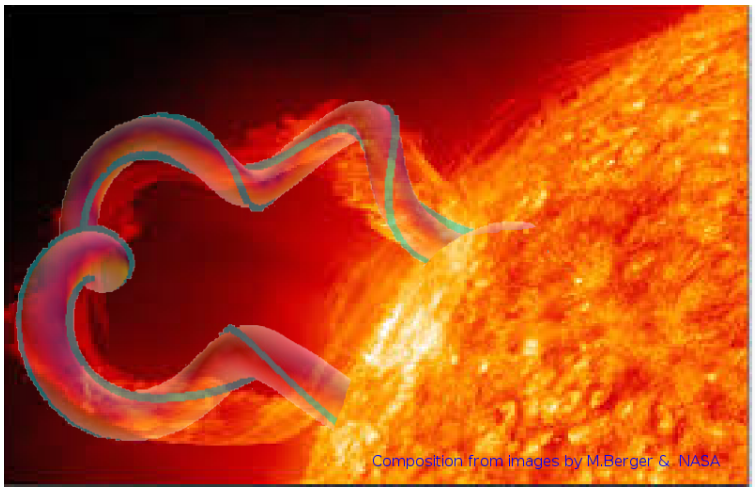
Report on the International Team "Magnetic Helicity estimations in models and observations of the solar magnetic field" ISSI-Bern 2014-2016



INTERNATIONAL SPACE SCIENCE INSTITUTE

International Team on

Magnetic Helicity

http://www.issibern.ch/teams/magnetichelicity/index.html

Introduction

The ISSI IT on magnetic helicity followed in full the program approved at the time of selection: namely the team of 8 scientists + 2 early-career researchers, benefiting from the Young Scientist Scheme, met three times over three years for four and half days each time. All the designed members could take part in all meetings, in two occasions via internet. Following ISSI approval, part of the unused funding were devoted to invite an additional scientist for the last team meeting.

Objectives

The IT has significantly exceeded the expected results. The IT succeeded in

– comparing and benchmarking different methods used for the estimation of magnetic helicity in solar physics. These benchmarks are or about to/be published in a series of four papers that are also reviewing the state of the art in helicity measurements

– preparing a set of test data to be used as benchmark for future innovative method that would estimate magnetic helicity. These dataset are publicly available from the ISSI team website and servers.

– producing relevant scientific articles covering both general as well as specific aspects of magnetic helicity (see list below)

Additionally, the ISSI team has laid the foundation for future collaborations among all members which will seed future scientific investigations.

Published articles

1. **Testing magnetic helicity conservation in a solar-like active event** E. Pariat, G. Valori, P. Démoulin, K. Dalmasse published in Solar Physics (DOI: 10.1051/0004-6361/201525811)
2. **Magneto-Frictional Modeling of Coronal Nonlinear Force-Free Fields: I. Testing with Analytic Solutions** Y. Guo, C. Xia, R. Keppens, G. Valori published in ApJ (DOI: 10.3847/0004-637X/828/2/83)

3. **Magnetic helicity estimations in models and observations of the solar magnetic field. Part I: Finite volume methods** Gherardo Valori, Etienne Pariat, Sergey Anfinogentov, Feng Chen, Manolis K. Georgoulis, Yang Guo, Yang Liu, Kostas Moraitis, Julia K. Thalmann, Shangbin Yang, published in Space Science Review (DOI: 10.1007/s11214-016-0299-3)
4. **Magnetic Helicity Estimations in Models and Observations of the Solar Magnetic Field. Part III: Twist Number Method** Yang Guo, Etienne Pariat, Gherardo Valori, Sergey Anfinogentov, Feng Chen, Manolis K. Georgoulis, Yang Liu, Kostas Moraitis, Julia K. Thalmann, Shangbin Yang, published in ApJ (DOI : 10.3847/1538-4357/aa6aa8)
5. **Relative magnetic helicity as a diagnostic of solar eruptivity** Etienne Pariat, James E. Leake, Gherardo Valori, Mark G. Linton, Francesco P. Zuccarello, Kevin Dalmasse, published in A&A (DOI : 10.1051/0004-6361/201630043)
6. **On flare-CME characteristics from Sun to Earth combining remote-sensing image data with in-situ measurements supported by modeling** M. Temmer, J.K. Thalmann, K. Dissauer, A.M. Veronig, J. Tschernitz, J. Hinterreiter, L. Rodriguez published in Solar Physics (DOI: 10.1007/s11207-017-1112-5)
7. **Algorithms of the Potential Field Calculation in a Three Dimensional Box** G.V. Rudenko, S.A. Anfinogentov published in Solar Physics (10.1007/s11207-017-1126-z)

Articles in preparation

There are two additional articles in preparation with ISSI acknowledgment

1. **Magnetic helicity estimations in models and observations of the solar magnetic field. Part II: Flux-injection methods**
   The paper is dedicated to the comparison of flux-injection methods using numerical simulations, and is lead by E.Pariat and G.Valori
2. **Magnetic helicity estimations in models and observations of the solar magnetic field. Part IV: Application to solar observations**
   The paper is dedicated to the application of all tested methods to an observed solar case, and is lead by J.Thalmann and M.Georgoulis.

The data preparation and analysis for both articles is fully or to a very large extent done, and we expect to submit these two papers in the coming months.

Conferences

The results from the IT were presented in several national and international conferences by the Team members. As a measure of the impact of the team's results on the scientific community, two invited talks were fully dedicated to the results summarized in the Valori *et al*. 2016 review paper in Sp.Sci.Rev, namely at

– EWASS 2016, Athens (G)
– UKMHD 2017 meeting, Duhram (UK)

Acknowledgment

We want to take this occasion for thanking ISSI for the unique possibility that has offered us to gather a team of experts on a topical issue in a timely manner. The results by our IT stand to show the importance of the ISSI mission and the effectiveness the International Team format. The competent support and prompt assistance of the Bern office were exceptional, always. Thank you from the magnetic helicity IT.

This report is available also at http://www.issibern.ch/teams/magnetichelicity/Report_IT_magnetic_helicity.pdf