COOLNEWS
A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN
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Stellar Abstracts

Dust Production and Mass Loss in the Galactic Globular Cluster NGC 362

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We investigate dust production and stellar mass loss in the Galactic globular cluster NGC 362. Due to its close proximity to the Small Magellanic Cloud (SMC), NGC 362 was imaged with the IRAC and MIPS cameras onboard the *Spitzer Space Telescope* as part of the Surveying the Agents of Galaxy Evolution (SAGE-SMC) *Spitzer* Legacy program. We detect several cluster members near the tip of the Red Giant Branch that exhibit infrared excesses indicative of circumstellar dust and find that dust is not present in measurable quantities in stars below the tip of the Red Giant Branch. We modeled the spectral energy distribution (SED) of the stars with the strongest IR excess and find a total cluster dust mass-loss rate of $3.0^{+2.0}_{-1.2} \times 10^{-9} M_\odot$ yr^{-1}, corresponding to a gas mass-loss rate of $8.6^{+5.6}_{-3.4} \times 10^{-6} M_\odot$ yr^{-1}, assuming [Fe/H] = -1.16. This mass loss is in addition to any dust-less mass loss that is certainly occurring within the cluster. The two most extreme stars, variables V2 and V16, contribute up to 45% of the total cluster dust-traced mass loss. The SEDs of the more moderate stars indicate the presence of silicate dust, as expected for low-mass, low-metallicity stars. Surprisingly, the SED shapes of the stars with the strongest mass-loss rates appear to require the presence of amorphous carbon dust, possibly in combination with silicate dust, despite their oxygen-rich nature. These results corroborate our previous findings in ω Centauri.

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Chromospheric Changes in K Stars with Activity

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We study the differences in chromospheric structure induced in K stars by stellar activity, to expand our previous work for G stars, including the Sun as a star. We selected six stars of spectral type K with 0.82< $B-V$ <0.90, including the widely studied Epsilon Eridani and a variety of magnetic activity levels. We computed chromospheric models for the stars in the sample, in most cases in two different moments of activity. The models were constructed to obtain the best possible match with the Ca II K and the Hβ observed profiles. We also computed in detail the net radiative losses for each model to constrain the heating mechanism that can maintain the structure in the atmosphere. We find a strong correlation between these losses and Sc, the index generally used as a proxy for activity, as we found for G stars.

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The Hamburg/ESO R-process Enhanced Star Survey (HERES) IV. Detailed Abundance Analysis and Age Dating of the Strongly r-Process Enhanced Stars CS 29491−069 and HE 1219−0312.

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We report on a detailed abundance analysis of two strongly r-process enhanced, very metal-poor stars newly discovered in the HERES project, CS 29491−069 ([Fe/H] = −2.51, [r/Fe] = +1.1) and HE 1219−0312 ([Fe/H] = −2.96, [r/Fe] = +1.5). The analysis is based on high-quality VLT/UVES spectra and MARCS model atmospheres. We detect lines of 15 heavy elements in the spectrum of CS 29491−069, and 18 in HE 1219−0312; in both cases including the Th II 4019 Å line. The heavy-element abundance patterns of these two stars are mostly well-matched to scaled solar residual abundances not formed by the s-process. We also compare the observed pattern with recent high-entropy wind (HEW) calculations, which assume core- collapse supernovae of massive stars as the astrophysical environment for the r-process, and find good agreement for most lanthanides. The abundance ratios of the lighter elements strontium, yttrium, and zirconium, which are presumably not formed by the main r-process, are reproduced well by the model. Radioactive dating for CS 29491−069 with the observed thorium and rare-earth element abundance pairs results in an average age of 9.5 Gyr, when based on solar r-process residuals, and 17.6 Gyr, when using HEW model predictions. Chronometry seems to fail in the case of HE 1219−0312, resulting in a negative age due to its high thorium abundance. HE 1219−0312 could therefore exhibit an overabundance of the heaviest elements, which is sometimes called an "actinide boost".

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For preprints via WWW: http://arxiv.org/abs/0910.0707

Pre-Discovery 2007 Image of the HR 8799 Planetary System

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We present a pre-discovery H-band image of the HR 8799 planetary system that reveals all three planets in August 2007. The data were obtained with the Keck adaptive optics system, using angular differential imaging and a coronagraph. We confirm the physical association of all three planets, including HR 8799d, which had only been detected in 2008 images taken two months apart, and whose association with HR 8799 was least secure until now. We confirm that the planets are 2-3 mag fainter than field brown dwarfs of comparable near-infrared colors. We note that similar under-luminosity is characteristic of young substellar objects at the L/T spectral type transition, and is likely due to enhanced dust content and non-equilibrium CO/CH_4 chemistry in their atmospheres. Finally, we place an upper limit of 18 mag per square arc second on the >120 AU H-band dust-scattered light from the HR 8799 debris disk. The upper limit on the integrated scattered light flux is 1e-4 times the photospheric level, 24 times fainter than the debris ring around HR 4796A.

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For preprints via ftp or WWW: http://arxiv.org/abs/0910.0915

A Volume-limited Sample of 63 M7–M9.5 Dwarfs I. Space Motion, Kinematic Age, and Lithium

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In a volume-limited sample of 63 ultracool dwarfs of spectral type M7–M9.5, we have obtained high-resolution spectroscopy with UVES at the Very Large Telescope and HIRES at Keck Observatory. In this first paper we introduce our volume-complete sample from DENIS and 2MASS targets, and we derive radial velocities and space motion. Kinematics of our sample are consistent with the stars being predominantly members of the young disk. The kinematic age of the sample is 3.1 Gyr. We find that six of our targets show strong Li lines implying that they are brown dwarfs younger than several hundred million years. Five of the young brown dwarfs were unrecognized before. Comparing the fraction of Li detections to later spectral types, we see a hint of an unexpected local maximum of this fraction at spectral type M9. It is not yet clear whether this maximum is due to insufficient statistics, or to a combination of physical effects including spectral appearance of young brown dwarfs, Li line formation, and the star formation rate at low masses.

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For preprints via ftp or WWW: http://arxiv.org/abs/0909.4647

Cross-Listed Abstracts (Pre-Main Sequence Stars)

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

Evidence for early disk-locking among low-mass members of the Orion Nebula Cluster

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Context. We present new high-resolution spectroscopic observations for 91 pre-main sequence stars in the Orion Nebular Cluster (ONC) with masses in the range $0.10 - 0.25 M_{\odot}$ carried out with the multi-fiber spectrograph FLAMES attached to the UT2 at the Paranal Observatory.

Aims. Our aim is to better understand the disk-locking scenario in very low-mass stars.

Methods. We have derived radial velocities, projected rotational velocities, and full width at 10% of the Hα emission peak. Using published measurements of infrared excess ($\Delta(I_{\rm C} - K)$), as disk tracer and equivalent width of the near-infrared CaII line λ8542, mid-infrared difference [3.6]−[8.0] μm derived by *Spitzer* data, and 10% Hα width as diagnostic of the level of accretion, we have looked for any correlation between projected angular rotational velocity divided by the radius ($v \sin i/R$) and presence of disk and accretion.

Results. For 4 low-mass stars, the cross-correlation function is clearly double-lined indicating that the stars are SB2 systems. The distribution of rotation periods derived from our $v \sin i$ measurements is unimodal with a peak of few days, in agreement with previous results for $M < 0.25 M_{\odot}$. The photometric periods were combined with our $v \sin i$ to derive the equatorial velocity and the distribution of rotational axes. Our $< \sin i >$ is lower than the one expected for a random distribution, as previously found. We find no evidence for a population of fast rotators close to the break-up velocity. A clear correlation between $v \sin i/R$ and $\Delta(I_{\rm C} - K)$ has been found. While for stars with no circumstellar disk ($\Delta(I_{\rm C} - K) < 0.3$) a spread in the rotation rates is seen, stars with a circumstellar disk ($\Delta(I_{\rm C} - K) > 0.3$) show an abrupt drop in their rotation rates by a factor of ~ 5. On the other hand, only a partial correlation between $v \sin i$ and accretion is observed when other indicators are used. The X-ray coronal activity level ($\log L_{\rm X}/L_{\rm bol}$) shows no dependence on $v \sin i/R$ suggesting that all stars are in a saturated regime limit. The critical velocity is probably below our $v \sin i$ detection limit of 9 km s^{-1}.

Conclusions. The ONC low-mass stars in our sample, close to the hydrogen burning limit, at present seem to be not locked, but the clear correlation we find between rotation and infrared color excess suggests that they were locked once. In addition, the percentage of accretors seems to scale inversely to the stellar mass.

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For preprints via WWW: http://arxiv.org/abs/0909.5035

Review Articles

Coronal Holes

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Coronal holes are the darkest and least active regions of the Sun, as observed both on the solar disk and above the solar limb. Coronal holes are associated with rapidly expanding open magnetic fields and the acceleration of the high-speed solar wind. This paper reviews measurements of the plasma properties in coronal holes and how these measurements are used to reveal details about the physical processes that heat the solar corona and accelerate the solar wind. It is still unknown to what extent the solar wind is fed by flux tubes that remain open (and are energized by footpoint-driven wave-like fluctuations), and to what extent much of the mass and energy is input intermittently from closed loops into the open-field regions. Evidence for both paradigms is summarized in this paper. Special emphasis is also given to spectroscopic and coronagraphic measurements that allow the highly dynamic non-equilibrium evolution of the plasma to be followed as the asymptotic conditions in interplanetary space are established in the extended corona. For example, the importance of kinetic plasma physics and turbulence in coronal holes has been affirmed by surprising measurements from the UVCS instrument on SOHO that heavy ions are heated to hundreds of times the temperatures of protons and electrons. These observations point to specific kinds of collisionless Alfvén wave damping (i.e., ion cyclotron resonance), but complete theoretical models do not yet exist. Despite our incomplete knowledge of the complex multi-scale plasma physics, however, much progress has been made toward the goal of understanding the mechanisms ultimately responsible for producing the observed properties of coronal holes.

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For preprints via ftp or WWW: http://arXiv.org/abs/0909.2847

Announcement: Conference Proceedings

The Biggest, Baddest, Coolest Stars

Edited by Donald G. Luttermoser[1]**, Beverly J. Smith**[1]**, and Robert E. Stencel**[2]

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Cool evolved stars are among the brightest point sources in the infrared sky, and contribute significantly to the interstellar dust of galaxies. They are in a short-lived but important stage of stellar evolution, characterized by pulsations, dust formation, and the production of expanding circumstellar shells. This conference highlighted the physics of evolved cool stars in relation to their stage of evolution, atmospheric structure and dynamics, stellar winds, and associated dust formation.
This conference was held at the Millennium Centre near the campus of East Tennessee State University in Johnson City, Tennessee in July 2007. It brought together astronomers, both professional and amateur, who are working on different aspects of cool star research. These included dust theorists, numerical modelers, and experts in observations at different wavelengths. The result is summarized herein, yielding a more complete picture of these stars.
Several recent developments have motivated the need for this conference. Recent hydrodynamical models of evolved stars are able to reproduce the optical/UV spectra of such stars. However, modeling the infrared spectrum simultaneously has proven difficult. Also, adding dust to such modeling is problematic because of the complicated physics of dust formation, destruction, and emission in these dynamic environments. Furthermore, the exact evolutionary relationship between the various types of cool evolved stars still is uncertain. The astute reader will discover a number of provocative research directions embedded in the many fine contributions herein.

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For further information contact: lutter@etsu.edu

e-Book version can be purchased at: http://www.aspbooks.org (e-Book ISBN: 978-1-58381-705-6)

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

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