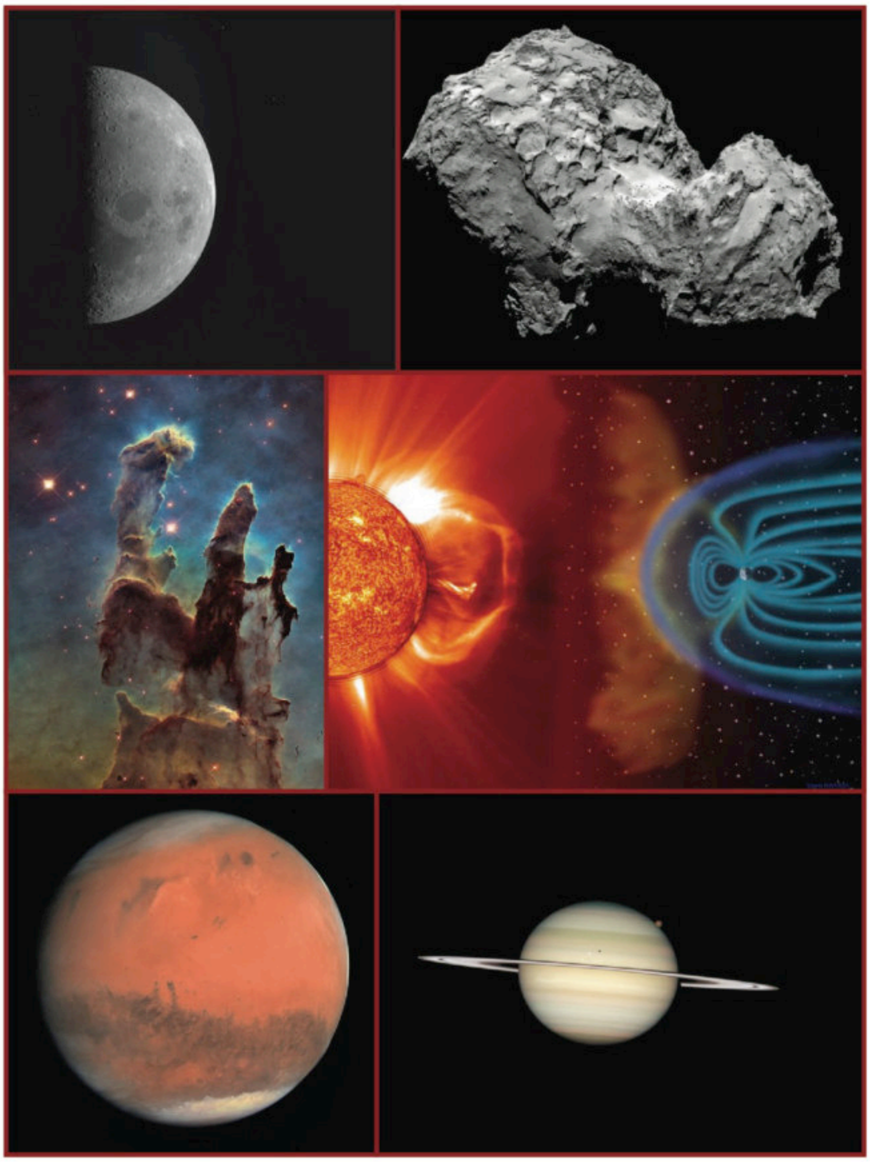
European Geosciences Union

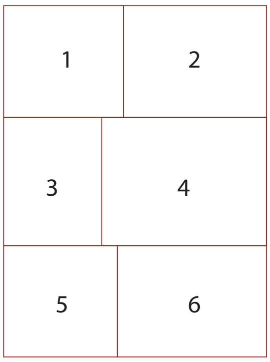
GIFT – Geosciences Information For Teachers



GIFT WORKSHOP - 2016

THE SOLAR SYSTEM AND BEYOND

Vienna, Austria, 17-20 April 2016



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6) NASA, ESA and the Hubble Heritage Team (STScI/AURA). Acknowledgment: M. Wong (STScI/UC Berkeley) and C. Go (Philippines)

Dear Teachers,

Welcome to the 20th GIFT workshop of the European Geosciences Union (EGU) organized in collaboration with the European Space Agency (ESA)!
This year the workshop will unite 80 teachers from over 20 different countries around the general theme "The Solar System and Beyond".

Fascination for the worlds around us has been a universal constant since the beginning of human cultures. In Mesopotamia, some 5000 years ago, observation of the sky led to a very precise calendar. The astronomers also grouped the stars of the Zodiac into 12 constellations very similar to those of today, and they also recognized that "the Morning Star" and the "Evening Star" were actually the same celestial body (Venus). They used a mathematical system with a base of 60, and later this base has been used for dividing the hours into 60 minutes and the minutes into 60 seconds.

On the other side of the Earth, in Yucatan, the Mayan civilisation independently developed a calendar so precise that it even considered the 0.24 fraction of a day in addition to the 365 days of the year, (which in our own modern calendar leads to bissextiles years - leap years), and also recognized the importance and uniqueness of solar solstices.

In both Mesopotamia and Yucatan, one of the main reasons for astronomical observations for developing the calendar was a practical one (agricultural). The search for knowledge of the cosmological laws was also in itself an objective, and in this respect one can say that it has been one among the first "scientific" investigations of mankind.

Scientific investigation was also the main motivation of the impressive work of the Greek philosopher-scientists Aristoteles, Aristarchus, Eratosthenes and Thales …and more recently the Europeans Kepler, Copernicus, Tycho Brahe and Galileo …

Today, this search continues and increases every day! In this workshop, after an introduction to the solar system by Özgür Karatekin of the Royal Observatory of Belgium, you will listen to a detailed report on our "father" star, the Sun and some of its interaction with our "mother" planet, the Earth, given by Pål Brekke from the Norwegian Space Center.

You will then learn about the impact craters on Earth and the moon from Christian Koeberl, of the Natural History Museum Vienna and about the internal structure of the solar planets from Philippe Lognonné of the Institut de Physique du Globe de Paris, IPGP.

Beyond the range of human sight, the discovery of extra-solar planets, or exoplanets, has been a major achievement in recent years and it has made a difference in human perception of the possible existence of other planets harbouring life. Michel Mayor (University of Geneva) and Athena Coustenis (Paris-Meudon Observatory) will give two fascinating presentations on these topics.

We'll then be introduced to NASA HYPERWALL by Steve Clarke, Michael Freilich and James Green of the National Aeronautics and Space Administration (NASA), and after that we'll go to your poster session to look at your activities!

On Wednesday, ESA scientist Matt Taylor will tell us how the very recent Rosetta mission may provide a key to understanding the origin and evolution of the solar system. And Olivier Witasse, also from ESA, will speak about the ESA mission “JUICE” (JUpiter ICy moons Explorer) – which is the first large-class mission in ESA's Cosmic Vision 2015-2025 programme.

As a final presentation, ESA Astronaut André Kuipers will tell us about his experience aboard the International Space Station.

In the first day of the workshop, Sophie Allan and Andy McMurray (National Space Centre, UK) with Diane Carrer (Mountain High School, Valdebore, France) will present some of the ESA-developed hands-on activities specially suited for the classroom.

As in every GIFT Symposium, contributions by the attending teachers with activities that they have used in their classrooms are particularly welcome in the poster session “Science in Tomorrow’s Classroom”. The session features any type of pedagogic activity, as well as posters describing the solar system.

Also, a first step will be a guided visit to the Natural History Museum Vienna, on Sunday afternoon, April 17, 2016, after which teachers will still have time to participate to the “Ice Breaker Party” at the Austria Centre where the General Assembly of EGU and the GIFT workshop will take place.

The GIFT workshop is sponsored not only by EGU, but also by several science organizations. We would like to continue to offer teachers the opportunity to attend GIFT and similar workshops, but this depends upon us being able to show our sponsors that teachers have used the GIFT information and science didactics in their daily teaching, or as inspiration for new ways to teach science in their schools.

Therefore, we ask you
1. To fill in the evaluation forms as soon as possible and email them back to us,
2. Make a presentation of your experiences at GIFT to a group of your teaching colleagues sometime after you return from EGU, and
3. Send us reports and photographs about how you have used the GIFT information in your classrooms.
We also encourage you to write reports on the GIFT workshop in publications specifically intended for geosciences teachers.

Information on past GIFT workshops is available on the EGU homepage:
http://www.egu.eu/education/gift/workshops/ where you can find the brochures (pdf) and the slides of the different presentations given at the GIFT workshops for the last 10 years. Beginning in 2009, we have also included web-TV presentations, which may be freely downloaded and used in your classrooms.

And clicking on http://www.egu.eu/education/ you will learn about all the educational activities of the European Geosciences Union.

We are looking forward to meeting you in Vienna!

The Committee on Education
European Geosciences Union

Acknowledgements

The GIFT-2016 workshop has been organized by the Committee on Education of the European Geosciences Union. EGU has supported the major share of the expenses, but the workshop has also benefited from the generous help of:

The European Space Agency

Istituto Nazionale di Geofisica e Vulcanologia

William S. Goree Award

Westermann Verlag, Braunschweig, Germany

Géoazur laboratory and INSIGHT program

And we thank all the speakers who have contributed to this educational workshop and their institutions!

European Geosciences Union
Committee on Education

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Program

European Geosciences Union – General Assembly

GEOSCIENCE INFORMATION FOR TEACHERS (GIFT) WORKSHOP

Austria Center Vienna, 18-20 April 2016

'The Solar System and Beyond'

Sunday April 17, 2016

16:00 - 18:00 **GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA**
Herbert Summesberger and Mathias Harzhauser
Natural History Museum Vienna

Monday April 18, 2016

Chairperson: Carlo Laj

08:30 - 08:45 **WELCOME!**
Hans Thybo
President of EGU

08:45 - 09:15 **INTRODUCTION TO THE 2016 GIFT WORKSHOP**
Carlo Laj
EGU Committee on Education

9:15 – 10:00 **INTRODUCTION TO THE SOLAR SYSTEM**
Özgür Karatekin
Royal Observatory of Belgium

10:00 – 10:30 COFFEE BREAK

Chairperson: Annegret Schwarz

10:30 – 11:15 **THE SUN**
Pål Brekke
Norwegian Space Center, Oslo, Norway

11:15 – 12:00 **IMPACT CRATERS ON EARTH AND IN THE SOLAR SYSTEM**
Christian Koeberl
Natural History Museum Vienna & University of Vienna

12:00 – 12:15 **INSTRUCTIONS FOR THE POSTER SESSION EOS03**
Eve Arnold
EGU Committee on Education

12:15 – 14:00 LUNCH (SANDWICHES)

Chairperson: Francesca Cifelli

14:00 -14:15 **ONE YEAR AFTER THE GIFT WORKSHOP**
Video by Anna Elisabetta Merlini
'Il Geco' Foundation
Milano, Italy

14:15 – 18:00 **HANDS-ON ACTIVITIES**
Sophie Allan and Andrew McMurray
National Space Academy, Leicester, UK
&
Diane Carrer
Mountain High School, Valdebore, France

Tuesday April 19, 2016

Chairperson: Stephen Macko

08:30 - 09:15 **FROM MOON SEISMOLOGY TO MARS WITH THE SEIS INSTRUMENT ON THE NASA INSIGHT MISSION**
Philippe Lognonné
Institut de Physique du Globe, Paris, France

09:15 – 10:00 **A PATH TO THE DETECTION OF EARTH-TYPE PLANETS**
Michel Mayor
University of Geneva, Switzerland

10:00 – 10:30 COFFEE BREAK

Chairperson: Friedrich Barnikel

10:30 – 11:15 **THE SEARCH FOR HABITABLE WORLDS IN THE OUTER SOLAR SYSTEM**
Athena Coustenis
LESIA, Observatoire Paris-Meudon, France

11:15 – 11:45 **THE NORTHERN LIGHTS (VIDEO)**
Pål Brekke And Fredrik Broms
Norwegian Space Center, Oslo, Norway

11:45 – 12:00 **OPEN QUESTIONS from the audience**

12:00 - 13:30 LUNCH (SANDWICHES)

13:30 – 15:30 **NASA HYPERWALL**
Steve Clarke, Michael Freilich, James Green
National Aeronautics and Space Administration (NASA)

15:30 – 19:00 **EOS3 – POSTER SESSION**

Wednesday April 20, 2016

Chairperson: Carlo Laj

08:30 - 09:30 **THE ROSETTA MISSION**
Matt Taylor
European Space Agency, ESTEC,
Noordwijk, The Netherlands

09:30 - 10:00 **THE "JUICE" MISSION**
Olivier Witasse
European Space Agency, ESTEC
Noordwijk, The Netherlands

10:00 – 10:30 COFFEE BREAK

→ → → Move to Room B (red level)!!

Chairperson: Carlo Laj

10:45 – 11:45 **LIVING AND WORKING IN SPACE**
André Kuipers
ESA Astronaut, The Netherlands

11:45 – 12:00 **GOOD BYE!**

END OF THE WORKSHOP!

Optional:

14:00 - 15:30 **GEOLOGICAL PATHWAY FROM MARIA THERESIA'S MONUMENT TO ST. STEPHEN'S CATHEDRAL**
Herbert Summesberger, Natural History Museum Vienna

Speakers

GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA

Herbert Summesberger and Mathias Harzhauser
Natural History Museum Vienna

Standing on each side of the bronze elephant (an artwork of the Viennese artist Gottfried Kumpf) in front of the entrance, our two hosts for the visit to the Natural History Museum Vienna :

Mathias Harzhauser, on the left, Head of the Department of Geology and Palaentology, has earned his degrees from the University of Vienna and has been employed by the NHM after his Master's thesis. His PhD thesis deals with the Paleoceanography of the Oligocene and Lower Miorece Gastropoda of the Eastern Mediterranean and the Western Indo-Pacific.

Herbert Summesberger, on the right, has earned his degrees from the University of Vienna. His PhD thesis deals with structural geology, stratigraphy and palaentology in the Northern Calcareaou Alps. He has organized several international symposia and is the leader of the Working Group on Geosciences, School and Public Relations of the Austrian Geologica Society. Retired since 2004, he is a member of the Board of the Friends of the Museum of Natural History, and organizes exhibitions and seminars for High School teachers. He has also written high school books and a Vienna city guide for building and decoration stones.

Özgür Karatekin

Senior Research Scientist

Royal Observatory of Belgium

Education

Ph.D in applied sciences. Université Libre de Bruxelles (ULB), Belgium. Diploma course. von Karman Institute for Fluid Dynamics, Brussels, Belgium. M.S Aeronautical Engineering. Middle East Technical University, Ankara, Turkey. B.S Aeronautical Engineering. Middle East Technical University, Ankara, Turkey.

Research Interests

Thermal and atmospheric evolution of planets and moons, Planetary rotation and gravity variations, Planetary exploration and entry probes.

Summary of Publications

Number of publications : 44 Number of citations 767 H-Index : 16

Honours

Team member for the "Le Prix La Recherche en Astrophysics 2012" in France. Bronze Medal in the International Apophis Mission Design Competition of the Planetary Society with the APEX team. 2007. NATO Science Scholarship for Ph.D studies through the Sci.

Voluntary Activities

President. Planetary and Solar System Sciences Division of the European Geosciences Union (EGU) (2013-..) Co-Chair of International Planetary Probe Workshop (IPPW), (2012) Science secretary. Planetary and Solar System Sciences Division of the European Geosciences Union (EGU). (2009-2013)

Editor for Journal of Geophysical Research Planets and Journal of Planetary and Space Science.

INTRODUCTION TO THE SOLAR SYSTEM

Özgür Karatekin

Royal Observatory of Belgium

This lecture will give an introduction to our Solar System including its origin and evolution. Our solar system consists of the sun and the surrounding planets, natural satellites, dwarf planets, asteroids comets, dust and debris. These objects have different relative dimensions, masses and distances from each other. The sun is by far the most massive part of the solar system, containing almost 99.9% of the system's total mass. The planets revolve around the Sun in elliptical orbits. They were recognized by the ancient culture as the 'wandering stars' that migrate against the background of the 'fixed' stars. Terrestrial planets (Mercury, Venus, Earth and Mars) are distinguished by having rocky exteriors, made largely of silicate minerals whereas the giant gas planets are less dense and lack of solid surfaces. Their current physical properties and habitability results from the individual evolutionary paths taken since their origin at 4.6 Gyr ago.

Dr. Pål Brekke
Senior Advisor
Norwegian Space Centre
Oslo, Norway

PhD in 1993 from the Institute of Theoretical Astrophysics, University of Oslo.
His work focused on observations of the Sun from instruments on sounding rockets and the space shuttle Challenger.

After the launch of Solar and Heliospheric Observatory (SOHO) in December 1995 he was part of the science operation team at NASA Goddard Space Flight Center (GSFC).

In 1999 he joined the European Space Agency (ESA) as the SOHO Deputy Project Scientist stationed at GSFC. His responsibility included being in charge of outreach and media activities, making SOHO to one of the most well known current satellite projects.

Dr. Bekke is a Norwegian delegate to several ESA Programme Board and WMOs Space Weather programme. He is also a Prof. II at the University Center at Svalbard (UNIS).

He received a Fulbright Fellowship in 1994, ESA´s Exeptional Achievement Award in 2002, Laurels for Team Achievements from the International Academy of Astronautics in 2003. Served on several NASA Review Panels and as referee for various scientific journals.

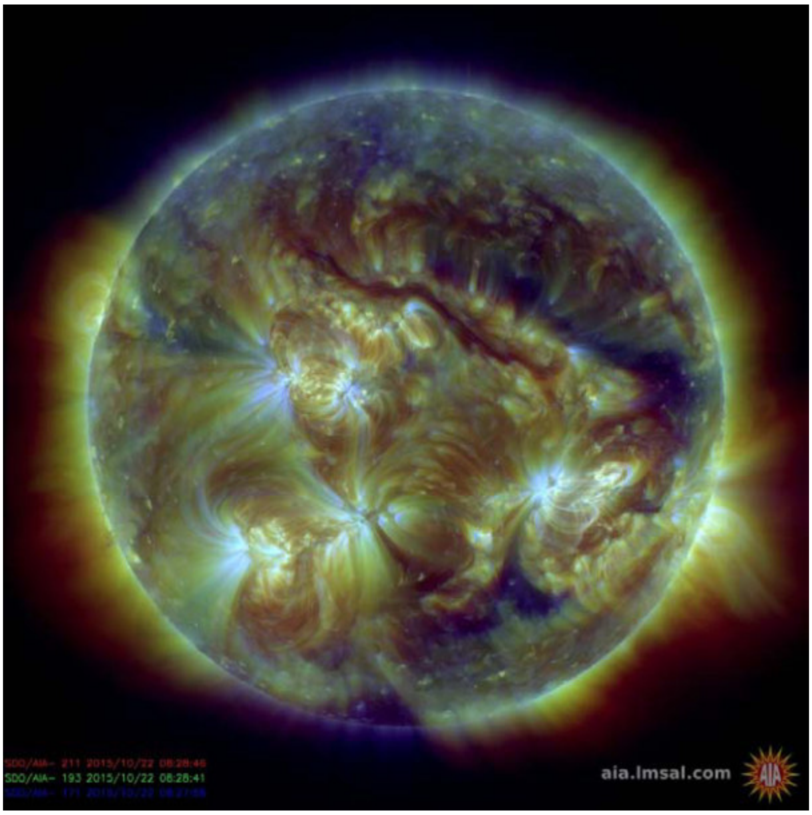
Dr. Brekke is also an author of several international popular science books about the Sun and the Northern Lights and recently produced the award-winning documentary, The Northern Lights - a Magic Experience (2015).

THE SUN

Pål Brekke

Norwegian Space Centre, Oslo, Norway

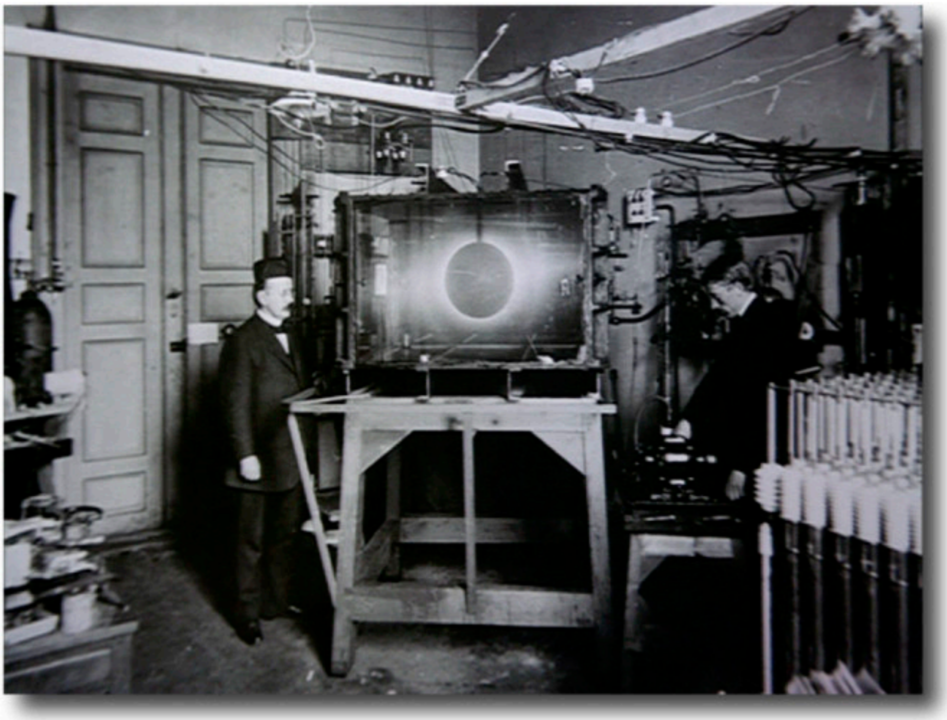
The Sun provides energy to all life on Earth and drives the climate system and is therefore very important to all of us. It powers photosynthesis in plants and is the ultimate source of all food and fossil fuel. However, storms on the Sun can also interfere with systems on Earth that our society depends upon. Looking at the sky with the naked eye, the Sun seems static, placid, and constant. From ground the only noticeable variation in the Sun is its location (where it will rise and set today?). But the Sun gives us more than just a steady stream of warmth and light. Situated 150 million kilometers way from us the Sun is a huge thermonuclear reactor, fusing hydrogen atoms into helium and producing million degree temperatures and intense magnetic fields. Near the surface, the Sun is like a pot of boiling water, with bubbles of hot electrified gas. The steady stream of particles blowing away from the Sun is known as the solar wind. Blustering at 1.5 million kilometer per hour the solar wind carries a million tons of matter into space every second (that's the mass of Utah's Great Salt Lake). Every 11 year the Sun undergoes a period of activity called the "solar maximum", followed about 5 years later by a period of quiet called the "solar minimum". During solar maximum there are many sunspots, and during solar minimum there are few. Thus, one way of tracking solar activity is by observing the number of sunspots. Sunspots are dark patches like freckles on the solar surface formed when magnetic field lines just below the Sun's surface are twisted and poke through the solar surface. Sunspots can last from a few hours to several months, and a large sunspot can grow to several times the size of Earth. Though the Chinese recorded some observations as early as 28 B.C., scientists have been observing and recording sunspots sine about 1610 when Galileo Galilei pointed his telescope towards the Sun. Why do scientists care about sunspots? Because they are visible signs of the turmoil inside the Sun that lead to space weather effects on Earth. Coronal mass ejections (CMEs) and solar flares are often associated with sunspot groups. The twisted magnetic fields above sunspots are sites where solar flares are frequently observed to occur. Solar flares are short, intense explosions that accelerate particles and intense X-ray radiation into space. CMEs, caused by temporary breaks in the magnetic controlling field lines, are much larger storms that thrust billions of tons of particles (a mass equal to that of 100,000 battleships) at speeds up to 8 million kilometers per hour!! During solar maximum CMEs and flares can occur several times per day with some of them aimed in the Earth's direction. Fortunately, our planet is protected from the harmful effects of the radiation and the hot plasma by our atmosphere and by an invisible magnetic shell known as the magnetosphere. Produced as a result of the Earth's own magnetic field, the magnetosphere shields us from most of the Sun's particles by deflecting them around the Earth.



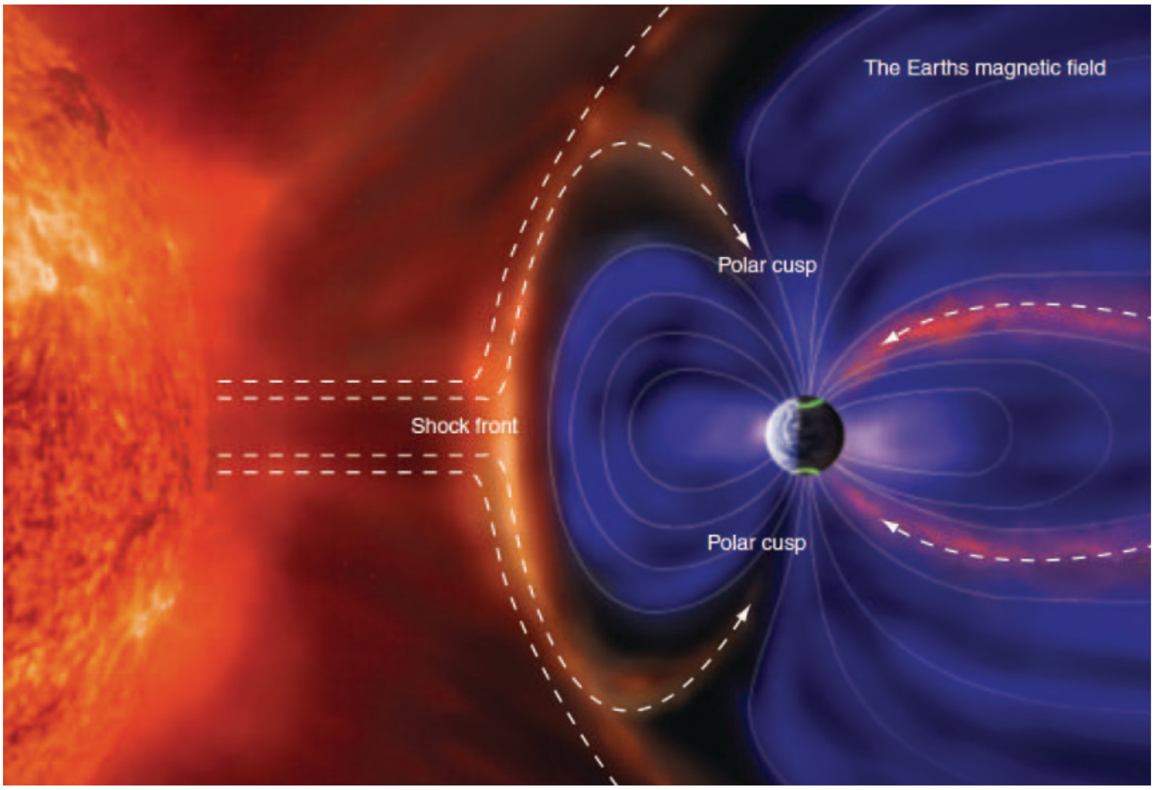
The Sun observed with a camera sensitive to X-ray radiation, which lets us see the Sun's outer atmosphere - the Corona. The temperature of the gases are over a million degrees and they are tracing out the Sun's magnetic fields (NASA/SDO).

The Aurora

There has been a hundreds of stories and theories to explain the Aurora (also known as the Northern or Southern lights). But no one suspected a connection with the Sun. An eccentric Norwegian scientist – Kristian Birkeland (1867-1917) built his own world in a glass box – electrified his model earth with its own magnetic field and showed how particles from the Sun could ignite auroras and that they would be identical and simultaneous at both poles. Birkeland was right but proof of his theories had to wait until we could step into space. The aurora is caused by CMEs or gusts in the solar wind that will push on our magnetosphere so that particles inside the magnetosphere are injected into the Earths upper atmosphere where they collide with oxygen and nitrogen. These collisions – which usually takes place between 60 – 300 km above ground – cause the oxygen and nitrogen to become electrically excited and to emit light (fluorescent lights and televisions works in much the same way). The result is a dazzling dance of green, blue, white, and red light in the sky.



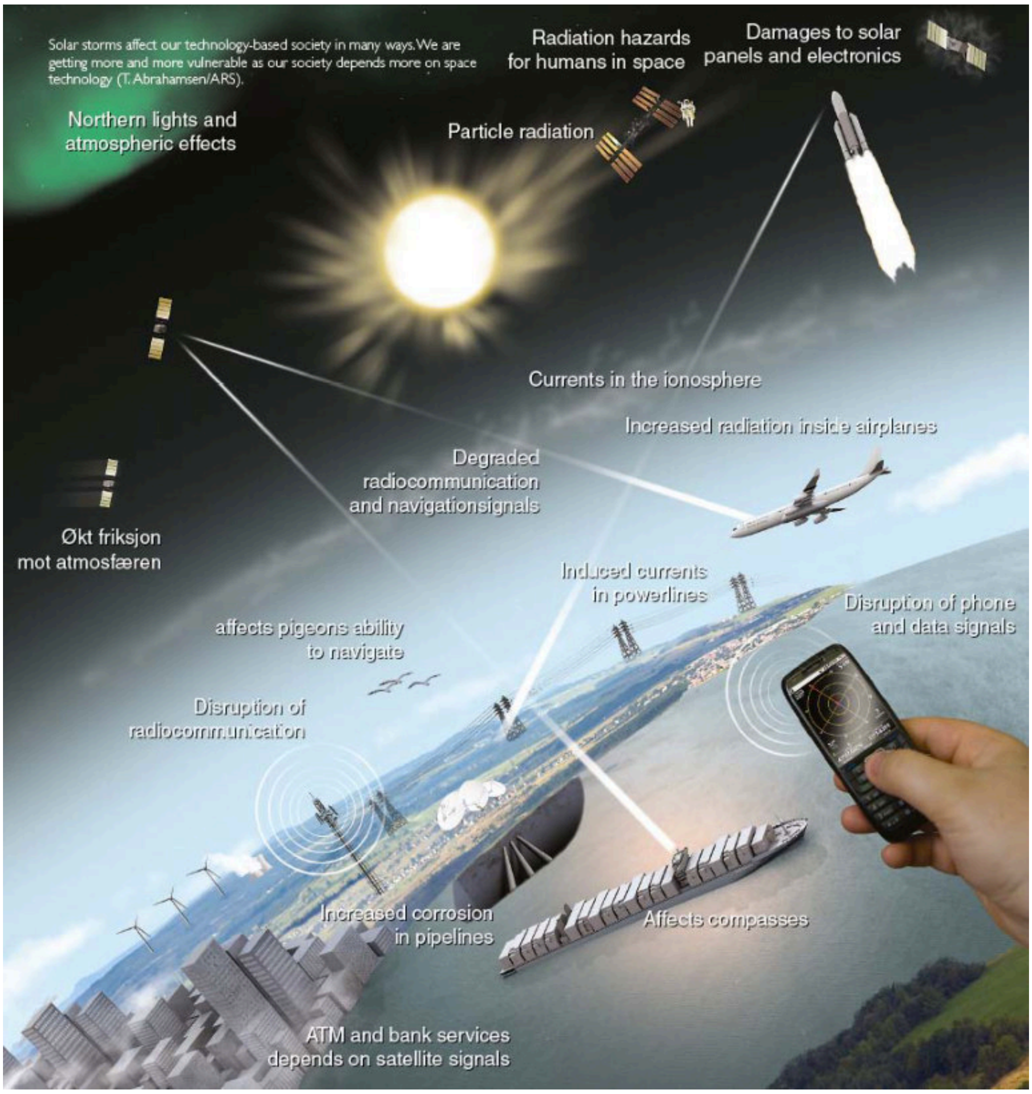
Kristian Birkeland with his Terella experiment.The metal sphere was his model Earth, while the vacuum glass container was space. When Birkeland sent particles toward the sphere, the polar regions glowed (UiO).



Earth's magnetosphere protects us from solar particles. Some particles still manage to penetrate through a "cusp" in this shield and create the daytime aurora. Most of the particles from the Sun penetrate the magnetosphere on the night side and then follow the magnetic field lines back toward the polar regions (T. Abrahamsen/ARS)

Space Weather

Aside from the bright auroras, there are less benevolent effects of the connection between the Sun and Earth. In fact, bright auroras are merely a visible sign that the balance of the electrical and magnetic energy in the Earth's magnetosphere has been upset. With the average CME dumping about 1500 Gigawatts of electricity into the atmosphere (double the power generating capacity of the entire United States), big changes can occur in space. Those changes can wreak havoc on a world that has become dependent on satellites, electrical power, and radio communication – all of which are affected by electric and magnetic forces. The energy from these solar blasts can disrupt radio communication, upset electrical power systems, damage satellites and change their orbits, and cause errors in navigational systems. Astronauts walking in space can be endangered by radiation from these events.



Solar storms affect our technology-based society in many ways. We are getting more and more vulnerable as our society depends more on space technology (T. Abrahamsen/ARS).

Christian Koeberl
Natural History Museum Vienna & University of Vienna, Austria
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webpage: http://www.nhm-wien.ac.at/en/christian_koeberl

Education:
Study of chemistry and physics, Technical University of Vienna 1978-1983
Study of astronomy and chemistry, University of Vienna, 1979-1983
PhD in astronomy, University of Graz, 1983
Habilitation, Earth Sciences (Geo- and Cosmochemistry), University of Vienna, 1990

Career:
Assistant professor, University of Vienna, 1985-1990
Associate professor, University of Vienna, 1990-2008
Visiting professor, Darmouth College, USA, 1994,
Visiting Research Professor, Dept. Earth Sciences + Planetary and Space Science Research Institute, Open University, Milton Keynes, United Kingdom, 2007-2010
Full professor (planetary geology), University of Vienna, 2009-today
Director general, Natural History Museum Vienna, 2010-today

Publications and Services:
ca. 410 peer-reviewed publications, 16 books (authored or edited), over 550 abstracts
Books Editor, Geological Society of America
Associate Editor, Meteoritics and Planetary Science
Associate Editor, Geochimica et Cosmochimica Acta

Awards and honors:
• 1994 – Fellow of the Meteoritical Society
• 2000 – Fellow of the Geological Society of South Africa
• 2006 – elected Full Member of the Austrian Academy of Sciences
• 2006 – Asteroid (15963) named "Koeberl"
• 2007 – Barringer Medal and Award of the Meteoritical Society
• 2012 – elected Fellow of the Geological Society of America

IMPACT CRATERS ON EARTH AND IN THE SOLAR SYSTEM

Christian Koeberl
Natural History Museum Vienna, Austria

All bodies in the solar system that have solid surfaces are covered by craters. In contrast to many other planets and moons in the solar system, the recognition of impact craters on the Earth is difficult, because active geological and atmospheric processes on our planet tend to obscure or erase the impact record in geologically short time periods. Impact craters must be verified from the study of their rocks – remote sensing and geophysical investigations can only provide initial hints at the possible presence of an impact crater or supporting information. Craters of any type and morphology are not a common landform on Earth. About 180 impact structures are currently known on Earth. Considering that some impact events demonstrably affected the geological and biological evolution on Earth, and that even small impacts can disrupt the biosphere and lead to local and regional devastation, the understanding of impact structures and the processes by which they form is of broad interest.

Impact craters (before post-impact modification by erosion and other processes) occur on Earth in two distinctly different morphological forms. They are known as simple craters with diameters up to about 2 to 4 km, and complex craters, which have larger diameters.

Complex craters are characterized by a central uplift in the form of either a central peak or a central ring of hills. The recognition of geological structures and ejecta layers on Earth as being of impact origin requires the detection of either shock metamorphic effects in minerals and rocks, and/or the presence of a meteoritic component in these rocks. Apart from studying meteorite impact craters, information can also be gained from the study of impact ejecta. In some cases, impact events have been identified solely from the discovery and study of regionally extensive or globally distributed impact ejecta. Geochemical methods have been used to determine the presence of the traces of such an extraterrestrial component. In the absence of actual meteorite fragments, it is necessary to chemically search for traces of meteoritic material that is mixed in with the target rocks in breccias and melt rocks. Both trace element and isotope methods are used.

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EDUCATION

2007-2012: Junior researcher at University of Milan in collaboration with UT technologies and Kraomita Malagasy (Madagascar)

2007: Phd in ore geology on Cr-minerals genesis and alteration of podiform chromitites, Earth Science Department Milan Univerity.

2004: Master in Geology on geological and geochemical evolution of volcanic areas; at Earth Science Department, University of Milan and UNAM, Universidad National Autonoma de Mexico.

CARREER

Actually president of Il Geco foundation (Geoscienze, Ecologia Cultura, Orientamento), teacher and promoter of Earth related projects in school of all levels. She also works as geologist in mining area as supervisor of quality assurance control and as expertise in European Standard of aggregates for concrete and bituminous mixtures.

2015: Assistant for mineralogy laboratories in Cultural Heritage and Environment at University of Milan.

2015: Teacher in TFA (Tirocini Formativi Attivi) as a trainer for new teachers of public schools (geoscience area)

2006: Teacher in SILSIS (Scuola Interuniversitaria Lombarda di Specializzazione per l'Insegnamento) qualifying courses of new teachers. Subjects: geology, mineral resources, volcanology

RESEARCH INTERESTS

Engaged in the dissemination of Earth sciences topics, she dedicates the last four years of her career in developing and searching new strategies to approach extremely young generation in Earth sciences issues. Actually she is leading an experimental project named GIFK (Geosciences Information for Kids) involving contemporaneously more than 300 students at the beginning of their scholastic life.

PUBLICATIONS AND SERVICES

- Scuola terra e fantasia: un progetto sperimentale per la diffusione delle geoscienze nelle scuole dell'infanzia. -Merlini A., Grieco G., Oneta C. (2014). Rend. Online Soc. Geol. It., Suppl. n. 1 al Vol. 31, 556
- Nuove metodologie didattiche per la diffusione del geoturismo nelle scuole: il progetto GECO. Grieco G., Merlini A., Porta M., (2013). Geologia e Turismo, Atti del 5° Congresso Nazionale, 195-196
- The tectonic significance of PGM-bearing chromitites at the Ranomena mine, Toamasina chromite district, Madagascar. Giovanni Grieco, Anna Merlini, Alberto Cazzaniga. Ore Geology Reviews, Volume 44, Feb. 2012, Pg. 70–81
- Probe and SIMS investigation of clinopyroxene inclusions in chromites from the Troodos chromitites (Cyprus): Implications for dunite–chromitite genesis. Anna Merlini, Giovanni Grieco, Luisa Ottolini , Valeria Diella. Ore Geology Reviews 41 (2011) 22–34.

ONE YEAR AFTER THE GIFT WORKSHOP

The G.I.F.K. project: Geosciences Information For Kids

Elisabetta Merlini, Il geco Foundation, Milano, Italy

"The imagination is more important than knowledge!" and with these words of A. Einstein we try to use most of our imagination to discover new ways to approach very young students to geoscience topics.

With this short video we want to present our GIFK project (Geoscience Information For Kids), born after the GIFT experience in 2015 when the Geco Foundation created a workshop focused on mineral resources. The Geco (Geoscienze, Ecologia, Cultura e Orientamento) is an Italian organization promoting didactical projects, related to geosciences, in schools of all levels starting from kindergarten to secondary school. After the GIFT workshop, we came back with an extremely clear vision of the fragility of our planet in relation to our "exploiting" society and we felt the need to find a new way to expose young generations to geoscience topics in order to help students to achieve a more eco-aware generation in the future.

With the GIFK Project's support we had more than 300 students (3 to 8 years old) in the school year learning geoscience topics. We introduced a general view of the planet Earth in relation to the Solar System and the Universe. The observation of the Earth from space led the children to see the Earth like a unique and small object, which showed the fragility of this special place.

We experimented with a program where the scholastic experiences become part of the daily life in order to eliminate the concept of "lesson". With our project we want to involve students, parents, teachers and the scientific community, in a unique dialogue.

Our journey through the Solar System started from real "space news" focusing on the most important missions performed by international space agencies. We used ESA (European Space Agency) and NASA (National Aeronautics and Space Administration) educational material creating a long-term program that can help children to feel closer to the Earth as planet.

In particular, for the ongoing scholastic year, we will focus on the amazing recent Sentinels mission performed by ESA, related to the observation of the Earth from space. The main aim of this project is to discuss about environmental and exploitation problems that the Earth is facing, using satellite images in order to observe direct changes to the Earth surface over time. Pupils are led to notice and understand how close the relation between daily life and planet Earth, realizing that our behavior can change things in even small individual acts. Observing the Earth from space and in the Solar System the students gain the awareness of how the life-balance of our planet is in serious danger now.

Andrew McMurray
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EDUCATION

Guthlaxton Sixth Form	GCE A-Levels	
	Physics	B
	Chemistry	B
	Mathematics	B
	General Studies	B
Loughborough University	B.Sc. Physics	Class II Div. I
Leicester University	P.G.C.E. - Physics / Science	
	MBA – Educational Management and Leadership	

CAREER

1. Large secondary school in Leicester:
   i. Teacher of physics/science Sept 1990
   ii. Subject Leader in Physics March 1994
   iii. Head of House Sept 2000
   iv. Assistant Principal Sept 2007
   Member of the Senior Leadership Team with responsibility for Teaching and Learning, Staff Development and Training, Teacher Training, New Teacher Induction and Leadership Development Porgramme

2. National Space Academy
   i. Head of Teaching Jan 2014
   With responsibility for the development and quality assurance of the National Space Academy's programme of intensive curriculum focused student Masterclasses and teacher CPD in Biology, Chemistry, Applied Science, Physics, Mathematics and GCSE Astronomy.

To manage the network of Lead Educators (outstanding current secondary school teachers seconded to the project) and support their work with Project Scientists to develop new activities and programmes.

Deliver Masterclasses and teacher CPD; recent delivery events have included:

- IOP Physics Teacher conference
- IOP Extreme Physics
- ASE Welsh Physics Teacher conference
- InSIGHT meeting in Nice

Sophie Allan
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EDUCATION

Invicta Grammar School	GCE A-Levels		
	Physics	B	
	Chemistry (AS)	B	
	Mathematics	C	
	History	A	
	Philosphy and Ethics	A	
	General Studies	B	
Loughborough University	B.Sc. Physics with Astrophysics		Class II Div. II
Leicester University	P.G.C.E. - Physics / Science		

CAREER

1. Large secondary school in Leicester:
   i. Teacher of physics/science Sept 2006

2. National Space Academy
   i. Lead Physics Teacher Sep 2008

   Responsibility for:
   Development of activities for the National Space Academy's programme of intensive curriculum focused student Masterclasses and teacher CPD in Applied Science, Physics and GCSE Astronomy.
   Delivery of National Space Academy activities including masterclasses, regular teaching of students on our Space Engineering qualification, lectures and teacher CPD.
   Development of programmes for external organisations focusing on Physics and space science. Recent projects have included:
   - Destination Space (for UK Space Agency) – the programme for 20 Science Centres across the UK to celebrate the UK's first ESA Astronaut Tim Peake. http://www.destinationspace.uk/
   - Explore Your Universe (For STFC) – a programme for 40 Science Centres across the UK to celebrate UK research in Physics. http://www.exploreyouruniverse.org/

Other Activities:

Group leader and lecturer at European Space Camp (Norway)
Resident expert for All About Space magazine

Diane Carrer
Earth Science and Life Science Teacher
Mountain's High School, Académie de Nice
Valdeblore, France
Diane.carrer@ac-nice.fr /

EDUCATION

2013 University of Lyon " Claude Bernard - Lyon 1" , Lyon, France
2014 Intensive courses to prepare the highest competitive exam to become a teacher in Life, Earth Sciences. Admitted to the competitive exam "agrégation"

2011 University of Nice Sophia- Antipolis, Sciences Department , Valrose Campus
2013 Intensive courses to prepare the competitive exam to become a teacher (CAPES), in Life and Earth Sciences.
Admission to the CAPES : 2nd rank.

2009 Toulouse Tech Engineering school « Institut National Polytechnique" ENSEEIHT-ENSIACET-ENSAT
2010 Third year of engineering school and Master's degree in Environmental Sciences
Research Master's degree (M2 Recherche) in Hydrology - Hydrochemistry - Soil sciences - Environmental sciences

2009 Lincoln University, New Zealand
6 months' exchange: Water and Soil Sciences, Environmental Sciences, Hydrology, depollution techniques.

2007 Engineering School in Toulouse « Ecole Nationale Supérieure Agronomique de Toulouse »
2009 1st and 2nd year of agro-engineering school

2005 Masséna High School : Intensive courses to prepare the competitive exams to enter engineering schools.
2007 Biology, Geology , Chemistry, Physics and Mathematics (CPGE : "BCPST-Veto")

2005 International Center of Valbonne High School (CIV , Valbonne Sophia – Antipolis)
A-Level , international courses in Sciences , with Honours.

CAREER

2014 Teacher at the Henri Matisse High School , and Mountain's High School , France.
2016 Responsible for various classes: 11th grades, 12 grades, Personal Support, and Scientific Methodology (called MPS).
Training at the Academic Institute for Teacher Training (ESPE) : courses in pedagogy and didactics

2010 Engineer responsible for the set-up of the Environmental Management System , to pass the standard ISO
2011 14 001 (in a Motorways company).
Environmental Impact Statement (EIS) and risk assessment. Implementation of a plan of action to reduce environmental impacts ; plan focused on water pollution, air pollution, and soil pollution.

2010 Disposal and recycling of clinkers from household waste incineration. Study on an industrial process and its optimization.
Project management, work on sizing of the Eddy current separators, Research and Development , Group work.

2009 Internship in a research laboratory on plant physiology. Study of various strategies and mechanisms involved in plant defense against the herbivorous, and Darwinian evolution study .

RESEARCH INTERESTS

Educational programs on seismology , geology at school, outreach in geology and biology .

PUBLICATIONS AND SERVICES

Participation to the EGU GIFT 2015 (focused on mineral resources) and presenting a poster intitled " Adopt a Mermaid (Mobile Earthquake Recording in Marine Areas by Independent Divers): participative science and seismology at school".

Participation to an educational workshop on InSIGHT and SEIS (September 2015) with NASA, CNES, IPGP, Geoazur lab, and French National Education representatives to elaborate an educational program sharing data with schools all around the world.

SIMPLE EXPERIMENTS MODELING METEORITE CRATER IMPACT AND THE EXPLOITATION OF REGISTERED SEISMOLOGICAL DATA AT SCHOOL

Sophie Allan(1), Diane Carrer(2), and Andrew McMurray(1),

(1) National Space Academy,Leicester, UK
(2) Mountain High School, Valdebore, France

In this session we employ a simple impact experiments using low velocity impactors, flour and cocoa to simulate meteorite strikes. We use the experiments look at the relationships between crater size and impact energy. In addition we look at seismic waves propagation produced by the impactor. Teachers will leave with examples of hands-on activities that can be used with a wide range of ages and abilities.

Key-words: *Mars, Modelling, InSight mission, seismology, SEIS seismometer, meteorites impact craters, Mars Quakes, low-velocity experiment, Audacity software, seismic waves, Martian interior model.*

A few weeks ago (mid-Mars 2016), the NASA has launched its new mission to the Red Planet called InSIGHT (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport). One of the most important aims of this geophysical mission is to implement a seismometer to study Mars' deep interior. The seismometer, called SEIS (and made by the French labs CNES and IPGP), will be measuring the Red Planet's "vital signs" such as its pulse, recorded through seismology. Scientists hope to improve the Martian interior model (such as the Earth model PREM) thanks to seismological data analysis. Even more excitingly, the InSight and SEIS projects seek to answer one of science's most fundamental questions: *how did the terrestrial planets form?*
The only problem is that scientists are not certain to record any seismic data from tectonic activity (which probably stopped thousands of years ago). Thus, they have to look for another source of seismic vibration.
Meteorite strikes, which impact Mars five times a year on average, appear to be the right candidates to generate seismic vibration and seismic waves (in addition to potential Marsquakes, dust devils, and thermic contractions of the crust). Scientists and seismologists expect those meteorite strikes to generate enough signals to investigate the interior structure of this rocky planet.
In such a context, meteorite impact craters are very interesting to study, from their formation, to the analysis of the waves they produce.
Here, in this presentation, we will develop an example of a hands-on activity focused on meteorites impacts, its modeling, and its data analysis.
We will start with a craters description based on satellite images of the Martian surface (ejecta blankets, overturned crater rim …). We then simulate impact craters using low-velocity experiments (to model real high velocity impacts). Videos of the flour and cocoa surface, impacted by marbles, tennis balls, baseballs, or pingpong balls will demonstrate what teachers can easily do in classroom.

The geophysical investigation will then be explained through a broad range of activities:

- Size of Impactor and Crater Formation
- Mass of impactor and Crater Formation

- Velocity of Impactor and Crater Formation : Potential energy and Kinetic energy can be introduced in terms of energy transfer as the impactor falls: calculate the velocity of impact and plot that against crater diameter using $v = (2gh)^{1/2}$
- Simple Mathematical Modelling : A crater is modelled as a cubic hole, with sides of dimension L, dug into the flour (*Byfleet, 2007; Florida State University*)
- Advanced Mathematical Modelling: Experimental investigations have shown that there is a power law relationship between the kinetic energy of the impactor E and the crater diameter D (*Bunce, 2006; Leicester University*).
- Imaging and video techniques to analyse craters.

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http://www.ipgp.fr/fr/lognonne-philippe

EDUCATION

Ecole Normale Supérieure de Saint Cloud, 1982
Master in fundamental Physics, University of Paris- Pierre and Marie Curie, 1983
Agrégation des Universités, Physics (ranked 6), 1984
PhD in Geophysics, University of Paris-Diderot, 1989
Diplomed from the Institut des Hautes Etudes de l'Entreprise (IHEE) 2006

CAREER

Professor, Military Inter-Army college, Strasbourg (military service, 1984-1985)
Post-doctoral fellow, National Center for Space Studies (CNES), Paris, (1989-1991)
Associate professor in geophysics, University of Paris Diderot (1991-1998)
Professor in geophysics, University of Paris Diderot (since 1998)
Director of the IPGP Planetary Geophysics and Space studies laboratory IPGP (1996-2012)
Head and Coordinator of the Paris Diderot Space campus (http://www.spacecampus-paris.eu)
Principal Investigator of the SEISmometer onboard the NASA InSight mission to Mars

RESEARCH INTERESTS

Normal modes of Telluric planets, Coupling of seismic waves and tsunamis with the atmosphere, Planetary geophysics and Planetary seismology, Instrumental development in the field of planetary seismology and participation in the design of the future Moon and Mars network projects.

PUBLICATIONS AND SERVICES

Full list at **http://www.researcherid.com/rid/F-8846-2010**
F. Forget, F. Costard, P. Lognonné, Planet Mars, Story of another World, Springer-Praxis, ISBN : 978-0-387-48925-4, 226 pages, 2007
W. B. Banerdt, V.Dehant, R. Grimm, M.Grott, P.Lognonné, S Smrekar, Probing the Interiors of Planets with Geophysical Tools, Encyclopedia of the Solar System, Elsevier, edited by T.Spohn, T.V.Johnson, D.Breuer, ISBN : 978-0-12-416034-7 , chapter 55, 2013

AWARDS AND HONORS

Institut Universitaire de France (2000-2005, Junior award) (2014-2019, Senior award)

From Moon seismology to Mars with the SEIS Instrument on the NASA InSight mission

Philippe LOGNONNE
Institut de Physique du Globe de Paris
Université Paris Diderot-Sorbonne Paris Cité and InStitut Universitaire de France

The first pages of planetary seismology were written 46 years ago, in July 1969, when Earth seismologists discovered the first data from a seismometer installed by the crew of Apollo 11 on the Moon. About 8 years later, in 1977, NASA decided to turned of the seismic network installed by the following missions Apollo 12, 14, 15, 16 and 17 with about 12500 quakes on the detection score of the extremely sensitive Apollo Seismometers. Surprisingly, discoveries on this unique set of data continue to be done by the science community, and we first present the most recent results obtained in the re-processing of the Apollo data since 2000: re-estimation of the lunar crustal thickness, discovery of the Lunar core reflected seismic waves, characterization of the source dynamics of the deep moon quake and impacts. These studies have strongly impacted our understanding of the Lunar interior, especially of the Deep lower mantle and core on which we will focus. We then discuss and present the few challenge remaining, not only in term of Apollo data processing, but also for future missions to the Moon.

The next page of planetary seismology will start soon with for the launch in March 2016 of the NASA mission, 40 years after the unsuccessful Viking seismometer and 20 years after the launch failure of the Mars 96 mission, equipped also with seismometers.

InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) is the next NASA Discovery mission selected in 2012. It will land on Mars near the Elysium volcanoe, in Elysium Planitia, by the end of September 2016. Science operation will start in January 2017 after payload deployment. The payload is a complete geophysical observatory, with a seismometer (SEIS), an heat flux experiment (HP^3), a geodesy experiment (RISE), a magnetometer and a suite of atmospheric sensors measuring wind, atmospheric temperature, and pressure. SEIS is the primary instrument of the mission and consists of a 3-axis very-broad-band (VBB) instrument and a 3-axis short period (SP) instrument. It is expected to provide the very first seismic records of Mars. The implementation of the science goals is challenging due to the almost complete lack of information on the deep seismic interior structure of Mars, as well as its level of seismic activity and surface seismic noise. We describe both the SEIS instrument and the strategy of single-station seismic analysis as well as the expected seismic signals and seismic noise which will be recorded by the mission and later released not only to the scientific community but also to Schools and High Schools in the frame of the InSight SEIS Educational program.

Prof. Michel Mayor
University of Geneva, Switzerland
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EDUCATION

- Master in Physics, Lausanne University, 1966
- PhD, University of Geneva, 1971

CAREER

- Research associate (SNF) 1971 – 1984 ; Associate professor, Geneva University, 1984 - 1988
- Professor, University of Geneva ,1988 - 2007
- Director of the Geneva Observatory, 1998 - 2004
- Professor Emeritus, University of Geneva, since 2007

RESEARCH INTERESTS

Extrasolar Planets, Instrumentation, Stellar Multiplicity, Stellar Kinematics, Galactic Dynamics

PUBLICATIONS AND SERVICES

- Swiss delegate for the ESA (Agence Spatiale Europenne) "Astronomical Working Group", 1985 – 1987
- President of the Commission 33 on "Structure and dynamics of the galactic system" of the International Astronomical Union (IAU), 1988 – 1991
- Chairman of the "Scientific Technical Committee of ESO (European Southern Observatory)", 1990-1992
- Swiss Delegate to the ESO Council, 2003 – 2007
- President of the IAU commission on "Extra-solar planets", 2006 – 2009
- Foreign Associate of the French Academy of Sciences, 2003
- Honorary Fellow of the Royal Astronomical Society (UK), 2008
- Foreign Member of the National Academy of Sciences (USA), 2010
- Foreign Member of the American Academy of Arts and Sciences, 2010
- Honorary Member of the AAS (American Astronomical Society), 2015

AWARDS AND HONORS

BALZAN international Award 2000; EINSTEIN Medal 2004; SHAW Prize for Astronomy 2005; KARL SCHWARSHILD Medal 2010 ; AMBARTSUMIAN Prize 2010, BBVA Prize "Frontiers of Knowledge, 2012 ; Gold Medal of the Royal Astronomical Society, 2015, KYOTO Prize in Basic Science , 2015.

HONORARY DEGREES

Honorary Doctor of Katholieke Universiteit Leuven (Belgium), 2001 ; the Swiss Institute of Technology 2002 ; the Federal University of Rio Grande do Norte (Brazil), 2006 ; the Uppsala University (Sweden), 2007 ; the Paris Observatory (France), 2008 ; the Université Libre de Bruxelles (Belgium), 2009 ; the University of Provence (Marseille,France), 2011; the Joseph Fourier University (Grenoble,France), 2014.

A PATH TO THE DETECTION OF EARTH-TYPE PLANETS.

Michel Mayor
University of Geneva

« How many planets in the Milky Way ? » « How many planets similar to our Earth ? »

On the last twenty years, significant results have been obtained in the domain of extrasolar planets. More than two thousand planets have characterized orbits, for several hundred of them their radii are known. We have discovered an amazing diversity of planetary systems. These observations have revealed the importance of new physical process to be taken into account for the formation and evolution of planetary systems. The synergy between ground-based radial velocity measurements and the detection of transiting planets have permitted exciting possibilities to characterize planets. Already we have the possibility to get clues on the internal composition of exoplanets and their atmosphere.

Do we have the instrumental capabilities to detect and study planets as Earth analogues ? What are the intruments in development and their scientific goals.

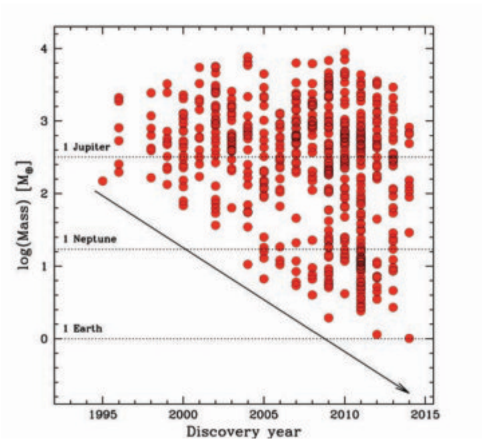

Fig.1 : Masses of exoplanets detected by Doppler spectroscopy during the last 20 years. Not only the number of exoplanets is impressive but take note of the improvment by a factor 100 of the lowest planetary masses discovered .

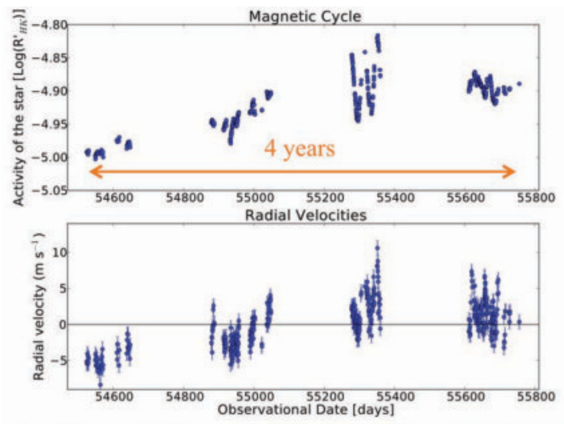

Fig.2 : Despite the improvment of spectrographs (with present precision better than 0.5 m/s) , the detection of terrestrial planets in the « habitable zone » is facing the limitation set by the intrinsic variability of stellar velocities resulting from magnetic activity (spots, plages, solar cycle analogues). Do we have the possibility to overcome that difficulty ?

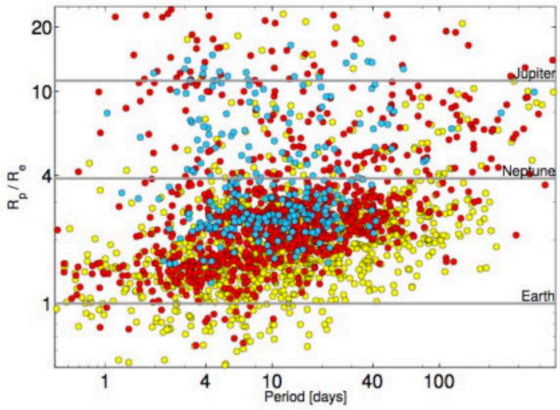

Fig.3 : The exceptional galore of transiting planets done by the Kepler space mission. A large number of planets with radii smaller than the Earth have been detected. However the region of that plot with radius comparable to the Earth and orbital periods of about one year is empty.

Fig. 3.— Radius versus orbital period for each of the planet candidates in the B10 (Borucki et al. 2011a) catalog (blue points), the B11 (Borucki et al. 2011b) catalog (red points), and this contribution (yellow points). Horizontal lines marking the radius of Jupiter, Neptune, and Earth are included for reference.

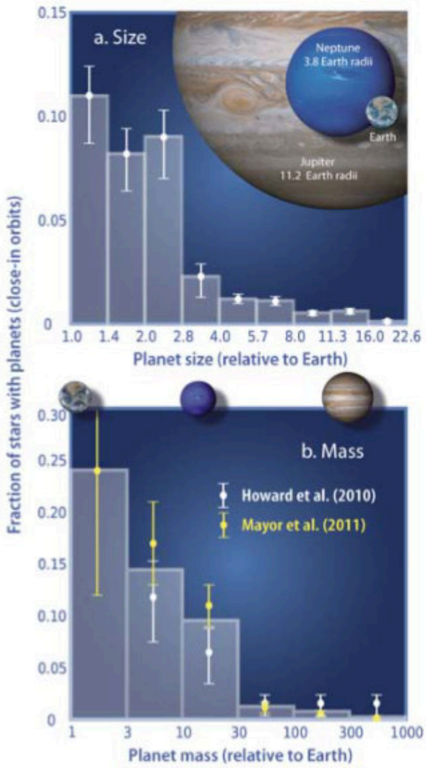

Fig. 4 : The distribution of transiting planets clearly increase towards Earth-type radii.

The planetary mass distribution derived from two radial velocity surveys also increase towards low mass planets (Super-Earth and Earth-type planets)

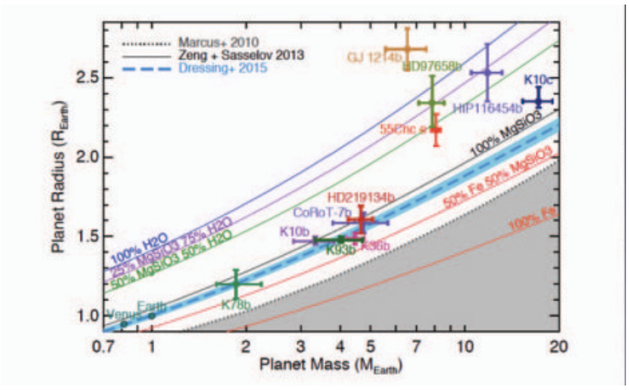

Fig. 5 : Radial velocity follow-up measurements of small transiting planets detected by ground-based or space experiments (CoRoT or Kepler) allow an estimation of the bulk density of planets.
Measurements mostly done with the HARPS spectrograph at La Palma observatory seems indicate the existence of rocky planets up to 5 Earth-masses.

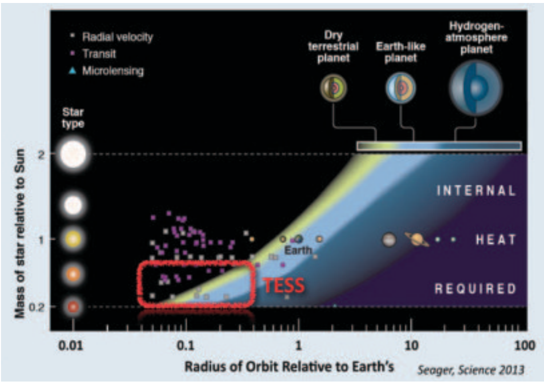

Fig.6: The TESS mission (NASA, 2017) is expected to detect Earth-type planets and Super-Earths hosted by bright stars.
Planets orbiting low mass stars in the habitable zone will be identified .

The CHEOPS mission (ESA, 2018) will get precise measurements of low mass planets and provide a better understanding od Super-Earth internal composition.

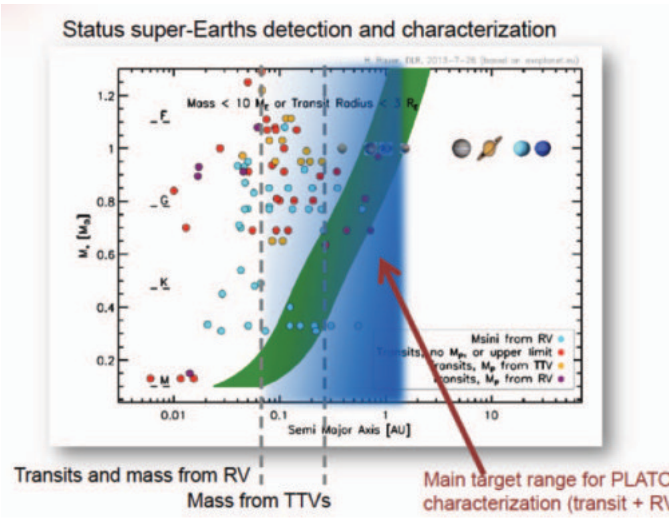

Fig.7: The PLATO 2 mission (ESA, 2024) will permit the detection of transiting planets in the habitable zone of solar-type stars.
This mission will also provide a characterization of host stars via asterosismology measurements.

Dr Athena Coustenis
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http://cosmicdiary.org/acoustenis/

Athena Coustenis is Director of Research 1st class with the National Centre for Scientific Research (CNRS) of France, working at Paris Observatory in Meudon. Her specialty is Planetology (exploration and study of the Solar System from ground-based and space observations).

EDUCATION

- Master and PhD in Astrophysics and Space techniques, Univ. Paris 7 (P. & M. Curie)
- Master in English Literature, Univ. Paris 3 (Nouvelle Sorbonne)
- Habilitation to Direct Research (HDR), Univ. Paris 6 (P. & M. Curie).

RESEARCH INTERESTS

Her research is devoted to the investigation of planetary atmospheres and surfaces, with emphasis on the outer solar system objects and in particular Jupiter and Saturn and their icy moons, like Titan and Enceladus, Ganymede and Europa, objects with high astrobiological potential. She also works on the characterisation of exoplanetary atmospheres. In the recent years she has been leading efforts towards the definition of future space missions like ESA'S JUICE and ARIEL.

PUBLICATIONS AND SERVICES

A. Coustenis has produced more than 230 scientific papers and chapters in various books and Encyclopedias, and co-written 3 books, e.g. A. Coustenis, and F.W. Taylor, *Titan : Exploring an Earth-like World*. World Scientific Press, Singapore (2008); A. Coustenis and Th. Encrenaz, *Life beyond Earth: the search for habitable worlds in the Universe*. Cambridge Univ. Press (2013)
She also has the following current functions:

- President of the European Science Foundation Space Sciences Committee (*ESF/ESSC*)
- Ex-officio member of different Advisory committees of *ESA* : the Space Sciences Advisory Committee, the High High-level Science Policy Advisory Committee, the Human Exploration and Science Advisory Committee and of *NASA* : the Space Science Board
- Member /Academician of the *International Academy of Astronautics (IAA)*
- Member of the Science committee of ISSI (International Space Sciences Institute)
- Deputy Coordinator of *EUROPLANET RI 2020*
- Member of the Outer Solar System Task Group of the Working Group for Planetary System Nomenclature (*WGPSN*) and of the Steering Committee of Division F of *IAU*.
- Member of the Editorial Board of *Astronomy & Astrophys. Reviews*, of the *Astronomy and Astrophysics Library* and of the *Philosophical Transactions A*.
- Councilor of *ISSOL* (http://issol.org/about/issol-leadership/).
- Member of the *HITRAN* International Committee
- Chair of the EGU Jean Dominique *Cassini Medal EGU committee* and member of the *Copernicus medal* committee. Past President of EGU/PS

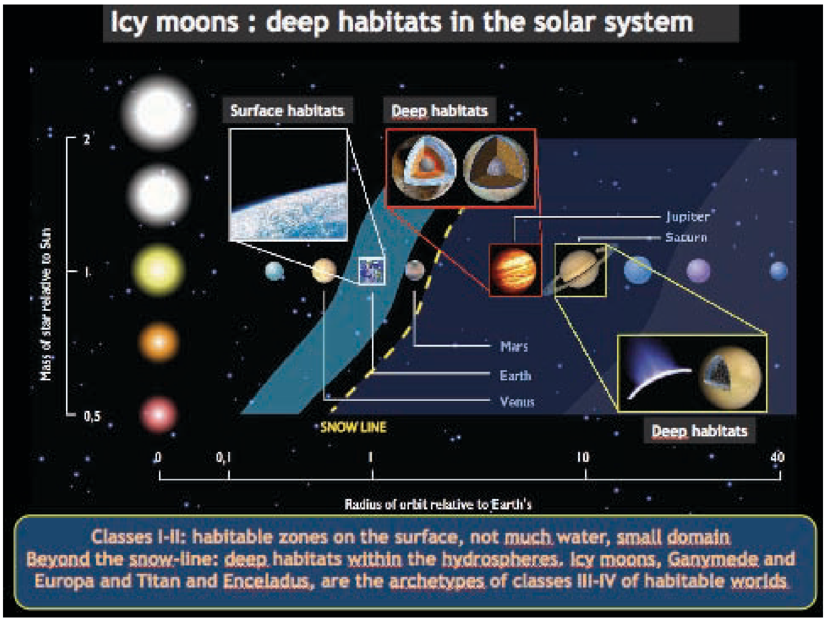
AWARDS AND HONORS

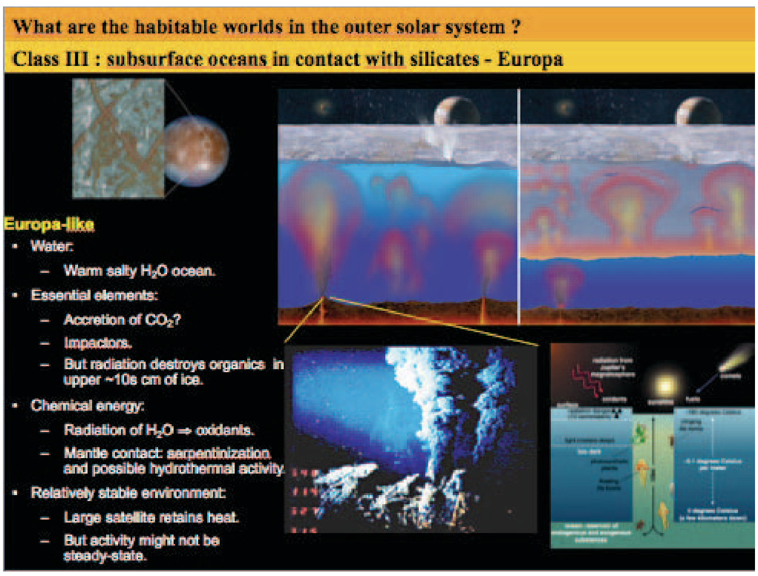
- The NASA Group Achievement and Public Service Awards for the Cassini Programme Huygens Atmospheric Structure Instrument (HASI) and the Cassini Program Descent Imager Radiometer Spectrometer (DISR)
- The ESA Award for making an outstanding contribution to the Huygens Probe.
- The 2014 Masursky AAS/DPS Award for meritorious service to Planetary Science.

THE SEARCH FOR HABITABLE WORLDS IN THE OUTER SOLAR SYSTEM

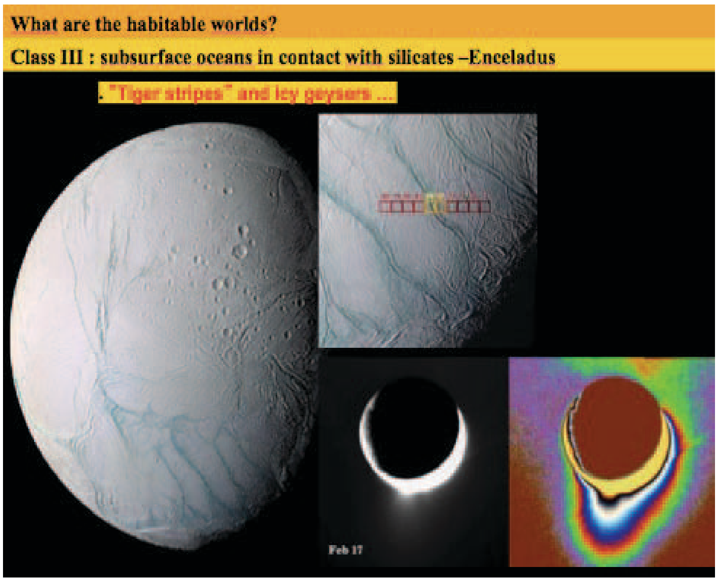
Athena Coustenis
LESIA, Observatoire de Paris, CNRS, Univ. P. et M. Curie, Univ. Paris-Diderot

Looking for habitable conditions in the outer solar system our research focuses on the natural satellites rather than the planets themselves. Indeed, the habitable zone as traditionally defined may be larger than originally conceived. The strong gravitational pull caused by the giant planets may produce enough energy to sufficiently heat the interiors of orbiting icy moons. The outer solar system satellites then provide a conceptual basis within which new theories for understanding the habitable zone push it beyond the traditional limits of the snow line. Measurements from the ground but also by the Voyager, Galileo and the Cassini spacecrafts revealed the potential of these satellites in this context, and our understanding of habitability in the solar system and beyond can be greatly enhanced by investigating several of these bodies together [1]. Their environments seem to satisfy many of the "classical" criteria for habitability (liquid water, energy sources to sustain metabolism and chemical compounds that can be used as nutrients over a period of time long enough to allow the development of life).



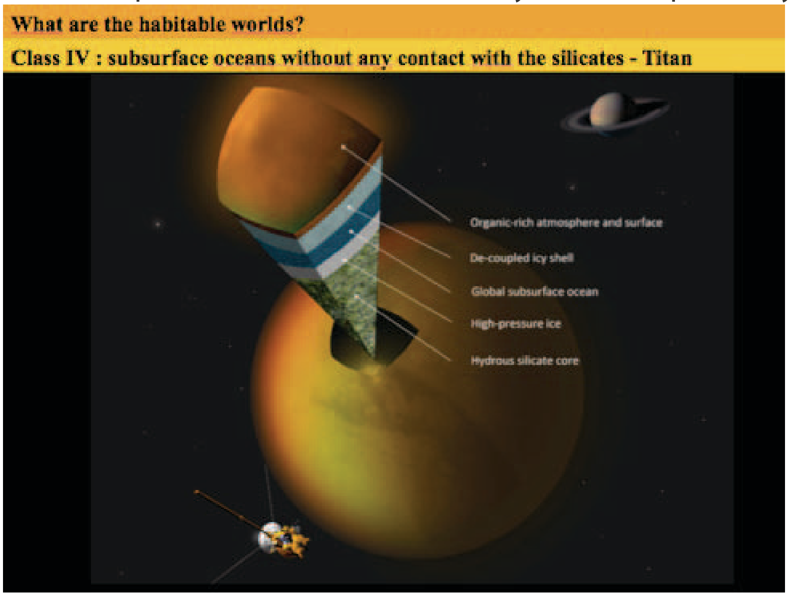


Indeed, several of the moons show promising conditions for habitability and the development and/or maintenance of life. Europa, Callisto and Ganymede may be hiding, under their icy crust, putative undersurface liquid water oceans [2] which, in the case of Europa [3], may be in direct contact with a silicate mantle floor and kept warm by tidally generated heat [4].
Titan and Enceladus, Saturn’s satellites, were found by the Cassini-Huygens mission to possess active organic chemistries with seasonal variations [5], unique geological features and possibly internal liquid water oceans. Titan’s rigid crust and the probable existence of a subsurface ocean create an analogy with terrestrial-type plate tectonics, at least surficial [6], while Enceladus’ plumes find an analogue in geysers. As revealed by Cassini the liquid hydrocarbon lakes [7] distributed mainly at polar latitudes on Titan are ideal isolated environments to look for biomarkers. Currently, for Titan and Enceladus, geophysical models try to explain the possible existence of an oceanic layer that decouples the mantle from the icy crust. If the silicate mantles of Europa and Ganymede and the liquid sources of Titan and Enceladus are geologically active as on Earth, giving rise to the equivalent of hydrothermal systems, the simultaneous presence of water, geodynamic interactions, chemical energy sources and a diversity of key chemical elements may fulfill the basic conditions for habitability.

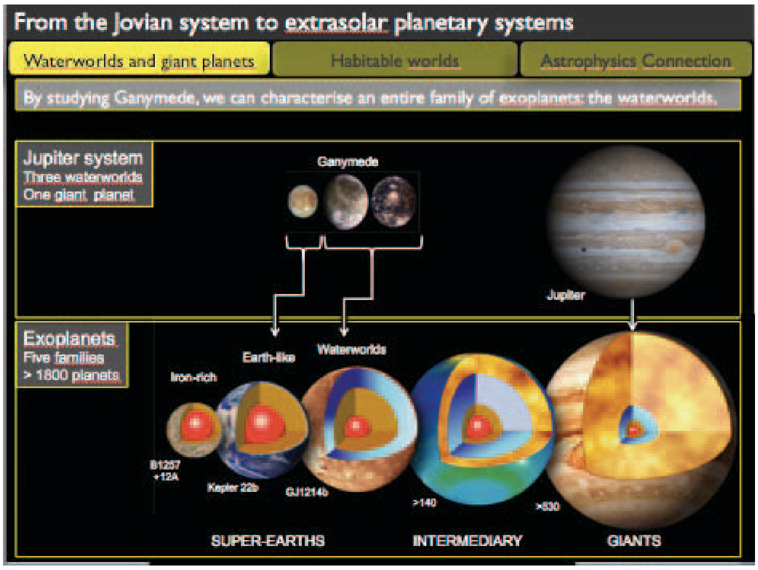


Enceladus, only ~500 km in diameter, is a puzzling moon with dramatic jets of organic-laden water vapour and dust-sized icy particles emanating from its south polar region, possibly from liquid water reservoirs, Enceladus’ jetting activity, the mechanism responsible for this activity, and the moon’s astrobiological potential are of primary interest, as are the long-term variability of Saturn’s magnetospheric plasma, neutral gas, E-ring ice grain density, radio emissions, and the co-rotation of Saturn's planetary magnetic field in response to the active jets.
Titan has been suggested as a possible cryovolcanic world due to the presence of local complex volcanic-like geomorphology and the indications of surface albedo changes with time [8,9]. Such dynamic activity that would most probably include tidal heating, possible internal convection, and ice tectonics, is believed to be a pre-requisite of a habitable planetary body as it allows the recycling of minerals and potential nutrients and provides localized energy sources. In a recent study [4], we have shown that tidal forces are a constant and significant source of internal deformation on Titan and the interior liquid

water ocean can be relatively warm for reasonable amounts of ammonia concentrations, thus completing the set of parameters needed for a truly habitable planetary body.



Such habitability indications from bodies at distances of 10 AU, are essential discoveries brought to us by space exploration and which have recently revolutionized our perception of habitability in the solar system. They represent a whole class of bodies among the waterworlds which could be numerous among the exoplanetary systems.



In the solar system's neighborhood, such potential habitats can only be investigated with appropriate designed space missions, like ESA's L1 JUICE (JUpiter ICy moon Explorer) for Ganymede and Europa [10].

References:

[1] Coustenis, A., Encrenaz, Th., in "Life Beyond Earth : the search for habitable worlds in the Universe", Cambridge Univ. Press, 2013. [2] Grasset, O., et al.: Astrobiology 13, 991-1004, 2013. [3] Patterson, G.W., et al.: AGU P41F-09, 2011. [4] Sohl, F., et al., JGR-Planets 119, 2014. [5] Coustenis et al., Icarus, sous presse. [6] Solomonidou, A., et al.: PSS 77, 104-117, 2013. [7] Stofan, E.R., et al.: Nature 445, 61-64, 2007. [8] Solomonidou, A., et al., JGR-Planets 119, 2014 (a). [9] Solomonidou, A., et al., Icarus, in press, 2015 (b). [10] Grasset, O., et al.: PSS, 78, 1-21, 2013.

THE NASA'S HYPERWALL

From Space Observations to Earth System Science

by Dr. **Michael Freilich**, Director of NASA Earth Science Division, Science Mission Directorate, NASA Headquarters, Washington, DC. USA

Abstract:
The vantage point of space provides an excellent way of studying the Earth's climate by enabling observations with equivalent quality of all part of the Earth's surface and the atmosphere. NASA's Observations from satellites are now providing quantitative information about how the Earth system varies on a variety of spatial and temporal time scales, documenting longer-term evolution, and providing information that can inform prediction and enable better policy and management decisions. Satellite-based information helps improve understanding not only of how individual Earth system components (atmosphere, ocean, cryosphere, biosphere, Earth surface) evolve but how they interact with each other and both contribute and respond to naturally-occurring and human induced change. New capability will continue to become available with additional launches, and continued investment in calibration/validation and associated process study and modeling assures the continuing enhancement of our knowledge of the Earth System.

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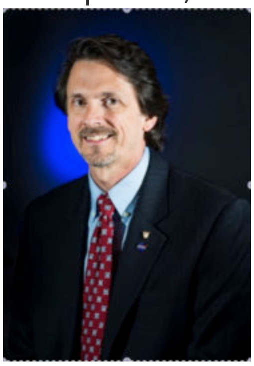
Our Dynamic Sun — Solar Storms and Space Weather

by **Steve Clarke**, Director of Heliophysics Division, Science Mission Directorate, NASA Headquarters, Washington, D.C., USA



Abstract:
We live in the extended atmosphere of an active star. While sunlight enables and sustains life, the Sun's variability produces streams of high-energy particles and radiation that can harm life or alter evolution. Under the protective shield of a magnetic field and atmosphere, the Earth is an island in the Universe where life has developed and flourished. The origins and fate of life on Earth are intimately connected to the way the Earth responds to the Sun's variations.
This presentation will highlight the connections between the Sun, solar wind, planetary space environments, and our place in the Galaxy. Understanding the connections between the Sun and its planets will allow us to predict the impacts of solar variability on humans, technological systems, and even the presence of life itself.

“The Martian” — Science Fiction and Science Fact

by **Dr. James Green**, Director of NASA Planetary Division, Science Mission Directory, NASA Headquarters, Washington, DC. USA

Abstract:
The best-selling book about an astronaut stranded on Mars was brought to life in Ridley Scott’s film, *The Martian*. Before production started, Ridley called NASA to obtain information about NASA’s plans for human exploration of Mars in addition to the science of Mars that would contribute to a realistic look and feel of the film in keeping with the approach laid out in Andy Wier’s book. An intense period of interaction over several months followed between Ridley’s design team and NASA’s journey to Mars personnel on everything from habitats, vehicles, spacesuits, ion engines, radioisotope power systems, and Mars terrains. The result was a tremendously popular and award winning film. Having been one of the main consultants on the film, Dr. Green will discuss what NASA’s real plans and challenges are to sending humans to Mars as compared to this fictional account.

Dr. Matt Taylor
European Space Agency
Email: mtaylor@esa.int

EDUCATION

1997-2000 Imperial College of Science, Technology and Medicine.
Ph.D. at Space and Atmospheric Physics Group. Thesis title: MHD Modelling of Space Plasmas. Supervisor Peter Cargill.

1993-1997 University of Liverpool, MPhys (Hons) Physics

CAREER

2013 –date Project Scientist Rosetta
2009-2013 Acting Project Scientist for Cluster .

2009-2010 Study Scientist for Cross-scale

2005-2009 Deputy Project Scientist, Cluster and Double Star

Joined ESA 2005

2004-2005 Double Star/Cluster Operations support, Mullard Space Science Laboratory (MSSL), University College London.
2002-2004 Postdoctoral Research Associate, Space and Atmospheric Sciences, ISR-1, Los Alamos National Laboratory.
2000-2002 Cluster Science Research Fellow, Mullard Space Science Laboratory (MSSL), University College London

RESEARCH INTERESTS

Investigation of energetic particle interactions in near Earth space, in particular relating to space plasma instabilities such as Kelvin Helmholtz waves.

PUBLICATIONS AND SERVICES
> 70 peer reviewed publications.

AWARDS AND HONORS
Metal Hammer Spirit Of Hammer Award 2015

THE ROSETTA MISSION

Matt Taylor
European Space Agency

Rosetta is the European Space Agency's comet-chasing mission to 67P/Churyumov-Gerasimenko. Launched on 2 March 2004 the spacecraft travelled for 10 years before homing in on its destination, requiring three vital gravity assist flybys at Earth and one at Mars to set course with the comet. Rosetta is the first spacecraft to rendezvous with a comet and the first to deploy a lander on the surface of a comet nucleus. While previous comet missions have only spent fleeting moments flying past their targets at high velocity, Rosetta is the first spacecraft to fly alongside a comet as it heads towards the inner Solar System, watching how its ices are transformed by the warmth of the Sun. Rosetta has continued past closest approach to the Sun, watching how the comet's activity subsides again until September 2016 and the end of the mission.

The Rosetta mission was named after the famous Rosetta stone that led to the deciphering of Egyptian hieroglyphics almost 200 years ago. Rosetta's lander Philae is named for the island in the River Nile on which an obelisk was found that had a bilingual inscription that enabled the hieroglyphs of the Rosetta Stone to be deciphered. Scientists hope that by studying a comet close up and for an extended period of time, the comet-chasing spacecraft by the same name will unlock the mysteries of how the Solar System evolved.

Comets are considered the most primitive building blocks of our cosmic neighbourhood, surviving the Solar System's chaotic 4.6 billion year history. Laced with ice and organic materials, comets likely helped 'seed' the Earth with water, and maybe even the ingredients for life. As such, comets are considered the Rosetta Stones of the Solar System, and ESA's Rosetta mission is set to unlock the secrets of these icy treasure chests.

Rosetta's mission has its roots buried in the legacy of Giotto, ESA's first deep space mission, which sent back the closest images ever of a comet nucleus, from a distance of about 600 km. Despite taking heavy hits from comet dust, Giotto went on to fly by Grigg-Skjellerup in 1992. As such, Giotto was also the first deep-space mission to change orbit by retuning to Earth for a gravity-assist manoeuvre.

After a 14-month launch delay that led to the mission's destination being changed from comet 46P/Wirtanen to 67P/Churyumov-Gerasimenko, Rosetta finally launched on 2 March 2004 on an Ariane-5 G+ from Europe's spaceport in Kourou, French Guiana.

Comet 67P/Churyumov-Gerasimenko is a regular visitor to the inner Solar System. It orbits the Sun once every 6.5 years, commuting between the orbits of Jupiter and Earth – its closest distance to the Sun is 185 million kilometres (by comparison, Earth is about 150 million kilometres from the Sun). The comet was first observed from Earth in 1969 – Klim Churyumov discovered the comet in a photograph taken by Svetlana Gerasimenko, giving rise to its name. The 67P indicates that it was the 67th short period (P) comet discovered.

To get to this target, Rosetta exploited the gravity of Earth and Mars to set course with the comet. Thus for the first half of its journey Rosetta played a game of cosmic pinball, first getting a boost from Earth's gravity on 4 March 2005, then Mars on 25 February 2007, before bouncing back to Earth on 13 November 2007 and again in 13 November 2009. Along the way, Rosetta delved twice into the Solar System's asteroid belt, taking the opportunity to return spectacular close-up images and perform scientific analysis of two previously uncharted bodies: asteroid 2867 Steins on 5 September 2008, and 21 Lutetia on 10 July 2010.

Rosetta travelled far away from the Sun, such that solar energy was not enough to support the platform completely and entered into hibernation on 8 June 2011 for the coldest leg of its journey as it headed towards the orbit of Jupiter. All systems were switched off except for the thermal control and onboard computer, powered only by the solar panels. On 20 January 2014, 957 days later, the spacecraft autonomously woke up from hibernation, 9 million-kilometres from the comet. The next months were spent closing in on the comet, eventually entering a 10 km orbit and mapping it for landing. On 12 November 2014, Rosetta deployed Philae to the surface. The lander successfully landed, then bounced and finally came to rest on the surface around 1 km from the original landing site.

The Rosetta mission is set to re-write the books on cometary science. The mission will end in September 2016 when a controlled impact will bring the Rosetta spacecraft to join Philae on the surface of the comet

The presentation will provide an overview of the mission to date and a look to the future.

http://blogs.esa.int/rosetta/

http://sci.esa.int/rosetta/53593-outreach-resources/

Olivier Witasse
Project Scientist
European Space Agency
ESTEC, Scientific Support Office
Noordwijk, The Netherlands

EDUCATION

2000: PhD in Aeronomy, Université Joseph Fourier, Grenoble, France

1995 : Agregation (teaching diploma) in Physics, France

CAREER

2003-present: Planetary scientist at the European Space Agency

- 2015-present: Juice mission project scientist
- 2003-2014: Involved in the following planetary missions as deputy project scientist or project scientist: Cassini-Huygens, Chandrayaan-1, Venus Express, Mars Express, ExoMars Trace Gas Orbiter

RESEARCH INTERESTS

Planetary ionospheres, solar wind-atmosphere interactions, exploration of the Martian moons

JUICE: A EUROPEAN MISSION TO JUPITER AND ITS ICY MOONS

Olivier Witasse
European Space Agency, ESTEC,
Noordwijk, The Netherlands

JUICE - JUpiter ICy moons Explorer - is the first large mission in the ESA Cosmic Vision 2015-2025 programme [1]. The mission was selected in May 2012 and adopted in November 2014. The implementation phase starts in July 2015, following the selection of the prime industrial contractor. Planned for launch in May 2022 and arrival at Jupiter in October 2029, it will spend at least three years making detailed observations of Jupiter and three of its largest moons, Ganymede, Callisto and Europa.

Science Objectives

The focus of JUICE is to characterise the conditions that might have led to the emergence of habitable environments among the Jovian icy satellites, with special emphasis on the three worlds, Ganymede, Europa, and Callisto, likely hosting internal oceans [2]. Ganymede, the largest moon in the Solar System, is identified as a high-priority target because it provides a natural laboratory for analysis of the nature, evolution and potential habitability of icy worlds and waterworlds in general, but also because of the role it plays within the system of Galilean satellites, and its unique magnetic and plasma interactions with the surrounding Jovian environment [3]. The mission also focuses on characterising the diversity of coupling processes and exchanges in the Jupiter system that are responsible for the changes in surface, ionospheric and exospheric environments at Ganymede, Europa and Callisto from short-term to geological time scales. Focused studies of Jupiter's atmosphere and magnetosphere, and their interaction with the Galilean satellites will further enhance our understanding of the evolution and dynamics of the Jovian system.

The overarching theme for JUICE is: *The emergence of habitable worlds around gas giants*. At Ganymede, the mission will characterise in detail the ocean layers; provide topographical, geological and compositional mapping of the surface; study the physical properties of the icy crusts; characterise the internal mass distribution, investigate the exosphere; study Ganymede's intrinsic magnetic field and its interactions with the Jovian magnetosphere. For Europa, the focus will be on the non-ice chemistry, understanding the formation of surface features and subsurface sounding of the icy crust over recently active regions. Callisto will be explored as a witness of the early solar system trying to also elucidate the mystery of its internal structure.

JUICE will perform a multidisciplinary investigation of the Jupiter system as an archetype for gas giants. The circulation, meteorology, chemistry and structure of the Jovian atmosphere will be studied from the cloud tops to the thermosphere. The focus in Jupiter's magnetosphere will include an investigation of the three dimensional properties of the magnetodisc and in-depth study of the coupling processes within the magnetosphere, ionosphere and thermosphere. Aurora and radio emissions will be elucidated. JUICE will study the moons' interactions with the magnetosphere, gravitational coupling and long-term tidal evolution of the Galilean satellites.

The Payload

The JUICE payload consists of 10 state-of-the-art instruments plus one experiment that uses the spacecraft telecommunication system with ground-based instruments. This payload is capable of addressing all of the mission's science goals [2], from *in situ* measurements of the plasma environment, to remote observations of the surface and interior of the three icy moons, Ganymede, Europa and Callisto, and of Jupiter's atmosphere. A *remote sensing* *package* includes imaging (JANUS) and spectral-imaging capabilities from the ultraviolet to the sub-millimetre wavelengths (MAJIS, UVS, SWI). A *geophysical package* consists of a laser altimeter (GALA) and a radar sounder (RIME) for exploring the surface and subsurface of the moons, and a radio science experiment (3GM) to probe the atmospheres of Jupiter and its satellites and to perform measurements of the gravity fields. An *in situ package* comprises a powerful suite to study plasma and neutral gas environments (PEP) with remote sensing capabilities via energetic neutrals, a magnetometer (J-MAG) and a radio and plasma wave instrument (RPWI), including electric fields sensors and a Langmuir probe. An experiment (PRIDE) using ground-based Very Long Baseline Interferometry (VLBI) will support precise determination of the spacecraft state vector with the focus at improving the ephemeris of the Jovian system.

The table below lists the JUICE instruments.

Acronym	Instrument
3GM	Radio-Science
GALA	experiment
JANUS	Laser Altimeter
J-MAG	Imaging system
MAJIS	Magnetometer
	Visible-Infrared
PEP	Hyperspectral Imaging
RIME	Spectrometer
RPWI	Particle Environment
	Package
SWI	Ice Penetrating Radar
	Radio and Plasma Wave
UVS	Instrument
	Submillimetre Wave
	Instrument
	Ultraviolet Imaging
	Spectrograph

Main Mission Milestones

The table below lists the main milestones of the JUICE mission. The trajectory related events are taken from the current baseline scenario.

Date	Event
May 2012	Mission selection
February	by ESA
2013	Payload selection
November	by ESA
2014	Mission adoption
July 2015	by ESA
	Start of the
May 2022	implementation
October	phase
2029	Launch
October	Jupiter Orbit
2030	Insertion
August	Europa flybys
2032	Ganymede Orbit
June 2033	Insertion
	End of mission

References

[1] JUICE Definition Study Report, Reference ESA/SRE(2014)1,2014. http://sci.esa.int/juice/54994-juice-definition-study-report/

[2] Grasset, O., et al., JUpiter ICy moons Explorer (JUICE): An ESA mission to orbit Ganymede and to characterise the Jupiter system, Planetary and Space Science, Volume 78, p. 1-21, 2013

[3] Grasset, O., et al., 2013. Planetary protection requirements at Ganymede, Astrobiology 13, issue 10, 991-1004.

Astronaut Andre Kuipers
The Netherland

André Kuipers is the first Dutchman with two space missions to his name. André Kuipers spent a grand total of 204 days in space: 11 days during his first flight, the DELTA Mission in 2004 and 193 days during the PromISSe mission in 2011/2012. On board of the International Space Station (ISS), as flight engineer, he performed many diverse tasks including scientific experiments, coupling of spaceships and vital maintenance and repair work.

EDUCATION
In 1977 André Kuipers graduated from the Van der Waals Lyceum in Amsterdam. André Kuipers received a Doctor of Medicine degree from the University of Amsterdam in 1987.

CAREER
During his medical studies, André Kuipers was involved in research on the equilibrium system at the Vestibular Department of the Academic Medical Centre in Amsterdam.
As an officer of the Royal Netherlands Air Force Medical Corps, he carried out research on disorientation in fighter pilots.
He worked for the Research & Development department of the Netherlands Aerospace Medical Centre in Soesterberg as Medical Examiner researcher. He was involved in research on the Space Adaptation Syndrome, contact lenses for pilots, vestibular apparatus, blood pressure and cerebral blood flow in both high-acceleration conditions in a human centrifuge and in microgravity conditions in airplanes. He performed medical examinations of pilots and monitored human centrifuge training as well as teaching pilots physiological aspects of flying.
In July 1999, André Kuipers became a member of the European Space Agency Astronaut Corps.
André Kuipers first spaceflight as a Flight Engineer on a Soyuz flight to the International SpaceStation took place from 19th to 30th April 2004. The DELTA mission was sponsored by the Dutch government in an agreement between ESA and the Russian Federal Space Agency. The flight had three objectives: to exchange the Soyuz spacecraft that serves as Space Station lifeboat; to exchange the Station crew; and for André Kuipers to perform 21 experiments in human physiology, biology, technology and education. After his first spaceflight, André Kuipers performed post flight activities and other duties at EAC and ESA/ESTEC. He supported ESA payload development, parabolic flight campaigns and healthcare spin-offs, as well as offering ground-support for missions of other ESA astronauts. André Kuipers also qualified as a "Eurocom", communicating with astronauts from Columbus Control Centre in Munich, Germany.
In August 2009, André Kuipers was assigned to Expedition 30/31, a long-duration mission called PromISSe to the International Space Station. During his mission in 2011/2012, André Kuipers participated in 50 experiments covering a wide range of disciplines. He was the prime crew member for the rendezvous and docking of ESA's third Automated Transfer Vehicle (ATV). With the robotic arm he berthed SpaceX's Dragon ferry, the first commercial cargo ship to visit the ISS. Since his return to earth in July 2012, André has inspired large groups of people young and old with his space talks promoting Dutch and European activities in space.

AWARDS AND HONORS
Knight of the Order of the Netherlands Lion
Officer in the Order of Orange-Nassau
King of Arms at the inauguration of King Willem-Alexander
Honorary Doctorate by University of Amsterdam
Andreaspenning of the city of Amsterdam
Honorary citizen of Haarlemmermeer
Honorary citizen of Ouder-Amstel
Recipient of the Order of Friendship of Russia
NASA Space Flight Medal

Living and working in Space

Astronaut André Kuipers offers a unique look behind the scenes of international human space flight. He shares his story about the training, the mission and his exceptional view of our planet.

Geological pathway
from Maria Theresia's Monument to St. Stephen's Cathedral
20th April 2016, 2.00 – 3.30 pm