REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
	Federal Financial Report	09, 05, 2011 - 04, 14, 2012

4. TITLE AND SUBTITLE
Conference Support for IAU SYMPOSIUM 286; COMPARATIVE MAGNETIC MINIMA: CHARACTERIZING QUIET TIMES IN THE SUN AND STARS

5a. CONTRACT NUMBER

5b. GRANT NUMBER
FA9550-11-1-0285

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
DR. CRISTINA MANDRINI

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

UBATEC S.A.
Gral. Juan Jose Viamonte 577
Piso 6 Depto 56
Ciudad de Buenos Air C1053ABK
Argentina

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
USAF AFRL AFOSR
875 N. Randolph St. Room 3112
Arlington VA 22203

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
AFRL-OSR-VA-TR-2012-0935

12. DISTRIBUTION / AVAILABILITY STATEMENT

DISTRIBUTION A: Approved for Public Release

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Solar and stellar minima represent times of low magnetic activity and simple helio/asterospheres. They are thus excellent targets for interdisciplinary, system-wide studies of the origins of stellar variability and consequent impacts on planetary systems. The recent solar minimum lasted longer and was "quieter" than any we have observed in the Space Age, inspiring both scientific and public interest. It also extends our knowledge of the dynamic range of solar activity and how it affects space weather to unprecedented low levels. A rich variety of satellite and ground-based observations, in conjunction with theoretical and numerical modeling advances, have allowed us to probe the peculiarities of this minimum as never before. The implications are far-reaching, connecting Earth to Sun to stars, radio to X-ray to cosmic rays, and the plethora of observations of recent minima to the Sun's past behavior as preserved in cosmogenic isotopes and historical sunspot and auroral records.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE		3	Alejandra Saccomandi
					19b. TELEPHONE NUMBER *(include area code)* +54-11-43133600

IAU Symposium 286: Comparative Magnetic Minima: Characterizing quiet times in the Sun and stars

3-7 October 2011, Mendoza, Argentina

Symposium Program

(Click here for the Abstract Book in PDF format)

Sunday 2 October

16:30 - 18:30 Registration (at the auditorium)

20:30 - 23:30 Icebreaker (at Huentala Hotel's Kitek Cava Lounge)

Monday 3 October

8:30 – 9:20 Registration

9:20 – 9:40 Welcome Words

Session 1 – Solar and Stellar Minima (Chairs: Hebe Cremades, Sarah Gibson)

9:40 – 10:25 Keynote Talk - *The Nature and Significance of Solar Minima* Eric Priest (Presentation file)

10:25 – 10:55 Invited Talk - *Solar and Stellar Activity Diagnostics and Indices* Michael Thompson(Presentation file)

10:55 – 11: 25 Coffee break

11:25 – 11:45 Solicited Talk - *How Well Do We Know Sunspot Number?* Leif Svalgaard (Presentation file)

Session 2 – Dynamos and Cycle Variability (Chairs: Daniel Gómez, Gustavo Guerrero)

11:45 – 12:15 Invited Talk - *Dynamo Action and Magnetic Activity in the Sun and Stars* A. Sacha Brun (Presentation file)

12:15 – 12:45 Invited Talk - *Cycles and Cycle Modulation in Large-Scale Turbulent Dynamos* Axel Brandenburg

12:45 – 13:00 Contributed Talk - *Magnetic Helicity Fluxes and their Effect on the Solar Dynamo* Simon Candelaresi, A. Brandenburg (Presentation file)

13:00 - 15:00 Lunch break

15:00 – 15:30 Invited Talk - *Kinematic Dynamo Models of the Solar Cycle: Past, Present, and Future* Dibyendu Nandi (Presentation file)

15:30 – 16:00 Invited Talk - *Global MHD Simulations of Stellar Dynamos and the Ingredients for Large-scale*

Field Organization Matthew Browning, B. Brown, M. Miesch, et al. (Presentation file)

16:00 – 16:15 Contributed Talk - *Dynamo Action and Magnetic Buoyancy in Convection Simulations in Simulated Tachoclines* Gustavo Guerrero, P. Käpylä (Presentation file)

16:15 – 16:30 Contributed Talk – *Tayler Instability and Stellar Magnetic Fields* Fabio del Sordo, A. Brandenburg (Presentation file)

16:30 – 16:45 Contributed Talk - *Understanding the Origin of the Extended Minimum of Sunspot Cycle 23* Andrés Muñoz-Jaramillo, D. Nandy, P.C.H. Martens (Presentation file)

16:45 – 17: 15 Coffee break

17:15 – 19:00 Poster Session

Tuesday 4 October

8:15 – 9:15 Registration

Session 2 – Dynamos and Cycle Variability (Chairs: Daniel Gómez, Gustavo Guerrero)

9:15 – 9:45 Invited Talk - *Helioseismic Probing of Dynamo Related Flows* Michael Thompson (on behalf of Frank Hill) (Presentation file)

9:45 – 10:00 Contributed Talk - *Analyzing the Evolution of the Photospheric Magnetic Field in Terms of Spherical Harmonics and Consequences for the Solar Dynamo* Marc DeRosa, A.S. Brun, J.T. Hoeksema (Presentation file)

Session 3 – Comparative Solar Minima from Sun to Earth (Chairs: Margit Haberreiter, Andrey Tlatov, David Webb)

10:00 – 10:30 Invited Talk – *Helioseismology: A View of the Solar Interior* Yvonne Elsworth (Presentation file)

10:30 – 10:45 Contributed Talk - *Reconstruction of Magnetic Field Surges to the Poles from Sunspot Impulses* Nadezhda Zolotova, D.I. Ponyavin (Presentation file)

10:45 – 11:15 Coffee break

11:15 – 11:45 Invited Talk - *Total Solar Irradiance, Absolute Value and an Estimate of a Long-term Trend from Minimum to Minimum* Werner Schmutz, A. Fehlman, W. Finsterle, M. Suter (Presentation file)

11:45 – 12:00 Contributed Talk - *The Ni I Lines in the Solar Spectrum* Mariela Vieytes, P. Mauas, J. Fontenla (Presentation file)

12:00 – 12:15 Contributed Talk - *Modeling the Solar EUV Variability* Margit Haberreiter (Presentation file)

12:15 – 12:30 Contributed Talk - *The Use of 17 GHz Radio Emission to Characterize the Solar Minimum* Caius Selhorst, L. Svalgaard, C.G. Giménez de Castro, et al. (Presentation file)

12:30 – 13:00 Invited Talk - *Polar Magnetic Fields and Coronal Holes during the Recent Solar Minima* Giuliana de Toma (Presentation file)

13:00 – 15:00 Lunch break

15:00 – 15:30 Invited Talk - *Global Magnetic Fields: Variation of Solar Minima* Andrey Tlatov, V.N. Obridko (Presentation file)

15:30 – 16:00 Invited Talk - *The 3D Solar Minimum Corona with Differential Emission Measure Tomography* Alberto Vásquez, R.A. Frazin, Z. Huang, et al. (Presentation file)

16:00 – 16:15 Contributed Talk - *Solar Cycle 23 and 24 Minima Seen through the Eyes of Coronal MHD Models* Jon Linker, Z, Mikic, P. Riley, et al. (Presentation file)

16:15 – 16:30 Contributed Talk - *Large-scale Photospheric Flow Patterns around Coronal Structures* Neal Hurlburt (Presentation file)

16:30 – 16:45 Contributed Talk - *The Role of Streamers in the Deflection of Coronal Mass Ejections: Comparison between STEREO 3D Reconstructions and Numerical Simulations* Francesco Zuccarello, A. Bemporad, C. Jacobs, et al. (Presentation file)

16:45 – 17:15 Coffee break

17:15 – 17:45 Invited Talk - *The Structure of the Heliosphere in Solar Minima and Consequences on Interplanetary Flux Rope Properties* Sergio Dasso, A.M. Gulisano, P. Démoulin (Presentation file)

17:45 – 18:00 Contributed Talk - *Coronal Transients during Two Solar Minima: Their Source Regions and Interplanetary Counterparts* Hebe Cremades, C.H. Mandrini, S. Dasso (Presentation file)

18:00 – 18:15 Contributed Talk - *Dynamo-driven Plasmoid Ejections above a Spherical Surface* Jörn Warnecke, A. Brandenburg, D. Mitra (Presentation file)

18:15 – 18:30 Contributed Talk - *Dynamic Evolution of Interplanetary Wave Shocks Driven by CMEs* Pedro Corona Romero, J.A. González Esparza (Presentation file)

18:30 – 18:45 Contributed Talk - *Dynamical Evolution of Anisotropies of the Solar Wind Magnetic Turbulent Outer Scale* María Emilia Ruiz, S. Dasso, W.H. Matthaeus, et al. (Presentation file)

Wednesday 5 October

Session 3 – Comparative Solar Minima from Sun to Earth (Chairs: Margit Haberreitter, Andrey Tlatov, David Webb)

9:00 – 9:30 Invited Talk - *Interplanetary Conditions: Lessons from this Minimum* Janet Luhmann, C.O. Lee, P. Riley, et al. (Presentation file)

9:30 – 9:50 Solicited Talk - *The Floor in the Solar Wind Magnetic Field: Status Report* Ed Cliver (Presentation file)

9:50 – 10:05 Contributed Talk – *Long-term Solar Wind Variations and the Coming Solar Minimum* Ramón López (Presentation file)

10:05 – 10:35 Invited Talk – *Probing the Heliosphere with the Directional Anisotropy of Galactic Cosmic Ray Intensity* Kazuoki Munakata (Presentation file)

10:35 – 10:50 Contributed Talk – *Search for Solar Energetic Particles Signals on Mexico City Neutron Monitor Database* Bernardo Vargas, J.F. Valdés Galicia (Presentation file)

10:50 – 11:15 Coffee break

11:15 – 11: 45 Invited Talk – *On the Cause of Extremely Low Geomagnetic Activity during the Recent Deep*

Solar Cycle Minimum Ezequiel Echer, B. Tsurutani, W.D. González (Presentation file)

11:45 – 12:00 Contributed Talk – *WHI in the Context of a Long and Structured Solar Minimum: An Overview of Sun-to-Earth Observations* Sarah Gibson, G. de Toma, Y. Elsworth, et al. (Presentation file)

12:00 – 12:30 Invited Talk – *Modeling of the Atmospheric Response to a Strong Decrease of the Solar Activity* Eugene Rozanov, T. Egorova, A. Shapiro, W. Schmutz (Presentation file)

12:30 – 13:00 Invited Talk – *Ionosphere and Upper Atmosphere under the Extremely Prolonged Low Solar Activity of Solar Cycle 23 /24* Inez Batista, C.M.N. Candido, C. Brum, M.A. Abdu (Presentation file)

13:00 – 15:00 Lunch break

Session 4 – Stellar Cycles (Chairs: Cristina Mandrini, Adriana Válio)

15:00 – 15:30 Invited Talk – *Stellar cycles: General Properties and Future Directions* Mark Giampapa (Presentation file)

15:30 – 16:00 Invited Talk - *Investigating Stellar Surface Rotation Using Observations of Starspots* Heidi Korhonen (Presentation file)

16:00 – 16: 20 Solicited Talk – *Modulated Stellar and Solar Cycles: Parallels and Differences* K. Oláh, Lidia van Driel- Gesztelyi (Presentation file)

16:20 – 16:35 Contributed Talk – *The Solar Wind in Time: Internal and External Forcing* Jeffrey Linsky, B. Wood, S. Redfield (Presentation file)

16:35 – 16:50 Contributed Talk – *Stellar Activity Cycles in a Model for Magnetic Flux Generation and Transport* Emre Isik (Presentation file)

16:50 – 17:15 Coffee break

17:15 – 19:00 Poster Session

Thursday 6 October

Session 4 – Stellar Cycles (Chairs: Cristina Mandrini, Adriana Válio)

9:00 – 9:30 Invited Talk – *Magnetic Activity among Cool Stars in the HR-diagram* Jürgen Schmitt

9:30 – 9:45 Contributed Talk – *On the Origin of Stellar Magnetic Fields* Raphael Steinitz, J. Portnoy (Presentation file)

9:45 – 10:15 Invited Talk – *Semi-empirical Modeling of Solar/Stellar Magnetic Cycles* Adriana Válio (Presentation file)

10:15 – 10:30 Contributed Talk – *The Rotation-activity Connection in Young Low Mass Stars* Jenny Rodríguez Gómez, O. Restrepo Gaitán, M. Cuervo Oses, G. Pinzón Estrada (Presentation file)

10:30 – 10:50 Solicited Talk – *12 Years of Stellar Activity Observations in Argentina* Pablo Mauas, A. Buccino, R. Díaz, et al. (Presentation file)

10:50 – 11:15 Coffee break

Session 5 – Grand Minima and Historical Records (Chairs: Alisson Dal Lago, Ilya Usoskin)

11:15 – 11:45 Invited Talk – *Stars in Magnetic Grand Minima: Where Are They and What Are They Like?* Steven Saar (Presentation file)

11:45 – 12:00 Contributed Talk – *Soft X-ray Emission as Diagnostics for Maunder Minimum Stars* Katja Poppenhäger, J.H.M.M. Schmitt (Presentation file)

12:00 – 12:15 Contributed Talk – *Is the Small-scale Quiet Sun Dynamo a Pedestal for Solar (and Stellar) Activity?* Karel Schrijver (Presentation file)

12:15 – 12:35 Solicited Talk – *Interplanetary Space Weather and Space Climate Prediction: Opportunities* Madhulika Guhathakurta

12:35 – 14:30 Lunch break

14:30 Excursion followed by Conference Dinner (see Social Program)

Friday 7 October

Session 5 – Grand Minima and Historical Records (Chairs: Alisson Dal Lago, Ilya Usoskin)

9:00 – 9:30 Invited Talk – *Dynamo Models of Grand Minima* Arnab R. Choudhuri (Presentation file)

9:30 – 9:50 Solicited Talk – *A Simple Dynamo Model for Grand Minima and Geomagnetic Reversals* Dmitry Sokoloff, G. Sobko, V. Trukhin, V. Zadov (Presentation file)

9:50 – 10:05 Contributed Talk – *Is Meridional Circulation Important in Modeling the Irregular Solar Cycle?* Bidya Karak, A.R. Choudhuri (Presentation file)

10:05 – 10:35 Invited Talk – *Grand Minima of Solar Activity on Long-term Scales* Ilya Usoskin, S.K. Solanki (Presentation file)

10:35 – 10:50 Contributed Talk – *Geomagnetic Storms and Solar Activity since 1806* Volker Bothmer, E. Bosman (Presentation file)

10:50 - 11:15 Coffee break

11:15 – 11:45 Invited Talk – *Historical Records of Solar Grand Minima: A Review* José Vaquero (Presentation file)

11:45 - 12:15 Invited Talk - *Does Solar Activity Affect Climate?* Blanca Mendoza (Presentation file)

12:15 – 12:45 Invited Talk - *Effects of Solar Variability on Planetary Plasma Environments and Habitability* César Bertucci (Presentation file)

12:45 – 13:00 Contributed Talk – *EV-Lac as a Potential Host for Habitable Planets* Ximena Abrevaya, E. Cortón, P. Mauas

13:00 – 14:30 Lunch break

14:30 – 15:00 Invited Talk - *Variations of Solar and Cosmic Ray Cycles at the Maunder Minimum* Hiroko Miyahara, Y. Yokoyama, Y.T. Yamaguchi, et al. (Presentation file)

Discussion and Summary (Chair: Cristina Mandrini)

15:00 – 16:00 Discussion led by Karel Schrijver *Can We Establish if We Are Entering a Grand Minimum, and to Whom would that Matter?* (Presentation file)

16:00 – 16:15 Publication Plans - Meeting Summary Cristina Mandrini & David Webb – Hebe Cremades & Sarah Gibson

Public Outreach Talk

17:30 - 18:30 Public Outreach Talk - *Global Warming: Greenhouse Effect or Solar Activity? - Calentamiento Global: ¿Efecto Invernadero o Actividad Solar?* Pablo Mauas (the talk will be given in Spanish)

Poster Contributions

S2 – P1 *Solar Grand Minima and On-Off Intermittent Dynamo* Abraham C.-L. Chian, A. Brandenburg, M.R.E. Proctor, E.L. Rempel

S2 – P2 *Plasma Flow vs. Magnetic Feature Tracking Speeds in the Sun* G. Guerrero, Matthias Rheinhardt, A. Brandenburg, M. Dikpati

S2 – P3 *The Butterfly Diagram Structure in the Minimal Activity Phases* Maurizio Ternullo, P. Romano

S2 – P4 *Creating a database and Analysis of Sunspots at the Solar Observatory of Ica National University in Peru* Lurdes Martínez Meneses, M. Ishitsuka, J. Ishitsuka, H. Trigoso

S3 – P5 *Study of Ground Cosmic Ray Periodicities during Solar Minimum Using the Multidirectional Muon Detector at the Southern Space Observatory* Alisson Dal Lago, L. Ramos Vieira, N.J. Schuch, N.R. Rigozo

S3 – P6 *Long-term Variation of Solar Wind Parameters and their Geoeffectiveness* Vidya C. Dwivedi, D.P. Tiwari, S.P. Agrawal

S3 – P7 *Observations of Coronal Holes during Two Solar Minima* Heidy Gutiérrez, L. Taliashvili

S3 – P8 *Coronal Mass Ejection Deflection in the Corona during the Last Two Solar Minima* Fernando M. López, H. Cremades, L. Balmaceda

S3 – P9 *A Cellular Automaton Model for Coronal Heating* Marcelo López Fuentes, J.A. Klimchuk

S3 – P10 *Magneto-seismology of Solar Atmospheric Loops in the Solar Minimum* Marialejandra Luna-Cardozo, G. Verth, R. Erdélyi

S3 – P11 *High Speed Streams in the Solar Wind during the Last Solar Minimum* G. Maris, O. Maris, Constantin Oprea, M. Mierla

S3 – P12 *Geomagnetic Effects on Cosmic Ray Propagation under Different Conditions* J.J. Masías Meza, X. Bertou, Sergio Dasso

S3 – P13 *Forbush Decreases not Related to Transient Solar Events* Guadalupe Muñoz Martínez, J.F. Valdés Galicia

S3 – P14 *The 3D Solar Corona Cycle 24 Rising Phase from SDO/AIA Tomography* Federico Nuevo, A.M. Vásquez, R.A. Frazin, Zhenguang Huang, W.B. Manchester

S3 – P15 *Earth-directed Coronal Mass Ejections and their Geoeffectiveness during the 2007 – 2010 Interval* Constantin Oprea, M. Mierla, G. Maris

S3 – P16 *Evolution of a Very Complex Active Region during the Decay Phase of Cycle 23* Mariano Poisson, M. López Fuentes, C.H. Mandrini, et al.

S3 – P17 *Cosmic Ray Particles Behavior during the Last Solar Minimum* Marlos Rockenbach Da Silva, A. Dal Lago, W.D. González, et al.

S3- P18 *Radio Signatures Associated with the Origin of LASCO/STEREO CMEs* Carolina Salas Matamoros, L. Taliashvili

S3- P19 *Very Intense Geomagnetic Storms: Solar Sources, Characteristics and Cycle Distribution* Natalia Szajko, G. Cristiani, C.H. Mandrini, A. Dal Lago

S3 – P20 *A Solar Station in Ica: A Research Center to Improve Education at the University and Schools* Raul Terrazas Ramos, M. Ishitsuka, J. Ishitsuka, H. Trigoso

S4 – P21 *Solar Radius and Limb Brightening Variability in the Submillimetric Range* Laura A. Balmaceda, A. Válio, C.L. Selhorst

S4 – P22 *A Statistical Analysis of the Hα – Ca II K Relation for Solar Type Stars of Different Activity Levels* A.P. Buccino, Mariela C. Vieytes, P.J.D. Mauas

S4 – P23 *Determination of the Effective Temperature from Hα Spectral Line Analysis of Solar Type Stars* Deysi Cornejo Espinoza, I. Ramírez, P. Barklem, W. Guevara Day

S4 – P24 *Calibrating the Sun-as-a-star: Using Hinode XRT to Measure Stellar Coronae* Steven H. Saar, P. Testa

S5 – P25 *Potential Energy Stored by Planets and Grand Minima Events* Rodolfo Cionco

S5 – P26 *A new Imminent Grand Minima?* Rodolfo Cionco, R.H. Compagnucci

S5 – P27 *Long-term Relation between Sunspot Activity and Surface Temperature at Different Geographical Regions* M.P. Souza Echer, Ezequiel Echer, W.D. González, et al.

S5 – P28 *Parallels among the "Music Scores" of Solar Cycles, Space Weather and Earth's Climate* Z. Kolláth, K. Oláh, Lidia van Driel-Gesztelyi

S5 – P29 *TTVs Detection in Southern Hemisphere Stars* Romina Petrucci, A.P. Buccino, E. Jofré, et al.

S5 – P30 *Climate Interaction Mechanism between Solar Activity and Terrestrial Biota* Jaime Osorio Rosales, B. Mendoza Ortega

S5 – P31 *The Coronae of Ca II HK-selected Magnetic Grand Minima Candidate Stars* Steven H. Saar, P. Testa

Late Posters

S3 – P32 *Seeing Measurement at Sasahuine Mountain, Moquegua, Peru* M. Huamán, W. Guevara Day, E. Meza, J. Samanes, P. Becerra, Cristian Ferradas

S3 – P33 *Installation and Operation of the Water Cherenkov Detector for the Large Aperture GRB Observatory (LAGO)* L.J. Otiniano Ormachea, Edith Tueros Cuadros, W. Guevara Day (LAGO collaboration)

COMPARATIVE MAGNETIC MINIMA:
CHARACTERIZING QUIET TIMES IN THE SUN AND STARS

IAU SYMPOSIUM No. 286

COVER ILLUSTRATION:

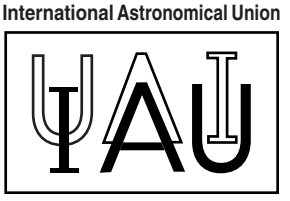
Mendocinean landscape showing a typical vineyard plantation with the Andes mountains in the background. Surrounded by a mixture of arid and semiarid landscapes, the city of Mendoza and its rural outskirts have been turned into a fertile oasis, sustained by the melting of glaciers and snow and manmade dams, channels, and drains. Also called "The land of Sun and good wine", its diaphanous skies and wine-producing fields attract over a million tourists every year.

Our Mendoza IAU Symposium on "Comparative Magnetic Minima" brought together scientists who studied the Sun, stars, and effects of magnetic activity on planetary space environments. One such "space weather" effect is that of beautiful aurorae, as illustrated here on a star field background courtesy of NASA and The Hubble Heritage Team (STScI/AURA). The solar disc image is courtesy of SDO (NASA) and the AIA consortium, while the solar corona is courtesy of Williams College Eclipse Expedition (Jay M. Pasachoff, Muzhou Lu, and Craig Malamut), captured on July 11, 2010.

IAU SYMPOSIUM PROCEEDINGS SERIES
2011 EDITORIAL BOARD

INTERNATIONAL ASTRONOMICAL UNION

UNION ASTRONOMIQUE INTERNATIONALE



COMPARATIVE MAGENTIC MINIMA: CHARACTERIZING QUIET TIMES IN THE SUN AND STARS

PROCEEDINGS OF THE 286th SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION HELD IN MENDOZA, MENDOZA, ARGENTINA OCTOBER 3–7, 2011

Edited by

Cristina H. Mandrini
Instituto de Astronomía y Física del Espacio, IAFE, CC. 67, Suc. 28, 1428 Buenos Aires, Argentina

and

David F. Webb
ISR, Boston College, Kenny Cottle, 106A, 885 Centre St., Newton, MA 02459, USA

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UnitedKingdom
40 West 20th Street, New York, NY 10011–4211, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

First published 2012

Printed in the United Kingdom at the University Press, Cambridge

Typeset in System LaTeX 2ε

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publication data

This journal issue has been printed on FSC-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the worlds forests. Please see www.fsc.org for information.

ISBN 9781107019867 hardback
ISSN 1743-9213

Table of Contents

Session 5: Grand Minima and Historical Records
Chairs: A. Dal Lago & I. Usoskin

Session 6: General Topics

Preface

IAU Symposium 286, "Comparative Magnetic Minima: Characterizing Quiet Times in the Sun and Stars", was coordinated through Division II, with the strong support of Division IV, including several of their associated commissions. It was held in Mendoza, Argentina, from 3 to 7 October 2011, and attracted nearly 100 scientists expert on various pertinent topics from 23 countries. The goal of the symposium was to consider solar and stellar minima, from generative dynamo mechanisms to in-depth analyses from Sun to Earth for recent well-observed and modeled minima, to a range of stellar cyclic activity, to outlier "grand minima". Solar, heliospheric, geospace, atmospheric, stellar, and planetary sciences were included in the meeting's scope.

Solar and stellar minima represent times of low magnetic activity and simple helio/asterospheres. They are, thus, excellent targets for interdisciplinary, system-wide studies of the origins of stellar variability and consequent impacts on planetary systems. The recent solar minimum extended longer and was "quieter" than any we have observed in the Space Age, inspiring both scientific and public interest. A rich variety of satellite and ground-based observations, in conjunction with theoretical and numerical modeling advances, have allowed us to probe the peculiarities of this minimum as never before. The implications are far-reaching, connecting Earth to Sun to stars, radio to ~~X-ray~~ X to cosmic rays, and the plethora of observations of recent minima to the Sun's past behavior as preserved in cosmogenic isotopes and historical sunspot and auroral records.

At the meeting, the keynote talk on "The nature and significance of solar minima" was given by Eric Priest. This was followed by 28 invited, 6 solicited talks and 28 contributed presentations spread over five sessions: Solar and Stellar Minima, Dynamos and Cycle Variability, Comparative Solar Minima from Sun to Earth, Stellar Cycles and Grand Minima, and Historical Records. A closing discussion on whether we are entering a grand minimum was led by Karel Schrijver. Thirty one poster presentations were put up and remained during the entire meeting. A public outreach talk on global warming and solar activity was given by Pablo Mauas at the end of the symposium.

The presentations described how magnetic fields can be cyclically generated in solar and stellar interiors via various dynamo processes. Numerical models have increased in complexity to the point where many observed aspects of the cycles in the Sun and stars are captured, although mysteries remain such as the origins of extended, or "grand" minima. Both stellar observations and historical and cosmogenic records at the Earth were presented, forming a basis of understanding of such intervals, and of solar/stellar long-term variability in general. A simple method to reconcile the Zürich Sunspot Number and the Group Sunspot Number was presented, with important and wide ranging implications towards an agreed-upon and vetted single sunspot series for use in the future.

The recent extended minimum was the lowest and longest minimum in about a century, having weak polar magnetic fields, a complex corona and heliosphere, and recurrent high-speed streams. Simultaneously, it was found that solar minima do not all look alike, given that the Sun can have different magnetic flux configurations even during very quiet times, yielding distinct 3D magnetic flux distributions and, therefore, diverse structure of the corona and heliosphere. During this recent minimum, the solar magnetic field achieved a solar maximum-like corona and solar wind source situation, but with weak magnetic fields and associated weak heating. The discussed results point out the need for textbooks and solar physics educators to revise the way they describe the solar wind and its sources.

In addition, the recent minimum provoked discussions on the possibility of a trend in the Sun's current magnetic cycles towards a grand minimum and the potential implications for the Earth's climate. For instance, there is evidence that a strong decrease of solar activity can lead to a delay of ozone recovery, partially compensating greenhouse warming, and that irradiance variability is the most important forcing for global problems. A combination of the bottom-up and top-down models seems appropriate for radiative solar forcing of the atmosphere. Although the forcing due to anthropogenic influences is about seven times larger than the radiative solar forcing, solar activity certainly does affect climate, and all relevant observations need to be maintained or extended.

The question of the origins and implications of cyclic behavior, for the Sun-Earth system and also for other stellar-planetary systems, was the subject of several presentations. For instance, it was shown that induced magnetospheres directly interact with the solar wind and, therefore, are more prone to atmospheric evolution than intrinsic magnetospheres.

This symposium was undoubtedly unique in the sense that it brought together a diverse group of scientists that were able to take part in discussions, appreciate the scientific disciplines of others, and discover the common aspects of the physical processes involved in the different studied environments from Sun to Earth, and stars to planets. The editors take this opportunity to thank Germán Cristiani and Marcelo López-Fuentes for their valuable assistance in preparing this volume. We also are grateful to the following reviewers who assisted us in improving the papers: Drs. Thomas Ayres, Alisson Dal Lago, Sergio Dasso, Marcelo López-Fuentes, Daniel Gómez, Manuel Güdel, Gustavo Guerrero, Jeffrey Hall, Margit Haberreiter, Kanya Kusano, Georgeta Maris, Leif Svalgaard, Andrey Tlatov, Ilya Usoskin, Adriana Valio, and Alberto Vásquez. Please note that many of the papers contain color figures, which are printed here in black and white but which can be viewed online in color.

Sarah Gibson and Hebe Cremades, co-chairs SOC
Cristina H. Mandrini, chair LOC
Cristina H. Mandrini and David F. Webb, Proceedings Editors
Buenos Aires, Argentina, 29 March 2012

THE ORGANIZING COMMITTEES

Scientific

Hebe Cremades (co-chair, Argentina)
Sarah Gibson (co-chair, USA)
Thomas Ayres (USA)
Alisson Dal Lago (Brazil)
Daniel Gómez (Argentina)
Manuel Güdel (Austria)
Gustavo Guerrero (Sweden)
Margit Haberreiter (Switzerland)
Johanna Haigh (UK)
Jeffrey Hall (USA)
Kanya Kusano (Japan)
Cristina Mandrini (Argentina)
Georgeta Maris (Romania)
Valentín Martínez-Pillet (Spain)
Andrey Tlatov (Russia)
Ilya Usoskin (Finland)
Adriana Valio (Brazil)

Local

Cristina Mandrini (chair)
Laura Balmaceda
Hebe Cremades
Germán Cristiani
Sergio Dasso
Marcelo López-Fuentes
María Luisa Luoni

Acknowledgements

The symposium was coordinated through IAU Division II (Sun and Heliosphere) and sponsored and supported by IAU Divisions III (Planetary System Sciences) and IV (Stars), including several of their associated Commissions: 10 (Solar Activity), 12 (Solar Radiation and Structure), 49 (Interplanetary Plasma and Heliosphere), and 36 (Theory of Stellar Atmospheres).

The Local Organizing Committee operated under the auspices of the Instituto de Astronomía y Física del Espacio (IAFE) and the Universidad Tecnológica Nacional - Facultad Regional Mendoza (UTN-FRM).

Funding support by the
International Astronomical Union (IAU),
Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT),
Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET),
Air Force Office of Scientific ~~Research Southern~~ Office of Aerospace Research and Development (AFOSR-SOARD),
Scientific Committee on Solar-Terrestrial Physics (SCOSTEP),
Committee on Space Research (COSPAR),
Comisión Nacional de Actividades Espaciales (CONAE),
and
Centro Latinoamericano de Física (CLAF),
is gratefully acknowledged.

CONFERENCE PHOTOGRAPH

1. Lela Taliashvili
2. Blanca Mendoza
3. Inez Batista
4. Werner Schmutz
5. Madhulika Guhathakurta
6. Caius Selhorst
7. Eric Priest
8. Adriana Valio
9. Cristina Mandrini
10. Hebe Cremades
11. Cesar Bertucci
12. María Luisa Luoni
13. Lidia van Driel-Gesztelyi
14. Ximena Abrevaya
15. Mariela Vieytes
16. Bernardo ~~Vargas~~ Lagos
17. Sarah Gibson
18. Romina García
19. Nadezhda Zolotova
20. Maximiliano Crescitelli
21. Deysi Cornejo Espinoza
22. Lurdes Martínez Meneses
23. Lois Linsky
24. Accompanying person (Raphael Steinitz)
25. Raphael Steinitz
26. Jaime Osorio Rosales
27. Jeffrey Linsky
28. Mariano Poisson
29. Marlos Rockenbach da Silva
30. Carolina Salas Matamoros
31. Andrey Tlatov
32. Ilya Usoskin
33. Francesco Zuccarello
34. Sasha Brun
35. Michael Thompson
36. Kate Thompson
37. Ivonne Elsworth
38. Hiroko Miyahara
39. David Webb
40. Heidi Korhonen
41. Marcelo López-Fuentes
42. Katja Poppenhaeger
43. Dibyendu Nandi
44. Volker Bothmer
45. Romina Petrucci
46. Eugene Rozanov
47. Alisson Dal Lago
48. Pablo Mauas
49. Ezequiel Echer
50. Margit Haberreiter
51. Carlene Skeffington
52. Ed Cliver
53. Joern Warnecke
54. John Linker
55. Dmitry Sokoloff
56. Matthias Rheinhardt
57. Marc DeRosa
58. Andres Muñoz Jaramillo
59. Leif Svalgaard
60. Laura Balmaceda
61. Pedro Corona Romero
62. Matthew Browning
63. Karel Schrijver
64. Bidya B. Karak
65. Raul Terrazas Ramos
66. Giuliana de Toma
67. Cristian Ferradas Alva
68. Emre Isik
69. Alberto Vásquez
70. Germán Cristiani
71. Steven Saar
72. Jurgen Schmitt
73. Abraham Chian
74. Mark Giampappa
75. Arnab Choudhuri
76. Axel Brandenburg
77. Federico Nuevo
78. Simon Candelaresi
79. José Vaquero
80. Gustavo Guerrero
81. Jenny Rodríguez Gómez
82. Marialejandra Luna Cardozo
83. Fabio del Sordo
84. Fernando López
85. Daniel Gómez
86. María Emilia Ruiz
87. Ramon Lopez
88. Paulo Batista
89. Sergio Dasso
90. Francisco Iglesias
91. Janet Luhman
92. Vera Hurlburt
93. Neal Hurlburt
94. Kazuoki Munakata

Participants

Ximena **Abrevaya**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — abrevaya@iafe.uba.ar

Laura **Balmaceda**, Inst. de Cs. Astronómicas de la Tierra y del Espacio, ICATE, San Juan, Argentina — lbalmaceda@icate-conicet.gob.ar

Inez **Batista**, Instituto Nacional de Pesquisas Espaciais, INPE, São José dos Campos, Brazil — inez@dae.inpe.br

César **Bertucci**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina, — cbertucci@iafe.uba.ar

Volker **Bothmer**, Institute for Astrophysics, University of Göttingen, Göttingen, Germany — bothmer@astro.physik.uni-goettingen.de

Axel **Brandenburg**, Nordic Institute for Theoretical Physics, NORDITA, Sweden — brandenb@nordita.org

Matthew **Browning**, CITA, University of Exeter, UK — browning@cita.utoronto.ca

Allan S. **Brun**, CEA, Saclay, France — sacha.brun@cea.fr

Simon **Candelaresi**, Nordic Institute for Theoretical Physics, NORDITA, Sweden — iomsn@physto.se

Abraham **Chian**, Paris Observatory, Meudon, Paris, France — abraham.chian@gmail.com

Arnab **Choudhuri**, Department of Physics, Indian Institute of Science, Bangalore, India — arnab@physics.iisc.ernet.in

Rodolfo **Cionco**, Facultad Regional San Nicolás, Universidad Tecnológica Nacional, Argentina — gcionco@frsn.utn.edu.ar

Edward **Cliver**, Air Force Research Laboratory, USA — edcliver@gmail.com

Deysi **Cornejo Espinoza**, Comisión Nacional de Investigación y Desarrollo Aeroespacial, CONIDA, Perú — veronicadce@gmail.com.pe

Pedro **Corona Romero**, Instituto de Geofísica, UNAM, México — piter.cr@gmail.com

Hebe **Cremades**, Facultad Regional Mendoza, Universidad Tecnológica Nacional, Argentina — hebe.cremades@frm.utn.edu.ar

Maximiliano **Crescitelli**, Facultad Regional Mendoza, Universidad Tecnológica Nacional, Argentina — albertut@hotmail.com

Germán **Cristiani**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — gcristiani@iafe.uba.ar

Alisson **Dal Lago**, Instituto Nacional de Pesquisas Espaciais, INPE, São José dos Campos, Brazil — dallago@dge.inpe.br

Sergio **Dasso**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — sdasso@iafe.uba.ar

Giuliana **De Toma**, High Altitude Observatory, National Center for Atmospheric Research, USA — detoma@ucar.edu

Fabio **Del Sordo**, Nordic Institute for Theoretical Physics, NORDITA, Sweden — brandenb@nordita.org

Ezequiel **Echer**, Instituto Nacional de Pesquisas Espaciais, INPE, São José dos Campos, Brazil — ezequiel.echer@gmail.com

Yvonne **Elsworth**, School of Physics and Astronomy University of Birmingham, UK — y.p.elsworth@bham.ac.uk

Cristian **Ferradas Alva**, Comisión Nacional de Investigación y Desarrollo Aeroespacial, CONIDA, Perú — cristian.ferradas@pucp.edu.pe

Romina **García**, Universidad Nacional de San Juan, San Juan, Argentina — rominita dance@hotmail.com

Mark **Giampapa**, National Solar Observatory, NOAO, USA — giampapa@noao.edu

Sarah **Gibson**, High Altitude Observatory, National Center for Atmospheric Research, USA — sgibson@ucar.edu

Daniel **Gómez**, ~~Instituto de Astronomía y Física del Espacio, IAFE,~~ Buenos Aires, Argentina — dgomez@df.uba.ar

Walter **González**, Instituto Nacional de Pesquisas Espaciais, INPE, São José dos Campos, Brazil — gonzalez@dge.inpe.br

Gustavo **Guerrero**, Nordic Institute for Theoretical Physics, NORDITA, Sweden — guerrero@nordita.org

Madhulika **Guhathakurta**, Heliophysics Division, NASA Headquarters, USA — madhulika.guhathakurta@nasa.gov

Heidy **Gutiérrez**, Centro de Investigaciones Espaciales, Universidad de Costa Rica, Costa Rica — heidy.gutierrez@ucr.ac.cr

Margit **Haberreiter**, Physikalisch-Meteorologisches Observatorium Davos, WRC, Switzerland — margit.haberreiter@pmodwrc.ch

Neal **Hurlburt**, Lockheed Martin Advanced Technology Center, USA — hurlburt@Lmsal.com

Francisco **Iglesias**, Facultad Regional Mendoza, Universidad Tecnológica Nacional, Argentina — franciscoaiglesias@hotmail.com

Emre **Isik**, Istanbul Kultur University, Istanbul, Turkey — e.isik@iku.edu.tr

Bidya **Karak**, Department of Physics, Indian Institute of Science, Bangalore, India — bidya karak@physics.iisc.ernet.in

Heidi **Korhonen**, Niels Bohr Institute University of Copenhagen, Copenhagen, Denmark — heidi.h.korhonen@utu.fi

Jon **Linker**, Predictive Science Inc., USA — linkerj@predsci.com

Jeffrey **Linsky**, Joint Institute for Laboratory Astrophysics, University of Colorado, — jlinsky@jila.colorado.edu

Fernando **López**, Universidad Nacional de San Juan, San Juan — ferl1983@hotmail.com

Ramón ~~López~~, Department of Physics, University of Texas at Arlington, USA — relopez@uta.edu

Marcelo **López Fuentes**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — lopezf@iafe.uba.ar

Janet **Luhmann**, Space Sciences Laboratory, University of California, Berkeley, USA — jgluhman@ssl.berkeley.edu

Marialejandra **Luna Cardozo**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — mluna@iafe.uba.ar

María L. **Luoni**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — mluoni@iafe.uba.ar

Cristina H. **Mandrini**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — mandrini@iafe.uba.ar

Lurdes **Martínez Meneses**, Universidad Nacional San Luis Gonzaga de Ica, Perú — lurdesmartinez5@yahoo.es

Pablo **Mauas**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina — pablo@iafe.uba.ar

Blanca **Mendoza Ortega**, Instituto de Geofísica, UNAM, México	blanca@geofisica.unam.mx
Hiroko **Miyahara**, The University of TokyoLeiden Observatory, Tokio, Japan	hmiya@icrr.u-tokyo.ac.jp
Kazuoki **Munakata**, Physics Department, Shinshu University, Japan	kmuna00@shinshu-u.ac.jp
Andrés **Muñoz Jaramillo**, Harvard-Smithsonian Center for Astrophysics, USA	amunoz@cfa.harvard.edu
Dibyendu **Nandi**, Indian Institute of Science Education and Research, Kolkata, India	dnandi@iiserkol.ac.in
Federico **Nuevo**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	federico@iafe.uba.ar
Constantin **Oprea**, Institute of Geodynamics, Romanian Academy, Romania	const_oprea@yahoo.com
Jaime **Osorio Rosales**, Instituto de Geofísica, UNAM, México	jaime@geofisica.unam.mx
Romina **Petrucci**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	romina@iafe.uba.ar
Mariano **Poisson**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	mpoisson@iafe.uba.ar
Katja **Poppenhaeger**, Hamburg Observatory, Hamburg, Germany	katja.poppenhaeger@hs.uni-hamburg.de
Eric **Priest**, Saint Andrews University, UK	eric@mcs.st-and.ac.uk
Matthias **Rheinhardt**, Nordic Institute for Theoretical Physics, NORDITA, Sweden	mreinhardt@nordita.org
Marlos **Rockenbach da Silva**, Universidade do Vale do Paraíba, UNIVAP, Brazil	marlosrs@gmail.com
Jenny **Rodríguez Gómez**, Observatorio Astronómico Nacional, Universidad Nacional de Colombia, Colombia	jemfisi@hotmail.com
Eugene **Rozanov**, Physikalisch-Meteorologisches Observatorium Davos, WRC, Switzerland	e.rozanov@pmodwrc.ch
María E. **Ruiz**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	meruiz@iafe.uba.ar
Steven **Saar**, Smithsonian Astrophysical Observatory, USA	saar@cfa.harvard.edu
Carolina **Salas ~~Matamorros~~**, Centro de Investigaciones Espaciales, Univ. de Costa Rica, Costa Rica	carolina.salas@planetario.ucr.ac.cr
Jürgen **Schmitt**, Hamburger Sternwarte, Germany	jschmitt@hs.uni-hamburg.de
Werner **Schmutz**, Physikalisch-Meteorologisches Observatorium Davos, WRC, Switzerland	werner.schmutz@pmodwrc.ch
Karel **Schrijver**, Lockheed Martin Advanced Technology Center, USA	schrijver@lmsal.com
Caius **Selhorst**, Universidade do Vale do Paraíba, UNIVAP, Brazil	caiuslucius@gmail.com
Dmitry **Sokoloff**, Moscow State University, Moscow, Russia	sokoloff@dds.srcc.msu.su
Raphael **Steinitz**, Ben Gurion University, Israel	raphael@bgu.ac.il
Leif **Svalgaard**, Stanford University, USA	leif@leif.org
Natalia **Szajko**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	pajarin@gmail.com
Lela **Taliashvili**, Centro de Investigaciones Espaciales, Universidad de Costa Rica, Costa Rica	lela.taliashvili@cinespa.ucr.ac.cr
Raúl **Terrazas Ramos**, Universidad Nacional San Luis Gonzaga de Ica, Perú	raulterrazas81@gmail.com
Michael **Thompson**, High Altitude Observatory, National Center for Atmospheric Research, USA	mjt@ucar.edu
Andrey **Tlatov**, Kislovodsk Mountain Astronomical Station, Pulkovo Observatory, Russia	tlatov@mail.ru
Ilya **Usoskin**, Department of Physics, University of Oulu, Finland	ilya.usoskin@oulu.fi
Adriana **Válio**, CRAAM, Mackenzie University, São Paulo, Brazil	avalio@craam.mackenzie.br
Lidia **van Driel-Gesztelyi**, Konkoly Observatory, Hungary	Lidia.vanDriel@obspm.fr
José **Vaquero**, Universidad de Extremadura, España	jvaquero@unex.es
Bernardo **~~Vargas~~**, Instituto de Geofísica, UNAM, México	bernardo@geofisica.unam.mx
Alberto **Vásquez**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	albert@iafe.uba.ar
Mariela **Vieytes**, Instituto de Astronomía y Física del Espacio, IAFE, Buenos Aires, Argentina	mariela@iafe.uba.ar
Joern **Wernecke**, Nordic Institute for Theoretical Physics, NORDITA, Sweden	joern@nordita.org
David **Webb**, Institute of Scientific Research, Boston College, USA	david.webb@bc.edu
Nadezhda **Zolotova**, Saint Petersburg State University, Saint Petersburg, Russia	myagkalapka@gmail.com
Francesco **Zuccarello**, Centrum voor Plasma-Astrofysic, KU Leuven, Belgium	francesco.zuccarello@wis.kuleuven.be