# *COOLNEWS*

**A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN**

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## *Coolnews on the Web*

The current and previous issues of *Coolnews* are available on the following web page in pdf, postscript, and Latex format: **http://casa.colorado.edu/∼skinners/coolnews.html**

## *Stellar Abstracts*

### Exoplanets as Probes of the Winds of Host Stars: The Case of the M Dwarf GJ 436

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Winds of cool dwarfs are difficult to observe, with only a few M dwarfs presenting observationally-derived mass-loss rates ($\dot{M}$), which span several orders of magnitude. Close-in exoplanets are conveniently positioned in the inner regions of stellar winds and can, thus, be used to probe the otherwise-unobservable local properties of their host-stars' winds. Here, we use local stellar wind characteristics observationally-derived in the studies of atmospheric evaporation of the warm-neptune GJ 436b to derive the global characteristics of the wind of its M-dwarf host. Using an isothermal wind model, we constrain the stellar wind temperature to be in the range [0.36,0.43] MK, with $\dot{M} = [0.5, 2.5] \times 10^{-15}\ M_\odot$/yr. By computing the pressure balance between the stellar wind and the interstellar medium, we derive the size of the astrophere of GJ 436 to be around 25 au, significantly more compact than the heliosphere. We demonstrate in this paper that transmission spectroscopy, coupled to planetary atmospheric evaporation and stellar wind models, can be a useful tool for constraining the large-scale wind structure of planet-hosting stars. Extending our approach to future planetary systems discoveries will open new perspectives for the combined characterisation of planetary exospheres and winds of cool dwarf stars.

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*For preprints via WWW*: https://arxiv.org/abs/1706.05894

## TOSC: An Algorithm for the Tomography of Spotted Transit Chords

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Photometric observations of planetary transits may show localized bumps, called transit anomalies, due to the possible crossing of photospheric starspots. The aim of this work is to analyze the transit anomalies and derive the temperature profile inside the transit belt along the transit direction. We have developed t he algorithm TOSC, a tomographic inverse-approach tool which, by means of simple algebra, reconstructs the flux distribution along the transit belt. We test TOS C against some simulated scenarios. We find that TOSC provides robust results fo r light curves with photometric accuracies better than 1 mmag, returning the spot-photosphere temperature contrast with an accuracy better than 100 K. TOSC is a lso robust against the presence of unocculted spots, provided that the apparent planetary radius given by the fit of the transit light curve is used in place of the true radius. The analysis of real data with TOSC returns results consistent with previous studies.

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## Lithium Depletion in Solar-like Stars: Effect of Overshooting Based on Realistic Multi-dimensional Simulations

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We study lithium depletion in low-mass and solar-like stars as a function of time, using a new diffusion coefficient describing extra-mixing taking place at the bottom of a convective envelope. This new form is motivated by multi-dimensional fully compressible, time implicit hydrodynamic simulations performed with the MUSIC code. Intermittent convective mixing at the convective boundary in a star can be modeled using extreme value theory, a statistical analysis frequently used for finance, meteorology, and environmental science. In this letter, we implement this statistical diffusion coefficient in a one-dimensional stellar evolution code, using parameters calibrated from multi-dimensional hydrodynamic simulations of a young low-mass star. We propose a new scenario that can explain observations of the surface abundance of lithium in the Sun and in clusters covering a wide range of ages, from $\sim$ 50 Myr to $\sim$ 4 Gyr. Because it relies on our physical model of convective penetration, this scenario has a limited number of assumptions. It can explain the observed trend between rotation and depletion, based on a single additional assumption, namely that rotation affects the mixing efficiency at the convective boundary. We suggest the existence of a threshold in stellar rotation rate above which rotation strongly prevents the vertical penetration of plumes and below which rotation has small effects. In addition to providing a possible explanation for the long standing problem of lithium depletion in pre-main sequence and main sequence stars, the strength of our scenario is that its basic assumptions can be tested by future hydrodynamic simulations.

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## The GAPS Programme With HARPS-N at TNG: XV. A Substellar Companion Around a K Giant Star Identified With Quasi-simultaneous HARPS-N and GIANO Measurements

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*Context:* Identification of planetary companions of giant stars is made difficult because of the astrophysical noise, that may produce radial velocity variations similar to those induced by a companion. On the other hand any stellar signal is wavelength dependent, while signals due to a companion are achromatic.
*Aims:* Our goal is to determine the origin of the Doppler periodic variations observed in the thick disk K giant star TYC 4282-605-1 by HARPS-N at the Telescopio Nazionale Galileo (TNG) and verify if they can be due to the presence of a substellar companion.
*Methods:* Several methods have been used to exclude the stellar origin of the observed signal including detailed analysis of activity indicators and bisector and the analysis of the photometric light curve. Finally we have conducted an observational campaign to monitor the near infrared (NIR) radial velocity with GIANO at the TNG in order to verify whether the NIR amplitude variations are comparable with those observed in the visible.
*Results:* Both optical and NIR radial velocities show consistent variations with a period at 101 days and similar amplitude, pointing to the presence of a companion orbiting the target. The main orbital properties obtained for our giant star with a derived mass of $M = 0.97 \pm 0.03\ M_{\odot}$ are $M_P \sin i = 10.78 \pm 0.12\ M_{\rm J}$; $P = 101.54 \pm 0.05$ days; $e = 0.28 \pm 0.01$ and $a = 0.422 \pm 0.009$ AU. The chemical analysis shows a significant enrichment in the abundance of Na I, Mg I, Al I and Si I while the rest of analyzed elements are consistent with the solar value demonstrating that the chemical composition corresponds with an old K giant (age = 10.1 Gyr) belonging to local thick disk.
*Conclusions:* We conclude that the substellar companion hypothesis for this K giant is the best explanation for the observed periodic radial velocity variation. This study also shows the high potential of multi-wavelength radial velocity observations for the validation of planet candidates.

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# The Young L Dwarf 2MASS J11193254−1137466 is a Planetary-mass Binary

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We have discovered that the extremely red, low-gravity L7 dwarf 2MASS J11193254−1137466 is a 0.14″ (3.6 au) binary using Keck laser guide star adaptive optics imaging. 2MASS J11193254−1137466 has previously been identified as a likely member of the TW Hydrae Association (TWA). Using our updated photometric distance and proper motion, a kinematic analysis based on the BANYAN II model gives an 82% probability of TWA membership. At TWA's $10 \pm 3$ Myr age and using hot-start evolutionary models, 2MASS J11193254−1137466AB is a pair of $3.7^{+1.2}_{-0.9}$ $M_{\rm Jup}$ brown dwarfs, making it the lowest-mass binary discovered to date. We estimate an orbital period of $90^{+80}_{-50}$ years. One component is marginally brighter in $K$ band but fainter in $J$ band, making this a probable flux-reversal binary, the first discovered with such a young age. We also imaged the spectrally similar TWA L7 dwarf WISEA J114724.10−204021.3 with Keck and found no sign of binarity. Our evolutionary model-derived $T_{\rm eff}$ estimate for WISEA J114724.10−204021.3 is ≈230 K higher than for 2MASS J11193254−1137466AB, at odds with the spectral similarity of the two objects. This discrepancy suggests that WISEA J114724.10−204021.3 may actually be a tight binary with masses and temperatures very similar to 2MASS J11193254−1137466AB, or further supporting the idea that near-infrared spectra of young ultracool dwarfs are shaped by factors other than temperature and gravity. 2MASS J11193254−1137466AB will be an essential benchmark for testing evolutionary and atmospheric models in the young planetary-mass regime.

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*For preprints via WWW*: http://arxiv.org/abs/1706.01883

*Upcoming Meeting*

# Cool Stars 20:
# The Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun

### 29 July - 3 August , 2018

### Boston/Cambridge, MA, USA

FIRST ANNOUNCEMENT

The Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun ("Cool Stars") has been running for 37 years. The first workshop was held in Cambridge, Massachusetts in 1980. Since then, Cool Stars has been held largely biennially, alternating between North America and Europe, where approximately 400 international experts in Low-Mass Stars, Solar Physics, and Exoplanets meet to exchange ideas in a cross-disciplinary and friendly environment.

Four institutions in the Boston area (Boston University, Harvard-Smithsonian Center for Astrophysics [Harvard College Observatory / Smithsonian Astrophysical Observatory], MIT, and the University of Massachusetts Lowell) jointly organize Cool Stars 20 which will be held at Boston University in Boston/Cambridge, MA from 29 July to 3 August, 2018.

We will accept proposals for splinter sessions and abstracts for talks and posters in the fall of this year. Registration will open early in 2018. Until then, you can register on our website for further announcements.

More details can be found on the frequently-updated website

http://www.coolstars20.com .

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# *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 .`

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