Cosmic ray detection on a planetary scale - engaging citizen scientists and smartphones to explore the structure of the Universe

Type of Funding Request: Online Funding Inquiry
Status of this Funding Request: Submitted

Instructions:

This PDF document is a read-only version of the final Full Proposal you submitted to the John Templeton Foundation. You may print or save this document for your records. No further edits to this funding request can be made at this time.

Funding Request Info

- **Title:** Cosmic ray detection on a planetary scale - engaging citizen scientists and smartphones to explore the structure of the Universe
- **Request Status:** Submitted
- **Funding Area:** Natural Sciences
- **Last Updated Date:** 08/31/18 8:33am

Cycle & Area

Grant Program:

Large Grant Program - 2018 Cycle

- Request Amount is Greater Than or Equal to $234,801 USD
- Submission Due Date is August 31, 2018
- Notification by September 28, 2018

Is this funding inquiry related to Science and the Big Questions, or to one of the Foundation's other funding areas (Character Virtue Development, Genetics, Individual Freedom and Free Markets, etc.)?: Natural Sciences
Please select the Funding Area Theme that is most relevant for your funding inquiry: Fundamental Structures and the Laws of Nature

Project Description

Project Title: Cosmic ray detection on a planetary scale - engaging citizen scientists and smartphones to explore the structure of the Universe

Executive Summary:

Earth is continually bombarded by high energy particles, or cosmic rays, travelling at the speed of light from outside the Solar System. They are fundamental to our Universe, yet we have a limited understanding of their origins as no large scale survey has been undertaken.

This innovative project will use the world's network of smartphones to turn the surface of Earth into an instrument, able to detect cosmic-ray ensembles; groups of cosmic rays resulting from cascade reactions outside the atmosphere. A global community of citizen scientists will take part, contributing towards cutting-edge scientific research and gaining knowledge.

The existing Cosmic Ray Extremely Distributed Observatory (CREDO) has a basic smartphone network. This project will mature the technology and also expand the network by engaging participants around the world, and providing desktop detectors to public institutions.

The project will use a novel methodology to probe the structure of space-time, the very stage on which the Universe is evolving. The data will inform the world's scientists, while the process will inspire the next generation. Open educational resources, engagement activities, and art-science projects will further enable anyone to explore the fundamental questions of the Universe.

Project Description:

This project is focused on identifying and analysing cosmic ray ensembles (CREs). These are excesses of cosmic ray detections at a specific time or geographical location on Earth. They hold the imprint of the space-time structure of the Universe. Observing them is almost like observing the lights of urbanization on Earth at night --- when new lights appear, this indicates that new infrastructure is being built over time. There is precedent for the detection of CREs, since long-lasting excesses of cosmic rays have been reported in the literature (e.g. Smith et al., 1983). However, they are considered unexplainable at this time and have not received further investigation. This project aims to show that CREs are fundamental to understanding the structure of our Universe.

The project will employ the millions of smartphones around the world as the key means of data acquisition. It will utilize an enhanced version of the phone app already developed by CREDO - CREDO Detector. By offering the app in Android and iOS based versions as well as multiple languages it can be used by a diverse, international community. To increase access for even more citizen scientists, and perform a vital cross-check of smartphone detections, we will produce 'desktop' detectors. These detectors, optimised for efficiency and economy, will be conceived through a crowdsourcing initiative and hackathon, to create public ownership for this aspect of the project. We aim to produce 1,000 detectors to ensure scientifically verifiable results. They will be supplied free of charge to educational institutions, interest groups, and public spaces around the world. The wide availability of these detectors will engage, and raise the aspirations of, participants who would not otherwise get involved in science or continuing education.

The inclusivity of the app and detectors are essential to the success of the project from both a scientific and social perspective. To create a planetary scale detector that is able to capture widely distributed cascades of cosmic rays, it is essential to acquire as many participants across the world as possible. The app will also act as a central hub for scientific and philosophical resources, allowing users to socially explore our place in the Universe.

The data acquired from the cosmic ray detectors will be fed into servers provided by ACC Cyfronet AGH-UST, an external institution with an existing relationship with CREDO. The two-step analysis of the data will also be a community effort, and provide another opportunity for education and discussion. We will use two online 'citizen science' experiments: 'Private Particle Detective' (PPD) and 'Dark Universe Welcome' (DUW). PPD focuses on the identification of genuine and useful cosmic rays within CREDO detector app data, supported by telescope calibration 'dark frames'. DUW focuses on the identification of patterns in the timings and locations of global cosmic ray detections. Both projects already exist through CREDO, but their use and accessibility is currently very limited. The project proposed here will connect all of these components (CREDO Detector, PPD, and DUW) to create a contiguous pathway for scientific analysis and a learning journey for participants.

Data mining and visualization components will be built into each stage, from data acquisition to filtering to pattern identification, such that users can follow 'their' particles, and their achievements, throughout the project. This will give participants a far more tangible connection to science than any existing citizen science project. Furthermore, as the project progresses, the scientific results will be disseminated, explored and discussed with the community as a whole via online and face-to-face events, art-science projects (led by the project's artist in residence) and a wide variety of educational and edutainment resources, including an augmented reality platform.

Project Description Attachment:

Statement of Significance:

CREs may be the best medium we have to gain a deep and intimate insight into the space-time structure of our Universe. It has been probed for years by others, but their work is not open to public participation, and has only provided upper limits to the scale of space-time. As CRE particles have energies many orders of magnitude higher than previously used (even in expensive particle accelerators), and higher energy particles have greater sensitivity to fluctuations in space-time, this project aims to probe space-time with a sensitivity far beyond anything ever seen before.

Science and its philosophical debates are still elitist, with few opportunities for the public to take part in the process and interact with meaningful projects that they can take pride in. This project offers a unique and powerful opportunity to engage a broad cross section of society in cutting-edge science. Through the education and exploration of our place in the Universe, we have the opportunity to further the broader scientific, technological, and investigative skills of participants, thereby addressing the shortfall in these skill sets in many communities.

This project aims to look at the Universe through a new window designed by the public, and who knows what we will collectively see through it!

Outputs:

Year 1:•R&D of initial desktop detectors to work in parallel with mobile apps
•R&D of algorithms for fraud detection, smartphone calibration and gamification models
•Industrial-scale server accepting data from mobile apps + future desktop detectors
•Upgraded smartphone app capable of detecting cosmic rays + delivering feedback to the server at scale
•Automated data flow of detections from the app to the citizen science (CS) experiments
•Upgrade of the CS experiments + CREDO website to incl. educational resources
Year 2:•Addition of basic data mining, competition arenas, educational resource links + online discussions for the app
•Development of data mining and machine learning algorithms for automated data analysis
•Development of the first version of an edu-tainment augmented reality(AR) package
•Production and distribution of desktop detectors
•Production of 60 second animations explaining CREDO and this project
•Worldwide publicity of the project incl. initial results + competitions
Year 3:•Continued distribution of the desktop detector, supplemented by educational packs
•Worldwide release of the first art-science collaborations
•Final release of the AR edu-tainment package
•Final release of scientific findings, art-science collaborations + educational results

Outcomes:

1. A minimum of half a million active users of the mobile app making particle detection part of everyday life

2. A minimum of five thousand education institutions worldwide regularly teaching lessons related to this project and its outputs

3. A minimum of three peer-reviewed scientific articles on the results obtained within this project, with co-authorship offered to any citizen scientist who contributed to data acquisition and/or analysis

4. A Guinness record for the largest scientific collaboration, largest author list of a peer reviewed article or largest physics lesson taught

5. A 'discoverology' course at a minimum of 3 universities teaching the principles of science exploration

6. Educational resources made available on the OpenLearn platform giving access to over 6 million annual visitors

7. An increased understanding of this aspect of physics within a wide community through engagement with animations and augmented reality education platforms

Capacity for Success:

The Open University (OU) is partnering with the Institute of Nuclear Physics (IFJ PAN) to combine the particle physics expertise of IFJ PAN with the educational technology experience of the OU.

IFJ PAN have developed CREDO which is already gathering data so the structure of the data capture system is in place. The Institute carries out basic and applied research in physics, with emphasis on nuclear physics. This research is aimed at explaining the structure of matter from microscopic to cosmic scales, through experiments and/or application of theoretical methods.

The OU is ideally placed to fully exploit the data that the project produces, disseminating it through a variety of media. This includes open educational resources on the OpenLearn online learning portal which has over 6m visitors annually. This will enable anyone, anywhere to build their knowledge on this subject. It will not be limited to project participants.

The OU has a great deal of experience of citizen science with projects including the OpenScience Observatories (online access to telescopes) and has created OpenSTEM Labs - online simulated and remote-access science experiments. The OU's Knowledge Media Institute also develops augmented reality apps that allow users to interact with 3D virtual models.

Relation to Sir John Templeton's Donor Intent:

This project will not only seek to answer the big questions around space-time and dark matter but it will involve a large, scientifically curious audience. Participants will come from all backgrounds and age ranges. Taking part in this project will inspire them to begin their own journeys of discovery, embracing science and all it has to offer. The Universe can seem too big to contemplate for many people, too complex to comprehend. This project will bring it closer, into focus, into their homes. This project is huge, dynamic and global, unlike anything attempted before. We believe that the project's scale and vision, along with its intensely human element, align it well to the Foundation's intent.

Project Relationship to Previous Grants: No
Proposed Project Start Date: 10/01/2019
Proposed Project End Date: 09/30/2022

JOHN TEMPLETON
FOUNDATION

Personnel

Primary Contact Information

Project Leader

Project Leader Status: The Project Leader is different than the Primary Contact

Project Leader Contact Information

Prefix: Dr.
First Name/Given Name: Johanna
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Suffix:
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Project Leader's CV/Resume Upload: Jarvis-CV- August18.docx

Project Co-Leader

Project Co-Leader Status: The Project Co-Leader is different from the Primary Contact

Project Co-Leader Contact Information

Prefix: Dr.
First Name/Given Name: Piotr
Middle Names:
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Suffix:
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Phone Number: +48 12 662 8341

Project Co-Leader's CV/Resume Upload: homola-cv-2016.docx

To the best of your knowledge, is the Project Leader or Project Co-Leader a JTF Trustee, Officer or staff member or related to a JTF Trustee, Officer or staff member as a spouse, sibling, child, or parent?: No
Additional Personnel:

Associate Professor Dariusz Góra (IFJ PAN)

Associate Professor Robert Kami?ski (IFJ PAN)

Professor Jerzy Mietelski (IFJ PAN)

Doctor Niraj Dhital (IFJ PAN)

Mr Konrad Kopa?ski (electronics technician, IFJ PAN)

Eng. S?awomir Stuglik (software engineer, IFJ PAN)

Mr Katarzyna Smelcerz (software engineer, CUT, IFJ PAN)

Mr Oleksandr Sushchov (Phd student, IFJ PAN)

Mr Kevin Almeida Cheminant (Phd student, IFJ PAN)

Mr Micha? Nied?wiecki (software engineer, CUT)

Associate Professor Teresa Grabi?ska (philosopher of nature, AWL)

Dr. Eng. William Wu (CEO QED (https://qed.ai))

History with the Foundation:

The John Templeton Foundation is well known in Kraków, home of IFJ PAN, via the Templeton Prize laureate Fr. Prof. Micha? Heller. He supports the Copernicus Center for Interdisciplinary Research: an active and visible think-tank at which this projects co-leader gave an invited public lecture in 2017. This lecture was uploaded to YouTube and an article was published in Tygodnik Powszechny, a Polish country-wide paper and partner of the Copernicus Center. Thus, the Foundation has already indirectly helped CREDO grow and promote its program. We are thankful for this and welcome the opportunity for a direct relationship.
The OU are also grateful for the funding that they have received from the Foundation to support the 'Magical thinking in contexts and situations of unbelief' project, which aims to understand atheism and other forms of 'unbelief'. The 'Space, Time and Consciousness' podcast funded by the Foundation and created by Professor Russell Stannard is also available on OpenLearn.

Organization

Applicant Country: United Kingdom
Organization Name: The Open University
Also Known As: The OU
Did this organization receive 50% or more of its annual funding in any one of the last three years from any combination of the John Templeton Foundation, Templeton World Charity Foundation or Templeton Religion Trust?: No

Budget

In what currency are you requesting support from the Foundation?: GBP
Request Amount: [　　　　]
Total Project Amount: [　　　　]
Brief Budget explanation and Sources of Additional Funding:

This project is receiving significant funding in kind from IFJ PAN and its employees in the form of time and knowledge from those listed in section 16.

Personnel:[　　　　]
•Public Engagement Lead - UK

•Art-science practitioner - UK

•Project administration - Poland & UK

Travel & Subsistence: [　　　　]
•UK/Poland trips for lead and co-lead teams

•Attendance of conferences and other international events

Hardware/Software: [　　　　]
•1,000 desktop detectors

•Android and iOS mobile app development

•Website enhancement

•ACC Cyfronet AGH-UST server use

Education Resources: [　　　　]
•Augmented Reality edutainment package

•10,000 teacher packs

•3 animations

•Translation Services

Additional Small Elements and Overheads not exceeding 15%: [　　　　]