



**NSDL/NSTA Web Seminar**  
**APS: Studying the Human Physiological Limits  
of Exploring Mars**



Wednesday, May 13, 2009

Resource list for tonight's presentation:  
<http://www.diigo.com/list/nsdlworkshops/web-sem-mars>



## Today's NSDL Expert

PENNSTATE

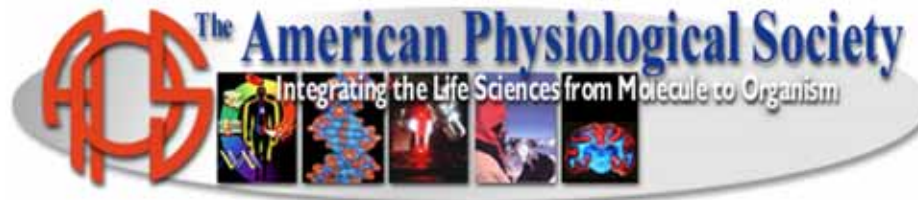


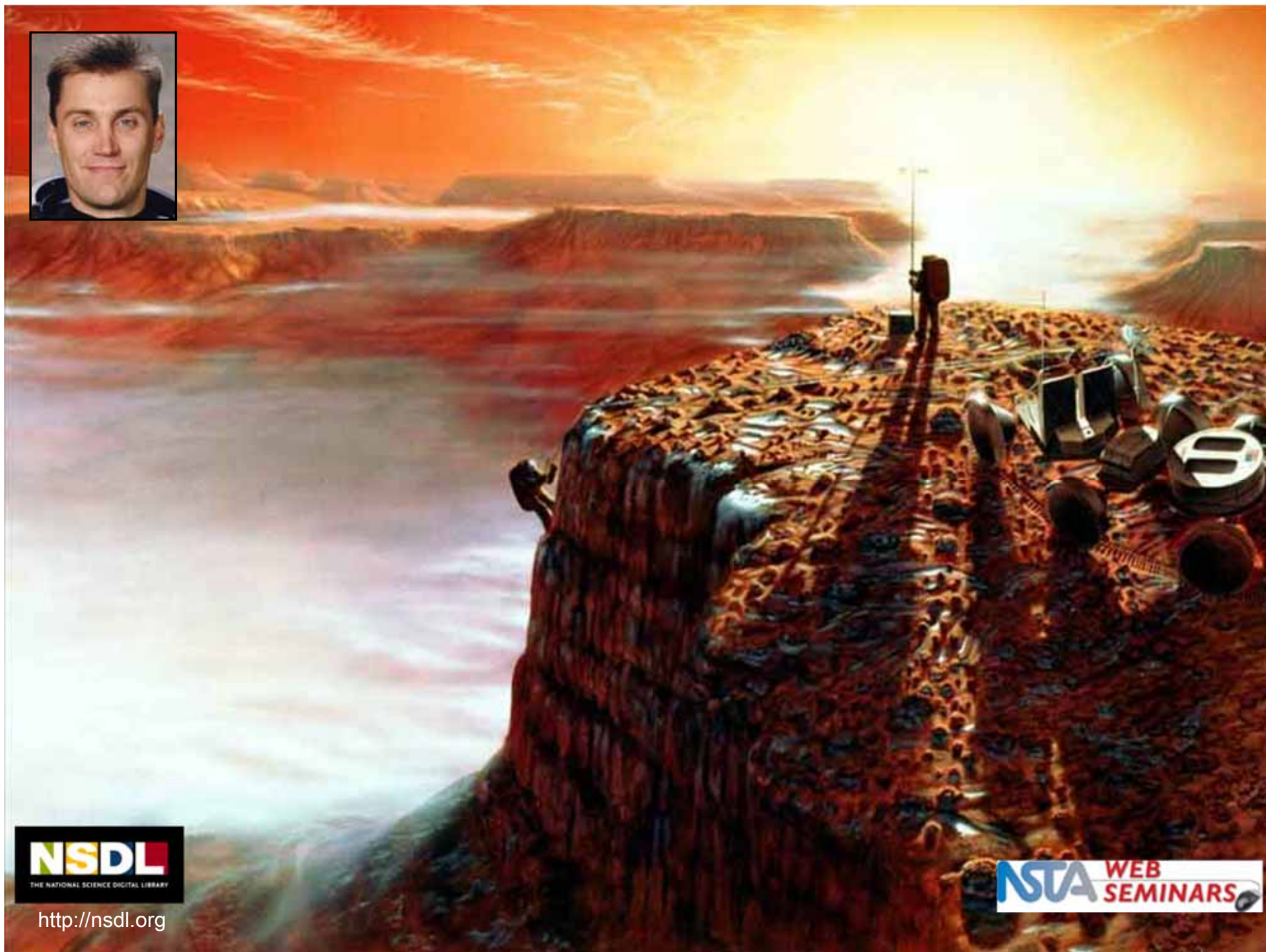
**Jim Pawelczyk, Ph.D.**

Associate Professor of Physiology & Kinesiology, College of Health and Human Development, Pennsylvania State University



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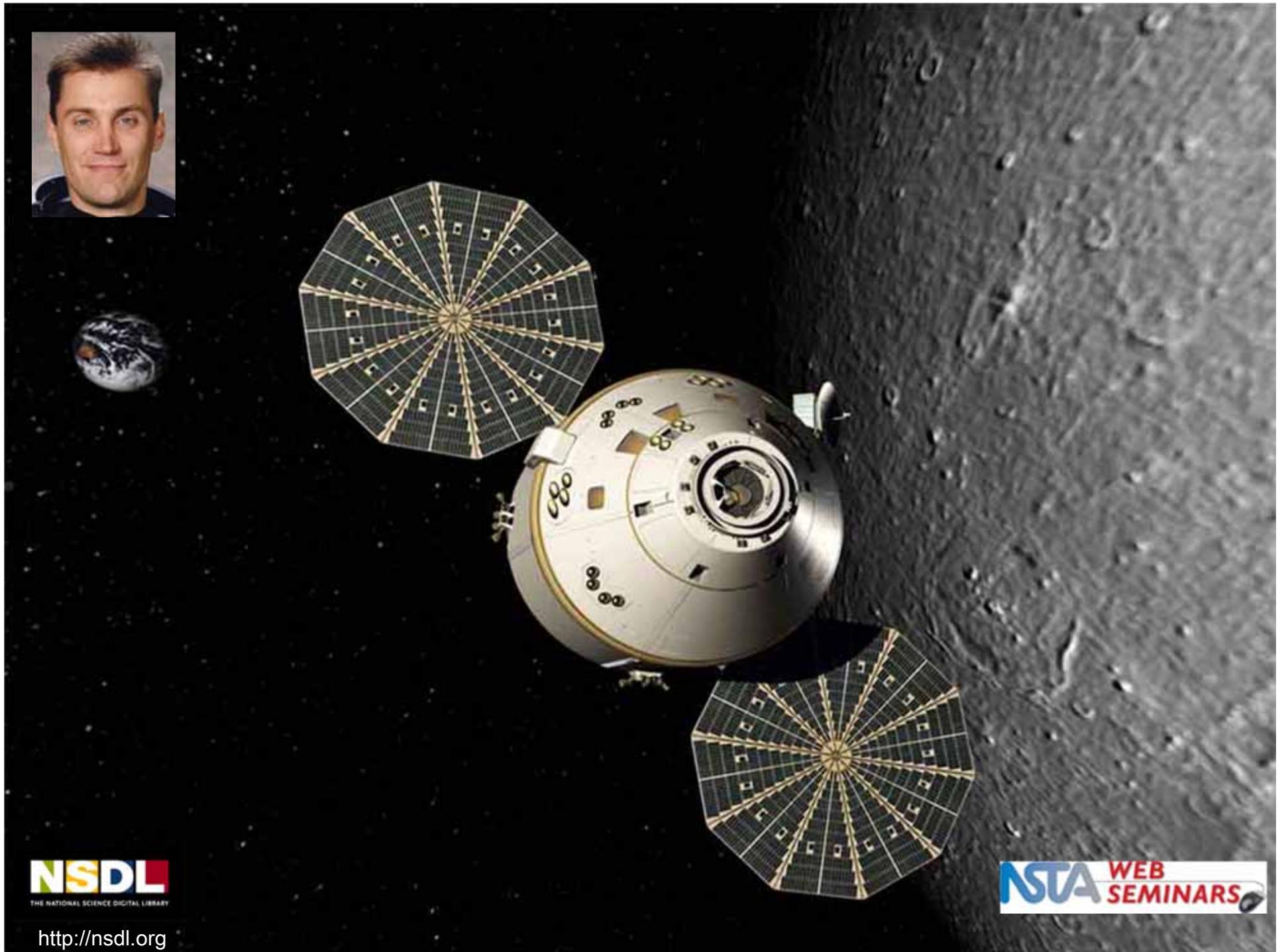






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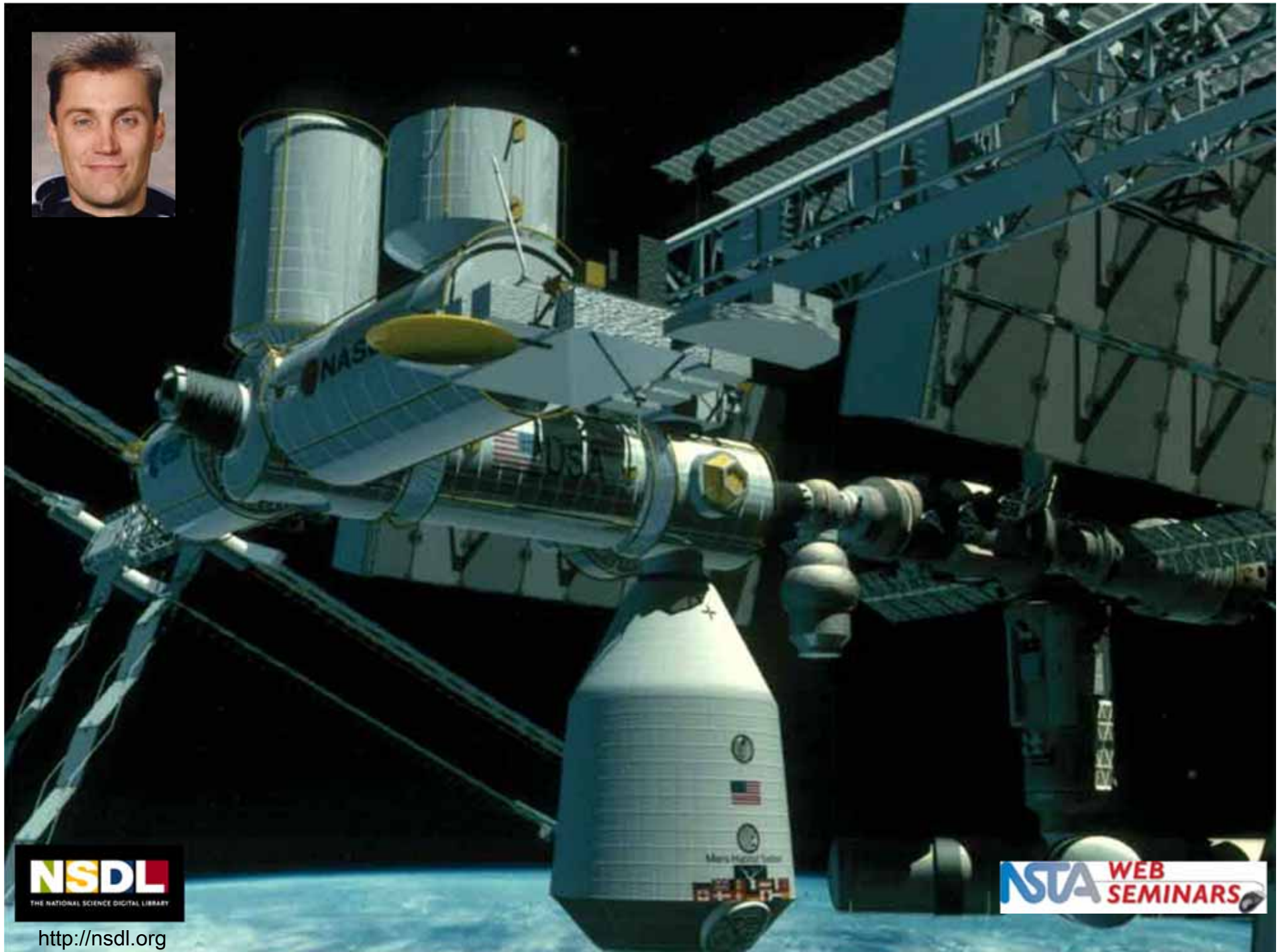




# International Space Station

<http://spaceflight.nasa.gov/realdata/sightings/>









What research is necessary for humans to travel to Mars?



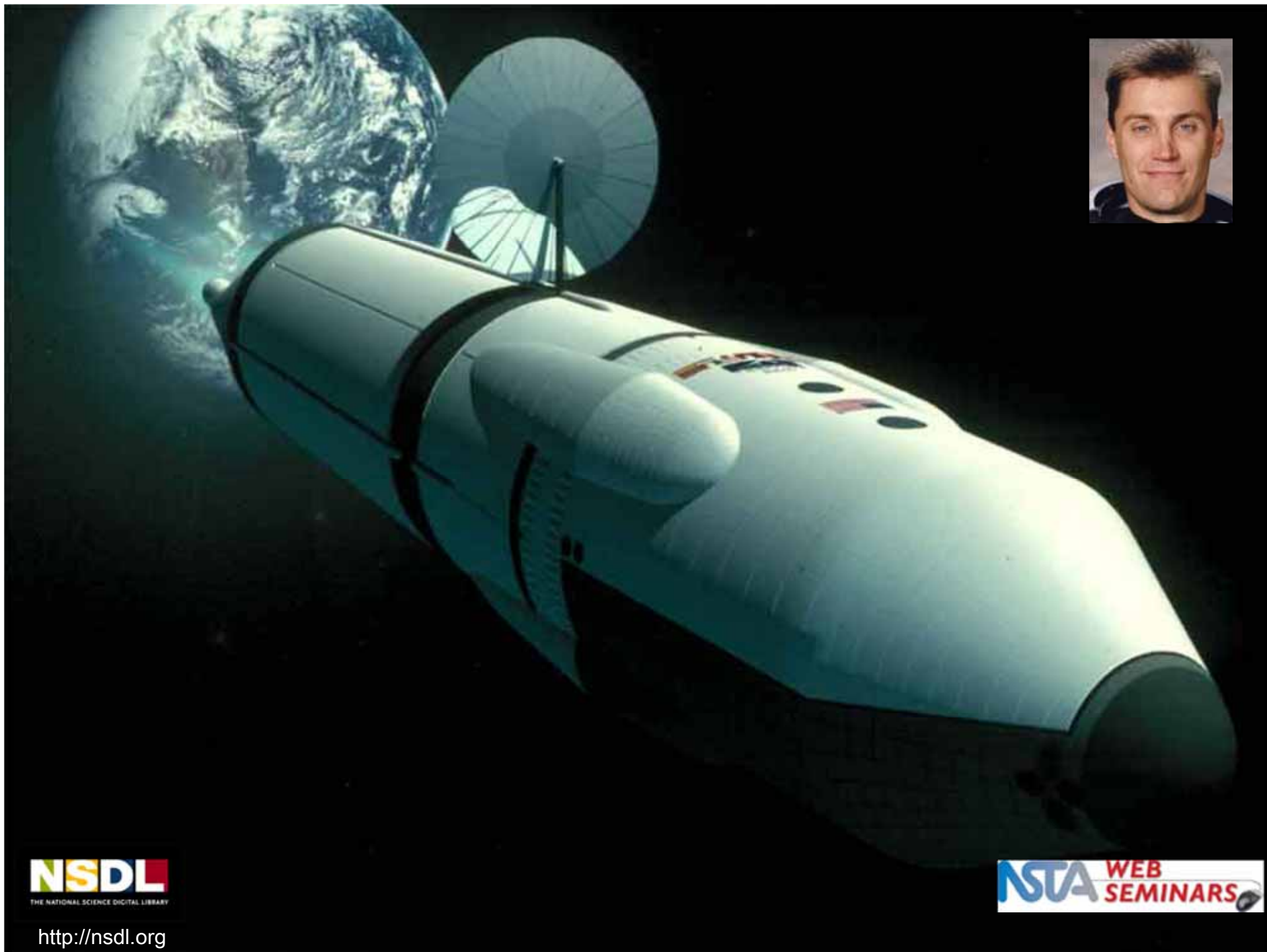
Type your responses in the chat



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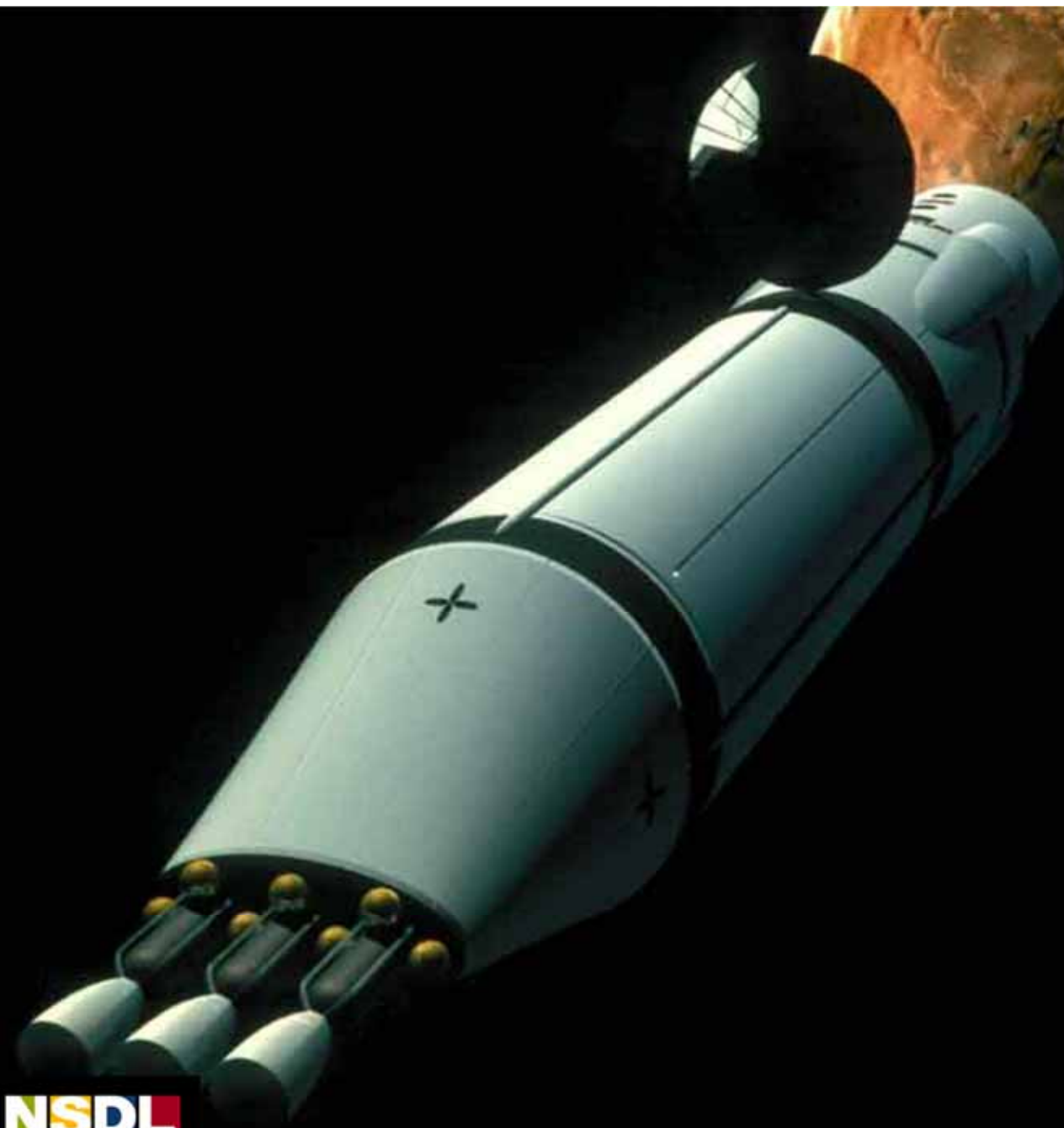




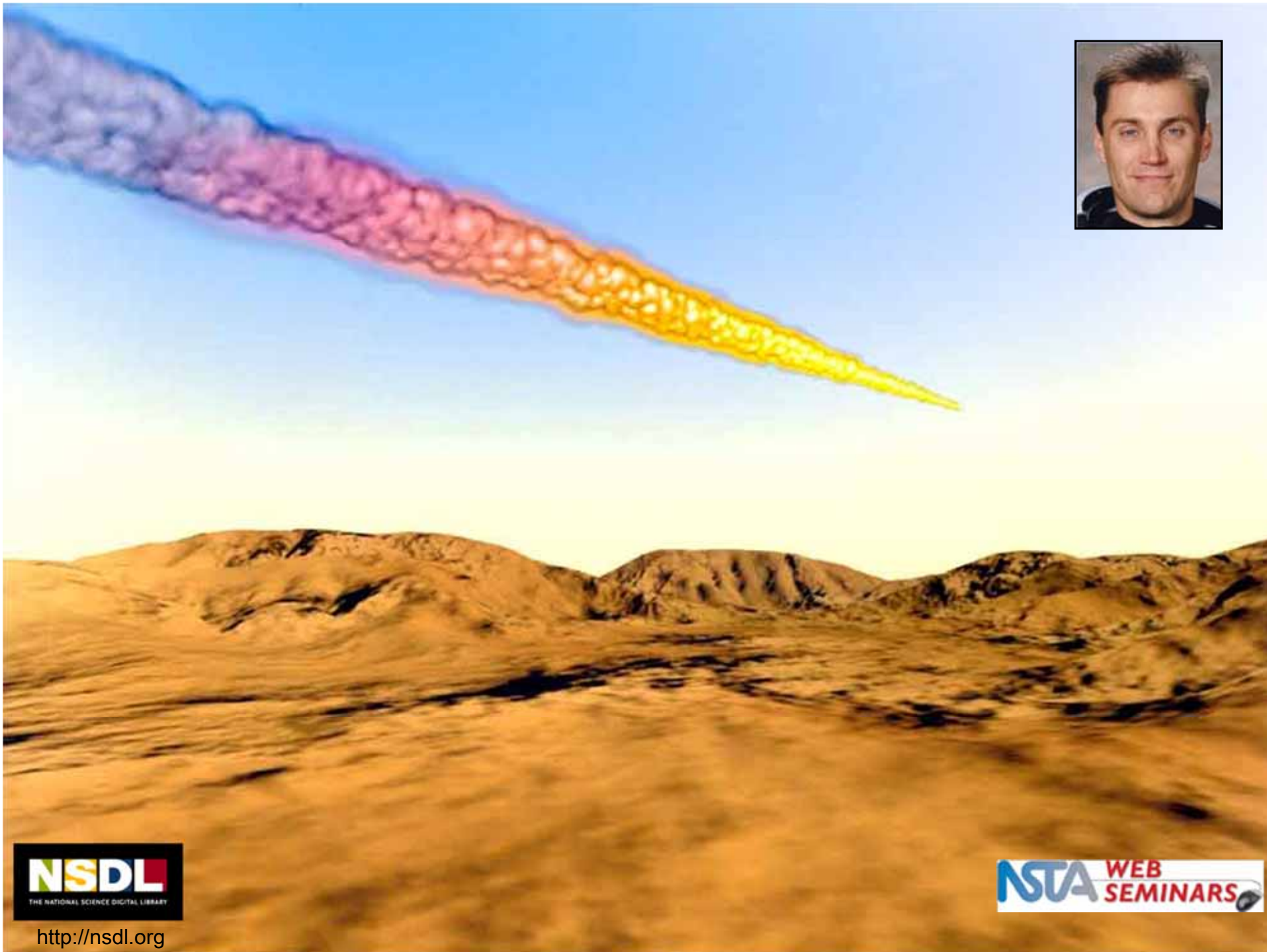
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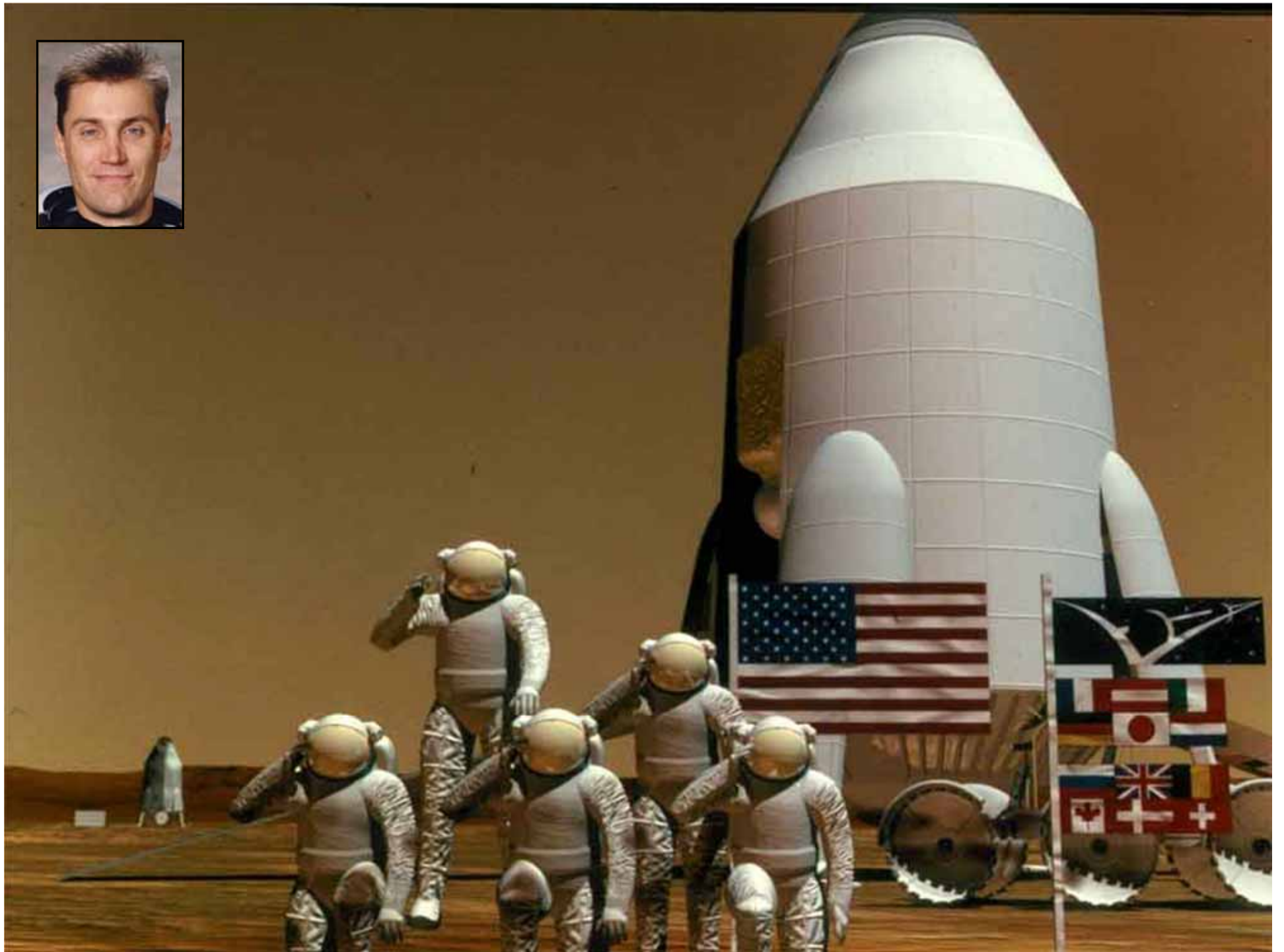






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# The Exploration Vision

4-6 crew to lunar surface

**Lunar Lander:** Lunar surface operations 14-30 days

2015-2020

Spiral 2

Spiral 3

Spiral 4

Spiral 1

Spiral 5

2020

4-6 crew to lunar surface  
for long-duration stay

**Lunar Habitat:** Lunar surface  
operations 60-90 days

2030+

Crew to Mars surface

**Surface Habitat**

2014

4-6 crew to low earth orbit

**Crew Exploration Vehicle:** LEO Environment  
Earth entry, water (or land) recovery

2025+

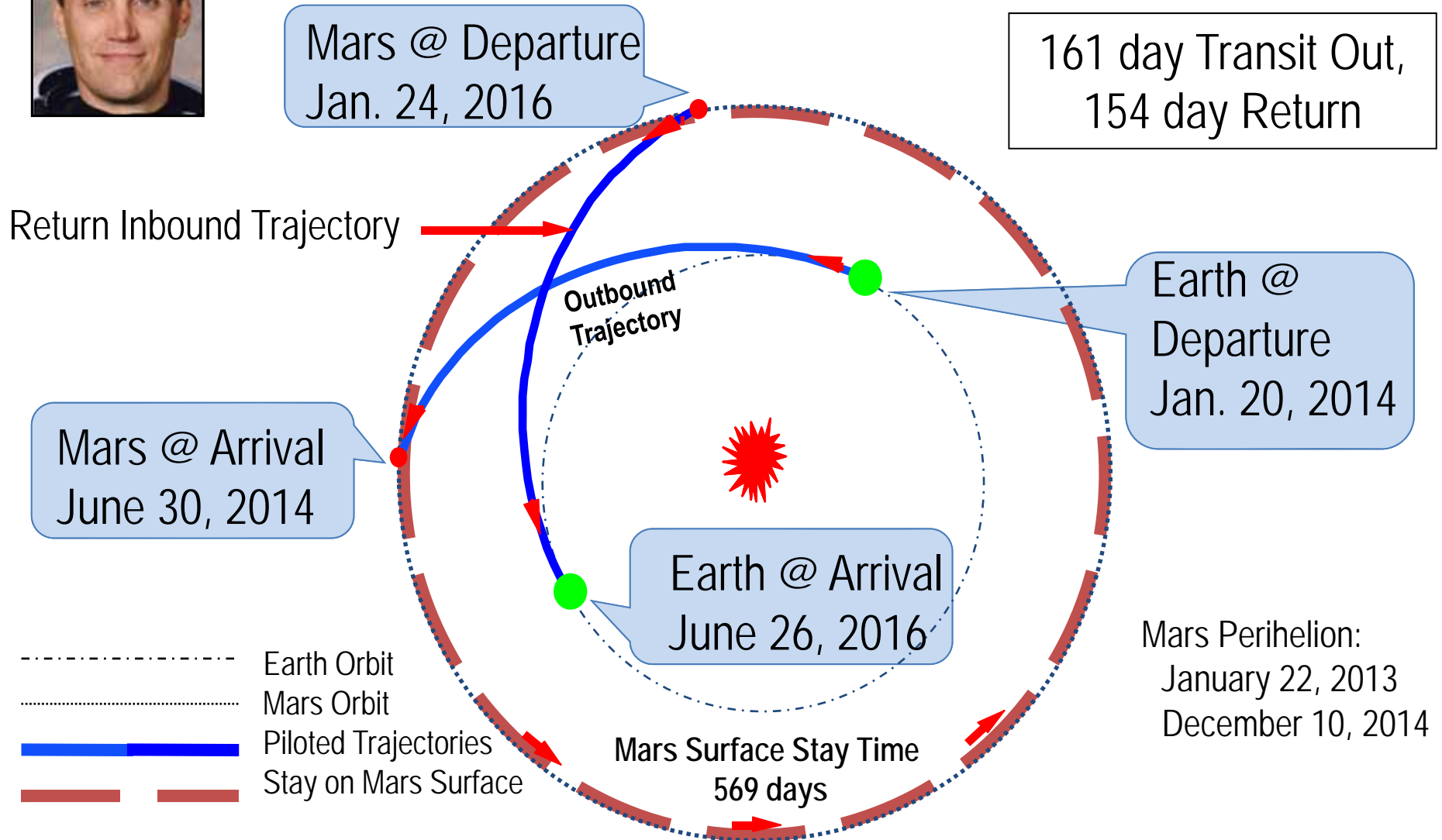
Crew to Mars orbit

**Transit vehicle:** Earth-Mars cruise – 6-9 months  
Mars vicinity operations – 30-90 days  
Mars-Earth cruise – 9-12 months

**noll**



# Mars flight profile - 2014



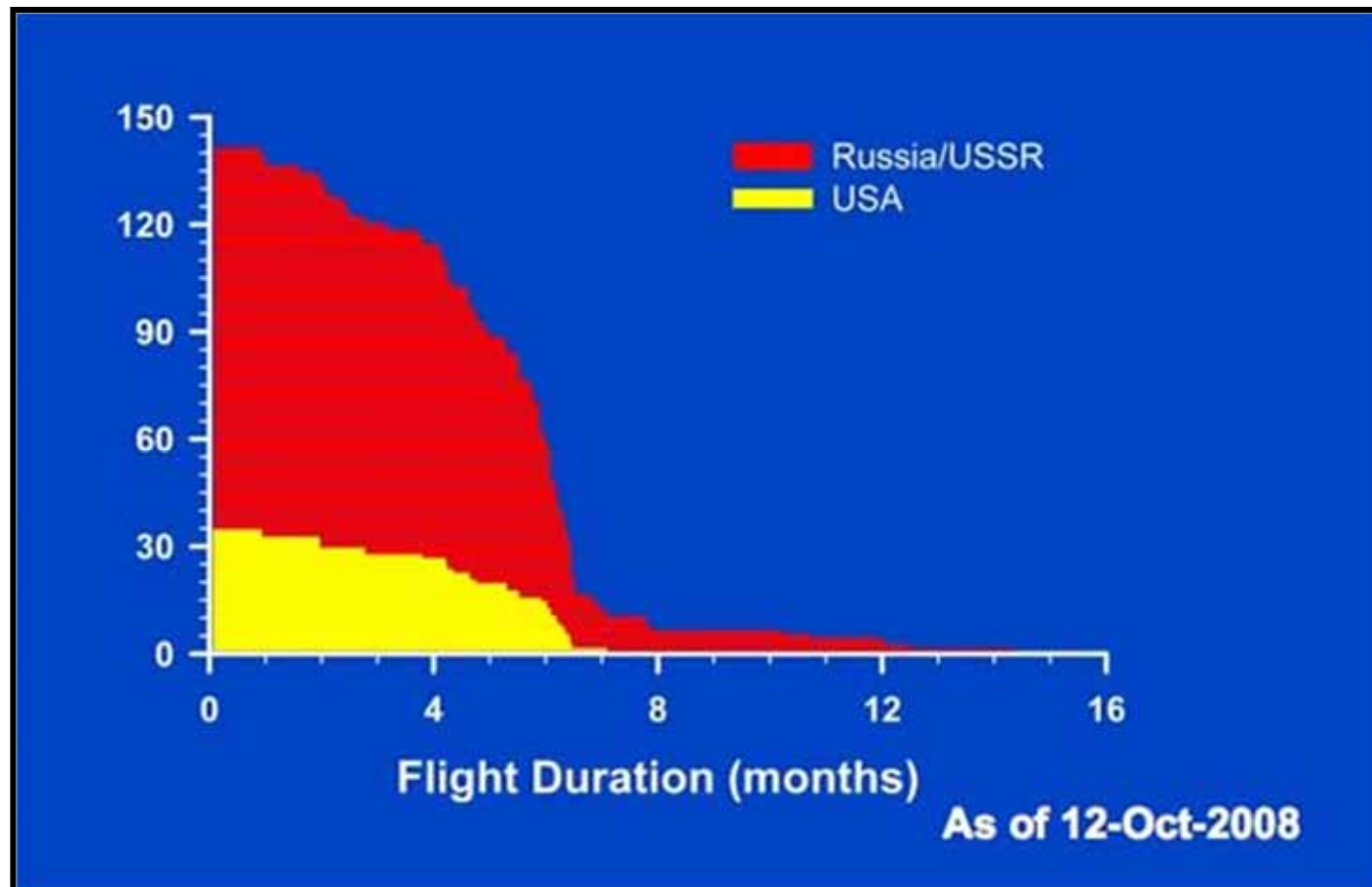
<http://nsdl.org>







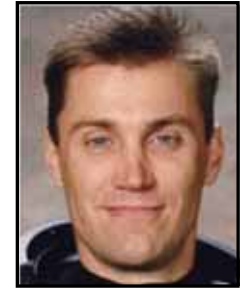
## Summary of human long-duration spaceflight





Let's pause for  
questions from  
the audience....

Which factor(s) pose the greatest human challenge to Mars exploration?  
Stamp your answer(s)

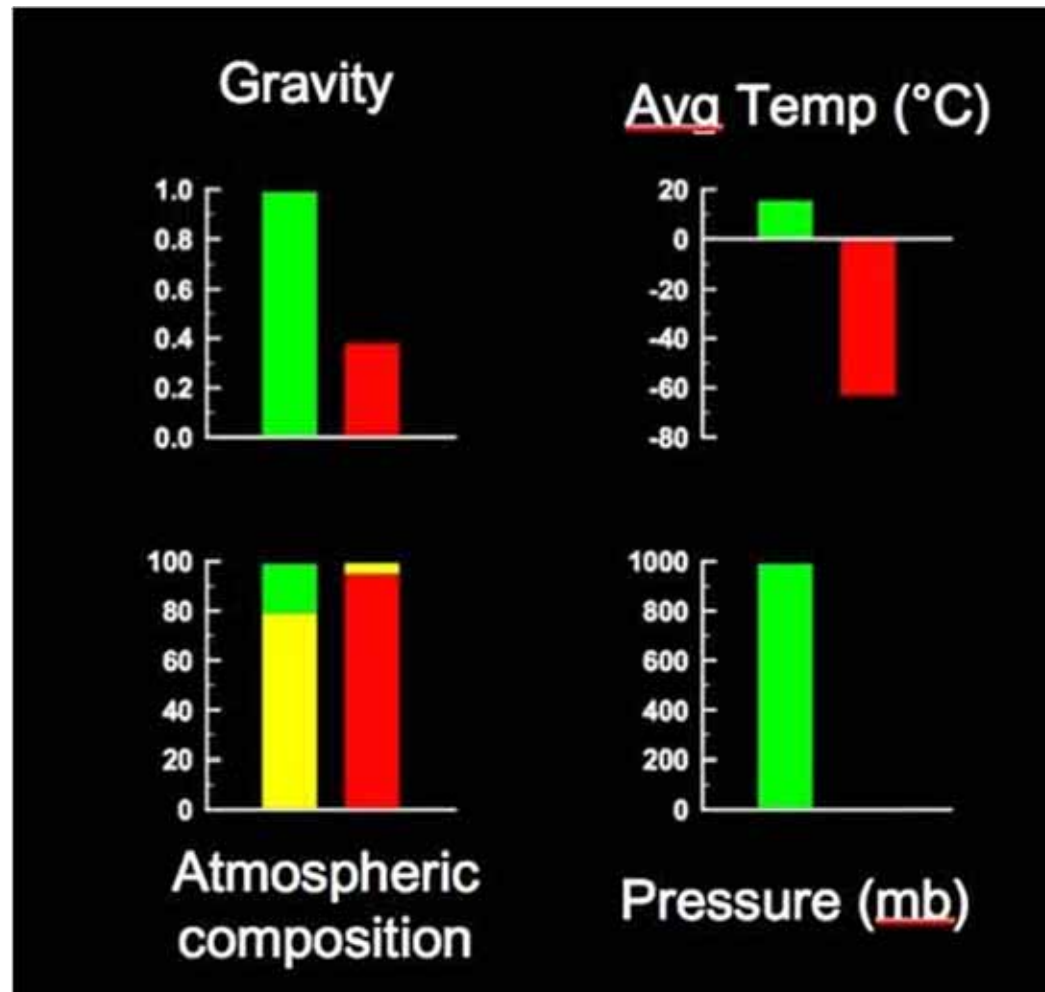


Environmental	Muscle	Cardiovascular	Neurological
Psychological	Ambulation	Radiation	Hydration & Nutrition
Immunological	Bone	Life Support	Medical





# The Martian environment





# Potential for near surface water on Mars

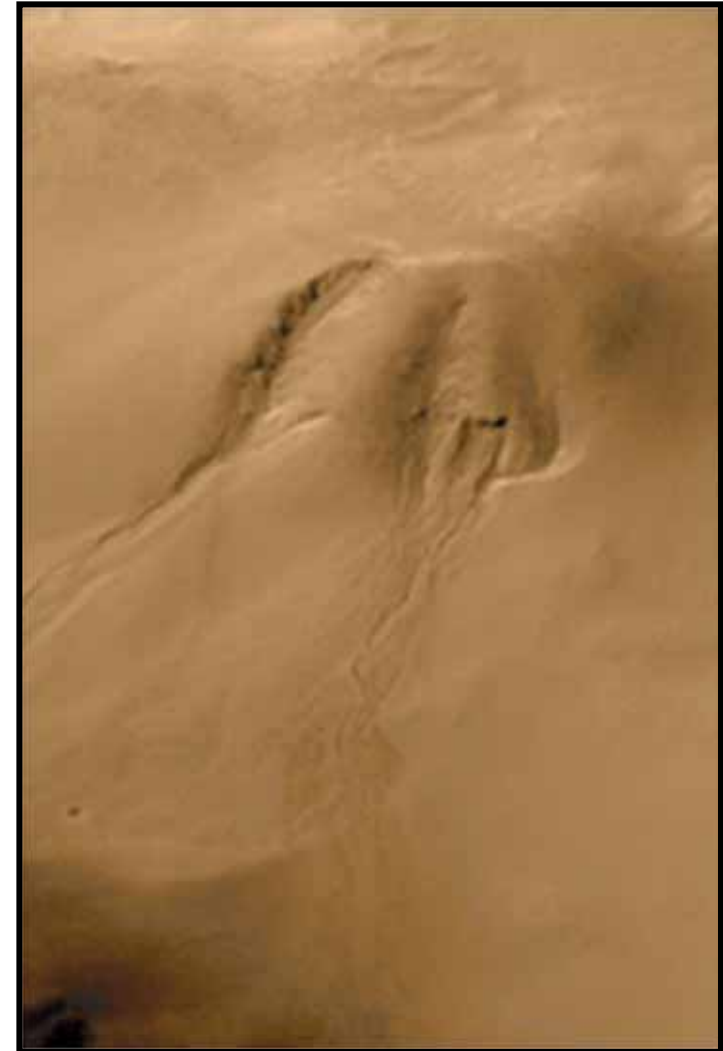


Image courtesy of Malin  
Space Systems / NASA

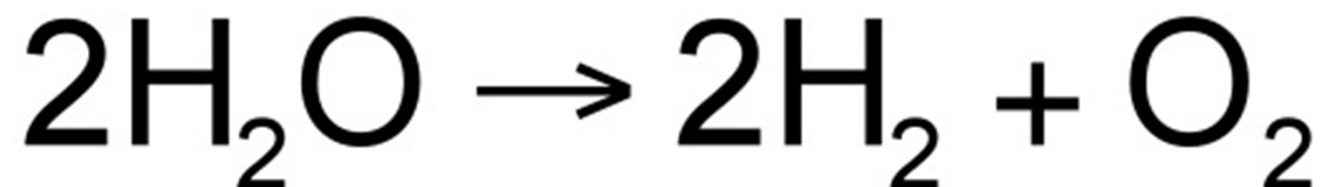


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# Sabatier Reaction



*(in situ resources)*





# Dust devils on Mars

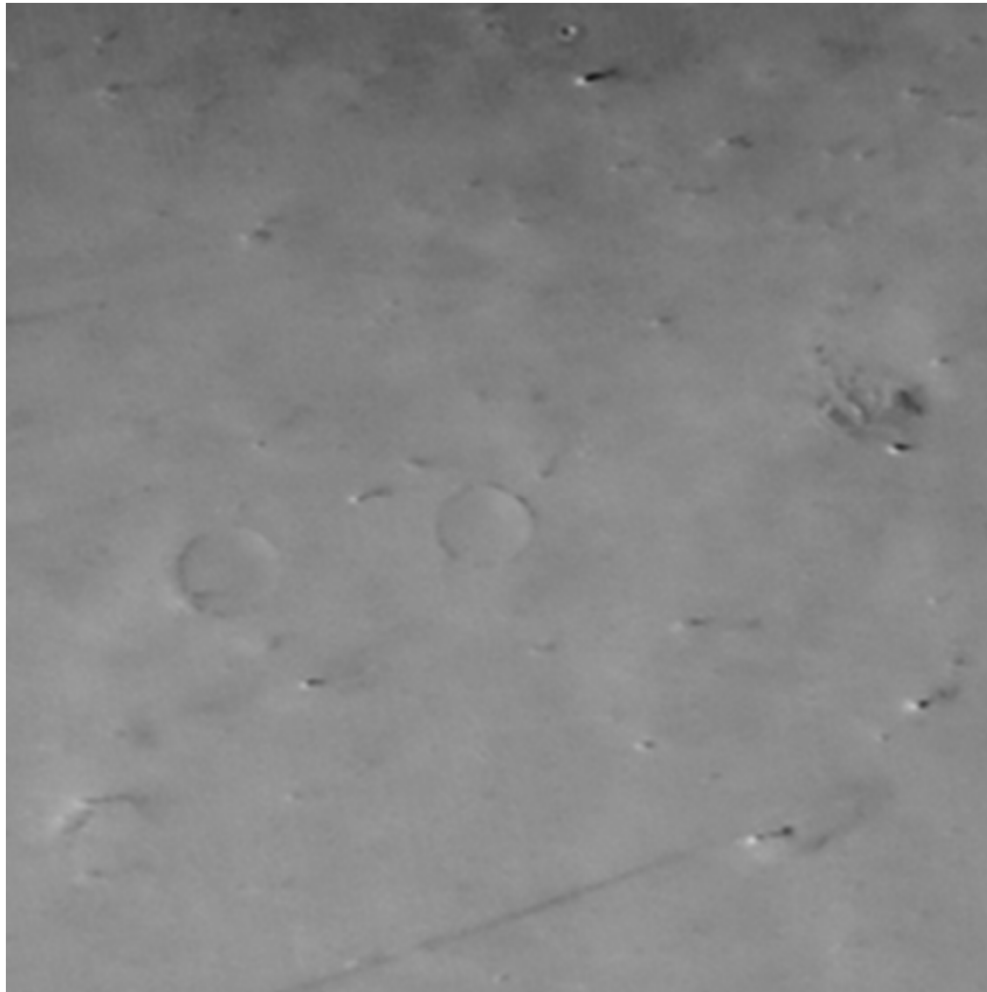


Image courtesy of Malin  
Space Systems / NASA



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# Dust devils on Mars

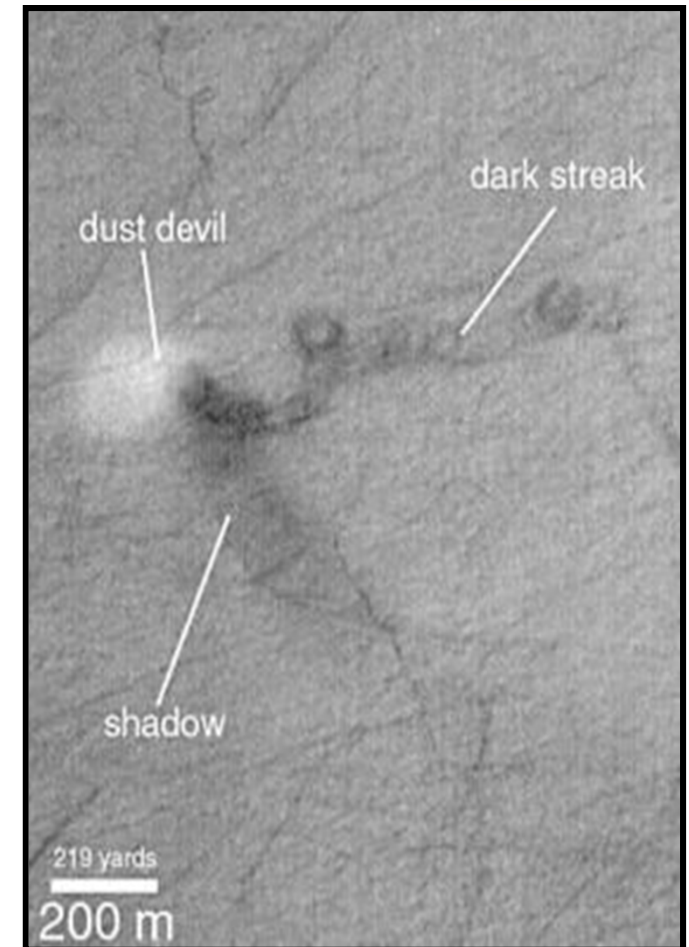
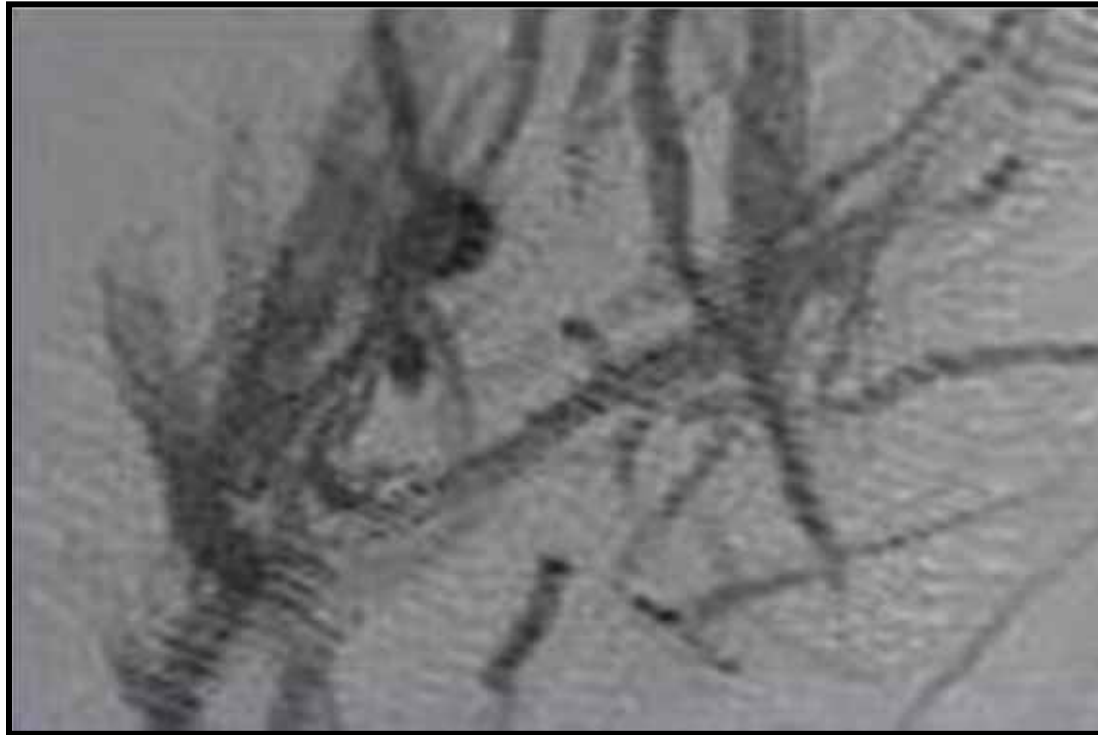


Image courtesy of Malin  
Space Systems / NASA



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# Dust devils on Mars



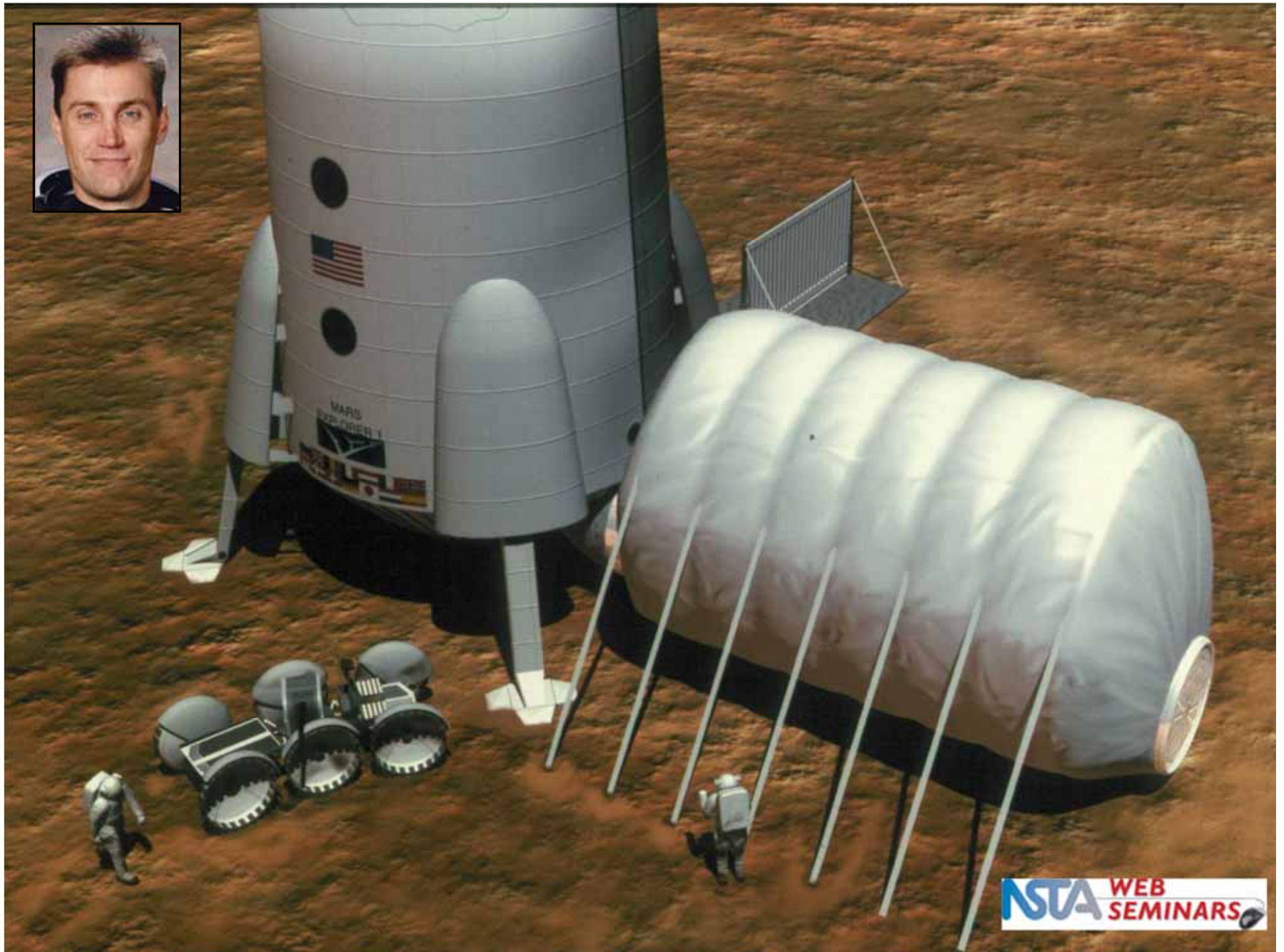
Image courtesy of Jet Propulsion  
Laboratory / NASA and Eric Hartwell



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Let's pause for  
questions from  
the audience....



# Poll Question:

During spaceflight, osteopenia ...

- A. Doesn't occur
- B. Occurs slower than in the elderly
- C. Occurs at a rate similar to the elderly
- D. Occurs more quickly than in the elderly





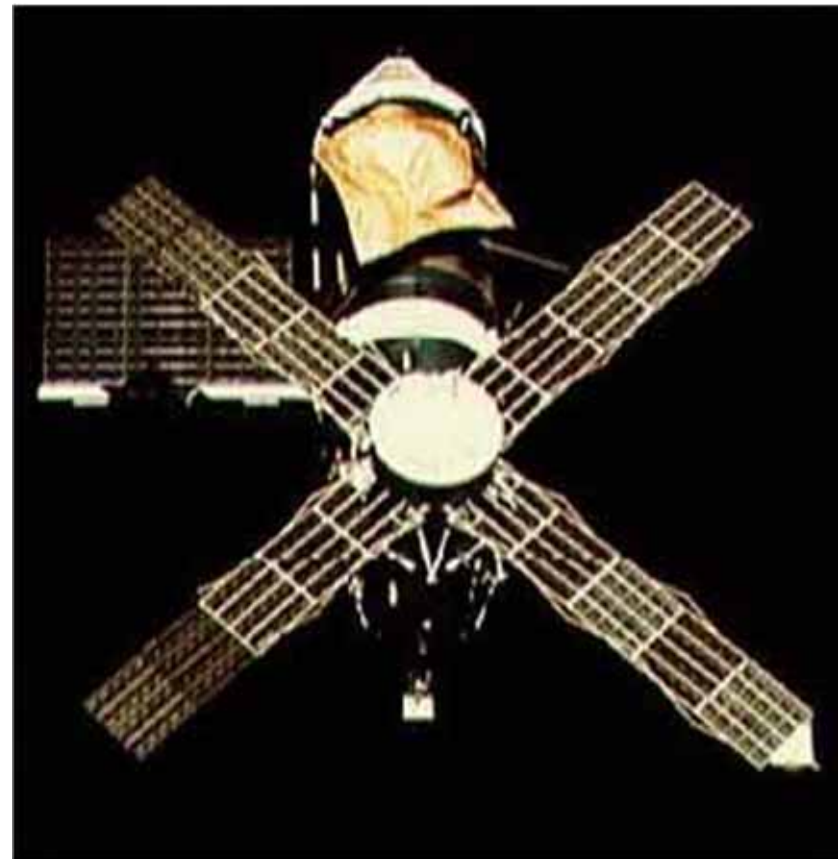


# Osteoporosis / Osteopenia





## Skylab – A repository of physiological data

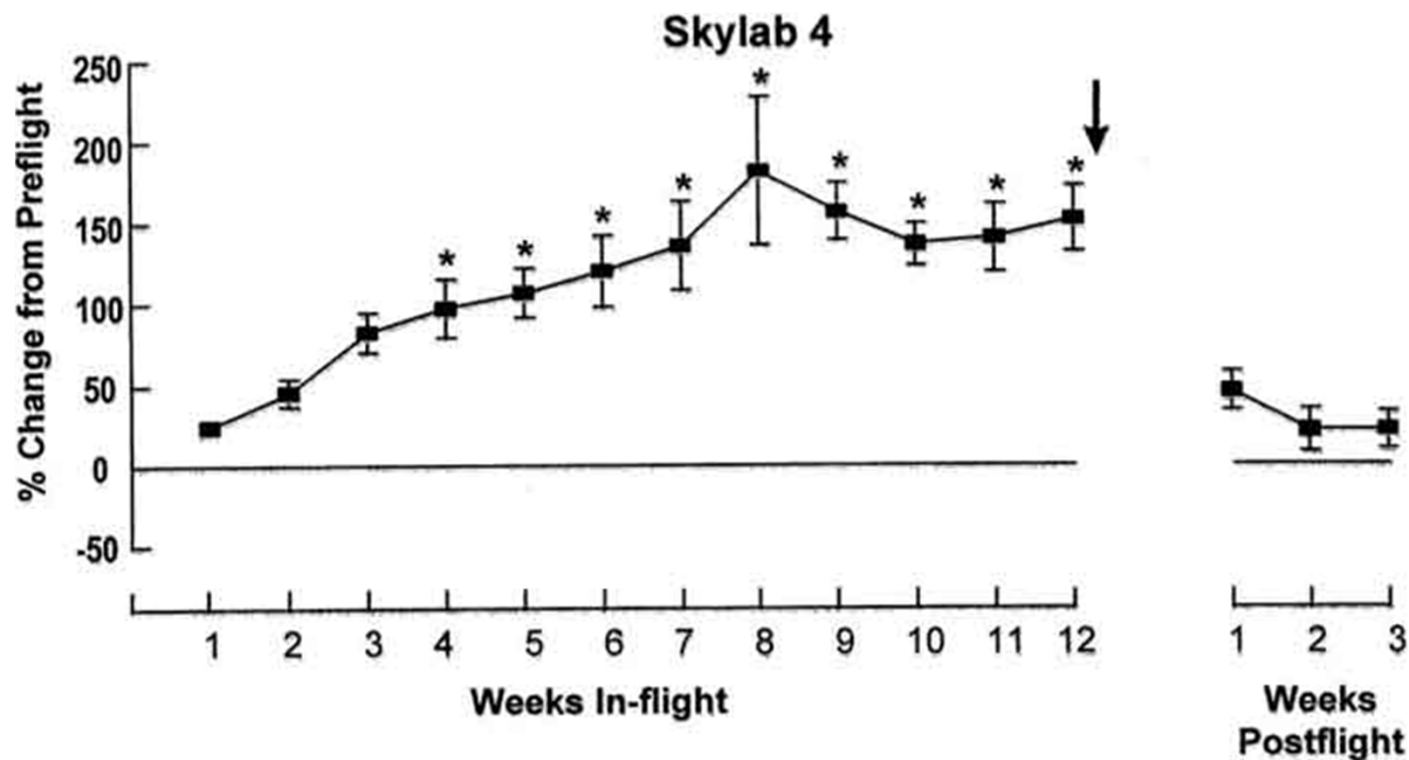


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# Spaceflight accelerates bone loss

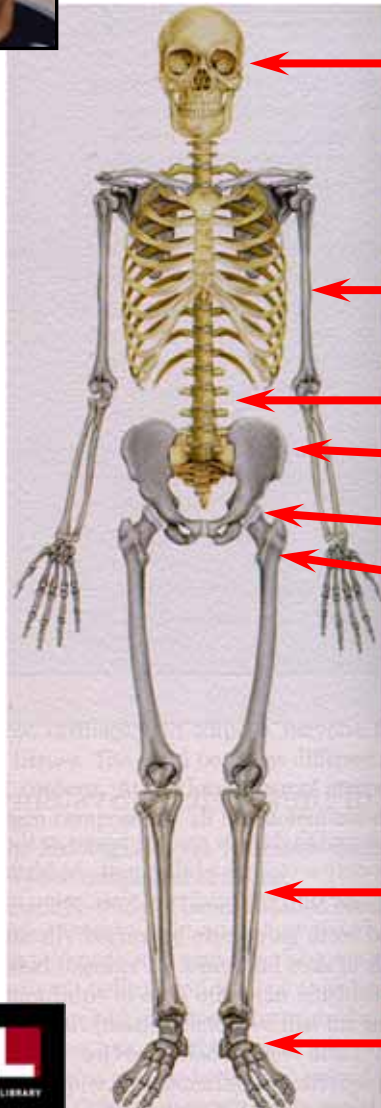


Smith *et al.*, J. Clin. Endocrinol. Metab. 83:3584-3591, 1998.





# Bone mineral losses from spaceflight



+0.6 % / mo

+0.1 % / mo

-1.1 % / mo

-1.4 % / mo

-1.2 % / mo

-1.6 % / mo

-1.3 % / mo

-1.5 % / mo

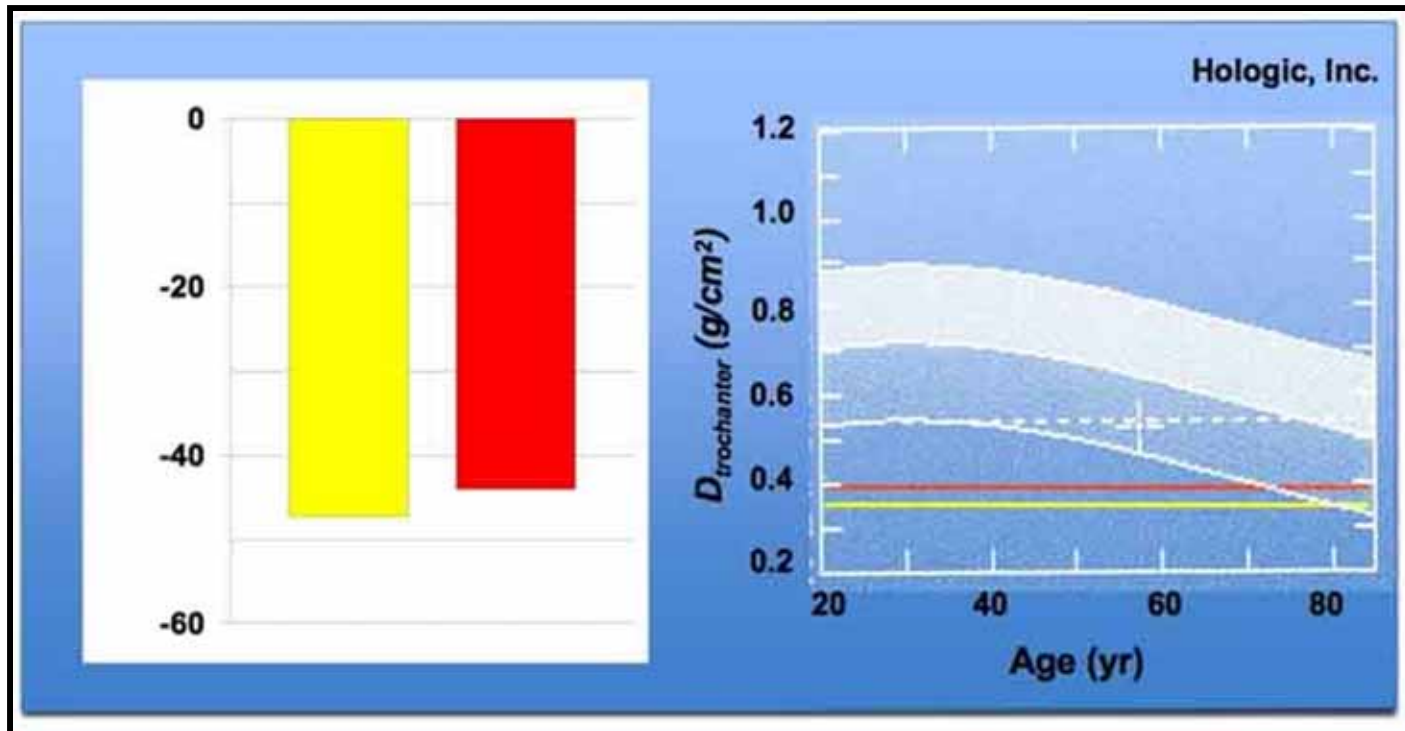
**LeBlanc et al., *Bone*  
11:S323, 1996**

**Lang et al., *J Bone  
Mineral Res*  
19:1006-1012, 2004**





# Chronic bone mineral loss is debilitating



LeBlanc *et al.*, J. Bone Mineral Res. 11:S323, 1996



Moynahan *et al.*, J. Spinal Cord Med. 19:249, 1996



# Poll Question:

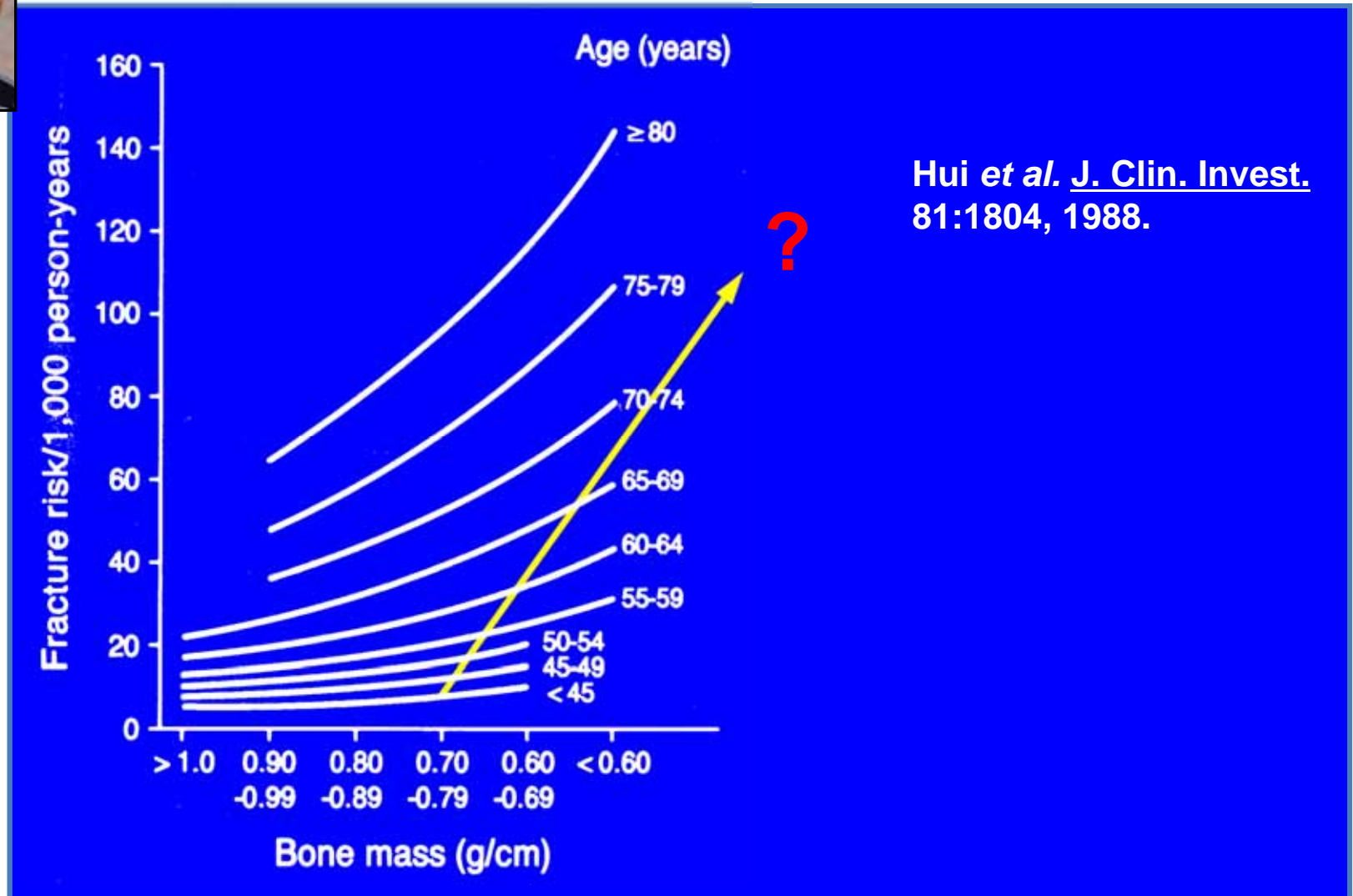
During spaceflight, osteopenia ...

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- D. Occurs more quickly than in the elderly





# Fracture risk





## The occupational risks of spaceflight

### If astronauts went to Mars today ...

- 100% would have >15% bone mineral loss
- ~80% would have >25% bone mineral loss
- >40% would lose >50% of their bone mineral
- ~20% would have >25% loss in exercise capacity
- ~40% would have >30% loss in muscle strength





## Information and technology critical for human Mars missions

- Site selection for human missions
- Extend stay time
- Demonstrations of critical technologies to “live off the land”
- Protection from physical/environmental hazards
- Understand and minimize physiological hazards to human explorers





***Earth is the cradle of humanity,  
but one cannot remain in the cradle  
forever.***

***Konstantin Eduardovich Tsiolkovsky***



Let's pause for  
questions from  
the audience....





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The NAST Four Year University/College Sartinn's 2d-hr Research Committee

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Symposium to Look at Genetic Basis of Exercise



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Inhalers & Heart Attacks: How Air Pollution Can Cause Heart Disease



For Patients With Cirrhosis, Inflammation May Be Common Threat to Survival

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The Archive is a collaborative library with many professional societies contributing resources. With one search, you can find resources in physiology, anatomy, developmental biology and other fields.

The Archive also is a colleague-to-colleague sharing community. We encourage you to share resources you have developed, recommend resources for review, and participate in user groups.

**This Month in History**

**May 1, 2009:** May is Asian Pacific American Heritage Month. [Learn More](#) »

**May 5, 1961:** American astronaut Alan B. Shepard Jr. became America's first space traveler. [Learn More](#) »

**May 5, 1847:** In May of 1847, the first permanent national U.S. medical society was organized. The American Medical Association.



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Please note! For some variables, the number of items currently in the Archive in that category are noted in brackets ([ ]) beside the variable. If you select items with more than 200 items in the category, your browser may need additional time (1-3 minutes) to present the long list of items for your review. Your screen may be blue or white during this waiting period. Please be patient. This is not a function of the Archive search engine but of your specific web browser. For more information, go to [Frequently Asked Questions](#).

### Disciplines

- Agriculture & aquaculture [13]
- Anatomy [613]
- Anthropology & archaeology [5]
- Bacteriology [5]
- Behavioral science [30]
- Biochemistry [53]
- Biocomplexity [10]
- Biodiversity [13]
- Bioengineering [18]
- Bioethics [15]
- Bioinformatics [13]
- Biophysics [22]
- Biostatistics [8]
- Biotechnology [10]
- Botany & plant science [24]
- Cardiology [260]
- Cell biology [249]
- Conservation biology [15]
- Cryobiology [5]
- Developmental biology [279]
- Ecology [26]
- Education [1272]
- Embryology [121]
- Endocrinology [94]
- Entomology [16]
- Environmental sciences [22]
- Enzymology [7]
- Epidemiology [55]
- Evolutionary biology [25]
- Exercise & kinesiology [141]
- Exobiology [5]

### Learning Resources

- 35mm slide [1]
- Abstract [4]
- Animation [50]
- Application [7]
- Assessment: exam w/o answer key [23]
- Assessment: exam with answer key [16]
- Assessment: other [34]
- Assessment: tool [57]
- Assignment/activity (non-laboratory) [236]
- Atlas [18]
- Audio [45]
- Bibliography [6]
- Biography [2]
- Book [5]
- Book chapter [37]
- Course syllabus [24]
- Database [12]
- Dataset [66]
- Diagram [64]
- Dictionary/glossary [28]
- Digital presentation (Powerpoint) [118]
- Discussion group/listserv [7]
- Discussion group/listserv archive [6]
- Fieldtrip guide [1]
- Graph/Chart [37]
- Illustration [93]

### Grade Levels


- Preschool [14]
- Primary Elementary (Grades K-2) [51]
- Intermediate elementary (Grades 3-5) [66]
- Middle School (Grades 6-8) [329]
- High School lower division (Grades 9-10) [687]
- High School upper division (Grades 11-12) [897]
- Undergraduate lower division (Grades 13-14) [1829]
- Undergraduate upper Division (Grades 15-16) [1854]
- Graduate [1507]
- Professional (degree program) [1495]
- General Public [823]
- Informal Education [411]
- Continuing Education [1138]

































## Keyword Search Results

Found 8 teaching resources.

Click the  icon for the description; click on any teaching resource's title for detailed information. You must be logged in to the left in order to save searches or resources. Once you save a search, go to **My Saved Searches** to e-mail those results to someone.

<input type="text"/>	<a href="#">Search within Results</a>	<a href="#">Go Back</a>	<a href="#">New Search</a>
<input type="text"/>	<a href="#">Save This Search</a>		

Title/Author/Resource Type/Format/  Description	Level(s)	Partner
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Analysis Questions Student Handout</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio Assignment/activity (non-laboratory)(Portable Document Format - PDF)	 	
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Analysis Questions Teacher Answer Key</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio Teaching strategies & guidelines(Portable Document Format - PDF)	 	
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Bone Density Lab Student Directions</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio Laboratory exercise, Lesson plan(Portable Document Format - PDF)	 	
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Bone Density Lab Teacher Directions</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio Lesson plan, Teaching strategies & guidelines(Portable Document Format - PDF)	 	
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Class Data Collection Student Worksheet</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio Laboratory exercise(Portable Document Format - PDF)	 	
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Graphing Bone Density Student Handout</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio Assignment/activity (non-laboratory)(Portable Document Format - PDF)	 	
 <b>Bone Health: Determination of Bone Density with Bone Specimens - Group Data Collection Student Worksheet</b> UTHSCSA Faculty, The University of Texas Health Science Center at San Antonio	 	



Jim Pawelczyk, Ph.D.  
jap18@psu.edu

THANK  
YOU!

Resource list for tonight's presentation:  
<http://www.diigo.com/list/nsdlworkshops/web-sem-mars>



<http://nsdl.org>





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