51.11 Rotation and Long-Term Activity in Evolved Stars


At the Mt. Wilson Observatory 60" reflector, we have begun a survey of time-series of chromospheric activity in evolved stars in the field. The stars in the sample have a magnitude limit of $m_{V} \leq 5.75$ and declination limits $-25^\circ \leq \delta \leq 25^\circ$, their absolute magnitudes have been determined from the widths of their Ca II K lines (Wilson 1976, 1978). Nearly 200 stars with spectral types ranging from mid-G to mid-M in luminosity classes IV and III are contained in the sample.

We have monitored the relative chromospheric emission strength, $S$, by measuring the flux in 2A passbands centered on Ca II H and K compared to the nearby photospheric continuum. The longest-time-series of the giants span four years. We report on the measured rotations, average chromospheric emission strengths, and long-term activity variations. We discuss the observed evolution of chromospheric activity and angular momentum.

We gratefully acknowledge support from NSF (AST 81–21726), National Geographic Society (2548–82), and the Scholarly Studies Program of the Smithsonian Institution.

51.12 Ultraviolet and Visible Observations of the Atmospheric Structure of the Active G8III Component of FF Aquarii

J.G. Loeser, S.L. Baliunas, J.C. Raymond (CFA), E.F. Guinan (Vil- laanova U.), J.D. Donren (U. of Penn.)

A G8III and an sdOB star in a 9.2 day orbit compose the eclipsing binary system FF Aquarii. We studied this unusual binary system with ultraviolet spectra from the IUE satellite, high resolution Hα spectra from Oak Ridge Observatory, and photometric light curves from Biruni and Villanova Observatories. The photometric light curve of the binary system shows not only a sharp, total eclipse of the subdwarf by the G8III star, but also a dramatic wave-like modulation with nearly the same period as the orbital period. The photometric wave is best explained by rotational modulation of an uneven distribution of visibly darker spot regions covering nearly 50% of the surface of the G8III star. The ultraviolet emission line fluxes of the cool star are extremely bright; for example, the surface fluxes of CIV and NV are 20-50 times brighter than those of the active sun. Such extreme activity in the cool star is caused by the rapid rotation induced by tidal forces developed in the close binary system.

In the ultraviolet, the subdwarf dominates the light most of the time with a hot (T$_{eff} \sim 35-40,000$ K) continuum and prominent absorption features of CII, NIV, and CIV. The giant star's ultraviolet emission spectrum can only be observed during the eclipse of the subdwarf.

During ingress and egress of total eclipse the strengths of the ultraviolet absorption lines in the subdwarf spectrum are enhanced over their strengths during quadrature. The excess absorption is likely caused by an extended, ultraviolet line-forming region of the G8III star. By sampling the ultraviolet spectrum at different rotational phases over several years during ingress and egress, we determined that the persistent line-forming region extends out to at least 1.5 stellar radii.

Hα emission appears strongest (~3 times brighter than the nearby continuum) during the annular transit of the subdwarf. The hot subdwarf produces local Hα emission in the atmosphere of the G8III star that varies with the aspect to our line of sight. This research is supported by NASA grant NAG 5–87.

51.13 Spots on T Tauri Stars

C. Bertout (UC Berkeley and IAP, France), J. Bouvier (IAP, France)

This is a report of long-term, multi-telescope monitoring of T Tauri stars meant to detect periodicities in their light-curves. Two sets of periodic components were detected in ten T Tauri stars of various masses and activity levels. We interpret these light variations as rotational modulation by groups of spots on the stellar surface. Detailed modeling shows them to be similar to spots found on RS CVn and BY Dra stars. The data suggest that large spots are a common occurrence in the T Tauri class and that magnetically-driven activity in T Tauri stars compares to that in other late-type stars with similar rotation rates.

51.14 Evolution of Active Regions on the Spotted T Tauri Star V410 Tau

W. Herbst (Wesleyan U./VVO), J.F. Booth (KPMO), P.J. Vrba (USNO)

The spotted T Tauri star V410 Tau has been monitored photometrically at the Van Vleck Observatory and at the U.S. Naval Observatory's Flagstaff Station for several seasons. The rotation period discovered by Ryder and Vrba (1983, Ap. J. 267, 191) of about 1.9 days, based on data obtained in 1981 is confirmed. The amplitude of the variation was larger in 1984/85 by about 4X, while the slopes of relations between $V$ and $K$ and $R-I$ and $V$ did not change. The period appears to have shortened slightly from 1.92 to 1.87 days between 1981 and 1984. Hα photometry shows that significant variations occur in the Hα equivalent width and that they are not simply phase related. All of the data available to us has not been analyzed at the time of writing of this Abstract, and further details of the observations will be presented in the poster. It is clear, however, that we now have evidence of spot evolution on a pre-main sequence star, including quite possibly, a measure of differential rotation in its atmosphere.

51.15 Mg II Emission Line Variability of Hybrid Chromosphere Stars

A. Brown, J. L. Linesky (JILA, Univ. of Colo. & NBS), S. A. Ireland (STScI) at GSFC), K. G. Carpenter (CASA/Univ. Colo.)

Hybrid-chromosphere stars are early G supergiants and early K bright giants which possess an unusual set of atmospheric characteristics. Their ultraviolet spectra suggest both transition region plasma ($T \sim 10^{5}$ K) as evidenced by C IV, Si IV and N V emission lines and a substantial stellar wind, seen as a high velocity (~100-200 km/s) shortward-shifted absorption in the Mg II h and k lines. This combination is unlikely the solar-like chromosphere-corona structure of the other chromospheres of K and G giants. We report on a study of the variability of both the integrated Mg II fluxes and the wind absorption components of eight hybrid-chromosphere stars ($\delta$ Aqu, $\alpha$ Aqu, $\delta$ Tra, $\alpha$ Tra, $\gamma$ Aql, $\iota$ Aur, $\delta$ Her, $\zeta$ Car) based on systematic monitoring over the period 1985 April to 1986 May and also earlier IUE spectra. Both short exposures optimal for the measurement of the Mg II flux and deeper exposures to study wind absorption were obtained using IUE. The changes in emission line fluxes are examined.

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