

SIMULATION OF MARTIAN ENVIRONMENT AND STUDY OF LIMIT CONDITIONS FOR LIFE

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We aim to realise the first interdisciplinary search of Astrobiology developed inside the Padua University, with a collaboration between researchers of Astronomy, Space Engineering and Biology, by simulating the Martian environment in a test chamber in order to see in what thermal conditions and under which soil materials extremophile lifeforms may survive or chemical processes and prebiological synthesis may happen.

The main goals of the program are:

1 – Building of the test chamber for the experiments. This phase is supervised by the participants of the Departments of Astronomy and Engineering and of the Astronomical Observatory. The chamber will be located in the laboratories of the Padua Interdepartmental Center of Studies and Spatial Activities (CISAS);

2 - Biological experiments. They will be preceded by the installation of an anaerobic cap in the Department of Histology, Microbiology and Medical Biotechnology (DIMBM), necessary to prepare and incubate anaerobic cultures exempt from terrestrial contamination for the next biological experiments. It is expected to make tests in function of the pressure, temperature, UV flux and covering materials, in order to verify how the following parameters change:

a) chemical syntheses in Martian atmosphere.

b) modification of the land samples used to simulate the soil.

c) cell survival

d) genetic mutations

e) modifications of the cellular ultra-structure

f) protein synthesis

g) nucleic acid synthesis.

They would establish the limits needed to some types of lifeforms that one cannot expect to find in the future missions on Mars.

3 - Moreover the minimal conditions of sterility of the probes to be sent in extraterrestrial environment will be defined, in order to guarantee the lack of inverse contamination (from the Earth to Mars).

4 - Beyond the precise goals of this research (definition of the physical-chemical conditions at which bacteria or viruses may resist), the results of this research may give useful information on wider problems connected to the origin of the life in the space and to the risks of contamination of the planetary environments, also in the frame of the return to Earth of samples of extraterrestrial material in near future.

Project 1: Building of the Martian environment simulator.

The realisation of the machine to simulate the Martian environment (S.A.M.) is started in February 2004. We established a subdivision of the project between the CISAS, the DIMBM, l'INAF - Astronomical Observatory of Padua (OAP). The coordinator of Astronomy Department keep the contacts between the various groups and with external factories, promoting common discussions to establish the solutions to adopt.

The CISAS, with the coordination of Prof. Fanti, started since February 2004 the project studies of the reaction cells and of the control, thermo-vacuum chamber. We decided to start with the project of the reaction cells ideated to allow the maximum transportability between the DIMBM and

CISAS, with the complete isolation of the coltures from external environment. The cell project was completed in June and the reaction cells in September. We bought a set of Suprasil filters (ϕ 51 mm) to be mounted on reaction cells and on thermo-vacuum chamber to allow the UV illumination of the bacteriam samples contained inside, blocking the UV radiation shorter than 200 nm, non typical of Martina atmosphere. After the cells building, one has discussed the control thermo-vacuum chamber that will contain them. One has projected a chamber containing six cells, to contemporary perform six experiments of different lengths and to build a time-curve of cellular activity. This oblige to open the thermo-vacuum chamber to extract every time a cell and to insert a new one. Since September 2004 one has studied how to insert the cells on a nitrogen-cooled plate containing a heater, to reproduce the night/day cicle of Mars. One has decide also to allow the circulation of the Martian gas by means of a system of valves able to resist both to very low temperatures, to -100 °C, and to a low pressure, 7 millibar. One has studied the appropriate valves and the filters needed to prevent the exit of bacterial, different from that normally used in the laboratories, that would explode in conditions of rapid change of pressure. The final project of the control chamber has been sent to the factory to be realised in April 2005.

L'OAP, with the coordination of Dr. D'Alessandro, started the study of the illumination system that will simulate the Martian Sun. Being the radiation at 220 nm the more harmful to bacteria, one has selected an UV lamp feeded by an high voltage apparatus. A Xenon lamp has been chosen, "ozone free", with a filter cutting UV shorted than 160 nm. To focalise the light on the samples a parabolic reflector has been built to insert the lamp in the focus. This has been performed in the OAP mechanical workshop at Cima Ekar – Asiago. The parabola was completed in December 2004 by digging an aluminium block. The OAP workshop has produced also some flat vessels in aluminium, similar to "Petri capsules " for biological samples, able to resist to the extreme experiment conditions.

The DIMBM, with the coordination of Prof. Bertoloni, has studied the biological aspect of experiments, waiting for the S.A.M. completion. An anaerobic cap of the Analytical Control, suitable for the specific exigencies of this project, has been buyed. In the mean time one has obtained by Prof. K. Venkatswaran, JPL Institute of Technology, Pasadena, USA, some bacterial samples derived from bacterial stocks transported in space and particularly UV resistant. These samples have been cultivated in the DIMBM and are waiting for the begin of experiments.

G. Galletta contacted a group composed by Prof. P. Nicolosi and Dr. M. Pelizzo at the Electronic and Informatic Department. They built a spectrograph able to measure the UV radiation collimated by the illumination apparatus. To extend the study of the spectral response curve at higher frequencies two UV a 220 e 240 nm interferential filters has been buyed and adapted to the instrument.

Personnel:

Prof. Giulio Bertoloni, Associato, Dip. Istologia, Microbiologia e Biotecnologie Mediche;

Prof. Giulio Fanti, Associato, Dip. Ingegneria Meccanica;

Prof. Giuseppe Galletta, Associato, Dip. Astronomia;

Dr. Carlo Bettanini Fecia DiCossato, Assegnista, CISAS;

Dr. Francesca Ferri, Assegnista, CISAS;

Dr. Daniele Pavarin, Tecnico, Dip. Ingegneria Meccanica;

External researcher:

D'Alessandro Maurizio, Astronomo Associato, INAF – Osservatorio Astronomico di Padova

Research Products:

Is a completely new research with biological characterisation, with nothing similar in Italy.

One of the final products will be the realisation of the first Italian simulator of the extreme Mars environment. It could be also used at the end of the Martian experiments to simulate Antarctica and other planets.

Most representative products:

Project and realisation of apparatuses of environment simulation, not present in the market.