

The background of the image is a dark, starry space scene. In the upper left, a crescent moon is visible. In the lower half, there are dark, rolling hills or mountains. On the right side, there is a bright, glowing nebula or aurora-like structure in shades of blue and green. The title 'JUNO SPACECRAFT' is written in a large, white, stylized font across the center. Below it, the subtitle '— and Earth Flyby Gravity Assist —' is written in a smaller, white, sans-serif font. At the bottom center, the author's name 'ARTHUR ALEGRO DE OLIVEIRA' and the date 'November 2017' are displayed in a white, sans-serif font.

# JUNO SPACECRAFT

— and Earth Flyby Gravity Assist —

ARTHUR ALEGRO DE OLIVEIRA

November 2017



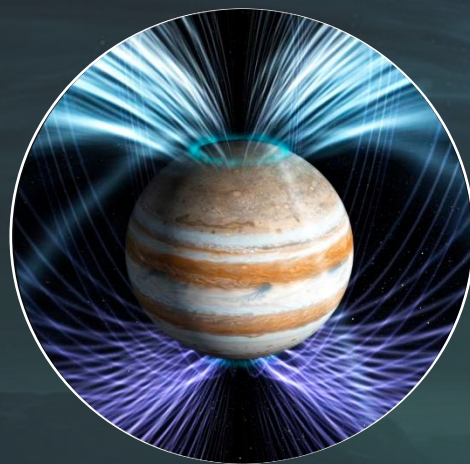
# Juno Mission

## “ Objetivo ”

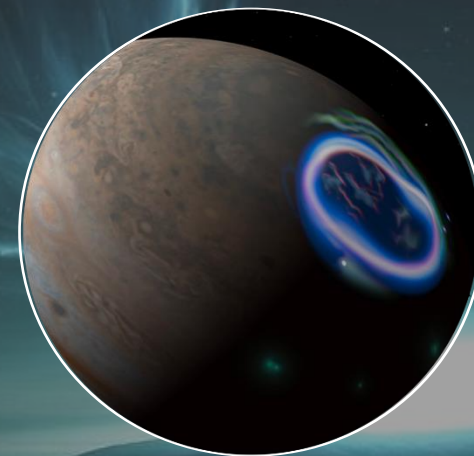
Investigar origem e formação de Júpiter



Atmosfera



Campo Magnético



Auroras



# Juno Spacecraft

## “Destruidora de Recordes”

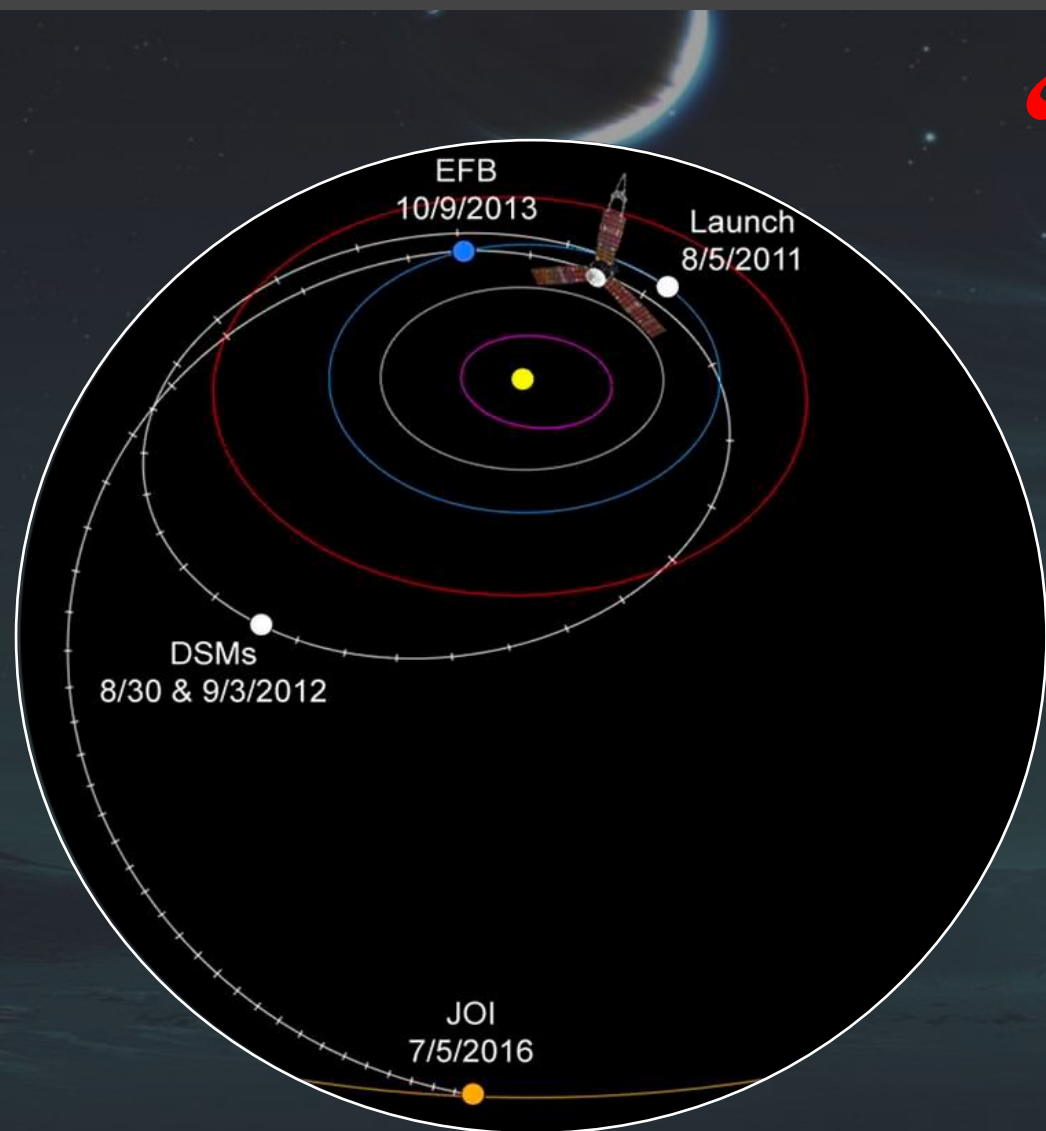
- A mais rápida
- A mais distante (solar)
- A mais próxima de Júpiter

Jupiter Near-Pole Orbiter





# Juno Orbit



## “ Flyby Gravitational Assist ”

( Estilingue Gravitacional )

Responsável por aproxima-  
damente **70%** do ganho  
de velocidade



Juno Mission

“ Pergunta ”

Em quanto tempo Juno  
chegará em Júpiter ?

( Qual a influência de um “flyby gravitational assist” ? )

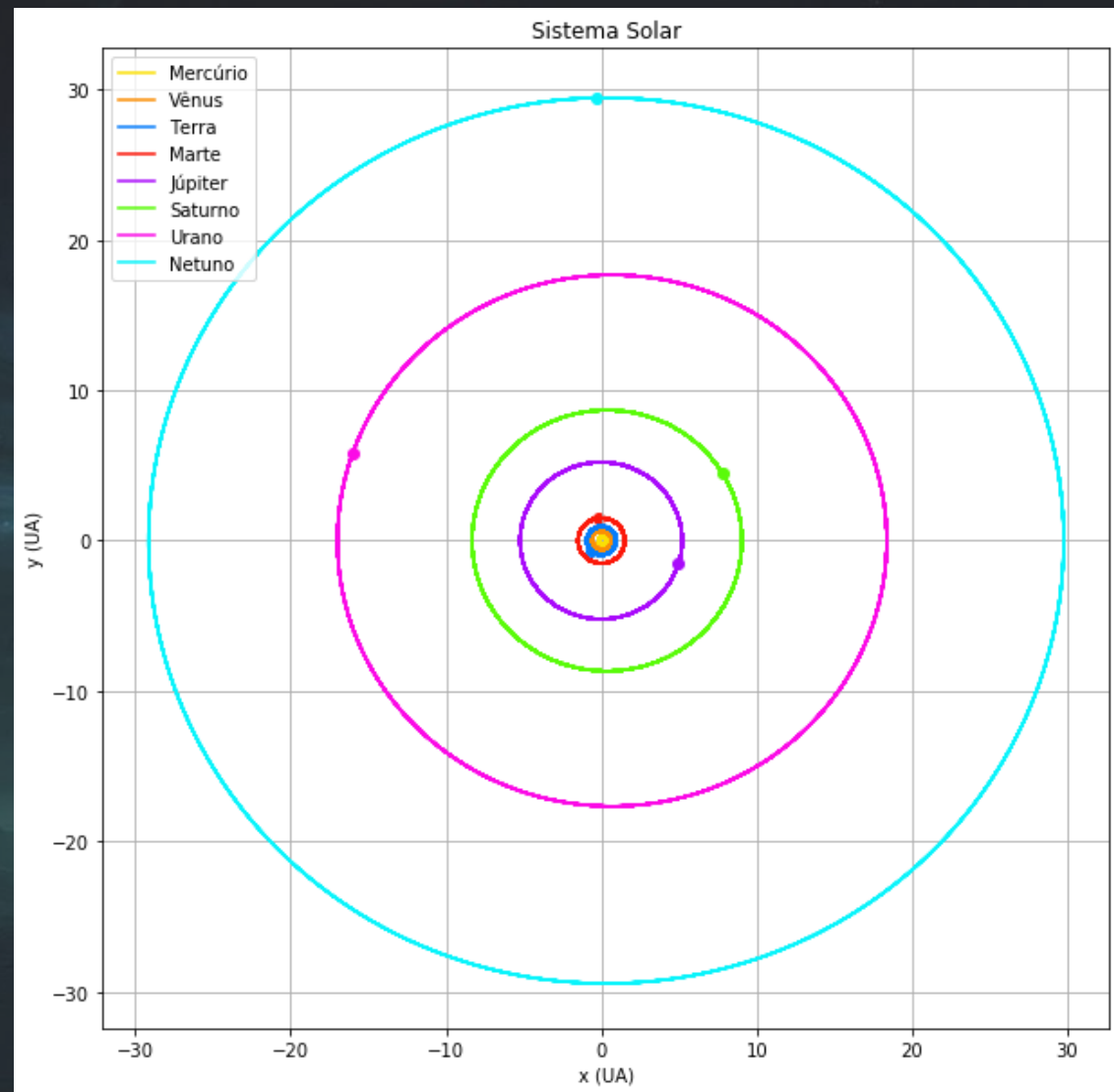


# Solar System

## “Equacionamento e Simulação”

$$a_{x_{sol-planeta}} = -GP^2 \cdot M_{sol} \cdot \frac{x_{planeta}}{(x_{planeta}^2 + y_{planeta}^2)^{3/2}}$$

$$a_{y_{sol-planeta}} = -GP^2 \cdot M_{sol} \cdot \frac{y_{planeta}}{(x_{planeta}^2 + y_{planeta}^2)^{3/2}}$$







## “Equacionamento”

Influência da  
Gravidade  
Planetária

$$a_{x_{planeta-juno}} = -GP^2 \cdot \frac{M_{planeta}}{M_{sol}} \cdot \frac{(x_{planeta} - x_{juno})}{\left((x_{planeta}^2 - x_{juno}^2) + (y_{planeta}^2 - y_{juno}^2)\right)^{3/2}}$$

$$a_{y_{planeta-juno}} = -GP^2 \cdot \frac{M_{planeta}}{M_{sol}} \cdot \frac{(y_{planeta} - y_{juno})}{\left((x_{planeta}^2 - x_{juno}^2) + (y_{planeta}^2 - y_{juno}^2)\right)^{3/2}}$$

Influência  
Total  
(Sol + Planetas)

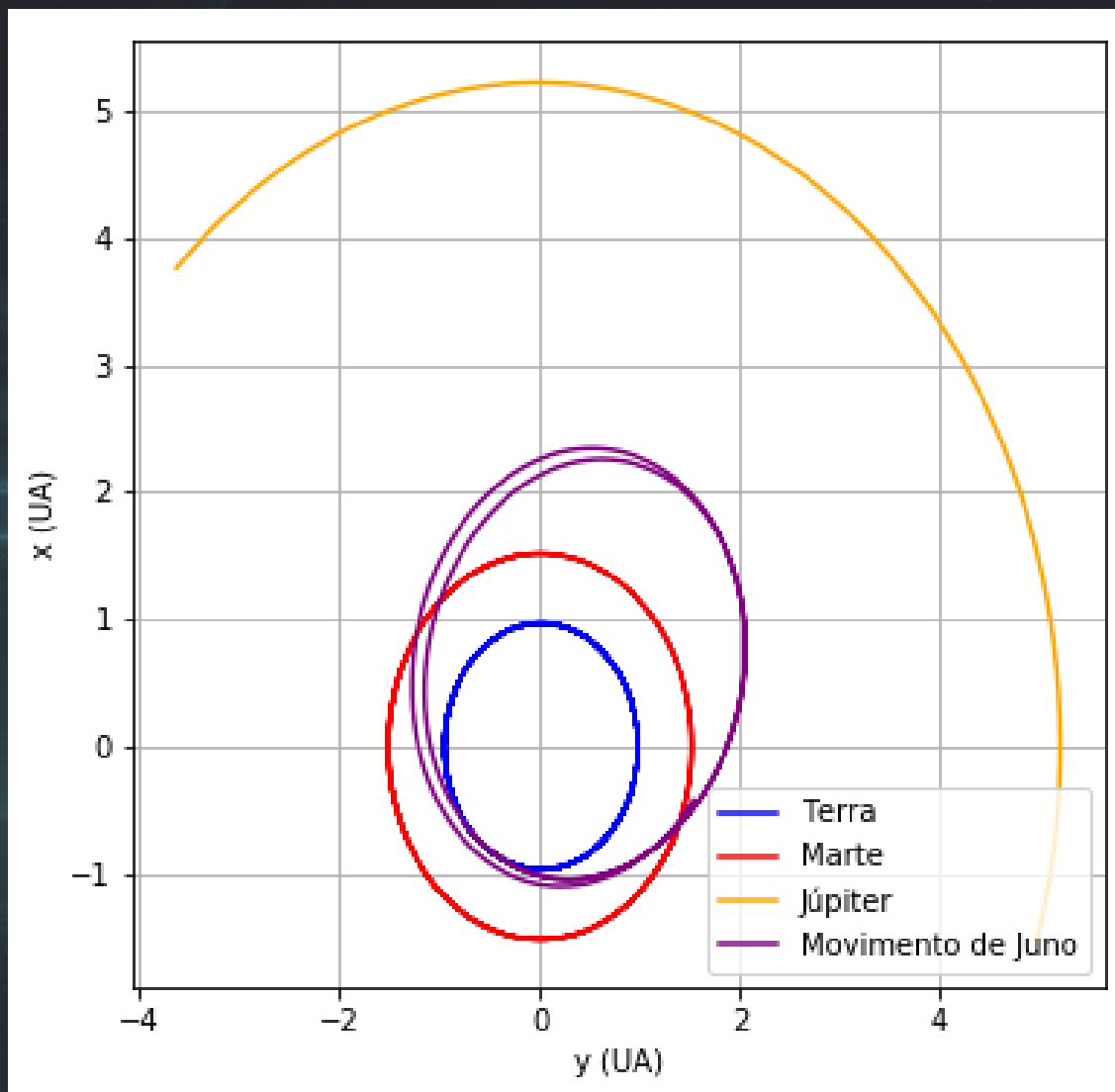
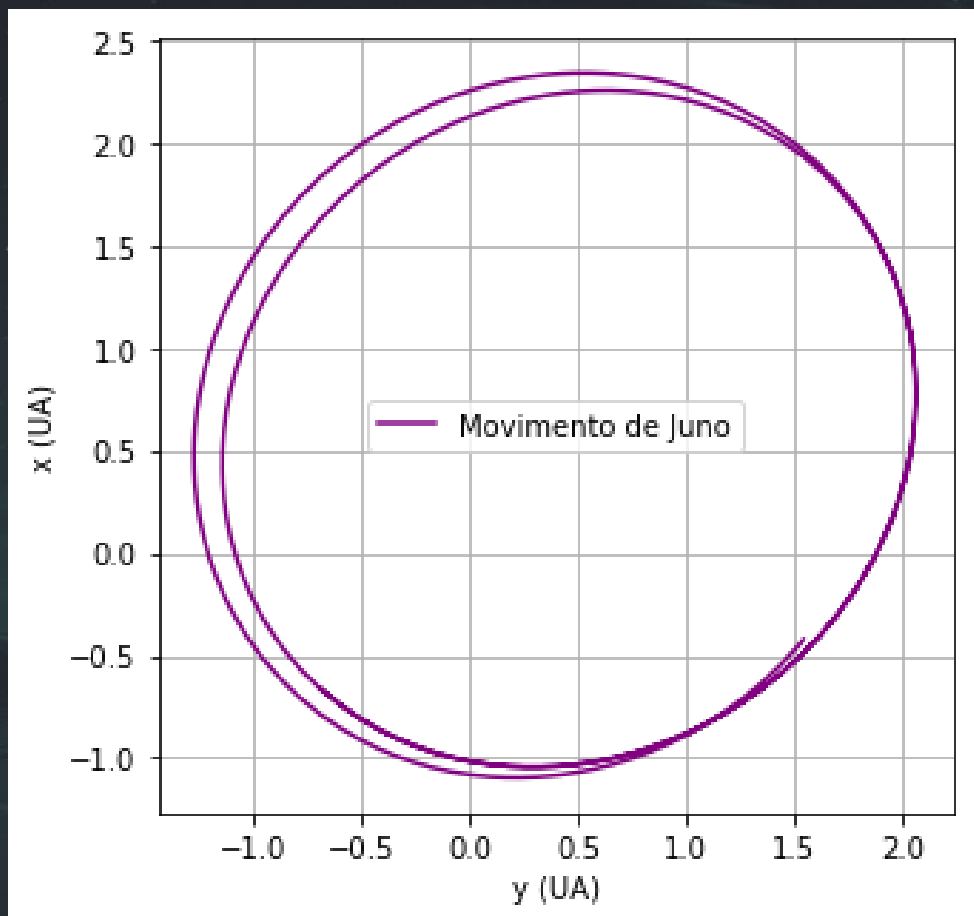
$$a_{x_{sol-juno}} = -GP^2 \cdot M_{sol} \cdot \frac{x_{juno}}{(x_{juno}^2 + y_{juno}^2)^{3/2}} + \sum a_{x_{planeta-juno}}$$

$$a_{y_{sol-juno}} = -GP^2 \cdot M_{sol} \cdot \frac{y_{juno}}{(x_{juno}^2 + y_{juno}^2)^{3/2}} + \sum a_{y_{planeta-juno}}$$



# Juno Orbit

“ Simulação ”







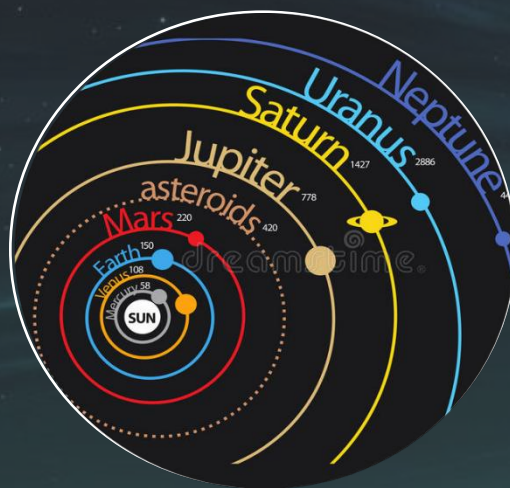
# Solar System

## “Validação”



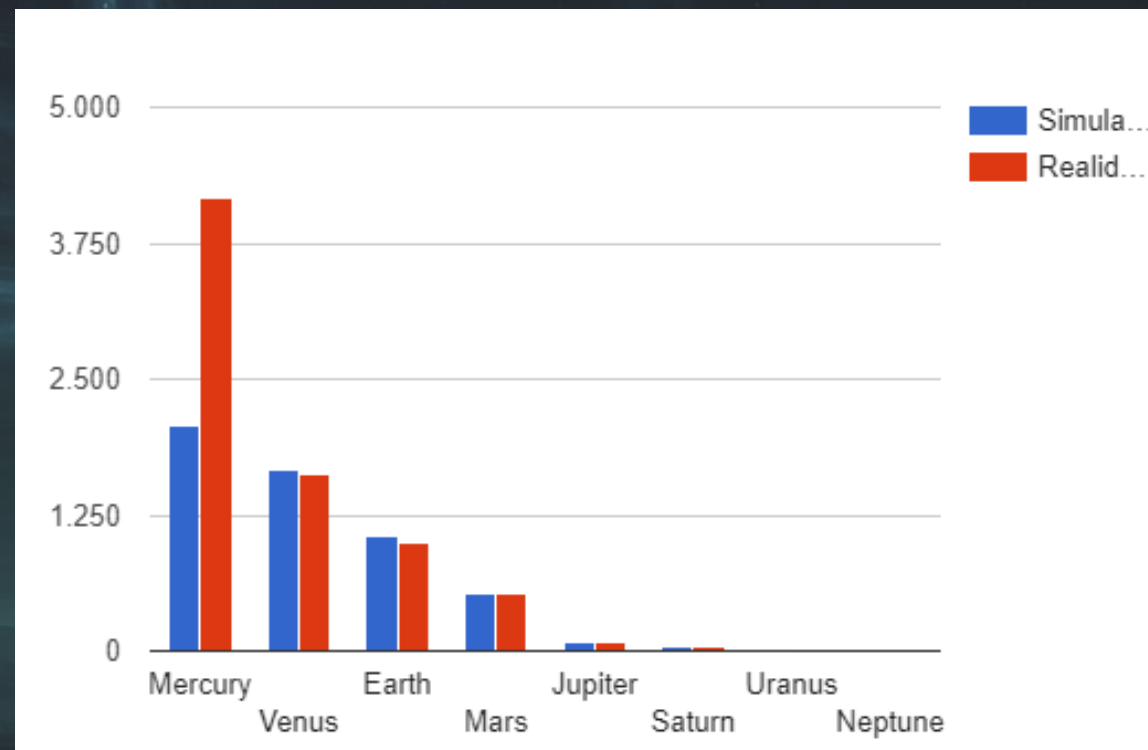
Realidade

X



Simulação

## Ciclos Orbitais



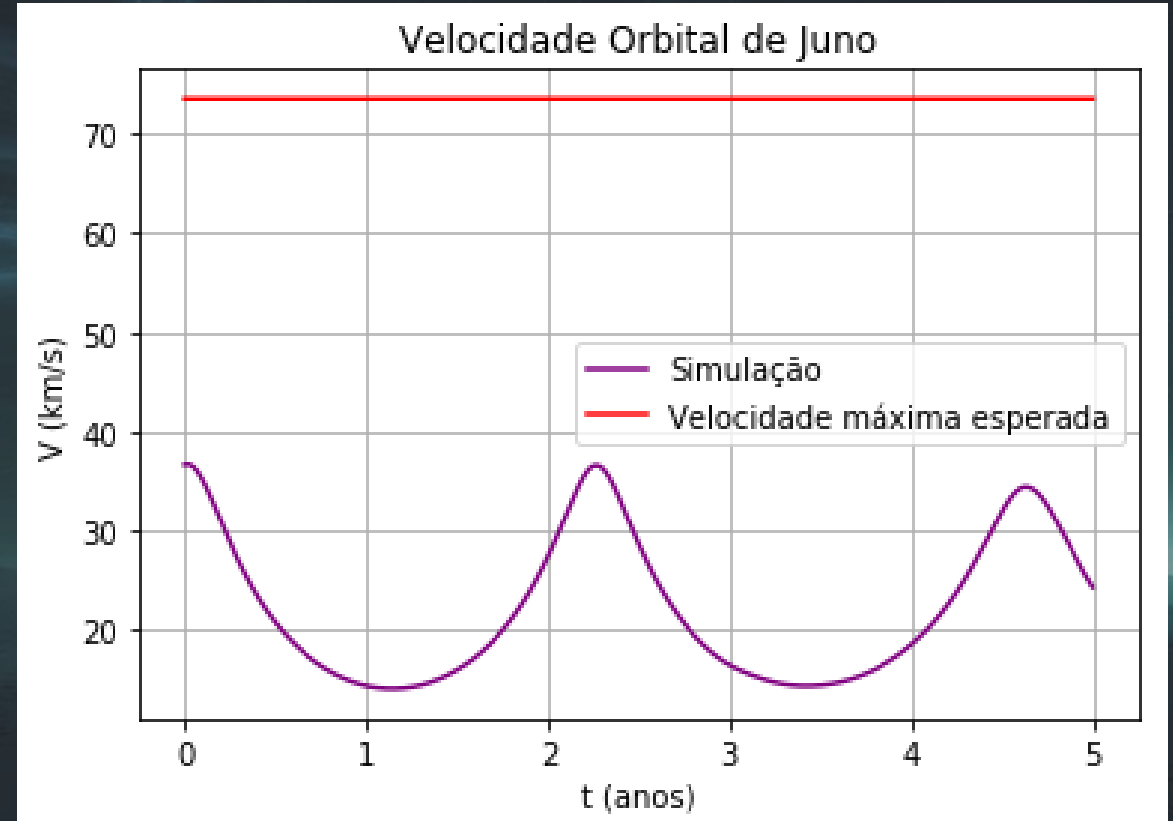
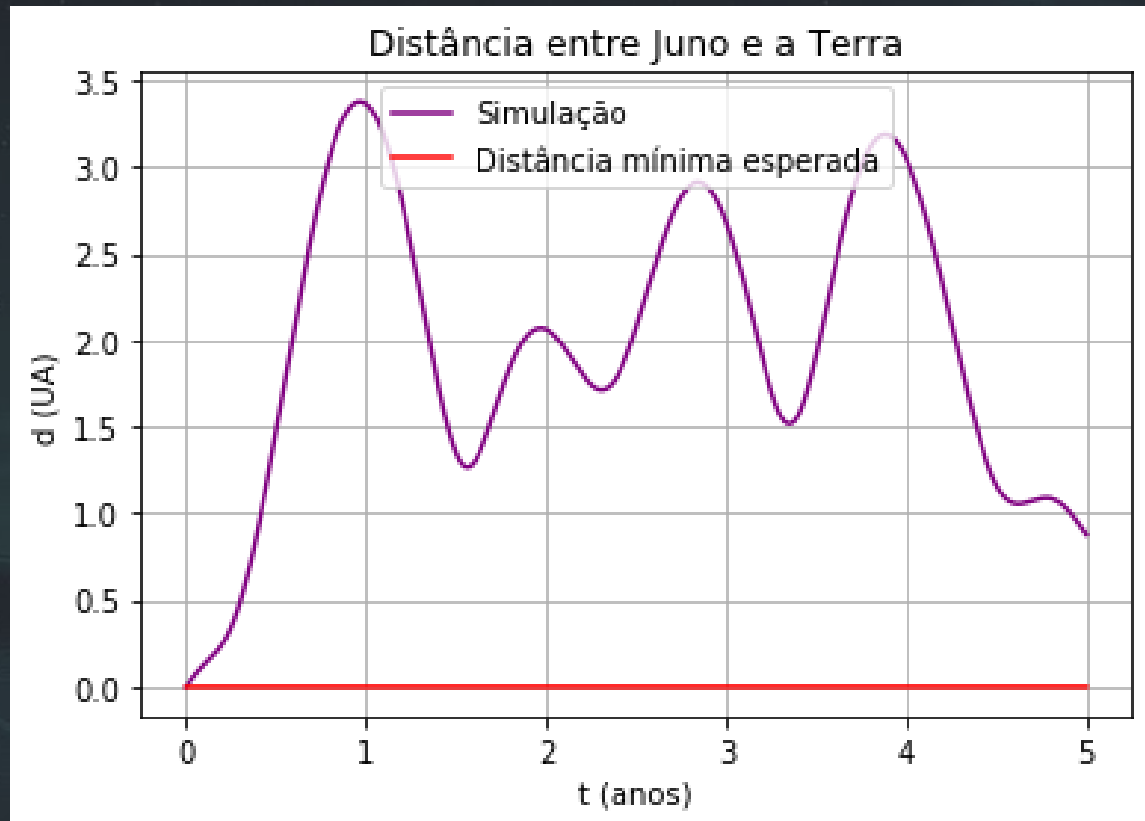
Discrepância gerada pelo uso do afélio como raio-vetor



# Juno Orbit

## “Validação”

Flyby Gravity Assist  
insuficiente





## “Causas”

- Simplificações feitas no modelo
  - Uso do Afélio como raio-vetor
- Aproximação dos dados de lançamento
  - Limite de capacidade computacional
- Necessidade de absurda precisão



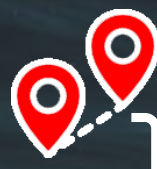


# Juno Orbit

“Mas quanta precisão?”

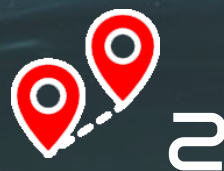


=



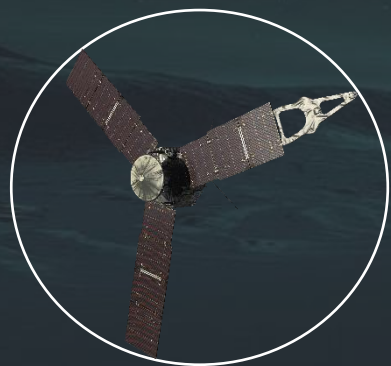
≈

27,003 km



≈

61,101 km



=



≈

$3,92 \cdot 10^{-8}$  mm



“

You have to learn the rules of the game. And then  
you have to play better than anyone else

— Einstein