Mars and exoplanetary bacteria

ANGELIKI CHRISTAKOPOULOU
Motivation for thesis

- Discovery of lifeforms outside the Earth
- Is it possible to find life beyond Earth?
- Could any Earth based form of life survive on other planets in our solar system?
- Simulated Environments for testing
- How bacteria perform in such environments
- Interdisciplinary work
Overview

- Why Mars? (Main characteristics, chamber)
- Biology Experiments
- Atmospheric Composition Experiment
- The origin of the atmosphere (theoretical approach)
- Future goals
Why Mars?

- **Active Past**
  - Water during Noachian period
  - Early dense Atmosphere

- **Conditions on Mars**
  - Mean Surface temperature – 63°C
  - Surface pressure 1-7 mbar
  - UV radiation 200-400 nm
  - Water in form of permafrost (subsurface layers)
  - Perchlorates compounds in the soil
Mars as a testing environment

- Mars Chamber
- Controlled Variables
  - Atmospheric composition
  - Pressure
  - Soil composition
  - Temperature
  - Radiation
- Quadrupole Mass spectrometer
Biology Experiments

- Could bacteria survive in environments that can be found on Mars?
- Analogue environments on Earth (Atacama, Antarctica)
- 16 different bacteria
- Anaerobic environment
- 4 degree temperature
- UV experiment
- Pressure experiment in chamber
  Analogue Martian soils (with and without perchlorates)
What kind of changes could the survived cultures occur in terms of the atmospheric composition?

- Martian Analogue Atmosphere
- Measure the atmospheric composition before and after the bacteria introduction
Origin and Evolution of the Atmosphere

- How Mars lost the atmosphere and Earth did not?
- Understanding the origin of water on Earth and Mars
- How long do we expect the Mars to have a bio-friendly environment?
- How their atmospheres evolved?
- Is life automatically originate as soon as the right conditions arise?
  - Atmospheric origin on Earth and Mars (outgassing, collision impact)
  - How physical mechanisms (Solar wind, magnetic field) are related to the atmospheric loss on Mars
  - How long we expect the Mars to have biology in the past due to collision or outgassing scenario?
  - How quickly the magnetic field disappeared?
Collision scenario

\[ l^2 = r^2 \left( 1 + \frac{2GM}{ru^2} \right) \]

\[ \left( \frac{l_E}{l_M} \right)^2 \sim 4 \]

\[ r_M = \frac{r_E}{2} \rightarrow S_M = \frac{S_E}{4} \]

We expect the biology conditions on Earth and Mars to be the same in the past.

Outgassing scenario

\[ \left( \frac{r_E}{r_M} \right)^3 \sim 6 \]

Ion loss due to Magnetic field

Solar wind

3.9 Gy ago \( \rightarrow \) 40 times stronger
Future goals

- Is life manipulate the physical surroundings and change the cosmic conditions in order to keep them suitable for life?
- The way the bacteria perform and penetrate the Martian environment could lead us to results related to other exoplanets
- Would be possible to colonize and terraforming Mars?