



IV SPANISH-RUSSIAN
ICT FORUM
September 19-23, 2011



*Mars Exploration within the Programme
MetNet / MarsNet*

Luis VÁZQUEZ

Facultad de Informática

Universidad Complutense de Madrid (UCM)

lvazquez@fdi.ucm.es

www.meiga-metnet.org



Coordinates of a Joint Project for Mars Exploration: Russia, Finland and Spain

MetNet/ MarsNet Programme

- It could become the first Scientific Network on Mars surface.
- The need for Miniaturization:
 - Lower power and mass
 - High reliability. High performance
 - Extended environmental survivability
 - Optical wireless technology developments

UCM: MARS EXPLORATION

- The University UCM has been recognized by the Ministry of Education as an International Campus of Excellence. The UCM covers most fields of knowledge and has 14 research assistance centres for experimental research.
- Collaboration with INTA (Instituto Nacional de Técnica Aeroespacial) Space Exploration Programs.
- **Luis Vázquez (UCM)**
 - Calibration Coordinator of the *Beagle 2* UV sensors.
 - Principal Investigator of *REMS-Mars Science Laboratory-NASA (2004-2007)*.
 - *Science Leader of Spanish Science Team for Mars MetNet Precursor Mission.*
 - *Co-I of the DREAMS project associated to the Landing Demonstrator Module (EDM) of ExoMars 2016. Mission to Mars of ESA-NASA.*

KEY EXPERIENCE

- ***Scientific Experience:*** Nonlinear Dynamics; Nonlinear Wave Equations; Random Processes; Fractional Calculus; Long-Memory Processes; Numerical Algorithms; Data Mining; Retrieval Algorithms; Applications of Cloud Computing.
- ***Scientific-Technological Experience:***
 - ***Related to Missions to Mars:*** Martian Electromagnetic Radiation, Martian Atmospheric Issues, Planetary Boundary Layer and Martian Dust.
 - ***Generation and properties of electromagnetic shock waves.***
- ***Innovation Experience:***
 - **Foro de Empresas Innovadoras (FEI):**
www.encuentroinnovacion.es
 - **Parque Científico y Tecnológico del Bierzo (PCTB, 2011).**

UCM: MARS EXPLORATION

- **The relevant research areas at UCM related to the exploration of Mars at different levels are the following:**
 - **Dynamics of regional climate and paleoclimatic modelling.**
 - **Geodesic studies of Mars, geostationary satellites control, celestial mechanics and astrodynamics as well as applications of the relativity theory in fundamental astronomy and space geodesy.**
 - **Radiative transfer theory and scattering phenomena applied to seismic coda waves. Ionosphere models and electron density anomalies.**
 - **Highperformance Computing: Large and massive computations, cloud computing.**
 - **Data Mining.**

THE MARTIAN ATMOSPHERIC BOUNDARY LAYER

A. Petrosyan,¹ B. Galperin,² S. E. Larsen,³ S. R. Lewis,⁴ A. Määttänen,⁵ P. L. Read,⁶ N. Renno,⁷ L. P. H. T. Rogberg,⁶ H. Savijärvi,⁸ T. Siili,⁹ A. Spiga,^{4,12} A. Toigo,¹⁰ L. Vázquez,¹¹

The planetary boundary layer (PBL) represents the part of the atmosphere that is strongly influenced by the presence of the underlying surface and mediates the key interactions between the atmosphere and the surface. On Mars, this represents the lowest 10 km of the atmosphere, with turbulent convective plumes and vortices rising to altitudes of 5-10 km during the daytime. This portion of the atmosphere is extremely important, both scientifically and operationally, being the region within which surface lander spacecraft must operate, as well as determining the short- and long-term exchanges of heat, momentum, dust, water and other tracers between surface/sub-surface reservoirs and the free atmosphere. To date, this region of the atmosphere has been studied both directly, by instrumented lander spacecraft, and to some extent from orbital remote sensing, though not so far to the extent that is necessary to fully constrain its character and behavior.

Current data strongly suggest that, as for the Earth's PBL, classical Monin-Obukhov similarity theory applies reasonably well to the Martian PBL under most conditions, though with some intriguing differences relating to the lower atmospheric density at the Martian surface and the likely greater role of direct radiative heating of the atmosphere within the PBL itself. Most of the modeling techniques used for the PBL on Earth are also being applied to the Martian PBL, including novel uses of very high resolution Large Eddy Simulation methods that allow direct simulation of microscale phenomena such as cellular convection and dust devil formation with significant success. In the final section, we review those aspects of the PBL that will require further investigation and new measurements in order to constrain models, and discuss the extent to which anticipated missions to Mars in the near future will fulfill these requirements.

me spacecraft need to pass through to s of operations. A clear and quantita- g of this part of the atmosphere, and it interacts with the surface and free ld therefore be a vital part of any pro- and understand the Martian environ- nt or future. Such an understanding eliable predictions to be made of en- tions encountered during spacecraft ions, which are essential for mission t design.

time, our understanding of the Mar- lity to model it are strongly guided studies of its terrestrial counterpart. e a valid initial approach, the Martian rs from that of the Earth in a num- spects. The much lower atmospheric artian surface may be significant, ese thin surface layer, affecting the de- entum and mass fluxes. The range of ntered in the Martian PBL may also ore extreme than found typically on l contrasts from intensely convective ustained super-adiabatic thermal gra-

surface and atmospheric reservoirs. It is also the region of the atmosphere through which landed and (at least) gradients, to very strongly stably stratified conditions during the night. Such widespread and extreme variability

“Mars as a Service: Cloud Computing for the Red Planet Exploration Era”.

José Luis Vázquez-Poletti. HPC in the Cloud, February 7th, 2011.

HPC In the Cloud

Dedicated to covering technical cloud computing news and data

Welcome
Subscribe



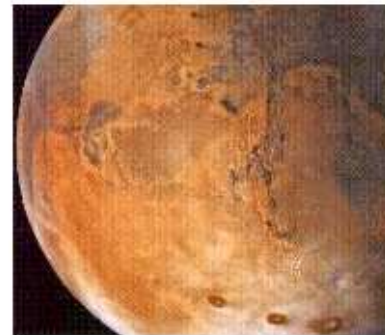
View by Topic

- Virtualization
- Networking
- Public Clouds
- Private Clouds
- Storage
- Research
- Applications
- Cloud Management
- Security
- Standards
- Compliance
- Datacenters
- Hardware

- Home
- Around the Web
- Features
- Blogs
- HPC Cloud Markets
- Events
- Jobs

Today's Top Feature

Feb 3, 2011



Mars as a Service: Cloud Computing for the Red Planet Exploration Era

The MetNet project aims to go where no other Mars missions have gone before, at least in terms of the way it will gather and then process data. This mission to Mars will be based on the power of a new type of dandelion seed-shaped landing vehicle called the MetNet Lander. Dr. Jose Luis Vazquez-Poletti describes the project's goals, methods, and how cloud computing is set to provide the resources for this data-intensive mission. [Read more...](#)

METNET

Finnish Meteorological Institute
Russian Space Research Institute
Lavochkin Association, Russia
INTA, Spain



METNET

The Next Generation Lander Mission
For Martian Atmospheric Science



Mars MetNet Precursor Mission
A tri-Lateral International Consortium



MEIGA
Mars Environmental Instrumentation
for Ground and Atmosphere

Product Assurance



SCIENCE



Universidad del País Vasco - UPV

Scientific Instrumentation

Technology



Wind Sensor*

EM for the 2014



Dust Sensor

IR Backscattered bi-band
(EM with 5 bands for 2014)



Flexible Actuator

with a Shape Memory Alloy



3 ASIC

Mixed signal
OWLS-MOURA-PHOT



Magnetometer

MOURA
Anisotropic MagnetoResistance
(with ASIC-MOURA for 2013)



Solar Irradiance Sensor

SIS + OWLS
(with ASIC-WLS 2012 & ASIC-PHOT for 2014)



OWLS

Optical Wireless Links
for intraSpacecraft
communications

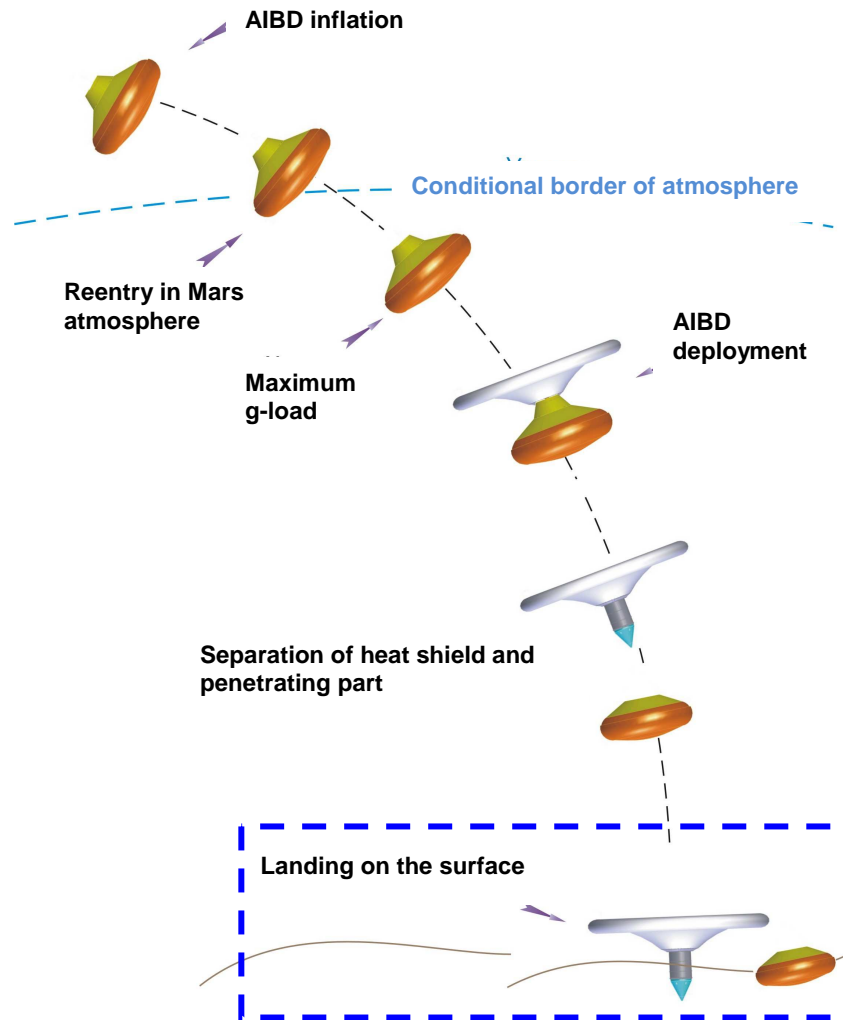


MEREX

Miniature Electronic Resources
for Planetary EXploration

Entry, Descent and Landing Scenario of MetNet

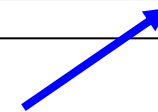
Scheme of MML descent in atmosphere (Option 1)



Main phases of MML descent

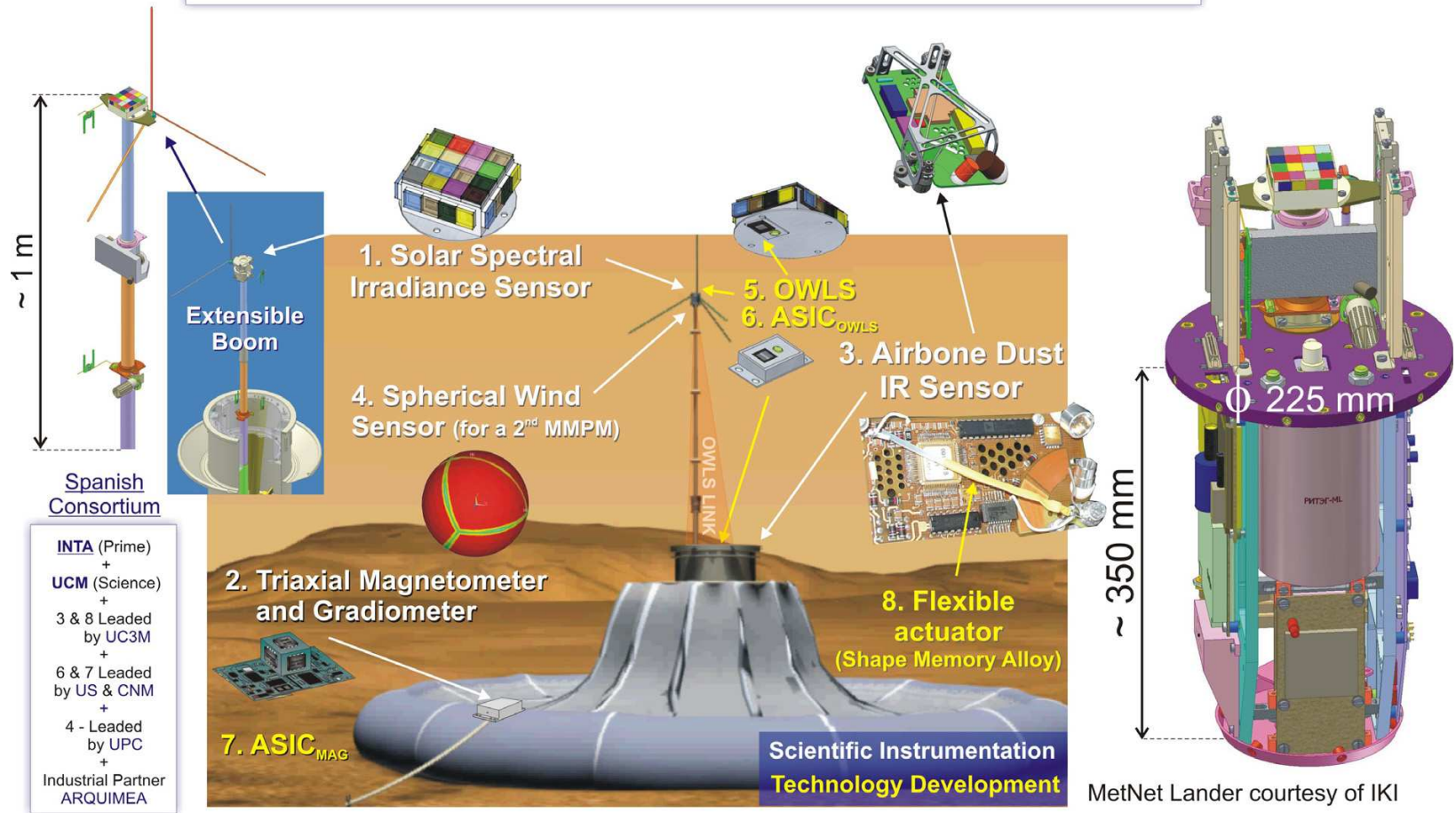
	Flight phases	Time from the moment of reentry T_0	Phase description
1	MIBD inflation	$T_0 - 30$ min.	
2	Oriented reentry in Mars atmosphere	$T_0 = 0$	H = 120 km V _{abs} ≈ 4.83 km/sec θ _{abs} = -14±3 degr.
3	Maximum g-load	$T_0 + 67$ s...118s	H = 30...39 km θ = -7.6...-15.7 degr. Q _{max} = 2880 Pa N _{xmax} = -14.7
4	AIBD deployment (command for deployment is defined on-board depending on change of g-load N _x)	$T_0 + 170$ s...282s	H = 4.3...10.4 km Q _{max} = 126 Pa M = 0.7...0.8
5	Separation of aerodynamic shield and penetrating part	$T_0 + 180$ s...292s	H = 3.1...9.1 km θ = -67.1...-75.7degr. Q _{max} = 55 Pa M = 0.45...0.51
6	Landing on the surface:	level 2 km	V = 51.1...65.8 m/sec Q = 16.5...24.1 Pa
		level 0 km	V = 47.1...55.5 m/sec Q = 16.7...20.6 Pa

Velocity at Mars ground arrival: between 47 and 56 m/s



Spanish Payload

Spanish Payload Distribution in the first MMPM



MEIGA-MARS-METNET-PRECURSOR

The Modelling and Simulation of the Planetary Boundary Layer on Mars.

Martian Surface Radiation

- **The objective is the measurement of the Local Radiation Martian Environment in the range 190-1100 nm:**
 - **Intensity of the ultraviolet (UV) radiation in the Martian surface.**
 - **The atmospheric opacity due to the Martian dust.**
 - **Measure of the seasonal asymmetries in the ground Martian radiation.**
 - **Concentration of Ozone and Water Vapour in the Martian atmosphere.**
 - **Correlations between the radiation with the temperature, pressure and water on the Martian surface.**

•

MEIGA-MARS-METNET-PRECURSOR

Magnetic Studies

- The magnetic field on the Martian surface has the static components, related to the crustal magnetic field, and the dynamic components associated to the interaction with the solar wind, atmospheric dynamics and induced planetary magnetic effects.
- For the *first time*, we will have the opportunity to measure the Martian magnetic field at surface. These data will shed light on the internal structure and composition of the Martian magnetic field.

Geodesic Studies

- Characterization of the eclipses of Phobos and Deimos.
 - They will be detected through the variations of the flux radiation on the Martian surface. This will provide information about the rotation and orbit of Mars.

Data Mining

Ph.D. Programme and Outreach Activities

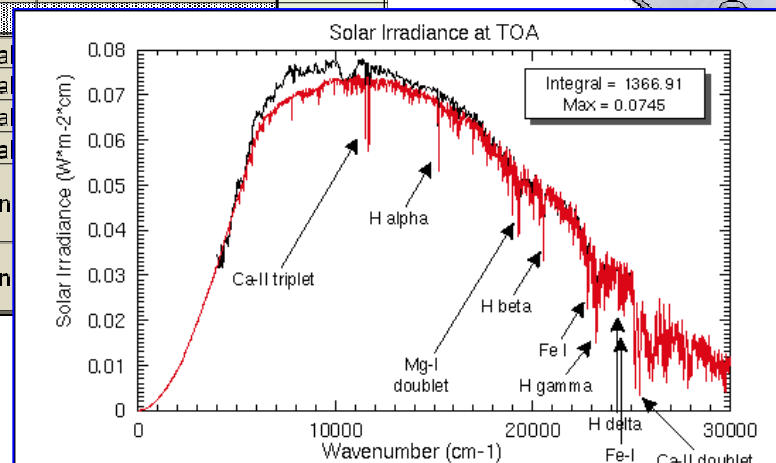
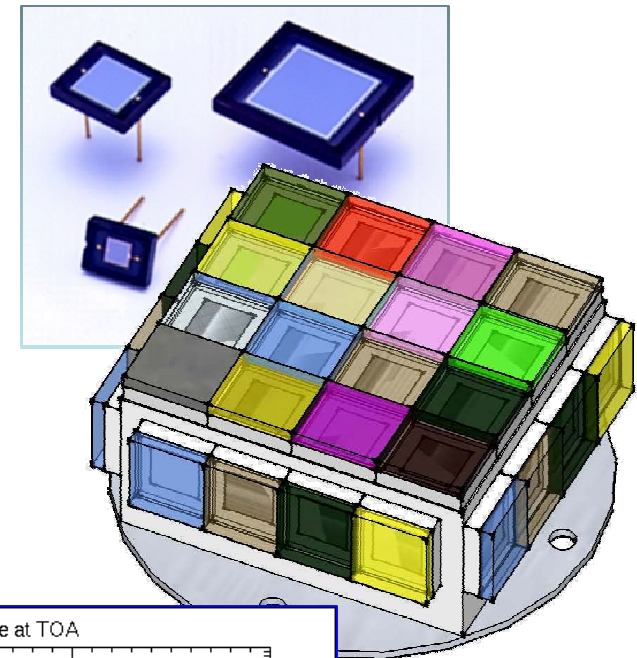
1 – SIS - Solar Irradiance Sensor



Bands detection

SOLAR IRRADIANCE SENSOR ACQUISITION CHANNELS							
Channel	Wavelength	Use	Position	Wavelength	Use	Channel	
1	----	Background reference	Top Surface	440 / 660 nm	Dust Optical Depth	21	
2	190 - 1100 nm	Total luminosity reference		Side 2	700 - 1100 nm	IR	22
3	710 - 730 nm	H ₂ O			400 - 700 nm	VIS	23
4	810 - 830 nm	H ₂ O					24
5	930 - 950 nm	H ₂ O		Side 3	440 / 660 nm	Dust Optical Depth	25
6	759 - 771 nm	A Band - O ₂			700 - 1100 nm	IR	26
7	315 - 400 nm	UVA			400 - 700 nm	VIS	27
8	280 - 315 nm	UVB					28
9	200 - 280 nm	UVC		Side 4	440 / 660 nm	Dust Optical Depth	29
10	200 - 310 nm	Hartley Band - O ₃			700 - 1100 nm	IR	30
11	300 - 345 nm	Huggins Band - O ₃			400 - 700 nm	VIS	31
12	440 nm	Dust Optical Depth		Additional features	non optical		
13	600 nm	Dust Optical Depth			non optical		
14	700 - 1100 nm	IR			non optical		
15	400 - 700 nm	VIS			non optical		
16	245 - 290 nm	UV Redundancy			non optical		
17	440 / 660 nm	Dust Optical Depth	Side 1	760 - 1100 nm			
18	700 - 1100 nm	IR		760 - 1100 nm			
19	400 - 700 nm	VIS					
20							

Si photodiodes



Solar Irradiance

Eclipses: Phobos and Deimos



Martian Surface Solar Radiation:190-1100 nm

- The objective is the measurement of the Local Solar Radiation Martian Environment in the range 190-1100 nm:
 - Intensity of the ultraviolet (UV) radiation in the Martian surface.
 - The atmospheric opacity due to the Martian dust.
 - Measure of the seasonal asymmetries in the ground Martian radiation.
 - Concentration of Ozone and Water Vapour in the Martian atmosphere.
 - Correlations between the radiation with the temperature, pressure and water at the Martian surface

Geodesic Studies

- **Characterization of the eclipses of Phobos and Deimos.**
 - They will be detected through the variations of the flux radiation on the Martian surface. This will provide information about the rotation and orbit of Mars.

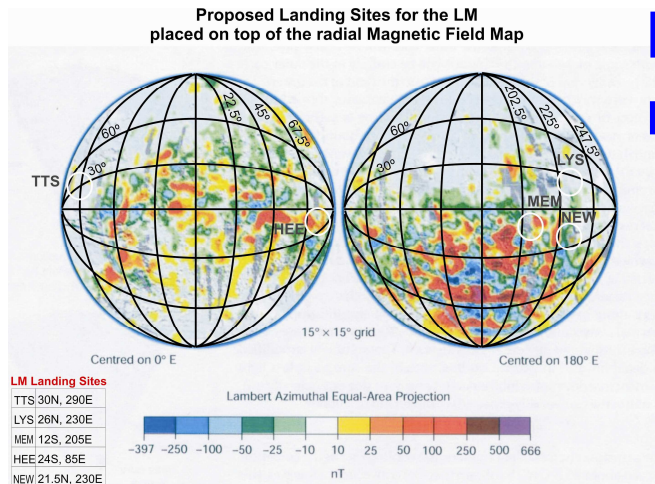
The Objectives

- **Development** of a chronogram of eclipses of Phobos and Deimos in the band of latitude $\pm 5^\circ$, and its geometric parametrization in order to determine the position of the landing site. Study of the accuracy by analyzing the influence of Phobos's irregular shape, the precision of the light curves, and Mars and Phobos orbits.
- **Characterization**, by using a rotation model, of the core inertia moments and nucleus size from the proper frequencies obtained from the derived polar motion data.

2 – MOURA: The first magnetometer on Mars surface?

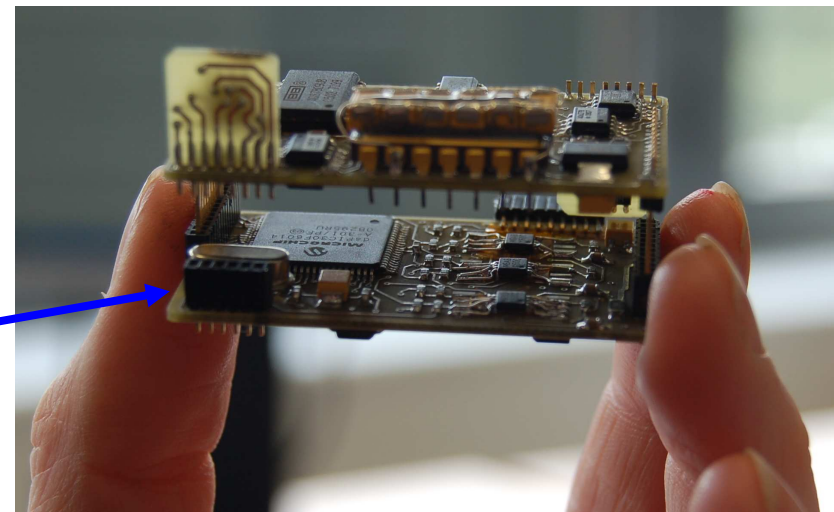
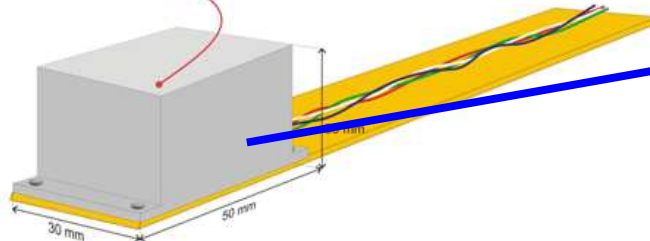
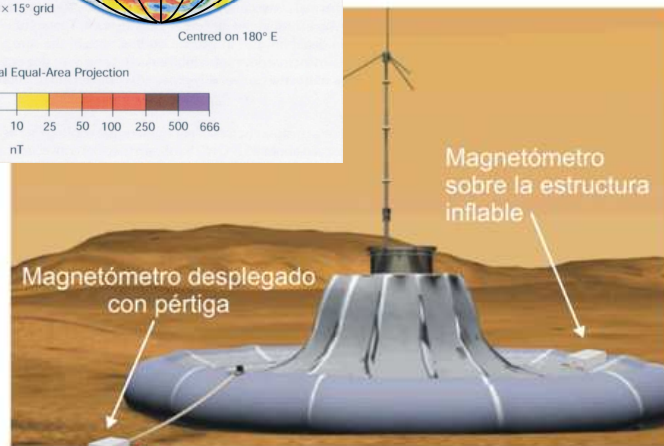


Mars: A magnetic world!



Based on the AMR technology (Anisotropic MagnetoResistance)

- Previous heritage
- Resolution less than 3 nT
- Mass of order 45 g
- Deployment system (tbd)



MARTIAN MAGNETIC FIELD

- Useful data about the magnetic field and about the plasma environment near Mars: ***Missions Phobos 2 and Mars Global Surveyor.***
- The magnetic field on the Martian surface has the **static components**, related to the crustal magnetic field, and the **dynamic components** associated to the interaction with the solar wind, atmospheric dynamics and induced planetary magnetic effects.
- In situ measurements for the *first time* of the Martian magnetic field at surface. These data will shed light on the internal structure and composition of Mars. Local and global models of the Martian magnetic field.

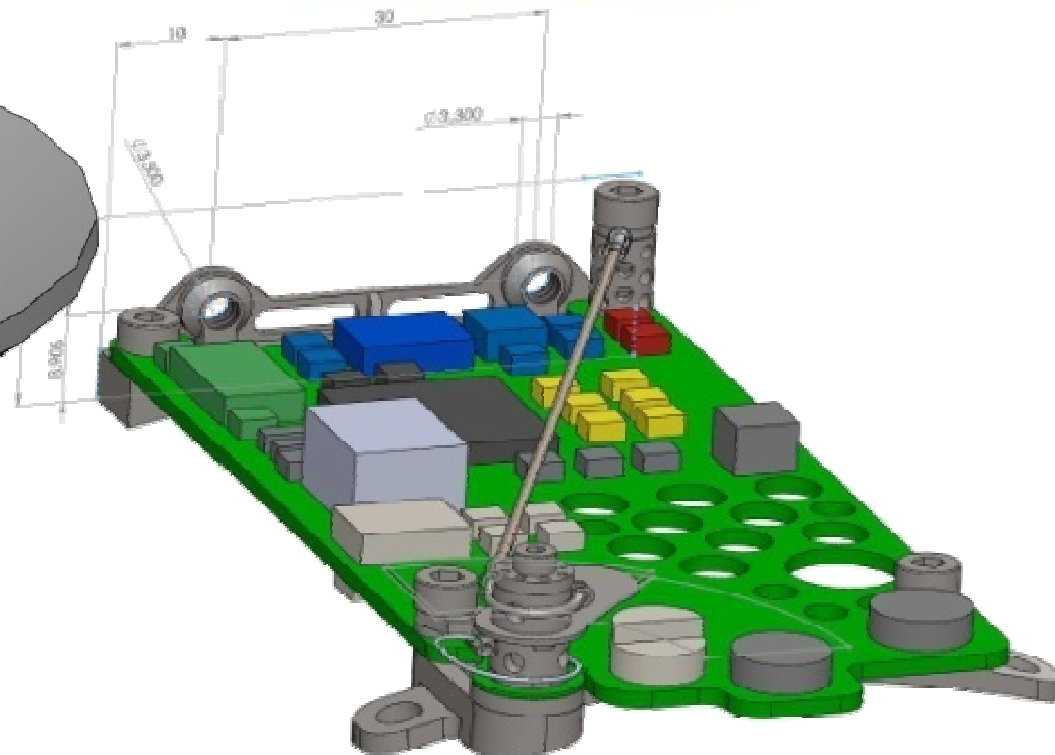
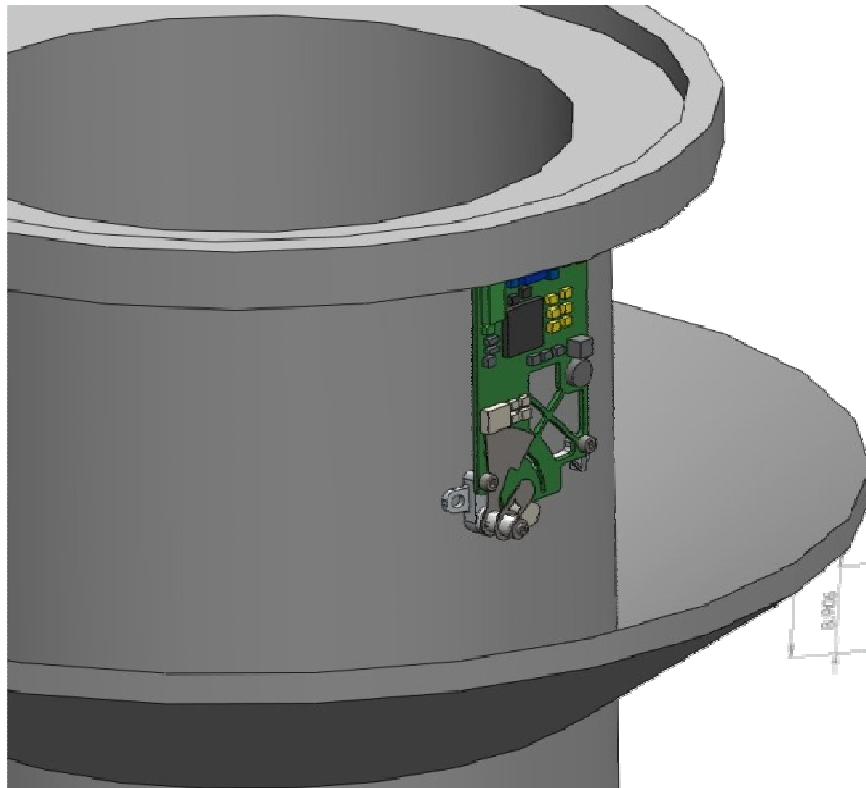
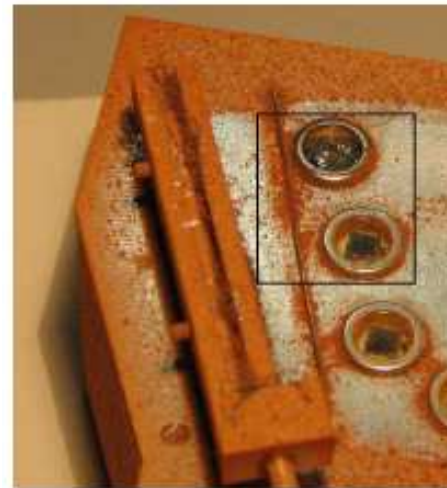
Surface magnetic measurements will provide information for the following science objectives

- Solar wind-atmosphere interactions.
- Mars magnetosphere properties.
Ionosphere.
- Solar explosive events and Martian environment.
- Geophysical properties of the landing site.
- Correlation of the induction effects and Mars interior.

3. Dust Deposited and Dust Airbone Sensor



ARQUIMEA



Environment of Martian Studies: Outreach

UNIVERSIDAD COMPLUTENSE CURSOS de VERANO 2009

SEMANA DEL 13 AL 17 DE JULIO

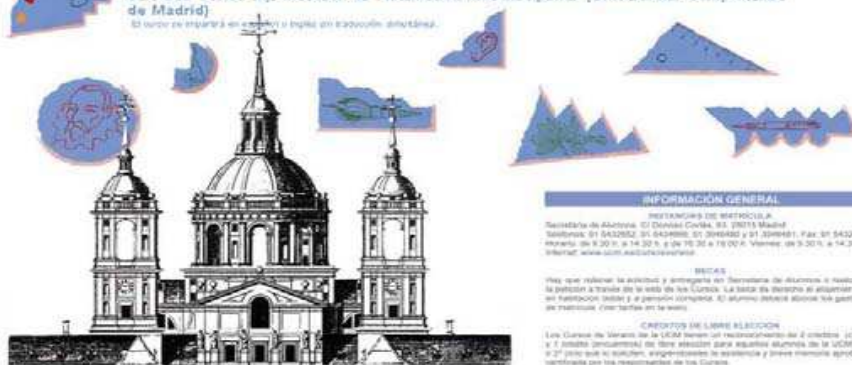
*LA EXPLORACIÓN DE MARTE

Directores: Luis Vázquez, Univ. Complutense
Héctor Guerrero, INTA

Participantes: Alexander Lapatov, IQ, Álvaro Giménez, CSIC y ESA, Ari-Matti Harri, FMI, Bruce P. Bliocli, Univ. Michigan, Dietrich Mohr, DLR, Diego Fernández, Argemón, Diego Rodríguez, SENER, EVA Ullat, INTA, Fernando López, Univ. Carlos III, Fernando Ruiz, Univ. Valladolid, Francisco Esposto, INAF-OAC, Francisco Valero, Univ. Complutense, François Forget, UMD-PSU-CHAR, Gracia Rodríguez-Casteda, Univ. Complutense, Ignacio Amigo, INTA, Idelfonso Díaz, Univ. Complutense, Jaime Sánchez, INTA, James A. Slavin, GSFC-NASA, Jesús Rodríguez, Univ. Rey Juan Carlos, Jorge Vago, ESA-ESTEC, José J. López, IAA-CSIC, José Torres, INTA, Juan Barbero, Aiter Technology Group, Jussi Leinonen, FMI, Lida Babau, INTA, Luigi Cotroneo, INAF-OAC, Luis Castañer, Univ. Politécnica de Cataluña, Luis Moreno, Univ. Carlos III, Manuel Gerrano, CDTI, Maena Díaz-Michelena, INTA, Marta Folgueira, Univ. Complutense, Miguel Herráiz, Univ. Complutense, Nilton O. Renno, Univ. Michigan, Oleg Korablev, IKI, Pilar Romero, Univ. Complutense, Rafael Pérez, INTA, Salvador Jiménez, Univ. Politécnica Madrid, Sandro M. Radice, ICTP, Veronique Dehant, RGB, Victor Reglero, Univ. Valencia y MICINN, Vyacheslav Lankin, IQ, Walter Schmidt, FMI.

Patrocinadores: Instituto Nacional de Técnica Aeroespacial (Ministerio de Defensa); Ministerio de Ciencia e Innovación; Instituto de Investigación P. J. de Lastras (Universidad Carlos III); Instituto de Matemática Interdisciplinar (Universidad Complutense de Madrid).

El curso se impartirá en español o inglés en cualquier combinación.



INFORMACIÓN GENERAL

Se inscribirá en el curso a través de la web www.ucm.es/cursosverano.
Secretaría de Admisión: C/ Daniel Coñita, 83. 28013 Madrid
Teléfono: 91 5432652 y 91 5432653. E-mail: admision@ucm.es. Fax: 91 5432612
Horario: de 9:30 h. a 14:30 h. y de 16:30 a 18:00 h. Viernes: de 9:30 h. a 14:30 h.
Internet: www.ucm.es/cursosverano

BECAS
Las becas que otorga la Admisión y el Servicio de Alumnos al realizar la petición a través de la web de los Cursos, la beca de acceso al alojamiento en habitación doble y el premio completo. El alumno deberá abonar los gastos de matrícula. (Ver tarifas en la web).

CREDITOS DE LIBRE ELECCIÓN
Los Cursos de Verano de la UCM tienen el reconocimiento de 2 créditos (Cursos) y 1 crédito (encuentros) de libre elección para aquellos alumnos de la Universidad Complutense de 1º o 2º ciclo que lo soliciten, cumplan los requisitos de asistencia y elaboren una breve memoria aprobada y certificada por los responsables de los Cursos.



El Escorial
www.ucm.es/cursosverano



UNIVERSIDAD COMPLUTENSE CURSOS DE VERANO 2010

SEMANA DEL 12 AL 16 DE JULIO

MARTE Y SUS ENIGMAS*

Directores: Luis Vázquez, Universidad Complutense
Héctor Guerrero, INTA

Participantes: James A. Slavin, GSFC-NASA EE UU; Dario Maravall, RAC; Pilar Romero, Univ. Complutense; Prof. Hua, Agencia Espacial China; Gracia Rodríguez-Caderot, Univ. Complutense; Marta Folgueira, Univ. Complutense; Salvador Jiménez, Univ. Politécnica Madrid; Oleg Korablev, IKI, Rusia; Ari-Matti Harri, FMI, Finlandia; S. Alexashkin, Lavochkin, Rusia; Maite Álvarez, INTA; Agustín F. Chicarro, ESA; Rosario Lunar, Univ. Complutense; Nilton O. Renno, Univ. Michigan; David S. McKay, JSC-NASA EE UU; Ignacio Arruego, INTA; Diego Rodríguez, SENER; Victor Reglero, Univ. Valencia y MICINN; José Torres, INTA.

Patrocinadores: Instituto Nacional de Técnica Aeroespacial (INTA); Ministerio de Ciencia e Innovación (MICINN); Instituto de Matemática Interdisciplinar de la Universidad Complutense de Madrid (IMI-UCM)

INFORMACIÓN GENERAL

INSTANCIAS DE MATRÍCULA

Secretaría de los Cursos de Verano: Calle Donoso Cortés, 83, planta baja, 28015 Madrid. Teléfonos: 913046460-913046481-913046408. Fax: 913046407.

www.ucm.es/cursosverano

Horario: de lunes a viernes: de 9:00 a 15:00 horas; y martes y jueves de 16:30 a 18:30 horas. Esta oficina permanecerá abierta hasta el 30 de junio.

www.ucm.es/cursosverano

BECAS

La beca da derecho a alojamiento en régimen de pensión completa en habitación doble compartida, debiendo abonar el becario los gastos de matrícula. La beca hay que solicitarla antes del 28 de mayo.

CREDITOS DE LIBRE ELECCIÓN


Los Cursos de Verano de la UCM tendrán reconocimiento de 2 créditos (Cursos) y 1 crédito (encuentros) de libre elección para aquellos alumnos de la Universidad Complutense de 1º o 2º ciclo que lo soliciten, cumplan los requisitos de asistencia y elaboren una breve memoria aprobada y certificada por los responsables de los Cursos.



El Escorial
www.ucm.es/cursosverano




Environment of Martian Studies: Outreach



MARTE Y SOCIEDAD* 13, 14 y 15 de julio

Directores: Luis Vázquez, Universidad Complutense
Héctor Guerrero, INTA

Participantes: Salvador Jiménez, Univ. Politécnica Madrid; América Valenzuela, RNE; Ángel Gómez, revista Astronomía; Ari-Matti Harri, Finish Meteorological Institute (FMI); Ashley W. Stroupe, JPL/NASA; David S. Mackay, NASA; Francisco Anguita, Univ. Complutense; Ignacio Arruelo, INTA; Jesús Martín, MICINN/CSIC; Miguel A. Sabadell, revista Muy Interesante; Nilton O. Renno, Michigan Univ. EE.UU.; Patricia Fernández de Lis, Público; Pilar Román, CDTI; Steve Squyres, Cornell Univ. EE.UU.; Vladimir Ivanov, Rusia.



Este curso no dispondrá de traducción simultánea

Patrocinadores: Ministerio de Ciencia e Innovación; Instituto Nacional de Técnica Aeroespacial, INTA; Instituto de Matemática Interdisciplinar, IMI-UCM; Centro Ruso de Cultura y Ciencia.


*Reconocido por el Ministerio de Educación con 1,5 créditos para profesores de enseñanzas no universitarias

INFORMACIÓN GENERAL

REQUISITOS:
La inscripción y el pago en el momento de inscripción completa en el momento de inscripción, debiendo abonar el curso, en todo caso, los gastos de matrícula. El plazo de solicitud finaliza el 31 de mayo.

MATRÍCULA ONLINE EXCLUSIVAMENTE:
La matrícula solo se podrá realizar a través de la web:
<https://matriculas.ucm.es/CursosComplutense/Identificacion/IdentificacionPw.aspx>
Información: Departamento de Asesoría de los Cursos de Verano, C/ Doctor Casto, 63, 28015 Madrid. Teléfonos: 913946482 / 913946481 / 913946404 / 913946405 / 913946406. Fax: 913946407. Horario: de lunes a viernes de 9:00 a 14:00 horas, y miércoles de 16 a 18 horas. Correo: info@cursoverano.ucm.es

CRÉDITOS:
Los Cursos de Verano de la UCM tendrán reconocimiento de créditos de libre elección (2 créditos para los cursos de 5 días y 1 crédito para los encuentros de 2/3 días) para aquellos alumnos de la Universidad Complutense de Madrid de 4º y 5º de los cursos. Cuando los resultados de asistencia y exámenes sean mejores serán otorgados y certificados por los responsables de los Cursos, que deberá entregarse en los cursos días siguientes a la finalización del curso. Y reconocimiento de créditos de grado, 1 crédito ECTS sólo para cursos de 5 días y encuentros de 3 días, para aquellos alumnos de cualquier Universidad que lo solicite y realicen un examen en el aula.



www.ucm.es/cursosverano

www.rusiahoj.com/blogs/limites-cientificos

POSSIBLE FUTURE COLLABORATION

- **The Spanish-Russia collaboration within MetNet / MarsNet programme should be boosted.**
- **To develop jointly technologies and scientific instrumentation for space (ASICs,..).**
- **Integration and tests of scientific payloads.**
- **Organization of a serie of Joint Summer Space Schools.**
- **Interchange of students in the framework of a Space Programme.**



Спасибо!
¡Muchas gracias!
Thank you!...