Name_____Date_____Period_____

The Hertzsprung-Russell Diagram

Introduction

Named in honor of the research conducted by astronomers Einar Hertzsprung and Henry Russell, the HR Diagram is now considered one of the most important tools ever designed for the study of stars. Throughout the early 1900s, Hertzsprung and Russell were both intrigued, albeit separately, by the possibility that the amount of light a star shed was related to the temperature of the star. Extensive research soon proved this relationship did exist (with a few notable exceptions) and the two scientists produced their first star diagrams shortly thereafter.

The HR Diagram

Since this chart is still used today, an understanding of the Diagram is essential to any astronomy course. First, the diagram provides an easy to read map that shows the relationship between a star's surface temperature and absolute magnitude. Also, since temperature determines both the spectral class and color of a star, the HR Diagram can be used as a simple scale to determine these two characteristics of any star. In addition, is was also found that, when these basic relationships were plotted together, much of the diagram was empty with no stars while the rest gathered into distinct groups. Later, these groups were actually found to provide valuable clues into what phase of the star's life it was in.

Instructions

Included with this sheet are two sets of data. The first set consists of a listing of stars within approximately 12 LY of Sol and represent our astronomical next door neighbors. The second set includes those stars that appear brightest from Earth based upon their apparent magnitude and not their true luminosity. However, in order to determine the true characteristics of these stars, absolute magnitude is plotted on the HR Diagram. Look closely at the distance to these stars, their size and magnitude to understand why they are the brightest.

For this exercise, you will be using a logarithmic graph paper so pay careful attention to the varying scales this type of graphing application uses...its easy to make mistakes. At the current time, plot or indicate the following information on the chart:

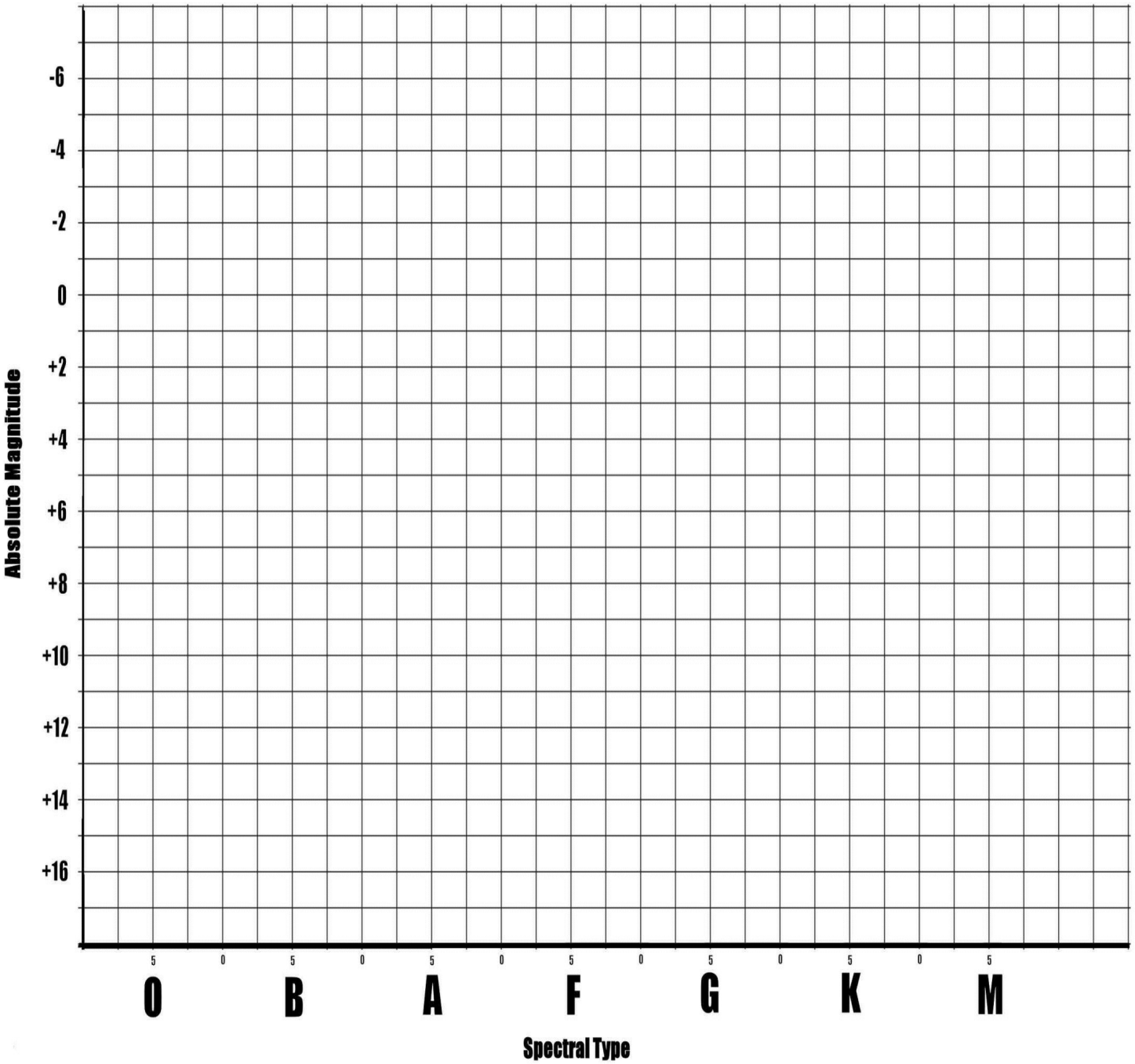
- Label the axes accordingly for the data plotted
- Plot the stars from each data set on the graph in ^{o}C
- Indicate spectral classes across the bottom of the Diagram
- Indicate star colors for the appropriate temperature ranges
- Approximate regions of specific luminosity classes based on representative stars

Brightest Stars from Earth

#	Common Name	Scientific Name	Const.	Distance (LY)	m	M	Spectral Class
A	Sirius	Alpha CMi	Cmi	8.6	-1.46	4.8	A1Vm
B	Canopus	Alpha Car	Car	74	-.72	-2.5	A9II
C	Rigil Kentaurus	Alpha Cen A	Cen	4.3	-.27	4.4	G2V+K1V
D	Arcturus	Alpha Boo	Boo	34	-.04	.2	K1.5IIIp
E	Vega	Alpha Lyr	Lyr	25	.03	.6	A0Va
F	Capella	Alpha Aur	Aur	41	.08	.4	G6III+ G2III
G	Rigel	Beta Ori	Ori	1400	.12	-8.1	B8Iae
H	Procyon	Alpha CMi	CMi	11.4	.38	2.6	F5IV-V
I	Achernar	Alpha Eri	Eri	69	.46	-1.3	B3Vap
J	Betelgeuse	Alpha Ori	Ori	1400	.5 v	-7.2	M2Iab
K	Hadar	Beta Can	Cen	320	.61 v	-4.4	B1III
L	Acrux	Alpha Cru	Cru	510	.76	-4.6	B0.5Iv+ B1Va
M	Altair	Alpha Aql	Aql	16	.77	2.3	A7Va
N	Aldebaran	Alpha Tau	Tau	60	.85 v	-.3	K5III
O	Antares	Alpha Sco	Sco	520	.96 v	-5.2	M1.5Iab
P	Spica	Alpha Vir	Vir	220	.98 v	-3.2	B1V
Q	Pollux	Beta Gem	Gem	40	1.14	.7	K0IIIb
R	Fomalhaut	Alpha PsA	PsA	22	1.16	2.0	A3Va
S	Becrux	Beta Cru	Cru	460	1.25 v	-4.7	B0.5III
T	Deneb	Alpha Cyg	Cyg	1500	1.25	-7.2	A2Ia
U	Regulus	Alpha Leo	Leo	69	1.35	-.3	B7Va
V	Adhara	Epsilon CMa	CMa	570	1.5	-4.8	B2II
W	Castor	Alpha Gem	Gem	49	1.57	.5	A1V+ A2V
X	Gacrux	Gamma Cru	Cru	120	1.63 v	-1.2	M3.5III
Y	Shaula	Lambda Sco	Sco	330	1.63 v	-3.5	B1.5IV

Stars Nearest Earth

#	Common Name	Scientific Name	Const.	Distance (LY)	m	M	Spectral Class
1	Proxima Centauri	V645 Cen	Cen	4.2	11.05 v	4.8	M5.5Vc
2	Rigil Kentaurus	Alpha Cen A	Cen	4.3	-.01	4.4	G2V
3		Alpha Cen B	Cen	4.3	1.33	5.7	K1V
4	Barnard's Star	Ross 858	Oph	6.0	9.54	13.2	M3.8V
5	Wolf 359	CN Leo	Leo	7.7	13.5 v	16.7	M5.8Vc
6	Lalande 21185	BD+36 2147	UMa	8.2	7.5	10.5	M2.1Vc
7	Luyten 726-8A	UV Cet A	Cet	8.4	12.5 v	15.5	M5.6Vc
8	Luyten 726-8B	UV Cet B	Cet	8.4	13.0 v	16.0	M5.6Vc
9	Sirius A	Alpha CMa A	CMa	8.6	-1.46	1.4	A1Vm
10	Sirius B	Alpha CMa B	CMa	8.6	8.3	11.2	DA2
11		Ross 154	Sgr	9.4	10.45	13.1	M3.6Vc
12		Ross 248	And	10.4	12.29	14.8	M4.9Vc
13	Epsilon Eridani	Epsilon Eri	Eri	10.8	3.73	6.1	K2Vc
14		Ross 128	Vir	10.9	11.1	13.5	M4.1V
15	61 Cygni A	61 Cyg A	Cg	11.1	5.2 v	7.6	K3.5Vc
16	61 Cygni B	61 Cyg B	Cyg	11.1	6.0	8.4	K4.7Vc
17		Epsilon Ind	Ind	11.2	4.68	7.0	K3Vc
18	Groombridge 34	BD +43 44 A	And	11.2	8.08	10.4	M1.3Vc
19		BD +43 44 B	And	11.2	11.06	13.4	M3.8Vc
20		Luyten 789-6	Aqr	11.2	12.18	14.5	M6
21	Procyon A	Alpha Cmi A	CMi	11.4	.38	2.6	F5IV-V
22	Procyon B	Alpha Cmi B	CM1	11.4	10.7	13.0	DA6
23		BD +59 1915 A	Dra	11.6	8.9	11.2	M3.0V
24		BD +59 1915 B	Dra	11.6	9.69	11.9	M3.5V
25		CoD -36 15693	Gru	11.7	7.35	9.6	M1.3Vc


-6
-4
-2
0
+2
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+10
+12
+14
+16
Absolute Magnitude
5 0 5 0 5 0 5 0 5 0 5 0 5
O B A F G K M
Spectral Type

Name_____Date_____Period_____

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Lab Sheet

1. What changes would have occurred to the diagram had Hertzsprung and Russell used apparent magnitude instead of absolute magnitude for the diagram? (Hint: This is not as "easy" as you might first think. Imagine Pick a few stars and hypothetically plot them to find the answer.)

2. Several binary star systems are included in both lists for this lab. They can be identified by two unique spectral classes for a "single" star or are listed as "A" and "B"). Although such a small set of examples can hardly be considered enough for a true comparison, look at the spectral classes of the binary stars on the charts. Is there any relationship between the two partners?

3. Chart the sun on the HR Diagram (spectral class G2V, m=4.8). How does it compare to the "stars nearest earth" and also the "brightest stars from Earth"?

4. ***Mathematically*** compare the luminosity of the stars Rigel, Spica and Betelgeuse to the Sun. (Consult notes Stellar Astronomy 3 for luminosity patterns). In other words, *how much* brighter is one star from the others?

5. Although they are still classified as stars, why are brown dwarfs not charted on the HR Diagram? (Consult notes Stellar Astronomy 4 or an independent source to figure this out).