# *COOLNEWS*

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

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## *Stellar Abstracts*

### The Decaying Long-Period Oscillation of a Stellar Megaflare

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We analyse and interpret the oscillatory signal in the decay phase of the U-band light curve of a stellar megaflare observed on 2009 January 16 on the dM4.5e star YZ CMi. The oscillation is well approximated by an exponentially decaying harmonic function. The period of the oscillation is found to be 32 min, the decay time about 46 min and the relative amplitude 15%. This observational signature is typical of the longitudinal oscillations observed in solar flares at EUV and radio wavelengths, associated with standing slow magnetoacoustic waves, suggesting a similar nature. In this scenario, macroscopic variations of the plasma parameters in the oscillations modulate the ejection of non-thermal electrons. The phase speed of the longitudinal (slow magnetoacoustic) waves in the flaring loop or arcade, the tube speed, of about 230 km/s, would require a loop length of about 200 Mm. Other mechanisms, such as standing kink oscillations, are also considered.

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## Multi-wavelength Radio Continuum Emission Studies of Dust-Free Red Giants

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Multi-wavelength centimeter continuum observations of non-dusty, non-pulsating K spectral-type red giants directly sample their chromospheres and wind acceleration zones. Such stars are feeble emitters at these wavelengths however, and previous observations have provided only a small number of modest signal-to-noise measurements slowly accumulated over three decades. We present multi-wavelength Karl G. Jansky Very Large Array thermal continuum observations of the wind acceleration zones of two dust-free red giants, Arcturus ($\alpha$ Boo: K2 III) and Aldebaran ($\alpha$ Tau: K5 III). Importantly, most of our observations of each star were carried out over just a few days, so that we obtained a snapshot of the different stellar atmospheric layers sampled at different wavelengths, independent of any long-term variability. We report the first detections at several wavelengths for each star including a detection at 10 cm (3.0 GHz: *S* band) for both stars and a 20 cm (1.5 GHz: *L* band) detection for $\alpha$ Boo. This is the first time single (non-binary) luminosity class III red giants have been detected at these continuum wavelengths. Our long-wavelength data sample the outer layers of $\alpha$ Boo's atmosphere where its wind velocity is approaching (or possibly has reached) its terminal value and the ionization balance is becoming *frozen-in*. For $\alpha$ Tau, however, our long-wavelength data are still sampling its inner atmosphere, where the wind is still accelerating probably due to its lower mass-loss rate. We compare our data with published semi-empirical models based on ultraviolet data, and the marked deviations highlight the need for new atmospheric models to be developed. Spectral indices are used to discuss the possible properties of the stellar atmospheres, and we find evidence for a rapidly cooling wind in the case of $\alpha$ Boo. Finally, we develop a simple analytical wind model for $\alpha$ Boo based on our new long-wavelength flux measurements.

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*For preprints on WWW*: http://arxiv.org/abs/1309.0860

## PO and PN in the Wind of the Oxygen-Rich AGB Star IK Tau

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*Context:* Phosphorus-bearing compounds have only been studied in the circumstellar environments of the asymptotic giant branch star IRC +10 216 and the protoplanetary nebula CRL 2688, both carbon-rich objects, and the oxygen-rich red supergiant VY CMa. The current chemical models cannot reproduce the high abundances of PO and PN derived from observations of VY CMa. No observations have been reported of phosphorus in the circumstellar envelopes of oxygen-rich asymptotic giant branch stars.
*Aims:* We aim to set observational constraints on the phosphorous chemistry in the circumstellar envelopes of oxygen-rich asymptotic giant branch stars, by focussing on the Mira-type variable star IK Tau.
*Methods:* Using the IRAM 30 m telescope and the Submillimeter Array, we observed four rotational transitions of PN ($J = 2-1, 3-2, 6-5, 7-6$) and four of PO ($J = 5/2-3/2, 7/2-5/2, 13/2-11/2, 15/2-13/2$). The IRAM 30 m observations were dedicated line observations, while the Submillimeter Array data come from an unbiased spectral survey in the frequency range $279-355$ GHz.
*Results:* We present the first detections of PN and PO in an oxygen-rich asymptotic giant branch star and estimate abundances $X(\mathrm{PN/H_2}) \approx 3 \times 10^{-7}$ and $X(\mathrm{PO/H_2})$ in the range $0.5-6.0 \times 10^{-7}$. This is several orders of magnitude

higher than what is found for the carbon-rich asymptotic giant branch star IRC +10 216. The diameter ($\leq$ 0.7 arceseconds) of the PN and PO emission distributions measured in the interferometric data corresponds to a maximum radial extent of about 40 stellar radii. The abundances and the spatial occurrence of the molecules are in very good agreement with the results reported for VY CMa. We did not detect PS or $PH_3$ in the survey.
*Conclusions:* We suggest that PN and PO are the main carriers of phosphorus in the gas phase, with abundances possibly up to several $10^{-7}$. The current chemical models cannot account for this, underlining the strong need for updated chemical models that include phosphorous compounds.

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# *Solar Abstracts*

## One Possible Reason for Double-Peaked Maxima in Solar Cycles: Is a Second Maximum of Solar Cycle 24 Coming?

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We investigate solar activity by focusing on double maxima in solar cycles and try to estimate the shape of the current solar cycle (Cycle 24) during its maximum. We analyzed data for Solar Cycle 24 by using Learmonth Solar Observatory sunspot group data since 2008. All sunspot groups (SGs) recorded during this time interval were separated into two groups: The first group includes small SGs [A, B, C, H, classes by the Zurich classification], and the second group consists of large SGs [D, E, and F]. We then calculated small and large sunspot group numbers, their sunspot numbers [SSN] and Zurich numbers [Rz] from their daily mean numbers as observed on the solar disk during a given month. We found that the temporal variations for these three different separations behave similarly. We also analyzed the general shape of solar cycles from Cycle 1 to 23 by using monthly International Sunspot Number [ISSN] data and found that the durations of maxima were about 2.9 years. Finally, we used ascending time and SSN relationship and found that the maximum of the Cycle 24 should be later than 2011. Thus, we conclude that i) one possible reason for a double maximum in solar cycles is the different behavior of large and small sunspot groups, and ii) a double maximum is coming for Solar Cycle 24.

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## A Search for L/T Transition Dwarfs With Pan-STARRS1 and *WISE*: Discovery of Seven Nearby Objects Including Two Candidate Spectroscopic Variables

**William M. J. Best[1], Michael C. Liu[1,6], Eugene A. Magnier[1], Kimberly M. Aller[1,6], Niall R. Deacon[2], Trent J. Dupuy[3], Joshua Redstone[4], W. S. Burgett[1], K. C. Chambers[1], K. W. Hodapp[1], N. Kaiser[1], R.-P. Kudritzki[1], J. S. Morgan[1], P. A. Price[5], J. L. Tonry[1] and R. J. Wainscoat[1]**

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We present initial results from a wide-field (30,000 deg$^2$) search for L/T transition brown dwarfs within 25 pc using the Pan-STARRS1 and *WISE* surveys. Previous large-area searches have been incomplete for L/T transition dwarfs, because these objects are faint in optical bands and have near-infrared colors that are difficult to distinguish from background stars. To overcome these obstacles, we have cross-matched the Pan-STARRS1 (optical) and *WISE* (mid-IR) catalogs to produce a unique multi-wavelength database for finding ultracool dwarfs. As part of our initial discoveries, we have identified seven brown dwarfs in the L/T transition within $9-15$ pc of the Sun. The L9.5 dwarf PSO J140.2308+45.6487 and the T1.5 dwarf PSO J307.6784+07.8263 (both independently discovered by Mace et al. 2013) show possible spectroscopic variability at the $Y$- and $J$-bands. Two more objects in our sample show evidence of photometric $J$-band variability, and two others are candidate unresolved binaries based on their spectra. We expect our full search to yield a well-defined, volume-limited sample of L/T transition dwarfs that will include many new targets for study of this complex regime. PSO J307.6784+07.8263 in particular may be an excellent candidate for in-depth study of variability, given its brightness ($J = 14.2$ mag) and proximity (11 pc).

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*For preprints via WWW*: http://arxiv.org/abs/1309.0503

*Upcoming Meeting*

## Why Galaxies Care About AGB Stars III

### 28 July - 1 August 2014

### Vienna, Austria

After our well received interdisciplinary meetings in 2006 or 2010 we invite you to attend *Why Galaxies Care About AGB Stars III: A Closer Look in Space and Time* from 28 July 1 August 2014 at Vienna, Austria, University Campus.

First details are found on our web-page:

http://www.univie.ac.at/galagb/

Please distribute this information and see you all in Vienna in 2014 !

Hans Olofsson and Franz Kerschbaum (franz.kerschbaum AT univie.ac.at), on behalf of the SOC and LOC.

# *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.***