

LSST:UK Science Centre EPO proposal for Phase B

Title: *LSST:UK Science Centre - Education and Public Outreach (LUSC-EPO)*

Proposing team and staff request:

Staff request: EPO Coordinator, 0.1 FTE; EPO Project Officer, 0.5 FTE (*both to be appointed*)

Proposing team: Andrew Norton (OU, Phase A EPO Coordinator); Edward Bloomer (RMG); Sarah Casewell (Leicester); Dave Clements (ICL); Chris Lintott (Oxford); Andrew Newsam (NSO & LJM); Bob Nichol (Portsmouth); Tracey Dickens (Leicester); Kathy Romer (Sussex); Aprajita Verma (Oxford).

LSST Science Collaboration: *Education and Public Outreach*

Scientific Justification

Education and Public Outreach (EPO, within which we also include Public Engagement with Research) is an essential facet of any modern research programme. It is recognized that to achieve effective outcomes, the EPO element and its evaluation should be planned and resourced from the outset. Accordingly, there is a well-planned and well-resourced US-based LSST EPO programme which aims to facilitate a pathway from entry-level exploration of astronomical imagery through to more sophisticated interaction with LSST data using tools that are similar to those used by professional astronomers. This will be delivered via an EPO portal comprising four interfaces: (i) a multimedia gallery including video clips, images, 3D models etc; (ii) an interactive skyviewer including curated objects with links to other information; (iii) online science notebooks utilizing the Jupyter web-based interactive computing platform; and (iv) a citizen science programme through the well-established Zooniverse project allowing volunteers to contribute to real research projects. Each of these interfaces will be designed to be accessible using mobile devices and will allow users to interact directly with the cloud-based LSST EPO data center, so allowing for scalable, on-demand computing. During the period of the Phase B funding, the US EPO team will be constructing this portal and its interfaces, but will not begin rolling them out to public use until 2022 when science operations begin.

A key principle of this LUSC-EPO proposal is to not duplicate effort that is already planned by the US EPO team, but to focus on areas where LSST:UK can make complementary contributions to the overall programme, and to areas that are UK-specific which fit within the STFC public engagement strategy. We will therefore aim to develop the use of LSST EPO assets in ways that allow UK scientists to share their own research stories with diverse audiences. On the timescale of the Phase B funding we will also pilot and evaluate LSST EPO assets, and we will plan how to leverage further EPO funding so that this activity can become sustainable moving forward into the operational phase of the LSST project. **We envisage that this requires two LUSC-EPO staff directly funded by this work package: a Coordinator and a Project Officer. These staff will carry out *some* education, outreach and engagement activities themselves, but more importantly will act as the conduit to enable effective LSST EPO activities to be carried out by the wider UK community of scientists who are pursuing their own research with LSST data.**

The STFC Public Engagement Strategy (2016-2021) includes five core principles:

1. **Showcasing STFC science and technology** – LSST science naturally fits within two of the five themes of STFC's work: "Big Telescopes" and "Big Data and Computing".
2. **Building the right partnerships** – the LSST:UK EPO activities must be properly coordinated with the US-based EPO team, headed by Amanda Bauer. She has been involved with all stages of development of this activity and will remain involved throughout the Phase B timeframe and beyond. Partnerships with appropriate UK organizations are also vital to deliver UK-based EPO, and some potential partners (e.g. FutureLearn, NSO, BAP, Zooniverse) are described below.

3. **Developing and supporting STEM influencers** – producing assets which others can use to deliver public engagement with research is at the heart of the LSST EPO design. Through annual workshops, the LUSC-EPO staff will empower UK scientists to share their research effectively.
4. **Improving our reach with diverse audiences** – the US EPO team will ensure that deliverables are relevant, accessible, interesting and engaging to diverse audiences, including those traditionally under-represented in STEM. Around 30 UK institutions are part of LSST:UK so we have capacity to deliver EPO activities throughout the UK, including to schools with low STEM engagement.
5. **Delivering high quality public engagement activities and outcomes** – the LUSC-EPO staff will build on the high quality assets produced by the US EPO team to deliver high quality activities and teaching resources to UK audiences, and will evaluate their outcomes.

We recognize the necessity to evaluate all aspects of the EPO programme that we pursue, and to this end we propose to adopt the STFC Public Engagement Evaluation Framework. This will involve capturing quantitative and qualitative data about both the inputs and outputs of the programme, as well as its reach (number and diversity of people engaged), the generic learning outcomes that audiences take from the work, and the processes by which the programme is planned and delivered.

Work package description and justification of resources

The LUSC-EPO Coordinator will coordinate EPO activities from the LSST:UK community and direct the Project Officer to facilitate the delivery of those activities, in conjunction with UK scientists engaged in LSST research. Hence, a first core role for the LUSC-EPO Project Officer will be to discover, and keep up-to-date with, the assets produced by the US EPO team, and be the go-to expert for the LSST:UK scientists to seek advice from on their best use. A second core role will be to evaluate the LSST EPO assets with UK audiences, during commissioning, before their release to the wider public community.

Many ideas for EPO activities utilizing the US assets will undoubtedly emerge from the wider LSST:UK community in due course, but here we highlight a few that have been suggested by the proposing team. Some of these could be carried out directly by the LUSC-EPO staff under the funding sought here, some involve collaboration between the LUSC-EPO staff and external partners, whilst others will need additional funding for materials or directly incurred costs, bid for through further coordinated proposals. A key role for the LUSC-EPO staff will be to develop this programme, investigating and prioritizing activities as appropriate. This includes seeking out other sources of funding, in liaison with members of the LSST:UK community, in order to make the LUSC-EPO effort sustainable in the long run. Examples of projects that might be undertaken are as follows:

1. **Social media presence:** To showcase UK science and technology via LSST, a Twitter / Facebook / Instagram feed may be implemented to highlight an “LSST:UK scientist of the week” and “LSST:UK thought for the day”. This will link to a mobile-friendly LSST:UK EPO website where information is curated and which provides links to the LSST EPO portal. This could be modelled on similar activities already used successfully in the Dark Energy Survey public engagement programme (led by Romer).
2. **The Royal Society Summer Science Exhibition:** Held annually, the RSSSE attracts 10,000+ attendees in person and 10× that number via its website. Audiences are diverse, including school groups and media representatives who, as STEM-influencers, ensure that the stories featured have a life beyond the exhibition. Astronomy-themed exhibits have been selected in each of the last few years. A stand in 2021 or 2022 to coincide with LSST’s science first-light would allow us to highlight early project results and the role of UK astronomers in core science areas. The exhibit would then have an extended life as a touring item which could be taken to a range of UK science centres or fairs, and to non-traditional venues such as shopping centres, sporting events, music festivals, etc. Members of the proposing team (Norton, Clements, Verma) have prior experience of running successful exhibits at the RSSE and beyond. This activity would need additional funding for both materials and staffing budgets (typically £20k + £10k respectively), which the LUSC-EPO staff would assist in bidding for.

3. Short animated cartoons: The Open University's "60 second adventures in astronomy" (funded by STFC in 2012, with Norton as co-I) are a series of 12 humorous animations, voiced by David Mitchell, showcasing core STFC science and technology. They have attracted over 1 million views on YouTube, are used widely in informal teaching material, and mirrored on various educational websites. A further series of "60 second adventures with the LSST" might focus on the four top level LSST science goals: mapping galaxies through time and space; cataloging the Solar System; exploring the changing sky; and the structure and formation of the Milky Way. These would complement the US EPO assets by offering a uniquely British comedic view of the science which is particularly engaging for diverse UK audiences. Although concepts and draft scripts for the cartoons could be worked-up by the LUSC-EPO staff, this activity would need additional budget (of order £25k) to pay the media production company, which could be sought as a separate funding bid.

4. Massive Online Open Course: The UK-based FutureLearn MOOC platform has 7 million users worldwide studying short, free courses from 135 partner organizations. There are six astronomy-themed courses currently on FutureLearn, including two ("Moons" and "In the night sky: Orion") produced by the OU (with Norton). These each comprise 12 study hours over 4 weeks; they provide tutor support via student-led discussion forums and material is presented as short chunks of text/audio/video/quizzes and interactive challenges. One of the existing astronomy MOOCs had >44,000 participants in its first six presentations, of whom almost 5,000 (>10%) completed the course – this far exceeds the typical completion rate for a MOOC and illustrates the appeal of astronomy-themed educational resources. We envisage a MOOC on "Astronomy with the LSST" may be produced, utilizing the cartoons above, as well as many of the assets produced by the US EPO team, particularly from the multimedia gallery and the skyviewer. They could conceivably include science notebooks and citizen science projects too, depending on the level at which it is pitched. The focus of such a MOOC could be on developing STEM skills as much as it is on showcasing STFC science and technology. Mirroring the key LSST science topics, the four MOOC study weeks could cover: (i) the nature of dark matter and gravitational lensing, the nature of dark energy and the fate of the Universe; (ii) the outer Solar System and the Kuiper belt, near-Earth objects and potentially hazardous asteroids; (iii) supernovae and variable stars; (iv) the fundamental properties of stars in the Solar neighbourhood, and the evolutionary history of the Galaxy. Although authoring of materials could be led by the LUSC-EPO staff, the standard FutureLearn MOOC production cost (of order £45k) would need an additional source of funding to be secured.

5. Planetarium resources: There is a well-established planetarium community in the UK, linked through the British Association of Planetaria (BAP), comprising static facilities (e.g. Royal Museums Greenwich) and mobile planetaria, often operated by universities. As key STEM-influencers, the BAP bring astronomy to UK school and family audiences, and also to diverse audiences at open events and festivals, reaching 1.4 million people/yr, with 0.5 million attending presenter-led, space-themed shows into which STFC content could be inserted. The key here is that media must be available in a suitable format for the most commonly used UK projection systems. In collaboration with Bloomer (RMG) & Jeffries (Keele), the LUSC-EPO staff will enable the production of media (images, animations, etc.) by exploiting US EPO assets and disseminating the results to appropriate UK organizations. Accompanying notes could also be provided by LUSC-EPO staff for those not so expert in the field.

6. National Schools Observatory: When Liverpool John Moores University inaugurates its 4m robotic "LT2" on La Palma in 2023 (with LSST follow-up a key science goal), a new role for the current Liverpool Telescope will begin. Equipped with a 2°×2° wide-field camera, ~50% of its time will be available for use by UK schools. This will offer pupils a taste of robotic astronomy alongside professional astronomers: LSST's high transient rate lends itself naturally to follow-up work of this kind. The NSO is a key STEM-influencer and is very experienced in matching what schools do to the research activities of UK astronomers, and in reaching diverse audiences to promote STEM. Close collaboration between the LUSC-EPO staff and NSO Director Newsam will enable this to be extended into the LSST era and provide a strong UK narrative for LSST science.

7. **Zooniverse:** Citizen science projects are known to inspire people to learn about the topic they are researching, beyond what is presented to them in the project itself. As such, they provide exceptional impact in developing STEM skills in the wider population. Having its origins in the “Galaxy Zoo” project, Zooniverse is the world’s leading citizen science platform, allowing hundreds of thousands of volunteers to assist professional researchers to carry out genuine cutting-edge research projects (see <https://www.zooniverse.org/about/publications>). We note that a crowd-sourced project for gravitational lens discovery is already planned as part of the phase B proposal from the strong lensing community. Through its newly created “Zooniverse Lab” the platform offers the ability for scientists to create their own bespoke citizen science projects. UK Astronomers will be able to query the LSST database for their required data and feed this into Zooniverse to create projects which can quickly be launched to citizen users. The LSST construction budget has already funded this development, and this is therefore a vital UK-led aspect of the overall LSST EPO programme. Liaising with Zooniverse Director Lintott, the LUSC-EPO staff will support UK scientists to make best use of this capability to bring their research to diverse audiences in order to showcase STFC science.

8. **Other potential partners:** the Association of Science Discovery Centres (ASDC) have previously had great success with their “Explore your Universe” and “Destination Space” programmes. There may be the possibility to pursue another project similar to these, focused on LSST and its science. Funding for such a programme could be sought jointly by the LUSC-EPO staff and the ASDC. Another activity could be to seek to translate LSST EPO assets into Welsh and Gaelic, and there may be Welsh and Scottish national government funding available to facilitate this diversification.

Resources

A. We anticipate a role for a **LUSC-EPO Coordinator** at 0.1 FTE/yr for 4 years who will coordinate all UK EPO projects and funding bids, provide lead academic authorship of material for created content (e.g. exhibition, cartoons, MOOC, planetarium resources), direct the activity of the LUSC-EPO Project Officer, and maintain effective liaison with Amanda Bauer and the wider LSST EPO team.

B. We anticipate a role for a **LUSC-EPO Project Officer** at 0.5 FTE/yr for 4 years who will be the go-to expert for the LSST:UK community of scientists to seek advice from on the best use of LSST EPO assets and resources. This individual will also evaluate the LSST EPO assets and resources with UK audiences, in advance of their being released more widely, and will contribute to academic authorship of material for any created content (as above). The Coordinator and Project Officer may be based at any of the LSST:UK institutes actively involved in EPO activities, not necessarily both at the same place.

C. **Materials and directly incurred costs:** The two staff appointed will each require computing kit (laptop *and* mobile device) on which to develop and evaluate resources, estimated total cost is £6k. A miscellaneous consumables budget for outreach materials of £1k/yr is also required. **Total cost: £10k**

D. **Travel and subsistence:** The LUSC-EPO team will organize an annual workshop to share EPO expertise between scientists from across the LSST:UK institutes. A budget of £2k/yr (£8k total) will be required. The Coordinator and Project Officer each require funding for 10 UK trips/yr to coordinate with UK institutes, at £100/trip, cost is £2k/yr (£8k total). An annual trip to the US for collaboration with the US EPO team is necessary, for one person, at £2k/yr (£8k total). **Total cost: £24k**

Additionally, we suggest that £50k/yr be ear-marked within the STFC public engagement grants line, to be specifically used for LSST:UK EPO activities and awarded under the *Spark Awards* and *Nucleus Awards* schemes. This will ensure that proposals for EPO funding are open to the whole LSST:UK community and will go through the same level of scrutiny as other requests for STFC PE funds. These might be used to fund media and MOOC production costs, exhibit materials and staffing (for projects such as those above), or other specific directly incurred costs, as required.