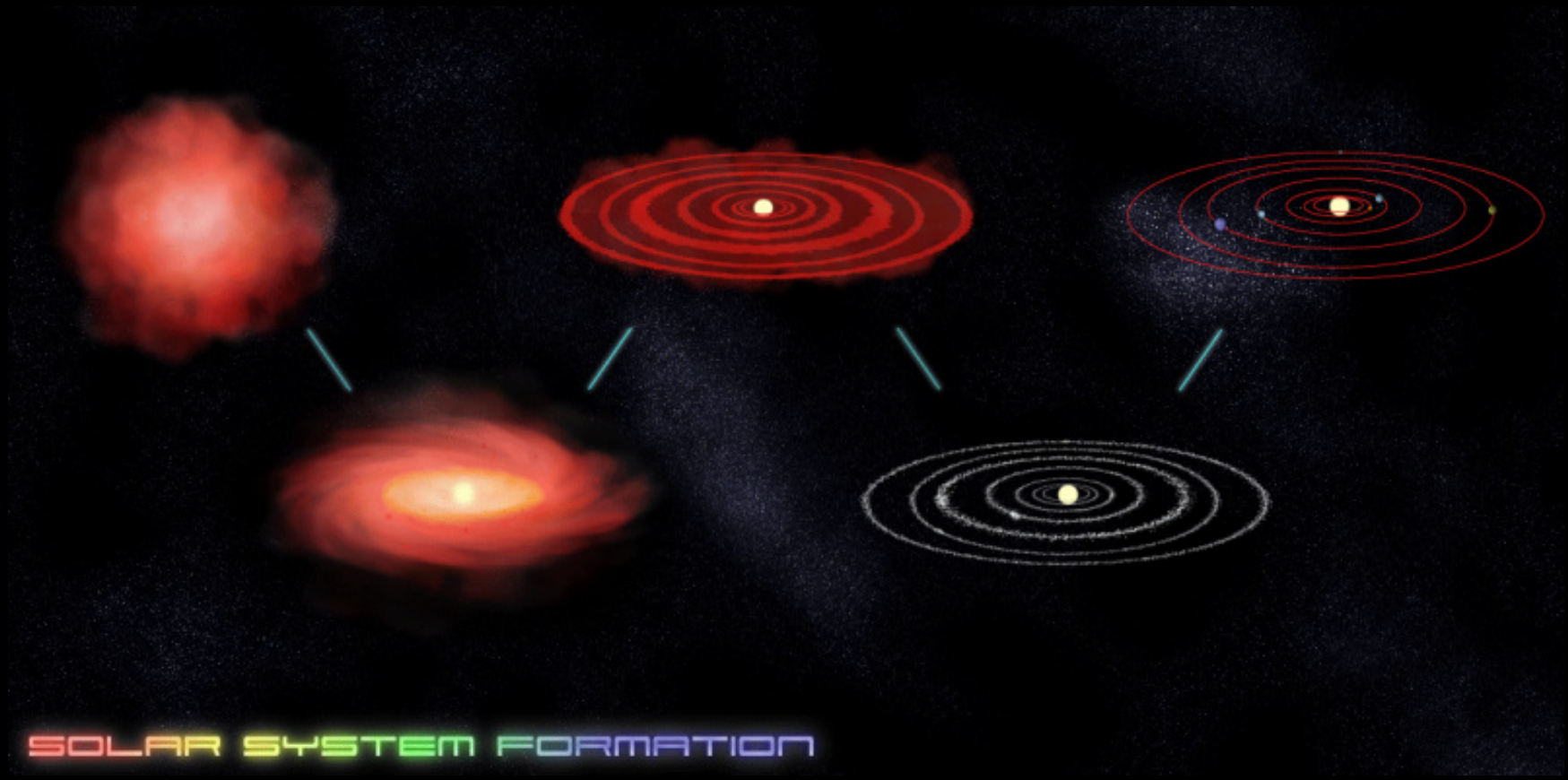
Solar System Series:
The Asteroid Belt

Peterborough Astronomical Association
Novice Astronomy Class
April 3, 2026
Brett Hardy

Early Solar System Formation

- Giant cloud of gas and dust
- Formation of Sun
- Planetary formation
- Importance of supernovae



NAAP Labs

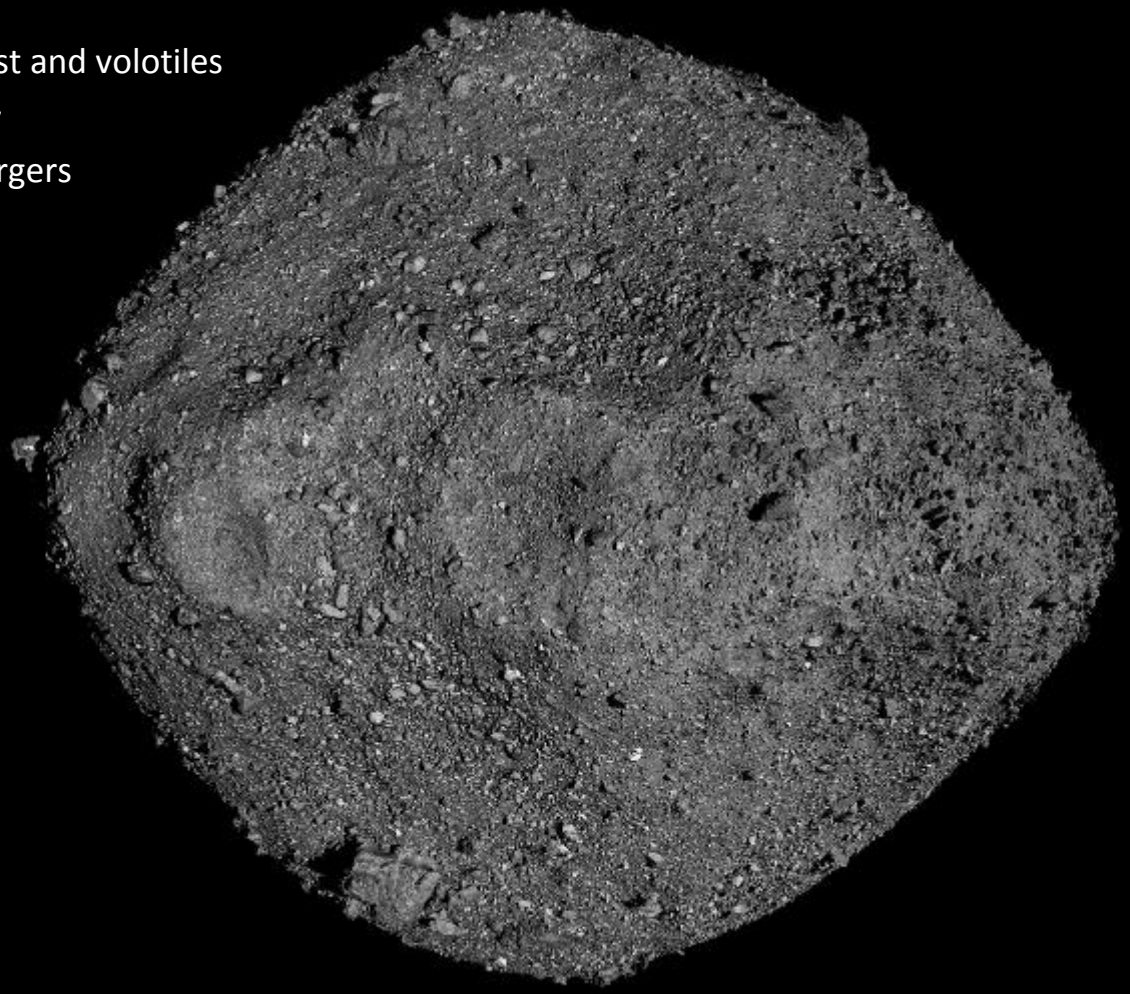
What Are Asteroids?

- Small rocky bodies
- Unchanged since the formation of the solar system
- Sizes: metres to hundreds of kilometres

NASA Galileo Spacecraft

How Are Asteroids Formed?

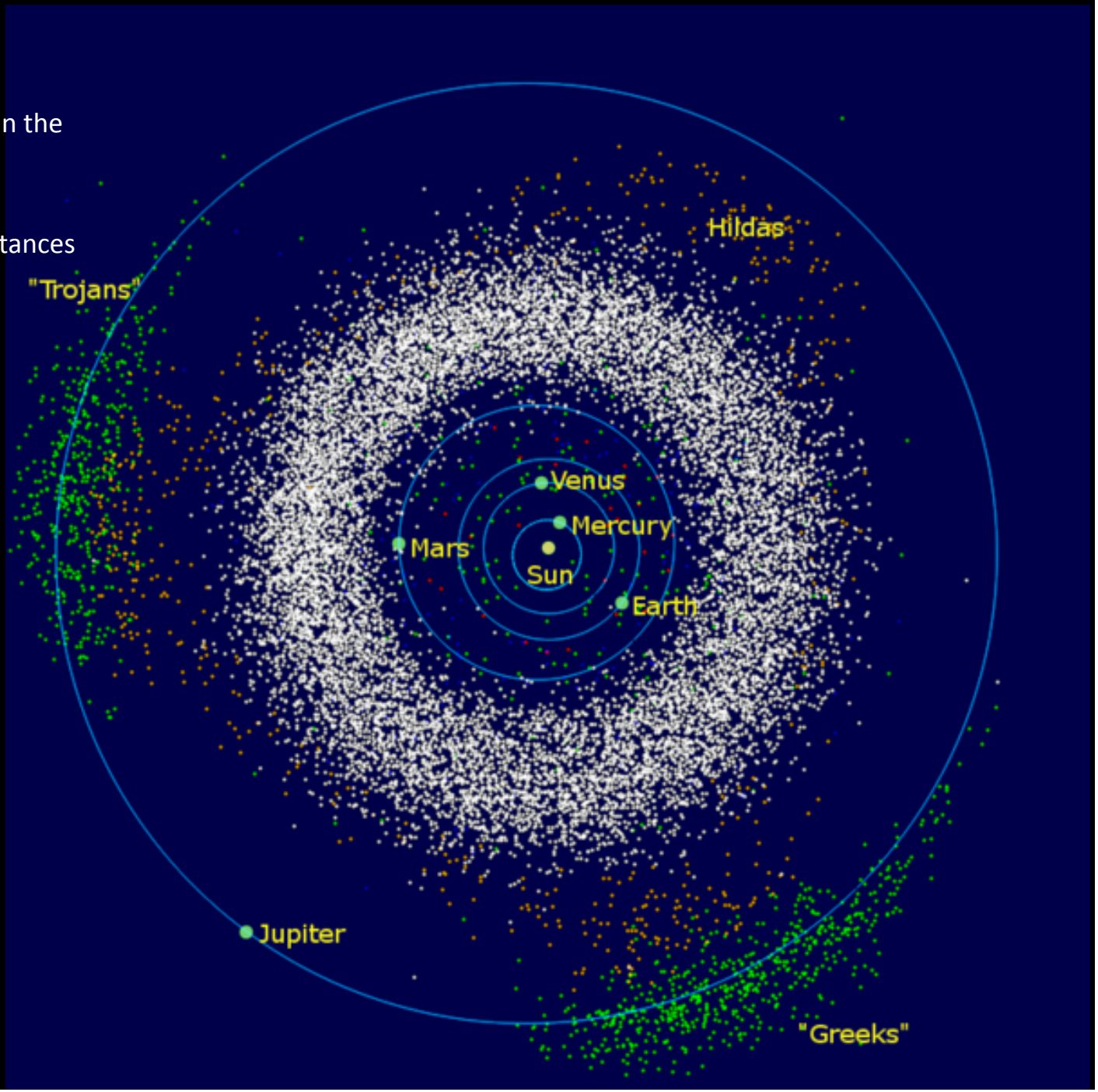
- Leftover remnants of solar system formation
- Accretion of dust and volotiles
- Jupiter’s gravity
- Collisions & mergers
- Rubble piles



NASA's OSIRIS-REx spacecraft

The Asteroid Belt

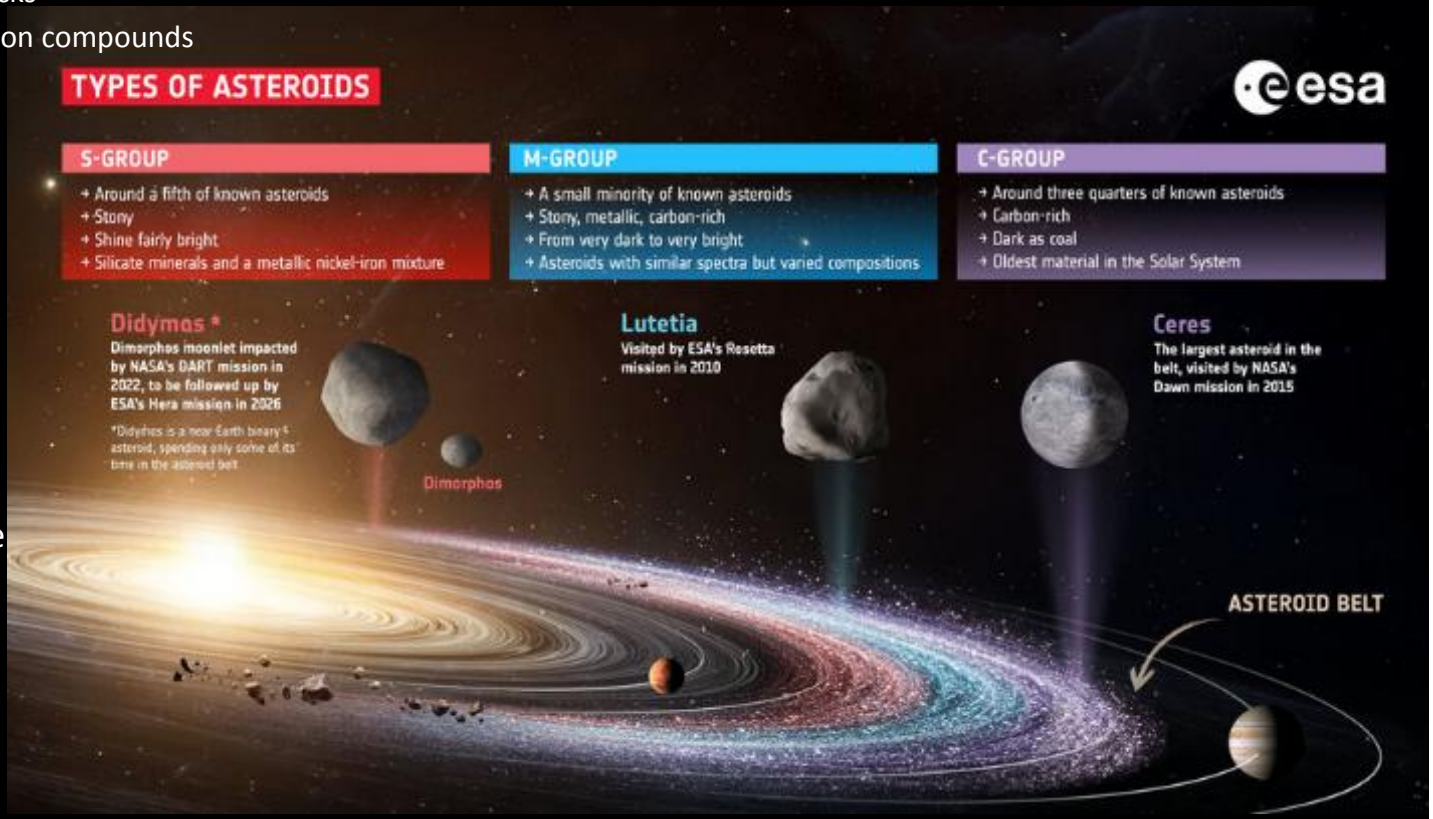
- Predominantly found in the asteroid belt
- Millions of asteroids
- Separated by huge distances



Wikimedia Commons

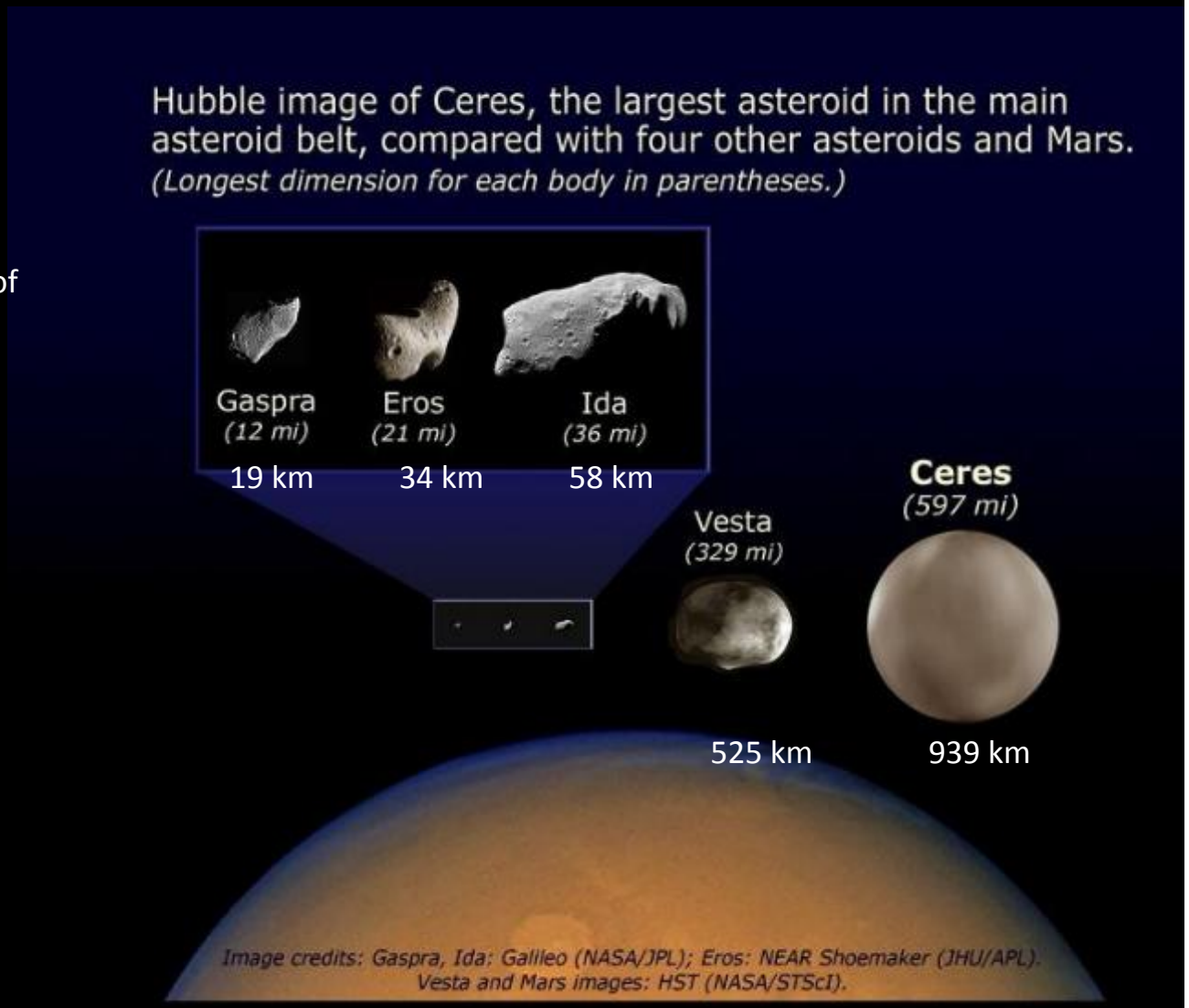
Types of Asteroids & Composition

- Chondrites (C-type)
  - Most common
  - Clay & silicate rocks
  - Dark, rich in carbon compounds
- Silicaceous (S-type)
  - Silicate rocks, iron & nickel
- Metallic (M-type)
  - Iron and nickel
  - ~ 1%
- Water Ice
- Carbon compounds
- Organic molecules
- Building blocks of life



Size Comparison

- Total mass of all asteroids in Asteroid Belt is about 1/25 the mass of the Moon
- Ceres a little more than 25% of that mass
- Three largest asteroids account for half of the total mass



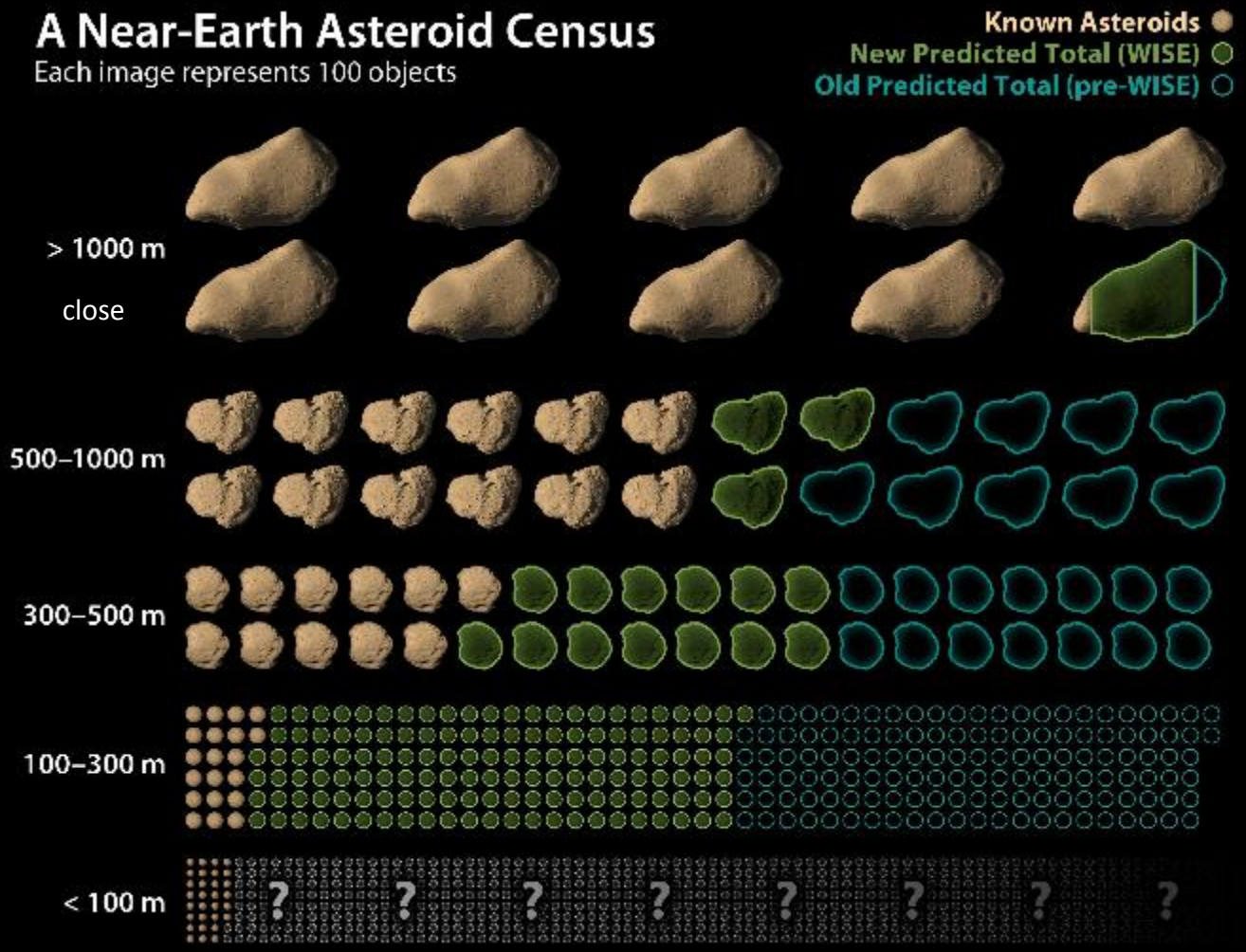
Large Asteroids

- Dwarf planets
- Show evidence of geological processes

Wikimedia Commons

Near-Earth Asteroids

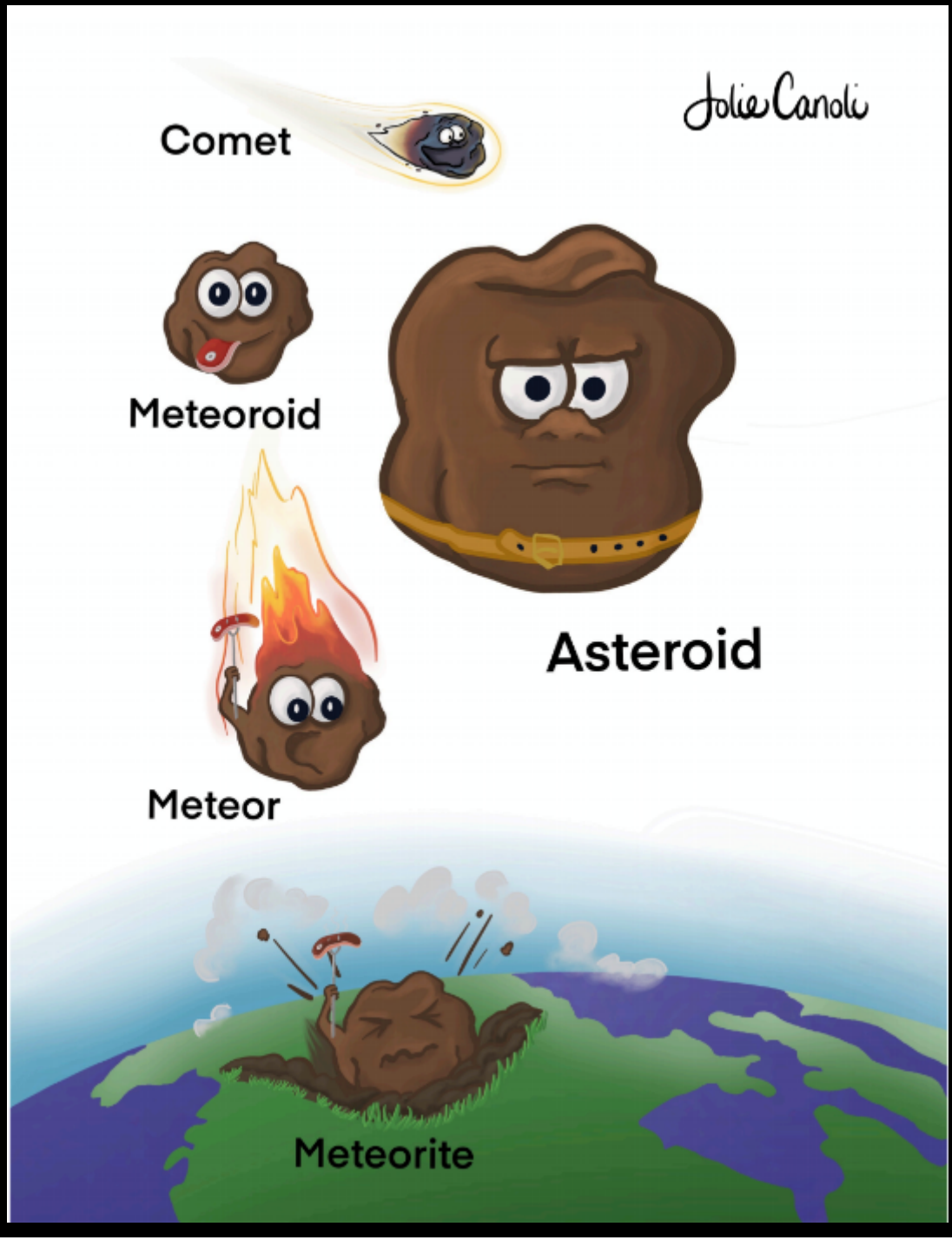
- Asteroids that orbit close to Earth
- Potentially Hazardous Objects (PHO) cross Earth's orbit
- Thousands discovered
- Meticulously monitored and tracked
- Apophis
  - ~ 375 metres
  - April 13, 2029 approach
  - 32,000 km



The Planetary Society

Asteroid, Meteor, Meteorite oh My!

- Location matters



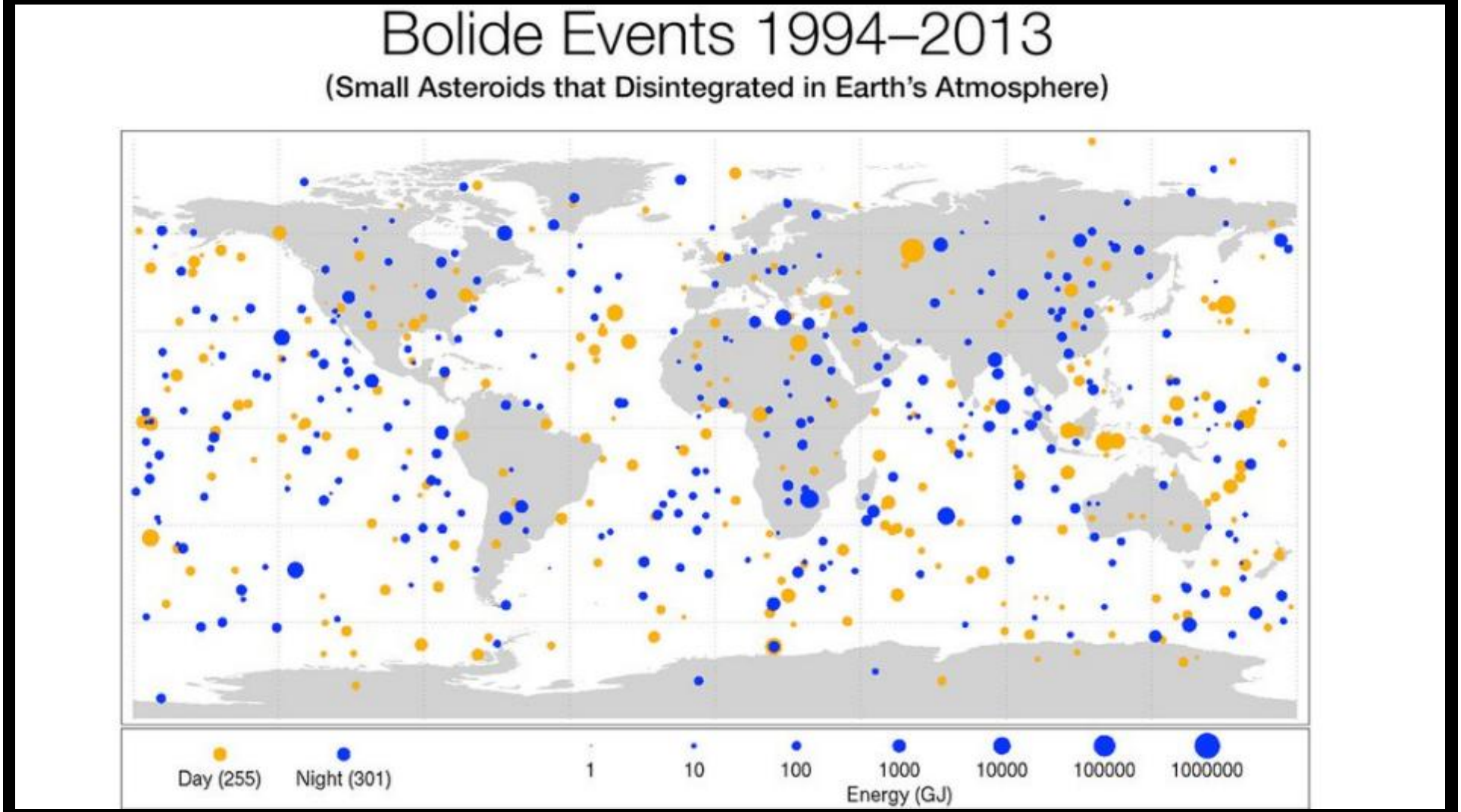
Asteroid Impact History

- Large impacts have shaped planetary surfaces
- Responsible for bringing volatiles
- Responsible for transporting the building blocks of life
- Cretaceous − Paleogene extinction event
- 66 million years ago
- ~ 10 km in size
- Chichulub Crater
- Global climate change
- Berringer Crater 50 metre asteroid 50,000 years ago
    - Crater 1 km across ~ 200 metres deep
- 1908 Tunguska ~ 50-60 metres
- 2013 Chelyabinsk ~ 17-20 metres

EduPic Graphic Resource/The Planetary Society

Asteroid Impact History

- 556 incidents in 20 years
- 1 metre to 20 metres



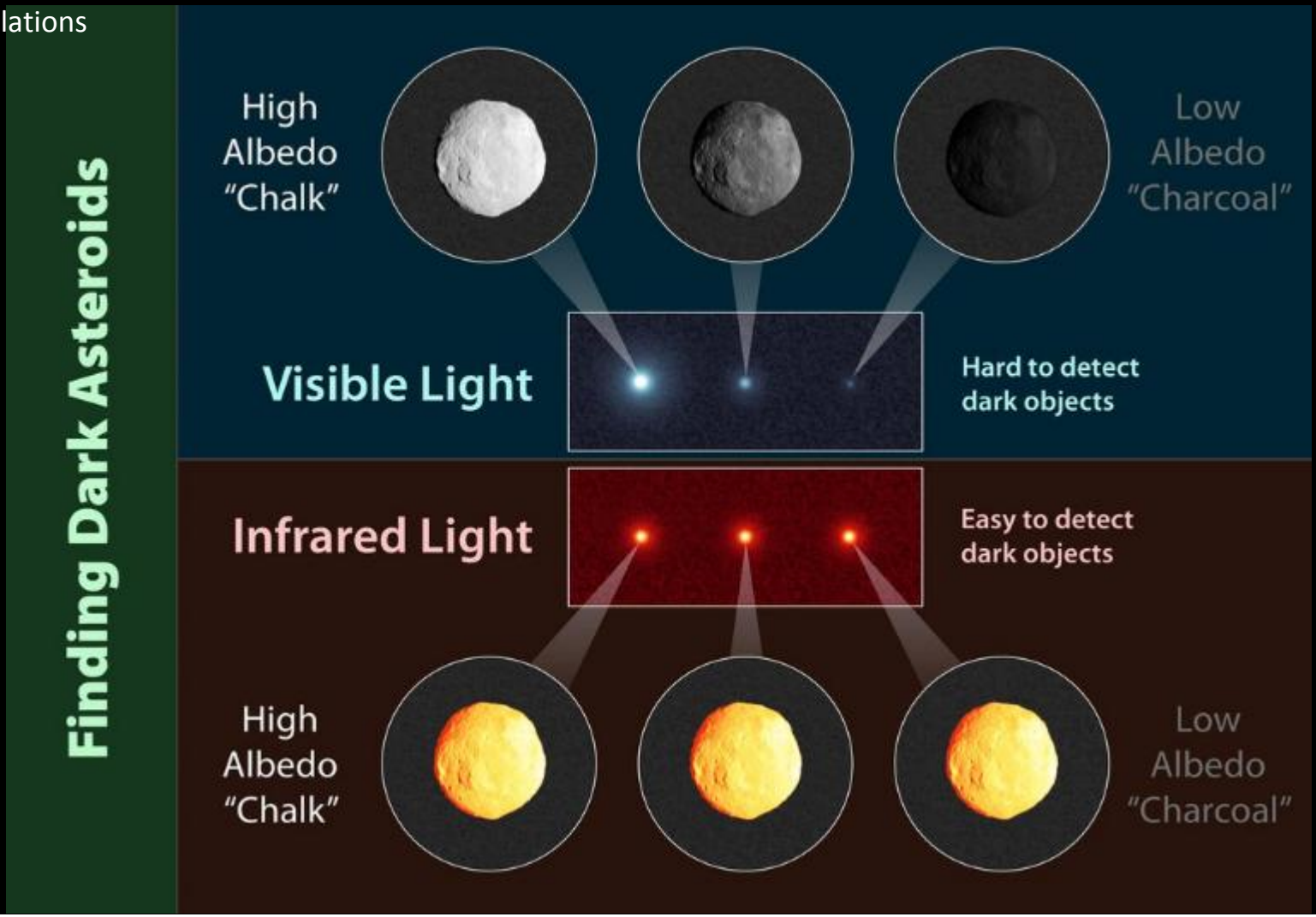
Craters Across the Solar System

- Moon
- Mars
- Mercury
- Asteroids

ASA/JPL-Caltech/Space Science Institute

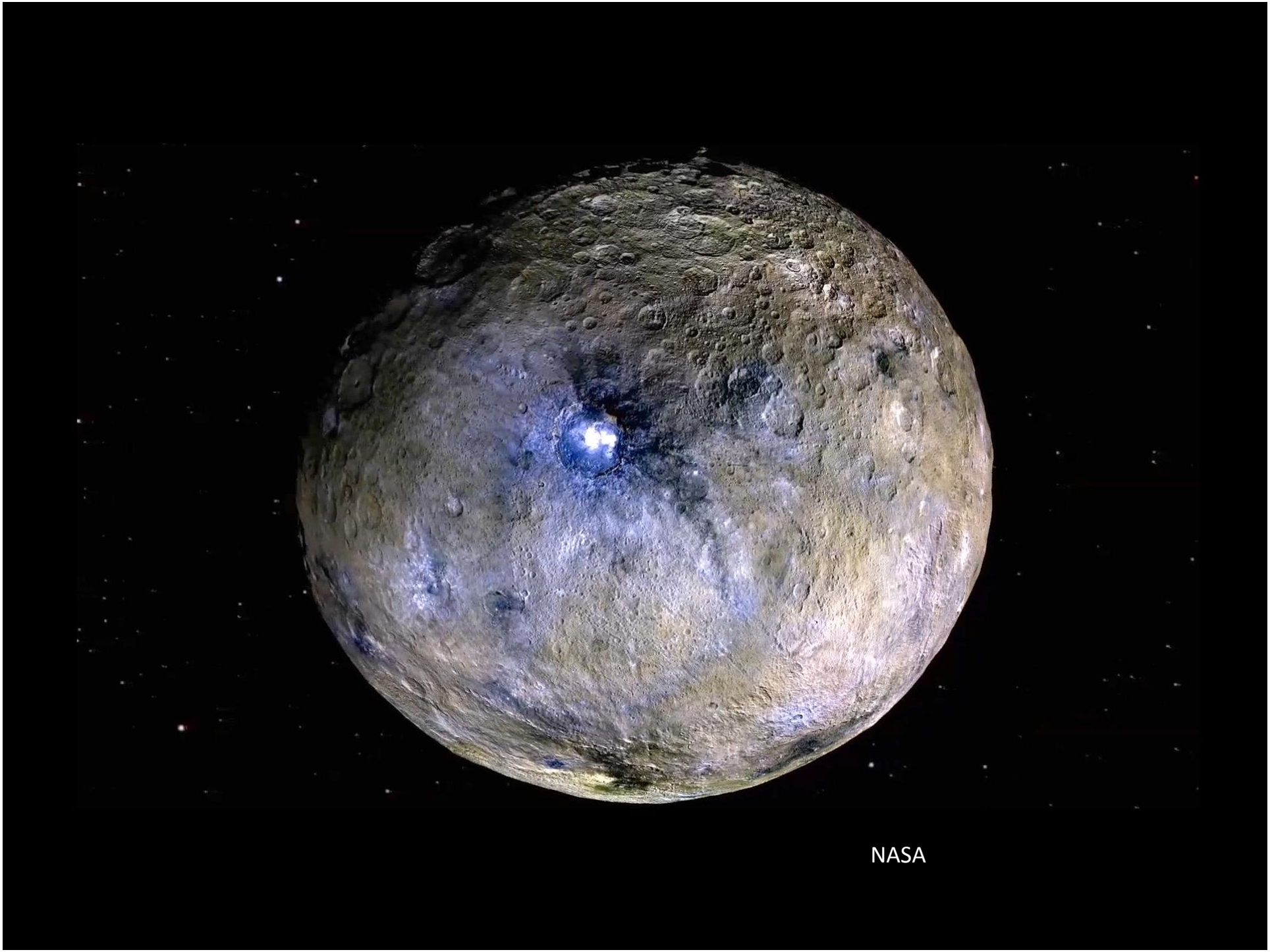
Detecting Asteroids

- Automated sky surveys
  - Catalina Sky Survey
- Large telescopes
  - Vera C Rubin Observatory
- Orbit calculations



Asteroid Exploration

- Why study?
  - solar system formation
  - organic molecules
  - early planetary chemistry
- OSIRIS-Rex
- Asteroid Bennu
- Near-Earth Asteroid
- Sample return 2023
  - Made from fragments of larger parent body
  - Materials transformed by water
  - High carbon congtent
  - Organic compounds
- Hayabusa2
- Asteroid Ryugu
  - Nucleic acids & nucleobases
- Dawn
- Ceres & Vesta
  - Differentiated
  - Geologically active?

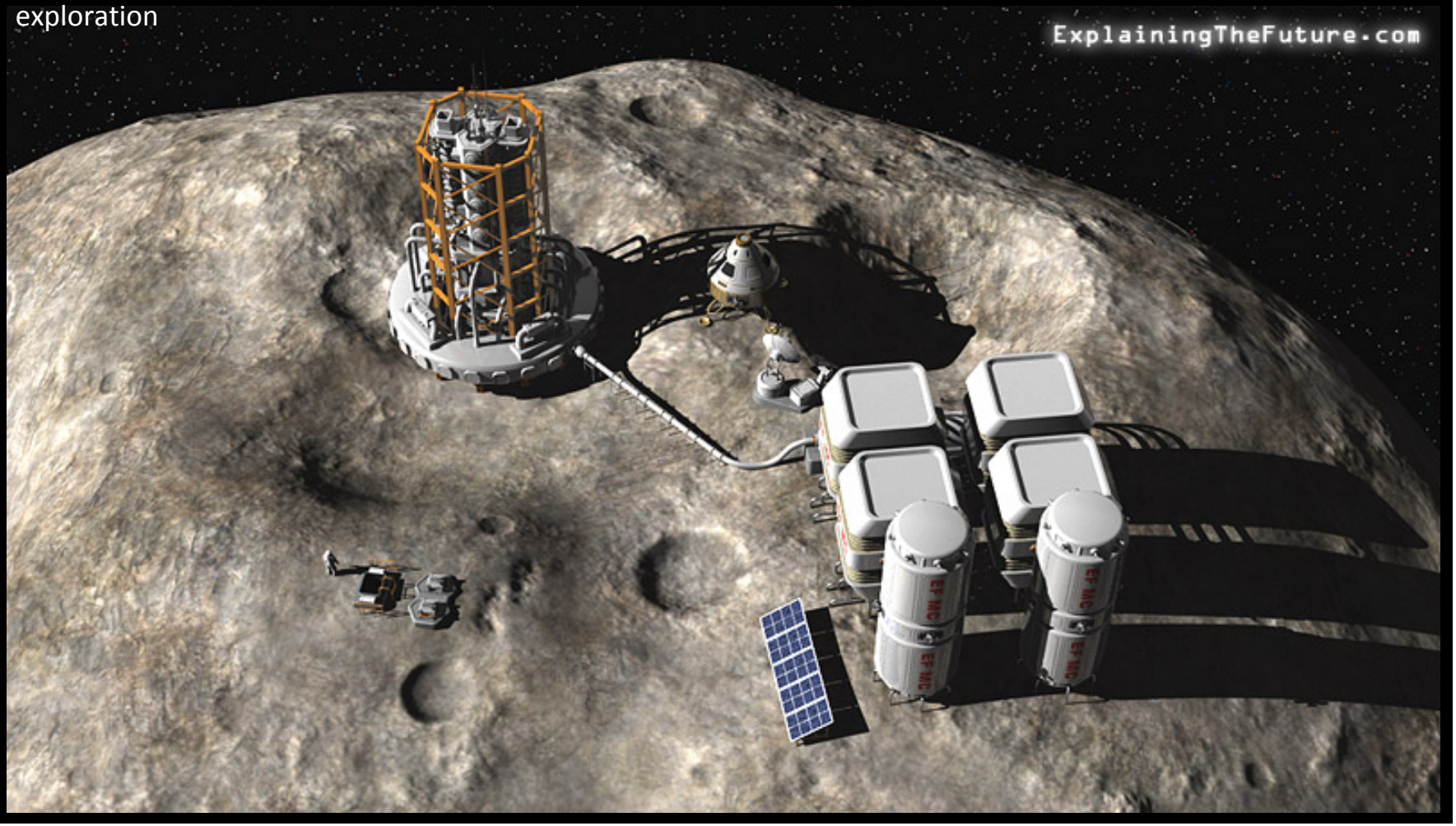

NASA

Planetary Defense

- Track potentially hazardous objects
- Detect potential threats decades in advance
- NASA test mission: DART
  - **D**ouble **A**steroid **R**edirect **T**est
- Target asteroid: Dimorphos (150m)
- First demonstration of asteroid deflection
- Slowed orbit by 32-33 minutes
- ESA's Hera Mission 2026

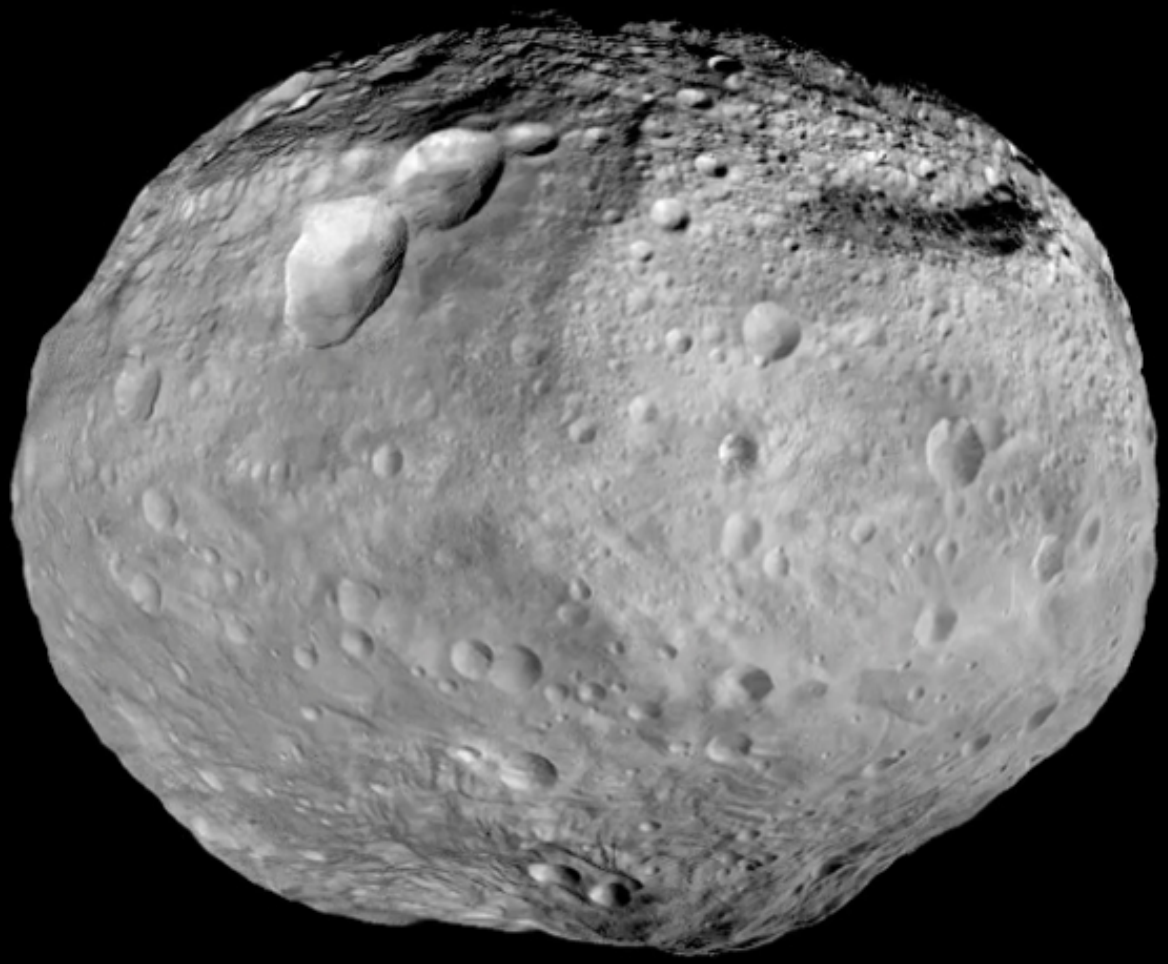
Future Use

- Asteroid mining
- Metals
- Water
- Fuel for spacecraft
- Could support future space exploration



Why Do Asteroids Matter?

- Understand Solar System history
- Protect civilization
- Find resources
- Space exploration



NASA: Vesta

Observing Opportunities

Ceres

- Low in West after sunset in Cetus
- Rises in East just before 20:00 in November
- Magnitude 8

Vesta

- Visible very early in the morning until September in Cetus
- Magnitude 7

Pallas

- Same as Vesta

Hygiea

- Visible now in Gemini
- Sets just before 01:00
- Magnitude 12

Novice Astronomy Class
May 1, 2026
How Far is Far? Astronomical Measurement