

Institution: University of Central Lancashire		
Unit of Assessment: 09: Physics		
Title of case study: From the Earth to the Sun and Beyond: astrophysics outreach and engagement through art, storytelling and dance		
Period when the underpinning research was undertaken: The underpinning research began in 2013 and is ongoing.		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Robert W. Walsh	Professor (Solar Physics); Uni Dir of Research (2008-2017)	2000 – present
Joanne Pledger (nee Bibby)	Snr Lecturer (Astrophysics); Ogden Science Officer (2013 – 2018)	2012 – present
Megan Argo	Lecturer (Astrophysics)	2016 – present
Period when the claimed impact occurred: 2016-2020		
Is this case study continued from a case study submitted in 2014? No.		
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>Using differing artistic approaches, researchers in the Jeremiah Horrocks Institute (JHI) have promoted both an enhanced understanding of and subsequent interest in Astronomy and Astrophysics through innovative large-scale art installations, storytelling, and dance. Collaborating with museums, artists, dancers and light festivals, the resulting national and international projects led directly to the co-creation of new forms of well received artistic expression and cultural output. Artistic partners reported a broadening and deepening of their creative approach and portfolio, while museum and festival professionals outlined a change in working practices to include additional science engagement opportunities and hence improve and develop further the visitor experience. Merging concepts of astronomy/astrophysics with distinct cultural elements has engaged a new range of audiences, both physically and online. This has broken down gender stereotypes relating to both STEM subjects and art, while the active learning techniques employed helped overcome common preconceptions of the subject as dry, complex and overly academic. All programmes were funded by external bodies with one of them (SUN) now being designated as an Science and Technologies Facilities Council national engagement partnership project.</p>		
<p>2. Underpinning research (indicative maximum 500 words) (496)</p> <p>The research areas of the Jeremiah Horrocks Institute (JHI) are of interest to society as together we explore and define our place in the Universe. Each of the staff indicated are active researchers in their particular specialisms.</p> <p>Walsh's research focuses on utilising both space-based observations and magnetohydrodynamical (MHD) modelling to explore the Sun's inner corona. His research examines coronal heating by numerous small-scale energy release events – the nanoflare scenario. In particular, his work on high resolution extreme ultraviolet (EUV) imaging via instrumentation on NASA's sounding rocket programme is yielding unique insights into the fundamental plasma scales operating in this highly dynamic MHD environment [1, 2].</p> <p>Massive stars rapidly consume all their fuel, living short but very active existences. With masses at least 20 times that of our Sun, theoretical modelling suggests these stars should die as supernova; however currently there is scant evidence to confirm this. Pledger's research focuses on obtaining precursor images and spectroscopy of massive stars before they explode in a bid to confirm (or deny) this theory [3].</p> <p>Argo's interest is in radio astronomy, including investigations into radio supernovae in nearby starbursts and masers in the nearby starburst galaxy M82. Her public and school</p>		

Impact case study (REF3)

talks include "The Kaleidoscopic Universe", looking at how different parts of the electromagnetic spectrum can help us build a complete picture of the universe [4], and "When Galaxies Collide!", looking at what happens when galaxies undergo collisions [5], as well as presentations on supernovae and black holes.

Astronomy and astrophysics are inspirational disciplines that allow for a captivating introduction to a wide range of scientific topics. The worlds of art and science, despite sometimes being viewed as polar opposites, are complimentary disciplines whose approaches to practice and public engagement can be beneficial to each other. In 2016, JHI researchers decided to deliver targeted public engagement activity through specific collaborations with artistic practitioners, actively seeking external funding to develop new science/art experiences. Each academic brings relevant elements of their research into the specific outreach and public engagement work with new and creative collaborations with artists, storytellers and dancers.

3. References to the research (indicative maximum of six references)

All publications in peer reviewed journals

- [1] Cirtain, J. plus 11 co-authors including **Walsh, R.W.** (2013) Energy release in the solar corona from spatially resolved magnetic braids. *Nature*, 493 (7433). pp. 501-503. ISSN 0028-0836 DOI:10.1038/nature11772
- [2] Williams, T., **Walsh, R. W.**, Winebarger, A.R. et al (2020), Is the High-resolution Coronal Imager Resolving Coronal Strands? Results from AR 12712. *The Astrophysical Journal*, 892 (2). p. 134. ISSN 0004-637X DOI: 10.3847/1538-4357/ab6dcf
- [3] **Pledger, J**, Moffat, A F J et al (2018) The First Optical Spectra of Wolf Rayet Stars in M101 Revealed with Gemini/GMOS. *Monthly Notices of the Royal Astronomical Society*, 473 (1). pp. 148-164. DOI: 10.1093/mnras/stx2190
- [4] Rampadarath, H, **Argo, M K**, Baldi, R D et al (2018) Jets, Arcs and Shocks: NGC 5195 at radio wavelengths. *Monthly Notices of the Royal Astronomical Society*, 476 (3). pp. 2876-2889. DOI: 10.1093/mnras/sty390
- [5] Muxlow, T W B, Ivison, R J, **Argo, M K**, et al (2020) The e-MERGE Survey (e-MERLIN Galaxy Evolution Survey): overview and survey description. *Monthly Notices of the Royal Astronomical Society*, 495 (1). pp. 1188-1208. ISSN 0035-8711 DOI: 10.1093/mnras/staa1279

4. Details of the impact (indicative maximum 750 words)

Exploring Light and Dark

The collaboration between the University of Central Lancashire and the Beacon Museum, Whitehaven, Cumbria entitled *Exploring Light and Dark*, was the first science exhibition held at the museum and attracted over 2,500 visitors over four weeks. Arising from a GBP9,805 Science and Technology Facilities Council Spark Award, the collaboration piloted three artistic strands by;

- creating a new large-scale science/art installation work;
- exploring astronomical heritage by the way of local cultural storytelling and,
- advancing astronomy education through movement and dance.

This partnership held further significance in a region with observable inequalities; local science and technology industries introduce a transient population of highly skilled workers that results in these jobs not being seen as attainable for many young people in the area itself. At a time of increased funding pressures on cultural institutions such as the Beacon Museum, Alan Gillon, the Beacon's Learning and Public Engagement Manager commented that *Exploring Light and Dark* was "...a unique exhibition and we are finding that audience engagement is proving to be very strong." [A1]. The exhibition contributed to local cultural preservation and interpretation through attracting new audiences to the museum and enhancing the museum offer. One school pupil summed up the engagement: "No one told me before that science could be taught like this! Science is interesting... I didn't know." [A2]

From the Earth to the Sun This three-metre high astronomy/art installation piece consisted of a semi-circular rear projected installation of NASA Solar Dynamic Observatory Atmospheric Imaging Assembly (SDO AIA) EUV movies of the Sun with an Inca-inspired soundtrack in a completely blacked-out environment. The piece generated a new way of thinking about our closest star and stimulated interest in solar research from both the general public and school groups. One teacher commented: “[**The children**] **were absolutely fascinated by the Sun and the fact it was moving and almost seemed like a living thing. I think anything like that, that can inspire them, is worthwhile.**” [A2] It should be noted that the installation was subsequently exhibited in Preston, as part of the Lancashire Encounter Festival in 2016, and then at the John Mackintosh Cultural Centre, Gibraltar in 2018, where it was also the focus of an episode of ‘Rock Explorers’, a popular natural science programme broadcast by the Gibraltar Broadcasting Company [B].

Astronomical heritage and story-telling: The use of a storyteller (Steve Warton) was also explored to link the local heritage of stone circles prevalent in Cumbria with astronomy. This approach enhanced not just the listener’s understanding of astronomical topics (e.g. the movement of the stars) but also of local myths and legends that were part of their own cultural tradition. Warton commented: “**When you can hang concepts and ideas on a person’s story, many people can engage. It also allowed the children to relax and have fun and made them more open... on the way out, they’re asking different questions ... particularly about the characters and why did they do things? So, they were starting to develop their own inquiries.**”[A1]

Astronomy and Dance: Learning about science at school is often portrayed as a boring and stultifying encounter, passively listening to teachers explaining complex subjects. By introducing astronomy with dance, JHI researchers have transformed the approach into a vibrant, dynamic and interactive experience. Linking the behaviour of celestial objects to movement broke down gender barriers to both the understanding of the science as well as the arts. The dance workshops, attended by nearly 400 primary school students, showed a positive impact on perceptions of science, technology, engineering and maths (STEM) from female students. When asked about the impact of the workshops on the girls in their class, one teacher responded: “**...the [dance] workshop was a very good way to encourage and promote an interest in STEM subjects.**” [A2] Additionally, one teacher noted the positive impact that the workshops had had on boys in their class: “**For the boys especially, the superb science content detracted from the ‘dance’ aspect which meant they were fully engaged in the sessions.**” [A2] This also encouraged teachers to change their teaching methods in other subjects: “**We could use dance to explore other areas of science for example solids, liquids and gases, the digestive system, evolution.**” [A2]

Sun, Moon and Sky

The success of the exhibition outlined above led to further exploration of engaging astronomy and astrophysics through art. In 2019 Walsh collaborated with artist Alex Rinsler to create the touring art installation *SUN*. Also in 2019 Argo collaborated with storyteller Cassandra Wye to deliver the *We share the same moon* project as part of the International Astronomical Union (IAU) 100 Special Projects. In 2020 Pledger and dancer Lucy Starkey developed *Into Our Skies*, an online dance workshop targeted at primary school pupils. Outlined in the following, to date, these projects have successfully obtained competitive peer-reviewed funding of over GBP215,000 from STFC, Arts Council England, the Royal Astronomical Society and the International Astronomical Union.

SUN Walsh, Rinsler, and digital animators Pufferfish UK created *SUN* [D], a seven-metre diameter sphere suspended four metres above the ground into which is projected a digitally combined movie of the NASA’s SDO AIA EUV images, stitched together to form a full 360-degree presentation. Ten weeks in the life of the Sun over five different EUV wavelengths are presented in a twelve-minute spectacle with additional smoke special effects flowing



over the sphere to represent the outer solar corona. *SUN* is experienced as a constantly changing, dynamic piece of art/science engagement that transforms the viewer's perception of our closest star. As outlined by Rinsler [C2], this collaboration generated for him a new way of approaching his creative practice, retaining the integrity of the raw observational data but portraying the resulting imagery in a way to best recreate the size and scale of the Sun. Specifically, Rinsler states: **“It is hard to understate the impact of Prof Walsh’s contribution to SUN: quantitatively in terms of the instances of engagement for festival audiences (predominantly local families) in high quality research, but qualitatively, insofar as SUN can be enjoyed as a festival attraction, critiqued as a contemporary artwork, and discussed as a tool for public engagement in science...Working with Prof Walsh has opened up new avenues for me as an artist. ...The wonders of the sky and stars opens up an entirely new field of imagination.”** [C2]

The *SUN* installation premiered in October 2019 at the Lightpool festival which runs in conjunction with the Blackpool Illuminations. These form key parts of the local tourism economy, attracting visitors from across the North West to the town after the traditional summer tourist season has ended. *SUN* at Lightpool was supported by (i) JHI astronomers on-site each evening to converse directly with *SUN* visitors; (ii) a focused primary school engagement programme in collaboration with another STFC project – the SunSpaceArt project with support from artist, Helen Schell; and (iii) a series of evening public lectures [C1]. *SUN* was the first educational and public engagement of this type in the 140 years history of the Illuminations and the most popular Lightpool installation, attracting over 8,500 visitors from across the North West. Coverage of the *SUN* and Lightpool festival on *Granada Reports* raised awareness locally of the festival with Creative Director, Phil Holmes noting that the reporting gave a **“...huge promotion not only to the *SUN*, but the wider festival, something I am not sure we would have received had it not been for the ‘Wow factor of *SUN*.”** [C1] *SUN* was then exhibited in November 2019 at the Light Up Lancaster Festival, attracting a further 2,000 attendees. The success of the *SUN* has also influenced festival organisers working practices going forward, seeking installations that can be developed to include additional engagement opportunities and enhance the visitor experience further [C1].

Festival attendees were also able to see the process behind the installation on a dedicated webpage. This provided insights into the science behind the images and the work involved in turning that complex information into an amazing art installation [G].

In December 2020, STFC formally acknowledged *SUN* as one of only two nationally strategic engagement projects for the research council, providing funding of GBP85,000 for a two-year programme. *SUN* will tour a number of sites and festivals during 2021-2022 [F, I].

We Share the Same Moon

This activity was one of just 22 worldwide International Astronomical Union (IAU) 100th Anniversary Special Projects [E1]. *We Share the Same Moon* used storytelling narratives of folktales, myths and legends linked to the Sun, Moon and stars to introduce astrophysical concepts. Stories have an amazing power to captivate children and inspire them to be curious, wanting to learn more. By capturing their attention and interest with stories, the project then moved on to explore and explain the science behind them. The project developed, tested and evaluated twenty educational curriculum-linked resources linking stories and astronomy, delivered a series of pilot workshops in schools and informal settings around the UK, and produced a publicly available website of fully-accessible educational resources [E1]. The science activities covered aspects of the primary science curriculum such as Earth, Space and Forces, as well as linking with several other aspects across the

wider curriculum base. Over 1,800 people attended events linked to the project and the project website received over 17,000 visitors with online resources being downloaded more than 2,000 times [E2].

Into the Skies

Following the success of the dance workshops held during the *Exploring Light and Dark* exhibition, Pledger and Starkey collaborated to create the *Into Our Skies* project. Although originally planned as a series of face-to-face dance workshops, due to the COVID-19 restrictions these activities were repurposed to be online interactive workshop videos. Each workshop begins with Pledger introducing the astronomy topic, an important link to connect with a real scientist. Against a starry backdrop and to a specially composed soundtrack, Starkey leads participants through movements and dance-related activities that delve into that particular astronomy theme.

The *Into our Skies* project produced three, high quality interactive workshop videos and several hands-on classroom investigations designed to allow pupils to explore space science in this unique and creative way. By moving and physicalising scientific concepts, participants use active learning to explore new astronomy ideas. Ruth Spencer, University of Central Lancashire course leader in dance and performance has also designed a set of teaching notes to help primary teachers facilitate the sessions as many may not have any dance experience. This creative learning environment allows teachers to play, pause and rewind the session, providing time for pupils' own creativity and to work at their own pace. The resources have been downloaded more than 200 times by educators across the UK, Ireland and the Netherlands and 33 educators attended CPD training to aid delivery of the sessions. Teachers using the resources reported greater levels of participation and understanding of both science and dance, praising the cross disciplinary nature of the material: **"...a great resource to bring science and dance together and to make science knowledge memorable and more real for the children."** [F]

Starkey commented that *Into our Skies* **"...exceeded my expectations, we reached a larger audience than I anticipated."** The project also provided professional development for Starkey, being the first pre-recorded collaborative educational resource she had produced and **"...a fantastic artistic challenge"** [C3].

5. Sources to corroborate the impact (indicative maximum of 10 references)

[A] "Exploring Light and Dark" (2016), Exhibition 11th June-10th July 2016 Beacon Museum, Whitehaven

[A1] Evaluation video for "Exploring Light and Dark", Beacon Museum

[A2] Evaluation report for "Exploring Light and Dark", Beacon Museum

[B] GBC Rock Explorers TV programme - <https://www.gbc.gi/tv/programmes/rock-explorers-995/clips/season-4-episode-9-519>

[C] Factual statements from artists and festival organisers:

[C1] Phil Holmes, Creative Director, Lightpool Festival, *SUN*

[C2] Alex Rinsler, artist, *SUN*

[C3] Lucy Starkey, choreographer/dancer, *Into our Skies*

[D] Statement from STFC for strategic partnership with *SUN*

[E] We Share The Same Moon Project

[E1] Website for IAU 100 Special Projects

www.iau-100.org/we-share-the-moon

www.wesharethesamemoon.org

[E2] Engagement report for We Share the Same Moon

[F] Evaluation for Into our Skies: Space in Schools

[G] Official *SUN* website – <http://www.seethesun.org>