



Report on the 4th IAGA School July 2 – 7, 2019 Station de biologie des Laurentides (near Montreal), Quebec, Canada

The 4th IAGA School, prior to the IUGG General Assembly in Montreal, Canada, was held at the Station de biologie des Laurentides (SBL), ca. 80 km NW of Montreal. This venue provided two ideally sized lecture room and accommodation and full board for all participants. The School was attended by 20 students out of more than double the amount of nominations from the IAGA Divisions, and including four IAGA Young Scientist awardees. The selection criteria combined scientific excellence and good diversity regarding IAGA Division topics, geographical origin and gender. The group comprised 9 female and 11 male PhD students, with 5 from Europe (France, Germany, Poland), 3 from Russia, 5 from Asia (India, Japan, China), 6 from North America (USA, Mexico, Canada) and 1 from South America (Brazil).

Topics across all the disciplines of IAGA were covered by lectures given by experts in their fields: The geomagnetic field (David Kerridge, BGS Edinburgh, UK), Core dynamics (Mathieu Dumberry, University of Alberta, Canada), Ionosphere and Magnetosphere (Andrew Yau, University of Calgary, Canada), Electromagnetic Induction (Stephan Thiel, Geological Survey of South Australia), Solar Physics (Alexandre Lemerle, Collège de Bois-de-Boulogne, Canada) and Planetary Magnetism (Manar al Asas, University of British Columbia, Canada). Lectures were accompanied by practical exercises prepared by David Kerridge and Martin Connors (Athabasca University, Canada).

Both the students and the lecturers gave very positive feedback on the event. Interactions among students and between students and lecturers were very friendly and informal and friendships and networks were formed. This was facilitated by the convenient location where all students and lecturers stayed together, so that not only coffee breaks, but also meal times and evenings were used for lively scientific discussion. A half day outing to Mont Tremblant and a hike at the SBL complemented the event. The students initiated an online time-table to visit each others presentations at the following IUGG General Assembly. The main aims, increasing the visibility and attractiveness of IAGA to young researchers, providing the young promising researchers with overview of the activities carried out within IAGA across all fields of research related to the Earth's magnetic field and aeronomy, and to facilitate establishing new personal contacts were fully accomplished. We are very grateful to the European Geophysical Union (EGU) and GEM Systems, who both provided valuable financial support. We thank the Biology Department of the University of Montreal for use of the SBL and in particular for the tremendous hospitality and support of the local staff.



**4th IAGA School
July 2 – 7, 2019
Station de biologie des Laurentides (near Montreal),
Quebec, Canada**

Program

| Time/Date | 02. July Tuesday | 03. July Wednesday | 04. July Thursday | 05. July Friday | 06. July Saturday | 07. July Sunday |
|-----------|----------------------|-----------------------------|--------------------------------|--------------------------------------|----------------------|---------------------------|
| 7:30 | Arrival at SBL | Breakfast | Breakfast | Breakfast | Breakfast | Breakfast |
| 8:30 | | Welcome | | | | Planetary Magnetism I |
| 9:00 | | Geomagnetic Field I | Core Dynamics | Electromag- netic Induction I | Solar Physics I | |
| 10:30 | | Break | Break | Break | Break | Break |
| 11:00 | | Geomagnetic Field I & II | Ionosphere Magnetosphere I | Electromag- netic Induction II | Solar Physics II | Planetary Magnetism II |
| 12:30 | | Lunch | Lunch | Lunch | Lunch | Lunch |
| 13:30 | | Geomagnetic Field II | Ionosphere Magnetosphere II | Outing | Project Work | Project Presentations |
| 15:00 | | Project Assignment | | | | Break |
| 15:30 | | Project Work | Project Work | | Project Work | |
| 18:00 | | Dinner | Dinner | | Dinner | Dinner |

The Geomagnetic Field

David Kerridge

British Geological Survey, Edinburgh, UK

1. Geomagnetic observations

- A little bit of history of people and observations
- Magnetic observatories and instruments. INTERMAGNET.
- Magnetic surveys: from Captain Cook to the 3-satellite Swarm mission
- Magnetic activity indices and observatory data applications

2. Modelling the geomagnetic field

- Spherical harmonic analysis
- The International Geomagnetic Reference Field: the main field and its secular variations
- Building 'comprehensive models' that incorporate other magnetic field sources
- Using geomagnetic field data to investigate the core



Core dynamics and the geodynamo

Mathieu Dumberry

University of Alberta, Canada

- Force balance in the Earth's fluid core
- Quasi-geostrophic flows
- Magnetic field generation: competition between dynamo action and decay
- Observed magnetic field variations
- Decadal to millennial timescale flows in the core

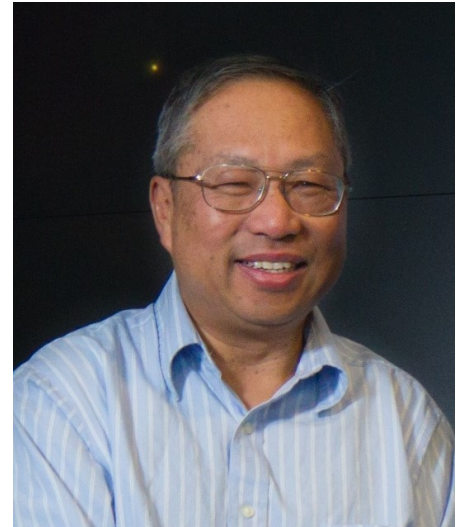


Ionosphere and Magnetosphere

Andrew Yau

University of Calgary, Canada

- Formation of planetary ionosphere
- The Earth's ionosphere: composition and structure
- The Earth's (internal and external) magnetic field: the solar wind
- The Earth's magnetosphere: origin, composition and structure
- Dynamics of the ionosphere: plasma processes in a magnetic field
- Magnetosphere-Ionosphere Coupling: the aurora and space weather



Electromagnetic induction methods and applications

Stephan Thiel

Geological Survey of South Australia

- Introduction to electrical and EM methods
- Electrical conductivity of Earth materials
- Source fields for electromagnetic induction
- Theoretical background of electromagnetic methods with focus on magnetotellurics
- Analysing MT data: dimensionality, strike, anisotropy
- Modelling of MT data: from 1D to 4D
- Case studies: Tectonics and mineral exploration
- Case studies: Geothermal exploration and hydraulic fracture monitoring



Solar magnetic fields and activity cycle

Alexandre Lemerle

Collège de Bois-de-Boulogne, Canada

- Observations of solar activity
- Solar magnetism
- The solar dynamo
- MHD induction
- Full set of MHD equations
- Numerical modeling
- Solar activity forecasting
- Eruptive events, radiative variability, coronae, etc.



Planetary Magnetic Fields

Manar Al Asad

University of British Columbia

- A tour of planetary magnetic fields: our solar system
- Flybys vs orbital data
- Data sets available: how/where to get them
- Separating internal and external fields
- Upward and downward continuation
- Core, crustal and induced fields
- Discussion of Science/Nature papers



Projects:

Geomagnetism

David Kerridge

British Geological Survey, Edinburgh

Guided computer-based exercises including:

- Signals in magnetic observatory data from seconds to decades
- Examples of spherical harmonic analysis in action including using the IGRF to trace field lines and find conjugate points
- Building a 'mini-IGRF' from a Swarm data set
- Estimating the core radius using geomagnetic field models

Magnetometers

(emphasis on fluxgate low frequency)

Martin Connors

Athabasca University, Canada

- Magnetic detection, B and dB/dt
- Signal transduction (A/D conversion)
- Control and data transmission systems (small computers)
- Assembly of test system
- Data storage and plotting
- Near-real-time results
- Remote data access and magnetometer networks
- Aspects of data inversion (advantages and pitfalls of indices; problems with inversions)



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