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Spectral Class Distribution of Galactic Phenomena

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ABSTRACT

We present a study of potential relationships between Harvard stellar classification and notable phenomenon that have been discovered and cataloged in the Milky Way.

Keywords: Barnacles — Bark Mounds — Brain Trees — Crystalline Shards — Guardian — Habitable Worlds — Lagrange Clouds – Sinuous Tubers — Terraforming — Thargoid — Tube Worms

1. INTRODUCTION

Understanding the relationship between the Harvard Stellar Classification of a primary star, and what phenomena may be discovered in a system can help guide exploration efforts. Rather than broad surveys which collect data on a somewhat random distribution of stellar classes and return a mix of survey results, a targeted survey, such as all K class stars in a sector can increase the quality of survey data.

Current models place the total number of systems in the Milky Way at 4.0×10^{11}. According to what little data has been provided by the Pilots Federation, we estimate approximately 1.2×10^{8} explored systems, which amounts to less than 0.1% of the Milky Way explored.

At the current rate of exploration, barring a 1-2 order of magnitude increase in Frame Shift Drive jump range, it will take at least 16,000 years to explore every system in our galaxy.

Unfortunately, The Pilots Federation does not provide direct access to collected exploration data. Given the lack of direct data access, the EDSM independent exploration database only tracks approximately 4.2×10^{7} systems, which is significantly less than the total estimated number of explored systems in our galaxy. Efforts are being made to encourage more CMDR's to assist with data collection.

We present detailed information on stellar class distribution in the Milky Way and observations of notable phenomenon discoveries. We also present potential patterns and biases in the data collected.

2. DATA AND ANALYSIS

Starting with a data survey comprised of 3.28×10^{7} known explored systems, filters were used to then obtain systems with notable phenomenon, both biological, and non biological. We analyzed the distribution of phenomenon by Harvard stellar classification to determine any correlations between spectral class, and the frequency of certain phenomena.

At present, we only look for stellar classes O,B,A,F,G,K,M, and to a lesser extent, L,T,and Y. There are numerous occurrences of phenomena in systems with Neutron Stars, White Dwarfs, Herbigs, and Carbon stars. The primary focus of this survey is to determine the frequency of certain phenomena with respect to mostly main-sequence systems.

We see the data trend favor M class systems. Given the prevalence of M class dwarf stars, this is an expected result. Conversely, we see very few O and B stars, which is also expected. One area of potential concern is bias due to which stellar classes can be "scooped" for fuel by explorers (OBAFGKM). Across nearly all data charts, the more temperate stellar classes (F,G,K, and M) dominate with between 55% and 80% coverage, depending on phenomena.

Figure 1 presents the distribution of Harvard stellar classifications, as reported by independent explorers, who have submitted data to the EDSM network. The observed data largely follows theoretical models using ground and space telescope data from the Sol system.

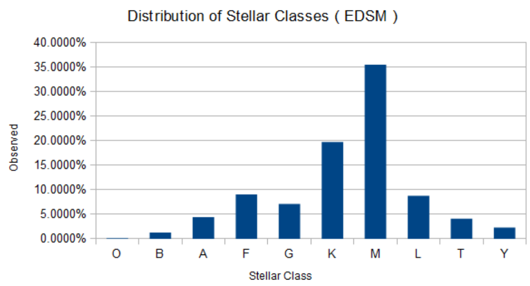


Figure 1. Distribution of stellar classes from exploration data submitted to EDSM

Figure 2 presents the distribution of Harvard stellar classifications, based on ground and space telescope observations from the Sol system, and theoretical models.

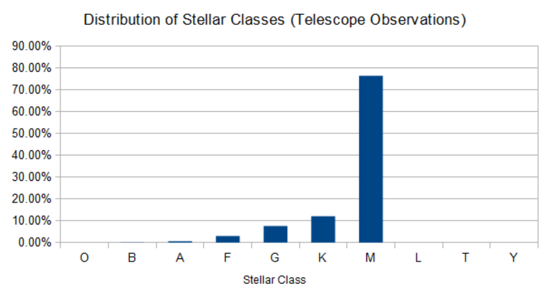


Figure 2. Distribution of stellar classes based on ground and space telescope data (Sol System).

The data show a similar trend toward spectral class M, and very few O/B class stars. Given the faintness of class L, T, and Y dwarfs, it does seem reasonable that actual exploration data would show more of those systems than telescope observations from the Sol system.

In both graphs, M class systems largely dominate. Given that both sets of data are based on limited observation data, and not the entire Milky Way, follow up work will be needed as additional systems are discovered by explorers, stellar probes, and ground/space telescopes.

A proposal has been submitted to AEGIS and other Federal, Imperial, Alliance, and Independent research organizations to establish several large telescopes (Radio, Infrared, Near-IR/Visual/UV, X/Gamma ray) in the Oevasy SG-Y d0 system, which is currently the most distant known system from Sol. Collecting data from the opposite side of Sgr A* would be of great benefit to the entire Astrophysics community.

The following sections provide detailed analysis of several notable phenomena found throughout explored portions of the galaxy. We discuss each phenomena and the implications of observed stellar class distributions.

2.1. *Bark Mounds*

Bark Mounds were first discovered in the Colonia system (3 c a), and are a fungal growth with potential connections to Guardian Brain Tree, and Guardian Ruins sites. Research has been done to understand the 0.18Hz audio signals emitted by Bark Mounds, given their similarity to Brain Tree and Guardian Obelisk audio signals. (Maligno, et al. 3304)

Figure 3 shows known Bark Mound locations, and their distribution by stellar classification. Classes A through M largely dominate, with less than 1% out of 575 known and documented Bark Mound sites being located in a system with an O type primary star.

7% of Bark Mound sites are located in systems with a B type primary star. Habitable systems are generally found in systems with F through M type stars. Follow up studies on Bark Mound sites could investigate average surface temperatures, and distances from the primary star the host planet orbits. It is well within the realm of possibility that Bark Mounds on planets orbiting cooler stars would be found closer to the host star, and Bark Mounds on planets orbiting hotter stars would be further out. How this is related to the "Habitable Zone" of the host star is unknown at this point, and worth additional investigation.

Based on the data currently collected, explorers have nearly equal chances of finding Bark Mound sites in systems with hotter primary stars (spectral classes O, B, A, and F) as they do finding Bark Mound sites in systems with cooler primary stars (spectral classes G, K, M, L, T, and Y).

Current information regarding the Guardians and their physiology does correlate to the very low occurrence of Bark Mound, Brain Tree, Guardian Ruin, and Guardian Structure sites in systems with primary star spectral classes L, T, and Y, since such brown dwarf stars only range in temperature between 300K to 2,000K and generally do not sustain Hydrogen fusion for long, if at all.

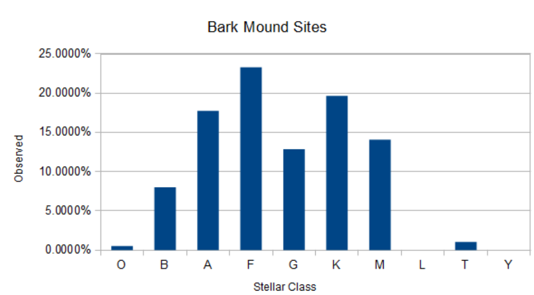


Figure 3. Distribution of Bark Mound locations by stellar class

2.2. *Thargoid Barnacles*

Thargoid Barnacles are organic structures that convert surface resources into Meta-Alloys, which are used in the construction of Thargoid ships and technology. Often found on low gravity planets with metal contents greater than 9%. Notable locations rich in barnacle sites are close to the Pleiades, Witch Head, and California nebulae. (Canonn Research, Et al. 3303).

The organic nature of Thargoid Barnacles corresponds well to the data in Figure 4. Despite a low sample size (54 systems), we see nearly 80% of systems containing one or more Thargoid Barnacle sites with a spectral type K or M primary star.

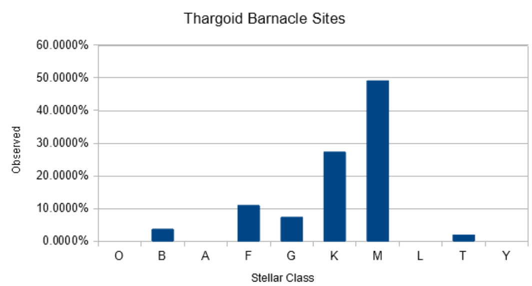


Figure 4. Distribution of Thargoid barnacle locations by stellar class

Given the organic nature of Thargoid Barnacles, and their distribution heavily favoring the more habitable side of the stellar classification chart, it would be reasonable to conclude that Thargoid Barnacles could be deposited, and thrive on any metal rich, habitable world - even Earth, or any number of terraformed worlds in the "bubble" region near Sol.

With human settlements and Thargoids incursions on the rise, precautions should be taken to ensure Thargoid Barnacles are not deposited on human occupied worlds. Reports have been made of Thargoid scout ships "checking in" on Barnacle formations, possibly using the Meta-Alloy secretions to refuel and/or repair.

2.3. *Brain Trees*

Mainly found in Ejecta Craters around Guardians Ruins areas, Brain Trees are found on any type of world as long as the world has some form of Volcanism. Ejecta Craters can be recognized from orbital cruise. You usually see lines coming off of the crater, though sometimes these can be hard to see. Brain Trees have also been found in the lines radiating from these craters, and more rarely elsewhere on suitable planets. The temperature range has to be between 200k up to 496k.

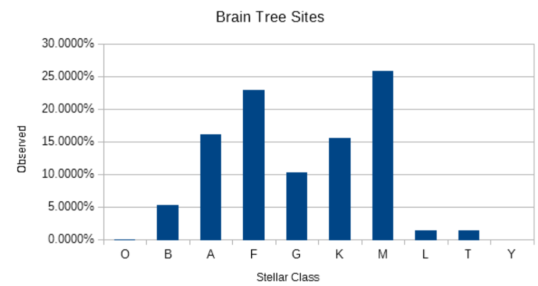


Figure 5. Distribution of Brain Tree locations by stellar class

Figure 5 shows interesting data trends in that the hotter stars (B,A,F) show an increase of Brain Tree site presence the cooler the central star. This trend also appears on the cooler side (G,K,M). One other possibility is that there are a significant number of undiscovered Brain Tree sites in systems with a spectral class G, or K primary star.

The sample size (700 systems) is one of the largest sample sizes analyzed. We conclude the large number of Brain Tree systems submitted to the EDSM database relates significantly to high interest in Guardians, and their technology. Since Brain Tree sites are found near Guardian Ruin locations, we will explore the similarity between Brain Tree distribution, and Guardian Ruin distribution in later sections.

2.4. *Crystalline Shard*

Crystalline Shards are structures created by micro-organism colonies, not unlike coral formations once found in Earth's Oceans. Found frequently in sectors located in the outer rim of the galaxy such as the Sanguineous Rim and The Abyss. Additionally, Crystalline Shards only form on planets at least 12,000 LS from the host star, and with volcanic activity.

At present there is only one known classification of of crystalline shards. CMDR's can utilize the weapons on a Surface Reconnaissance Vehicle (SRV) to knock loose valuable (and rare) resources. Crystalline shards differ from most other biological sites in that there is a tendency to find them located near geological features such as active vents and plumes. (Factabulous, Et Al. 3304)

Figure 6 shows the distribution of Crystalline Shard sites by spectral class.

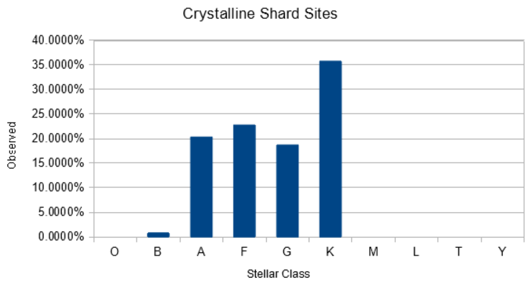


Figure 6. Distribution of Crystalline Shard locations by stellar class

Of the 123 reported systems with known Crystalline Shard locations, over 90% have class A-K primary stars. Given the remote locations of Crystalline Shards, and the small sample size, it is difficult to draw any meaningful conclusions at this time. It is possible that Crystalline Shard formation may depend less on what type of star the planet is orbiting, and instead depend more on planetary geology, and volcanic activity.

2.5. *Lagrange Clouds*

Lagrange Clouds are Notable Stellar Phenomena featuring dense regions of gas locked into a fixed Lagrange point, where the combined gravitational forces of multiple bodies create a stable region. At present, there are thirteeen known subtypes, featuring different colors, with some experiencing electrical storms. Lagrange Clouds are some of the least understood phenomena in our galaxy. The currently known Lagrange Cloud types are: Caeruleum, Croceum, Luteolum, Proto, Roseum, Rubicundum, and Viride. At present, storm cloud variants have been found for most sub-types. Explorers should exercise caution when entering Lagrange Cloud sites as certain actions such as scans, and enabling external lighting have been known to trigger reactions.

Figure 7 shows the distribution of the 248 known Lagrange Cloud locations with respect to the host systems primary star stellar class.

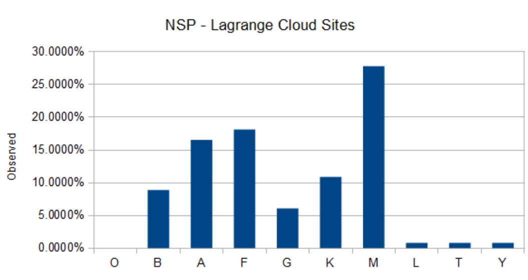


Figure 7. Distribution of Lagrange cloud locations by stellar class

Examining the nearly flat distribution across stellar classifications, we see a similar trend as Crystalline structures in that stellar classification may be less of a criteria to consider when searching for these types of phenomena. Given the crystalline and gaseous nature of Lagrange clouds, a follow up investigation could be done to examine host star metallicity, and proximity to nearby molecular gas clouds or nebulae.

2.6. *Guardian Ruins*

Guardian Ruins are the remains of what is believed to be the Guardian interstellar communications network. The first Guardian Ruins site was discovered in 3302 by CMDR XDeath in the Synuefe XR-H d11-102 system. Guardian Ruins continue to be a subject of interest for explorers and xenoarcheologists.

The Guardians were a technologically advanced humanoid race that colonized an area of the Orion arm before humans mastered interstellar travel. They were a strongly communal society arranged in co-operative city-states. They used a system of monoliths to share information between settlements many light-years apart. The Guardians had a strong spiritual connection to their environment, and carefully managed their impact on the world around them, maintaining a connection to their pack-hunter origins. They were highly adept at genetic manipulation and used this to modify both themselves, and their environment to improve quality of life, or to wage war.

Although peaceful for the majority of their history, technological disparity gave rise to two major conflicts. The second of these was an ideological and religious war fought in response to the increasing technological advancements facilitated by artificial intelligence. Sadly the escalating automation of this war destroyed the habitat and majority of the population of the Guardians home world. Only now are humans discovering the remains of this once great civilization, and there are many questions left unanswered. (Atrum, CRG, Et al. 3303).

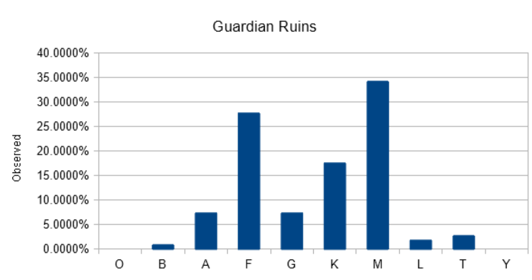


Figure 8. Distribution of Guardian Ruins by stellar class

Figure 8 shows a remarkably similar distribution to Brain Tree sites, despite a small data set of 108 systems. Explorers have noted that systems with Brain Tree sites almost always have Guardian Ruins nearby. 87% of known Guardian Ruins locations are in systems with spectral classes F, G, K or M. Given what is currently known about Guardian physiology, we expect the Guardian Ruins sites in class F and class G systems to be further from to the host star, whereas Guardian Ruins sites with class K and M host stars should be located very close to the host star.

2.7. *Guardian Structures*

Guardian researcher Ram Tah discovered the first Guardian structure site on February 27, 3304. It should be noted that while several Ancient Ruins are often found in the same system, so far only one Guardian Structure site has been found per system. At present, Guardian Structures have been located in the Synuefe, Col 173 and Vela Dark Region areas all near the permit locked Regor sector.

After his initial discovery, and analysis of recovered Guardian artifacts, Tah announced that he had determined three possible new Guardian sites in the Col 173 Sector: QU-O d6-25, HD 63154, and Synuefe EU-Q c21-10 systems. Some of the discovered sites featured interactive data devices classified as Ancient Data Terminals.

The Ancient Data Terminals contain various Guardian data files, Module Blueprint Segments, Ship Blueprint Segments, and Weapon Blueprint Segments. (Factabulous, CRG, Et al. 3303).

Figure 9 shows the distribution of 129 known Guardian Structure locations. Since Guardian Structures are related to Guardian Ruins, which are also related to Brain Tree sites, we see almost exactly the same distribution pattern in Guardian Structure locations.

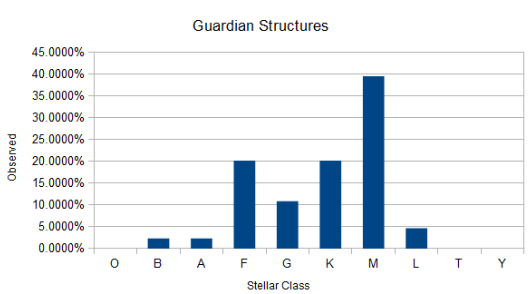


Figure 9. Distribution of Guardian Structure locations by stellar class

2.8. *Sinuous Tubers / Tube Worms*

Sinuous Tubers (AKA Tube Worms) are organic structures distinguished by a tubular shape and vivid coloration. These tubers are currently found on airless planets and moons, and appear to be fungal life of some sort, and may have some relation to the extremely rare Amphoras Plant. Roseus Sinuous Tuber are the only known type of Sinuous Tuber.

Figure 10 shows the distribution of the 91 known systems, with respect to stellar class.

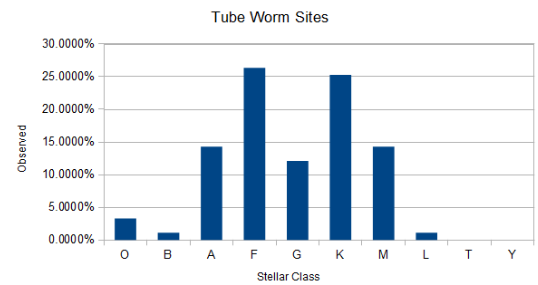


Figure 10. Distribution of Sinuous Tubers / Tube Worm locations by stellar class

Given the biological nature of Sinuous Tubers, we expect as more sites are discovered, the dips in G and M class systems will fill in, and a fairly flat distribution across systems most suitable for life (Classes F, G, K, and M). Additional studies by exobiologists will need to determine what, if any connection Sinuous Tubers have to Amphora plants, and if either of these have connections to Guardians, Thargoids, or other unknown life forms.

2.9. *Terraformable Worlds*

One of the most important phenomena in the Milky Way would be planets suitable for terraforming. As humanity spreads across the Milky Way, more habitable worlds will be necessary, along with resource-rich "high metal content" worlds, ammonia worlds, and water worlds. Our present knowledge of habitable worlds agrees with the data in Figure 11, in that habitable worlds are mostly (78%) found in systems with stellar classes F through M.

Habitable worlds are more dependent on distance from their host star (goldilocks zone) than stellar class, however smaller, stable, and more temperate stars produce more systems with habitable worlds than O, or B class stars. Obtaining more precise constraints on which systems are more likely to host habitable worlds will be of great benefit to exploration efforts across the entire galaxy.

Figure 11 presents the distribution of 2.93×10^6 terraformable systems orbiting main-sequence stars

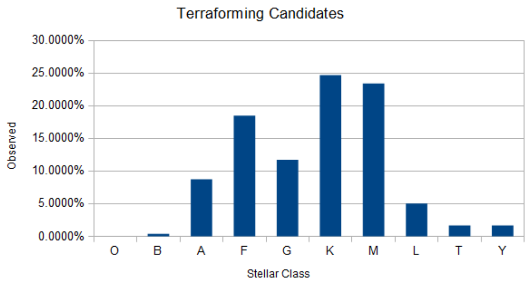


Figure 11. Distribution of Terraforming Candidate sites by stellar class

With a sample size of nearly three million systems, this is the largest sample size analyzed - by several orders of magnitude. Interestingly enough, we see similarities in this graph and other data previously discussed.

3. CONCLUSIONS

In most of the data plots, we see a possible dip in "G" systems. Follow up studies could be performed to determine if this from observational bias due to high exploration activity near the galactic core and the "bubble" around Sol, or if there are several mass curve functions which govern star system creation. Specifically, questions remain if higher mass OBA systems behave differently than lower mass FGKM, LTY dwarfs / Herbigs/Proto stars, or even "exotic" systems containing Black Holes, Neutron Stars, White Dwarfs, or Planetary Nebulae.

The data indicate biological entities such as Bark Mounds, Tube Worms, and Brain Trees are more sensitive to the distance from the star the host planet orbits, rather than spectral class. We see similar patterns with terraformable, and "Earth Like" worlds, in that most main-sequence systems have a habitable zone within certain distances from the host star.

A large portion of Thargoid Barnacles have been discovered in areas selected for human colonization, with the distribution almost entirely within spectral classes F - M. There does seem to be significant overlap in "habitable" planetary conditions between Human, Thargoid, and Guardian physiology.

With respect to Guardians, we do know that Brain Tree sites are a strong indicator of nearby Guardian Ruins. All three charts (Brain Trees, Ruins, Structures) show a similar pattern. We see in Figure 12, there are at least two guardian "bubbles", with the possibility for more. V429 Carinae is an as-yet-unexplored Wolf-Rayet on the very edge of the Milky Way. Gamma Velorum is permit locked, and thought to be the Guardian home system.

Figure 12 shows a map of all discovered phenomena across the Milky Way

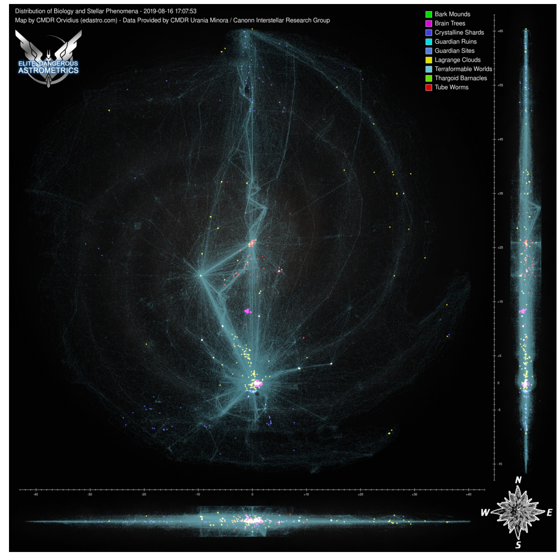


Figure 12. Map of Notable Phenomena across the Milky Way. (EDAstro / CRG)

Overall the patterns in the data support explorers selecting spectral classes F,G,K,and M in their COVAS route plotter to maximize discovery opportunities. Given the very high percentage of M class dwarfs present in the galaxy, even selecting spectral classes F,G, and K would provide ample opportunities for explorers. Combining spectral class constraints with Milky Way structural data can help develop more targeted searches for interesting biological and alien phenomena. For example, we see in Figure 12 that Crystal Shard sites are heavily favored along the outer arms of our Galaxy, whereas Guardian related sites are clustered heavily in a few locations.

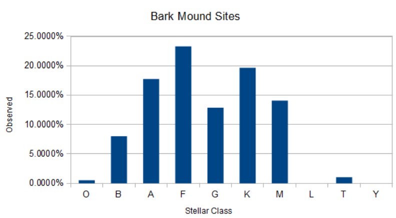
4. FUTURE WORK

We plan to investigate the potential sources of bias in the collected data, and investigate the distribution of "Exotic" star systems such as Neutron Stars, White Dwarfs, Herbigs, Carbon Stars, Planetary Nebulae, and other unusual stellar classes.

5. ACKNOWLEDGEMENTS

The author would like thank the Federal Science Academy, Canonn Interstellar Research Group, EDSM, CMDR Orvidius (ED Astro), and all the brave explorers who have shared their exploration data with the community-at-large.

APPENDIX



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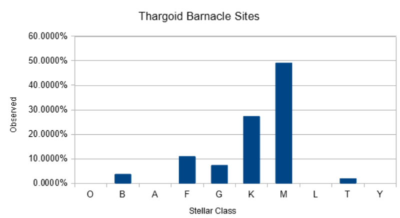

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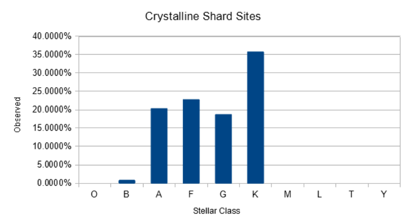

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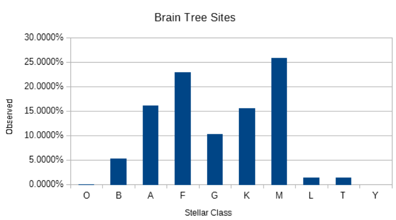

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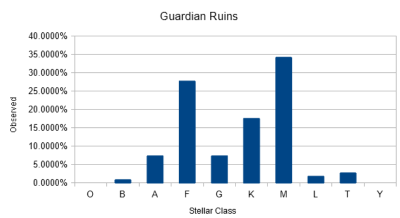

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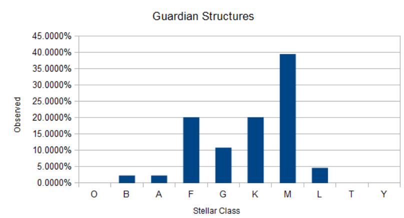

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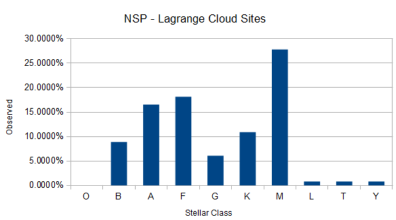

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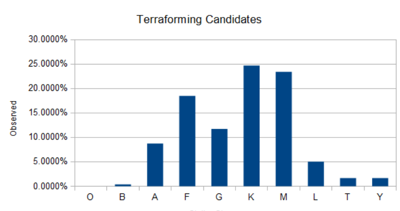

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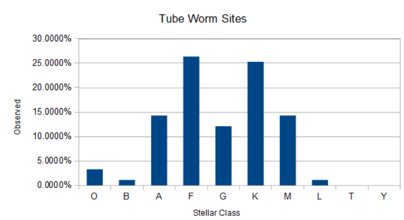
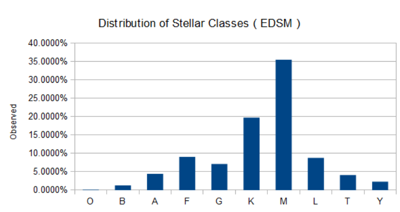


(i)

Figure 13. Stellar distribution of notable phenomena. (a) Bark Mounds, (b) Thargoid Barnacles, (c) Crystalline Structures, (d) Guardian Brain Trees, (e) Guardian Ruins, (f) Guardian Structures, (g) NSP - Lagrange Clouds, (h) Terraforming Candidates, and (i) Tube Worms



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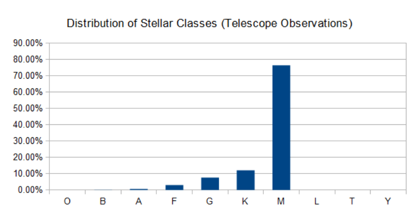

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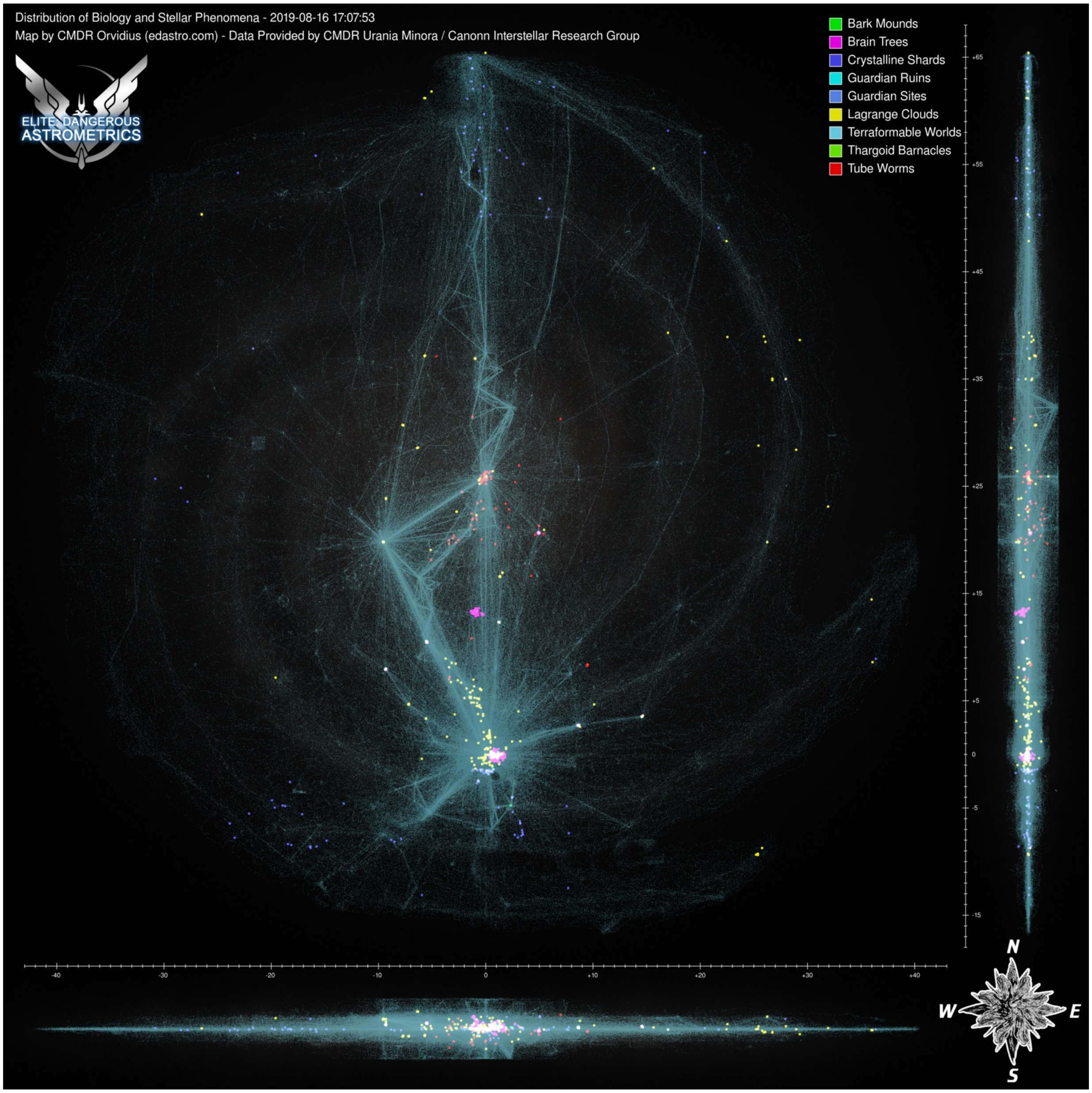
Figure 14. Stellar distribution. (a) Observed Milky Way (EDSM), (b) Ground/Space Telescope data (Sol System).



(a)

Figure 15. Map of Notable Phenomena across the Milky Way. Bark Mounds, Thargoid Barnacles, Crystalline Structures, Guardian Brain Trees, Guardian Ruins, Guardian Structures, Lagrange Clouds, Terraforming Candidates, and Tube Worms. (EDAstro / CRG)

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