PROJECT TITLE: Characterisation of ionospheric irregularities

DTP Research Theme(s): Dynamic Earth

Lead Institution: University of Bath

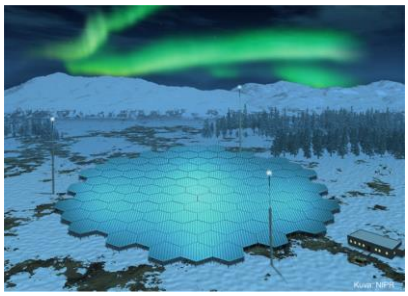
Lead Supervisor: Dr Biagio Forte, University of Bath, Electronic and Electrical Engineering

Co-Supervisor: Dr Ivan Astin, University of Bath, Electronic and Electrical Engineering

Co-Supervisor: Dr Andrew Kavanagh, BAS

Project Enquiries: b.forte@bath.ac.uk; i.astin@bath.ac.uk

Project keywords: space weather, scintillation, ionosphere, GNSS, EISCAT



Artist's impression of EISCAT 3D (courtesy of NIPR)

Aurora Borealis.

Project Background

The Earth's ionosphere can affect the propagation of radio waves that traverse it. Ionospheric disturbances associated with adverse space weather conditions introduce perturbations on trans-ionospheric radio waves that translate into fluctuations of signal intensity and phase, known as scintillation.
Large-scale structures in the ionospheric electron density (typically associated with plasma instability mechanisms) cascade into smaller scale structures in a turbulent fashion. It is the presence of these small-scale ionospheric structures (i.e. irregularities) that introduces scintillation on radio waves.
The cascade from larger to smaller scale irregularities can be characterised and modelled by observing scintillation over different radio wave frequencies (as scintillation varies with the radio wave frequency). The characterisation of the cascade is critical for the forecast of scintillation in the presence of diverse space weather conditions.

Here, we will use sophisticated radars, radio telescopes, Global Navigation Satellite System (GNSS) radio receivers to answer fundamental questions about ionospheric turbulence. We will investigate the spatial scales over which ionospheric irregularities cascade; we will establish the type of the cascade and the type of plasma instability that determines it.

Project Aims and Methods

You will join a vibrant team of researchers at Bath and BAS. We will use new data from EISCAT/ESR incoherent scatter radars in the European polar and auroral located at Tromso and Svalbard (Norway). We will combine these measurements with observations from KAIRA (a radio telescope in Northern Finland) as well as from ground and space-borne GNSS receivers. We will:

1. Determine the spatial scales over which ionospheric irregularities cascade in a turbulent fashion.
2. Ascertain the shape and size of the ionospheric irregularities generating scintillation at GNSS as well as lower radio wave frequencies.
3. Identify the conditions that trigger the turbulent cascade leading to ionospheric scintillation.

There is considerable scope for the student to take the project in new and exciting directions. There will be strong international collaboration with groups in the Canada, Europe, South America.

Candidate requirements

Applicants must have or expect to receive a good degree in physics, mathematics, meteorology or engineering. No prior knowledge of ionospheric physics and radio propagation is necessary: suitable training will be provided. Applicants should first contact Dr Biagio Forte who will be happy to discuss the project in full (email: b.forte@bath.ac.uk).

Proficiency in the use of programming languages such as MATLAB and Python is an advantage.

Training

The supervisor is Dr Biagio Forte and the co-supervisors are Dr Ivan Astin (Bath) and Dr Andrew Kavanagh (BAS) Full training in essential research skills will be provided through Bath's Graduate School and the NERC GW4+ DTP. In addition, the student may attend the EISCAT Summer Schools and similar summer schools in space weather and radio propagation routinely organised in Europe, USA, Canada. The student will present their work at national and international conferences and interact with staff from the Met Office and British Antarctic Survey.

Background reading and references

An introduction to the problem can be found in:

1. Forte, B, Coleman, C, Skone, S, Häggström, I, Mitchell, C, Da Dalt, F, Panicciari, T, Kinrade, J & Bust, G 2017, 'Identification of scintillation signatures on GPS signals originating from plasma structures detected with EISCAT incoherent scatter radar along the same line of sight' Journal of Geophysical Research: Space Physics, vol 122, no. 1, pp. 916-931. DOI: 10.1002/2016JA023271.
2. Fallows R. A., B. Forte, I. Astin, T. Allbrook, A. Arnold, A. Wood, G. Dorrian, M. Mevius, H. Rothkaehl, B. Matyjasiak, A. Krankowski, J. M. Anderson, A. Asgekar, I. Max Avruch, M. Bentum, M. M. Bisi, H. R. Butcher, B. Ciardi, B. Dabrowski, S. Damstra, F. de Gasperin, S. Duscha, J. Eislöffel, T. M.O. Franzen, M. A. Garrett, J.-M. Grießmeier, A. W. Gunst, M. Hoeft, J. R. Hörandel, M. Iacobelli, H. T. Intema, L. V.E. Koopmans, P. Maat, G. Mann, A. Nelles, H. Paas, V. N. Pandey, W. Reich, A. Rowlinson, M. Ruiter, D. J. Schwarz, M. Serylak, A. Shulevski, O. M. Smirnov, M. Soida, M. Steinmetz, S. Thoudam, M. C. Toribio, A. van Ardenne, I. M. van Bemmel, M. H.D. van der Wiel, M. P. van Haarlem, R. C. Vermeulen, C. Vocks, R. A.M.J. Wijers, O. Wucknitz, P. Zarka, P. Zucca, (2020), A LOFAR observation of ionospheric scintillation from two simultaneous travelling ionospheric disturbances, J. Space Weather Space Clim., 10, 10, DOI: 10.1051/swsc/2020010

Useful links

Enquiries relating to the project should be directed to the lead supervisor (see email address above for Project Enquiries). Enquiries relating to the application process should be directed to doctoraladmissions@bath.ac.uk

In order to apply, you should select the relevant University of Bath PhD online application form found here: https://www.bath.ac.uk/study/pg/applications.pl. When completing the form, please state in the 'Finance' section that you wish to be considered for GW4+ DTP funding and quote the project title and lead supervisor's name in the 'Your research interests' section.

Further information about the application process may be found here: http://www.bath.ac.uk/topics/postgraduate-research/

The application deadline is Friday 8 January 2021 at 2359 GMT. Interviews will take place from 8th to 19th February 2021. For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.