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FINAL REPORT

FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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DK UMa, A STAR ON THE ASCENT

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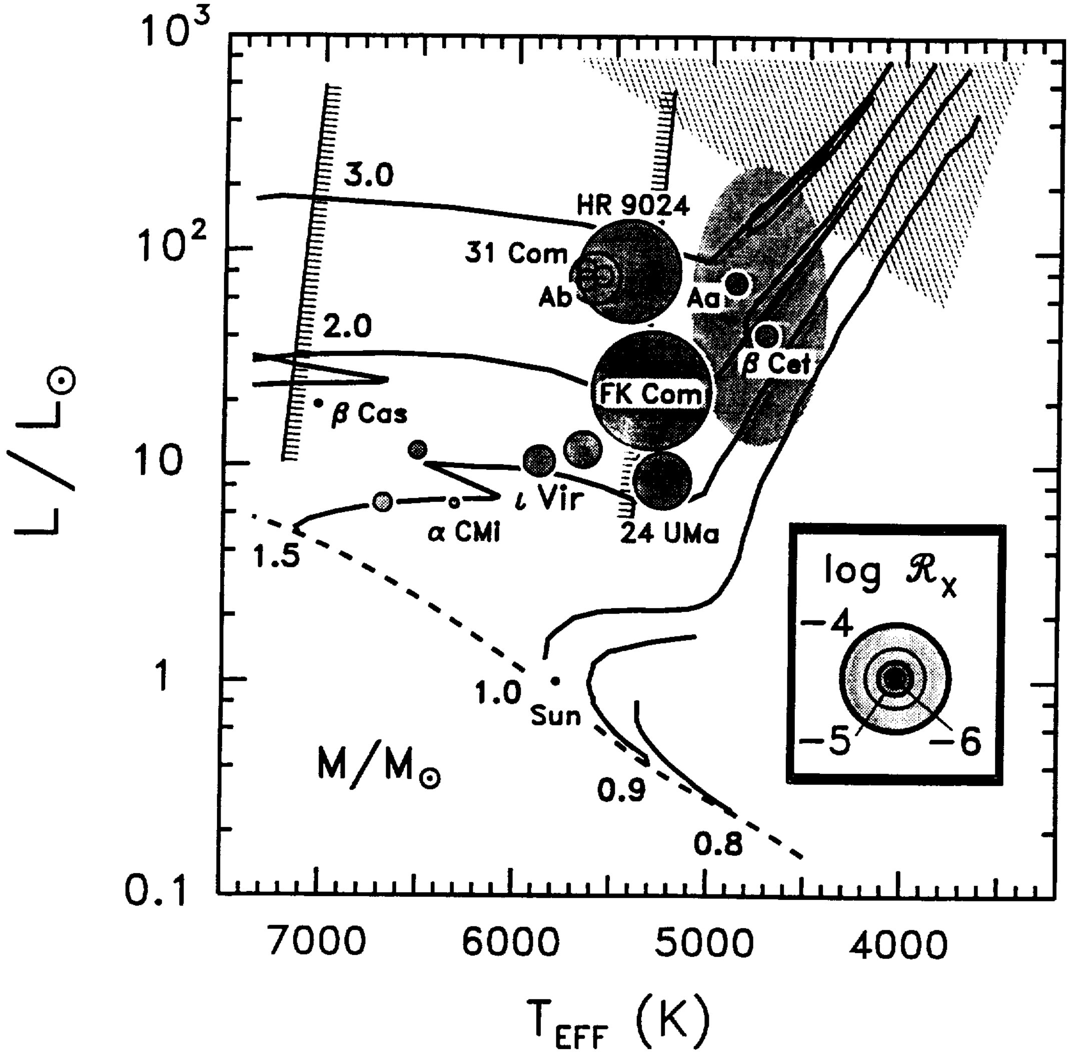
I. Papers Published Under this Grant

Ayres, T. R., Simon, T., Stern, R.A., Drake, S. A., Wood, B. E., and Brown, A. The Coronae of Moderate-Mass Giants in the Hertzsprung Gap and the Clump. 1998, Astrophys. J., 496, 428-448.

II. Major Scientific Results

DK UMa (= 24 UMa = HD 82210) is a G4 IV–III star. According to its M_V and $B - V$ color, and as shown in first figure below, it is located at the base of the red giant branch, having recently exited from the Hertzsprung Gap. Now poised to start its first ascent along the giant branch, DK UMa is at a significant juncture in its post-main–sequence evolution, offering an important evolutionary comparison for magnetic activity with stars like 31 Comae, which is just entering the Hertzsprung Gap, and older stars like the Hyades giants or β Ceti, which have passed the tip of the giant branch and lie in the so-called "clump".

As part of a major survey of the ultraviolet and X ray properties of a well-defined sample of evolved giant stars, DK UMa was observed with the Extreme Ultraviolet Explorer (*EUVE*) spacecraft in March 1997, for a total exposure time of 230 kiloseconds. A plot of the extracted short-wavelength (SW) spectrum of this star is shown in the second figure below (Figure 3 from the Ayres et al. 1998 publication listed in section I above), where it is compared with similar *EUVE* exposures for other yellow and red giant stars in the activity survey. In terms of the spectral lines of different ionization stages present in these spectra, the transition region and coronal temperature of DK UMa appears to be intermediate between those of 31 Com and β Ceti. Combining the relative strengths of the *EUVE* lines with *HST* data at near UV wavelengths and with *ROSAT* X-ray fluxes, the differential emission measure (DEM) distributions of these stars form a sequence in coronal temperature, which peaks at $10^{7.2}$ K for 31 Com, at $10^{6.8}$ K for β Ceti, and at intermediate temperatures for DK UMa – consistent with the evolutionary stages represented by the three stars. The integrated fluxes of the strongest emission lines found in the *EUVE* spectrum of DK UMa are listed in the table below, which appeared as Table 4 in the Ayres et al. paper, again compared with similar measurements for other giant stars that were observed in the course of other *EUVE* Guest Observer programs.



L / L⊙
T_EFF (K)
10^3
10^2
10
1
0.1
7000
6000
5000
4000
3.0
2.0
1.5
1.0
0.9
0.8
M/M⊙
HR 9024
31 Com
Ab
Aa
β Cet
FK Com
β Cas
ι Vir
α CMi
24 UMa
Sun
log ℛX
−4
−5
−6

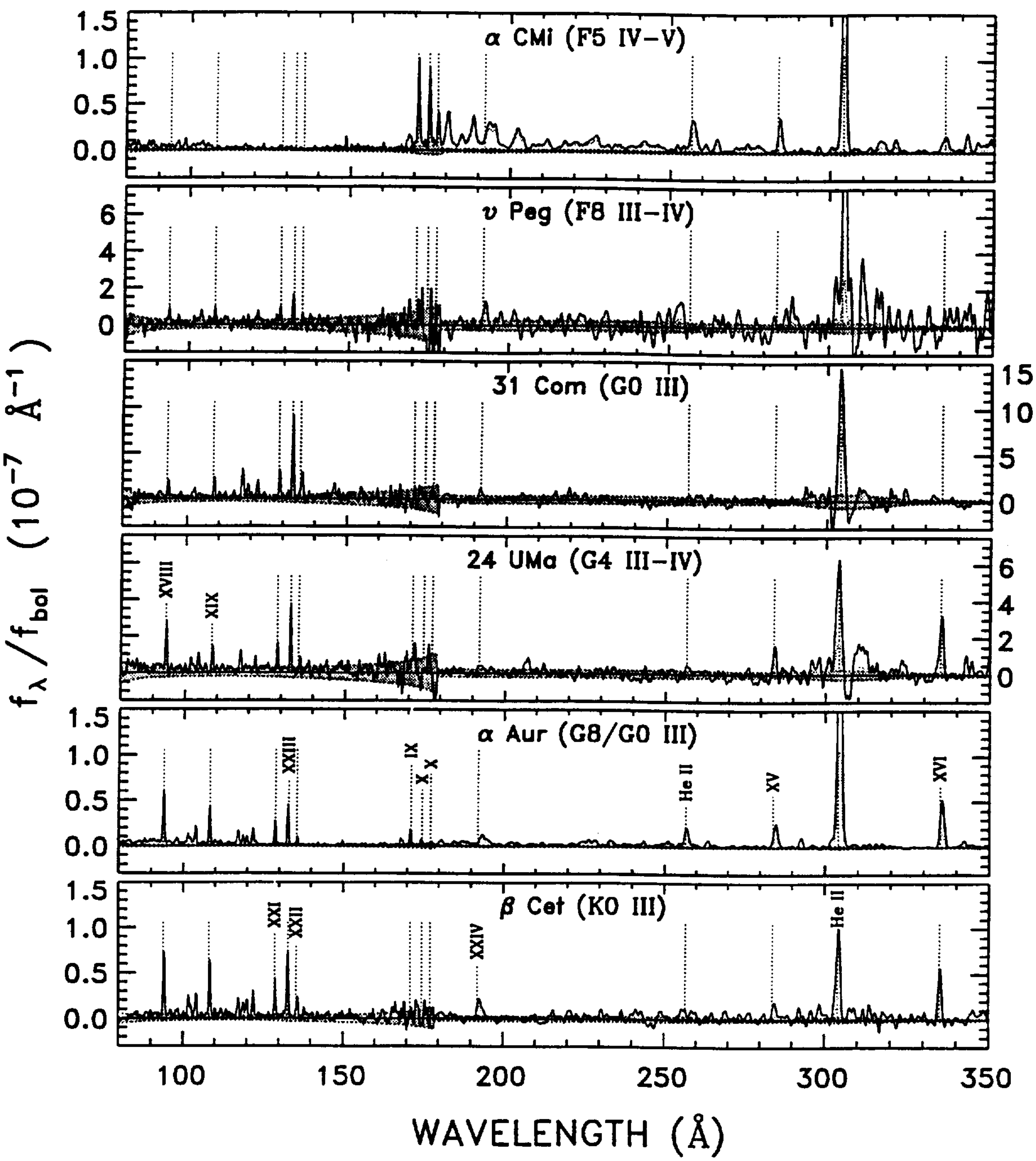


Fig. 3.— *EUVE* spectra of selected stars, depicted in normalized flux density (corrected for interstellar absorption). Shading indicates ±2 σ photometric errors. SW and MW spectra were spliced at 180 Å. Important features are identified explicitly: unadorned Roman numerals indicate ionization stages of iron.

Table 4. EUVE Line Flux Measurements

ID	λ_L (Å)	υ Peg	31 Com	24 UMa	β Cet
		f_L (10^{-13} ergs cm^{-2} s^{-1})			
Short Wavelength Spectrometer (70–190 Å)					
Fe XVIII	93.9	0.30 ± 0.09	0.40 ± 0.08	0.82 ± 0.09	2.4 ± 0.1
Fe XVIII	103.9	0.27 ± 0.08	$\lesssim 0.2$	0.30 ± 0.06	0.90 ± 0.10
Fe XIX	108.4	0.26 ± 0.06	0.40 ± 0.06	0.44 ± 0.07	2.0 ± 0.1
Fe XXII	117.2	$\lesssim 0.2$	0.70 ± 0.08	0.33 ± 0.08	0.70 ± 0.10
Fe XX	118.7	$\lesssim 0.2$	0.33 ± 0.07	$\lesssim 0.2$	0.54 ± 0.09
Fe XIX	120.0	$\lesssim 0.2$	$\lesssim 0.2$	$\lesssim 0.2$	0.64 ± 0.10
Fe XX	121.8	$\lesssim 0.2$	0.41 ± 0.08	0.24 ± 0.08	0.93 ± 0.10
Fe XXI	128.7	0.28 ± 0.09	0.56 ± 0.09	0.42 ± 0.08	1.2 ± 0.1
Fe XXIII/XX	132.8	0.41 ± 0.10	1.6 ± 0.1	0.95 ± 0.11	2.4 ± 0.2
Fe XXII	135.8	$\lesssim 0.3$	0.62 ± 0.11	$\lesssim 0.2$	0.71 ± 0.13
Fe IX	171.1	$\lesssim 0.7$	$\lesssim 0.7$	$\lesssim 0.7$	$\lesssim 0.8$
Fe X	174.5	$\lesssim 0.9$	$\lesssim 0.8$	$\lesssim 0.8$	$\lesssim 1.0$
Fe X	177.2	$\lesssim 1.1$	$\lesssim 0.9$	$\lesssim 0.9$	$\lesssim 1.3$
Fe XI/X	180.4	$\lesssim 1.3$	$\lesssim 1.4$	$\lesssim 1.4$	$\lesssim 1.9$