

## Workshop 3

1. For one open cluster and one globular cluster use the colour-magnitude diagrams and tables provided to:
  - a) determine the location of the main sequence turn off point and the apparent magnitude  $V$  (or  $m_V$ ) of the stars there
  - b) use the distance given to convert the apparent magnitude  $m_V$  to absolute magnitude  $M_V$ . From the tables provided determine the mass of the star at the turn off point
  - c) estimate the age of the cluster
2. On your colour-magnitude diagrams or those of your neighbours see if you can:
  - a) identify stars that are not members of the cluster, i.e. are foreground or background stars. What factors influence this and compare and contrast these for open and globular clusters.
  - b) identify where the faintness of the stars introduces larger errors in the observed colours and magnitudes
  - c) identify possible unresolved binary members of the cluster
  - d) if there are red giants present estimate the spectral type and parameters of the brightest ones

Stellar parameters for main sequence stars:

Main-Sequence Stars (Luminosity Class V)									
Sp. Type	$T_e$ (K)	$L/L_\odot$	$R/R_\odot$	$M/M_\odot$	$M_{\text{bol}}$	$BC$	$M_V$	$U - B$	$B - V$
O5	42000	499000	13.4	60	-9.51	-4.40	-5.1	-1.19	-0.33
O6	39500	324000	12.2	37	-9.04	-3.93	-5.1	-1.17	-0.33
O7	37500	216000	11.0	—	-8.60	-3.68	-4.9	-1.15	-0.32
O8	35800	147000	10.0	23	-8.18	-3.54	-4.6	-1.14	-0.32
B0	30000	32500	6.7	17.5	-6.54	-3.16	-3.4	-1.08	-0.30
B1	25400	9950	5.2	—	-5.26	-2.70	-2.6	-0.95	-0.26
B2	20900	2920	4.1	—	-3.92	-2.35	-1.6	-0.84	-0.24
B3	18800	1580	3.8	7.6	-3.26	-1.94	-1.3	-0.71	-0.20
B5	15200	480	3.2	5.9	-1.96	-1.46	-0.5	-0.58	-0.17
B6	13700	272	2.9	—	-1.35	-1.21	-0.1	-0.50	-0.15
B7	12500	160	2.7	—	-0.77	-1.02	+0.3	-0.43	-0.13
B8	11400	96.7	2.5	3.8	-0.22	-0.80	+0.6	-0.34	-0.11
B9	10500	60.7	2.3	—	+0.28	-0.51	+0.8	-0.20	-0.07
A0	9800	39.4	2.2	2.9	+0.75	-0.30	+1.1	-0.02	-0.02
A1	9400	30.3	2.1	—	+1.04	-0.23	+1.3	+0.02	+0.01
A2	9020	23.6	2.0	—	+1.31	-0.20	+1.5	+0.05	+0.05
A5	8190	12.3	1.8	2.0	+2.02	-0.15	+2.2	+0.10	+0.15
A8	7600	7.13	1.5	—	+2.61	-0.10	+2.7	+0.09	+0.25
F0	7300	5.21	1.4	1.6	+2.95	-0.09	+3.0	+0.03	+0.30
F2	7050	3.89	1.3	—	+3.27	-0.11	+3.4	+0.00	+0.35
F5	6650	2.56	1.2	1.4	+3.72	-0.14	+3.9	-0.02	+0.44
F8	6250	1.68	1.1	—	+4.18	-0.16	+4.3	+0.02	+0.52

Main-Sequence Stars (Luminosity Class V)									
Sp. Type	$T_e$ (K)	$L/L_\odot$	$R/R_\odot$	$M/M_\odot$	$M_{\text{bol}}$	$BC$	$M_V$	$U - B$	$B - V$
G0	5940	1.25	1.06	1.05	+4.50	-0.18	+4.7	+0.06	+0.58
G2	5790	1.07	1.03	—	+4.66	-0.20	+4.9	+0.12	+0.63
Sun <sup>a</sup>	5777	1.00	1.00	1.00	+4.74	-0.08	+4.82	+0.195	+0.650
G8	5310	0.656	0.96	—	+5.20	-0.40	+5.6	+0.30	+0.74
K0	5150	0.552	0.93	0.79	+5.39	-0.31	+5.7	+0.45	+0.81
K1	4990	0.461	0.91	—	+5.58	-0.37	+6.0	+0.54	+0.86
K3	4690	0.318	0.86	—	+5.98	-0.50	+6.5	+0.80	+0.96
K4	4540	0.263	0.83	—	+6.19	-0.55	+6.7	—	+1.05
K5	4410	0.216	0.80	0.67	+6.40	-0.72	+7.1	+0.98	+1.15
K7	4150	0.145	0.74	—	+6.84	-1.01	+7.8	+1.21	+1.33
M0	3840	0.077	0.63	0.51	+7.52	-1.38	+8.9	+1.22	+1.40
M1	3660	0.050	0.56	—	+7.99	-1.62	+9.6	+1.21	+1.46
M2	3520	0.032	0.48	0.40	+8.47	-1.89	+10.4	+1.18	+1.49
M3	3400	0.020	0.41	—	+8.97	-2.15	+11.1	+1.16	+1.51
M4	3290	0.013	0.35	—	+9.49	-2.38	+11.9	+1.15	+1.54
M5	3170	0.0076	0.29	0.21	+10.1	-2.73	+12.8	+1.24	+1.64
M6	3030	0.0044	0.24	—	+10.6	-3.21	+13.8	+1.32	+1.73
M7	2860	0.0025	0.20	—	+11.3	-3.46	+14.7	+1.40	+1.80

Stellar parameters for giant stars:

**Giant Stars (Luminosity Class III)**

Sp. Type	$T_e$ (K)	$L/L_\odot$	$R/R_\odot$	$M/M_\odot$	$M_{\text{bol}}$	$BC$	$M_V$	$U - B$	$B - V$
O5	39400	741000	18.5	—	-9.94	-4.05	-5.9	-1.18	-0.32
O6	37800	519000	16.8	—	-9.55	-3.80	-5.7	-1.17	-0.32
O7	36500	375000	15.4	—	-9.20	-3.58	-5.6	-1.14	-0.32
O8	35000	277000	14.3	—	-8.87	-3.39	-5.5	-1.13	-0.31
B0	29200	84700	11.4	20	-7.58	-2.88	-4.7	-1.08	-0.29
B1	24500	32200	10.0	—	-6.53	-2.43	-4.1	-0.97	-0.26
B2	20200	11100	8.6	—	-5.38	-2.02	-3.4	-0.91	-0.24
B3	18300	6400	8.0	—	-4.78	-1.60	-3.2	-0.74	-0.20
B5	15100	2080	6.7	7	-3.56	-1.30	-2.3	-0.58	-0.17
B6	13800	1200	6.1	—	-2.96	-1.13	-1.8	-0.51	-0.15
B7	12700	710	5.5	—	-2.38	-0.97	-1.4	-0.44	-0.13
B8	11700	425	5.0	—	-1.83	-0.82	-1.0	-0.37	-0.11
B9	10900	263	4.5	—	-1.31	-0.71	-0.6	-0.20	-0.07
A0	10200	169	4.1	4	-0.83	-0.42	-0.4	-0.07	-0.03
A1	9820	129	3.9	—	-0.53	-0.29	-0.2	+0.07	+0.01
A2	9460	100	3.7	—	-0.26	-0.20	-0.1	+0.06	+0.05
A5	8550	52	3.3	—	+0.44	-0.14	+0.6	+0.11	+0.15
A8	7830	33	3.1	—	+0.95	-0.10	+1.0	+0.10	+0.25
F0	7400	27	3.2	—	+1.17	-0.11	+1.3	+0.08	+0.30
F2	7000	24	3.3	—	+1.31	-0.11	+1.4	+0.08	+0.35
F5	6410	22	3.8	—	+1.37	-0.14	+1.5	+0.09	+0.43
G0	5470	29	6.0	1.0	+1.10	-0.20	+1.3	+0.21	+0.65
G2	5300	31	6.7	—	+1.00	-0.27	+1.3	+0.39	+0.77
G8	4800	44	9.6	—	+0.63	-0.42	+1.0	+0.70	+0.94
K0	4660	50	10.9	1.1	+0.48	-0.50	+1.0	+0.84	+1.00
K1	4510	58	12.5	—	+0.32	-0.55	+0.9	+1.01	+1.07
K3	4260	79	16.4	—	-0.01	-0.76	+0.8	+1.39	+1.27
K4	4150	93	18.7	—	-0.18	-0.94	+0.8	—	+1.38
K5	4050	110	21.4	1.2	-0.36	-1.02	+0.7	+1.81	+1.50
K7	3870	154	27.6	—	-0.73	-1.17	+0.4	+1.83	+1.53
M0	3690	256	39.3	1.2	-1.28	-1.25	+0.0	+1.87	+1.56
M1	3600	355	48.6	—	-1.64	-1.44	-0.2	+1.88	+1.58
M2	3540	483	58.5	1.3	-1.97	-1.62	-0.4	+1.89	+1.60
M3	3480	643	69.7	—	-2.28	-1.87	-0.4	+1.88	+1.61
M4	3440	841	82.0	—	-2.57	-2.22	-0.4	+1.73	+1.62
M5	3380	1100	96.7	—	-2.86	-2.48	-0.4	+1.58	+1.63
M6	3330	1470	116	—	-3.18	-2.73	-0.4	+1.16	+1.52