# PROPOSAL FOR AN AGU BOOK BASED ON CHAPMAN CONFERENCE

## "Magnetic Helicity in Space and Laboratory Plasmas"

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# Contents


**1 Book Proposal Form** **3**

1.1 CONFERENCE INFORMATION . . . . . . . . . . . . . . . . . 3
1.2 A. PROPOSER . . . . . . . . . . . . . . . . . . . . . . . . . 3
1.3 B. BOOK DESCRIPTION . . . . . . . . . . . . . . . . . . . . 3
1.4 C. PRODUCTION INFORMATION . . . . . . . . . . . . . . . 5
1.5 D. MARKET ASSESSMENT . . . . . . . . . . . . . . . . . . . 6

**2 Conference Description and goals** **9**

**3 Preliminary Program** **10**

3.1 Monday, July 27 . . . . . . . . . . . . . . . . . . . . . . . . 10
3.2 Tuesday, July 28 . . . . . . . . . . . . . . . . . . . . . . . . 10
3.3 Wednesday, July 29 . . . . . . . . . . . . . . . . . . . . . . . 11
3.4 Thursday, July 30 . . . . . . . . . . . . . . . . . . . . . . . . 11
3.5 Friday, July 31 . . . . . . . . . . . . . . . . . . . . . . . . . 12

**4 Additional Information (Preface from the Conference Proposal)** **13**

**5 List of Invited Speakers** **15**

**6 Resume and Recent Publications** **23**

# 1 Book Proposal Form

## 1.1 CONFERENCE INFORMATION

**Title:** Magnetic Helicity in Space and Laboratory Plasmas
**Date:** 28-31 July, 1998
**Place:** Boulder, CO, USA
**Conveners:** Canfield R.C., Pevtsov A.A.

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## 1.3 B. BOOK DESCRIPTION

1. How do you plan to develop the proposed volume so that it will be a cohesive book?

A book will consist of 5 different sections

- basic ideas of using magnetic helicity to study topological properties of physical objects and theoretical justification of helicity concept

- laboratory experiments on magnetic reconnection, dynamo, plasma relaxation, MHD stability involving magnetic helicity
- magnetic helicity on the Sun (solar dynamo, numerical simulations on evolution of helicity through the convective zone, observations of magnetic helicity in the photosphere, chromosphere and corona)
- magnetic helicity in the outer solar atmosphere (interplanetary magnetic field, solar wind, coronal mass ejections, terrestrial magnetosphere-solar wind interaction)
- astrophysical applications of helicity (accretion disks, jets and winds).

2. How will the proposed volume differ from the Conference? (AGU Books publishes monographs based on conferences, but not conference proceedings per se.) Please be specific. The final book title will be selected after the preface and table of contents are final.

We envision this book as serving two purposes - as a textbook for students and as a reference book for researchers in laboratory and space physics. Neither purpose will be addressed by the conference. Each invited speaker will be asked to write a paper for the book, based on his talk, but considering the goals mentioned above: to be as instructive as a textbook and/or as innovative as a research paper. After the Conference we will ask program committee to indicate the most interesting poster papers, which we will include in the conference book. Given the character of the conference and its topic we envision including some of central issues discussed during the conference as a closing paper, which we (editors/conveners) will write.

3. What is the outstanding feature of this volume?

It will be first book on the subject of magnetic helicity. The book will contain both comprehensive review of basic concepts of magnetic helicity and recent results of laboratory plasma experiments, theoretical studies, numerical simulations and solar/space plasma observations, as well as some possible astrophysical applications. We think that such a book would be extremely useful both for students and young researchers as a textbook and as a reference book for the scientists from laboratory and space plasma physics.

4. Is the proposed volume to be made up entirely of new research?

**NO**

If no, what percentage of the volume will consist of review papers?

**60%**

5. Who will edit the volume? AGU requires that at least one of the editors was not involved in the organization of the conference. Who is this editor?

**Richard C. Canfield** (Montana State University)
**Alexei A. Pevtsov** (Montana State University)
**Michael R. Brown** (Swarthmore College)

Dr. M.R. Brown is not involved in the organization of the conference.

6. Describe the proposed peer review process.

Scientific review will be handled by the editors with outside assistance as needed.

7. Have the papers or major parts of them been published previously?

**NO**

8. What is the proposed time schedule? (AGU's goal is to publish within a year of the meeting.)

Oct. 5, 1998 (2 months after the meeting) - manuscripts or individual chapters will be ready for peer review.

Jan. 4, 1999 - peer review will be completed and revised manuscripts and preface will be sent to AGU for production.

## 1.4 C. PRODUCTION INFORMATION

1. AGU requires that proposals be peer-reviewed before a publishing decision is made. Please suggest colleagues not associated with this proposal who are qualified to review it.

List of proposed reviewers (program committee):
**Dr. W.H. Matthaeus**, University of Delaware
**Dr. B.C. Low**, High Altitude Observatory
**Dr. E.R. Priest**, University of St. Andrews, Scotland
**Dr. R. Rosner**, University of Chicago
**Dr. D.M. Rust**, The Johns Hopkins University
**Dr. N. Seehafer**, University of Potsdam, Germany

**Dr. K. Shibata**, National Astronomical Observatory of Japan
**Dr. M. Yamada**, Princeton University

2. Who will prepare camera-ready copy? (AGU will provide specifications for the preparation of camera-ready copy.)

**X** a) individual authors b) volume editor

3. Estimate the maximum and minimum number of double-spaced MANUSCRIPT pages (including any tables, figure captions, references, appendix, but excluding the figures themselves):

600 Maximum 460 Minimum

What is the basis for the page estimate?

A final program of the Conference contains 33 invited talks, which defines our minimum. Papers will be limited to 14 pages, and 6 figures. Some posters may be presented that form the basis for additional papers, also with review aspects. These define our maximum (10 additional papers).

4. Estimate the maximum and minimum number of figures:

260 Maximum 200 Minimum

5. Estimate the maximum and minimum number of BOOK pages (add totals from 3 and 4 and divide by two):

430 Maximum 330 Minimum

6. Will there be special features such as an index, color printing or foldout pages? Will there be any electronic features? Please describe.

We expect to have small number of color illustrations. We plan to have an index. We do not expect foldout pages.

## 1.5 D. MARKET ASSESSMENT

1. Describe the readers of your book. For what organizations and in what countries would they work? What journals would they read? To which membership organizations would they belong?

The book will have wide spectrum of readers both experimentalists and theorists working in solar physics, space plasmas, laboratory MHD plasma and astrophysics. The book will be useful as a textbook for graduate students and postdoctoral researchers. USA, UK, Germany, Japan and Russia are the countries where these people work. The main scientific journals are Astrophysical Journal, Astronomy and Astrophysics, Journal Fluid Mechanics, Journal Geophysical Research, Geophysical Research Letters, Physics Fluids, Physical Review B, Plasma Physics, Publications of Astronomical Society of Japan, Royal Astronomical Society Monthly Notices, Solar Physics.

2. To which AGU sections would they belong? Please list the top three in decreasing order of importance.

SPA - Space Physics and Aeronomy - Solar and Heliospheric Physics
Magnetospheric Physics

Planetology (to small extent)

3. What other books published by AGU would the readers of your volume have read in the last seven years?

- "**Coronal Mass Ejections**", Eds. N. Crooker, J. A. Joselyn, and J. Feynman, 1997.
- "**Space Plasmas: Coupling Between Small and Medium Scale Processes**", Eds. M. Ashour-Abdalla, T. Chang, P. Dusenburg, 1995
- "**Physics of Magnetic Flux Ropes**", Eds. C.T. Russell, E.R. Priest, L.C. Lee, 1990

4. Name any other books on the same or related subjects recently published by another publisher. How does your book differ from these volumes?

**None**

5. Please estimate the total number of book sales you project.

**200**

On what information did you base this number?

The cost of a book is included in the conference registration fee. Each participant will receive a copy of the book. Maximum attendance limited by the conference facilities is 125 participants. We anticipate that each major university library will buy this book.

6. What is an appropriate price for your volume for AGU members?

Under $35 $35-$50 **X** Above $50

7. Please indicate any possible special or bulk sales. Whom should AGU contact?

The conveners of the conference will buy as many books as a number of registered participants.

8. List publications in the order of importance that should receive a copy of the book for review.

"Space Physics Review"
"Solar Physics"
"Plasma Physics"
"Physics Today"
"Astronomy and Astrophysics"
"Astronomy and Astrophysics Review"

9. List professional conferences where the book or promotional materials should be exhibited.

AGU annual meetings
APS meetings and conferences on plasma physics
AAS/SPD meetings

10. Please list the professional associations and societies of which you are a member.

American Geophysical Union (AGU)
American Astronomical Society/Solar Physics Division
International Astronomical Union (IAU)

## 2 Conference Description and goals

The topic of magnetic helicity is relatively new to solar and stellar physicists, who are interested in knowing which processes generate magnetic helicity in solar/stellar interiors, how helicity is transformed when magnetic field rises through the convection zone, what the role of magnetic helicity is in magnetic reconnection and flare activity, and how the helicity of the solar/stellar wind and interplanetary magnetic field are related to that of the solar/stellar surface. On the other hand, magnetic helicity has been intensively studied in the laboratory and in interplanetary plasma physics. At the present time these diverse scientific communities are developing their own understanding rather independently. The purpose of the proposed conference is to bring them together.

A Chapman conference will encourage both exposition and discussion of this rather focussed, yet interdisciplinary, topic. Our expectation is that about two-thirds of the conference participants will be solar physicists, and the remainder from other fields. Presumably the former will attend the conference in order to improve their understanding of the the basic concepts of topology, including helicity, and how they have been applied in other disciplines, most notably space and laboratory physics. Quite likely the non-solar participants will bring an understanding of helicity that is relatively well developed within the framework of their own discipline, as well as an enthusiasm for applying it to a new discipline.

For both solar and non-solar participants to benefit, it is essential to structure the meeting to get the facts on the table, yet leave enough time for interdisciplinary discussion. We plan to have one discussion session each day of the conference. The topics of these sessions will be directly related to the invited talks and posters of the day. The discussion topics will be chosen to focus on controversial issues. When possible, the discussions will start with short presentation by the protagonists of the opposing views. The topics of days two and three lend themselves particularly well to that approach.

# 3 Preliminary Program

## 3.1 Monday, July 27

18:00 RECEPTION, REGISTRATION

## 3.2 Tuesday, July 28

TOPIC: INTRODUCTION TO THE SUBJECT

8:15 Opening remarks

8:30 History of subject in solar-, space-, geo-physics, possible future directions

9:00 Topology and helicity (basic concepts)

TOPIC: HOW ARE MAGNETIC AND KINETIC HELICITY RELATED?

9:30 What we can learn about magnetic and kinetic helicity from laboratory experiments

10:00 Coffee break

10:30 Planetary dynamos

11:00 Limitations of using magnetic helicity to study solar and space plasmas

11:30 Magnetic helicity and other rugged invariants in an MHD turbulent plasma

12:00 LUNCH

TOPIC: MHD PLASMA RELAXATION AND HELICITY CONSERVATION

13:30 Helicity conservation: theory

14:00 Magnetic helicity and relaxation phenomena in laboratory plasmas

14:30 Magnetic helicity and relaxation phenomena in solar corona

15:00 Coffee break + poster viewing

16:30 DISCUSSION

What are the theoretical limitations behind the magnetic helicity concept for closed and open physical systems? How well does magnetic helicity represent the topology of the plasma flows?

## 3.3 Wednesday, July 29

TOPIC: DYNAMOS, SOLAR CONVECTION ZONE

8:30 Dynamo phenomena in laboratory plasmas
9:00 Solar dynamo and magnetic helicity
9:30 Helicity spectrum: numerical modeling
10:00 Coffee break
10:30 Flows in the convection zone: SOHO SOI/MDI results
11:00 Creation of twist at the core-convection zone interface
11:30 Evolution of helicity through the convection zone: modeling
12:00 LUNCH

TOPIC: SOLAR PHOTOSPHERE

13:30 Photospheric current helicity
14:00 Photospheric motions as a source of twist in the photosphere and corona
14:30 The role of magnetic helicity in reconnection in the electron MHD regime
15:00 Coffee break + posters
16:30 DISCUSSION

What roles does magnetic helicity play in the solar dynamo? What we can learn about plasma flows in the Sun from observations of the vector magnetic field at its surface. Where does the current helicity of the magnetic fields observed in the photosphere originate?

18:00 Banquet, NCAR

## 3.4 Thursday, July 30

TOPIC: MAGNETIC RECONNECTION IN SOLAR AND LABORATORY PLASMAS

8:30 Role of magnetic helicity in 3D reconnection: theory
9:00 Role magnetic helicity in 3D reconnection: numerical experiments
9:30 Helicity and coronal reconnection: observations
10:00 Coffee break
10:30 Magnetic helicity and reconnection in spheromaks
11:00 Solar flares, jets and helicity
11:30 Helicity and MHD Stability

12:00 LUNCH

TOPIC: CHROMOSPHERE, CORONA, SOLAR WIND, IMF

13:30 Solar prominences and CMEs

14:00 Helicity of coronal magnetic fields (Quiet, CMEs, Emerging Flux Ropes)

14:30 Helicity in the interplanetary B field

15:00 Terrestrial magnetosphere - magnetic helicity and the solar wind-magnetosphere interaction

15:30 coffee break + posters

16:30 DISCUSSION

Where does the helicity observed in the corona and the interplanetary magnetic field originate? How does observed "helicity" reflect magnetic helicity? What do observers need to measure?

### 3.5 Friday, July 31

TOPIC: HELICITY – LONG TERM VARIATION AND ASTROPHYSICAL APPLICATIONS

8:30 Solar-cycle variation of magnetic helicity: IMF observations

9:00 Solar-cycle variation of magnetic helicity: theory

9:30 Role of helicity in cosmic ray scattering

10:00 Coffee break+ posters

10:30 Galactic/accretion disk dynamo.

11:00 Jets in active galactic nuclei

11:30 DISCUSSION

How should we expect magnetic helicity to vary during the solar cycle?

12:00 OVERVIEW

12:20 ADJOURN

# 4 Additional Information (Preface from the Conference Proposal)

Helicity is a topological property describing the complexity of an object; magnetic helicity describes the topological complexity of a magnetic field [6, 7, 8]. Among other things, helicity is relevant to twist, being left-handed (negative) or right handed (positive). The concept of magnetic helicity arises in both observational and theoretical studies of plasmas in laboratories, interplanetary space, the Sun and other stars, the galaxy, and beyond. It is not practical to cover all these magnetic-helicity-related topics in a conference of 100 participants, in order to ensure informal discussion and interaction. Although we plan to bring in results from the full scope of disciplines through invited speakers, we will focus discussion on solar and solar-related questions.

The importance of magnetic helicity, in the context of solar physics, accrues from its relevance to both the solar interior, now being explored extensively through helioseismology, and solar "weather" in the near-Earth environment. Broad interest in this topic is reflected in recent review articles in *Physics Today* [8], as well as solar and plasma physics journals [5, 4]. This interest has been stimulated by new solar observations, both X-ray images of the solar corona from the Yohkoh satellite [1] and measurements of vector magnetic fields in the solar photosphere from ground-based observatories [3, 2]. These observations motivate solar researchers to improve their understanding of fundamental definitions of helicity-related quantities, methods of their measurement, and the state of knowledge of helicity in related fields: topology, fluid mechanics, and laboratory plasma physics. The purpose of the proposed Chapman conference is to foster interdisciplinary discussions among theorists and experimenters in these fields, to improve the understanding of the topology of magnetic fields and plasma flows in the Sun from the deep interior to the solar wind: how magnetic helicity is generated on the Sun, how it propagates and evolves via magnetic reconnection, what its role is in solar flares, coronal mass ejections, and the solar wind - magnetosphere interaction, and how it is related to practical measurements. We also plan to discuss appropriate laboratory plasma experiments. We expect that this multidisciplinary discussion of laboratory experiments, theory and space observations will significantly help participants to understand problems and results of solar observations.

# References


[1] Acton, L. W., *et al.* 1992, *The YOHKOH Mission for High Energy Solar Physics*, Science, 258, 618 (1992).

[2] Canfield, R. C., de La Beaujardiere, J.-F., Fan, Y., Leka, K. D., Mc-Clymont, A. N., Metcalf, T. R., Mickey, D. L., Wuelser, J.-P., & Lites, B. W. 1993, Astrophysical Journal, 411, 362.

[3] Lites, B. W., Martinez-Pillet, V., & Skumanich, A. 1994, Solar Phys., 155, 11.

[4] Low, B. C., 1994, Phys. Plasmas, 1, 1684.

[5] Low, B. C., 1996, Solar Phys., 167, 217.

[6] Moffatt, H.K. 1978, Magnetic Field Generation in Electrically Conducting Fluids, Cambridge Univ. Press.

[7] Moffatt, H.K., & Ricca, R.L., 1992, Proc. R. Soc. Lond. A, 439, 411.

[8] Ricca, R.L., Berger, M., 1996, Phys. Today, 12, 28.

## 5 List of Invited Speakers

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# 6 Resume and Recent Publications