
AWS
re:Invent
NOV. 28 – DEC. 2, 2022 | LAS VEGAS, NV

IMP104

The next frontier: Computational deep space and ocean life exploration

Nelson Gonzalez (he/him)

Head of Global Impact Computing
Amazon Web Services

Dr. Robert Shelton

President
Giant Magellan Telescope

David Gruber

President and founder
Project CETI
Cetacean Translation Initiative

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Agenda

1. From **human in the loop** to **life in the loop**
2. Computing for social impact
3. SimTech to improve life
4. Re-centering sustainability by understanding non-human cognition
5. Deep space: simulation to enable extraterrestrial communication
6. Deep ocean: simulation to decipher whale communication

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From human in the loop



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To life in the loop



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Success and scale bring broad responsibility

We started in a garage, but we're not there anymore; we are big, we impact the world, and we are far from perfect

We must be humble and thoughtful about even the secondary effects of our actions; our local communities, planet, and future generations need us to be better every day

We must begin each day with a determination to make better, do better, and be better for our customers, our employees, our partners, **and the world at large**; and we must end every day knowing we can do even more tomorrow

Leaders create more than they consume and always leave things better than how they found them

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Computing for social computing

Help customers **improve lives** of humans, other species, and natural ecosystems through modeling, simulation, and data-rich compute solutions













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The **Amazon Sustainability Data Initiative (ASDI)** significantly reduces the **cost**, **time**, and **technical barriers** associated with analyzing large datasets to generate sustainability insights

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ASDI: Making access to data faster, cheaper, and easier

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NOAA

MAXAR

NASA

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Met Office

FINNISH METEOROLOGICAL INSTITUTE

- Climate data projections
- Weather forecasts
- Historical weather records
- Satellite imagery
- Air quality
- Water
- Energy
- Ocean forecasts
- Sea surface temperature
- Environmental indicators

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Innovation for social impact

Automating large-scale HPC runs

HPC

Data lakehouse formation	Life-in-the-loop simulation	Systems digital twins
ASDI	Energy, water, and climate simulation for policy design	National/regional economy for UN SDGs
AWS social determinants of health lake	Financial health simulation	Social determinants of health IoT for building design and engineering
AWS ESG measurement	Nuclear fusion simulation	Circular economy modeling

ML

Applying extreme edge AI/ML – responsible AI

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Innovation for social impact

Automating large-scale HPC runs

HPC

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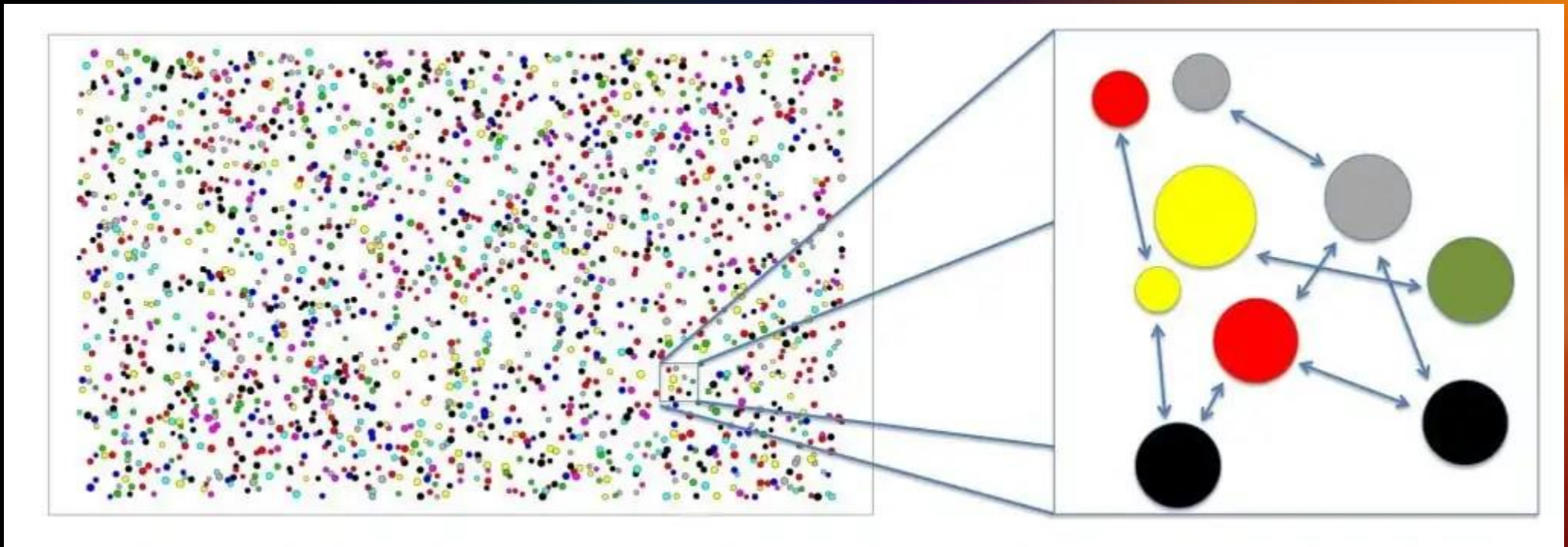
ML

Applying extreme edge AI/ML – responsible AI

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Agent/individual-based modeling



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Computational economics: Sim to improve life







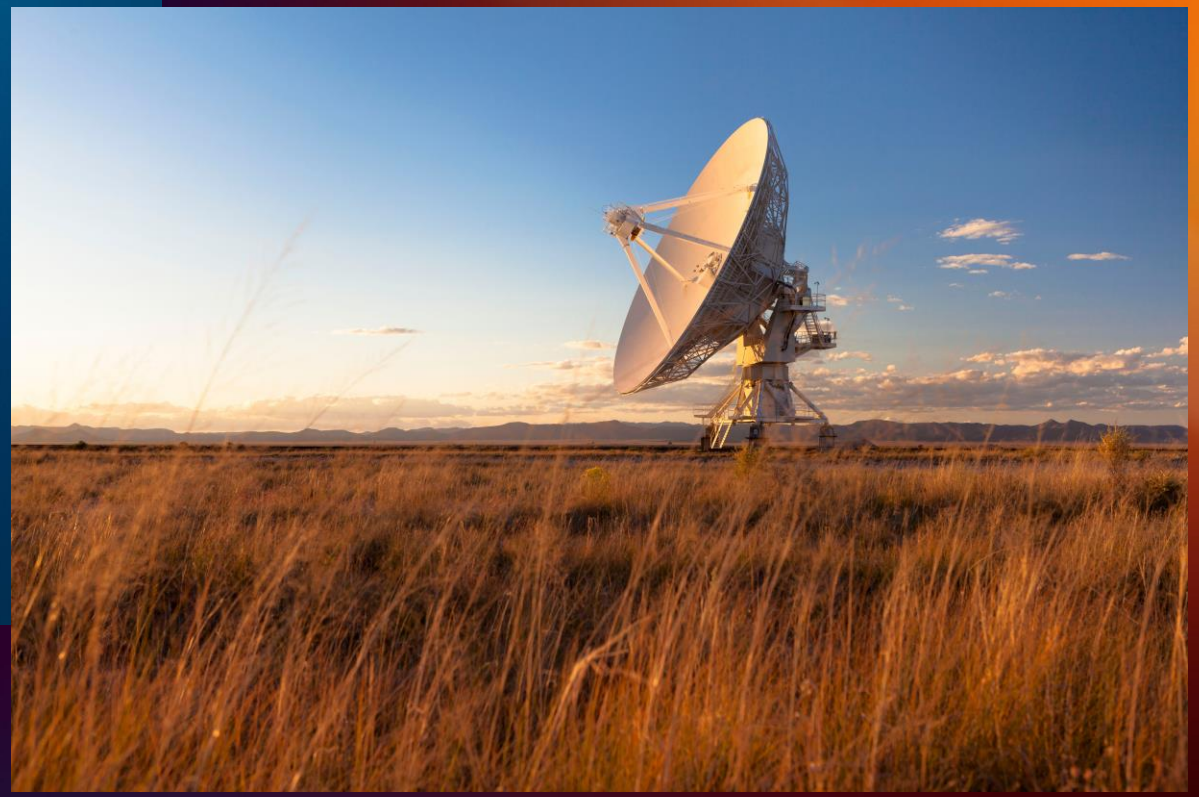




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Re-centering sustainability: Beyond humans





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ARE WE ALONE IN THE UNIVERSE?

DR. ROBERT N. SHELTON, PRESIDENT OF THE GIANT MAGELLAN TELESCOPE

GIANT MAGELLAN TELESCOPE

THE UNIVERSE AWAITS



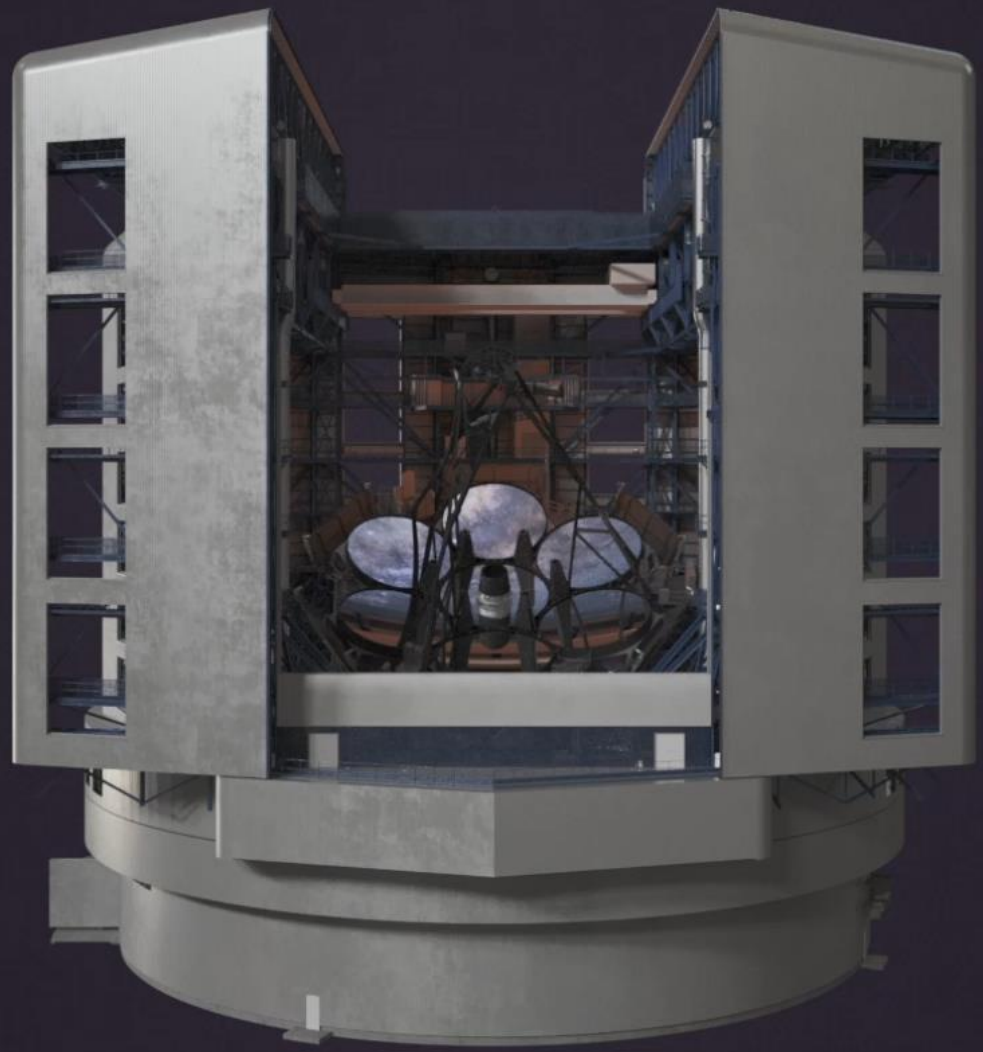
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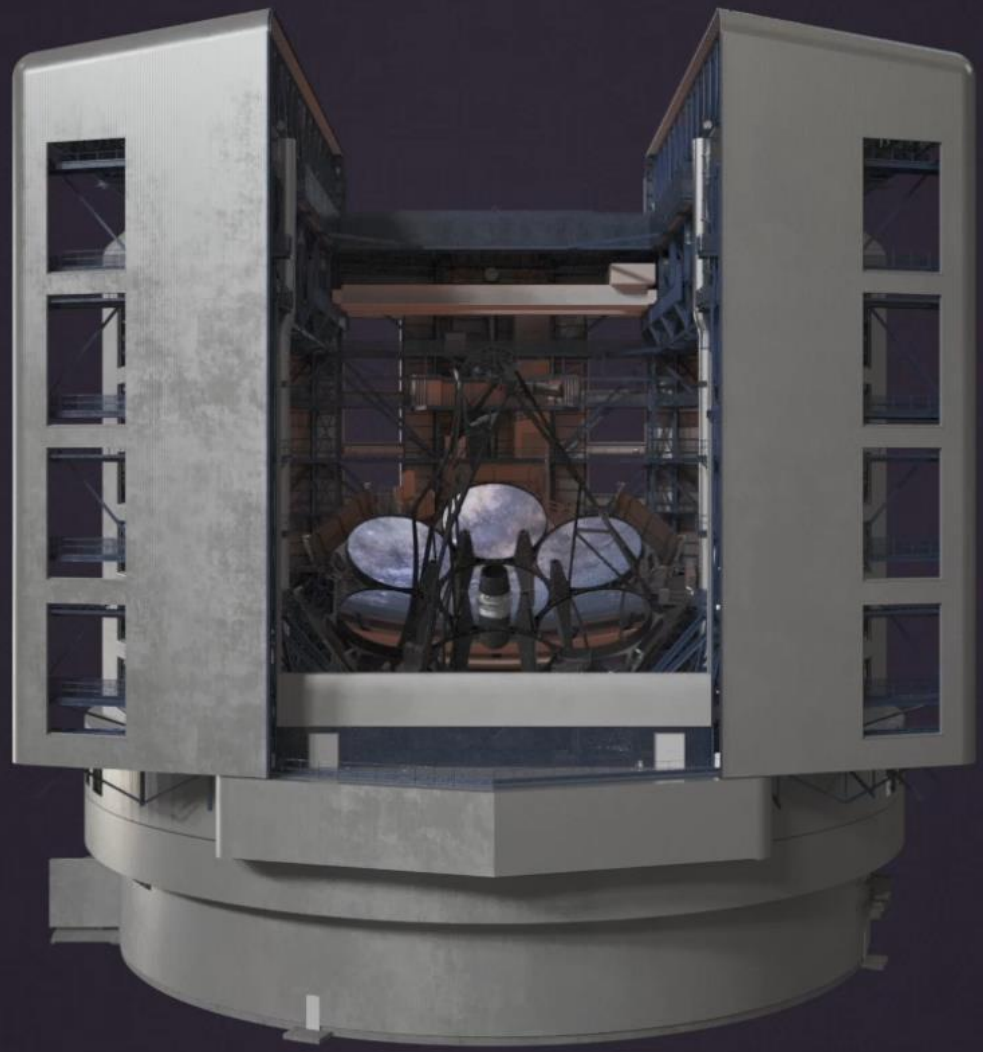
DR. ROBERT N. SHELTON, PRESIDENT OF THE GIANT MAGELLAN TELESCOPE

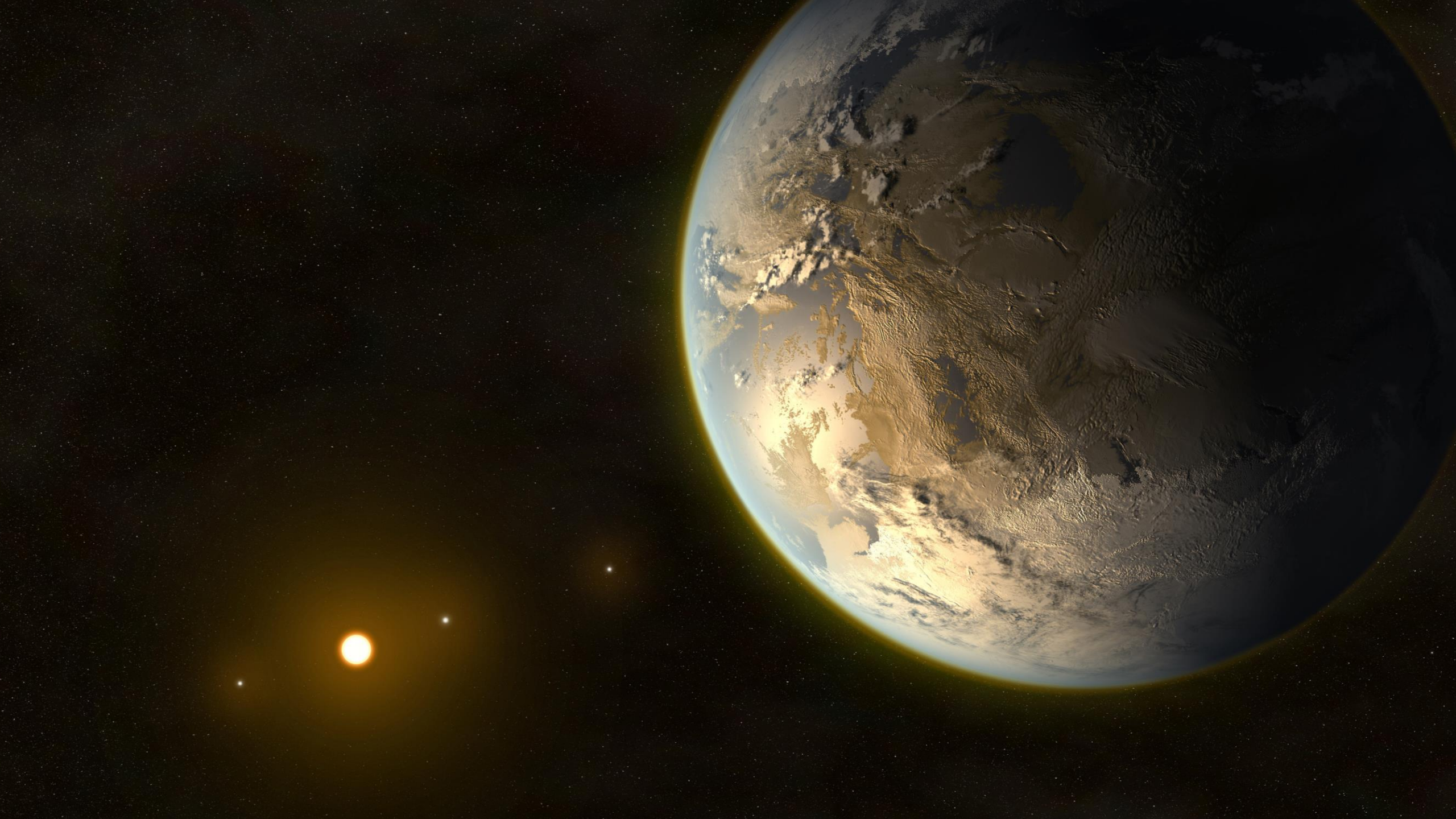
GIANT MAGELLAN TELESCOPE

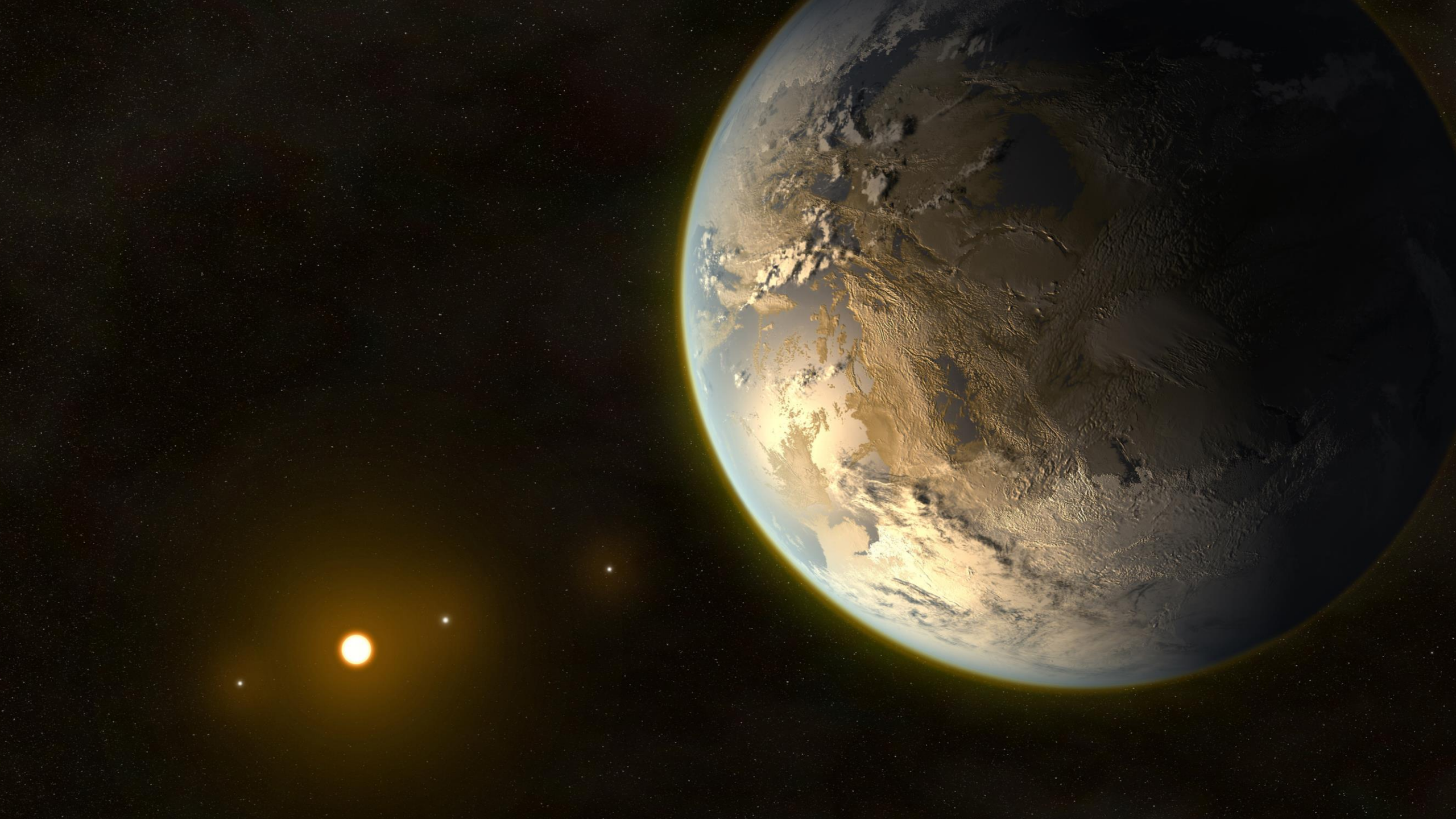
THE UNIVERSE AWAITS

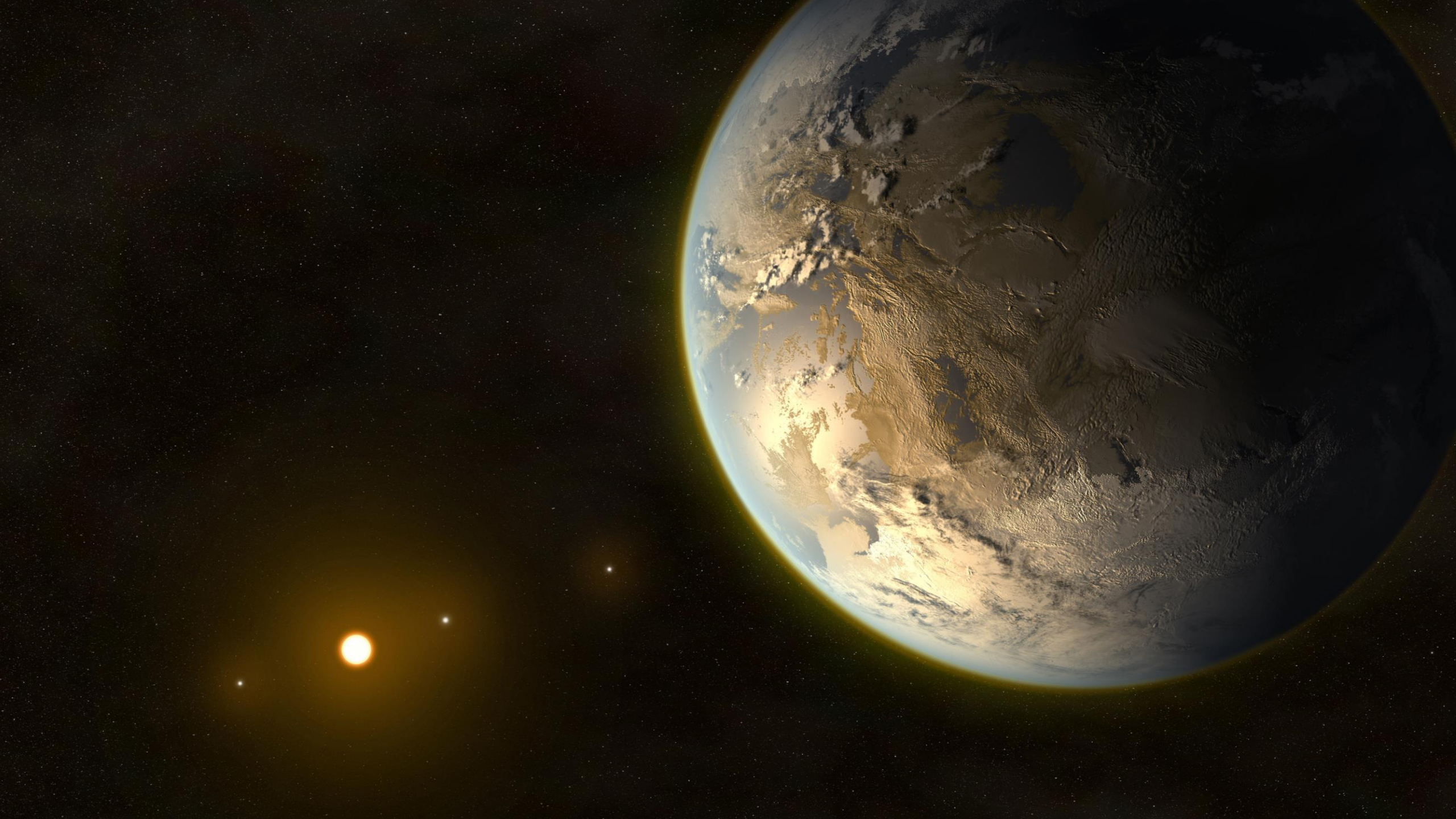


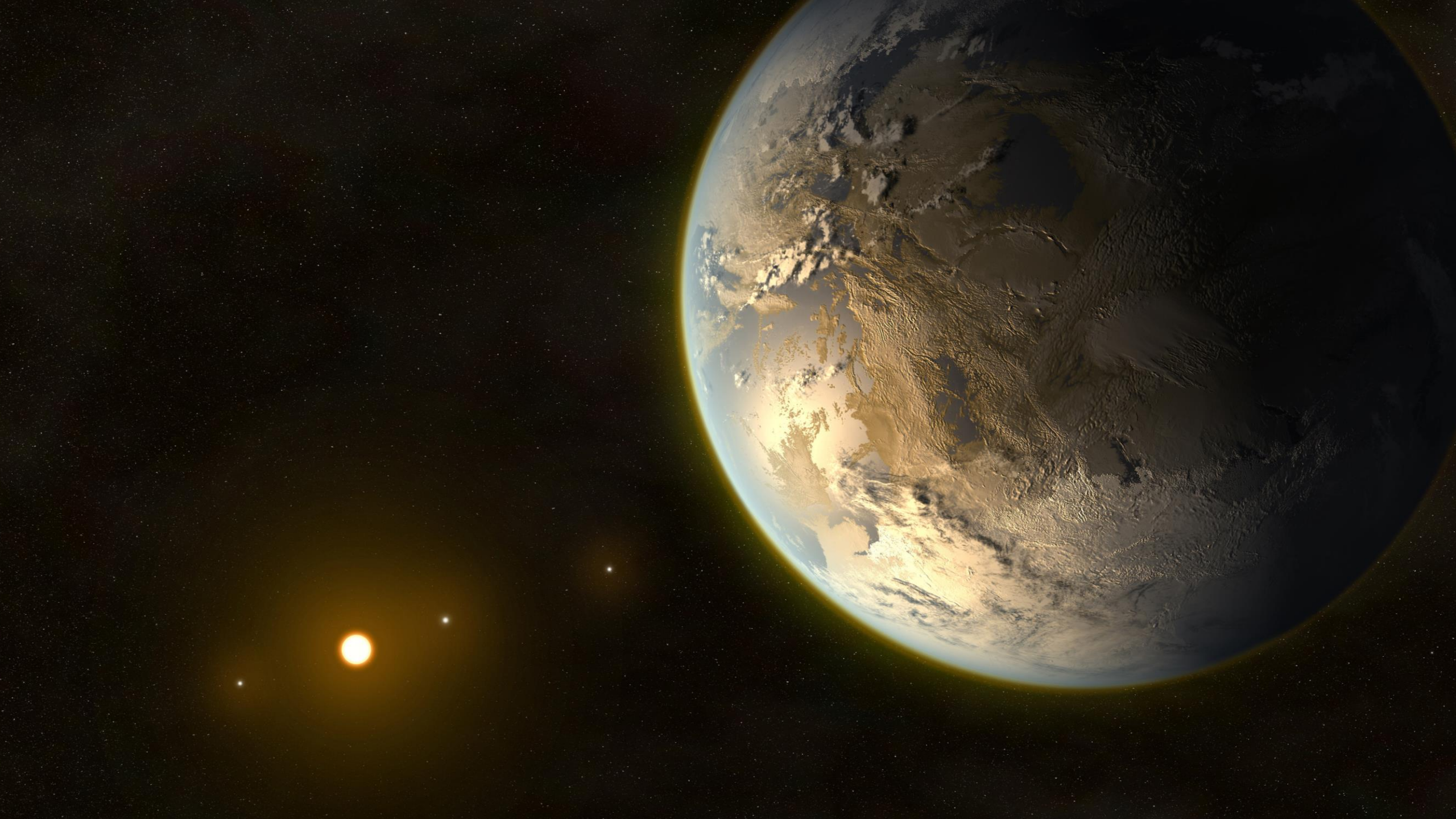


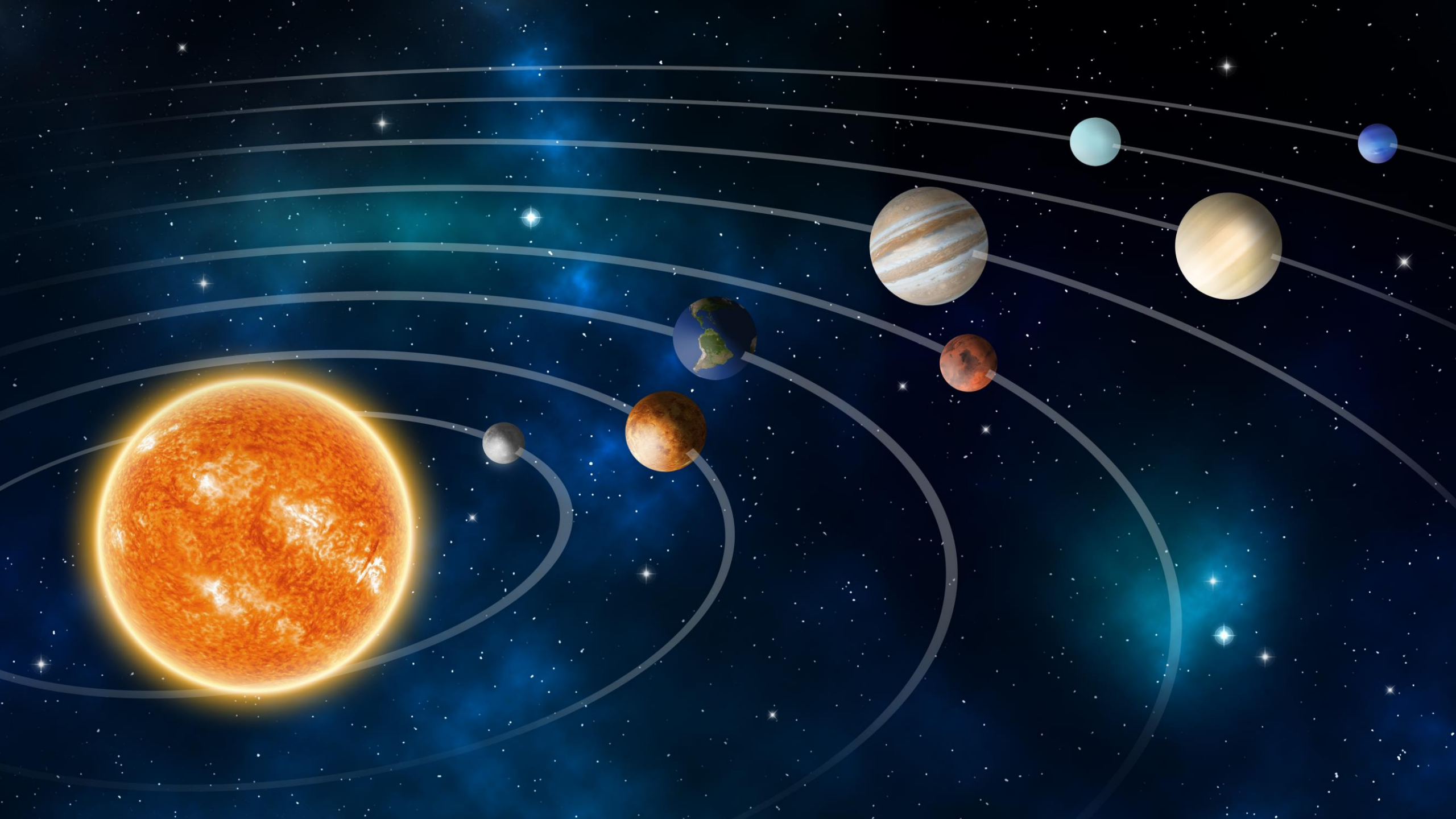


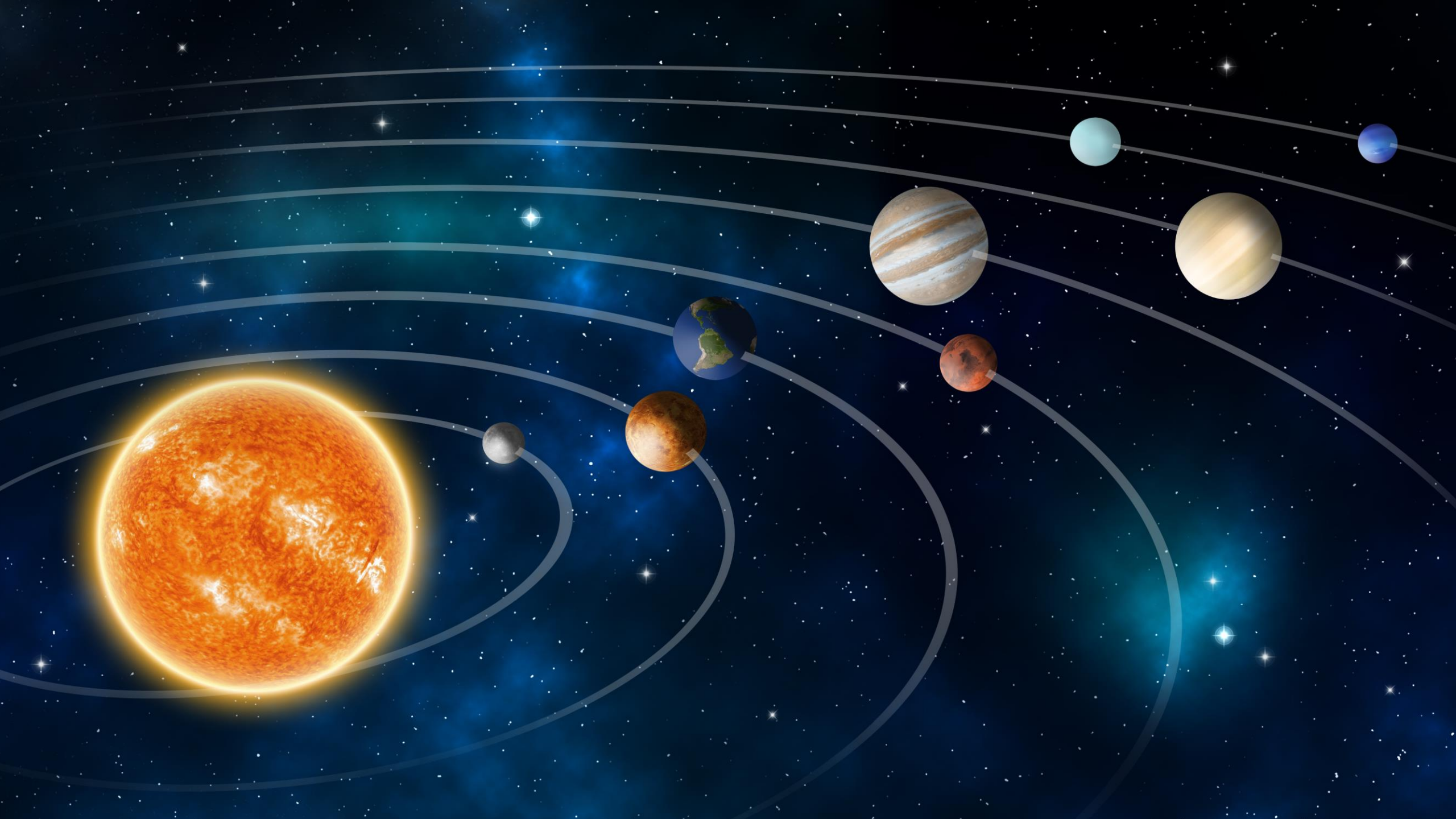


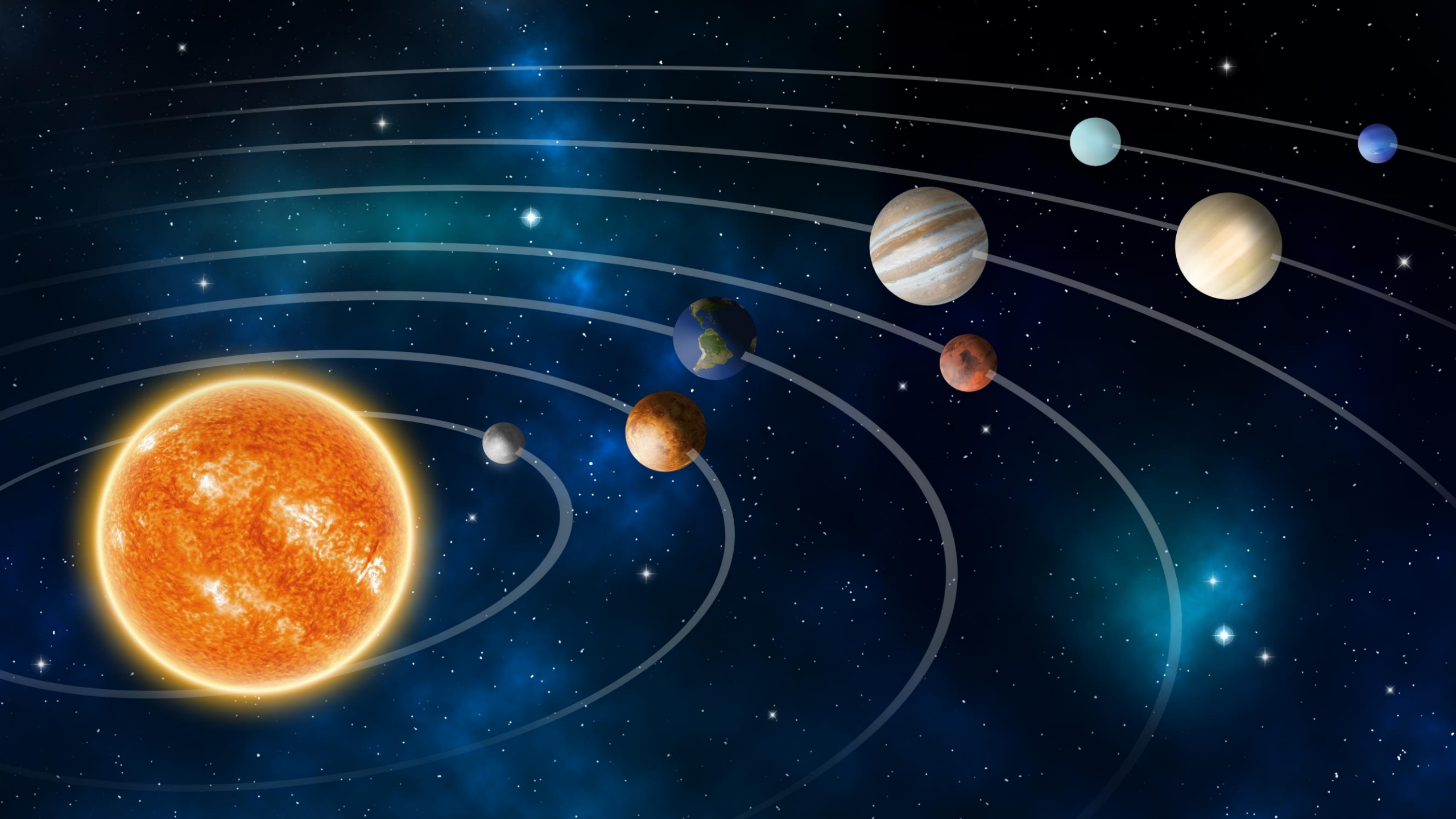


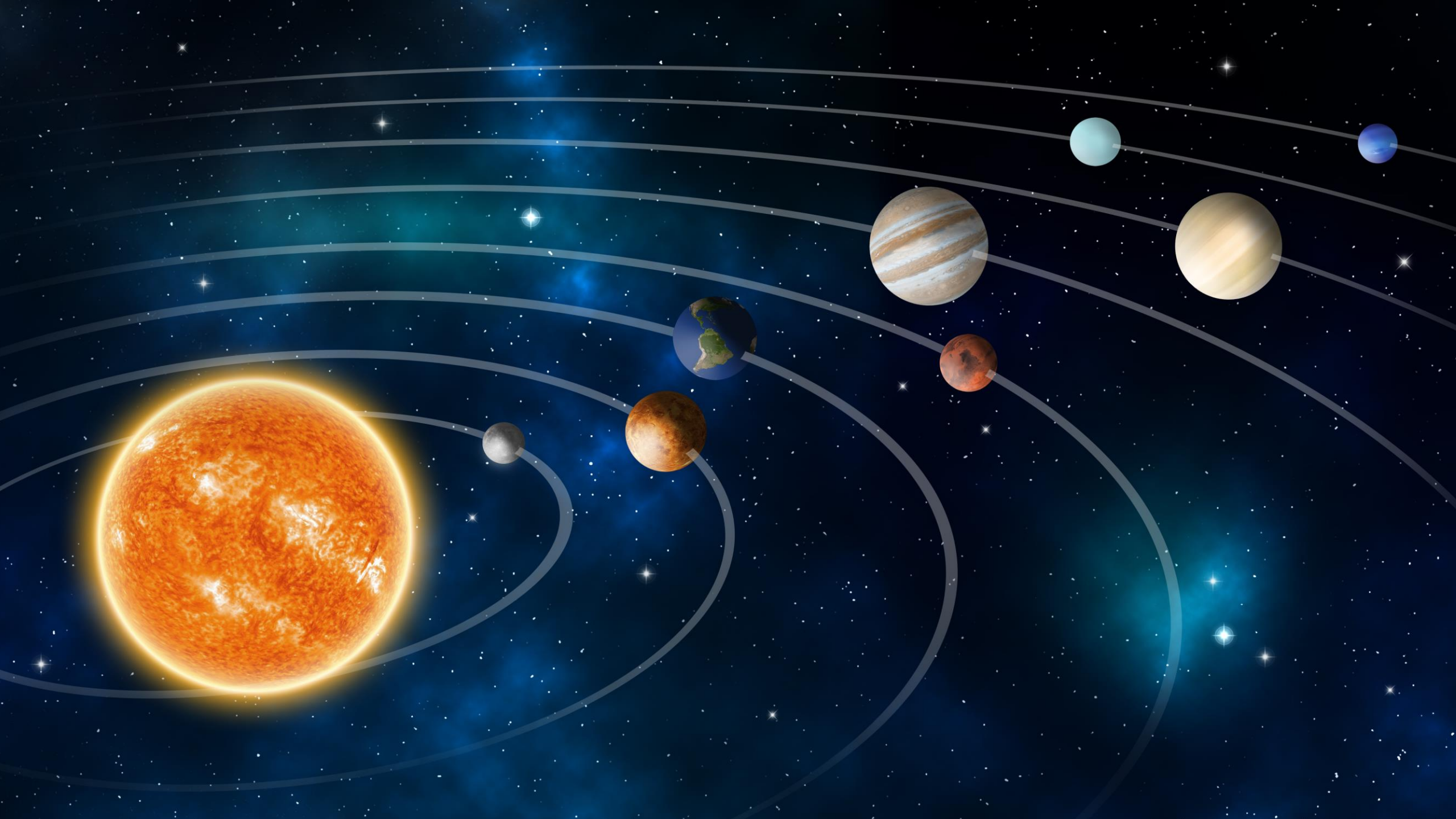




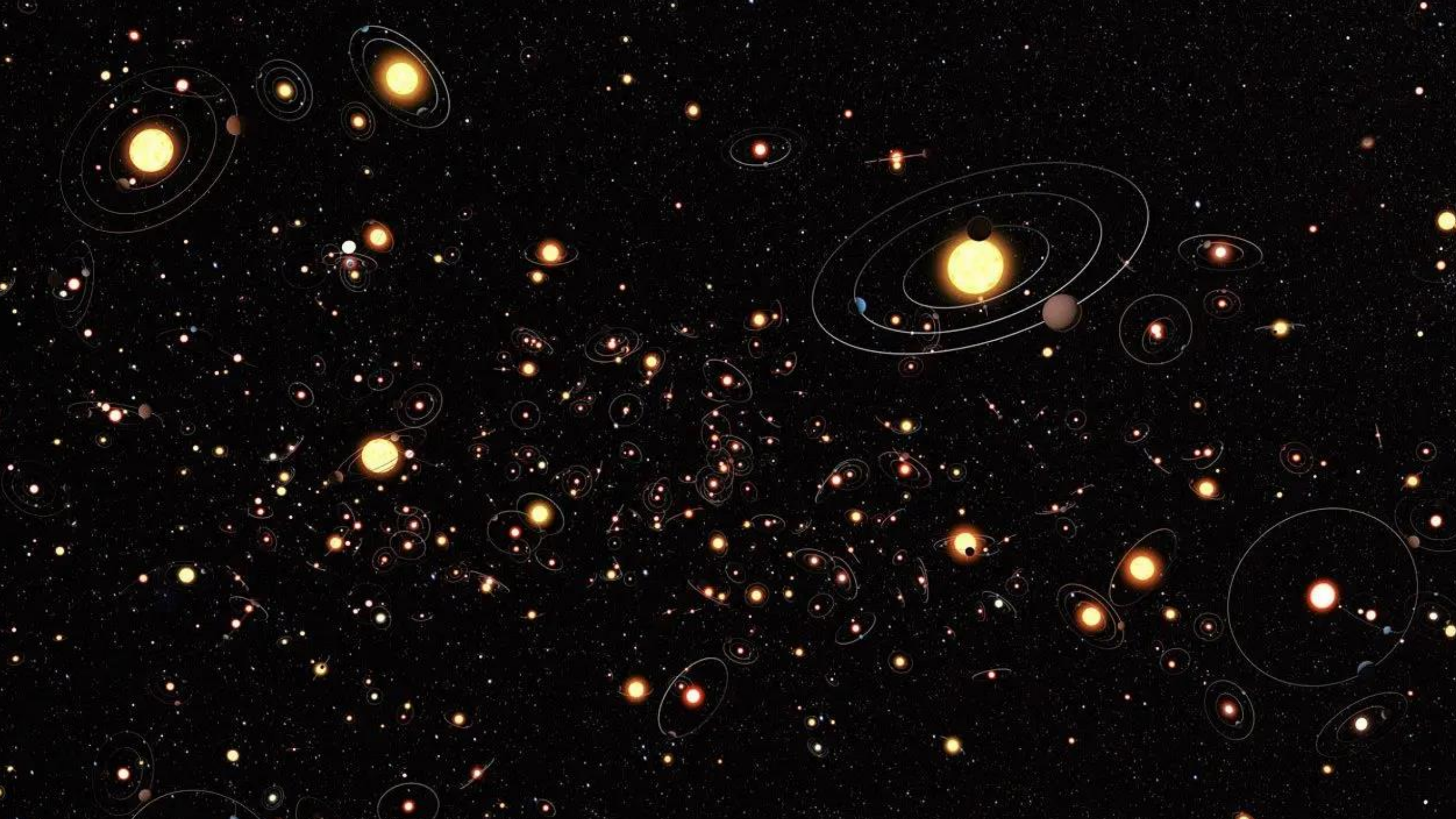


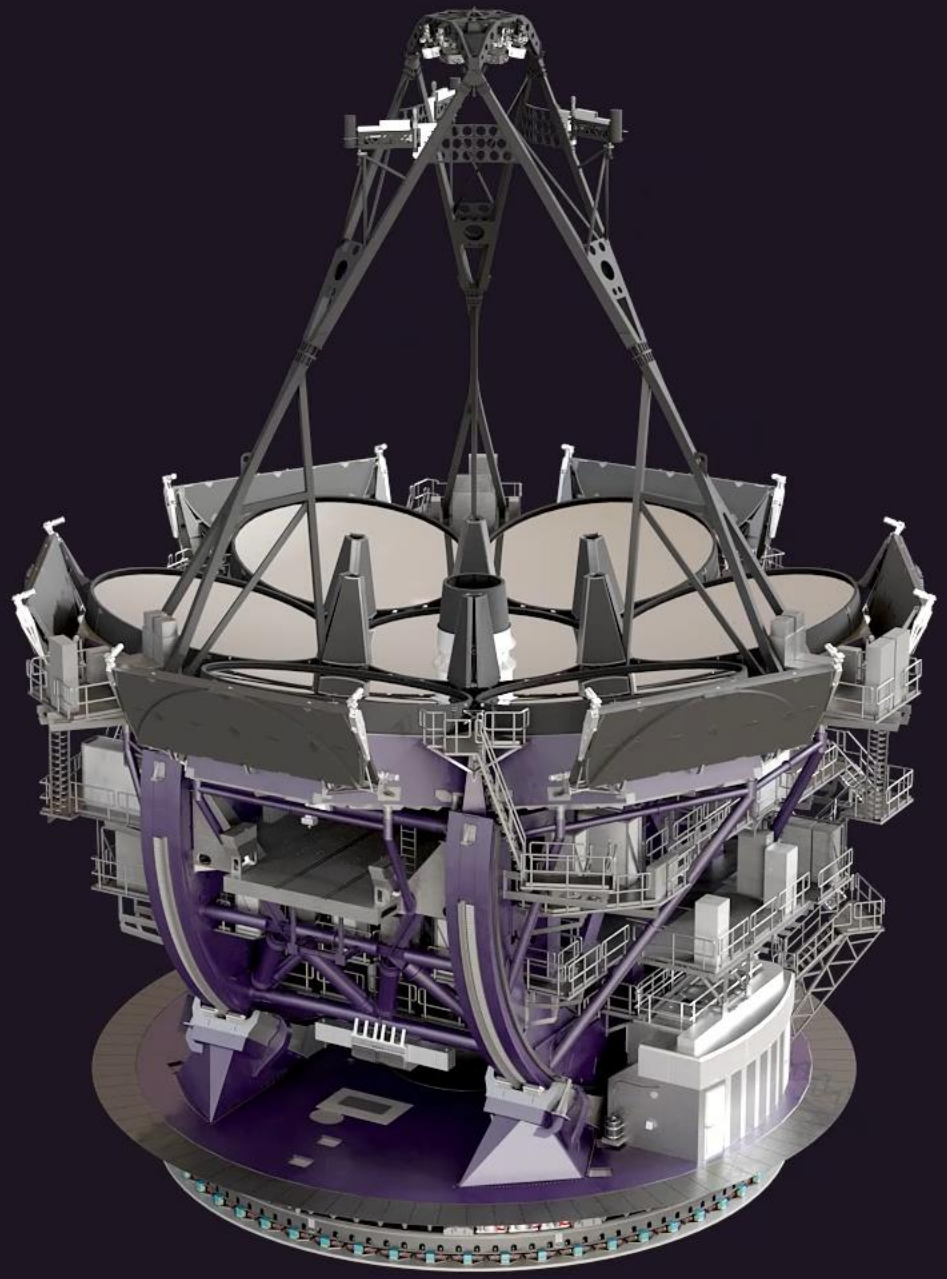


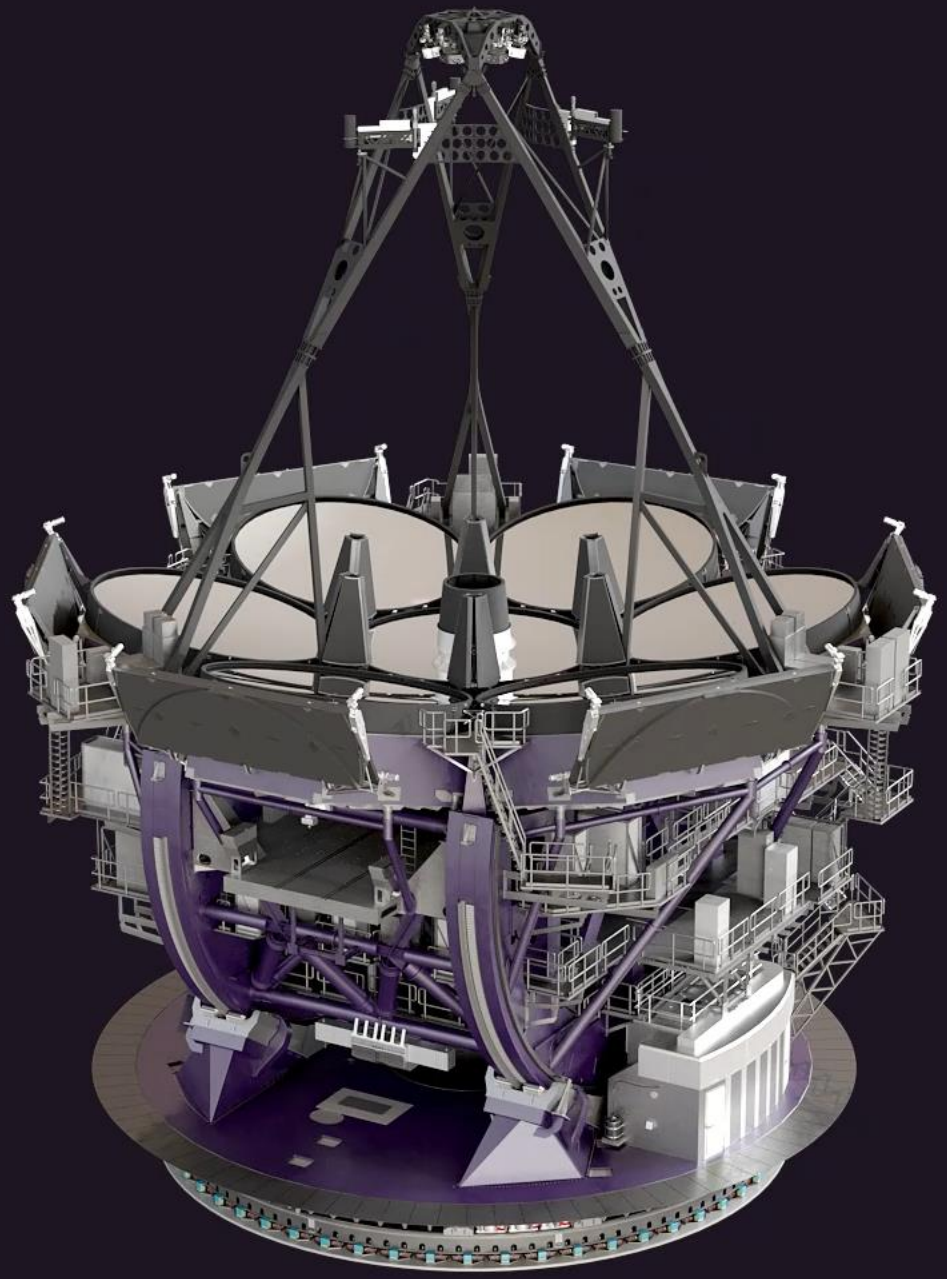
















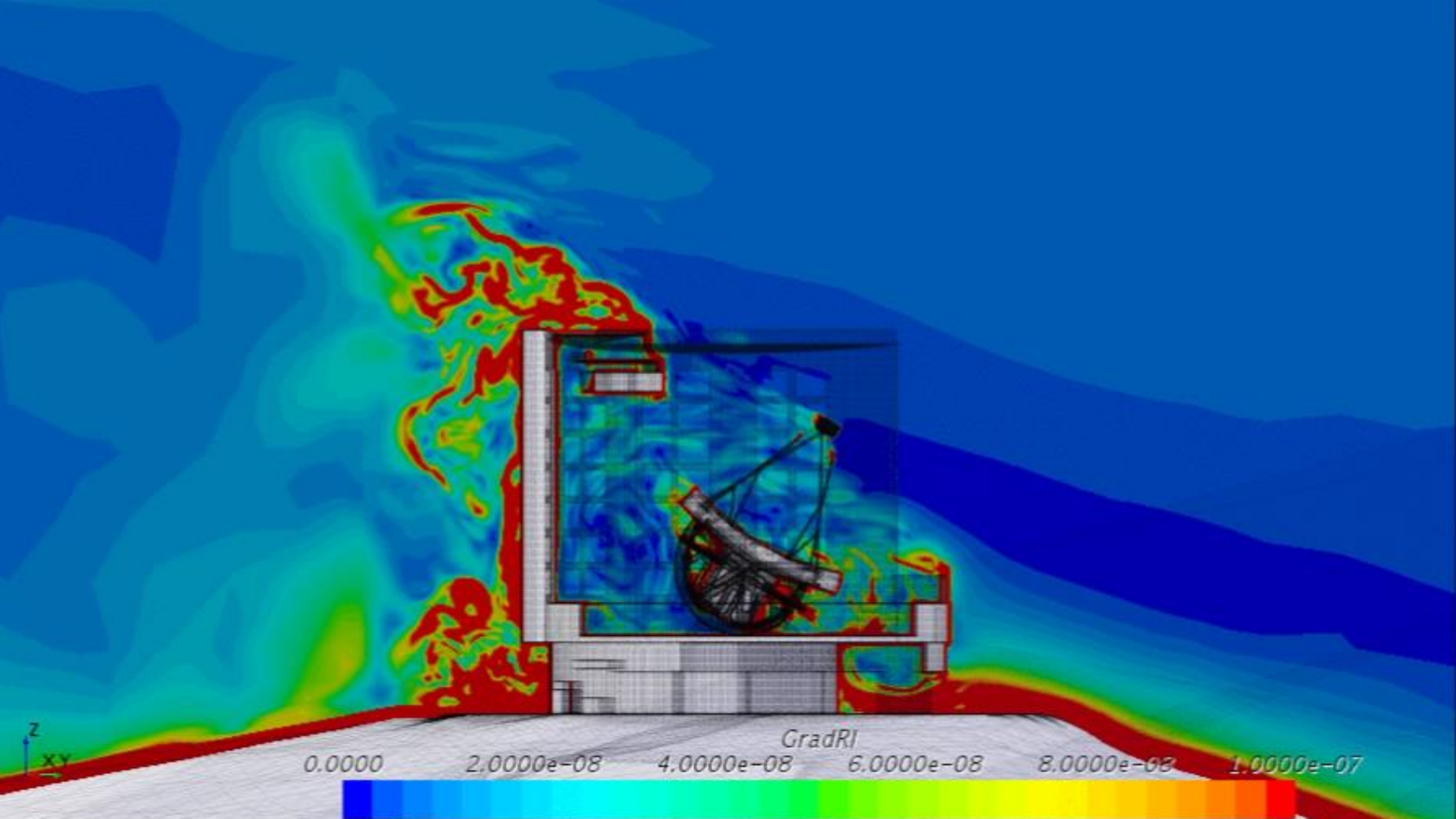


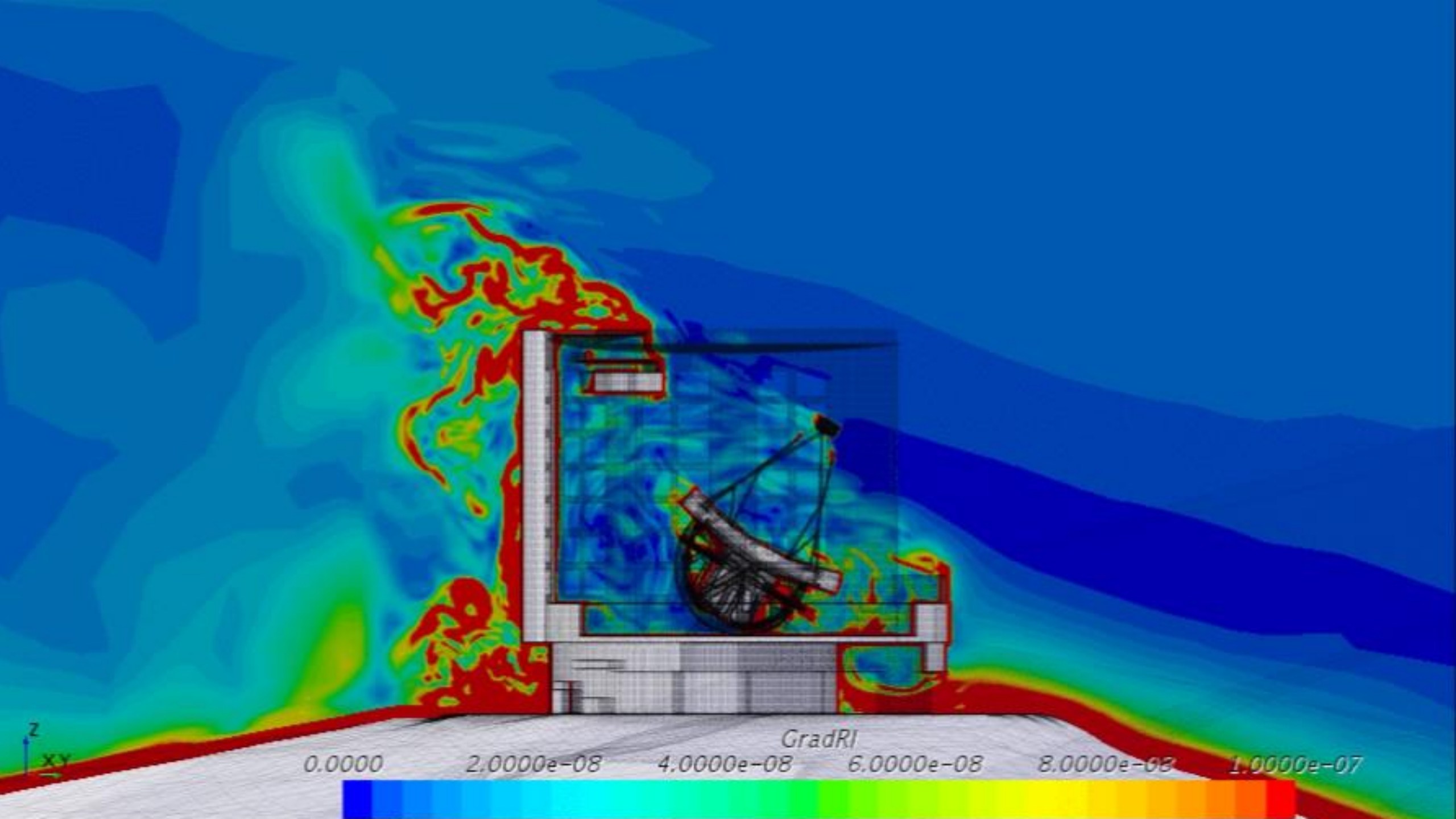


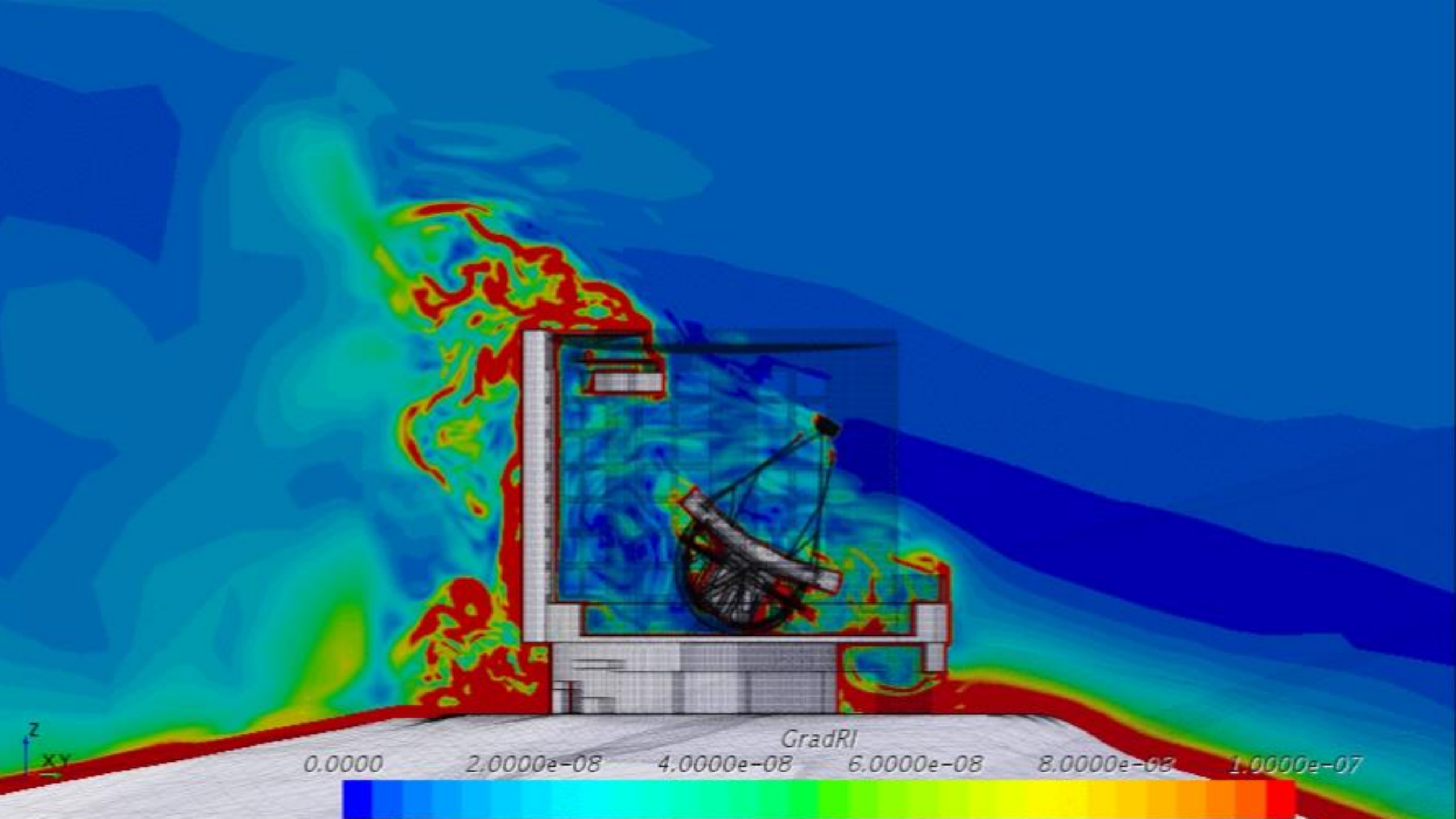


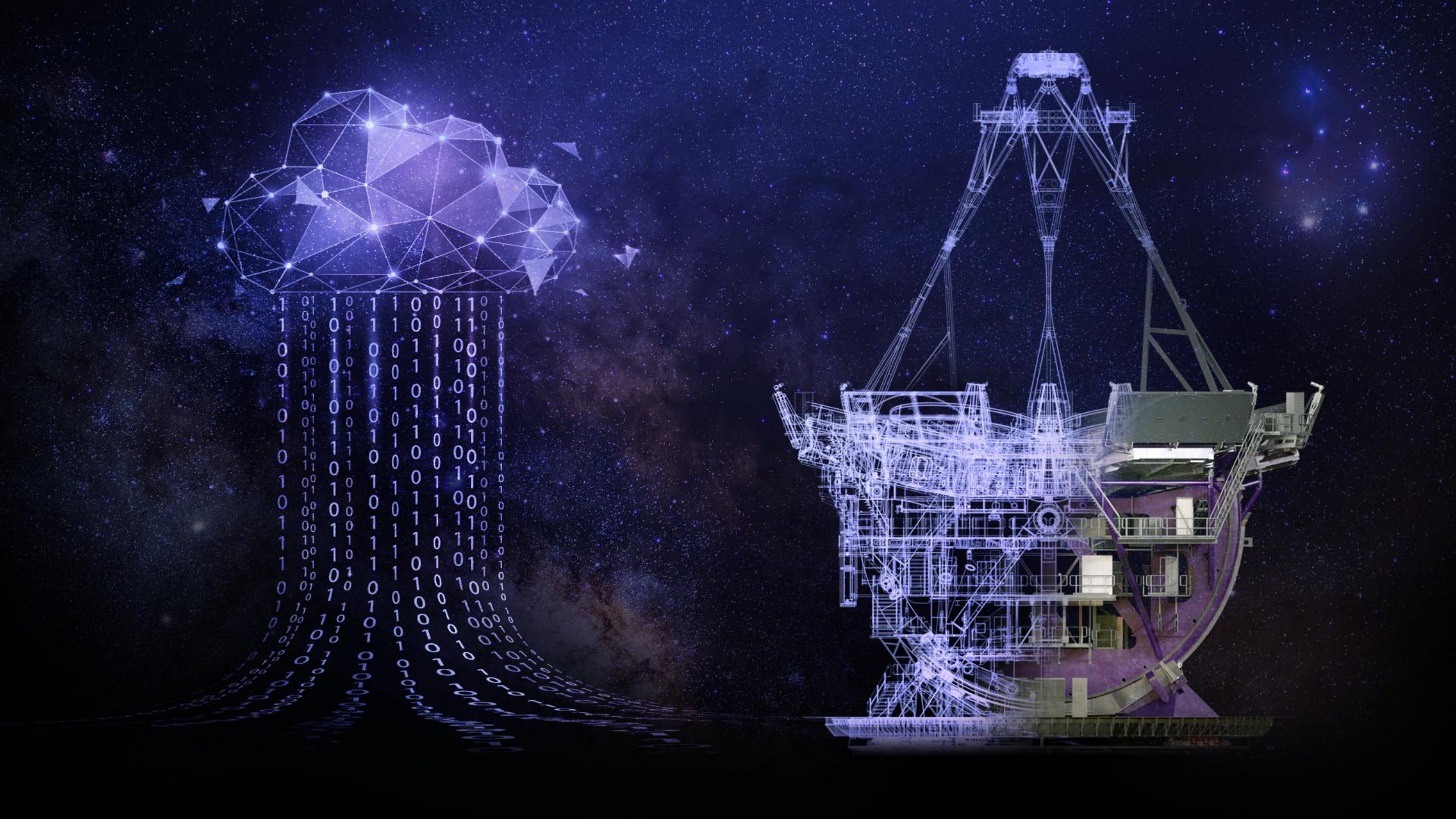





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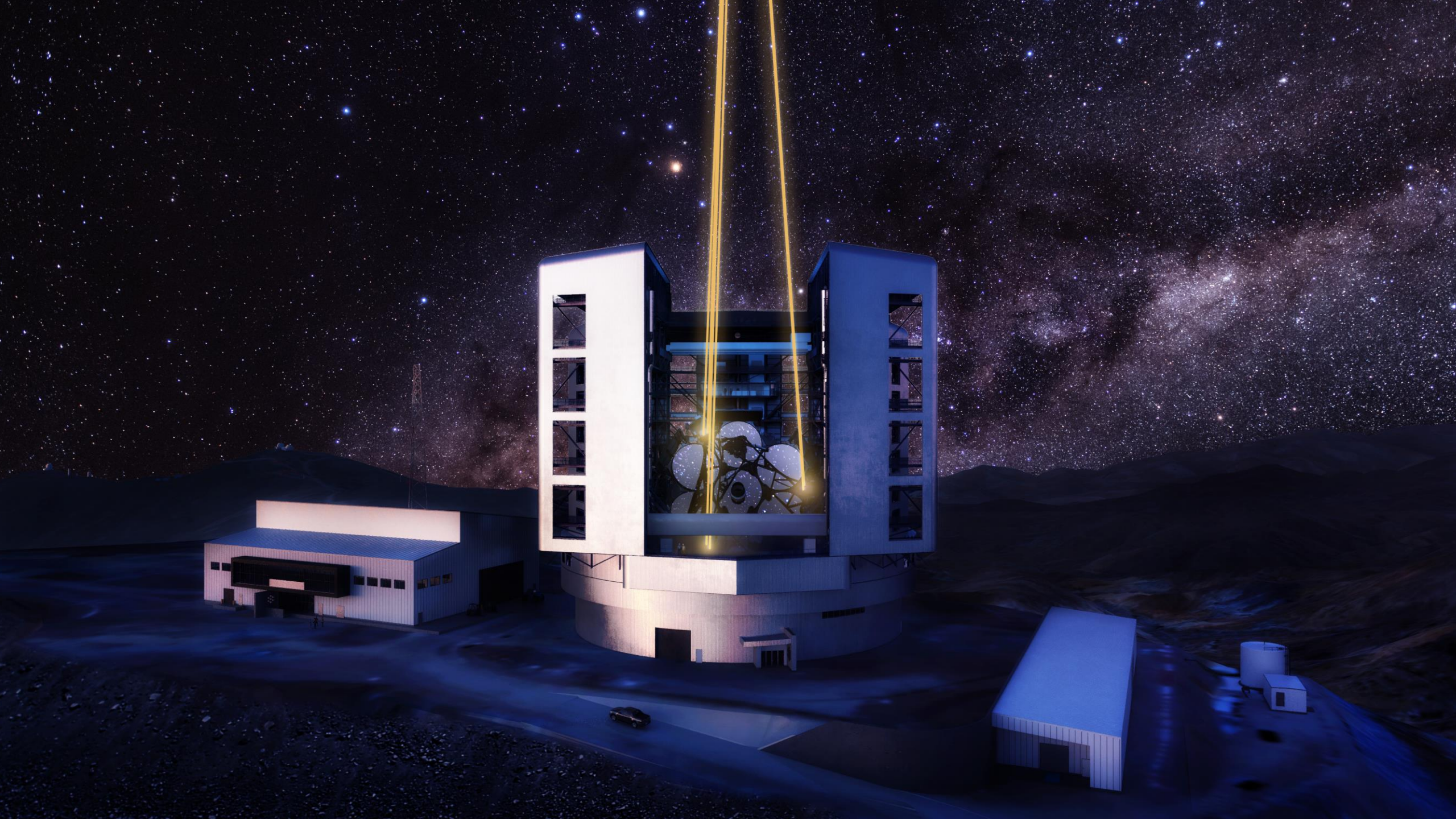

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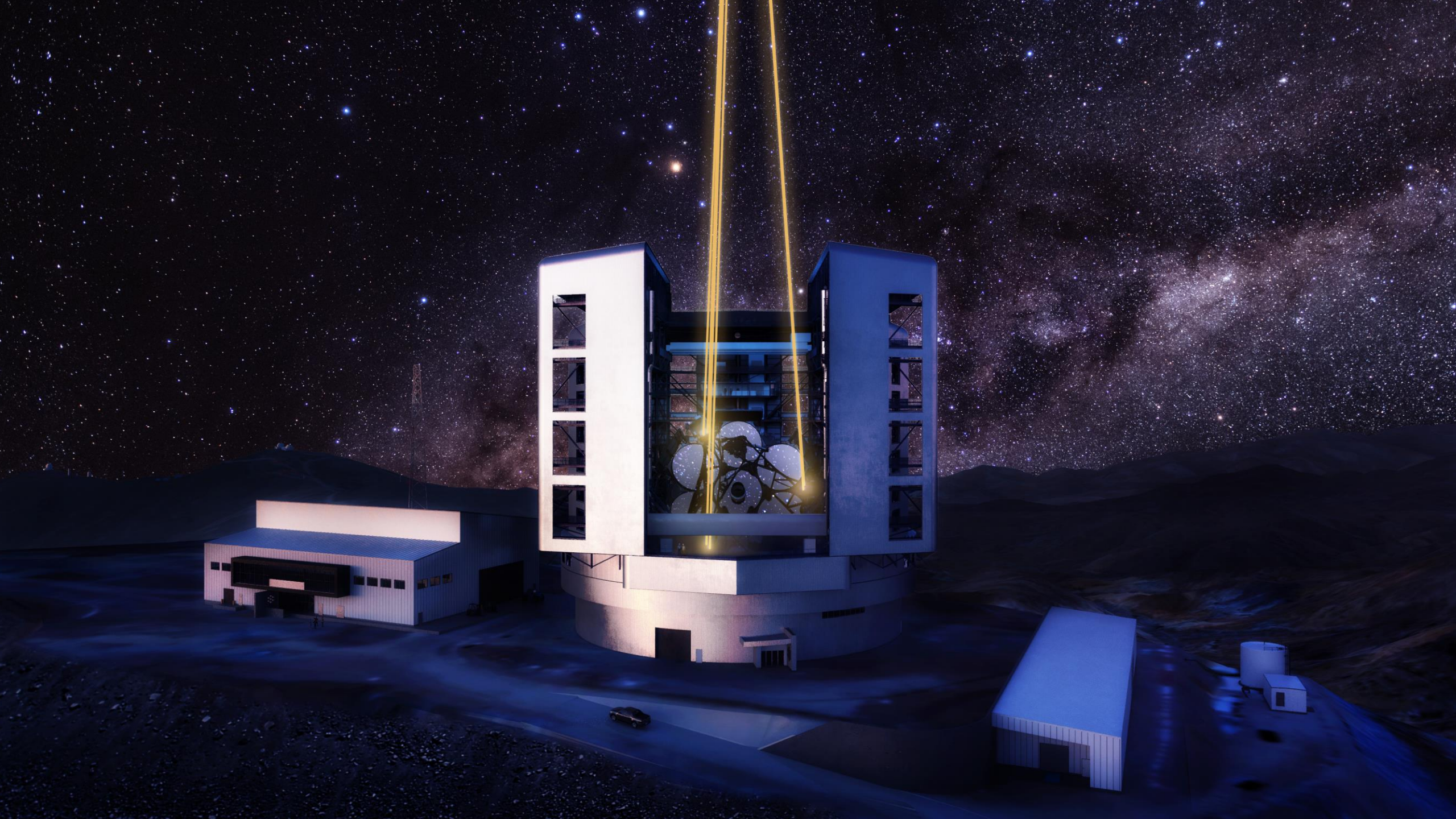

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PROJECT CETI

DR. DAVID GRUBER, PRESIDENT AND FOUNDER
CETACEAN **T**RANSLATION **I**NITIATIVE

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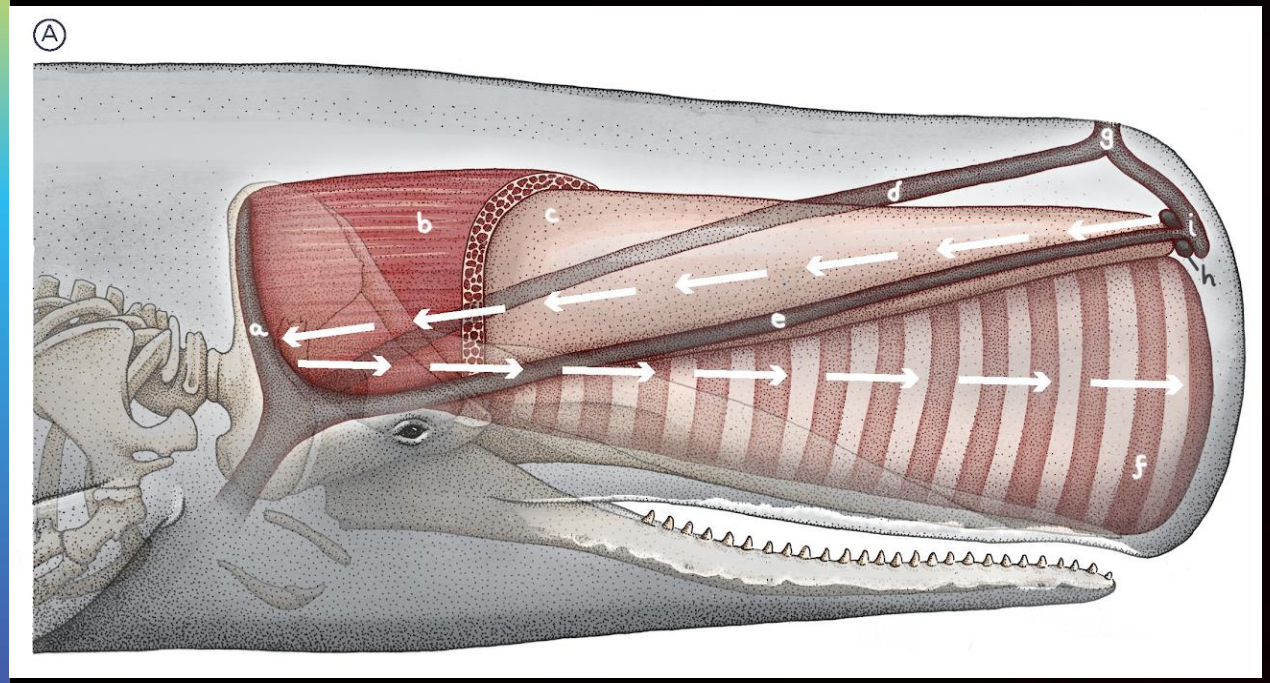


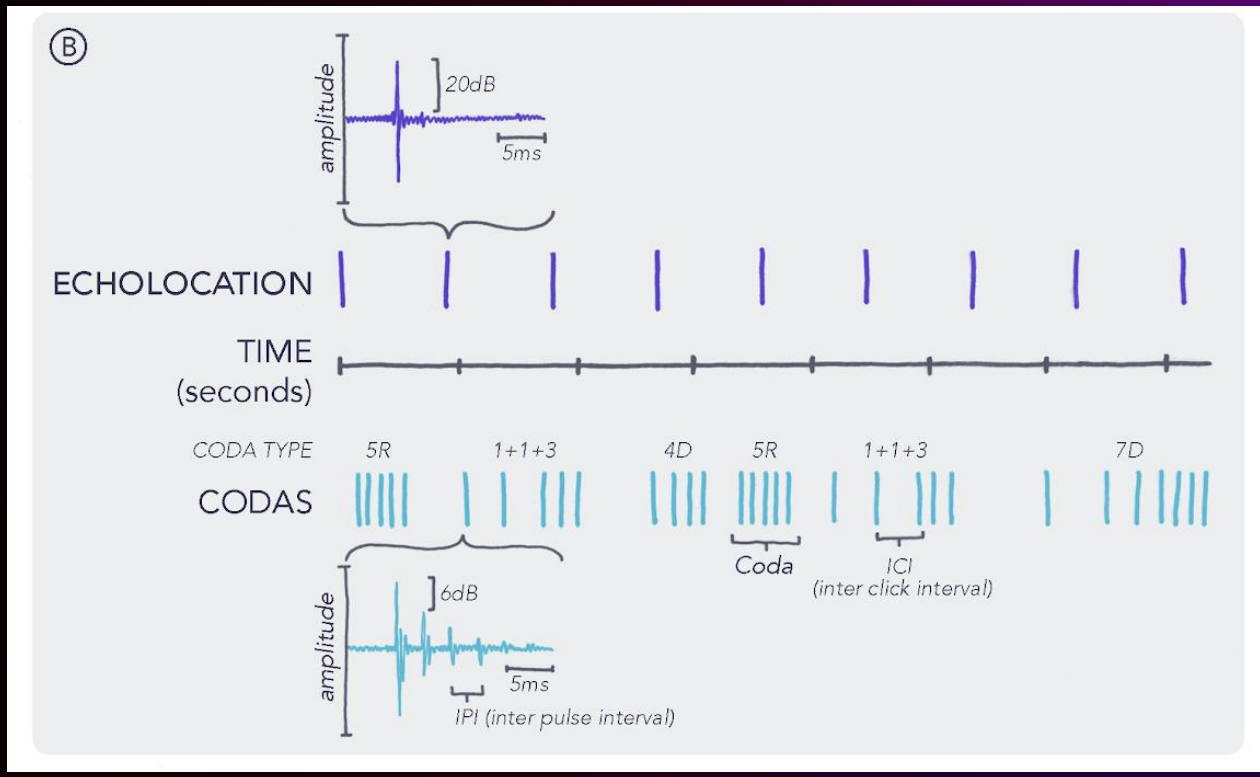
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Photo: Eric Cheng



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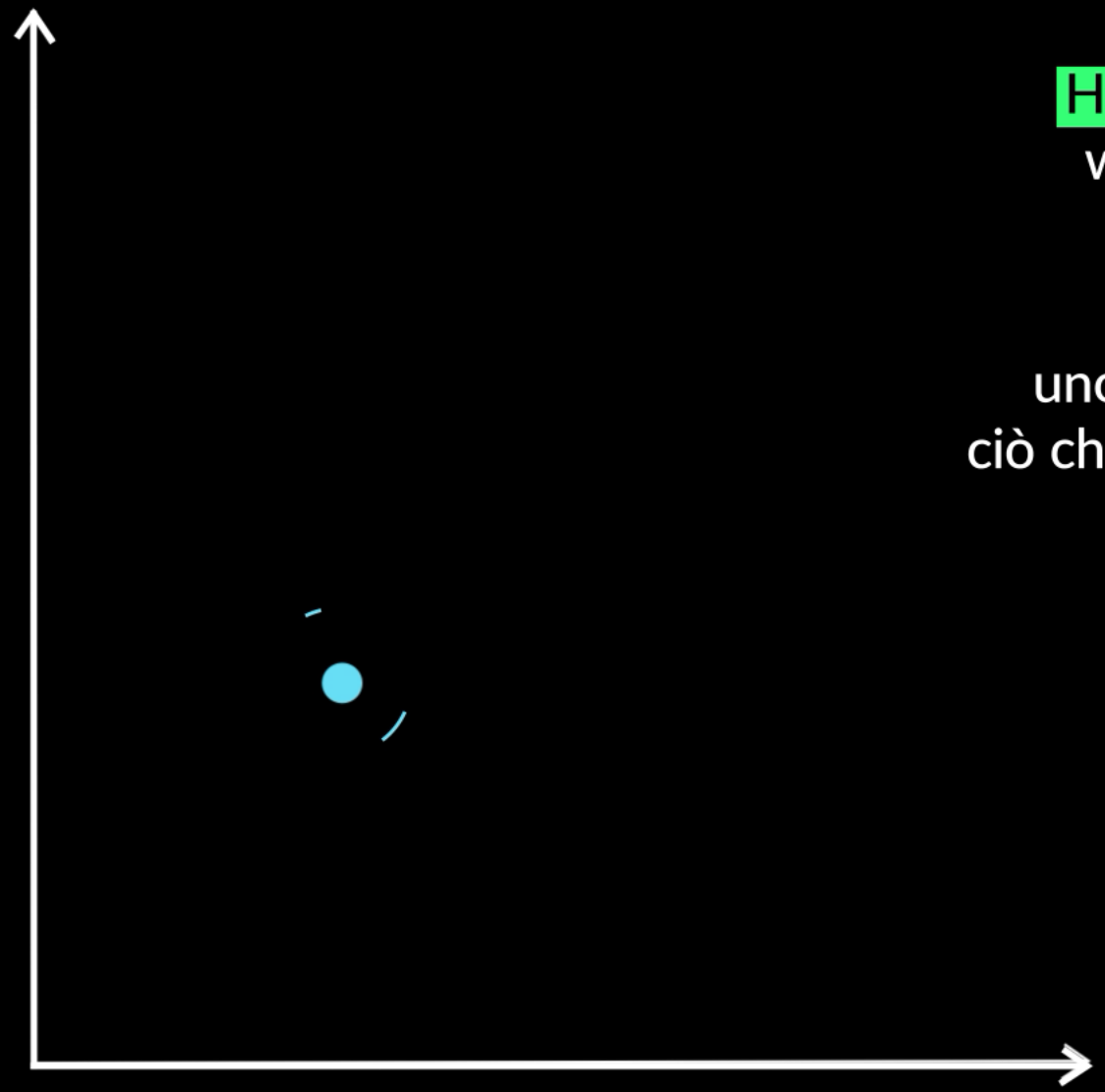
Image: A. Boersma

“There is now a way to learn to translate between, say, Urdu and English by having access only to text in English and completely unrelated text in Urdu – without having any of the respective translations.”

Guillaume Lample

Facebook AI Research (2018)

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Painting is a blind man's profession.
He paints not what he sees, but what he feels,
what he tells himself about what he has seen.

La pittura è una professione da cieco:
uno non dipinge ciò che vede, ma ciò che sente,
ciò che dice a se stesso riguardo a ciò che ha visto.

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RADCLIFFE INSTITUTE
FOR ADVANCED STUDY
HARVARD UNIVERSITY

Shafi Goldwasser: Simons Institute, director; Turing Award (2012) for “revolutionizing the science of cryptography”



Michael Bronstein: DeepMind professor of AI at Oxford; Twitter, head of Graph Learning/Fake News

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THE AUDACIOUS PROJECT

PROJECT CETI | 2020

DECODING THE COMMUNICATION OF WHALES WITH ADVANCED MACHINE LEARNING AND STATE-OF-THE-ART ROBOTICS



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David Gruber
Project Lead

Distinguished Professor, Baruch College, City University of New York and National Geographic Explorer



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Assistant Professor of Electrical Engineering and Computer Science, MIT



Zethra Baron
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Fisheries Officer, Ministry of Blue and Green Economy, Agriculture and National Food Security



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Linguistics

Assistant Professor, Department of Linguistics, University of California, Berkeley



Roee Diamant
Lead, Underwater Acoustics

Assistant Professor, University of Haifa



Shai Einbinder
Lead, Marine Operations



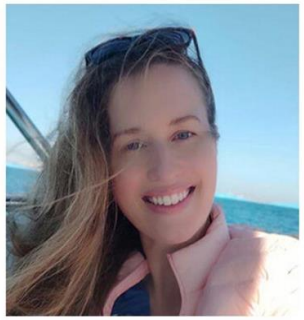
Khade Elwin
2022/2023 Fellow

Project CETI Dominica Marine Conservation Fellowship Program



Shane Gero
Lead, Field Biology

Founder, Dominica Sperm Whale Project



Leigh Livne
Project Coordinator

Postdoctoral Fellow, Haifa University



Peter Malkin
Machine Learning

Software Engineer, Google Research



Whitney McLawrence
2022/2023 Fellow

Project CETI Dominica Marine Conservation Fellowship Program



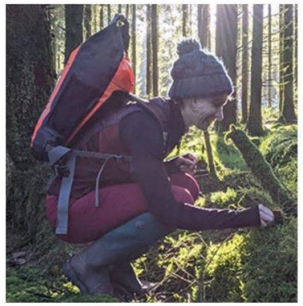
Yaly Mevorach
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PhD student, University of Haifa



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DeepMind Professor of Artificial Intelligence at Oxford University and Head of Graph ML Research, Twitter



Sarah de Haas
Program Manager

Program Manager, Google Research



Jullan Defoe
CETI Liaison, Government of Dominica

Chief Fisheries Officer, Fisheries Division, Ministry of Blue and Green Economy, Agriculture and National Food Security



Denley Delaney
CETI Liaison, National Geographic Society

Program Specialist, Labs team, National Geographic Society



Stephanie Gil
Robotics

Assistant Professor of Computer Science, Harvard University



Shafi Goldwasser
Lead, Theoretical Analysis

Director, Simons Institute for the Theory of Computing, UC Berkeley, Professor of



Omari John-Rose
2022/2023 Fellow

Project CETI Dominica Marine Conservation Fellowship Program



Adam Tauman Kalai
Theoretical Analysis

Senior Principal Researcher, Microsoft Research



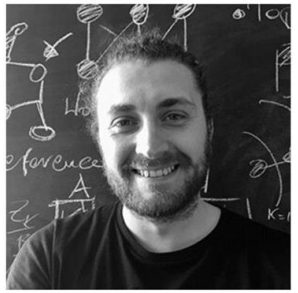
Nikolay Pavlov
Machine Learning

Data Science Engineer, People.ai



Roger Payne
Principal Advisor and Whale Biology

Whale biologist, conservationist and MacArthur Fellow



Giovanni Petri
Machine Learning

Senior Research Scientist, CENTAI (Turin)



Daniela Rus
Machine Learning & Robotics

Director, MIT's Computer Science & Artificial Intelligence Laboratory (CSAIL) and MacArthur Fellow

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Pratyusha Sharma
Machine Learning

PhD student, MIT's Computer Science & Artificial Intelligence Laboratory (CSAIL)



Dan Tchernov
Chief Operating Officer

Professor, University of Haifa



Pernille Tønnesen
Field Biology

Postdoctoral Associate, Aarhus University



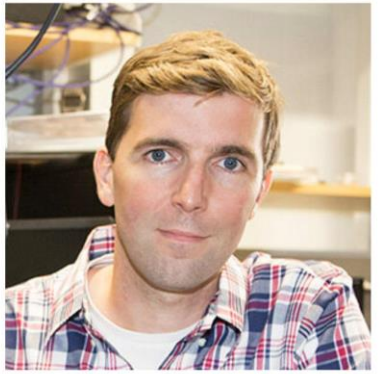
Antonio Torralba
Machine Learning

Professor of Electrical Engineering and Computer Science at MIT



Makeda Warner
Program Manager

Dominica Marine Conservation Fellowship Program and Geography Instructor at Dominica State College



Robert Wood
Lead, Robotics

Chair of Bioengineering, Harvard, Principal Investigator of the Harvard Microrobotics Laboratory and National Geographic Explorer

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HARVARD John A. Paulson School of Engineering and Applied Sciences

MIT CSAIL

DSWP

CUNY

אוניברסיטת חיפה University of Haifa جامعة حيفا

Berkeley UNIVERSITY OF CALIFORNIA

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Partnership with Dominica





Initiative launched in Dominica to facilitate communication with sperm whales

Dominica News Online - Tuesday, April 20th, 2021 at 10:57 AM



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Whale-attached robots



Surface drones



Aerial-aquatic drones



Tethered arrays

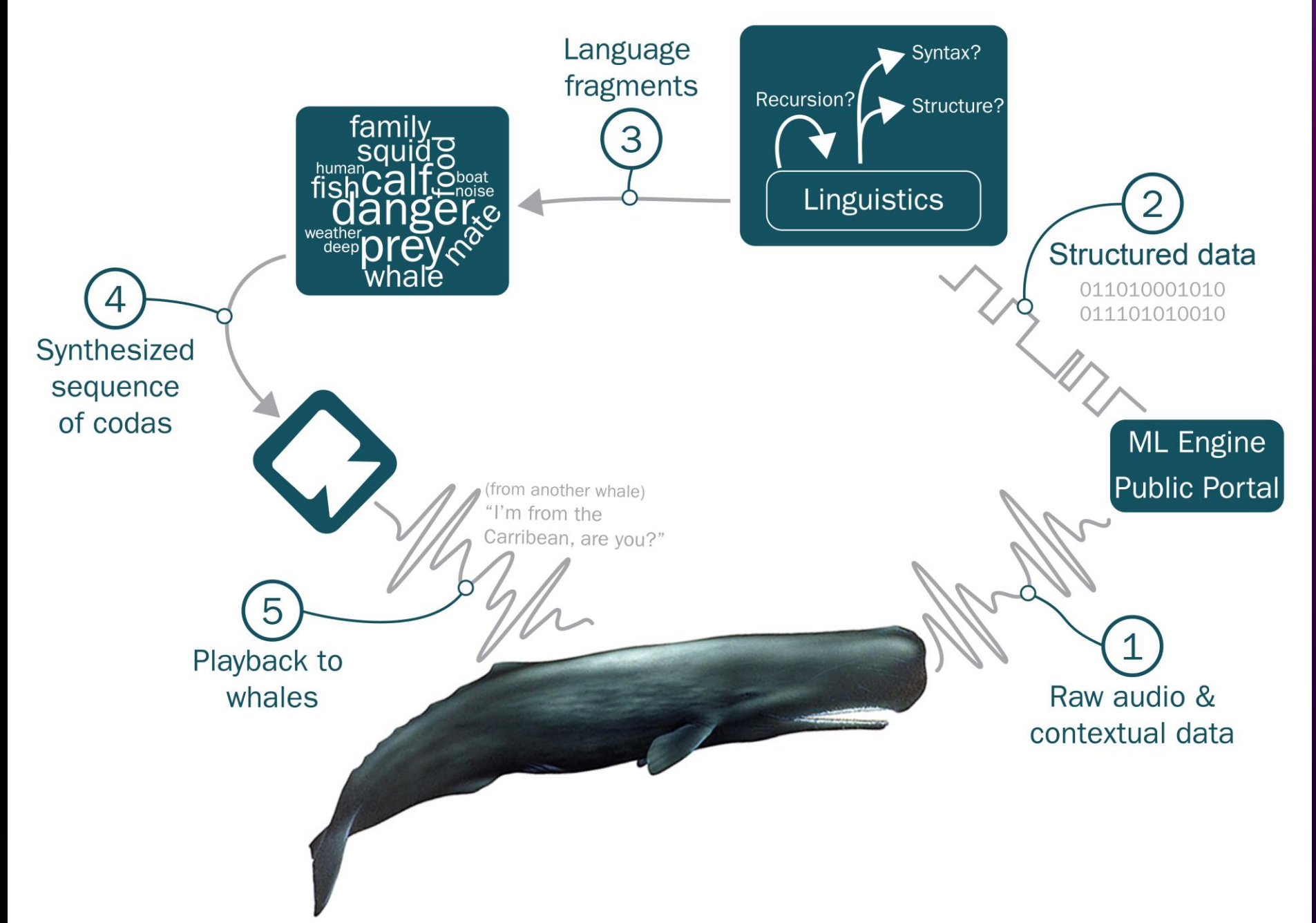


Free-swimming robots

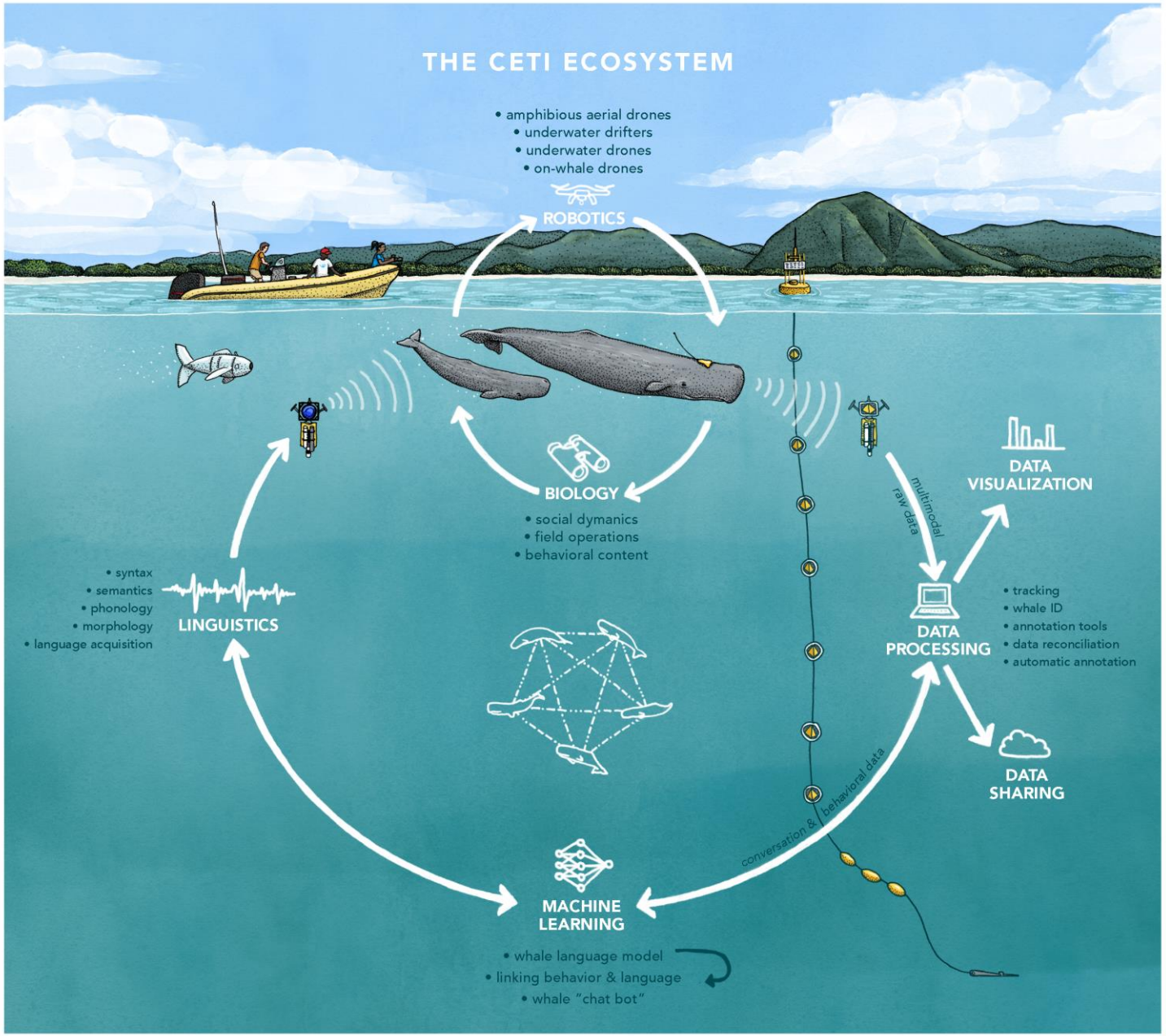


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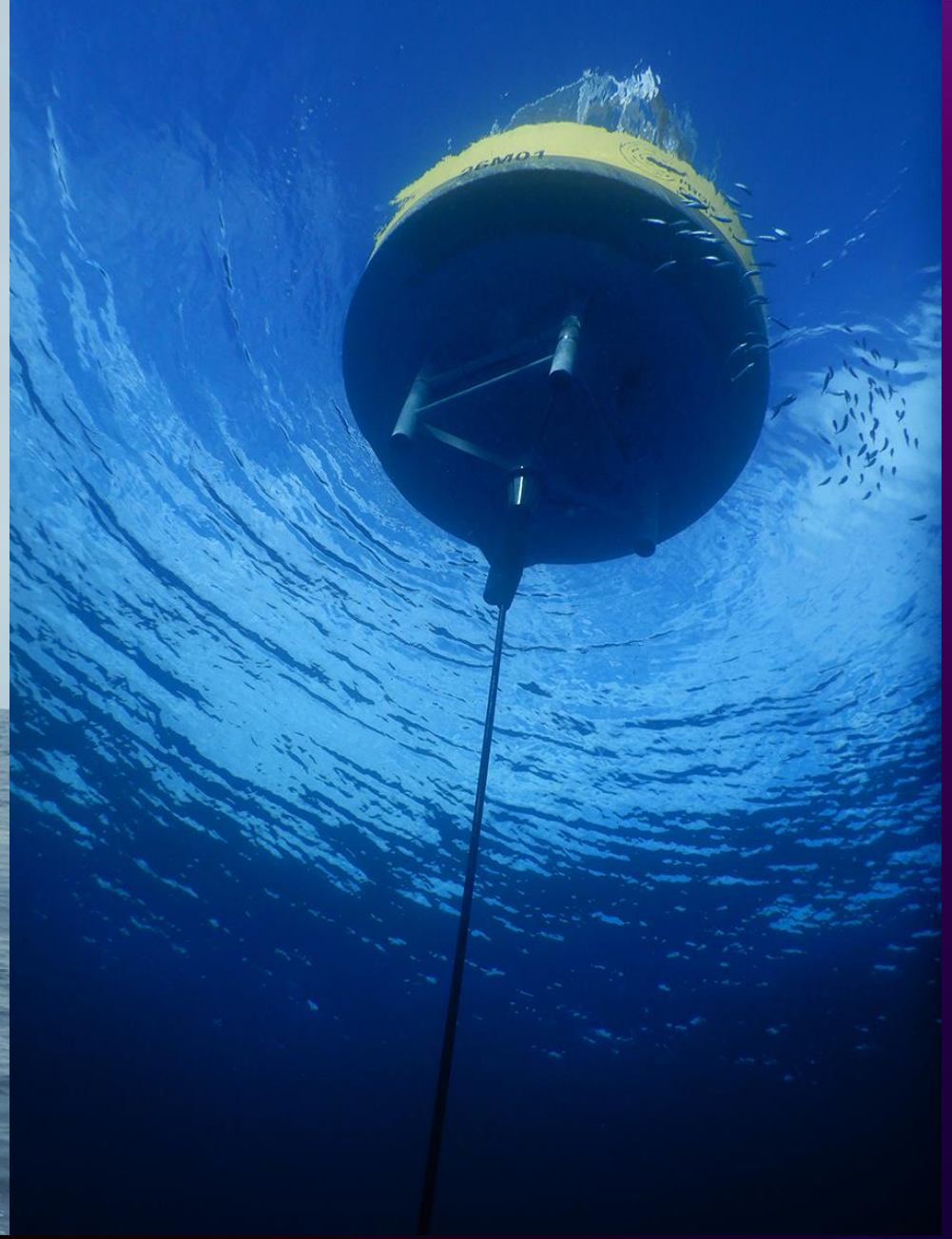


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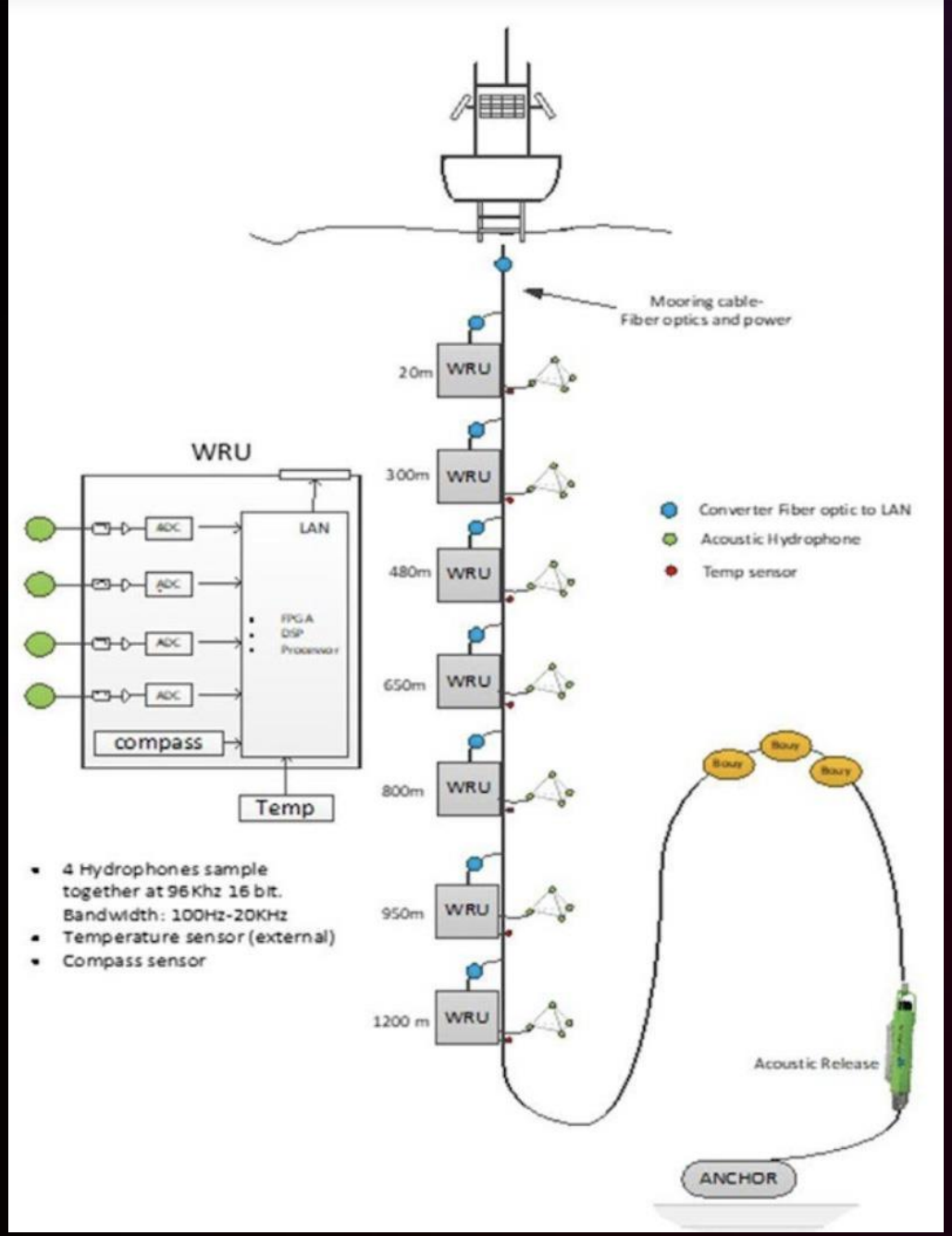


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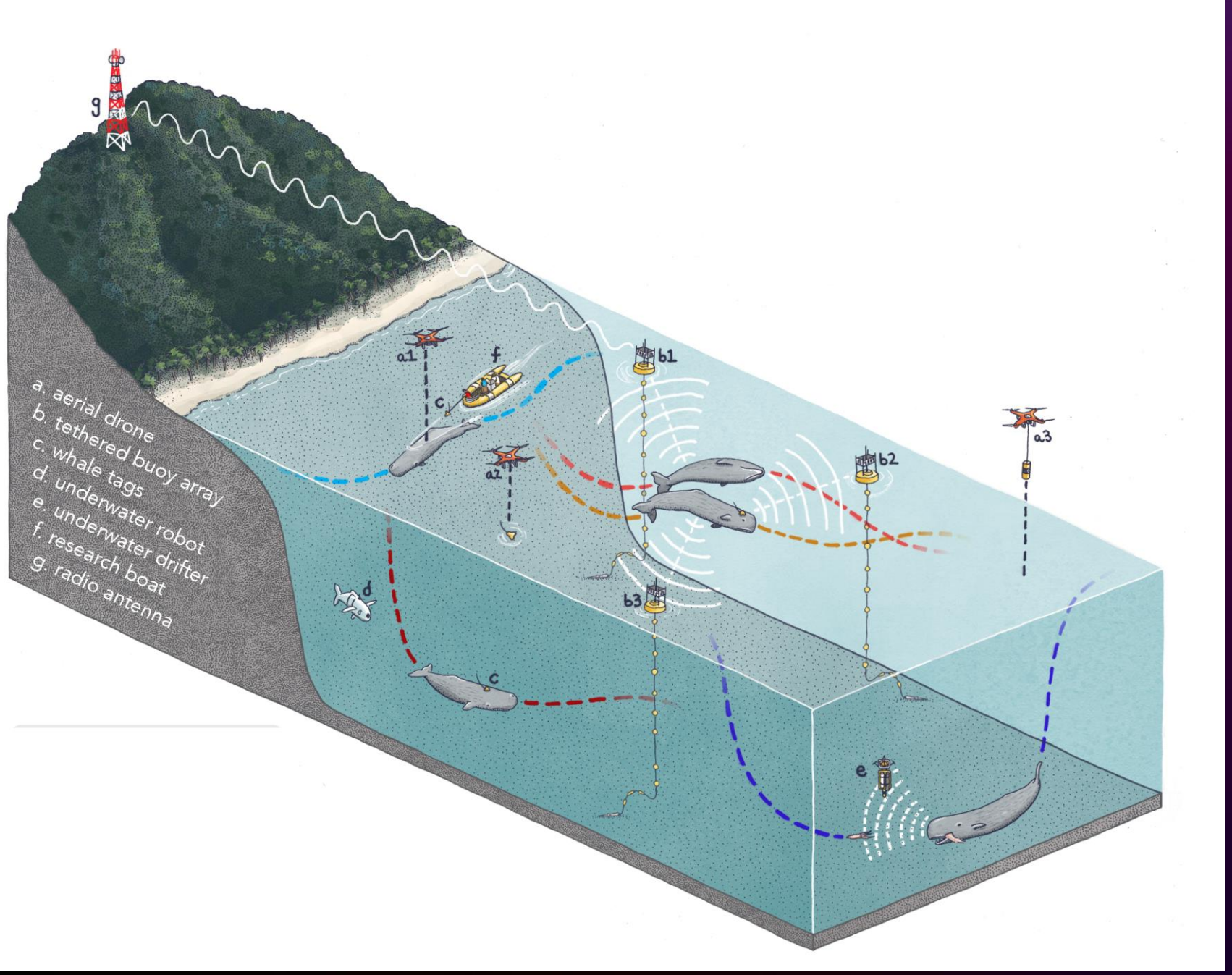




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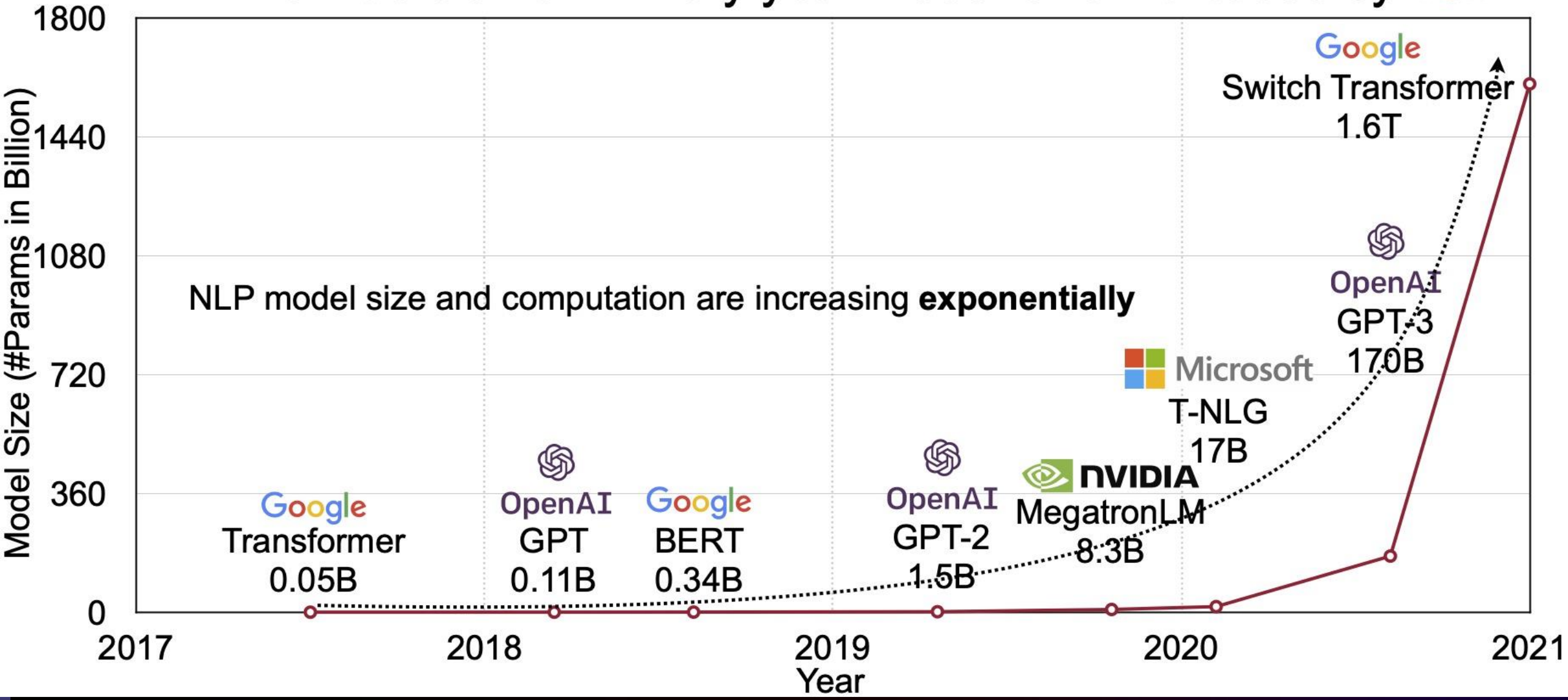


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NLP's Moore's Law: Every year model size increases by 10x



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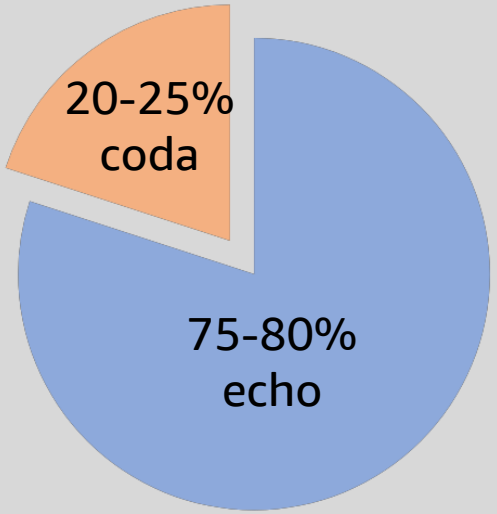
400M–4B clicks/year

20 km^2 area
off Dominica shore



50–400 whales
depending on season
vocalizing
continuously





Typical coda: 5 clicks, 4 sec



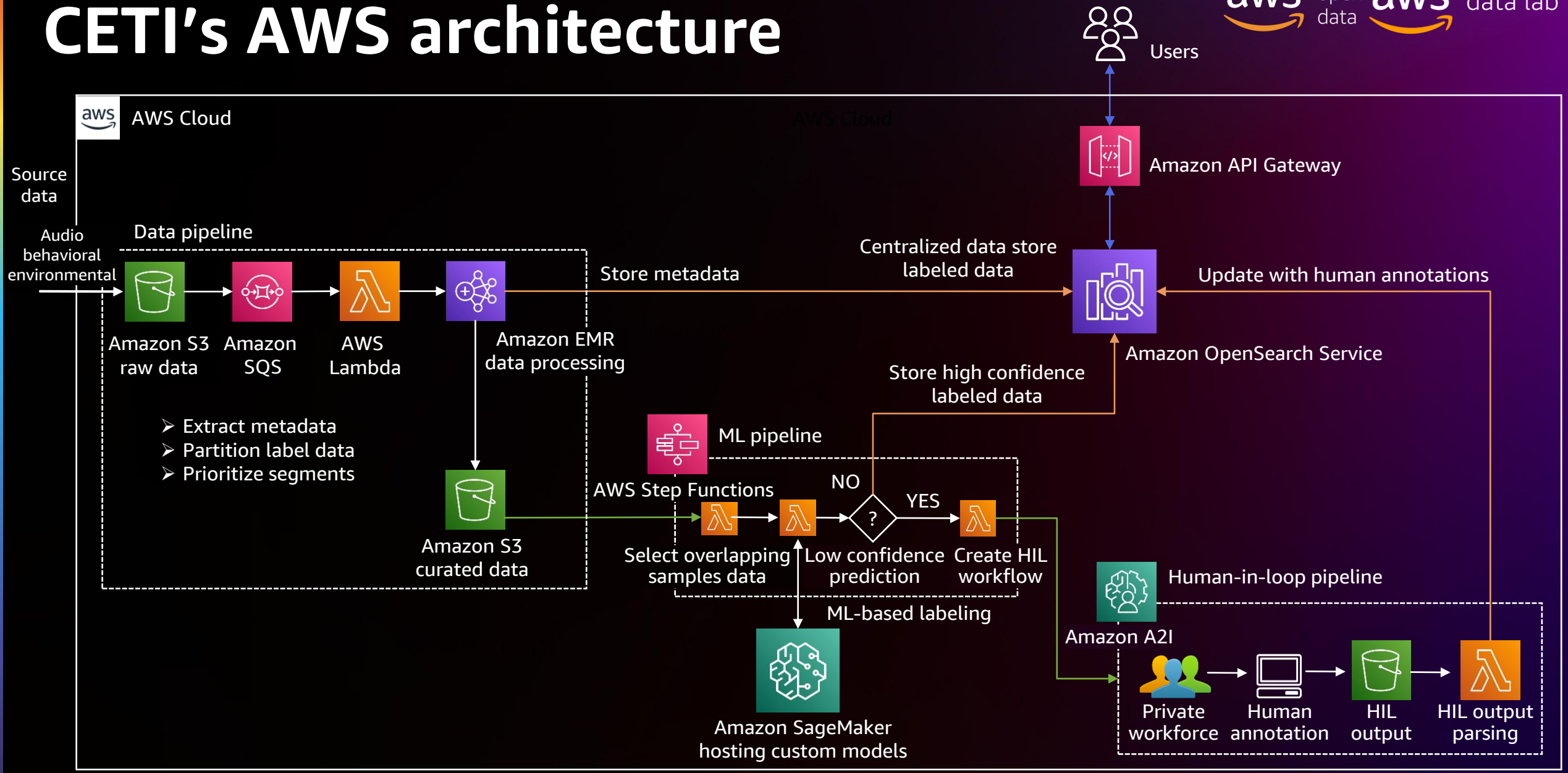
1.25 clicks/sec

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CETI's AWS architecture



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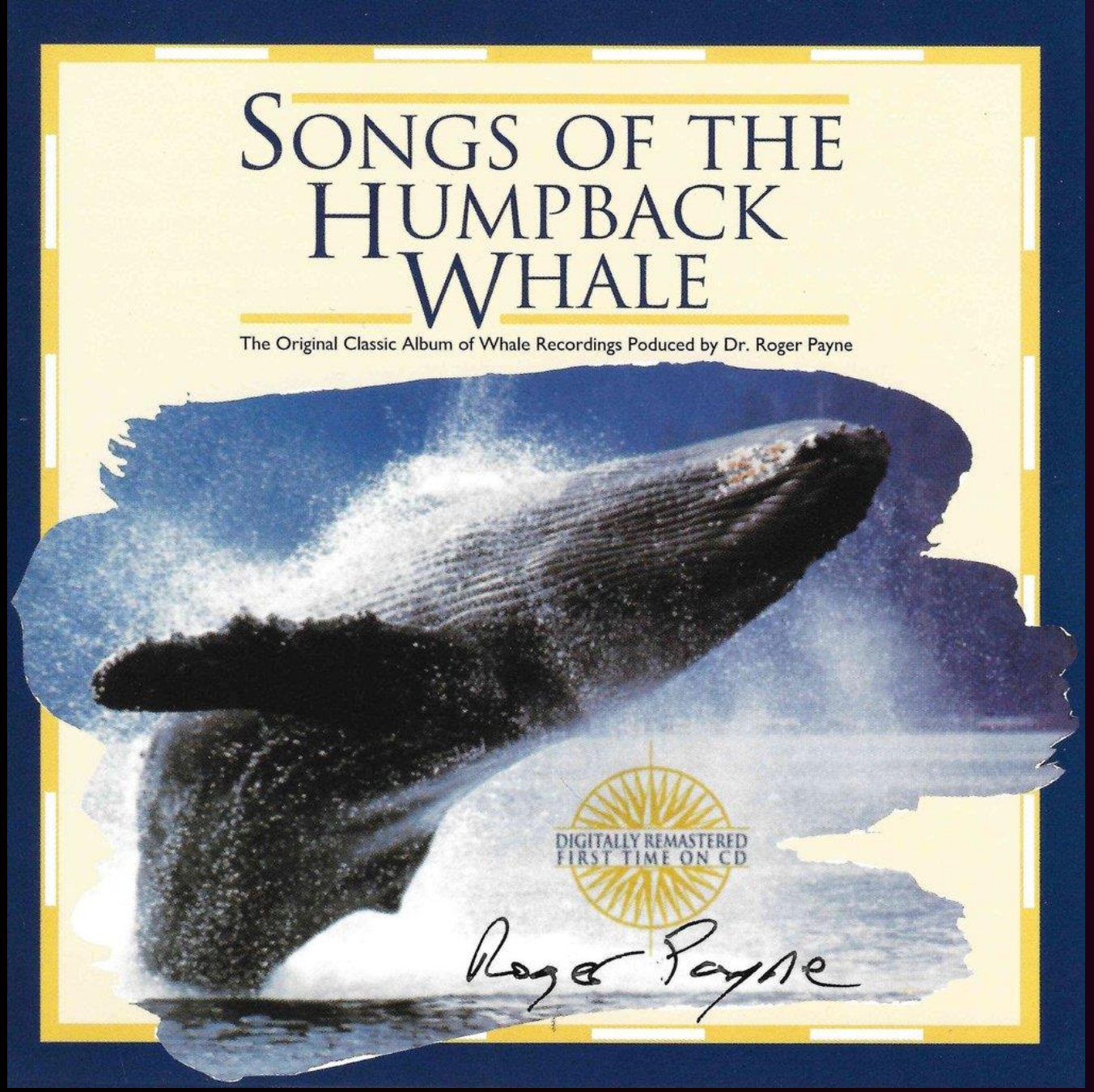
Groundbreaking effort launched to decode whale language

With artificial intelligence and painstaking study of sperm whales, scientists hope to understand what these aliens of the deep are talking about.

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