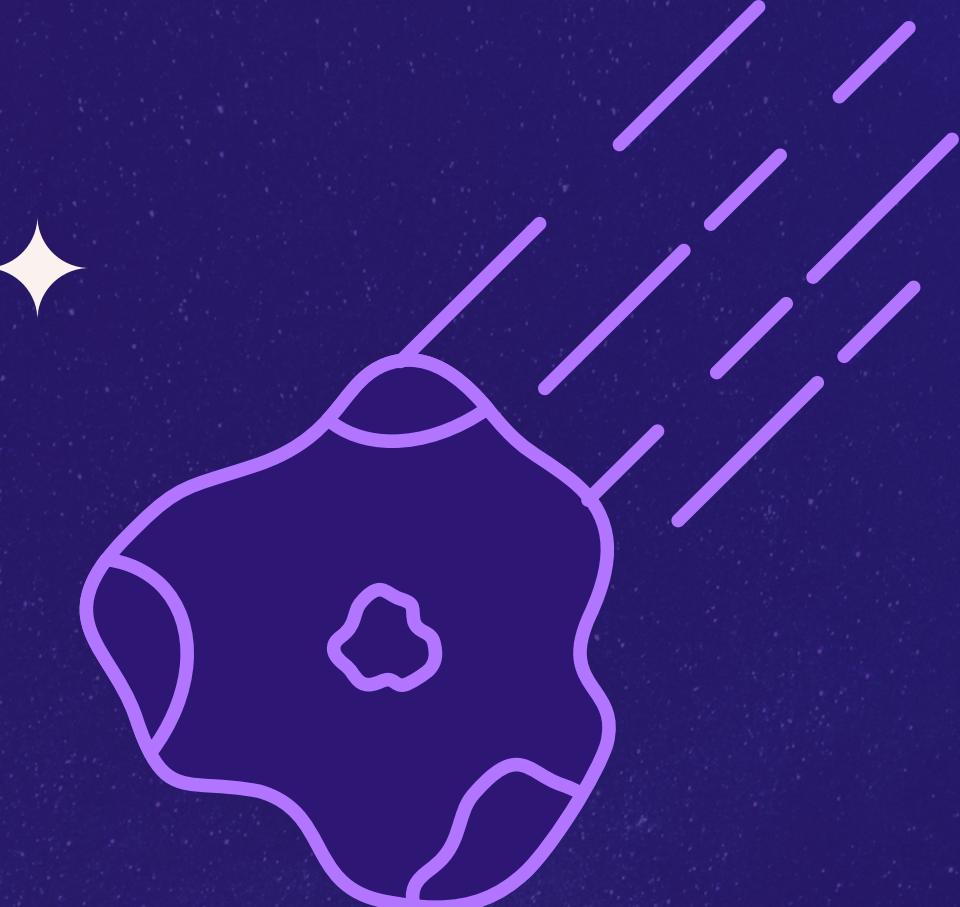


# ASTEROID CLASSIFICATION

BY MARIA FLORES

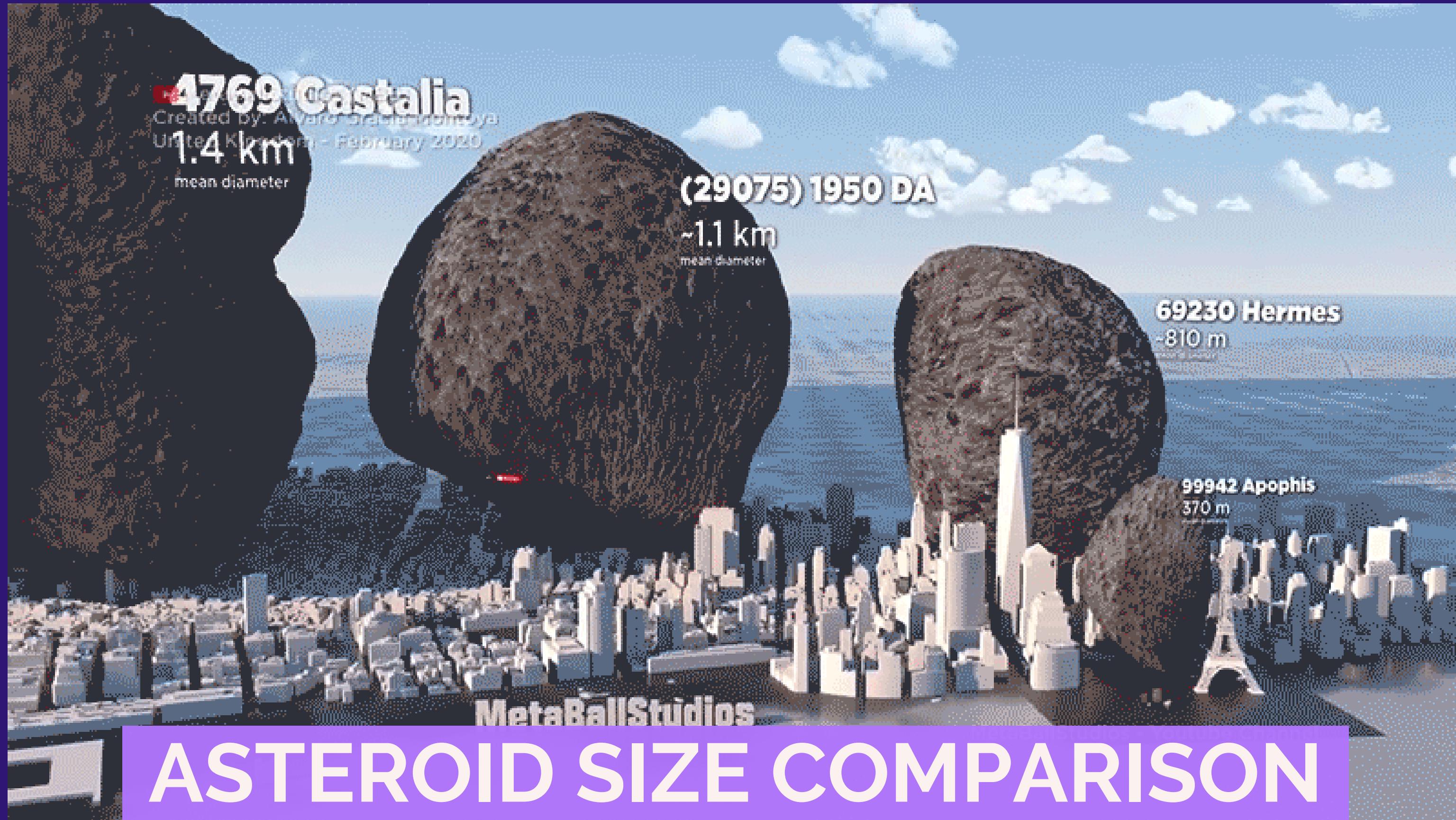


# PROBLEM STATEMENT

NASA NEEDS TO CLASSIFY  
POTENTIALLY HAZARDOUS  
ASTEROIDS

- What are an asteroid's orbital characteristics?
- What characteristics make an asteroid hazardous?





# PHAs

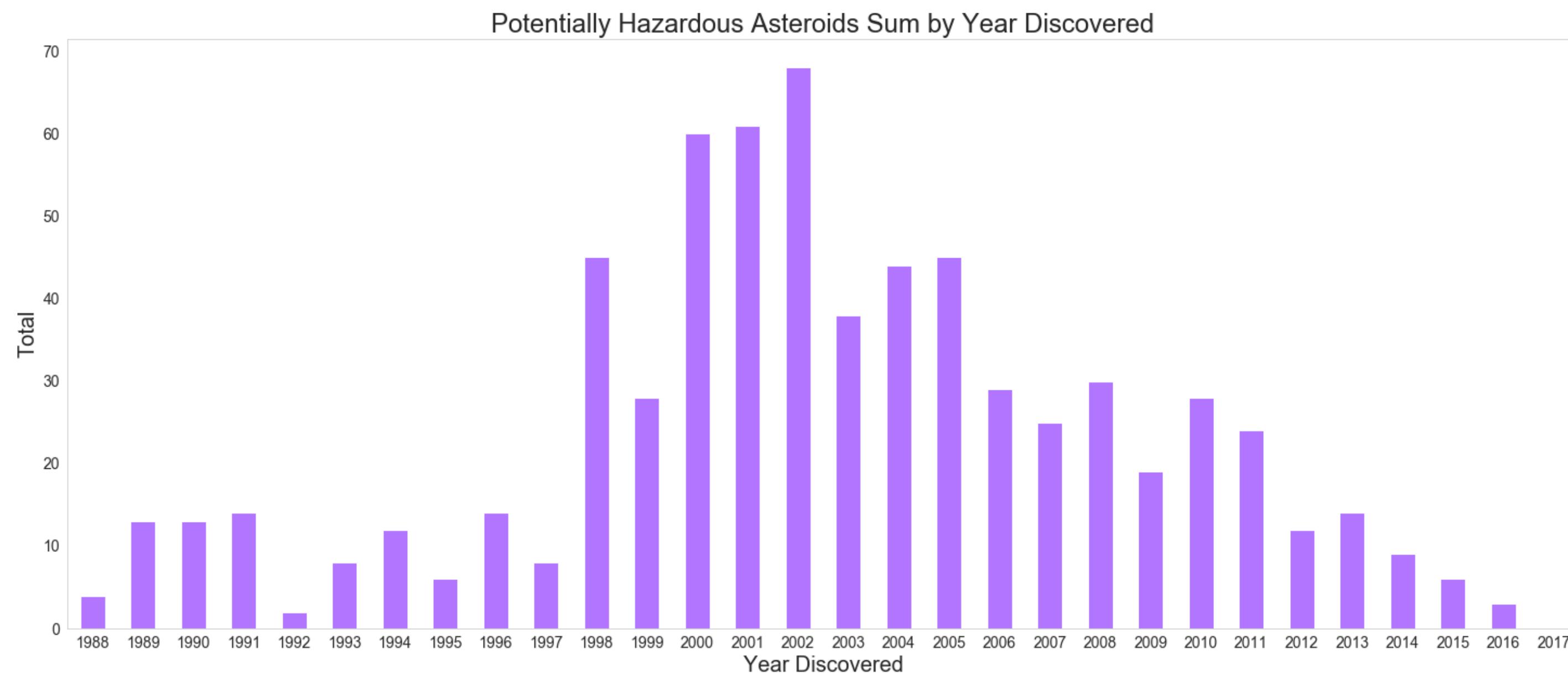
## : POTENTIALLY HAZARDOUS ASTEROIDS

- PHAs are defined based on parameters that measure the asteroid's potential to make threatening close approaches to the Earth.
- Asteroids with an Earth Min. Orbit Intersection Dist. of 0.05 au or less and an absolute magnitude of 22.0 or less

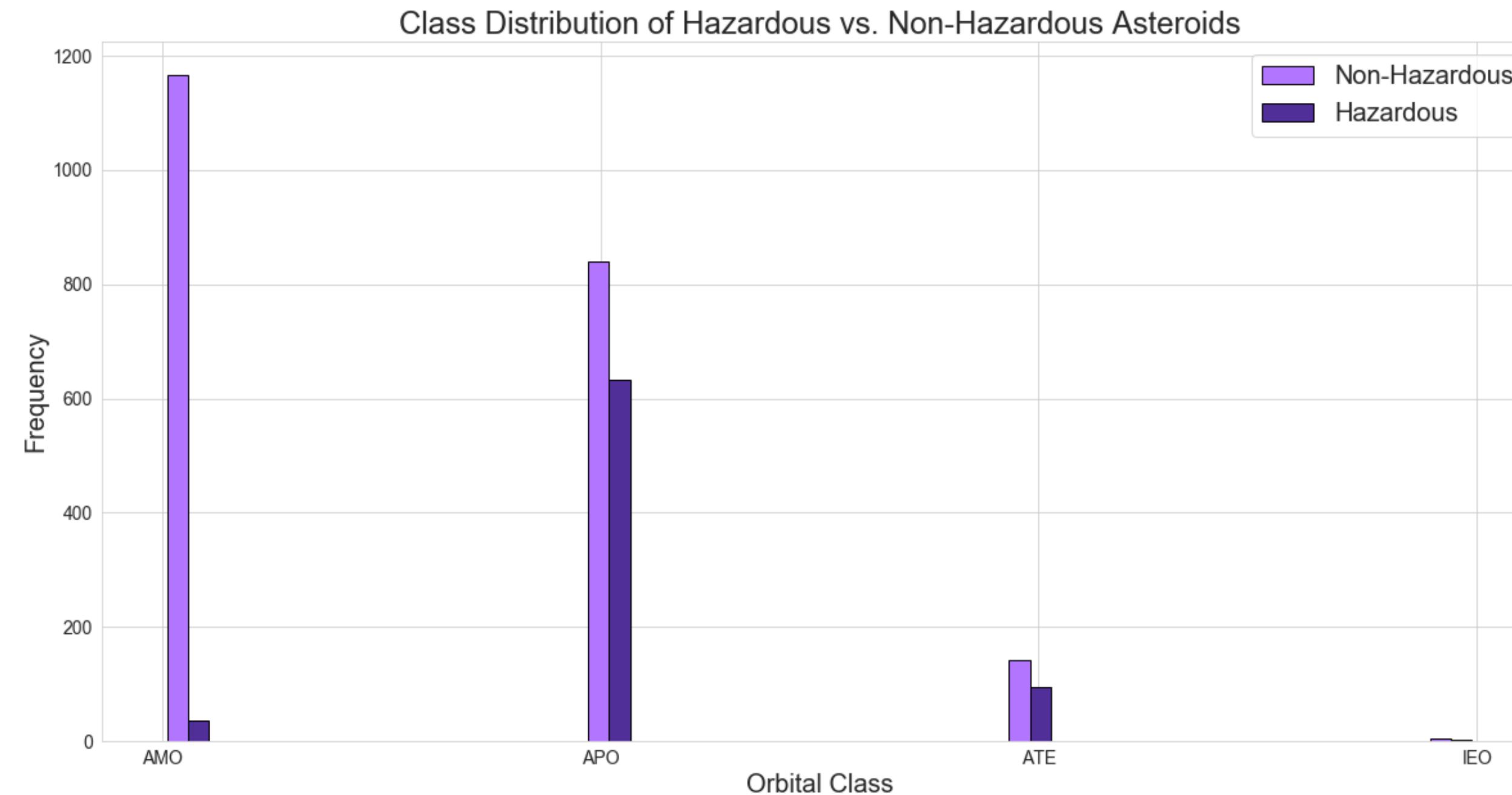


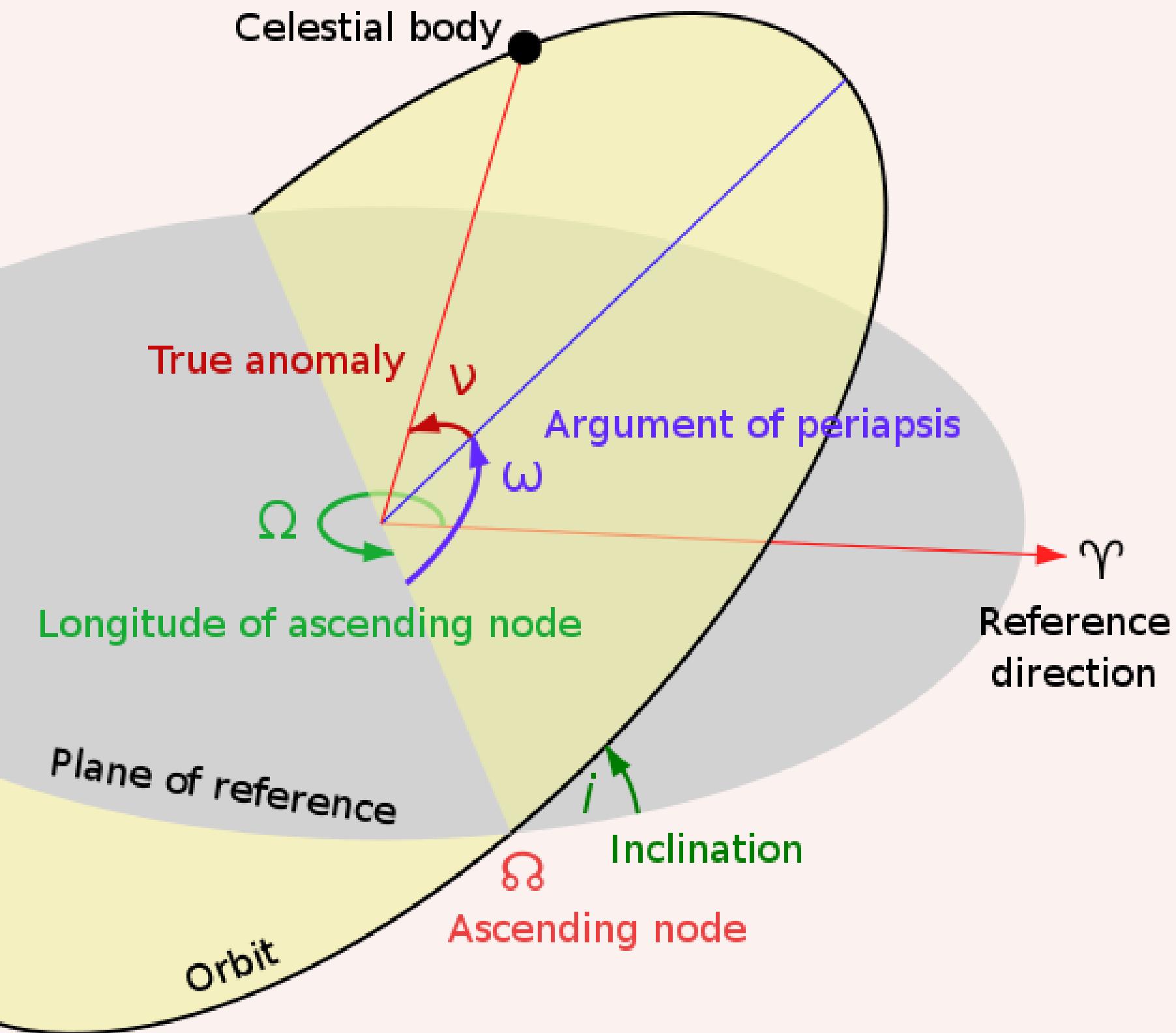


# DISCOVERY OVER THE LAST 30 YEARS



# ORBITAL CLASSES DISTRIBUTION





# ORBITAL CHARACTERISTICS

# FEATURE ENGINEERING

## FINDING THE STANDARD GRAVITATIONAL PARAMETER TO FIND INSTANTANEOUS VELOCITY

Standard Gravitational Parameter:

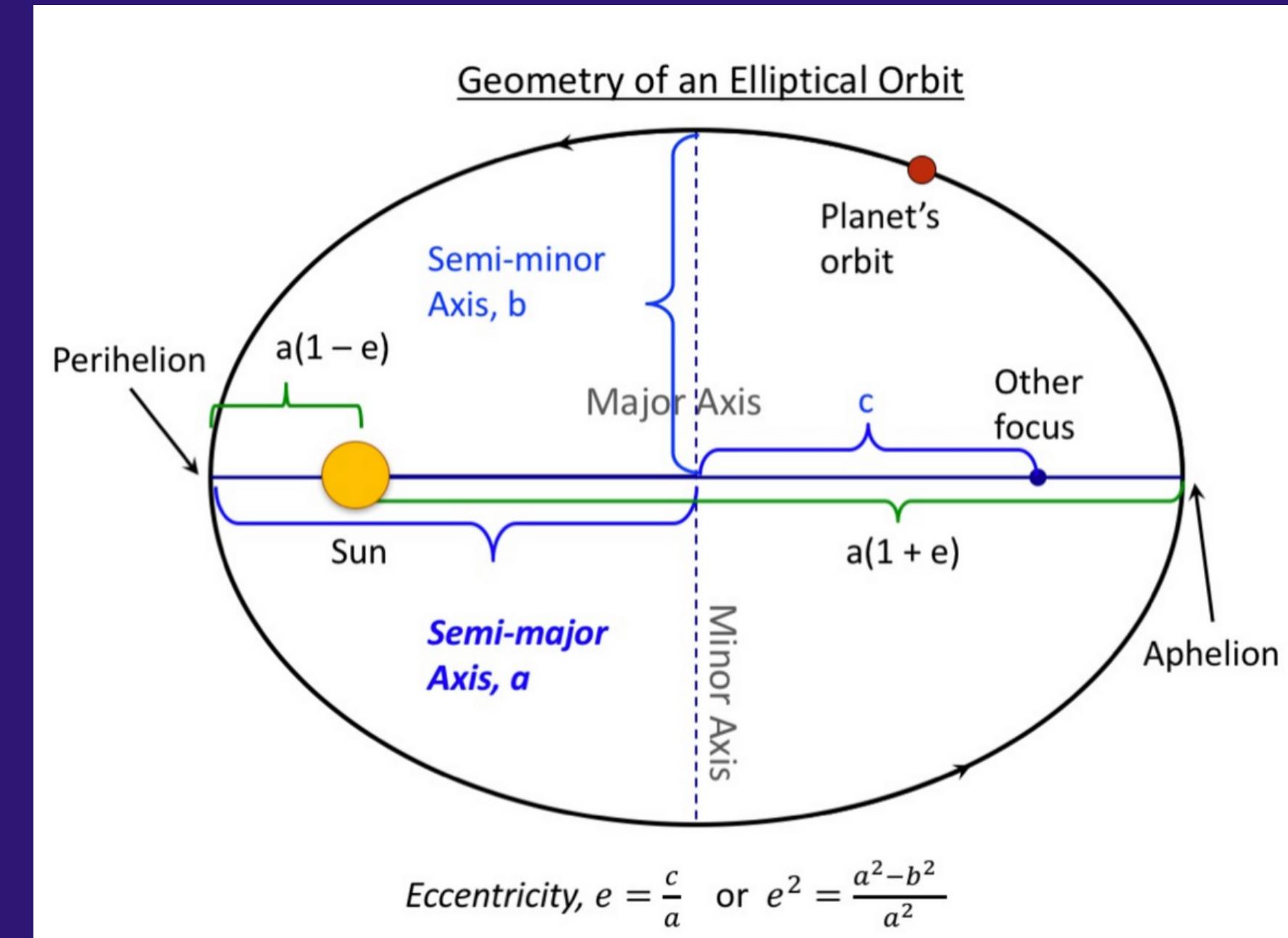
$$\mu = GM$$

Generalized for Elliptic Orbits:

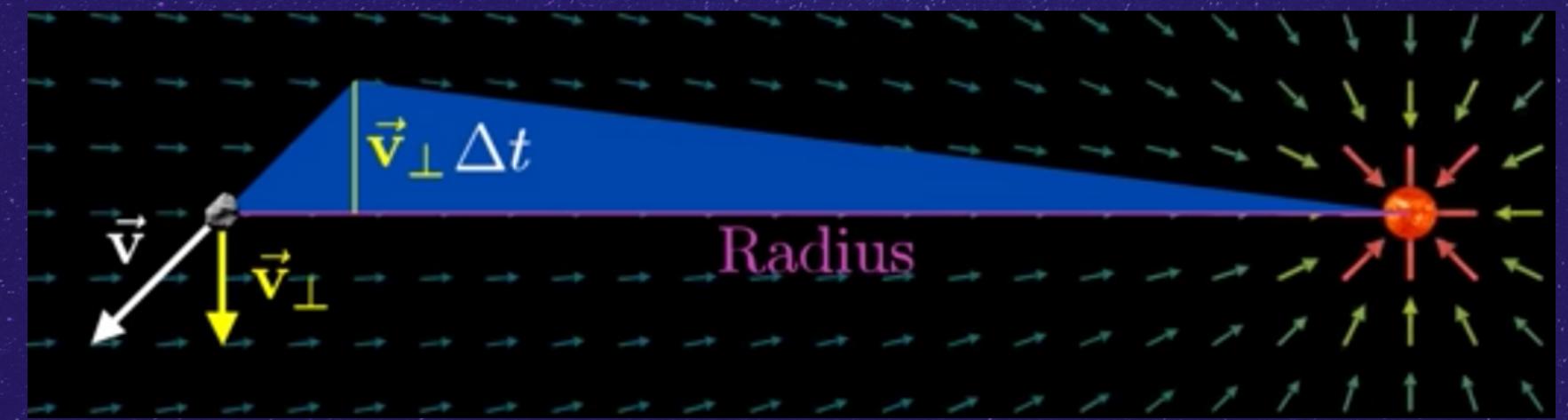
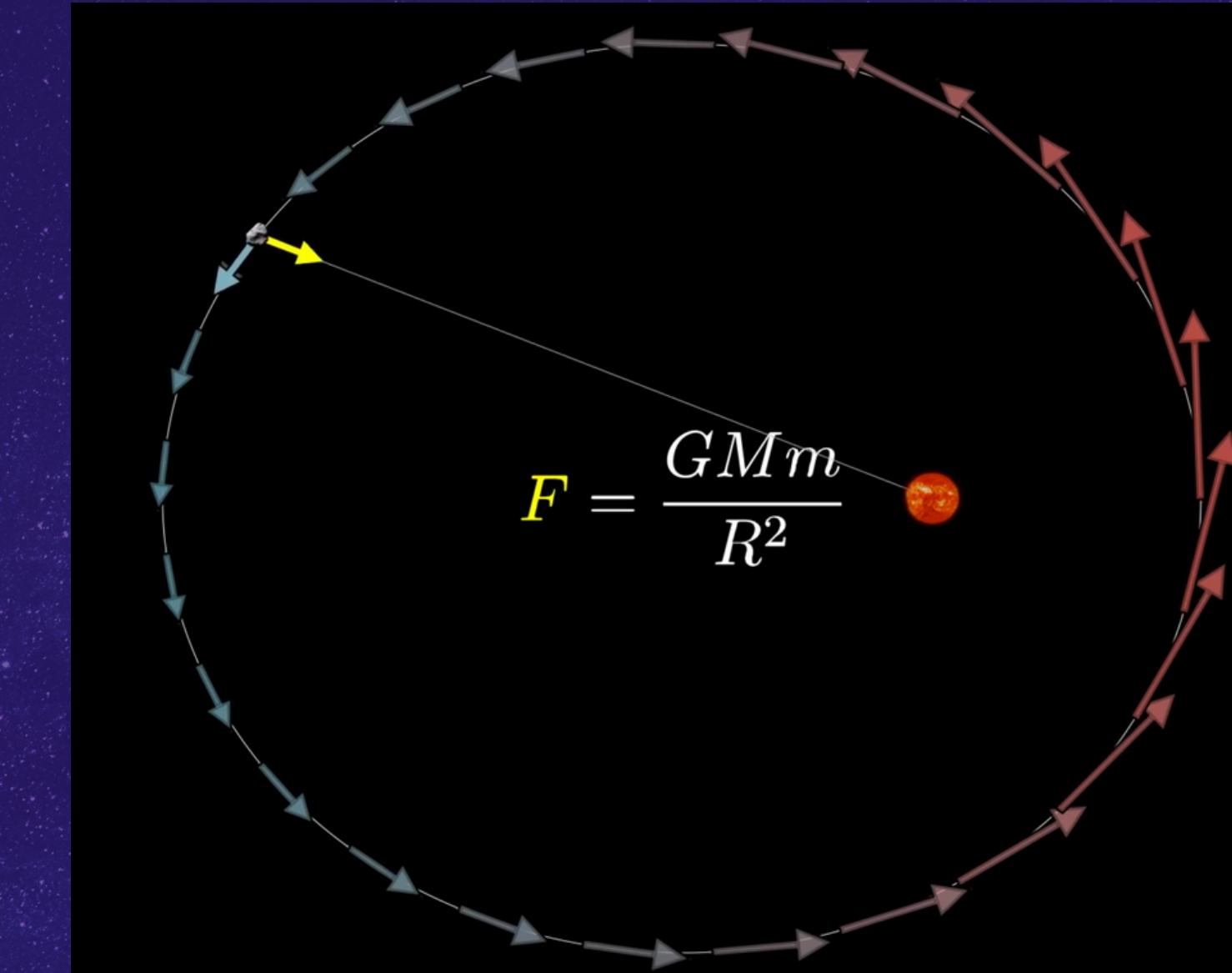
$$\mu = \frac{4\pi^2 a^3}{T^2}$$

Instantaneous Elliptical Orbit Velocity:

$$v^2 = GM \left( \frac{2}{r} - \frac{1}{a} \right)$$



# MORE MATH



# MODELING

74%

Baseline

97.7%

Logistic Regression

96.3%

Support Vector Classifier

99.9%

Random Forest Classifier

99.7%

Decision Tree Classifier



Should I be  
worried?



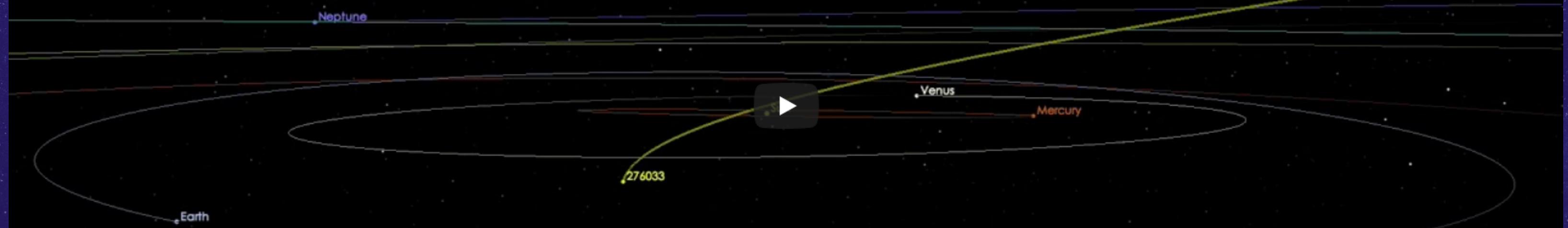
Trajectory of Asteroid 2002 AJ129

2018-Jan-09 06:45:43 UTC  
1,000,000x time



Watch later

Share



FEB. 4, 2018

2.6 MILLION MILES AWAY



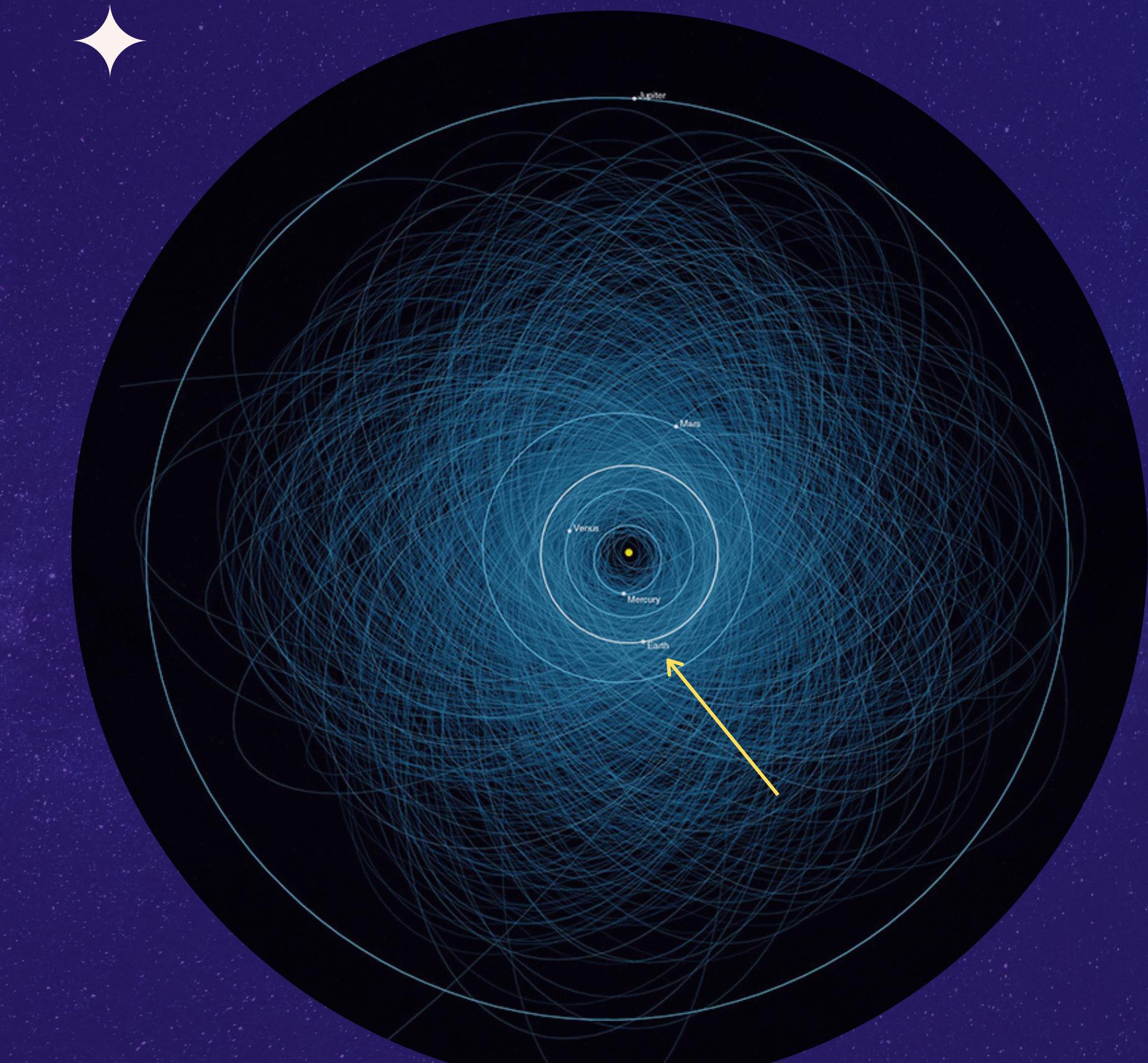
# NASA'S SENTRY IMPACT MONITORING

| Object Designation       | Year Range | Potential Impacts | Impact Probability (cumulative) | V <sub>infinity</sub> (km/s) | H (mag) | Estimated Diameter (km) |
|--------------------------|------------|-------------------|---------------------------------|------------------------------|---------|-------------------------|
| (2010 RF12)              | 2095-2118  | 62                | 4.9e-2                          | 5.10                         | 28.4    | 0.007                   |
| (2018 VP1)               | 2020-2025  | 3                 | 4.1e-3                          | 9.53                         | 30.9    | 0.002                   |
| (2012 HG2)               | 2052-2119  | 469               | 2.8e-3                          | 3.33                         | 27.0    | 0.014                   |
| (2000 SG344)             | 2069-2113  | 101               | 2.6e-3                          | 1.36                         | 24.8    | 0.037                   |
| (2019 DS1)               | 2082-2108  | 5                 | 1.4e-3                          | 10.48                        | 25.6    | 0.025                   |
| (2017 US)                | 2085-2111  | 16                | 1.4e-3                          | 4.53                         | 26.0    | 0.021                   |
| (2013 VW13)              | 2071-2084  | 9                 | 4.3e-4                          | 16.35                        | 26.2    | 0.019                   |
| 101955 Bennu (1999 RQ36) | 2175-2199  | 78                | 3.7e-4                          | 5.99                         | 20.2    | 0.490                   |

Sentry is a highly automated collision monitoring system that continually scans the most current asteroid catalog for possibilities of future impact with Earth over the next 100 years.

# CONCLUSION

- Asteroids are fascinating!!
- Target class is highly unbalanced so it takes meaning away from the accuracy of the model.
- The most influential feature is the distance from the orbit of intersection, which was obvious from the beginning.



# NEXT STEPS



## Asteroid Deflection App (Kinetic Impactor)

- How much velocity change is required to make the asteroid miss the Earth?
- When could an impactor spacecraft be launched in order to intercept the asteroid
- What is the maximum size of asteroid that can be deflected with a single launch?
- In which direction will the asteroid be deflected most easily?

## OSIRIS-REx



Elapsed Mission Time:

08 YRS : 07 MOS : 08 DAYS

- Wait (until 2023) for asteroid Bennu's orbit insights and collected sample.
- 0.0032228 au (482,120 km) away at Earth MOID