The Unusual UV Spectra of EUV-Discovered AM Herculis Stars

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International Ultraviolet Explorer observations of the *ROSAT* WFC-discovered AM Hers RE2107-05, RE1938-46, RE1833-74, RE1149+28, and RE0751+14 reveal UV spectra (1200 – 2000 Å) which are unique when compared with previously studied systems. Specifically, the intensities of individual emission lines due to C IV, C II, N V, He II, and Si IV, are 2 – 4 times stronger then typically seen. However, the equivalent width ratios of these same emission lines, (C II/C IV, N V/C IV, He II/C IV, and Si IV/C IV), are similar to those in typical AM Hers. These results indicate that the EUV-discovered AM Hers must have larger UV emitting volumes. Using additional observations of these stars made by EUVE, we speculate on the cause of their larger UV line fluxes.

1. Introduction

During its EUV all-sky survey, the wide field camera (WFC) on the *ROSAT* satellite discovered several new AM Herculis type stars. In this paper, we present observations of RE0751+14, RE1149+28, RE1844-74, RE1938-46, and RE2107-05. Using the *International Ultraviolet Explorer* (*IUE*), spectra were obtained of these systems over a band pass of 1200–3400 Å. These AM Her stars, discovered in the EUV, and faint at optical wavelengths, proved be bright UV emission line sources. The intensities of the individual emission lines due to C IV, C II, N V, He II, and Si IV are 1.5–3 times stronger then usually seen. However, the equivalent width ratios of these same emission lines are similar to those seen in typical AM Hers. Using additional observations of these stars in the EUV, we compare the continuum flux of the new AM Hers at optical, UV, and EUV wavelengths to previously studied AM Hers, and discuss some of the implications of these data.

2. Ultraviolet Spectroscopy

The *International Ultraviolet Explorer* (*IUE*) satellite was used to obtain ultraviolet spectra of five new AM Hers. The short wavelength prime (SWP) camera was used to make observations during November of 1993, and March and June of 1994. The long wavelength prime (LWP) camera was used to make observations of two of these stars, RE2107 and RE0751, during November of 1993, and June of 1994. Table 1 correlates the individual stars with their relevant observational data. Due to the length of the exposures, which were greater than one orbital period in all cases, phase dependent effects were averaged over.

Figure 1 shows the SWP UV spectra of the 5 new AM Hers. From this figure, it is clear that the UV spectra of these AM Hers are dominated by the extremely strong emission lines. The emission lines are identified as N V (1240), Si III (1297), C II (1333),

S. Bowyer and R. F. Malina (eds.), Astrophysics in the Extreme Ultraviolet, 361–365.

TABLE 1.

Star	Camera	Exp (min)	Date	P_{orb}[a] (min)	B[b] (MG)	Dist[a] (pc)
RE1149	SWP 49336	435	Nov 93	90	—	—
RE2107	SWP 49337	180	Nov 93	125.02	36	190
	LWP 28365	120	Jun 94			
RE1844	SWP 47791	410	Mar 94	89.91	—	—
RE1938	SWP 51048	189	Jun 94	140	56	300
RE0751	SWP 49329	180	Nov 93	340	8–18	—
	SWP 50159	155	Mar 94			
	LWP 26811	115	Nov 93			

Notes: [a] Ritter & Kolb 1993; [b] Warner 1995.

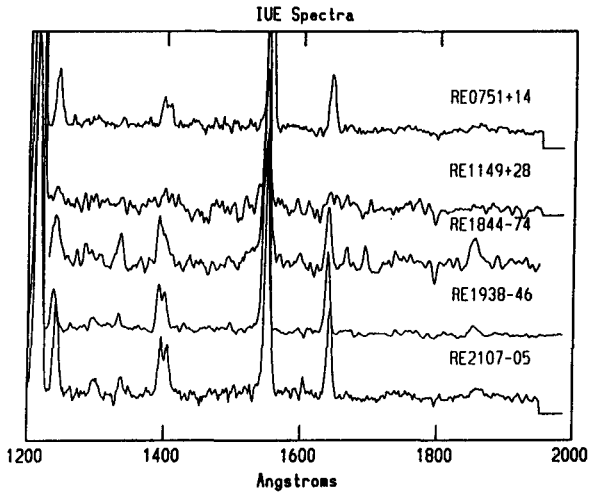

FIGURE 1. *IUE* spectra of RE0751+14, RE1149+28, RE1844-74, RE1938-46, and RE2107-05.

Si IV (1400), C IV (1550), He II (1640), and Fe I (1858). Most likely, the Lyman Alpha line present is contaminated by geocoronal emissions. The LWP data obtained showed no obvious features due to their poor quality.

3. Data Analysis

The spectra of the five new AM Hers were extracted and reduced using *IUE* standard processing. With the wavelength scale and fluxes calibrated, we then used IRAF/splot routines to analyze the spectra. Compared to previously known AM Hers, the emission line equivalent widths are 1.5–3 times stronger, however, the line ratios are similar to those seen in other AM Hers. (See Tables 2 and 3). Figure 2 shows RE2107 and MR Ser plotted together to show the greater dominance of the emission lines in the newly discovered AM Hers. We then compared the fluxes from these sources in the optical,

https://doi.org/10.1017/S025292110003623X Published online by Cambridge University Press

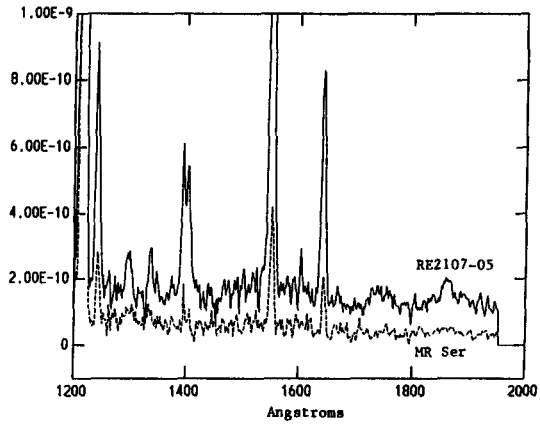

FIGURE 2. Compared to a typical AM Her, the emission line equivalent widths are 1.5–3 times stronger in the EUV discovered stars.

UV, and EUV. Since the EUV data was only obtained during high states, and both our *IUE* observations and those from the *IUE* archives we believe were also obtained at high states, archival V magnitudes at maximum were used to obtain optical flux values. Our UV fluxes came directly from measurements of an average value across the line-free region 1450–1525 Å. Using catalogued EUV fluxes from the EUV all-sky survey (Malina et al. 1994), and the assumptions that the objects have low column densities, blackbody-like spectra near 89 Å, and a constant effective area of the detector, we could calculate EUV flux estimates.

In Figures 3 and 4, we show the spectral energy distributions for the five new AM Hers plus those of two previously studied AM Hers for comparison. The plots were separated onto two graphs for clarity. RE1149 has had five EUV measurements made (Oct 1990, Dec 1992, Feb 1993, Mar 1993, Dec 1994) which are plotted to show its variability. RE0751, a suspected DQ Herculis star, shows a comparatively flat spectral energy distribution, while RE1844 shows a very steep slope between the UV and optical data points. The EUV/UV/Optical flux distributions of the other stars are similar to and generally equivalent with previously known AM Hers.

4. Conclusions

The major differences in the ROSAT/WFC discovered sources appear to be in their larger UV emission line strengths. Although the variability of these sources is quite apparent even in the "high" states, the overall spectral energy distributions, which are similar between the new AM Hers and typical AM Hers, do not change. These results indicate that the EUV discovered AM Hers are likely to have a larger UV emitting volume. The emission line strengths do appear to show a correlation with the magnetic field strength, becoming stronger up to approximately 35 MG and weaker thereafter. This may be related to the weakening of bremsstrahlung emission for fields above 35 MG as noted by Beuermann & Schwope (1994). Full details of this ongoing project will be published elsewhere.

AEH acknowledges support from NSF/REU grant #AST9217971. SBH acknowledges

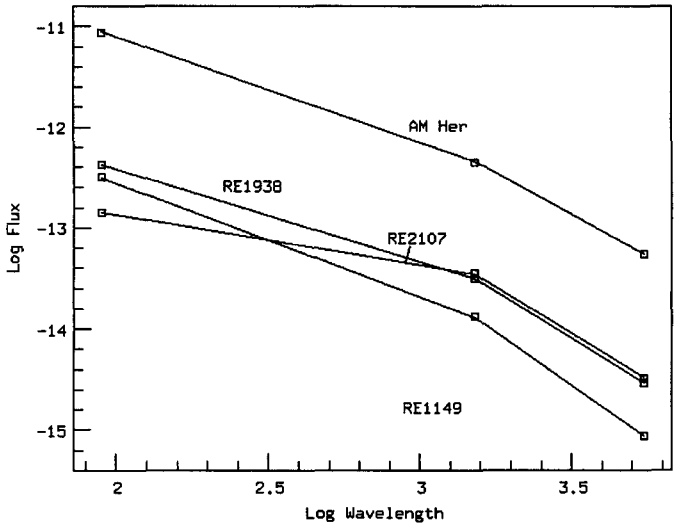

FIGURE 3. The spectral energy distributions for RE1938, RE2107, RE1149, and AM Her. RE1149 has had 5 EUV measurements made which are plotted to show its variability.

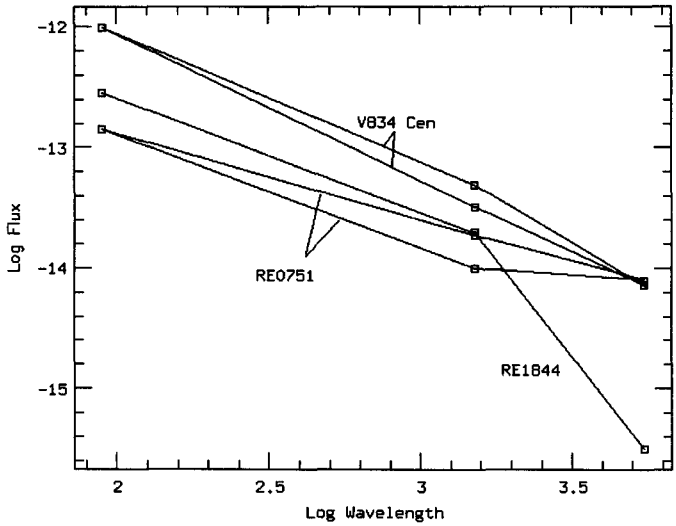

FIGURE 4. The spectral energy distributions for RE0751, RE1844, and V834 Cen.

support from NASA/EUVE grant NAG5-2902. We would like to thank Liz Puchnarewicz for her help with some of the *IUE* data.

Table 2. Emission line equivalent widths (Å)

Star	N V	Si III	C II	Si IV	C IV	He II	Fe I
RE2107	41	8	7	44	122	46	17
RE1938	20	6	4	36	154	45	13
RE0751	24	6	3	19	112	39	11
	19	4	4	22	102	38	8
RE1844	64	8	39	63	175	69	37
RE1149	27	—	—	—	227	94	—
V834 Cen[a]	4	—	4	14	53	11	—
V834 Cen[c]	7	—	5	51	67	18	—
AM Her[c]	17	3	5	23	96	25	—
MR Ser[b]	28	13	5	19	48	19	—

Notes: [a]Maraschi & Treves 1984; [b]Szkody et al. 1985; [c]Nousek & Pravdo 1983.

Table 3. Ratios of emission line equivalent widths

Star	C II/C IV	N V/C IV	C II/He II	He II/C IV	Si IV/N V	Si IV/C IV	Si IV/He II
RE2107	0.05	0.34	0.14	0.38	1.07	0.36	0.96
RE1938	0.03	0.13	0.10	0.29	1.81	0.23	0.80
RE0751	0.03	0.22	0.08	0.35	0.78	0.17	0.49
	0.03	0.19	0.10	0.36	1.15	0.22	0.62
RE1844	0.22	0.36	0.56	0.40	0.99	0.36	0.90
RE1149	—	0.12	—	0.41	—	—	—
V834 Cen	0.08	0.08	0.36	0.21	3.50	0.26	1.27
V834 Cen	0.07	0.10	0.28	0.27	7.29	0.76	2.83
AM Her	0.05	0.18	0.20	0.26	1.35	0.24	0.92
MR Ser	0.10	0.58	0.26	0.40	0.36	0.21	0.53

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