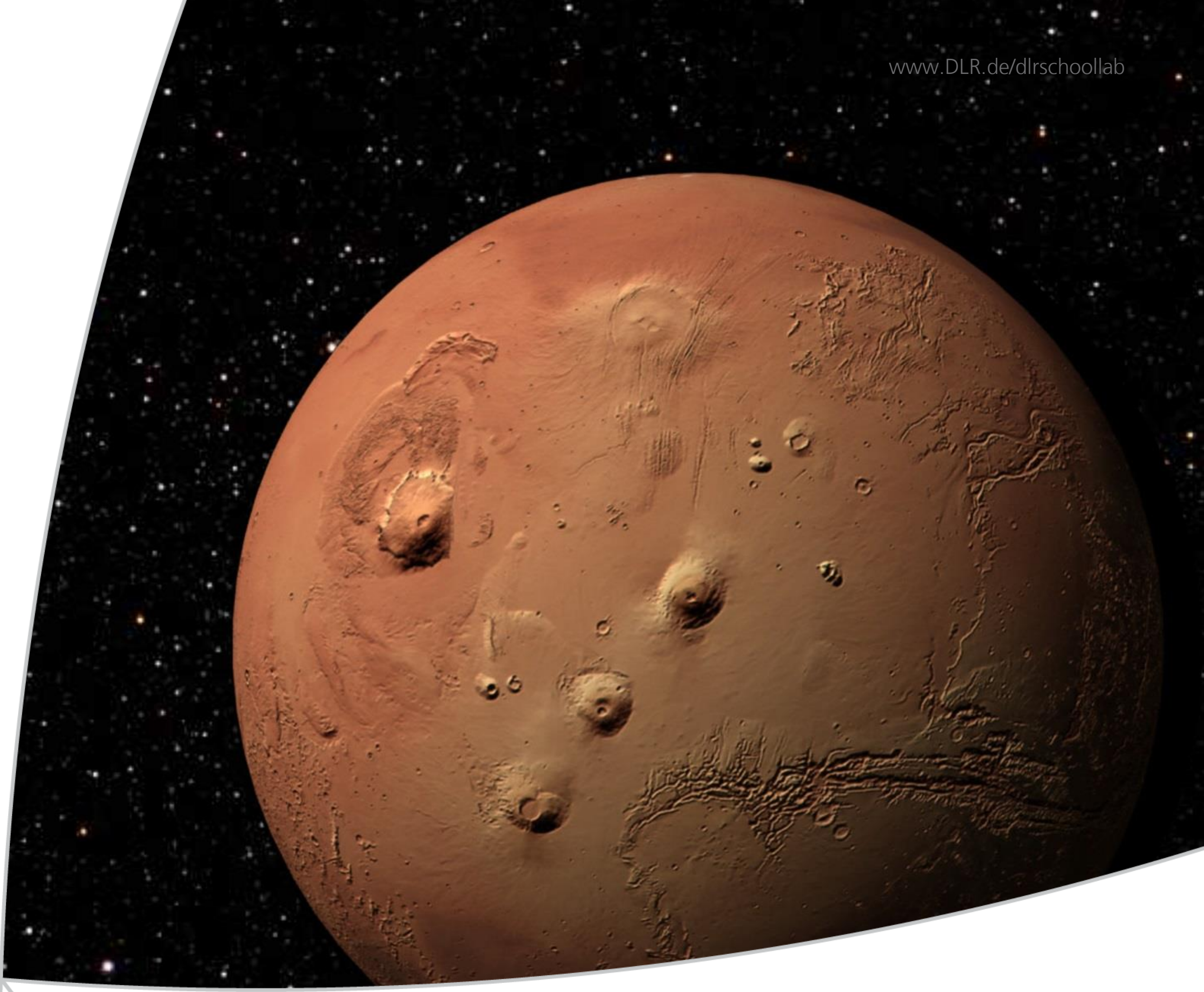
DLR



DLR_School_Lab Köln

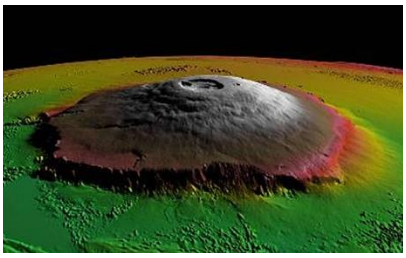
Mission to Mars

It is the year 2051. Eight months after leaving its moon base and 75 million km later, AQVILA M1, the International Space Agency's space craft, is readying for landing on Mars. In a few short hours, the first human will set foot on an extraterrestrial planet …

Whether there will be a manned Mars mission in 30 years or not... we shall see. But even without having been there, we already have a good idea of what it looks like on Mars. Since the first probe to pass Mars, Mariner IV, flew past the red planet at an altitude of around 10,000 km in 1964, a further 31 satellites have sent us thousands of pictures of Mars's surface. Robots have been deployed on Mars successfully ten times – each new rover being bigger than the last. Most recently "Perceverence" and "Zhurong" in February and May 2021.

The Gale crater, Curiosity's landing site in August 2012 (Photo: NASA)

The surface structure on Mars is much more rugged than on Earth. It has been shaped by a large number of meteorites. Strong storms swirl the reddish brown, rusty dust around. The differences in height are particularly pronounced: Mars has less mass compared to Earth (less than 1/9 of the Earth's mass) and also has less gravity – only 0.38 g[1]. This means that volcanos were able to build up much higher layers of ash and lava before the ground gave way beneath them. Mars's highest mountain, an inactive volcano, Olympus Mons, stands at 26,400 m (above the ground plane) – making it three times higher than Mount Everest.



Olympus Mons is the highest vulcano in our solar system (the colors in the pictures are false – they are used to show corresponding altitudes.)

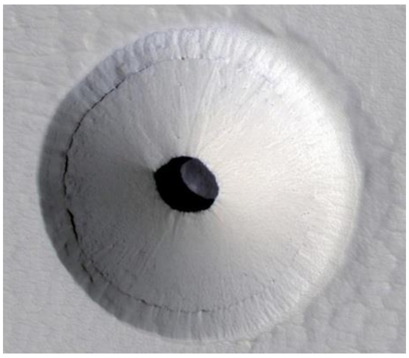
Why fly to Mars?

The planet closest to earth is Venus. Yet Venus is not suitable for a manned space mission. Surface temperatures of around 450 °C and atmospheric pressure of 92 bar, along with active volcanoes make Venus seem like hell.

Technological circumstances permitting, humans would be able to survive on Mars: Temperatures range between -130 °C and +30°C and the atmospheric pressure on Mars is 6 mbar. The thin atmosphere consists almost entirely of carbon dioxide. Future astronauts would therefore have to take oxygen with them or produce it from water or CO_2. Ice was discovered at the poles e.g. and the marks on the surface suggest that millions of years ago, water flowed across Mars. Most of the northern hemisphere might even have been completely covered by an ocean.

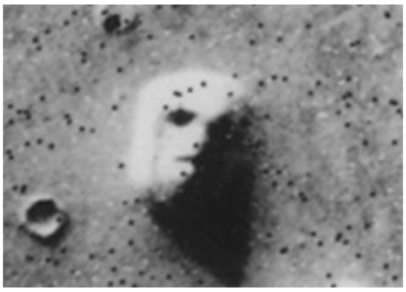
Are there inhabitants on Mars?

Liquid water is a condition for life – at least for life as we know it. Did living organisms ever exist on Mars or are they perhaps still alive today? Single cell organisms might have survived in crevices in the underground soil or in caves that were the results of caved-in volcanic vents. These would offer protection from the cosmic radiation that hit the surface.



"Hole" near Pavonis Mons. The top of a thin layer of lava has broken away and made a cave. (Photo: NASA)

In order to explore Mars's surface, we need to land on the planet. Several robots have analysed rock samples.



The famous "Face on Mars" is actually the flat-topped mountain Cydonia mensa. The direction of the light causes shadows to fall that our brains interpret as a face. (Photo: NASA)

In 2007, the Phoenix probe searched for organic material near Mars's North Pole – unsuccessfully. Also "Curiosity" has not found any organic material yet either. However, the exciting search for traces of life continues with "Perseverance". Nevertheless, we cannot expect higher forms of life. The "Face on Mars" that was discovered on pictures taken by the Viking I probe in 1976 turned out to be an optical illusion – as many other structures.

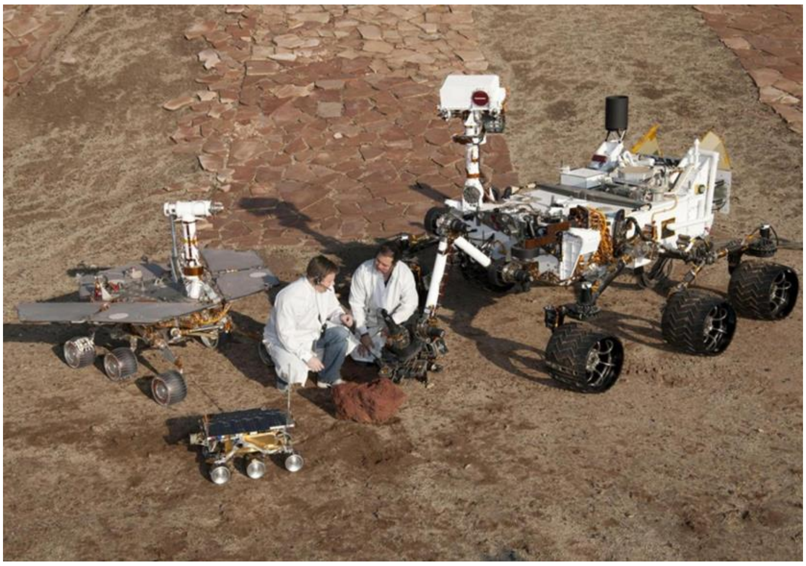
Your mission

In the DLR_School_Lab, you will steer a simple Mars robot. The robot is equipped with a camera, lights and various sensors. It will explore the surface of our Mars model. First, get used to the steering. Then, try to find the entrance to the lower level of our model.

The model of Mars in Cologne's DLR_School_Lab (Photo: DLR)

Your mission is to draw a map of our Mars "cave" – as accurately as possible. You will be competing against the other groups. As in a real mission, you will only be successful if you work together as a team. Tasks will need to be delegated: Who will be the navigator and steer? Who will become the cartographer and draw the map? And who will take responsibility for the mission and be the commander? One of the commander's most important jobs is making sure the cartographers can keep up with what the navigator is doing. You will see that orientating yourself and drawing a map is not so easy when your visibility is limited.

[1] in this context, the (unofficial) unit of measurement g denotes Earth's apparent gravity: 1g ≈ 9.81 m/s²



Comparing the sizes of three generations of Mars robots: In the front Sojourner (1997), on the left Mars Exploration Rover (2003) and on the right Curiosity (2012). (NASA's Mars testing ground; Photo: NASA)

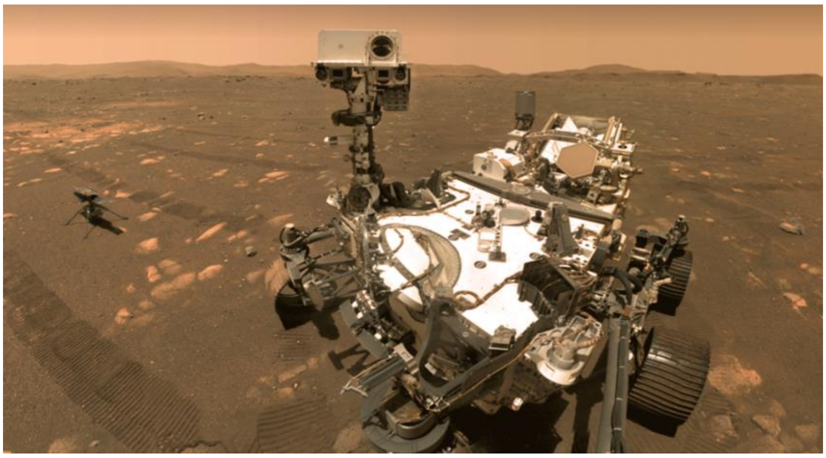
Long distance

Mars is at least 56 million km away. A radio signal to Mars therefore takes at least 3 minutes (and 3 minutes back). Try adding a delay of a few seconds to the programme that controls the robot and compare its navigation to before.

Autonomous systems

You will see that it is not possible to control a robot on Mars in real time. That is why the robot is equipped with programmes that ensure that it carries out tasks autonomously, using data that is gathered through different kinds of sensors. Engineers in the rover control centre on Earth can determine the sequence in which tasks are performed or devise ways in which existing programmes can be adapted to given circumstances.

Which commands should be programmed into our robot, if we want it to explore our Mars model without getting stuck somewhere? We also want it to be able to find darker areas on the model's surface and for it to stop above such an area – discuss.



Similar to its predecessor, the Mars rover Perseverance weighs almost a tonne and has the size of a small car. It transported a small helicopter to Mars, which – despite the very thin Martian atmosphere – succeeded in making the first flight on an alien celestial body. (Image: NASA)

How far to Mars?

The Moon orbits the Earth at a distance of between 363,000 and 405,000 km. Because the variation in distance is so small, lunar missions can be planned at almost any time. Mars missions, however, require a lot of foresight.

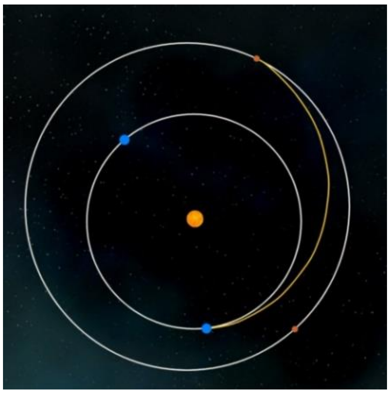
In the 16th century, Johannes Keppler discovered that the planets' orbits are ellipses with the sun at a focal point. As Earth and Mars move around the Sun at different speeds (the Earth orbits the Sun in 365.25 Earth days, Mars in 687 Earth days), the distance between Mars and Earth varies between 56 and 401 million km.

In addition, the Earth's orbit looks almost like a circle. But it's different for Mars. That is why the orbits of Mars and Earth do not have the same distance everywhere.

So it is important to wait for an opportune moment when travelling to Mars. Observe the variations in distance in our simulation programme. Mars missions can start about every 25 months. In April 2018, Mars and Earth were particularly close. Of course, this has been far too early for a manned mission.

Apart from the distance, there are many other things that have to be considered when planning a manned Mars mission in order for the astronauts to be able to return. Read up on the subject here:

http://www.bernd-leitenberger.de/flug-zum-mars1.shtml
(German only)



The trajectory from Earth to Mars, as demonstrated by the "Mars Reconnaissance Orbiter" (a satellite that orbits and explores Mars). The mission began on 12.08.2005, long before Earth and Mars were closest to each other (19.10.2005). The satellite reached Mars on 10.03.2006, by which time the Earth was about 240 million km away. Over this distance, signals are transmitted with a delay of about 13 minutes.
In this illustration, only the orbits of the planets are true to scale, the size of the planets themselves are not. If they were, you would not be able to see them. (Illustration: DLR)

Links

Institut für Planetenforschung:
http://www.dlr.de/pf/

NASA Mars exploration programme:
http://mars.jpl.nasa.gov/

DLR next: http://www.dlr.de/next/desktopdefault.aspx/tabid-6121/query=mars/

About DLR

DLR is the Federal Republic of Germany's research centre for aeronautics and space. We conduct research and development activities in the fields of aeronautics, space, energy, transport, security and digitalisation. The German Space Agency at DLR plans and implements the national space programme on behalf of the federal government. Two DLR project management agencies oversee funding programmes and support knowledge transfer.

Climate, mobility and technology are changing globally. DLR uses the expertise of its 55 research institutes and facilities to develop solutions to these challenges. Our 10000 employees share a mission – to explore Earth and space and develop technologies for a sustainable future. In doing so, DLR contributes to strengthening Germany's position as a prime location for research and industry.

DLR Cologne

Aviation, space travel, transportation, energy and safety are the research areas pursued in the nine research facilities at DLR Cologne. The basis of the research and development carried out on site are the large testing facilities such as wind tunnels, turbine and materials test benches and a high-flux density solar furnace. The 55 hectare/ 136 acre site is home not only to the research and administrative facilities of the DLR, but also to the European Space Agency's (ESA) European Astronaut Centre (EAC). The DLR has around 1400 employees in Cologne.

About the experiment:

Recommended for grade(s): 4 to 10
Group size: 5 to 6
Duration: 50 minutes
Subject matter:
- Robotic
- Astronomy
- Geography
- Physics

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