ARIZONA FORGE

Aerospace Update
University of Arizona, Feb 2022

Stephen Fleming
Executive in Residence
@stephenfleming

Who Am I?

Since 2017: University of Arizona.
Founder, Arizona Space Business Roundtable.

Earlier: Georgia Tech, venture capitalist, telecom executive, and lifetime space enthusiast.

Angel investor in **multiple space startups** since 2000.

Who Am I?

Stephen Fleming
1990

The Washington Post FRIDAY, OCTOBER 12, 1990

Go Get An Asteroid

I am concerned by the tone of Jessica Tuchman Mathews's op-ed piece last week, "The Mars Extravaganza" {Oct. 5}. I am not going to debate whether sending Americans to the Moon and Mars is wise or affordable under current budget restraints. I am not going to deny that there are numerous challenges facing our environment (pollution, deforestation, extinctions, etc.), as Mrs. Mathews points out. But Mrs. Mathews falls into the environmentalist trap of asking, "Why should we spend all that money on space when there are so many problems here on Earth?"

The right question to ask is, "How can we best spend money to solve these problems here on Earth?" The surprising answer is: in space. Only through space-based observations can we understand what's happening to this planet. More important, only through space-based industry can we halt and reverse the trends threatening our environment.

Are messy industrial processes threatening groundwater supplies? Move the industries to orbit and send down only the finished goods. Is open-pit mining erasing huge tracts of wilderness? Go get an asteroid, which contains far more nickel, iron and other metals than humanity has mined to date. Are burning fossil fuels polluting the atmosphere and contributing to CO2 buildup? Put solar power stations in orbit and beam down limitless quantities of safe, clean, unpolluting energy. Are Third World children dying from disease for lack of medicine? Build a pharmaceutical factory in the microgravity of orbit, where we can make life-saving drugs for a tiny fraction of the cost of Earth-based processes.

These activities, and hundreds more, do not require a trip to Mars, but they cannot be carried out by machines. Only the intelligence and flexibility of men and women in orbit can break the grip of Earth's gravity and bring the bounty of space to all mankind.

America knows how to carry out these activities quickly, safely and economically. So do Japan, the Soviet Union and the Europeans. But we are hobbled by NASA, a bureaucracy beholden to its unreliable and obsolete Shuttle, its bloated Space Station Freedom and a host of other constituencies. If private industry were encouraged to begin the commercial and profitable use of space without the 1,001 regulations enforced by our government, then we could see astonishing gains in space technology-and in the benefits of space for the first, second and third worlds-by the end of the decade.

A vigorous and independent space program could be the best friend of the entire environmental movement. I encourage Mrs. Mathews to explore its potential benefits for the problems she deplores; she shouldn't throw out this baby industry with NASA's dirty bath water.

STEPHEN FLEMING

Metals, Mining, Materials, and Resources

Extracting materials from the Moon, asteroids, and other objects in the solar system.

Converting them into useful forms for use in space.

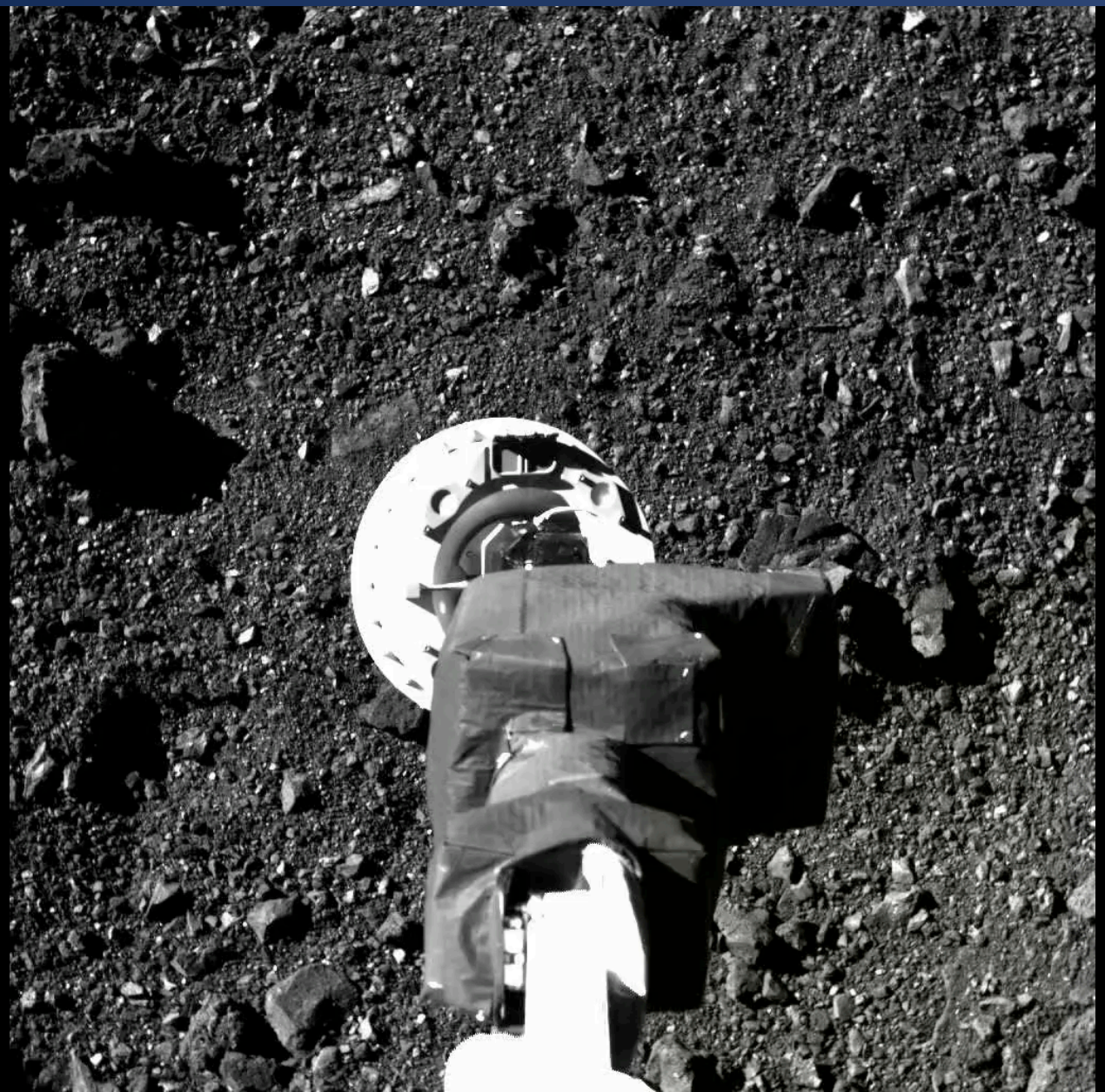
Maybe bringing some of them back to Earth *(platinum)*…

Deloitte.

Space Resource Development

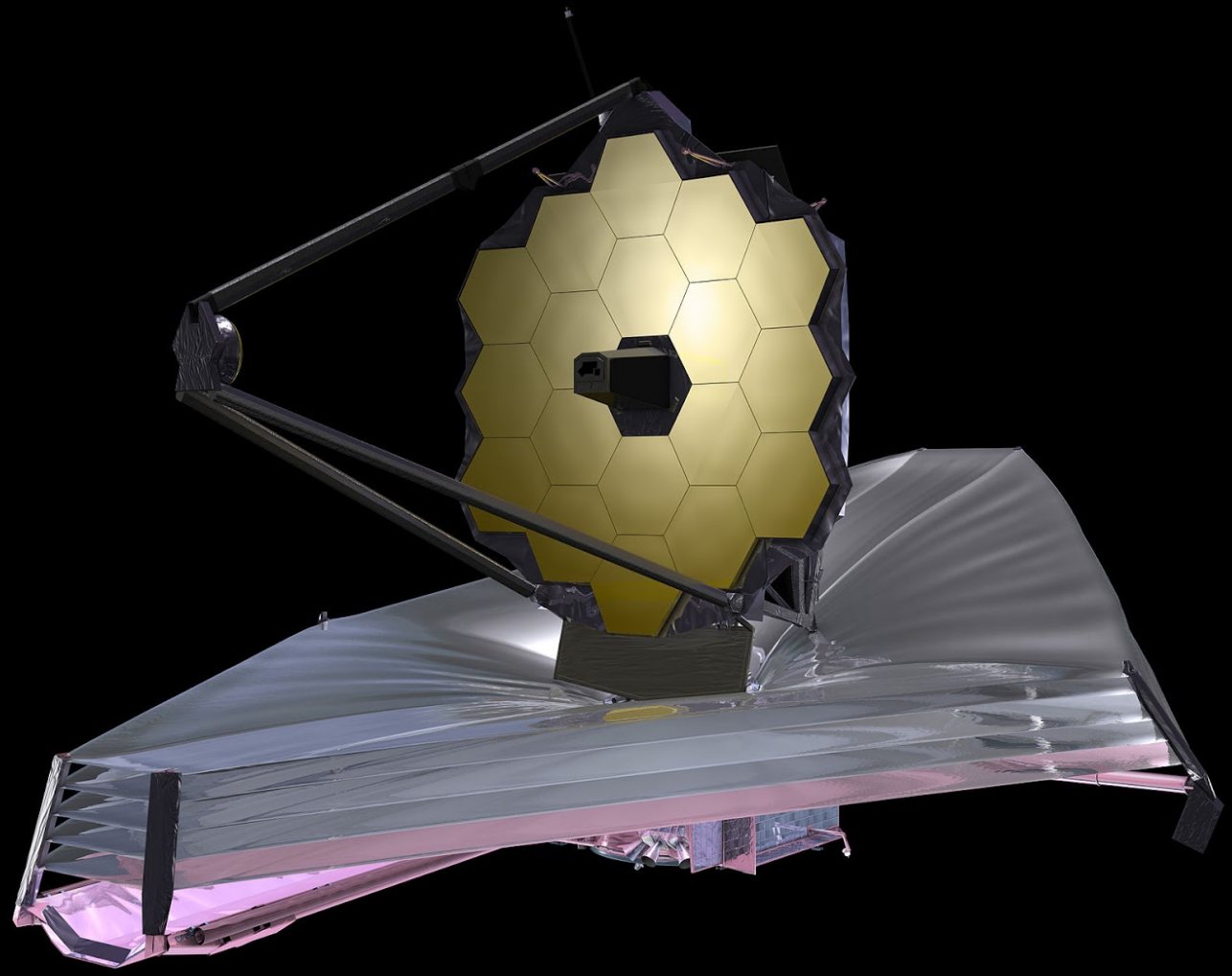
Space Resource Development

OSIRIS-REx Touches an Asteroid

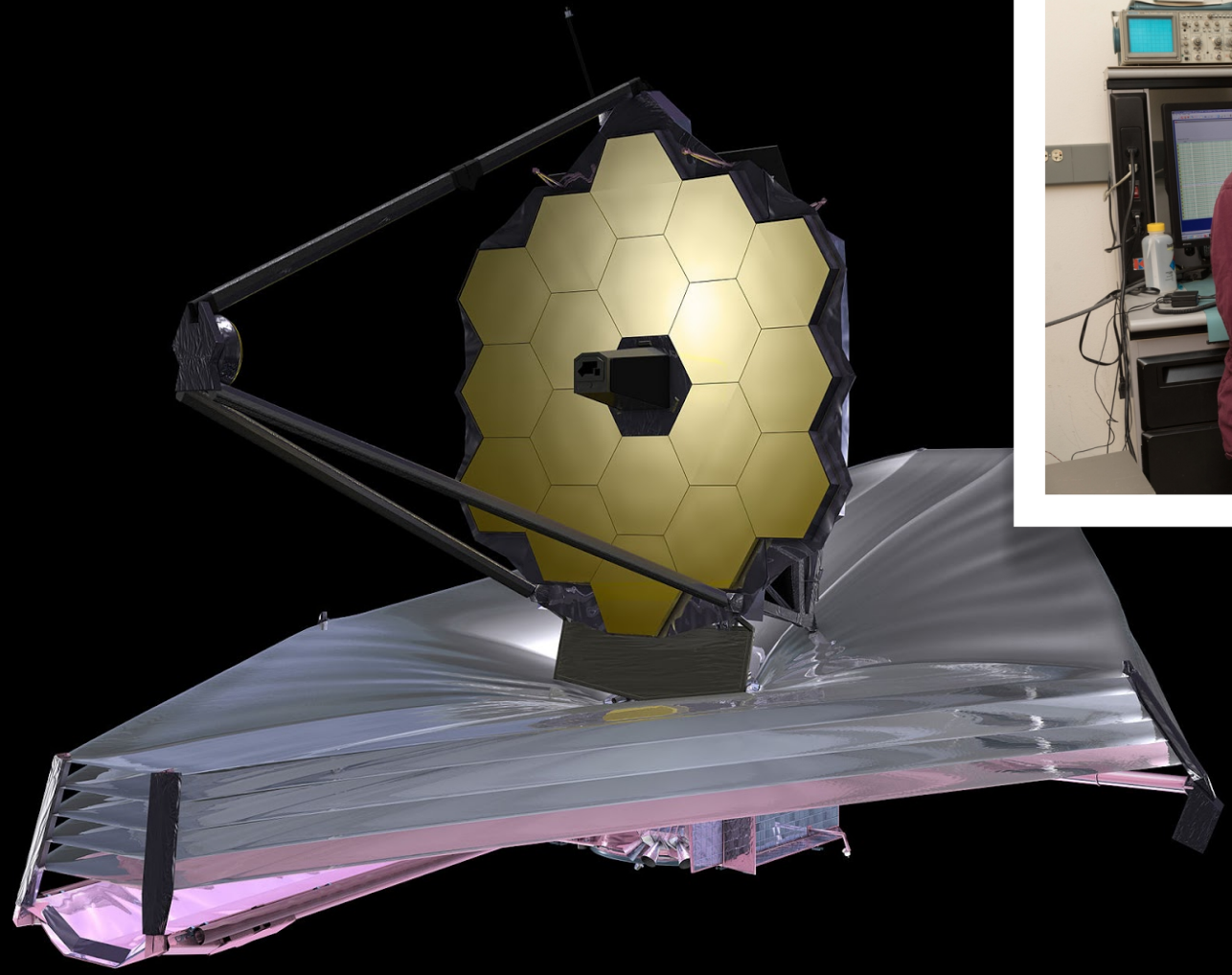


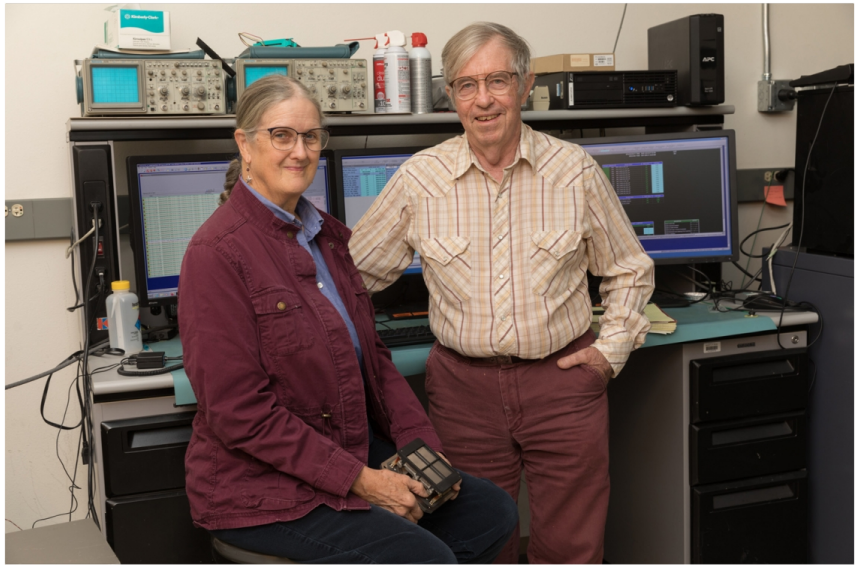
OSIRIS-REx is now homeward bound

James Webb Space Telescope Launched



James Webb Space Telescope Launched





Science Leads:
George & Martha Reike, UArizona

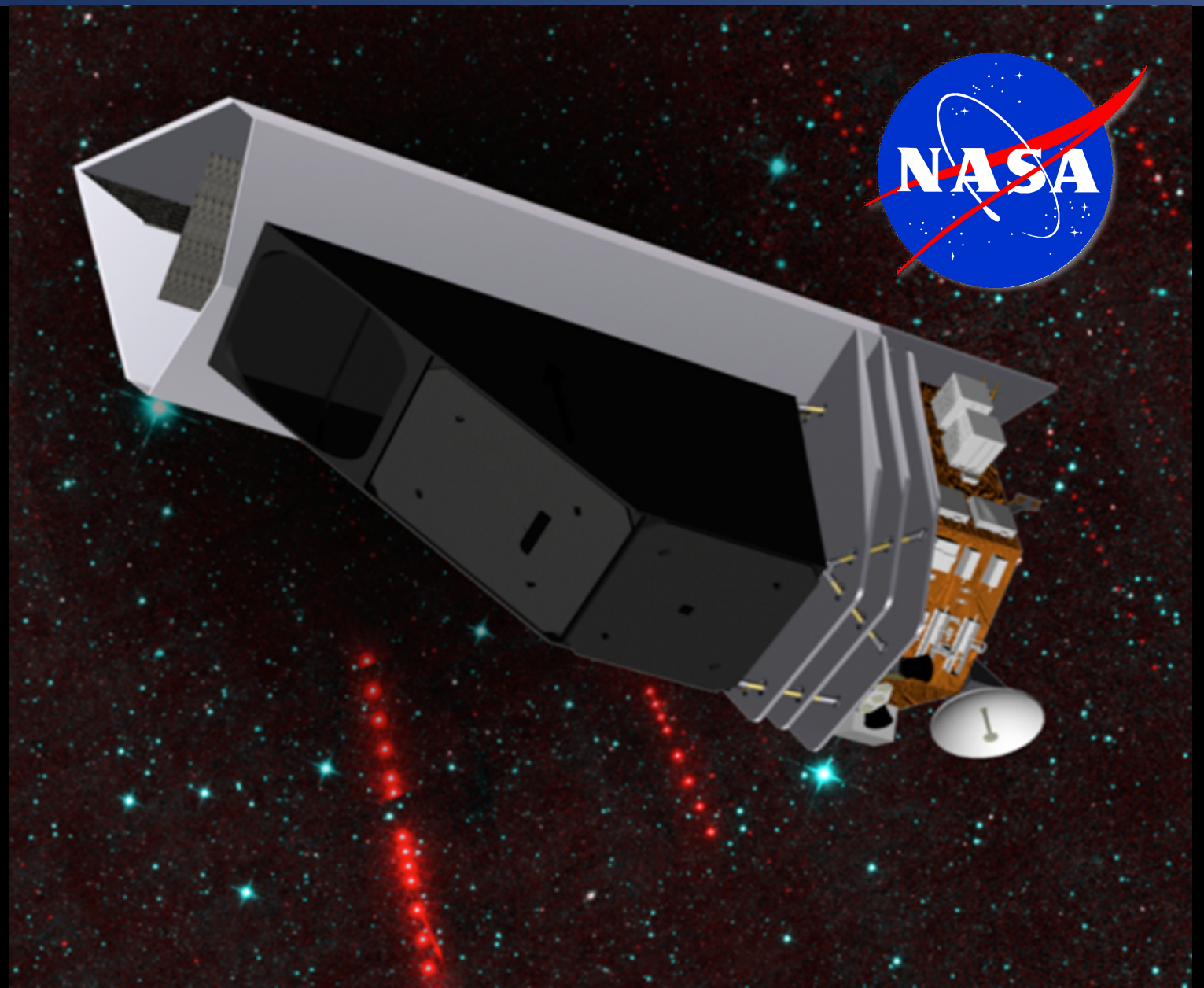
6th Mirror Cast for Giant Magellan Telescope

GMT Construction Underway in Chile

HiRISE Photographs Mars Rover Landing

NEO Surveyor in Development

Science Lead: Amy Mainzer, UA



NEO Surveyor in Development

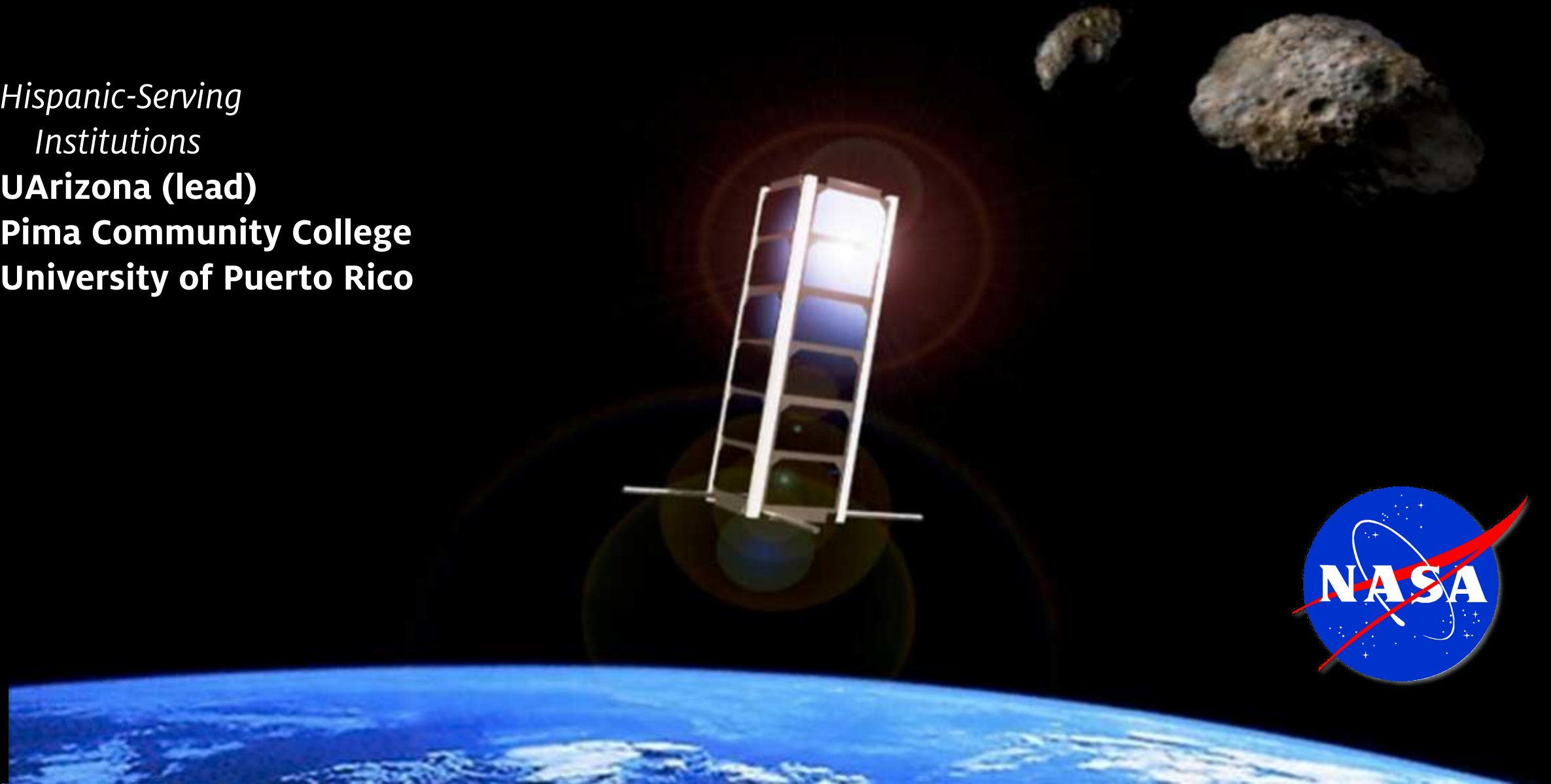
NEOcam Mission Extended

ASPERA Ultraviolet Galactic Halo Explorer

CatSats: Student-built and operated!

Hispanic-Serving Institutions

UArizona (lead)
Pima Community College
University of Puerto Rico



Capabilities for the Future:

In Development Instruments.

- Spatial Heterodyne Spectrometers: (PI Harris)
- Compact Seismometers: (PI DellaGiustina)
- Mission Cameras: (PI Rizk)
- Metabolic Imaging Camera: (PI Byrne)
- Inflatable SmallSat Antenna: (PI Walker)

Future Instrument & Project Concepts:

Submitted and In Development Missions.

- ZEPHYR: Earth Venture (PI Russell)
- Chimera: Discovery (PI Harris)
- IVO: Discovery (PI McEwen)
- OASIS: Midex (PI Walker)
- Hyperion: Midex (PI Hamden)
- Explorer Earth Observer: Midex (PI Zeng)
- SHIELDS: SMEX Mission of Opportunity (PI Corliss)
- Inflatable SmallSat Antenna: (PI Walker)
- NASA Balloon Operations Contract: (PI Bailey)

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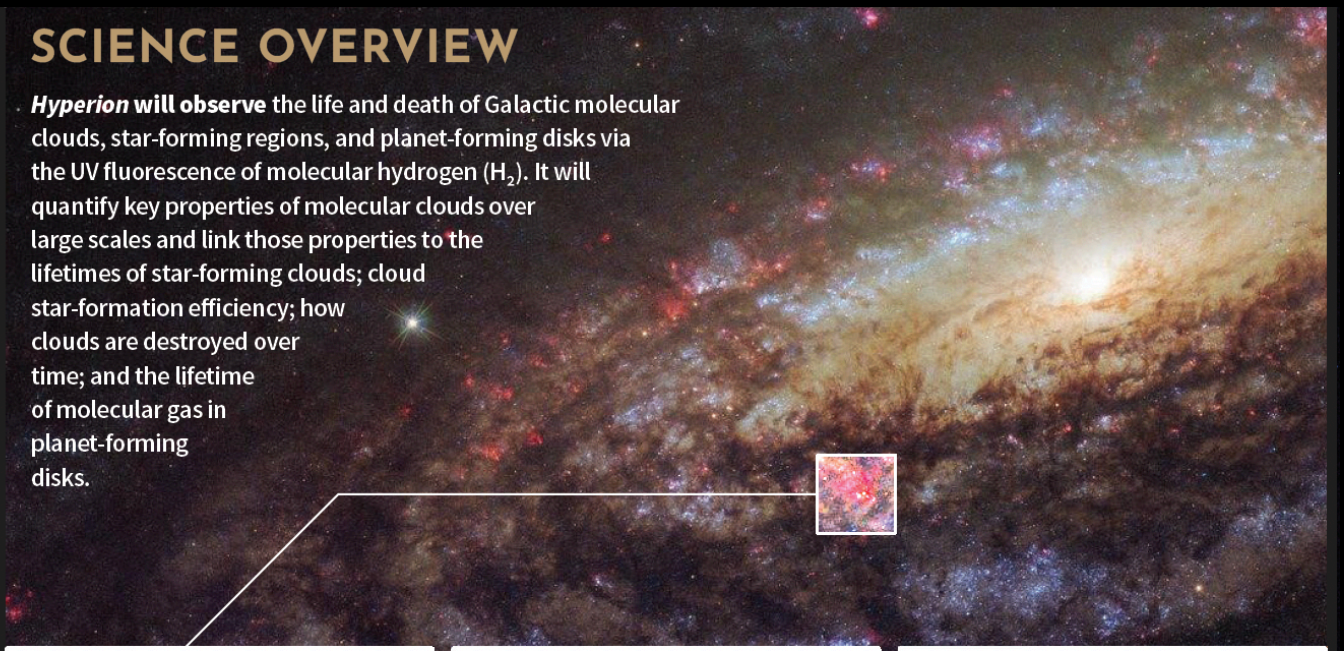
Hyperion: A NASA MIDEX concept FUV Spectrograph
PI: Prof. Erika Hamden

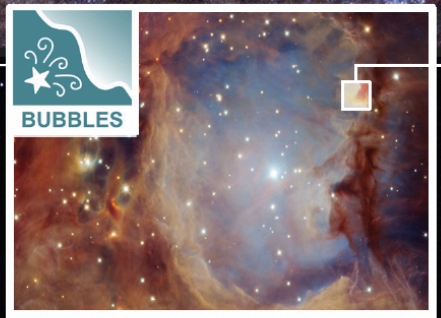
HYPERION
THE ORIGIN OF THE STARS

SCIENCE OVERVIEW

***Hyperion* will observe** the life and death of Galactic molecular clouds, star-forming regions, and planet-forming disks via the UV fluorescence of molecular hydrogen (H_2). It will quantify key properties of molecular clouds over large scales and link those properties to the lifetimes of star-forming clouds; cloud star-formation efficiency; how clouds are destroyed over time; and the lifetime of molecular gas in planet-forming disks.



FORMATION
Hyperion determines the rates of production and destruction of star forming material, molecular hydrogen.



FEEDBACK
Hyperion determines how energy from massive stars sculpts star-forming regions and galaxies.

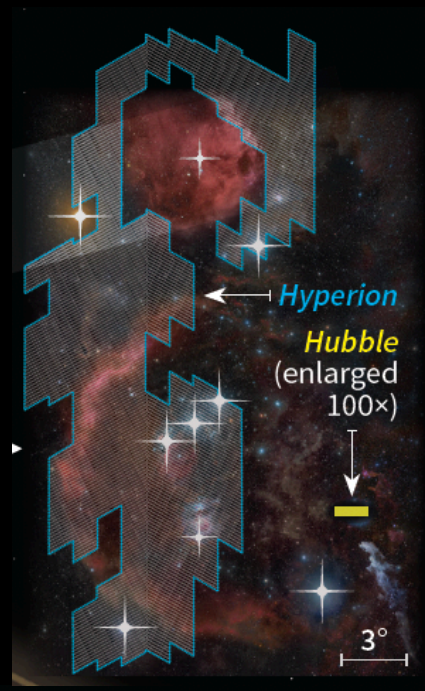
DISK DISPERSAL
Hyperion determines how planet-forming disks are stripped of material by their central stars and by their environments.

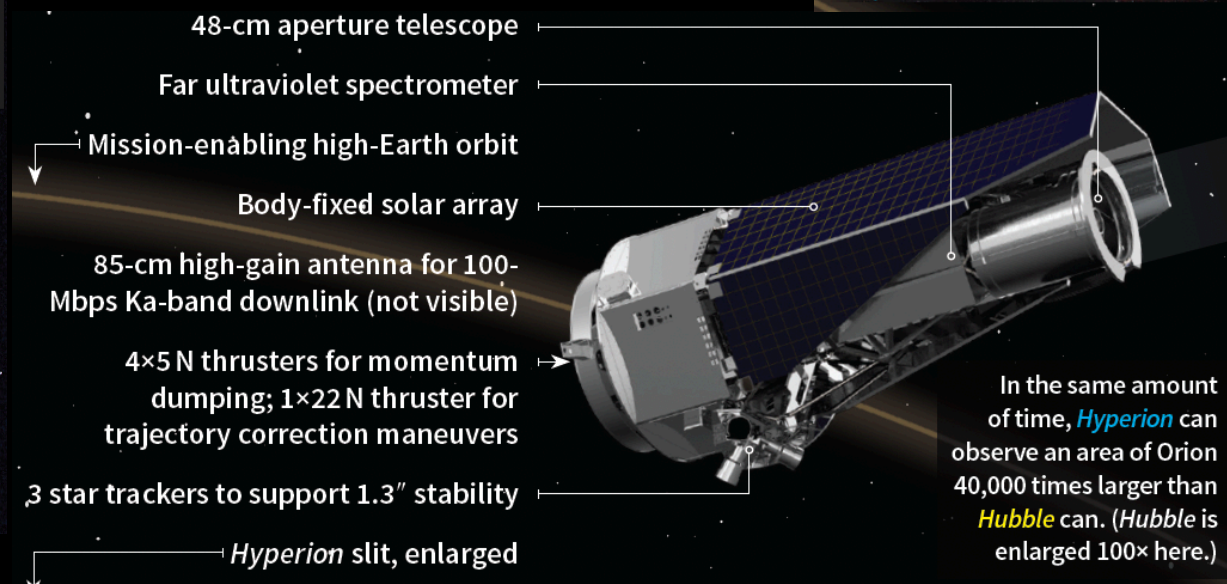
Proposed to NASA in Dec 2021

Budget: $300 Million

Technical team:
University of Arizona
JPL
Ball Aerospace

Science team members: UA, Columbia, JPL, Iowa, Rutgers, TMU, ANY, UCSC, Maryland, KASI, QMU





In the same amount of time, *Hyperion* can observe an area of Orion 40,000 times larger than *Hubble* can. (*Hubble* is enlarged 100× here.)

GUSTO Stratospheric Observatory

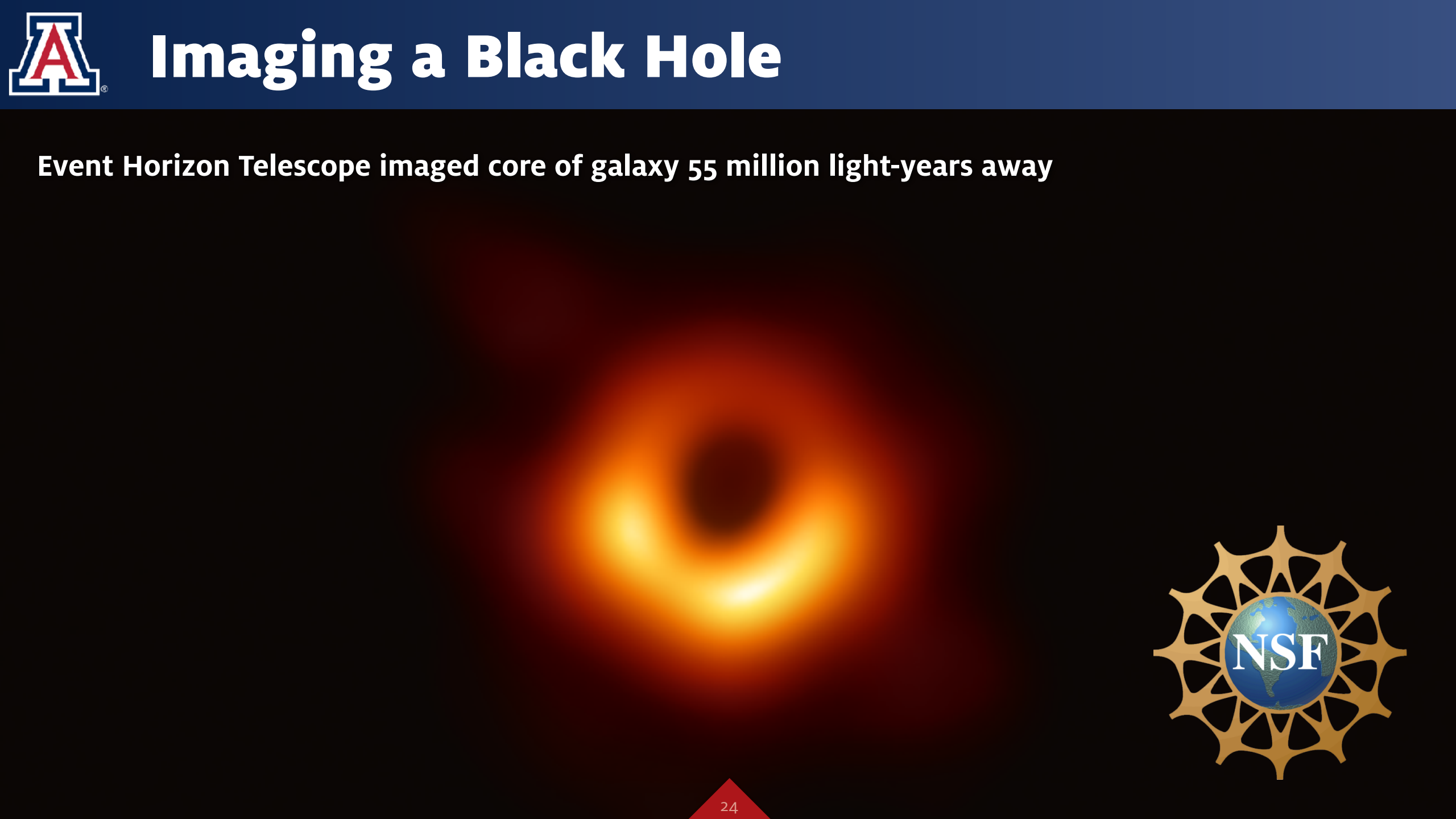
Studying interstellar space from 17 miles above the atmosphere

Applied Research Building

New thermal vacuum chamber will support satellite/space probe integration & testing

Imaging a Black Hole

Event Horizon Telescope imaged core of galaxy 55 million light-years away



Top-Ranked Astronomy Program

#1 in Astronomy and Astrophysics expenditures each year since 1998!

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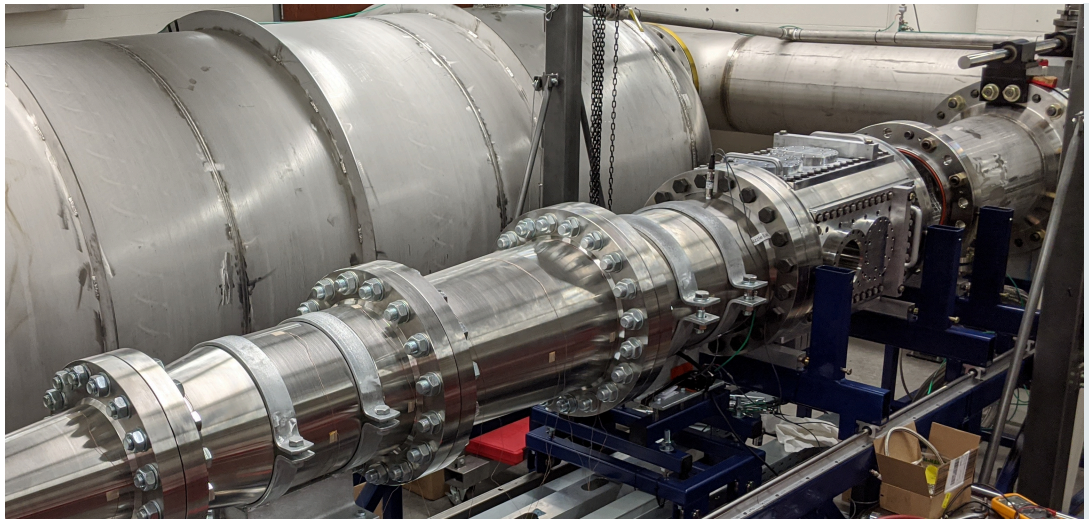
SAM Mars Analog at Biosphere 2

LT5 and ASWT wind tunnels – Current status



Mach 5 Ludwieg Tube (LT5)

PI: Craig (sacraig@arizona.edu)

- Operational as of Jan. 2021
- Approved for restricted access testing
- 15” diameter test section
- Short-duration, low-disturbance free stream
- Quiet nozzle in fabrication stage

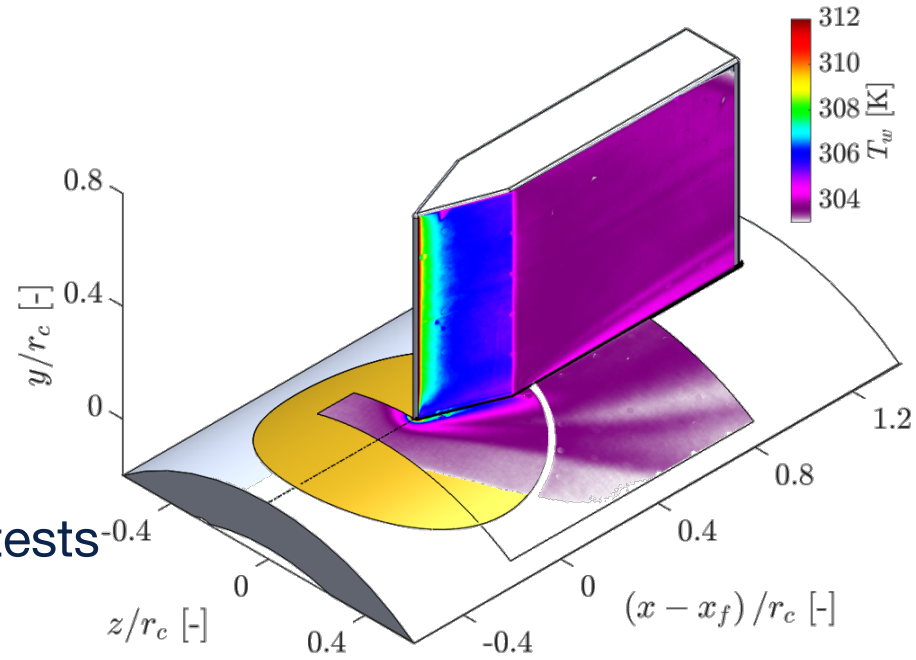
Arizona Supersonic Wind Tunnel (ASWT)

PI: Little (jesselittle@arizona.edu)

- Operational March 2022
- 15” by 15” test section
- Mach 1.75—4.0
- Long-duration conventional operation
- Previously a production tunnel at GASL in NY

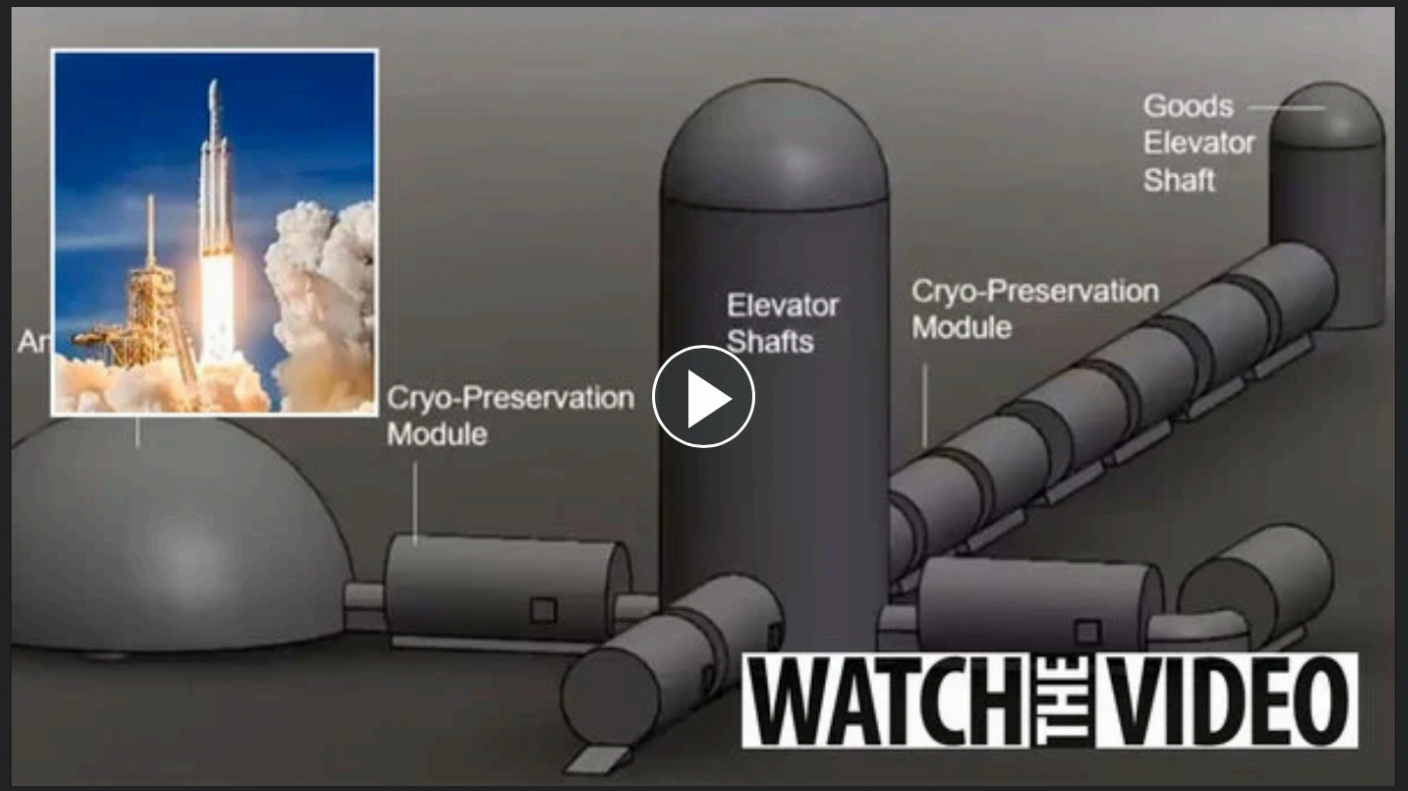
Key impacts

- New hypersonic ground test capacity
  - Nationally-unique combination of wind tunnel facilities
  - Among the largest tunnels at a US university
  - Fundamental and applied research
  - Addresses a bottleneck in national hypersonic ground tests
- Workforce development
  - Undergraduate and graduate students (approx. 25 students currently)
  - Students can graduate with security clearances
  - Students spend time on applied problems more relevant to industry
- Improved competitiveness for federal grants and contracts, industry collaboration
  - Key to two recently-awarded University Consortium for Applied Hypersonics contracts totaling $6.5M
  - Complements $6.5M infrastructure investment from DoD



Proposed: **Noah's Ark on the Moon**

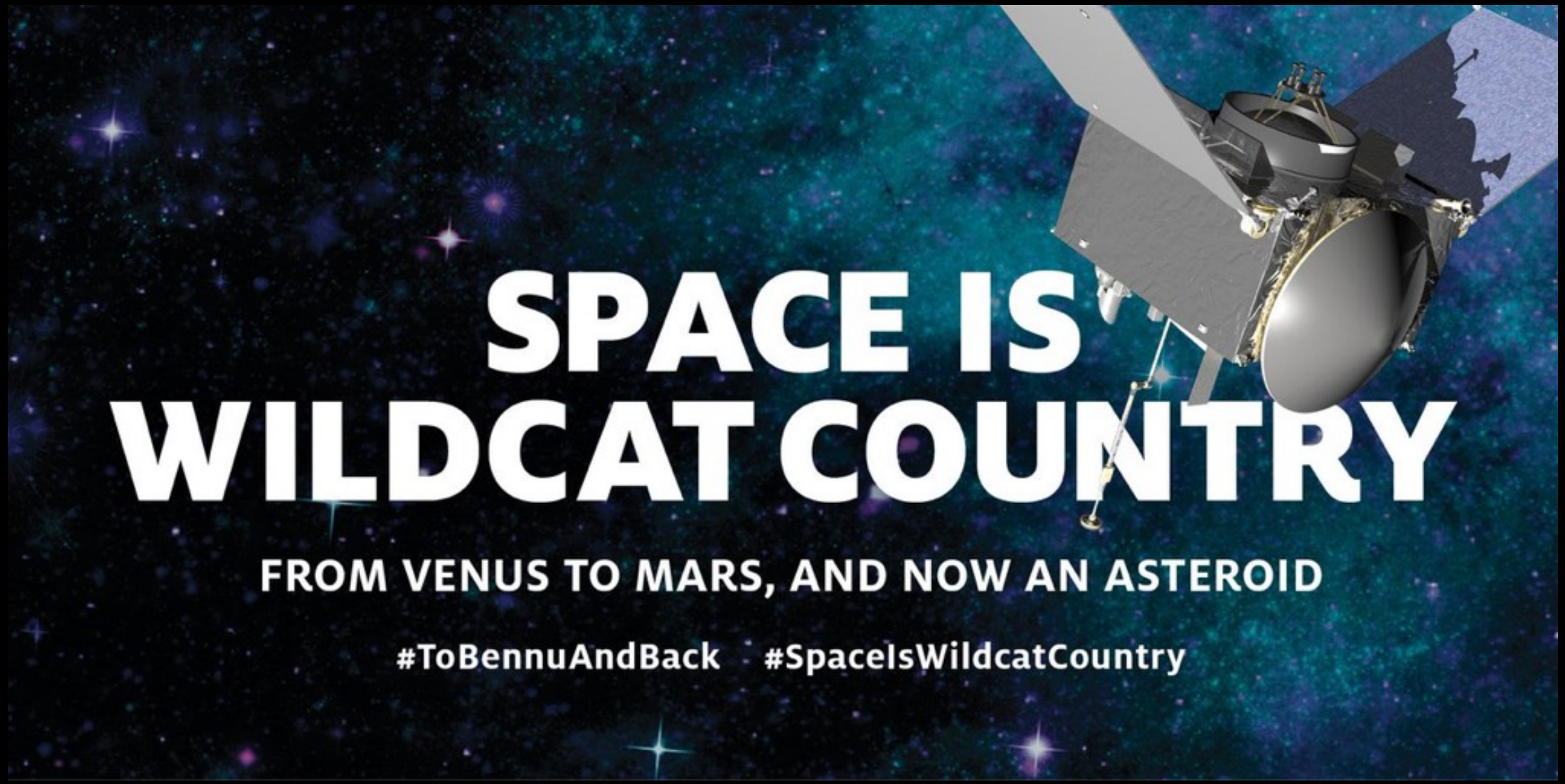
Jekan Thanga, UArizona



Tech > Science

LIFE PRESERVER Noah's Ark on the MOON will preserve 6.7million species in case Earth is destroyed – will need 250 rocket trips to build

Charlotte Edwards, Digital Technology and Science Reporter
13:24, 15 Mar 2021 | **Updated**: 21:38, 15 Mar 2021



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Thank You!

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