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ON THE VARIABILITY OF K5–M STARS

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Recently (Adelman 2000) examined the Hipparcos photometry (ESA 1997) of K0–K4 stars in the Bright Star Catalogue, 5th edition (Hoffleit & Warren 1991) and the 4th edition Supplement (Hoffleit et al. 1983). Many were not particularly variable. Here for comparison I examine the K5–M stars which include BY Draconis variables, eclipsing binaries, Algols, irregular variables, Miras, microvariables, small amplitude red variables, and semi-regular variables as well as many unsolved variables.

Table 1 presents the mean amplitudes of K5–M stars with 3 or more class members. Stars with spurious variability due to duplicity were omitted. Values are often recalculated omitting a star which significantly skews the average. Maeder (1980), who found that supergiant variability increases with luminosity, gave as mean values for V photometry $0\overset{\mathrm{m}}{.}213$ for M0–M2 Iab stars, $0\overset{\mathrm{m}}{.}028$ for K0–K9Ib stars, $0\overset{\mathrm{m}}{.}028$ for K0–K9II stars, and $0\overset{\mathrm{m}}{.}113$ for M0–M2Ib and II stars. The Hipparcos average values are $0\overset{\mathrm{m}}{.}308 \pm 0\overset{\mathrm{m}}{.}148$ for 10 M0–M3Iab stars, $0\overset{\mathrm{m}}{.}202 \pm 0\overset{\mathrm{m}}{.}200$ for 16 K5-M5Ib stars, and $0\overset{\mathrm{m}}{.}306 \pm 0\overset{\mathrm{m}}{.}512$ ($0\overset{\mathrm{m}}{.}208 \pm 0\overset{\mathrm{m}}{.}177$ without a Mira variable) for 24(23) K5–M6II stars. The discrepancies most likely reflect the choices of passbands and stars (see also Adelman 2000).

Except for the K5II, K5III, K6III, and K7III stars, the mean amplitudes are usually greater than those of K0–K4 stars whose values are typically of order $0\overset{\mathrm{m}}{.}02$ to $0\overset{\mathrm{m}}{.}03$. A few exceptionally stable stars with standard errors $\leq 0\overset{\mathrm{m}}{.}006$ and amplitudes $\leq 0\overset{\mathrm{m}}{.}02$ are the K5III stars HR 851, HR 2549, and HR 7541. The larger mean amplitudes were seen also for some K4 spectral types. Almost all M luminosity I, II, and III stars are certainly variable. Many currently unresolved variables with amplitudes of order $0\overset{\mathrm{m}}{.}05$ require further observation. For some stars, one can find evidence for longer term variability via comparison of the Hipparcos magnitudes with the Bright Star Catalog (and other published) V magnitudes. For example, VX Sgr and R Dra show large discrepancies much greater than produced by the use of different bandpasses.

Table 2 (available electronically from the IBVS Web-site as 4959-t2.txt and 4959-t2.tex) contains the values for the stars whose averages appear in Table 1 as well as those which were not used in compiling these values. Table 3 lists stars whose amplitudes of variability are significantly greater than those of other stars with similar spectral types; usually at least twice those of the average amplitude of the class. Although many have been classified, additional observations especially of those which are unresolved types are desirable. No Miras are included as they are usually well-known stars.

Table 1: The Mean Amplitudes of Various Types of K5 though M Stars.

Spectral Classes	Number	Mean Amplitude (mag)
K5Ib	5	0.060 ± 0.029
K5II	3	0.033 ± 0.006
M1II	3	0.083 ± 0.083
M3II	5	0.146 ± 0.111
M4II	4	0.302 ± 0.131
M5II	4	1.012 ± 1.046
	3	0.493 ± 0.156 without R Cen
M0II–III	4	0.060 ± 0.000
M2II–III	3	0.110 ± 0.096
M3II–III	4	0.170 ± 0.075
K5III	169	0.035 ± 0.026
K6III	5	0.034 ± 0.005
K7III	9	0.034 ± 0.014
K5–M0III	8	0.044 ± 0.012
M0–III	4	0.042 ± 0.032
	3	0.027 ± 0.000 without γ Phe
M0III	73	0.050 ± 0.059
	72	0.043 ± 0.021 without V341 Car
M0+III	3	0.043 ± 0.006
M0.5III	7	0.053 ± 0.014
M1III	86	0.062 ± 0.044
M1.5III	11	0.058 ± 0.031
M2III	94	0.083 ± 0.100
M2.5III	10	0.394 ± 1.000
	9	0.078 ± 0.041 without S Car
M3–III	6	0.107 ± 0.048
M3III	75	0.143 ± 0.181
	74	0.126 ± 0.097 without X Mon
M3+III	3	0.070 ± 0.000
M3.5III	11	0.130 ± 0.008
M4III	69	0.314 ± 0.718
	67	0.193 ± 0.120 without R Tri & T UMa
M4+III	3	0.140 ± 0.010
M4.5III	11	0.528 ± 0.992
	10	0.235 ± 0.206 without R Vir
M5 III	35	0.433 ± 0.661
	34	0.328 ± 0.235 without R Dra
M6III	16	1.042 ± 1.244
	13	0.478 ± 0.272 with 3 Mira variables
M6.5III	3	2.733 ± 2.207 includes 2 Mira variables
M7III	15	3.121 ± 1.411 includes 12 Mira variables
K5V	3	0.247 ± 0.375 61 Cyg A large contributor

Table 3: Some stars with amplitudes different than stars of similar spectral type

Name	HD No.	Spectral Type	HIP Number	SE (mag)	Amp. (mag)	Comments
VX Sgr	165674	M4Iae	88838	0.0643	1.31	SRC
TV Gem	42475	M0–1Iab	29416	0.0131	0.61	SRC
α^1 Her	156014	M5Ib–II	84345	0.0189	0.40	SRC
V959 Her	159968	M1II	86153	0.0083	0.18	SR
CI Boo	126009	M3II	70236	0.0064	0.34	LB
BO Mus	109372	M4II	61404	0.0125	0.43	LB
V2093 Cyg	187880	M4IIb	97651	0.0168	0.40	L
XY Lyr	172380	M4.5–M5+II	91373	0.0262	0.47	LC
T Cet	1760	M5IIe	1728	0.0334	0.66	SR
SV Crv	111499	M5II	62611	0.0288	0.47	SRB
AF Col	42682	M2II–III	29263	0.0059	0.22	U
	33872	K5III	24189	0.0017	0.07	U
	39853	K5III	27938	0.0016	0.06	U
V448 Car	49877	K5III	32531	0.0153	0.20	SR
	95314	K5III	53778	0.0014	0.06	U
QT Hya	99712	K5III:	55953	0.0048	0.09	SR
V918 Cen	102461	K5III	57512	0.0022	0.07	SR
AW CVn	120933	K5III	67665	0.0042	0.12	SR
CW CVn	121212	K5III	67803	0.0085	0.26	SR
	159881	K5III	86317	0.0019	0.08	U
γ Phe	9053	M0-IIIa	6867	0.0041	0.09	SR
CF Cet	402	M0III	696	0.0062	0.16	SR
BI Scl	9692	M0III	7330	0.0021	0.09	U
69 υ Gem	60522	M0III–IIIb	36962	0.0023	0.08	U
	62689	M0III	36982	0.0021	0.08	U
V341 Car	65750	M0III	38834	0.0292	0.52	L
	91056	M0III	51313	0.0032	0.08	L
NSV 7351	142804	M0III	78120	0.0037	0.09	I
RV Cae	28552	M1III	20856	0.0049	0.12	NSV 1615, I
SW Col	35515	M1III	25194	0.0057	0.33	LB:
SX Col	46431	M1III	31099	0.0054	0.12	L
V436 Pup	70946	M1III	41107	0.0021	0.12	NSV 4056, I
V914 Cen	101541	M1III	56970	0.0030	0.13	NSV 5289, I
DX Boo	127093	M1III	70800	0.0058	0.11	I
V854 Ara	155035	M1–2III	84105	0.0028	0.12	I
AW Phe	9184	M2III	6952	0.0089	0.21	SR
V805 Cas	21179	M2III	16319	0.0052	0.21	SR
WW Pic	35158	M2III	24943	0.0181	0.60	NSV 1946, SR
NO Aur	37536	M2IIIS	26718	0.0111	0.17	L
EM Leo	85162	M2III	48292	0.0058	0.21	I
FR Cam	104216	M2III	58545	0.0071	0.21	L
RY UMa	107397	M2IIIe	60180	0.0413	0.79	SRB
OW Ser	137570	M2III	75584	0.0104	0.15	NSV 7079, I
σ Lib	133216	M3–III	73714	0.0100	0.17	SR
V1472 Aql	190658	M2.5III	98954	0.0138	0.18	SR
47 TV Psc	2411	M3III	2219	0.0146	0.40	SR

Table 3 (cont.)

Name	HD No.	Spectral Type	HIP Number	SE (mag)	Amp. (mag)	Comments
15 Tri	16058	M3IIIa	12086	0.0091	0.57	NSV 866, L
η Gem	42995	M3III	29655	0.0053	0.23	SRA+E
X Mon	51478	M3IIIe	33441	0.0647	1.45	SRA
27 BP Cnc	71250	M3III	41400	0.0084	0.21	SR
GK Com	104207	M3III	58519	0.0049	0.20	I
V768 Cen	130328	M3III	72432	0.0195	0.25	SRB
GG Lib	138344	M3III	76075	0.0138	0.23	SR
IQ Aqr	198272	M3III	102770	0.0077	0.56	NSV 13326, SR
V414 Cep	197939	M3III	102358	0.0100	0.23	SR
92 χ Aqr	219576	M3III	114939	0.0153	0.21	L
LY Ser	139608	M3/4III	76573	0.0071	0.36	LB:
Z Eri	17491	M4III	13064	0.0100	0.46	SRB
AK Hya	73844	M4III	42502	0.0339	0.68	SRB
CG UMa	80390	M4IIIa	45915	0.0104	0.36	LB
TV UMa	102159	M4III	57362	0.0281	0.38	SRB
V335 Hya	106198	M4III	59588	0.0101	0.51	NSV 5503, I
FP Vir	118289	M4III	66345	0.0177	0.51	SRB
V3879 Sgr	172816	M4III	91781	0.0140	0.39	SRB
HD Peg	207932	M4III	107956	0.0161	0.38	LB
ST UMa	99592	M4/5III	55936	0.0176	0.60	SRB
L_2 Pup	56096	M5IIIe	34922	0.0356	0.86	SRB
GO Vel	73588	M5III	42315	0.0332	0.83	SR
V744 Cen	118767	M5III	66666	0.0134	0.98	SRB
FY Lib	132112	M5III	73213	0.0145	0.50	SRB
V2113 Oph	156860	M5IIIab	84780	0.0114	0.51	SR:
W Cyg	205730	M5IIIae	106642	0.0417	0.85	SRB
RX Lep	33664	M6III	24169	0.0287	0.59	SRB
S Lep	41698	M6III	28874	0.0260	0.79	SRB
RS Cnc	78712	M6IIIase	45058	0.0267	0.93	SRC
EU Del	196610	M6III	101810	0.0227	0.45	SRB
S Phe	224583	M6IIIe	118249	0.0420	1.01	SRB
61 Cyg A	201091	K5V	104214	0.0259	0.68	V1803 Cyg, BY

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