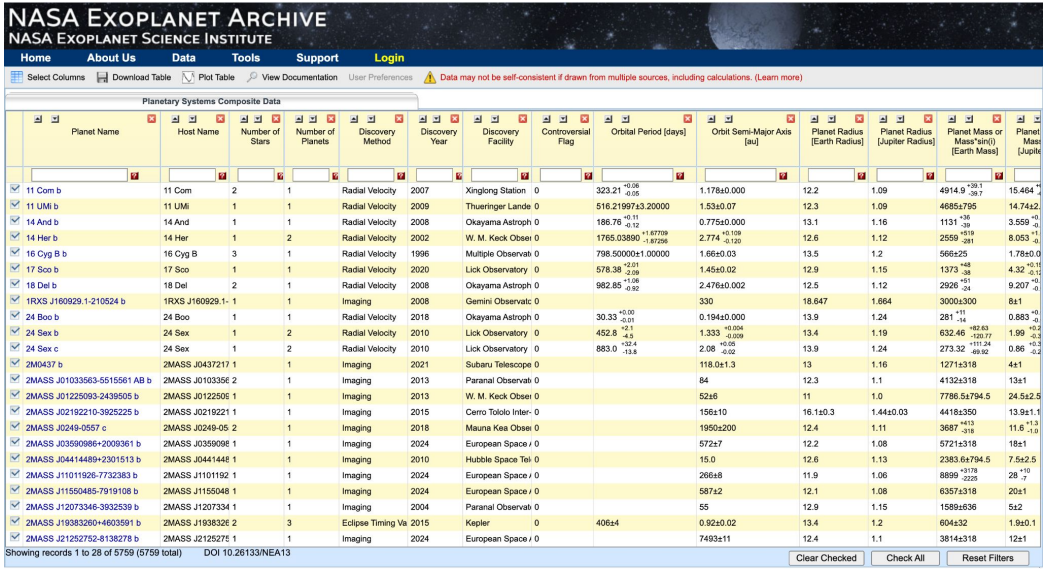
september 23, 2024

exoplanet exploration

data sources

Exoplanet data from NASA Exoplanet Archive - Planetary Systems Composite Data on September 15th, 2024:

https://exoplanetarchive.ipac.caltech.edu/cgi-bin/TblView/nph-tblView?app=ExoTbls&config=PSCompPars



data sources

Solar system planetary data from NASA as well:

https://nssdc.gsfc.nasa.gov/planetary/factsheet/

Planetary Fact Sheet - Metric

	MERCURY	VENUS	EARTH	MOON	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Mass (10^{24}kg)	0.330	4.87	5.97	0.073	0.642	1898	568	86.8	102	0.0130
Diameter (km)	4879	12,104	12,756	3475	6792	142,984	120,536	51,118	49,528	2376
Density (kg/m^3)	5429	5243	5514	3340	3934	1326	687	1270	1638	1850
Gravity (m/s^2)	3.7	8.9	9.8	1.6	3.7	23.1	9.0	8.7	11.0	0.7
Escape Velocity (km/s)	4.3	10.4	11.2	2.4	5.0	59.5	35.5	21.3	23.5	1.3
Rotation Period (hours)	1407.6	-5832.5	23.9	655.7	24.6	9.9	10.7	-17.2	16.1	-153.3
Length of Day (hours)	4222.6	2802.0	24.0	708.7	24.7	9.9	10.7	17.2	16.1	153.3
Distance from Sun (10^6 km)	57.9	108.2	149.6	0.384*	228.0	778.5	1432.0	2867.0	4515.0	5906.4
Perihelion (10^6 km)	46.0	107.5	147.1	0.363*	206.7	740.6	1357.6	2732.7	4471.1	4436.8
Aphelion (10^6 km)	69.8	108.9	152.1	0.406*	249.3	816.4	1506.5	3001.4	4558.9	7375.9
Orbital Period (days)	88.0	224.7	365.2	27.3*	687.0	4331	10,747	30,589	59,800	90,560
Orbital Velocity (km/s)	47.4	35.0	29.8	1.0*	24.1	13.1	9.7	6.8	5.4	4.7
Orbital Inclination (degrees)	7.0	3.4	0.0	5.1	1.8	1.3	2.5	0.8	1.8	17.2
Orbital Eccentricity	0.206	0.007	0.017	0.055	0.094	0.049	0.052	0.047	0.010	0.244
Obliquity to Orbit (degrees)	0.034	177.4	23.4	6.7	25.2	3.1	26.7	97.8	28.3	119.5
Mean Temperature (C)	167	464	15	-20	-65	-110	-140	-195	-200	-225
Surface Pressure (bars)	0	92	1	0	0.01	Unknown*	Unknown*	Unknown*	Unknown*	0.00001
Number of Moons	0	0	1	0	2	95	146	28	16	5
Ring System?	No	No	No	No	No	Yes	Yes	Yes	Yes	No
Global Magnetic Field?	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Unknown
	MERCURY	VENUS	EARTH	MOON	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO

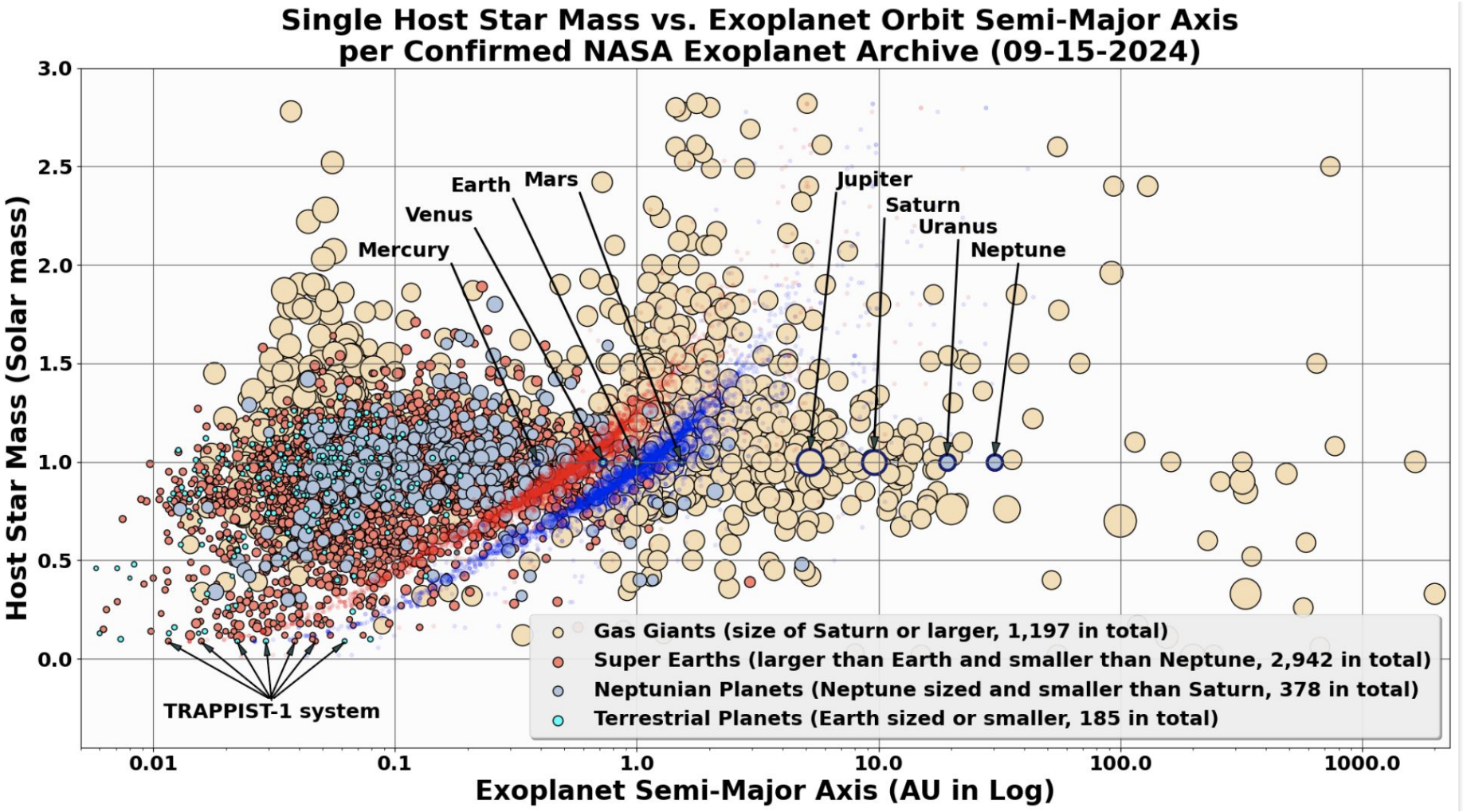
formula to calculate HZ range

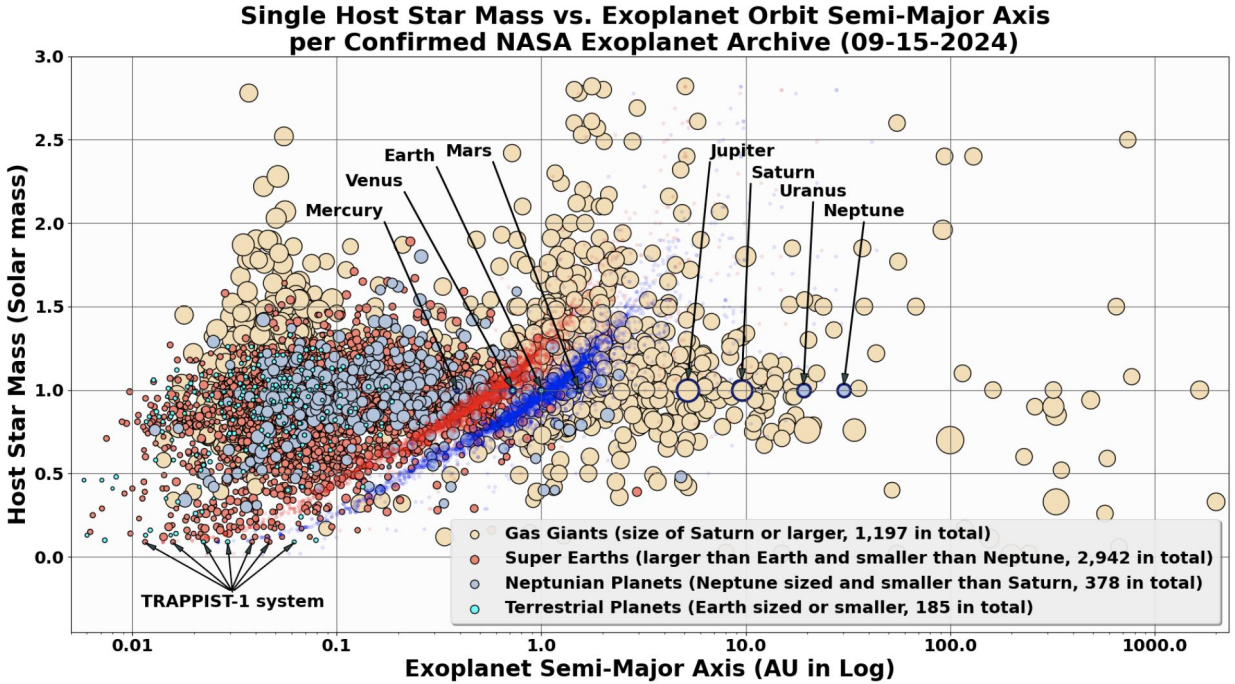
```
hz_zone_plot_data['hz_zone_inner'] = (((hz_zone_plot_data['st_rad'] * 696000) * (hz_zone_plot_data['st_teff'] ** 2) * (1.13 ** 2) * ((1 - 0.306) ** 0.5)) / (2 * (373.15 ** 2))) / 149598023

hz_zone_plot_data['hz_zone_outer'] = (((hz_zone_plot_data['st_rad'] * 696000) * (hz_zone_plot_data['st_teff'] ** 2) * (1.13 ** 2) * ((1 - 0.306) ** 0.5)) / (2 * (273.15 ** 2))) / 149598023
```

^^ based on the formula brought forth in our paper: $T_{surf,ave} = kT_{\odot}(1-A)^{0.25}(\frac{R_{\odot}}{2d})^{0.5}$

from the paper's formula, we can calculate the inner and outer HZ boundaries:

$$d = \frac{R_{\odot} \times (T_{\odot})^2 \times k^2 \times (1-A)^{0.5}}{2 \times (T_{surfave})^2}$$


Single Host Star Mass vs. Exoplanet Orbit Semi-Major Axis
per Confirmed NASA Exoplanet Archive (09-15-2024)
Host Star Mass (Solar mass)
Exoplanet Semi-Major Axis (AU in Log)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.01
0.1
1.0
10.0
100.0
1000.0
Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
TRAPPIST-1 system
Gas Giants (size of Saturn or larger, 1,197 in total)
Super Earths (larger than Earth and smaller than Neptune, 2,942 in total)
Neptunian Planets (Neptune sized and smaller than Saturn, 378 in total)
Terrestrial Planets (Earth sized or smaller, 185 in total)



thoughts

- noticed that compared to most of the **terrestrial planets,** earth is very far away from its host star → could be something?
- our solar system just happens to have planets very far away…
  - probably already studied; i'll go take a look on like jstor or something
- separately analyze 185 terrestrial for more patterns?

next steps

- **density graph** for areas harder to see?
- closer look + analysis of 185 terrestrial planets
- looking at these? → terrestrial planets within our habitable zone