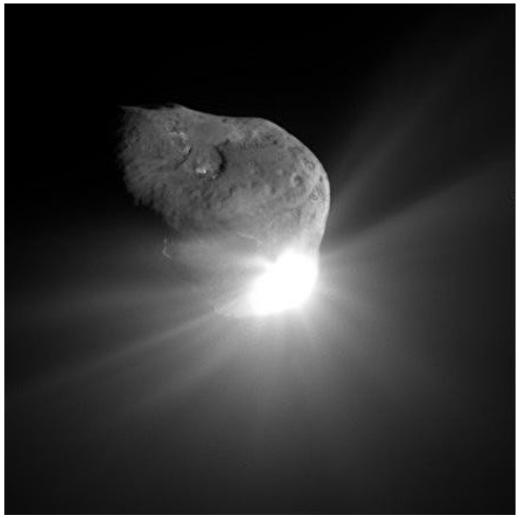
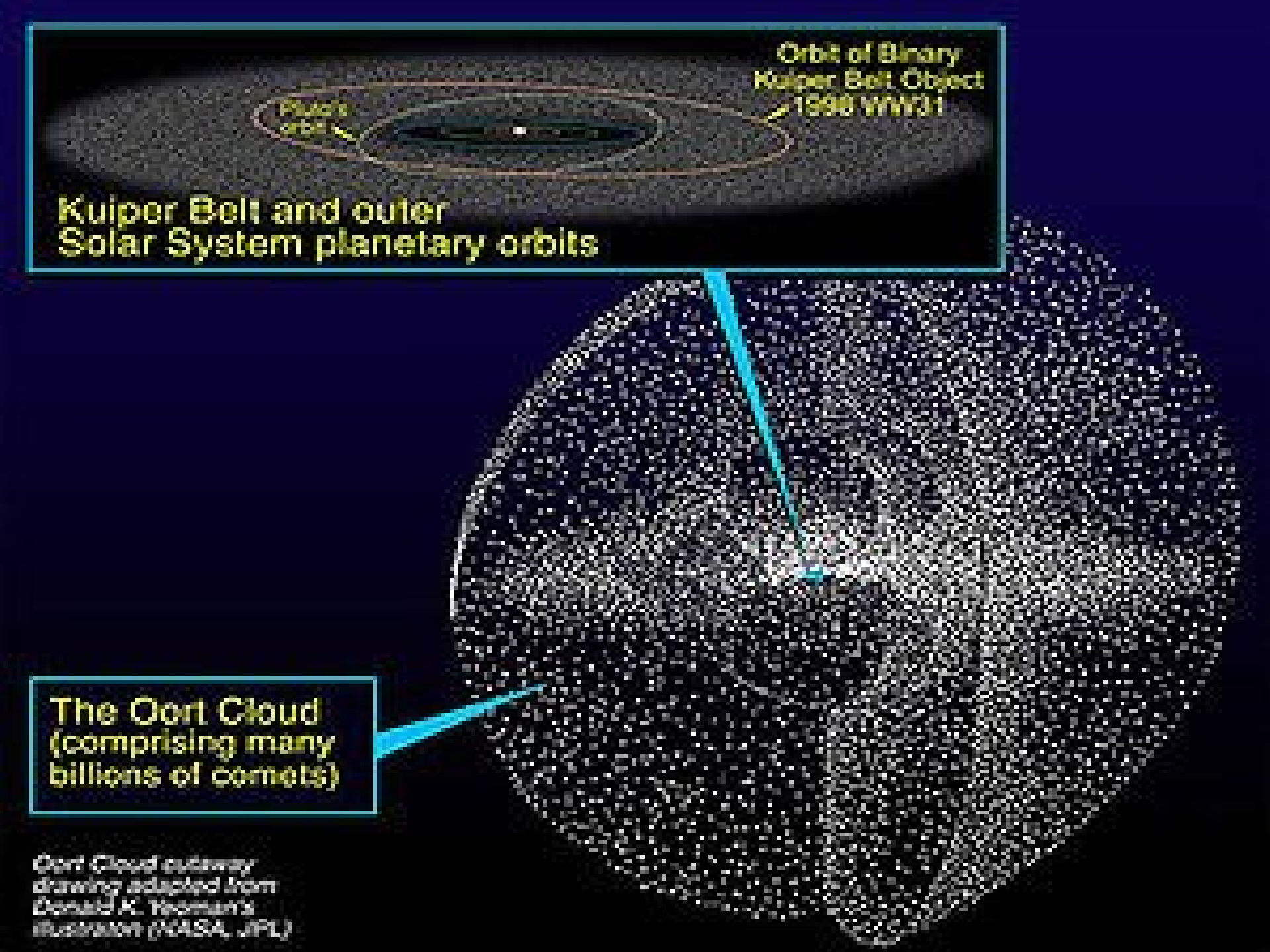

The Oort Cloud
The Edge of the Solar System

What is the Oort Cloud?

- Spherical area between 5,000 and 100,000 AU from the sun (Kuiper belt ends at 55 AU)
- Proxima Centauri is 270,000 AU from sun
- Contains between 0.1 and 2 trillion comets
- Distance between Oort Cloud Comets: 50-500 million km (0.33-3.33 AU)
- Surface temp. in Oort Cloud ~5-6 K

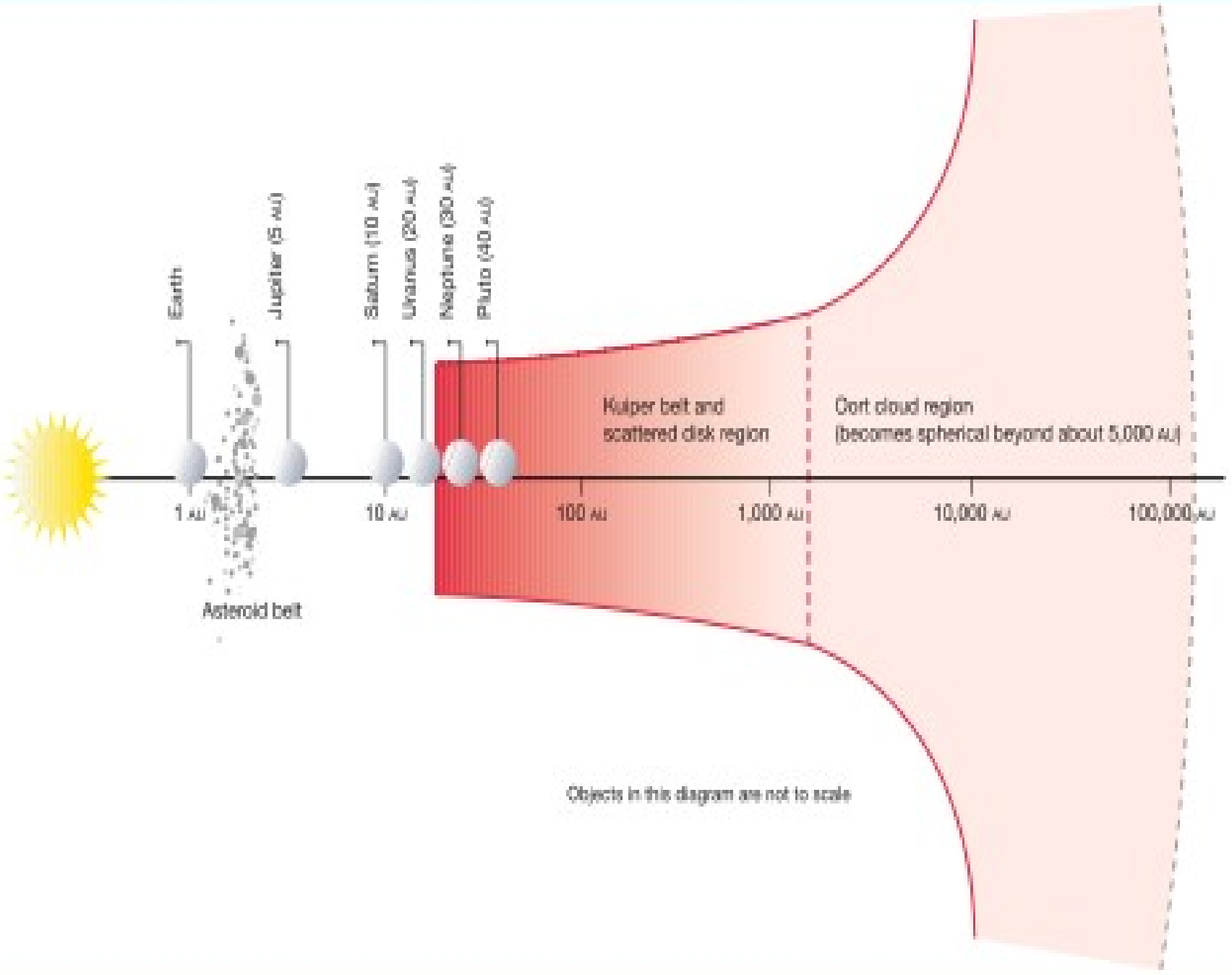
  (Kuiper belt 30-60 K)
- Named after Jan Oort




Orbit of Binary
Kuiper Belt Object
1998 WW31
Pluto's orbit
Kuiper Belt and outer
Solar System planetary orbits
The Oort Cloud
(comprising many
billions of comets)
Oort Cloud cutaway
drawing adapted from
Donald K. Yeomans's
illustration (NASA, JPL)

Oort Cloud Comets

- 12 comets per year leave Oort Cloud to become long-range comets
  - Pushed out by large molecular clouds, passing stars, or tidal interactions with Milky Way's disc
  - 5 of these enter inner solar system per year
  - It takes thousands of years for them to orbit the sun
- Orbital velocities of Oort Cloud Comets: ~0.2 km/s
- Comet composition: equal parts non-volatile solids and volatile ices


Earth
Jupiter (5 AU)
Saturn (10 AU)
Uranus (20 AU)
Neptune (30 AU)
Pluto (40 AU)
Kuiper belt and
scattered disk region
Oort cloud region
(becomes spherical beyond about 5,000 AU)
1 AU
10 AU
100 AU
1,000 AU
10,000 AU
100,000 AU
Asteroid belt
Objects in this diagram are not to scale

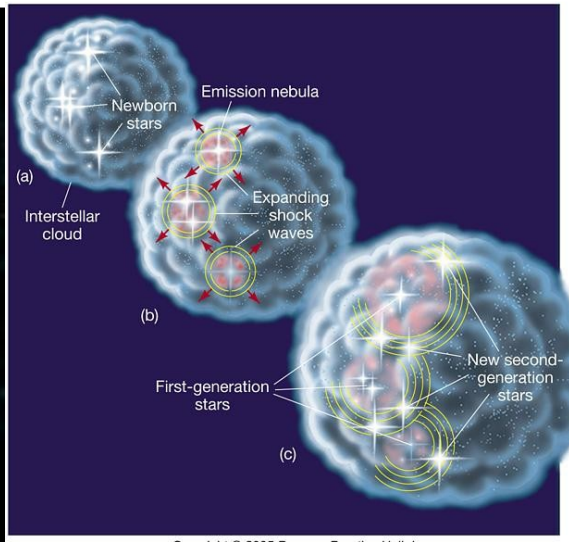
Origin of Oort Cloud Comets

- Could have formed near gas giants and slowly migrated outward
- Others believe 30% came from Kuiper Belt
- “It is likely that over 90% of the observed Oort Cloud Comets have an extrasolar origin” - H. Levison

Comet West

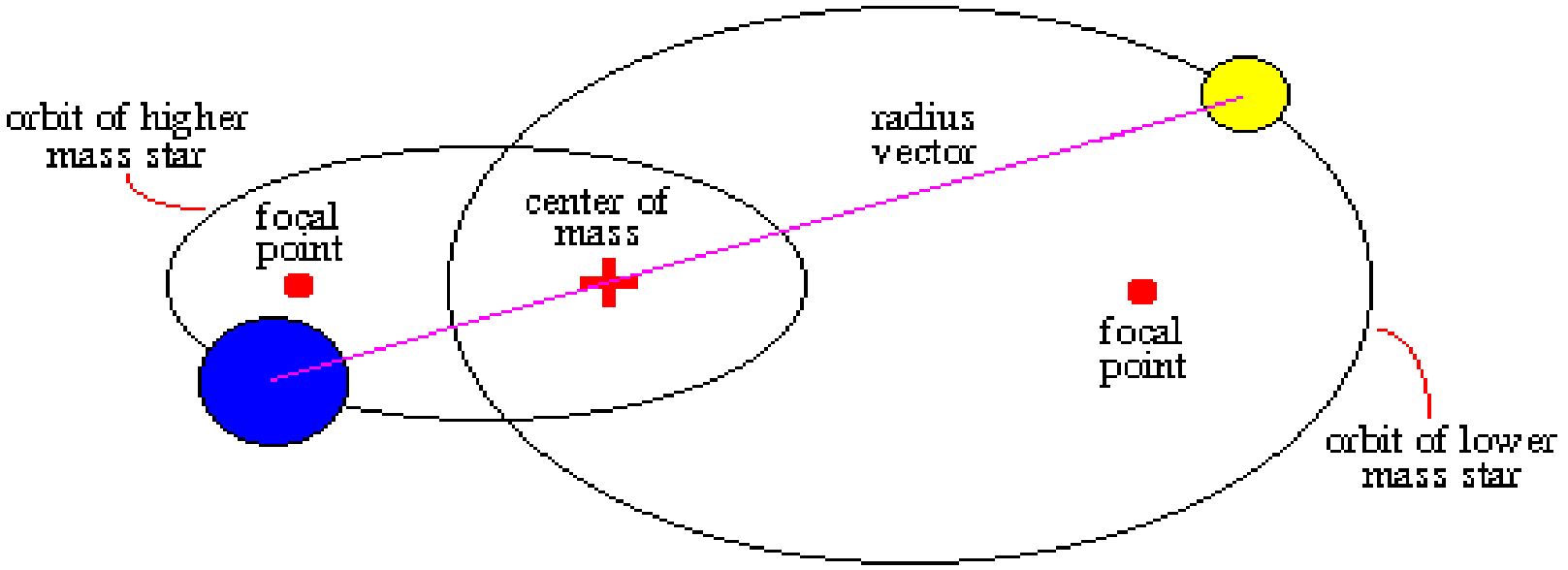
Binary Star Systems

- Primordial star cloud splits into two distinct parts with different gravitational areas
- Comprise 46% of star systems
- 55% of star systems have at least two stars



Binary Star System

Binary Star Orbit



Brown Dwarf Binary Systems

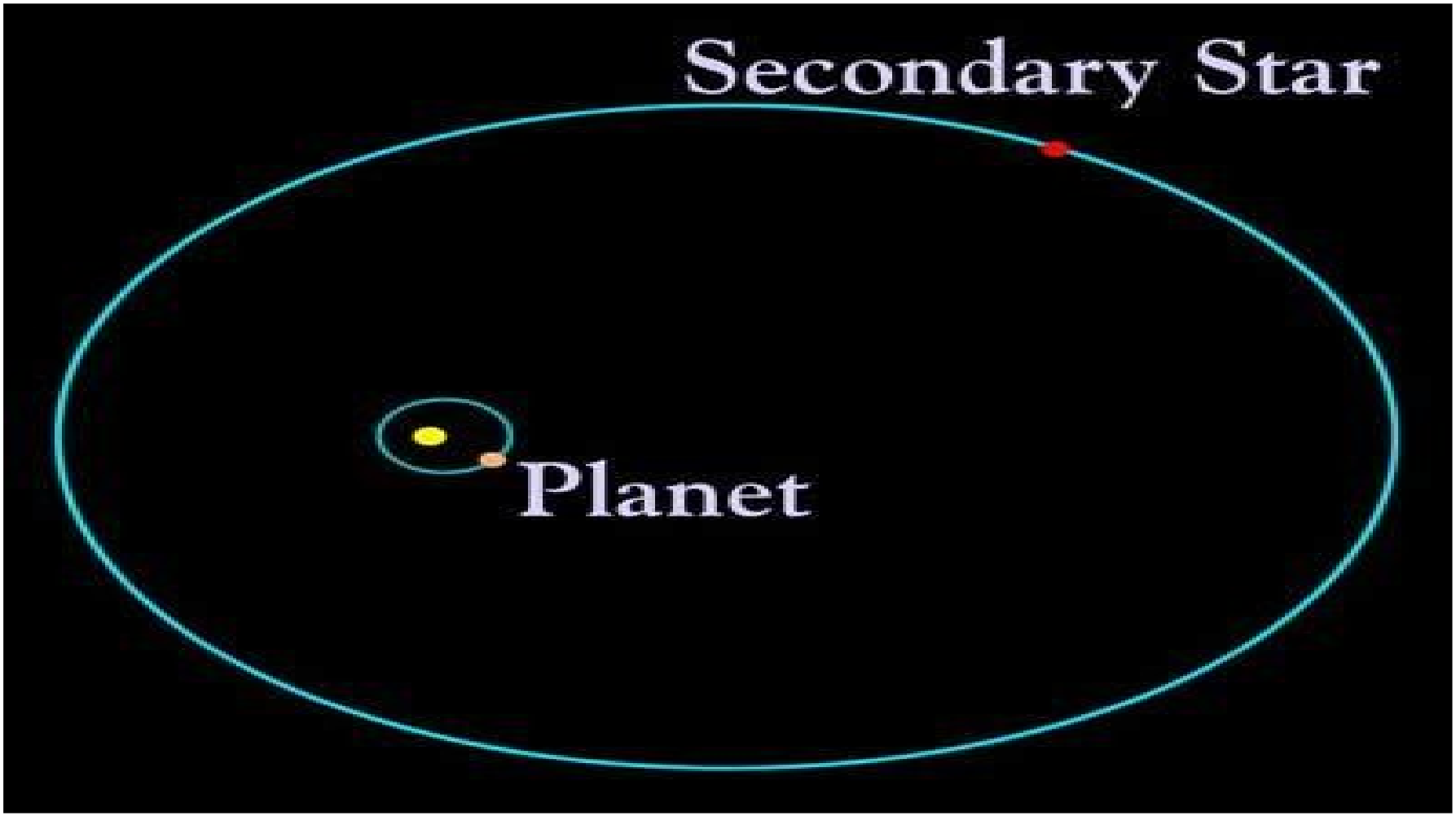
- Examples
  - LHS 2397a
    - 2.96 AU apart, brown dwarf as companion star
  - G196-3
    - 300 AU apart, brown dwarf companion size of Jupiter
      - Likelihood of brown dwarf solar companions increases as star distance increases

Is Our Sun a Binary Star?

- System found with materials for terrestrial planets
  - Like Earth...

Unrealistic!

Realistic!

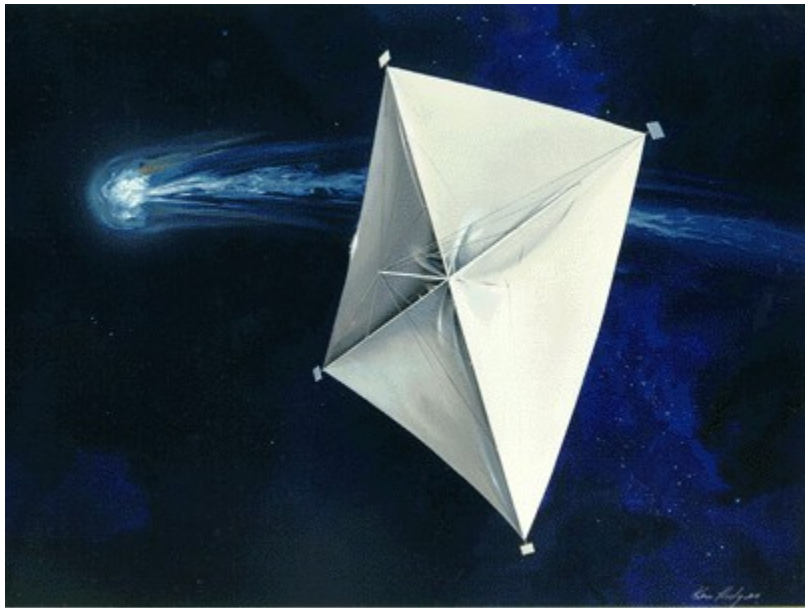


Does Our Solar Companion Exist?

- Efforts using gravitational pull have been unsuccessful
  - Last success was Neptune in 1846
  - Use data from comet orbits
    - Only 82 well studied comets
- Conflicting evidence over Jovian Body location
  - inside or next to oort cloud?

Applicable Technologies

- Infrared Imaging
  - Wide-Field IR Survey Explorer (WISE, 2009)
  - IR Astronomical Satellite (IRAS, 1983)
- Astrometric Microlensing
- Orbital Trajectory Anomalies
- Solar Sails



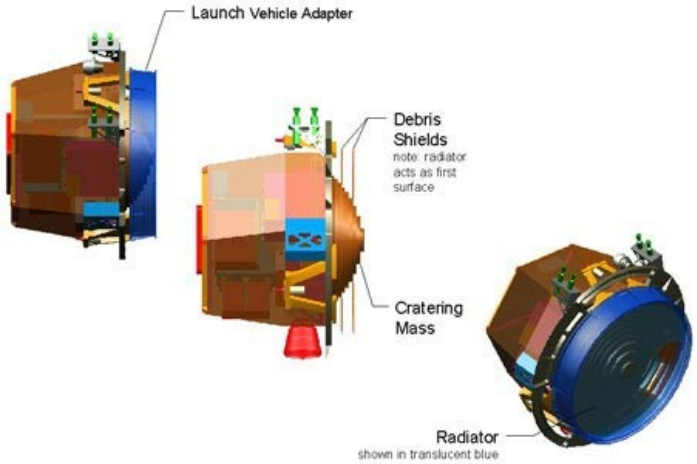
Past and Future Comet Missions

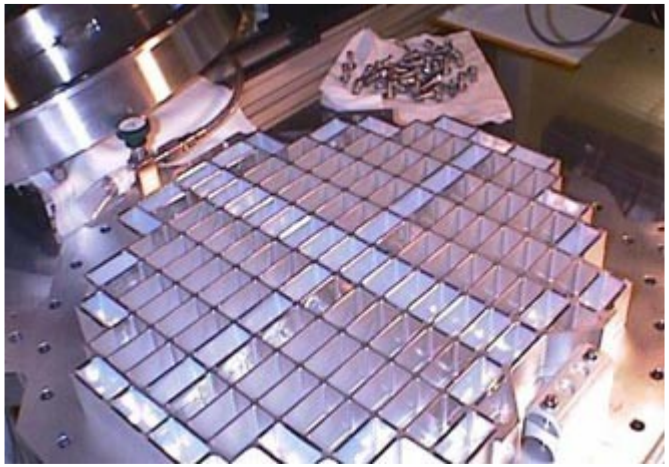
- Halley's Comet Revolution, 1986
  - Five international satellites
- Rosetta (ESA), 2004-Present
- Stardust, 2004-2011
- Deep Impact, 2005-2011
  - High Resolution and Medium Resolution Imagers (HRI and MRI)

ROCCET:

Researching an Oort Cloud Comet: Examination and Tracking

- Tracking device
- Impactor
- Aerogel dust collectors and analyzers
- Sample return
- Mass spectrometer
- HRI and MRI
- Solar panel





Top: Deep Impact's impactor
Bottom: Stardust aerogel dust collectors

ROCCET's Mission

- After ROCCET has been built, we will find an Oort Cloud Comet that is approaching the sun
- Launch ROCCET so it lands on comet before it reaches the sun
  - Take sample and return it to Earth before comet gets too close to sun
- ROCCET will stay on comet while it circles sun and track its path as it continues to the outer solar system

Cost of Mission

- Deep Impact: $267 million
  - NASA considers this a low cost mission
- STARDust: $300 million
- NASA's yearly budget: $18.4 billion
- Mission estimate: $325 million
  - 1.6% of NASA's yearly budget

In conclusion, we will be gaining lots of scientific information for relatively little cost!