PROJECT TITLE: Seismic exploration of Earth’s dynamic core

University of Bristol Theme: Climate and Environment Research Challenge Area
Research Group(s): Geophysics
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Project keywords: Earth’s Core; Seismology; Planetary Interiors
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Figure 1. Sensitivity of outer core-transiting phase SKKS to structure in the Deep Earth, shown superimposed on a model of mantle structure. Relative arrival times of waves which bounce on the underside of the CMB provide information about the uppermost outer core (figure from Wu & Irving, JGR, 2020).

Figure 2. Inner and outer-core body wave phases from one distant earthquake. Such signals can be used to probe both the inner and outer core and the interface between them (figure from Irving, PEPI, 2016).

Project Background:
Earth’s core, made from an iron alloy and located thousands of kilometres below the surface, generates the protective magnetic shield which envelops and protects our planet, making our environment more hospitable for habitation. Energy for the geodynamo comes from compositional core convection and the slow growth of the inner core; geodynamo power also depends on the properties of the lowermost mantle. Despite its clear importance in understanding our magnetic field, we still do not understand some of the basic properties of Earth’s core including the depth and extent of layers at the top and bottom of the outer core, and the growth rate and structure of the inner core. Seismology allows us to probe Earth’s core and is providing new insights into some of these questions, with new datasets, higher resolution computational simulations and new analytical techniques revealing structural variation in the core at length-scales from kilometres to thousands of kilometres.

Project Aims and Methods:
This project will use seismic data to investigate the elastic properties of the outer core, inner core, and the boundary between them. The PhD project will involve collecting and analyzing data from globally-distributed seismic stations to probe potentially compositionally-distinct layers in uppermost and lowermost outer core, as well as the uppermost inner-core. Target seismic phases will include SmKS – to look for layering in the shallowest regions of the outer core – and PKP with PKIKP to investigate the deeper outer core and uppermost inner core. More complex seismic signals, for example phases diffracted inside the core, can be
targeted to resolve more subtle structures. Depending on the interests of the student, core-transiting signals from MERMAID floating seismometers may be integrated into the datasets analyzed. There is considerable flexibility possible in this project – the lead supervisor will work with the student to tailor the research to their specific interests, and the focus of the science may be primarily on the inner or outer core as desired. State-of-the art computational methods will be used to assess wave propagation through the Earth. This project will involve the use of observational seismology and computational simulations using models of realistic Earth structure.

**Candidate requirements:**
We seek a student with broad interests in seismology and geophysics. A first degree in geophysics, geology, physics, maths, computer science, engineering, or a related quantitative subject is needed. The ideal candidate will have an interest in both observational and computational seismology. The student will present results at national and international conferences and publish findings in international journals, requiring communication and written skills. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

**Training:**
The project will be based around working with existing seismic data and simulating seismic waveforms. Training in all the software and techniques needed to conduct this research will be provided to the student. The student will be encouraged to attend local and international workshops where appropriate.

**Background reading and references:**
Please contact Dr Irving for a copy of any paper below.

**Useful links**
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

**Eligibility**
UK and International students are eligible for a University of Bristol Scholarship. UoB Scholarships are fully funded for 4 years and cover university fees, living expenses at the UKRI standard rate, and an allowance of £2000 per year towards research expenses.

**Application deadline:** Tuesday 16th January, 2024, 23.59 GMT
(Interviews are expected to take place in mid/late February)

**How to apply**
Applications are online only at: http://www.bristol.ac.uk/study/postgraduate/apply/
Please select “PhD in Geology” as the programme in the online application system.
Please specify the project title and supervisors for the project that you are applying for.
To ensure your application is considered under the University of Bristol Scholarship funding scheme you must complete the Funding page in your online PhD application as follows:
1. For “What is your likely source of funding?” select Studentship
2. For the free text field “Please give the name of your scholarship or studentship” enter University of Bristol Scholarship.
3. Set “Percentage from this source” to 100%
4. Set “Is this funding already secured?” to No