

## ROSAT WFC EUV OBSERVATIONS OF AB DOR (AND OTHER LOCAL GROUP STARS)

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### INTRODUCTION

The Rosat Observatory was launched on June 1<sup>st</sup>, 1990, and after a brief Performance Verification phase, performed an almost complete sky survey. One of the two main telescopes on the Observatory is the UK Wide Field Camera (WFC). The WFC is the first extreme ultraviolet (EUV) instrument to survey the whole sky, and during the survey detected several hundred active late-type stars.

The WFC (Wells *et al.*, 1990) was built by a consortium of five UK institutes, four Universities and the Rutherford Appleton Laboratory. During the all-sky survey, two filters were used. These allow broad-band photometry to be performed. The S1A filter (lexan/carbon/boron) and S2A filter (lexan/beryllium) were alternated on a one day basis. The S1A filter covers the energy range 0.085–0.180 KeV, centred on 0.124 KeV, while the softer S2A filter covers the range 0.070–0.110 KeV (centred on 0.090 KeV) (10% efficiency) [see Kent *et al.* (1990) for a full description of the WFC filters].

Because of the way that the survey was performed any given EUV source would be observed for a minimum of 5 days. However, the data would be composed of brief “snapshots” of the source lasting 30–80 seconds, separated by one Rosat orbit (about 96 minutes). Therefore, the typical exposure time is about 1000 seconds in each of the two survey filters.

### AB Doradus (HD36705)

AB Dor is a rapidly rotating young star which reveals its magnetic-related activity in a variety of ways. In particular, it is a strong X-ray source, with flares observed by the *Einstein* HRI, EXOSAT ME, and *Ginga* LAC [Vilhu & Linsky (1987), Collier-Cameron *et al.* (1988), Vilhu *et al.* (1991)]. *Ginga* was also able to show some marginal evidence for X-ray modulation with the 0.514 day rotation period of AB Dor.

In the Rosat All-Sky survey, AB Dor is nearly “circumpolar” and was visible for about 2 months (in the WFC) of the 6 month survey. During much of the survey, AB Dor would have been viewed from about the same point in the Rosat orbit. Unfortunately, this point is quite close to the southern auroral particle zones of the Earth, and consequently, the WFC detector was switched off for much of the potential survey time of AB Dor, and with quite a high background rate during much of the remaining time. This leads to a good deal of scatter in the data (although *some* of the scatter must also be due to the activity of AB Dor itself). However, AB Dor was detected as a very significant source in both the survey filters. The question of whether the survey data shows any modulation

on the 0.514 day rotation period of AB Dor is more difficult to establish because of the problems mentioned above. But it is possible that some modulation was present for at least part of the time. This conclusion was also reached by Kürster *et al.* 1992, from the Rosat XRT survey data.

### PZ Tel (HD174429)

Another well known fast rotator is PZ Tel. Unfortunately, the WFC survey of PZ Tel was badly affected by data loss (similar to AB Dor), and only received a relatively short exposure (see Table 2). It is also much further away than AB Dor (68 pc versus 20 pc). Consequently, no EUV flux was detected from PZ Tel

### “Speedy Mic” – the new fast rotator

During the WFC survey, many previously unknown late-type stars were found to be EUV emitters. Optical follow-up spectroscopy has confirmed many of them to be very active indeed. One of the most interesting of the early discoveries was a new source in the southern constellation *Microscopium*. The new source was quickly christened “Speedy” for reasons that will become apparent. The source was clearly variable during the survey. In fact, detailed analysis has shown that the S1 and S2 detections of this source are due *entirely* to the presence of a long-lasting flare on the star, with *NO* quiescent emission being detected from Speedy (Bromage *et al.*, 1992).

The WFC position lies very close to a catalogued 9<sup>th</sup> mag K0 star (HD197890). Optical follow-up spectra of Speedy taken with the 1.9m SAAO telescope with the RPCS detector clearly indicated broad emission lines of Ca II H + K in the spectrum of Speedy. We estimate a (deconvolved) FWHM of ~230 km/s, which is faster than AB Dor.

Further optical monitoring of Speedy has failed to show any signs of binarity, so we have concluded that this is a very rapidly rotating single K dwarf. It also shares the same common proper motion shown by AB Dor and PZ Tel. In fact all 3 K dwarfs are members of the Pleiades or Local group (see Innis *et al.*, 1986, Bromage *et al.*, 1992).

### The Local Group K dwarfs

In recent years, 4 other K dwarfs have been associated with the Local Group (see Anders *et al.*, 1991). These stars are listed in Table 1, along with the stars already discussed. Although these 4 K dwarfs all show much smaller  $v \sin i$ 's than the stars already discussed above (based on their relative photometric periods, given in Table 1, for example), all 4 were clearly detected in the survey. Table 2 summaries the WFC EUV observations of these ~K0V stars. In all 4 cases, detailed analysis of the data has shown that these detections are “quiescent” emission from these stars; ie. there are no significant variations present in the data which might indicate the presence of flares.

**TABLE 1:** Local Association K Stars

HD Number (Name)	V	Sp.Typ.	$P_{phot}$ (d)	$P_{orb}$ (d)	$d_{pc}$
17433 (VY Ari)	6.87	G9Ve	17.4	13.20	21
36705 (AB Dor)	6.95	K1-2III-IVp	0.514	–	20
82558	7.50	dK0	1.66	–	13
102077 (V838 Cen)	8.97	K0-1Vp	1.84	–	42
139084 (V343 Nor)	8.14	K0V	4.2	–	55
174429 (PZ Tel)	8.45	K0III-Vp	0.945	–	68
197890 (“Speedy”)	9.3	K0V	0.338	–	~40

**TABLE 2:** WFC Survey Results

Star	S1A Filter		S2A Filter	
	Survey (s)	Cts/Sec	Survey (s)	Cts/Sec
VY Ari	1261.2	0.094	849.0	0.096
AB Dor	13442.	0.075	12539.	0.090
HD82558	1955.2	0.033	2106.7	0.028
V838 Cen	954.2	0.025	861.8	0.030
V343 Nor	1261.5	0.021	1780.6	0.040
PZ Tel	589.5	<0.009	710.3	<0.034
Speedy	1126.0	0.030	1302.7	0.072

## CONCLUSION

The WFC EUV survey results presented here show that the Local Association K dwarfs are strong EUV emitters. The stars in the association are thought to be 50–70 million years old, and it would seem it is these stars relatively young age that make them so active; since the “slow” rotators, like V343 Nor and VY Ari, appear just as strong as the rapid stars, like AB Dor and Speedy. In fact, as already mentioned, Speedy Mic was *NOT* seen in quiescence, whereas the 4 K dwarfs added to this study were *ALL* clearly detected in quiescence.

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## REFERENCES

- Anders, G.J., Innis, J.L., Coates, D.W., & Thompson, K., 1991, *MNRAS*, **252**, 408.
- Bromage, G.E., *et al.*, 1992, *PASP Conf. Ser. (Proc. Tucson Workshop, Oct. 1991)*, in press.
- Collier-Cameron, A., *et al.*, 1988, *MNRAS*, **231**, 131.
- Innis, J.L., Thompson, K., & Coates, D.W., 1986, *MNRAS*, **223**, 183.
- Kent, B.J., *et al.* 1990, *Proc. S.P.I.E.*, **1344**, 255.
- Kürster, M., *et al.*, 1992, *PASP Conf. Ser. (Proc. Tucson Workshop, Oct. 1991)*, in press.
- Vilhu, O., & Linsky, J.L., 1987, *PASP*, **99**, 1071.
- Vilhu, O., Tsuru, T., & Collier-Cameron, A., 1991, “Iron Line Diagnostics in X-ray Sources”, Eds. Treves, A., Perola, G.C., & Stella, L., 30.
- Wells, A., *et al.* 1990, *Proc. S.P.I.E.*, **1344**, 230.