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Journal of Astrobiology and Outreach

Dr. Daniela Billi

Editorial Board member

Assistant Professor
Department of Biology
University of Rome
Italy

Biography

Dr. Erik Persson

- Daniela Billi is Assistant Professor of Botany at the Department of Biology, University of Rome "Tor Vergata"). She obtained her MSc in Biological Sciences in 1992 (University of Rome "La Sapienza"), the PhD in Cellular and Molecular Biology in 1996 and the title of Specialist in Biotechnological Application in 1999 (University of Rome "Tor Vergata"). She was a Postdoctoral Research Associate at Virginia Tech Center for Genomics, Virginia Tech directed by Prof. Malcolm Potts and at the Polar Desert Research Center, Florida State University, directed by Imre E. Friedmann. She has a deep expertise on the ecophysiology and genetic diversity of phototrophic communities of desert environments developed in more than 15 years of researches, which recently included the study of microbial communities in Antarctic lakes. Researches focus on the cellular and molecular basis of cyanobacterial survival in extreme environments, like the Dry Valleys in Antarctica and the Atacama Desert in Chile, which are considered two terrestrial analogous of Mars. Astrobiological experiments are carried out by exposing desert cyanobacteria to space and Martian simulations in preparation of the next EXPOSE-R2 mission on the International Space Station. The aims are to investigate the endurance of life as we know it, to identify biosignatures to search for life on Mars, to validate the lithopanspermia theory and develop life-support systems. She maintains ~200 Chroococcidiopsis isolates from hot and cold deserts (as part of the Culture Collection of Microorganisms from Extreme Environments (CCMEE) established by E. Imre Friedmann, Florida State University, NASA). She is currently the coordinator of a MAE Bilateral Relevant Project (Italy-USA, NASA), is team member of two ESA-ILSRA 2009 projects (BOSS and BIOMEX), PI of two projects fund by the Italian Space agency ASI (BOSS_Cyano e BIOMEX_Cyano) and PI of the CNR-PNRA/PEA A1.01 and unit PI within a CNR-PNRA 2013 project for research in Antactic.

Research Interests

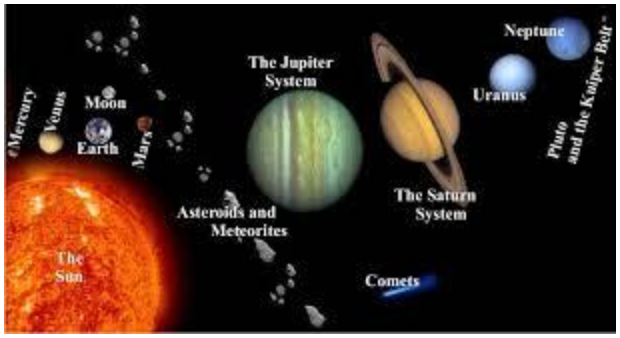
- Her researches focus on the ecophysiology and genetic diversity of phototrophic communities from desert environments and more recently on microbial communities from Antarctic lakes.
- Studies are dealing with the cellular and molecular basis of the cyanobacterial tolerance against environmentsl stressors, like desiccation, ionizing and UV radiations.
- A key part of her researches focuses on astrobiological experiments carried out by exposing desert cyanobacteria to space and Martian simulations in preparation of the next EXPOSE-R2 mission on the International Space Station.
- The aims are to investigate the endurance of life as we know it, to identify biosignatures to search for life on Mars, to validate the lithopanspermia theory and to develop life-support systems for the human space exploration.

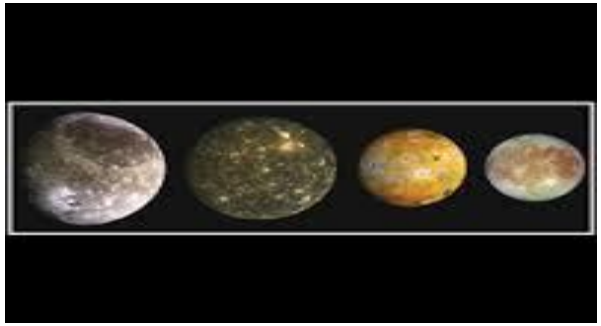
Recent Publications

Ionizing-radiation resistance in the desiccation-tolerant cyanobacteriumChroococcidiopsis
D **Billi**, EI Friedmann, KG Hofer, MG Caiola… - Applied and …, 2000 - Am Soc Microbiol

Engineering desiccation tolerance inEscherichia coli
D **Billi**, DJ Wright, RF Helm, T Prickett… - Applied and …, 2000 - Am Soc Microbiol

A novel staining protocol for multiparameter assessment of cell heterogeneity in Phormidium populations (cyanobacteria) employing fluorescent dyes
D Tashyreva, J Elster, D **Billi** - PloS one, 2013 - dx.plos.org





What is Astrobiology?

"Astrobiology is the study of life in the universe. It investigates the origin, evolution, distribution, & future of life on Earth, & the search for life beyond Earth. "

Astrobiology addresses three fundamental questions:

1) How does life begin & evolve?

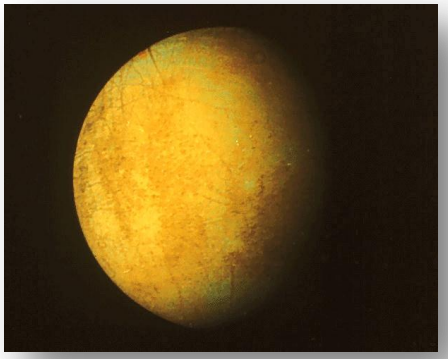
2) Is there life beyond Earth & how can we detect it?

3) What is the future of life on Earth & in the universe?"

Astrobiology addresses the question of whether life exists beyond Earth, and how humans can detect it if it does!!

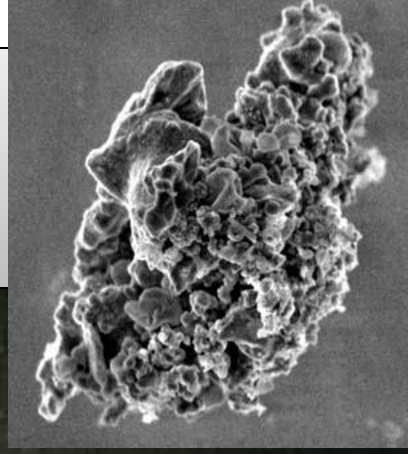
Life Elsewhere

- Studies of life in extreme environments on Earth have led us to focus on some prime places to look for life
- Mars
- Europa (moon of Jupiter)
- Titan (moon of Saturn)



Life in the Universe

Hubble Space Telescope image of Sedna- takes 10,500 years to circle the Sun!



Interplanetary Dust Particle -10 µm across made by dying and exploded stars

Our Solar System has planets, dwarf planets, moons, asteroids, comets, and interplanetary dust.

Milky Way galaxy has 100 billion (100,000,000,000) stars.
Universe has 100 billion (or more) galaxies.
Many stars have planets.
Some like Jupiter and Saturn.
Some may be like Earth.
Potential for a large number of Earth-like planets (ELPs).

Astrobiology, Incremental Data Accumulation, New Ideas & Understanding, Paradigm Shifts

NOTICE THE TIME FRAMES….

Search for Extrasolar Planets	~ 15 years
Deep Time: Reinterpreting Early Earth	< 5-10 years
Life on the Edge (extreme environments)	Late 70's Vents
The Rock that Started it all- Scientific Process	Mid 90's
Asteroids and Dinosaur Extinction	~ '79
Human Microbiomes	~ 5-10 years

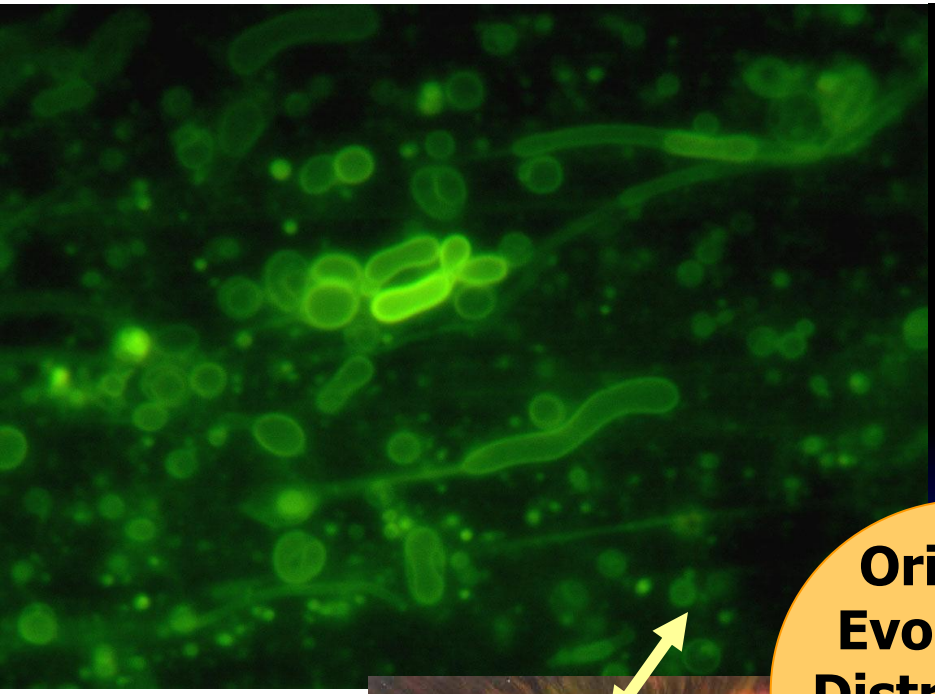
Astrobiology makes use of physics, chemistry, astronomy, biology, molecular biology, ecology, planetary science, geography, and geology to investigate the possibility of life on other worlds and help recognize biospheres that might be different from the biosphere on Earth.

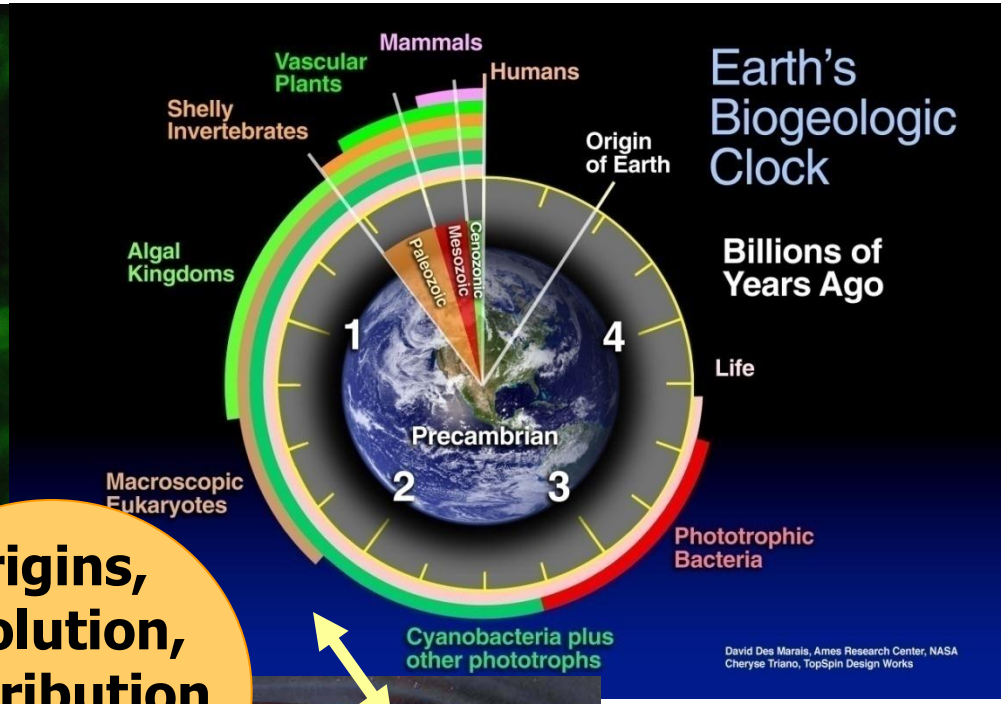
Astrobiology concerns itself with interpretation of existing scientific data; given more detailed and reliable data from other parts of the universe, the roots of astrobiology itself—physics, chemistry and biology—may have their theoretical bases challenged.

Although speculation is entertained to give context, astrobiology concerns itself primarily with hypotheses that fit firmly into existing scientific theories.

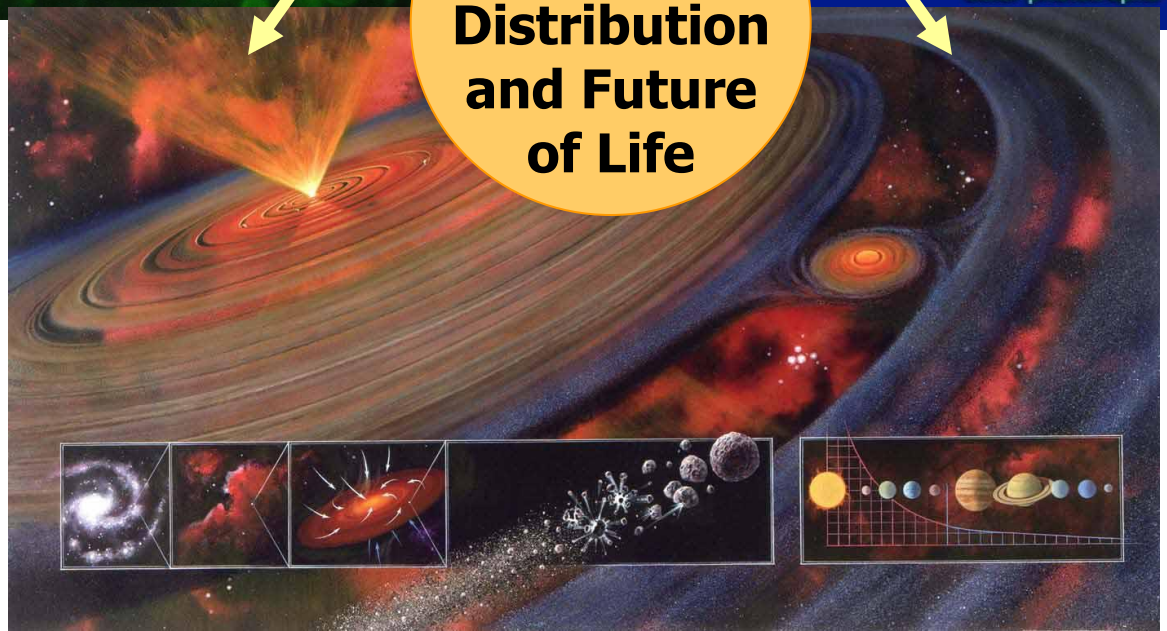
It has been proposed that viruses are likely to be encountered on other life-bearing planets.Efforts to discover current or past life on Mars is an active area of research.

Astrobiology Unites Disciplines to Study Life in the Universe





Origins, Evolution, Distribution and Future of Life



While it is an emerging and developing field, the question of whether life exists elsewhere in the universe is a verifiable hypothesis and thus a valid line of scientific inquiry. Though once considered outside the mainstream of scientific inquiry, astrobiology has become a formalized field of study.

Earth is the only place in the universe known to harbor life.However, recent advances in planetary science have changed fundamental assumptions about the possibility of life in the universe, raising the estimates of habitable zones around other stars, along with the discovery of hundreds of extrasolar planets and new insights into the extreme habitats here on Earth, suggesting that there may be many more habitable places in the universe than considered possible until very recently.

On 4 November 2013, astronomers reported, based on *Kepler*space mission data, that there could be as many as 40 billion Earth-sized planets orbiting in the habitable zones of sun-like stars and red dwarf stars within the Milky Way Galaxy.11 billion of these estimated planets may be orbiting sun-like stars.

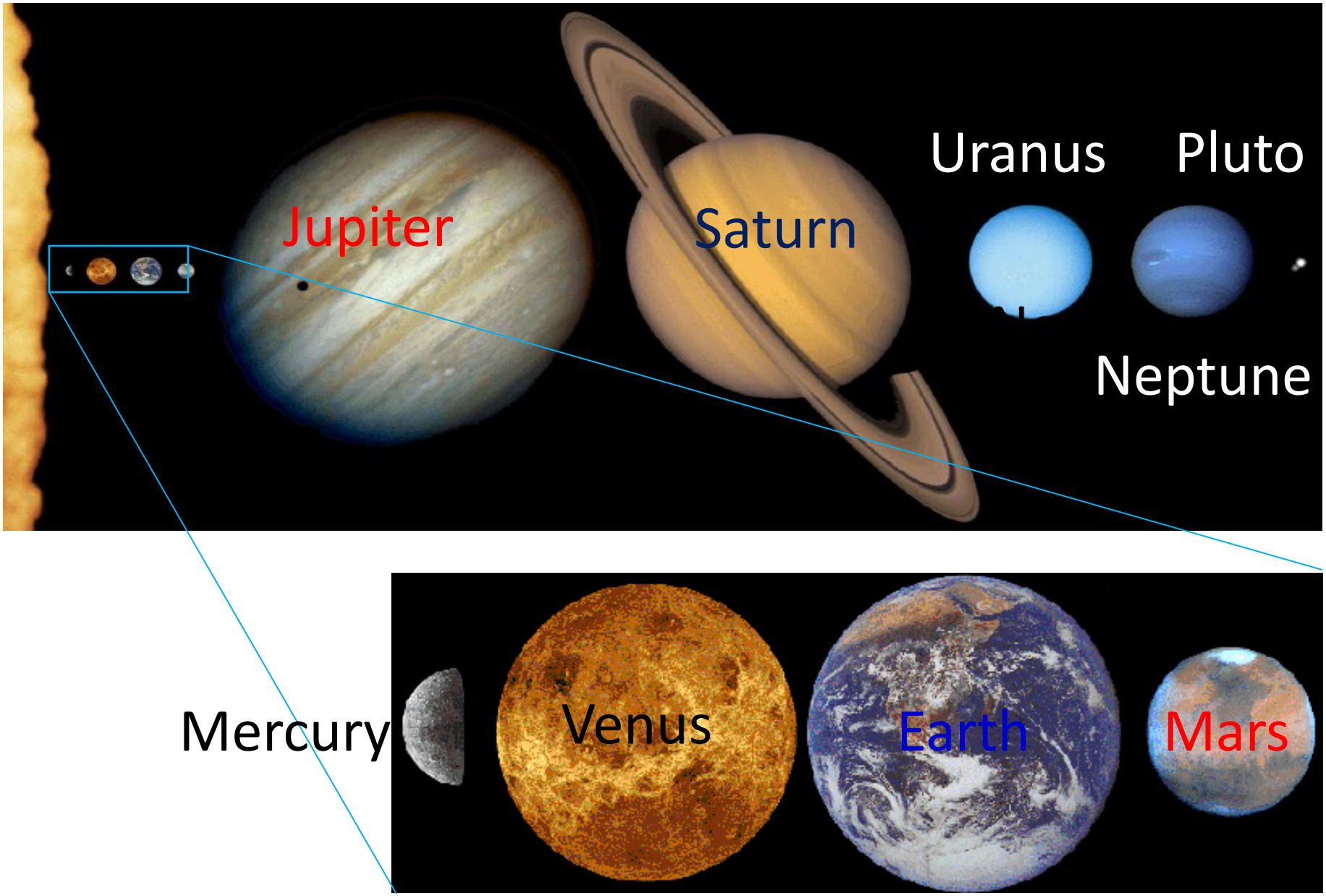
The Origin of Life on Earth

4 billion years ago

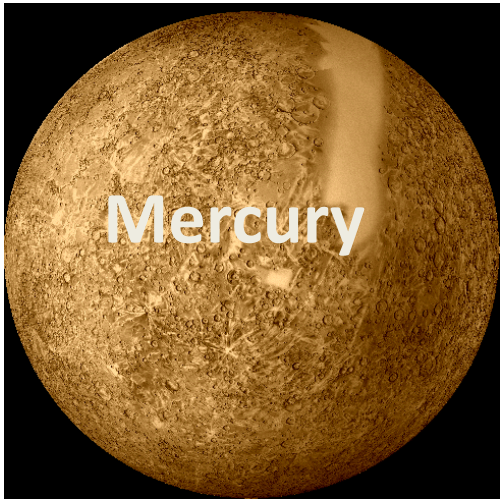
The nearest such planet may be 12 light-years away, according to the scientists.

A particular focus of current astrobiology research is the search for life on Mars due to its proximity to Earth and geological history. There is a growing body of evidence to suggest that Mars has previously had a considerable amount of water on its surface, water being considered an essential precursor to the development of carbon-based life

Our Solar System

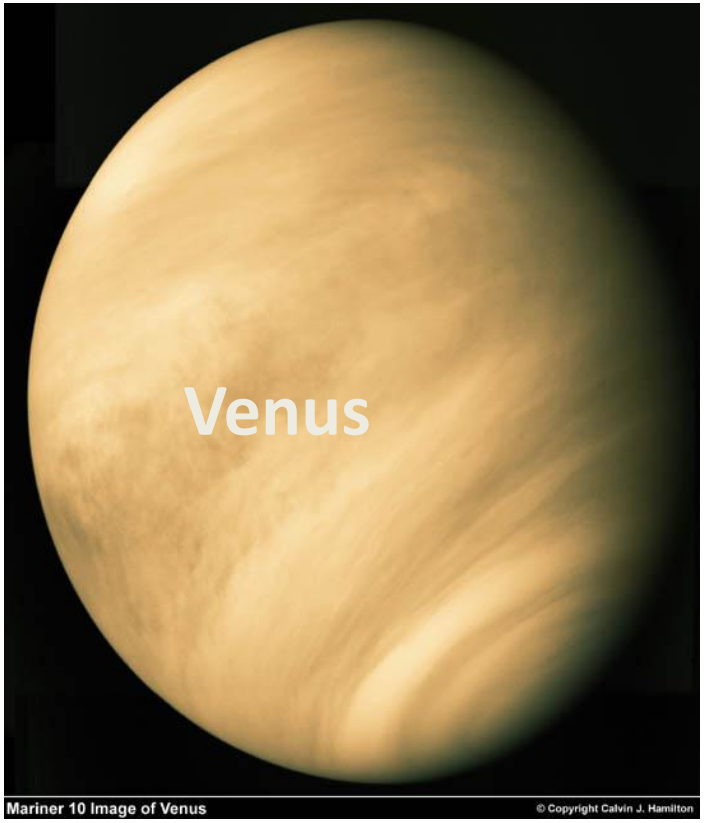


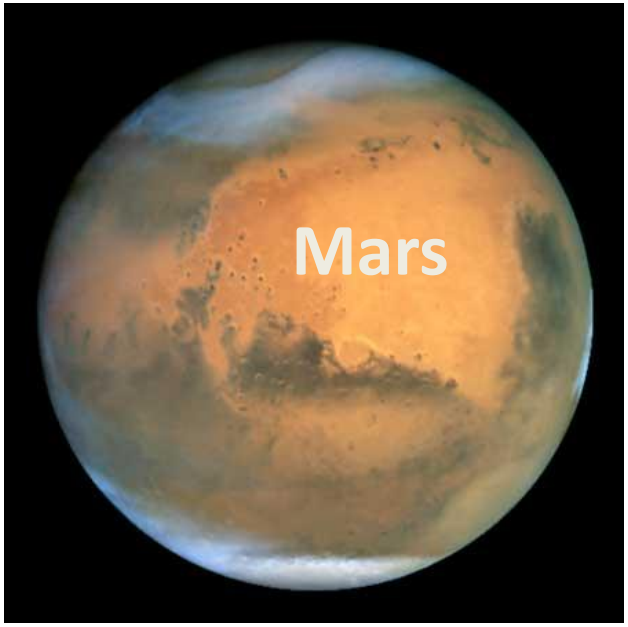
The Terrestrial Planets



Very near the Sun

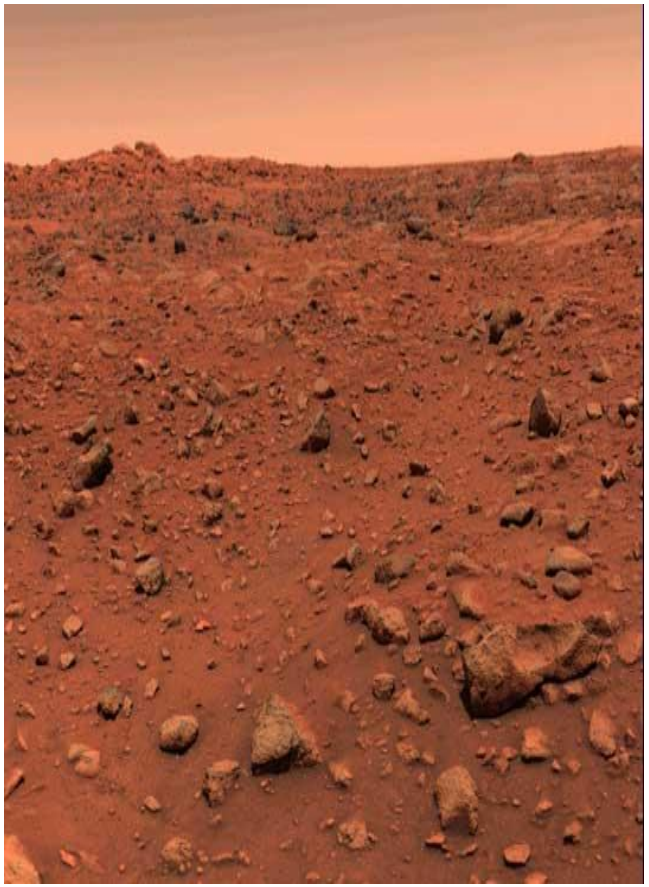
Very hot because its atmosphere



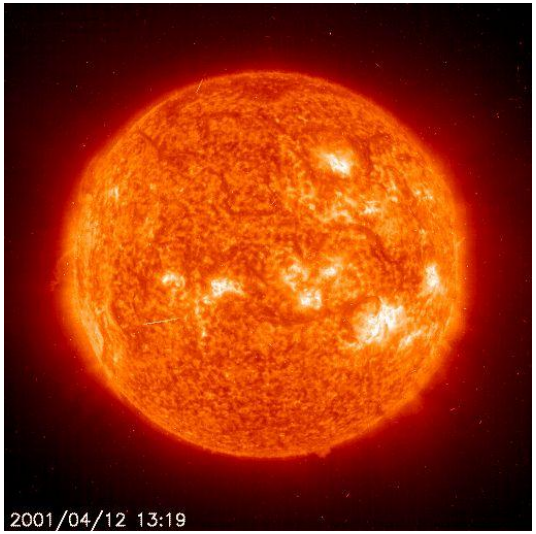


No atmosphere, cold but…

Mars



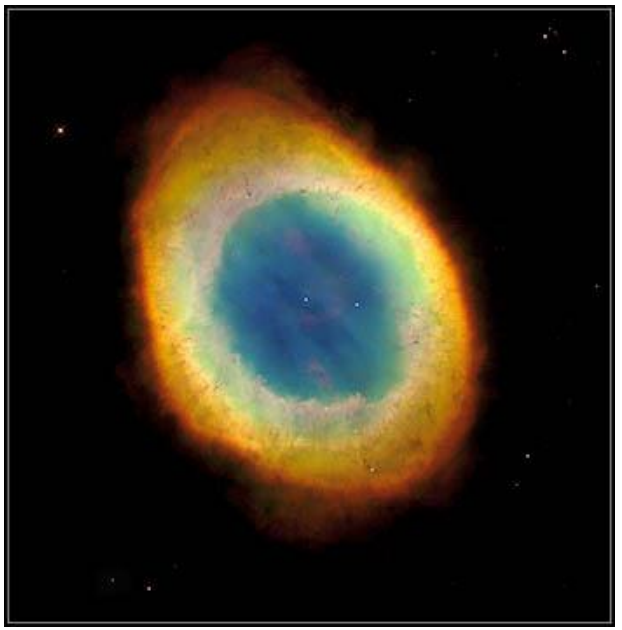
The life of the stars



Yellow dwarf
10 billion years

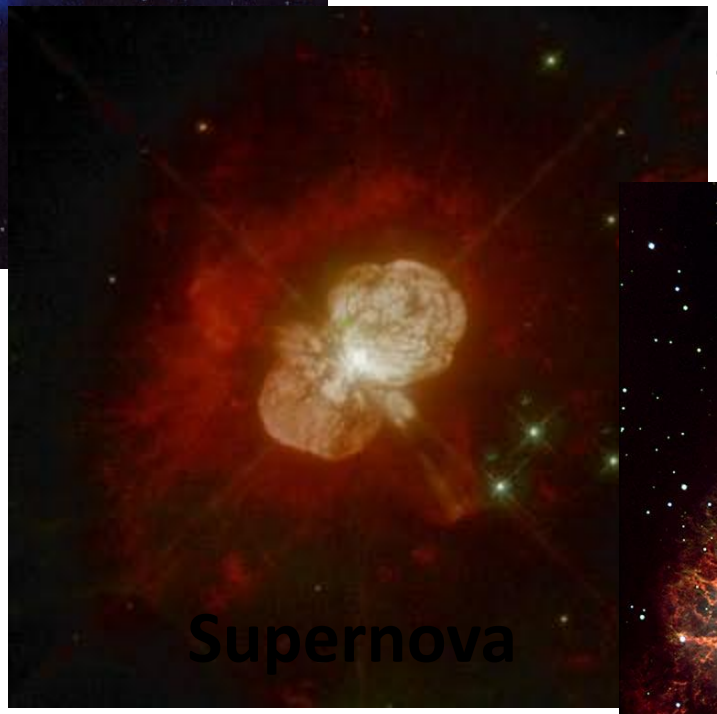
Red Giant

Panetary nebula
and white dwarf



The life of the stars

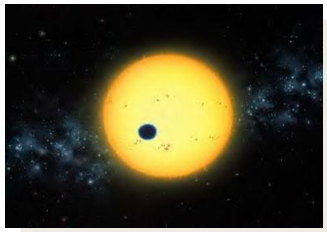
100 million years



Supernova remmanent and neutron star

Multiple Different Search Types

SETI Searches



Extrasolar/Habitable Planets

Exobiology in the Solar System

Multiple Different Search Types

SETI Searches

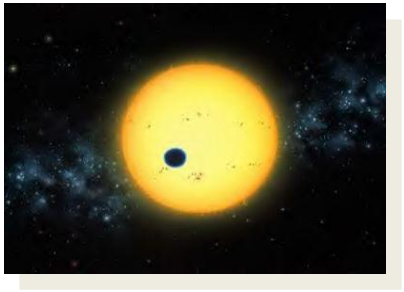
Radio-telescopes - within Galaxy

Discovery: Intelligent Life

Unknown Biology or Chemistry

Light Years Away (still exist?)

Aliens ???



Extrasolar/Habitable Planets

Telescopes - within Galaxy

Discovery: Other Solar Systems; Terrestrial Planets?

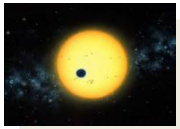
Information on Atmospheres (Compostion/Conditions?)

Maybe Habitable?

Life ???

Multiple Different Search Types

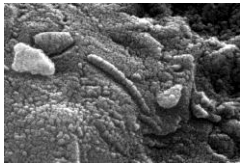
SETI Searches



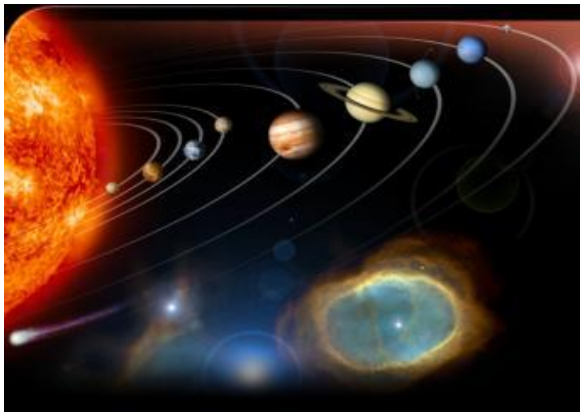
Extrasolar/Habitable Planets

➢ Exobiology in the Solar System **

Missions -- *visits*



Meteorites -- Fossil Evidence?



Cosmochemistry (Process; Replication)
Origin of Life Research (Lab Experiments)

** ***Real Time; Potential for Cross Contamination; Biohazards***

Strategy Has Worked on Mars…

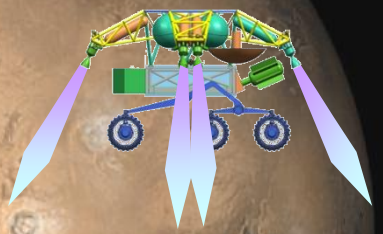
1976

1996

Built Understanding about Mars and its Environment over time...

2003

2007



2011

More and more indications of water found...
Small and large scales...

According to Erik Persson„

- If we eventually discover extraterrestrial life, do we have any moral obligations for how to treat the life-forms we find; does it matter whether they are intelligent, sentient, or just microbial—and does it matter that they are extraterrestrial?
- *What does it take to be a moral object?* and *What has value of what kind?* I will start with the first of these questions by looking at the most important attempts to answer this question on our own planet and by asking whether and how they could be applied to extraterrestrial life.
- The results range from a very strong protection of all extraterrestrial life and all extraterrestrial environments, whether inhabited or not, to total exclusion of extraterrestrial life.
- Subsequently, I also examine whether extraterrestrial life that lacks moral status can have value to human or alien life *with* moral status, and if that could generate any obligations for how to treat extraterrestrial life.
- Based on this analysis, I conclude that extraterrestrial life-forms can have both instrumental value and end value to moral objects, which has strong implications for how to treat them

Approved By

E-signature: *Daneilla Billi*

This ppt ahs been approved by Dr. Daneilla Billi

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