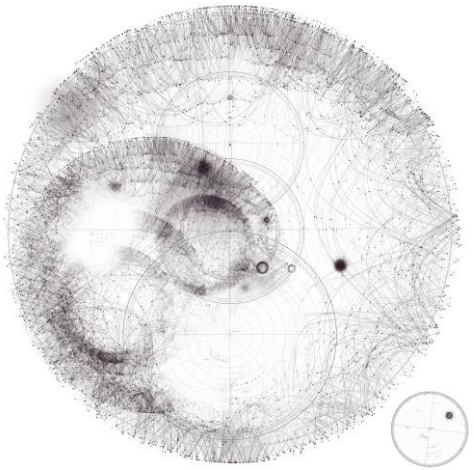


LIFE IN THE UNIVERSE & PRIVATE-SECTOR SPACE SCIENCE INITIATIVES

BREAKTHROUGH INITIATIVES

Brig Gen (ret), USAF, Dr. S. PETE WORDEN - CHAIRMAN, BREAKTHROUGH PRIZE FOUNDATION – worden@breakthrough-initiatives.org

TOPICS

- Breakthrough Initiatives – Private Sector Space Science
- Public-Private Partnership – Sun Divers
- Venus

BREAKTHROUGH PRIZE

FUNDAMENTAL PHYSICS
MATHEMATICS
LIFE SCIENCES

NEW HORIZONS
JUNIOR CHALLENGE


BREAKTHROUGH
PRIZE


NATIONAL
GEOGRAPHIC
CHANNEL

BREAKTHROUGH JUNIOR CHALLENGE

KHAN ACADEMY

CHAN ZUCKERBERG INITIATIVE

NATIONAL GEOGRAPHIC CHANNEL

CSH Cold Spring Harbor Laboratory







BREAKTHROUGH INITIATIVES FUNDAMENTAL QUESTIONS:

IS THERE INTELLIGENT LIFE ELSEWHERE?

IS THERE OTHER LIFE IN THE UNIVERSE?

CAN WE TRAVEL BETWEEN THE STARS?

BREAKTHROUGH LISTEN 2015 -



Berkeley UNIVERSITY OF CALIFORNIA

GREEN BANK OBSERVATORY

CSIRO

UNIVERSITY OF CALIFORNIA OBSERVATORIES

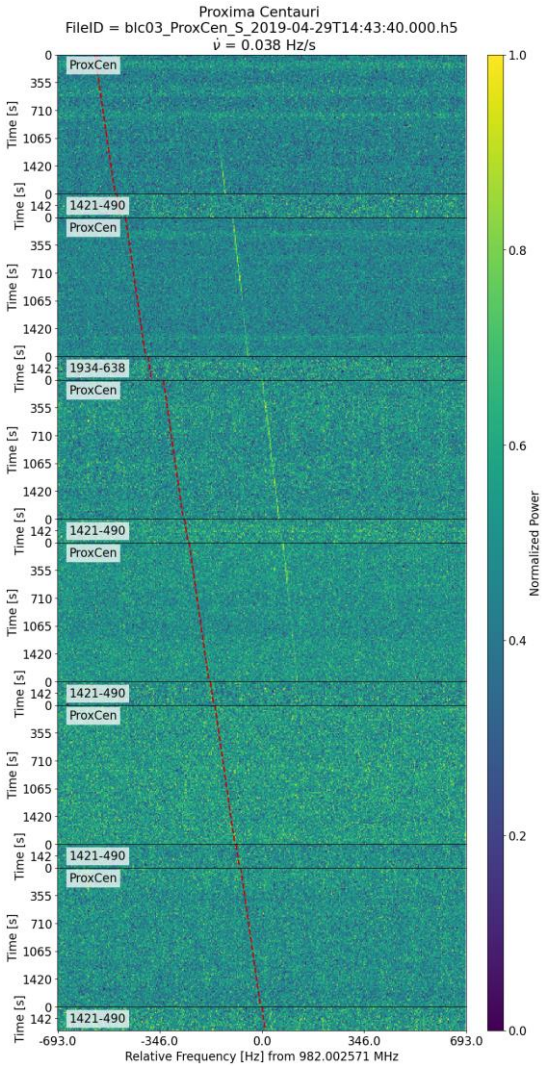
NRF National Research Foundation | SARAO South African Radio Astronomy Observatory

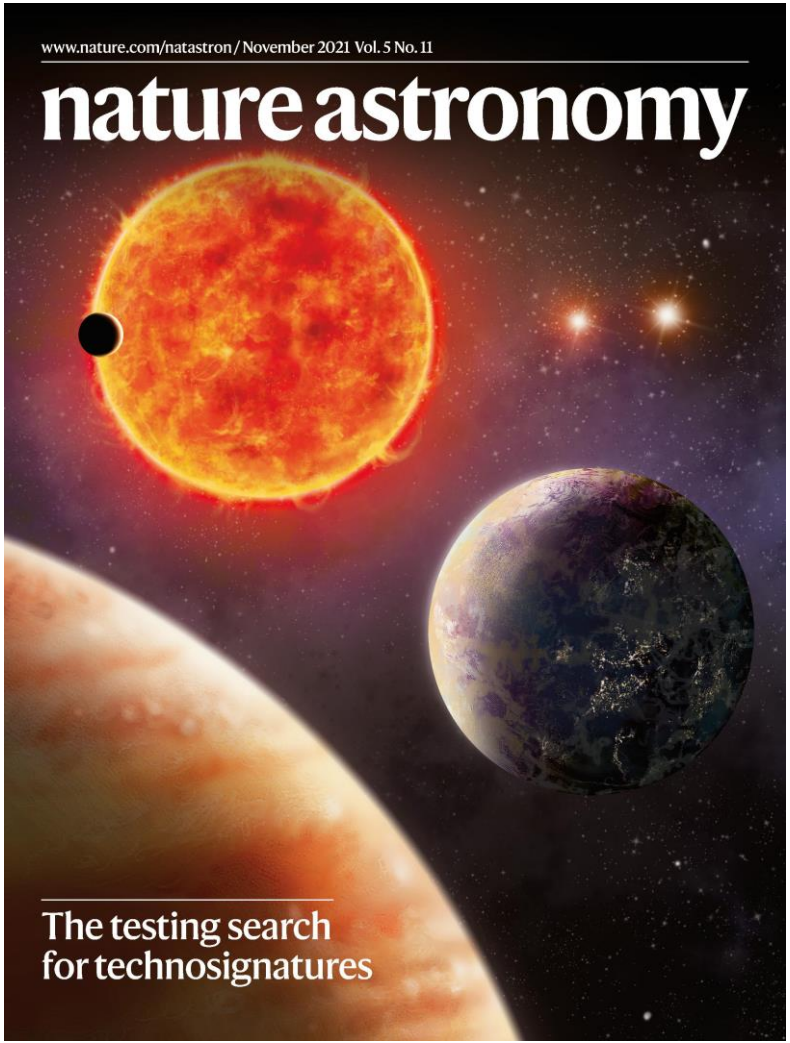

BERKELEY SETI
RESEARCH CENTER
2019 -
BREAKTHROUGH
LISTEN

Space

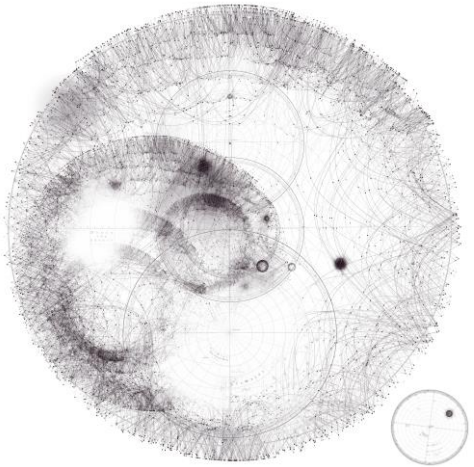
Scientists looking for aliens investigate radio beam 'from nearby star'

Tantalising 'signal' appears to have come from Proxima Centauri, the closest star to the sun


Proxima Centauri
FileID = blc03_ProxCen_S_2019-04-29T14:43:40.000.h5
$\dot{\nu}$ = 0.038 Hz/s
ProxCen
1421-490
1934-638
Time [s]
Normalized Power
Relative Frequency [Hz] from 982.002571 MHz


www.nature.com/natastron / November 2021 Vol. 5 No. 11
nature astronomy
The testing search for technosignatures

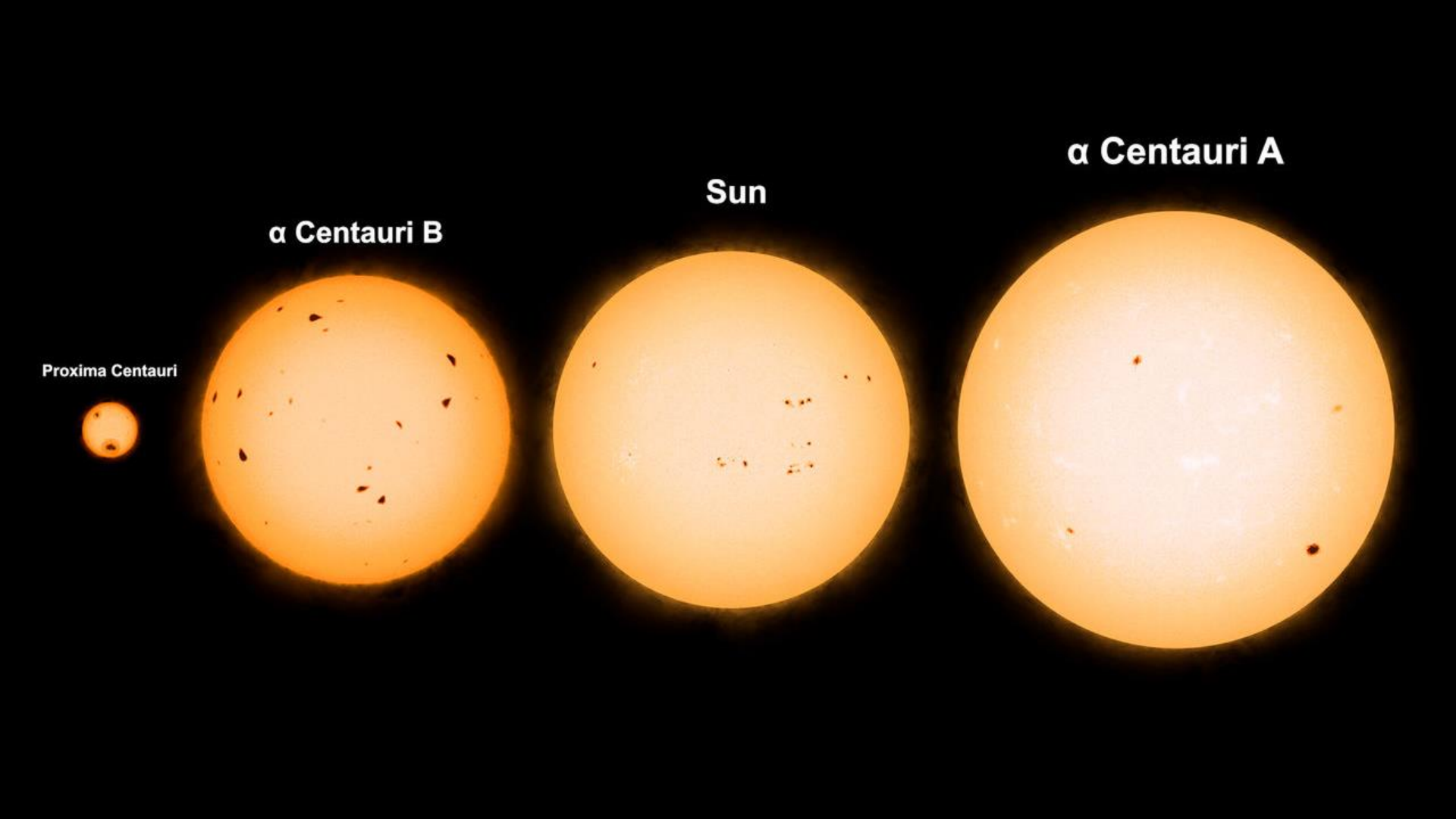

BREAKTHROUGH
LISTEN



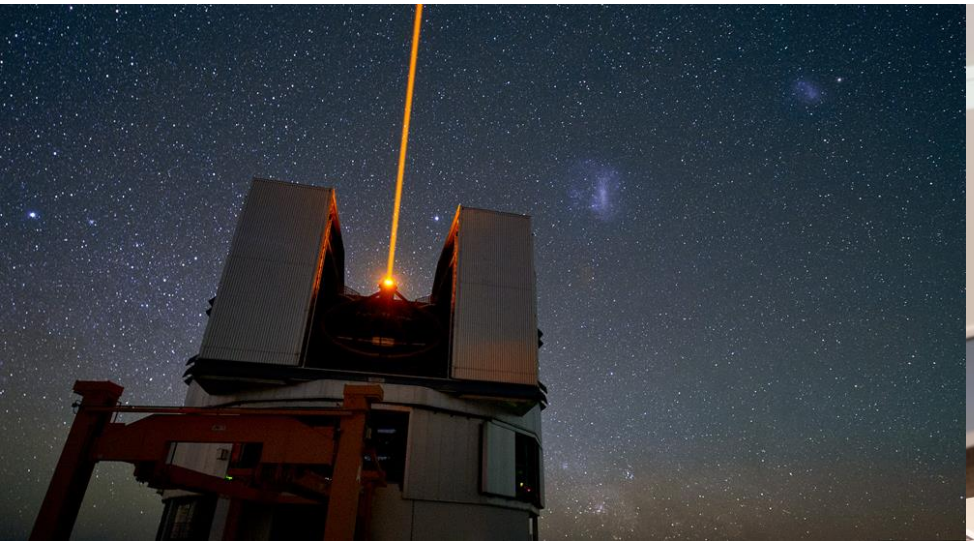
THE SEARCH FOR LIFE IN THE UNIVERSE: ALPHA CENTAURI

BREAKTHROUGH INITIATIVES

Dr. S. PETE WORDEN - CHAIRMAN, BREAKTHROUGH PRIZE FOUNDATION – WORDEN@BREAKTHROUGH-INITIATIVES.ORG


α Centauri A
Sun
α Centauri B
Proxima Centauri

BREAKTHROUGH
WATCH

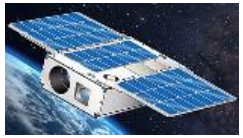


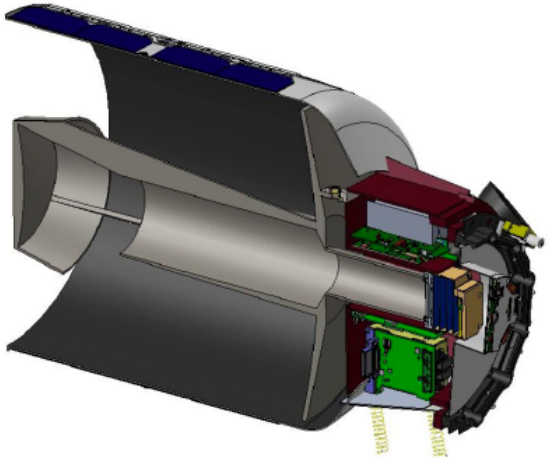
Day 1: Breakthrough Discuss 2021: Alpha Centauri System: A Beckoning Neighbor

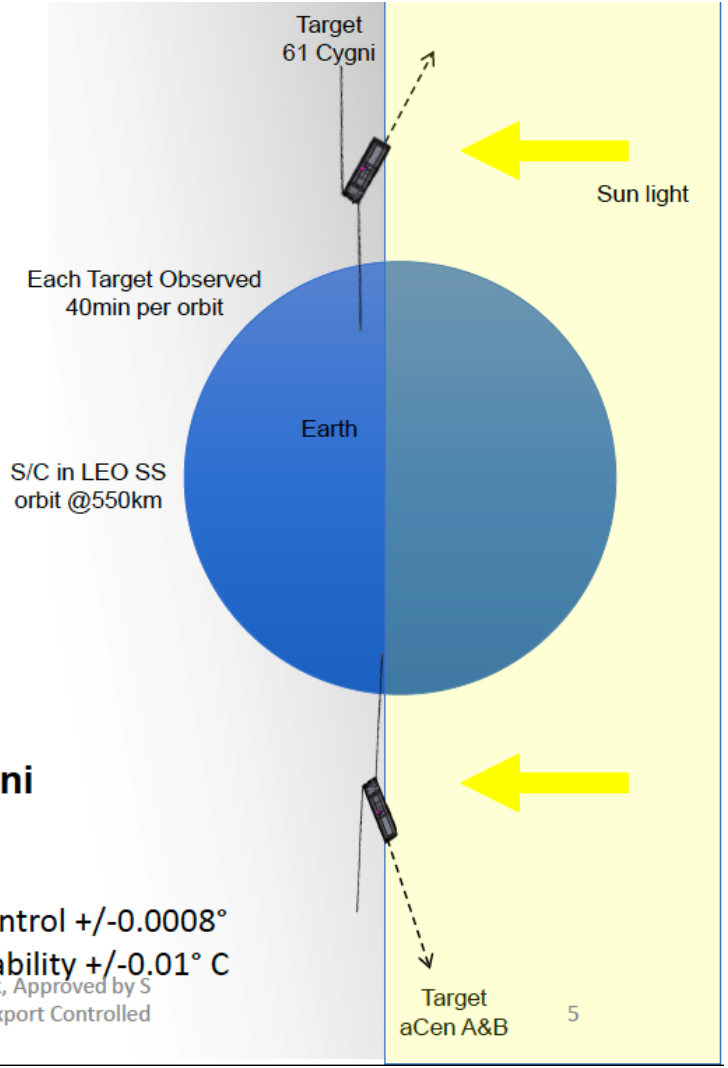
zoom

2:06:51 / 5:49:07

The Results Toliboy Mission Description





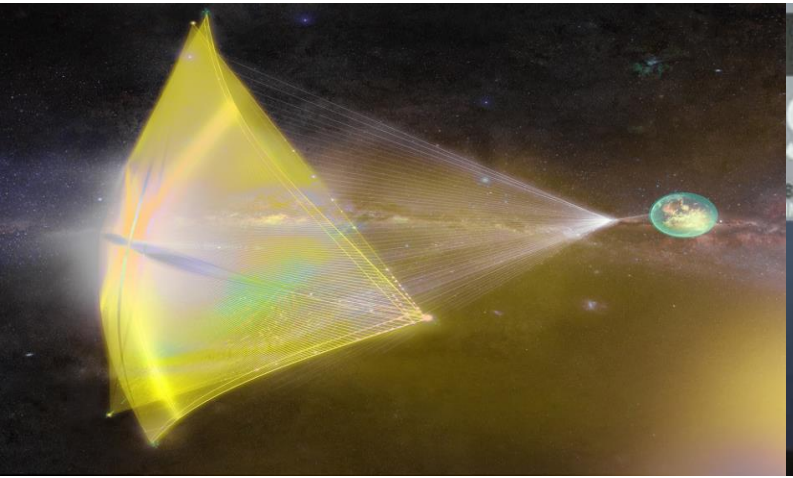


Detect Earth Mass Planets around Alpha Cent and 61 Cygni

20 Kg Spacecraft
9 cm F21 Telescope
3 Year Mission
Launch June 2021
$1.5 M

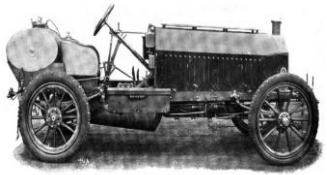
Pointing Control +/-0.0008°
Thermal Stability +/-0.01° C

BREAKTHROUGH
STARSHOT

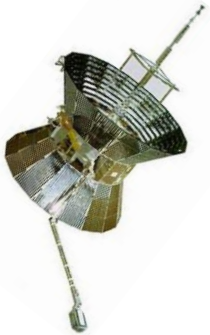


VELOCITY?

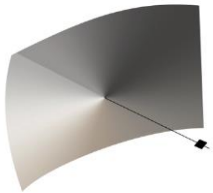
Napier Racer



Helios 2
1976

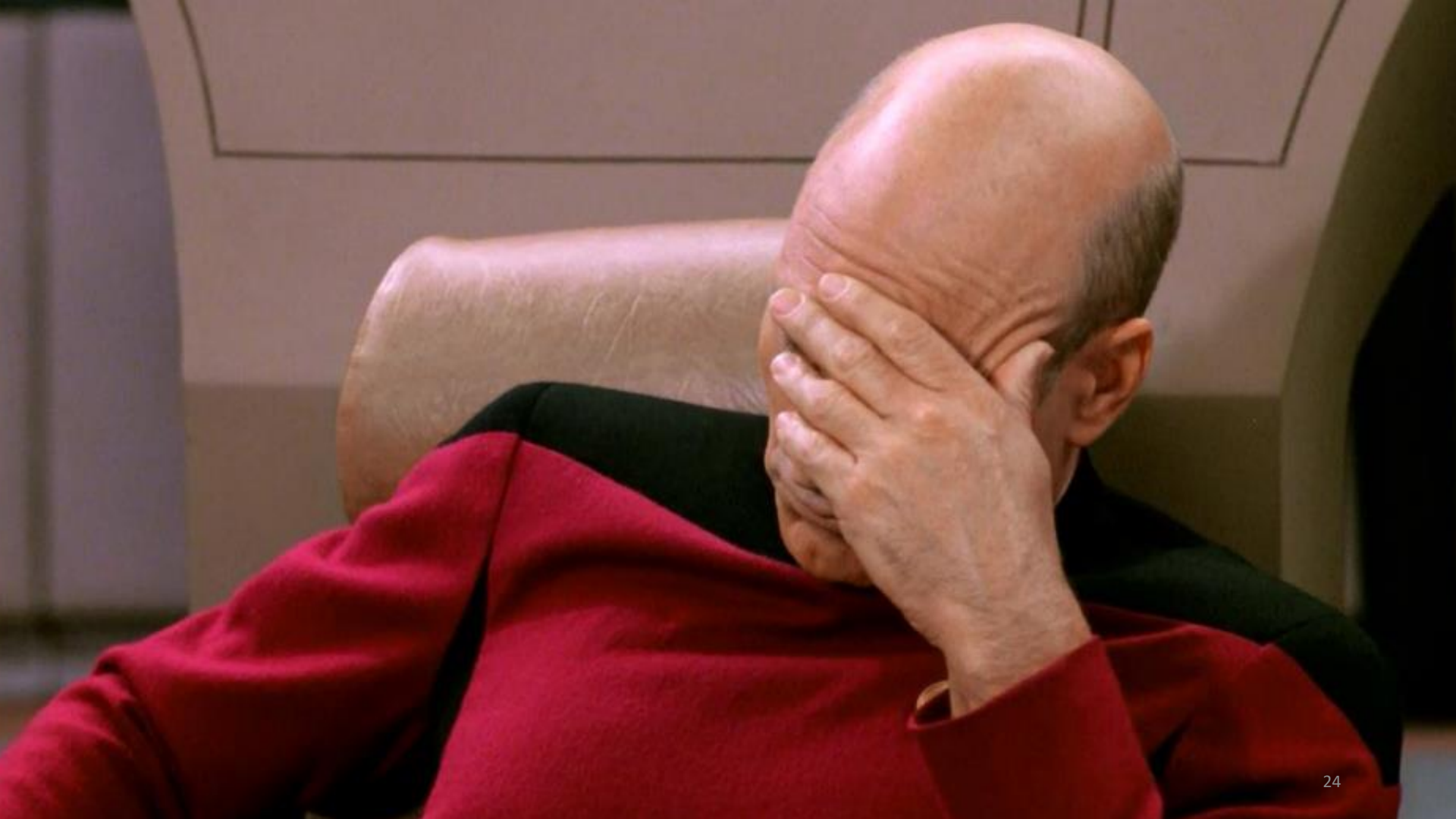


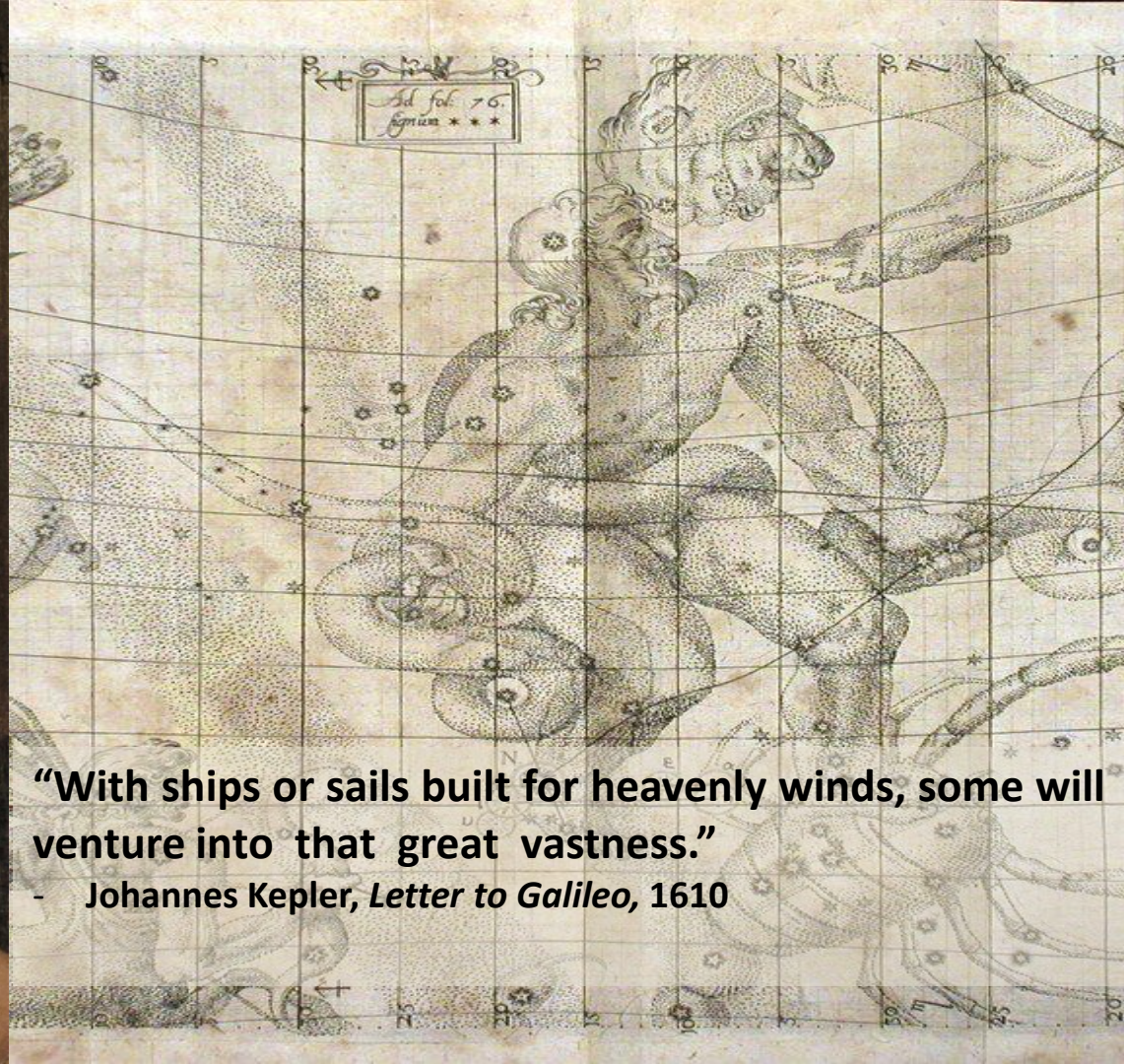
?



1000 times faster within 100 years

1000 times faster within ? years



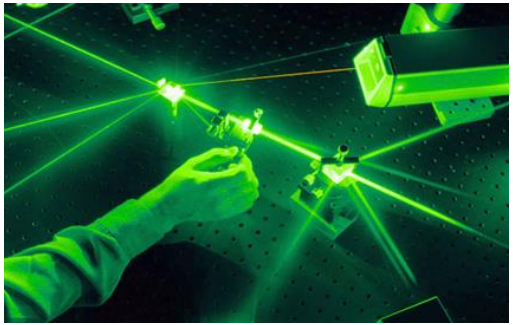


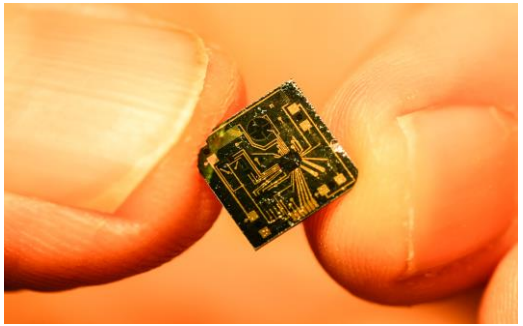
“With ships or sails built for heavenly winds, some will venture into that great vastness.”

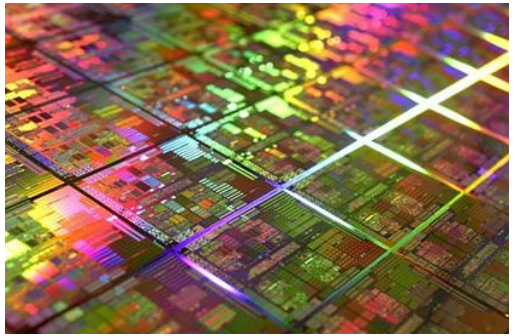
- **Johannes Kepler, *Letter to Galileo,* 1610**

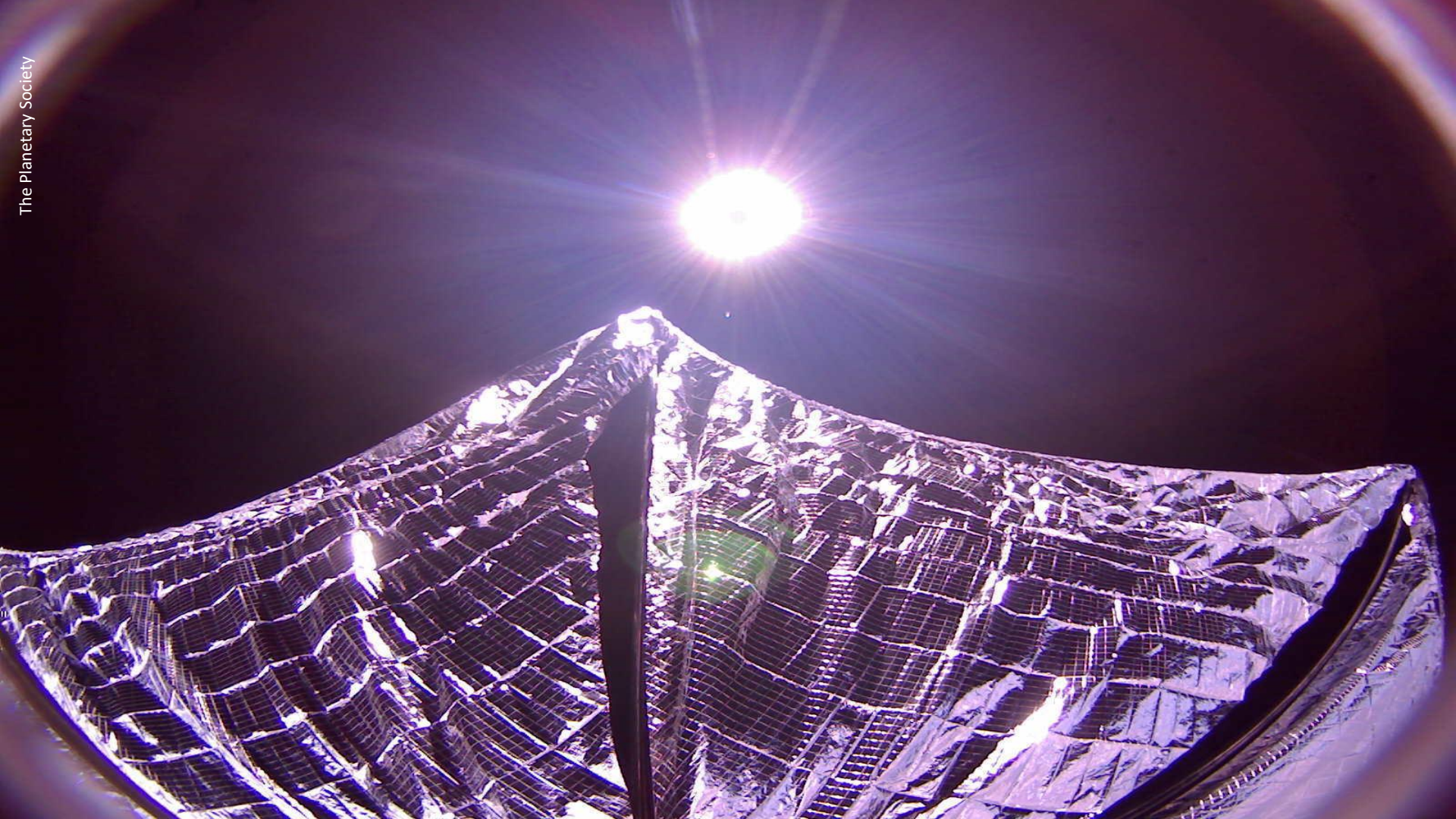
VELOCITY SOLUTIONS

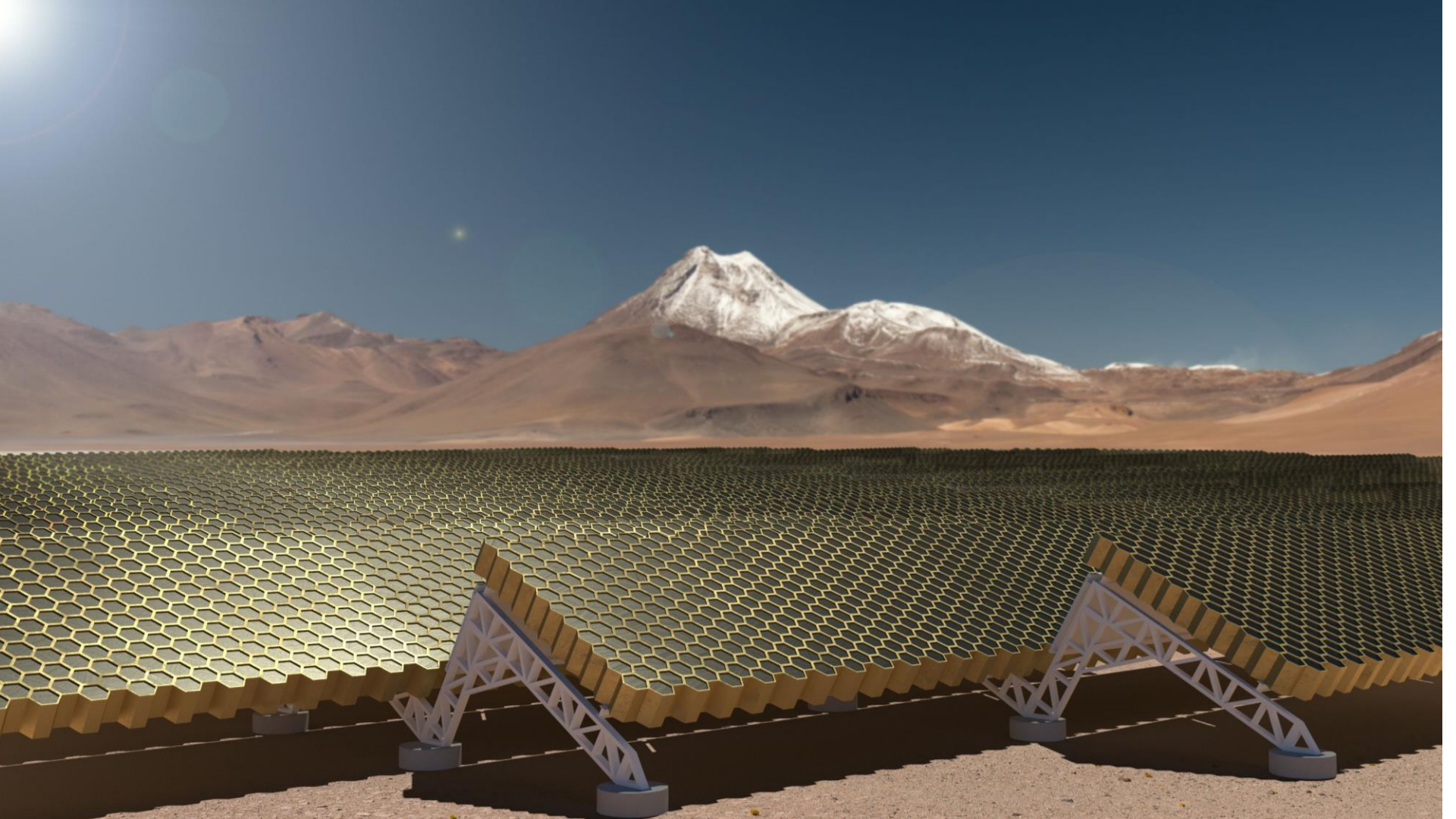
1. LOWEST POSSIBLE MASS
2. LEAVE ENGINE/FUEL ON EARTH
3. ATTACH A CHIP TO A SAIL
4. LASER BEAM IS THE WIND

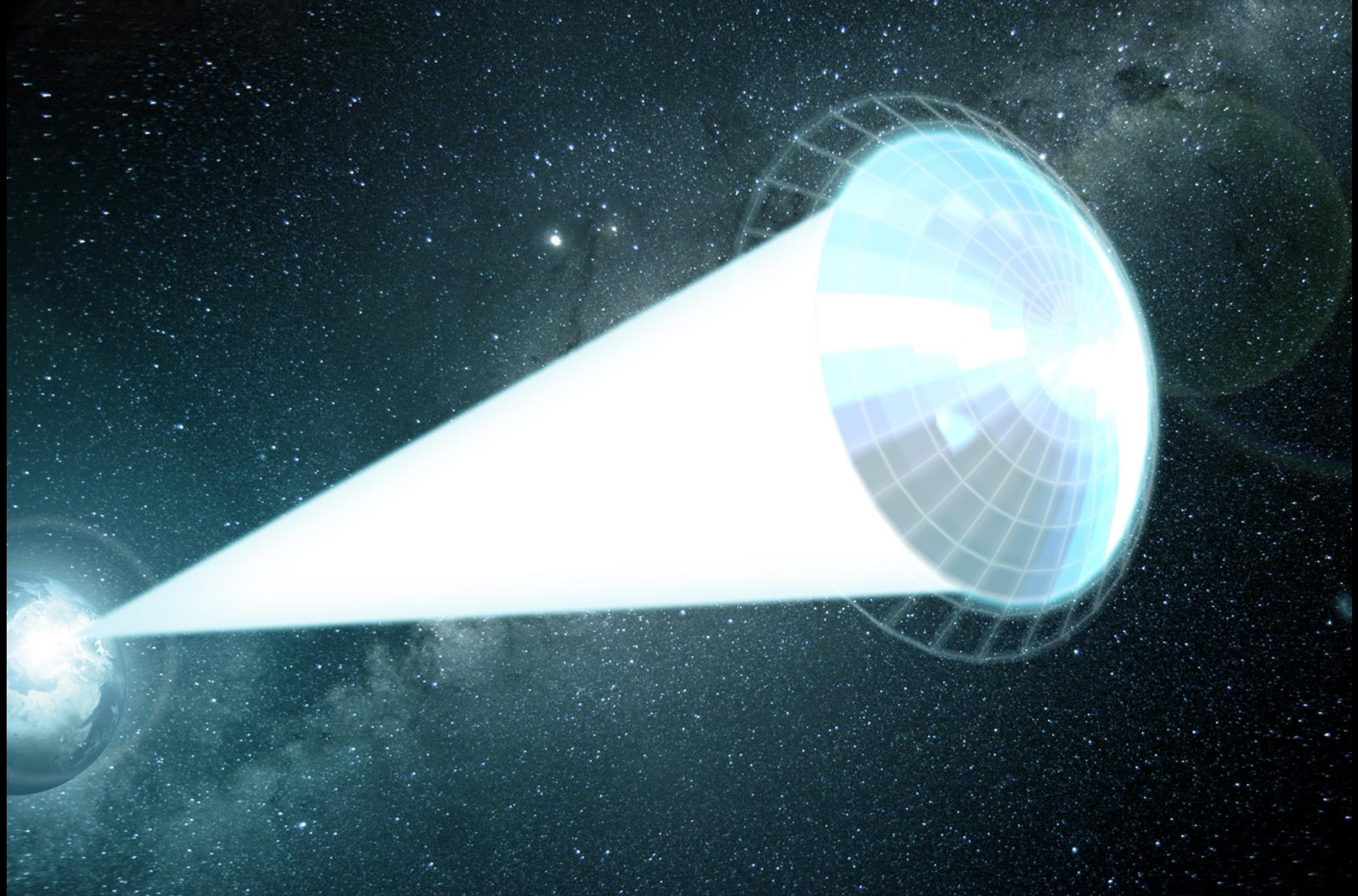




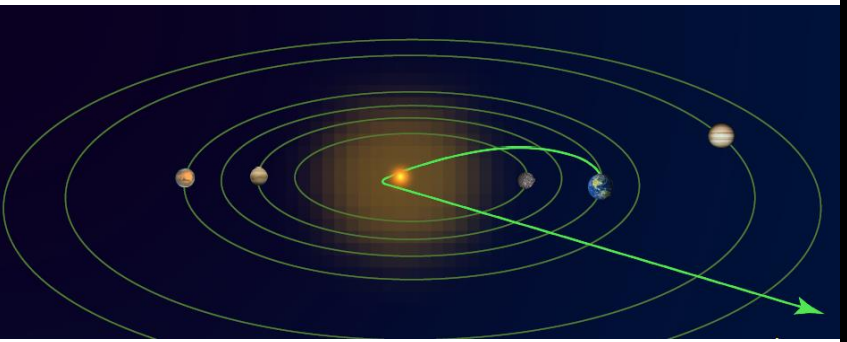


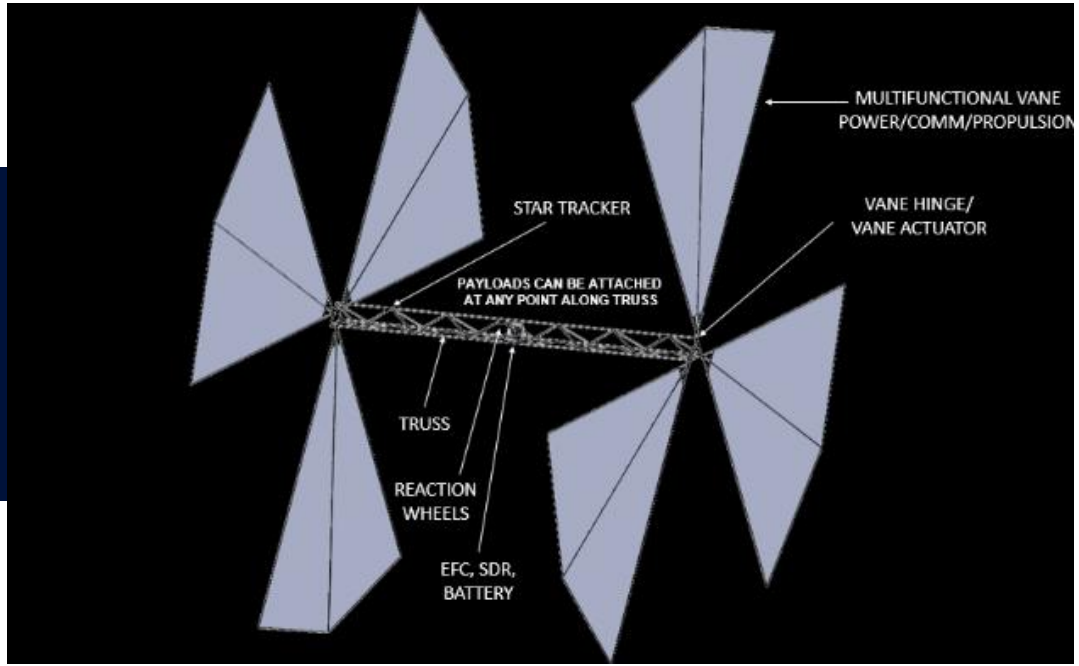

The Planetary Society





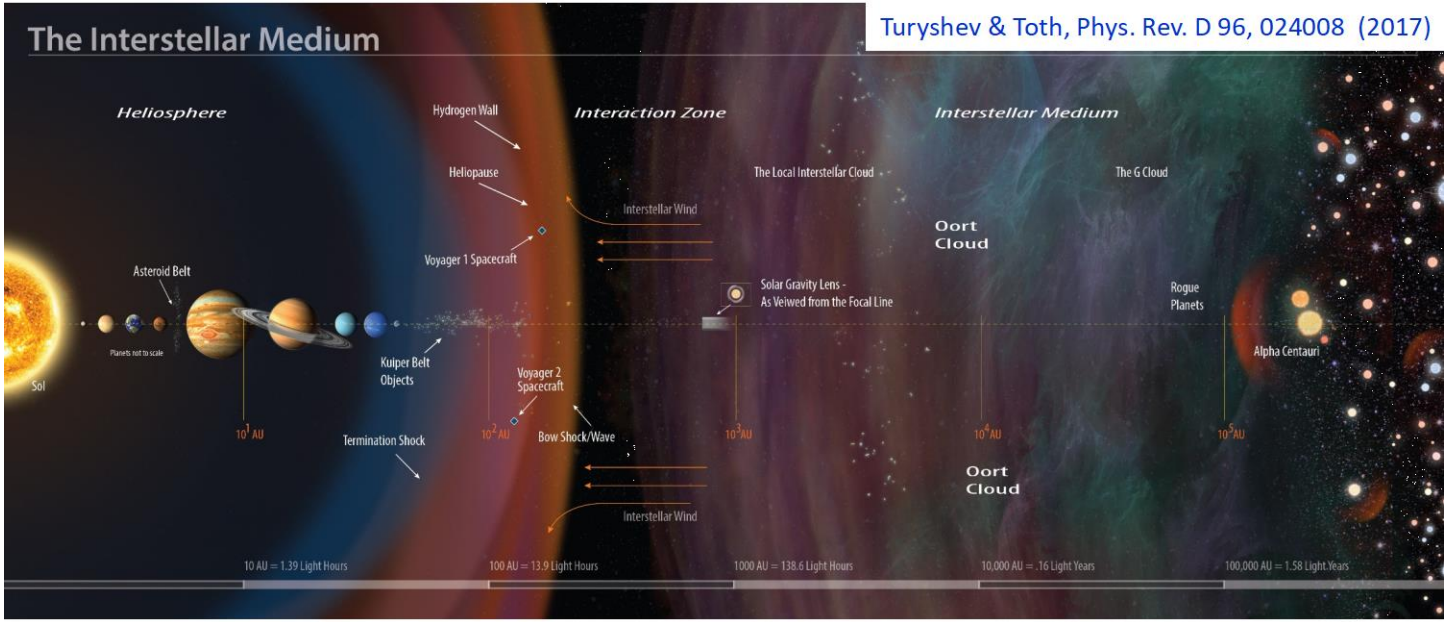
LIGHT SAILS TO THE OTHER SOLAR SYSTEM



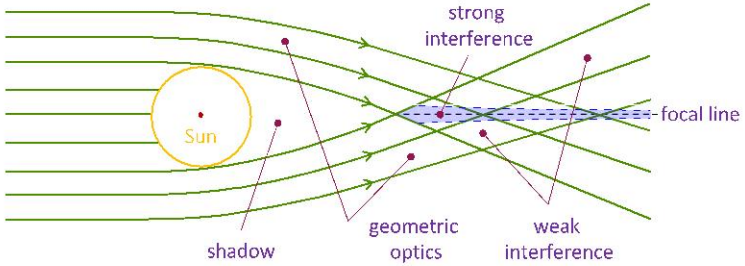


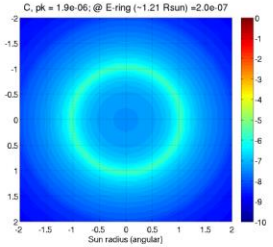
The Solar Gravitational Lens (KISS study, 2015)

Turyshev & Toth, Phys. Rev. D 96, 024008 (2017)



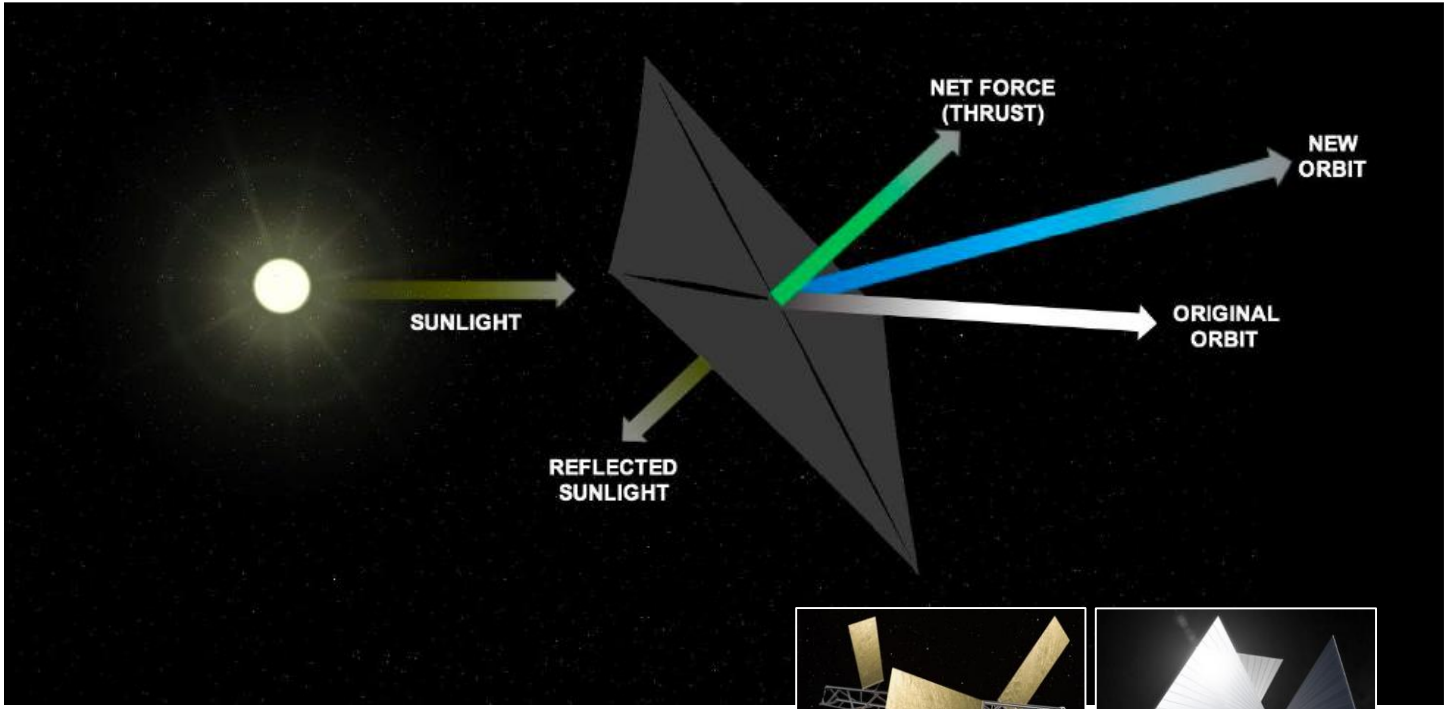
Earth-like exoplanet

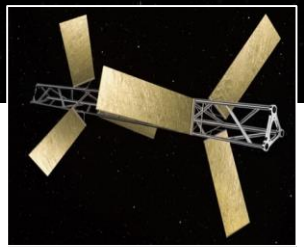


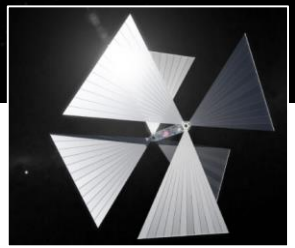


Image

Sail Dynamics and Design Parameters



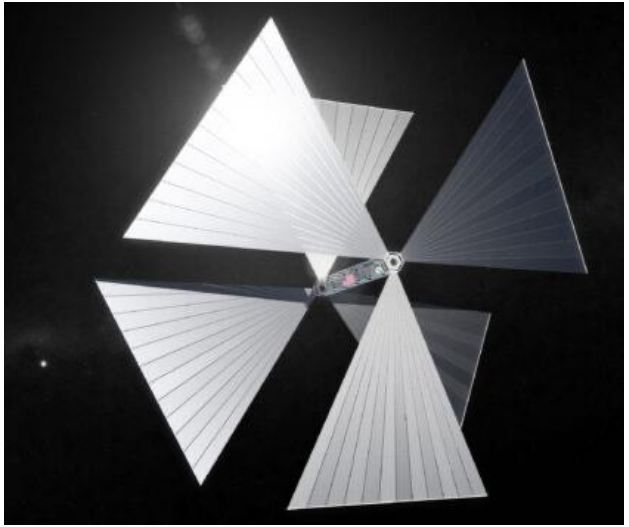




Vane technology allows for precision sailcraft navigation & attitude control

SGLF Technology Demonstration Mission

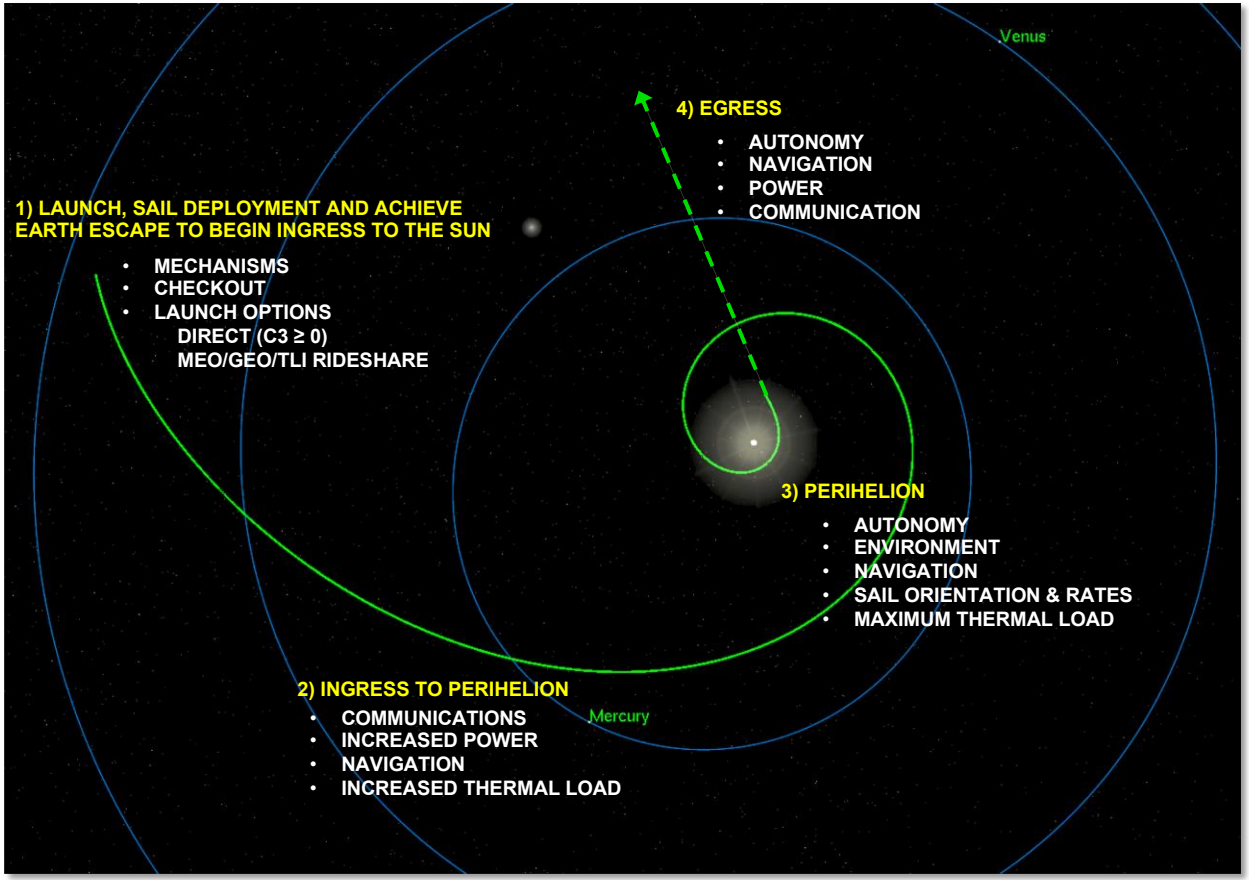
- TDM Objectives:
  - A/m ratio: > 50 m^2/kg;
  - Achieve 6-8 AU/yr exit velocity;
  - Survive perihelion of 0.2 AU;
  - Low Cost & Manufacturable;
  - Capabilities-based, no development;
  - Rideshare compatible.
- TDM study point of departure:
  - A/m: 22.3 m^2/kg (3x NEA Scout);
  - Six 20-m^2 vanes:
    (775 g per vane, 5-! m Kapton);
  - Carbon fiber truss (120g).



- Avionics & GNC leverages MARCO
  - 500 g for UHF SDR, 3 wheels, 2 star-trackers, battery;
  - 100 g for shape memory motors.
- Total mass: 5.37 kg
  - 86% of mass is in vanes.

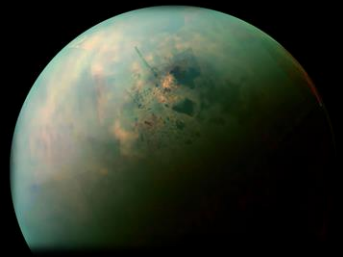
Our effort increases the current A/m ratios by at least a factor of 2

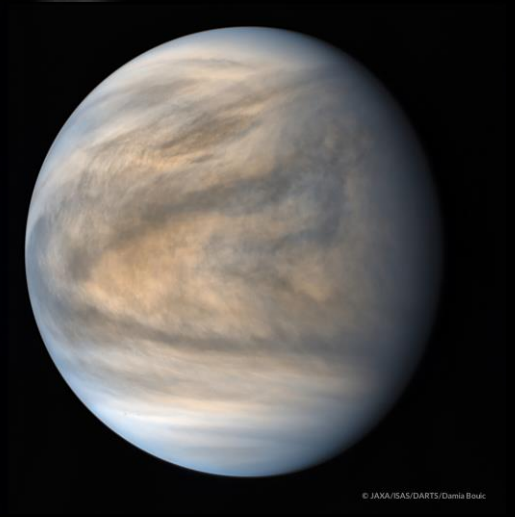
Technical Demonstration Mission PHASES



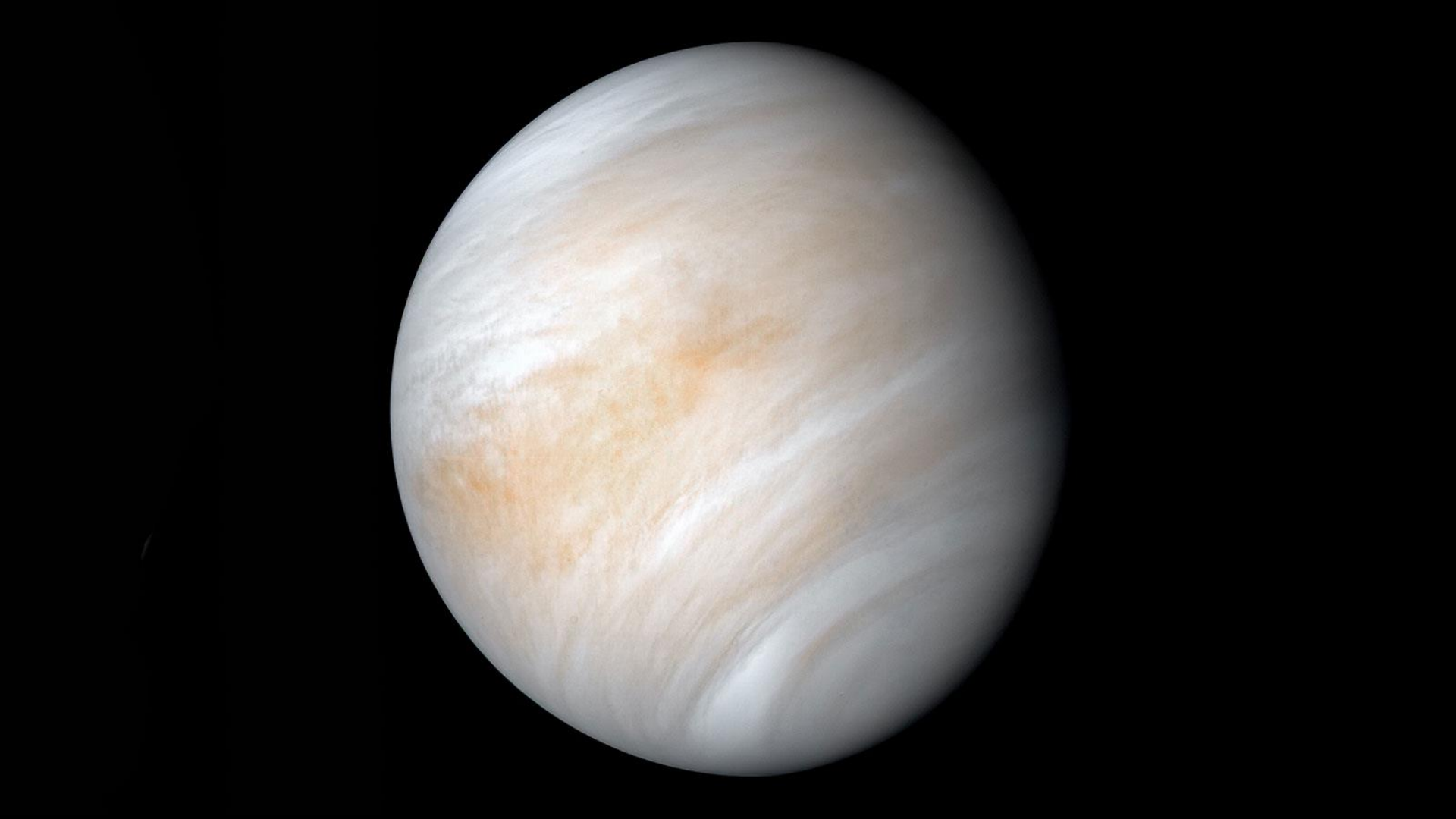
LightCraft 1:3 model at Xplore

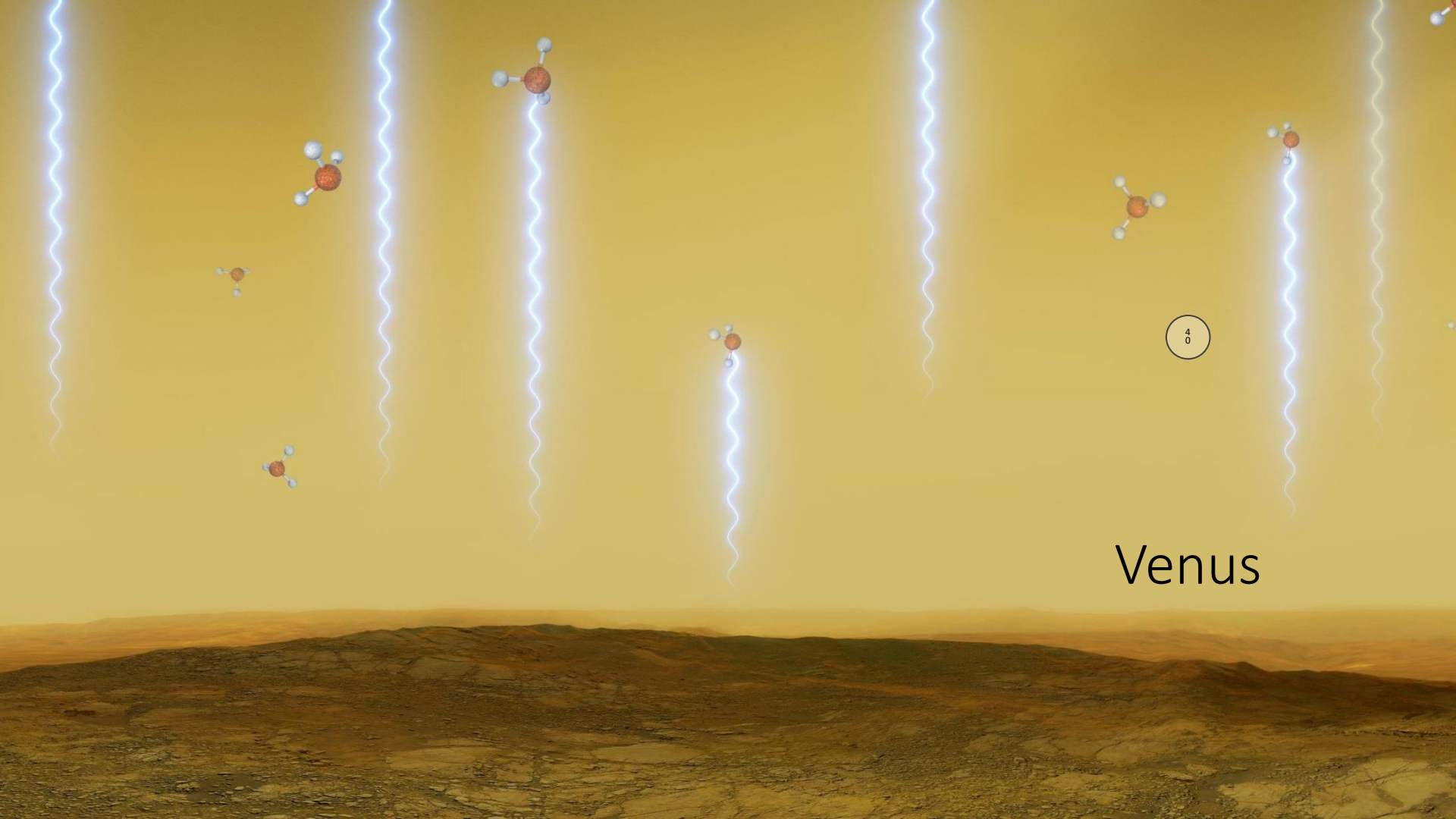
WHERE (ELSE) IS THERE LIFE IN OUR SOLAR SYSTEM?





ENCELADUS?
EUROPA?
TITAN?
VENUS?
MARS?




40
Venus


ROCKET LAB LTD