

Fall Semester 2004

Part 11

No. 1



# S·P·A·C·E TOURISM II™

Lecture Series given by Dr.-Ing. Robert Alexander Goehlich

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## General Contact

No. 2



Dr.-Ing. Robert Alexander GOEHLICH

Mobile: +81-(0)90 1767 1667

Fax: +81-(0)45-566-1778

Email: [mail@robert-goehlich.de](mailto:mail@robert-goehlich.de)

Internet: [www.robert-goehlich.de](http://www.robert-goehlich.de)



Ms. Akiko FUJIMOTO (Teaching Assistant)

Mobile: +81-(0)80-5039-6222

Email: [af07302002@yahoo.co.jp](mailto:af07302002@yahoo.co.jp)



Mr. Kenji HASEGAWA (Webmaster)

Mobile: n.a.

Email: [malayzaru@hotmail.com](mailto:malayzaru@hotmail.com)



Keio University  
Department of System Design  
Engineering  
Ohkami Laboratory  
(Space System Engineering)  
Office 14-609/14-620  
3-14-1 Hiyoshi  
Kohoku-ku  
Yokohama 223-8522  
JAPAN

## Content

No. 3



➤ **General**

➤ **Guest Speaker: Dr. Knud Jahnke,  
Astrophysical Institute Potsdam, Germany**

**Note: The following slides were provided  
courtesy of Dr. Knud Jahnke**

➤ **Requests from Audience for Lectures**

## Space Tourism — Destination Universe

Dr. Knud Jahnke  
Astrophysical Institute Potsdam  
<http://www.aip.de/~jahnke>

## Space - Infinite Distances

- The universe is very very large:
  - visible universe has about 100,000,000,000 galaxies
  - about 10,000,000,000,000,000,000,000 stars
- So: there is *very very* much to be seen in the universe
- But: where can we actually go?
- Limits:
  - speed of light (says Einstein), 300,000 km/s
  - Human life time (or anual vacation time)

## Most distant galaxies



- Distance: 12 billion ( $10^9$ ) light-years (ly)

Image: STScI/UDF

## Closest Galaxy: Andromeda

- Distance: 3 million light-years (ly)

## The Milky Way

- Distance across: 100,000 ly
- Distance earth to centre: 20,000 ly

Image: COBE

## The Closest Stars

- Proxima Centauri: 4.2 ly
- Optimistic round trip: 20 years?

Image: D. Malin/AAO

## #1: Mercury

- Distance from Sun: 0.39 AU
- Diameter: 4,878 km
- Surface gravity: 0.38 g
- Temperat.:  $-170^{\circ}/+425^{\circ}$  C
- Atmosphere: near none
- Missions: orbiter
- Human landing: no
- Class: Cruise target

Image: NASA/Mariner 10

## #2: Venus

- Dist. from Sun: 0.72 AU
- Diameter: 12,104 km
- Surface gravity: 0.91 g
- Temperature: +465° C
- Atmosphere: CO<sub>2</sub>, N<sub>2</sub>
- Missions: orbiter, lander
- Human landing: no
- Class: Cruise target



Image: Magellan, Pioneer Venus Orbiter, Venera 13+14

## #3: Earth

- Distance from Sun: 1 AU
- Diameter: 12,756 km
- Surface gravity: 1 g
- Temperature: -50°/+40° C
- Atmosphere: N<sub>2</sub>, O<sub>2</sub>
- Class: Fun place



Image: NASA/Apollo 8

## #3a: Moon

- Distance from Sun: 1 AU
- Diameter: 3,476 km
- Surface gravity: 0.16 g
- Temperat.: -150°/+120°C
- Atmosphere: none
- Missions: orbiter, lander
- Human landing: yes
- Class: Hotel site



Image: NASA/Apollo 11

## #3a: Moon

- + temperatures ok
- + gravity acceptable
- + nearby
- no atmosphere



Image: NASA

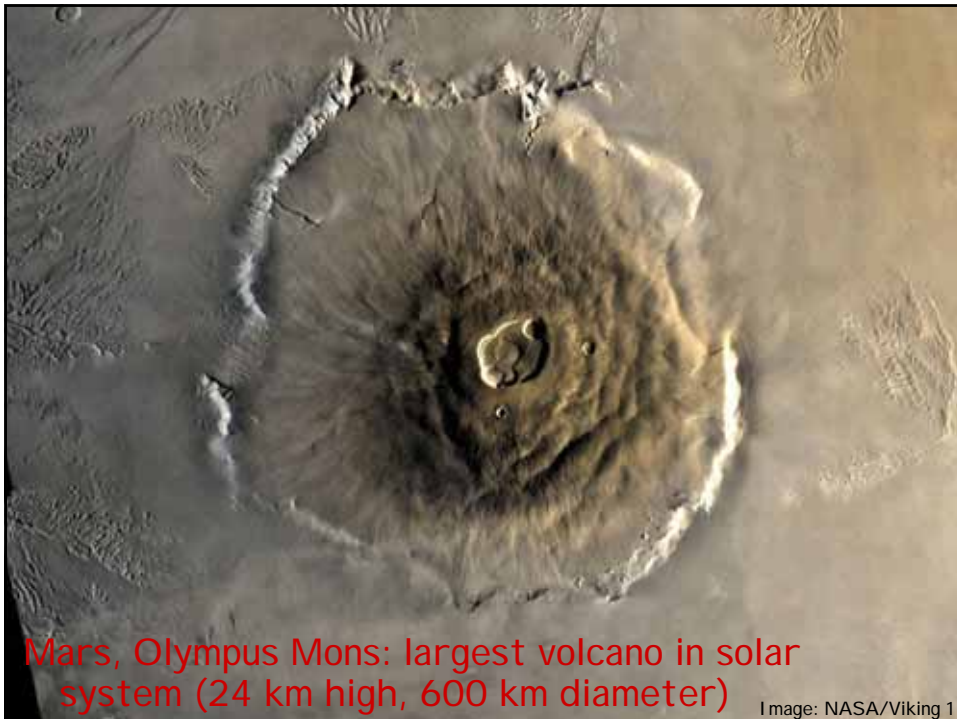
## #4: Mars

- Distance from Sun: 1.52 AU
- Diameter: 6,794 km
- Surface gravity: 0.38 g
- Temperat.: -130°/+25° C
- Atmosphere: weak, CO<sub>2</sub>, N<sub>2</sub>
- Missions: orbiter, lander
- Human landing: possible

- Class: Hotel site



Image: STScI + NASA



Mars, Olympus Mons: largest volcano in solar system (24 km high, 600 km diameter)

Image: NASA/Viking 1



## #4: Mars



- Best studied planet outside earth

Image: NASA/Spirit+Opportunity

## #4: Mars



- Best studied planet outside earth

Image: NASA/Spirit+Opportunity

## #5: Jupiter

- Gas giant
- Distance from Sun: 5.2 AU
- Diameter: 140,000 km
- Surface gravity: 2.4 g
- Temperature: -150° C
- Atmosphere: H<sub>2</sub>, He<sub>2</sub>
- Missions: several
- Human landing: no
- Class: cruise target

Image: NASA/Voyager 2



## #5a: Io

- Volcanoes
- Diameter 3,642 km
- Human landing: no
- Class: cruise target

Image: NASA/Voyager 2



## #5b: Ganymede

- Rock and Ice
- Diameter 5,262 km
- Water?
- No atmosphere
- Human landing: possible
- Class: Hotel site



Image: NASA/Voyager 2

## #5c: Callisto

- Rock and Ice
- Diameter 4,820 km
- Water?
- No atmosphere
- Human landing: possible
- Class: Hotel site

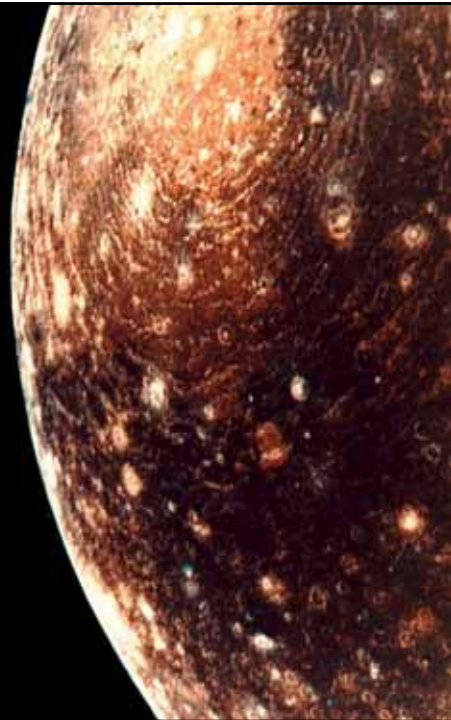


Image: NASA/Voyager 2

## #5d: Europa

- Ice over rock
- Diameter 3,120 km
- Likely Water!
- No atmosphere
- Human landing: possible
- Class: Hotel site

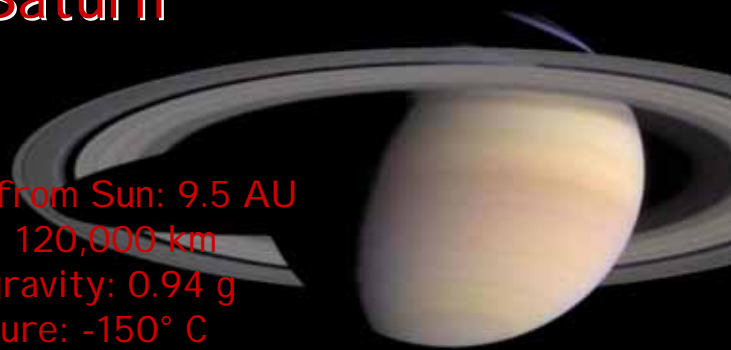
Image: NASA/Voyager 2



## #6: Saturn

- Gas giant
- Distance from Sun: 9.5 AU
- Diameter: 120,000 km
- Surface gravity: 0.94 g
- Temperature: -150° C
- Atmosphere: H<sub>2</sub>, He
- Missions: Voyager, Cassini/Huygens
- Human landing: no
- Class: cruise target

Image: Cassini



## #6a: Titan

- Diameter: 5,150 km
- Temperature:  $-180^{\circ}\text{C}$
- Atmosphere: thick!
  - 1500 mbar;  $\text{N}_2$ ,  $\text{CH}_4$
- Missions: Cassini/Huygens
- Human landing: possible
- Class: hotel site

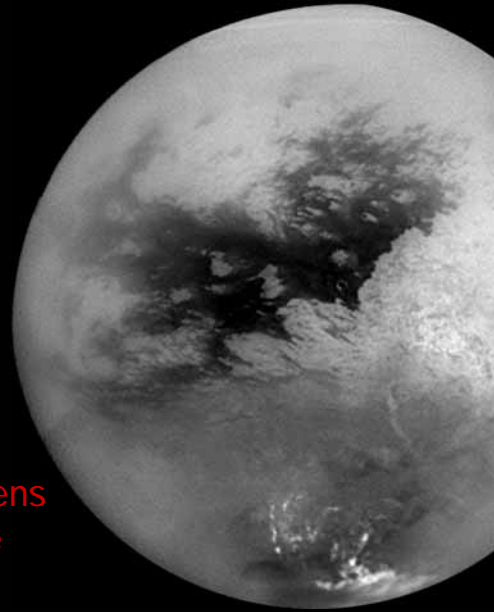


Image: Cassini

## #6a: Titan

- Water? Life?
- Huygens will land 14/01/2005!!!
- Testing: atmosphere, surface composition



Image: NASA Artist

## #7: Uranus

- Gas giant
- Distance from Sun: 19.2 AU
- Diameter: 51,000 km
- Surface gravity: 0.9 g
- Temperature:  $-200^{\circ}\text{C}$
- Atmosphere:  $\text{H}_2$ , He,  $\text{CH}_4$
- Missions: Voyager
- Human landing: no
- Class: cruise target

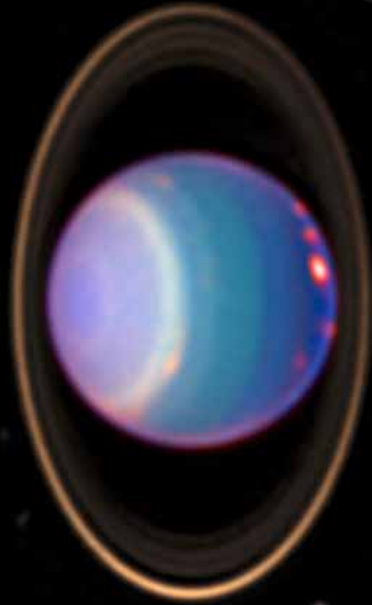


Image: STScI/NASA

## #7a: Uranus' moons

- Umbriel:
  - 1,129 km
- Titania:
  - 1,578 km
- Oberon:
  - 1,522 km
- Class: hotel sites



Image: NASA/Voyager 2

## #8: Neptune

- Gas giant
- Dist. from Sun: 30 AU
- Diameter: 49,000 km
- Surface gravity: 1.1 g
- Temperature:  $-200^{\circ}\text{C}$
- Atmosphere:  $\text{H}_2$ , He,  $\text{CH}_4$
- Missions: Voyager
- Human landing: no
- Class: cruise target

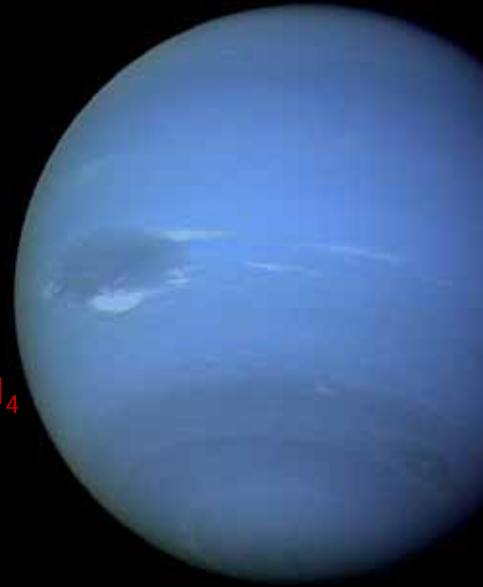


Image: STScI/NASA

## #8a: Triton

- Diameter: 2,707 km
- Temperature:  $-200^{\circ}\text{C}$
- Atmosphere: none
- Missions: Voyager
- Human landing: possible
- Class: hotel site



Image: NASA/Voyager 2

## #9: Pluto

- Dist. from Sun: 39 AU
- Diameter: 2,390 km
- Surface gravity: 0.06 g
- Temperature:  $-220^{\circ}\text{C}$
- Atmosphere: near none
- Missions: none
- Human landing: possible
- Class: very remote

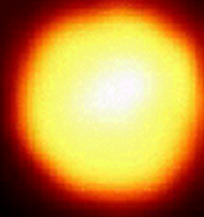


Image: STScI/NASA

## #9a: Charon

- Dist. from Sun: 39 AU
- Diameter: 1,186 km
- Surface gravity: 0.03 g
- Temperature:  $-220^{\circ}\text{C}$
- Atmosphere: none
- Missions: none
- Human landing: possible
- Class: very remote



Image: STScI/NASA



## Summary

- Only solar system can be destination
- Best places to go:
  - Moon: nearby, temperature ok
  - Mars: reachable, water?, temperature ok
  - Titan: remote, water?, cold but atmosphere
  - Triton: remote, large
- But: very good sightseeing in *all* of the solar system



Dr.-Ing. Robert Alexander GOEHLICH  
Keio University  
Department of System Design Engineering  
Space System Engineering (Ohkami Laboratory)  
3-14-1 Hiyoshi, Kohoku-ku  
Yokohama 223-8522, JAPAN  
email: [mail@robert-goehlich.de](mailto:mail@robert-goehlich.de)  
Mobile: +81-(0)90-1767-1667  
Fax.: +81-(0)45-566-1778  
Internet: <http://www.robert-goehlich.de>