Humanity's next big Journey: Exploring Proxima Cen b and Habitable Planets around Nearby Stars

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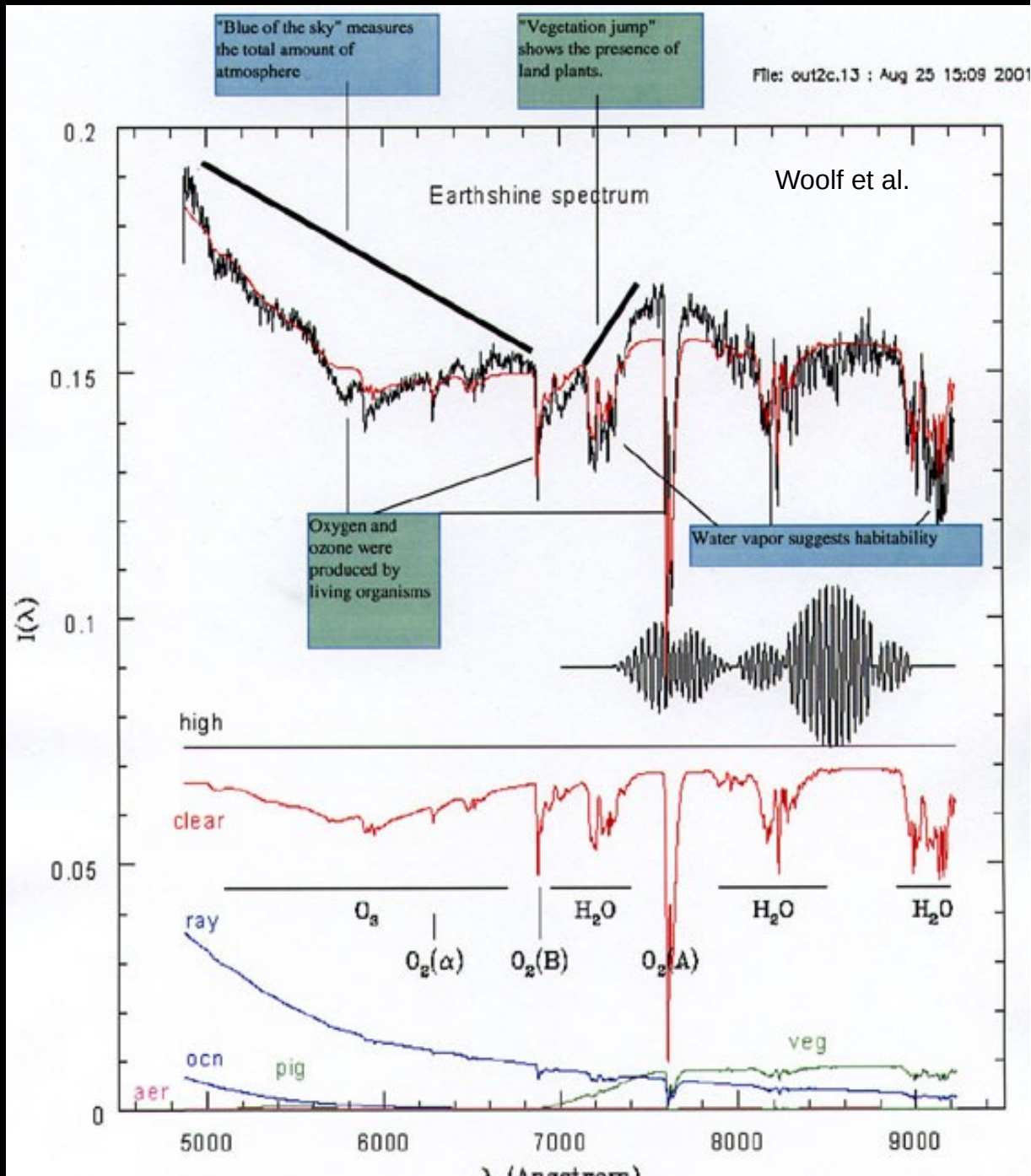
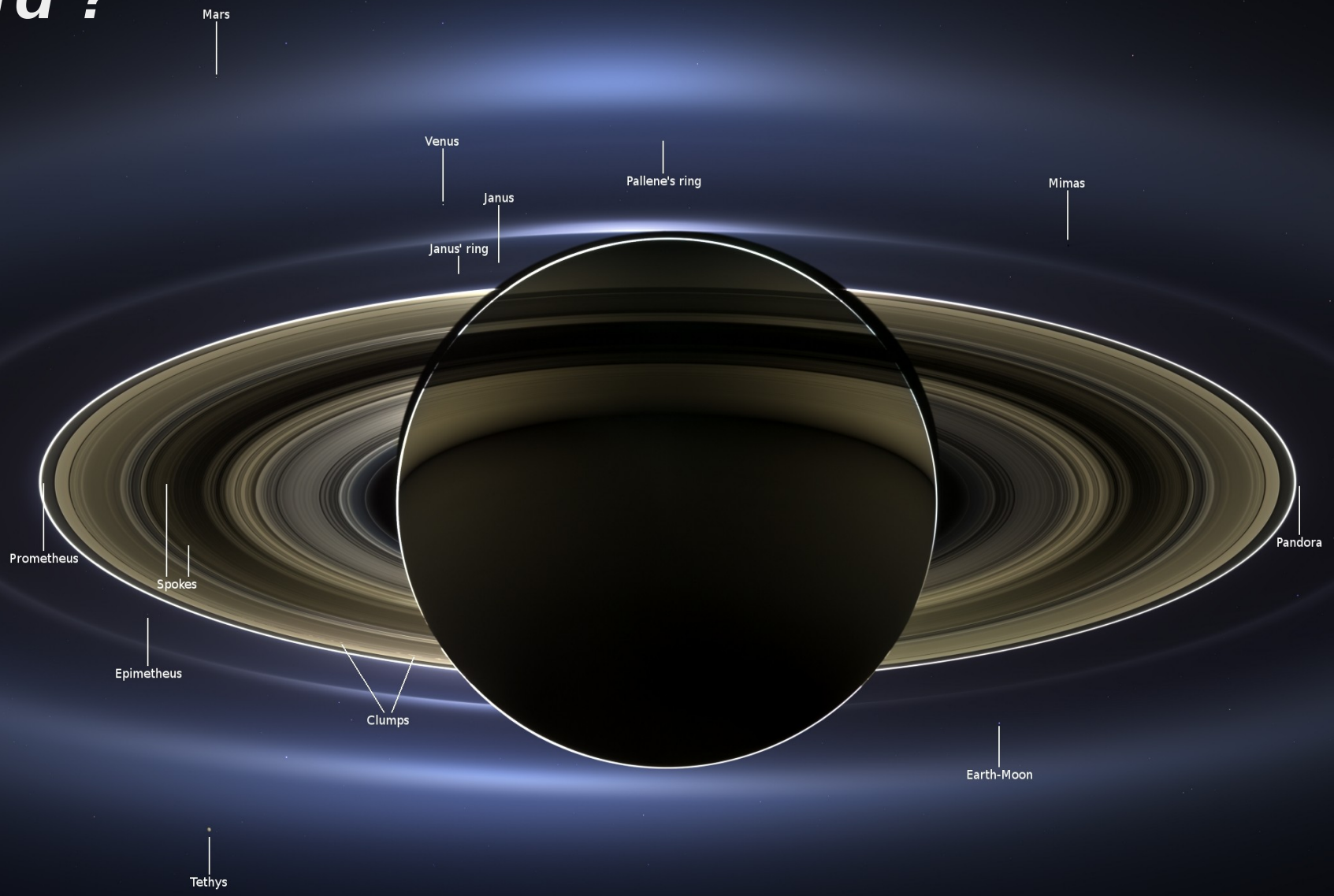
Why directly imaging ?

Spectrum of Earth (taken by looking at Earthshine) shows evidence for life and plants



Taking images of habitable exoplanets: Why is it hard ?



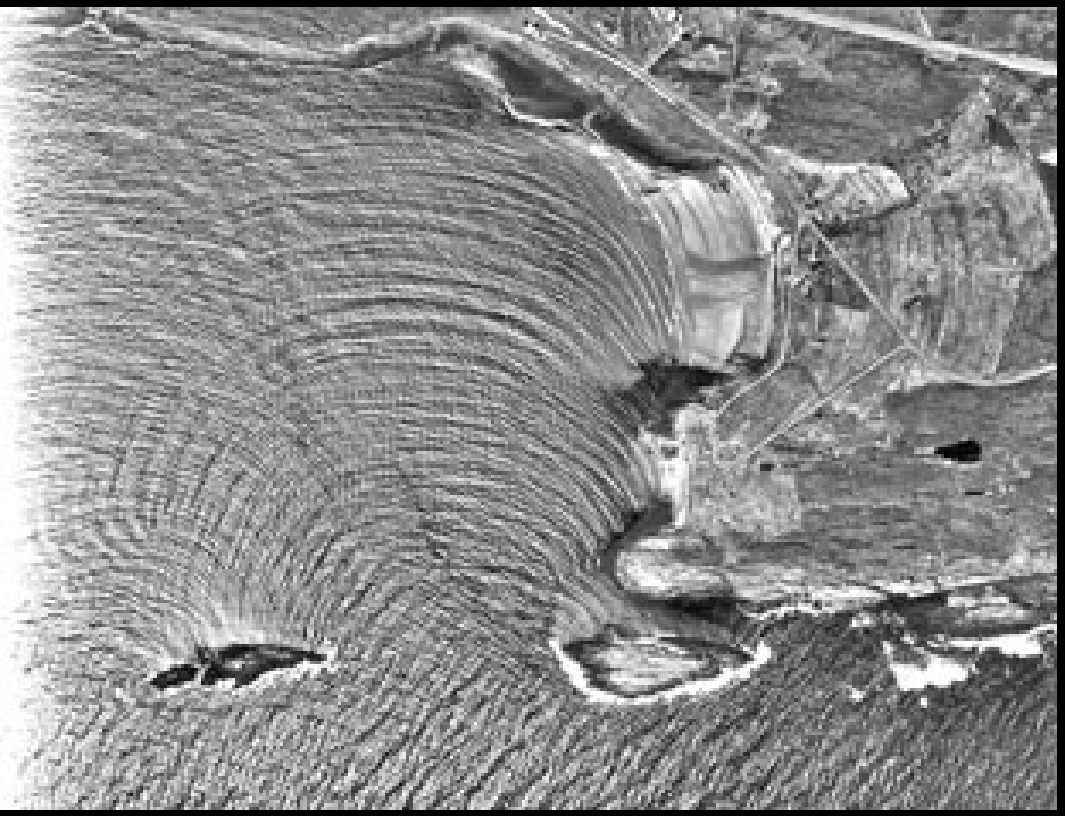

Saturn
Earth

Coronagraphy ... Using optics tricks to remove starlight (without removing planet light)

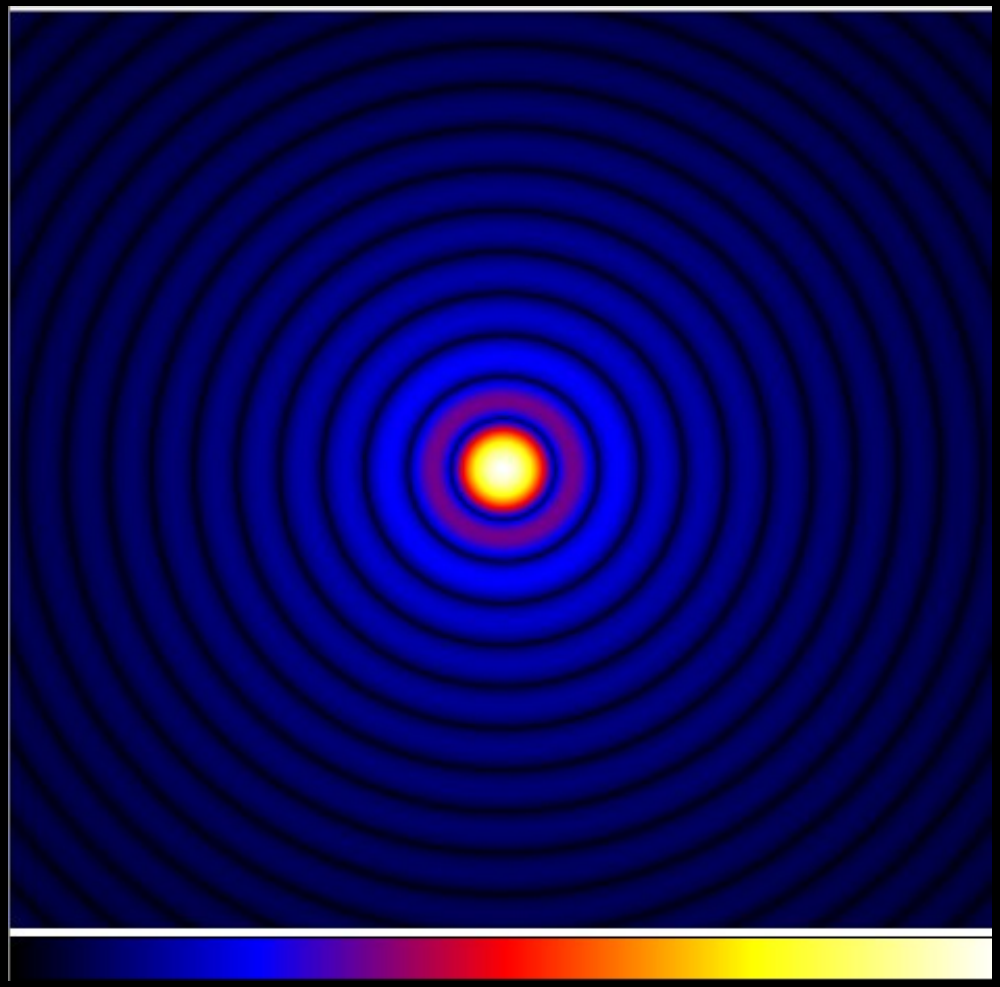
← Olivier's thumb...
the easiest coronagraph
Doesn't work well enough to
see planets around other stars

We need a better coronagraph... and a larger eye (telescope)

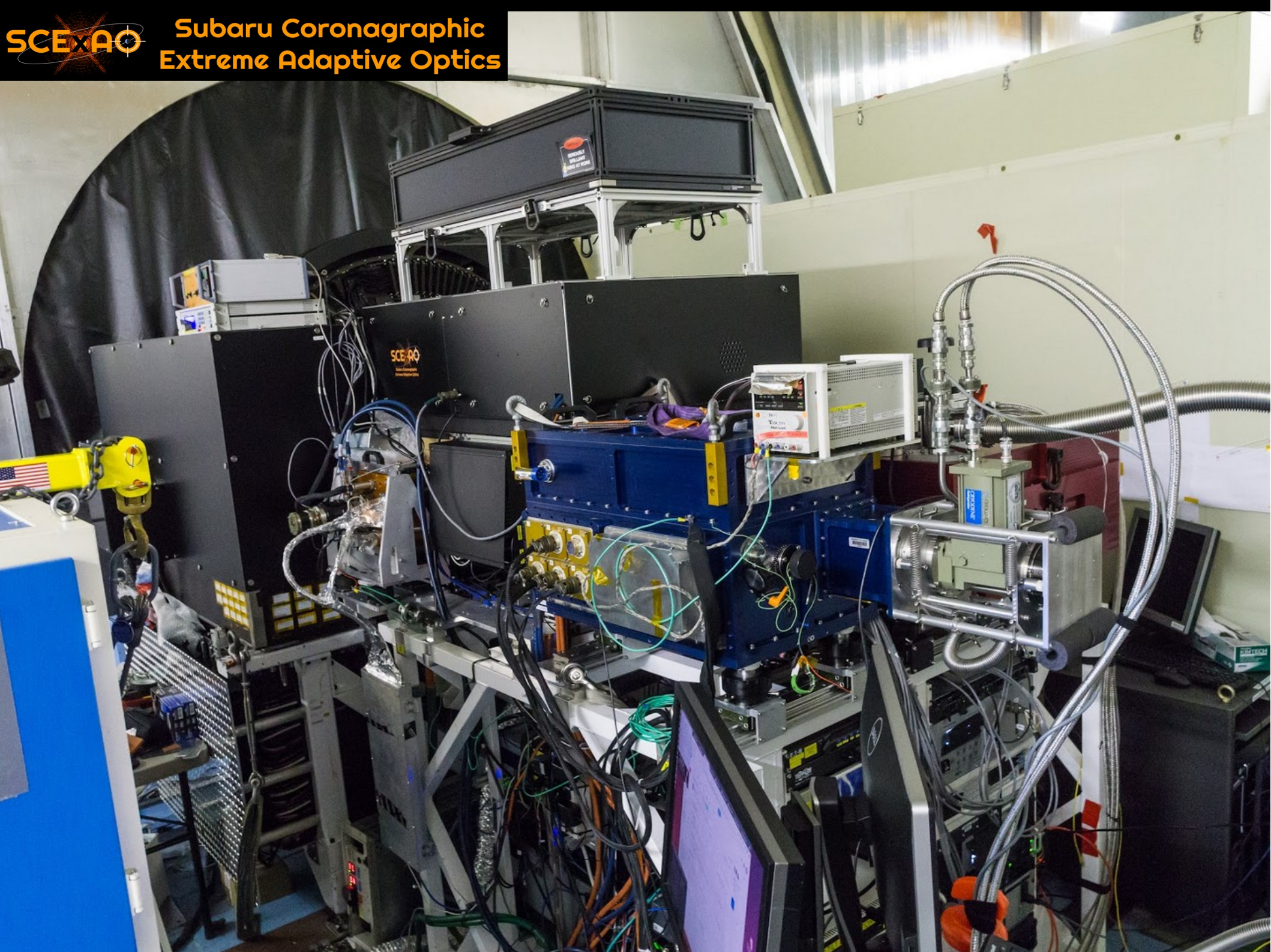
Water waves diffract around obstacles, edges, and so does light



Waves diffracted by coastline and islands



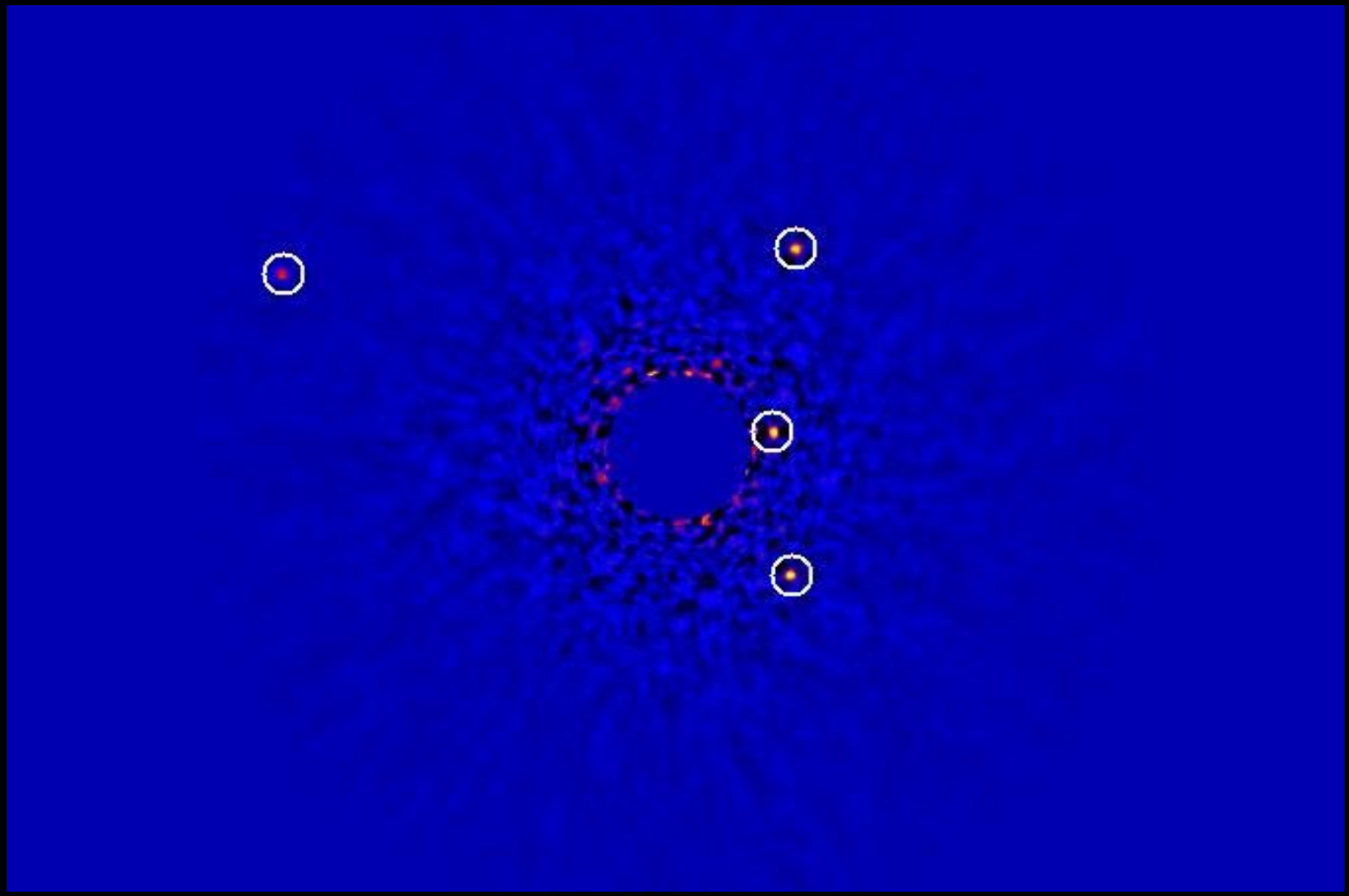
Ideal image of a distant star by a telescope
Diffraction rings around the image core


SCExAO
Subaru Coronagraphic
Extreme Adaptive Optics

HR8799

Four planets, orbital periods on the order of 100yr
Each planet 5 to 7 Jupiter Mass

Subaru Telescope/ SCExAO (Currie et. al 2017)



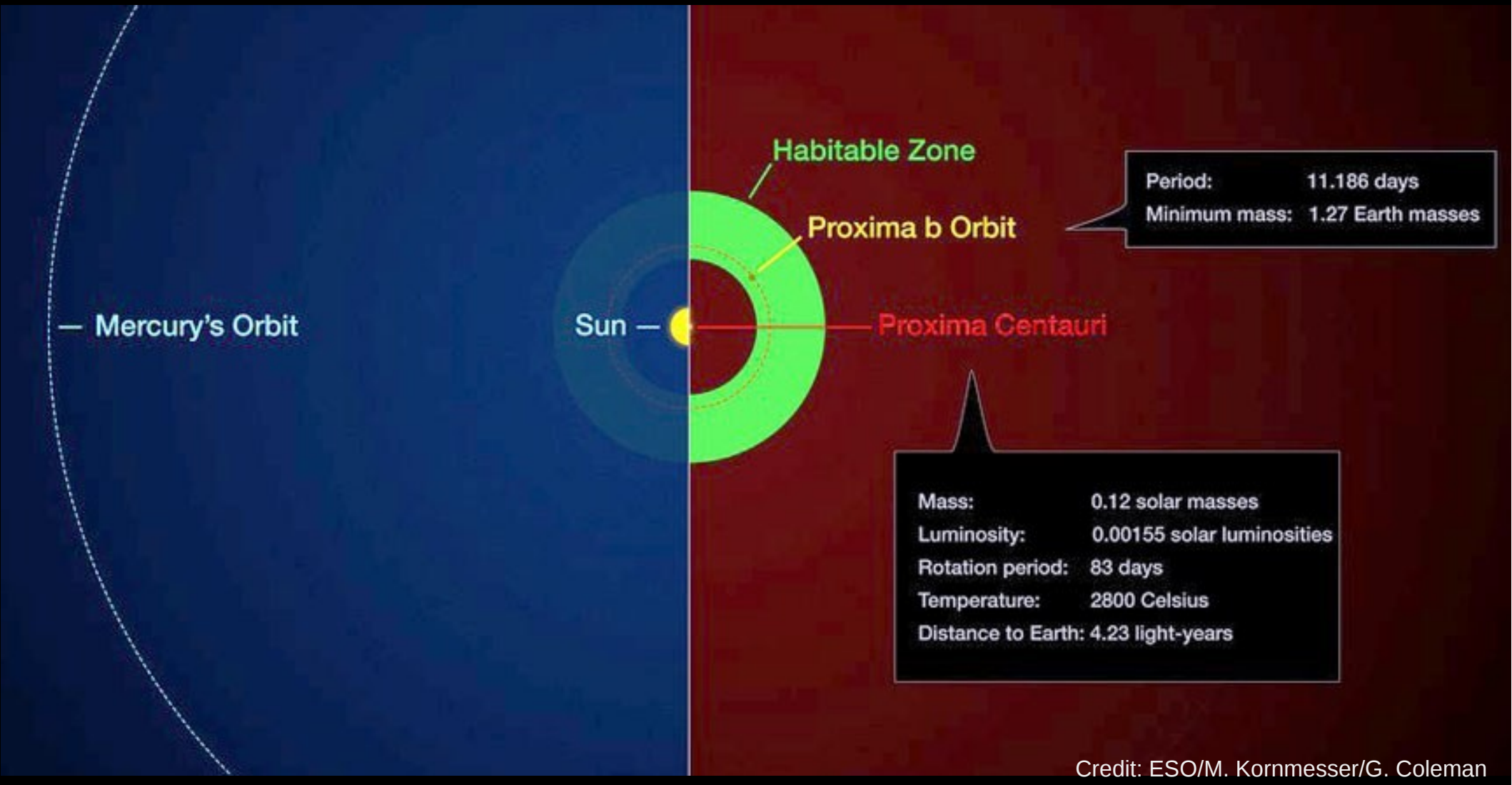
M-type stars (low mass)

Habitable zone is close to star

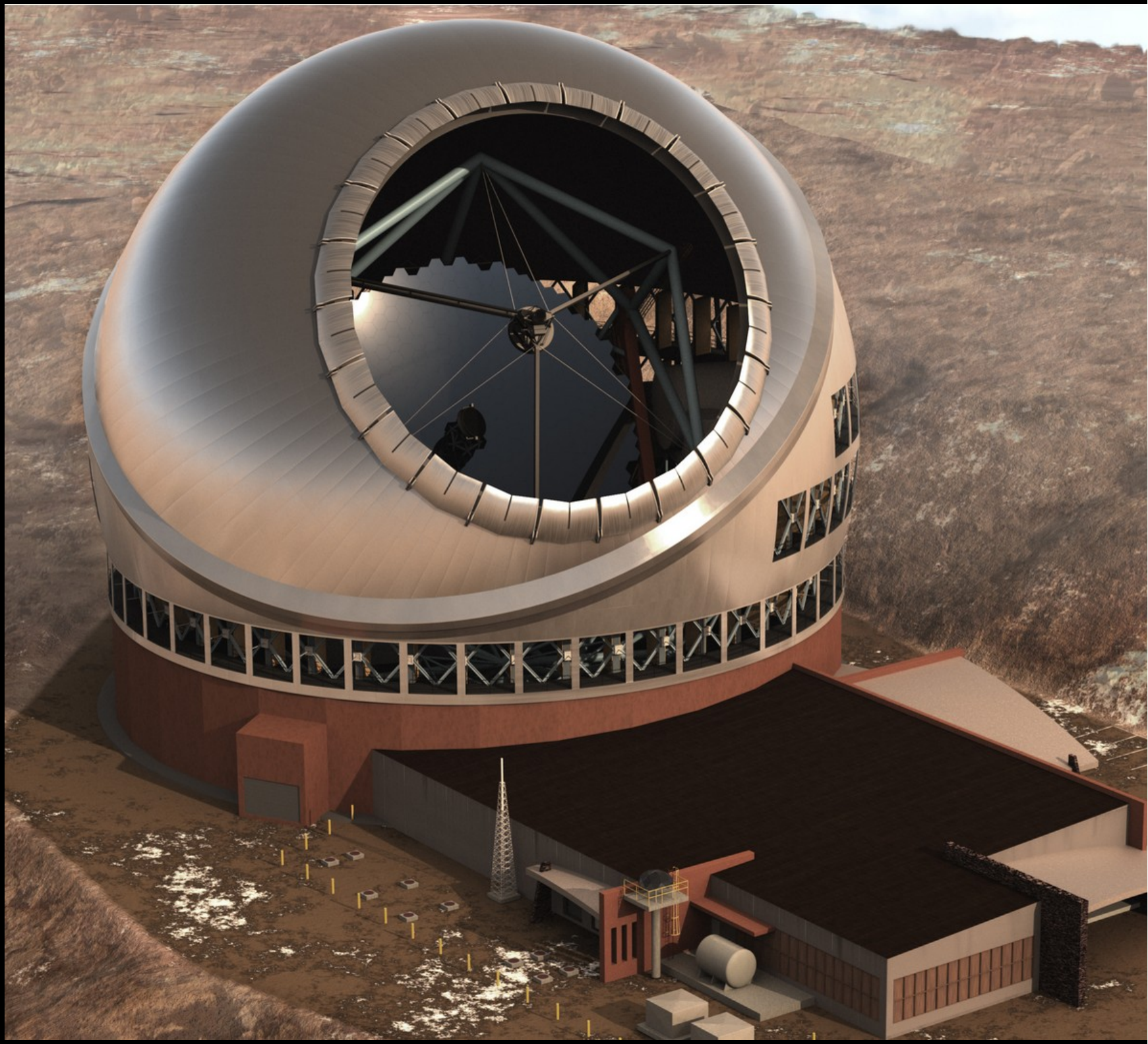
→ big telescope needed to resolve it

Star is fainter, so Star/Planet contrast is easier

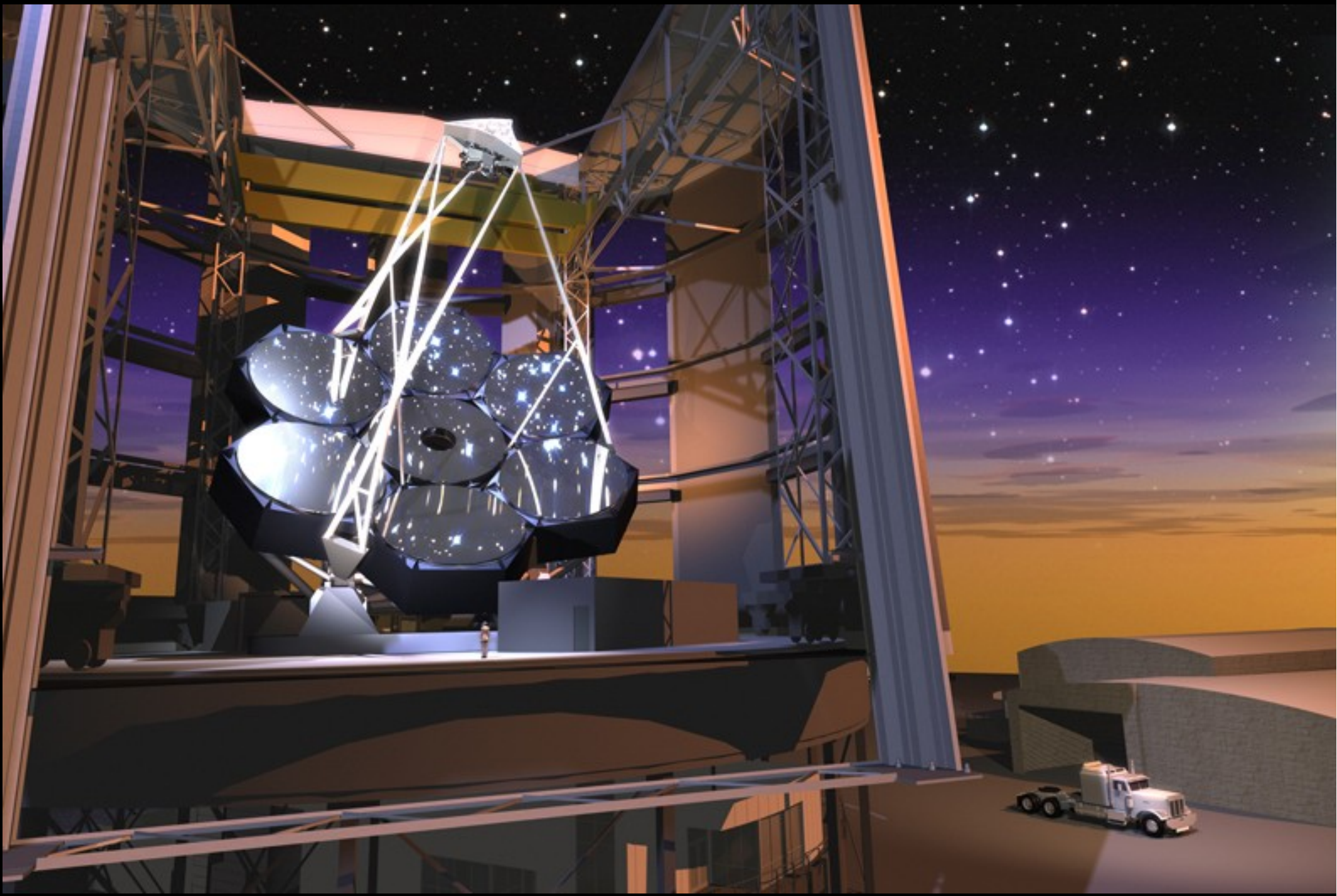
→ can be done from ground (no need to be in space)



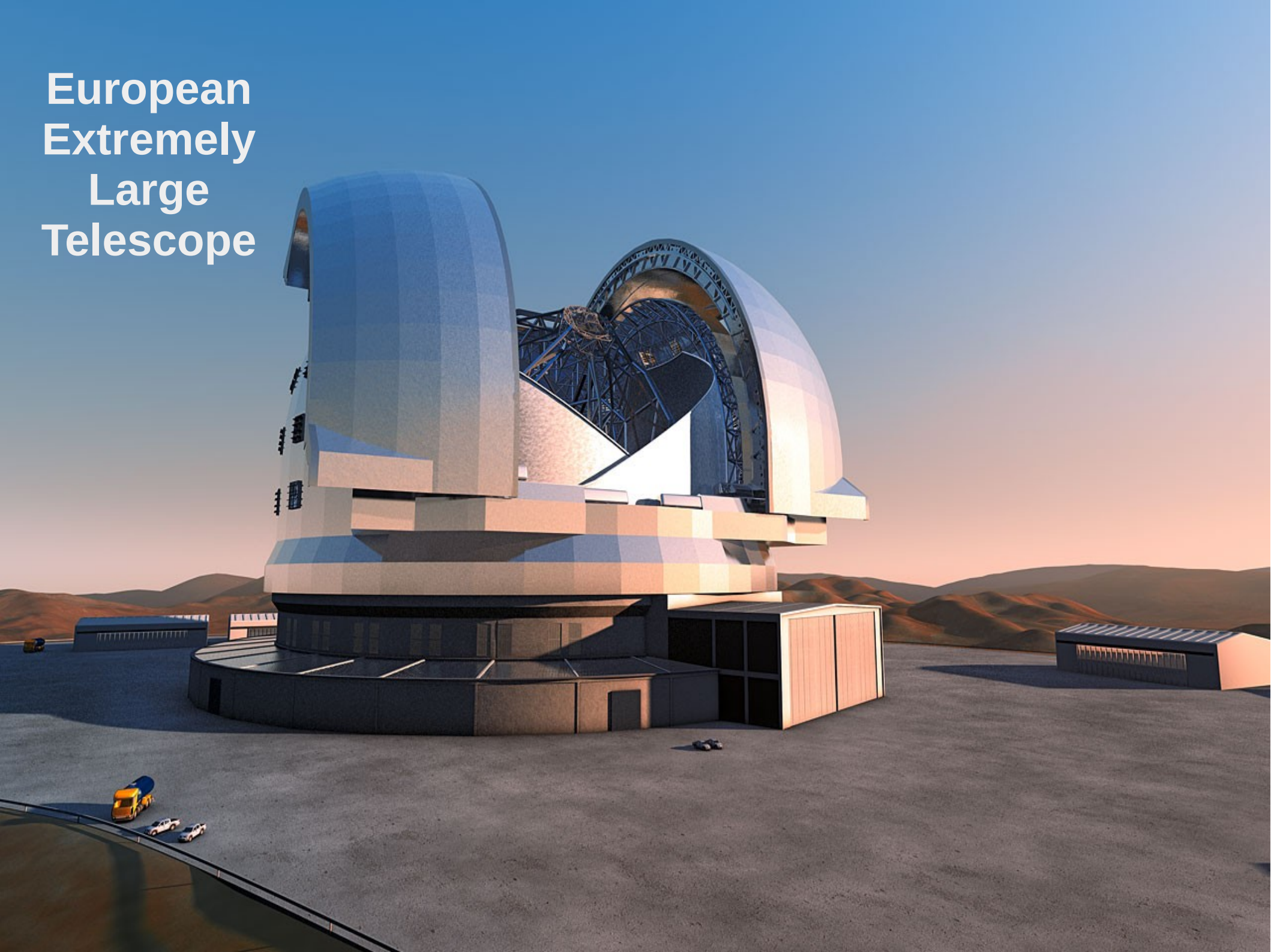
Thirty Meter Telescope



Giant Magellan Telescope



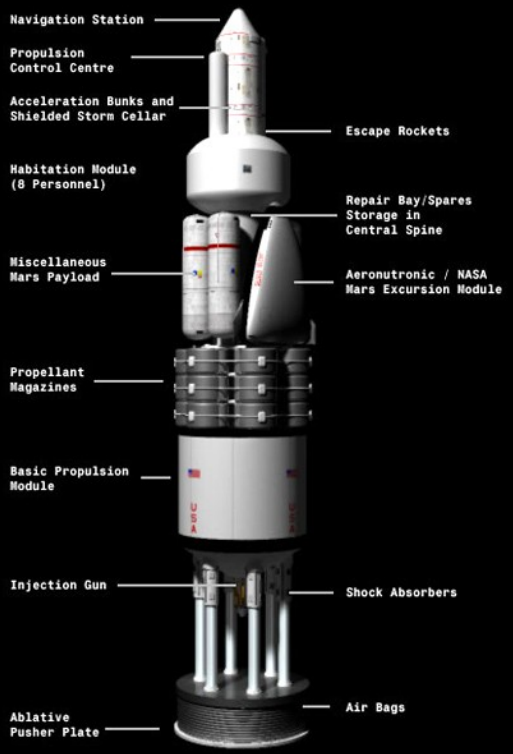
European Extremely Large Telescope

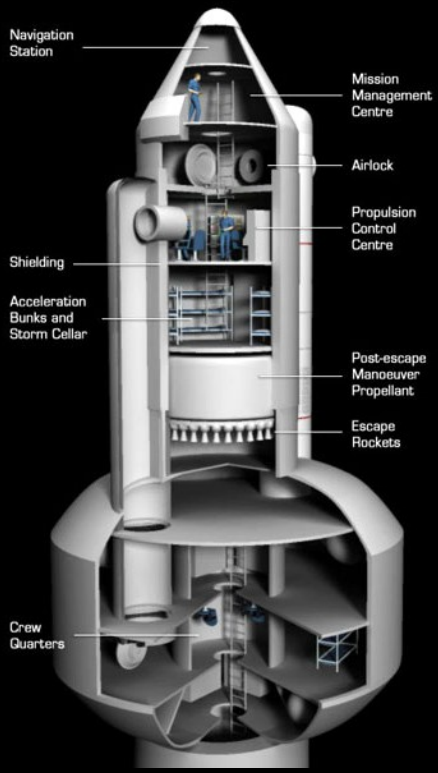


Interstellar travel: pre-2000 studies

Several serious studies (Longshot, Orion, Deadalus)

Propulsion challenge is significant





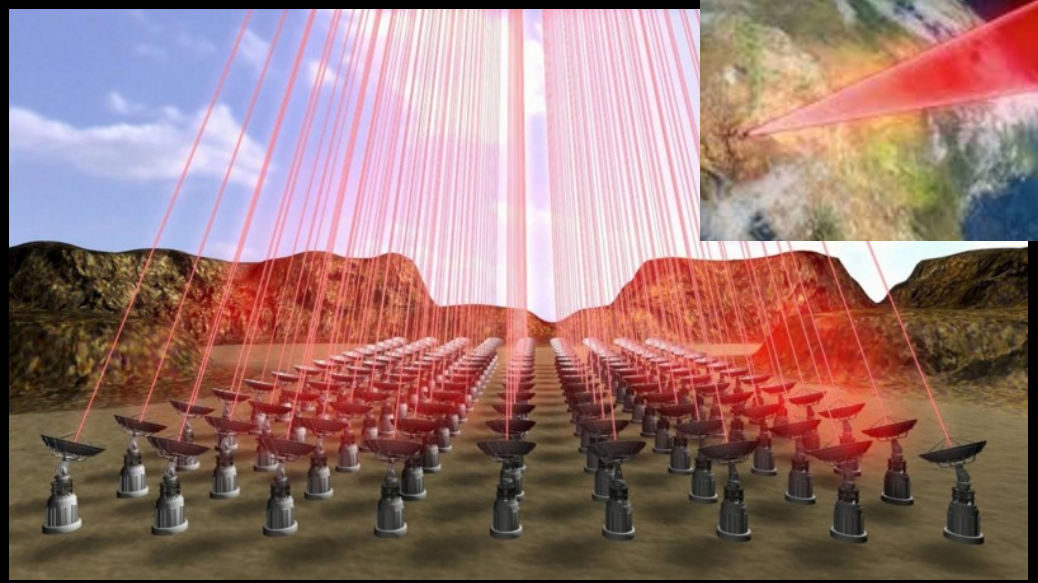
Project Orion – using nuclear propulsion, massive spacecraft

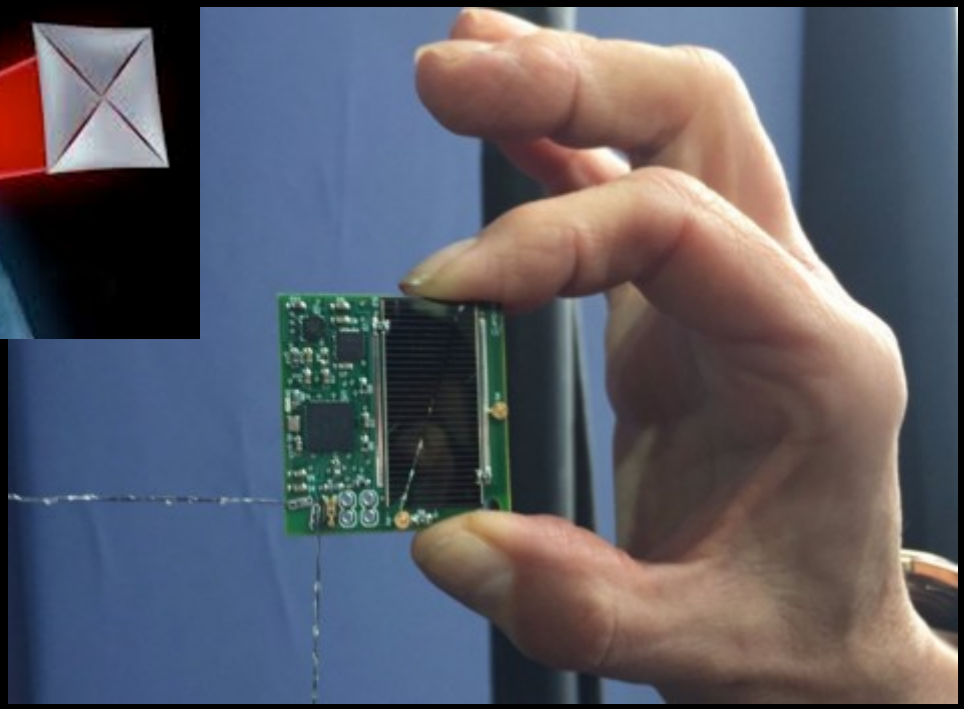
Starshot project: Laser propulsion, robotic spacecraft (no human)

Leverages current/future technology developments:

- Small spacecraft (~gram)
- Ground-based laser propulsion (“don't carry your fuel”)

breakthroughinitiatives.org






~300 billion stars in our galaxy

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~30 billion habitable planets ?

If 100 explorers were sent to visit each habitable for 10 seconds (only 300 million planets/explorer)...

… it would take 95 yrs to complete the habitable exoplanets tour … in our galaxy alone


200 billion galaxies
in the observable
universe