

DAPHNIS AND ITS CHAOTIC MOTION

THAMIRIS DE SANTANA

t.santana@unesp.br



Daphnis is a small moon (around 4 km in radius) of Saturn, orbiting in the middle of the A ring. It was discovered in 2005 by Cassini Spacecraft inside the Keeler Gap.

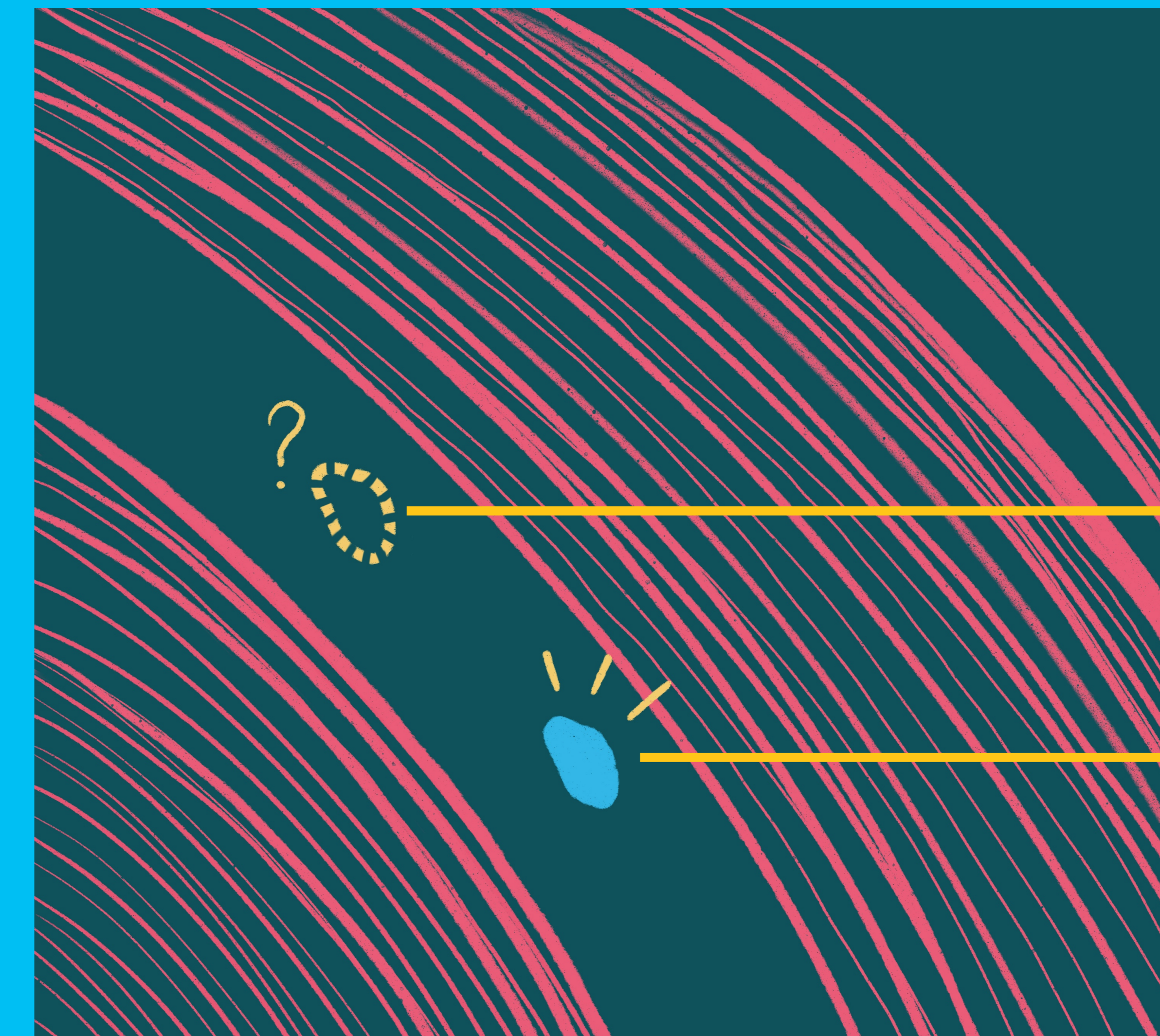
The moon existence was inferred due to the waves caused by the gravitational disturbance in the edges of the gap.

WHAT IS DAPHNIS?

WHAT HAPPENED WITH DAPHNIS?

WITH ALL DATA FROM CASSINI MISSION COMBINED, IT WAS NOT POSSIBLE TO FIND A UNIQUE ORBIT TO DESCRIBE DAPHNIS' MOTION. IT SEEMS LIKE THE MOON WAS JUMPING AMONG DIFFERENT ORBITS.

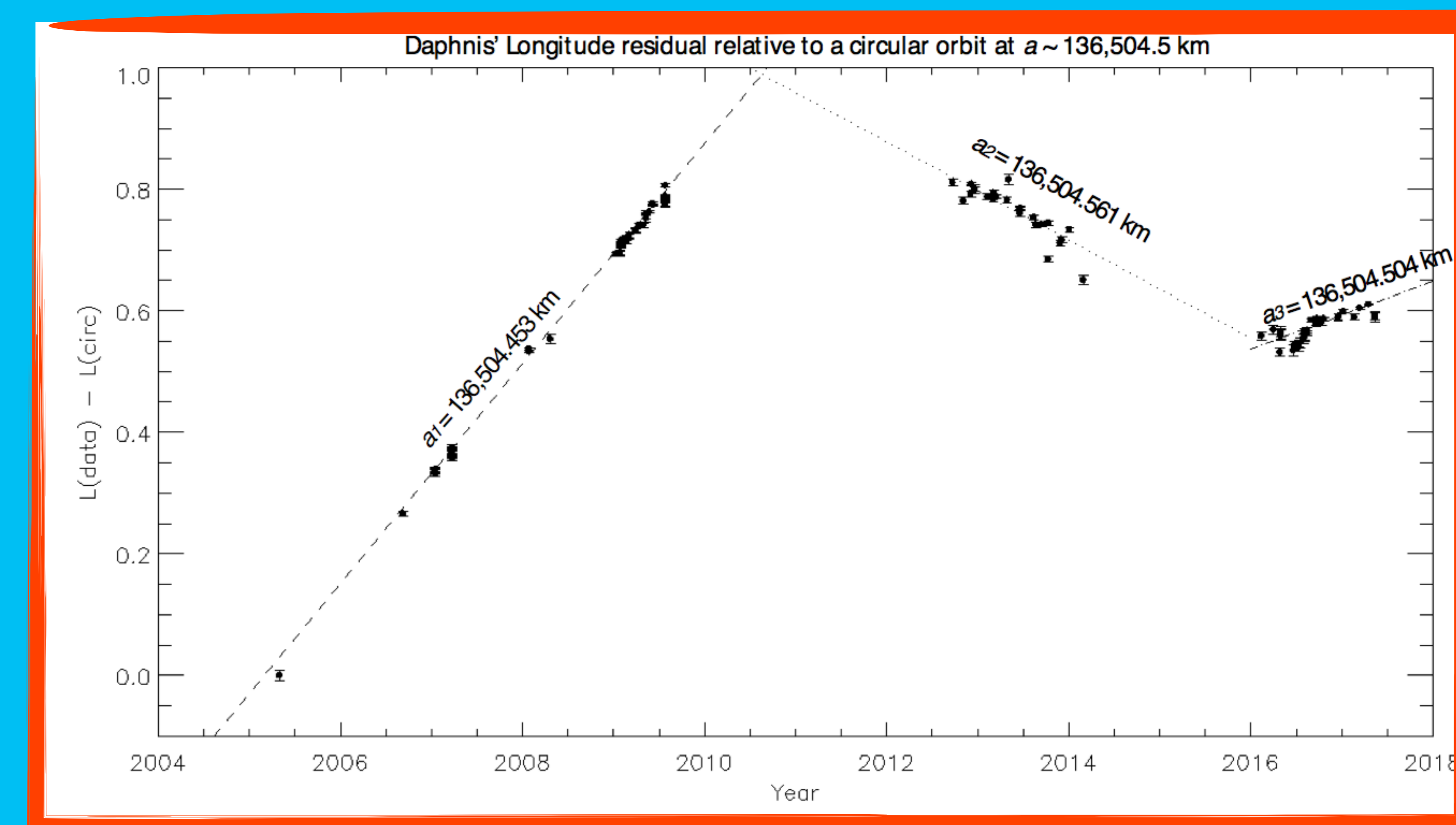
- We performed the astrometry of Daphnis, i.e. measured its location in space, and made corrections on all useful images took during the Cassini Mission from 2005 to 2017 and found out that this jump happened twice on this period.
- To understand why Daphnis was changing orbits, we did a dynamical study of its motion.



Expected in a position

Founded in another

If the motion is regular, all points should lie in a straight line. It would imply that the moon follows a well behaved circular orbit.



DYNAMICAL ANALYSIS

We performed numerical simulations that allowed us to discover that two other Saturn moons, Prometheus and Atlas are related with Daphnis, through mean motion resonances.

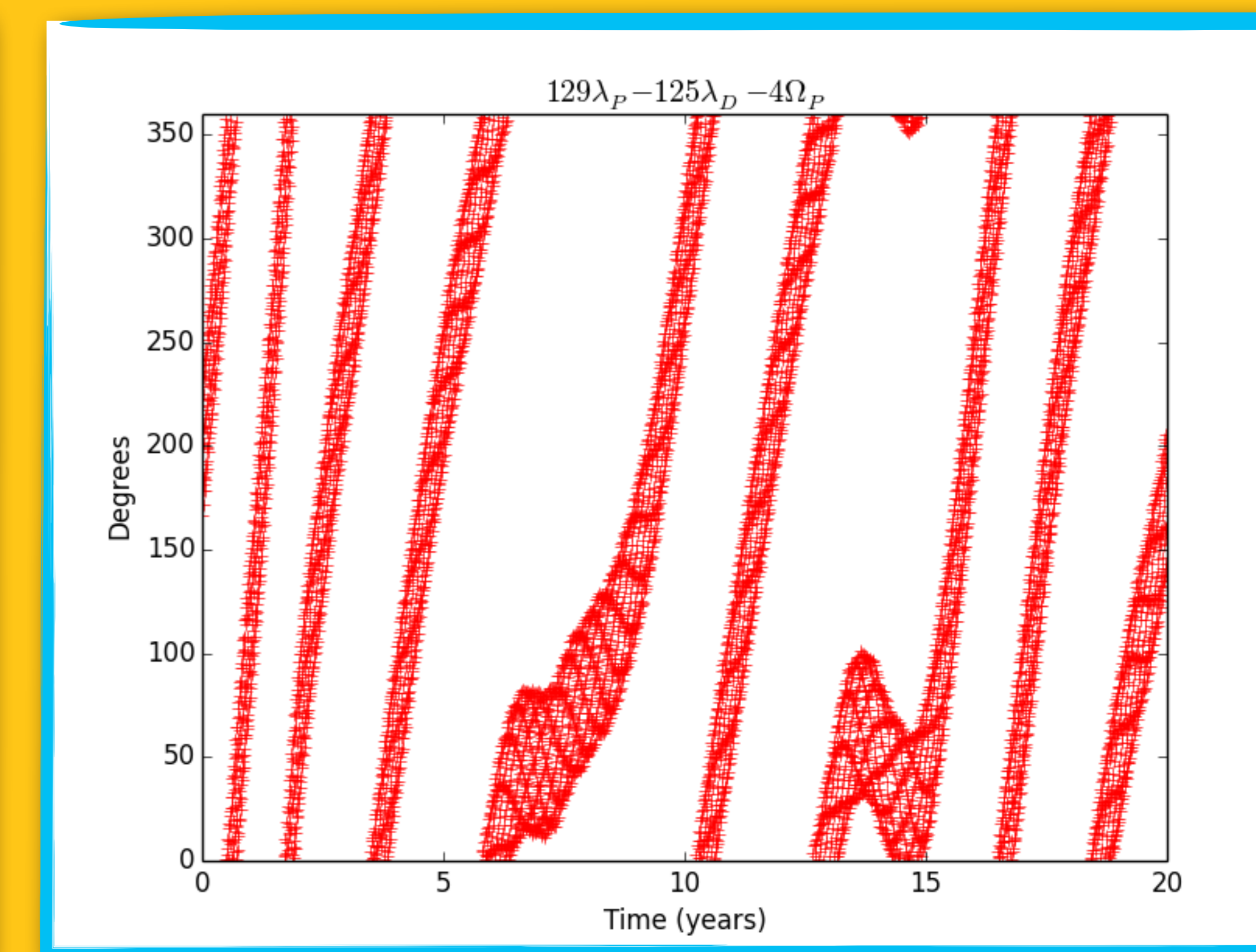
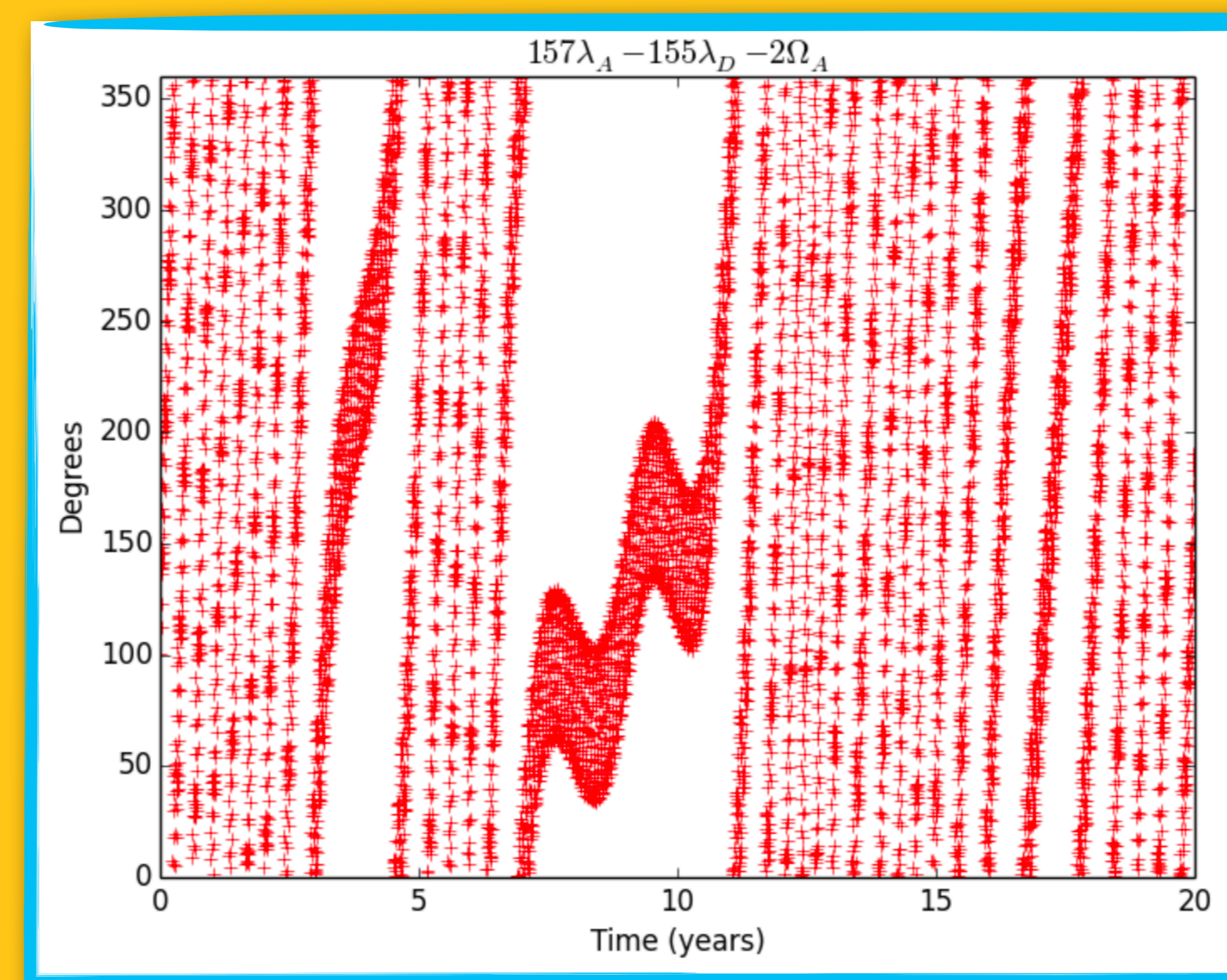
Mean Motion Resonance

a gravitational mechanism among two or more bodies that can intensify their interaction in a way that sometimes it can

The resonance angles are indicators for this relation.

When an angle circulates between 0° and 360° , the resonance is not active. The resonance signature is when the angle oscillates within limited ranges.

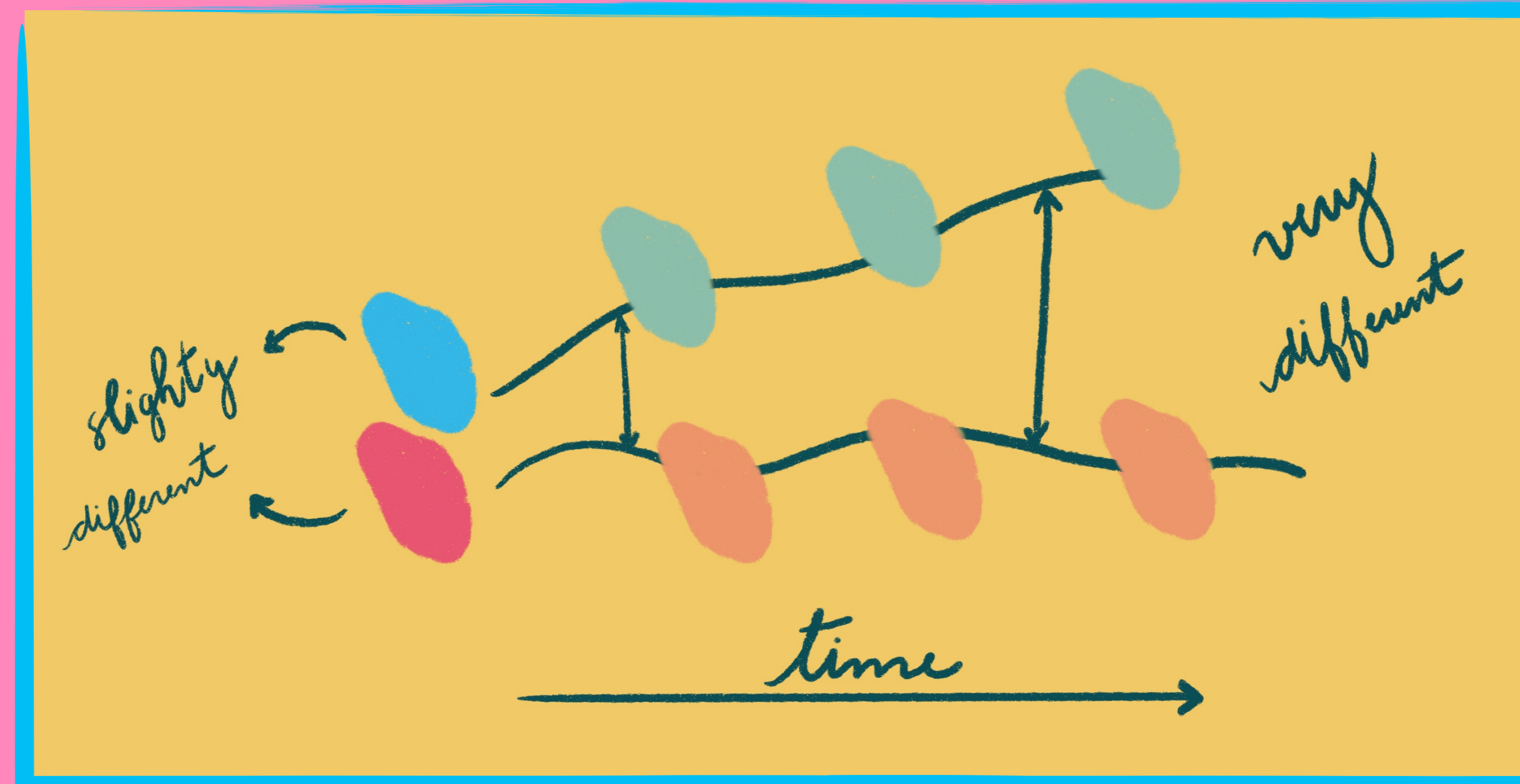
We found a mixed behaviour between the two cases (the structures like waves in the plots), what suggests that the resonances are relevant and also that Daphnis could be in a chaotic orbit.



CHAOS

Chaos :

Behavior of a dynamical system that evolves over time and is governed by equations whose solutions are extremely sensitive to the initial conditions. This way, small differences at the beginning will result in extremely different later states.



The Fast Lyapunov Indicator (FLI) is a tool that allows to measure if a system is chaotic or not. If its grows in a logarithm way, the system is regular. If it grows linearly, it is chaotic.

We tested Daphnis orbit with and without the gravitational influence of Prometheus and Atlas. When these satellites are not considered, Daphnis orbit is regular. If we include the other moons, the FLI increases quickly over time. It shows that both satellites are responsible for Daphnis chaotic orbit.

DAPHNIS IS ONLY 8 KM WIDE, AND ORBITS IN A RING GAP OF 42 KM. IT USES ITS TINY GRAVITY TO DISRUPT SATURN'S MIGHTY RINGS AND MAKE WAVES. ITS RELATION WITH OTHERS MOONS RESULTED IN AN INCREDIBLE HIGH CHAOTIC ORBIT. DAPHNIS DOESN'T LET BEING A TINY INSIGNIFICANT SPECK IN A VAST UNCARING UNIVERSE STOP IT.



BE LIKE DAPHNIS.

Adapted from @astrokatie.

ALL ARTS PRESENTED HERE WERE MADE BY THE AUTHOR.
THE AUTHOR THANKS THE CO-AUTHORS: RADWAN TAJEDDINE, MARYAME EL MOUTAMID, PHILIP D. NICHOLSON AND OTHON C. WINTER AND THE FINANCIAL SUPPORT FROM CAPES.

