UNIVERSE

INTERSTELLAR CHARTS

FIRST EDITION

STARS WITHIN 30LY OF SOL

STAR SYSTEM	STAR	X	Y	Z	SC	LY	PP
36 Ophiuchi	36 Ophiuchi a	-4	-16	-8	K0	18	
36 Ophiuchi	36 Ophiuchi b	-4	-16	-8	dK1	18	
36 Ophiuchi	36 Ophiuchi c	-4	-16	-8	K5	18	*
41 Arae	41 Arae a	-3	-18	-19	G8	26	R
41 Arae	41 Arae b	-3	-18	-19	M0	26	
61 Cygni	61 Cygni a	+6	-6	-7	K5	11	R
61 Cygni	61 Cygni b	+6	-6	+7	K7	11	R
61 Ursae Majoris	61 Ursae Majoris	-24	+2	+17	G8	29	*
61 Virginis	61 Virginis	-26	-9	-9	G6	29	*
70 Ophiuchi	70 Ophiuchi a	0	-16	+1	K0	16	
70 Ophiuchi	70 Ophiuchi b	0	-16	+1	K5	16	
82 Eridani	82 Eridani	+10	+11	-14	G5	20	*
AC +17°	AC +17°	+16	-13	+7	dM4	22	
AC +18°	AC +18°	-2	-23	+8	dM1	24	
AC +23°	AC +23°	-19	+5	+9	M3	22	*
AC +3°	AC +3°	+26	+12	+2	dM2	29	
AC +48°	AC +48°	-7	-15	+19	dM3	25	
AC +65°	AC +65°	+7	-9	+24	dM3	27	
AC +66°	AC +66°	-11	-2	+26	M4	28	*
AC +79°	AC +79°	-3	0	+16	dM4	16	
AD Leonis	AD Leonis	-13	+6	+5	M4	15	*
Alpha Centauri	Alpha Centauri a	-2	-1	-4	G2	5	R
Alpha Centauri	Alpha Centauri b	-2	-1	-4	dK5	5	
Alpha Centauri	Proxima Centauri	-2	-1	-4	M5	5	
Alpha Mensae	Alpha Mensae	0	+8	-29	G5	30	*
Altair	Altair	+7	-14	+2	A7	16	*
Barnard's Star	Barnard's Star	0	-6	0	M5	6	*
BD +11°	BD +11°	-25	-10	+5	M1	27	*
BD +15°	BD +15°	+20	-6	+6	dM2	22	
BD +2°	BD +2°	-4	-26	+1	K7	26	*
BD +32°	BD +32° a	+6	-21	+14	dM4	26	
BD +32°	BD +32° b	+6	-21	+14	M5	26	
BD +33°	BD +33°	-8	-22	+15	K7	28	*
BD +4°	BD +4°	+22	+4	+2	K2	22	*
BD +45°	BD +45° a	-3	-14	+15	M3	21	
BD +45°	BD +45° b	-3	-14	+15	M3	21	
BD +46°	BD +46°	-17	-8	+20	dM2	27	
BD +50°	BD +50°	-8	+4	+11	dM0	14	
BD +53°	BD +53° 1320	-9	+8	+16	M0	20	R
BD +53°	BD +53° 1321	-9	+8	+16	M0	20	R
BD +53° 935	BD +53° 935	+2	+17	+23	M1	29	*
BD +56°	BD +56°	+12	-3	+18	K3	22	*
BD +6°	BD +6° a	+17	+13	+2	K3	21	*
BD +6°	BD +6° b	+17	+13	+2	M4	21	
BD +61°	BD +61°	+8	-8	+21	dM2	24	
BD +63°	BD +63°	+12	+6	+26	K0	29	*
BD +68°	BD +68°	-1	-6	+14	M3	15	*
BD -1°	BD -1°	-23	+10	0	dM2	25	
Beta Comae	Beta Comae	-23	-7	+13	G0	27	*
Beta Hydri	Beta Hydri	+4	0	-21	G2	21	*
Canis Minoris	Canis Minoris	-9	+20	+1	dM4	22	
CC 658	CC 658	-6	0	-13	DA	14	
CD +21°	CD +21° a	+13	-5	-5	dM2	15	
CD +21°	CD +21° b	+13	-5	-5	M	15	
CD +36° 15	CD +36° 15	+9	-2	-7	M2	12	*
CD -11°	CD -11°	-16	-12	-4	M4	20	*
CD -12°	CD -12°	-5	-12	-3	dM4	13	
CD -13°	CD -13°	+14	+17	-6	dK0	23	
CD -18°	CD -18°	+24	+15	-9	M3	30	*
CD -20°	CD -20° a	-13	-12	-7	dK5	19	
CD -20°	CD -20° b	-13	-12	-7	dM2	19	
CD -21°	CD -21°	-1	+18	-7	dM2	19	
CD -21°	CD -21°	+6	+23	-9	dM1	25	
CD -24°	CD -24°	-9	-20	-10	dM2	24	
CD -27°	CD -27°	+14	-21	-13	K0	28	*
CD -3° (Alpha)	CD -3°	+3	+20	-1	M1	20	*
CD -3° (Beta)	CD -3°	0	-24	-1	dM2	24	
CD -31°	CD -31°	+17	-20	-16	dM2	31	
CD -32°	CD -32° a	+15	-18	-15	dM4	28	
CD -32°	CD -32° b	+15	-18	-15	dM4	28	
CD -34°	CD -34° a	-4	-19	-14	K3	24	
CD -34°	CD -34° b	-4	-19	-14	K4	24	
CD -34°	CD -34° c	-4	-19	-14	M2	24	
CD 36° 13	CD +36° 13 a	+8	-13	-12	K3	19	R
CD 36° 13	CD +36° 13 b	+8	-13	-12	M5	19	
CD -37°	CD -37° a	-9	-19	-16	M4	26	
CD -37°	CD -37° b	-9	-19	-16	M7	26	
CD -39°	CD -39°	+7	-7	-8	M0	13	*
CD -40°	CD -40°	-9	-12	-13	M4	20	*
CD -44°	CD -44°	-1	-11	-11	M5	16	*
CD -44°	CD -44° a	-5	+21	-21	M4	30	
CD -44°	CD -44° b	-5	+21	-21	M4	30	
CD -45°	CD -45°	+8	-12	-15	M0	21	*
CD -46°	CD -46°	-2	-10	-11	M4	15	*
CD -49°	CD -49°	+8	-6	-12	M3	16	*
CD -51 6	CD -51 6	-17	-3	-22	M3	28	*
CD -51° 5	CD -51° 5	-18	+1	-22	K0	28	*
CD -59°	CD -59°	-9	+8	-21	M0	24	*
CD -7°	CD -7°	-14	-16	-3	dM5	21	
CD -8°	CD -8° a	-6	-20	-3	dM3	21	
CD -8°	CD -8° b	-6	-20	-3	M4	21	R
Chara	Chara	-22	-3	+20	G0	30	*
Chi Draconis	Chi Draconis	+1	-8	+26	F7	27	*
Cincinnati	Cincinnati	+12	0	-9	dM3	15	
Delta Eridani	Delta Eridani	+17	+24	-5	K0	30	*
Delta Pavonis	Delta Pavonis	+4	-7	-18	G8	20	*
DQ Pegasi	DQ Pegasi a	+21	-3	+8	M4	23	
DQ Pegasi	DQ Pegasi b	+21	-3	+8	M6	23	
Epsilon Eridani	Epsilon Eridani	+6	+8	-2	K2	10	*
Epsilon Indi	Epsilon Indi	+5	-3	-10	K5	12	*
Eta Cassiopeiae	Eta Cassiopeiae a	+10	+2	+15	G0	18	R
Eta Cassiopeiae	Eta Cassiopeiae b	+10	+2	+15	dM0	18	
EV Lacertae	EV Lacertae	+10	-4	+11	dM5	15	
Fomalhaut A	Fomalhaut A	+19	-5	-11	A3	23	*
Fomalhaut B	Fomalhaut B	+22	-6	-14	K5	27	*
Gamma Leporis	Gamma Leporis a	+2	+25	-10	F6	27	R
Gamma Leporis	Gamma Leporis b	+2	+25	-10	K5	27	R
Gamma Pavonis	Gamma Pavonis	+9	-8	-27	F8	30	*
Groombridge	Groombridge 34 a	+8	+1	+8	M1	11	*
Groombridge	Groombridge b	+8	+1	+8	M6	11	*
Inne's Star	Inne's Star	-5	+1	-8	dM	9	
Jim	Jim	+6	-18	+2	M3	19	R
Jim	Joe	+6	-18	+2	dM4	19	
Kapteyn's Star	Kapteyn's Star	+2	+9	-9	M0	13	*
Kied	Kied a	+7	+14	-2	K1	16	*
Kied	Kied b	+7	+14	-2	DA	16	
Kied	Kied c	+7	+14	-2	dM4	16	
Kruger 60	Kruger 60 a	+6	-3	+11	dM3	13	
Kruger 60	Kruger 60 b	+6	-3	+11	dM4	13	
Lalande	Lalande	-6	+2	+5	M2	8	*
Lalande 46650	Lalande 46650	+20	-1	+1	M2	20	*
Lelande 25372	Lelande 25372	-14	-7	+4	M4	16	*
LFT 1729	LFT 1729	+10	-4	-3	dM6	11	
LFT 1747	LFT 1747	+7	-2	-27	K6	28	*
LFT 1849	LFT 1849	+19	0	-18	DA5	26	
LFT 215	LFT 215	+18	+14	+11	M6	25	*
LFT 507	LFT 507	-6	+22	-2	M6	23	*
LFT 543	LFT 543	-8	+17	-6	DF	20	
LFT 543	LFT 544	-8	+17	-6	M5	20	
LFT 598	LFT 598	-17	+21	-12	M6	30	*
LFT 661	LFT 661	-21	+15	-10	K6	28	*
LFT 698	LFT 698	-26	+14	-1	dM0	30	
Luyten 347-14	Luyten 347-14	+4	-13	-14	M7	20	*
Luyten 674-15	Luyten 674-15	-10	+15	-7	M6	19	*
Luyten 68-28	Luyten 68-27	-7	-1	-20	M	21	
Luyten 68-28	Luyten 68-28	-7	-1	-20	M	21	*
Luyten 97-12	Luten 97-12	-3	+6	-18	DF	19	
Luyten's Star	Luyten's Star	-4	+12	+1	dM4	13	
Mu Cassiopeiae	Mu Cassiopeiae	+13	+4	+20	dG5	24	
Mu Herculis	Mu Herculis a	-2	-25	+13	G5	28	*
Mu Herculis	Mu Herculis b	-2	-25	+13	M4	28	
Mu Herculis	Mu Herculis c	-2	-25	+13	M4	28	
Orionis	Orionis	+8	+25	+3	F6	26	*
Piscium	Piscium	+21	+10	+8	K1	25	*
Procyon	Procyon a	-5	+10	+1	F5	11	
Procyon	Procyon b	-5	+10	+1	DF	11	
Rho Eridani	Rho Eridani a	+11	+5	-18	K2	22	R
Rho Eridani	Rho Eridani b	+11	+5	-18	K2	22	R
Ross 128	Ross 128	-11	+1	0	dM5	11	
Ross 154	Ross 154	+2	-8	-4	dM4	9	
Ross 248	Ross 248	+7	-1	+7	dM6	10	
Ross 41	Ross 41	+4	+29	+5	M5	30	*
Ross 47	Ross 47	+2	+19	+4	dM4	20	
Ross 558	Ross 558	+17	+15	+11	dM4	25	
Ross 614	Ross 614 a	-2	+13	-2	dM4	13	
Ross 614	Ross 614 b	-2	+13	-2	M	13	
Ross 619	Ross 619	-11	+18	+3	dM5	21	
Ross 64	Ross 64	-2	+25	+11	M6	27	*
Ross 730	Ross 730	+7	-25	+10	dM2	28	
Ross 730	Ross 731	+7	-25	+10	dM2	28	
Ross 780	Ross 780	+14	-4	-4	dM5	15	
Ross 986	Ross 986	-4	+14	+12	dM5	19	
Sigma Draconis	Sigma Draconis	+3	-6	+17	K0	18	*
Sirius	Sirius a	-2	+8	-2	A1	8	
Sirius	Sirius b	-2	+8	-2	DA5	8	
Sol	Sol	0	0	0	G2	0	*
Struve	Struve a	+1	-6	+10	dM4	12	
Struve	Struve b	+1	-6	+10	dM5	12	
SZ Ursae Majoris	SZ Ursae Majoris	-11	+2	+26	M1	28	*
Tau Ceti	Tau Ceti	+10	+5	-3	G8	12	*
The Flying Star	The Flying Star	-22	+1	+17	dG8	28	
UC 48	UC 48	-1	-11	-16	M6	19	*
UV Ceti	UV Ceti a	+7	+3	-2	dM6	8	
UV Ceti	UV Ceti b	+7	+3	-2	dM6	8	
Van Maanen's Star	Van Maanen's Star	+13	+3	+1	DF3	13	
Vega	Vega	+3	-20	+17	A0	26	*
Wolf 294	Wolf 294	-3	+16	+11	dM4	20	
Wolf 358	Wolf 358	-22	+7	+3	dM5	23	
Wolf 359	Wolf 359	-7	+2	+1	dM6	7	
Wolf 424	Wolf 424 a	-14	-2	+2	M7	14	
Wolf 424	Wolf 424 b	-14	-2	+2	M7	14	
Wolf 489	Wolf 489	-23	-10	+2	DG8	25	
Wolf 562	Wolf 562	-10	-12	-2	M6	16	*
Wolf 629	Wolf 629	-6	-19	-3	dM4	20	
Wolf 922	Wolf 922	+20	-15	-4	dM4	25	
WX Ursae Majoris	WX Ursae Majoris a	-13	+4	+13	M2	19	R
WX Ursae Majoris	WX Ursae Majoris b	-13	+4	+13	dM5	19	
Xi Bootis	Xi Bootis A	-16	-14	+7	G8	22	
Xi Bootis	Xi Bootis B	-16	-14	+7	dK5	22	
Xi Ursae Majoris	Xi Ursae Majoris a	-23	+4	+14	G0	27	
Xi Ursae Majoris	Xi Ursae Majoris b	-23	+4	+14	G0	27	
Zeta Tucanae	Zeta Tucanae	+10	+1	-22	G0	24	*

CONTENTS

INTRODUCTION

The **UNIVERSE: Interstellar Charts** are 16 star charts displaying stellar location and other data for stars located within a 30 light year radius of the Sol system. The charts have been designed to be used in conjunction with *Universe*, The science fiction role playing game of the future; Copyright © Simulations Publications Inc 1981.

Origins

UNIVERSE: Interstellar Charts began with a desire for a more manageable format for star maps to use alongside SPI's Universe Science Fiction Role Playing Game printed in 1981.

The *"Universe Interstellar Display"* Copyright © Simulations Publications Inc 1981, was full colour, A0 format, poster sized map, and was one of the first if not, the only star map in publication for use in role playing games, which used actual star data in a three dimensional presentation.

While the Universe Interstellar Display was impressive in itself, it had two drawbacks for Game Masters. Firstly, its sheer size made it difficult to work with during planning and game sessions and secondly, map sections were not easily photocopied for game notes, because of its size and it's predominant use black for background colour.

UNIVERSE: Interstellar Charts takes the A0 wall poster format of the original Universe Interstellar Display and breaks it down into easier to manage A4 landscape pages. The coordinate system is the same as the Universe Interstellar Display, a slice of 60 light years (+30LY to -30LY) is taken along the Z axis, while the X and Y axis are presented in 15LY square sections. The colours used on the charts identical to the original display but are designed to be photocopied so individual charts can be used for notation and hand outs.

Additionally, each of the 16 charts have Star Data Notation showing their Star System name, X, Y and Z Coordinates, Spectral Type and Planet Potential making this easier to calculate distances from one star to another.

UNIVERSE: Interstellar Charts are a faithful reproduction of SPI's original 1981 Universe Interstellar Display, retaining consistency with the original Interstellar Display.

UNIVERSE: Interstellar Charts focus on the stars and data presented on the Universe Interstellar Display and expands on descriptions and data in the documentation where possible. Though these charts have been created primarily as an aid to playing *Universe*, the stars, their data and the information contained in *UNIVERSE: Interstellar Charts* is factual and up to date and can be used by anyone with an interest in the stars.

Inside Front Cover: 3D representation of stars within 20LY of Sol, H-R diagram and visual display of the evolution of stars.

Inside Back Cover: Spectral class data and Stellar scale chart.

The Interstellar Charts

Universe: Interstellar Charts contain the following on each chart:

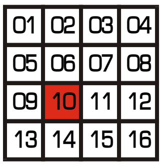


Chart Location Grid

Located at the top right of each chart is a small grid display of 16 boxes measuring 4 x 4 squares. This grid is a small representation of the entire area represented by the Universe: Interstellar Charts. The Sol System is located in the exact centre of the Chart Location Grid.

Each grid square has a number, which relates to an individual interstellar chart, the chart grid being viewed is coloured red and this way it is easy to locate which charts are adjacent to the one currently being viewed.

CHART 10

UNIVERSE: INTERSTELLAR CHARTS

X 00 to –15, Y 00 to –15, Z +30 to -30

Chart Identifier

The chart identifier shows the Chart Number, the title of the collection “Universe: Interstellar Charts” and the chart’s area range in typical **X**, **Y**, **Z** Cartesian coordinates which use the Sol System as the Origin Point.

Universe: Interstellar Charts cover the following areas:

Chart	X Range	Y Range	Z Range
1	X -15 to -30,	Y +15 to +30,	Z +30 to -30
2	X 00 to -15,	Y +15 to +30,	Z +30 to –30
3	X 00 to +15,	Y +15 to +30,	Z +30 to –30
4	X +15 to +30,	Y +15 to +30,	Z +30 to –30
5	X -15 to -30,	Y 00 to +15,	Z +30 to -30
6	X 00 to -15,	Y 00 to +15,	Z +30 to -30
7	X 00 to +15,	Y 00 to +15,	Z +30 to -30
8	X +15 to +30,	Y 00 to +15,	Z +30 to –30
9	X -15 to -30,	Y 00 to -15,	Z +30 to -30
10	X 00 to -15,	Y 00 to -15,	Z +30 to –30
11	X 00 to +15,	Y 00 to -15,	Z +30 to –30
12	X +15 to +30,	Y 00 to -15,	Z +30 to –30
13	X -15 to -30,	Y -15 to -30,	Z +30 to –30
14	X 00 to -15,	Y -15 to -30,	Z +30 to -30
15	X 00 to +15,	Y -15 to -30,	Z +30 to –30
16	X +15 to +30,	Y -15 to -30,	Z +30 to -30

To make visualising the are of space each chart represents, imagine a three dimensional rectangle measuring 15 x 15 x 60.

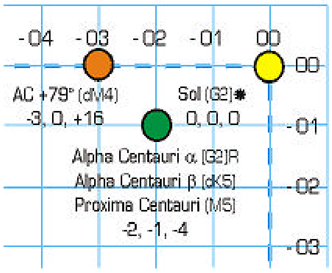
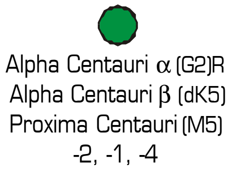


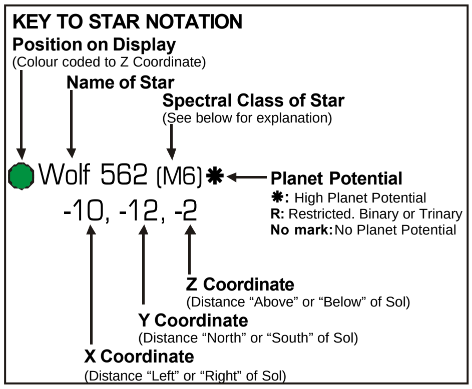
Chart Data

Each chart measures 15 light years to a side. Each grid square measures one light year to a side. A heavy dashed border denotes a region measuring 5 light years to a side. The X axis runs horizontally while the Y axis runs vertically and both are labelled with **X** and **Y**. The Stellar Coordinate System uses the Sol System as the Origin Point (**X 00, Y 00, Z 00**). Stellar Coordinates are noted along the **X** and **Y** axes.



Star System Chart Data

Each star is denoted by a filled colour coded circle.
The Star name, Spectral Type, Planet Potential and its Stellar Coordinate. The example shown is the Alpha Centauri System. This system has three stars present (a Trinary System). This is denoted by the presence of three data entries beside the single star symbol and Stellar Coordinate.



The Key to Star Notation shows Star Data in detail.

STAR	X	Y	Z	SC	LY	PP
AC +48°	-7	-15	+19	dM3	25	
AC +66°	-11	-2	+26	M4	28	✱
AC +79°	-3	0	+16	dM4	16	
Alpha Centauri a	-2	-1	-4	G2	5	R
Alpha Centauri b	-2	-1	-4	dK5	5	
Barnard's Star	0	-6	0	M5	6	✱
BD +45° a [illegible]	-3	-14	+15	M3	21	

Star System Data

The Star System Data is listed alphabetically and contains the individual star name, its **X**, **Y** and **Z** coordinate, its Spectral Class (**SC**), its distance from the Sol System in light years (**LY**) and its Planet Potential (**PP**), for individual stars that appear on the chart.

STAR SYSTEM CHARTS

The Star System Index is a listing of all **Star Systems** and their attendant stars; designated as **A**, **B**, **C** for the first, second and third stars present within the system. **CH** (Chart number) denotes the chart where the star system is located. A star system may appear on more than one chart if its coordinates are on a border. Several star systems share the same name; these systems are designated Alpha, Beta, etc to separate them.

STAR SYSTEM	CH	STAR SYSTEM	CH
36 Ophiuchi ABC	14	**Delta Pavonis**	11
41 Arae AB	14	**DQ Pegasi AB**	12
61 Cygni AB	11	**Epsilon Eridani**	7
61 Ursae Majoris	5	**Epsilon Indi**	11
61 Virginis	9	**Eta Cassiopeiae AB**	7
70 Ophiuchi AB	14/15	**EV Lacertae**	11
82 Eridani	7	**Fomalhaut A**	12
AC +17°	12	**Fomalhaut B**	12
AC +18°	14	**Gamma Leporis AB**	3
AC +23°	5	**Gamma Pavonis**	11
AC +3°	5/8	**Groombridge 34 AB**	7
AC +48°	10/14	**Inne's Star**	6
AC +65°	11	**Jewel CD -44°**	10
AC +66°	10	**Jim AB**	15
AC +79°	6/10	**Kapteyn's Star**	7
AD Leonis	6	**Kied ABC**	7
Alpha Centauri ABC	10	**Kruger 60 AB**	11
Alpha Mensae	6/7	**Lalande**	6
Altair	11	**Lalande 46650**	12
Barnard's Star	10/11	**Lelande 25372**	10
BD +11°	9	**LFT 1729**	11
BD +15°	12	**LFT 1747**	11
BD +2°	14	**LFT 1849**	8/12
BD +32° AB	15	**LFT 215**	8
BD +33°	14	**LFT 507**	2
BD +4°	8	**LFT 543/544**	2
BD +45° AB	10	**LFT 598**	1
BD +46°	9	**LFT 661**	1/5
BD +50°	6	**LFT 698**	5
BD +53° AB	6	**Luyten 347-14**	11
BD +53° 935	3	**Luyten 674-15**	2/6
BD +56°	11	**Luyten 68 AB**	10
BD +6° AB	8	**Luyten 97-12**	6
BD +61°	11	**Luyten's Star**	6
BD +63°	7	**Mu Cassiopeiae**	7
BD +68°	10	**Mu Herculis ABC**	14
BD -1°	5	**Orionis**	3
Beta Comae	9	**Piscium**	8
Beta Hydri	11	**Procyon AB**	6
Canis Minoris	2	**Rho Eridani AB**	7
CC 658	6/10	**Ross 128**	6
CD +21° AB	2/11	**Ross 154**	11
CD +36° 15	11	**Ross 248**	11
CD -11°	9	**Ross 41**	3
CD -12°	10	**Ross 47**	3
CD -13°	3	**Ross 558**	4/8
CD -18°	4/8	**Ross 614 AB**	6
CD -20° AB	10	**Ross 619**	2
CD -21° (Alpha)	3	**Ross 64**	2
CD -21° (Beta)	2	**Ross 730/1**	15
CD -24°	14	**Ross 780**	11

STAR SYSTEM	CH	STAR SYSTEM	CH
CD -27°	15	**Ross 986**	6
CD -3° (Alpha)	3	**Sigma Draconis**	11
CD -3° (Beta)	14/15	**Sirius AB**	6
CD -31°	16	**Sol**	6/7/10/11
CD -32° AB	15/16	**Struve AB**	11
CD -34° ABC	14	**SZ Ursae Majoris**	6
CD +36° 15	11	**Tau Ceti**	7
CD -36° AB	11	**The Flying Star**	5
CD -37° AB	14	**UC 48**	10
CD -39°	11	**UV Ceti AB**	7
CD -40°	10	**Van Maanen's Star**	7
CD -44° (Alpha)	10	**Vega**	15
CD -44° AB (Beta)	2	**Wolf 294**	2
CD -45°	11	**Wolf 358**	5
CD -46°	10	**Wolf 359**	6
CD -49°	11	**Wolf 424 AB**	10
CD -51° 6	9	**Wolf 489**	9
CD -51° 5	5	**Wolf 562**	10
CD -59°	6	**Wolf 629**	14
CD -7°	14	**Wolf 922**	12/16
CD -8° AB	14	**WX Ursae Majoris AB**	6
Chara	9	**Xi Bootis AB**	9
Chi Draconis	11	**Xi Ursae Majoris AB**	5
Cincinnati	7/11	**Zeta Tucanae**	7
Delta Eridani	4		

The Greek Alphabet

The Greek alphabet is used as a suffix to star names that share the same star system. An example of this are the two stars Alpha Centauri A and Alpha Centauri B sharing the Alpha Centauri System, these are noted as: Alpha Centauri **a** (alpha, the first star) and Alpha Centauri **b** (Beta, the second star).

Letter	English	Letter	English
a	alpha	n	nu
b	beta	x	xi
g	gamma	o	omicron
d	delta	p	pi
e	epsilon	r	rho
z	zeta	s	sigma
h	eta	t	tau
q	theta	u	upsilon
i	iota	f	phi
k	kappa	c	chi
l	lambda	y	psi
m	mu	v	omega

DEFINING STARS

The category to which a star is assigned depends on the characteristics of its spectrum. The current classification scheme (see **Main Sequence Spectral Types**) of stellar spectra consists of seven main groups which form a temperature sequence. From hottest to coolest they are: **O**, **B**, **A**, **F**, **G**, **K**, and **M**. Each class is characterized by the appearance of certain types of spectral lines and is further subdivided into 10 sub-classes numbered from 0 to 9. Sol (our sun), for example, is assigned the spectral class G2, corresponding to a surface temperature of about 5,700°C. Other spectral characteristics, such as the presence of emission lines, are indicated by an additional small letter placed after the spectral type (see **Non Standard Spectral Features**).

It was realized that stars of a particular spectral type could differ widely in luminosity and as a result, a system of luminosity classification were developed (see **Luminosity Classes**).

Main Sequence Spectral Types

Type	Features of Spectrum	Temp. (°C)	Colour
O	Both emission and absorption lines of ionized helium and other highly ionized ions of light elements	30,000 - >50,000	Bluish-white
B	No emission lines. Absorption line of ionized helium disappears after B5. Neutral helium reaches a max. at B2. Hydrogen becomes more prominent	9,400 - 30,000	Bluish-white or white
A	Neutral hydrogen lines dominant	6,900 - 9,400	White
F	Many lines of neutral and singly-ionized metals such as calcium, iron, chromium, and titanium	5,800 - 6,900	White or yellowish white
G	Lines of neutral metals dominate	4,200 - 5,200	yellow giants
		5,000 - 5,800	yellow main-sequence
K	Increasing numbers of lines of neutral metals and bands due to molecules such titanium oxide	3,200 - 4,600	orange giants
		3,600 - 5,000	orange main-sequence
M	Numerous neutral metal lines and prominent molecular bands	<3,000	red giants
		<3,600	red main-sequence

Luminosity Class

A star's full spectral classification includes a 'luminosity class', a Roman numeral from I to VII indicating the star's luminosity, which correlates with its mass. The luminosity class is simply appended to the spectral class. For example, Sol's full spectral classification, including its luminosity class, is G2V. The seven luminosity classes are listed below.

I	**Super Giants:** Extremely massive and luminous stars, usually nearing the end of their lifespan. They are sub-classified as Ia or Ib, with Ia representing the most luminous stars of all. Examples include Rigel (B8Ia), Betelgeuse (M2Ib) and Antares (M1Ib).
II	**Bright Giants:** A relatively uncommon group of giant stars which are particularly luminous, and can be a thousand times more than the Sun. Examples include Adara (B2II), Sargas (F1II) and Kraz (G5II).
III	**Normal Giants:** The giant stars in this category are typically a hundred times more luminous than Sol and considerably more massive. Examples of this populous group include Arcturus (K2III), Agena (B1III) and Aldebaran (K5III).
IV	**Sub-Giants:** Though still far more massive and luminous than Sol, sub-giants fall short of true giants. Examples include Acrux (B0.5IV), Shaula (B1.5IV) and Miaplacidus (A2IV).
V	**Dwarfs:** A very numerous class of main sequence star, whose mass and luminosity is generally comparable with that of the Sol. Examples include Sirius (A0V), Alpha Centauri (G2V) and Vega (A0V).
VI & VII	These classes designate sub-dwarfs and white dwarfs, respectively. They are not now in common use, but are included here for completeness.

Non-Standard Spectral Features

Spectral classifications sometimes carry notations which are lower case letters added before or after the main type. For example, the full spectral classification for Achernar is B3Vp, with 'p' indicating that it has a peculiar spectrum..

Designation	Feature
c	sharp lines
d	dwarf star
e	emission lines of hydrogen
f	emission lines of helium and neon
g	giant
k	interstellar lines
m	emission lines of metals
n	diffuse lines
p	peculiar spectrum
s	sharp lines
sd	subdwarf
v	variable
wd	white dwarf
wk	weak lines

STELLAR DESIGNATIONS

Some background notes to do with Star names and designations.

The origin of AC designation:

The Astrographic Catalogue (AC) was part of the international Carte du Ciel designed to photograph and measure the positions of all stars brighter than magnitude 11.0. (Actually, the brightest stars are missing due to their images being grossly over-exposed and, therefore, not being measured). In total, over 4.6 million stars were observed, many as faint as 13th magnitude. This project was started in the late 1800s; most observations were made between 1895 and 1920. To observe the entire celestial sphere without burdening only a handful of institutions, the sky was divided among 20 observatories, by declination zones. Each observatory exposed and measured the plates of its zone, subsequently publishing the plate measures.

The origin of BD designation:

The designation of stars with a prefix of BD comes from a catalogue that was originally published in 1863 by Friedrich Wilhelm August Argelander (1799-1875) on the position and brightness of 324,198 stars between +90° and -2° declination that were measured over 11 years from Bonn, Germany with his assistants Eduard Schönfeld (1828-1891) and Aldalbert Krüger (1832-1896). The catalogue became famous as the Bonner Durchmusterung ("Bonn Survey") and is typically abbreviated as BD. It was later expanded and extended during the early 20th Century with the Cordoba (observed from Argentina) then the Cape Photographic Durchmusterung (observed from South Africa).

The origin of CD designation:

The designation of stars with a prefix of CD came from a visual survey of southern stars begun in 1892 at the Astronomical Observatory of Cordoba in Argentina under the direction of its second director John M. Thome (1843-1908). Thome died before the completion of this southern sky atlas in 1914, when 578,802 stars from declination -22° to -90° were published as the Cordoba Durchmusterung ("Survey").

The "CD" is an extension of an older catalogue by Friedrich Wilhelm August Argelander (1799-1875) in 1863 on the position and brightness of 324,198 stars between +90° and -2° declination that were measured over 11 years from Bonn, Germany, made with his assistants Eduard Schönfeld (1828-1891) and Aldalbert Krüger (1832-1896), which became famous as the Bonner Durchmusterung ("Bonn Survey") abbreviated as BD. The BD and CD were greatly expanded and extended into the modern age of photographic surveys with the subsequent creation of the Cape Photographic Durchmusterung from South Africa.

SPECTRAL TYPE DATA

Universe: Interstellar Charts are only concerned with the following Main Sequence Spectral Classes: **A F G K M** and two Dwarf Star types: **d** Red Dwarfs and **D** White Dwarfs, stars, which appear on the charts. Spectral Classes outside of these types have been omitted.

Each of the spectral types discussed show the general characteristics followed by notes and an example of a star with a matching spectral class.

General Characteristics include:

Spectral Type: The letter designation for the spectral class.

Colour: A description of the star's colour.

Temperature: The surface temperature of the star in degrees Kelvin.

Radius (Sol = 1): The radius of the star in comparison to Sol.

Mass (Sol = 1): The mass of the star in comparison to Sol.

Luminosity (Sol = 1): The luminosity of the star in comparison to Sol.

Luminosity Class: A range between I to VII.

Life (Million years): The life span of the star measured in millions of years.

Abundance: The abundance of the star in relation to the galaxy.

Biosphere: Biospheres are defined as areas of space surrounding a star, which offer conditions needed to support Earth-type life, or more specifically the conditions in which water in its liquid state may exist. Earth-type life, is life, which depends on liquid water for survival. A biosphere is measured in AU from it's hot inner to it's cool outer edge.

Planet Potential: The potential for this type of star to have planets, based on the original 1981 Universe Interstellar Display. Planet Potential is related to the age of the star, where planets have had time to form.

Stellar Gravity Well: The Stellar Gravity Well, or "Max Safe Jump Point" is measured in AUs from the star's plane of the ecliptic, this is the maximum safe distance a spacecraft must be to execute a jump safely. To find the correct Safe Jump Point distance, subtracted the distance the spacecraft is from the star in AUs from the Stellar Gravity Well. The Stellar Gravity Well is also the outer extent of a dust and particle clouds associated with planetary systems. For the Sol system this is the Oort Cloud, home of comets, planetesimals, icy bodies and other debris left over from the formation of the planets and real hazard when negotiating at near relativistic speeds.

If the method of travelling from one star to another can be interfered with by gravity or particle debris, then the Stellar Gravity Well sets the safe jump point for interstellar navigation.

STELLAR NOTES

A selection of helpful information associated with **UNIVERSE: Interstellar Charts**.

Calculating Distances from Star to Star

Subtract the **x** coordinate of the Destination Star from the **X** coordinate of the Origin Star, then square the result. Repeat this for the other coordinates (**y – Y** and **z – Z**) and sum the result. Then take the square root of this sum to find the distance in Light Years between the Origin and Destination stars. The formula for this procedure is shown below:

$$\textbf{Distance in Light Years} = \sqrt{(X - x)^2 + (Y - y)^2 + (Z - z)^2}$$

Planet Potential

Planet Potential refers to planets within the world size ranges of **0** to **9** and excludes the presence of potential asteroid and Kuiper belts, dust rings, Oort clouds and **9+** or larger worlds such as Gas Giants along with any moons forming world systems that may be orbiting them. Discoveries have been made of 'useful' worlds, which orbit some stars listed on the charts as having 'No Planet Potential'. Calculating a world's orbital period (or year length) around its parent star is shown below:

$$\textbf{Planet Year} = (\text{Average Orbit AUs})^3 \div (\text{Solar Mass})$$

Planet Year: the result is measured in Earth Years.

Average Orbit AUs: refers to the average orbit of the planet orbiting the parent star measured in AUs.

Solar Mass: refers to the parent star's mass relative to the mass of Sol, i.e. Sol = 1.

Spheres of Development

Spheres of Development set in the 24th Century describe the scale of human endeavour taking place outward from the Sol System in broad terms. Colonization and exploration are all but established for the majority of star systems closest to Sol, with discoveries and activity diminishing as the distance from Sol increases.

The Established Sphere: 0LY to 10LY
Established colonies, trade routes, and intense exploration.

The Pioneer Sphere: 10LY to 20LY
Developing colonies, active exploration.

The Frontier Sphere: 20LY to 30LY
Research Outposts, limited exploration. Limit of expeditions.

Exceptions: Sixty cubic Light Years of space has a big potential for exceptions. Instances of a secluded colony in "The Frontier Sphere" or an uncharted world in "The Established Sphere" are almost certainties. Further more there is always the potential to locate uncharted systems which have some how remained undiscovered for a variety of reasons. Dark systems, worlds orbiting a star with no or a very low luminosity, proto stars or Brown Dwarfs, which have yet to ignite into full stars or rosette worlds which orbit each other without a central star are all possibilities for uncharted systems which are yet to be discovered.

Habitable Star Systems

Currently, our only guide to what type of star is likely to host an Earth-type planet suitable for human habitation without special environmental protection is our own Sun, Sol. A look at the Interstellar Charts, however, quickly reveals that Sol is not like most stars in the Solar neighbourhood. Indeed, Sol appears to have a few special characteristics:

It's a solitary star although most stars have stellar companions, which is fortunate for life on Earth because stable planetary orbits like the Earth's are much more likely around single stars.
It's among the most massive 10 percent of stars in its neighbourhood so that it is not too cool and dim, but also not so massive that it burns out before life has time to develop, evolve, and manufacture an oxygen atmosphere to create an Earth-type planet.

Finally, it appears to have roughly 50 percent more "heavy" elements than other stars of its age and type, but only about a third of their variation in brightness, which is also fortunate because elements heavier than hydrogen are essential to make rocky planets like Earth and large stellar flare-ups can harm planetary life with hard radiation.

Suitable Stars for Earth-type Life

The range of star types that can support Earth-type life on planets may be limited to those lower mass stars that "live" long enough as stable luminous stars for planets to form and complex life to evolve.

Although all main sequence stars generate luminous energy by converting hydrogen into helium through thermonuclear fusion, stars more massive than 1.5 times that of Sol (i.e., stars of spectral type O, B, or A dwarfs like Sirius) age too quickly to support the development of complex Earth-type life. Even the largest suitable stars i.e., spectral type F0 may only be able to support Earth-type life for about two billion years, and so planets in favourable orbits may not have sufficient time to develop complex life on land such as trees. Moreover, within a couple of billion years of a star's birth, comet and asteroid bombardment may still be so intense that living on such planets would be quite risky.

On the opposite extreme, stars with less than half of Sol's mass (e.g., smaller spectral type M dwarfs like Proxima Centauri) are likely to tidally lock planets that are orbiting close enough to have liquid water on their surface too quickly, before life can develop. Tidally locking (or synchronous rotation of the star and planet) may eventually cause the destruction of a life-sustaining atmosphere through condensation on the cold, perpetually dark side of the planet. Moreover, most M type red dwarf stars would tend to sterilize life on a close-orbiting Earth-type planet regularly with large stellar flares. Therefore, a search for habitable planets at nearby main sequence stars that are less massive than spectral type A but more massive than type M ; dwarf stars of types F, G, and K.

Biospheres

Biospheres are defined as areas of space surrounding a star, which offer conditions needed to support Earth-type life, or more specifically the conditions in which water in its liquid state may exist. Earth-type life, is life, which depends on liquid water for survival.

Any rocky planet, or sufficiently large moon that is orbiting within a star's biosphere with other additional factors such as the nature and density of its atmosphere, surface gravity, ultraviolet and other forms of radiation are high candidates for supporting Earth-type life.

The hot inner edge of a biosphere is located at the orbital distance where a planet's water is broken up by stellar radiation into oxygen and hydrogen. On the other extreme, atmospheric carbon dioxide condenses at the cold outer edge of the biosphere, which eliminates a greenhouse warming effect.

A Class Stars

Spectral Type:	A
Colour:	White
Temperature:	8500K
Radius (Sol = 1):	1.7
Mass (Sol = 1):	2
Luminosity (Sol = 1):	20
Luminosity Class:	V
Life (Million years):	1000
Abundance:	0.3%
Biosphere:	1.5 to 5 AU
Planet Potential:	Low
Stellar Gravity Well:	180 AU

Notes for A Class Stars: A bright white star, a spectral type A spectrum is dominated by absorption lines of atomic hydrogen, lines of heavier elements, such as iron, are noticeable at the cooler end of the range.

A type stars on the main sequence have a surface temperature of 6,900 to 9,500°C, a luminosity 7 to 50 times that of the Sun, and a mass of 1.5 to 3 solar masses, where 1 mass is equivalent to Sol.

Since their main sequence lifetime of an A type star is typically only a few hundred million years, it appears they are too short-lived to allow advanced life (or life at all) to evolve on any worlds that might circle around them.

Well-known examples of A Class stars include Sirius, Vega, and Altair.

A type supergiants, such as Deneb, have evolved off the main sequence and have masses up to 16 solar masses, a surface temperature of about 9,400°C, and luminosities over 35,000 times that of Sol.

It is worth noting that Alpha Lyrae or Vega as it is commonly known which has a spectral type of A0V, and 25.3 LY from Sol, is surrounded by a ring of dust reaching out to 80AU.

Example of Star Type A: Sirius

SIRIUS STELLAR DATA:
Type of Star: White.
Spectral Class: A1V.
Distance from Sol: 8.6 Light Years.
Luminosity: 24L.
Mass: 2.2 Solar Masses.
Surface Temperature: 10000 K.
Main Sequence Lifetime: 1 Billion Years.

SIRIUS ENVIRONMENT DATA:
Habitable Zone: 2 - 5AU.
Zone of Stable Planetary Orbits: Max 10AU.
Known Companion: White Dwarf Sirius B (Least Distance 20 AU, 1 Orbit in 49.9 Years)

Sirius: The most prominent A type star is Sirius. It is also the nearest star visible from Europe without a telescope. In winter and spring, Sirius is a cosmic jewel hardly to be missed.

With an age of 300 million years, Sirius is still a very young star, but this time would have been more than sufficient for terrestrial planets to form.

The biosphere of Sirius is very broad, ranging from 2 to about 5 AU. So Sirius might be orbited by three or even four habitable worlds, of course, the term *habitability* might mean creatures of Achaean times as well as complex vertebrates. The latter would have no chance of survival under Sirius, however.

Any terrestrial planet inside the biosphere of Sirius would be a young world, perhaps covered by warm, shallow oceans. If any continents could have formed already, they would be small, uneroded and volcanic.

A thick and very humid atmosphere would shield the planet and a bright, violent sun would dominate the scene.

At the bottom of the oceans, protected from Sirius's sterilizing ultraviolet light, simple forms of bacterial life may find their niche, nourished by hydrothermal vents from the planet's interior.

Any future explorers to this world would need protection from the extreme ultraviolet light radiated from Sirius. Any kind of life on the surface of our hypothetical planet would have died from ultraviolet exposure long before it ever had a chance to evolve.

Sirius will leave the main sequence in only 700 million years at best, destroying any of the planets it may have had. For this reason, stars of type A are routinely excluded from the search for extraterrestrial life.

F Class Stars

Spectral Type:	F
Colour:	White / Yellow
Temperature:	6500K
Radius (Sol = 1):	1.3
Mass (Sol = 1):	1.5
Luminosity (Sol = 1):	4
Luminosity Class:	V
Life (Million years):	5000
Abundance:	1.5%
Biosphere:	1.0 to 2.5 AU
Planet Potential:	Medium
Stellar Gravity Well:	130 AU

Notes for F Class Stars: A white or yellowish-white star of spectral type F spectrum shows strong absorption lines of ionized calcium which are more prominent than the hydrogen lines. Moderately strong lines due to iron and other heavier elements are also in evidence.

Main sequence F type stars, of which Procyon is an example, have a surface temperature of 5,800 to 6,900°C, a mass of 1.2 to 1.6 solar masses, and a luminosity of 2 to 6 times that of the Sol, where Sol is equivalent to 1.

Relatively nearby, late type members of this category are generally included in the list of target stars for extrasolar planet searches and targeted SETI (Search for Extra Terrestrial Intelligence) programs.

F type supergiants, of which Polaris (the Pole Star) is an example, have a mass up to 12 solar masses and a luminosity up to 32,000 times that of the Sun.

F class stars are hotter than Sol, but can probably support life in a planetary system.

Stars of type F are more massive and brighter than the sun, but most of them would still have a classic biosphere. This zone would be broader and more distant from the parent star, but their main sequence lifetime is shorter by some billion years, so their use as a home for advanced forms of life is somewhat restricted.

Example of Star Type F: Procyon

PROCYON STELLAR DATA:
Type of Star: White-Yellow Dwarf.
Spectral Class: F5V.
Distance from Sol: 8.6 Light Years.
Luminosity: 7.7 L.
Mass: 1.5 Solar Masses.
Surface Temperature: 7300 K.
Main Sequence Lifetime: 6 Billion Years.

PROCYON ENVIRONMENT DATA:
Habitable Zone: 1.2 – 2.5AU
Zone of Stable Planetary Orbits: Max 3AU.
Known Companion: White Dwarf Procyon B (Least Distance 14 AU, 1 Orbit in 41 Years).

Procyon: Procyon is a star of spectral type F5. Being stable for about 6 billion years, this represents the upper limit for advanced, mammal-like forms of life.

A hypothetical, habitable planet within the Procyon system would be a brighter place than most regions on Earth. Not only does Procyon emit more visible light, it also emits more ultraviolet radiation.

Life forms on this hypothetical world would require protective pigments in skin cells or a highly efficient mechanism for DNA repair to combat extreme ultraviolet exposure to be able to survive and evolve.

A further obstacle for the development of life in the Procyon system is the presence of a White Dwarf star; “Procyon B”.

When Procyon B became a Red Giant some hundred million years ago, the increase in brightness would have severely stressed the climate on our hypothetical planet.

If the planet survived the disaster, which is a real possibility, the life bearing world orbiting Procyon would be a desert planet now.

Any surviving creatures would be huddled around the last reservoirs of water, maybe the remnants of once widespread oceans or lurking underground.

G Class Stars

Spectral Type:	G
Colour:	Yellow
Temperature:	5700K
Radius (Sol = 1):	1.0
Mass (Sol = 1):	0.8 to 1.1
Luminosity (Sol = 1):	1.0
Luminosity Class:	I to VII
Life (Million years):	10000
Abundance:	4%
Biosphere:	1.0 to 2.0 AU
Planet Potential:	Medium
Stellar Gravity Well:	90 AU

Notes for G Class Stars: A yellow star of spectral type G spectrum contains many absorption lines of neutral and ionized metals, together with some molecular absorption bands.

Main sequence type G stars, of which the Earth's sun, Sol and Alpha Centauri A are examples, have a surface temperature in the range 5,000 to 5,800°C and mass of 0.8 to 1.1 solar masses, where Sol is equivalent to 1.

G type stars are the prime targets of searches for extrasolar planets and targeted SETI programs.

G type giant stars, such as Capella, are slightly cooler but more luminous than their main sequence counterparts, while G type supergiants have a mass of 10 to 12 solar masses and a luminosity of 10,000 to 300,000 times that of Sol.

G class stars are optimum for terrestrial worlds (by definition). Unfortunately, single star systems with G type primaries aren't common locally.

In all the great oceans of emptiness, stars of type G are the best candidates to look for life.

G type stars are of moderate, but comfortable brightness and remain stable for about 10 billion years, sufficient time for complex life forms to evolve.

Example of Star Type G: Tau Ceti

TAU CETI STELLAR DATA:
Type of Star: Yellow Dwarf.
Spectral Class: G8V.
Distance from Sol: 11.9 Light Years.
Luminosity: 0.45 L.
Mass: 0.8 Solar Masses.
Surface Temperature: 5500 K.
Main Sequence Lifetime: 12 Billion Years.

TAU CETI ENVIRONMENT DATA:
Habitable Zone: 0.6 - 0.9 AU.
Zone of Stable Planetary Orbits: Unlimited.
Known Companion: None.

Tau Ceti: A world orbiting Tau Ceti is perfect for complex life forms to evolve, a G type, sun like star, devoid of stellar companions.

Although Tau Ceti has about half the sun's luminosity, its biosphere still comprises about one third of an AU, which is wide enough for a terrestrial planet to have formed there.

Alternatively, we know from other stars that gas giant planets are common and they are often very close to their parent star. Should Tau Ceti have a system of planets, a gas giant may orbit within the biosphere, leaving no space for a terrestrial planet, however, a gas giant may have moons, possibly of Earth's size, where life may get a start.

Climate on such a large moon orbiting a gas giant of Tau Ceti would not be substantially different from our own.

Depending on the parent planet's orbital radius, this world might see the whole range of conditions from the greenhouse of the Mesozoic to the great ice ages of the Pleistocene, advanced forms of life, and sentient beings in these conditions, are not excluded.

K Class Stars

Spectral Type:	K
Colour:	Orange
Temperature:	4500K
Radius (Sol = 1):	0.8
Mass (Sol = 1):	0.5 to 0.8
Luminosity (Sol = 1):	0.2
Luminosity Class:	I to VII
Life (Million years):	50000
Abundance:	9%
Biosphere:	0.5 to 1.5 AU
Planet Potential:	Medium
Stellar Gravity Well:	60 AU

Notes for K Class Stars: An orange-red star, the type K spectrum contains strong absorption lines of neutral and ionized calcium, and, particularly at the lower end of the temperature range, numerous lines of neutral metals and molecular bands.

K type main sequence stars are intermediate in size and temperature between M type red dwarfs and Sol-like stars (type G), with a mass of 0.5 to 0.8 solar masses, a temperature of 3600 to 4900°C, and a luminosity 0.1 to 0.4 times that of the Sun.

Nearby examples include Epsilon Indi, Epsilon Eridani, and Tau Ceti, the latter two having been the target stars of Project Ozma.

Early type main sequence type K stars within a few tens of light-years of Sol are generally included in the list of target stars of searches for extrasolar planets and targeted by SETI programs, since if they have planets orbiting within their biospheres there is the possibility that these worlds support life of some kind.

Familiar examples of K type giant stars include Arcturus, Aldebaran, and Pollux.

K Class stars are almost as good as G Class stars for interstellar colonies. Main sequence stars of spectral type K are slightly smaller, less massive and cooler than Sol.

The second most common stars within the galaxy, they have a longer lifetime, and their biosphere is narrower and also closer to the star.

It is worth noting that Epsilon Eridani, a K2 Class Star 10.5LY from Sol, has at least one planet, which has been detected from Earth and that Beta Geminorum or Pollux as it is more commonly known which is a K0 III Class Star, 33.72LY from Sol is the nearest Giant Star.

Example of Star Type K: Epsilon Eridani

EPSILON ERIDANI STELLAR DATA:
Type of Star: Orange Dwarf.
Spectral Class: K2V.
Distance from Sol: 10.8 Light Years.
Luminosity: 0.3 L.
Mass: 0.7 Solar Masses.
Surface Temperature: 5200 K.
Main Sequence Lifetime: 15 Billion Years.

EPSILON ERIDANI ENVIRONMENT DATA:
Habitable Zone: 0.4 – 0.6AU
Zone of Stable Planetary Orbits: Unlimited.
Known Companion: None.

Epsilon Eridani: Epsilon Eridani is an excellent candidate for extraterrestrial life, although this is a star of spectral type K, it is still very similar to Sol. An Earth-sized planet may still have an acceptable climate provided it is located with in the Epsilon Eridani biosphere.

Epsilon Eridani does not have any stellar companions, which could have disturbed the formation of planets.

This star was among the first targets for Frank Drake's first run of SETI target programs in 1960, and future generations of telescopes should settle the question of life at Epsilon Eridani within the next few decades.

As a prerequisite for planets, a faint disk of dust with a 60 AU radius has already been detected around the Epsilon Eridani system. This appears to be similar to Sol’s own Oort Cloud, a remnant of planetary formation, which itself if made up of planetesimals, icy bodies and comets.

M Class Stars

Spectral Type:	M
Colour:	Red
Temperature:	3200K
Radius (Sol = 1):	0.3
Mass (Sol = 1):	0.2
Luminosity (Sol = 1):	0.01
Luminosity Class:	V
Life (Million years):	100000
Abundance:	80%
Biosphere:	0.04 to 0.5 AU
Planet Potential:	Low
Stellar Gravity Well:	41 AU

Notes for M Class Stars: A cool, red star, spectral type M, has an average surface temperature of less than 3,600°C. Molecular absorption bands are prominent in the spectrum, with bands of titanium oxide becoming dominant at the lower end of the temperature range.

Main sequence type M stars, have a mass of less than 0.5 solar mass and a luminosity less than 0.08 times that of Sol.

M type giant stars, occur in the mass range 1.2 to 1.3 solar masses and may exceed 300 solar luminosities. The largest stars of all are M type supergiants, such as Betelgeuse and Antares, with masses from 13 to 25 solar masses and luminosities 40,000 to 500,000 times the luminosity of Sol.

M class stars display strong differences between giants and main sequence dwarfs. Proxima Centauri is the closest type M star (part of the Trinary star system Alpha Centauri).

It is worth noting that Ross 780 an M5 Class Star, 15.34LY from Sol, has two planets, which have been detected from Earth.

Stars of type M are the weakest of all main sequence stars. Sometimes possessing one-tenth the mass of Sol and being 10,000 times less luminous, they can hardly be called *suns* at all, however these dim stars comprise around 80% of the stellar population of the galaxy.

M type stars have an extremely low energy output and will be stable from 50 billion to 50 trillion years, depending on their actual mass.

When all other stars in the galaxy have long ceased to exist, there will still be plenty of M class and Red Dwarfs stars around.

Example of Star Type M: UV Ceti

UV CETI STELLAR DATA:
Type of Star: Red Dwarf.
Spectral Class: M6V.
Distance from Sol: 8.4 Light Years.
Luminosity: 0.00004 L.
Mass: 0.15 Solar Masses.
Surface Temperature: 2.800 K.
Main Sequence Lifetime: 1 Trillion years.

UV CETI ENVIRONMENT DATA:
Habitable Zone: 0.04 – 0.07 AU
Zone of Stable Planetary Orbits: Until 1.2 AU.
Known Companion: Red Dwarf Luyten 726-8A; (Least Distance 6 AU, 1 Orbit in 25 Years)

UV Ceti: UV Ceti is a typical flare star, sometimes showing a double or threefold increase in brightness within a few minutes.

Red Dwarfs are so weak in luminosity, that any biospheres surrounding them will be narrow and very close to the parent star, usually between 0.04 and 0.2 AU.

This proximity would prevent a planet to rotate forcing one side of the planet to be immersed in eternal daylight, and the other to eternal darkness, in other words the planet will be tidally locked to the star preventing rotation about it’s axis.

Would this allow for a stable climate? Under such conditions, the gases of the atmosphere would freeze out on the night side, turning the entire planet into a Mars-like desert, however the climate would remain stable.

As long as the atmosphere contains at least 150 mbar of carbon dioxide, heat from the star will be trapped on the dayside via greenhouse effect and transported to the night side, effectively preventing the freezing of the atmosphere.

A 1 bar atmosphere of carbon dioxide and nitrogen would keep the dayside at an average temperature of +20°C, while the night side would be cooler by only 40°C. Warm air would move in two directions along the equator to the night side, while strong winds from the night side would bring cold air back across the polar regions.

Even if Red Dwarfs produced a comfortable climate for life, the light emitted by the star would pose more stringent problems. Red Dwarfs emit most of their energy in the infrared region of the spectrum. Very little energy is emitted in wavelengths suitable for photosynthesis, so green plants as found on Earth would not survive.

However there would be other sources of energy available. The planet would feel the full force of gravitational tidal friction. These forces would create a very active geology in the interior. Our model planet would show intense volcanism.

In the absence of effective photosynthesis, organisms on such a world may use geothermal energy for life. Such forms of life would thrive even on the planet's dark side. Life existing by way of geothermal energy would solve yet another life threatening problem inherent to M and Red Dwarfs, that threat being stellar eruptions or stellar flares. The atmosphere of our model planet could act as a buffer from considerable increase of heat, even if these flares should last for months and if the dominant forms of life do not directly depend upon the sun for their energy, they would not be seriously affected.

Dwarf Star D White Dwarfs

Spectral Types:	D+ A to F
Colour:	White
Temperature:	Under 50000K
Radius(Sol = 1):	Under 0.1
Mass (Sol = 1):	Under 1.4
Luminosity:(Sol = 1):	Under 0.01
Life (Million years):	N/A
Abundance:	5%
Biosphere:	None
Planet Potential:	None
Max Safe Jump Point:	Relative to the Spectral Type.

Notes for White Dwarfs: A to F class Dwarf stars are the dying remnants of larger stars that have suffered a violent collapse.

White Dwarfs are signified by the prefix of a capital 'D' in front of their Spectral Type.

These are small, dim stars in an advanced stage of evolution or more correctly, death.

White dwarfs formed from main sequence stars with masses similar to that of Sol. The first such object to be discovered was the companion of Sirius in 1862.

A white dwarf may contain up to 1.4 solar masses of compressed material, mainly carbon, supported from further collapse by degenerate electron pressure, within a sphere approximately the size of the Earth.

Essentially these are very dense stars with the mass of Sol compressed into the volume of the Earth.

Dwarf Star d Red Dwarfs

Spectral Types:	d+ Late K to M
Colour:	Red
Temperature:	Under 3500K
Radius(Sol = 1):	Under 0.1
Mass (Sol = 1):	Under 0.5
Luminosity:(Sol = 1):	Under 0.01
Life (Million years):	N/A
Abundance:	5%
Biosphere:	0.04 to 0.5 AU
Planet Potential:	Medium
Max Safe Jump Point:	Relative to the Spectral Type.

Notes for Red Dwarfs: Red Dwarfs are signified by the prefix of a lower case 'd' in front of their Spectral Type. These are smaller and dimmer than usual, main sequence stars of spectral type M or late K.

The term Red Dwarf is something of a misnomer as all Main Sequence stars fall into the V Luminosity Class or "Dwarf" type, therefore any late K to M Class star could be termed a Red Dwarf by the nature of it's colour. However Dwarf Stars of this type tend to be dimmer and smaller than normal. Normal M Class stars have very similar characteristics to Red Dwarfs and the term is generally interchangeable.

The characteristic properties of Red Dwarfs stem ultimately from their low mass, which is approximately in the range 0.1 to 0.5 solar mass. A low surface temperature, in the range 2,500 to 3,500°C, imparts to them a ruddy hue, while their combination of low temperature and small surface area results in them being very faint.

Red dwarfs survive longer and are more numerous than any other kind of star, with the probable exception of Brown Dwarfs, excessively large gas giant worlds on the brink of stellar ignition.

Of the 30 nearest stars to the Sun, for example, 21 fall into this category. Like other types of star, Red Dwarfs may be accompanied by planets. A Red Dwarf planetary system may already have been found, in the case of Lalande 21185.

However, there are doubts whether any worlds in orbit around such faint stars could harbour life. These doubts arise because of the extremely small habitable zone that would surround a Red Dwarf. It is not known whether a planet can form so close to its parent star. If it can, it will almost certainly end up in a gravitational lock, with one side permanently turned toward the star. Under such circumstances, it is not clear whether life would be able to evolve.

Some day we might learn that Red Dwarfs are home to most of the habitable worlds within the galaxy, inhabited by the strangest and hardiest of all creatures imaginable. And in a universe that is dying inevitably, Red Dwarfs might be the last refuge for advanced civilizations.

STELLAR GLOSSARY

Absolute magnitude
The apparent magnitude an object would have if placed at a distance of exactly 10 parsecs (=32.6 light years). A supergiant star might have an absolute magnitude of -8 whereas a dim red dwarf might have an absolute magnitude of +16. The Sun has an absolute magnitude of +4.8 - about half way between the two extremes.

Apparent magnitude
The system used to give the brightness of stars in the sky. Brighter stars have lower numbers and dimmer stars have higher numbers. The dimmest objects visible with giant telescopes have a magnitude of +30. A good portable telescope might see down to magnitude +15. Binoculars can see down to magnitude +9 and the faintest naked eye stars have a magnitude of +6. Very bright objects have a negative magnitude, the brightest star has a magnitude of -1.4, the full Moon has a magnitude of -12.7 and the noon Sun has a magnitude of -26.8.

Astronomical Unit (AU)
The average distance between the Earth and the Sun. It is equal to 149 597 871 km. It is often used for distances in a solar system or for distances between companion stars.

Bayer name
The combination of a Greek letter and the name of a constellation (Alpha Centauri, Epsilon Orionis etc.) used to identify bright stars. The system was first used by Johann Bayer in 1603. Brighter stars in a constellation usually have a letter near the beginning of the alphabet, and dimmer stars usually have a letter nearer the end of the alphabet. A few faint stars were given lower-case Roman letters from a to z or upper-case Roman letters from A to Q (p Eridani, N Velorum etc.) See also Flamsteed number.

Billion
1 billion = 1 000 000 000.

Biosphere
Biospheres are defined as areas of space surrounding a star, which offer conditions needed to support Earth-type life, or more specifically the conditions in which water in its liquid state may exist. Earth-type life, is life, which depends on liquid water for survival. A biosphere is measured in AU from it’s hot inner to it’s cool outer edge.

Black hole
The ultimate cosmic plughole formed when a high mass supergiant star explodes in a supernova explosion at the end of its life creating a super-dense point in space where nothing can escape the gravitational pull. A star probably has to have a mass of more than 40 solar masses to create a black hole which typically have a mass of about 3 solar masses. Black holes can be detected by the disrupting effects they have on neighbouring stars. The centres of most galaxies including our own are believed to have super-massive black holes which have sucked in thousands of stars.

Brown dwarf star
A failed star that was too small at its birth for nuclear reactions to occur in its core. They may be very common, but because they only glow very dimly they are very hard to detect. Brown dwarfs are <u>not</u> brown, they begin their lives by glowing a dull red and then fade. Brown dwarfs are more massive than planets, and range in mass from 10 to 80 times the mass of Jupiter (or 0.01 to 0.08 times the mass of the Sun). There are two main types of brown dwarfs - the hotter ones (1500K to 2500K) are type L; the cooler ones (200K to 1500K) are type T. The hottest brown dwarfs are sometimes classified as very cool type M red dwarf stars.

Constellation
Random patterns of stars in the night sky produced by the chance alignment of stars of different luminosities and distances. There are 88 constellations - 48 were listed by the ancient Greeks, and another 40 were added after 1600.

Dark matter
The visible stars and nebulae make up only a small fraction of all the matter in the universe. The rest is in a form that is not easy to detect, but clearly exists because of the effect it has on the motion of stars in galaxies and the motion of galaxies in clusters. Dark matter probably consists of various types of subatomic particles.

Declination (Dec)
See Equatorial coordinates.

Dwarf star
A normal main sequence star like the Sun that is burning hydrogen in nuclear reactions in its core. The brightest dwarf stars can be much larger than the Sun. See also Giant star, Supergiant star.

Equatorial coordinates (RA, Dec)
The most common coordinate system used by astronomers. It is the equivalent of the Earth's latitude and longitude projected onto the sky except that longitude is called Right Ascension and latitude is called Declination. For historical reasons, Right Ascension is not measured in degrees but in 'hours' - 24 hours being equivalent to 360 degrees. Another complication is that this coordinate system is very slowly moving with time - star positions for 1950 are slightly different to those for the year 2000 for example.

Flamsteed number
The combination of a number and the name of a constellation (61 Cygni, 36 Ophiuchi etc.) used to identify naked-eye stars. The numbers were applied to John Flamsteed's star catalogue published in 1725. Not all naked-eye stars have a Flamsteed number and most stars in the far southern hemisphere do not have one. See also Bayer name.

Galactic coordinates (l, b)
A coordinate system based on the plane of the Galaxy, it is centred on the Sun with the zero point of longitude and latitude pointing directly at the galactic centre. The symbols used for galactic coordinates are l (longitude) and b (latitude). The zero point of Galactic latitude and longitude is at RA=17h45m37s Dec=-28°56'10", and the Galactic north pole is at RA=12h51m26s Dec=+27°07'42", (epoch 2000 coordinates).

Galactocentric coordinates
The same coordinate system as galactic coordinates except that this system is centred on the centre of the Galaxy. The small uncertainty in the distance to the galactic centre prevents this system from being widely used.

Galaxy
A vast concentration of millions or billions of stars. There are four main types of galaxies: Elliptical Galaxies, Lenticular galaxies, Spiral Galaxies and Irregular galaxies. Our galaxy contains 200 billion stars, but the largest galaxies contain many trillions. See also Dwarf Galaxy.

Giant star
A star the size of the Sun will end its life after several billion years by expanding greatly because of changing energy balances at the core of the star. The surface temperature drops and the star becomes redder, this lasts several million years before the star throws off its outer layers and becomes a white dwarf. See also Dwarf star, Supergiant star.

Light year (ly)

The distance light travels in a year. It is equal to 0.3066 parsecs. It is 9461 billion km or 63 240 astronomical units.

Magnitude

See Apparent magnitude, Absolute magnitude.

Main sequence star

A normal star like the Sun that is burning hydrogen in nuclear reactions to produce its energy. Other types of stars include: giant stars, supergiant stars and white dwarfs.

Nebula

A cloud of interstellar gas and dust. Bright nebulae glow with light emitted by the gas of which they are composed (emission nebulae) or by reflected starlight (reflection nebulae) or both. Dark nebulae consist of clouds of gas and dust that are not illuminated. Planetary nebulae are shells of gas ejected by stars.

Neutron star

The core of a supergiant star, which has collapsed during a supernova explosion so much that it consists entirely of neutrons. Most stars between 8 and 60 solar masses end their lives like this usually producing a neutron star with a mass of about 1.4 solar masses. Neutron stars are only 10 kilometres across and have an incredible density - a teaspoon of neutron star material would have a mass of hundreds of millions of tonnes. See also Black hole.

Orange dwarf star

Stars with a luminosity in between the Sun-like yellow stars and red dwarfs. They are classified as type K stars.

Parsec (pc)

The distance a star has to be to have a parallax shift of 1 arc second. (No star is actually this close). 1 parsec = 3.2616 light years.

Planetary nebula

An expanding envelope of gas surrounding a hot white dwarf. It is formed at the end of a giant star's life when the core contracts ejecting the outer atmosphere of the star creating both the white dwarf and the nebula. The intense radiation from the central white dwarf makes the nebula glow. Planetary nebulae disperse within 50 000 years. They are called planetary nebulae because to early astronomers they looked a bit like planets.

Quasar

A galaxy with an extremely luminous nucleus outshining the parent galaxy by several hundred times. They lie billions of light years away and were a feature of the early universe. The energy source of a quasar is probably matter falling into a super massive black hole.

Red dwarf star

The smallest and dimmest stars. About 80% of all stars are red dwarfs although none are visible from Earth with the naked eye. Because they shine with less than 1% of the Sun's output they live a long time - the smallest are likely to last thousands of billions of years. They are classified as type M stars.

Right Ascension (RA)

See Equatorial coordinates.

Solar system

A star together with the planets, moons, asteroids, comets and dust, which orbit it, also referred to as a Star System.

Spectral Classification

The system used to classify stars. Stars fall into seven main catagories: O, B, A, F, G, K and M ranging from hot blue-white stars to cooler red stars. A number (0 to 9) is usually added to denote a sub-class. A roman numeral is sometimes added to denote the size of the star. Supergiant stars are class I, Giant stars are class III, and ordinary main sequence stars are class V. (Types II and IV are in between types). The Sun is type G2V, whereas Arcturus - an orange giant star - is type K2III.

Star classification

See Spectral classification.

Supergiant star

A star bigger than about 10 solar masses will become a supergiant star at the end of its life as hydrogen burning ceases causing the stars outer layers to expand. Supergiant stars are the largest and brightest of all stars and they usually end up exploding in a supernova explosion and creating a neutron star or a black hole. See also Dwarf star, Giant star.

Supernova

A catastrophic stellar explosion that can briefly outshine an entire galaxy of billions of stars. It can occur when a supergiant star exhausts all its nuclear fuel causing the core of the star to collapse releasing a vast amount of energy which blasts away the outer parts of the star and leaves behind a neutron star or in extreme cases a black hole.

Supernova remnant

The remains of a star visible as an expanding nebula of gas that have been ejected at high speed by a supernova explosion.

Temperature

In astronomy temperature is measured with the Kelvin scale (symbol K) which is equal to °C + 273°. Thus a midday Earth temperature of 20°C is equal to 293K and the Sun's surface temperature of 5500°C is about 5770K.

Trillion

1 trillion = 1 000 000 000 000.

Variable star

A star that varies in brightness. There are many types, some stars can change in brightness in a matter of minutes whereas others change slowly over many months. The first 334 variable stars discovered in a constellation are given a one or two letter code such as R Scuti or UV Ceti. Other variable stars are designated V335, V336, etc. Proxima Centauri for example is known to variable star astronomers as V645 Centauri.

White dwarf star

The dying remnant of a giant star that has blown away its outer layers to reveal an intensely hot core. Only the youngest white dwarfs are actually white, over billions of years they slowly cool and change colour to yellow or orange (although the coolest white dwarfs are bluer than expected because the compressed atmosphere of hydrogen filters out the red light). They eventually become a dead black dwarf, although because the universe is less than 15 billion years old none have yet cooled this much. They are classified as type D stars.

Yellow dwarf star

Any small yellow star like the Sun. They are classified as type G stars.