COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 179 — April-May 2012 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Stellar Abstracts

Lithium in M67: From the Main Sequence to the Red Giant Branch

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Lithium abundances in open clusters are a very effective probe of mixing processes, and their study can help to understand the large depletion of lithium in the Sun. Due to its age and metallicity, the open cluster M67 is especially interesting on this regard. Many studies on lithium abundances in M67 have already been performed, but a homogeneous global analysis of lithium in stars from subsolar up to the most massive members, was never accomplished for a large sample based on high-quality spectra. We tested our non-standard models, which were calibrated using the Sun with observational data. We collected literature data to follow, for the first time in a homogeneous way, NLTE lithium abundances of all observed single stars in M67 more massive than about 0.9 solar masses. Our grid of evolutionary models were computed with non-standard mixing at metallicity [Fe/H] = 0.01, using the Toulouse-Geneva evolution code. The analysis is started from the entrance in the ZAMS. Lithium in M67 is a tight function of mass for stars more massive than the Sun, apart of a few outliers. A plateau in lithium abundances is observed for turn-off stars. Both less massive and more massive stars are more depleted than those in the plateau. There is a significant scatter in lithium abundances for any given mass lower than M ¡= 1.1 solar masses. Our models qualitatively reproduce most of the features described above, although the predicted depletion of lithium is 0.45 dex smaller than observed

for masses in the plateau region, i.e. between 1.1 and 1.28 solar masses. Clearly, more work is needed to throughly match the observations. Despite hints that chromospheric activity and rotation play a role in lithium depletion, no firm conclusion can be drawn with the presently available data.

Accepted by A&A

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Time Resolved Spectroscopy of BD+46 442: Gas Streams and Jet Creation in a Newly Discovered Evolved Binary With a Disk

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Previous studies have shown that many post-AGB stars with dusty disks are associated with single-lined binary stars. To verify the binarity hypothesis on a larger sample, we started a high-resolution spectral monitoring of about 40 field giants, whose binarity was suspected based on either a light curve, an infrared excess, or a peculiar chemical composition. Here we report on the discovery of the periodic RV variations in BD+46 442, a high-latitude F giant with a disk. We interpret the variations due to the motion around a faint companion, and deduce the following orbital parameters: Porb = 140.77 d, e = 0.083, asini=0.31 AU. We find it to be a moderately metal-poor star ([M/H]=–0.7) without a strong depletion pattern in the photospheric abundances. Interestingly, many lines show periodic changes with the orbital phase: Hα switches between a double-peak emission and a PCyg-like profiles, while strong metal lines appear split during the maximum redshift. Similar effects are likely visible in the spectra of other post-AGB binaries, but their regularity is not always realized due to sporadic observations. We propose that these features result from an ongoing mass transfer from the evolved giant to the companion. In particular, the blue-shifted absorption in Hα, which occurs only at superior conjunction, may result from a jet originating in the accretion disk around the companion and seen in absorption towards the luminous primary.

Accepted by A&A

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Why Do Some Young Cool Stars Show Spot Modulation While Others Do Not?

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We present far-red, intermediate resolution spectroscopy of 572 photometrically selected, low-mass stars ($0.2 < M/M_\odot < 0.7$) in the young open cluster NGC 2516, using the FLAMES spectrograph at the Very Large Telescope. Precise radial velocities confirm membership for 210 stars that have published rotation periods from spot-modulated light curves and for another 144 stars in which periodic modulation could not be found. The two sub-samples are compared and no significant differences are found between their positions in colour-magnitude diagrams, the distribution of their projected equatorial velocities or their levels of chromospheric activity. We rule out differing observational sensitivity as an explanation and conclude that otherwise similar objects, with equally high levels of chromospheric activity, do not exhibit spot-induced light curve modulation because their significant spot coverage is highly axisymmetric. We propose that the spot coverage consists of large numbers of small, dark spots with diameters of about 2°. This explains why about half of cluster members do not exhibit rotationally modulated light curves and why the light curve amplitudes of those that do have mean values of only 0.01-0.02 mag.

Accepted by MNRAS

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The Solar Flare Sulphur Abundance from RESIK Observations

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The RESIK instrument on *CORONAS-F* spacecraft observed several sulphur X-ray lines in three of its four channels covering the wavelength range 3.8–6.1 Å during solar flares. The fluxes are analyzed to give the sulphur abundance. Data are chosen for when the instrument parameters were optimized. The measured fluxes of the S XV $1s^2 - 1s4p$ ($w4$) line at 4.089 Å gives $A(\mathrm{S}) = 7.16 \pm 0.17$ (abundances on a logarithmic scale with $A(\mathrm{H}) = 12$) which we consider to be the most reliable. Estimates from other lines range from 7.13 to 7.24. The preferred S abundance estimate is very close to recent photospheric abundance estimates and to quiet-Sun solar wind and meteoritic abundances. This implies no fractionation of sulphur by processes tending to enhance the coronal abundance from the photospheric that depend on the first ionization potential (FIP), or that sulphur, though its FIP has an intermediate value of 10.36 eV, acts like a "high-FIP" element.

Accepted by ApJ

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SphinX Measurements of the 2009 Solar Minimum X-ray Emission

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The SphinX X-ray spectrophotometer on the *CORONAS-PHOTON* spacecraft measured soft X-ray emission in the 1–15 keV energy range during the deep solar minimum of 2009 with a sensitivity much greater than *GOES*. Several intervals are identified when the X-ray flux was exceptionally low, and the flux and solar X-ray luminosity are estimated. Spectral fits to the emission at these times give temperatures of 1.7–1.9 MK and emission measures between 4×10^{47} cm^{-3} and 1.1×10^{48} cm^{-3}. Comparing SphinX emission with that from the *Hinode* X-ray Telescope, we deduce that most of the emission is from general coronal structures rather than confined features like bright points. For one of 27 intervals of exceptionally low activity identified in the SphinX data, the Sun's X-ray luminosity in an energy range roughly extrapolated to that of *ROSAT* (0.1–2.4 keV) was less than most nearby K and M dwarfs.

Accepted by ApJ

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The Bipolar Outflow and Disk of the Brown Dwarf ISO 217

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We show that the very young brown dwarf candidate ISO 217 (M6.25) is driving an intrinsically asymmetric bipolar outflow with a stronger and slightly faster red-shifted component based on spectro-astrometry of forbidden [S II] emission lines at 6716 Å and 6731 Å observed in UVES/VLT spectra taken in 2009. ISO 217 is only one out of a handful of brown dwarfs and very low- mass stars (M5-M8) for which the existence of an outflow has been detected and which show that the T Tauri phase continues at the substellar limit. We measure a spatial extension of the outflow in [S II] of up to ±190 mas (about ±30 AU) and velocities of up to ±40-50 $\mathrm{km\,s^{-1}}$. We find that the basic outflow properties (spatial extension, velocities, outflow PA) are of similar order as those determined in the discovery spectra from May 2007 by Whelan and coworkers. We show that the strong velocity asymmetry between both lobes of a factor of two found in 2007 might be smaller than originally anticipated (when using a more realistic stellar rest velocity) and likely evolves over a period of a few years. We detect also forbidden line emission of [Fe II]λ7155 Å, which could potentially originate at the hot inner region of the outflow. To comprehensively understand the ISO 217 system, we have determined the properties of its accretion disk based on radiative transfer modeling of the SED from 0.66 to 24 μm. This disk model is also in very good agreement with Herschel/PACS data at 70 μm. We find that the disk is flared and intermediately inclined ($i \sim 45\,^\circ$). The total disk mass of the best-fit model is $4\times10^{-6} M_\odot$. This is small compared to the accretion and outflow rate of ISO 217 from the literature ($\sim 10^{-10}\,M_\odot\,\mathrm{yr}^{-1}$). We suggest to explain this discrepancy by either a larger disk mass than inferred from the model because of strong undetected grain growth and/or by an on average lower accretion rate and outflow rate than the determined values. We show that a disk inclination significantly exceeding 45°, as suggested from Hα modeling and from the fact that both lobes of the outflow are visible, is not consistent with the SED data. Thus, despite its intermediate inclination angle, the disk of this brown dwarf appears to not obscure the red outflow component in [S II], which is very rarely seen for T Tauri objects in general (only one other case).

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http://www.mpia.de/homes/joergens/publications/iso217.pdf

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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

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