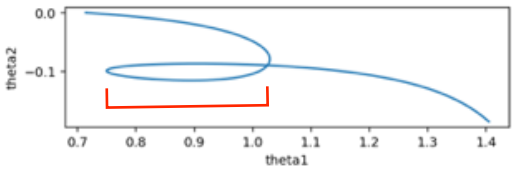
Does a planet's starting point on its orbit affect the nature of its retrograde?

By: Hadas Yosef-Zada and Leia Gill Supervisor: Dr. Daria Dubrovin

Introduction:

"Retrograde Motion" is the apparent motion of a planet moving in a direction opposite to that of the other bodies within the system, before returning to its original direction. We defined a planet's "nature of retrograde" as the angular distance between the start and end of its retrograde, as drawn on the following image:



Our code's output for the retrograde of Mars

The retrograde of Mars as seen from Earth in May, 2008

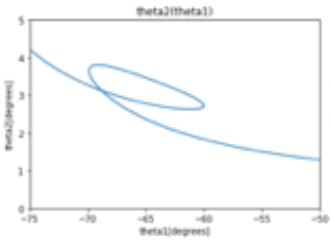
In this paper we researched the nature of the apparent retrograde motion of planets and dwarf planets in our solar system from the vantage point of an observer on Earth. We tried to determine what affects the nature of the apparent retrograde of the planets by changing a constant of our choosing. We chose our constant to be the planet's starting point on its orbit around the sun (φ), and sought to see if by changing it, the nature of the planet's apparent retrograde motion will be affected.

Research Process:

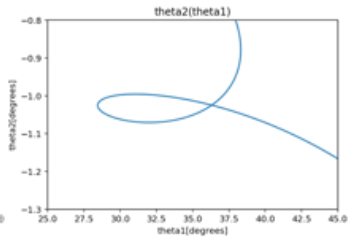
At the beginning we needed to save and load to a function all of the data required for the research about all of the planets & dwarf planets. For every body of our choosing (Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Haumia, Eris, Maka-Maka) we saved its distance from the sun (its average orbit radius), its orbit's inclination angle (while earth's orbital inclination=0) and its angular velocity (using its average orbiting period in Earth days).

We wrote a program that uses the data of every planet and calculates, using classical mechanics' equations of circular motion and simple harmonic motion, its position in the sky from a vantage point of an observer on Earth.

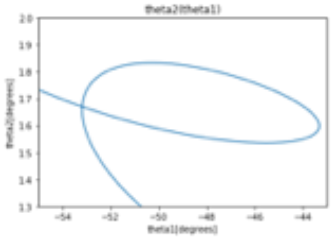
Later, we changed our program so that it will return graphs of the same planet's retrograde with a range of 5 different starting points on its orbit, (φ= -π, -1/2π, 0, 1/2π, π).



φ= 1/2π



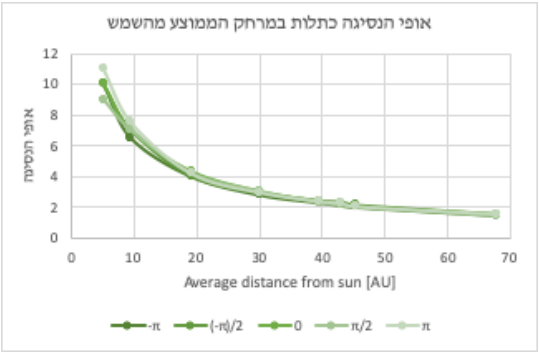
φ= 0



φ= -1/2π

Results:

For each starting angle on every orbit we built a graph of the nature of the retrograde vs. the planet's average distance from the sun. We discovered an exponential decay. The next graph shows visually the average of all the planets' in every angle of an orbital starting point.



We discovered, the angle of the planet's orbital starting point, does not affect the nature of its retrograde.

Conclusions:

The nature and length of each planet's retrograde is consistent and does not change with different starting points on the planet's orbit around the sun. our results are validated by looking at data of the lengths of planets' retrogrades in the previous years. Saturn's retrogrades in the last couple of years:

year	2012	2013	2014	2015	2016	2017	2018	2019
Retrograde length [days]	139	140	140	141	141	141	141	140