Space Travel of the Future

WOPAT #279

What I’m going to talk about:

- **Interplanetary travel**
- **Interstellar travel**
- **Intergalactic travel**
- **Faster than light travel**

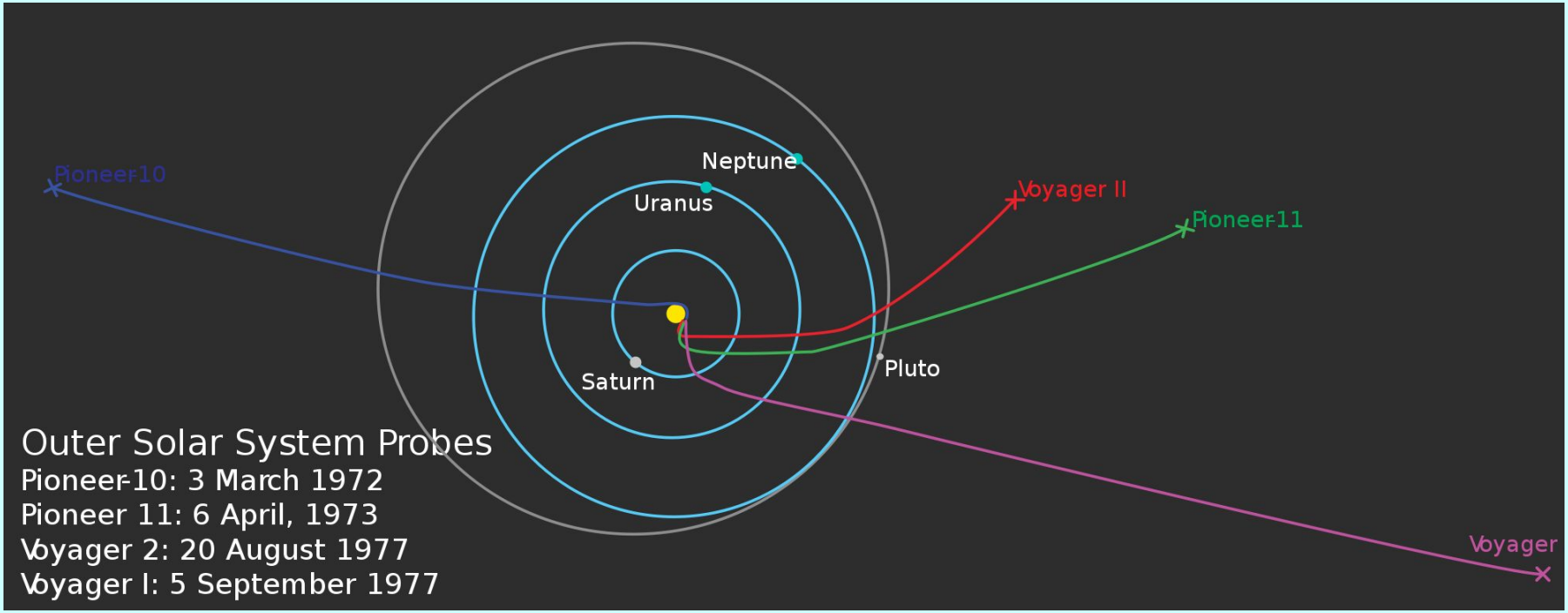
Space travel in the solar system

- Current accomplishments:
  - Voyager 1: farthest manmade object from Earth at 113 AU
    - Will remain powered until ~2025
    - Used gravity assists
  - Manned missions to the Moon
    - Saturn V rocket launches modular craft that docks on Moon
    - NASA's Constellation Program would have sent people to Mars - cancelled


Voyager 1

Launch of Voyager 1

Flight Paths of Farthest Probes

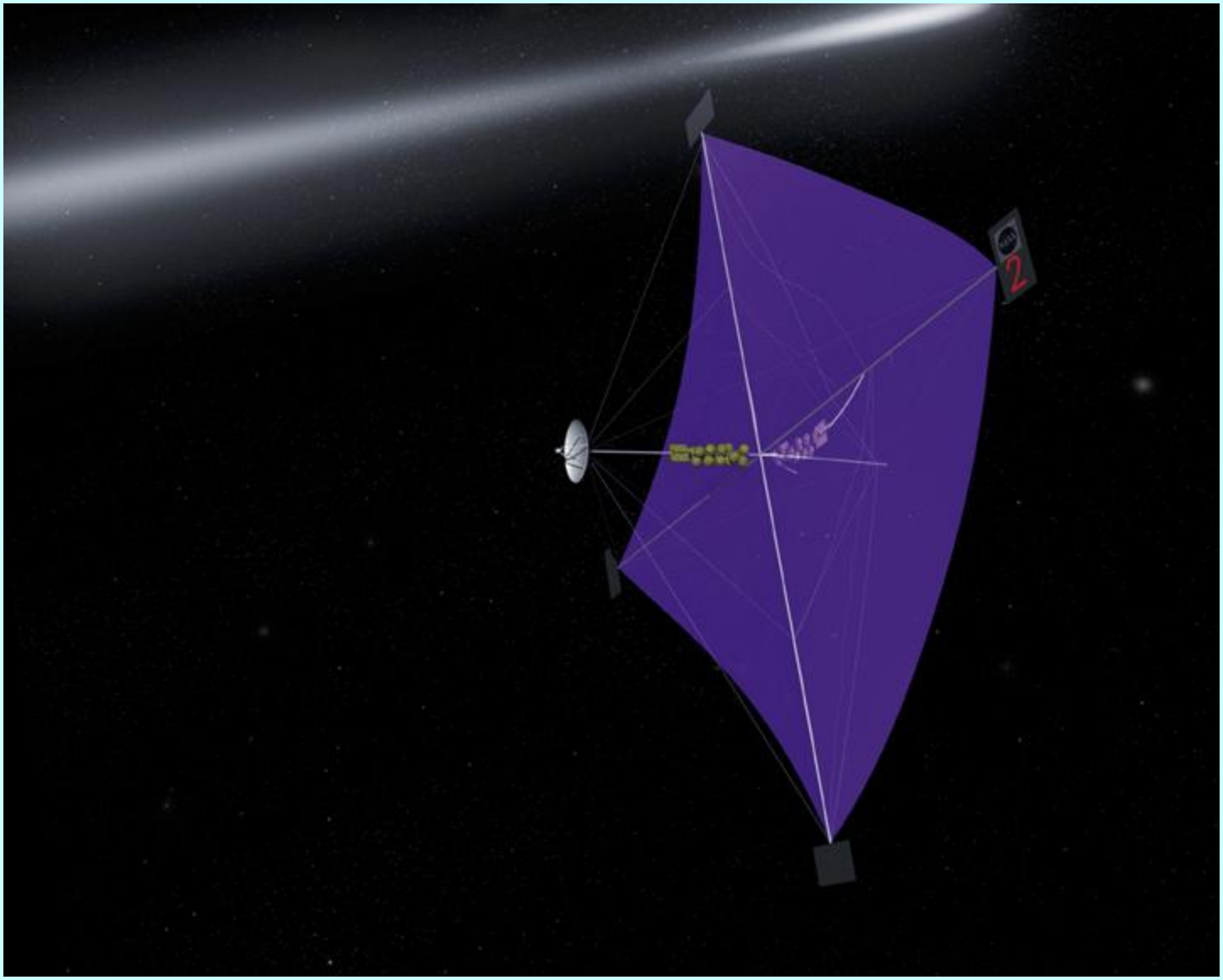


Future of Solar System travel

- Interplanetary Transport Network
  - Gravitationally determined pathways that require little energy
- Electric repulsion technology
  - Generate electricity, use electricity to propel matter generate thrust
  - Generally low thrust, but can operate for long times
  - Ion drives have already been developed (e.g. Deep Space 1)

Future of Solar System Travel

- Solar sails
  - Radiation pressure from sun or laser on sail propels craft
  - Some satellites use this technology to make minor flight adjustments
- Nuclear thermal or solar thermal
  - Nuclear or solar power used to heat up fluid which travels through nozzle to create thrust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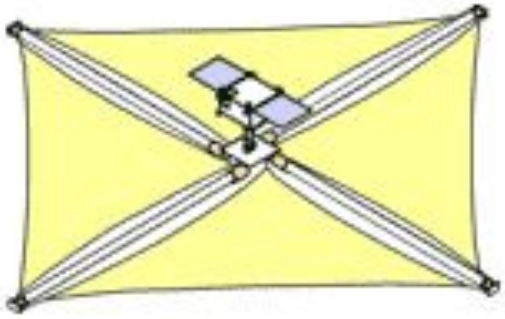
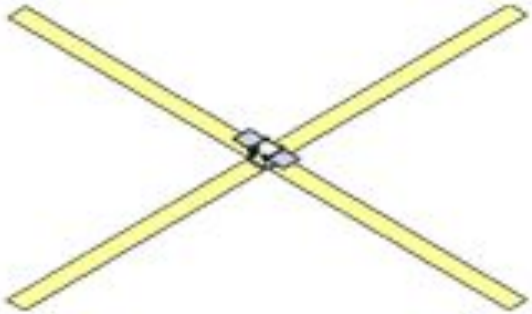
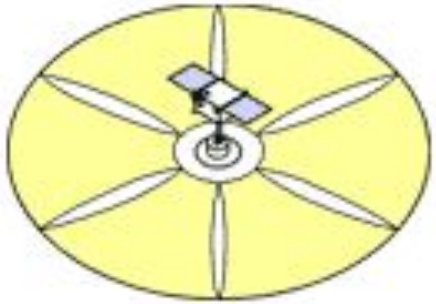


Square Sail (not to scale)



Heliogyro (not to scale)

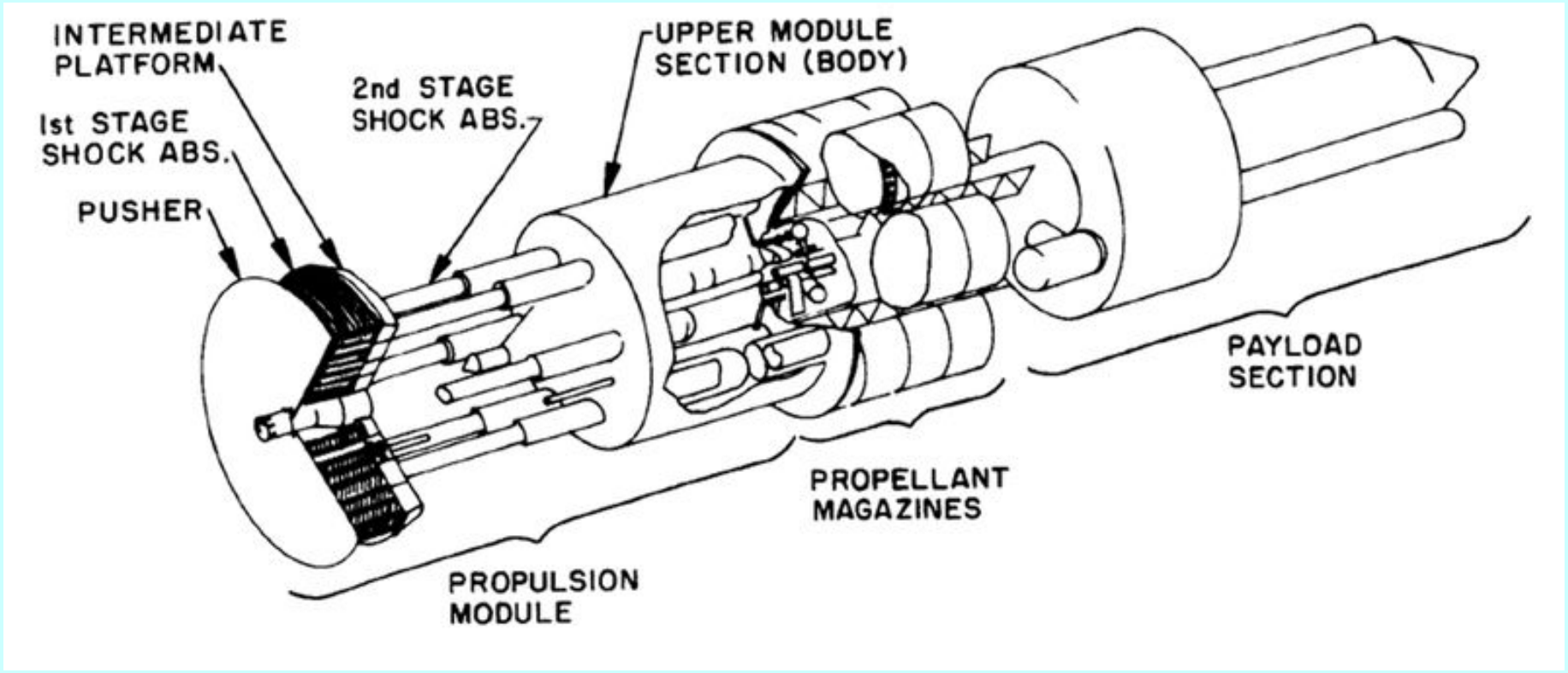


Spinning Disk Sail
(not to scale)

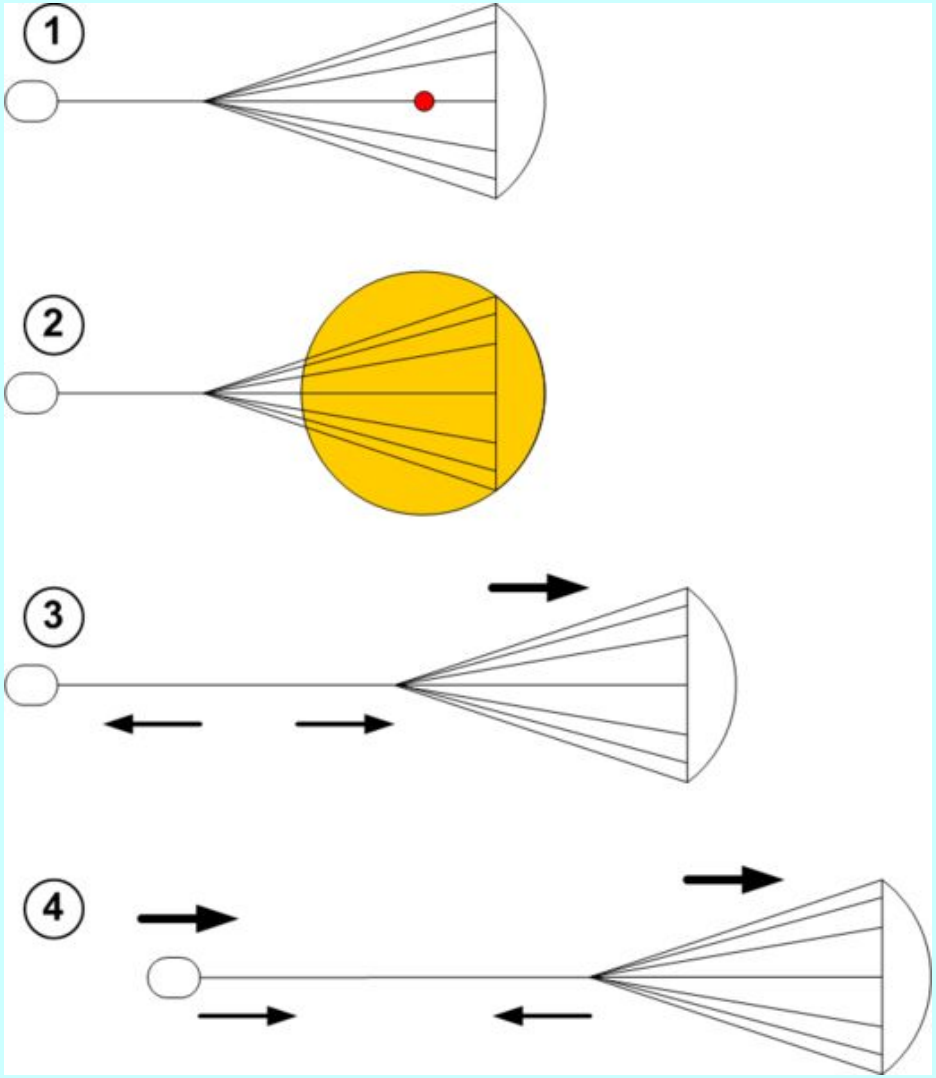
Interstellar Travel

- Closest known star is 4.23 lyr away
- Nuclear Pulse propulsion
  - Driven by series of nuclear explosions
  - Project Orion – would use nuclear bombs as propellant, possible with existing technology
  - Project Medusa – uses large sail to maximize energy deposited by nuclear blast
  - Antimatter Catalyzed NPP – antimatter reduces amount of material needed for fission reaction

Project Orion

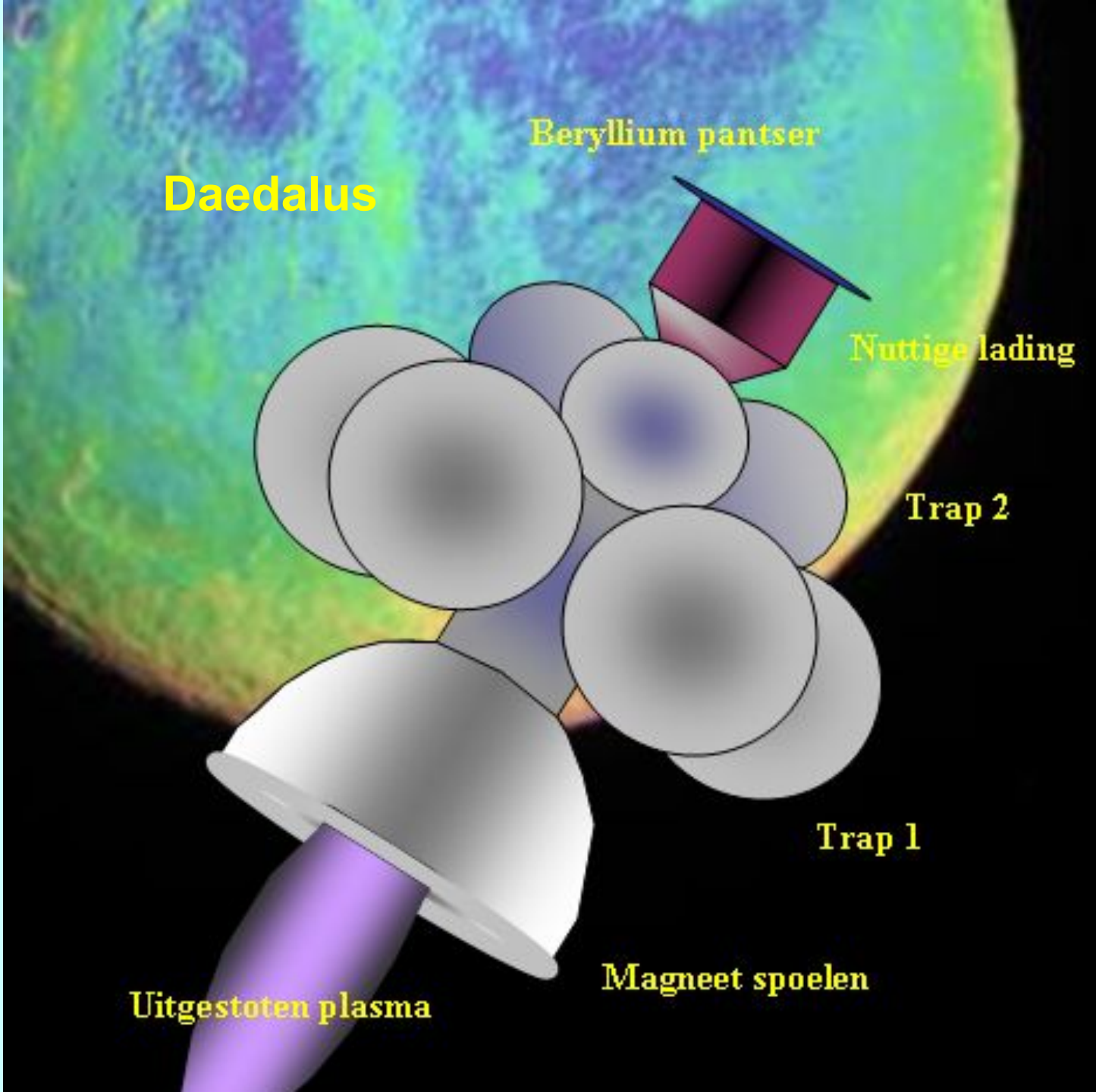


Project Medusa



Interstellar Travel

- Fusion rockets
  - Project Daedalus – laser fuses pellets plasma shot out of magnetic nozzle
  - Project Longshot – could reach Alpha centauri in 100 years, travel at 0.045c
  - Need to have fuel source – could possibly scoop it up as you go
- Antimatter rockets
- Beamed propulsion
  - Laser at home propels solar sail
- Hawking radiation propulsion


Daedalus
Beryllium pantser
Nuttige lading
Trap 2
Trap 1
Magneet spoelen
Uitgestoten plasma

Interstellar Travel

- Transmission “travel”
  - Transmit information needed to reconstruct a person to distant receiver
- Long trips
  - Hibernation
  - Frozen embryos
  - Extended lifespan
  - Generation ships

Destination	1G	2G	5G	10G	Planetary time
Alpha Centauri	4 years	2.8	1.8	1.3	5
Sirius	7	5	3	2.2	13
Galactic Core	340	244	155	110	30,000

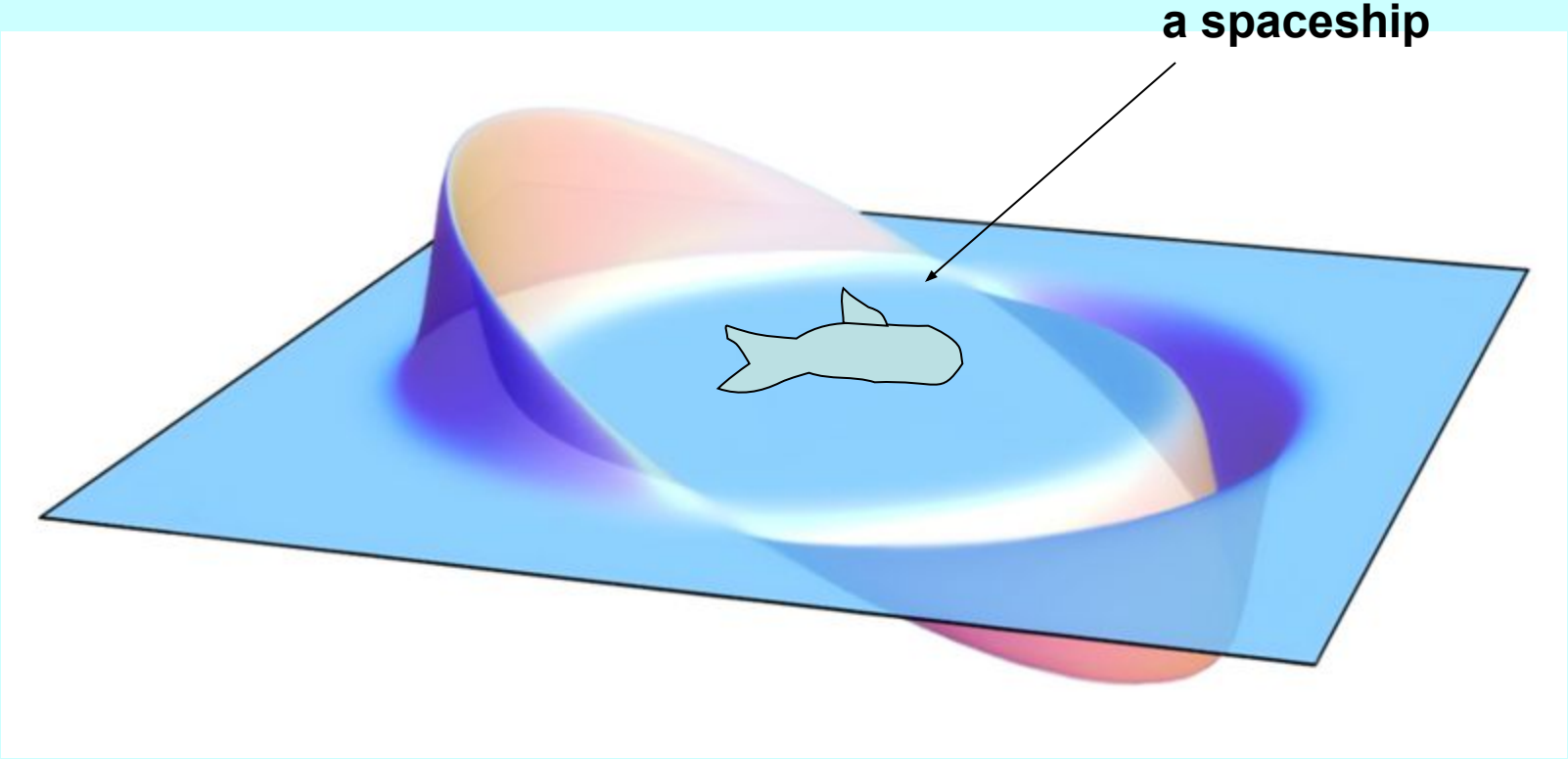
Intergalactic Travel

- 2.54 million lyr between us and Andromeda
- Need essentially light speed technology
- Few realistic proposals

Faster than light travel

- A bubble of space-time that is traveling faster than light does not violate relativity
  - Could place spaceship inside of such a bubble
  - Alcubierre drive
    - Space time wave – spacetime in front expands, spacetime in back contracts
    - Creation would likely require exotic matter
    - Could not be controlled our steered
  - Wormhole
- Still violates causality
  - Quantum gravity may force causality

Alcubierre Drive



Faster than Light Travel

- Vacuum effects
  - "Vacuum" in which c is measured has energy associated with quantum fluctuations
  - By changing vacuum energy, could change speed of light to higher than standard value of c = Scharnhorst effect
  - Casimir effect represents lowering of vacuum energy predicted increase in speed of light by 1 part in 10^{36} for plates that are 1 micrometer apart

The End