EXPLORING THE FEASIBILITY AND HABITABILITY OF OUR SOLAR SYSTEM

Austyn Brandenhoff

Faculty Advisor: Dr. Howard Chen, Department of Aerospace, Physics And Space Sciences, Florida Institute of Technology

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Introduction

Our Solar System is often been used as a reference when studying other planetary systems, to answer questions such as "How could that planet have formed there?" But it is less often that our own Solar System is examined through that same scope. This research hopes to shed some light on that question by examining how the Solar System would be affected by the Sun's mass – and therefore stellar classification – changing.

Methods

- MATLAB[1] was used to simulate the Solar System over ~951 yrs under two conditions: one with constant distance (F-D); one with constant velocity (F-V). The orbits are then plotted, and orbital properties[2,3] recalculated for the planets.
- The planets' new properties were then analyzed to determine any apparent patterns in the properties, which circumstances allow habitable planets, and what effects the properties might have on the planets.

Table 1: Stellar Classifications and Masses

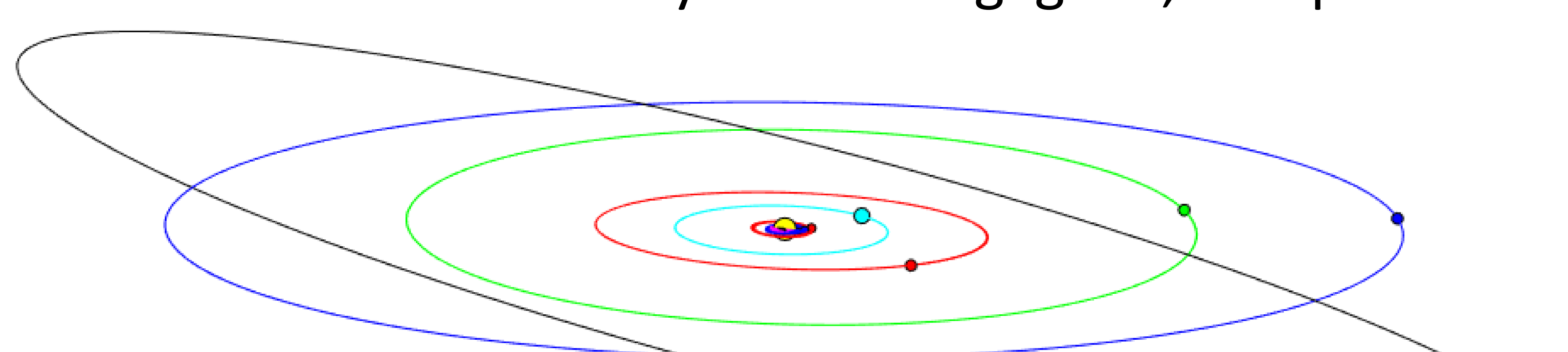
M-Type	0.25 $M_\odot$	F-Type	1.2 $M_\odot$	O-Type	20 $M_\odot$
K-Type	0.6 $M_\odot$	A-Type	1.7 $M_\odot$		
G-Type	1 $M_\odot$	B-Type	9 $M_\odot$		

Future Research

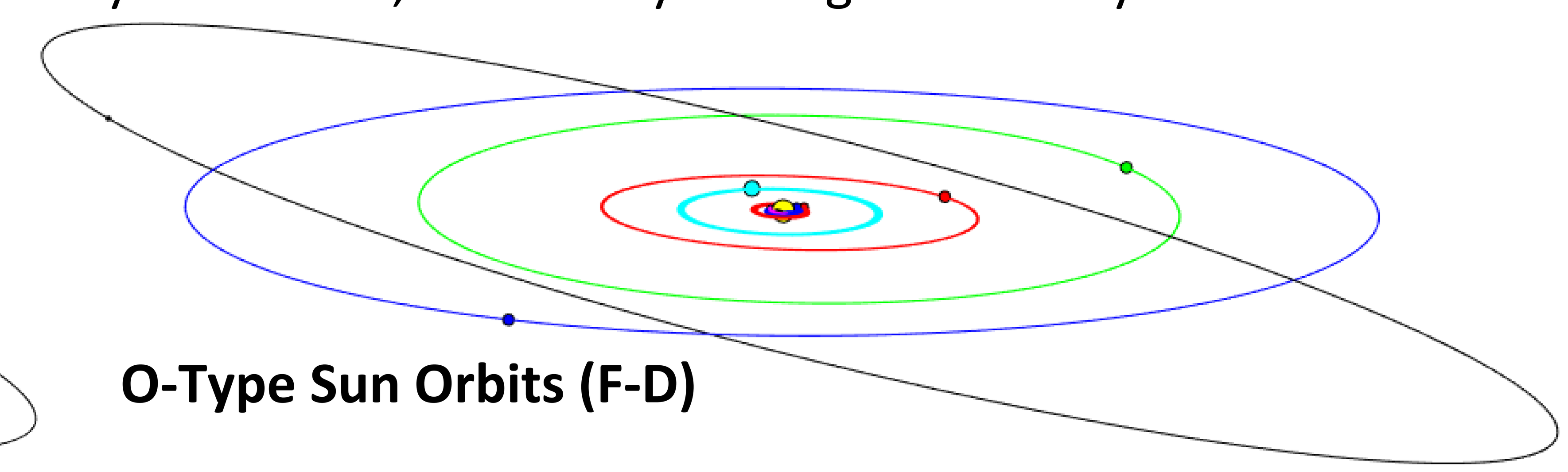
- Due to hardware limitations, the timespan and time steps were limited. Simulating longer timespans or shorter time steps could get more relevant and accurate data.
- Examine different Sun configurations, such as a binary star system; or a wider range of Sun masses to better understand the differences various star types have.

Results

- No apparent orbital collapse in the given timespan, despite it being expected at least for larger stars.
- Only a couple possible setups resulting in possible habitable[4] planets.
- Some planets end up "losing" their moons under different stars.
- Interesting pattern: M-Type Fixed Distance Orbital Periods are about 1/10 the Periods in O-Type Fixed Velocity.
- Effect on Solar day almost negligible, except for Mercury and Venus, whose days change drastically.



G-Type Sun Orbits



O-Type Sun Orbits (F-D)

Table 2 (below): Terrestrial Planets that Fall in Habitable Zone

		M-Type	K-Type		F-Type	A-Type
		Mercury	Mercury	Venus	Mars	Mars
Habitable Zone Limits (km)	Inner	*1.26E+07*	*5.83E+07*		*1.96E+08*	*3.61E+08*
	Outer	*1.82E+07*	*8.41E+07*		*2.83E+08*	*5.20E+08*
Semi-Major Axis (km)	F-D	5.79E+07	5.79E+07	1.08E+08	2.28E+08	2.28E+08
	F-V	1.45E+07	3.47E+07	6.49E+07	2.74E+08	3.88E+08
Average Distance (km)	F-D	6.05E+07	6.05E+07	1.09E+08	2.27E+08	2.27E+08
	F-V	1.51E+07	3.63E+07	6.53E+07	2.72E+08	3.86E+08
Periapsis (km)	F-D	4.60E+07	4.60E+07	1.07E+08	2.07E+08	2.07E+08
	F-V	1.15E+07	2.76E+07	6.45E+07	2.48E+08	3.51E+08
Apoapsis (km)	F-D	6.98E+07	6.98E+07	1.09E+08	2.49E+08	2.49E+08
	F-V	1.75E+07	4.19E+07	6.54E+07	2.99E+08	4.24E+08

Table 3 (below): Planets that "Lose" Moons During Simulations

		Earth	Jupiter	Saturn	Uranus	Neptune
Moon Limits (km)	Inner	*3.84E+05*	*1.28E+05*	*1.17E+05*	*4.98E+04*	*4.82E+04*
	Outer	*3.84E+05*	*2.48E+07*	*2.67E+07*	*2.09E+07*	*5.08E+07*
SOI (km)	M-Type (F-V)	-	2.10E+07	2.38E+07	-	3.79E+07
	B-Type (F-D)	3.84E+05	2.00E+07	2.27E+07	-	3.61E+07
	O-Type (F-D)	2.79E+05	1.45E+07	1.65E+07	1.56E+07	2.62E+07

			Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Solar Day (hr)	M-Type	F-D	2112	3785	24.0	24.6	9.93	10.7	17.2	16.1	153
		F-V	-844	1095	24.2	24.8	9.93	10.7	17.2	16.1	153
	K-Type	F-D	2911	3174	24.0	24.7	9.93	10.7	17.2	16.1	153
		F-V	-12637	2081	24.0	24.7	9.93	10.7	17.2	16.1	153
	G-Type	Normal	4225	2802	24.0	24.7	9.93	10.7	17.2	16.1	153
	F-Type	F-D	5222	2669	24.0	24.7	9.93	10.7	17.2	16.1	153
		F-V	3168	3067	24.0	24.7	9.93	10.7	17.2	16.1	153
	A-Type	F-D	10780	2420	24.0	24.7	9.93	10.7	17.2	16.1	153
		F-V	2316	3564	24.0	24.6	9.93	10.7	17.2	16.1	153
	B-Type	F-D	-1407	1374	24.1	24.7	9.93	10.7	17.2	16.1	153
		F-V	1520	5207	23.9	24.6	9.93	10.7	17.2	16.1	153
	O-Type	F-D	-710	999	24.2	24.8	9.93	10.7	17.2	16.1	153
		F-V	1456	5533	23.9	24.6	9.92	10.7	17.2	16.1	153

Table 4 (left): Change in Planets' Solar Days (Decreases Colored Red; Increases Colored Green)

Table 5 (below): Orbital Period Relationship Between M-Type and O-Type Simulations

		Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Orbital Period (yr)	M-Type (F-D)	0.482	1.23	2.00	3.77	23.8	59.3	168	332	497
	O-Type (F-V)	4.82	12.3	20.0	37.7	238	593	1680	3320	4970

References

[1] Jung, C. (2022). *solarSystem* (Version 1.0). GitHub.

[2] NASA. (2025). *Horizons system*. NASA.

[3] NASA. (2025). Planetary fact sheet. NASA.

[4] Kopparapu, R. K. et al (2013). *The Astrophysical Journal*, *765*(2), 131.