The Challenges Ahead

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TO MARS VIA ITS MOON DEIMOS

Luncheon Talk by

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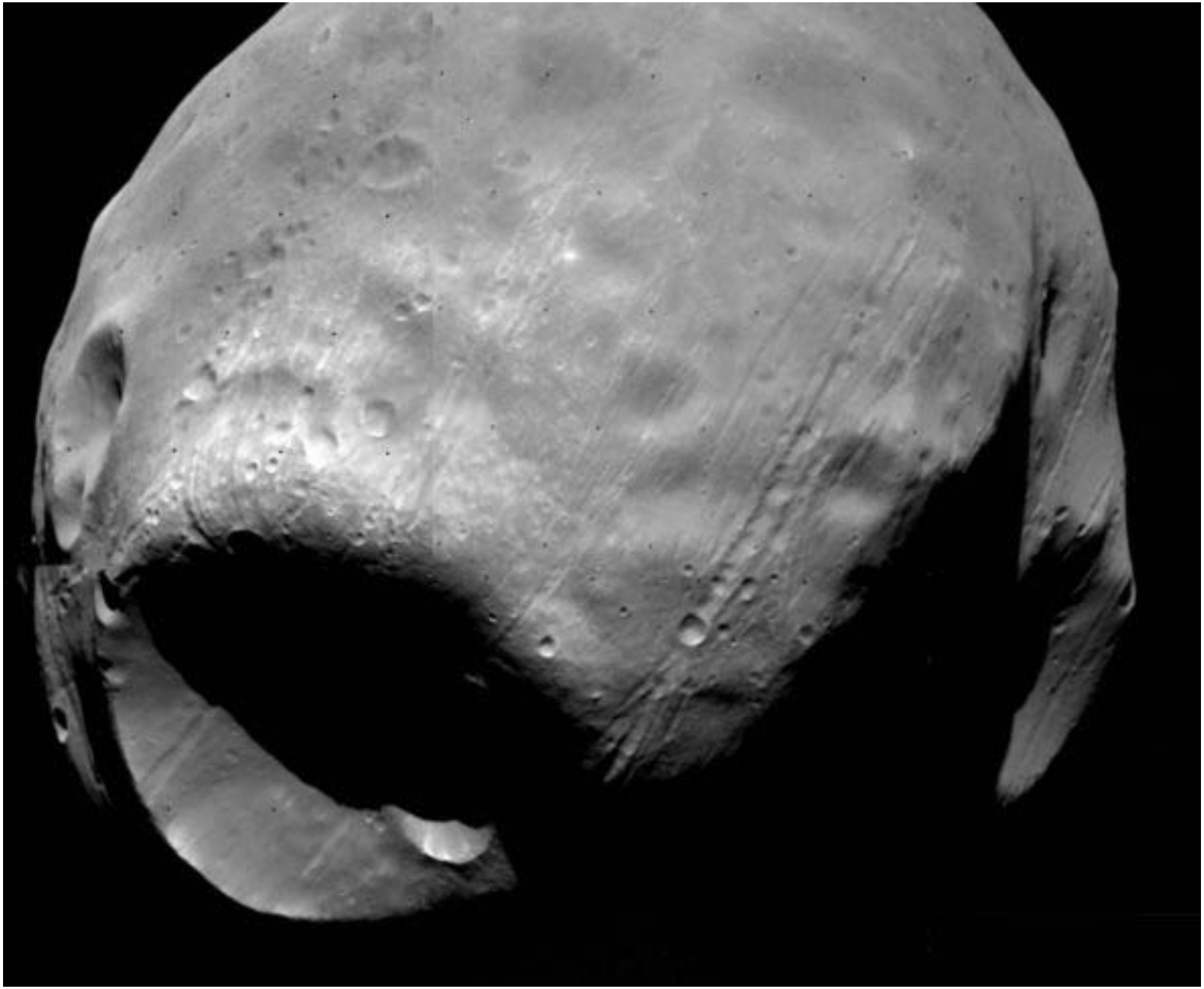
Mars • 2001 Opposition

Hubble Heritage

NASA and The Hubble Heritage Team (STScI/AURA)
Hubble Space Telescope WFPC2 • STScI-PRC01-24

PHOBOS



DEIMOS

National space program needs a single overarching goal

Manned exploration, with unique scientific content -- not a publicity stunt

First step: Ph-D Project, with a base on Deimos

Faster: **10- 15 years**

Better: **than a series of unmanned probes**
than a base on Mars surface

Cheaper: **than either alternative**
within current NASA budget

Manned Mission to the Moons of Mars (MMMM)

Phobos and Deimos
in near-circular equatorial orbits
at 2.8 and 7.2 Martian radii.
Rocks about size of Manhattan

Mystery of Origin
Captured asteroids? Co-formation?

Phobos orbit shrinking
Deimos near-synchronous

Deimos is an ideal base
low gravity and escape velocity
shelter from environmental hazards

Fundamental Science Goals

• How do planets develop?

Comparative Planetology

What happened to Mars oceans?

What happened to Mars magnetic field?

Mars volcanism and mountain building

• Climate history

Was Mars wet and warm? Climate change as spin axis moved

Do climate cycles exist as on Earth?

Can models explain climate changes?

• Origin of Life

Existence of fossil life forms?

Existence of hidden life?

beneath surface or near ice caps

Biochemistry and morphology

Similar to terrestrial life forms?

FASTER……..

Orbit transfer from Earth orbit to Mars orbit

Deimos provides shielding and shelter against meteor streams, cosmic rays, solar flares

Builds on ISS experience
Uses ongoing NASA developments, like Prometheus

No showstoppers

<u>Project attainable in 10-15 years</u>

BETTER……

• Unmanned rovers controlled in real time – no delay

• Tele-robots return data/samples to Deimos
Immediate evaluation permits sequential exploration
--- with results in hours instead of years

• Complete scientific laboratory setup
--- natural vacuum – for instruments

• Sortie to Phobos for sample collection

• Manned sortie to Mars surface --- for follow-up of scientific results

• Prototype automatic propellant factory

CHEAPER……

- **Assemble gradually in Earth orbit**
  ---30 tons, mostly propellant

- **Pre-position "Slow Freight " on Deimos**
  ---Investigate cheapest route – via L-1?

- **Test Manned Habitat and crew in LEO**
  When ready, send by fastest route
  --- propulsion vs. transit time trade-offs

- **Desirable technology developments**
  ---(now in pipeline)
  ---Heavy-lift vehicle ("Space Truck")
  ---Nuclear reactor electric power supply ("Prometheus")

- **Cost Estimate: $30 billion over 15 years**
  ---<u>within present NASA budget</u>

PhD Mission
of Manned-Robotic Cooperation
vs.
a Manned Planetary Base

• No delta-vee Penalty

(2 x 2.38 km/sec on Moon) (2 x 5.0 km/sec on Mars)

Hence: Less Need for Propellants

(and for their transport)

• No Need for High-Thrust Engine

since del-vee = thrust x time

No Landings—only Orbit Maneuvers

Hence: Use existing engine

(smaller, less weight, better mass ratio)

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• "Lifeboat" mission (*Chang-Diaz*)

100 days to Mars, 30 d at/near Mars, 100 d to return

We need further trade-off studies

Minimizing transit time *vs.* additional del-vee

Follow-ons:

Mars base:
Habitation & colonization
Propellant production
Detailed exploration & experiments
Terraforming & agriculture

Phobos / Deimos as cheapest sources
--for material for space construction