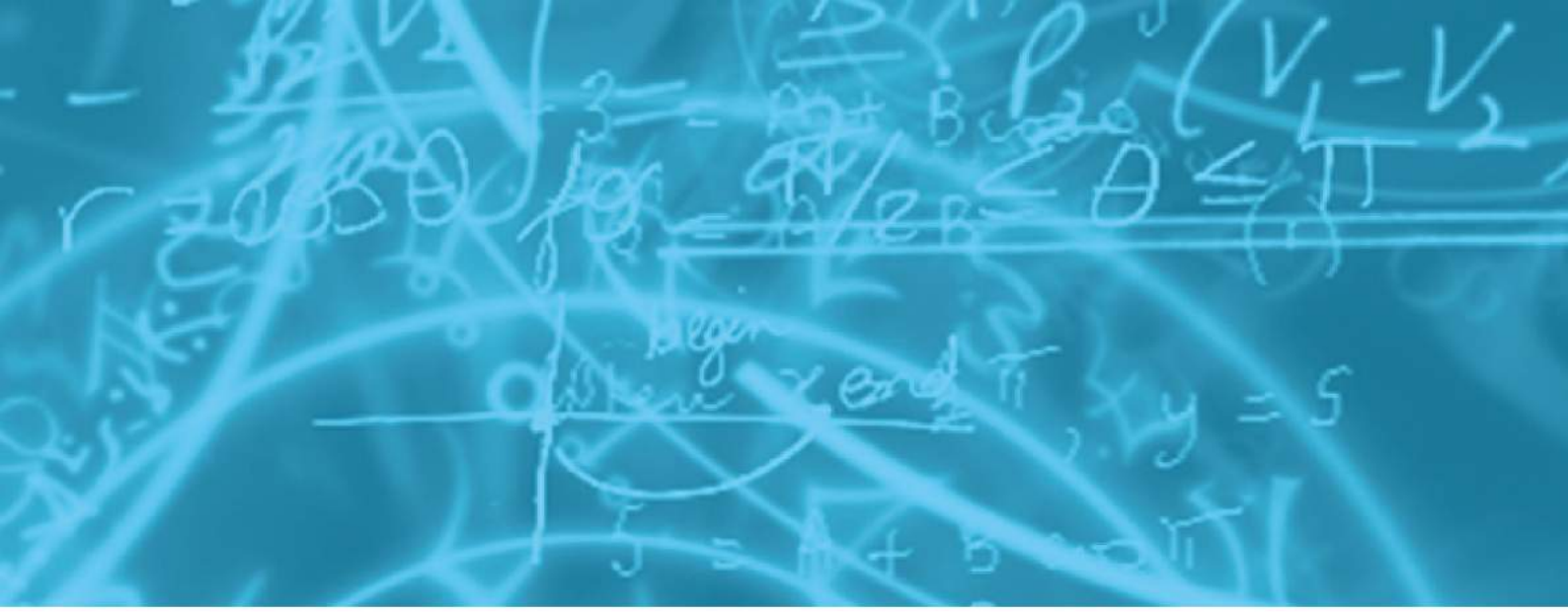

SēMA

Sociedad Española de Matemática Aplicada

BOLETÍN ELECTRÓNICO DE SēMA

Número 14, Enero 2017

SeMA

BOLETÍN ELECTRÓNICO NÚM. 14

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Índice

1 Editorial

Estimados socios:

A partir de este número, además del Boletín Electrónico tal como lo conocéis, podréis encontrar en la página web de SēMA un enlace directo a algunos de los artículos y contribuciones más interesantes del mismo. Esta iniciativa está encaminada a tratar de incrementar la visibilidad de las noticias y reseñas publicadas en el Boletín de forma desinteresada por los socios.

Queremos agradecer la colaboración de Luis Vázquez que, conjuntamente con otros compañeros de la Universidad Complutense, Universidad Politécnica y la Universidad Pontificia Comillas, todas ellas de Madrid, nos han hecho partícipes de su magnífico artículo "Some elements of the present Martian Research Environment at Universidad Complutense de Madrid".

Deseamos especialmente felicitar al profesor Jesús Ildefonso Díaz por su reciente elección como miembro de la *European Academy of Sciences*.

Damos asimismo las gracias al Comité Editorial y a todos los que habéis colaborado en la confección de este número.

Os deseamos un buen comienzo de año en vuestras actividades y que la lectura de este ejemplar os resulte interesante. Sólo nos resta recordaros que vuestra colaboración resulta imprescindible para la buena marcha e interés de este Boletín Electrónico. Sabéis que existe un correo electrónico específico (ver más abajo) para hacer llegar a los editores cuantas sugerencias, comentarios, reseñas y contribuciones estiméis oportuno difundir entre todos los socios de SēMA. En este sentido conviene apuntar la disponiblidad del Boletín para difundir entre la comunidad matemática española la actividad desarrollada por vuestros proyectos de investigación subvencionados con ayudas públicas. Es bien sabido que la difusión de los resultados de la investigación en la sociedad es un aspecto de creciente importancia en las sucesivas convocatorias de proyectos de investigación por parte de la Secretaría de Estado de Investigación, Desarrollo e Innovación.

Un cordial saludo

Los Editores
`boletin@sema.org`

2 Artículos

2.1 Some elements of the present Martian Research Environment at Universidad Complutense de Madrid

El siguiente artículo, remitido gentilmente por el profesor Luis Vázquez a petición de los editores, tiene por objeto describir la actividad en la investigación del planeta Marte por parte del Martian Research Environment en la Universidad Complutense de Madrid.

Some elements of the present Martian Research Environment at Universidad Complutense de Madrid

Luis Vázquez[1], Francisco Valero[1], Pilar Romero[1], María Luisa Martín[1*], María Pilar Velasco[2], Salvador Jiménez[2], Carlos Aguirre[3], Raquel Caro-Carretero[4], Gonzalo Barderas[1], David Usero[1], Germán Martínez[1*], Ignacio M. Llorente[1], José Luis Vázquez-Poletti[1], Pedro Pascual[3], Álvaro Vicente-Retortillo[1], María Ramirez-Nicolás[1]

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Abstract

We describe some data of the Martian research activity in the framework of the Martian studies at Complutense University.

Key words: Mars, Data bases and mining, Solar irradiance, Martian atmosphere and dust, Magnetic and electric fields, Mars Moons.

Introduction

The history of mankind is associated with the history of technological progress. In addition, there is one area in which that progress also exhibits some very human traits: curiosity, fascination and the basic instinct to explore the unknown, that along with the joy that provided discoveries are engines that drive men to investigate what there are other worlds and search for life beyond Earth. One of these giant steps in that ”space adventure” may be the first man to Mars and the subsequent establishment of a human colony. Planetary exploration has had a series of milestones that mark the limits of the new frontier. Each of them has aroused enthusiasm involving new generations of scientists and engineers, and helping to form innovative professionals. In this regard, it is sufficient to recall the global events associated with the launch of the first Sputnik (1957), first manned Vostok 1 (Yuri Gagarin, 1961), landing on the Moon with Apollo 11 (1969) and contemporary exploration Martian robots Spirit, Opportunity and Curiosity. The fascination of space exploration is contagious, while it brings to humanity a glowing desire to understand and learn and provides an endless source of questions about the universe seen with charm and admiration.

In this context of enthusiasm we have to locate some of the activities of the Martian Research Environment at Complutense University from 2007. Inside the Complutense University different Faculties and Departments are involved. At the same time, we have to consider the participation of other universities: Universidad Autónoma de Madrid, Universidad Politécnica de Madrid and Universidad Pontificia Comillas.

1. The beginnings

We have to start with the video from NODO that we can find in Youtube: `https://www.youtube.com/watch?gl=SN&hl=fr&v=HYXnJHpKpdo`, from 1956 related to the Martian studies of the Professors Gullón, Martín Lorón and López Arroyo from Madrid Observatory. This information is also provided by the newspaper ABC of 8/9/1956.

Later on, we have to refer the “Grupo de Planetology” of Professor Francisco Anguita Virella (1944-) in the Geology Faculty of Complutense University as a suggestive and great scientific group. A result of the above activity was the publication: F. Anguita, “Historia de Marte, Mito y Exploración”. Editorial Planeta. ISBN 978-84-0802-698-3. (1998).

The singular event to push and to launch the Martian research at Complutense University was the creation of the Astrobiology Center associated to NASA (`http://www.cab.inta-csic.es/es/inicio`) in 1998.

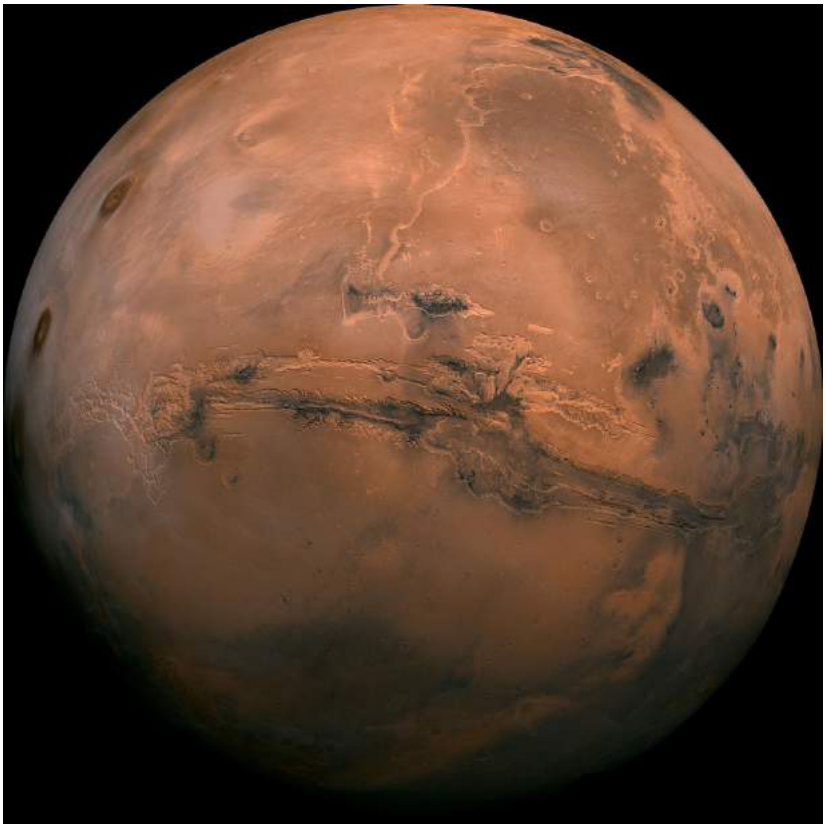


Figura 1: Planet Mars. Picture by NASA/JPL-Caltech.

Francisco Anguita and Luis Vázquez were cofounders of such a centre. In this context, Luis Vázquez started to be involved in the Missions to Mars. The first participation was in the period 2001-2003: Beagle 2 (Mars Express, ESA), by coordinating the calibration of the Ultraviolet sensors.

In the period 2004-2007, Luis Vázquez participated as PI and Francisco Valero as Co-I of REMS-Curiosity (NASA): `http://mars.jpl.nasa.gov/msl`.

The Mission which structured the Marian Research Environment at Complutense University was the joint project METNET (Meteorological Network) of Spain (INTA, UCM, UC3M and Instituto de Microelectrónica de Sevilla) with Russia, Finland and Spain (2007-2015). The goal of this project is to send to Mars a network of meteorological stations (`http://www.meiga-metnet.org`, `http://metnet.fmi.fi/index.php?id=72`).

2. Martian research achievements in the period 2007-2015

The research activity is carried out mainly in three thematic blocks described as follows:

2.1. Martian planetary boundary layer, magnetic field and radiation

The core research in this block has been regarding:

- To compare Mars and Earth planetary boundary layers (PBL) and the associated surface layers. The different scale processes.
- To compare the Turbulent Kinetic Energy (TKE) budgets in Mars and Earth.
- Aspects of the PBL that require new measurements in order to constrain models.
- Dynamics of the Martian dust. Electric fields.
- Modelling local Martian magnetic fields.
- Solar radiation on the Martian surface.
- Atmospheric effects on the remote determination of thermal inertia on Mars.

The results are reflected in the following publications:

- "Remote temperature retrieval from heating or cooling targets". M. P. Zorzano and L. Vázquez. Optics Letters 31, 1420-1422 (2006).
- "Spectral information retrieval from integrated broadband photodiode Martian ultraviolet measurements". L. Vázquez, M. P. Zorzano and S. Jiménez. Optics Letters 32, 2596-2598 (2007).
- "Retrieval of ultraviolet spectral irradiance from filtered photodiode measurements". M. P. Zorzano, L. Vázquez and S. Jiménez. Inverse Problems 25, 115023 (2009).
- "Characterization of the Martian Convective Boundary Layer". G. Martínez, F. Valero and L. Vázquez. Journal of the Atmospheric Sciences 66, 2044-2057 (2009).
- "Characterization of the Martian Surface Layer". G. Martínez, F. Valero and L. Vázquez. Journal of the Atmospheric Sciences 66, 187-198 (2009).

- "TKE Budget in the Convective Martian PBL". G. Martínez, F. Valero and L. Vázquez. Quarterly Journal of the Royal Meteorological Society, DOI: 10-1002/qj.883. (2011).

- "The Martian Atmospheric Boundary Layer". A. Petrosyan, B. Galperin, S.E. Larsen, S.R. Lewis, A. Määttänen, P.L. Read, N. Renno, L.P.H.T. Rogberg, H. Savijärvi, T. Siili, A. Spiga, A. Toigo and L. Vázquez. Reviews of Geophysics 49, RG3005, 1-46, (2011).

- "Martian dust devils detector over FPGA". E. de Lucas, M.J. Miguel, D. Mozos and L. Vázquez. Geosci. Instrum. Method. Data Syst., 1, 23–31, (2012).

- "Tomographic Signal Analysis for the Detection of Dust-Devils in Mars Atmosphere". A. Giménez-Bravo, C. Aguirre and L. Vázquez. The Fourth Solar System Symposium (4M-S3), Space Research Institute (IKI), Russian Academy of Sciences in Moscow (2013).

- "New Approaches for the Analysis of Geomagnetic Data". L. Vázquez, M. Ramírez-Nicolás, R. Caro-Carretero, C. Aguirre, B. Sánchez-Cano, R. Vilela and S. Jiménez. The Fifth Solar System Symposium (5M-S3), Space Research Institute (IKI), Russian Academy of Sciences in Moscow (2014).

- "Numerical studies of charged particles in a magnetic field: Mars application". M. Ramírez-Nicolás, D. Usero and L. Vázquez. Central European Journal of Physics, 12(8), 521-531, (2014).

- "NeMars: An empirical model of the Martian dayside ionosphere based on Mars Express MARSIS data". Sánchez–Cano, B., Radicella, S.M., Herraiz, M., Witasse, O.and Rodríguez-Caderot, G. Icarus, doi: 10.1016/j.icarus.2013.03.021 (2013).

- "The effect of the induced magnetic field on the electron density vertical profile of the Mars' ionosphere: A Mars Express MARSIS radar data analysis and interpretation, a case study". Ramírez-Nicolás, M., Sánchez-Cano, B., Witasse, O., Blelly, P.-L., Vázquez, L., Lester, M. Planetary and Space Science, 126, 49-62 (2016)

- "Numerical study of a charged particle in a general magnetic field". M. Ramírez-Nicolás, D. Usero, M. P. Velasco and L. Vázquez. International Journal of Pure and Applied Mathematics, 106 (2), 401-414 (2016).

- "Mars Science Laboratory Relative Humidity Observations – Initial Results". Ari-Matti Harri, M. Genzer, O. Kemppinen, J. Gomez-Elvira, R. Haberle, J. Polkko, H. Savijärvi, N. Renno, J. A. Rodriguez-Manfredi, W. Schmidt, M. Richardson, T. Siili, M. Paton, M. De La Torre-Juarez,T. Mäkinen, C. Newman, S. Rafkin, M. Mischna, S. Merikallio, H. Haukka, J. Martin-Torres, M. Komu, M.-P. Zorzano, V. Peinado, L. Vazquez and R. Urqui. Journal of Geophysical Research Planets 119, 2132-2147 (2014).

- "Pressure Observations by the Curiosity Rover – Initial Results". A.M. Harri, M. Genzer, O. Kemppinen, H. Kahanpaa, J. Gomez-Elvira, J. A. Rodriguez-Manfredi, R. Haberle, J. Polkko, W. Schmidt, H. Savijarvi, J. Kauhanen, E. Atlaskin, M. Richardson, T. Siili, M.Paton, M. De La Torre-Juarez, C. Newman, S. Rafkin, M. T. Lemmon, M. Mischna, S. Merikallio, H. Haukka, J. Martin-Torres, M.-P. Zorzano, V. Peinado, R. Urqui, A. Lapinette, A. Scodary, T. Makinen, L. Vazquez, N. Renno and the REMS/MSL Science Team. Journal of Geophysical Research: Planets 119, 82-92 (2014).

- "REMS: The Environmental Sensor Suite for the Mars Science Laboratory Rover". Gómez-Elvira, C. Armiens, L. Castañer, M. Domínguez, M. Genzer, F. Gómez, R. Haberle, A.M. Harri, V. Jiménez, H. Kahanpää, L. Kowalski, A. Lepinette, J. Martín, J. Martínez-Frías, I. McEwan, L. Mora, J. Moreno, S. Navarro, M.A. de Pablo, V. Peinado, A. Peña, J. Polkko, M. Ramos, N.O. Renno, J. Ricart, M. Richardson, J. Rodríguez-Manfredi, J. Romeral, E. Sebastián, J. Serrano, M. de la Torre Juárez, J. Torres, F. Torrero, R. Urquí, L. Vázquez, T. Velasco, J. Verdasca, M.P. Zorzano, J. Martín-Torres. Space Sci. Rev 170, 583-640 (2012).

- "Analysis of subtropical ciclones within the Northeastern Atlantic Ocean". J.J. González-Alemán, F. Valero, F. Martín-León and J. L. Evans. Poster at 15th EMS Annual Meeting. 07–11 September 2015. Sofia, Bulgaria.

- "A single method to estimate the daily global solar radiation from monthly data". A. Manzano, M.L. Martín, F. Valero, C. Armenta. Atmospheric Research 166 (2015) 70–82.

- "A model to calculate solar radiation fluxes on the Martian surface". Á. Vicente-Retortillo, F. Valero, L. Vázquez and G. M. Martínez. J. Space Weather Space Clim., 5, A33 (2015).

2.2. Data mining and modelling

The core research in this block has been regarding

- Cloud Computing. For more information see:
  - C. Catlett, W. Gentzsch, L. Grandinetti, G.R. Joubert and J.L. Vázquez-Poletti. “Cloud Computing and Big Data”. Advances in Parallel Computing, Vol. 23. IOS Press, October 2013.
  - J.L. Vázquez-Poletti, D. Santos Muñoz, I. M. Llorente and F. Valero: “A Cloud for Clouds: Weather Research and Forecasting on a Public Cloud Infrastructure”. Cloud Computing and Services Sciences, Springer, 512:3-11, 2015.
- Fractional Calculus: Suitable mathematical tool to model nonlocal phenomena either in time and/or in space:
  - M. P. Velasco, D. Usero, S. Jiménez, C. Aguirre and L. Vázquez. “Mathematics and Mars Exploration”. Pure and Applied Geophysics. Springer, 172, 33-47 (2015).
  - L. Vázquez and H. Jafari (Eds.).”Fractional Calculus: Theory and Numerical Methods”. Central European Journal of Physics 11, (2013).
- Tomographic methods and structural equations to identify events very localized either in time and / or space as the dust devils, auroras,etc
- Determine future trends of the geomagnetic field changes: detection of geomagnetic anomalies, identify different magnetic events related to the solar activity.
- At present we are involved in the electric and dust analysis of the data associated to the campaigns of DREAMS-ExoMars2016 with the group of Francesca Esposito.

2.3. Geodesic studies: modelling the Phobos eclipses

The fundamental research in this block is related to the following issues:

- To detect the Phobos eclipses
- Determination of rover/lander position using Phobos transits
- Implications for the Phobos orbit from its shadow information.
- To improve the estimate of tidal dissipation within from shadow of Phobos observations.

The results are reflected in the following publications:

- Romero, P., Barderas, G. and García-Roldán, J. "Station-Keeping Manoeuvres to Control the Inclination Evolution of Areostationary Satellites". Journal of Guidance, Control and Dynamics, 38, 2223-2227 (2015).

- G. Barderas, C. Plaza and P. Romero. "Comparación de la metodología utilizada para el cálculo de los parámetros orbitales en los Centros de Análisis del Servicio GNSS Internacional (IGS)". Física de la Tierra Vol. 26, 163-173 (2014).

- Barderas G. and P. Romero. "Positioning with Astrogeodetic Techniques for the Mars Exploration". Proceedings da 8ª Assembleia Luso Espanhola de Geodesia e Geofísica. ISBN: 978-989-98836-0-4 (2014).

- J.J. Silva and P. Romero. "Optimal longitudes determination for the station keeping of areostationary satellites". Planetary and Space Science. 87, 14-18, (2013).

- G. Barderas, P. Romero. "On the inverse problem of determining Mars, lander coordinates using Phobos eclipse observations". Planetary and Space Science 79, 39-44 (2013).

- G. Barderas, P. Romero L. Vazquez, J.L. Vazquez-Poletti, and I.M. Llorente. 2012. "Phobos Eclipse Observation Opportunities with the Mars Science Laboratory". Mon. Not. R. Astron. Soc.496, 3195-3200 (2012).

- Barderas, G., Romero, P., 2012. "Observations of Phobos shadow: Analysis of parameters connecting Earth-Mars reference frames". Planetary and Space Science, 10.1016/j.pss.2012.06.008.

- Barderas G., Romero P. and Vazquez L, 2012. "Phobos Eclipse Observation Opportunities with the Mars Science Laboratory". EPSC Abstracts, Vol. 7 EPSC2012-326. European Planetary Science Congress 2012.

- Harri A., Schmidt W., Romero P., Vazquez L., Barderas G., Kemppinen O., Aguirre C., Vazquez-Poletti J., Llorente I., Haukka H., Paton M., 2012. "Phobos eclipse detection on Mars: theory and practice". In Reports 2012:2, Finnish Meteorological Institute.

- Romero, P., Barderas, G., Vazquez-Poletti, J., Llorente, I., 2011. "Spatial chronogram to detect Phobos eclipses on Mars with the MetNet Precursor Lander". Planetary and Space Science 59, 1542–1550.

Figura 2: Mars Curiosity Rover after crossing Dingo Gap Sand dune.

- Vazquez-Poletti, J.L., Barderas, G., Llorente, I.M., Romero, P.. “A model for efficient onboard actualization of an instrumental cyclogram for the Mars Metnet mission on a public cloud infrastructure”. In: PARA 2010: State of the Art in Scientific and Parallel Computing. Lecture Notes in Computer Science. Elsevier, 2010.

- A recent publication which contains results on the three studied issues is: “Mars: A multidisciplinary scientific approach” Eds. M. Herraiz, F. Valero and J. Martínez. Física de la Tierra (Revista Cientifica Complutense) Vol. 28 (2016).

- A panoramic view of the different issues is also contained in the recent conference “Los Muchos Caminos hacia Marte”, Real Sociedad Española de Doctores de España:
`http://www.radoctores.es/pagina.php?item=424`

3. Ph.D. studies in the Martian Research Environment associated to the project Meiga-MetNet

The students are the vectors of the future and especially in the framework of the Space Science and Technology. For this reason, the MRE associated to the Project Meiga-MetNet dedicates special attention to the training and outreach at different levels (summer schools at El Escorial, conferences in high schools, international meetings, and interchanges with international space centres). Special achievements are the completed thesis under the umbrella of the Martian space research:

1. "Characterization of the Martian Planetary Boundary Layer". Germán Martínez Martínez. Universidad Complutense de Madrid (2010). Sobresaliente Cum Laude (European Doctorate). Directores: Prof. Francisco Valero Rodríguez and Luis Vázquez Martínez.

2. "Modelización Fraccionaria y Sistemas con Dinámica Anómala. Teoría y Aplicaciones". María Pilar Velasco Cebrián. Universidad Complutense de Madrid (2012). Sobresaliente Cum Laude (European Doctorate). Directores: Prof. Luis Vázquez Martínez and Prof. Juan J. Trujillo Jacinto del Castillo.

3. "Determinación de las Coordenadas de Amartizaje de las Sondas MetNet". Gonzalo Barderas Manchado. Universidad Complutense de Madrid (2013) Sobresaliente Cum Laude (European Doctorate). Director: Prof. Pilar Romero Pérez.

4. "Ionosfera de Marte: Calibración y Análisis de Datos, y Modelado". Beatriz Sánchez – Cano Moreno de Redrojo. Universidad Complutense de Madrid (2014) Sobresaliente Cum Laude (European Doctorate). Directores: Prof. Miguel Herraiz Sarachaga, Dr. Olivier Witasse and Prof. Gracia Rodríguez Caderot.

5. "Generalización de Polinomios de Hermite en la descripción de polinomios de tipo Chebyshev". Clemente Cesarano. Universidad Complutense de Madrid (2015) Sobresaliente Cum Laude (European Doctorate). Directores: Prof. Luis Vázquez Martínez and Prof. Salvador Jiménez Burillo.

6. "Análisis de los Campos Eléctricos y Magnéticos de Marte". María Ramírez Nicolás. Universidad Complutense de Madrid (2015). Sobresaliente Cum Laude (European Doctorate). Directores: Prof. Luis Vázquez Martínez and Prof. Miguel Herraiz Sarachaga.

7. "Navegación de Sistemas Aéreos Remotamente Pilotados Utilizando una Infraestructura de Datos Espaciales". Cristina Amoros Canet. Universidad Complutense de Madrid (2016). Directora: Prof. Pilar Romero Pérez.

8. “Desarrollo de Modelos de Transferencia Radiativa Adaptados a la Atmósfera de Marte y su Aplicación para el Análisis de las Medidas de REMS-MSL”. Álvaro de Vicente-Retortillo Rubalcaba. Universidad Complutense de Madrid. Presentation in academic year 2016-2017. Directores: Prof. Francisco Valero Rodríguez and Luis Vázquez Martínez.

4. Present status (2016-)

In this new period, we are supported by the Ministerio de Economía y Competitividad under the grant ESP2016-79135-R. On the other hand, the instruments previously developed in the framework of METNET are included in the missions ExoMars2016 and ExoMars2020. There is the possibility that one of the METNET stations could fly in the projected Russian Mission Phobos-Grunt for 2022/2024.

We are very involved in the Mission ExoMars2016 and we also will participate in ExoMars2020. In the first case, we participate as Co-Is in the payload package DREAMS (Dust Characterization, Risk Assessment and Environment Analyser in the Martian Surface) of the lander Schiaparelli, and in the Atmospheric Chemistry Suite (ACS) of the orbiter TGO (Trace Gas Orbiter). With TGO safely working its way into its final orbit, we hope to receive important new data on the Martian atmosphere, including the methane. On the other hand, the problems on-board Schiaparelli did not permit a soft landing unfortunately. The engineers of ESA are working hard to understand the causes. Our work in DREAMS is reflected in the following two publications:

- “The DREAMS experiment on board the Schiaparelli Module of the ExoMars 2016 mission: design, performances and expected results” F. Esposito, S. Debei, C. Bettanini, C. Molfese, I. Arruego Rodríguez, G. Colombatti, A-M. Harri, F. Montmessin, C. Wilson, A. Aboudan, P. Schipani, L. Marty, F.J. Álvarez, V. Apestigue, G. Bellucci, J-J. Berthelier, J. R. Brucato, S. B. Calcutt, S. Chiodini, F. Cortecchia, F. Cozzolino, F. Cucciarrè, N. Deniskina, G. Déprez, G. Di Achille, F. Ferri, F. Forget, G. Franzese, E. Friso, M. Genzer, R. Hassen- Kodja, H. Haukka, M. Hieta, J. J. Jiménez, J-L. Josset, H. Kahanpää, O. Karatekin, G. Landis, L. Lapauw, R. Lorenz, J. Martinez-Oter, V. Mennella, D. Möhlmann, D. Moirin, R. Molinaro, T. Nikkanen, E. Palomba, M.R. Patel, J-P. Pommereau, C.I. Popa1, S. Rafkin, P. Rannou, N.O. Renno, J. Rivas, W. 11 Schmidt, E. Segato, S. Silvestro, A. Spiga, D. Toledo, R. Trautner, F. Valero, L. Vázquez, F. Vivat, O. Witasse, M. Yela, R. Mugnuolo, E. Marchetti, S. Pirrotta. To be published in a special issue of Space Science Review.

- "Signal-adapted tomography as a tool for dust devil detection" C. Aguirre, G. Franzese, F. Esposito, Luis Vázquez, Rui Vilela-Mendes, Raquel Caro, María Ramírez-Nicolás, F. Cozzolino, C. Popa. To be submitted.

In this period, our activity could be summarized as follows:

- Continuation of the study of REMS-Curiosity data: Pressure, Humidity, Temperature, Ultraviolet Radiation.
- To complete the data analysis related to the instruments of DREAMS-Schiaparelli.
- Preparation of the structure and protocols of cloud computing to be used with the ACS data.
- Study of the eclipses of Phobos for the missions ExoMars2016 and ExoMars2020. Optimization of parameters. Communications.
- Study of data set with non-uniform acquisition.
- To complete the development of the tomographic method to detect events very localized either in space and / or time.
- Application of the Fractional Calculus to model non local phenomena either in space and/or time.
- Applications to the analysis of biological signals.
- Applications to the study of economic data in collaboration with Instituto de Investigaciones Económicas y Sociales "Francisco de Vitoria".

5. Conclusions

On the basis of the past activity, the Martian Research Environment associated to the Project Meiga-MetNet at Complutense University will continue because there are instruments and missions to Mars. A mission can fail but what cannot fail is the associated environment research. On the other hand, the Space Research Environment is a strategic issue for the University since it is interdisciplinary, transdisciplinary, global and international, at the same time that has provided a natural link with the industry. As an indicator of this context, we have the blog `http://es.rbth.com/blogs/limites-cientificos`.

Acknowledgments

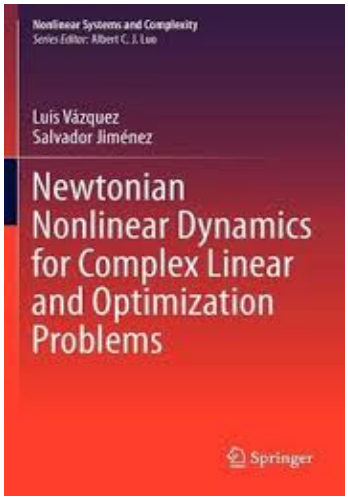
This paper is a summary of the presentation exposed in the seminar which took place at Universidad Francisco de Vitoria on 14th March, 2016. We thank the support of Instituto de Investigaciones Económicas y Sociales Francisco de Vitoria through the project "De la exploración de Marte a la economía: Minería de datos y cálculo fraccionario" (2016). We acknowledge the support through the projects and the associated scholarships granted by Ministerio de Educación y Ciencia ESP2007-30839-E (2008); Ministerio de Ciencia e Innovación AYA2008-06420-C04-03 (2009), AYA2009-14212-C05-05 (2010-2011); Ministerio de Economía y Competitividad AYA2011-29967-C05-02 (2012- 30/Sept/2015). We have to understand the above projects in the context of a strong collaboration with the Instituto Nacional de Técnica Aeroespacial (INTA) through Dr. Lola Sabau Graziati (Head of the Payloads and Instrumentation) and Dr. Hector Guerrero Padrón (Mission Director MEIGA-MetNet Precursor) to whom we are deeply indebted. Also, we thank the Universidad Complutense de Madrid for the administrative and outreach support along these years.

3 Reseñas de Libros y Tesis Doctorales

3.1 Libros

Newtonian Nonlinear Dynamics for Complex Linear and Optimization Problems

Luis Vázquez and Salvador Jiménez
Springer (2013)
ISBN 978-1-4614-5912-5



(From the authors)

This book represents a good example of how analysing and enjoying a game, we can generate new and refreshing approaches to old and new problems.

In a Pinball Machine, the player tries to score points by manipulating a metal ball on a playing field inside a glass covered case. The objectives of the game are to score as many points as possible, to earn free games and to maximize the time spent playing by earning extra balls and keeping balls in play as long as possible. Apart from the new challenging features, the good old pinball playing field is essentially a planar surface inclined upwards from 3 to 7 degrees, away from the player, and includes multiple targets and scoring objectives. The ball is put into play by the use of the plunger which propels upwards the ball. Once the ball is in play, it tends to move downwards towards the player, although the ball can move in any direction, sometimes unpredictably, as the result of contact with objects on the playing field or by the player actions. To return the ball to the upper part of the playing field, the player makes use mainly of one or more flippers. The game ends whenever the ball crosses downwards the "flippers barrier".

The Pinball Machine provides a simple mechanical example of the linear optimization problem, basically in a surface embedded in the three-dimensional space. In all pinball games, the play with every ball finishes when that ball reaches the minimum gravitational potential energy immediately after the flippers barrier. On the other hand, the playing field where the ball moves is, effectively, a convex planar region. The duration of the ball motion is always finite, even considering the human interaction. This fact indicates that the minimum of the

Objective Function (in this case, the Linear Potential Gravitational Energy) is always attained by the motion of the ball. *This example suggests us to associate the solutions of some optimization problems to the motion of Newtonian particles*. At the same time, this example is a bridge that allows us to construct algorithms for linear/nonlinear optimization problems and unconstrained extrema by applying to them the numerical algorithms used to simulate the equations of motion for a Newtonian particle. These are the motivation and the objective of this monograph. *The framework of this monograph wants to be constructive*: we want to present some methods and their features that show how Newton's equation for the motion of one particle in classical mechanics combined with finite difference methods can create a mechanical scenario within which we may solve some basic, though complex, problems. We, thus, *apply these ideas to solve linear systems and eigenvector problems, as well as programming, both linear and nonlinear, in different dimensions. In this framework the goal of the monograph is to show a breakthrough analysis method of optimization* by combining the features of the motion of a Newtonian classical particle and finite difference numerical algorithms associated with the equation of motion. *Many challenging questions remain open*, but we think that a new, fresh and feasible approach to solve them is shown. *This unified numerical and mechanical approach is new*, to the best of authors knowledge, and this view represents a simple but useful tool not yet fully exploited.

This monograph is intended for a broad public: undergraduate and graduate students or researchers who are confronted in their work with linear systems and eigenvalue or optimization problems and who are open to new perspectives in the way these problems can be addressed. To help the reader to explore these ideas, we propose *a list of related exercises at the end of each chapter*.

The basic mechanical equations and assumptions are presented in Chap. 1: a review of the basic laws for the motion of a particle under Newton's second law, in one and several dimensions, with and without dissipation. Two numerical schemes are described, to simulate the corresponding equations of the motion. In Chap. 2 it is proposed a new iterative approach to solve systems of linear equations. The new strategy integrates the algebraic basis of the problem with elements from classical mechanics and the finite difference method. These methods are general and depend on neither the matrix dimension nor the matrix structure. As a consequence, it is presented a general method to determine whether a given square matrix is singular or not. The application to several examples is shown in Chap. 3, together with the comparison with the classical methods as Jacobi, Gauss–Seidel, and Steepest Descent Methods. The computation of eigenvectors and eigenvalues of matrices is presented in Chap. 4. In Chap. 5 it is presented some ways to enhance the linear convergence of the method, combining it with two different quadratic methods.

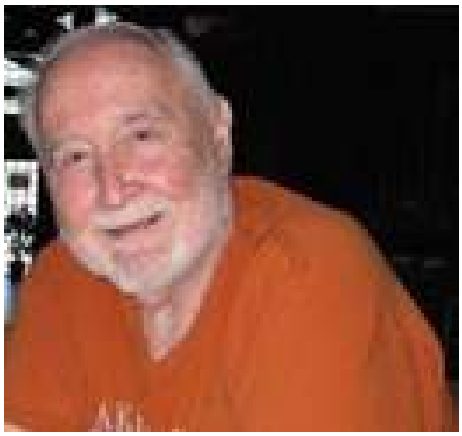
In Chaps.6 and 7, the mechanical ideas are applied to solve the so-called

programming problems. Chapter 6 is devoted to the classical linear programming problem. A new iterative process to approach the solution of the Primal Problem associated with the linear programming problem: $\max Z = C^t x$, with some linear constraints. The method is based on translating the problem to the motion of a Newtonian particle in a constant force field. The optimization of the objective function is related to the search for the minimum of the particle's potential energy. Several solution strategies which depend on the number of dimensions are developed and also illustrated through different examples.

Finally the Chap. 7 is devoted to the classical quadratic programming. The previous method is extended to the case of optimizing a quadratic objective function with linear constraints as well as to the case of a linear function with quadratic constraints. The method can also be extended to the general case of a nonlinear objective function with linear constraints.

4 Noticias y anuncios

4.1 William B. Gragg (1936-2016)



El pasado 25 de Diciembre de 2016 falleció en su casa de Monterey (California) el matemático norteamericano William (Bill) Bryant Gragg, a la edad de 80 años, después de una breve enfermedad.

Bill Gragg era *Emeritus Professor* en el Department of Applied Mathematics at the Naval Post Graduate School, una *graduate school* perteneciente a la United States Navy.

El profesor Gragg completó su tesis doctoral en la University of California at Los Angeles (UCLA) en 1964, bajo la dirección de Peter Henrici. Uno de los resultados de su tesis dio lugar al llamado *método de extrapolación de Gragg* para la resolución numérica de ecuaciones diferenciales ordinarias. Este método también es llamado algoritmo de Gragg–Bulirsch–Stoer.

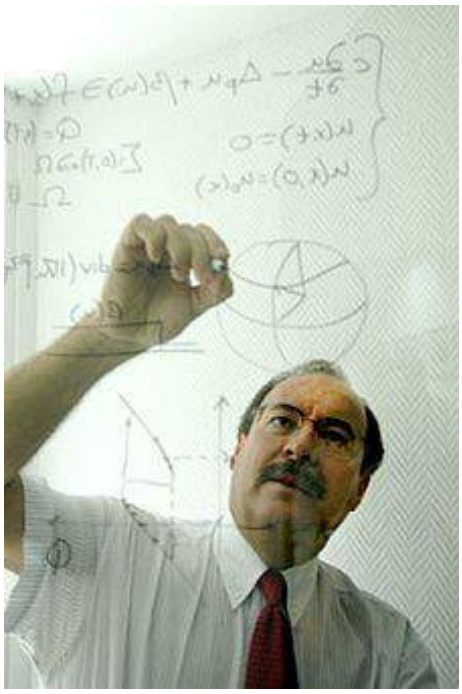
A lo largo de su carrera, el prof. Gragg hizo contribuciones fundamentales en varias áreas del análisis numérico, además del algoritmo que lleva su nombre. Así, podemos citar sus trabajos sobre el algoritmo QR para matrices de Hessenberg unitarias, soluciones super-rápidas para sistemas de Toeplitz, algoritmos paralelos para la resolución de problemas de valores propios, o sus trabajos sobre la tabla de Padé y su relación con otros algoritmos del análisis numérico.

Entre la lista de coautores cabe destacar a eminentes matemáticos de diferentes generaciones: A.S. Householder, Gene Golub, G.W. Stewart, Lothar Reichel, James Demmel, Randall J. LeVeque, etc. Sus trabajos, a día de hoy, recogen un

total de 737 citas por parte de 686 autores según MathSciNet, lo que da una idea de la amplitud e influencia de su actividad científica.

Con motivo de su 70 cumpleaños, en noviembre de 2006, sus colaboradores y amigos Gregg Ammar, Lothar Reichel y Marc Van Barel organizaron la conferencia "Numerical Analysis in Monterey", fruto de la cual fue la edición de un número especial de la revista *Journal of Computational and Applied Mathematics* (vol. **233**, issue 5, (2010)), en el que se recogen contribuciones en las diferentes áreas en las que trabajó el prof. Gragg. Más de seis años después de la aparición de ese volumen, siguen siendo especialmente apropidas las últimas palabras del Editorial que lo introduce: *"In addition to his direct contributions as a researcher, Bill Gragg also has stimulated progress in scientific computation and numerical analysis through his enthusiasm and encouragement of friends and colleagues"*.

4.2 Jesús Ildefonso Díaz, elegido miembro de la *European Academy of Sciences*



Jesús Ildefonso Díaz (Toledo, 1950) ha sido recientemente elegido miembro de la *European Academy of Sciences*. Como todos los socios de SëMA conocen, Ildefonso Díaz es Catedrático de Matemática Aplicada en la Universidad Complutense de Madrid (UCM) y académico de la Real Academia de Ciencias Exactas, Físicas y Naturales desde 1997 (medalla número 13). Fue fundador y director del Departamento de Matemática Aplicada de la UCM desde 1986 a 1994.

Su actividad investigadora, principalmente en ecuaciones en derivadas parciales no lineales, fue reconocida con el nombramiento de Doctor "Honoris Causa" por la Université de Pau et des Pays de l'Adour, Francia (29 de marzo de 1996). Ha sido fundador y primer editor de la Revista de la Real Academia de Ciencias. Serie A: Matemáticas (RACSAM) desde enero de 2001 hasta 2004. En 1980 obtuvo el Premio de Matemáticas de la Real Academia de Ciencias, en 1989 el Premio de la Academia Canaria de Ciencias, de la que es Académico Correspondiente desde 1989. En el 2015 obtuvo el *Grand Prix Jacques-Louis Lions* de la Acadèmie des Sciences de Francia.

El profesor Díaz fue uno de los organizadores del Primer Congreso de Ecuaciones Diferenciales y Aplicaciones (CEDYA), además de fundador y

Presidente de SëMA. También fue miembro del Comité Ejecutivo para la refundación de la Real Sociedad Matemática Española (RSME).

En el ámbito internacional, ha sido miembro activo de varios comités distinguidos de la International Mathematical Union, de la European Mathematical Society y otras instituciones internacionales. También fue miembro del Comité Español para el Año Mundial de las Matemáticas (CEAM) y del Comité de la Comunidad de Madrid (M2000M). Fue organizador (y editor de un libro conmemorativo) de la Jornada Matemática celebrada en el Congreso de los Diputados el 21 de enero de 2000.

Como reza en su página web, la *European Academy of Sciences* (EURASC) *"is a non-profit non-governmental, independent organization of the most distinguished scholars and engineers performing forefront research and the development of advanced technologies, united by a commitment to promoting science and technology and their essential roles in fostering social and economic development."*

"The European Academy of Sciences (EURASC) is a fully independent international association of distinguished scholars that aims to recognise and elect to its membership the best European scientists with a vision for Europe as a whole, transcending national borders both in elections and in actions, and with the aims of strengthening European science and scientific cooperation and of utilising the expertise of its members in advising other European bodies in the betterment of European research, technological application and social development."

La EURACS tiene varias divisiones, entre las que se encuentran las de Ciencias de la Computación y de la Información (encabezada por Alfio Quarteroni, Endre Süli y Olivier Pironneau, entre otros) y la de Matemáticas (dirigida por Benoit Perthame y en cuya lista de *Officers* figura Luis Vega). Entre los miembros de EURACS figuran premios Nobel, medallistas Fields y premios Abel. Otros matemáticos españoles de EURACS son Jesús Sanz-Serna y Juan Luis Vázquez

Desde SëMA queremos felicitar al profesor Jesús Ildefonso Díaz por su elección para formar parte de tan prestigioso foro.

4.3 SeMA Journal

Índice del Vol. 73, issue 4, December 2016 de SëMA Journal

1. A. Neirameh, *New soliton solutions to the fractional perturbed nonlinear Schrödinger equation with power law nonlinearity*, pages 309-323.

2. Ioannis K. Argyros and Munish Kansal, *Unified local convergence for a certain family of methods in Banach space*, pages 325-334.

3. Mohammadreza Foroutan, Ali Ebadian and Shahram Najafzadeh, *The use of generalized Laguerre functions for solving the equation of magnetohydydinamic flow due to a stretching cylinder*, pages 335-346.

4. Rafael Cantó, María J. Peláez and Ana M. Urbano, *On the characterization of totally nonpositive matrices*, pages 347-368.

5. Ioannis K. Argyros, Munish Kansal and V. Kanwar, *Local convergence for multipoint methods using only the first derivative*, pages 369-378.

6. S. Ariche, C. De Coster and S. Nicaise, *Regularity of solutions of elliptic or parabolic problems with Dirac measures as data*, pages 379-426.

5 Socios Institucionales de SeMA

1. Banco Santander (Socio de Honor)
2. Basque Center for Applied Mathematics (BCAM)
3. Centre de Recerca Matemàtica (CRM)
4. Iberdrola
5. Dep. de Matemáticas (Facultad de Ciencias, Univ. Autónoma de Madrid)
6. Instituto de Ciencias Matemáticas (ICMAT)
7. Dep. de Matemáticas (Escuela Politécnica Superior, Univ. Carlos III de Madrid)
8. Dep. de Matemática Aplicada (Facultad de CC. Matemáticas, Univ. Complutense de Madrid)
9. Dep. de Matemáticas (Facultad de Ciencias, Univ. de Cádiz)
10. Dep. de Matemática Aplicada y C. de la Computación (E.T.S.I. Industriales y de Telecomunicación, Univ. de Cantabria)
11. Dep. de Matemáticas, Estadística y Computación (Facultad de Ciencias, Univ. de Cantabria)
12. Dep. de Matemáticas (E.T.S.I. Industriales, Univ. de Castilla-La Mancha)
13. Instituto de Matemática Aplicada a la Ciencia y la Ingeniería (IMACI) (E. T. S. de Ingenieros Industriales, Univ. de Castilla-La Mancha)
14. Dep. de Informática y Análisis Numérico (Facultad de Ciencias, Univ. de Córdoba)
15. Dep. de Matemática Aplicada (Facultad de Ciencias, Univ. de Granada)
16. Dep. de Matemáticas (Facultad de Ciencias Experimentales, Univ. de Huelva)
17. Dep. de Matemáticas (Facultad de Informática, Univ. de La Coruña)

18. Dep. de Análisis Matemático (Facultad de Matemáticas, Univ. de La Laguna)
19. Dep. de Matemáticas (E.I. Industrial e Informática, Univ. de León)
20. Dep. de Matemàtica (Escuela Politécnica Superior, Univ. de Lleida)
21. Dep. de Análisis Matemático (Facultad de Ciencias, Univ. de Málaga)
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23. Facultad de Ciencias (Univ. de Oviedo)
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25. Dep. de Matemática Aplicada (Facultade de Matemáticas, Univ. de Santiago de Compostela)
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31. Dep. de Matemática Aplicada II (E.T.S.I. Telecomunicación, Univ. de Vigo)
32. Dep. de Matemática Aplicada I (E.T.S.I. Telecomunicación, Univ. de Vigo)
33. Dep. de Matemática Aplicada (Univ. de Zaragoza)
34. Dep. de Matemática Aplicada, Estadística e Investig. Operativa (Facultad de Ciencias, Univ. del País Vasco)
35. Dep. de Matemática Aplicada I (E.T.S.I. Industriales, Univ. Nacional de Educación a Distancia)
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37. Dep. de Matemática e Informática Aplicadas a la Ingeniería Civil (E.T.S.I. Caminos, Canales y Puertos, Univ. Politécnica de Madrid)

38. Dep. de Matemática Aplicada a la Ingeniería Aeroespacial (E.T.S.I. Aeronáuticos, Univ. Politécnica de Madrid)

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42. Departamento de Matemática Aplicada (Univ. Politécnica de Valencia)

43. Institut de Matemàtiques i Aplicacions de Castelló (IMAC, Universitat Jaume I))

44. Instituto de Matemática Multidisciplinar (IM2, Univ. Politècnica de València)

45. Instituto Universitario de Matemática Pura y Aplicada (IUMPA, Univ. Politècnica de València)

46. Dep. de Ingeniería Matemática e Informática (Univ. Pública de Navarra)

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