COOLNEWS

A RESEARCH NEWSLETTER DEDICATED TO COOL STARS AND THE SUN

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Stellar Abstracts

Modelling Near-IR Spectra and Mid-IR Dust Emission of Mira Variables at Different Phases

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We model the spectral changes of late oxygen-rich Miras observed in different pulsation phases. From a combination of variable near-IR spectra and *UKIRT* spectro-photometry of the 9.7 μm silicate dust emission feature in different phases we study the influence of the changing atmospherical circumstances on the conditions in the circumstellar dust shell. From a detailed modelling of TiO and VO bands in the near-IR spectra we determine changes of the effective temperature and the effective atmospheric acceleration of the central star. The corresponding model spectral energy distribution is redistributed through the dust shell by means of radiative transfer calculations in order to perform a detailed modelling of shape changes observed in the silicate feature. We show that the latter are mainly caused by changes in the flux distribution of the incident radiation field with stellar pulsation, whereas intensity changes of the dust emission result from stellar luminosity changes as they are enshrouded by very optically thin dust shells. In the case of Mira (o Cet) we compute that the effective temperature increases from $T_{\rm eff}$=2400 K in the minimum phase to 3000 K ($\pm$100 K) around maximum phase. The amplified momentum transfer around maximum light enhances the acceleration of the dust outflow near the dust condensation radius of $\sim$6 $R_{\star}$. This produces variations of the terminal dust outflow velocity with phase ($\Delta v_{\infty}\simeq$5 km s^{-1}) at larger distance from the star. The corresponding small changes in flux mean opacity and gas mass-loss rates (from 2.8 to 3.2 $\times$ 10^{-7} $M_{\odot}\,yr^{-1}$) are sufficient to model the shape changes observed in the dust emission feature. A comparison with the modelling results for another long period Mira U Ori is also provided.

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For preprints via WWW: ftp://cfa-ftp.harvard.edu/outgoing/lobel/miras/miras.ps

Ca II Activity and Rotation in F-K Evolved Stars

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Ca II H and K high resolution observations for 60 evolved stars in the field and in 5 open clusters are presented. From these spectra chromospheric fluxes are derived, and a *homogeneous* sample of more than 100 giants is built adding data from the literature. In addition, for most stars, rotational velocities were derived from CORAVEL observations. By comparing chromospheric emission in the cluster stars we confirm the results of Pasquini and Brocato (1992): chromospheric activity depends on the stellar effective temperature, *and* mass, when intermediate mass stars ($M \sim 4M_\odot$) are considered. The Hyades and the Praesepe clump giants show the same level of activity, as expected from stars with similar masses and effective temperatures. A difference of up to 0.4 dex in the chromospheric fluxes among the Hyades giants is recorded and this sets a clear limit to the intrinsic spread of stellar activity in evolved giants. These differences in otherwise very similar stars are likely due to stellar cycles and/or differences in the stellar initial angular momentum. Among the field stars none of the giants with $(V\text{-}R)_o < 0.4$ and Ia supergiants observed shows a signature of Ca II activity; this can be due either to the real absence of a chromosphere, but also to other causes which preclude the appearance of Ca II reversal.

By analyzing the whole sample we find that chromospheric activity scales linearly with stellar rotational velocity and a high power of stellar effective temperature: $F'_k \propto T_{\rm eff}^{7.7}$ (Vsini)$^{0.9}$. This result can be interpreted as the effect of two chromospheric components of different nature: one mechanical and one magnetic.

Alternatively, by using the Hipparcos parallaxes and evolutionary tracks, we divide the sample according to the stellar masses, and we follow the objects along an evolutionary track. For each range of masses activity can simply be expressed as a function of *only one parameter*: either the T_{eff} or the angular rotation Ω, with laws $F'_k \sim \Omega^\alpha$, because angular velocity decreases with effective temperature along an evolutionary track.

By using the evolutionary tracks and the observed *Vsini* we investigate the evolution of the angular momentum for evolved stars in the range 1-5 $M_\odot$. For the 1.6-3 solar mass stars the data are consistent with the $I\Omega$=const law while lower and higher masses follow a law similar to $I\Omega^2$=const, where I is the computed stellar momentum of inertia. We find it intriguing that *Vsini* remains almost constant for $1M_\odot$ stars along their evolution; if a similar behavior is shared by Pop II stars, this could explain the relatively high degree of activity observed in Pop II giants.

Finally, through the use of models, we have verified the consistency of the $F'_k \propto \Omega^\alpha$ and the $I\Omega^\beta$ = Const laws derived, finding an excellent agreement.

This representation, albeit crude (the models do not consider, for instance, mass losses) represents the evolution of Ca II activity and of the angular momentum in a satisfactory way in most of the portion of H-R diagram analyzed. Different predictions could be tested with observations in selected clusters.

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Mira's Wind Explored in Scattering Infrared CO Lines

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We have observed the intermediate regions of the circumstellar envelope of Mira (o Ceti) in photospheric light scattered by three vibration-rotation transitions of the fundamental band of CO, from low-excited rotational levels of the ground vibrational state, at an angular distance of $\beta \sim 2" - 7"$, away from the star. The data were obtained with the Phoenix spectrometer mounted on the 4 m Mayall telescope at Kitt Peak. The spatial resolution is approximately 0.5" and seeing limited. Our observations provide absolute fluxes, leading to an independent new estimate of the mass-loss rate of approximately $3 \times 10^{-7}\,M_{\odot}\ \mathrm{yr}^{-1}$, as derived from a simple analytic wind model. We find that the scattered intensity from the wind of Mira for $2" \lesssim \beta \lesssim 7"$ decreases as β^{-3}, which suggests a time constant mass-loss rate, when averaged over 100 years, over the past 1200 years.

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The Structure of Algol's Corona: A Consistent Scenario for the X-ray and Radio Emission

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We present a systematic analysis of the four known large X-ray flares detected to date on the eclipsing binary system Algol, using an approach based on hydrodynamic simulations of decaying flaring loops including sustained heating. This method yields, for the large BeppoSAX Algol flare of Aug. 1997 (where a geometrical estimate of the size of the flaring region is available) a more reliable size than approaches based on the free decay of the flaring loop. For the three flares analyzed here (one observed by EXOSAT, one by GINGA and one by ROSAT) we show that indeed sustained heating is present in all cases, so that the size of the flaring region is always smaller than previously derived. No evidence for the very long loops previously found through quasi-static analysis methods (extending out to several stellar radii) is found. Instead, the flaring corona of Algol is found to be rather compact. By comparing the imaging VLBI observations of the radio corona of Algol with the recent location of the Algol flare seen by BeppoSAX and with with present results, a consistent model of the Algol corona is deduced: the corona is essentially concentrated onto the polar regions of the K star in Algol, with a more compact (smaller than the star) flaring component and a perhaps somewhat more extended (comparable in size to the star) quiescent corona.

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Abundance Analysis of Two Extremely Metal-poor Stars from the Hamburg/ESO Survey

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We report on the first high spectral resolution analysis of extremely metal-poor halo stars from the Hamburg/ESO objective-prism survey (HES). The spectra were obtained with UVES at VLT-UT2. The two stars under investigation (HE 1303–2708 and HE 1353–2735) are main-sequence turnoff-stars having metal abundances of [Fe/H] = −2.85 and −3.20, respectively. The stellar parameters derived from the UVES spectra are in very good agreement with those derived from moderate-resolution follow-up spectra. HE 1353–2735 is a double-lined spectroscopic binary.

The two stars nicely reproduce the strong scatter in [Sr/Fe] observed for extremely metal-poor stars. While we see a strong Sr II λ4215 Å line in the spectrum of HE 1303–2708 ([Sr/Fe] = -0.08), we can only give an upper limit for HE 1353–2735 ([Sr/Fe] < -1.2), since the line is not detected. We report abundances of Mg, Ca, Sc, Ti, Cr for both stars, and Co, Y for HE 1303–2708 only. These abundances do not show any abnormalities with respect to known trends for metal-poor stars.Lithium is also detected in these stars, to a level which places them among Lithium-plateau metal-poor dwarfs.

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Doppler Imaging from Artificial Data. Testing the Temperature Inversion from Spectral-line Profiles

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We present extensive numerical tests of our temperature-based image reconstruction code TempMap. Two test cases that represent a rapidly-rotating low-inclination star and a moderately-rotating high-inclination star are used for the forward problem. Tests are then made to recover the original input map and include data errors and input-parameter errors. The former include variations of photon noise, continuum displacement, continuum slopes, scattered light in the spectrograph, and phase gaps with and without continuum information. The input-parameter tests include the confusion in the recovery of hot versus cool spots, uncertainties of atmospheric parameters such as radial-tangential macroturbulence and gravity, and the influence of line strength and line damping. In general, we find that the geometric information is less dependent on photon noise and on input errors than the temperature information. Our test inversions also show that, at the $v \sin i$ of these test cases, no significant gain in image quality is achieved once S/N of 300:1 is surpassed.

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Abstract Guidelines

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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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