

Mars and exoplanetary bacteria

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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 – 63C

 - Surface pressure 1-7 mbar

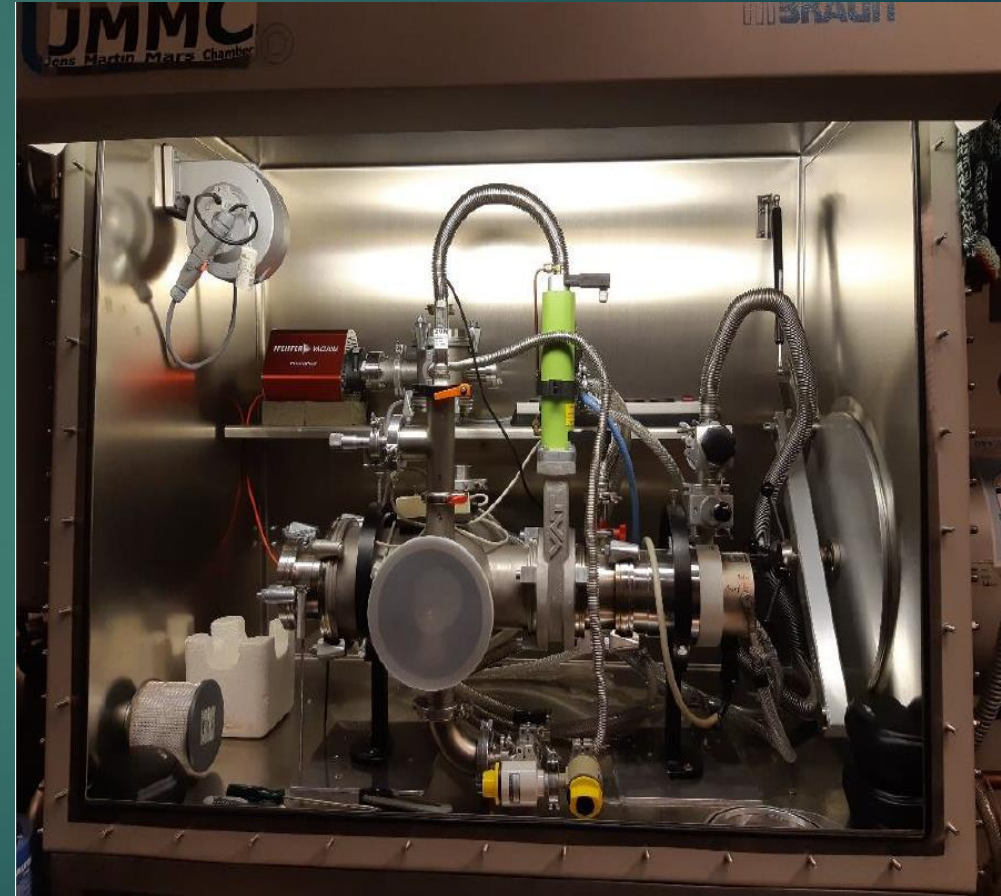
 - UV radiation 200-400 nm

 - 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)

Atmospheric Composition

- ▶ 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 had 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

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

$$(l_E/l_M)^2 \sim 4$$

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

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

- ▶ Outgassing scenario

$$(r_E/r_M)^3 \sim 6$$

- ▶ 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?