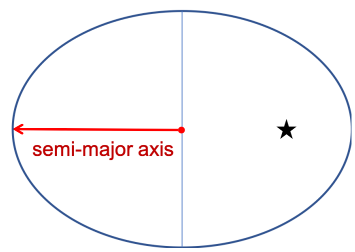
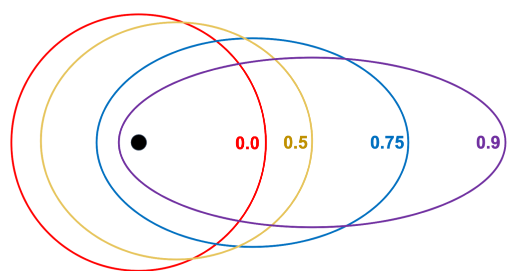
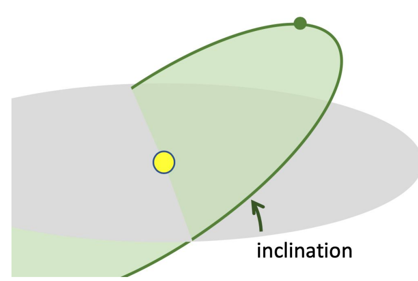
Orbital Parameters

Parameter	Symbol	Code Name	Description	Range/Units
Mass	M	`mass`	Mass of the star/planet	stars: $M_{\odot}$ planets: M_{Jup}
Semi-major axis	a	`a`	Average size of the orbit 	AU
Eccentricity	e	`e`	How circular or elliptical the orbit is 	0 - 1 (no units; 0=circle, 1=line)
Inclination	i	`i`	Tilt of the orbit relative to a reference 	0 - 90 (degrees)
Argument of pericenter, Longitude of ascending node	ω, Ω	`omega`, `Omega`	Angles that describe the orientation of a planet's orbit	0 - 360 (degrees)
True anomaly	f	`f`	Angle that describes a planet's current position along its orbit	0 - 360 (degrees)

Activity 2: Simulating a Hot Jupiter Exoplanet

Which hot Jupiter did you choose? Write down the quantities you'll need for your simulation.

Sketch the orbit you saw in your simulation below. Be sure to include axis labels and units!

Activity 3: Simulating the Solar System

Below is a table of orbital parameters for objects in our Solar System. What do you notice about the properties of the planets in our Solar System?

Star	**Mass ($M_{\odot}$)**	**a**	**e**	**i**	**ω**	**Ω**	**f**
Sun	1	-	-	-	-	-	-
Planet	**Mass (M_{Jup})**	**a**	**e**	**i**	**ω**	**Ω**	**f**
Mercury	0.00017	0.38	0.22	7.1	30	48	201
Venus	0.0026	0.74	0.02	3.4	91	7	347
Earth	0.0031	1.00	0.01	0.0	335	133	86
Mars	0.00034	1.51	0.09	1.9	292	49	281
Jupiter	1.0	5.2	0.05	1.3	275	101	268
Saturn	0.30	9.5	0.05	2.5	339	114	202
Uranus	0.046	19.2	0.05	0.8	97	74	225
Neptune	0.054	30.1	0.01	1.8	274	132	302
Pluto-Charon	0.000007	39.5	0.25	17.1	114	110	69

Activity 3 wrap-up & Activity 4 preparation: How to Break the Solar System

What does it mean to “break” the Solar System?

Which parameters do you think the Solar System’s stability is most sensitive to? Think in terms of the orbital elements, time, etc.

For each of the following Solar System objects, do they need to be included in your simulations? Why or why not?

(a) Sun

(b) Inner planets (Mercury, Venus, Earth Mars)

(c) Outer planets (Jupiter, Saturn, Uranus, Neptune)

(d) Pluto-Charon

In your groups, decide on the **specific** criteria will you use to determine if the Solar System "breaks" during a simulation:

Activity 4: Breaking the Solar System

Record what you learn from the simulations into the table below.

Parameter tested. How did you test it (e.g., what values did you use)?	Describe what happens to the Solar System.	Did you break the Solar System? How long did it take?