07.03

89 Her: The Atmosphere of a Strange Yellow Supergiant

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89 Her (HD 163506; F2 Ia) belongs to a class of A and F-type supergiants, lying at moderately high galactic latitudes. They appear not to be young Population I objects, but otherwise their identification and evolutionary status is unclear. It has been variously suggested that this class represents: a, single, older, low-mass stars evolving off the tip of the asymptotic giant branch toward the regime of central stars of planetary nebulae; b, binary stars; c, coalesced binary stars. It is known from spectroscopic observations in the visible and ultraviolet regions and the presence of IR excesses that mass loss must occur. Both Hα and Mg II spectra reveal broad asymmetric profiles indicating rapid mass outflow with a velocity comparable to the escape velocity from the star. Photometric monitoring shows that 89 Her varies, sometimes irregularly with a period of ~65 days. This paper reports on a monitoring program of 89 Her for ~65 days during May, June, and July 1990 using IUE, for ultraviolet spectroscopy, and with the SOO 0.25m Automatic Photoelectric Telescope (APT) located at the F. L. Whipple Observatory, yielding V, R, and I photometry. The star showed its 65-day period during the time of our observations, and reached minimum light near the mid-point of the monitoring period. The purpose of this study is to identify the response of an atmosphere to the pulsation of the photosphere and the development of an extended atmosphere.

07.04

Recent Spectroscopy of Mira

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The 1989 maximum of Mira was early and brighter than usual. High dispersion spectra were obtained near maximum in October, 1989. Classification spectra were obtained near maximum and through March 1990. High dispersion spectra and classification spectra have been obtained for the 1990 maximum for comparison. Spectral types are presented and the appearance of hydrogen and the aluminum oxide bands are discussed.

07.05

Lithium, Chromospheric Activity, and Rotation in G and K Dwarfs of the Pleiades

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We have obtained Hamilton echelle spectra of about 100 Pleiades G and K dwarfs. The spectra include Li λ6708, Hα, and the Ca II infrared triplet, and are of sufficient resolution to detect rotation at the 6 km s⁻¹ level. We first confirm that a large and significant spread is present in all of the age-related properties in these stars: Li abundance, chromospheric emission (CE), and rotation (v sin i). The spread in Li grows dramatically with decreasing mass, while the spreads in CE and v sin i are roughly constant over this mass range. Deviations in Li abundance are correlated with excess rotation, but not strictly enough to be consistent with a causal relationship. However, excess Li and excess CE are very well correlated, suggesting that line formation conditions may be playing a role in adding to the spread in Li. This is supported by deviations in the strength of the K I line at 7699Å that are also correlated with CE.

Rotational velocities in the Pleiades lack any characteristic value at a given mass, due to the broad distribution. Although ultra-fast rotators (v sin i > 100 km s⁻¹) are not present earlier than about K0, there are rapid rotators (230 km s⁻¹) at all spectral types. There are also large numbers of slow rotators (v sin i ≤ 56 km s⁻¹) at all colors. Because of this, it is not clear if it is possible to evolve the Pleiades v sin i distribution into the rotational distribution seen in the Hyades, regardless of how angular momentum is lost.

07.06

Net Redshifts of Chromospheric Spectral Lines

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Net redshifts of the Mg II k emission line have been seen in IUE spectra of several rapidly-rotating stars. I review these instances and discuss the implications for a simultaneous study of both structure and dynamics of chromospheres.

In a series of spectra obtained over nearly two full rotational cycles of El Eri (HD 26337), the Mg II k centroid was systematically redshifted 10 km s⁻¹ with respect to the photospheric velocity. While an instrumental cause for this systematic offset has not been entirely ruled out, a systematic difference between the photospheric and chromospheric velocity would have a major impact on a fundamental assumption in the ultraviolet spectral imaging technique. The basic assumption of this technique is that a uniformly bright, rapidly-rotating star will produce a chromospheric emission line profile that is symmetric and is centered at the photospheric velocity. Departures from symmetry are then interpreted as discrete regions. It is therefore critical that we know the correct axis of symmetry.

It is possible to simultaneously measure asymmetries that are phase-dependent and therefore due to active regions and asymmetries that are not phase-dependent, such as a red-wing asymmetry. Unfortunately, a systematic offset of the chromospheric velocity has led to an ambiguity in the interpretation of the spectral imaging results for AR Lac and HD 199178. Fortunately, either interpretation is physically interesting. I will review these cases, discuss the two interpretations, and suggest ways to resolve the ambiguity.

07.07

Long-term Variation of Magnetic and Chromospheric Flux on κ Ceti

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We present measurements of photospheric magnetic flux, and chromospheric Mg II and Ca II fluxes for the active G5 dwarf, κ Ceti, spanning 6, 12, and 22 years, respectively. We have focused in particular on long-term variability which might be associated with the stellar analog of the solar magnetic cycle. The longer time series of Ca II data indicate rather complex behavior: a slowly increasing decline in activity from 1968 to a minimum around 1978, followed by quasiperiodic behavior thereafter. We compare these data with the Mg II and magnetic fluxes, and discuss the results in the context of the cyclic magnetic activity of the Sun and other dwarf stars.