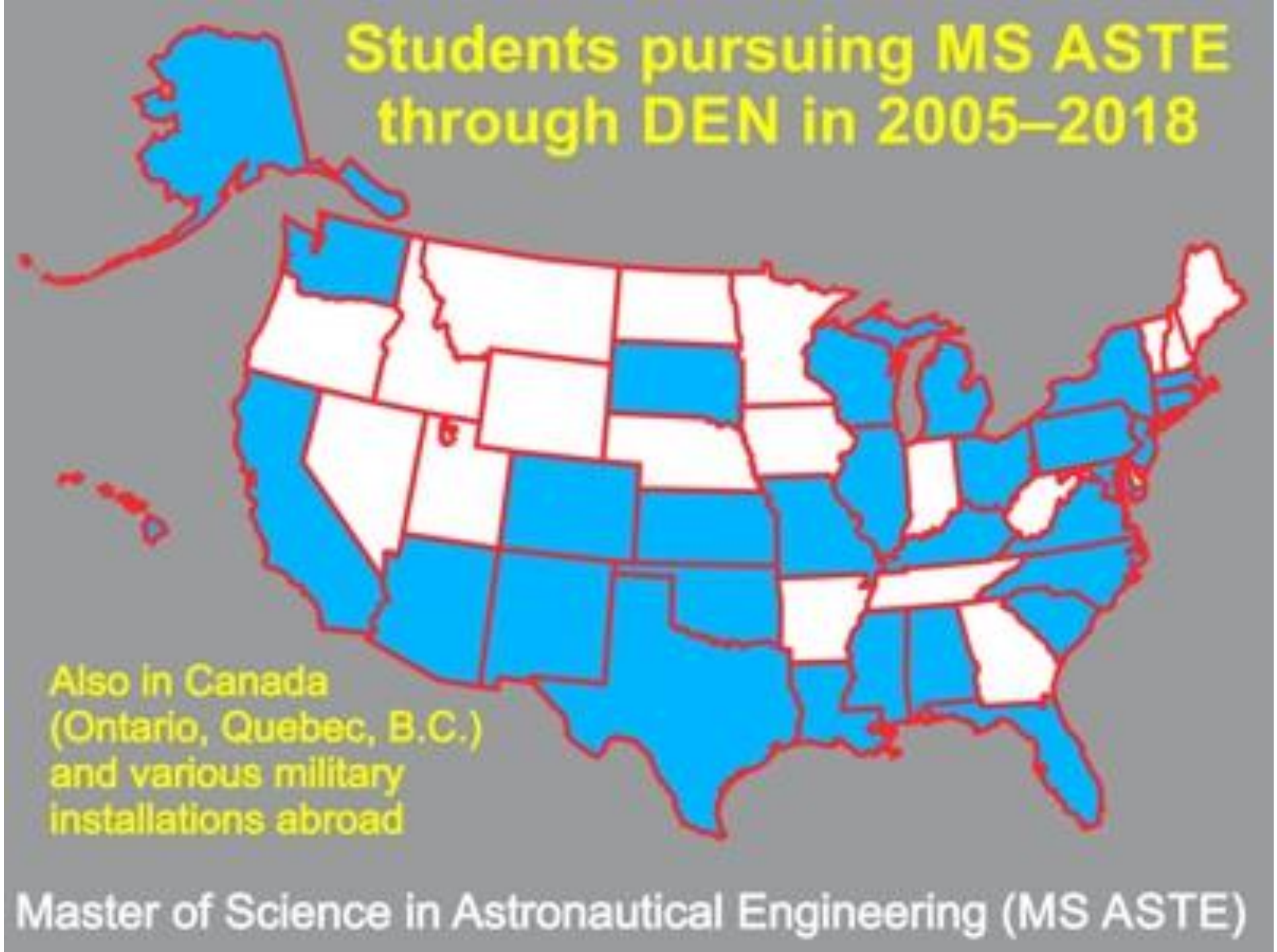
SHAPING THE FUTURE OF AEROSPACE
AIAA Los Angeles - Las Vegas Section

AIAA Los Angeles-Las Vegas Space Architecture Gathering

Madhu Thangavelu
Conductor ASTE527 Graduate Space Concept Synthesis Studio
Viterbi School of Engineering & USC School of Architecture
University of Southern California
Saturday, August 22nd 2020

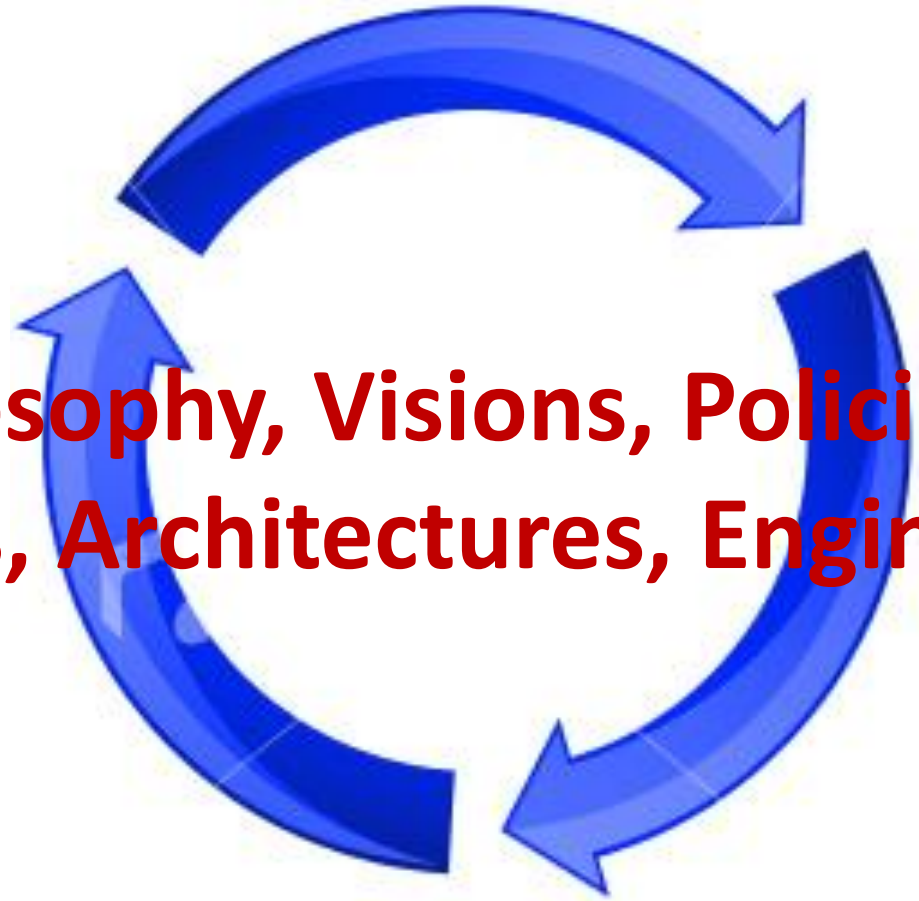
USC

UNIVERSITY OF SOUTHERN CALIFORNIA 1880 PALMAM QUI MERUIT FERAT


Students pursuing MS ASTE
through DEN in 2005–2018
Also in Canada
(Ontario, Quebec, B.C.)
and various military
installations abroad
Master of Science in Astronautical Engineering (MS ASTE)

USC ASTE 527 – Graduate Space Concept Synthesis Studio – 3 units

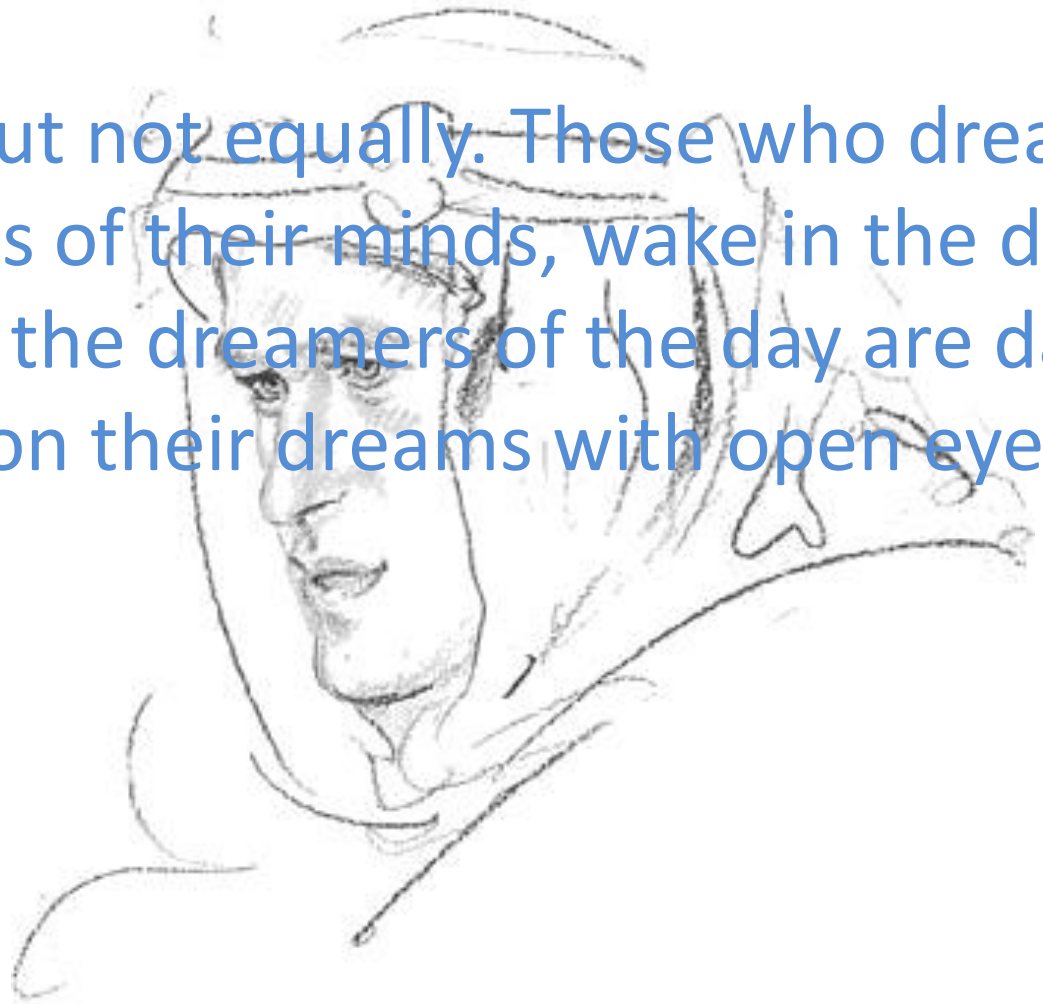
- Viterbi School of Engineering
- USC Astronautical Engineering Department – ASTE
- ASTE 527
- Ideation, Conception, Creativity, Imagination, Visualization
- Skills borrowed from civil Architecture education
- -https://sites.google.com/a/usc.edu/aste527/home



Philosophy, Visions, Policies, Concepts, Architectures, Engineering

T.E.Lawrence

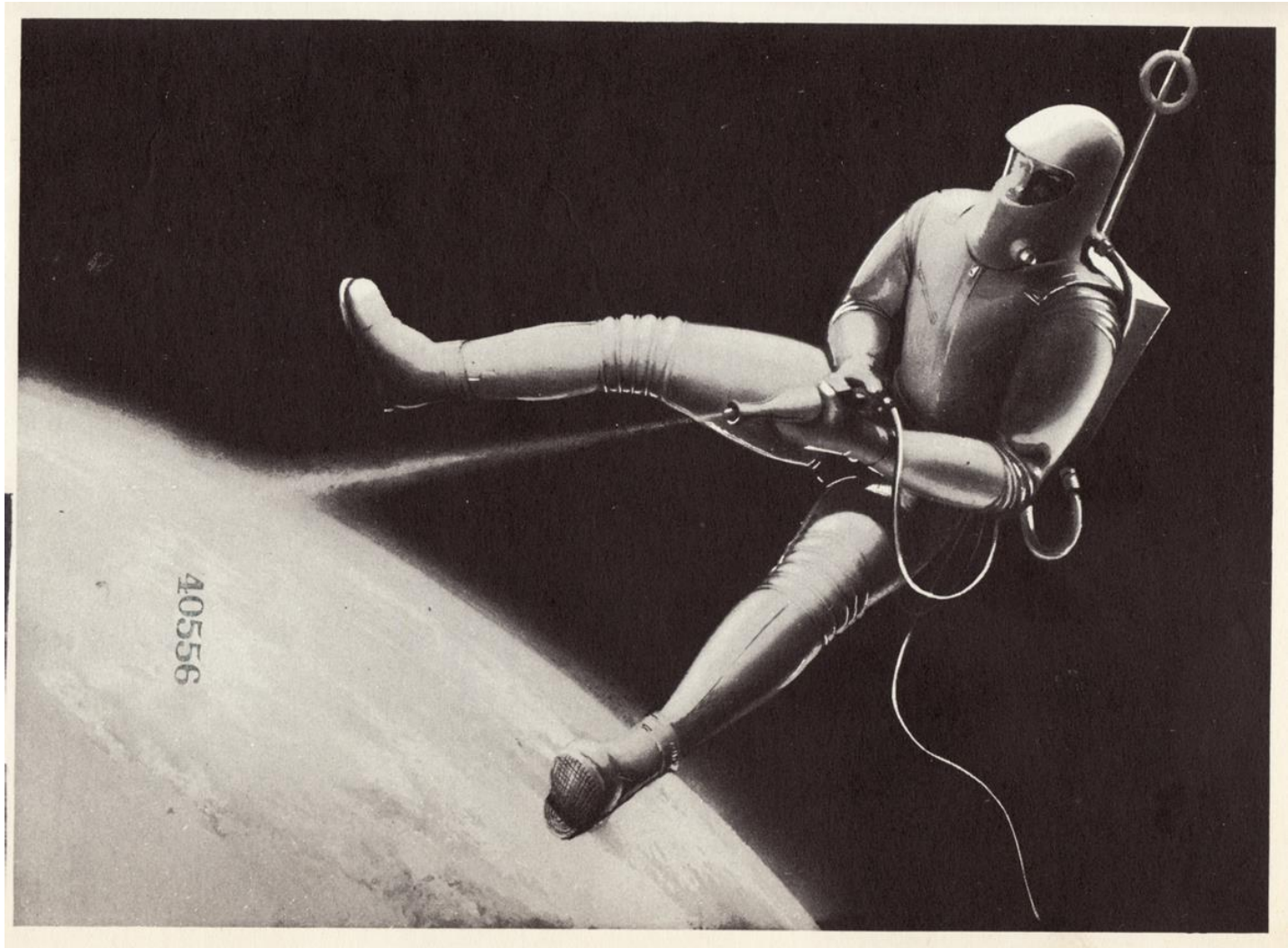
- All men dream, but not equally. Those who dream by night in the dusty recesses of their minds, wake in the day to find that it was vanity: but the dreamers of the day are dangerous men, for they may act on their dreams with open eyes, to make them possible.



1 – Imagination and Prescience

- Jules Verne - Moon and Florida
- H.G.Wells and World Brain/Wikipedia
- Teilhard de Chardin – Omega Man
- Vernadsky - Noosphere
- Asimov – Robotics
- A.C. Clarke and Moon

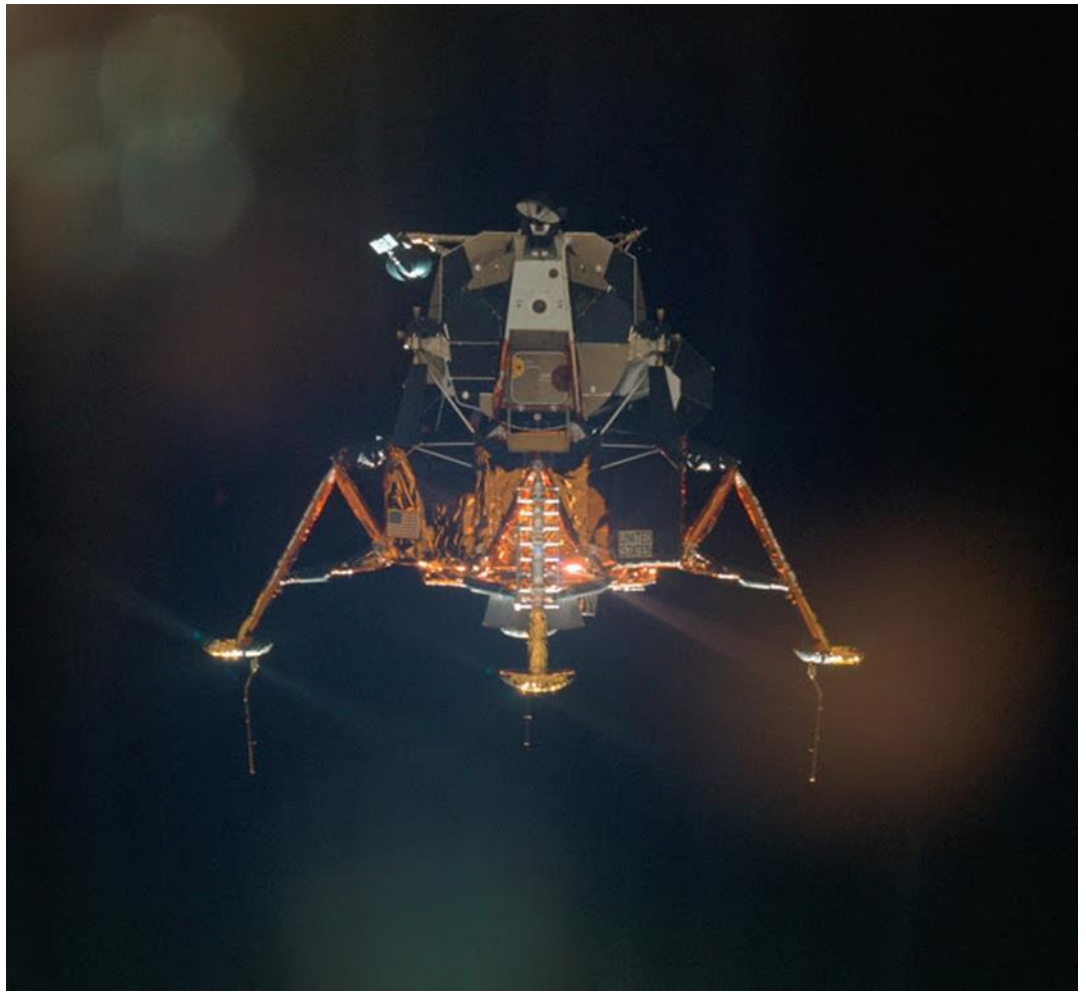
1954



June 1965

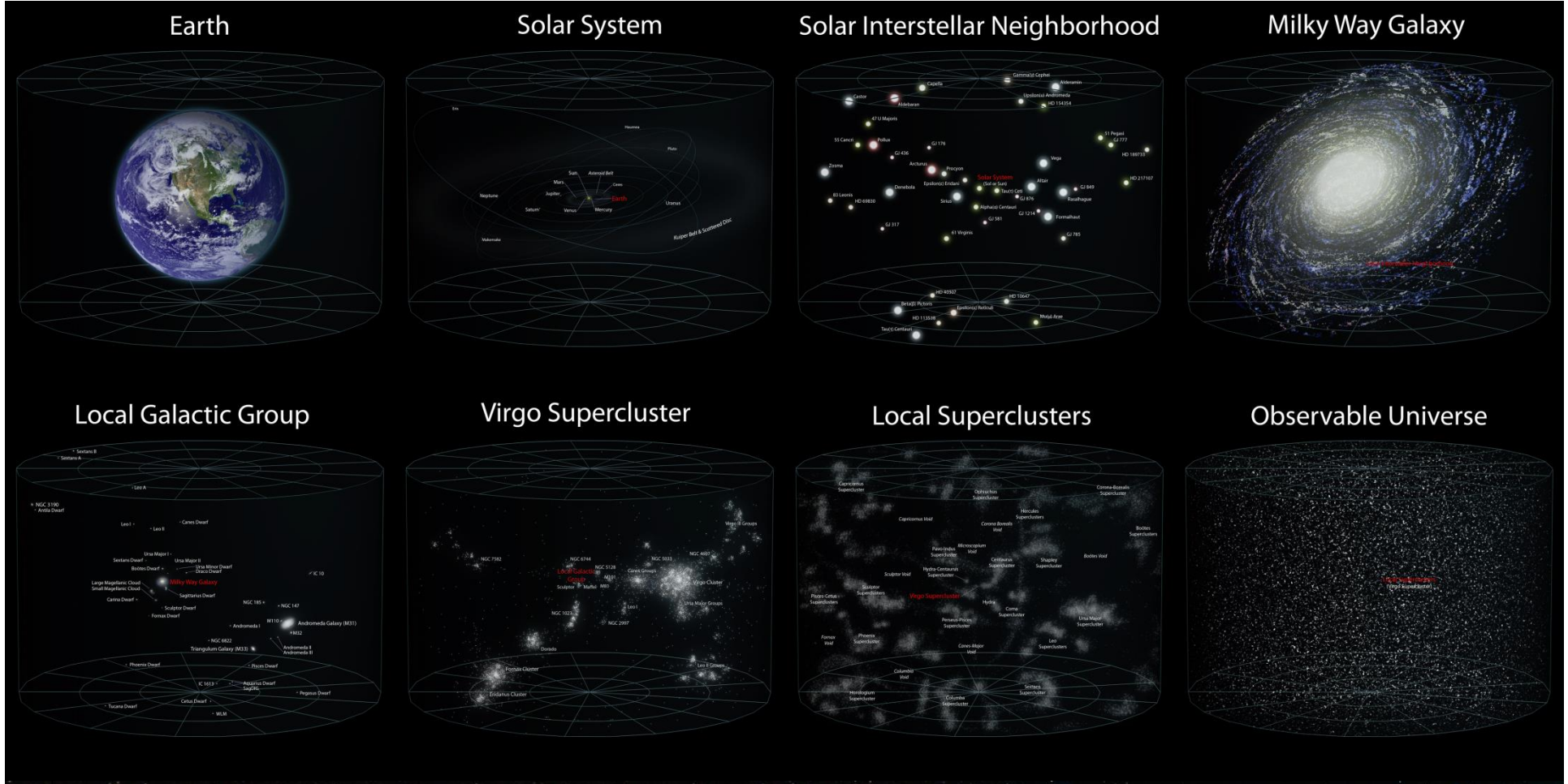
1954

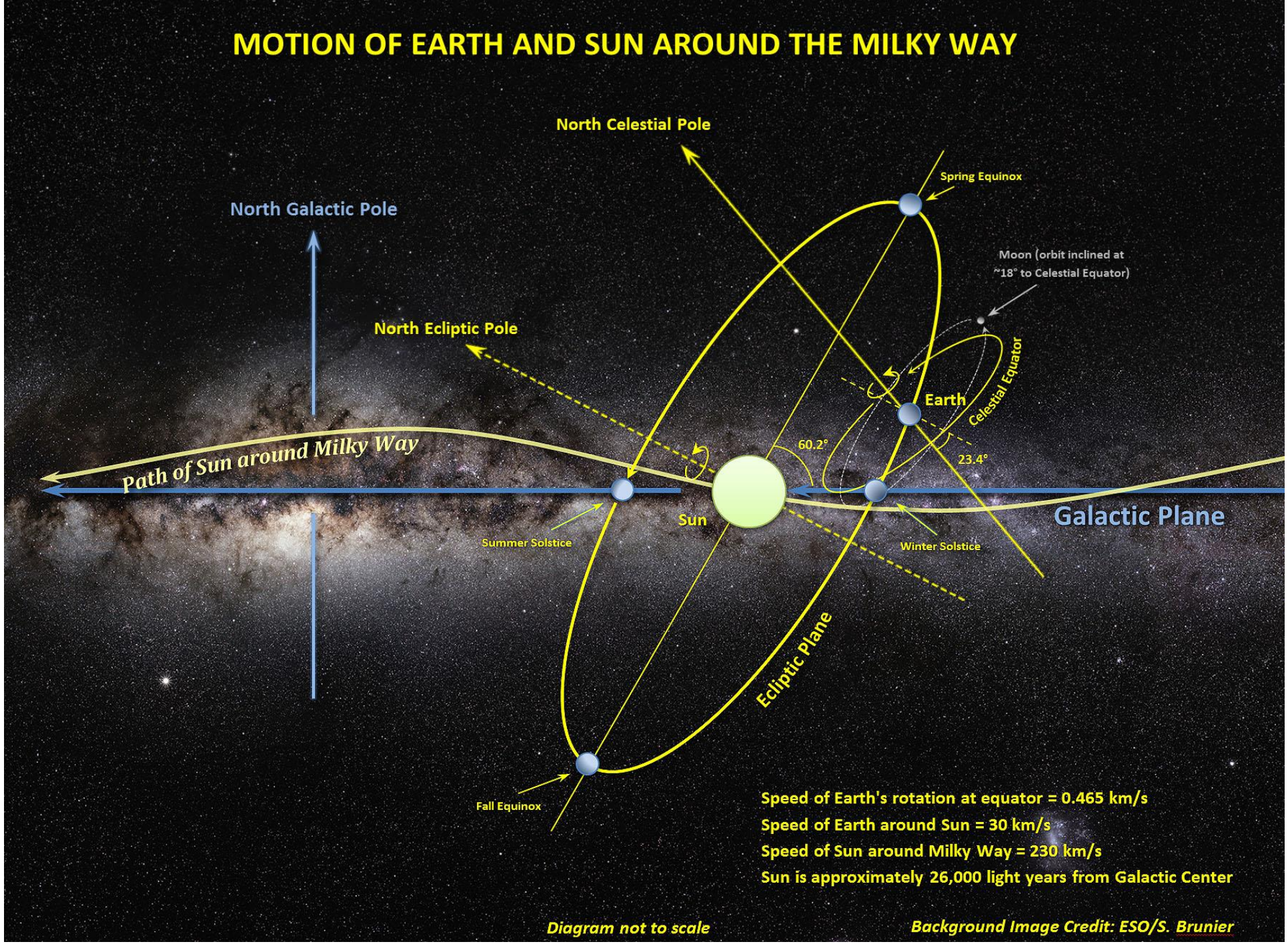
1969

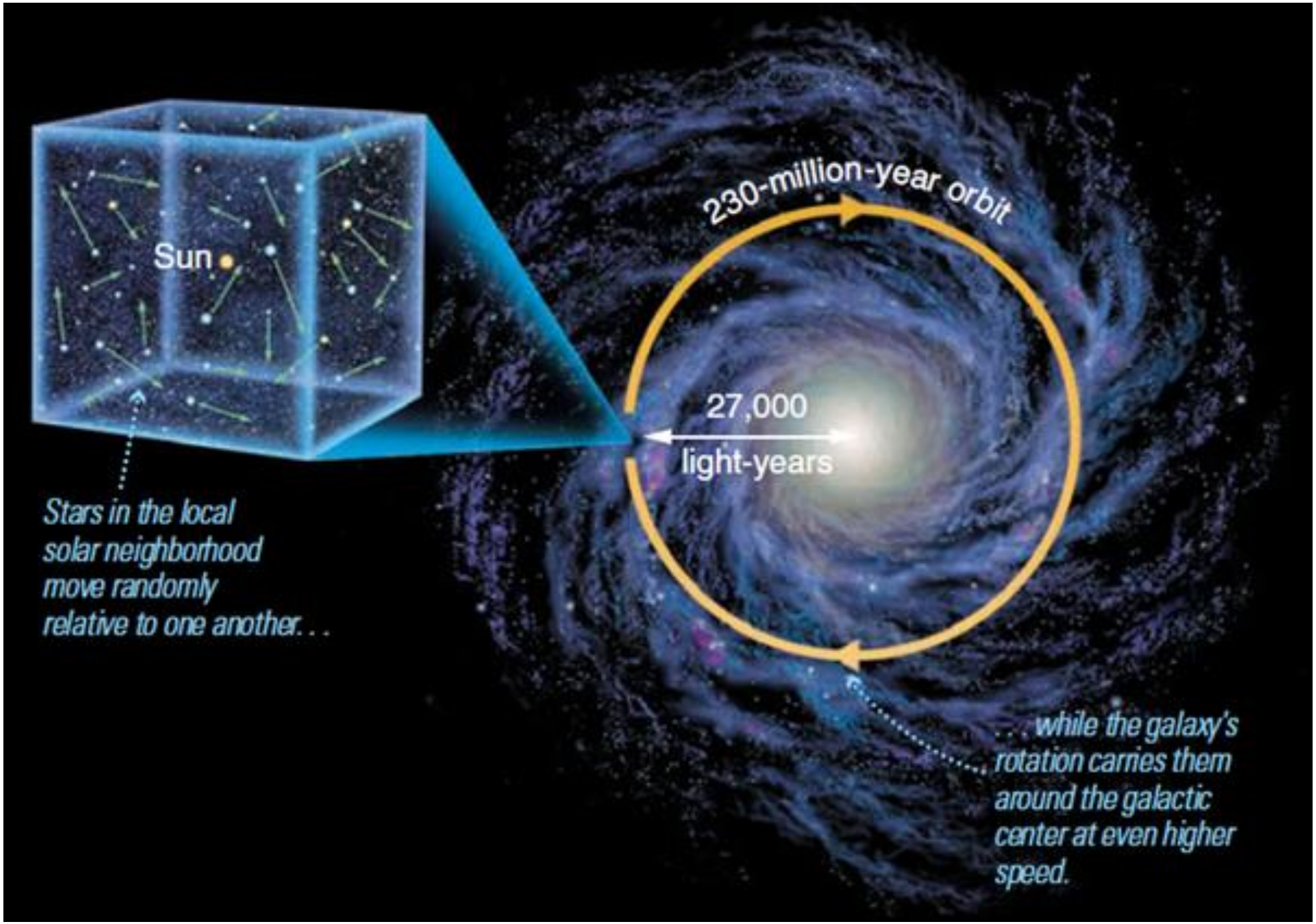


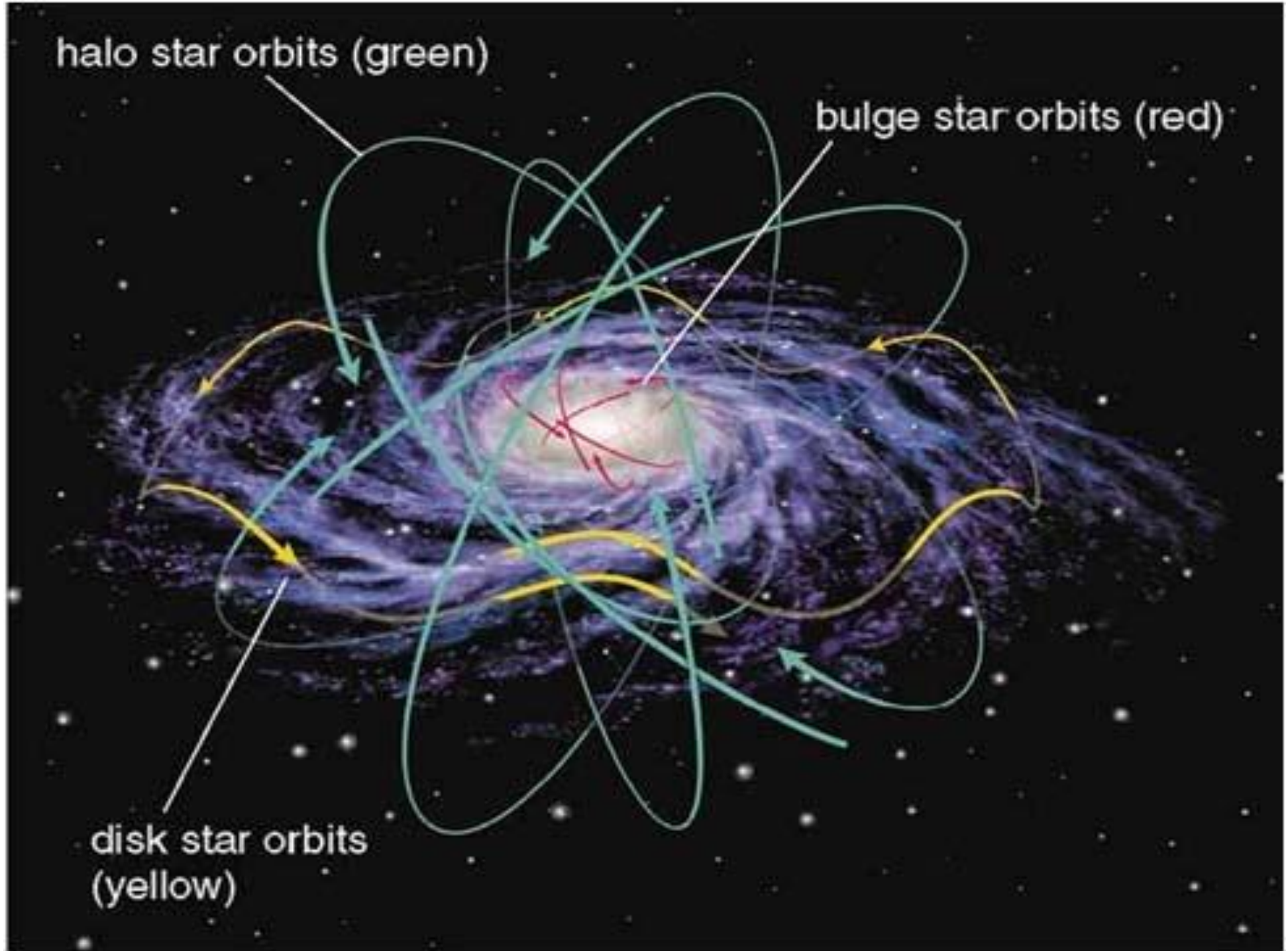
Dynamic Universe

- Cosmic Velocities and Energies
- Milky Way Rotation
- Anisotropic medium ?
- Fate of Stellar Systems
- Orphan planets and wandering bodies
- Radial Migration ?


Earth
Solar System
Solar Interstellar Neighborhood
Milky Way Galaxy
Local Galactic Group
Virgo Supercluster
Local Superclusters
Observable Universe


MOTION OF EARTH AND SUN AROUND THE MILKY WAY
North Celestial Pole
Spring Equinox
North Galactic Pole
Moon (orbit inclined at ~18° to Celestial Equator)
North Ecliptic Pole
Celestial Equator
Earth
60.2°
23.4°
Path of Sun around Milky Way
Sun
Galactic Plane
Summer Solstice
Winter Solstice
Ecliptic Plane
Fall Equinox
Speed of Earth's rotation at equator = 0.465 km/s
Speed of Earth around Sun = 30 km/s
Speed of Sun around Milky Way = 230 km/s
Sun is approximately 26,000 light years from Galactic Center
Diagram not to scale
Background Image Credit: ESO/S. Brunier


Sun
230-million-year orbit
27,000
light-years
Stars in the local solar neighborhood move randomly relative to one another. . .
. . . while the galaxy's rotation carries them around the galactic center at even higher speed.


halo star orbits (green)
bulge star orbits (red)
disk star orbits
(yellow)

The Wicked Problem

- Complex problem
- Many dynamic variables
- Moving goal posts
- Introduce new parameters
- Solved “out of bounds”

Heuristics

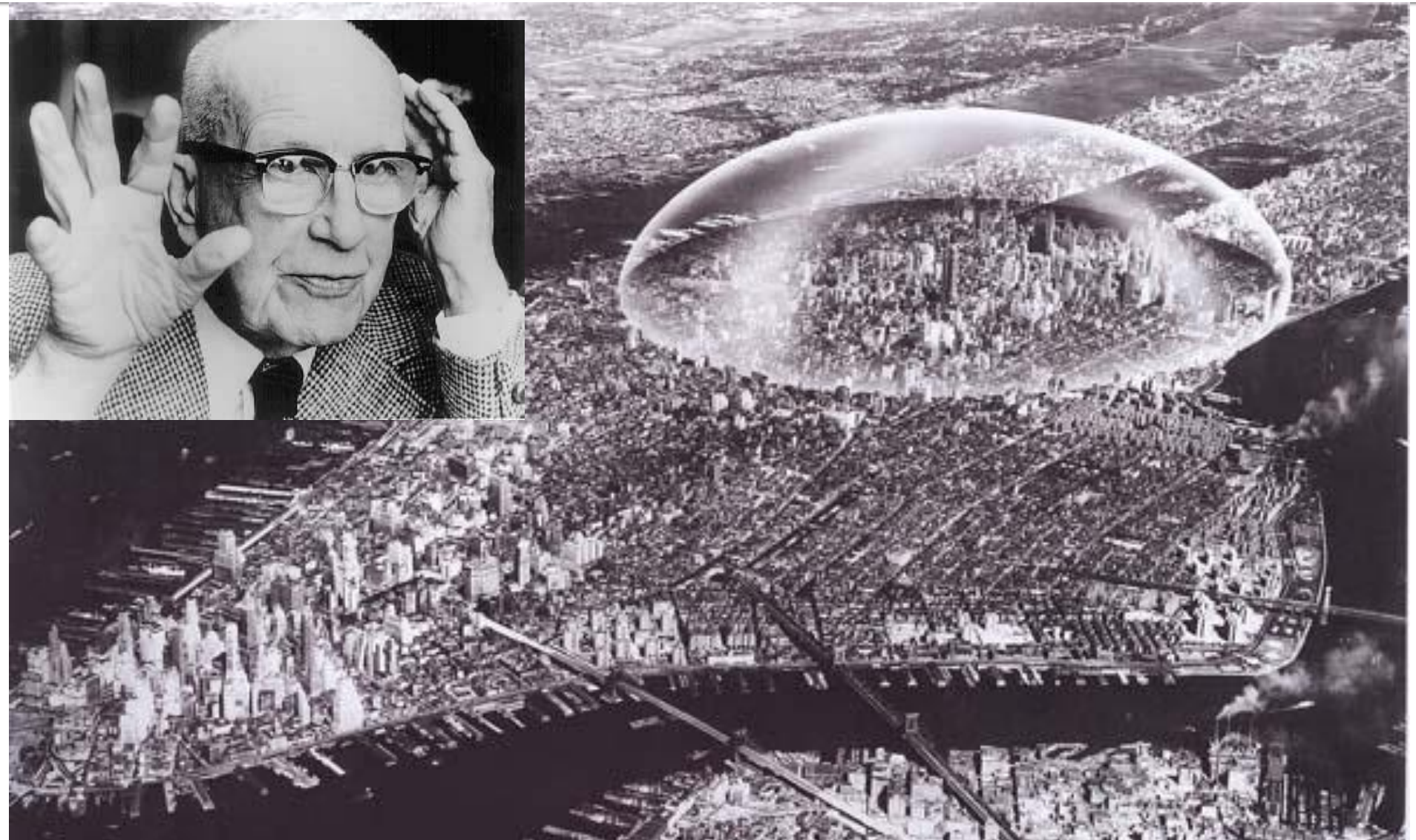
- Murphy’s Law
- Parkinson’s Law
- Augustine’s Laws
- Akin’s Laws
- Surgeon’s Heuristic - The eye cannot see what the mind cannot comprehend.
- Peter Principle

Critical Skill - Connections

- Synthetic Intelligence
- Context and Associative Logic
- Looking for Patterns
- Apply Heuristics
- Quilting
- Common Model – Debate and Discussion

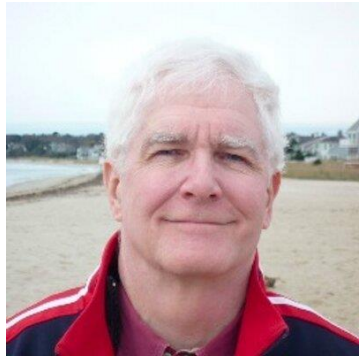
Space Philosophy

Spaceship Earth – Buckminster Fuller

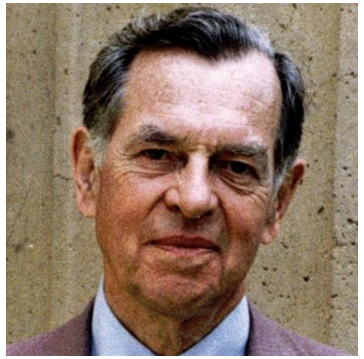


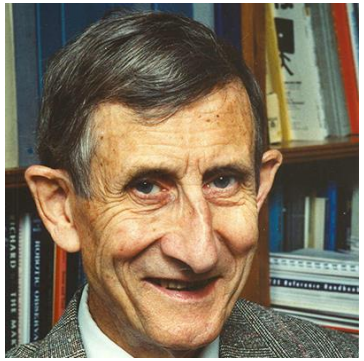
New Space Paradigms

- Musk – Settle other planets –human survival insurance
- Bezos – Protect and make Earth beautiful
- Marburger lll – Economic sphere of influence
- Campbell - Return of the Hero
- Dyson – Beautify our Universe
- Frank White –Overview Effect
- Protect Our Space Heritage



Dr. John H. Marburger III (1941–2011)






NASA
SEAL OF THE PRESIDENT OF THE UNITED STATES

Space Policy Directive SPD -1

"Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations;".

Take People to the Moon and then to Mars and Beyond.

December 11th 2018 – The USC ADAM Project

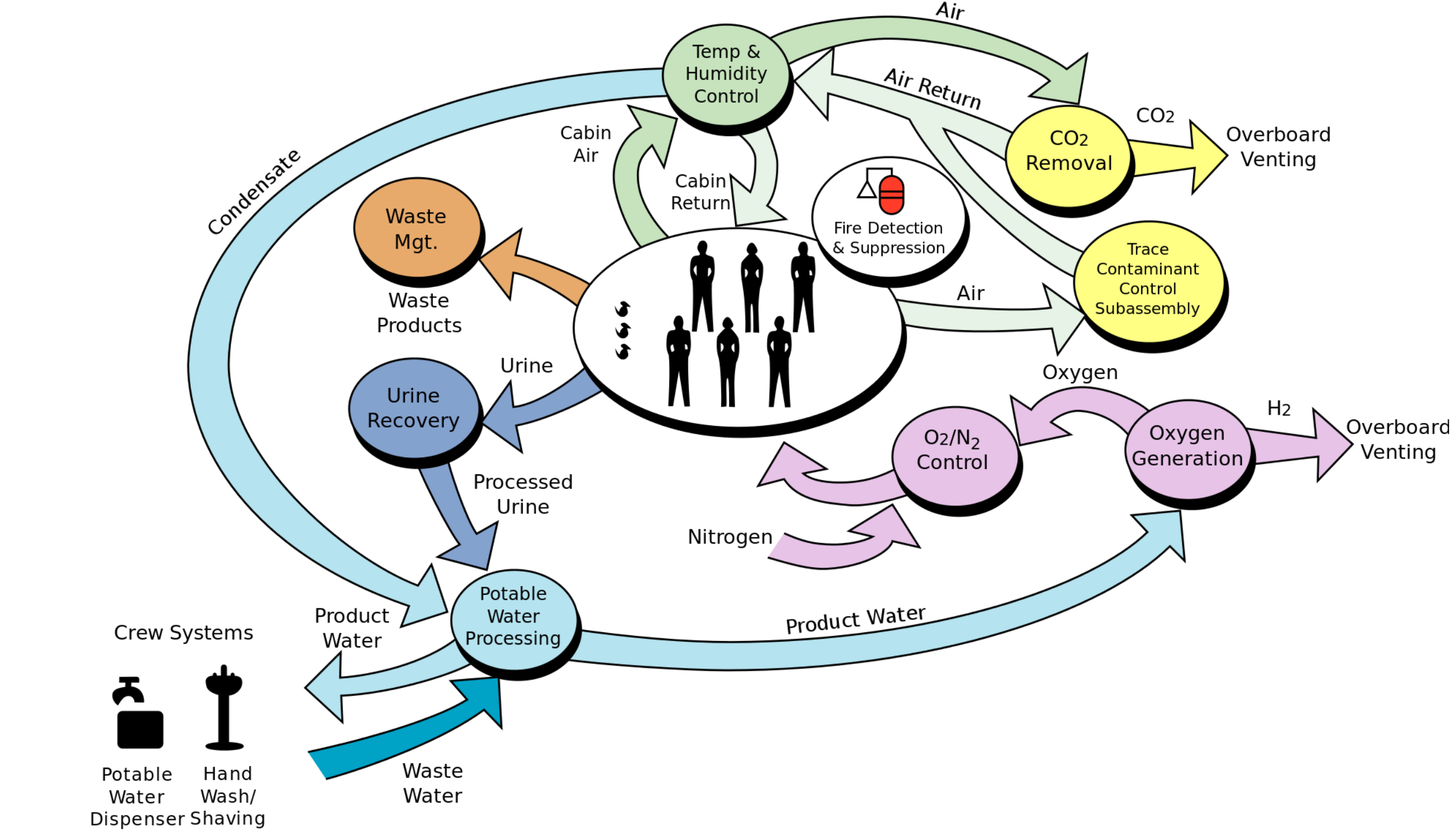

APOLLO XI

Spring 2018 USC School of Architecture
Space and City Seminar

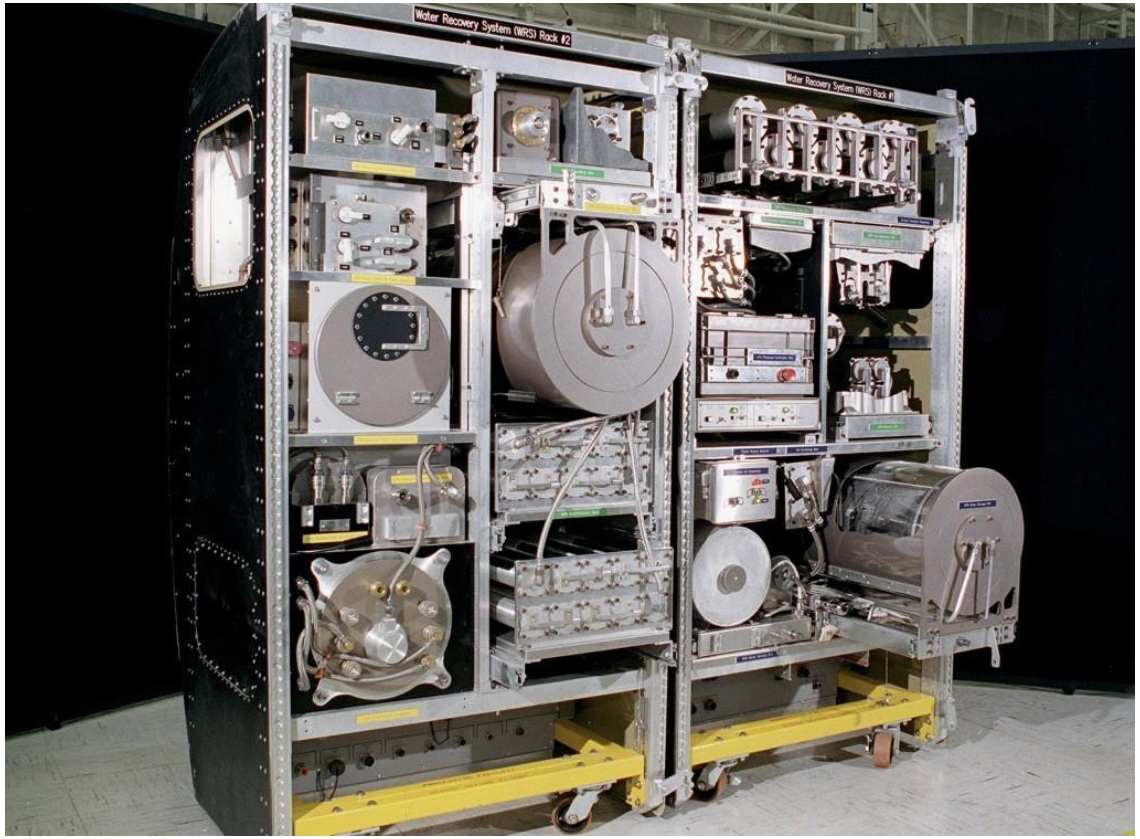
What can human spaceflight and human space activity do now for the multitude of the world's population ?


URBAN FARMING in ISTANBUL/KADIKOY
MANORA

International Space Station 120kW


Air
Temp & Humidity Control
Air Return
CO2 Removal
CO2
Overboard Venting
Cabin Air
Cabin Return
Fire Detection & Suppression
Trace Contaminant Control Subassembly
Air
Condensate
Waste Mgt.
Waste Products
Urine
Urine Recovery
Oxygen
O2/N2 Control
Oxygen Generation
H2
Overboard Venting
Processed Urine
Nitrogen
Potable Water Processing
Product Water
Product Water
Crew Systems
Potable Water Dispenser
Hand Wash/ Shaving
Waste Water

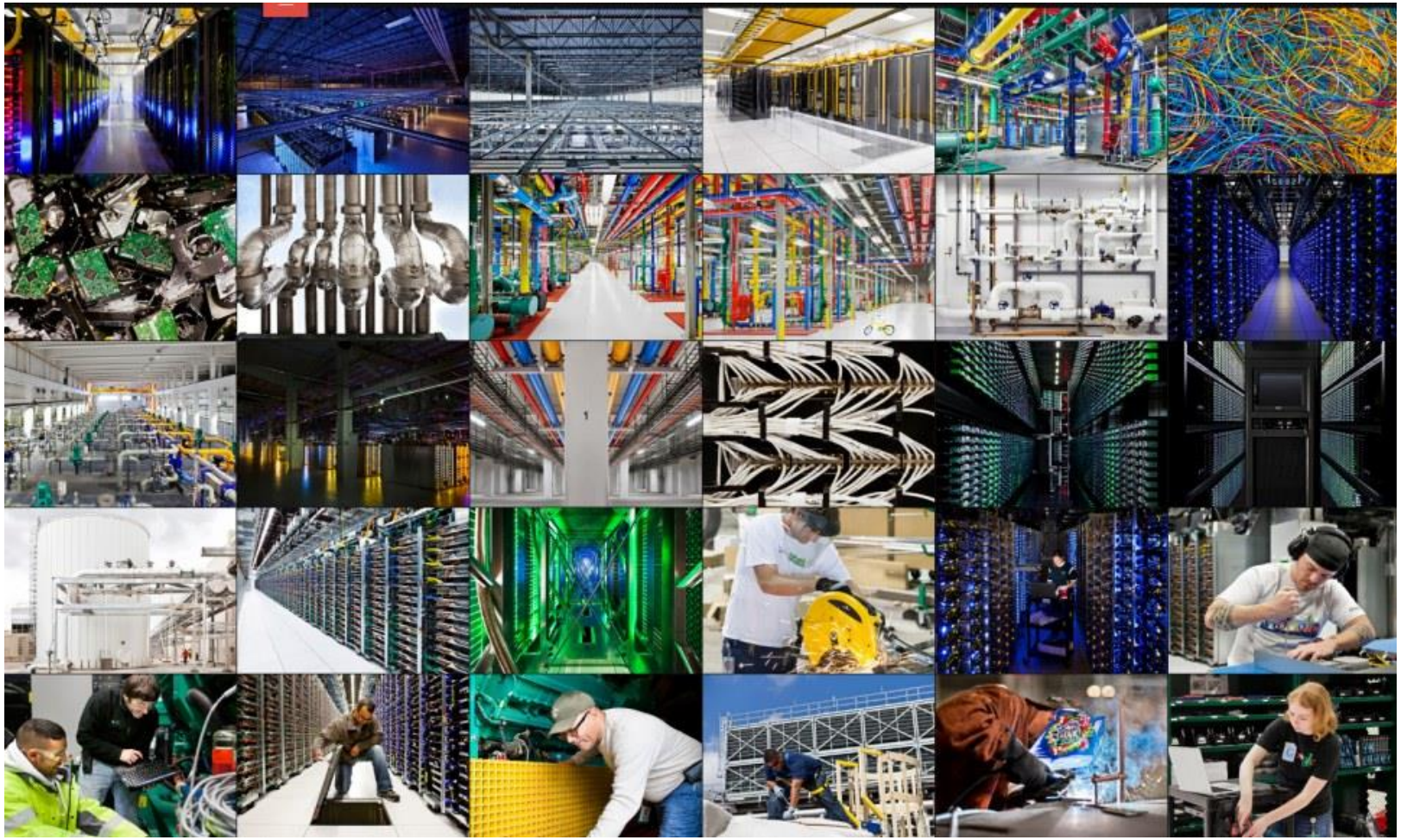
ISS Water Reclamation



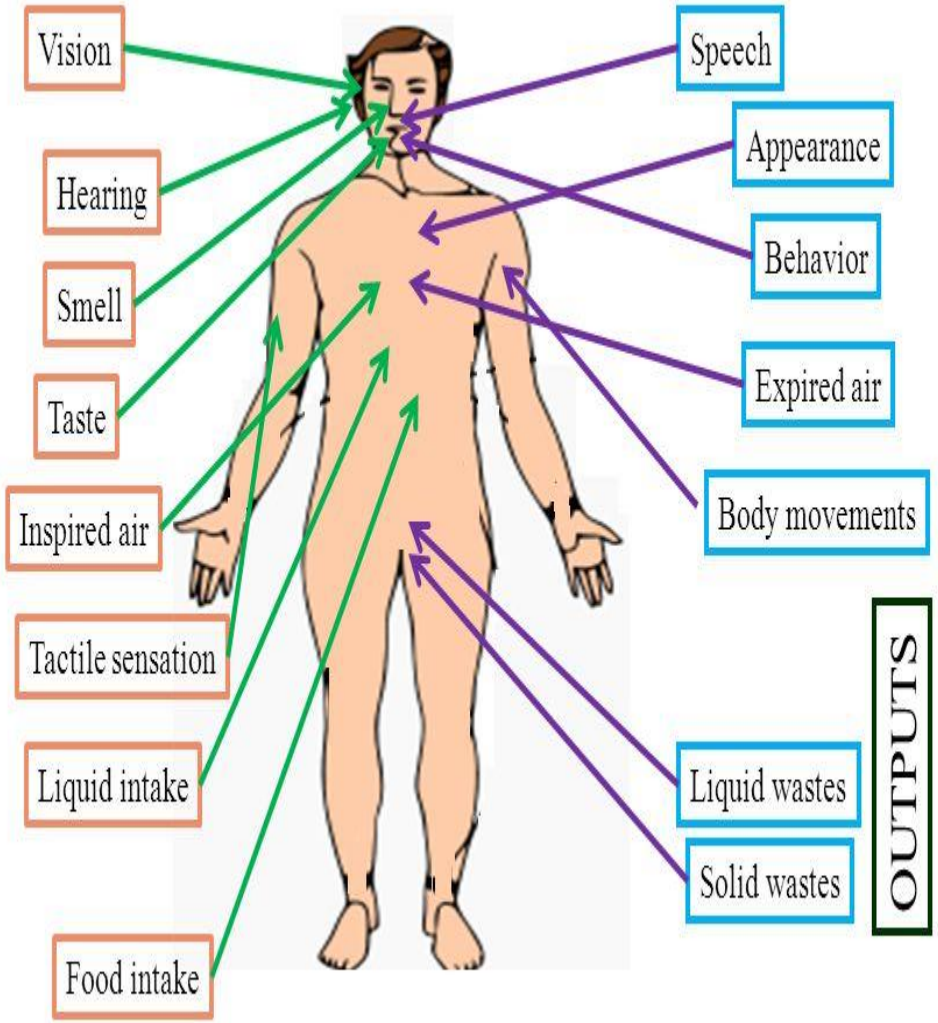
- https://www.youtube.com/watch?v=BCjH3k5gODI

Where Internet Lives - Google Data Centers

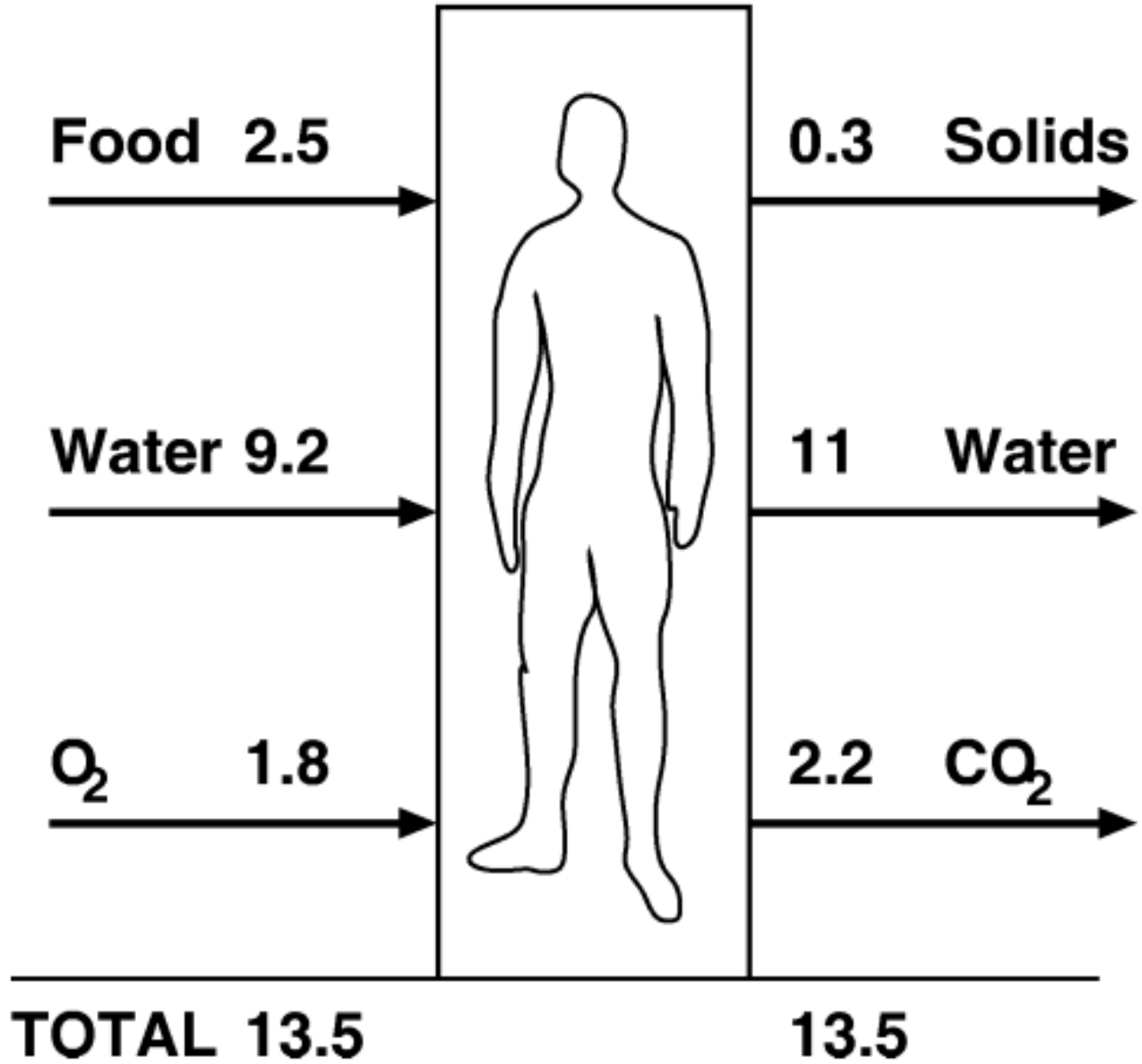
https://www.dailymail.co.uk/sciencetech/article-2219188/Inside-Google-pictures-gives-look-8-vast-data-centres.html

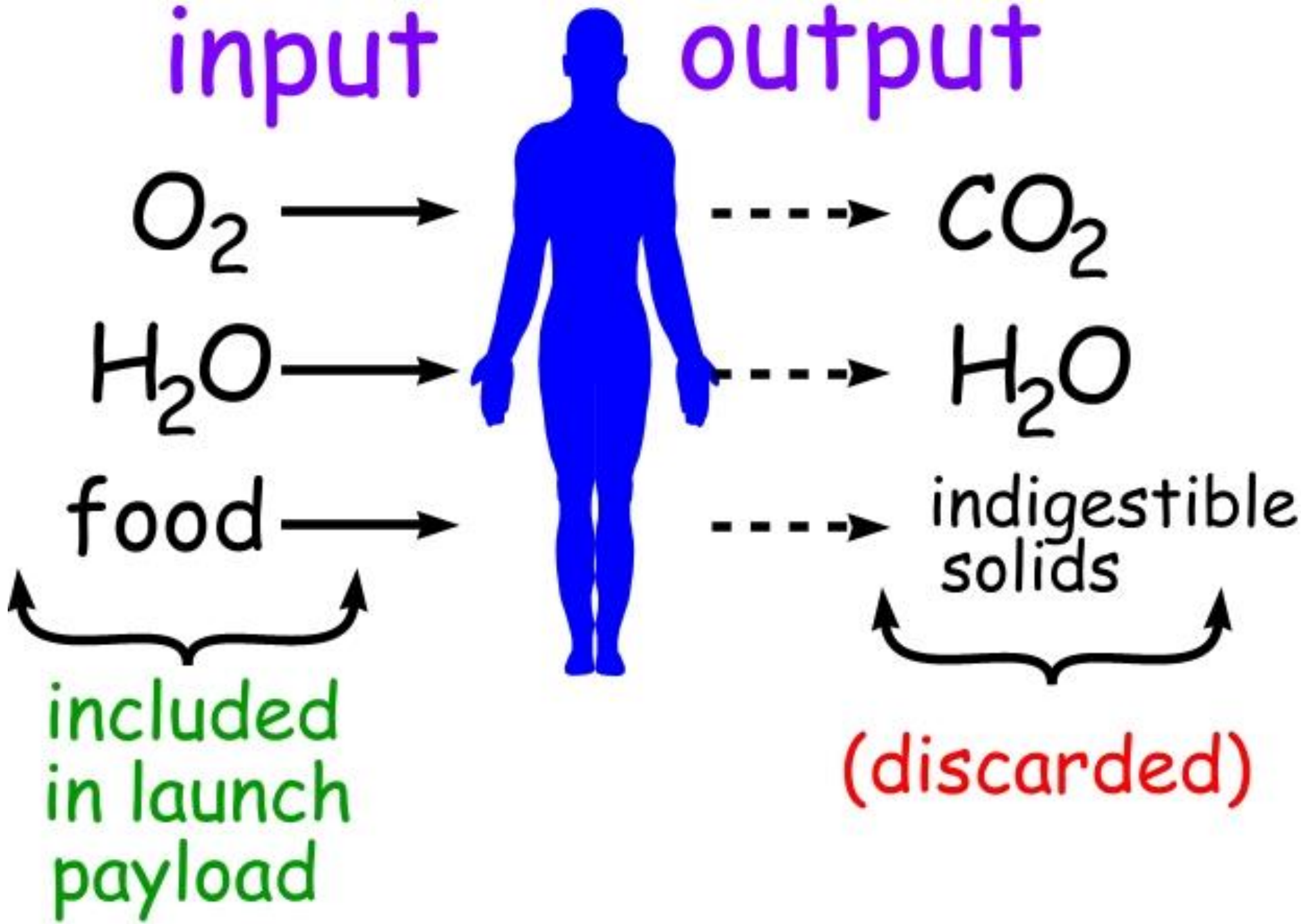


Physiological Systems in the Human body



Typical Human Mass Throughput
Pounds/Day




input
output
O_2
H_2O
food
CO_2
H_2O
indigestible solids
included in launch payload
(discarded)

Human Needs

- Human Spaceflight
- Isolation
- Health
- Safety
- Morale
- Productivity

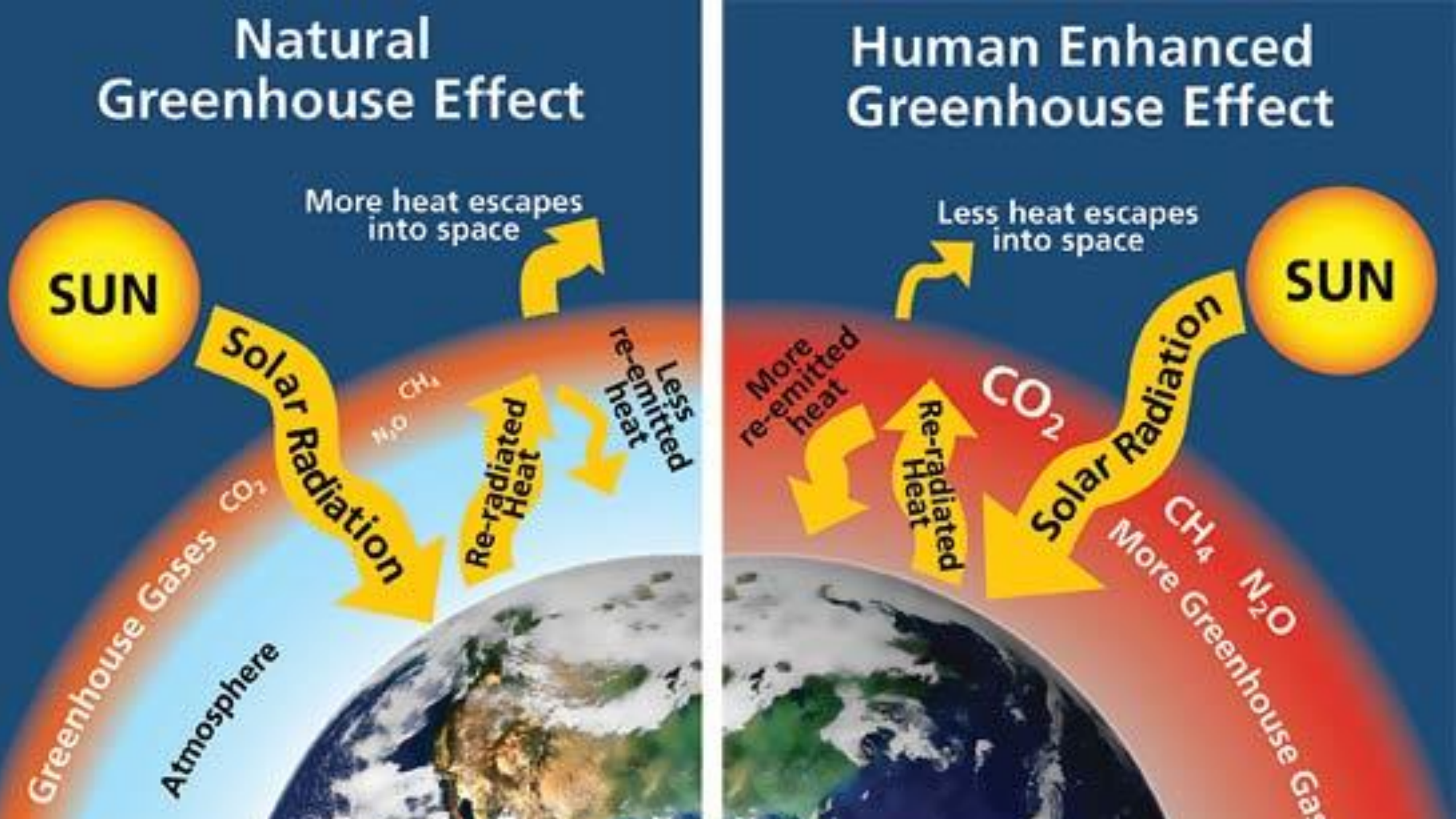
Maslow's hierarchy of needs

Submariners


USS NORFOLK
714

World Population 2050 -10 Billion

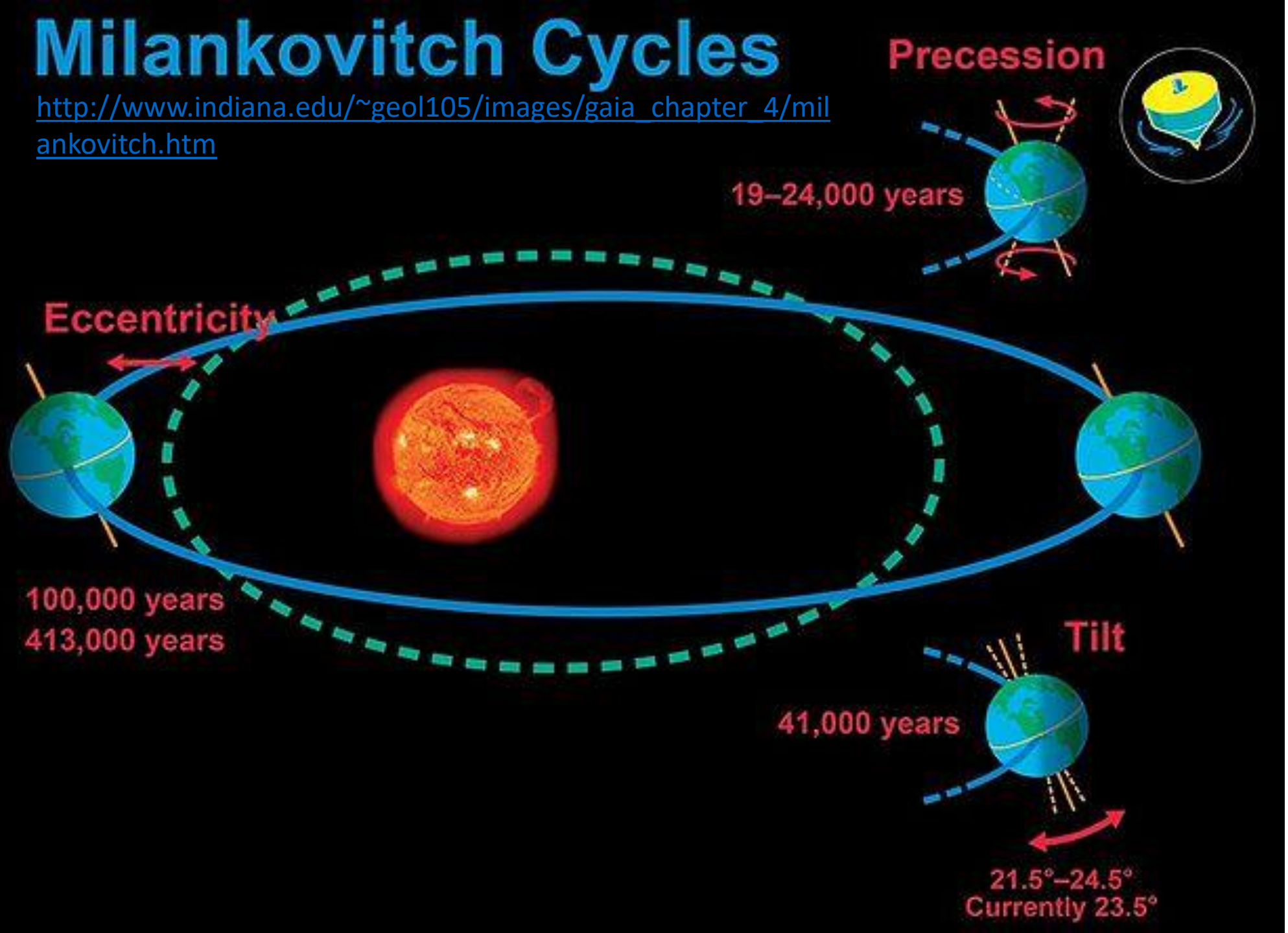
World Population Growth


Natural
Greenhouse Effect
SUN
More heat escapes
into space
Solar Radiation
Re-radiated
Heat
Less
re-emitted
heat
CH_4
N_2O
CO_2
Greenhouse Gases
Atmosphere
Human Enhanced
Greenhouse Effect
Less heat escapes
into space
SUN
More
re-emitted
heat
Re-radiated
Heat
CO_2
Solar Radiation
CH_4
N_2O
More Greenhouse Ga

Solar Activity

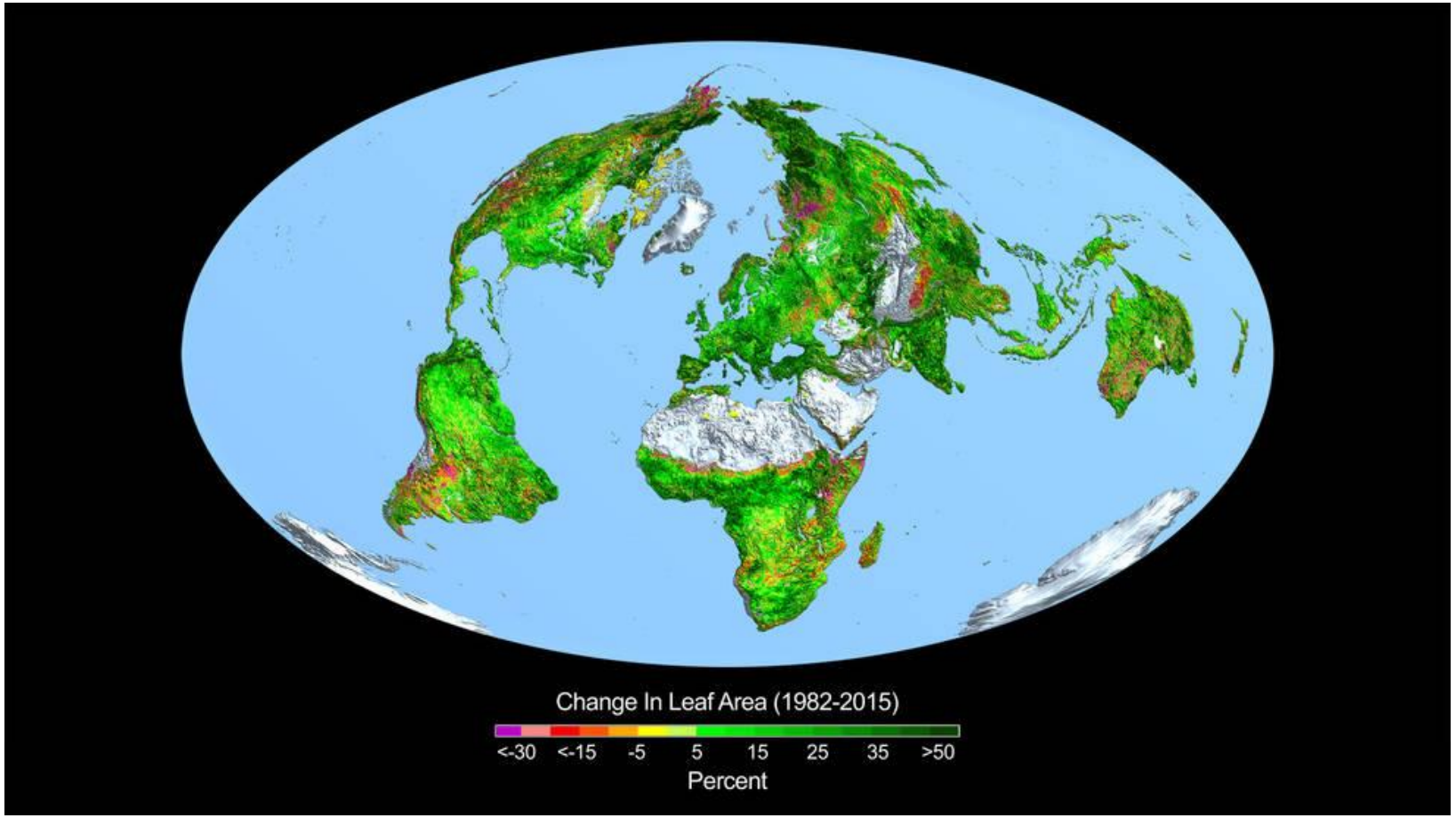
Milankovitch Cycles

http://www.indiana.edu/~geol105/images/gaia_chapter_4/milankovitch.htm

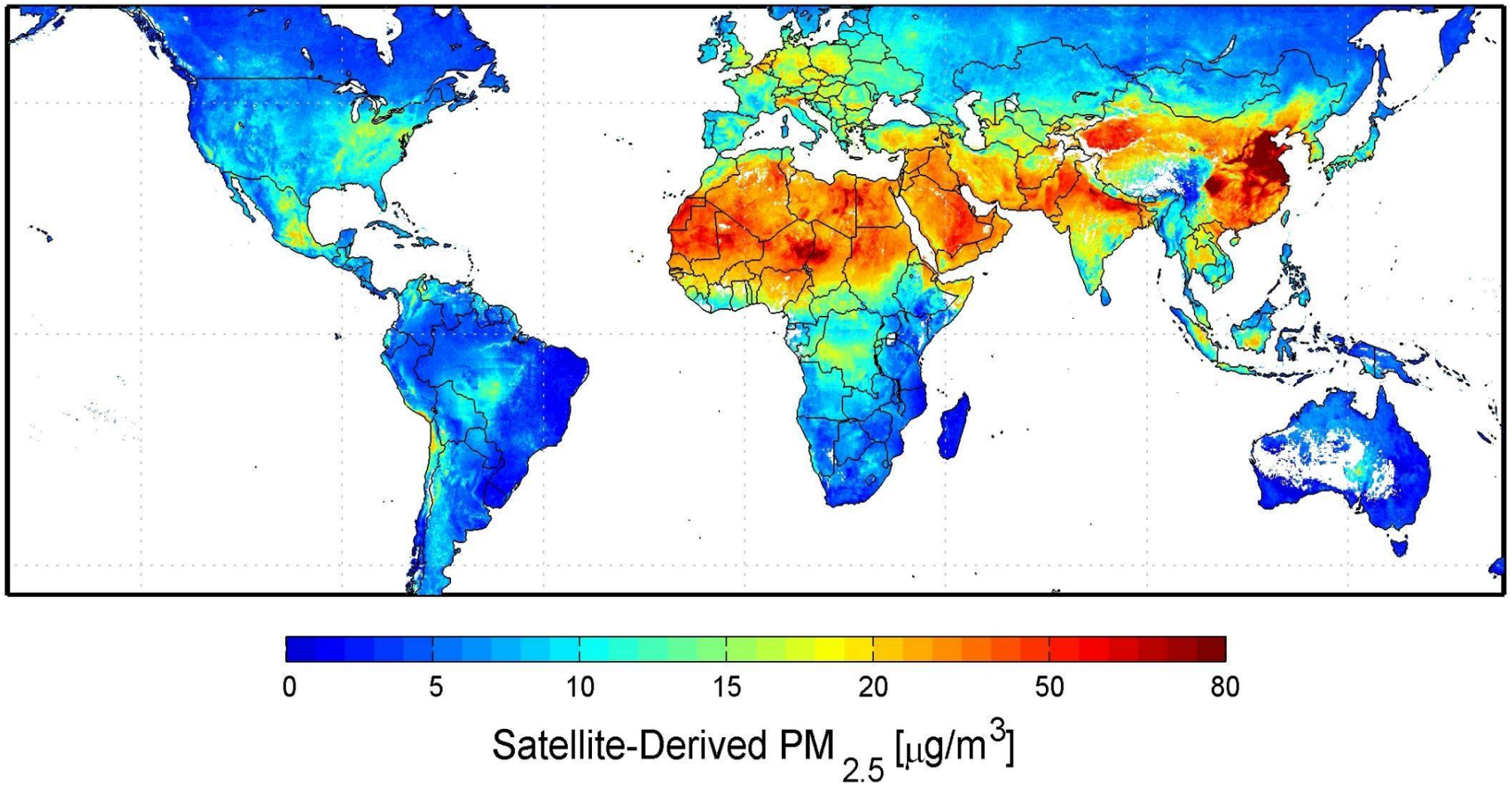


Climate Change

Consequences - CO2 Fertilization - Greener Earth

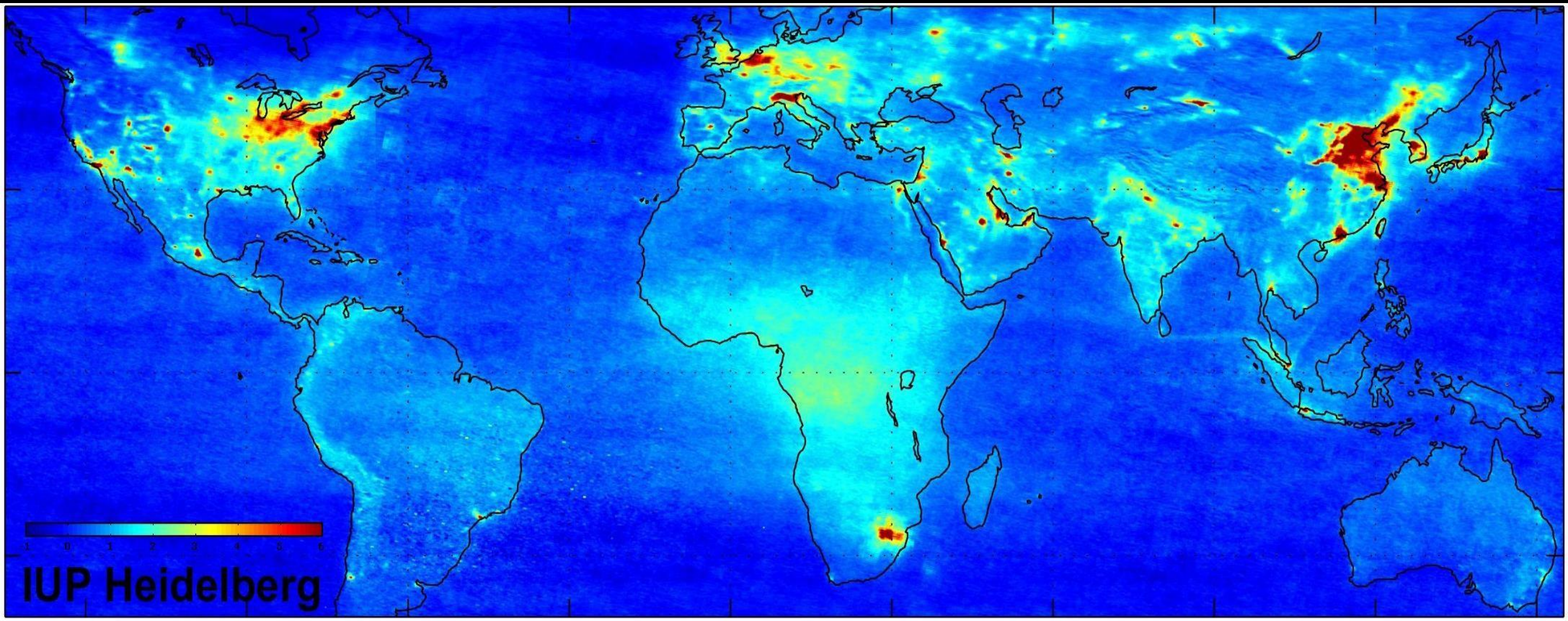


Pollution- Fine Particulate Matter($PM_{2.5}$)



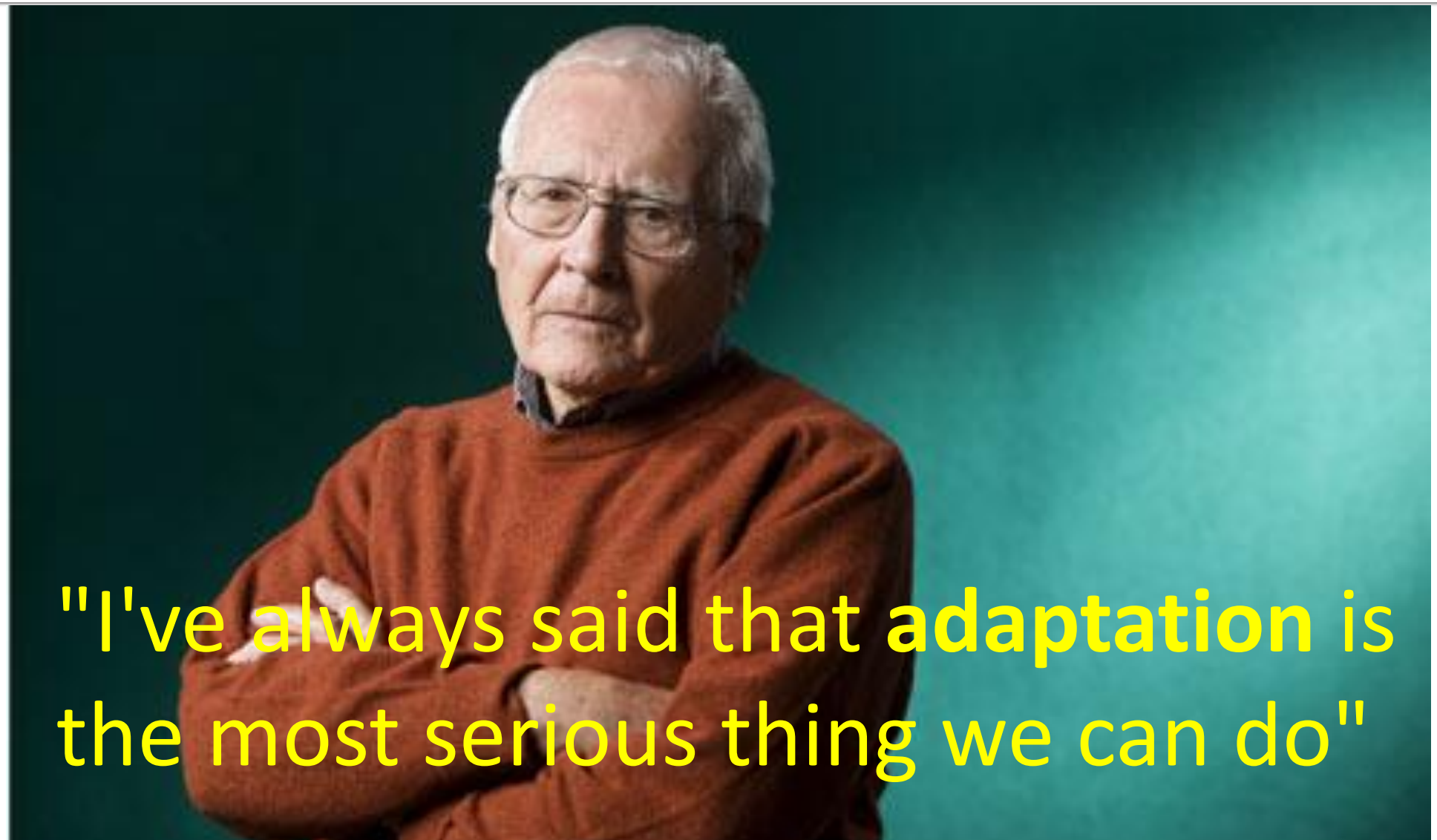
ESA NO_2 map

GLOBAL AIR POLLUTION MAP PRODUCED BY ENVISAT'S SCIAMACHY



World Travel

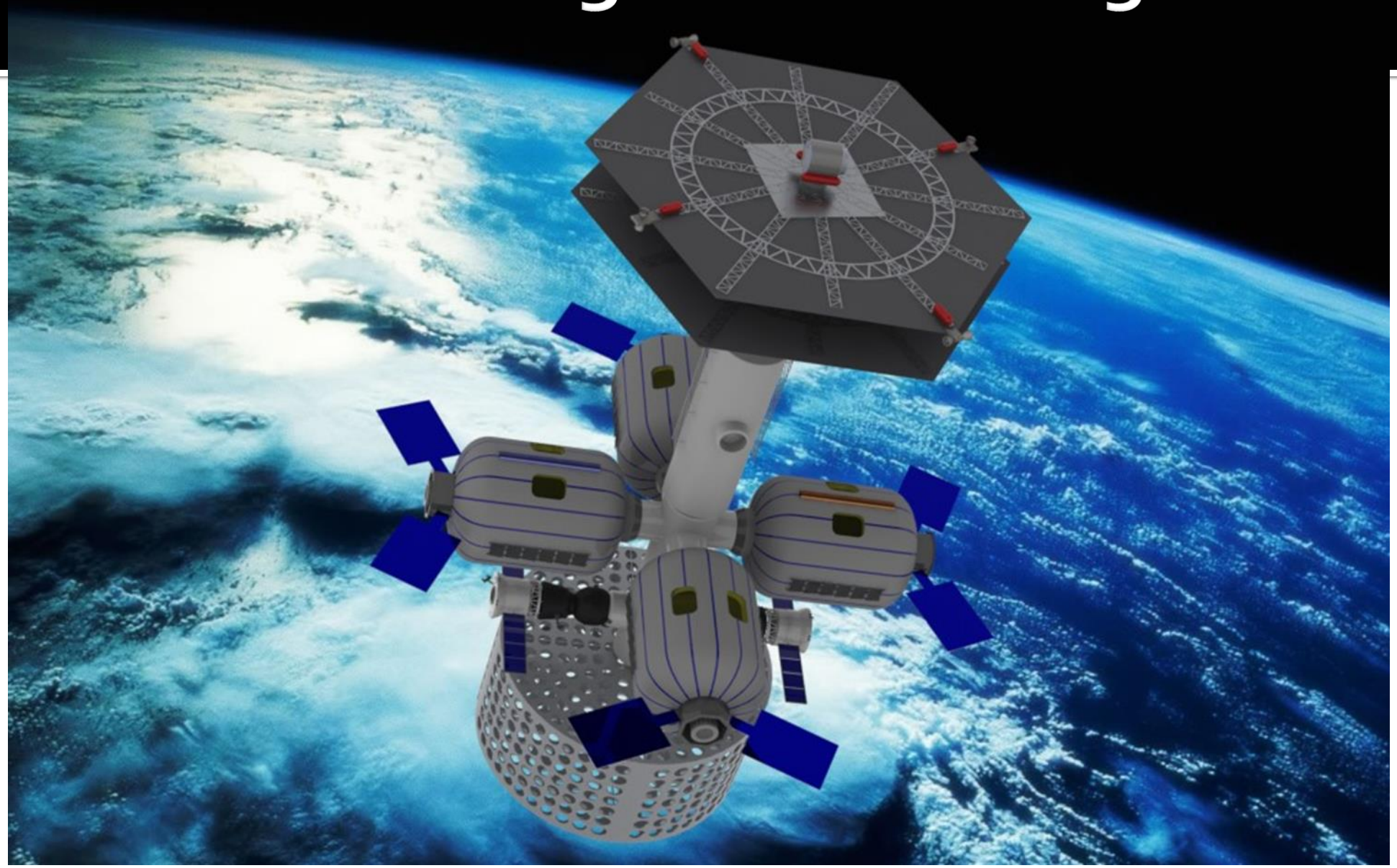
Prof.James Lovelock on Adaptation to Climate Change



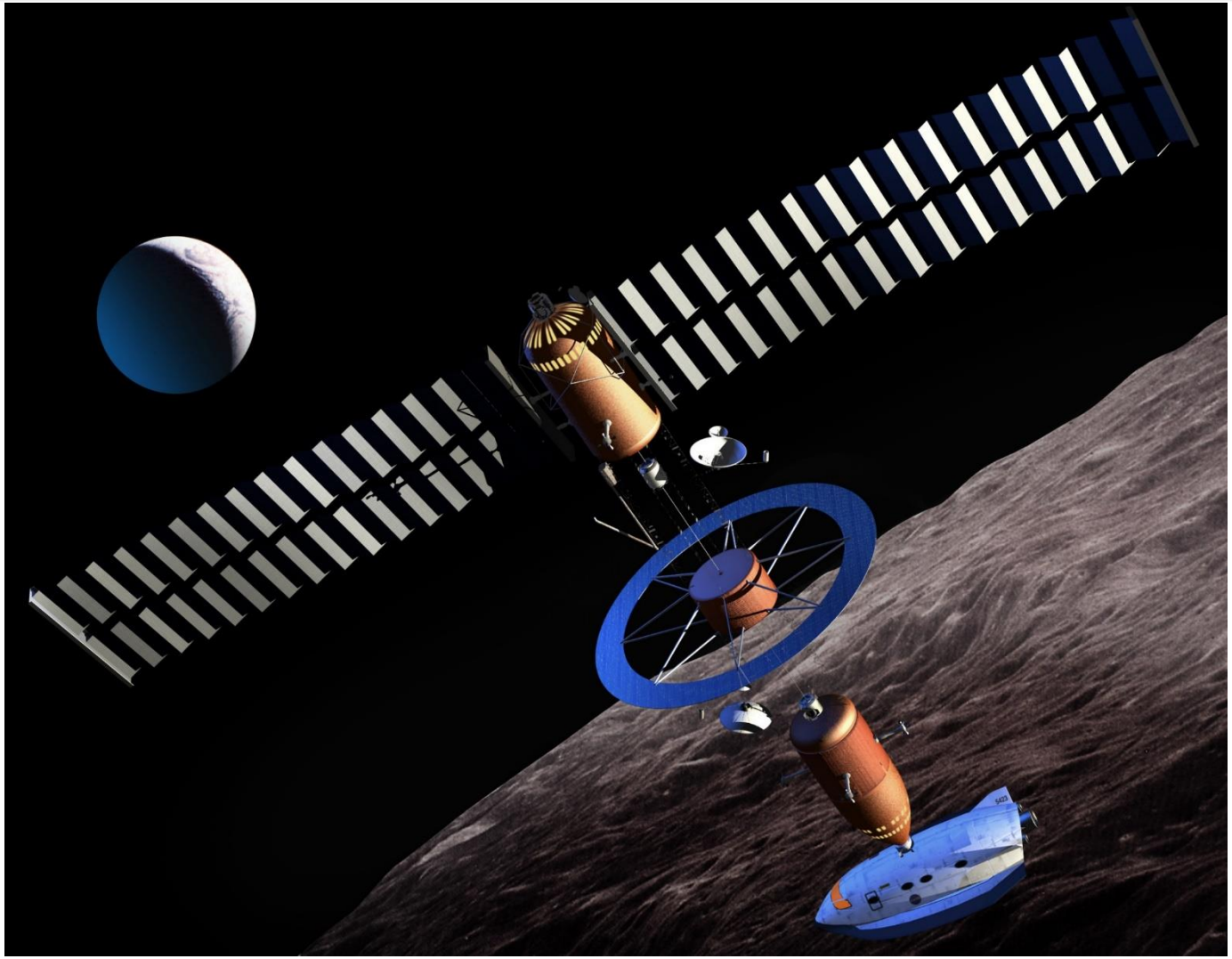

The most important thing about Spaceship Earth - an instruction book didn't come with it.
R. Buckminster Fuller

Some Concepts

Earth Orbiting Transit Lounge

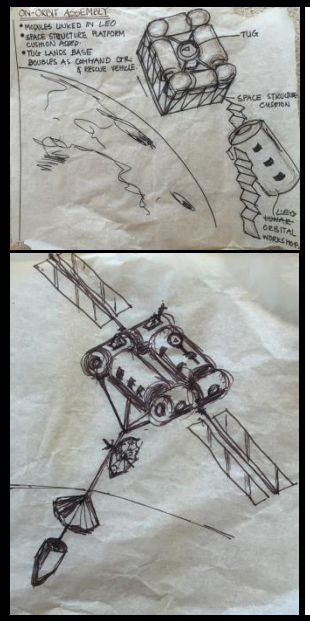


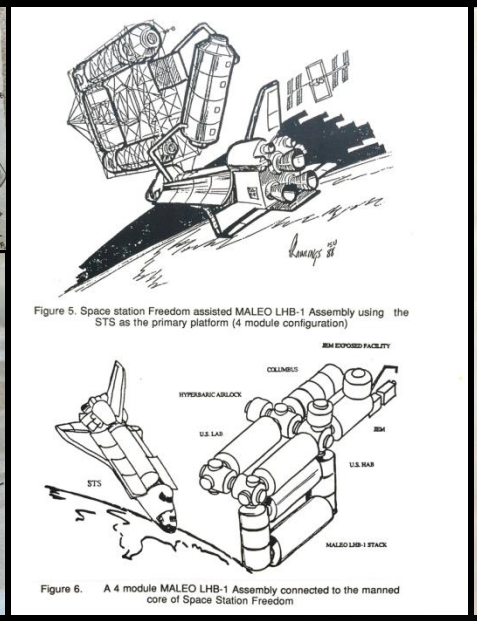
Lunar Orbiting Lounge

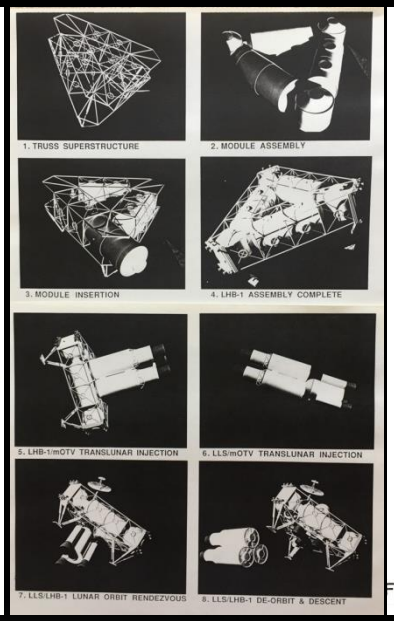


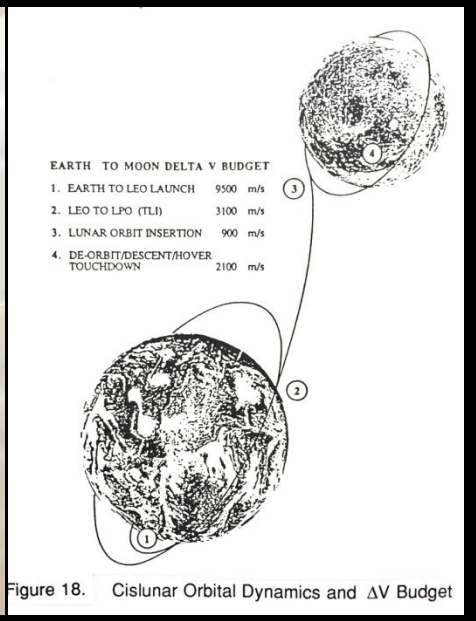
MALEO : MODULE ASSEMBLY IN LOW EARTH ORBIT

- **A strategy to build and commission a lunar surface habitat complex by integrating several modules in LEO using the ISS and her crew, and ship it to the lunar surface using custom propulsion systems, thereby avoiding the infrastructure otherwise needed to construct one piece by piece, and eliminating the clingy dust nuisance that hampers lunar surface activity.**







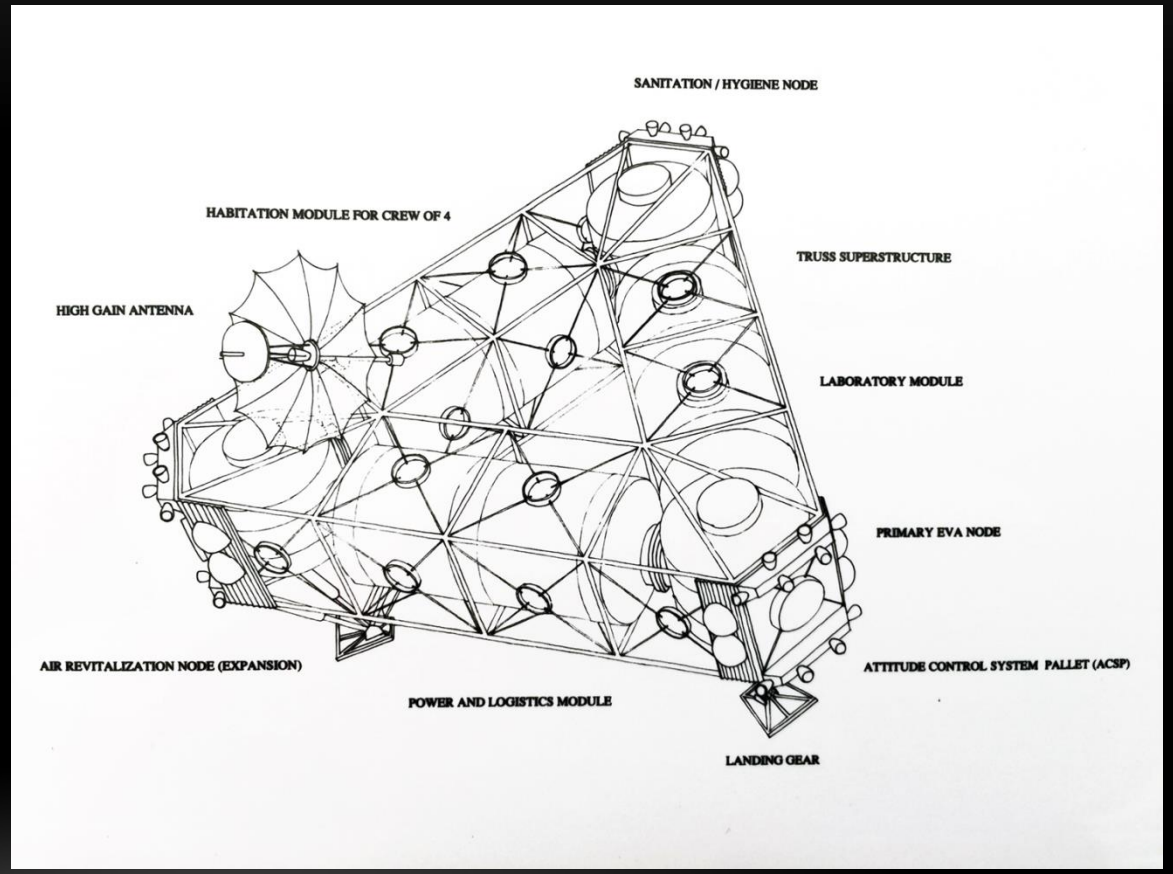


- First proposed at the inaugural summer session of the International Space University at MIT in 1988
- First presented and published at the 1988 IAC in Bangalore, India
- Several subsequent publications including USC 1988, IAC Dresden1990, ASCE 1992, JBIS 1993

USC Viterbi School of Engineering

MALEO - SALIENT FEATURES

- **Payload Summary [MT]**
- Habitat Module = 15
- Lab Module = 15
- Power/Logistics = 15
- ECLSS Node = 5
- Sanitation/Hygiene = 5
- Airlock/EVA = 10
- Truss/Landing gear = 10
- 100kWSolar Arrays/Comm = 5
- Unpress.Electric Rover X2 = 10
- Attitude Control Pallet X3 = 6
- **Touchdown Mass ~100MT**
- + lander propulsion stack



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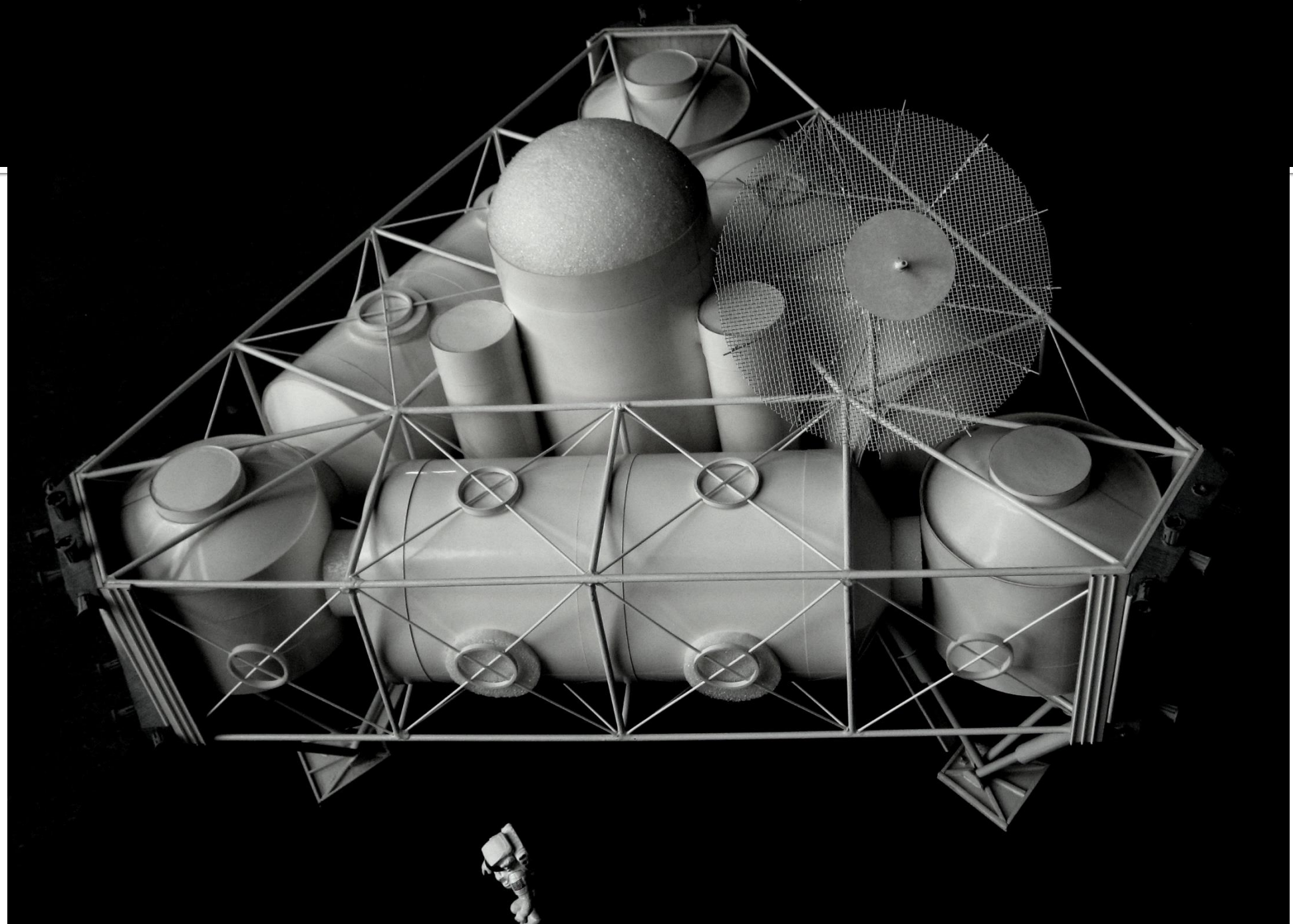
INTERNATIONAL SPACE UNIVERSITY

USC School of Architecture



Module Assembly in LEO(MALEO)

MALEO

MALEO:Modular Assembly in Low Earth Orbit, Coke Nation Corporate Lunar Lander Artwork by Chloe Saras Thangavelu 2012

Telephone: 599757 94255
Cable: UNDERSEA COLOMBO
Fax: 598730

දුරකථනය: 599757 94255

ARTHUR C. CLARKE

"LESLIE'S HOUSE"
25, BARNES PLACE, COLOMBO 7, SRI LANKA

ආතර් සී. ක්ලාක්
"ලෙස්ලිගෙ නිවස"
25, බාන්ස් පෙදෙස, කොළඹ 7, ශ්‍රී ලංකාව

Mr Madhu Thangavelu
Institute of Aerospace Systems
Architecture & Technology
University of Southern California
Los Angeles, Ca 90089-1191.

7th July 1989

Dear Madhu,

Thank you very much for the copy of "USC Trojan Family" and "International Student News" - I read the articles about your Lunar Base project with great interest.

To the best of my knowledge, this is a novel idea - everyone has always assumed that a Lunar Base will be constructed piece-meal. However, the advantages of having it complete are obvious, and there seems to be no particular penalty - especially if the landing module can take-off and be used again after a new habitat is fitted around it.

I was delighted to see your remarks about the ISU - as you may know, I've just been appointed its Chancellor.

My collaborator Gentry Lee, who was Chief Engineer on the "Galileo" project, and has just completed the manuscript of Rama II is currently working on a major Japanese television script with me, one section of which involves space habitats. I'm passing on this letter to him, because he may be interested in contacting you.

All good wishes,

Arthur C Clarke

cc: Mr Gentry Lee

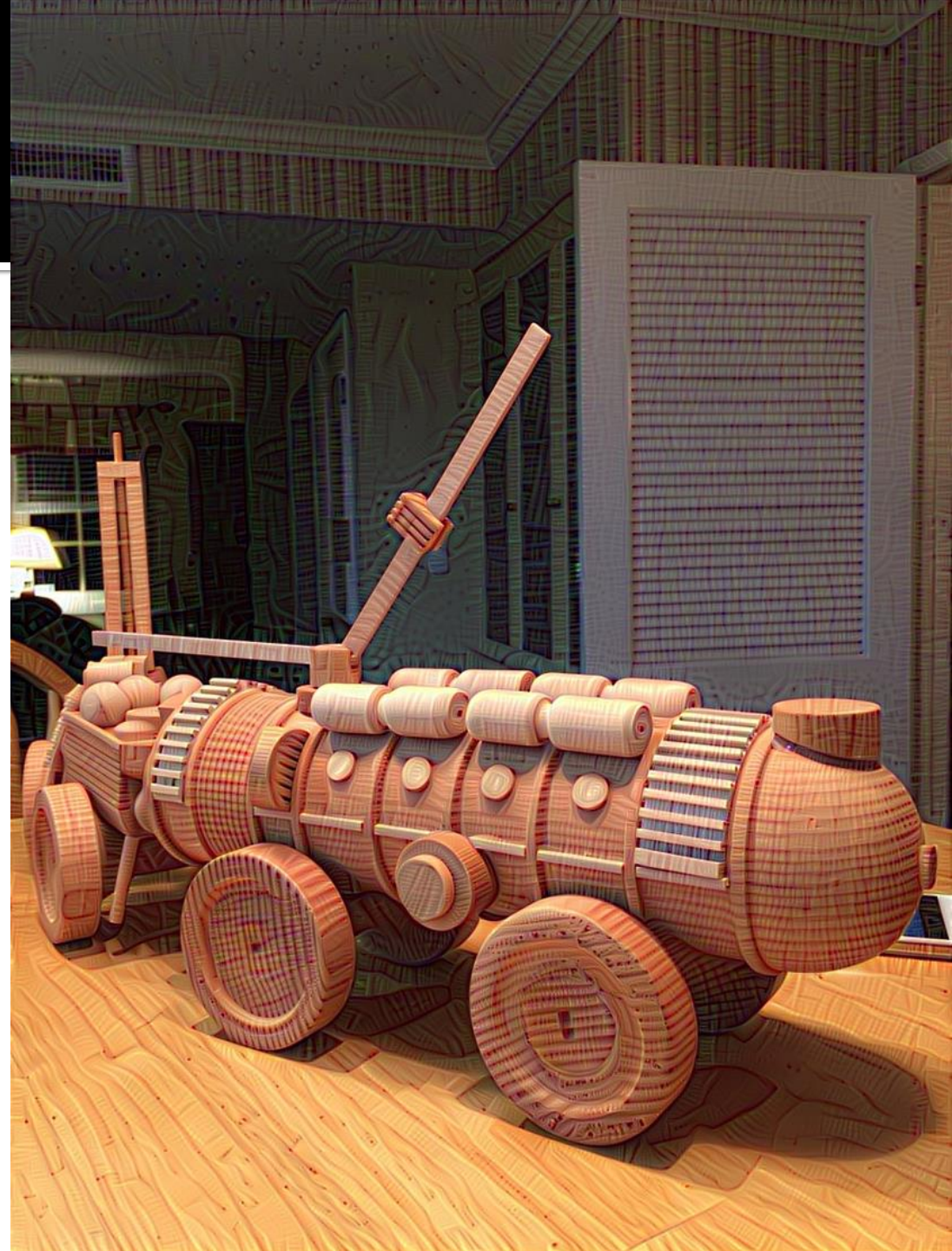
Nomad Explorer 1992

NOMAD Explorer II

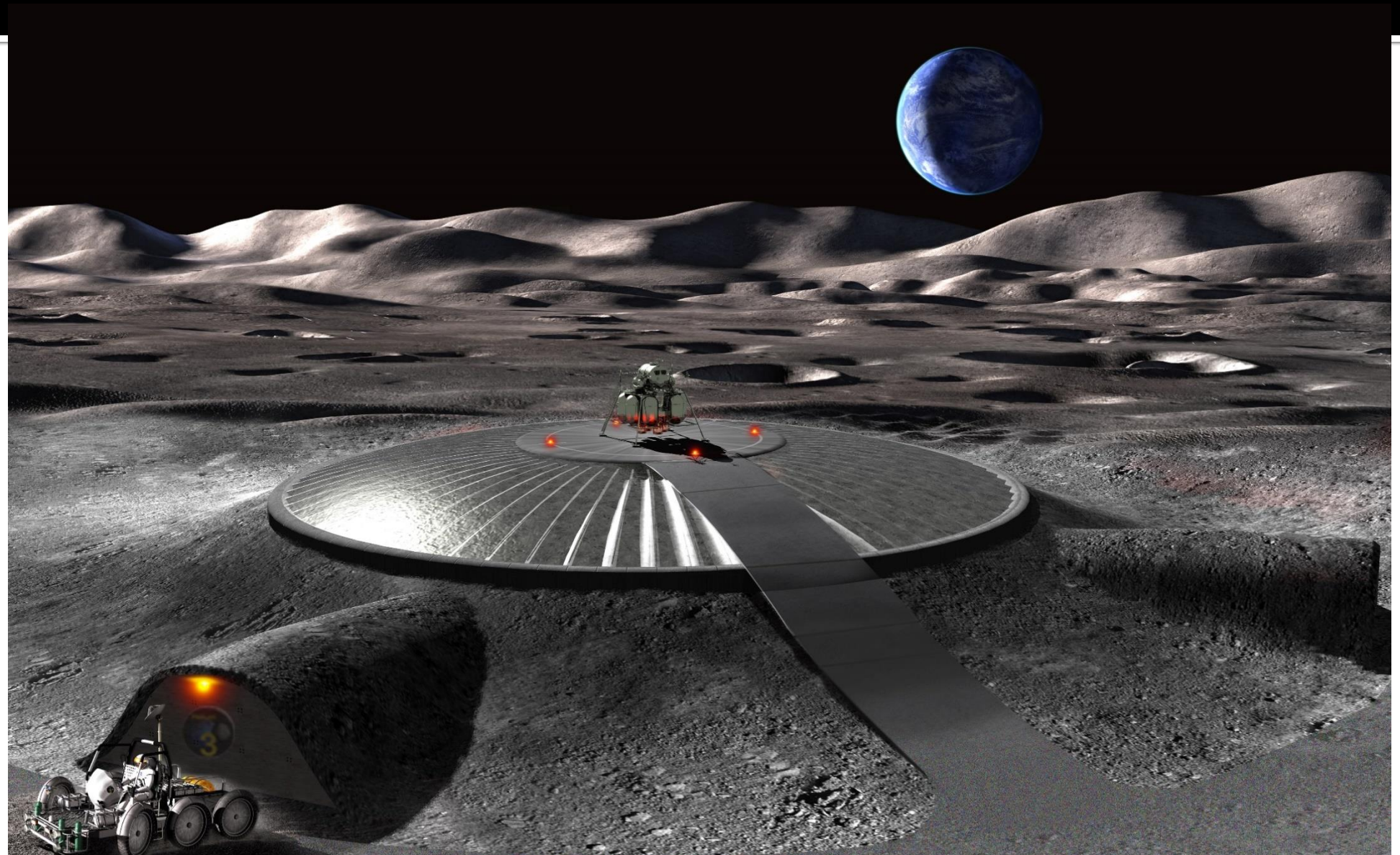
ASTE527 Mars Project 1999

Mars Rover

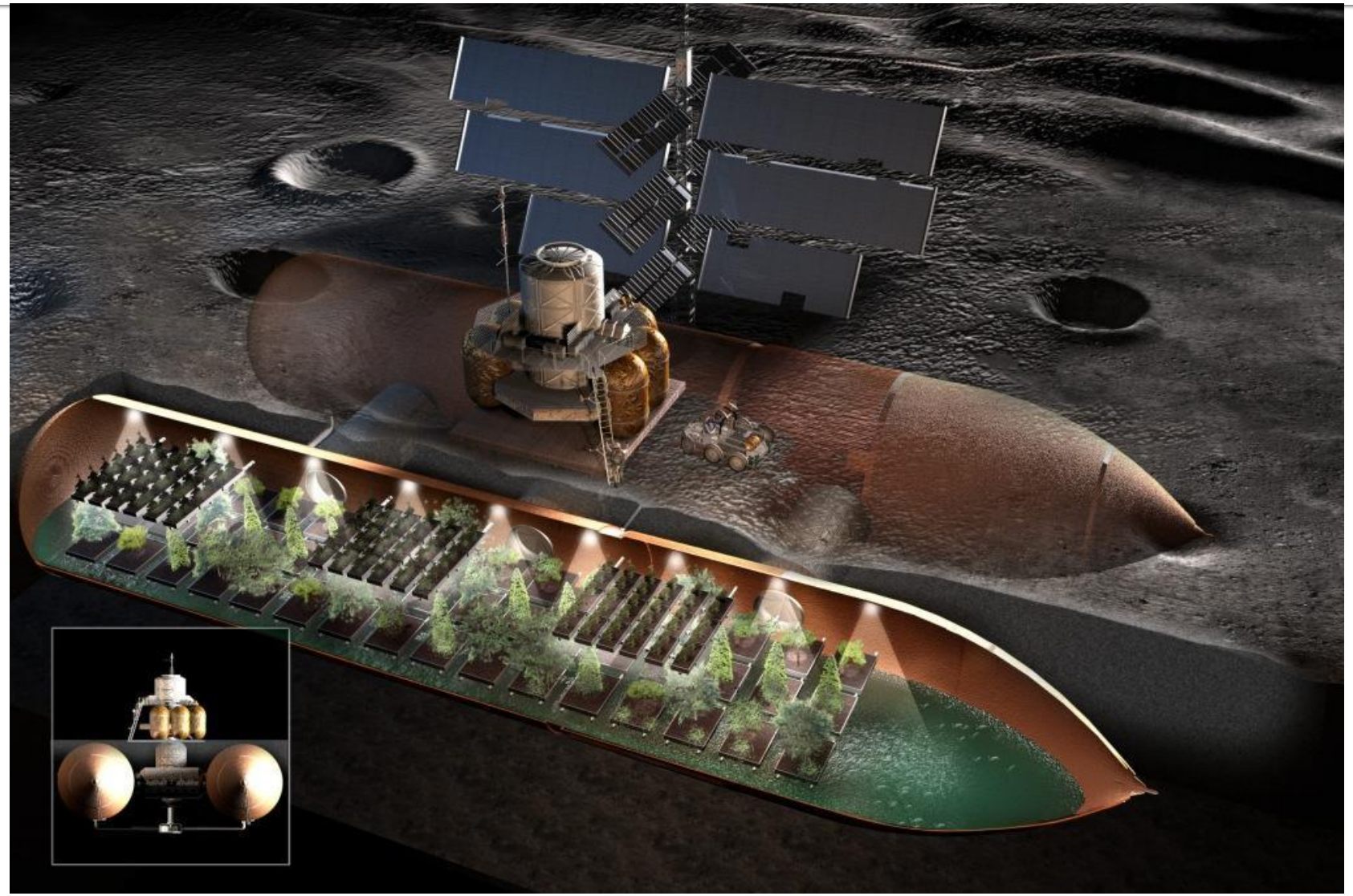
- Long Range 10,000km
- 6 crew
- Methane ICE
- Fuel Cells
- Deep Drill
- Crane
- Shirt sleeve Workshop
- Assembly Assist
- City Builder



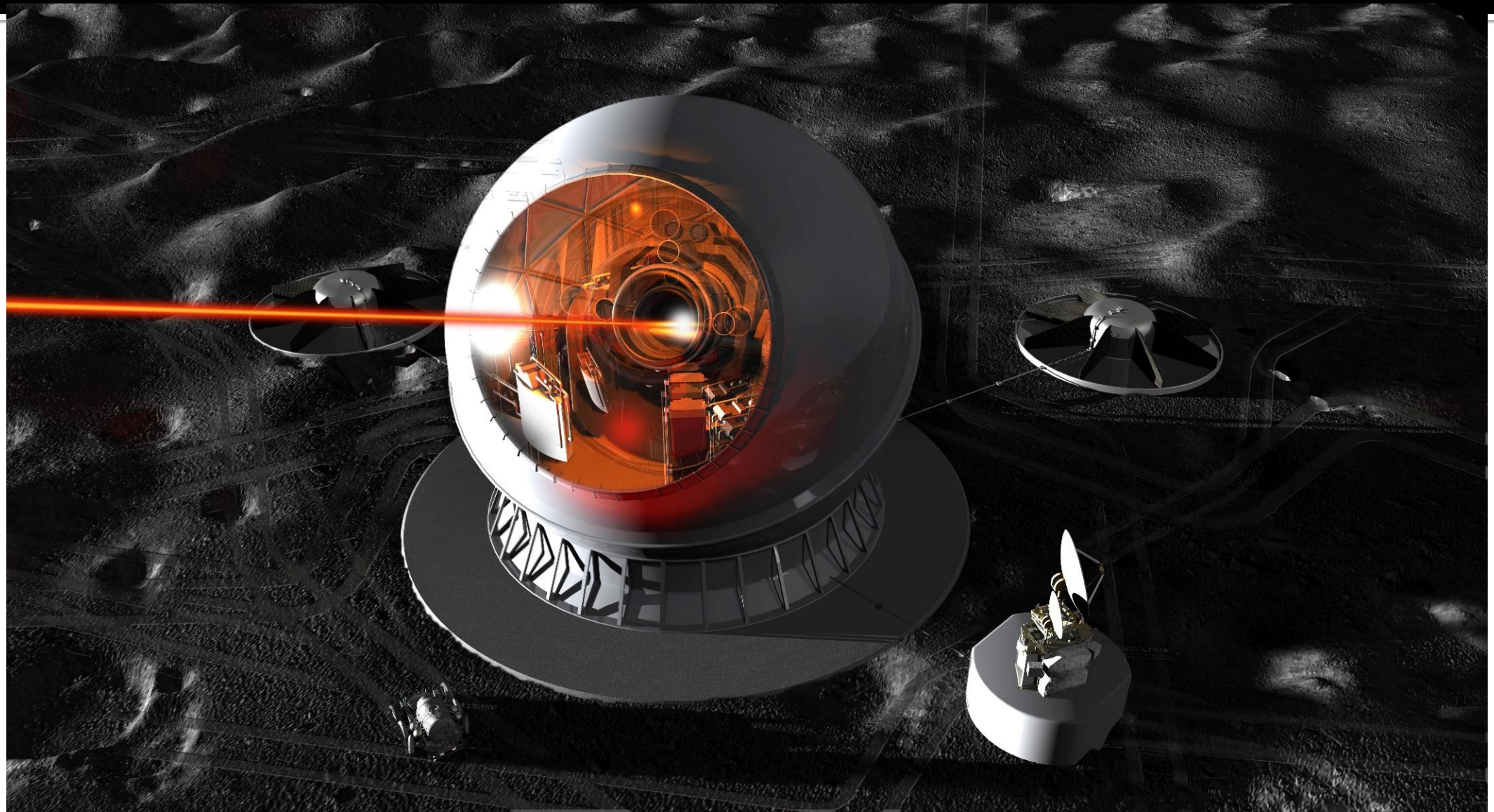
Lunar South Polar Landing Pad



Lunar Agriculture



Planetary Defense from our Moon



Lunar SuperComputer

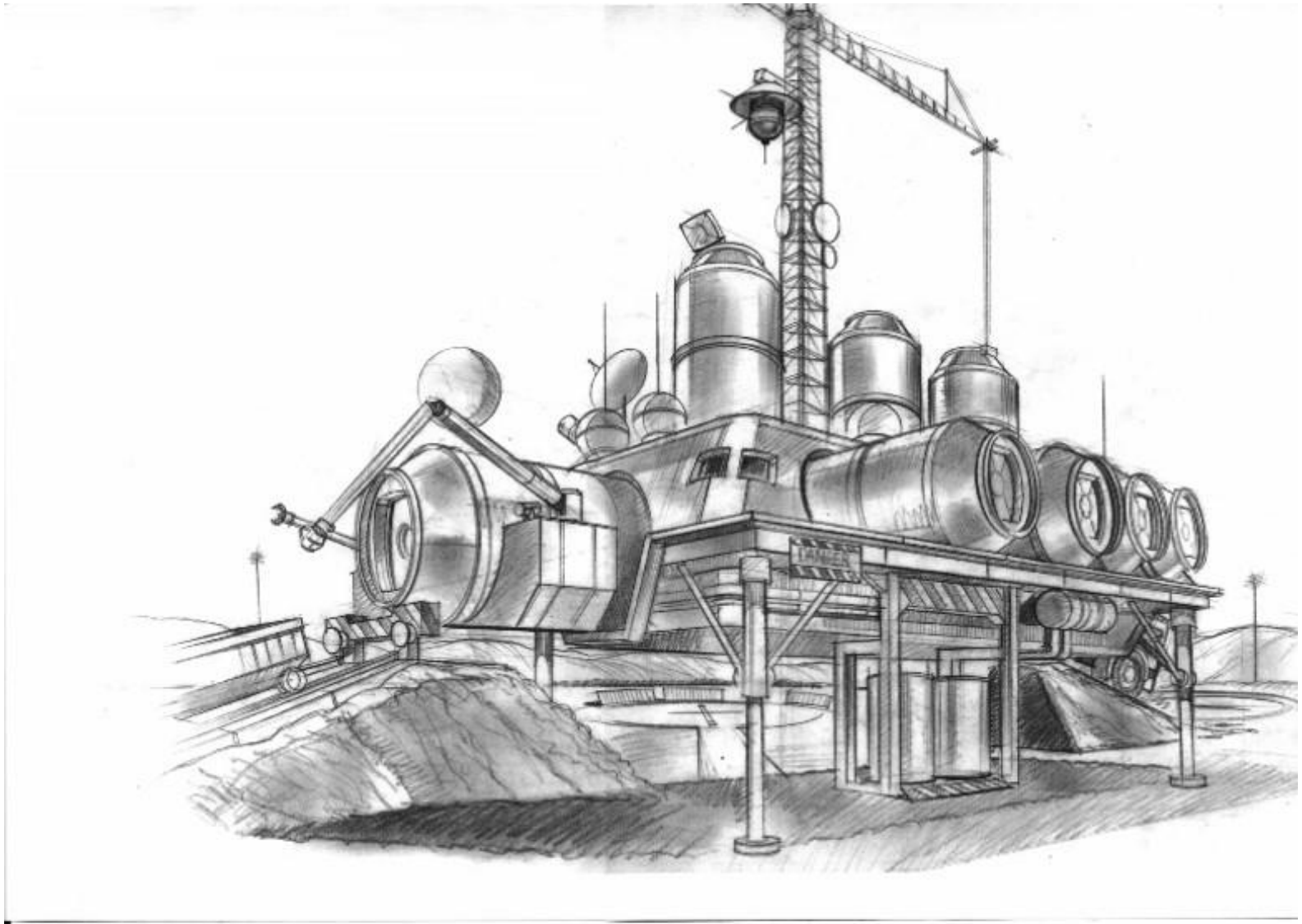
Lunar Lava Tube Habitat

3. From IOC to Permanent

3.17. Permanent Habitation in Lava Tubes [credit Vincent Ip USC Architecture]

The site of the Humanity Archives

P4+ Solar System Quarantine Facility on Moon



3D Food for Space Missions

Spiritual Bath

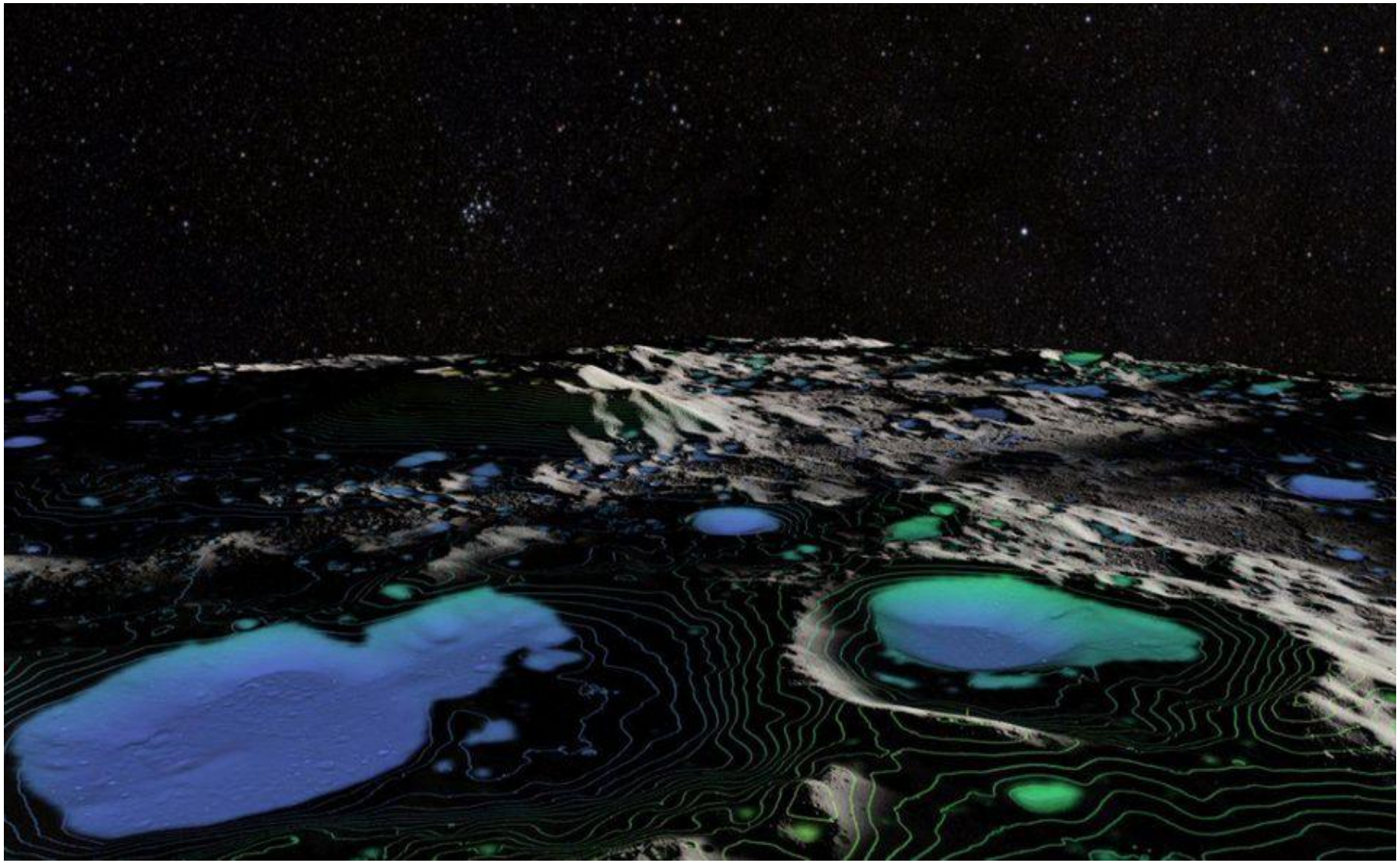
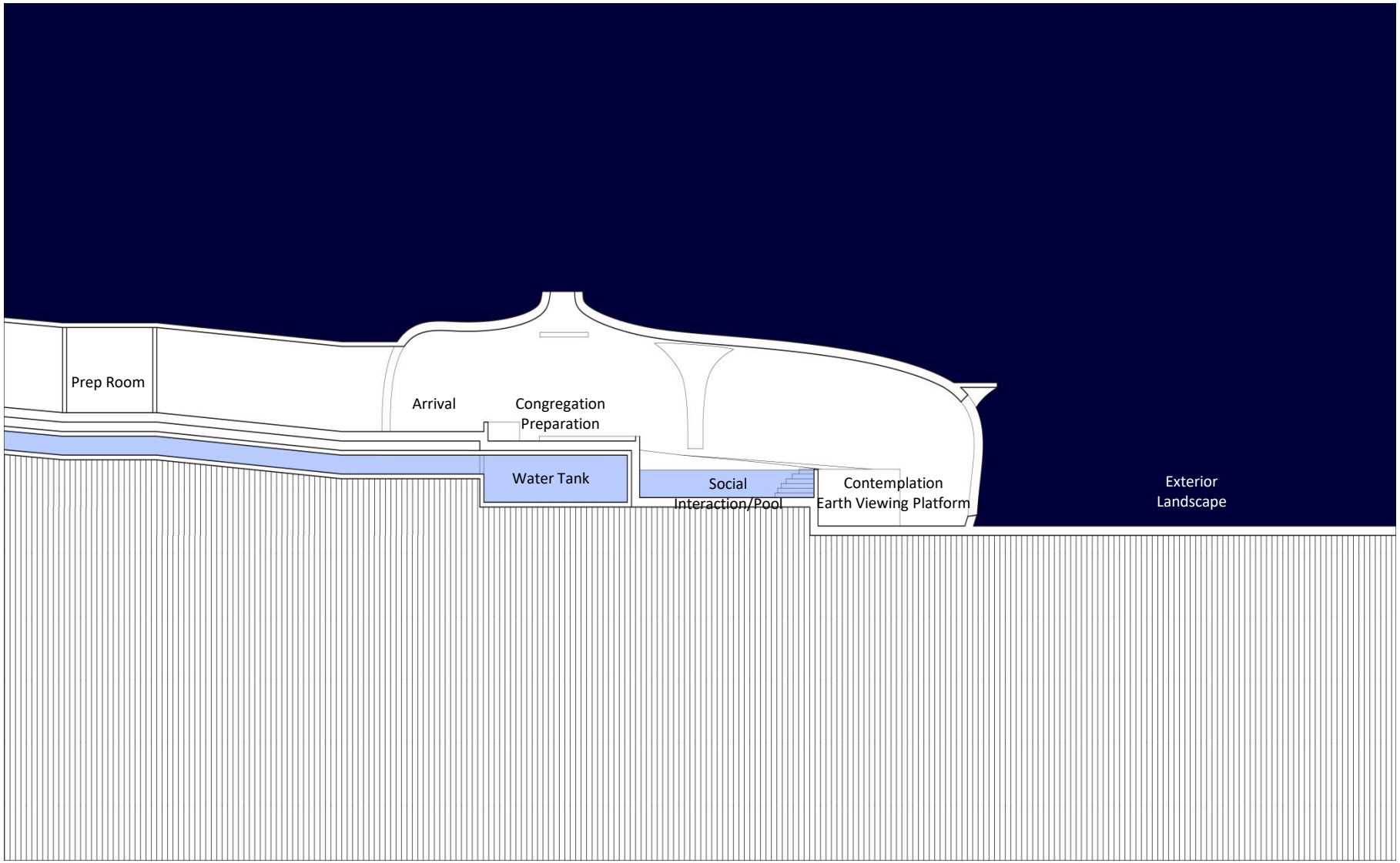
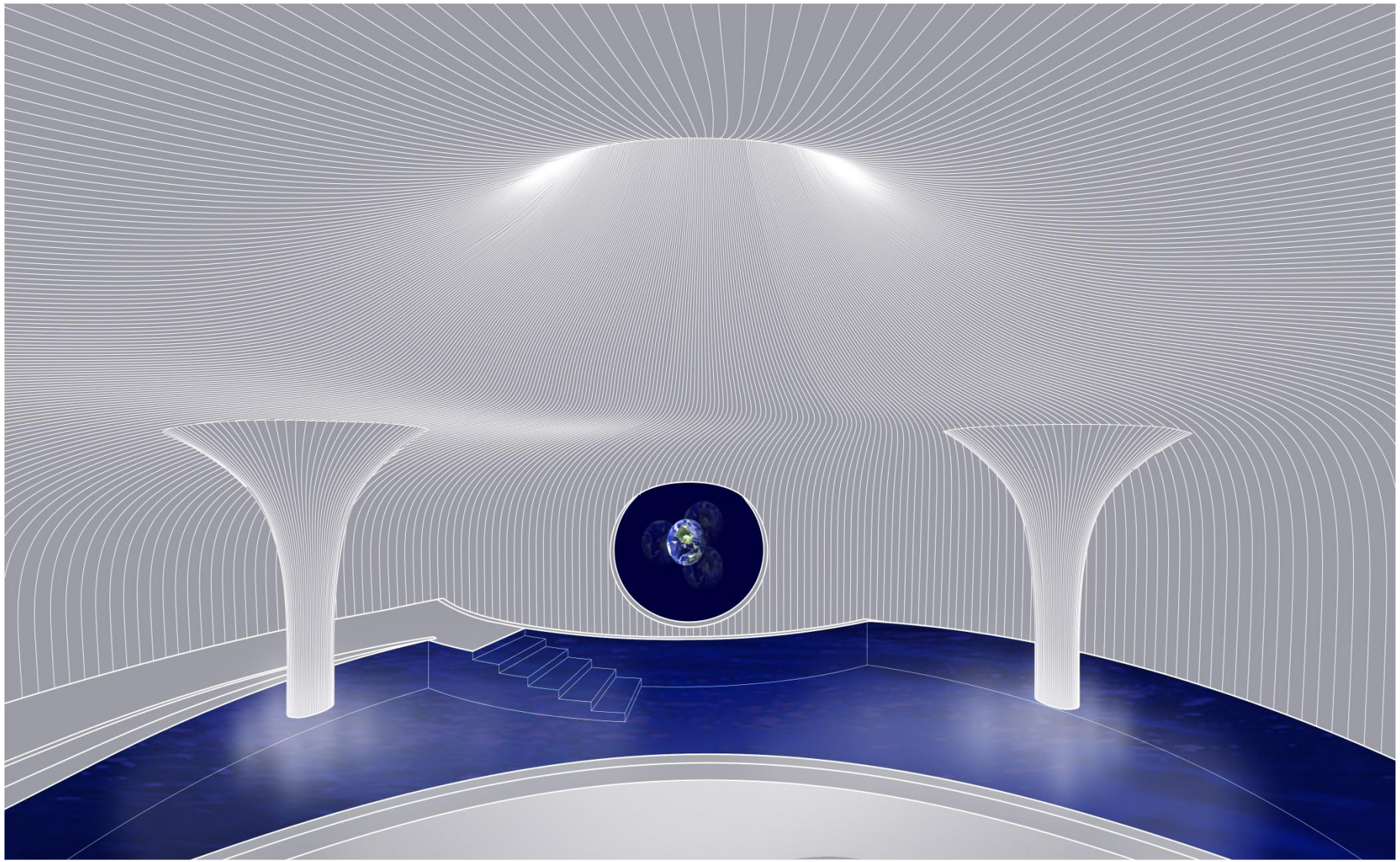


Fig 5. A Nasa Spacecraft explores the Moon’s permanent shadowed polar regions

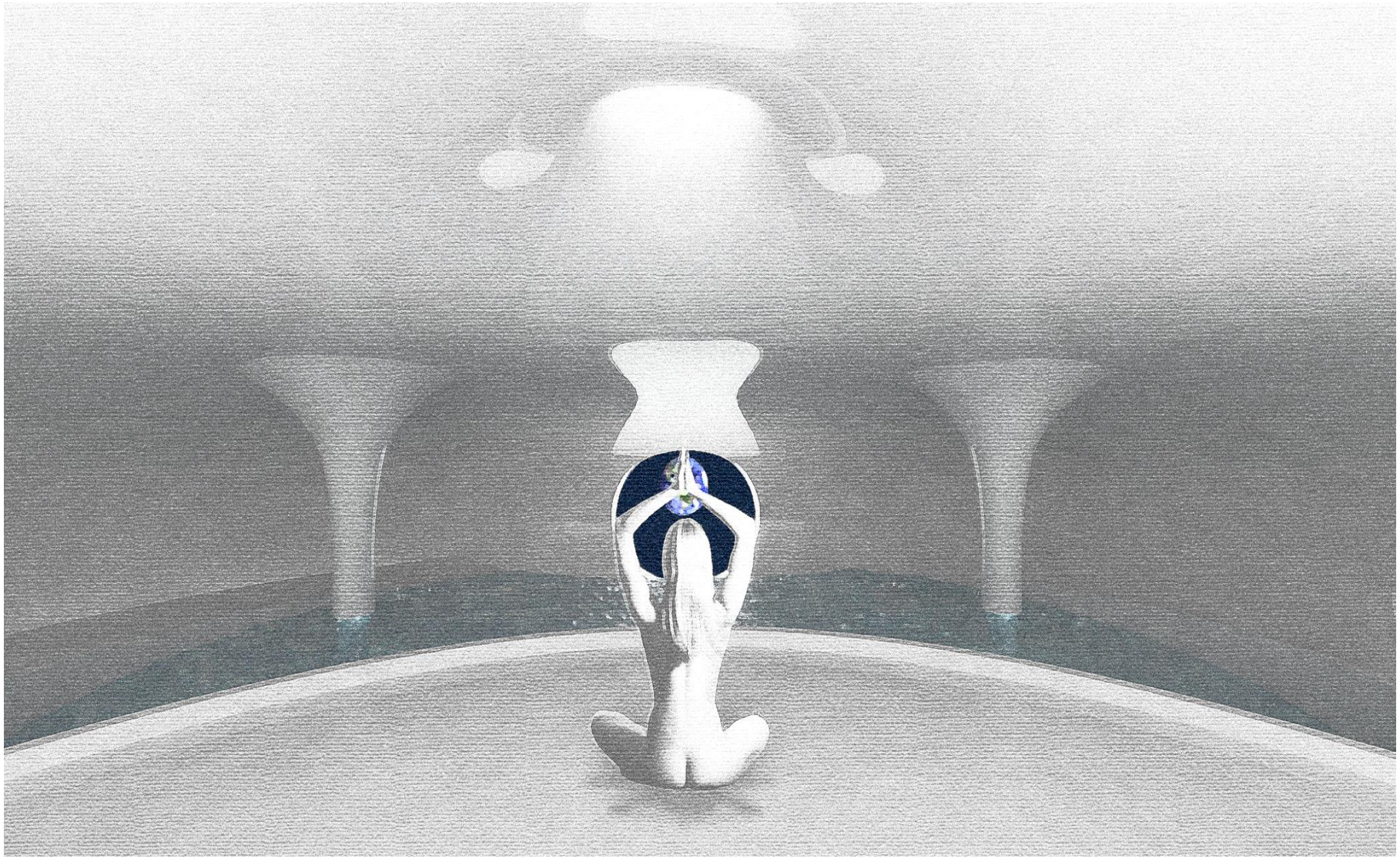
Is there water in the Moon?


Prep Room
Arrival
Congregation
Preparation
Water Tank
Social
Interaction/Pool
Contemplation
Earth Viewing Platform
Exterior
Landscape

Section A



Bathing Space – View to the Earth



Congregation Space – View to the Earth

Lunar Bath and Spiritual Nexus

ARCH 599 – Space Architecture
Spring 2018 – Professor Madhu Thangavelu
Pornpavee Mungrueagsakul

Today’s Program

- University Graduate Programs
- Orbital Habitats
- Lunar Habitats
- Mars Settlements
- Human Needs for long duration missions

Volunteers are needed for all AAIAA activities, please contact: cgsonwane@gmail.com

AIAA Los Angeles-Las Vegas

Space Architecture Gathering

August 22, 2020, 10 AM (Add to Calendar)

RSVP and Information: conta.cc/3f9jJYT

Dr. Olga Bannova
Director, SICSA, College of Engineering, University of Houston
Chair, AIAA Space Architecture Technical Committee (SATC)

Ms. Barbara Belvisi
Founder and CEO of Interstellar Lab

Dr. Marc Cohen
Mission Architecture Lead at Space Cooperative
Founding Member, AIAA SATC

Mr. Brand Griffin
Program Manager
Genesis Engineering Solutions
Member of AIAA Space Architecture Technical Committee
ISU Faculty Emeritus

Dr. A. Scott Howe
Senior Systems Engineer, Space Architect
Jet Propulsion Laboratory (NASA / Caltech)

Dr. Barbara Imhof
Researcher, Univ. of Applied Arts Vienna
Professor, Universität Kassel

Ms. Kriss J. Kennedy
Architect, Space Architect
TECHNE' Architects, LLC
Adjunct Assistant Professor, University of Houston-SICSA

Mr. John Mankins
Vice President, Moon Village Association
Founder and President, Mankins Space Technology, Inc.
NSS Board of Directors

Dr. Jack Stuster
President, Anacapa Sciences,Certified Professional Ergonomist
Author, Bold Endeavors: Lessons from Polar and Space Exploration

Ms. Anastasia Prosina
Founder & CEO at Stellar Amenities
Award-winning aspirational futurist and practitioner in Space Architecture

Mr. John Spencer
Outer Space Architect
Founder, President, Space Tourism Society
Co-Founder and Chief Designer: Mars World Enterprises, Inc.
Co-Founder and President: Red Planet Ventures, Inc.

Prof. Madhu Thangavelu
(Chair/Moderator of the Panel/Event)
Faculty Member, USC / ISU
NSS Board of Directors

Ms. Melodie Yashar
Design Architect, Researcher and
co-founder of Space Exploration Architecture (SEArch+)

Agenda

10:05 - Welcome Message (Dr. Chandrashekar Sonwane)
10:10 - Brief Introduction (Prof. Madhu Thangavelu)
10:30 - Olga Bannova - SATC and SICSA work
10:45 - Ana Prosina - thoughts on SA
11:00 - Marc Cohen - Lunar Studies
11:15 - Brand Griffin - Lunar Concepts
11:30 - Kriss Kennedy - Space Architecture @ the Tipping Point
11:45 - Scott Howe - Space Architecture & Construction
12:00 - John Mankins - Moon Village
12:15 - Barbara Imhof - SHEE & EDEN
12:30 - Barbara Belvisi - Simulators
12:45 - John Spencer -Tourism
13:00 - Melodie Yashar - Robotic Construction & Mars Forward
13:15 - Jack Stuster - Tasks, Skills, and Abilities for the First Human Expeditions to Mars
13:30 - Discussion
14:30 - Fin

[events.aiaalalv@gmail.com] [http://aiaa-lalv.org/]

Online Gathering Mechanics

- Request online audience to mute microphones and turn off cameras
- 10min for each speaker
- Followed by 5 min Q&A
- Moderator will be happy to pick queries from chat box

- Followed by Panel Discussion
- Again, moderator will be happy to pick questions from chat box
- Fin