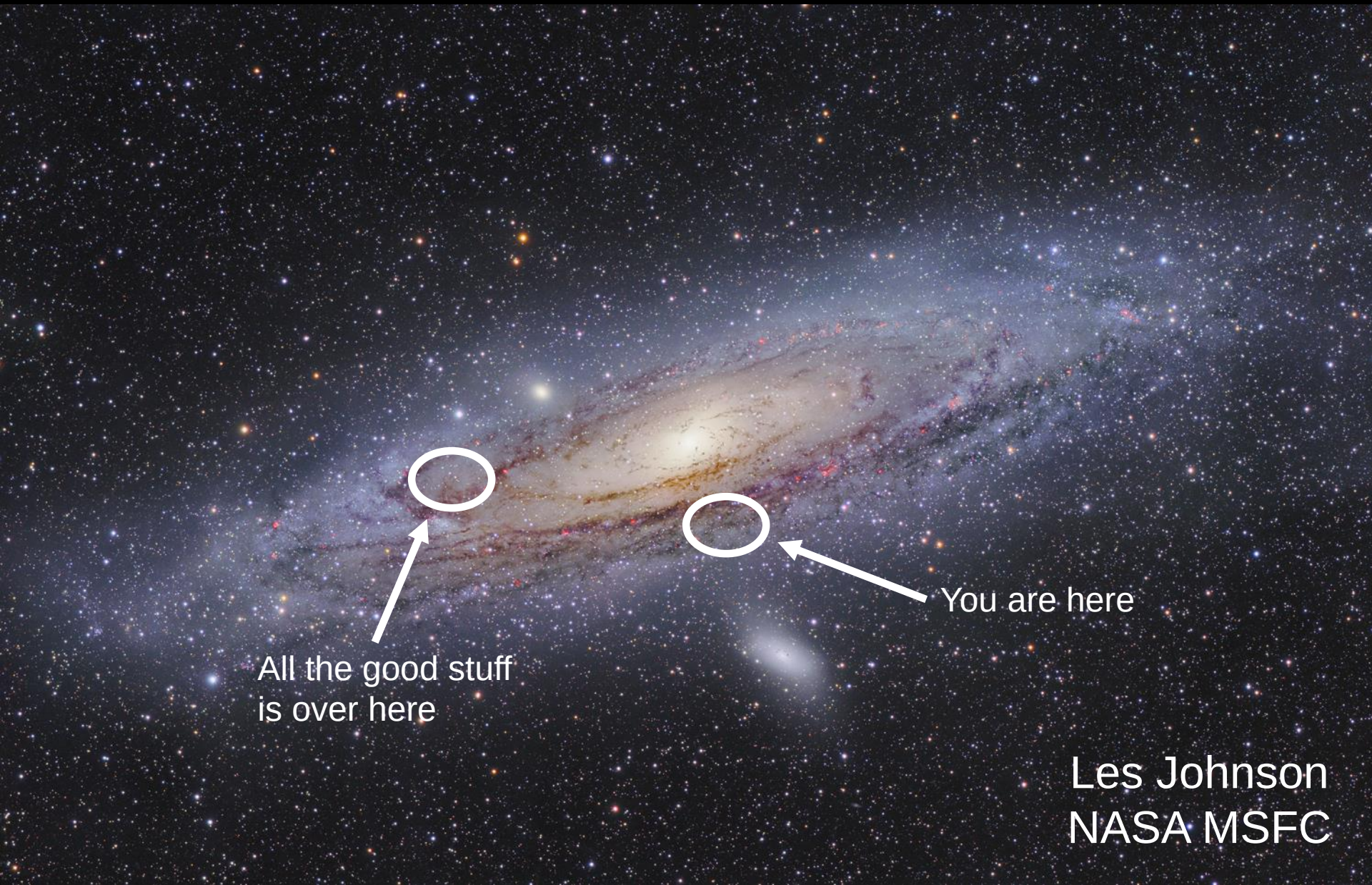
Realistic Interstellar Travel

Les Johnson
NASA MSFC

Realistic Interstellar Travel

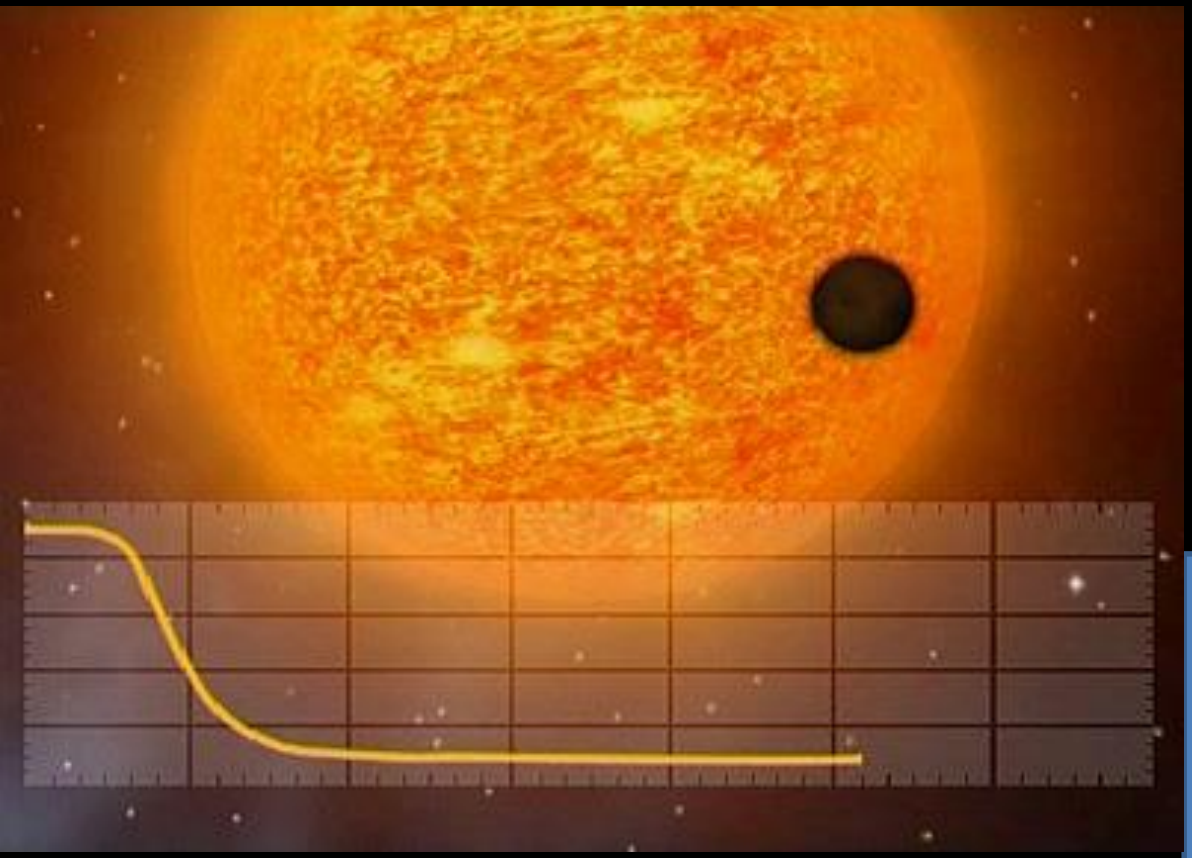


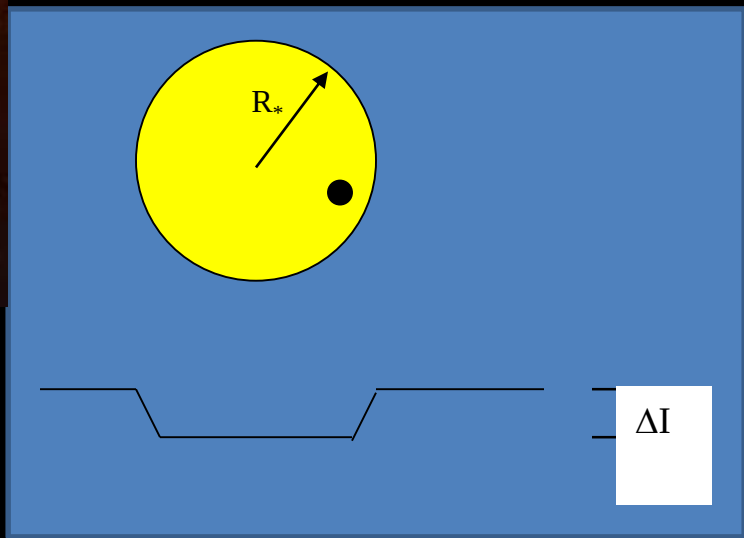
Les Johnson
NASA MSFC

Before 1992

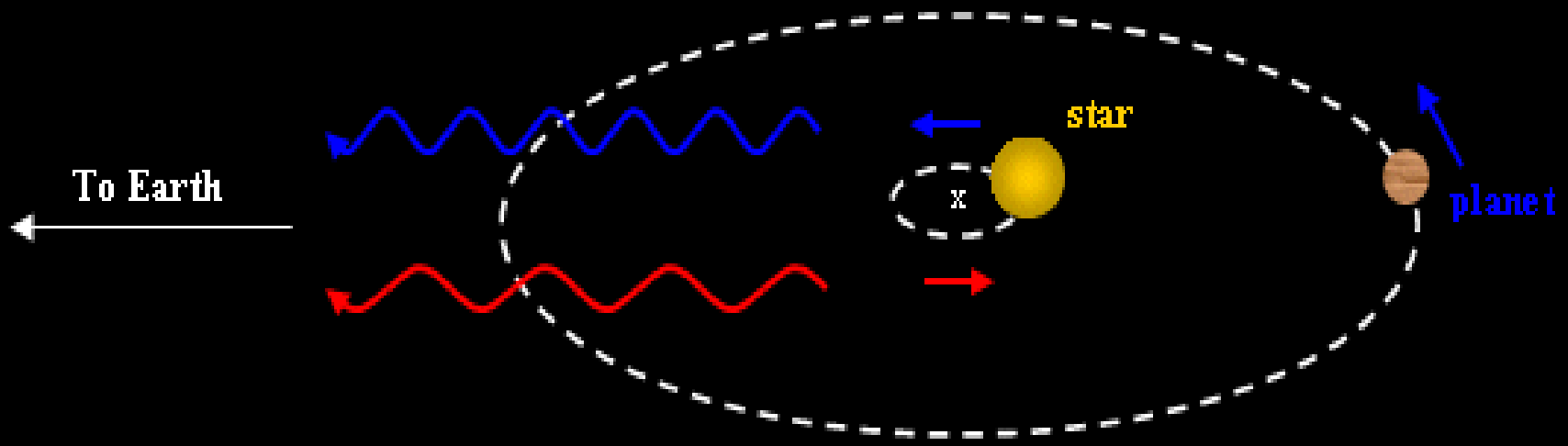
- We could only confirm the existence of 8 planets (9 at the time – poor Pluto)
- The only planets around other stars were in science fiction

Finding Exoplanets by The Transit Method





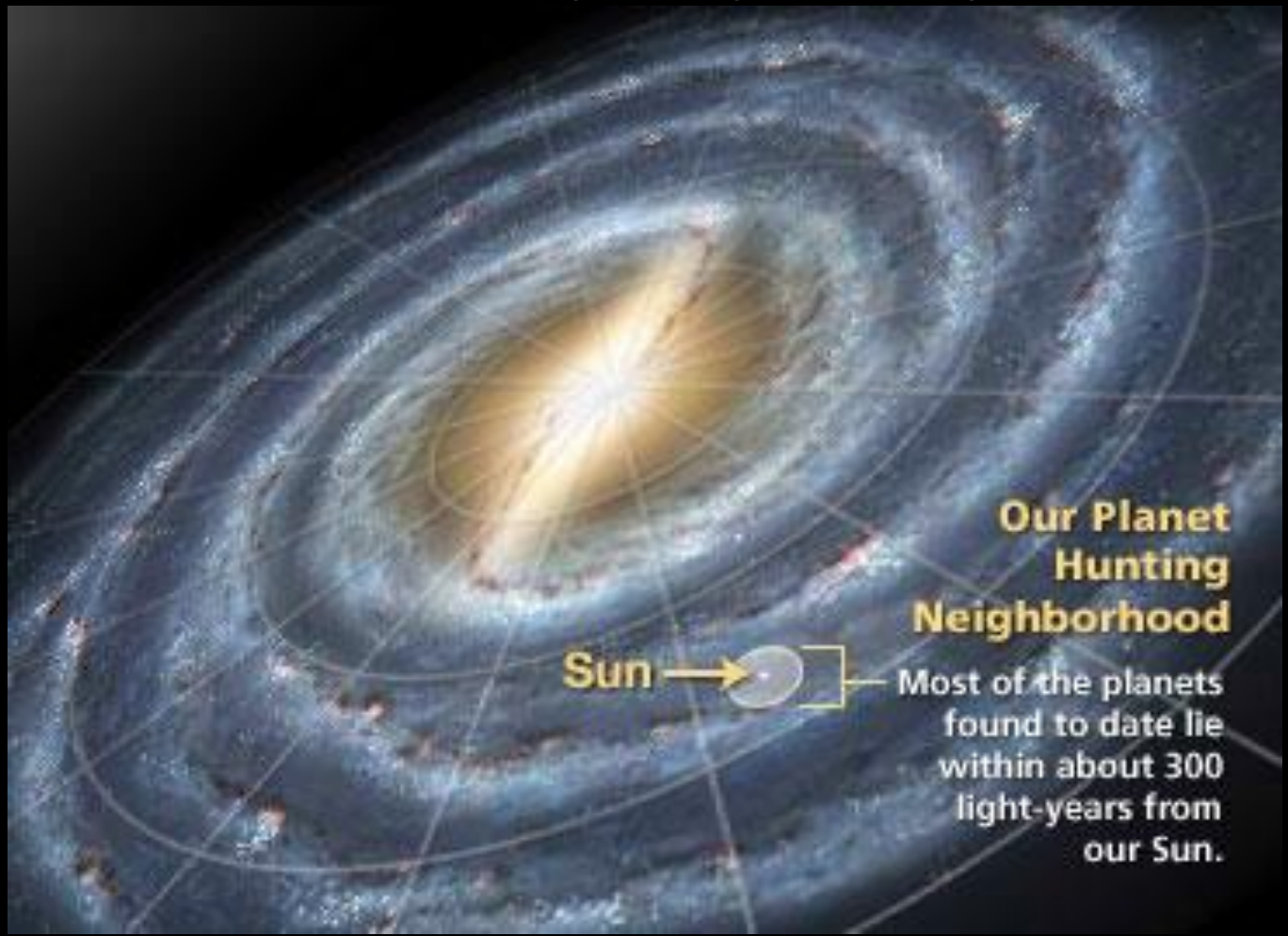
Finding Exoplanets by Doppler Shift



The star orbits about the system's centre of mass, when the star moves towards the earth the spectrum is 'Blue-shifted', as it moves away it is 'Red-shifted'

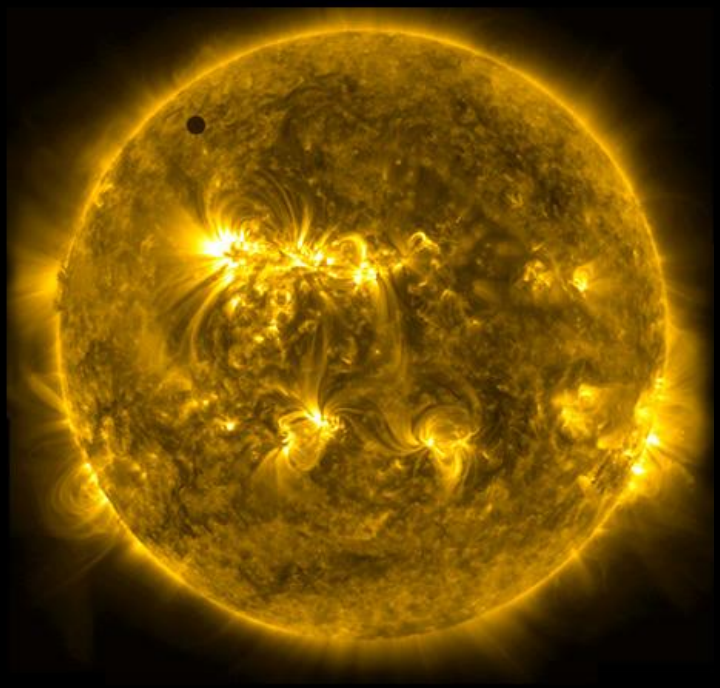
>2000 Confirmed Exoplanets

- It is now estimated that there are *100 – 400 billion* exoplanets in the Milky Way Galaxy alone



Earth-to-Sun Distance:

– 93,000,000 miles or 1 AU [imagine 1 foot]



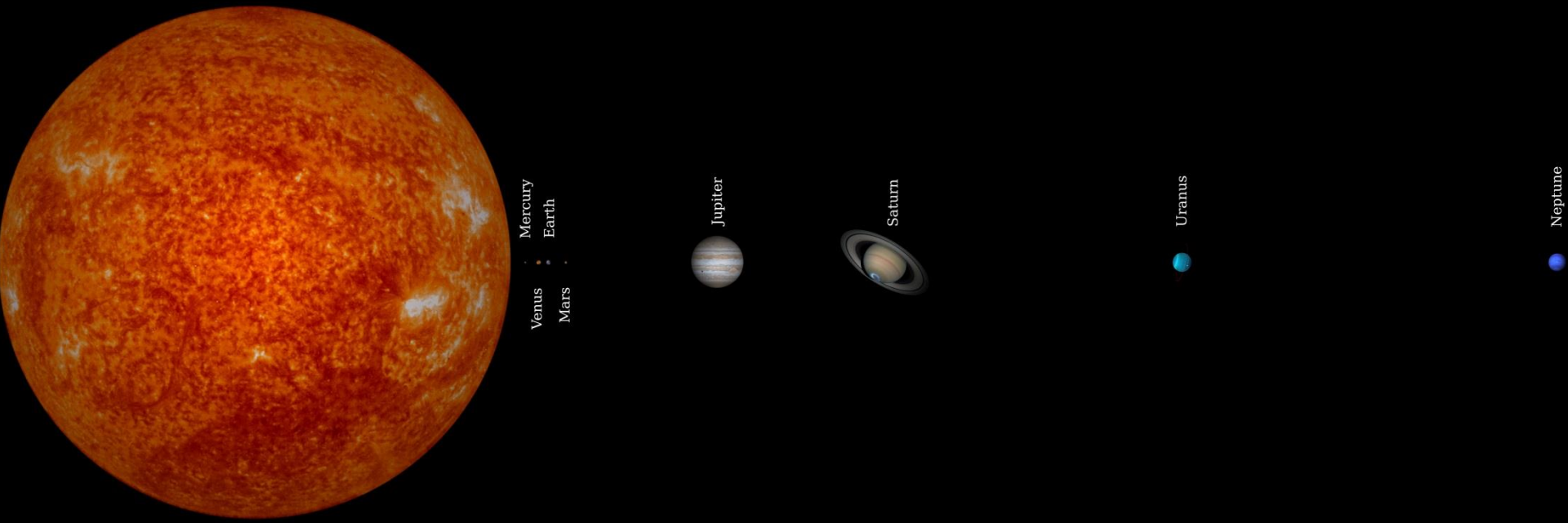
Sun’s Diameter: 857,500 miles

Earth’s Diameter: 7,918 miles

Sun to Venus Distance: 67,481,000 miles

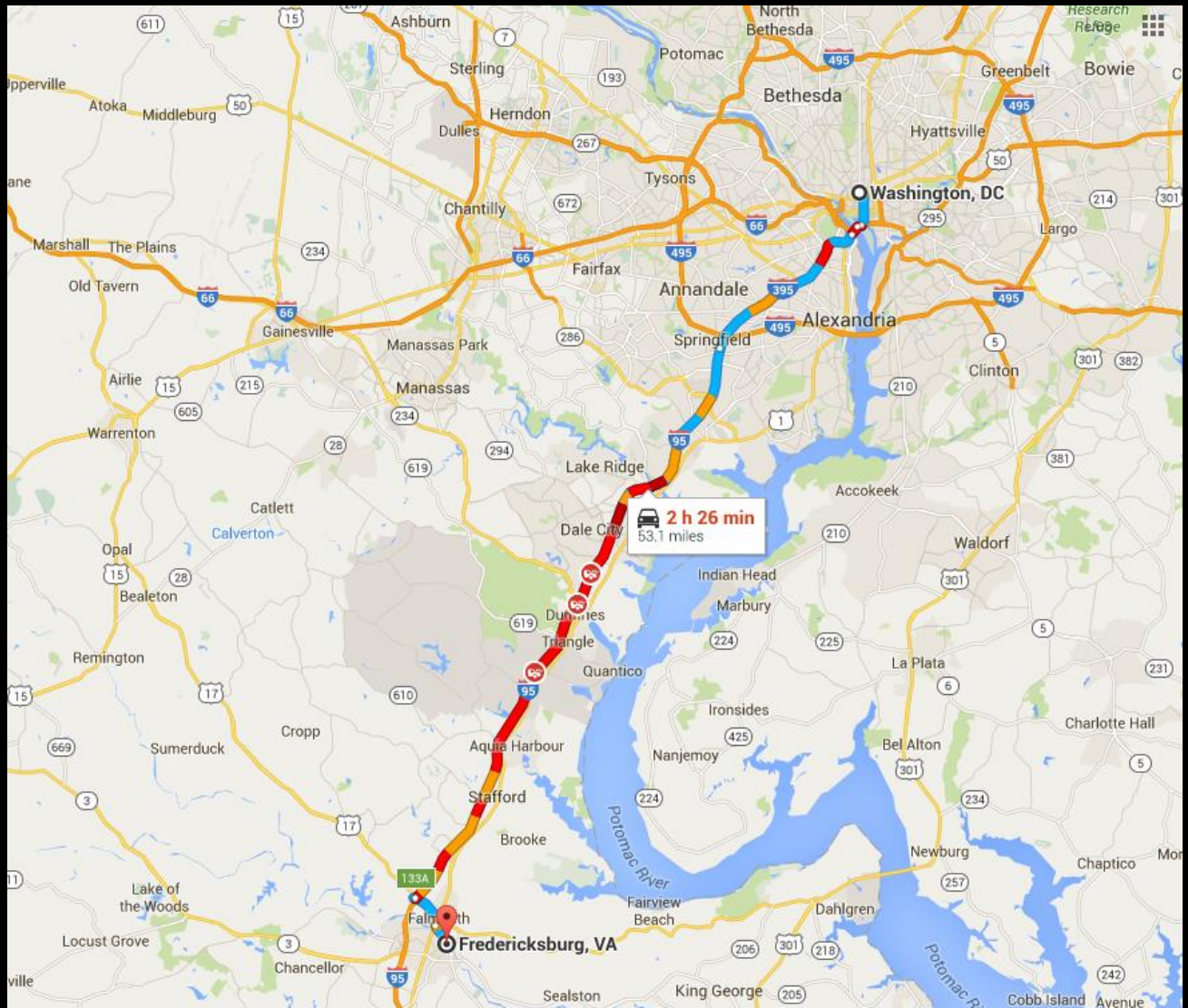
Neptune-to-Sun Distance:

– ~30 AU or 30 X 93,000,000 miles [imagine 30 feet]



Alpha Centauri-to-Sun Distance:

– ~271,000 AU or 24,777,900,000,000 miles [~271,000 feet or ~51.3 miles]



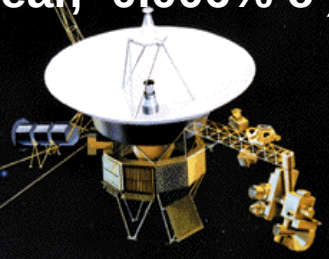
How Do We Get There?

~Today

Voyager I (launched April 1977)
(Launch + 39 Years)

Distance:
~134 Astronomical Units (AU)

Speed:
17 km/sec
35,000 miles per hour
(3.7 AU/Year, 0.006% c)



Time to Travel
150 AU: 40 Years
4.3 Light Years: 74,000 Yrs

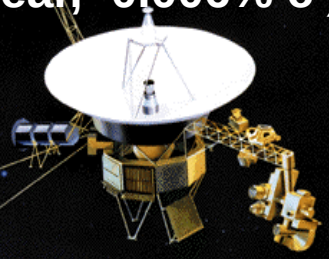
Today plus 74,000 years
Alpha Centauri Bb will be ours!
(If Voyager were going in the right direction…)

~Today

Voyager I (launched April 1977)
(Launch + 39 Years)

Distance:
~134 Astronomical Units (AU)

Speed:
17 km/sec
35,000 miles per hour
(3.7 AU/Year, 0.006% c)



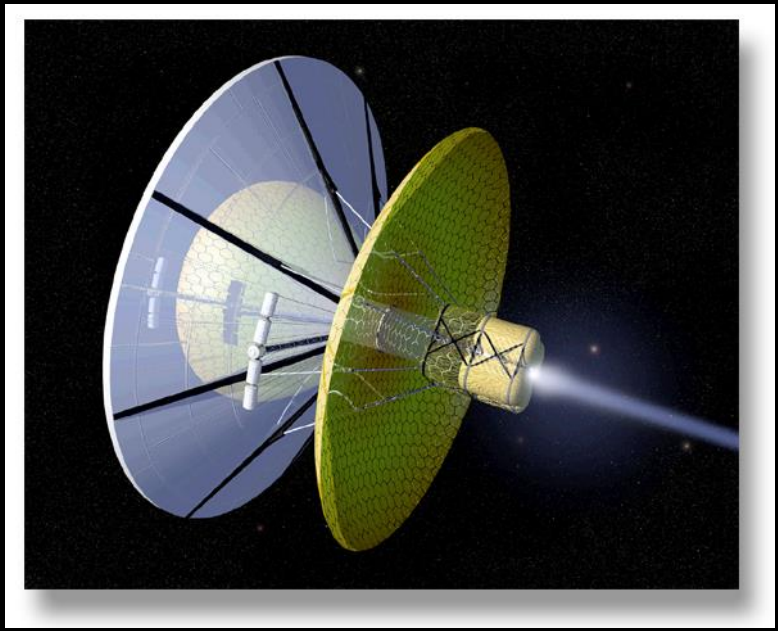
Time to Travel
150 AU: 40 Years
4.3 Light Years: 74,000 Yrs

Chemical rockets are not going to get us there…

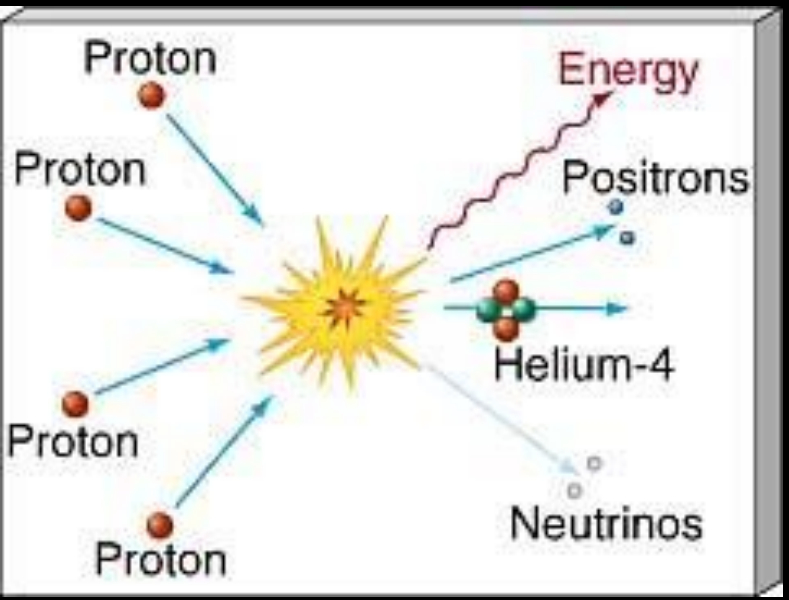
Today plus 74,000 years
Alpha Centauri Bb will be ours!
(If Voyager were going in the right direction…)

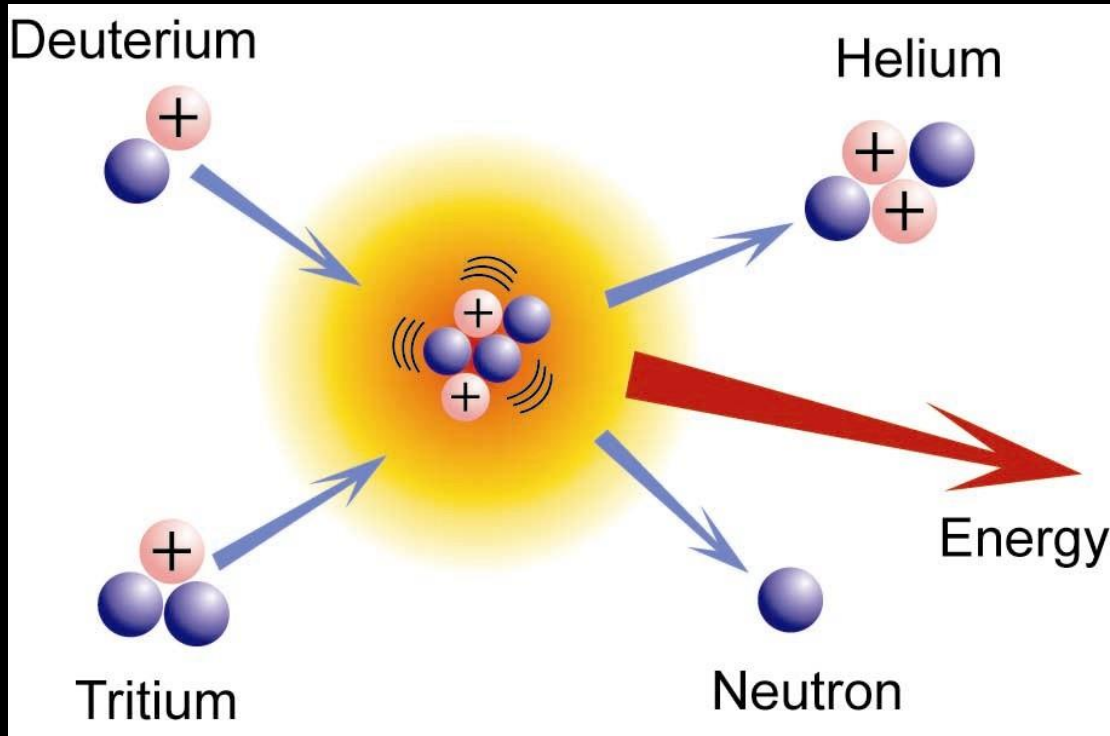
Nuclear fission doesn’t have the energy density required

Nuclear Fusion Propulsion



- Fusion propulsion will enable human exploration beyond Mars to the moons of the outer planets and perhaps, the stars
- Energy produced by the fusing of two hydrogen isotopes into helium - with the resulting energy release

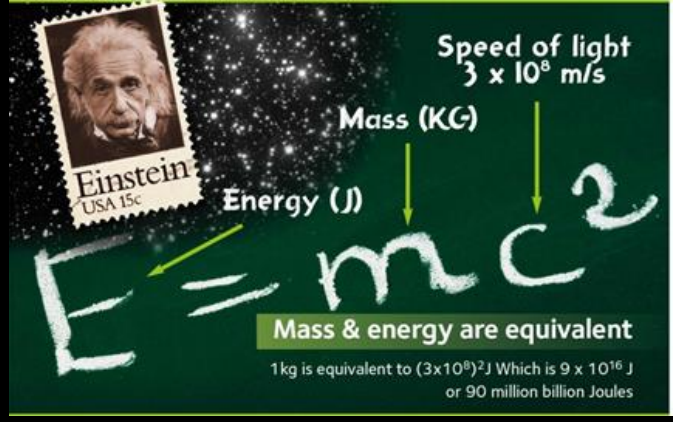




The Daedalus Fusion Starship Design

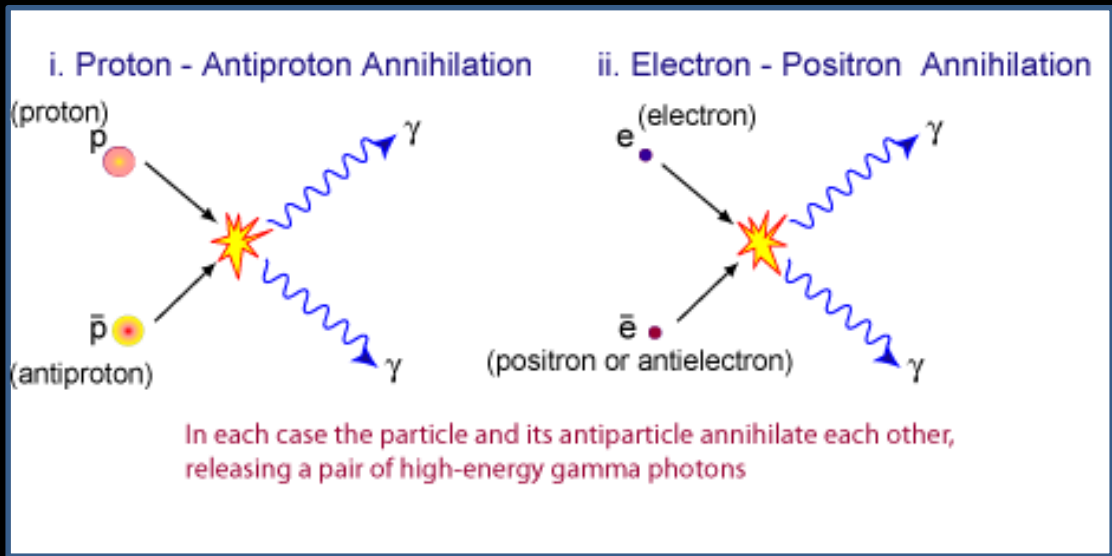
Artwork: Adrian Mann

Antimatter Propulsion



10 milligrams of antimatter is the energy equivalent of 120 tons of conventional rocket fuel

- As you learned from watching Star Trek, antimatter is real
- Matter and antimatter annihilate producing energy



How much antimatter do we need to reach the Centauri system?

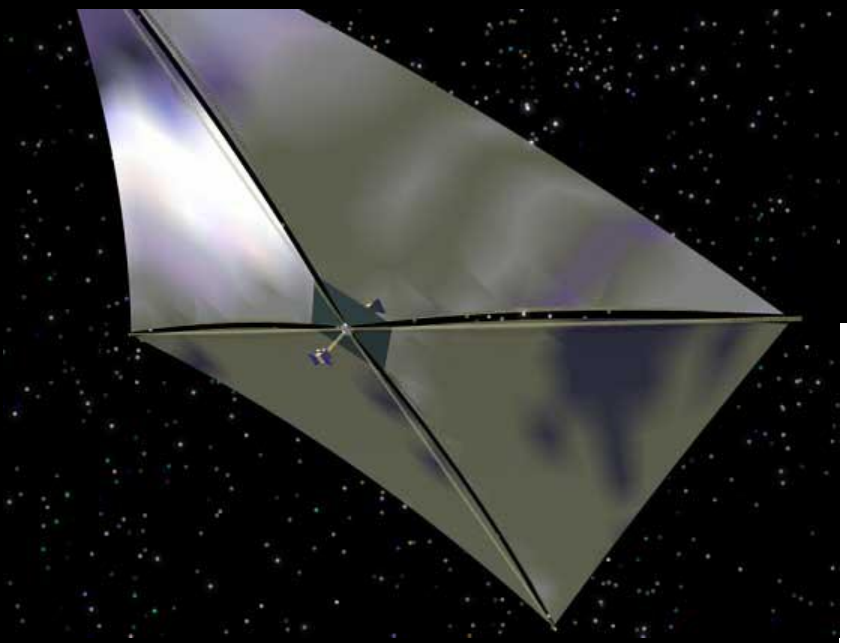
100 – 1000 tons

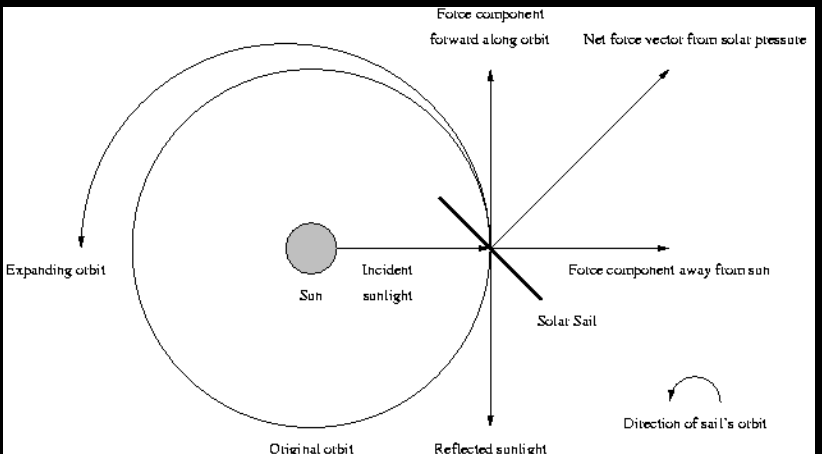
How much antimatter do we need to reach the Centauri system?

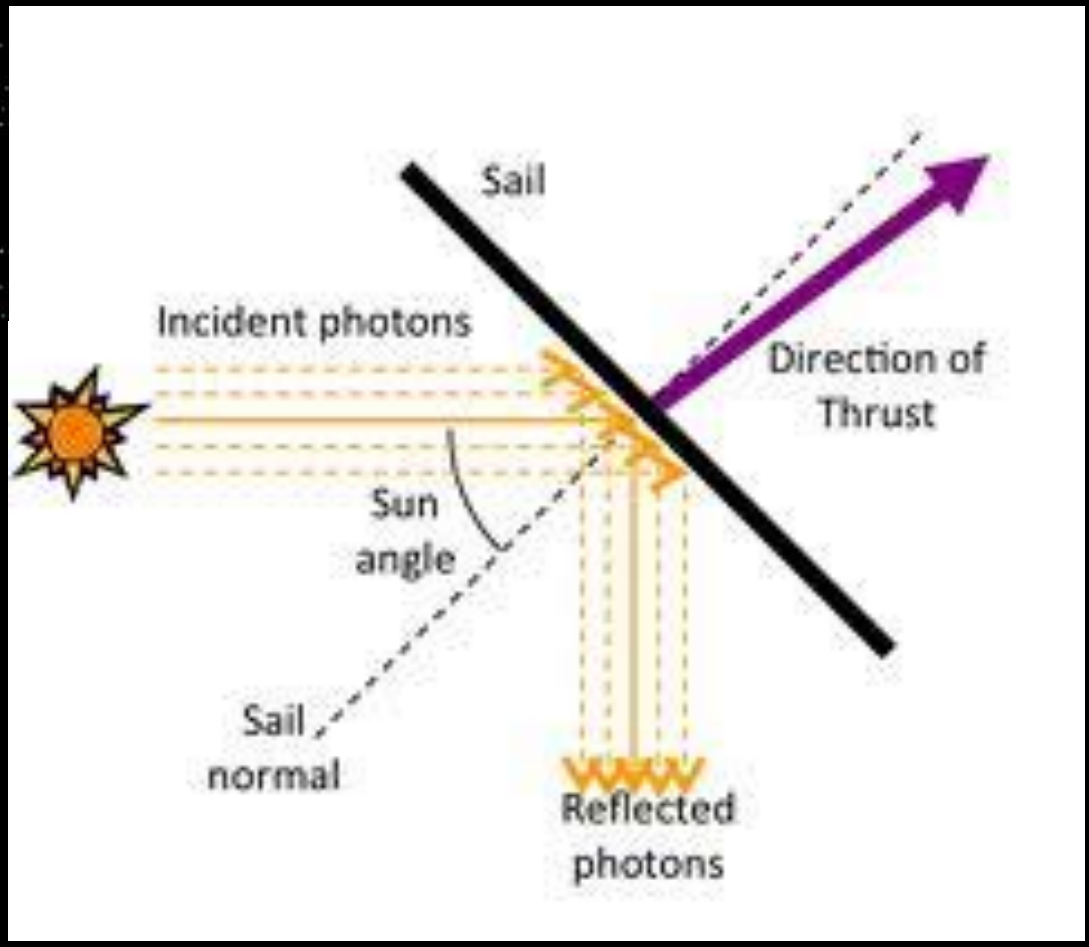
100 – 1000 tons

2016 Estimated total antimatter production:
nanograms (~0.000000001 grams)
at ~$100 Trillion per gram

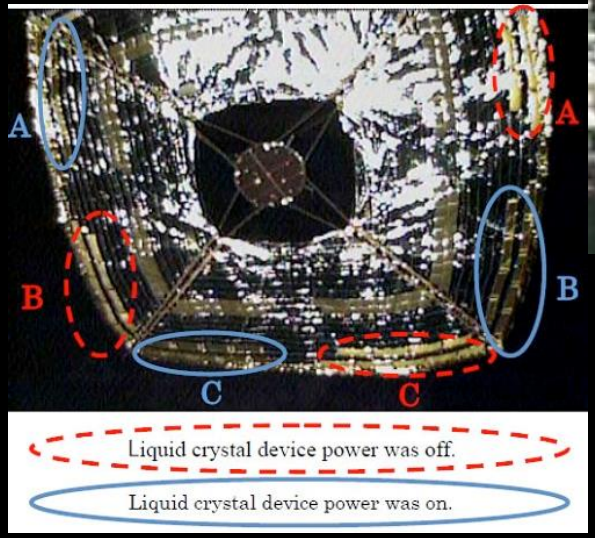
Solar sails use photon “pressure” or force on thin, lightweight reflective sheet to produce thrust.



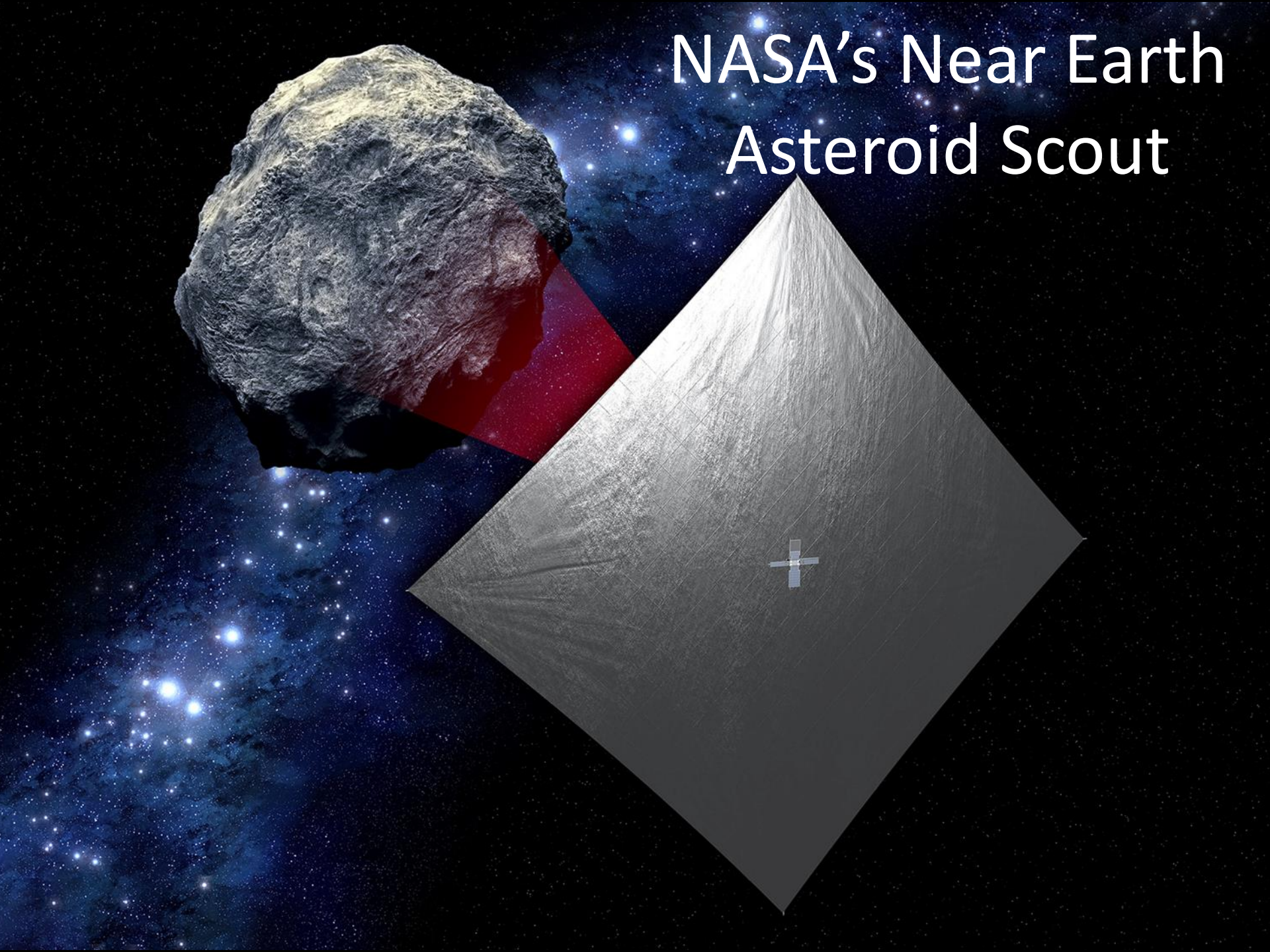




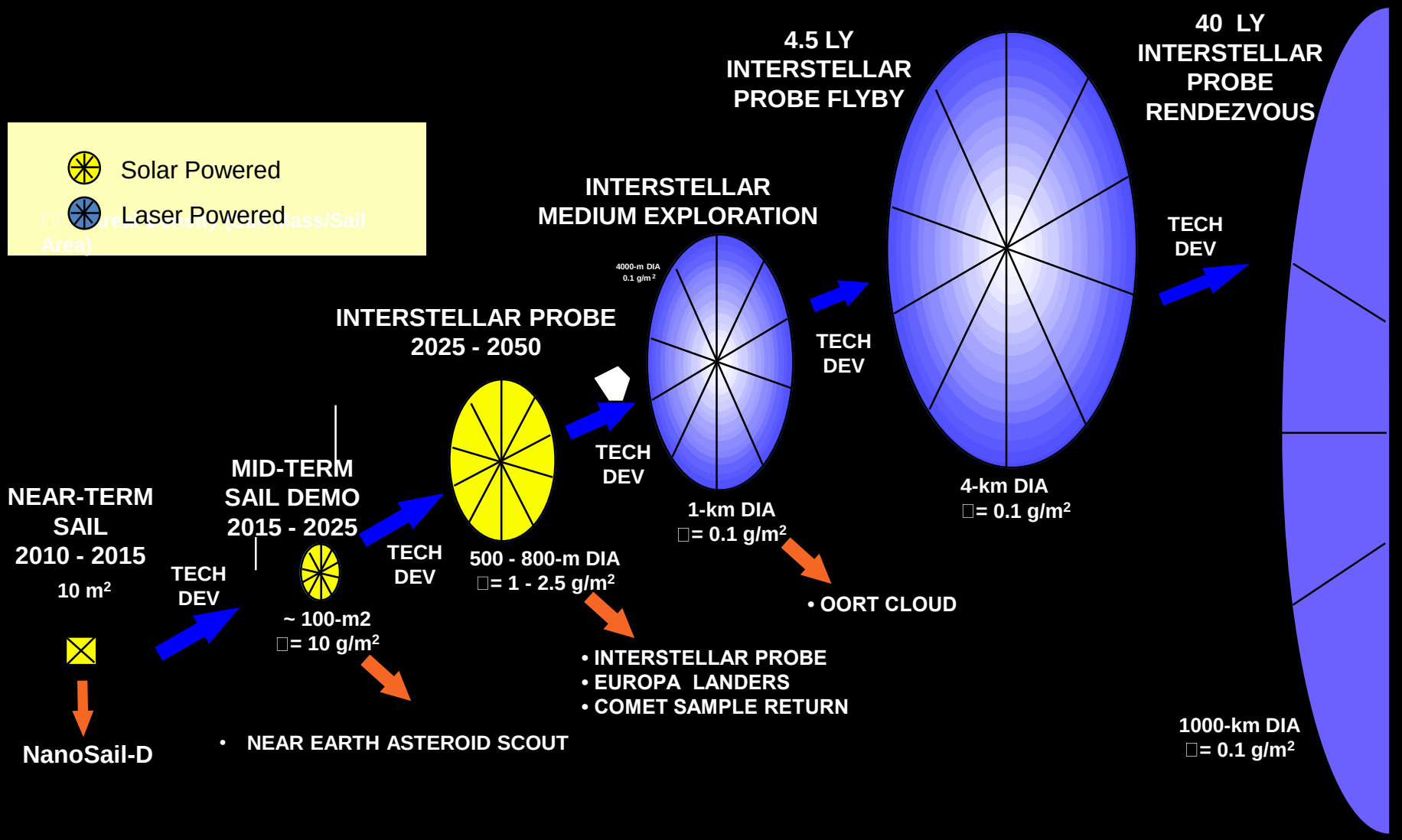
Japan's Interplanetary Kite-craft Accelerated by Radiation of the Sun (IKAROS)



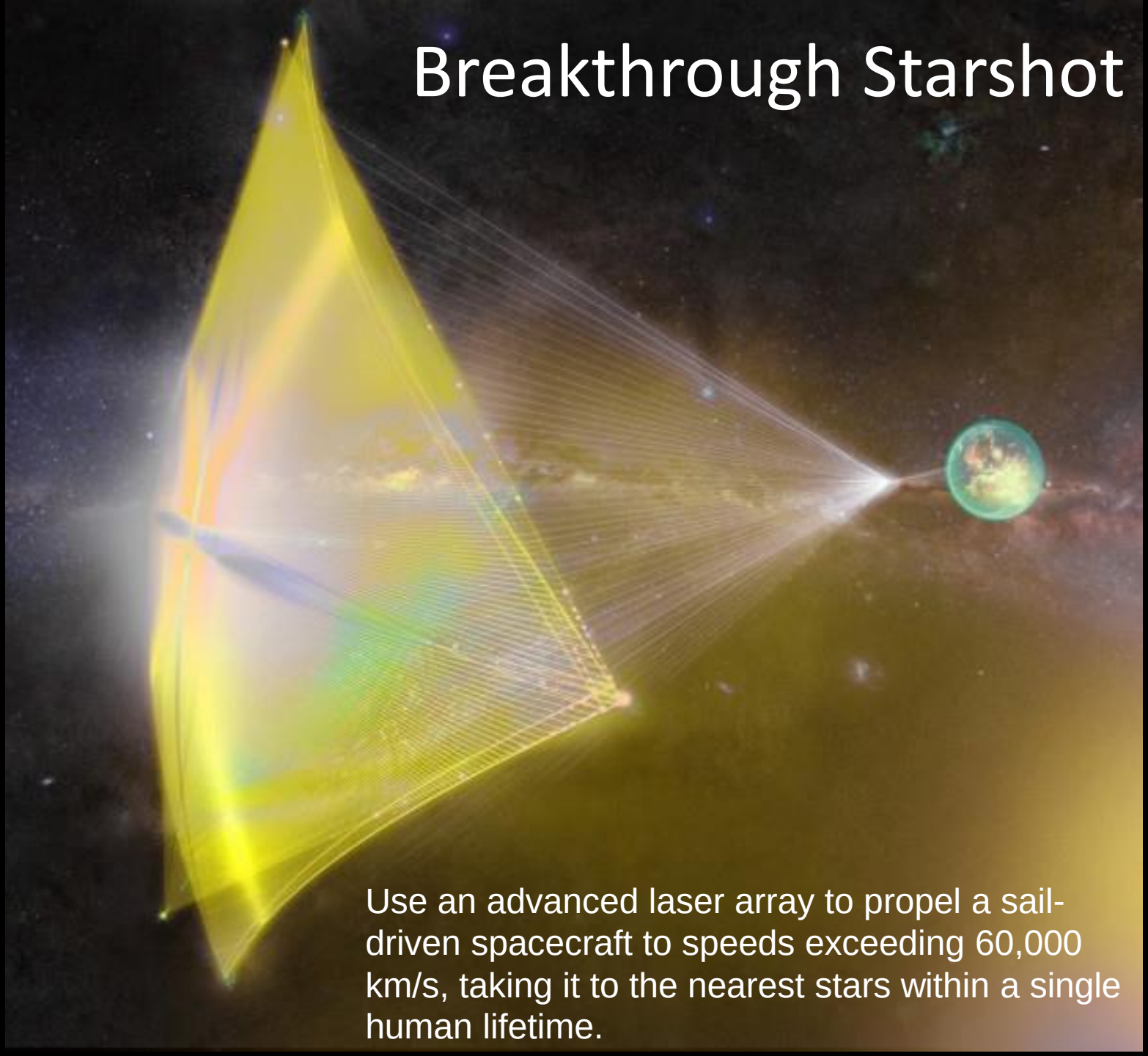
NASA's Near Earth Asteroid Scout



Near-Term Solar Sail Applications Lead to Interstellar Capability with Laser Sails

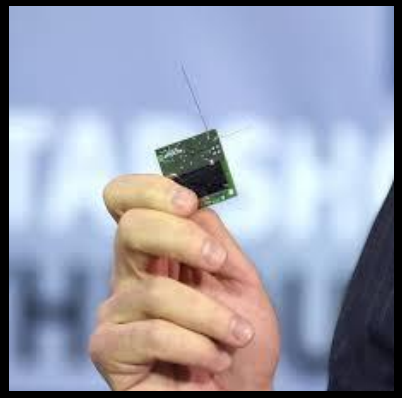


Breakthrough Starshot

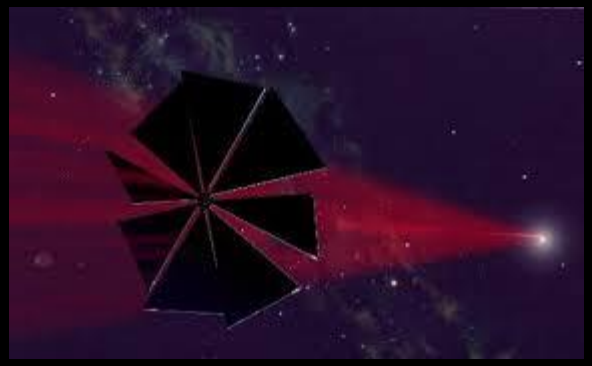


Use an advanced laser array to propel a sail-driven spacecraft to speeds exceeding 60,000 km/s, taking it to the nearest stars within a single human lifetime.

Breakthrough Starshot



StarChip: Moore's law has allowed a dramatic decrease in the size of microelectronic components. This creates the possibility of a gram-scale wafer, carrying cameras, photon thrusters, power supply, navigation and communication equipment, and constituting a fully functional space probe.

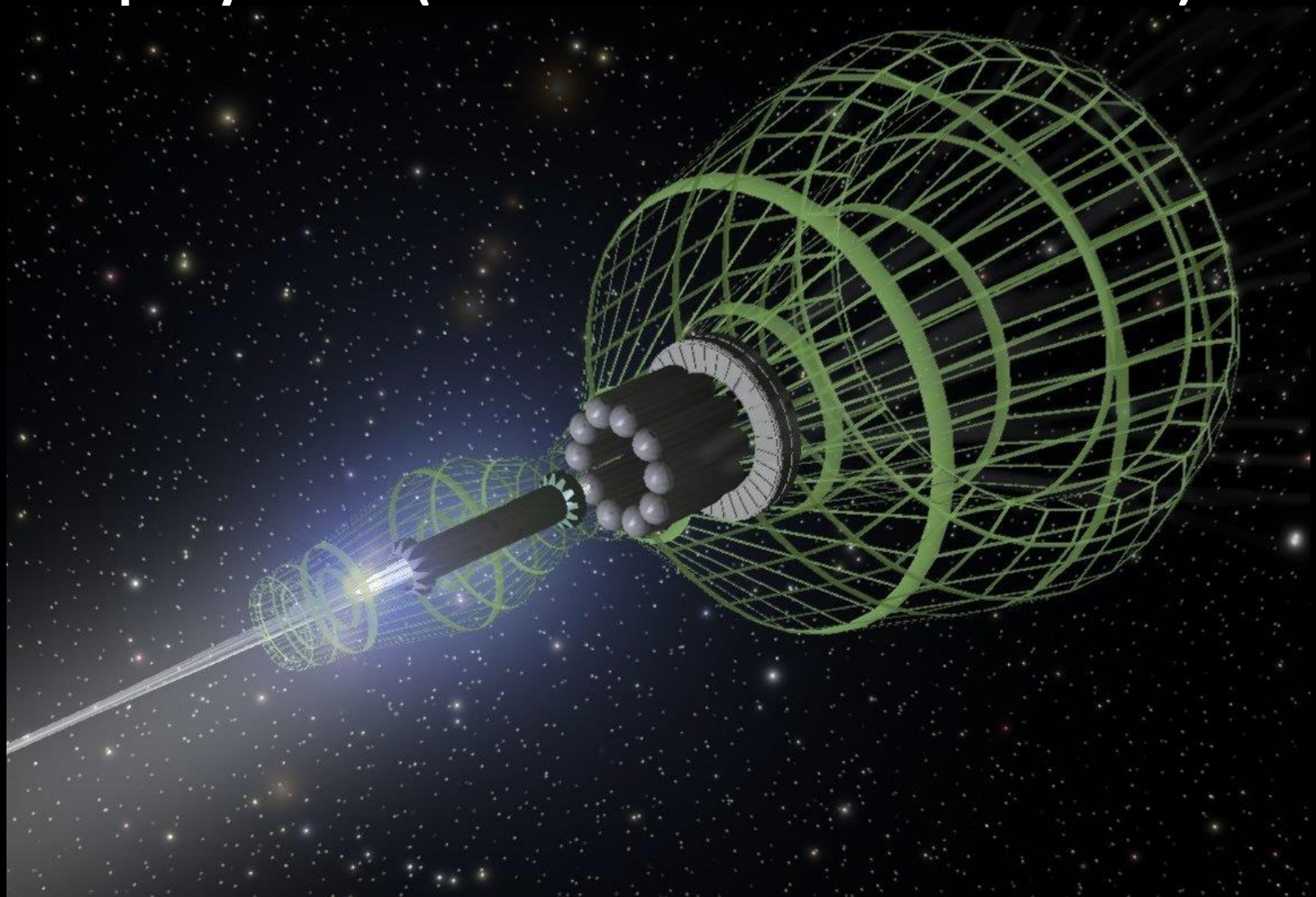


Lightsail: Advances in nanotechnology are producing increasingly thin and light-weight metamaterials, promising to enable the fabrication of meter-scale sails no more than a few hundred atoms thick and at gram-scale mass.

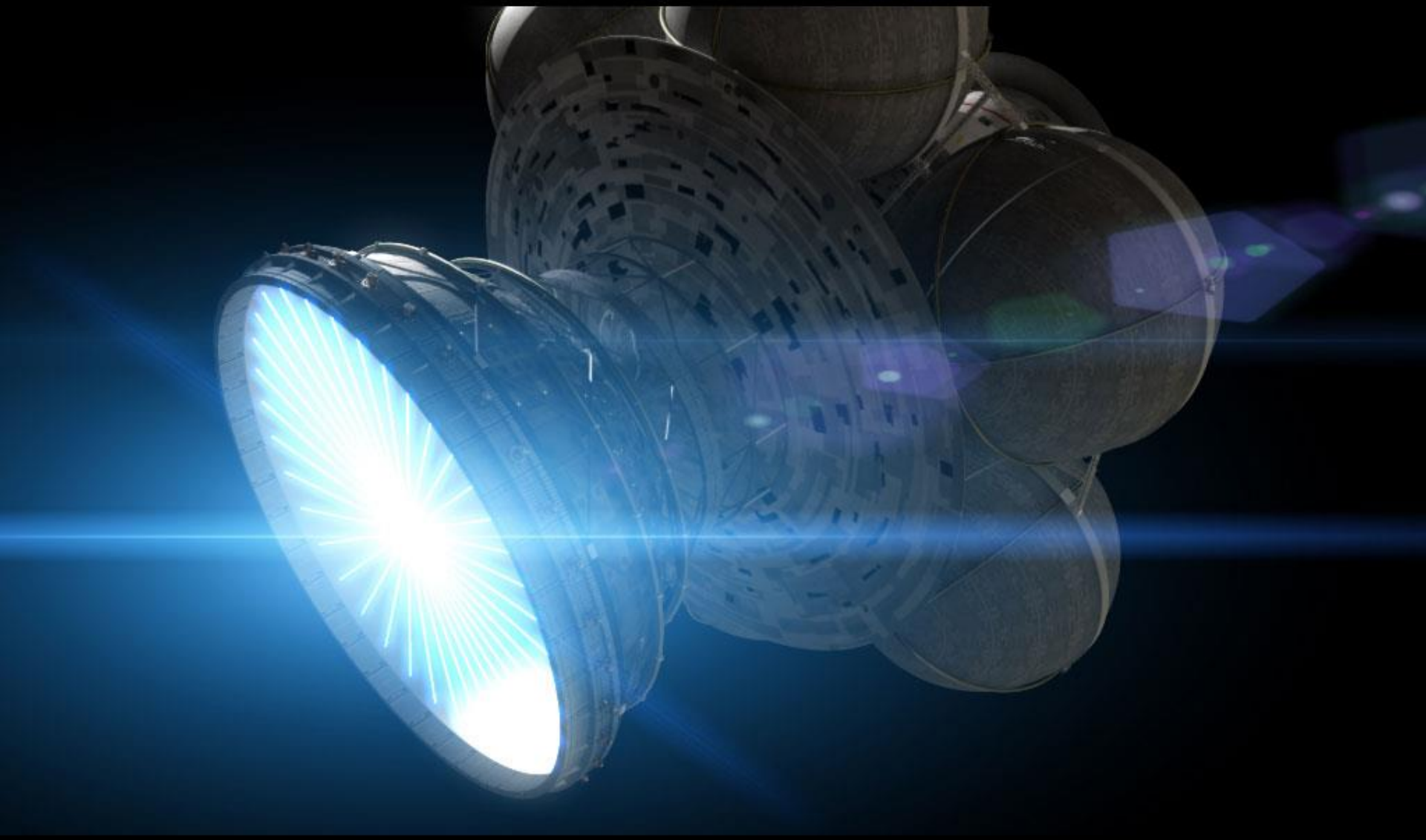
Laser: The rising power and falling cost of lasers, consistent with Moore's law, lead to significant advances in light beaming technology. Meanwhile, phased arrays of lasers (the 'light beamer') could potentially be scaled up to the 100 gigawatt level.

The galaxy is full of planets

Reaching the stars is allowed by physics (as we understand it)



Are we up to the challenge?



Looking Back Toward Home