Astro-Navigation Made Easy

New Edition, Expanded and Revised

Introduction

Not that easy, I'm afraid, but anyone who has a copy of the Introduction to Navigation booklet that came with the Star Trek Maps will find this information compatible with the guidance there, although the x, y and z coordinates are not transferable (and that's a whole long story in itself). The maps themselves use many of the same basic assumptions as the ones in the Star Trek Star Charts; light years rather than parsecs as the unit of measurement, a twenty light-year sector grid, Earth at the zero point and the top of the map aligned in the direction of the centre of the Galaxy. For my own ease of use more than anything else, the x, y and z coordinates have been “adapted” from standard galactic coordinates, so that plotting x and y coordinates on the map is exactly the way you’d normally do it. If that means nothing at all, don’t worry. It just means that I’ve fixed things so that x coordinates run horizontally across the width of the map, and the y coordinates run across the height of the map, even though the centre of the Galaxy is off the top of the map, rather than off to the right-hand side, as in a “standard” set of galactic coordinates.

This is still a very early “proof of concept” version of the maps, which is why they’re still a bit “sparse” when it comes to identified star systems. Originally, I was just going to update the Star Trek Star Charts with more accurate star positions, and a lot more stars. It all got a bit more complicated than that. The bad news is that these maps don’t fit that well with the Star Charts. The good news is that the results are something new, and that was a lot of fun to work on.

This “even newerer” version has a drastically revised suggestion as to the locations of “Bajor” and “Cardassia”. Whatever anyone else thinks, within my own selection criteria, these are the “least worst” candidates within 300 light years of Earth. I've also added a fifth map, a highly-speculative interpretation of the area near Alpha Doradus where part of Star Trek: Picard plays out.

Core Worlds of the Federation Map

Perhaps not surprisingly, the closest stars to Earth are the best-studied. They’re the ones that seem brightest in the sky because they’re close, not because of their intrinsic brightness. That means they’re more likely to have been given names. The stars with well-established “popular” names like Sirius are much more likely to find their way into science fiction stories, and Star Trek is no exception.

What’s Missing?

The star Zeta² Reticuli has been matched to “Tranome Sar” in the Star Trek Star Charts, and in the “Star Trek: Discovery” map. I’m not sure that it’s the best place for a battle between the Klingons and Romulans, so I've omitted the name from my map. I also have
reservations about the location of the Andorian home-world at the star Procyon, so I’ve not
used that identification.

Appendix: Astrogation

Aldus Prime
7.3, -11.2, -1.4
Identified as the real star Ross 614. It has a spectral class of M4.5V. Gaia suggests the
absolute magnitude is 11.508. There is a close orbiting companion, about 4 AU away, with
a magnitude of about 14. The stars orbit each other every 16.6 years.

Alpha Centauri
3.1, 3.1, -0.1
A real star, the closest star system to our own Sun. There are three components. Alpha
Centauri A has the official name Rigil Kentaurus. The spectral class is G2V. The two main
components are too bright in our sky for Gaia, so other sources give an absolute
magnitude of 4.38. A mass 1.1, radius 1.2234 and luminosity 1.519 of the Sun's have been
calculated. The B component has the official name Toliman. Its spectral class is K1V, and
the absolute magnitude is 5.71. Mass 0.907, radius 0.8632 and luminosity 0.5502 of the
Sun's. The two stars orbit every 79.91 years, and the distance between them varies
between 11.2 and 35.6 AU. The C component is much more distant, a red dwarf with the
name Proxima Centauri. The distance varies between approximately 4,100 and 13,000
AU, and it takes about 547,000 years to complete a single orbit around the inner stars. At
its current point in its orbit, Proxima Centauri is significantly closer to our Solar System
than any other star, which is the source of the name “Proxima.” The spectral class is
M5.5Ve, and Gaia gives an absolute magnitude of 13.382. Other sources give a mass
0.1221, radius 0.1542 and luminosity 0.0017 of the Sun's. Proxima Centari is the only one
of the three stars to have confirmed planets orbiting it. The inner planet has at least 1.17
times the mass of Earth, and orbits at 0.04857 AU, taking 11.18418 days to complete one
orbit. The other confirmed planet has about 7 times the mass of Earth, and completes an
orbit in around 5.2 years. The distance from the star is 1.489 AU. All three of the
components have a suspected planet, although none of these has been confirmed.

Altair
-12.3, 11.1, -2.6
A real star, spectral class A7IV-V. Hipparcos data gives an absolute magnitude of 2.271.
Other sources give a mass 1.79, radius 1.63 and luminosity 10.6 times the Sun's.

Arcturus
-3.4, 12.6, 34.3
A real star. The spectral class is K2IIIp. Hipparcos data gives an absolute magnitude of-
0.145. Other sources give mass 1.08, radius 25.4 and luminosity 170 the Sun's. It is
possible that the star has a fainter binary companion, but that has not been confirmed.
**Argus**  
-31.3, 32.8, -26.2  
This planet has been matched to the real star Ross 193. It is a widely-separated binary. The A component is a red dwarf, spectral class M3V. Gaia measurements give an absolute magnitude of 9.622. The B component is a white dwarf, spectral class DC10, with an absolute magnitude of 15.316, calculated from Gaia data.

**Axanar**  
1.9, -6.7, -7.8  
Matched to the real star Ran, or Epsilon Eridani. This star has the spectral class K2V. The Gaia data suggests an absolute magnitude of 5.841. A radius 0.83 of the Sun's and a luminosity of 0.38 has been derived from the Gaia measurements. The Epsilon Eridani star system is suspected to have at least one large planet. It is 0.78 the mass of Jupiter and orbits at 3.48 AU, taking 7.4 of our years to complete one orbit. There are also two asteroid belts, one stretching about 8 to 20 AU from the star, whilst an outer belt is 35 to 100 AU out.

**Babel**  
4.3, 1.5, 13.6  
Wolf 424 was the real star identified as “Babel” in the Star Trek Maps and in the Star Trek Star Charts. The spectral class is M5.5V. Gaia data indicates an absolute magnitude of 14.256. This is another close binary system. The components orbit once every 15.5 years, and are 4.1 AU apart. The two stars are calculated to have 0.14 and 0.13 times the mass of our Sun, and 0.17 and 0.14 the radius.

**Benecia Colony**  
-1.7, 1.7, 29.9  
This has been matched to the real star Beta Comae Berenices. It has the spectral class F9.5V. Gaia gives an absolute magnitude of 4.209. A radius 1.11 and luminosity 1.521 of the Sun's have been derived. Other sources give a mass 1.15 times the Sun’s.

**Benzar**  
8.5, 14.5, -10.7  
Matched to the star Delta Pavonis. This star has a spectral class of G8IV. Gaia gives an absolute magnitude of 4.341. A radius 1.64 of the Sun's and a luminosity of 1.51 has been derived from the Gaia measurements.

**Borka**  
15.4, 10.7, -15.6  
This has been matched to the star Beta Hydri. The spectral class is G0V. An absolute magnitude of 3.164 has been calculated from the Gaia data. Other sources suggest it has about the same mass as the Sun, but a radius 1.8 times the Sun’s, with a luminosity of 3.4.
**Capella**  
-12.6, -40.1, 3.4

A real star. Two sets of binary stars, forming a star system with four components, not resolved individually by Gaia, so this is information from other sources. The main components are Capella Aa and Ab. Aa has spectral class K0III, and mass 2.5867, radius 11.98 and luminosity 78.7 of the Sun's. The absolute magnitude is 0.296. Ab has spectral class G1III, and mass 2.4828, radius 8.83 and luminosity 72.7 of the Sun's. The absolute magnitude is 0.167. These two stars orbit each other every 104.02128 days, and are 0.72 AU apart (less than the distance between Earth and the Sun). These stars are in turn orbited by another pair of stars, Capella H and L. H has spectral class M2.5V, and mass 0.57, radius 0.54 and luminosity 0.05 of the Sun's. The absolute magnitude is 9.53. L has spectral class M4, and mass 0.53 of the Sun's. The absolute magnitude is 13.1. These two red dwarves orbit each other in approximately 300 years, and are separated by around 40 AU. The orbit around the A components is very distant, with a separation of around 9,500 AU.

**Celes**  
40.5, -27.1, 31.4

Matched to the star Tau¹ Hydrae. This is a triple system. The main component is a star of spectral class F5V. The Gaia data suggests an absolute magnitude of 3.191, and a radius of 1.58 of the Sun's with a luminosity of 3.86 has been derived. There is a close orbiting companion, which takes less than three days to complete an orbit around the main star, and has a mass of about 0.1 of the Sun's making it likely to be a brown dwarf. The visible companion is a K0 star. Gaia data suggests an absolute magnitude of 5.651, and a radius of 0.81 and a luminosity of 0.435 have been derived. It's about 1,120 AU from the A component, making it a widely-separated pair.

**Coridan**  
4.2, -28.5, -1.4

This has been matched to the star Chi¹ Orionis. The Gaia data gives an absolute magnitude of 4.447, and a radius of 1.01 and a luminosity of 1.225 have been derived. Other sources suggest that this is an unlikely star to have inhabited planets. Unfortunately, there is a faint companion. It has been calculated to have a mass 0.15 of the Sun's and takes 14.1 years to complete an orbit. The distance between the stars varies from 3.3 to 8.9 AU, and it’s this eccentricity in the orbit that is likely to prevent a habitable planet, since the orbits of hypothetical planets at the right distance would be disrupted by the companion star. That would lead to massive variations in the amount of sunlight reaching the planet, and variations in temperature on the surface that would make life extremely unlikely.

**Draylon**  
-19.8, -25.7, -15.4
Matched to the real star Delta Trianguli. It's a binary system. The main component has the spectral class G0V, whilst the companion is a K-class star. They orbit each other in 10.02 days, and the distance between them is calculated to be only 0.106 AU. The Gaia data suggests an absolute magnitude for the pair of 4.414. Other sources suggest that the two stars have luminosities 0.8 and 0.3 times that of the Sun. The masses are calculated at 1.0 and 0.8, and radii at 0.86 and 0.84 of the Sun's. A planet would orbit both stars, and the sky would be pretty spectacular.

Earth
0, 0, 0

Home-world of humanity, and the headquarters of the United Federation of Planets. The spectral class of the Sun is G2V, and the absolute magnitude is 4.83.

Farius
-30.4, -27.4, -15.4

Matched to the real star Upsilon Andromedae. It's a binary system. The main component also has the official name Titawin. It has a spectral class of F9V and the Gaia data suggests an absolute magnitude of 3.261. A radius of 1.7 and a luminosity of 3.64 of the Sun's have been derived from the Gaia data. This star has not one, but four gas-giant planets orbiting it. The companion star orbits at a distance of around 750 AU, and the spectral class is M4V. Gaia data gives an absolute magnitude of 11.865, so it's pretty small, in star terms.

Festus
-0.4, 4.3, -9.8

Matched to Lacaille 9352. This star has a spectral class M0.5V. Gaia gives an absolute magnitude of 8.938. Other sources give mass 0.486, radius 0.47 and luminosity 0.0367 of the Sun's. There are at least two and possibly three planets orbiting this star. The innermost has 4.2 times the mass of earth and orbits in 9.262 days at a distance of 0.68 AU. Beyond that a planet with a mass 7.6 times Earth's orbits in 21.789 days at a distance of 0.12 AU. There may be a third planet, around 8.3 Earth masses, orbiting every 50.7 days, at a distance of 0.21 AU, but this discovery awaits confirmation.

Inferna
-21.4, 16.3, 22.8

This system has been matched to the real star Zeta Herculis. It's a double star, with the A component having a spectral class of F9IV. The mass has been calculated as about 1.5 times that of the Sun, the radius 2.5 times, and it is around six times as luminous. The B component has the spectral class G7V, and has around 0.85 of the Sun's mass, and 0.65 of the luminosity. The two stars complete an orbit every 34.45 years, and are separated by between 8 and 21 AU, with an average distance of about 15 AU. This variation might be enough to prevent the formation of a planetary system, but it doesn't seem to have in Star Trek.
Kaferia
-0.4, -3.3, -11.3

The identification with the real star Tau Ceti goes right back to the Star Trek Maps. The star has a spectral class of G8V. The Gaia data suggests an absolute magnitude of 5.35. A radius of 0.86 and a luminosity of 0.559 of the Sun's have been derived from the Gaia measurements. A number of planets, including four "super-Earths" orbit the star, but not all the suspected planets have been confirmed. Astronomers have detected an unusual amount of dust and debris around the star, certainly more than in our own Solar System. That might mean that impacts are more common on the planets there.

Klaestron
-34.4, -27.5, 1.2

This planet has been matched to the real star with the catalogue number HD 10436. It has the spectral class K5V. The Gaia measurements allow the calculation of an absolute magnitude of 7.271, and radius of 0.61 and luminosity 0.124 of the Sun's have been derived. A planet with 8.3 times the mass of Earth is suspected, orbiting close to the star in just under four days, but the discovery has not been confirmed.

Loracus
-37.3, -20.7, 11.7

This planet has been matched to the real star Gamma Cephei. It's a binary system. The main component has the official name Errai. It has the spectral class K1III-IV. The Gaia data gives an absolute magnitude of 2.146. Other sources suggest it has a mass of 1.41, a radius of 4.93 and a luminosity 11.6, all measured against our Sun. There is a confirmed planet named tadmor orbiting this star. It has a mass 1.85 times that of Jupiter, and completes an orbit in about 2.5 years. It’s about 2 AU from the star. The companion star has a mass 0.409 of the Sun's, and it is almost certainly a red dwarf. It completes an orbit in about 67.5 years, at a distance varying between 12 and 26 AU.

Lorillia
19.2, -18.1, -11.9

Matched to the real star Gamma Leporis. This star has the spectral class F6V. The Gaia measurements allow an absolute magnitude of 3.626 to be calculated. A radius of 1.36 and a luminosity of 2.259 of our Sun's have been derived. Although it is not a multiple system, there is a close companion star, AK Leporis. This is a varaible star, with the spectral class K2V. The calculated absolute magnitude is 6.109, and a radius of 0.75 and a luminosity of 0.3 of the Sun's have been derived from the Gaia measurements.

Luyten’s Star
6.5, -10.3, 2.2

The Star Trek Star Charts identify this as the location of P’Jem, but I'm not entirely convinced. It has a spectral class of M3.5V, and Gaia gives an absolute magnitude of
10.694. Other sources give mass 0.26, radius 0.35 and luminosity 0.0088 of the Sun’s. Planets have been detected. The innermost is almost the same size as Earth, with 1.18 times the mass. It orbits in 4.7234 days, at a distance of 0.036467 AU. The next planet has 2.89 times the mass of Earth, and orbits in 18.65 days at a distance of 0.0911 AU. Because this star is so much smaller than the Sun, this would actually place it at a distance where the amount of sunlight would be only slightly higher than Earth gets, making it one of the nearest candidates for a planet with life on it. Beyond these two planets, a further two are suspected, but not yet confirmed. Both of them would be about ten times the mass of Earth, if they’re there.

**Neethia**
-39.3, 6.0, -33.9

This has been matched to the real star Xi Pegasi. It is a double system. The main component has the spectral class F6III-IV. Gaia gives an absolute magnitude of 2.931. A radius 1.87 and luminosity 4.913 of the Sun’s have been derived. The companion star is spectral class M3.5. Gaia gives an absolute magnitude of 9.677, so it appears to be a red dwarf. Other sources suggest the separation of the two stars is over 180 AU, and the orbital period is more than 2,000 years.

**Nehru**
-32.0, -11.4, -23.4

Matched to the real star 85 Pegasi. This is a binary, and possibly triple system. The main star has the spectral class G5V. Gaia gives an absolute magnitude of 4.992. A radius 0.94 and luminosity 0.762 of the Sun’s has been derived. Other sources suggest the B component is K7V, with 0.55 of the mass, 0.67 the radius and about 0.5 the luminosity of the Sun. It orbits the A component every 26.28 years, varying in distance between 6.4 and 14.2 AU. This B component is suspected to be a close binary, with a red dwarf companion with 0.11 the Sun’s mass orbiting at about 2 AU.

**Ophiuchus Colony**
-8.2, 14.2, 3.3

I’ve diverged from the *Star Trek Star Charts* in using the real star 70 Ophiuchi, mainly because I wanted Guniibuu (36 Ophiuchi A) on my map. The A component is spectral class K0V, and the Gaia data gives an absolute magnitude of 5.374. Other sources suggest a mass 0.9, radius 0.91 and luminosity 0.59 of the Sun’s. The B component takes 88.38 years to complete an orbit, and the distance varies between 11.4 and 34.8 AU. The B component has spectral class K4V, and the Gaia data gives an absolute magnitude of 6.956. A radius 0.68 and luminosity 0.162 of the Sun’s has been derived. Other sources suggest a mass 0.7 of the Sun’s.

**Orion**
4.8, -23.7, -10.3
This star has been matched to Tabit, also known as Pi³ Orionis. It is spectral class F6V, and the Gaia data gives an absolute magnitude of 3.439. A radius 1.64 and luminosity 3.1 of the Sun's has been derived. Other sources suggest the mass is 1.236 the Sun's.

**Paan Mokar**

0.6, -8.9, 29.9

Matched to the real star 61 Ursae Majoris. It has the spectral class G8V. Gaia measurements give an absolute magnitude of 5.176, and a radius 0.86 and luminosity 0.643 of the Sun's have been derived. Other sources suggest a mass 0.93 of the Sun's.

**Pollux**

6.6, -30.2, 13.4

A real star, too bright in the sky to be measured by Gaia. The spectral class is K0III, and the absolute magnitude is 1.08. Mass 1.91, radius 9.06 and luminosity 32.7 times the Sun's. This star is orbited by the planet Thetias, which has at least 2.3 times the mass of Jupiter, and orbits at 1.64 AU in 589.64 days. The age of this star is 724 million years, and so the age given in TOS “Who Mourns for Adonais?” of four billion years makes Apollo’s planet quite considerably older than the star it orbits.

**Pree’**

-26.4, -1.1, -35.0

This system has been matched to the real star Iota Piscium. It has the spectral class F7V. The Gaia data gives an absolute magnitude of 3.284. A radius 1.64 and luminosity 3.56 of the Sun’s have been derived from the Gaia measurements.

**Procyon**

6.2, -9.2, 2.6

A real star. The Star Trek Star Charts identified this star as the home system of the Andorians, but I’m not convinced, not least because the star has also been referred to by name. It’s a binary. The A component has the spectral class F5IV-V, and Hipparcos gives an absolute magnitude of 2.742. Other sources give mass 1.499, radius 2.048 and luminosity 6.93 of the Sun's. The B component is a white dwarf, spectral class DQZ. Other sources give an absolute magnitude of 13.0, and mass 0.602, radius 0.01234 and luminosity 0.00049 of the Sun's. The two stars orbit at a distance that varies between 8.9 and 21 AU, taking 40.84 years to complete one revolution.

**Pyritia**

-38.3, -0.7, 24.6

Matched with the real star 26 Draconis. It is a spectroscopic binary, and other sources suggest the two components are spectral class F9V and K3V. The masses are 1.3 and 0.83 times the Sun’s. They orbit each other every 76 years. There is a very much more distant companion, with the spectral class M1V. Gaia data gives this star an absolute magnitude of 8.387. Radius 0.54 and luminosity 0.06 of the Sun's have been derived from
the Gaia measurements. A planet has been detected for this red dwarf star. It has around 9 times the mass of Earth, and orbits every 24.16 days, at a distance of 0.1344 AU.

**Ranous**
-9.3, -3.4, -3.0
Matched to the real star Ross 248. Spectral class M5V. Gaia data gives an absolute magnitude of 12.87. Other sources give mass 0.12, radius 0.16 and luminosity 0.002 of the Sun’s.

**Sauria**
48.2, -6.0, 35.3
Matched to the real star Psi Serpentis. It is a triple system, not separated by Gaia. Other sources suggest the main “A” component is spectral class G5V, with mass 0.993, radius 1.0 and luminosity 0.98 of the Sun’s. The other two components of the system are red dwarves in a close orbit with each other, but distant from the main component. These outer stars orbit Psi Serpentis A every 528.79 years. The two stars, probably spectral class M3, orbit each other at a distance of 3 AU, suggesting an orbital period of about 6 years. Their masses are assumed to be about 0.25 of the Sun’s, so the luminosity of each is only going to be around 0.014 of the Sun’s.

**Sigma Draconis**
-17.1, -3.4, 7.0
This star isn’t matched. It is mentioned by name in TOS “Spock’s Brain”. Since that show was made, the star has been assigned the official name Alsaﬁ. The spectral class is K0V. Gaia suggests an absolute magnitude of 5.577. Radius 0.75 and luminosity 0.45 of the Sun’s have been derived. Other sources suggest a mass 0.85 of the Sun’s. There may be a planet about the size of Uranus orbiting this star, but the discovery is not confirmed.

**Sirius**
6.2, -5.8, -1.3
A real star, it’s a binary. The A component has spectral class A1V, and Hipparcos gives an absolute magnitude of 1.807. Other sources give a mass 2.063, radius 1.711 and luminosity 25.4 the Sun’s. The white dwarf B component has spectral class DA4. Gaia gives an absolute magnitude of 11.354. Other sources give a mass 1.018, radius 0.0084 and luminosity 0.056 of the Sun’s. The two stars take 50.1284 years to complete an orbit, and the distance between them varies between 8.2 and 31.5 AU.

**Stameris**
-7.5, 26.6, 26.8
The real star Lambda Serpentis has been matched to this planet. It is spectral class G0V. The Gaia data gives an absolute magnitude of 3.841, radius 1.35 and luminosity 2.14 of the Sun’s have been derived. Other sources suggest a mass 1.14 that of the Sun. A planetary system is suspected, but not confirmed.
Tellar
-11.2, 1.5, -1.2

The *Star Trek Maps* matched this to the real star 61 Cygni. This is a binary system, with the larger component being spectral class K5V. Gais suggests an absolute magnitude of 6.998, radius 0.72 and luminosity 0.164 have been derived. The secondary star has spectral class K7V. Gaia measurements give an absolute magnitude of 7.707 and radius 0.58 and luminosity 0.092 of the Sun’s have been derived. Other sources suggest masses of 0.7 and 0.63 of the Sun’s for the two stars. They complete an orbit once every 659 years, with the distance between them varying between 44 and 124 AU. There have been claims of a planetary system, but so far no planets have been positively confirmed orbiting either star.

Terra Nova
-16.0, -10.2, -1.7

Matched to the real star Eta Cassiopeiae. It's a binary system, and Eta Cassiopeiae A has the official name Achird. The spectral class is F9V and the Gaia data gives an absolute magnitude of 4.356. Radius 1.35 and luminosity 1.392 have been derived. The B component has spectral class K7V. Gaia gives an absolute magnitude of 7.891, radius 0.57 and luminosity 0.082 of the Sun’s have been derived. Other sources give masses 0.97 and 0.57 of the Sun’s to the two stars. They orbit around each other in 480 years, with the distance between them varying between 36 and 106 AU.

Theta
-8.0, -30.7, 32.4

Matched to the real star Theta Ursae Majoris. The spectral class is F6IV. Gaia gives an absolute magnitude of 2.258. Other sources give mass 1.41, radius 2.365 and luminosity 7.871 of the Sun’s. It may be a binary star, but the companion has not been confirmed.

Triacus
3.2, 7.3, -8.8

It's very strongly suggested by *TOS* “And the Children Shall Lead” that the planet Triacus is in the Epsilon Indi system. This star is labelled “Draylax” in the *Star Trek Star Charts*, and was the candidate star for Andor in the *Star Trek Maps*. It’s a triple system, the companion stars were discovered in 2003. The main component has spectral class K5V. Gaia gives an absolute magnitude of 6.468, a radius 0.78 and luminosity 0.239 of the Sun’s has been derived. Other sources suggest a mass 0.75 of the Sun’s. The companion stars are brown dwarves in a very distant orbit. They are spectral class T, and have masses of about 68 and 52 times that of Jupiter. They orbit each other every 15 years or so, at a distance of 2.1 AU. This pair orbit the main component at a distance of at least 1,500 AU, and quite possibly more. A planet has been detected around Epsilon Indi A, with a mass 3.25 that of Jupiter, orbiting every 45.2 years at an average distance of 11.55 AU.
Vega
-22.1, 9.2, 8.3
A real star. The spectral class is A0Vvar. This star is too bright to be measured by Gaia, so other sources give an absolute magnitude 0.582, and a mass 2.135 and luminosity 40.12 of the Sun’s. Vega rotates very rapidly, sufficiently to make the “bulge” into a flattened sphere. The radius of the star at the equator is 2.818 times the Sun’s, whilst at the poles it is 2.362. No planet has been confirmed orbiting this star, although there is an extensive disc of dust and debris around it.

Vulcan
4.6, -12.1, -10.1
40 Eridani has long been matched to this planet, and it’s as close to official as you can get without an explicit statement. It is a triple system. The A component has the official name Keid. It has a spectral class of K0V. The Gaia data gives an absolute magnitude of 5.597, a radius 0.83 and luminosity 0.457 of the Sun’s has been derived. The two other components orbit each other, at a distance of about 400 AU from Keid, and take something around 8,000 years to complete an orbit around the A component. 40 Eridani B has the spectral class DA4, meaning that it is a white dwarf, the remains of a star that has expanded into a red giant, and then exploded in a nova. Gaia gives an absolute magnitude of 10.981. The C component is a red dwarf of spectral class M4.5V. Gaia gives this star an absolute magnitude of 11.26. These two stars orbit each other every 252 years, at a distance that varies from 21 to 49 AU. Masses of 0.84, 0.573 and 0.2036 of the Sun’s have been calculated for the three stars. A planet has been detected in orbit around Keid. It has a mas around 8.47 times that of Earth, and orbits every 42.378 days at a distance of 0.224 AU.

Wolf 359
4.0, -1.9, 6.6
A real star, and the site of the famous battle. The spectral class is M6.5Ve. The Gaia data release doesn’t have this star, but other sources give an absolute magnitude of 16.65, and mass 0.09, radius 0.16 and luminosity 0.0014 of the Sun’s. Two planets have been discovered orbiting this star. The inner planet has 3.8 times the mass of earth, and orbits every 2.68687 days at a distance of 0.018 AU. There is a much larger outer planet with 43.9 times the mass of the Earth. It orbits in 2,938 days at a distance of 1.845 AU.

The Romulan Neutral Zone Map

Introduction
At the risk of stating the blindingly obvious: No two patterns of essentially random dots are ever going to match up more than very superficially. The resemblance between the source maps used on screen and my versions is never going to be all that close. Even if you don’t try to match anything to what we know about the stars of the real Galaxy, reconciling the various maps of the Romulan Neutral Zone is no easy task.
The “Balance of Terror” Map

Here's the map. (“Borrowed” from Memory Alpha, but the original image is presumably still the copyrighted property of CBS/Paramount. The use here isn’t authorised, but I’m not trying to make money from it.) It looks pretty good, especially when you consider an artist actually made it; computer graphics were still years and years away. It explains the plot, and makes sure the audience can follow what’s going on. But what happens when someone comes along and tries to map that onto what we know about “real” outer space?
There are certain assumptions in any map. Some are mine, and some are reasonable inferences taken from the available evidence. That the real star Gamma Hydrae is near the Romulan Neutral Zone is very firmly stated in TOS “The Deadly Years”. Whether it’s near the bit of the Neutral Zone in the map from TOS “Balance of Terror” is more of a leap, but it’s not just something I’ve made up out of thin air.

For a start, TOS “Balance of Terror” says that it’ll take three weeks to send a message to Starfleet Command and get a reply. That could be because the Romulan attack has disrupted the communications network, but it also is a strong hint that the map shows an area of space quite distant from Earth. There’ll be another piece of evidence later, but I want to go at things in a certain sequence.

So, what’s the scale of the map? How big are all those little squares? There’s a scale marked on the map, but you can clearly see it’s just some shapes and the number 5000. If each square is a sector, then the map is absolutely huge, since each of them will be twenty light years across. Going to the other extreme, if the Romulan ship can only travel at impulse speeds (according to Scotty) then the map must be so tiny that the Romulan Neutral Zone will be too small to appear on a star chart, unless the Romulan attack is
conducted over a period of years. “Somewhere in the middle” seems the best answer. The Star Trek Encyclopedia suggests that the Neutral Zone is about a light year across. That estimate seems to be based on the travel time of a Romulan ship in TNG “The Defector”. I can’t attach that much weight to it. If it’s only a light year thick, a ship travelling at speed would barely notice it. More problematically, as we’ll see, the Neutral Zone has to have stars inside it. On the scale of outer space, a light year isn’t that much. Getting one star inside the Zone would be complicated, let alone several.

The Star Trek Star Charts decided that the squares were each two light years across. I’ve doubled that to four light years. The Neutral Zone is about 4.25 light years across at that scale, and manages to intersect a number of stars. Again, the decision isn’t entirely arbitrary, but I’ll be back to it later. Just now, I want to move onto the question of what the Neutral Zone looks like in three dimensions.

The “Side View”

What we have is a view looking down from Galactic North onto the plane of the Galaxy. Space is very definitely three-dimensional, so what does the Neutral Zone look like from the side?

Option One

This (rather crudely) shows the Neutral Zone curving around to completely enclose the Romulan Star Empire, with the outposts at the “equator.” The difficulty I see with this is that if you need closely-spaced outposts all along one section of the border, why don’t you need them elsewhere? Shouldn’t there be a network of outposts extending all across the “top view” of the Empire, covering the “top” and “bottom” of the enclosed area, not just running around the edge?

Option Two

This second drawing shows a Neutral Zone that can be monitored by the row of outposts, assuming that they’re all lined up horizontally. That seems pretty unlikely, so let’s move quickly along to the next idea.
Option Three

This shows a “taller” Neutral Zone, with the outposts at varying heights along the length of it. With the available evidence, I can’t help thinking that this is by far the least unlikely model for how the Neutral Zone should be.

My Version

This is where I have to stop sounding like I know it all, and suggest something for myself rather than just criticising. The first point to bear in mind is that none of the outposts are directly above (or below) any other. They fall in a nice sequence across the map. The second point is that they’re very close together. Especially now everyone has a clearer idea about what sensors might be able to do at that time, those outposts are really very near to each other. Of course, they could be widely separated vertically, but it’s difficult to see how that arrangement would work in practice, especially if you want to make sure that the temporary lack of one outpost doesn’t leave a huge gap in your cover. My own guess is that the arrangement is some variation on this:
I've used hexagons rather than circles to represent the “range” of the outposts, and obviously, the actual capabilities would be such that if one outpost failed, the adjacent ones would be able to provide cover for most of its zone. The whole arrangement is tilted slightly, so that a “top view” will show a row of outposts, without any overlaps. My guess is that the alignment of the proposed grid reflects the fact that the Neutral Zone itself isn’t aligned directly with the coordinate system, but it is taller than it might look. Based on this rough diagram, it could be as “deep” as the distance between Outpost 1 and Outpost 7, in other words an elliptical or rectangular shape in three dimensions. I’ve stuck to eight outposts. Seven are on the map in “Balance of Terror”, and Outpost 8 is also mentioned as being destroyed.

Are there only eight outposts? The Star Trek Star Charts has over forty running around the extended Neutral Zone in those maps, and a gravitic sensor array, too. I can't help thinking that if there's a row of outposts, and the numbering starts at “1” you’re seeing the start of the sequence (although the Star Charts solves that quite ingeniously). Naturally, just because the map ends at “7” doesn’t mean the sequence finishes there. Particularly since an eighth outpost is mentioned. Why not nine, or ten, or more? My pattern of outposts can be extended pretty much indefinitely, and outpost 8 does look a bit lonely off to one side. As it turns out, I think there’s a pattern of seven outposts, as shown, and Outpost 8 is further away.
Why don't I like an extended neutral zone? Because I think a “wall in space” is a silly idea. Trying to define and then closely monitor something like that is going to be an absolutely mammoth task. The one thing I like least about the Star Charts (and there’s a lot I like; I like the Star Trek Maps too, even if the star positions are wonky) were those long borders with strings of bases along them. It's not the sort of thing I see the Federation putting a lot of effort into. They want to seek out new worlds, and you can’t do that from behind a heavily defended border that’s assumed to be permanently fixed. How does a border like that work? The assumption seems to be that the Romulans would accept being enclosed into a closely-defined area of space. Why? More to the point, would Earth think it was a good idea to set up another war by imposing unduly harsh peace terms?

Some Extra Information
After hinting about it, it's time for me to go through some extra points raised in “Star Trek: The Next Generation”. Most importantly, TNG “The Defector” showed another map of the Neutral Zone. (Once again, the screencap is “borrowed” from the Memory Alpha website, and remains the property of CBS/Paramount. I'm using it without permission, but not for any commercial purpose.)
Yeah. Even twisted around a bit, this map is a poor fit to the one from TOS “Balance of Terror”. It does have a line of outposts, and away off in the corner, a dot labelled “Gamma Hydra”. (Yes, I know the real star’s name is Gamma Hydrae, but I’m struggling to think they could plausibly be two different stars.) There’s also a row of Outposts, numbered 3 to 6. They’re called “sierra” outposts in the story, but not on the map. The map itself is a “tactical” display. I’ve rather arbitrarily decided that means it isn’t meant to be taken as accurate. It simply shows everything of interest as clearly as it can. I’ve also decided that there aren’t any duplicated outpost numbers. There is only one “Outpost 1.” It might sound unreasonable, but there again, what if Enterprise had turned up at the wrong Outpost 4 in TOS “Balance of Terror”?

In TNG “Future Imperfect”, Riker is duped into thinking he has amnesia and can’t remember anything from the last few years. He points out that Outpost 23 is a key base along the Romulan border. Since Riker knows that, it must be accurate, not part of the deception.
So, where’s Outpost 23? It could be further along the Neutral Zone than the map in TOS “Balance of Terror” shows, but that’s getting a long way from Earth. The home star system of the Romulans is on the map. What’s the point in having elaborate border defences effectively in the middle of nowhere? My supposition is that the higher-numbered outposts are closer to Earth, not further away. Just past Outpost 1, off the bottom edge of the map, I think the Neutral Zone takes a pretty sharp dog-leg, and there’s a whole additional chain of bases. Strangely enough, there really does have to be something like that going on, otherwise, why does Commodore Stocker need to violate the Neutral Zone to get to Starbase 10?

Originally, I came up with a huge and elaborate network of outposts, with Outpost 23 occupying a central position. The problem with that was I couldn’t fit it on my map. It bumped into the Klingon Empire. Additionally, I was getting back to the “huge chain of fixed border defences” that I’ve already said I didn’t like. But that’s not what I need. TNG “Future Imperfect” is quite clear that Outpost 23 is the key to the Neutral Zone defences, and it’s secret. The whole point is that the Romulans are trying to find out where it is. If there’s an Outpost 22 and an Outpost 24, then it’s not going to be that hard to take a guess at where Outpost 23 might be. Based on the amount of room I had on my map, and my own preferences, I simply added another seven outposts, numbered 8 to 14. “Outpost 23” could be any one of the 14 numbered ones, or it could be somewhere else again.

I’ve tried to match up the objects on the “The Defector” map with objects on my chart. It’s helpful to remember that the diameters of the stars are wildly exaggerated. If they were to the same scale as the distances between them, you’d need a magnifying glass to spot them. Objects that look “half in, half out” are going to be completely inside or outside the Zone on a bigger-scale map.

I’ve included Iconia from TNG “Contagion”, since that’s in the Neutral Zone, and Galorndon Core from TNG “The Enemy”. I’ve not tried to find a candidate for “Eden” in TOS “The Way
To Eden. That's in Romulan space, but there's no indication it's behind a neutral zone. There's nothing to say it isn't, but in TAS “Practical Joker” Enterprise wanders inadvertently into Romulan-claimed space, so the Neutral Zone can't cover the whole border.

There was another map, in TNG "Birthright" Part II. That (very fortunately) has no outposts marked on it. It does show Khitomer, which ought to be near the Klingon Empire. That's a whole other kettle of fish, so I'm leaving it for later.

Even if all this isn't enough, there's:

**Nemesis**

Remember “Star Trek: Nemesis”? Not that, the bit in the Romulan Senate where they have a huge map on the floor. You never get a really good view of it, and although there is some
artwork out there, it all seems to be pre-production design sketches, not pictures of the actual map used on the set. The picture above is my highly impressionistic re-visualisation, based partly on a screenshot from the film, partly on the fact that it has to be a modification of the original neutral zone map, and lastly that it has to fit on my own star map (well it doesn't have to, but this whole project will run into trouble if it doesn't).

The neutral zone has changed shape, and there's no getting around it. (Or through it. I'm always amazed at how diligently the Romulans patrol. They seem to turn up almost immediately there's any violation. But I suppose that's something for another time.) There was a reference to a Treaty of Algeron in 2311, so this must have been the Federation-Romulan border throughout 24th century “Star Trek”. (Until they blew up Romulus.)

**My Conclusions**

After all those confusing drawings and the argumentative nitpicking, have I got anywhere? Maybe not, but here's my interpretation of the evidence. The neutral zone was set up at the end of the Earth-Romulan War, not as a gigantic division of the Galaxy, but as a mutual withdrawal as part of the initial ceasefire. As such, the neutral zone is a small area of space, separating hostile forces. Once the final agreement has been reached, this temporary zone becomes a permanent border between respective spheres of influence. Based on my guesswork to this point, I would reconstruct the end of the war as being a sudden outflanking of the Romulans. The main attack was being conducted in what I've called “Sector Tango,” but a secondary attack on the Romulan forces at Cheron left the Romulans with no choice but to seek a negotiated peace, or face a direct attack on their home star systems. The Treaty of Algeron represented a thawing of relations. One of the Romulan bases shown in the “Star Trek: Nemesis” map is in an area that would have been Federation territory, according to the TOS “Balance of Terror” map. It also appears that the Romulans got quite a bit more out of the deal than the Federation. Even so, I don't think it was intended as a cession of Federation territory. Based on what would have changed hands, I think it represents a “rationalisation” of the Neutral Zone, making it a fairer demarcation of the boundary between the two.
This is where I put everything to the test. Unlike all the other maps, this isn't an X-Y plane map, looking down from above, it's a Y-Z view from the side (to give the best view), using the actual coordinates of my candidate stars for Romulus, Romii and the other ones I've specifically assigned names to. The Y-axis (along the bottom) coordinates for all the outposts match my earlier map. The vertical Z-coordinates of the outposts are complete guesswork, but I hope that they give some indication that my ideas do work when they're applied to a “real” map. Bear in mind that the X-coordinates aren't shown, but Outpost 7 is about twenty light years “closer” than Outpost 1.

Appendix: Astrogation
A flat map can only tell part of the story, so here’s the numbers; X, Y and Z coordinates for Romulus, Romii, the other named stars, and the “Earth Outposts.”

Beta Hutzel
84.0, 48.4, 76.4
My candidate star is identified only as Gaia DR2 3500086050578451712. It has an absolute magnitude of 14.09, and has been assigned a temperature of 6,900°C, suggesting a spectral class of F.

**Cheron**

78.8, 41.07, 31.99

This isn't the star Omicron Gruis, identified as Cheron in the *Star Trek Star Charts* (although Lokai and Bele in TOS “Let That Be Your Last Battlefield” might be from that star). I've moved everything to be nearer Gamma Hydrae. My star has the Henry Draper number HD 109799, and is brighter and hotter than the sun, being spectral class F2IV, with an absolute magnitude of 2.64. Gaia data gives it a temperature of 6,900°C, a radius of 1.77 and a luminosity 6.44 of the Sun's.

There's a faint companion star, and Gaia suggests it has an absolute magnitude of 9.59, and a temperature of 4,040°C.

**Epsilon Legato**

85.5, 50.3, 78.6

My candidate for this star has the catalogue number LP 853-33. It's a dwarf star with an absolute magnitude of 13.91, and a spectral class M.

**Galarndon Core**

66.7, 37.6, 88.7

I've matched this to a star with the catalogue number EC 12393-1318, based on its proximity to where I have the Neutral Zone. It's a white dwarf star, with the Gaia absolute magnitude of 12.963. An effective temperature of 8,700°C has been derived. I took the “core” element of the name to suggest a nova remnant. There’s no guarantee that’s correct.

**Gamma Hydrae**

79.7, 69.5, 86.5

This is the only star I haven’t assigned the name to. It's a giant star of spectral class G8III, with an absolute magnitude of -0.5. The current best is that it has three times the mass of the Sun, and 16 times the radius. It's 115 times brighter, too.

Spectroscopic analysis suggests it's a binary star, but Gaia wasn't able to resolve any companions. (The other stars are vertically above and below; Gaia has no stars closer than 4.5 light years.)

**Iconia**

103.1, 76.3, 86.0

This star is identified in the Henry Draper catalogue as HD 113569. It has a spectral class of K2V, although the Gaia data gives it a temperature of 5,000°C, a radius of 0.74 and a
luminosity 0.31 of the Sun’s. That suggests it might be spectral class G, as I’ve shown on my charts.

**Moore's Star**
97.7, 68.7, 67.1

Catalogue number HD 112935. It has a spectral class of F3V. The Gaia catalogue has calculated a temperature of 6,630°C, a radius of 1.8 and a luminosity 5.67 of the Sun’s. The absolute magnitude is 2.77.

Again, this star has a suspected companion, but Gaia wasn’t able to resolve it.

**Nequencia**
90.4, 11.1, 43.2

I’ve matched this to the star HD 95456. It has the spectral type F8V. Gaia gives an absolute magnitude of 3.4706, and a radius 1.49 and luminosity 2.994 of the Sun’s have been derived. There is a suspected companion with 0.68 the mass of Jupiter, orbiting at 1.645 AU.

**Rator**
86.4, 24.5, 53.7

I’ve picked the star HD 101959. The spectral class is F9V. Gaia gives an absolute magnitude of 4.293. A radius 1.07 and luminosity 1.41 have been derived from the Gaia measurements. Thee is a suspected companion, with 0.7 the mass of Jupiter, orbiting at 1.571 AU.

**Romii**
97.3, 47.1, 71.4

This star has the catalogue number LP 908-54. Gaia assigns it a temperature of 3,940°C, a radius of 0.53 and a luminosity 0.06 of the Sun’s. The absolute magnitude is 8.3.

**Romulus**
100.0, 51.7, 69.8

My candidate star has the Henry Draper catalogue number HD 108682. It has an absolute magnitude of 5.79, and the spectral class K0V. Gaia assigns it a temperature of 5,300°C, a radius of 0.73 and a luminosity 0.38 of the Sun’s. My rough allocation of spectral classes made it a G type star.

Gaia strongly suggests that there's a companion star. It has an absolute magnitude of 12.2, and a temperature of 3,700°C.

**Sigma Nelvana**
88.7, 59.9, 64.8
In “The Defector” it’s the star system the Romulans weren’t building a secret base in. My candidate star has the catalogue number UPM J1255-3140. Gaia assigns it a temperature of 3,760°C, from which I’ve guessed a spectral class of K. The absolute magnitude is 10.58.

**Theta Curry**
96.2, 70.4, 85.0

LP 854-19 is the catalogue number of my candidate star. It’s been assigned the spectral class M3, but Gaia gives it a temperature of 3,700, so I assigned it a spectral class of K. The absolute magnitude is 10.33.

**Outpost 1**
72.1, 44.0, 72.3

**Outpost 2**
76.1, 47.3, 86.8

Destroyed in TOS “Balance of Terror”.

**Outpost 3**
78.7, 52.9, 59.1

Destroyed in TOS “Balance of Terror”.

**Outpost 4**
79.6, 59.2, 75.8

Destroyed in TOS “Balance of Terror”.

**Outpost 5**
84.3, 64.4, 90.3

**Outpost 6**
88.0, 69.6, 62.6

**Outpost 7**
93.7, 74.1, 79.3

**Klingon Map**

**Quite Frankly, it’s Canon!**

Anyone who has seen the first season of “Star Trek: Discovery” will doubtless remember that the course of the war between the Federation and the Klingon Empire was tracked on a big star map.
A number of points can be made about it, but the most important is that it matches the maps in the Star Trek Star Charts remarkably closely. Right down to the labels on the various stars. There are some differences, but they can’t obscure the main conclusion: that a map of the Klingon Empire really needs to pay close attention to what the Star Charts did.

**So, You’ve Just Copied It?**

Not exactly. There are a few differences, and some things that maybe shouldn’t have made it from the Star Charts onto this map. The major difference is that I’m plotting practically all the star positions on my map from data that wasn’t available then.

One point to make first. The Star Charts maps include stars I haven’t. I’m trying to think more closely about how all this is likely to work in three dimensions. My map is a cube of space, and is only as “deep” as the area it covers horizontally. That means “Brestant,” identified as the real star Delta Leporis is too far “south” for my map to include it. There are several other stars omitted for the same reason—they’re off the edges of the space I’ve mapped.

The grid lines on the “Disco” star map bear no relation to the ones in the Star Charts, or the ones on my map. In particular, the boundary between the Alpha and Beta Quadrants isn’t where you’d expect. It looks to me as though the idea is it’s a view of a three-dimensional “holographic” map, and the angle only makes it look as though things are placed differently. That has the huge advantage of meaning the star positions aren’t that fixed. As long as the stars are in the right general alignment, the precise positions are open to interpretation.

Even that isn’t always enough. Take a look at this excerpt from the Star Trek Star Charts.
Now look at a similar slice of my map.

You’ll notice that Omega Leonis, No’mat, Gorath and Kronos have shifted about a bit, in relation to each other and the sector grid. The problem is that more accurate parallax measures have narrowed down the distances of the stars. They’re still within the margin of error of the Hipparcos data, but Gaia has shifted them slightly. In many cases, it’s not a problem. Where stars are placed in a particular alignment to the sector grid, there are problems. The grid doesn’t move. Just wait until I get to Cardassia and Bajor!

When you’re faced with a problem like this, there are two possibilities: adjust the star identifications to more closely match the map, or just accept the change. In this case, I’m working to the “Star Trek: Discovery” map, not the Star Charts directly. That adds a useful element of uncertainty to where stars might be precisely. There are also clear labels saying what star “No’Mat” and “Gorath” are supposed to be. They’re just about clear enough to read, and I decided not to try and ignore them. Where stars aren’t clearly identified with real ones, like “Kronos,” I’ve taken my best guess.

I’m sure you’ve all spotted that “Kronos” isn’t actually in “Qo’noS Sector” in my map, and that the same is true of the “Disco” map. The only thing I can think of is that the designation is based on the Klingon division of space, and the Federation “sector grid” has nothing to do with it. It’s rather confusing.
Quite clearly marked along the Klingon border are a series of Federation monitoring posts. I'm sure you remember how V'Ger destroyed the Epsilon IX post in "Star Trek: The Motion Picture". What I'm not so sure of is whether those posts should be in the "Star Trek: Discovery" star chart. Was the Klingon “border” monitored that closely in the 2250s? It seems really unlikely to me.

**Appendix: Astrogation**

**Gorath (סרכסה, ghorat, Theta Hydrae)**

72.8, -63.8, 61.6

The map in "Star Trek: Discovery" identifies the real star Theta Hydrae as the star “Gorath.” I’ve kept that identification, although the position of the star in relation to the Klingon border is different from that taken from the Hipparcos distance measurement. The main star has the spectral class B5.9V, and a Gaia absolute magnitude of 1.058. Wikipedia lists a mass 2.52 times the Sun’s and a luminosity 52 times greater. There is a close-orbiting white dwarf companion, detected only by X-rays. It sounds just the place to have sulphur lagoons.

**Khitomer (קיטומר, QI’tomer)**

81.3, -48.6, 56.1

My selection for Khitomer is HD 81809 in the Henry Draper star catalogue. Although Gaia hasn’t resolved this pair, it’s a binary system. The main component is spectral class G2IV, and has 1.7 times the mass of our Sun, and the (slightly) smaller star is G9IV, and about the same mass as the Sun. The Gaia parallax gives the main star an absolute magnitude of 3.159, and the secondary component one of 4.159. The two stars take about 35 years to complete one orbit around their common centre of gravity.

**Kronos (קְרֹנְו, Qo’noS)**

81.6, -66.7, 42.1

The star I’ve picked as the home system of the Klingons has the Henry Draper catalogue number HD 74014. The spectral class is K0III, and the Gaia absolute magnitude is 4.689. Although it has a slightly lower surface temperature than our Sun, the radius and luminosity of the star are almost the same. The star has a brown dwarf companion, with about fifty times the mass of Jupiter. How it orbits the star isn’t known with any degree of precision, so I’ve assumed it’s distant enough not to be a problem. Since the “best match” model gave it an eccentric orbit (meaning it loops closer to the star and then travels in an ellipse much further away, rather than orbiting at roughly the same distance in a circular orbit) lasting about 19 years, I could be unlucky with that assumption.

**Morska (מורסקה, morSqa’)**

82.0, -53.7, 60.7

This star has the catalogue number Gaia DR2 3837244767180936704. I’ve given it a spectral class K, but it is more likely to be an M red dwarf. (A lot of the smaller stars ended up K rather than M, but I’m not an astronomer. I did my best.) Gaia gives it an absolute magnitude of 10.719. There’s not a lot I can say. It’s small, not tremendously bright, and vaguely on the way between Rura Penthe and Khitomer.
No'Mat (reur' pente’ Subra)
66.0, -66.9, 84.8

This star has also been identified from the “Disco” star map. It also has the name Omicron Leonis, which applies to the whole system. “Subra” is the name of the brightest star, one of three. The A component is a close-orbiting binary, and has been detected only by analysing the spectrum of the star. The combined components have a mass just over twice that of the sun, and about 39 times more luminous. The pair have a spectral class of F9III, and a Gaia absolute magnitude of 0.332. The more distant companion is a white dwarf, spectral class A5m. It has a mass of about 1.87 times the Sun, and a luminosity 15.4 times greater. The two stars orbit each other in about fourteen and a half days, so they’re all three very close together. The planet with the lava caves is likely to orbit all the stars, and be subject to quite a lot of gravitational stress, keeping it hot and molten.

Rura Penthe (reur’ pente’)
82.2, -56.6, 89.2

My candidate star has the catalogue number UCAC4 465-044659. Most of the information I could find has been derived from the Gaia data. I’ve assigned it a spectral class of K, but these classifications are only very approximate. The absolute magnitude is 8.961. Just the place for an icy prison planet.

Cardassia and Bajor (Version Two)

This should have been easy. Geoffrey Mandel matched the star chart in the Star Trek: Deep Space Nine Technical Manual carefully against the stars in the Hipparcos catalogue when he was preparing the Star Trek Star Charts. He found a pair of remarkably good candidates for “Bajor” and “Cardassia” and plotted his star chart around them. Alas, time moves on, and the measurement of how far away stars are has improved. The Hipparcos data was well beyond anything available before, but Gaia is even better. In practical terms, the distances to the two stars has been pinned down with greater precision. That’s a problem, because the stars have to sit in a particular relation to the sector grid if they are to match the Technical Manual map, even approximately. The revised positions of the stars don’t. The good news is that Gaia offers a lot of new candidate stars, but the options are not limitless.

One map, which I’ll return to later, places the Cardassian border close to the real star Gamma Tauri. There’s no absolute reason Cardassia and Bajor might not be on the fringes of the Hyades star cluster, which is where that map would put them. It’s nowhere near the location in the Star Trek Star Charts though. That means that every star map in “Star Trek” based on the charts and showing the Cardassians is going to be wrong. To match up to the map shown in “Star Trek: Picard”, for example, my new candidates for Cardassia and Bajor have to be in at least roughly the same relation to Earth, the Klingons and the Romulans. That further limits the options by quite a bit.

Surveying the Options

Although originally I tried to limit the area of space I was looking at, and then picked the two star I thought might fit, it wasn’t a particularly satisfying solution. What if there were better candidates that I’d missed? There then followed quite a long process of trying to extract the information I needed from the data I had. My two stars had to be in roughly the
right area of space. Although it drastically cut down the options, I arbitrarily decided that they had to fall on opposite sides of a sector boundary, and be less than ten light years apart. There were quite a number of possibilities, even with these restrictions. None of them seemed to be terribly good candidates, but I did find that there was a “least worst” option.

One of the problems I had was Stellar and substellar companions of nearby stars from Gaia DR2. Binarity from proper motion anomaly, by P. Kervella and colleagues. They’ve suggested that there are quite a few large companions to stars, and I kept finding that the stars I was looking at had been assigned prospective companions in this paper. Although I was reluctant to just ignore it, I found that all the candidate stars were effectively being ruled out, including the star I’ve eventually picked as “Bajor.” On the one hand, I may have selected a star that will later prove unsuitable, but on the other, these are “educated guesses,” not actual detections. There may well prove to be something there, but the information here might be wise of the mark. I’d be the first to admit I don’t know. What did strike me was that I was ruling out stars because they had large (over half the mass of Jupiter and upwards) companions orbiting very close to 1.5 Astronomical Units from the star. When I say “close,” practically every one of the suspected companions was at that distance. The masses varied quite a lot. The orbital distance hardly at all. That might be an amazing new discovery, but I’m tempted to think that it’s a feature of the “best fit” solutions the paper created for each star.

The difficulty with accepting a really big planet orbiting close in is that it not only doesn’t match the diagrams in the Star Trek: Deep Space Nine Technical Manual or the Star Trek Star Charts, but it’ll play havoc with the orbit of any potentially earthlike planet in the system. Even if I start getting ingenious and suggesting that the Wormhole is being mistaken for a planet, gravity is gravity. If something that massive is that close to the star, Bajor will be pushed and pulled into a complicated orbit that will take it too close to the star for people to survive, before taking it so far away the whole planet freezes. I’ve called out suspected companions, but I’m not convinced that they’ll all turn out to be accurately modelled.

Since I’m not just re-drawing the Star Trek Star Charts map, I had another look at the map of the Cardassian border that showed Gamma Tauri. It soon became pretty obvious that the Star Trek Star Charts had done quite a lot of reinterpretation. The map’s not that helpful. It has a star labelled “Andoria” in a very unlikely place, and the border itself is oriented in a way that’s very difficult to reconcile with the map of Cardassian space. As I noted earlier, the only “real” star on the map would put Cardassian space in a completely different location, “underneath” the Klingons. That’s definitely nothing like the map in “Star Trek: Picard”. Then I wondered if the map was showing what was going on on the other side of the Badlands? Once I’d put it there, I began to see why Federation encroachment was such a big deal. The Cardassians are effectively being “squeezed” from both sides. It also transforms the attack on Chin’Toka from a rather bewildering side-show into an assault aimed straight for Cardassia.

At first, it seemed a bit too much of a departure. If the Federation was that well established beyond the Badlands, what were the Dominion doing? As I looked at the star systems mentioned as being on the front lines, or threatened, it looked more and more to me as though the Dominion strategy was to get control of the Wormhole, and then launch an “all or nothing” assault directly on Earth.
**Astrogation**

**Bajor**

-58.14, -30.0, -145.7

The star I picked is HD 3964. It has the spectral class G5V, and Gaia suggests an absolute magnitude of 4.778, a radius about 0.98 of the Sun's, and it has about 0.92 times the luminosity. There is a suspected companion, with 1.42 Jupiter masses orbiting at 1.535 AU. That gives a suggested mass for the star of 1.081 times the Sun's. I've assumed that there's a glitch, and the star system is similar to the one in the *DS9 Technical Manual* and the *Star Charts*. I can't say I'd be devastated if I was proved wrong, although I doubt it would still be a good candidate for Bajor's sun.

**Cardassia**

-64.0, -28.0, -147.4

My candidate for this star has the Henry Draper catalogue number HD 3231. It's a K1V star, and Gaia suggests an absolute magnitude of 5.747, a radius 0.808 of the Sun's and 0.404 times the Sun's luminosity. This star also has an “inhabited planet unfriendly” suspected companion, with 0.58 the mass of Jupiter orbiting at 1.444 AU. That suggests a mass for the star of 0.9 of the Sun's. The Gaia position data puts this star 6.4 light years away from my “Bajor” candidate star.

**Chin'Toka**

-73.6, -34.5, -131.3

My candidate for this star bears no relation to where the *Star Trek Star Charts* has it in relation to Cardassia and Bajor. My candidate real star has the Henry Draper number HD 3167. Its spectral class is K0V. Gaia suggests an absolute magnitude of 5.385, a radius 0.88 of the Sun's and 0.547 of the luminosity. There are three confirmed exoplanets orbiting this star, the innermost has about five times the mass of earth, orbiting at 0.01815 AU every 0.959641 days. The next has a mass 6.9 times earth's, and orbits at 0.077 AU in 8.509 days. The outer known planet has 9.8 times the mass of Earth and orbits at 0.7195 AU in 29.875208 days. This suggests a mass for the star of 0.86 times the Sun's. It also makes rather a mess of the diagram of the Chin'Toka planetary system, but I can't say I'm all that bothered.

**Fahleena**

-51.7, -25.0, -169.5

My candidate star has the catalogue number BD-09 134. The Gaia information gives it an absolute magnitude of 5.899, a radius 0.712 of the Sun's and a luminosity of 0.344. Other sources suggest a mass 0.895 of the Sun's. I've assigned it an approximate spectral class of G, since I've not been able to find one elsewhere.

**Goralis**

-94.3, -37.3, -149.1
My candidate star is HD 2176. The Gaia data gives an absolute magnitude of 5.321, The spectral class is K0. The PRISM data calculated from the Gaia measurements assigns this star a radius 0.915 of the Sun's with a luminosity 0.583 of the Sun. Once again, there's a suspected companion, with 1.52 the mass of Jupiter, orbiting at 1.486 AU. This suggests a mass for the star of 0.98 of the Sun's.

**Prophet's Landing**  
-58.8, -35.2, -150.0

My candidate real star has the catalogue number HD 4620. It has a spectral class of K1/2(V). The Gaia data gives an absolute magnitude of 6.088, a radius 0.76 of our Sun's, with a luminosity of 0.307. Other sources suggest a mass of 0.824 the Sun's.

**Rondac**  
-97.5, -45.1, -153.4

My candidate for this star has the catalogue number HD 2934. The Gaia data gives an absolute magnitude of 5.295, a radius 0.915 of the Sun's with a luminosity of 0.594. It has the spectral class G5. Other sources suggest a mass 0.977 of the Sun's.

**Septimus**  
-96.4, -34.6, -124.5

My candidate for this star has the catalogue number G 30-57. It has a spectral class of K5V, and the Gaia data suggests an absolute magnitude of 7.515, a radius 0.563 of the Sun's and a luminosity of 0.101. Other sources suggest a mass 0.655 of the Sun's.

**Setlik**  
-98.2, -26.8, -154.2

I've not tried to match the location of this star in the *Star Trek Star Charts*, just placed it somewhere in the DMZ. My candidate has the catalogue number BD+04 16. It has a spectral class of K0. The Gaia data suggests an absolute magnitude of 5.804, with a radius 0.853 of the Sun's, with a luminosity of 0.396 of the Sun. There's a suspected companion with 35.46 times the mass of Jupiter, orbiting at 1.444 astronomical units. I'm not sure how Setlik III would fit with that arrangement, if it's accurate. The suggested mass of the star is 0.9 of the Sun's.

**Trivas/Empok Nor**  
-62.2, -29.7, -143.9

I've matched this to the star LP 585-64. It has an absolute magnitude of 8.854, and no radius or luminosity were derived for this star. Other sources suggest a radius 0.482 or the Sun's and a mass of 0.48. The spectral class is M. Gaia position data has it 4.4 light years from my Bajor candidate star.
“Star Trek: Picard”

This is without doubt the most subjective of the four maps. Unlike the Romulans, Klingons and Cardassians, there’s no existing map for me to work from. All I can really say for certain is that Vashti is somewhere in the space beyond Alpha Doradus.

Iconia Sector?

Michael Chabon’s notes about Freecloud place it in the “Iconia Sector”. That’s not altogether wrong. If you look at the Star Trek Star Charts, then the star labelled “Iconia” is pretty close to where Alpha Doradus would be if it was there. I’d guess that the star was omitted purely because it had never previously been mentioned.

That raises again the question I discussed earlier in relation to the Romulan Neutral Zone: if it’s a giant “safety curtain” hundreds of light years “tall”, how can the arrangement of outposts along it effectively monitor more than a narrow strip along it? If the Neutral Zone isn’t hundreds of light years “tall”, then how can it be in close proximity to both Gamma Hydrae and Alpha Doradus? In this particular case, is “Iconia” less than 20 light years from “Freecloud”? Of course, since there are no “above” or “below” sector names anywhere on the main maps, just the introductory maps showing the space near Earth in three dimensions, it’s possible that the “Iconia Sector” extends vertically for much more than 20 light years. That’s not what the book is suggesting, and it still does nothing to answer my questions about how the Neutral Zone will work in three dimensional space.

The name of the sector is in background material, and unlike the identification of Alpha Doradus with Freecloud, there’s no absolute “on-screen” reference to it. It seems a really odd choice anyway. “Iconia” was the homeworld of a lost civilisation. Until Captain Varley tracked it down in TNG “Contagion” nobody knew where it was at all. Did they rename the sector, because Freecloud must have already been there? Why would they do that, and why pick Iconia? After all, by the time Picard and his pals had finished with it, there wasn’t much left, and it was in the middle of the Neutral Zone, too. The alternative is that Captain Varley’s search for Iconia was pretty easily narrowed down for him by the fact the sector this “unknown” planet was in was called after it. Seems like a pretty strong clue. I wonder how everyone else missed it?

Cheap sarcasm aside, I have reservations about the “Iconia Sector” that aren’t just because I’ve picked somewhere else for it to be. There’s nothing to stop me moving “Iconia” here, or from putting it anywhere along the Federation-Romulan border I like, but I still think it’s not a terribly obvious name for a sector.

Is That a Star Cluster?

Whilst plotting the stars on this map, it became obvious that there was quite a dense concentration of smaller stars at the top of it. It’s perhaps less immediately visible in the finished map, but there is certainly an unusual concentration of hotter “dwarf” stars along the top quarter of the map. Have I discovered something interesting? The simple truth is that I don’t know, because I’m not an astronomer. It’s hugely suspicious that such a big association of even small stars hasn’t been spotted already. It’s a near-certainty that I’m looking at some sort of artefact in the Gaia data when I discovered that this odd “star
cluster” is very coincidentally aligned between Earth and the Large Magellanic Cloud. There is absolutely no possibility at all that the LMC isn't well outside our galaxy, and a lot further away than this map shows. It’s also very unlikely that a nearer group of stars right "in front of" the LMC wouldn’t have been noticed sooner. I have no sensible way to filter the stars out of the map, other than arbitrarily just cutting them. That means they’re there on the map, but I’m pretty sure they aren’t “really” there. It’s a pity, but that’s the way it is.

Choosing a Star for Vashti

What do we know to narrow down the options for where Vashti might be? It's in the Qiris Sector, possibly the same sector as Daimanta. It's near where the Romulan Neutral Zone was. Perhaps the biggest clue is that it has two suns, very close together, in the sky.

So, we’re looking for a binary star in a sector with at least two other significant stars, to be “Daimanta” and “Qiris”. That “Qiris” is a star or planet is a guess, but it must apply to something in the sector, and a star is the most useful option in a star map. Whilst I’m not that convinced, it did strike me that it would be a good idea to try and make sure my “Vashti” candidate really is close to the Romulan Neutral Zone as shown in the Star Trek Star Charts. (Or indeed Stellar Cartography.) Just because I have my own ideas doesn't mean I shouldn't at least try to accommodate other options.

So, have I narrowed things down so far I've ruled everything out? Luckily for me, not quite. As I discovered with my researches into candidates for “Bajor” and Cardassia”, a LOT of stars have potential gas giant/brown dwarf companions in close orbits. As before, I've ignored them for the time being, although I might regret it later. On the same note, if GAIA has managed to resolve a multiple star system at this distance into separate components, then they're going to be far too widely spaced to look like the stars in Vashti's sky. Fortunately, one candidate sector remained, so I've used that.

Appendix: Astrogation

Daimanta

156.7, 1.9, -118.1

I've matched this star to HD 32384, purely on the grounds that it's fairly distant from my candidate for vashti, and still in the same sector. The GAIA data gives a radius of 1.03 and a luminosity of 1.01 compared to the Sun's. Other sources give a spectral class of G5V and a mass 1.03 of the Sun's. It's a wide binary system. The companion star has a mass of 0.53 of the Sun's and the pair complete an orbit every 3,100 years. The mass and magnitude suggest a K8V star, with a radius 0.63 of the Sun’s and a luminosity of 0.09.

In addition, there is a suspected companion with 2.46 the mass of Jupiter, orbiting at 1.535 AU. If it's there it makes a planet like Earth quite unlikely, but its existence is not yet confirmed.

Freecloud

131.0, -14.2, -116.2

This planet is clearly identified as orbiting the real star Alpha Doradus. Wikipedia says the main component is a giant star of spectral class A0IIIp. It has about 3.33 times the mass of our sun, a radius around 3.5 and is 195 times as luminous. The smaller (in relative terms) component is blue star of spectral class B9IV. Measured against our own sun, it has a
mass 2.7 times greater, a radius of 1.9 and a luminosity 70 times greater. The two stars orbit around each other every 12.1 years, and are separated by 2 to 17.5 Astronomical Units.

Information given as background (in other words it’s not definite) suggests Freecloud is about the size of Venus, and one year lasts around 700 Earth-days (that seems like a lot, but if a planet like Earth is going to orbit both the main stars, I think the local years are going to be really significantly longer than that).

**Qiris**

140.6, 4.6, -113.2
I’ve matched this star to HD 30295, mainly because it’s the star closest to Freecloud, and the first one likely to have been settled. In other words, a complete guess. The GAIA data has a radius 1.04 and luminosity 0.814 of the Sun’s. Other sources give a spectral class of K0/1V and a mass 1.043 of the Sun’s.

Once again, a companion has been suggested. It would have a mass 0.63 of Jupiter’s and orbit at a distance of 1.517 AU.

**Vashti**

151.6, 17.73, -119.9
I’ve matched this star to HD 29907. It’s a spectroscopic binary, but very little is known about the companion star, other than it orbits in 29.913 days. The truth is, it could look nothing at all like “Vashti” as seen in *Star Trek: Picard*, but there’s no absolute proof that it doesn’t. All I can say for sure is that there’s a close-orbiting companion. The GAIA data suggests a radius of 0.667 and a luminosity 0.372 of our sun’s. Other sources give a spectral class of G2VI and a mass 0.868 of the Sun’s.

*Orbital elements for double stars of Population II. The system HD 29907 by H. Lindgren and A. Ardeberg published in 1996 gives an orbital eccentricity of 0.407, and I think that’s more than enough to cause problems for a planet like Vashti, owing to the odd tidal effects. All I can say is: if you have a better candidate, please tell me!*

Timon Proctor,
18 August 2021.