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Polarimetry: From the Sun to Stars and Stellar Environments

Edited by

K. N. Nagendra

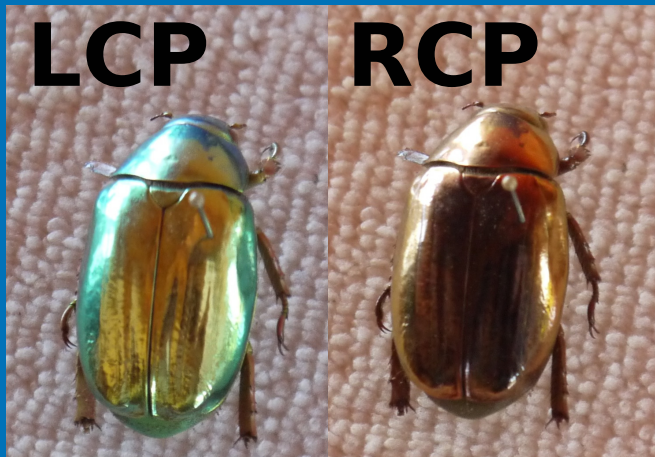
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POLARIMETRY: FROM THE SUN TO STARS AND
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COVER ILLUSTRATION: COSTA RICAN BEETLES IN POLARIZED LIGHT

Circularly polarized light reflected from beetles was first noticed by A. A. Michelson. The lustre of this Costa Rican iridescent gold-green beetle (*Chrysina batesi*, native of the mountains of southern Costa Rica) is enhanced in lefthanded circularly polarized light (LCP), but the beetle appears dark in righthanded circularly polarized light (RCP). The polarization is generated by a mechanism similar to that of a cholesteric liquid crystal. Circular polarization is uncommon in the biological world. Apparently this species uses circular polarization to identify its own kind.

Photo courtesy: Bruce Lites.

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POLARIMETRY: FROM THE SUN TO STARS AND STELLAR ENVIRONMENTS

PROCEEDINGS OF THE 305th SYMPOSIUM
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UNION HELD IN PUNTA LEONA, COSTA RICA
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Preface

The most important aim of the IAU Symposium No. 305 was to bring together the solar and stellar polarization communities. This Symposium represented the first such attempt, and turned out to be very rewarding and interesting. In the last three decades both fields have seen revolutionary developments in the areas of instrumentation, and the methods of data analysis and interpretation. Often the developments have happened in parallel.

In these three decades, the emphasis of solar polarimetry has been to achieve simultaneously high spectral, spatial, and temporal resolution for all four Stokes parameters. This in turn motivated rapid developments in the area of theoretical spectro-polarimetry such as the Hanle effect, partial frequency redistribution effects, and quantum interference effects, etc. High speed techniques of solving the polarized line transfer equation in 1D as well as multi-D geometries was also achieved in this period. All these difficult tasks were achieved almost simultaneously. The historical development of the field of SOLAR POLARIZATION is well documented in a series of seven proceedings volumes representing seven workshops which took place in the period 1995 – 2013.

The developments in the field of stellar polarimetry were equally impressive, allowing for instance the detection and surface mapping of magnetic fields across the Hertzsprung-Russell diagram. Nowadays, magnetic Doppler imaging techniques are systematically applied to stellar data to infer the thermodynamical and magnetic structuring in non resolved stellar atmospheres, to understand the influence of the magnetic activity in the transport of chemical species and angular momentum. Polarimetric measurements are also routinely employed for the modeling of stellar environments like for instance circum-stellar disks and supernova remnants, but also for the characterization of the objects of our solar system, and we are witnessing already the first attempts to exploit polarimetry as a tool to study the atmospheres of exosolar planets. Advances in non-solar polarimetric studies have been traditionally reported in the conference series ASTROPOL, the last of which was held in Grenoble in May 2014.

The mutual interactions between the stellar and solar polarimetry communities have been so far rather limited. It was this aspect that prompted Bruce Lites and Javier Trujillo Bueno to make efforts to bring together the two communities. This took place in the exotic country of Costa Rica. This Central American country was chosen in order to promote astronomy in Central and Latin America. This choice was supported by the IAU, who approved holding of a meeting as an IAU symposium (IAUS 305), enabling participation of young scientists and students from nearby countries. This goal was achieved, as can be seen from the list of participants. There was a good participation by scientists from all over the world, making this symposium an important event for the development of astronomy in Central America.

The list of topics covered were carefully chosen by the SOC. It is nicely balanced between nighttime and solar astronomy. Following is the list of the sessions held during the symposium:

- Solar and Stellar Surface Magnetic Fields
- Future Directions in Astrophysical Polarimetry
- Physical Processes
- Instrumentation for Astronomical Polarimetry
- Data Analysis techniques for Polarization Observations
- Polarization Diagnostics of Atmospheres and Circumstellar Environments

- Polarimetry as a Tool for Discovery Science
- Numerical Modeling of Polarized Emission

The above list was intended to promote dialog between the two communities. The solar and stellar related talks were interspersed to allow for a good mixing of the ideas used in the two fields (namely the similarities and the differences).

The symposium took place at the Hotel Punta Leona, Costa Rica, which provided a most beautiful natural setting for the meeting. It was a well organized event, thanks to the excellent work of the LOC team lead by Lela Taliashvili, Bruce Lites, and F. Frutos Alfaro. Apart from the IAU, the conference was co-sponsored by the High Altitude Observatory (HAO) of the National Center for Atmospheric Research, Colorado, USA; University of Costa Rica through its research foundation Fundación de la Universidad de Costa Rica para la Investigación (FUNDEVI); the National Solar Observatory (NSO), USA; Meadowlark Optics, USA; and CINESPA of Universidad de Costa Rica. The organizers would like to gratefully acknowledge the financial and logistical help extended by all these organizations to the success of the meeting.

The scientific sessions started with a series of four tutorial talks delivered on Sunday 29 November 2014, by authorities in their fields of specialization. They are:

- *The Physics of Polarization*:- by Egidio Landi Degl'Innocenti
- *Nighttime Polarimetry*:- by Stefano Bagnulo
- *Daytime Polarimetry*:- by Sami K. Solanki
- *Planetary Atmospheres and Surfaces*:- by Michael Mischenko

We thank these four speakers for orienting the younger audience, particularly towards the field of polarimetry. There were eight sessions. Each session had review talks, followed by shorter contributed talks, so that the given topic was covered in greater detail. There were a few keynote addresses to introduce a chosen topical area in a broader perspective. We thank these keynote and invited speakers for their efforts. The poster session was the highlight of IAUS 305. Aside from the poster displays, each author was given one minute of stage time to introduce their poster. These little snippets were grouped in vibrant poster sessions that were interspersed throughout the meeting. We thank all the chairpersons of the sessions, for maintaining the schedule of the meeting. Ample time was given for scientific discussions through extended lunch and tea/ coffee breaks.

We thank all the members of the SOC for putting together a perfectly balanced scientific program, which clearly reflected the aspirations of the organizers. The proceedings volume reflects what transpired in the symposium. The articles in this volume are organized according to the way in which the sessions were organized, and the same order in which the talks were delivered. This gives a feel of the spirit that prevailed in the meeting.

An excursion was organized by the LOC on the afternoon of Wednesday, 3 December 2014, when the participants went on a boat cruise along the Río Tárcoles. The main attraction of this excursion was the large population of crocodiles that inhabit this fresh/salt water environment near the mouth of the river. In addition to the crocodiles, the participants were given a tour of the mangrove swamps where they had the opportunity to experience first-hand this diverse ecosystem. The conference dinner was organized on Thursday, 4 December 2014, where the participants could experience the rich folk art and cultural heritage of Costa Rica. All the other local arrangements were excellent thanks to the courteous and friendly members of the LOC, who made each participant's visit to Costa Rica a memorable event. We thank Bruce Lites and Javier

Trujillo Bueno who conceived this meeting, and the LOC and SOC members who stood by them resulting in a very well-organized IAU Symposium.

Wendy Hawkins of HAO organized and efficiently maintained the IAUS 305 web-page. The credits for the photographs presented in this proceedings belong to Lela Taliashvili, David Orozco Suárez, and Rebecca Centeno. We thank Bruce Lites and his colleagues for preparing the picture that appears on the proceedings cover page, and also for preparing the proceedings poster and other graphics related works for the IAUS 305. The participation, excellent talks, and the lively discussions generated during the conference made it a very interesting meeting. We are grateful to all the participants who came from different parts of the world and for their scientific contributions. Bruce Lites volunteered to help the editors in all aspects of editing this volume. His contribution has been of substantial help. K.N. Nagendra would like to thank M. Sampoorna for her help with the preparation of this proceedings.

We would like to thank the CUP Editorial staff for their co-operation and help in bringing out this IAUS 305 proceedings book, which we hope will remain a landmark in the field of solar and stellar polarimetry. It is our hope that this meeting forms the first of a series of such meetings. This would greatly benefit the long standing need for intense co-operation between the solar and stellar polarimetry communities.

K. N. Nagendra, S. Bagnulo, R. Centeno, M. J. Martínez González

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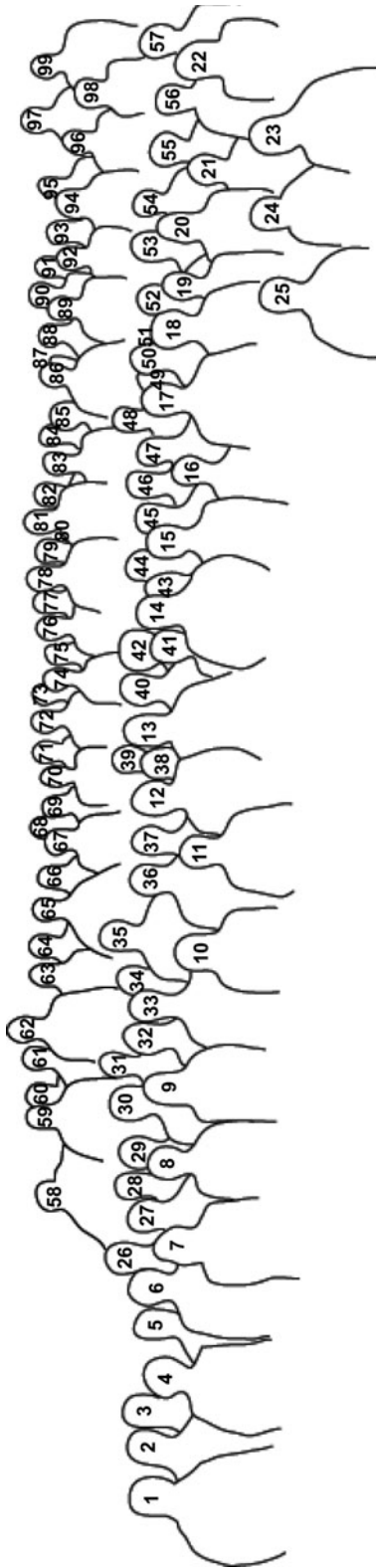
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CONFERENCE PHOTOGRAPH



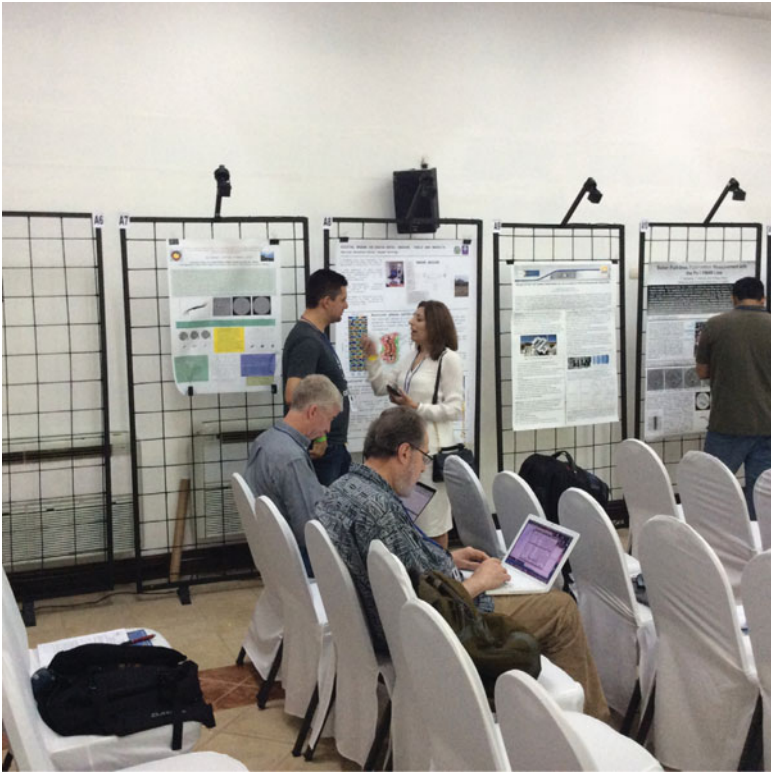


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