COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

No. 158 — July 2009 Editor: Steve Skinner (coolnews@jila.colorado.edu)

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Stellar Abstracts

Stellar Nucleosynthesis in the Hyades Open Cluster

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We report a comprehensive light element (Li, C, N, O, Na, Mg, and Al) abundance analysis of three solar-type main sequence (MS) dwarfs and three red giant branch (RGB) clump stars in the Hyades open cluster using high-resolution and high signal-to-noise spectroscopy. For each group (MS or RGB), the CNO abundances are found to be in excellent star-to-star agreement. Our results confirm that the giants have undergone the first dredge-up and that material processed by the CN cycle has been mixed to the surface layers. The observed abundances are compared to predictions of a standard stellar model based on the Clemson-American University of Beirut (CAUB) stellar evolution code. The model reproduces the observed evolution of the N and O abundances, as well as the previously derived 12C/13C ratio, but it fails to predict by a factor of 1.5 the observed level of 12C depletion. Li abundances are derived to determine if non-canonical extra mixing has occurred in the Hyades giants. The Li abundance of the giant gamma Tau is in good accord with the predicted level of surface Li dilution, but a 0.35 dex spread in the giant Li abundances is found and cannot be explained by the stellar model. Possible sources of the spread are discussed; however, it is apparent that the differential mechanism responsible for the Li dispersion must be unrelated to the uniformly low 12C abundances of the giants. Na, Mg, and Al abundances are derived as an additional test of our stellar model. All three elements are found to be overabundant by 0.2-0.5 dex in the giants relative to the dwarfs. Such large enhancements of these elements are not predicted by the stellar model, and non-LTE effects significantly larger (and, in some cases, of opposite sign) than those implied by extant literature calculations are the most likely cause.

Accepted by ApJ (arXiv:0906.4812)

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Spatially Resolving the Inhomogeneous Structure of the Dynamical Atmosphere of Betelgeuse with VLTI/AMBER

Keiichi Ohnaka[1], Karl-Heinz Hofmann[1], Myriam Benisty[2], Alain Chelli[3], Thomas Driebe[1], Florentin Millour[1,4], Romain Petrov[4], Dieter Schertl[1], Philippe Stee[5], Farrokh Vakili[4] and Gerd Weigelt[1]

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We present spatially resolved high-spectral resolution K-band observations of the red supergiant Betelgeuse (α Ori) using AMBER at the Very Large Telescope Interferometer (VLTI). Betelgeuse was observed between 2.28 and 2.31 μm using baselines of 16, 32, and 48 m with spectral resolutions of 4800–12000. This represents the highest spatial resolution (9 mas) achieved for Betelgeuse, corresponding to 5 resolution elements over its stellar disk. The AMBER data in the continuum can be reasonably fitted by a uniform disk with a diameter of 43.19±0.03 mas or a limb-darkening disk with 43.56 ± 0.06 mas. The K-band interferometric data taken at various epochs suggest that Betelgeuse seen in the continuum shows much smaller deviations from the above uniform/limb-darkened disk than predicted by 3-D convection simulations. On the other hand, our AMBER data in the CO lines reveal that the blue and red wings of the CO lines originate in spatially distinct regions over the stellar disk, indicating an inhomogeneous velocity field. Our AMBER data in the CO lines can be roughly explained by a simple model, in which a patch of CO gas is moving outward or inward at velocities of 10–15 km s^{-1}, while the CO gas in the remaining region in the atmosphere is moving in the opposite direction at the same velocities. The AMBER data are also consistent with the presence of warm molecular layers at 1.4–1.5 $R_\star$ with a CO column density of $\sim 1 \times 10^{20}$ cm^{-2}. Our AMBER observations of Betelgeuse are the first spatially resolved study of the so-called macroturbulence in a stellar atmosphere other than the Sun. The spatially resolved CO gas motion is likely to be related to convective motion or intermittent mass ejections in clumps or arcs.

Accepted by A&A

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For preprints via ftp or WWW: http://arxiv.org/abs/0906.4792

Observation and Modelling of Main Sequence Star Chromospheres VIII. High Resolution Observations of M and K Dwarf Chromospheric Lines

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We report on high resolution observations of chromospheric lines for M and K dwarfs.

We observed up to 13 spectral lines per star: the H_α, H_β, H_ϵ, Pa_ϵ, Pa_8, CaII H, CaII IR triplet, CaI 6572Å, NaI D_1/D_2 and HeI D_3 lines. We observed two dMe stars, one dM(e) star, 5 dM stars and 3 dK stars. We observed a self-reversal in the emission core of the CaII H line for the brightest stars only, indicating a rather optically thick region of formation. We present original spectra of the NaI doublet and the CaII IR triplet for active dMe stars and less active dM stars. Core emission is detected in the Sodium lines and the CaII IR triplet lines for the most active M dwarf AU Mic. We investigate the difference spectra between active dMe stars and dM stars and show that these provide interesting new constraints for the NLTE-radiation transfer modelling of the chromospheres. In our sample, emission H_α profiles have a rather homogeneous FWHM of about 1.5Å. This, according to our previous modelling, can be interpreted as the signature of a rather constant temperature break in the chromosphere. We found that one of our targets (MCC 332) is a binary with a faint but active H_α emission component. For the first time we detect the Pa_ϵ line for six dwarfs. It appears as weak absorption with possible weak wing emission in AU Mic. The region of the Pa_8 line was observed but the line was not detected.

Accepted by A&A

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Observation and Modelling of Main Sequence Star Chromospheres. XII. Two-component Model Chromospheres for Five Active dM1e Stars

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We aim to constrain the H_α, CaII H and CaII K profiles from quiescent and active regions on active dM1e stars. A preliminary analysis of all the data available for dM1e stars shows that the H_α/CaII equivalent width ratio varies by up to a factor of 7 for different stars in our sample. We find that spectroscopic binaries have a significantly smaller ratio than single dM1e star. We also find that the pre-main sequence stars Gl 616.2, GJ 1264 and Gl 803 have a ratio also lower than main-sequence single dM1e stars. These differences imply that different chromospheric structures are present on different stars, notably the temperature minimum must decrease with an increasing H_α/CaII equivalent width ratio. For these reasons it is impossible to reproduce all observations with only one grid of model chromospheres.

We show that the grid of model chromospheres of Houdebine & Stempels (1997) is adequate to describe the physical conditions that prevail in the chromospheres of spectroscopic binaries and pre-main sequence M1e stars, but not for the conditions in single dM1e stars. One or more additional grids of model chromospheres will be necessary to reproduce all observations.

We use the method developed in Paper XI in this series, in order to build two component model chromospheres for five M1e field stars: FF And A, FF And B, Gl 616.2, GJ 1264, AU Mic and Gl 815A. Our solutions provide an exact match of the H_α and the mean CaII H & K equivalent widths within measurements uncertainties. We compare the theoretical profiles and the observed profiles of H_α and the CaII H & K resonance lines. On the one hand, our fits to the CaII lines are reasonably good. On the other hand, our models tend to produce H_α profiles with a central absorption that is too deep. This suggests that the column mass at the transition region for plages is underestimated, but this would imply that the contrast factor between quiescent and active regions in the CaII lines is larger than 5.

We find that except in the cases of FF And A and AU Mic, the total H_α profile is dominated by the contributions from plage regions. The H_α profiles in quiescent regions is typically filled in or slightly in emission. We also find that, as in the case of the less active dM1 stars, CaII emission in dM1e stars is generally dominated by the contribution from plage regions. We find plage filling factors typically in the range 10%-60%. These are in average (40%) slightly larger than those derived for the less active dM1 stars (30%).

Our modelling shows that the grid of model chromospheres of Houdebine & Stempels (1997) is adequate for only a subset of dM1e stars. Physical conditions that prevail in the chromospheres of dM1e stars are very different from one star to another. For this reason this study demonstrates the critical need for several improved grids of model chromospheres as well as higher signal to noise ratio data. Accepted by MNRAS

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Stellar Coronal Magnetic Fields and Star-Planet Interaction

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Evidence of magnetic interaction between late-type stars and close-in giant planets is provided by the observations of stellar hot spots rotating synchronously with the planets and showing an enhancement of chromospheric and X-ray fluxes. Possible photospheric signatures of such an interaction have also been reported. We investigate star-planet interaction in the framework of a magnetic field model of a stellar corona, considering the interaction between the coronal field and that of a planetary magnetosphere moving through the corona. This is motivated, among others, by the difficulty of accounting for the energy budgets of the interaction phenomena with previous models. A linear force-free model is applied to describe the coronal field and study the evolution of its total magnetic energy and relative helicity according to the boundary conditions at the stellar surface and the effects related to the planetary motion through the corona. The energy budget of the star-planet interaction is discussed assuming that the planet may trigger a release of the energy of the coronal field by decreasing its relative helicity. The observed intermittent character of the star-planet interaction is explained by a topological change of the stellar coronal field, induced by a

variation of its relative helicity. The model predicts the formation of many prominence-like structures in the case of highly active stars owing to the accumulation of matter evaporated from the planet inside an azimuthal flux rope in the outer corona. Moreover, the model can explain why stars accompanied by close-in planets have a higher X-ray luminosity than those with distant planets. It predicts that the best conditions to detect radio emission from the exoplanets and their host stars are achieved when the field topology is characterized by field lines connected to the surface of the star, leading to a chromospheric hot spot rotating synchronously with the planet. The main predictions of the model can be verified with present observational techniques, by a simultaneous monitoring of the chromospheric flux and X-ray (or radio) emission, and spectropolarimetric observations of the photospheric magnetic fields.

Accepted by A&A

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For preprints via ftp or WWW: http://arxiv.org/abs/0906.1738

TEXES Observations of M Supergiants: Dynamics and Thermodynamics of Wind Acceleration

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We have detected [Fe II] 17.94 μm and 24.52 μm emission from a sample of M supergiants (μ Cep, α Sco, α Ori, CE Tau, AD Per, and α Her) using the Texas Echelon Cross Echelle Spectrograph on NASA's Infrared Telescope Facility. These low opacity emission lines are resolved at $R \simeq 50,000$ and provide new diagnostics of the dynamics and thermodynamics of the stellar wind acceleration zone. The [Fe II] lines, from the first excited term ($a\,^4F$), are sensitive to the warm plasma where energy is deposited into the extended atmosphere to form the chromosphere and wind outflow. These diagnostics complement previous *Kuiper Airborne Observatory* and *Infrared Satellite Observatory* observations which were sensitive to the cooler and more extended circumstellar envelopes. The turbulent velocities of $V_{turb} \simeq 12 - 13$ km s^{-1} observed in the [Fe II] $a\,^4F$ forbidden lines are found to be a common property of our sample, and are less than that derived from the hotter chromospheric C II] 2325 Å lines observed in α Ori, where $V_{turb} \simeq 17 - 19$ km s^{-1}. For the first time, we have dynamically resolved the motions of the dominant cool atmospheric component discovered in α Ori from multi-wavelength radio interferometry by Lim et al. (1998 Nature, 392, 575). Surprisingly, the emission centroids are quite Gaussian and at rest with respect to the M supergiants. These constraints combined with model calculations of the infrared emission line fluxes for α Ori imply that the warm material has a low outflow velocity and is located close to the star. We have also detected narrow [Fe I] 24.04 μm emission that confirms that Fe II is the dominant ionization state in α Ori's extended atmosphere.

Accepted by ApJ

For preprints: astro-ph arXiv:0906.4599

Photometric Study of Variable Stars in the Open Cluster NGC 6866

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We report the discovery of 19 variable stars and two blue stragglers in the field of the open cluster NGC 6866. Three of the variable stars we classify as δ Sct, two as γ Dor, four as W UMa, two as ellipsoidal variables, and one as an eclipsing binary. Seven stars show irregular variability. Two of the pulsators, δ Sct star NGC 6866-29 and γ Dor star NGC 6866-21, are multiperiodic.

From an analysis of proper motions, we conclude that the δ Sct stars, one of the γ Dor stars and both blue stragglers are very probable members of the cluster. The position on the color-magnitude diagram of seven other variables

suggests that they also belong to the cluster. The eclipsing binary, which we discover to be a new high velocity star, and the seven irregular variables are non-members.

We discuss in detail the age and metallicity of open clusters that host γ Dor stars and we show that none of these parameters is correlated with the number of γ Dor stars in cluster.

Accepted by Acta Astronomica

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No FIP Fractionation in the Active Stars AR Psc and AY Cet

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Context. The comparison of coronal and photospheric abundances in cool stars is an essential question pending of resolution. In the Sun an enhancement of the elements with low First Ionization Potential (FIP) is observed in the corona with respect to the photosphere. Stars with high levels of activity seem to show a depletion of elements with low FIP when compared to solar standard values. However the few cases of active stars in which photospheric values are available for comparison shed confusing results, and an enlargement of the sample is mandatory to solve this long-standing problem. *Aims.* We calculate in this paper the photospheric and coronal abundances of two well known active binary systems, AR Psc and AY Cet, to reach further insights in the complicate scene of coronal abundances. *Methods.* Coronal abundances of 9 elements are calculated by means of the reconstruction of a detailed Emission Measure Distribution, using a line-based method that consider the lines from different elements separately. Photospheric abundances of 8 elements are calculated using high-resolution optical spectra of the stars. *Results.* The results show once again a lack of any FIP-related effect in the coronal abundances of the stars. The presence of Metal Abundance Depletion (MAD) or inverse FIP effects in some stars could be due to a mistaken comparison to solar photospheric values, or to a deficient calculation of photospheric abundances in fast-rotating stars. *Conclusions.* The lack of FIP fractionation seems to confirm that Alfvén waves combined with pondermotive forces (Laming 2004) are dominant in the corona of active stars.

Accepted by A&A

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A Spectroscopic Survey of the Youngest Field Stars in the Solar Neighbourhood. I. The Optically Bright Sample

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Aims. We present the first results of an ambitious ground-based observation programme conducted on 1-4 meter class telescopes. Our sample consists of 1097 active and presumably young stars, all of them being optical (Tycho Catalogue) counterparts of ROSAT All-Sky Survey X-ray sources in the northern hemisphere. In this paper, we concentrate on the optically brightest ($V_T \leq 9.5$ mag) candidates (704 objects). We acquired high-resolution optical spectroscopy in the Hα and/or lithium spectral regions for 426 of such stars without relevant data in the literature. We describe the star sample and the observations and we start to discuss the physical properties of the investigated stars.

Methods. We used a cross-correlation technique and other tools developed by us to derive accurate radial and rotational velocities and to perform an automatic spectral classification for both single stars and double-lined systems. The spectral subtraction technique was used to derive chromospheric activity levels and lithium abundances. We estimated the fraction of young single stars and multiple systems in stellar soft X-ray surveys and the contamination by more evolved systems, like RS CVn binaries. We classified stars on the basis of their lithium abundance and give a glimpse of their sky distribution.

Results. The sample appears to be a mixture of quite young *Pleiades-like* and *Hyades-like* stars plus an older lithium-poor population probably born within the last 1-2 Gyr. Seven stars with a lithium abundance compatible with the age of IC 2602 (about 30 Myr) or even younger were detected as well, although two appear to be lithium-rich giants.The discovery of a large number of highly or moderately lithium-rich giants is another outcome of the present survey.

Conclusions. The contamination of soft X-ray surveys by old systems in which the activity level is enhanced by tidal synchronisation is not negligible, especially for K-type stars. Five stars with lithium content close to the primordial abundance are probably associated with already known moving groups in the solar neighbourhood. Some of them are good post-T Tauri candidates according to their positions in the HR diagram.

Accepted by A&A

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For preprints via ftp or WWW: http://arxiv.org/abs/0907.1157

Photometric Study of Kepler Asteroseismic Targets

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Reported are UBV and $uvby\beta$ observations of 15 candidates for Kepler primary asteroseismic targets and 14 other stars in the Kepler field, carried out at the M.G. Fracastoro station of the Catania Astrophysical Observatory. These data serve to plot the 29 stars in two-parameter diagrams with the photometric indices (such as $B-V$ or δm_1 and the atmospheric parameters (such as the MK type or [Fe/H]) as coordinates. The two-parameter diagrams show no evidence of interstellar reddening. The photometric indices $B-V$ and beta are then used to derive photometric effective temperatures, $T_{\rm eff}(B-V)$ and $T_{\rm eff}(\beta)$. For $T_{\rm eff}(B-V) > 6400$ K, the photometric effective temperatures turn out to be systematically higher than spectroscopic effective temperatures by 311±34 K and 346±91 K for $T_{\rm eff}(B-V)$ and $T_{\rm eff}(\beta)$, respectively. For $T_{\rm eff}(B-V) < 6250$ K, the agreement between $T_{\rm eff}(B-V)$ and the spectroscopic effective temperatures is very good. The photometric surface gravities, derived from c_1 and β, show a range of about a factor of two greater than their spectroscopic counterparts do. Accepted by Acta Astronomica

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Explosive Events Associated with a Surge

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The solar atmosphere contains a wide variety of small-scale transient features. Here, we explore the inter-relation between some of them such as surges, explosive events and blinkers via simultaneous spectral and imaging data taken with the TRACE imager, the SUMER, and CDS spectrometers on board SoHO, and SVST La Palma. The alignment of all data both in time and solar XY shows that SUMER line profiles, which are attributed to explosive events, are due to a surge phenomenon. The surge is triggered, most probably, by one or more Elerman bombs which are best visible in Halpha +-350 A but were also registered by TRACE Fe IX/X 171 A and correspond to a strong radiance increase in the CDS Mg IX 368.07 A line. With the present study we demonstrate that the division of small-scale transient events into a number of different subgroups, for instance explosive events, blinkers, spicules, surges or just brightenings, is ambiguous, implying that the definition of a feature based only on either spectroscopic or imaging characteristics as well as insufficient spectral and spatial resolution can be incomplete.

Accepted by ApJ

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Signatures of Alfvén Waves in the Polar Coronal Holes as Seen by EIS/Hinode

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We attempt to detect whether Alfvén waves are present in the polar coronal holes through variations in EUV line widths. Using spectral observations performed over a polar coronal hole region with the EIS spectrometer on Hinode, we study the variation in the line width and electron density as a function of height. We use the density sensitive line pairs of Fe XII 186.88 Å & 195.119 Å and Fe XIII 203.82 Å & 202.04 Å . For the polar region, the line width data show that the nonthermal line-of-sight velocity increases from 26 km s^{-1} at 10 arcsec above the limb to 42 km s^{-1} some 150 arcsec (i.e. ∼110,000 km) above the limb. The electron density shows a decrease from 3.3×10^9 cm^{-3} to 1.9×10^8 cm^{-3} over the same distance. These results imply that the nonthermal velocity is inversely proportional to the quadratic root of the electron density, in excellent agreement with what is predicted for undamped radially propagating linear Alfvén waves. Our data provide signatures of Alfvén waves in the polar coronal hole regions, which could be important for the acceleration of the solar wind.

Accepted by A&A

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A Solar Cycle Lost in 1793–1800: Early Sunspot Observations Resolve the Old Mystery

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Because of the lack of reliable sunspot observation, the quality of sunspot number series is poor in the late 18th century, leading to the abnormally long solar cycle (1784–1799) before the Dalton minimum. Using the newly recovered solar

drawings by the 18–19th century observers Staudacher and Hamilton, we construct the solar butterfly diagram, i.e. the latitudinal distribution of sunspots in the 1790's. The sudden, systematic occurrence of sunspots at high solar latitudes in 1793–1796 unambiguously shows that a new cycle started in 1793, which was lost in traditional Wolf's sunspot series. This finally confirms the existence of the lost cycle that has been proposed earlier, thus resolving an old mystery. This letter brings the attention of the scientific community to the need of revising the sunspot series in the 18th century. The presence of a new short, asymmetric cycle implies changes and constraints to sunspot cycle statistics, solar activity predictions, solar dynamo theories as well as for solar-terrestrial relations.

Accepted by ApJL

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The Solar Chromosphere at High Resolution with IBIS. IV. Dual-line Evidence of Heating in Chromospheric Network

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The structure and energy balance of the solar chromosphere remain poorly known. We used the imaging spectrometer IBIS at the Dunn Solar Telescope to obtain fast-cadence, multi-wavelength profile sampling of Hα and Ca II 854.2 nm line over a sizable two-dimensional field of view encompassing quiet-Sun network. We provide a first inventory of how the quiet chromosphere appears in these two lines by comparing basic profile measurements in the form of image displays, temporal-average displays, time slices, and pixel-by-pixel correlations. We find that the two lines can be markedly dissimilar in their rendering of the chromosphere, but that, nevertheless, both show evidence of chromospheric heating, particularly in and around network: Hα in its core width and CaII 854.2 in its brightness. We discuss venues for improved modeling.

Accepted by A&A (arxiv.org/abs/0906.2083)

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Low-Mass and Substellar Abstracts

Transit Mapping of a Starspot on CoRoT-2 – Probing a Stellar Surface by Planetary Transits

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We analyze variations in the transit lightcurves of CoRoT-2b, a massive hot Jupiter orbiting a highly active G star. We use one transit lightcurve to eclipse-map a photospheric spot occulted by the planet. In this case study we determine the size and longitude of the eclipsed portion of the starspot and systematically study the corresponding uncertainties. We determine a spot radius between $4.5 degrees$ and $10.5 degrees$ on the stellar surface and the spot longitude with a precision of about ± 1 degree. Given the well-known transit geometry of the CoRoT-2 system, this implies a reliable detection of spots on latitudes typically covered by sunspots; also regarding its size the modelled spot is comparable to large spot groups on the Sun. We discuss the future potential of eclipse mapping by planetary transits for the high-resolution analysis of stellar surface features.

Accepted by A&A

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Announcement

Third release of the POLLUX database within the Virtual Observatory.

Dear Colleagues:

The third release of the POLLUX database for high resolution synthetic spectra and spectral energy distributions is available through this webpage:

http://pollux.graal.univ-montp2.fr

and through some services of the Virtual Observatory such as VOSpec or Aladin.

This release contains new data based on stellar atmosphere models from CMFGEN (O to B spectral types), ATLAS12 (A and F spectral types) and MARCS (G to M spectral types). Both high resolution synthetic spectra and spectral energy distributions may be retrieved in various formats, including VOTable and FITS compatible with the standards of the virtual observatory.

The query via the above quoted webpage also allows simultaneous plotting of up to three spectra (row or nromalised to the continuum).

We invite you to visit this database and to send us your remarks/ suggestions.

With best regards

The POLLUX team

(Submitted by: Ana Palacios; palaciosATgraal.univ-montp2.fr)

JOB OPENING

VLT Operations Staff Astronomers

La Silla Paranal Observatory (Chile)

Several operations staff astronomer positions have just opened at the ESO-VLT (deadline for submitting applications is July 31, 2009). Below is a summary of the job description (more information and on-line applications at https://jobs.eso.org).

The successful candidate will have the opportunity to provide expert knowledge on novel instrumentation, and may be given the overall responsibility for an instrument at the Very Large Telescope. The successful candidate will: (1) Contribute to the observing support in both visitor and service mode at the La Silla Paranal Observatory, with duty station on Paranal, including short-term scheduling of observations, calibration of instruments and the assessment of the scientific quality of the astronomical data. (2) Work in collaboration with one or several of the teams operating the instruments currently on the mountain to improve their operations and scientific performances, and contribute to the VLT operations-readiness of the second generation of instruments. The successful candidate (Ph.D. in Astronomy, Physics or equivalent) will be member of the ESO Science Faculty, with an appointment at the level of Assistant or Associate Astronomer. S/he will be expected and encouraged to actively conduct astronomical research. We are seeking an active researcher staff astronomer, with substantial observing experience in any of the state-ofthe- art observing techniques available at Paranal. A good command of English and a strong sense of team spirit are essential. The position requires three letters of reference to be sent to vacancy AT eso.org.

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.***