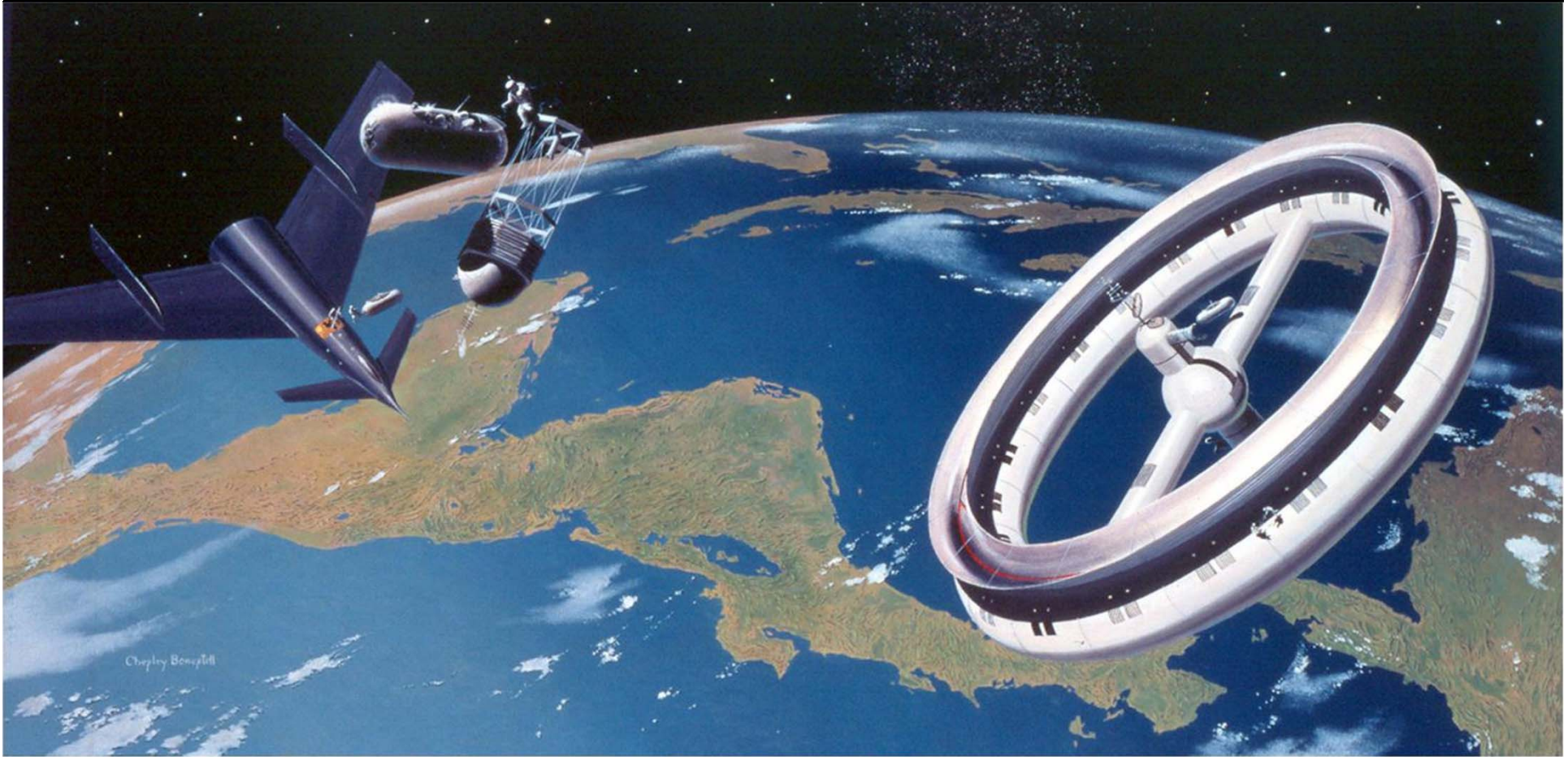


# ISS and beyond: What is in there for You?



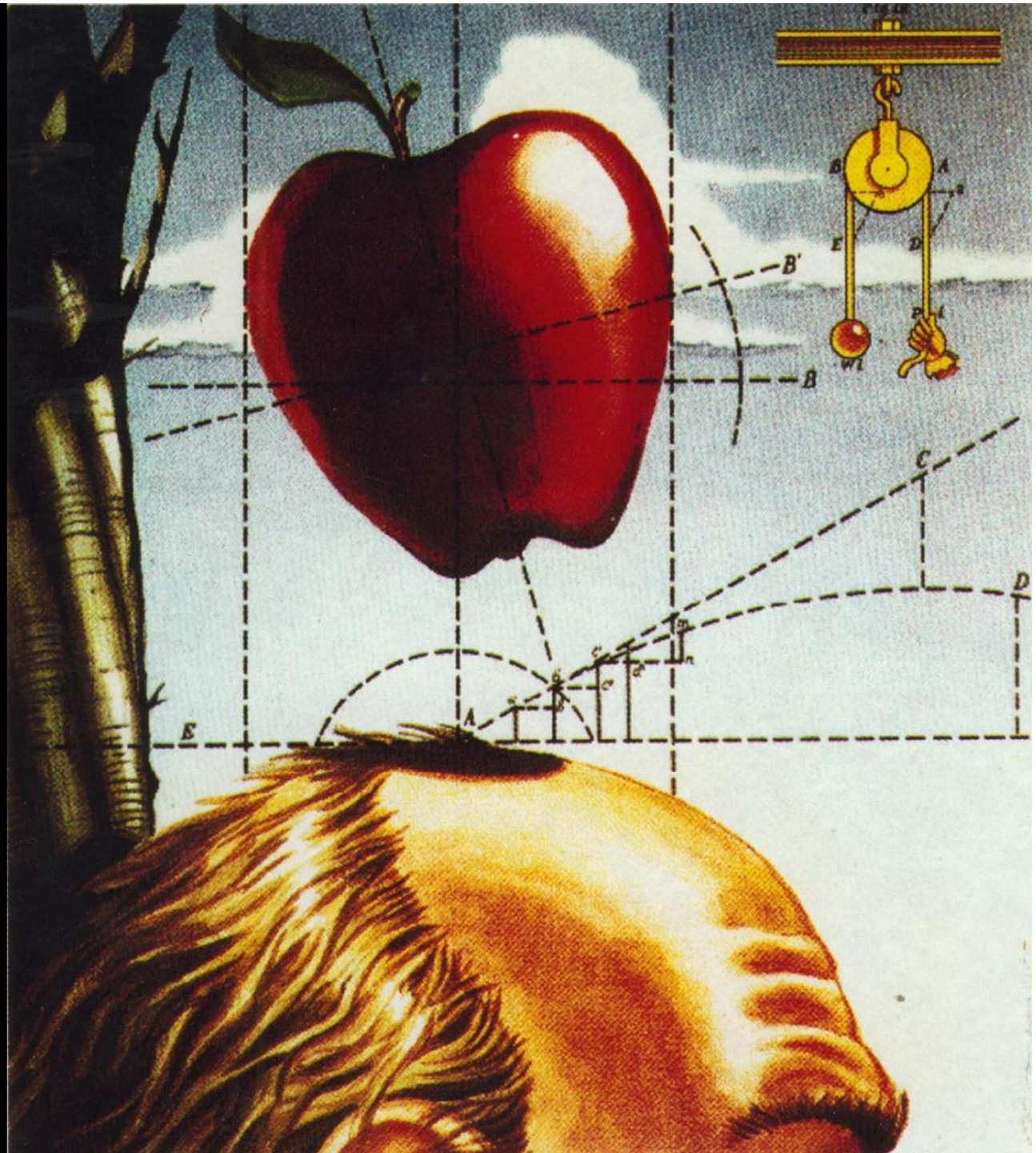
Berndt Feuerbacher  
A very personal view

# In the Beginning, there was a Dream



of science in Earth orbit  
and of factories and colonies in space

we have  
chosen the  
scientific  
approach



Spacelab was the European entry



A photograph of the Space Shuttle Columbia in orbit. The shuttle is oriented vertically, with its nose pointing towards the top of the frame. The large solar panel arrays are extended outwards, showing a grid pattern of solar cells. The white thermal blankets and various external components of the orbiter are visible. In the background, the structure of the International Space Station (ISS) is partially visible, including a large blue and white cylindrical module. The Earth's atmosphere is seen at the bottom of the frame, appearing as a bright blue and white arc against the blackness of space.

Columbus is based on Spacelab  
experience

Columbus Module is attached to ISS  
since February 2008

A photograph of the International Space Station (ISS) in orbit against a black background. The station's complex structure, including multiple modules and a large array of solar panels, is clearly visible. The solar panels are arranged in two main wings extending from the central core. The text "ISS is now complete" is overlaid in yellow at the top center.

ISS is now complete

all partner laboratories in orbit  
utilization resources available  
crew of 6 since 2009  
science just started, results begin to flow

# A perfectly equipped Laboratory in Space



with gravity as an experimental variable  
for extended periods of time  
and open space conditions (vacuum, radiation, view ...)

A photograph of the International Space Station (ISS) in space. The station's complex structure, including large solar panel arrays and various modules, is visible against the blackness of space. The Earth's blue and white horizon is seen at the bottom of the frame. The text is overlaid on the left side of the image.

# ISS offers benefits for You

## Science Progress in

Biology, chemistry, physics ...

## Examples:

Alpha Magnetic Spectrometer

Complex Plasmas

Metallic glasses



# ISS offers benefits for You

## Health research

- gravity effects on immune system
- new insight and cure of old-age diseases
- man under extreme stress conditions
- non-invasive diagnostics



# ISS offers benefits for You


Technology innovations

new materials and processes

exploration technologies



# ISS offers benefits for You

A satellite view of Earth from the International Space Station (ISS) showing a large volcanic eruption. A massive plume of ash and smoke rises from a mountain range, partially obscuring the sun. The surrounding landscape is rugged and mountainous, with a dark sea visible in the lower right. The Earth's surface is covered in white clouds, and the dark blue of the ocean is visible in the lower right.

## Earth and climate

High inclination orbit of ISS very suitable  
90% of inhabited Earth covered  
short reaction times

# ISS offers benefits for You

## Global cooperation of 14 nations

ISS international partnership is  
unprecedented

stable since 1998

has overcome financial, political, and  
technical difficulties

has advanced peaceful cooperation of nations  
on Earth

ISS partnership is a model for future global  
cooperation in space exploration



# ISS offers benefits for You

## Inspiration

Young people are fascinated by space  
Astronauts are our best ambassadors  
Unique way to stimulate science education



# But there is more in ISS for you ...

## Long term perspective

makes ISS attractive for new science communities

## ISS utilization is at a turning point

results enter industrial applications

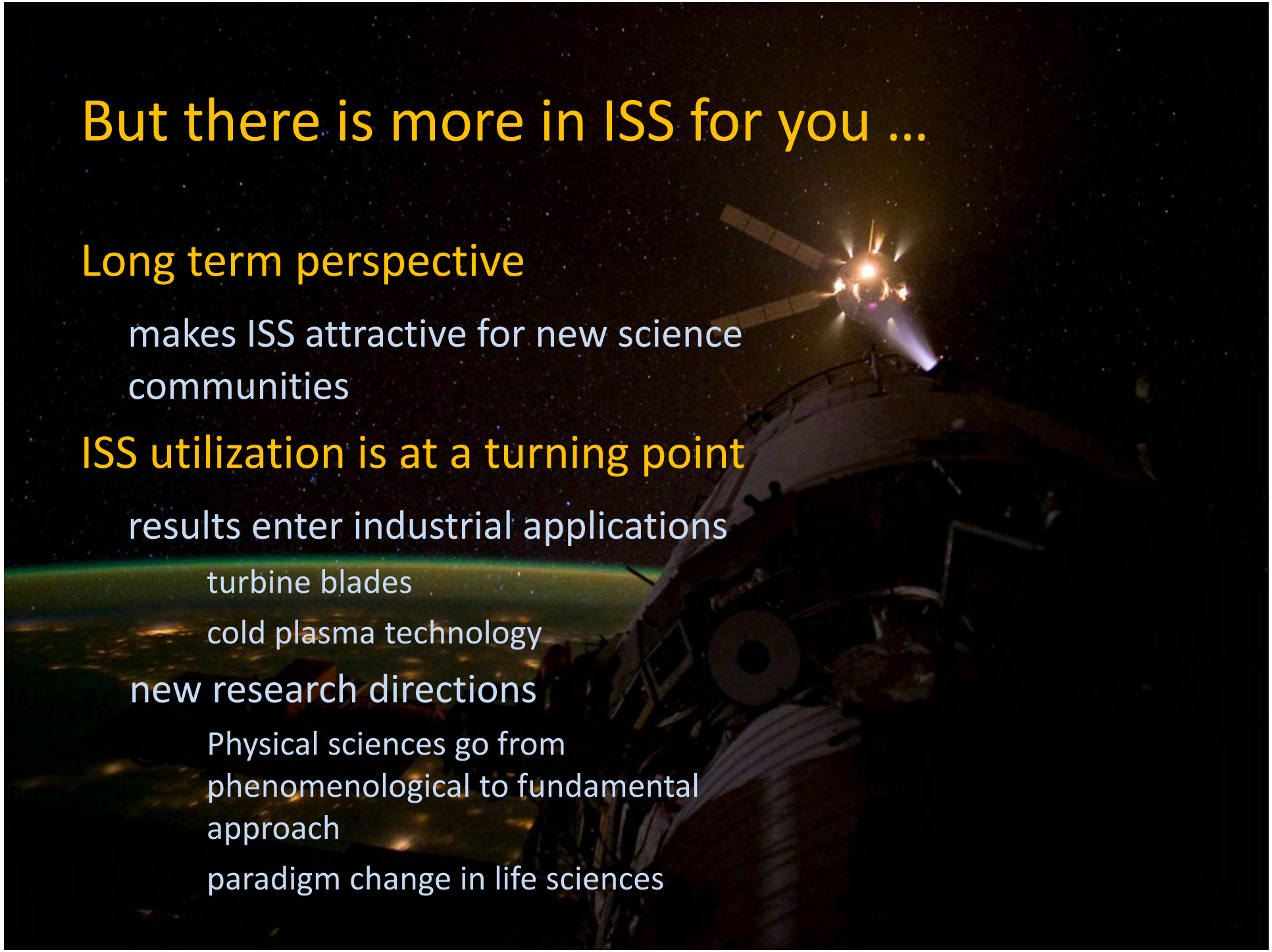
turbine blades

cold plasma technology

new research directions

Physical sciences go from phenomenological to fundamental approach

paradigm change in life sciences



# A single atom falls as fast as a hammer

Slow atoms make use of microgravity

Quantum physics enters ISS

ACES is a first step

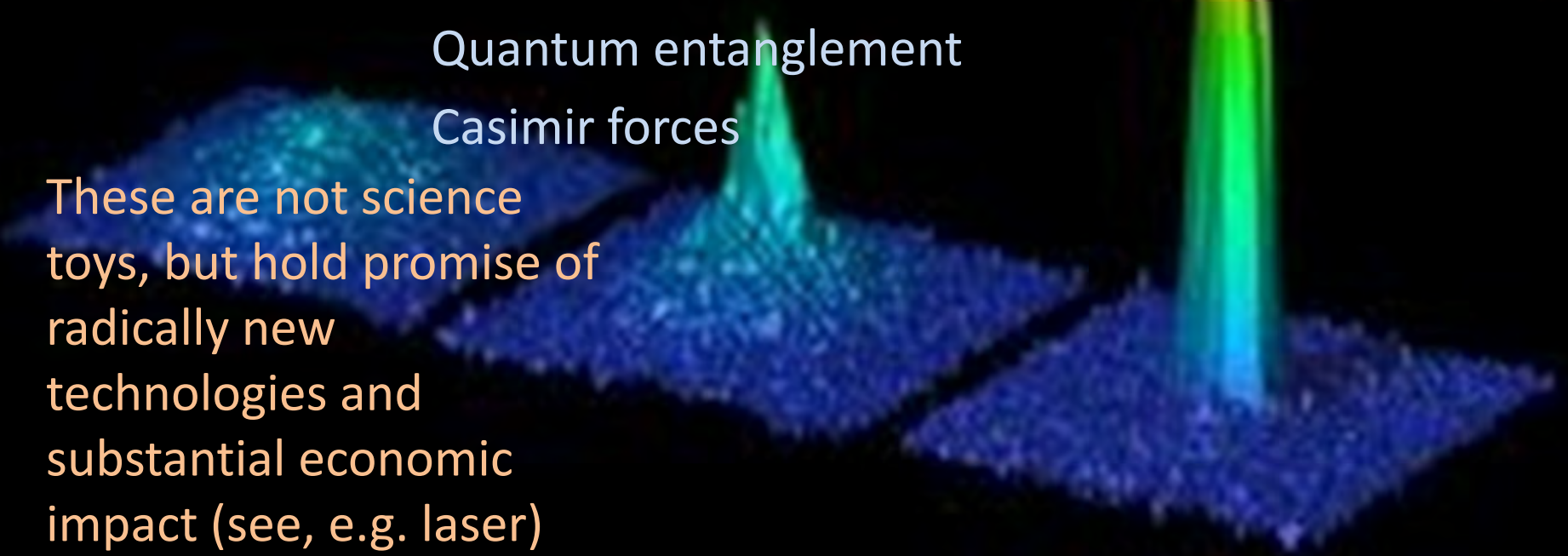
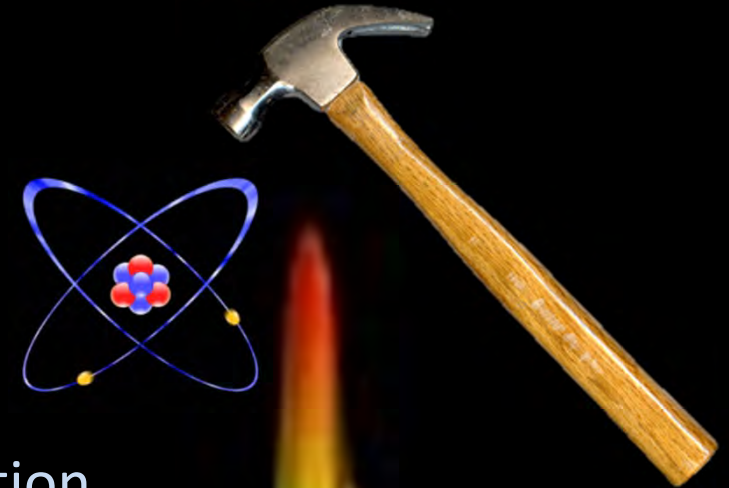
Other examples: Atom interferometry

Bose-Einstein condensation

Quantum entanglement

Casimir forces

These are not science toys, but hold promise of radically new technologies and substantial economic impact (see, e.g. laser)



# Life Sciences opens new paradigms

novel medical research techniques:

- holistic view of the system human body

- Individualisation of medicine

- remote diagnosis and treatment

cross-disciplinary links emerging for enabling human exploration





# ISS has a promising future

Operations agreed until 2020 at least

## Here are my wishes:

reduce operations cost

shorten access times, less paperwork

enhance user spectrum, include private sector

enlarge ISS cooperation with additional countries

**Open ISS to the best brains of the world in a competitive way**

# What to expect after 2020?

build on success and results of ISS

continue LEO activities in a prudent way

move from public to private funding

this requires preparation now

decrease operations cost

consider reduced human presence

ensure a LEO space outpost for human exploration



Exploration: Expand human presence in space

Do we need anything like exploration?

Should we send humans to Mars?

Is a human Mars mission possible at all?

If yes, when?

What is in there for you?

Lets us see, what we can do ...

We can bring Humans to the Moon



# But our action radius is not unlimited

## It includes

LEO (ISS)

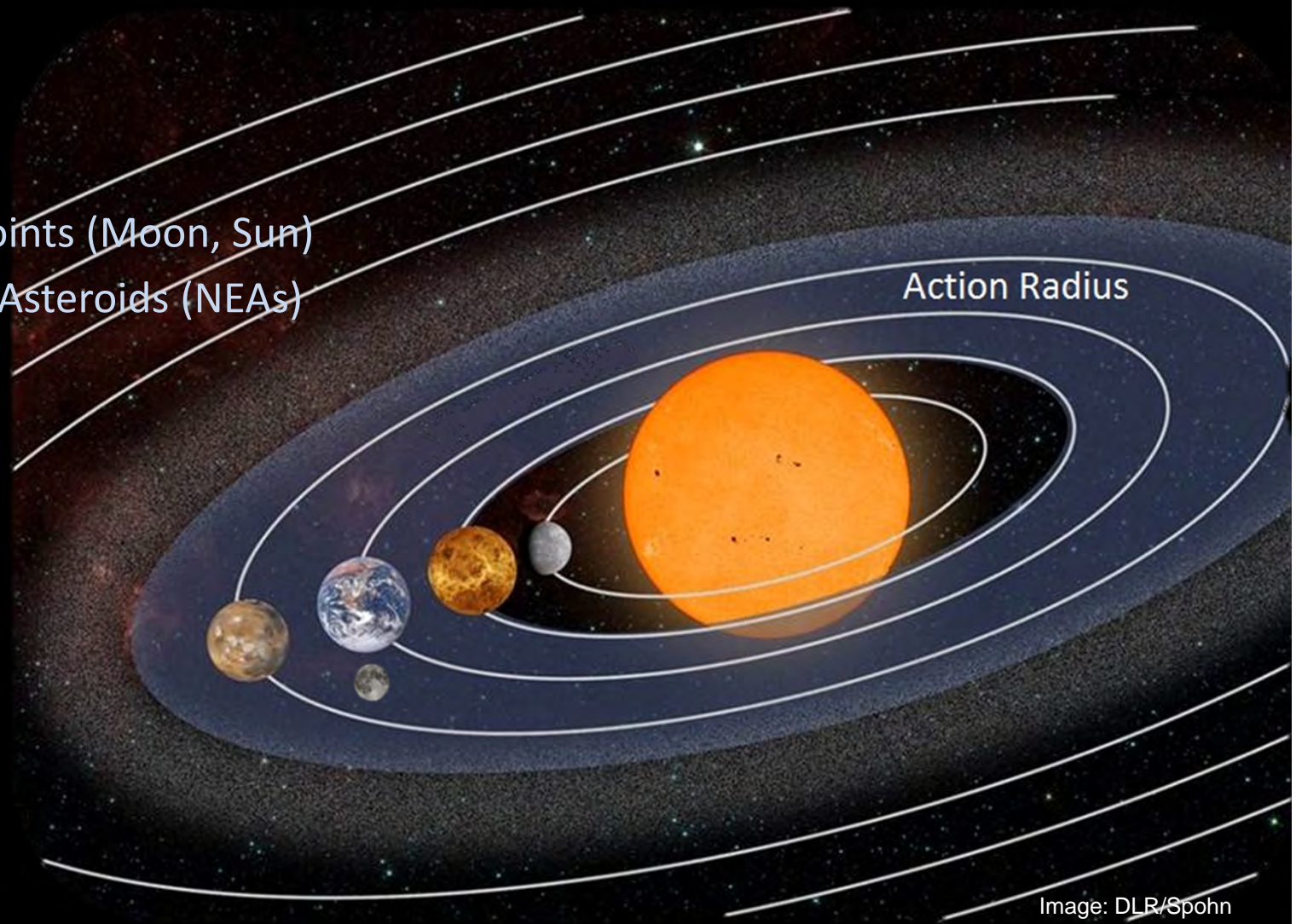
Moon

Lagrange Points (Moon, Sun)

Near-Earth Asteroids (NEAs)

Venus

Mars



# The most fascinating destination for humans is Mars



**Search for origin of life**  
**Mars is difficult to reach**  
intermediate way stations reduce effort and risk  
ISS is available as a starting point  
way stations could be

- the Moon
- a Lagrangian point
- a Near Earth Asteroid

**But it is always a long journey!**

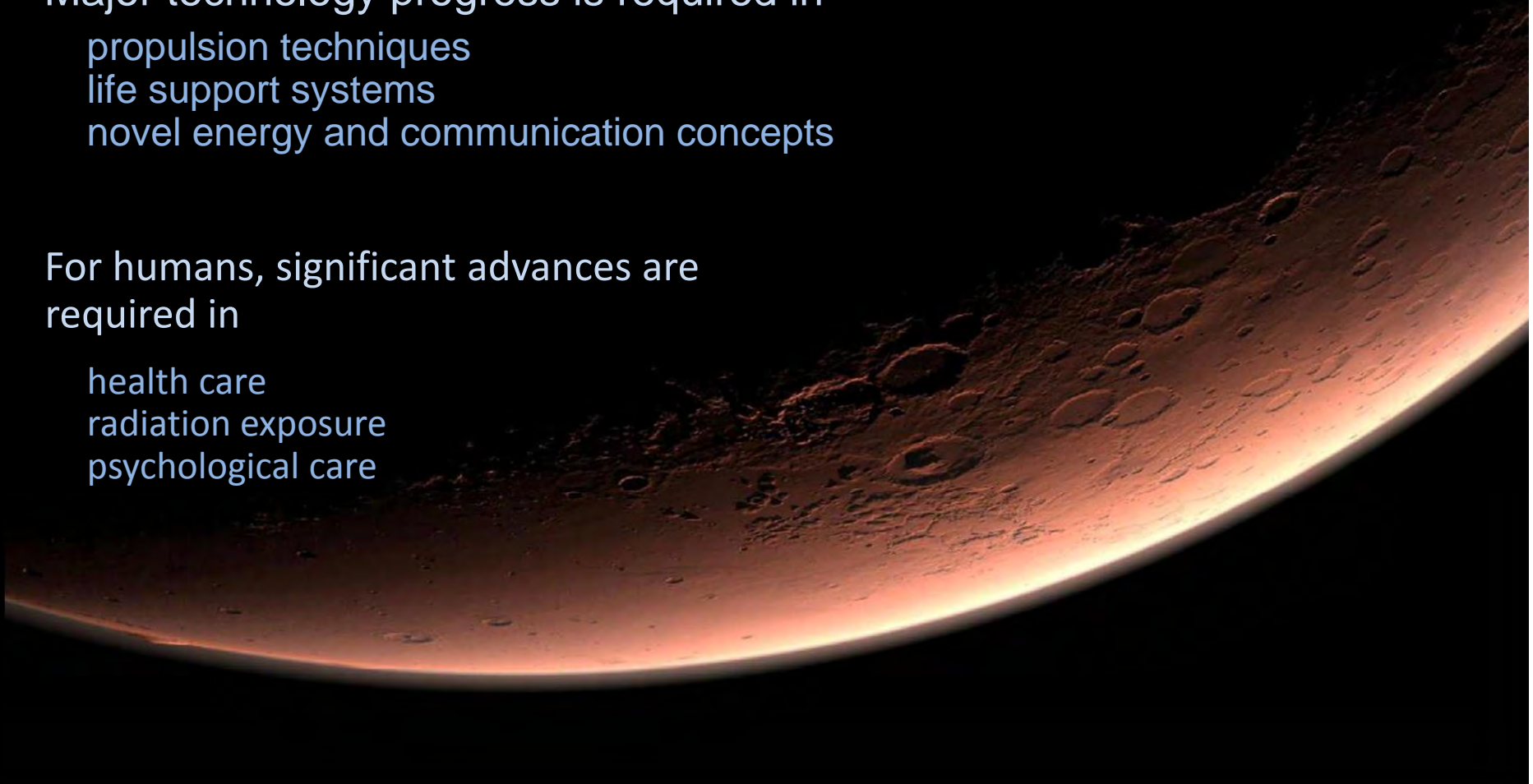
Image: ESA/DLR/FU Berlin (G. Neukum)

# Humans beyond Moon is not just an extrapolation of present technology

Major technology progress is required in  
propulsion techniques  
life support systems  
novel energy and communication concepts

For humans, significant advances are required in

health care  
radiation exposure  
psychological care



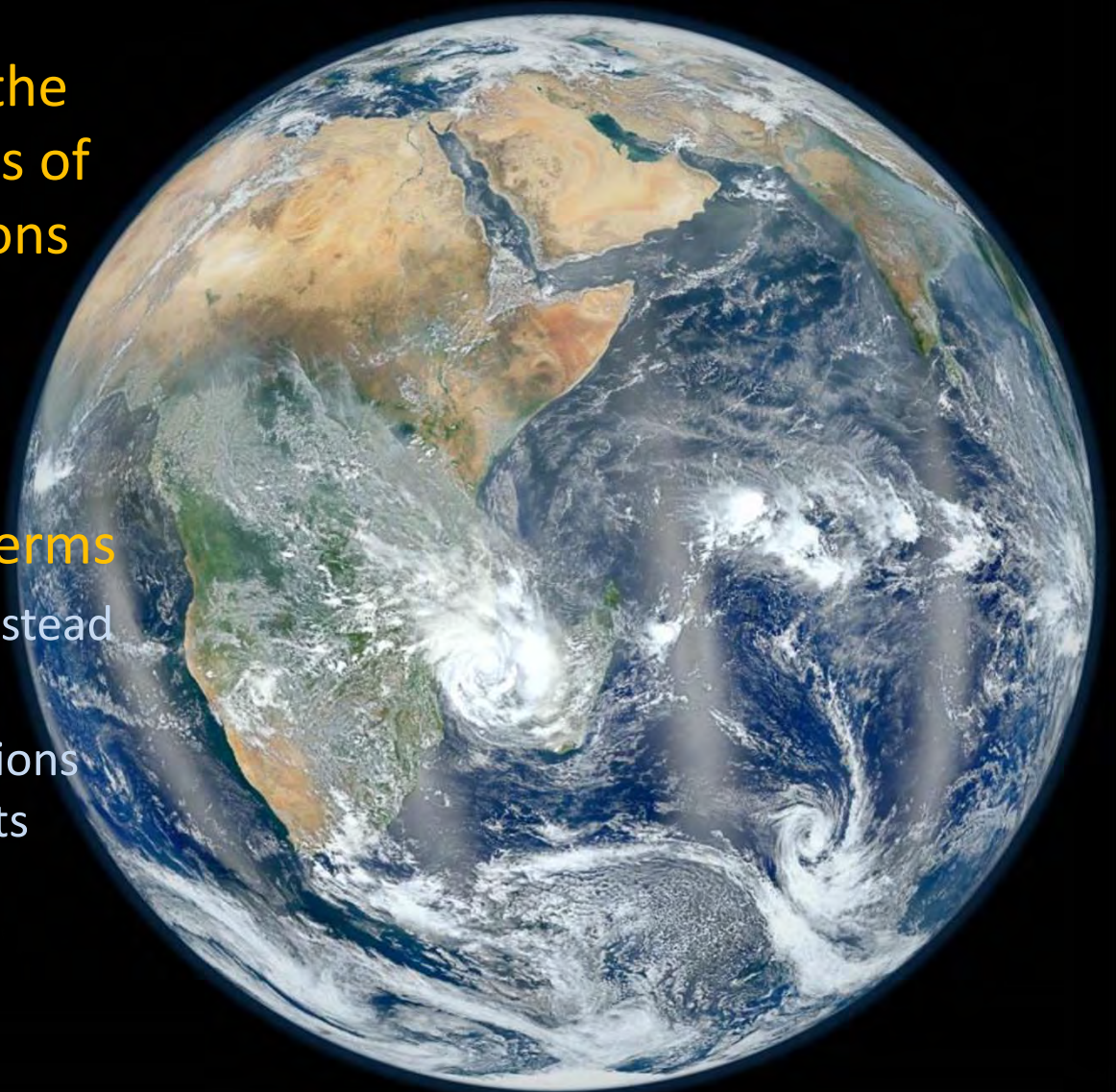
# Future exploration requires huge efforts, it is a task for humanity as a whole

It should bring together the capabilities and resources of as many as possible nations of the world.

Benefits are not only in technical and economic fields, but also in social terms

international cooperation instead of competition

better understanding of nations through peaceful joint efforts  
(see ISS)





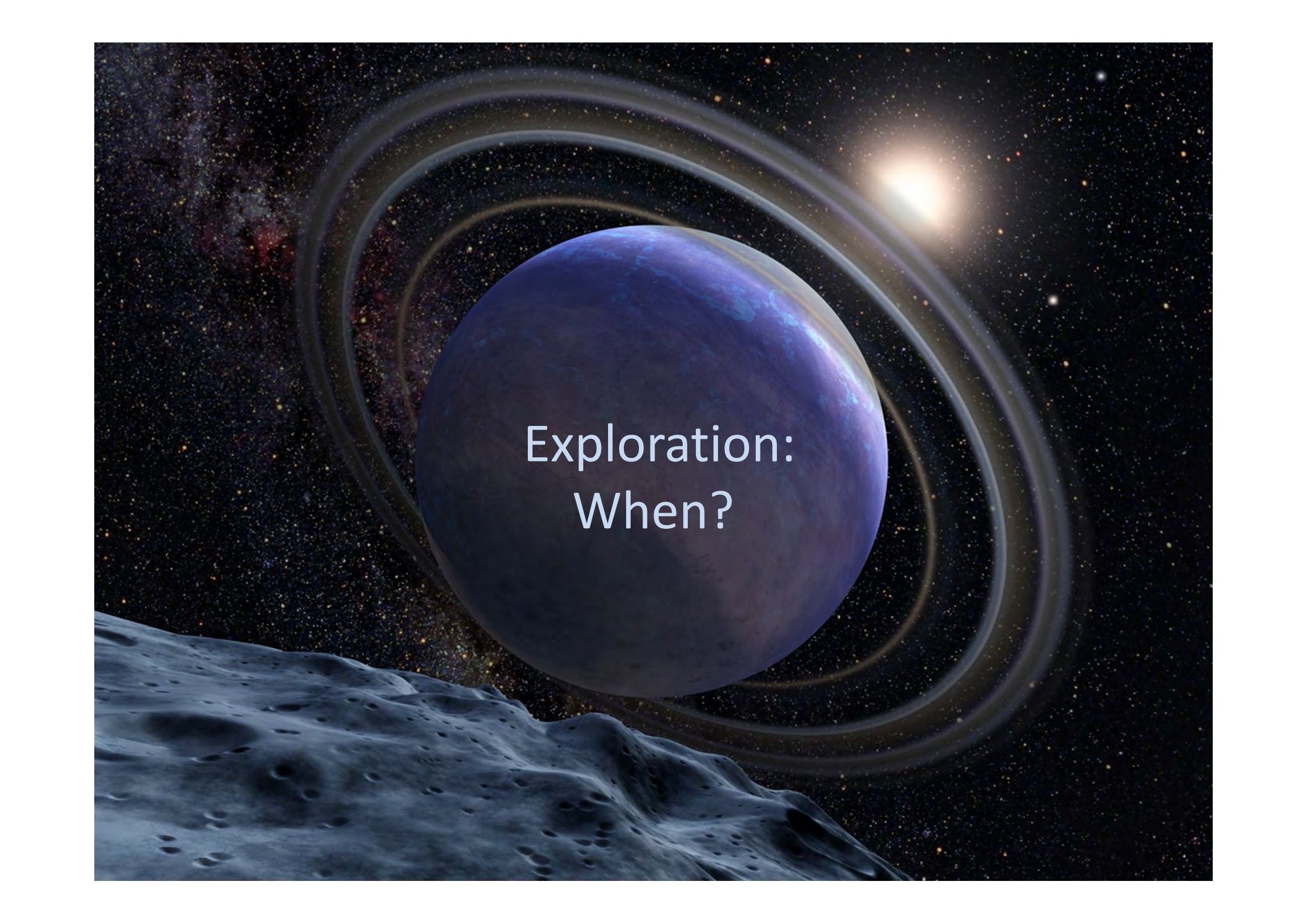
# There is a tool existing to coordinate a global effort in exploration

It is the International Space Exploration Coordination Group

## ISECG

brings together 14 space agencies  
works on the principle of consensus  
develops scenarios and roadmaps on a long time scale  
helps partners to align programs along a common objective  
emphasises a stepwise, modular approach



A digital illustration of a blue planet with a ring system, viewed from the surface of a cratered moon. The planet is the central focus, with its rings appearing as glowing, multi-layered bands. The background is a deep black space filled with stars and a faint, colorful nebula. A bright, glowing star is visible in the upper right quadrant. The foreground shows the dark, cratered surface of the moon, with various sized pits and craters. The text "Exploration: When?" is centered over the planet in a white, sans-serif font.

Exploration:  
When?

# Nobody can tell you when Humans will reach Mars

Wernher von Braun created a plan in 1970 to land humans on Mars in 1981

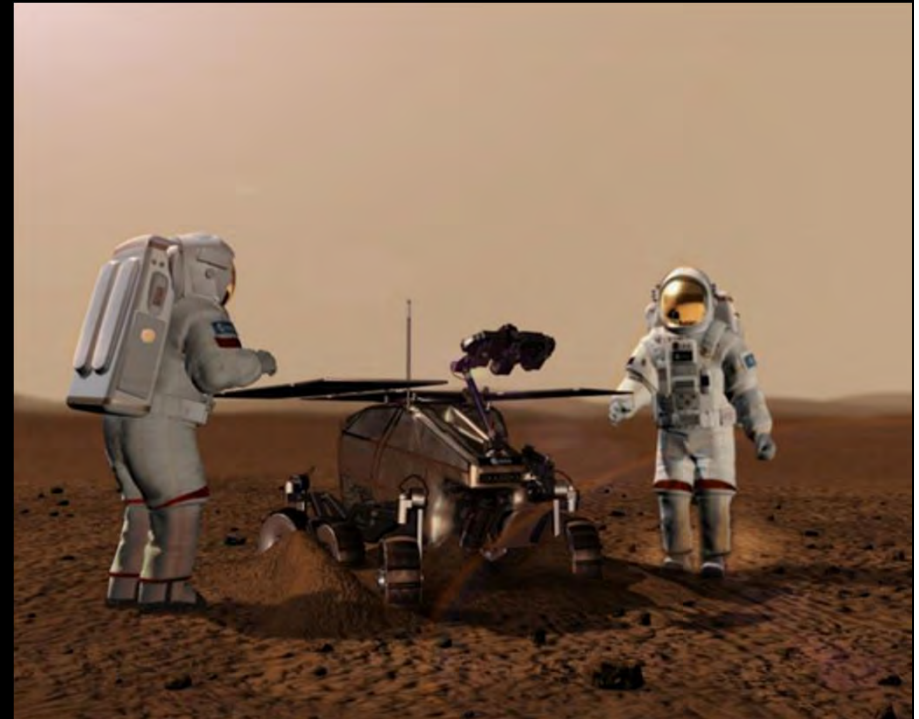
NASA's Space Exploration Initiative (G. Bush 1989) was intended to land on Mars in 2019

ESA Aurora Programme (2001) aimed at landing on Mars in 2030

G.W Bush "Vision" in 2004: return to the Moon by 2020 on way to Mars (2035)

it seems to be a moving target ...

... but we know when it is starting



# Human Exploration is starting today

ISS is the first permanent human outpost in space

Technologies for human exploration can be studied on  
ISS

Human habitation and health

Psychological barriers

Life support and environmental control

Technologies for long distance travel ...

# What is in there for you?

A detailed illustration of a Mars rover and lander on a reddish-brown planet surface. The rover is in the foreground, and the lander is in the middle ground. The background shows rolling hills and a thin atmosphere. The text 'What is in there for you?' is overlaid in yellow at the top left.

## Global cooperation

for a peaceful world with mutual understanding of nations

## Global economic progress

through investment in best brains and cutting-edge technologies

# What is in there for you?

## Innovation

numerous technologies have to be developed  
(energy, food, health ...)

## Sustainability

new methods of recycling, coping with limited  
resources in a closed environment



# What is in there for you?

A space scene featuring a large red planet with rings, a bright yellow star, and a smaller grey planet.

## Knowledge

search for origin and destiny of life

## Inspiration

fascinating the young generation

# Conclusions



ISS is now available for utilization: let us use it!

ISS achievements are bold and hold promise of mayor advances in near future

Continue human presence in LEO after 2020

Human exploration is a rewarding task for mankind

Mars is a challenging destination

Exploration offers benefits to you and all citizens