-1C, suggesting a morphology in which the candidate protoplanet may have been ejected from the TMR-1 system. Follow-up low-resolution spectroscopy by Terebey et al. 2000, however, could not confirm if this object is a protoplanet or a low-luminosity background star. We present two epochs of near-infrared photometric observations obtained at the CFHT of TMR-1C. The time span of ∼7 years between the two sets of observations provides with an opportunity to, (a) check for any photometric variability similar to that observed

among young stellar objects, which would indicate the youth of this source, and, (b) determine the proper motion. TMR-1C displays large photometric variability between 1 and 2 mag in both the H- and K_s-bands. From our 2002 observations, we find a $(H - K_s)$ color of 0.3 mag, which is much bluer than the value of 1.3 mag reported by T98 from HST observations. Also, we observe brightening in both the H- and K_s-bands when the colors are bluer, i.e. the object gets redder as it becomes fainter. We have explored the possible origins for the observed variability, and find extinction due to the presence of circumstellar material to be the most likely scenario. The observed large-amplitude photometric variations, and the possible presence of a circumstellar disk, are s trong arguments against this object being an old background star.

Accepted by A&A

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AKARI Observations of Brown Dwarfs I.: CO and CO_2 Bands in the Near-Infrared Spectra

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Near-infrared medium-resolution spectra of seven bright brown dwarfs are presented. The spectra were obtained with the Infrared Camera (IRC) on board the infrared astronomical satellite *AKARI*, covering 2.5–5.0 μm with a spectral resolution of approximately 120. The spectral types of the objects range from L5 to T8, and enable us to study the spectral evolution of brown dwarfs. The observed spectra are in general consistent with the predictions from the previous observations and photospheric models; spectra of L-type dwarfs are characterized by continuum opacity from dust clouds in the photosphere, while very strong molecular absorption bands dominate the spectra in the T-type dwarfs. We find that the CO fundamental band around 4.6 μm is clearly seen even in the T8 dwarf 2MASS J041519−0935, confirming the presence of non-equilibrium chemical state in the atmosphere. We also identify the CO_2 fundamental stretching-mode band at 4.2 μm for the first time in the spectra of late-L and T-type brown dwarfs.

As a preliminary step towards interpretation of the data obtained by *AKARI*, we analyze the observed spectra by comparing with the predicted ones based on the Unified Cloudy Model (UCM). Although overall spectral energy distributions (SEDs) can be reasonably fitted with the UCM, observed CO and CO_2 bands in late-L and T-dwarfs are unexpectedly stronger than the model predictions assuming local thermodynamical equilibrium (LTE). We examine the vertical mixing model and find that this model explains the CO band at least partly in the T-dwarfs 2MASS J041519−0935 and 2MASS J055919−1404. The CO fundamental band also shows excess absorption against the predicted one in the L9 dwarf SDSS J083008+4828. Since CO is already highly abundant in the upper photospheres of late-L dwarfs, the extra CO by vertical mixing has little effect on the CO band strengths, and the vertical mixing model cannot be applied to this L-dwarf. A more serious problem is that the significant enhancement of the CO_2 4.2 μm band in both the late-L and T dwarfs cannot be explained at all by the vertical mixing model. The enhancement of the CO_2 band remains puzzling.

Accepted by ApJ

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For preprints via astro-ph: http://arxiv.org/abs/1008.3732

Effect of Episodic Accretion on the Structure and the Lithium Depletion of Low-mass Stars and Planet-hosting Stars

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Following up our recent analysis devoted to the impact of non steady accretion on the location of young low-mass stars or brown dwarfs in the Herzsprung-Russell diagram, we perform a detailed analysis devoted to the effect of burst accretion on the internal structure of low-mass and solar type stars. We find that episodic accretion can produce objects with significantly higher central temperatures than the ones of the non accreting counterparts of same mass and age. As a consequence, lithium depletion can be severely enhanced in these objects. This provides a natural explanation for the unexpected level of lithium depletion observed in young objects for the inferred age of their parent cluster. These results confirm the limited reliability of lithium abundance as a criterion for assessing or rejecting cluster membership. They also show that lithium is not a reliable age indicator, because its fate strongly depends on the past accretion history of the star. Under the assumption that giant planets primarily form in massive disks prone to gravitational instability and thus to accretion burst episodes, the same analysis also explains the higher Li depletion observed in planet hosting stars. At last, we show that, depending on the burst rate and intensity, accretion outbursts can produce solar mass stars with lower convective envelope masses, at ages less than a few tens of Myr, than predicted by standard (non or slowly accreting) pre-main sequence models. This result has interesting, although speculative, implications for the recently discovered depletion of refractory elements in the Sun.

Accepted by A&A

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For preprints via ftp or WWW: http://arxiv.org/abs/1008.4288

Cross-Listed Abstracts (Pre-Main Sequence Stars)

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

Chronology of Star Formation and Disk Evolution in the Eagle Nebula

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Massive star-forming regions are characterized by intense ionizing fluxes, strong stellar winds and, occasionally, supernovae explosions, all of which have important effects on the surrounding media, on the star-formation process and on the evolution of young stars and their circumstellar disks. We present a multiband study of the massive young cluster NGC6611 and its parental cloud (the Eagle Nebula) with the aim of studying how OB stars affect the early stellar evolution and the formation of other stars. We search for evidence of: triggering of star formation by the massive stars inside NGC6611 on a large spatial scale (about 10 parsec) and ongoing disk photoevaporation in NGC6611 and how its efficiency depends on the mass of the central stars. We assemble a multiband catalog of the Eagle Nebula with photometric data, ranging from B band to 8.0 micron, and X-ray data obtained with two new and one archival CHANDRA/ACIS-I observation. We select the stars with disks from infrared photometry and disk-less ones from X-ray emission, which are associated both with NGC6611 and the outer region of the Eagle Nebula. We study induced photoevaporation searching for the spatial variation of disk frequency for distinct stellar mass ranges. The triggering of star formation by OB stars has been investigated by deriving the history of star formation across the nebula. We find evidence of sequential star formation in the Eagle Nebula going from the southeast (2.6 Myears) to the northwest (0.3 Myears), with the median age of NGC6611 members of about 1 Myear. In NGC6611, we observe a drop of the disk frequency close to massive stars (up to an average distance of 1 parsec), without observable effects at larger distances. Furthermore, disks are more frequent around low-mass stars (less equal to one solar mass) than around high-mass stars, regardless of the distance from OB stars. The star formation chronology we find in the Eagle Nebula does not support the hypothesis of a large-scale process triggered by OB stars in NGC6611. Instead, we speculate that it was triggered by the encounter (about 3 Myears ago) with a giant molecular shell created by supernovae explosions about 6 Myears ago. We find evidence of disk photoevaporation close to OB stars, where disks are heated by incident extreme ultraviolet (EUV) radiation. No effects are observed at large distances from OB stars, where photoevaporation is induced by the far ultraviolet (FUV) radiation, and long timescales are usually required to completely dissipate the disks.

Accepted by A&A

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The Magnetic Fields of Forming Solar-like Stars

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Magnetic fields play a crucial role at all stages of the formation of low mass stars and planetary systems. In the final stages, in particular, they control the kinematics of in-falling gas from circumstellar discs, and the launching and collimation of spectacular outflows. The magnetic coupling with the disc is thought to influence the rotational evolution of the star, while magnetised stellar winds control the braking of more evolved stars and may influence the migration of planets. Magnetic reconnection events trigger energetic flares which irradiate circumstellar discs with high energy particles that influence the disc chemistry and set the initial conditions for planet formation. However, it is only in the past few years that the current generation of optical spectropolarimeters have allowed the magnetic fields of forming solar-like stars to be probed in unprecedented detail. In order to do justice to the recent extensive observational programs new theoretical models are being developed that incorporate magnetic fields with an observed degree of complexity. In this review we draw together disparate results from the classical electromagnetism, molecular physics/chemistry, and the geophysics literature, and demonstrate how they can be adapted to construct models of the large scale magnetospheres of stars and planets. We conclude by examining how the incorporation of multipolar magnetic fields into new theoretical models will drive future progress in the field through the elucidation of several observational conundrums.

Accepted by Reports on Progress in Physics (review article)

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For preprints via ftp or WWW: http://arxiv.org/abs/1008.1883

Upcoming Meeting

Space Climate Symposium-4

16 - 21 January 2011

Goa, India

FIRST ANNOUNCEMENT

Dear Colleagues and Friends! We have the great pleasure to invite you to Space Climate Symposium-4 which will be held in Neelams the Grand Hotel, Goa, India on 16 - 21 January, 2011. Space Climate is an interdisciplinary science that deals with the long-term change in the Sun, and its effects in the heliosphere and in the near-Earth environment, including the atmosphere and climate. A special focus during this Symposium will be to study the causes, consequences and implications of the unusual solar cycle 23 that, most likely, has ended the Modern Grand Maximum of solar activity. Other topics include, e.g., solar dynamo, irradiance variations, solar wind, geomagnetic field and activity, cosmic rays and cosmogenic isotopes, and solar effects on different layers of the atmosphere and on local and global climate. Invited speakers include, e.g., Jrg Beer, Archana Bhattacharyya, Paul Charbonneau, Gufran Beig, Katya Georgieva, Sarah Gibson, Natchimuthuk Gopalswamy, Madhulika Guhathakurta, Joanna Haigh, Siraj Hasan, Monica Korte, P.K. Manoharan, Piet Martens, Hiroku Miyahara, Mark Miesch, Martin Mlynczak, Kalevi Mursula, Dibyendu Nandi, Vladimir Obridko, Dean Pesnell, Jean-Pierre Rozelot, Alexander Ruzmaikin, Annika Seppl, Sami Solanki, Brian Tinsley, Ilya Usoskin, and Tom Woods.

Further details on abstract submission, registration, and accommodation will be available soon at the meeting websites:

http://www.iiserkol.ac.in/∼spaceclimate4/

http://solar.physics.montana.edu/∼spaceclimate4/

and will be outlined in the second announcement. Partial financial assistance for needy students and scientists may be available contingent upon the availability of funding.

Welcome to SCS-4 in Goa!

Sincerely Yours,

Dibyendu Nandi (LOC chair) Kalevi Mursula (SOC chair)

JOB OPENING

Research Fellow
Solar and Stellar Flares
School of Mathematics and Physics
Queen's University , Belfast, U.K.

REFERENCE: 10/101468

CLOSING DATE : 4.00 pm, Friday 1 October 2010

SALARY : 29,853 - 38,951 pounds per annum (including contribution points). Initial salary placement will be up to 34, 607 pounds.

ANTICIPATED INTERVIEW DATE : Week beginning 18 October 2010.

CONTRACT DURATION : Three years.

JOB PURPOSE : To undertake research in the physics of solar and stellar flares within the Astrophysics Research Centre of the School of Mathematics and Physics.

MAJOR DUTIES : Undertake research in the physics of solar and stellar flares in collaboration with members of the Astrophysics Research Centre. Write proposals for telescope time and lead and support field trips to observatory sites, including for the ROSA instrument at the National Solar Observatory. Present results at national and international conferences. Publish results in high impact astronomical journals at a rate that at least matches your peer group. Publish results in high impact astronomical journals at a rate that at least matches your peer group. Help supervise (as necessary) and support postgraduate students working in this area. Read academic papers, journals and textbooks to keep abreast of developments. Carry out any other duties designated by a line manager and which fall within the general ambit of the post.

ESSENTIAL CRITERIA : 1. A PhD in a relevant subject either awarded or at least submitted at the time of taking up the post. 2. Experience in either (i) the reduction and analysis of solar and/or cool star observations from satellite-borne or ground-based instruments, or (ii) the development of theoretical models of solar and/or cool star atmospheres. 3. Experience with the IDL computing environment. 4. Refereed publications in the field commensurate with career stage. 5. Ability to contribute to method improvement where required. 6. Ability to interact with research colleagues and support staff. 7. Ability to analyse and communicate effectively. 8. Demonstrable intellectual ability. 9. Must be prepared to spend considerable time away from home due to observing commitments.

DESIRABLE CRITERIA : 1. PhD awarded and subject area directly relevant to this position. 2. Experience in the research field of solar and/or stellar flares. 3. Experience with the SolarSoft environment. 4. Demonstrated observational background.

ADDITIONAL INFORMATION: Informal enquiries may be directed to Prof. Mihalis Mathioudakis (telephone: +44 2890 973573; email: m.mathioudakis@qub.ac.uk)

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.***