

NASA Cell Science Conference



Human Exploration The Role of Life Sciences

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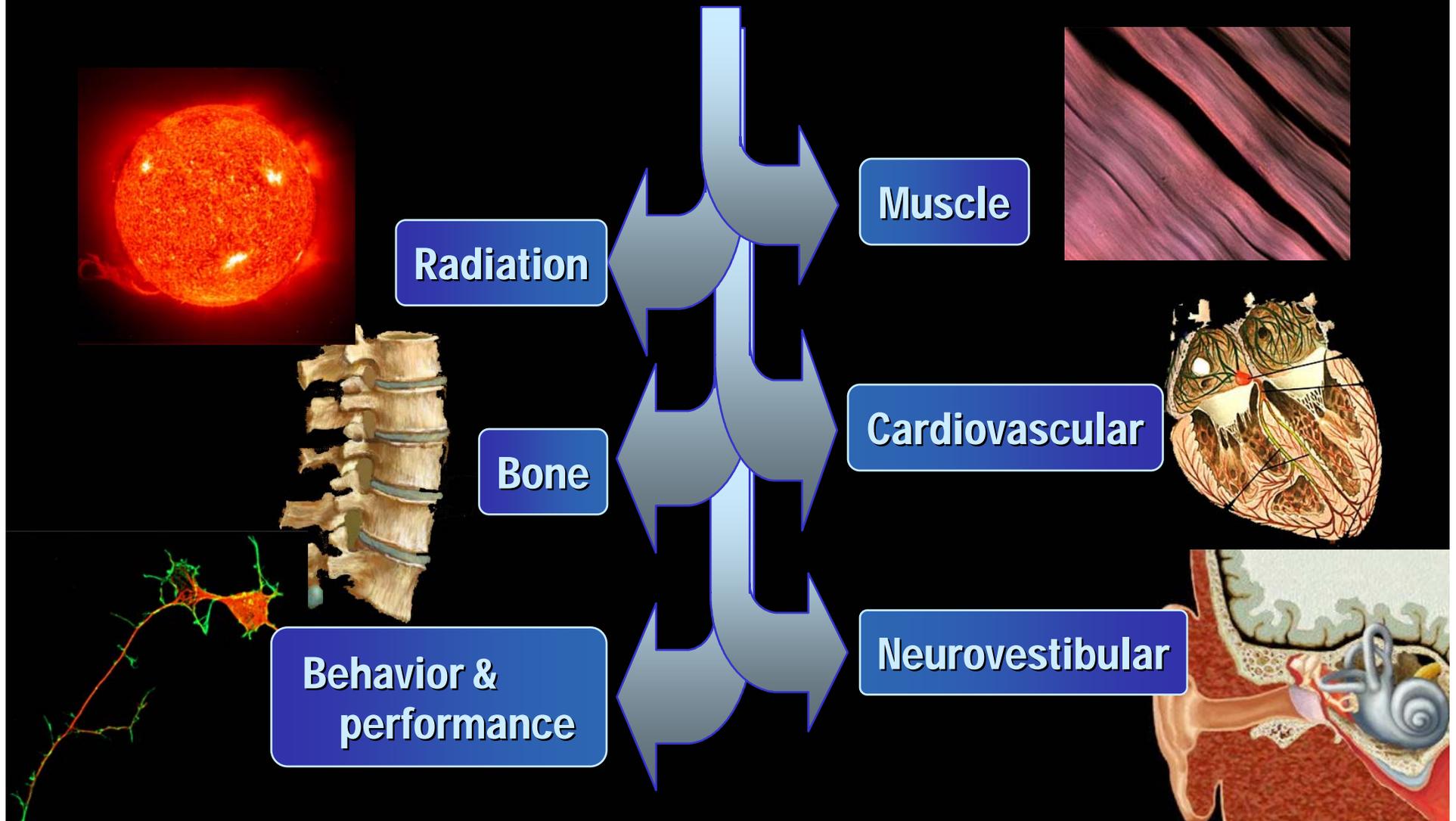
Presentation Overview

- ✓ Human space flight
- ✓ Human research
 - International Space Station
 - Ground studies
- ✓ Cell science
- ✓ Future plans





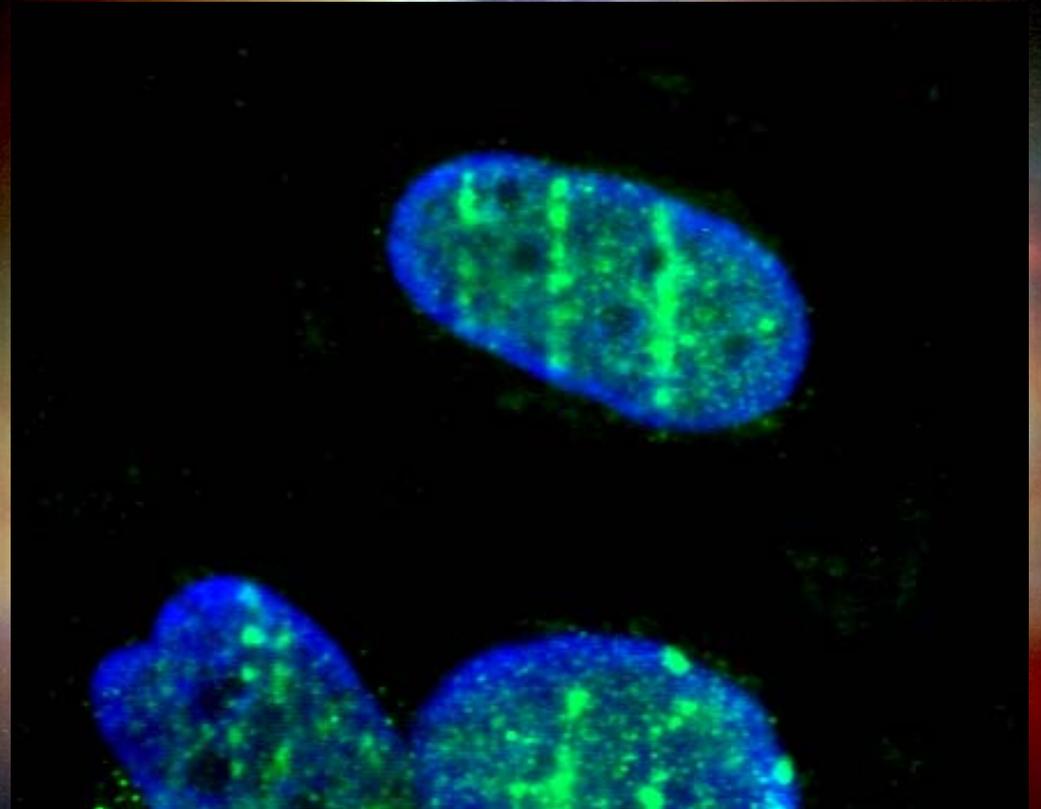
Effects of Microgravity on Human Physiology





Radiation

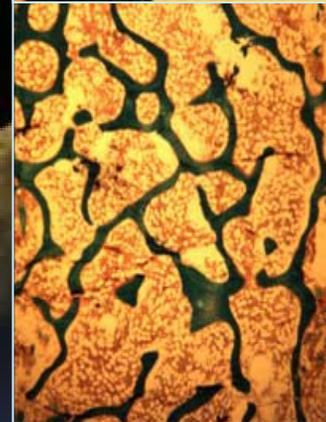
- ✓ All space travelers are subjected to radiation
- ✓ Due to
 - Galactic cosmic rays
 - Protons and electrons trapped in Earth's magnetic field
 - Solar particle events



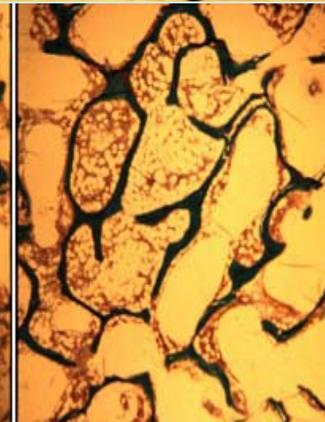


Bone Loss

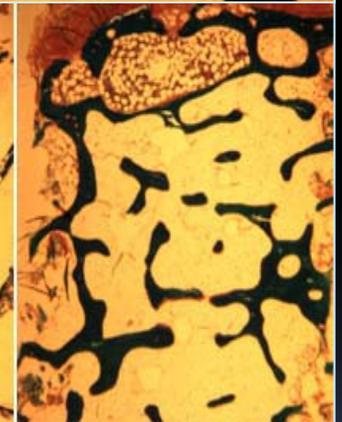
- ✓ Due to
 - Skeletal unloading
 - Biomechanical, hormonal and metabolic factors



Normal



Thinning



Osteoporotic



Interim Resistive Exercise Device





Behavior and Performance

- ✓ All subjected to factors that affect
 - Psychological well-being
 - Interactions with other crewmembers, families, and ground personnel
 - Performance of duties





Cardiovascular

- ✓ Early, fluid and blood pools in upper body, triggering sensors in the cardiovascular system





Ultrasound Imaging





Muscle

- ✓ Anti-gravity muscles decondition
- ✓ Continues unabated throughout flight





CEVIS and TVIS





Neurovestibular

- ✓ Altered sensory stimulus
- ✓ Rearrangement of signals from visual, skin, joint, muscle, and vestibular receptors





International Space Station 2003

Expedition 6

November 23, 2002 to May 3, 2003

Donald Pettit, Kenneth Bowersox,
and Nikolai Budarin



Expedition 7

April 25 to October 27, 2003

Yuri Malenchenko and Ed Lu



Expedition 8

Oct. 18, 2003 to April 29, 2004

Alexander Kaleri and Michael Foale



International Space Station





Soyuz



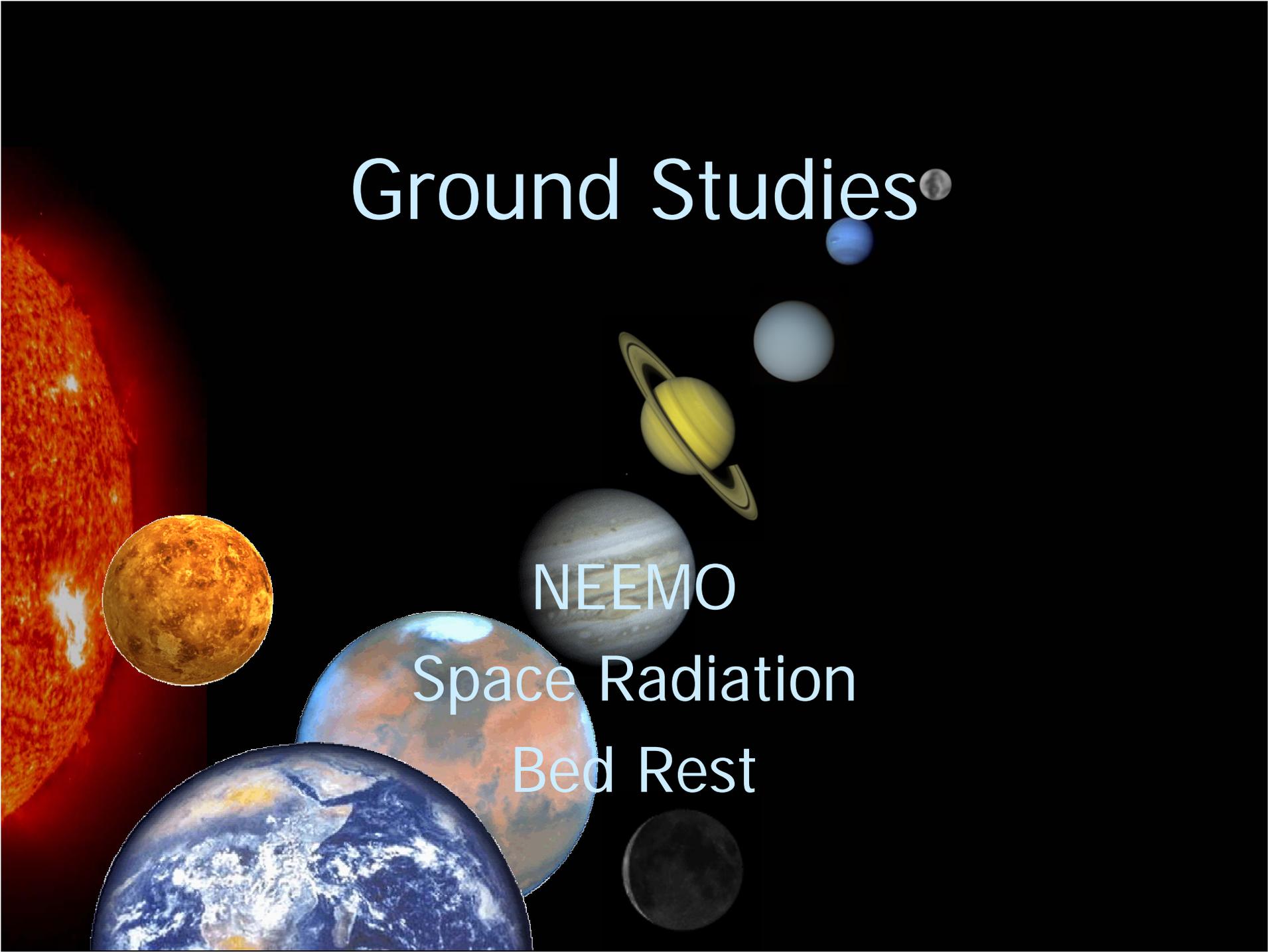


Summary Observations

(Increments 1-6)

- ✓ ALL crewmembers have lost significant amounts of bone in one or more specific regions
- ✓ Some crewmembers have preserved or gained bone in one or more specific regions
- ✓ ISS losses vary from 0-2.3% per month
- ✓ Orthostatic tolerance appears improved, but is still variable with about 40% of crewmembers failing post-flight stand test
- ✓ Neurovestibular symptoms have been variable
 - Some crewmembers test near the clinically abnormal range 5-7 days after return
 - Typically resolves to normal within 2-3 weeks post-flight

Ground Studies

A collage of celestial bodies against a black background. On the left, a large, bright orange and red sun is partially visible. Below it is a smaller, orange, cratered moon. In the foreground, a large blue and white Earth is shown. Behind it is a reddish-orange Mars. Further back are Jupiter with its characteristic bands, Saturn with its rings, Uranus, Neptune, and Pluto. The text 'Ground Studies' is written in white at the top.

NEEMO

Space Radiation

Bed Rest

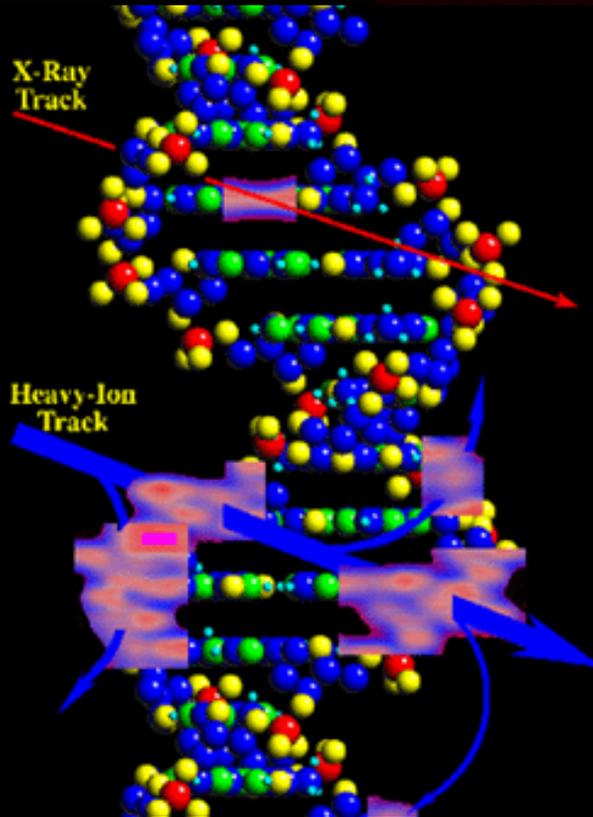


NASA Extreme Environment Mission Operations





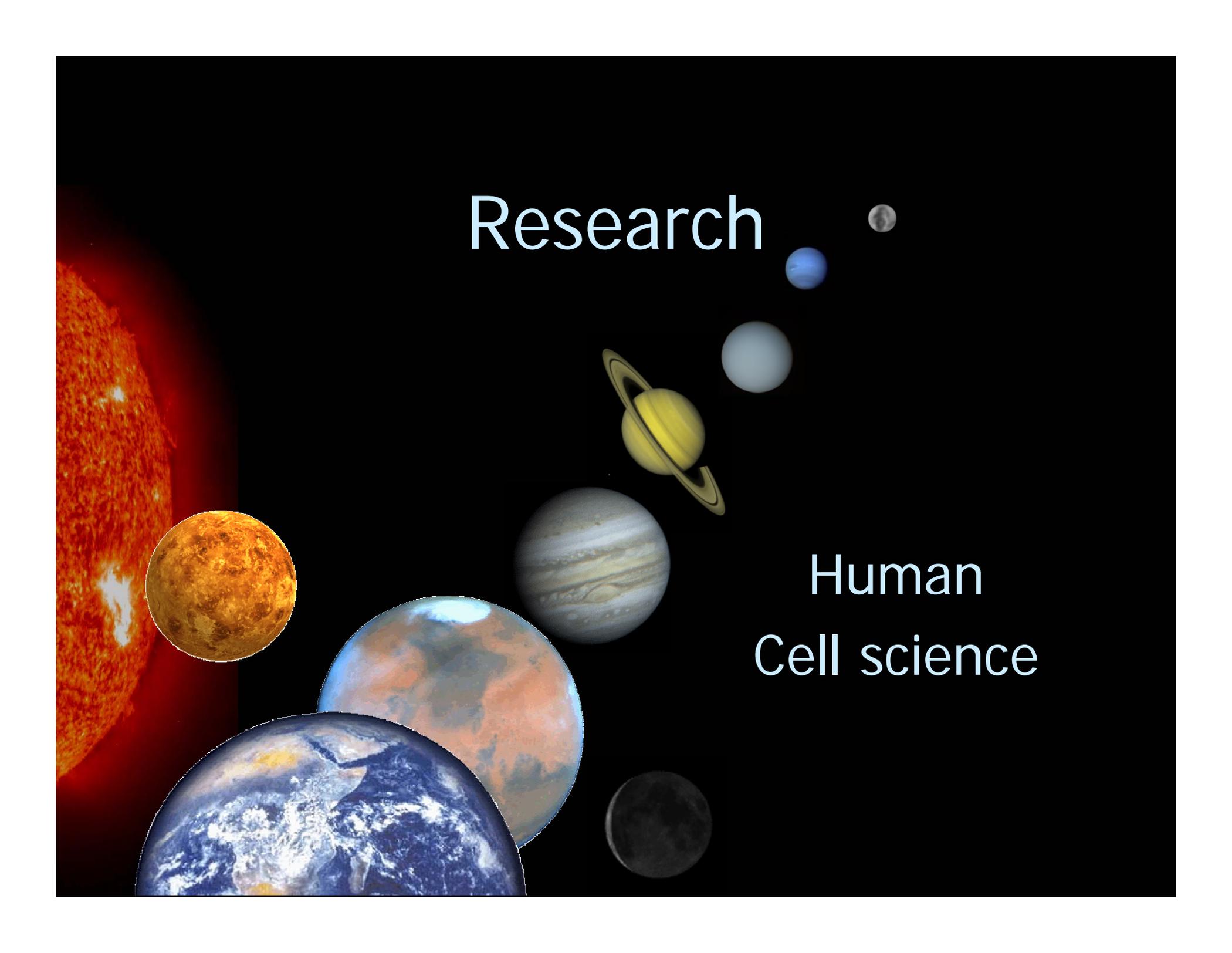
Space Radiation (NSRL)





Bed Rest



A composite image of various celestial bodies against a black background. On the left, a large, bright orange and red sun is partially visible. Below it, a smaller, orange, cratered moon is shown. In the foreground, a large blue and white Earth is visible, with a smaller, reddish-brown Mars behind it. Further back, a large, striped Jupiter is shown, followed by a yellow Saturn with its rings. To the right, a white Uranus and a blue Neptune are visible, along with a small, grey Pluto. The word "Research" is written in white text at the top, and "Human Cell science" is written in white text at the bottom right.

Research

Human
Cell science



Bioastronautics Research





Cell Science Research Supports Human Exploration

Human Health

- Bone
- Cardiovascular
- Immune
- Muscle

Radiation

- Carcinogenesis
- Early or acute effects

Human Cell and Tissue Based Research

Human life support

- Environmental monitoring and control
- Acceptable atmosphere
- Potable water

Moon and mars

- 1/6 lunar gravity response
- Automated research systems
- Data, not samples



Cell Science & Human Exploration

- ✓ Cell Science contributes to the human exploration of space initiative
 - Sustained microgravity analog state with robust ground research program
 - Human tissue models
 - Expansive PI community with proven track record of accomplishments
 - Currently 55 PIs
 - Hundreds of publications in peer-reviewed journals
 - Extensive collaborations leveraged with other federal agencies
 - NIH, NCI, FDA and 19 other cooperative agencies
 - Extensive and proven space flight experience with cell culture

Bioreactor Research and Human Health



Infectious diseases

- Model systems for diseases
 - HIV
 - Ebola



Drug efficacy

- Drug testing without using animals
- Human metabolic studies of drugs



Injury & surgery

- Biodegradable scaffolds
- Wound healing



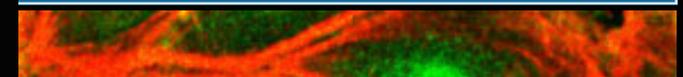
Cancer

- 3D tumor disease models
- Testing for sensitivity to chemotherapy



Heart disease

Engineered, transplantable heart tissue



Diabetes

- Pancreatic tissue for transplantation
- Diabetes cell growth

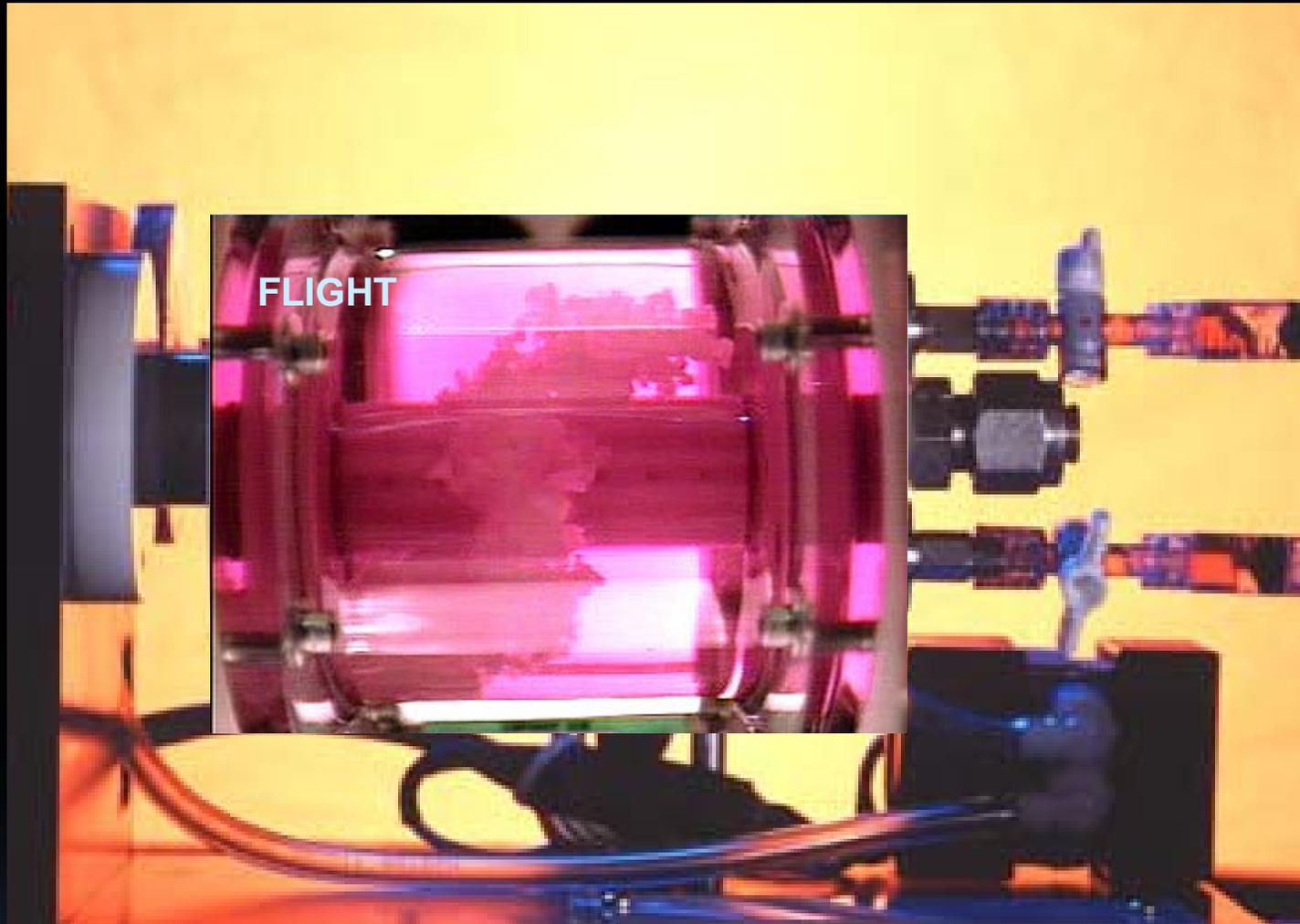


Bone loss

Micro-beads for growing bone tissue



Biological Systems and Applications





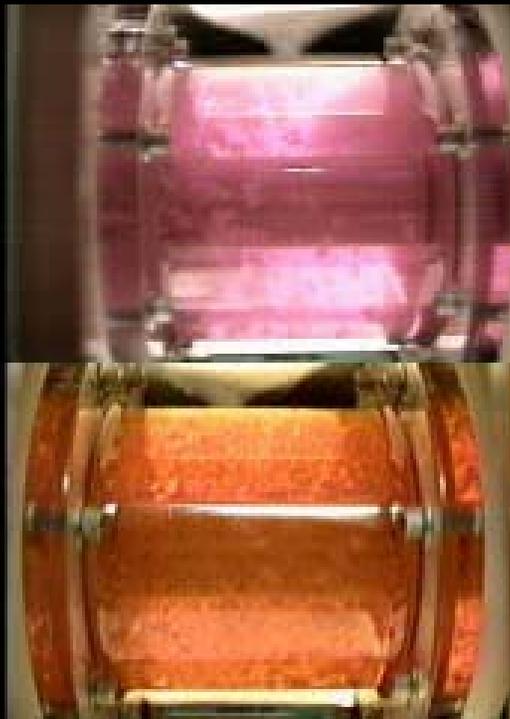
Biological Systems and Applications

Flight

Day

02

01/18/03





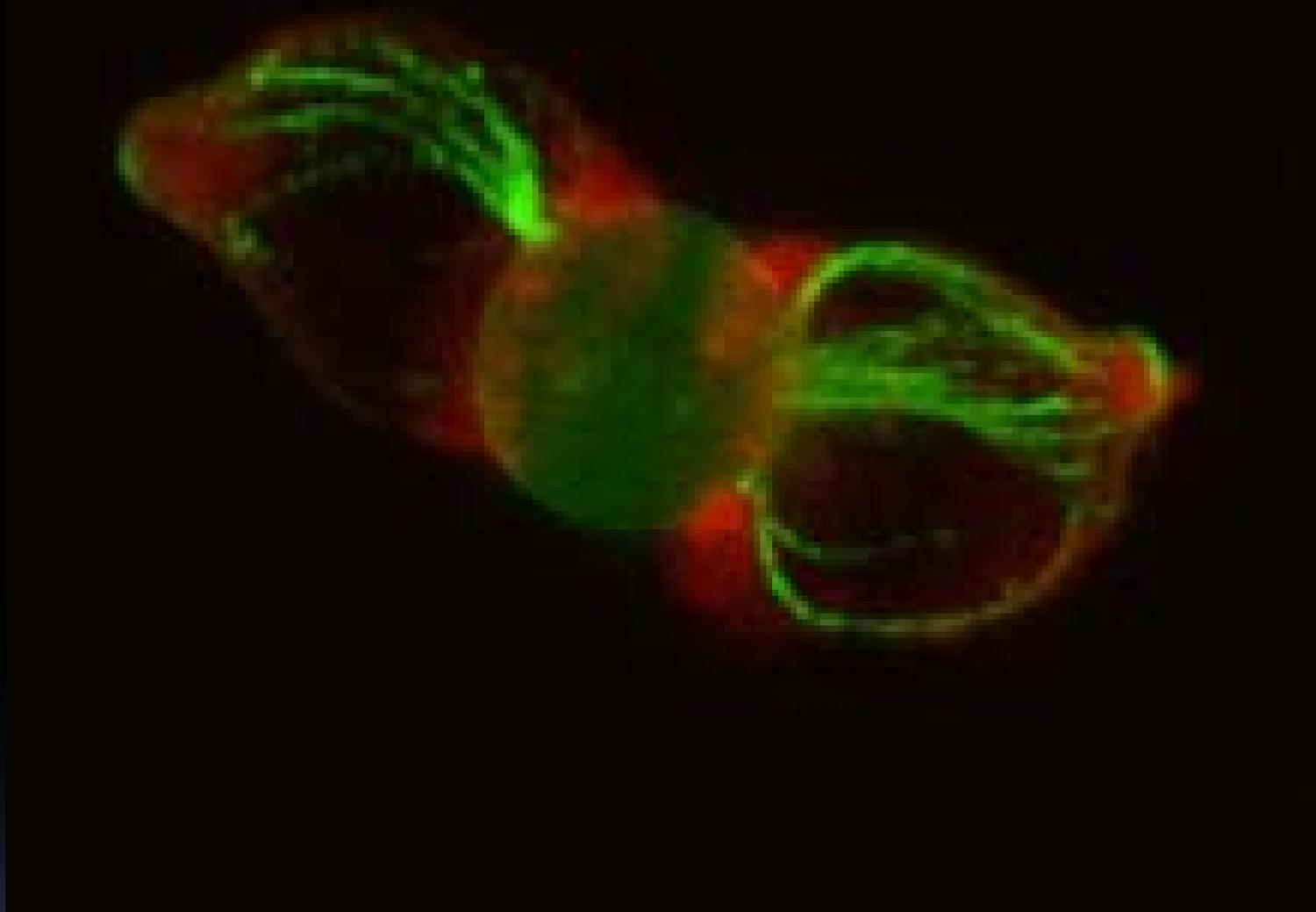
Microencapsulation

Particles heating in magnetic field



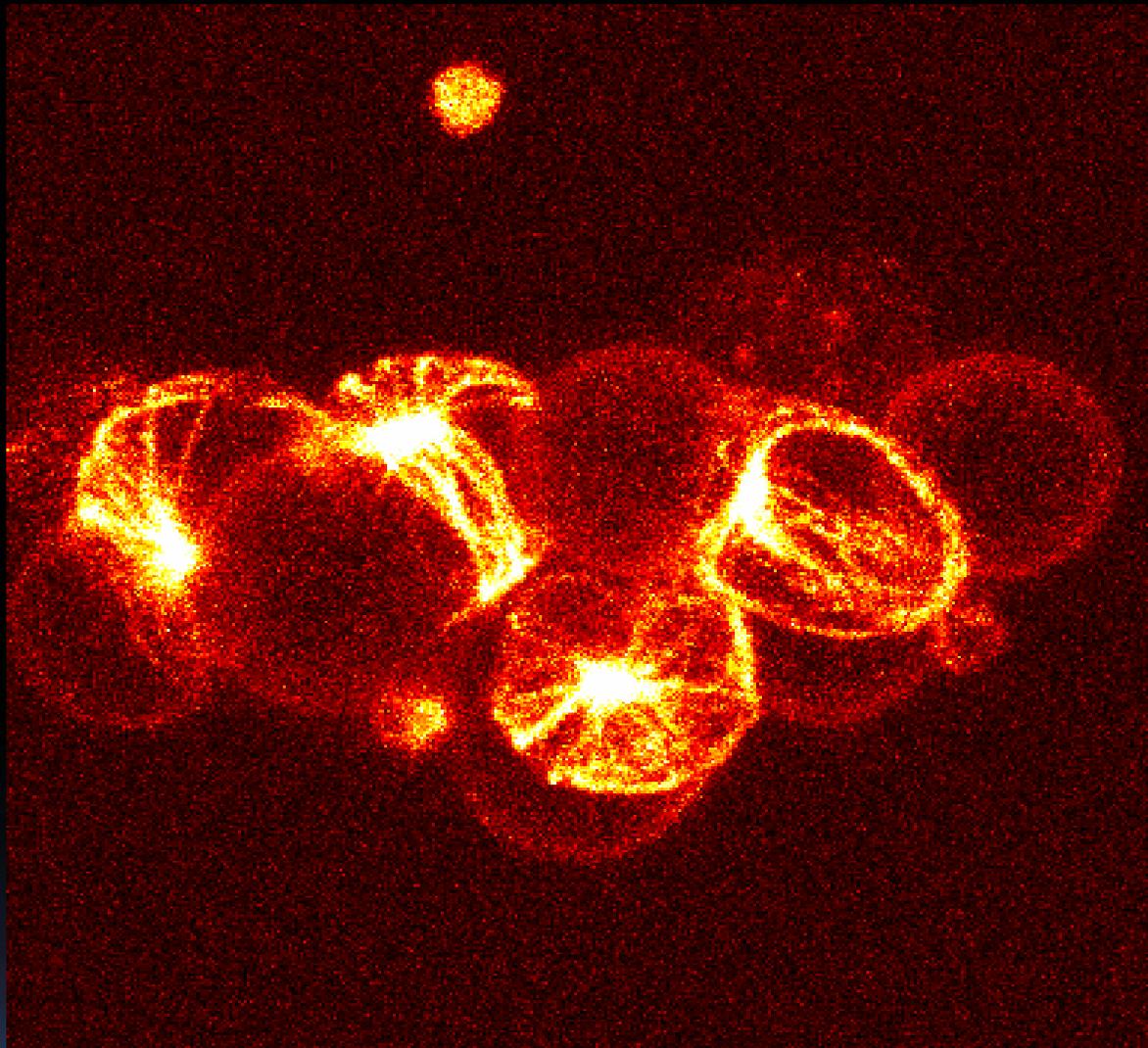
Drug exits through hole



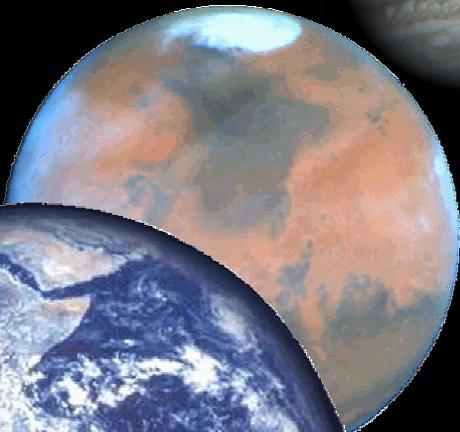
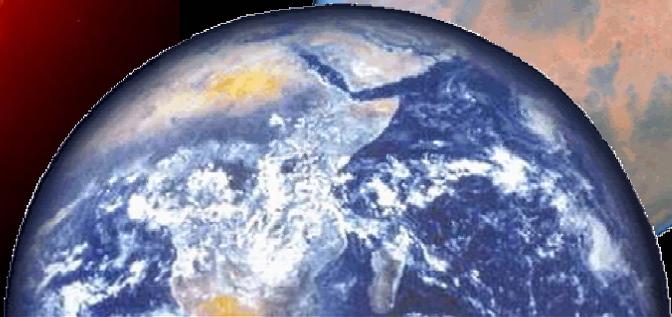
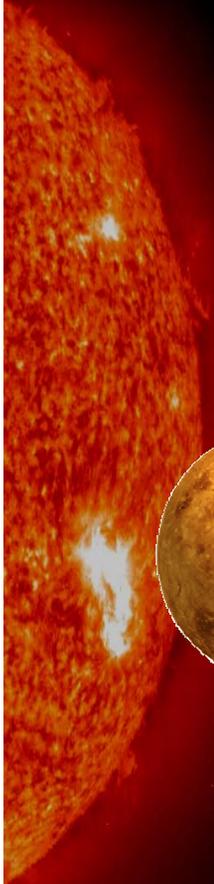




3D Structure



Future Plans





Future Activities

Human Exploration Science

“This cause of exploration and discovery is not an option we choose; it is a desire written in the human heart.”

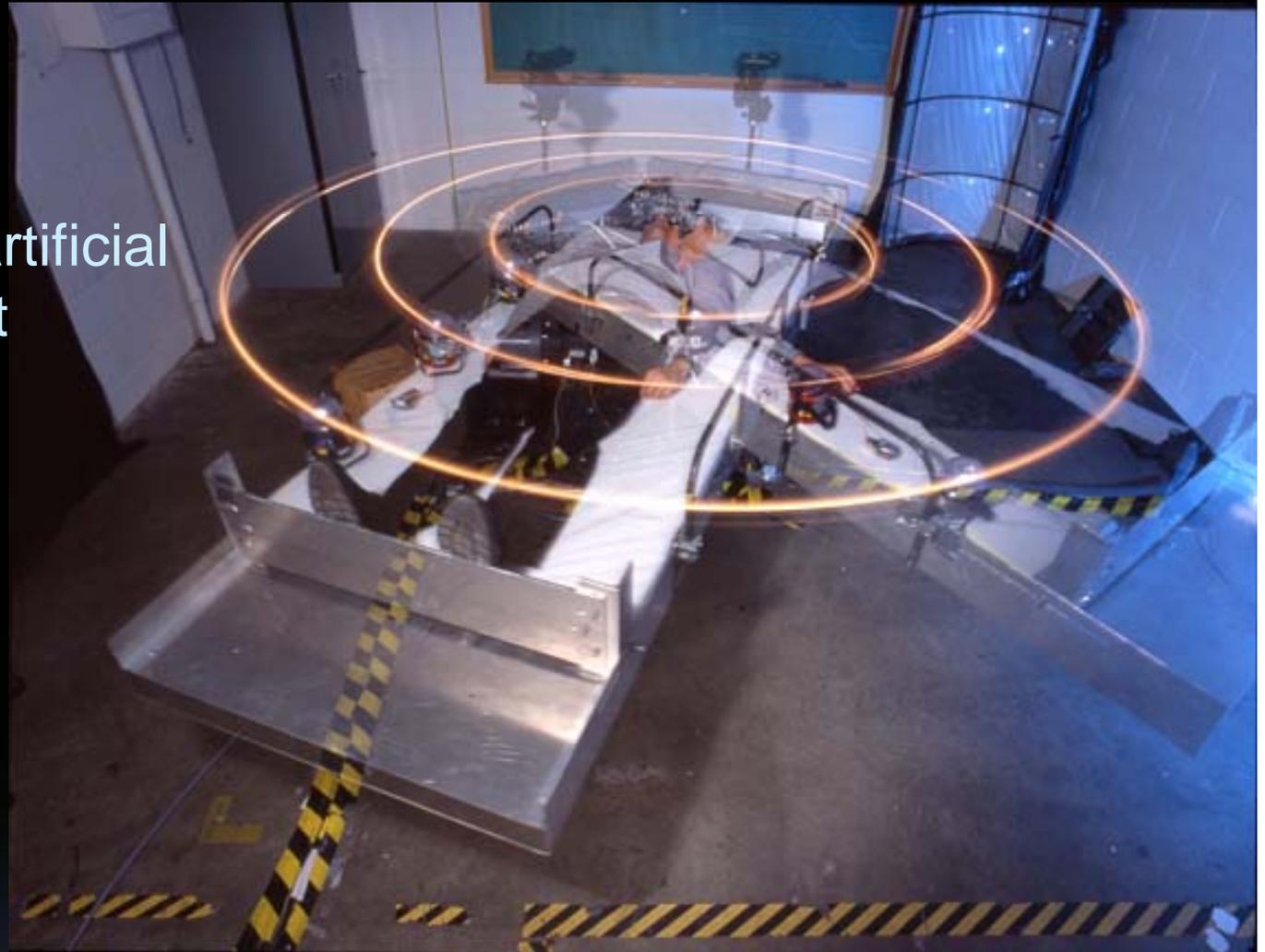
President Bush



Artificial Gravity

✓ International Artificial Gravity Project

- Participants
 - UTMB
 - DLR
 - IBMP

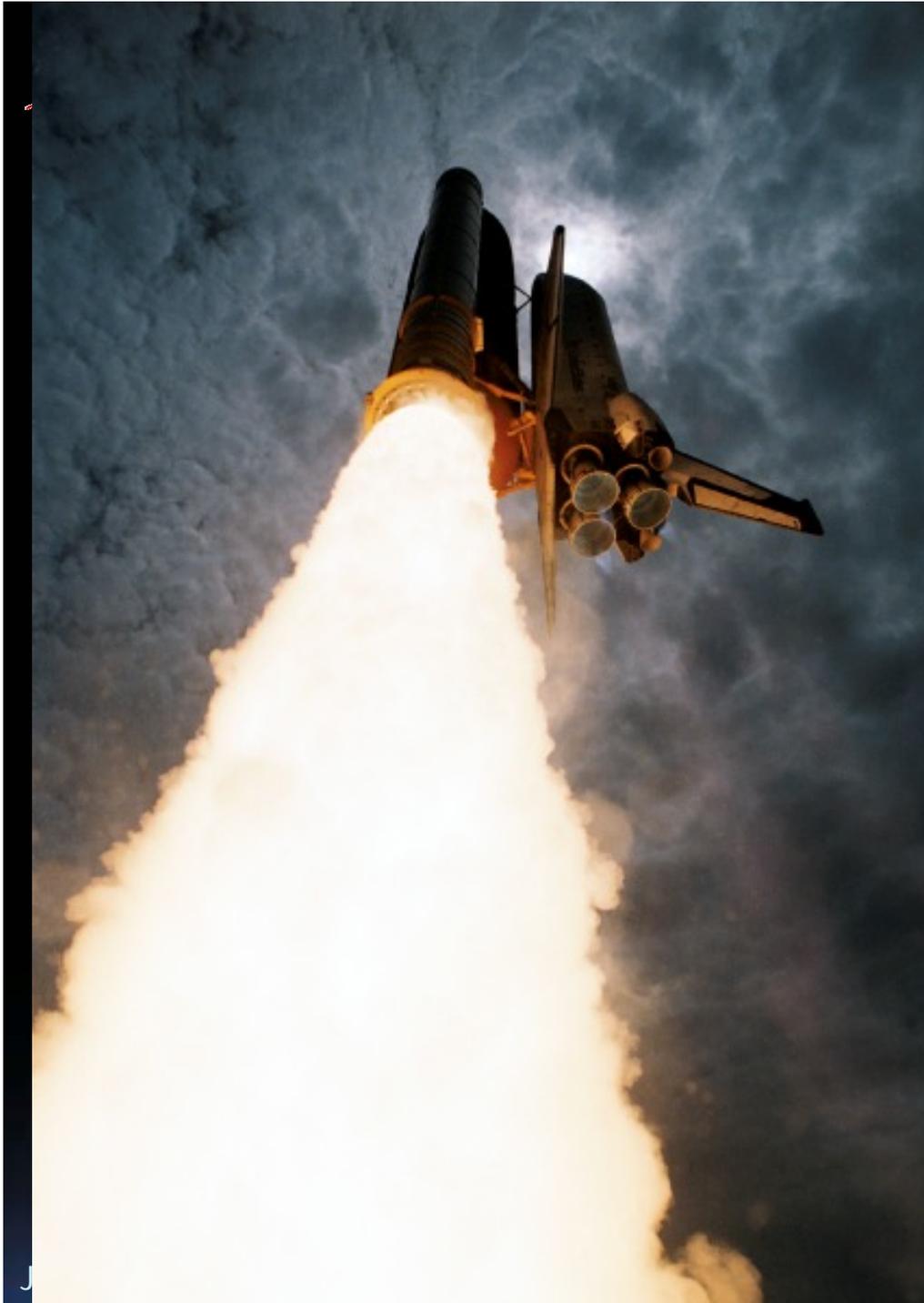




Bed Rest Studies

- ✓ *Participants*
 - *UTMB General Clinical Research Center*
 - *Herman Hospital*
- ✓ *Controlled studies*

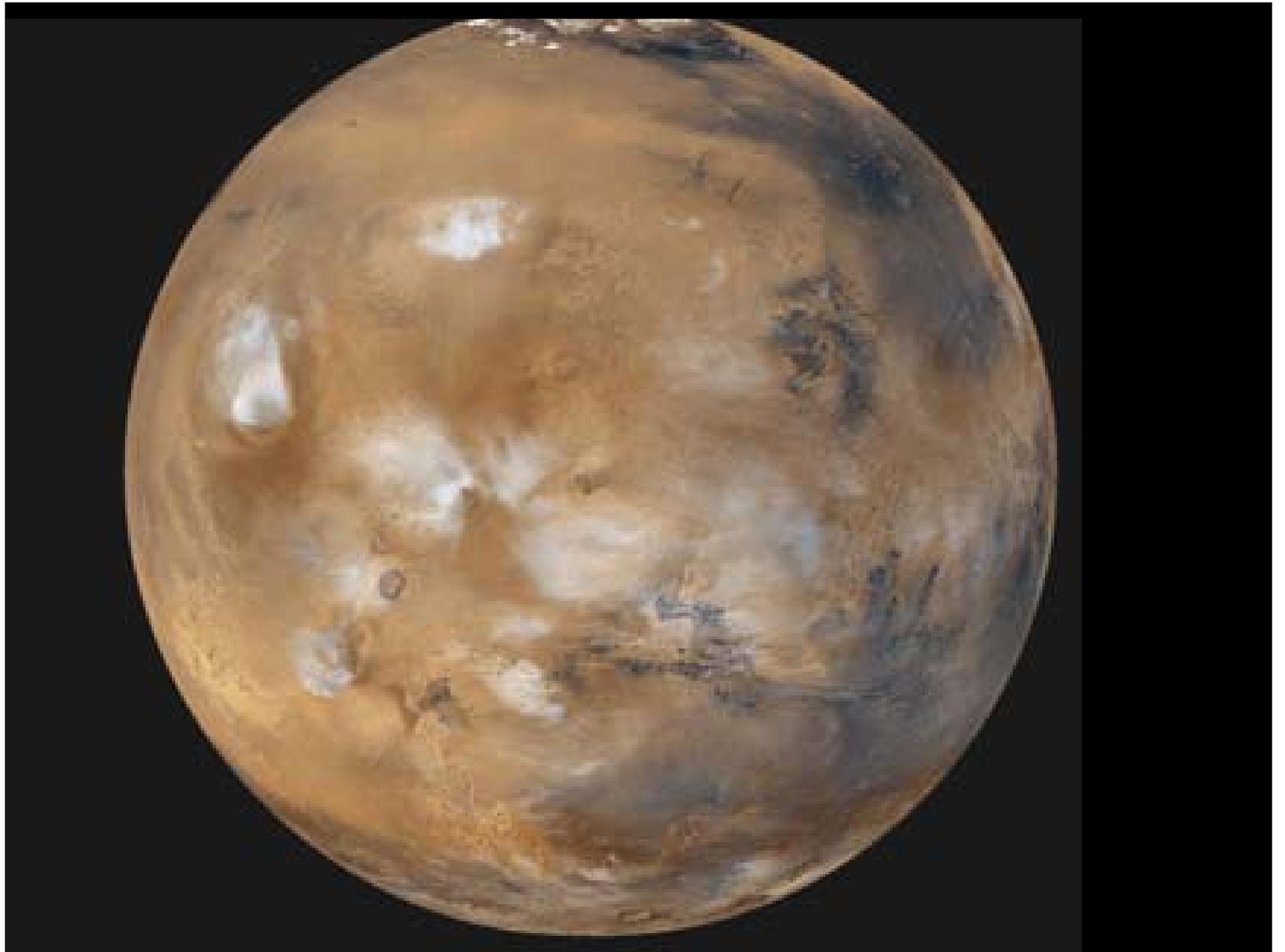


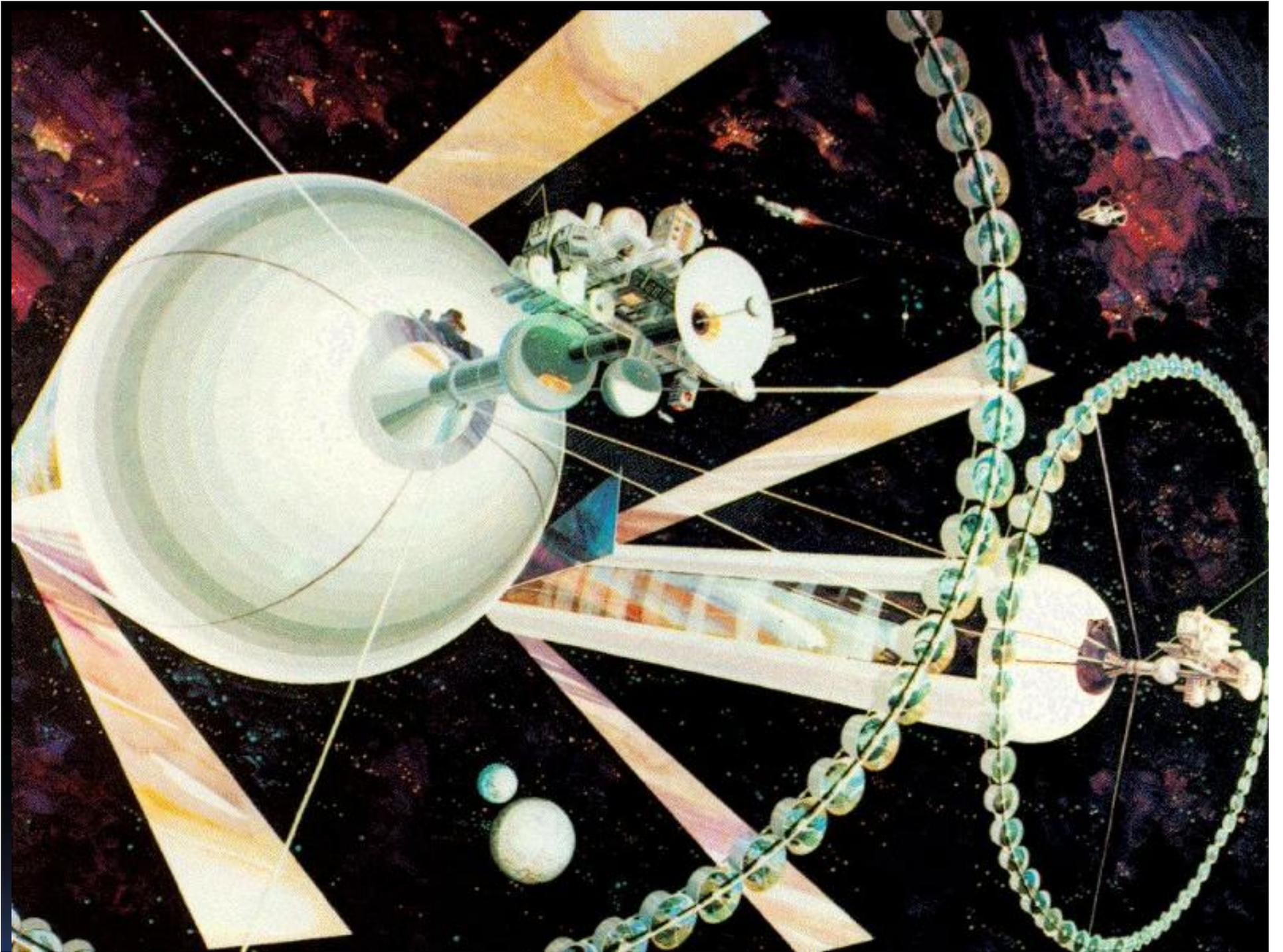
















Questions?