

Impact case study (REF3b)

Institution: Queen's University Belfast
Unit of Assessment: 9 (Physics)
Title of case study: Engaging the public in science and increasing awareness of physics and astronomy
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>Our high profile astronomy research discoveries in areas of public interest have allowed us to substantially increase the engagement of the public with science. Media appearances have led to a philanthropic donation of £200k to promote our science, the most successful public event series ever in Northern Ireland (engaging around 2000 people), a strategic partnership with Ireland's award winning science education centre W5 (reaching 26,000 people), and a 49% increase in applications to physics based degrees from NI students to UK HEIs. In 2008 we set three simple targets to substantially increase the public awareness of science and physics. The first was to increase our presence in the mass media (print, radio, TV, internet) to promote scientific research, and we have regularly reached audiences in excess of 295,000. The second was to increase the numbers of people attending science talks and events. The third was to substantially increase the application rate of school students to study physics and mathematics degrees. Through our outreach and engagement programme we have met, and surpassed, all of these targets. The impact of our research and our public outreach programme is a quantifiable societal change. Substantially more NI school students are now studying physics at third level UK HEIs.</p>
<p>2. Underpinning research (indicative maximum 500 words)</p> <p>Our place in the Universe and what lies beyond earth has intrigued humans since the dawn of consciousness. The research areas of the Astrophysics Research Centre (ARC) are of direct interest to modern society's engagement with the big science questions and we promote these aspects throughout our work. It is recognised throughout the government that science can be an inspirational subject, of vital importance to the future economy. We believe that there is no field more inspirational than astrophysics – particularly through the use of UK-led science as national exemplars. This case study relates to the specific impact described in the REF Main Panel B Criteria document : <i>"Impacts on society, culture and creativity"</i>.</p> <p>Exoplanet Research – is there life on other worlds?</p> <p>One of the most important scientific advances in recent years has been the discovery of exoplanets, or planets orbiting stars other than the Sun. The public are intrigued by the notion of extra-terrestrial life and the existence of other earth like worlds. The best method for discovering exoplanets is through transit surveys (watching for the transient dip in light flux from stars resulting from the planet passing directly between the star and the observer during its orbit). When coupled with follow-up observations, such transit surveys can allow measurement of true masses and densities, and potentially spectroscopy of planetary atmospheres. This can provide insights into the existence of water, oxygen, ozone and eventually habitability. The most successful Earth-based transit discovery has been SuperWASP, a project built and led by Queen's. Recently QUB staff (Watson) have begun work on a replacement system for SuperWASP. The NGTS (Next Generation Transit Survey) project is being designed to search for smaller planets around cooler stars. By targeting cooler, less luminous stars, it will be possible to discover smaller exoplanets. Although such hot-Neptunes and super-Earths have been seen previously, NGTS will result in</p>

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completely characterised systems that will allow their physical attributes to be studied using existing and planned astronomical instruments. The NGTS project will be the most sensitive ground-based survey for super-earths transiting their host stars.

Supernova Research – what is the origin of the chemical elements?

Smartt and Maund have led the world's most successful project for discovering the progenitor stars of supernovae. Supernovae are the explosions of stars at the end of their lives and have created all the heavy chemical elements we see in the Universe through nucleosynthesis. Their work allows us to see stars just before they explode, and this ten year project changed the field significantly and led to EURI award, a Royal Society URF, Leverhulme Prize and finally an ERC Advanced grant. They have written 10 papers in *Science* and *Nature* on supernova science since 2004, mostly highly cited discovery papers with major impact in the academic field. This work has led to new insights into the physics of how stars explode, nucleosynthesis of elements in the Universe and how neutron stars and black holes may form. The topic of exploding stars illustrating the dynamic Universe, combined with the leadership in the field has allowed this team to promote the work in the public domain.

Solar System research – will the Earth be hit by an asteroid?

Recent events such as the Chelyabinsk asteroid strike have underlined the public's interest in low-probability but high-impact events. Fitzsimmons' work on solar system asteroids and comets led to one of the most high profile science discoveries in 2009. An asteroid on a collision course with the Earth was monitored in space, and tracked as it hit the desert in Sudan. Pieces of the object were recovered, providing the first recovery of an asteroid which was discovered and observed before impact. Fitzsimmons took the only spectrum of this object before collision, published in *Nature* in 2009 (Jenniskens et al. 2009). Fitzsimmons and his postdoc at the time (S. Lowry) provided the first direct detection of the YORP effect in *Science* (2007). Both these high profile results again illustrated world-leading research that could be explained to the public in a concise and exciting manner.

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

The three most significant are marked with a *, all citations are from WoK (Aug 2013)

- [1] *The impact and recovery of asteroid 2008 TC₃*, Jenniskens et al, **Nature**, 2009, 458, 485 *
DOI: 10.1038/nature07920, cited 91 times
- [2] *Detection of a Red Supergiant Progenitor Star of a Type II-Plateau Supernova*, : Smartt S.J. et al. **Science**, 2004, 303, 567 * DOI: 10.1126/science.1092967 , cited 98 times
- [3] *A giant outburst two years before the core-collapse of a massive star* : Pastorello A., Smartt, S.J., et al. 2007, **Nature**, 447, 829 ***10.1038/nature05825**, cited 93 times
- [4] : *Direct Detection of the Asteroidal YORP Effect* Lowry S., Fitzsimmons A., et al. **Science** 2007, 316, 272 DOI: 10.1126/science.1139040, cited 55 times
- [5] *"Stellar jitter from variable gravitational redshift: implications for radial velocity confirmation of habitable exoplanets"*, H. Cegla, Watson C.A., et al., **Monthly Notices of the Royal Astronomical Society** 421, 54 (2012) DOI: 10.1111/j.1745-3933.2011.01205.x, cited 3 times
- [6] *"z'-band Ground-based Detection of the Secondary Eclipse of WASP-19b"*, Burton, J. Watson C.A., et al., **Astrophysical Journal Supplement Series**, 201, 36 (2012) DOI: 10.1088/0067-0049/201/2/36, cited 4 times

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We have had major success in publicising our research in the media, from local radio and newspapers through to national TV appearances. Highlights of our UK national media presence are the SuperWASP showcase on BBC TV “The Cosmos: A Beginner's Guide - Other worlds” with Adam Hart-Davis, four appearances on the Sky at Night, and eight appearances on BBC Radio 4/5/World (typical audience figures 1 – 10 million for these appearances). Fitzsimmons was the featured scientist on the BBC TV’s Horizon Special “*The Truth About Meteors*”, after the Chelyabinsk meteor impact and has been filmed for another Horizon broadcast on Comet Ison. To increase the public awareness of science in Northern Ireland we have made a focused effort to engage with the local media (BBC and independent broadcasters) to showcase our research highlights and related public events. In total we have had 51 appearances on BBC Northern Ireland (radio and TV), RTE (Republic of Ireland National broadcaster) or other regional broadcasts. These include the BBC Radio Ulster shows “Good Morning Ulster” and “Evening Extra” and the BBC NI Newslane (the main 6:30pm TV news show). These are the primary BBC news and magazine shows in the weekday morning and evenings, with typical listening figures of 295,000 for the morning and evening radio shows and 140,000 for TV. Our research underpins these appearances as our topics have broad societal interest. We have significantly raised the awareness of our place in the Universe through the studies of planets around other stars, searching for hazardous asteroids and assessing the Sun’s affect on the Earth through solar flares. Combining our breakthrough results (Section 3) with a high profile media appearance has allowed us to directly increase the numbers of people attending our organised science events.

Our profile allowed us to attract a £200k philanthropic donation from Dr. Michael West to enhance our engagement with the public and increase scientific awareness in this region. This funds a public lecture series and a research fellow who dedicates part of his time to public outreach. The funding is a direct impact of our research and media profile. Due to our geographical position, we need to work harder than other UK centres to get world leading scientists to visit here. We initiated the Michael West Lecture series to do exactly that and now run the most successful public science lecture series ever in Northern Ireland. Since 2008 our nine lectures have attracted over 160 people per event. Numbers have been rising, with excellent feedback which evidences our successful engagement with the public (Section 5). Further initiatives have also arisen from the Michael West fellowship and extra efforts in ARC. These are as follows :

- A partnership with the W5 Discovery Centre (Ireland’s award winning science and discovery centre at the Odyssey Arena in Belfast). We developed the “Planet Quest” exhibition, based on explaining the multi-wavelength nature of modern astronomy, particularly highlighting infrared radiation. The exhibition showcases our high-profile research, as well as some personal stories, to illustrate to the public that world leading, technology driven research is happening in Belfast. School and summer-school groups are brought to the exhibition, which ends with a game of infra-red laser-tag, based in an alien planet setting. The exhibition ran March-September 2012, and attracted 26,400 visitors. We are STEMnet ambassadors at W5 and have hosted talks, question and answer sessions and hands-on building games (aimed at Key Stage 3 pupils). We have further supported W5 through creation of astronomy CPD materials and a centralized web resource for secondary school physics teachers (Section 5; Source 9).
- We host, support and sponsor bi-monthly meetings of the Irish Astronomical Association (IAA) at Queen’s which brings in around 80 people each meeting. ARC staff regularly give lectures and use our influence (and financial resources) to bring in speakers from Britain and Europe. We regularly arrange for our research collaborators to spend more time at

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Queen's in order to give lectures to the Society and to provide the public with talks that they would otherwise not have access to. We sit on the IAA Council and advise on speakers, joint events and activities.

- In addition to lectures we have hosted science events attracting large audiences: "Jupiter Watch" as part of the BBC's Stargazing live in January 2012 (600 people) and January 2013 (800 people). The Large Hadron Collider exhibition in 2013 attracted over 1000 schoolchildren and members of the general public. Two related lectures and a Café Scientifique evening attracted another 700.
- Astronomy lectures and presentations at the following annual events: (i) QUB Horizons in Physics (which attracts around 400 Year 11-12 students per annum), (ii) Physics Open Days (around 200 Y13 students), (iii) Physics Teachers Conference (about 50 Physics teachers from schools in Ireland). Talks based specifically on our research described in Section 2 is in high demand in these outreach events for school children.
- Talks at schools, mostly at secondary level but also at primary level (we actively take part in STEPS (*Source 4*)), either in the classroom or at QUB. ARC staff deliver a total of about 40 talks annually to pupils. We also provide these presentations to amateur astronomical clubs and societies, as well as further education colleges, which are given typically 12 times per year. We collaborate with the School of Education at Queen's to deliver projects in astronomy and space science in Schools and public libraries. Over the REF Period we have had projects with 20 schools to develop science podcasts and science journalism. In any one year, we typically reach an audience of around 3000-5000 pupils.

In summary we have an active outreach programme aimed at popularising science, physics and astronomy particularly in N. Ireland. The impact has been a major increase in the appearance of scientists in the media in this UK region, but also a direct and tangible increase in the number of school students taking physics further. Between 2008 and 2012 we have seen an increase in the number of UCAS applications from Northern Ireland students to physics based courses across the UK of 71% (acceptances up by 56%). This is an impact not just in applications to Queen's but applications from NI students to all UK HEIs. In Queen's itself we increased applications by 80% from 272 (in 2008) to 491 (2012). This increase coincides directly with our increase in our public and schools engagement efforts and we believe the impact of our research has directly led to this societal change and increase in the desire of the NI school population to study physics further.

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

1. The Truth about meteors : a Horizon special (<http://www.bbc.co.uk/programmes/b01r6dys>)
2. SuperWASP showcase on BBC TV "The Cosmos: A Beginner's Guide - Other worlds" <http://www.open.edu/openlearn/whats-on/ou-on-the-bbc-the-cosmos-beginners-guide-other-worlds>
3. Letter of support from W5 Discovery Centre : (<http://www.w5online.co.uk/> - document on file)
4. Full list of all outreach activities by ARC members - documents on file
5. Participant numbers and audience feedback from the Michael West Lectures <https://star.pst.qub.ac.uk/wiki/public/outreach/michaelwest/start>
6. UCAS document on applicants to UK physics based courses – document on file, from Education Account Manager at UCAS.
7. Letter of support from the Irish Astronomical Association: <http://irishastro.org.uk/> (on file)
8. Letter of evidence from the BBC confirming the viewing/listening figures for our appearances on BBC news and magazine programmes (document on file)
9. ARC online resources for Schools : https://star.pst.qub.ac.uk/wiki/public/outreach/schools_resources