

# **Armagh Observatory and Planetarium**

## **Annual Report and Accounts For the year ended 31 March 2023**

*Laid before the Northern Ireland Assembly*

*under clause 8 of The Armagh Observatory and Planetarium (Northern Ireland) Order 1995,*

*as amended by Schedule 1, clause 6 of the Audit and Accountability (Northern Ireland)*

*Order 2003, by the Department for Communities*

*on*

*31 October 2023*

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# Armagh Observatory and Planetarium

## Annual Report and Accounts For the year ended 31 March 2023

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## The Trustees' Annual Report for the year ended 31 March 2023

The Board of Governors, who are the Trustees for Armagh Observatory and Planetarium (AOP) has pleasure in presenting its annual report and financial statements for this charity for the year ended 31 March 2023. These financial statements have been prepared in accordance with the accounting policies set out in note 1 to the accounts, with the guidance issued by the Department of Finance on the form and contents of the Annual Reports and Accounts of Executive Non-Departmental Public Bodies, *The Armagh Observatory and Planetarium (Northern Ireland) Order 1995* and Accounting and Reporting by Charities: Statement of Recommended Practice (SORP) applicable to charities preparing their accounts in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (FRS 102). The Remuneration and Staff report is prepared in accordance with direction set out in The Government Financial Reporting Manual (FReM) 2022-23.

The sponsor Department for Armagh Observatory and Planetarium is the Department for Communities (DfC) (the Department).

### Background to Charitable Status

Historically the Armagh Observatory and the Armagh Planetarium were treated as being distinct institutions; being two component divisions of a single statutory corporation and arms-length body (ALB), 'The Governors of The Armagh Observatory and Planetarium' as described in *The Armagh Observatory and Planetarium (Northern Ireland) Order 1995*. This 1995 Order superseded the original 1791 Act of the Irish Parliament entitled '*An Act for Settling and Preserving a Public Observatory and Museum in the City of Armagh For Ever*', and an Amendment ('The University and Collegiate and Scientific Institutions Act [Northern Ireland], 1938').

The principal function of the Armagh Observatory, founded in 1789 as part of Archbishop Richard Robinson's vision to see the creation of a university in the City of Armagh, is to undertake original research of a world-class academic standard that broadens and expands our understanding of astronomy and related sciences.

The Armagh Planetarium was founded by Dr Eric Mervyn Lindsay, the seventh director of the Armagh Observatory, and was officially opened on 1 May 1968. The Planetarium's primary activity is to disseminate scientific and technical knowledge of a wide range of science, technology, engineering, arts and mathematics (STEAM) subjects, and to promote public understanding of astronomy and science through its programme of educational services for schools and the wider public.

From 1 April 2016 the Charity Commission for Northern Ireland registered *The Governors of The Armagh Observatory and Planetarium*, (changed to *The Armagh Observatory and Planetarium* in 2023) as a charity under reference number NIC 103948.

### Objectives and Activities

The organisation's statutory functions are set out at Article 4 of *The Armagh Observatory and Planetarium (Northern Ireland) Order 1995*. The Order requires that '*the Governors shall, for the purpose of developing and improving the knowledge, appreciation and practice of astronomy and related sciences, maintain and manage the Armagh Observatory and Planetarium and may take such other action as the Governors may think proper for the purpose of acquiring or disseminating knowledge relating to astronomy and related sciences*'.

In accordance with Paragraph 8(1) of Schedule 1 of *The Armagh Observatory and Planetarium (Northern Ireland) Order 1995*, the Armagh Observatory and Planetarium (AOP) Board of Governors has delegated the primary responsibility for the governance and management of AOP to a Management Committee with the statutory purpose of 'developing and improving the knowledge, appreciation and practice of astronomy and related sciences'.

The AOP Management Committee has corporate responsibility for ensuring that AOP fulfils the aims and objectives set by the Department for Communities (our sponsor Department) and approved by the Minister and for promoting the efficient, economic and effective use of resources.

As the primary responsibility for the governance and management of AOP has been delegated to a Management Committee, the Governors consider the role of Charity Trustees would more appropriately align with their remit too. The Board of Governors has agreed in principle to this and discussions are currently ongoing with the Charity Commission of Northern Ireland to progress.

Armagh Observatory is the oldest scientific institution in Northern Ireland, and the longest continuously operating astronomical research institute in the UK and Ireland. Armagh Planetarium is also the oldest operating planetarium in the UK and Ireland.

Our Mission:

*“Our mission is the pursuit of knowledge and understanding of the cosmos, and the sharing of that knowledge in order to inspire future generations and enrich the intellectual, economic, social and cultural life of all.”*

Our Vision:

*“Our vision is to be recognised as an international centre of scientific excellence for the pursuit of astronomy and the public understanding of science, for our capacity for innovation and our extraordinary heritage, a place our community can be proud of.”*

The organisation operates on the international stage and is underpinned by core funding from the Department and the receipt of external grants from the UK Science and Technology Facilities Council (STFC), and other grant-awarding bodies.

A Strategic Plan for 2021-26 was launched in September 2021 and this is now being implemented. The strategy is built around four strategic themes – Enduring Relevance, National and International Standing, Offering More and Pursuing our Priorities.

As at 31 March 2023, there were 27.4 full time equivalent permanent employees which comprised approximately one-third Research, one-third Education and one-third Corporate. Additionally there were 5.4 full time equivalent temporary employees, some of whom were engaged on short term temporary projects. AOP also employs a number of casual staff on an ad hoc basis to meet operational needs. In addition, there is an Emeritus Director, an Emeritus Research Astronomer and 12 external research associates and academic visitors.

## **Public Benefits**

The Trustees confirm that they have complied with their duty to have regard to the guidance on Public Benefit produced by the Charities Commission of Northern Ireland under section 4 of the Charities Act (Northern Ireland) 2008 (the public benefit requirement statutory guidance) and that this has informed the activities of the organisation in the year to 31 March 2023. This is demonstrated in the following summary of Principal Activities which provides detail on how the organisation has delivered against its objectives and the public benefit which has flowed from this.

## **Principal Activities**

### **Impact of Brexit**

Some issues have been encountered with recruiting European nationals, claiming certain European research grants and importing some goods from Great Britain. EU residents now need to apply for a visa and pay a healthcare surcharge to live in the UK. For Post Doctoral Research Assistants (PDRAs) funded by the Science & Technology Facilities Council (STFC) such visa costs can be charged to the grant, but it is still unclear if a similar support can be offered to PhD students. UK Research and Innovation (UKRI) is presently reviewing their position in this respect, as STFC studentships are no longer restricted only to UK residents. Despite these issues, so far the United Kingdom exit from the European Union has had no significant impact on the overall operation of AOP.

### **Introduction to AOP Research and its International Standing**

AOP is one of the oldest scientific research institutes in the UK and Ireland with a long-established reputation of research excellence. It is also one of very few astronomical institutions in the world to have a modern planetarium through which its research can be effectively communicated and where a research-informed outreach and public engagement activity can be sustained.

AOP is engaged in front-line research in several key areas of astrophysics. These range from the study of our Sun and the Solar System to that of distant galaxies, in keeping with the long and varied history of scientific achievements of the Armagh Observatory and with the desire to be perceived by the public as leaders in of all strands of astronomical research that are communicated through the Planetarium.

Around a third of AOP research is funded by the award of project-specific external grants mainly from the STFC, together with several ad hoc grants. These grants support projects led by individual research astronomers with the provision of PhD scholarships, post-doctoral research assistant salaries, computing equipment and observation/conference travel funding. Early in 2021 AOP researchers secured two new STFC grants providing funding for additional Post-Doctoral Research Assistants (PDRAs) plus salary staff contribution and estate costs until March 2024, which adds up to similar funding secured early in 2020 and that is already funding a third PDRA until July 2023.

AOP research also requires the use of state-of-the-art observing and computing facilities internationally in order to obtain new astronomical data and allow their analysis. STFC and UK government support provides access to world-class international facilities, and AOP research staff regularly win telescope time on some of the best and most sought-after telescopes in the world such as the European Southern Observatory (ESO) Very Large Telescope (VLT) or the Hubble Space Telescope (HST).

In addition, through the AOP's membership of the UK SALT Consortium, its research staff have access to the 11-metre diameter Southern African Large Telescope (SALT). Similarly, AOP is also a founder member of the international consortia involved with the Gravitational-wave Optical Transient Observer (GOTO) project, a member of the UK consortia involved in building the detectors for Inouye Solar Telescope (IST), LOFAR (LOW Frequency Array (DKIST) radio telescope project and a consortium member of the Cherenkov Telescope Array (CTA) gamma-ray observatory. In early 2022, AOP was also able to join the BlackGem International consortium, which has built telescopes on La Silla in Chile. Like GOTO, its prime goal is the detection of the optical counterpart of gravitational wave events. Compared to GOTO, BlackGem has a smaller field of view, but is able to go deeper and fainter. The two surveys are therefore highly complementary in their reach.

These facilities can be extremely expensive to run (e.g. the running cost of one observing night at VLT is about £16,000 and a mid-size observing program with HST would be ten times more) so that through the award of their use, the international astronomical community essentially entrusts AOP to make effective use of the data. On average AOP researchers secure telescope time corresponding to a value of around £250,000 per year.

AOP research staff also play a full role in the international astronomical community. For instance, they serve on committees of bodies such as the Royal Astronomical Society, the UK Science and Technology Facilities Council, the International Astronomical Union (IAU, with three commission vice-presidents and two former presidents), ESO and Transiting Exoplanet Survey Satellite (TESS) time allocation panels, assess grant and research proposals on behalf of external funding agencies, review scientific papers and edit international academic journals, and act as external PhD examiners in the UK and beyond. AOP researchers also sit on scientific advisory panels or lead specific projects with future ground-based observing facilities (Vera Rubin Observatory, ELT-METIS, VLT-BlueMUSE), space satellites and missions (ESA's future Plato and Comet Interceptor missions) and large-scale surveys (MOONs).

This financial year has also seen AOP submitting six STFC grant applications for PDRA funding starting in April 2024, which will support all of AOP's current line of research and also bringing AOP staff salary contributions and estate costs. This is the first time since 2020 that AOP could apply for such a major source of funding, with AOP being one of the first UK institutions to participate in the newly remodelled STFC grant scheme that effectively replaces the previous consolidated grant, allowing researchers in practice to apply for grants every two years instead of every three years.

## Research Highlights

To provide a practical understanding of how the work of AOP research contributes to the region's international reputation and understanding of the cosmos, the following provides some highlights of the research undertaken at AOP in the past financial year. This draws from international collaborations and the award of observing time on highly competitive facilities, as well as direct support from the Department allowing AOP to participate in several key international projects (such as SALT, GOTO, IST, I-LOFAR, Comet Interceptor, CTA and BlackGem). Full bibliographic references can be found in the publication list appended to this report.

### Stellar and Galaxy Evolution

#### *Introduction*

When we look up on a dark night, we may think that stars are immutable and isolated. Yet, although stars can live for as long as the age of the Universe, they can also undergo dramatic changes in matter of seconds. They are also not isolated from other stars. Some are found in pairs or tight groups and more generally stars are related to each other through the very way in which they form and evolve. Stars are indeed born from giant clouds of gas and return matter to those clouds, seeding the birth of new stars as they fade away or sometimes explode in dramatic events. Furthermore, stars produce the heavy elements necessary for the formation of rocky planets and of life as we know it.

In turn, the formation history of stars relates to the formation and evolution of the galaxies that contain them. Some galaxies indeed no longer appear to form stars, unlike the case of the Milky Way. This may depend on whether fresh gas is available around them, on whether they have collided with other galaxies in the past or possibly also on whether their central supermassive black hole suddenly becomes active and pours out tremendous amounts of energy capable of clearing its host galaxy of any star-forming gas material. Finally, galaxies are carried by the

general expansion of the Universe and the evolution of the dominant, yet unknown dark-matter material in which they themselves are embedded. Understanding the formation and evolutions of stars and galaxies therefore ultimately means understanding our origin in relation to the very fabric of the Universe.

### *Recent results*

AOP stellar studies range from the most massive and brightest young stars to the faintest and ageing stars or stellar remnants such as white dwarfs and black holes.

The research in the group of Professor Jorick Vink is both theoretical and observational and is supported by STFC grants run in collaboration with Keele and York Universities. The theoretical work focuses on understanding of the formation of the heaviest stars and stellar black holes in the Universe. These stars are up to 10 million times brighter than the Sun. Key science questions involve the production of pair instability supernovae, where the entire star is disrupted, and one such event enriching galaxies with more heavy elements than all the lower mass stars combined. Recent papers lead by Vink's student Gautham Sabhahit and post-doctoral assistant Dr Erin Higgins uncovered that the most massive stars in our Milky Way evaporate entirely due to strong wind mass loss (*Higgins et al. 2022; Sabhahit et al. 2022*). On the observational side, Vink is leading an ESO-VLT Large Programme called XShooting ULLYSES (XShootU) with a team of 100 massive stars experts from around the globe trying to understand the stellar and mass-loss properties of massive star in pristine low-metallicity environments of the Large and Small Magellanic Clouds. These environments provide a key stepping stone to understand the very first stars in the distant Universe, which were likely very massive. In collaboration with Dr Jonathan Mackey and others, an IAU Symposium with over 200 participants was organised in Ballyconnell in County Cavan with the Topic: "Massive stars Near & Far".

The vast majority of stars will end their life as a "white dwarf", a very compact object with a mass comparable to that of the Sun but a size similar to that of the Earth. Stefano Bagnulo and AOP visiting astronomer John Landstreet are investigating the reasons why many white dwarfs possess a magnetic field, sometime much stronger than anything that could be produced in an Earth laboratory. They have concluded that whereas most white dwarfs are very rarely magnetic when they are young but become magnetic as they get old, the rare class of ultra-massive white dwarfs are magnetic since the very beginning of their formation (*Bagnulo & Landstreet 2022*). Bagnulo & Landstreet have also offered some explanations for the physical origin of the magnetic field and are continuing their studies thanks also to the award of more than 100 hours of time with the VLT in Chile and several more hours of telescope time at smaller telescopes. Bagnulo is capitalising on the impact of his research by the organisation of a 4-week workshop in Garching (Germany) on stellar magnetic fields at the Munich Institute for Astro and Particle Physics (<https://www.munich-iapp.de/magnetic-fields>, MIAPP) in October 2023 and will provide logistic support and funding for the participation of up to 45 researchers from all over the world.

Linking to external galaxies, Marc Sarzi has effectively concluded his survey of galaxies in the Fornax cluster producing studies that also relates directly to our understanding the latest stages of stellar evolution, publishing a comprehensive report of the use of the considerable amount of VLT telescope time (107h) that went into this project in the ESO messenger journal (*Sarzi & Iodice 2022*). In particular, the last stages of this collaboration saw a particularly important investigation into the properties of thin stellar disks in cluster galaxies, including those that are not immediately visible in images, but which are revealed only after a careful modelling of maps for the average motions and metal abundance (e.g. *Poci et al. 2022*). In this respect, AOP student Pablo Galan de Anta investigated how the interactions with other galaxies would affect such disks, potentially destroying them. For this he used large-scale cosmological simulations, showing that indeed such state-of-the-art models do not fully reproduce the properties of galaxies in Fornax-like clusters (*Galan de Anta et al. 2022*) suggesting, in particular, that numerical spurious effect may still affect such state-of-the-art simulations.

Finally, closer to home, Professor Michael Burton advanced our detailed understanding of the interstellar medium of the Milky Way that is in turn our closest laboratory for understanding the formation of stars (*Roueff, Burton, Geballe & Abgrall 2023*). His work relates to his previous discovery of Hydrogen molecules in clouds of shocked gas in interstellar space that are at temperatures of around 5,000 degrees celsius. This is much higher than it was expected that such molecules could exist at. The discovery closes one mystery about how interstellar shock waves work but opens another about how the gas can get so hot and yet the molecules survive? The original discovery was made using the 8m Gemini telescope in Hawaii, with which Michael Burton and his colleague Tom Geballe measured two, extremely weak, high excitation infrared lines of the hydrogen molecule observed in a source known as Herbig Haro 7 (or HH7), a supersonic jet of gas coming from a newly forming star. These two lines remained unidentified until through correspondence with Evelyne Roueff in Paris it was realised that they came from energy levels lying above the hydrogen molecule's dissociation energy. Indeed, Evelyne had predicted the existence of such lines arising from quasi-stable levels that in classical physics should not exist, which is why Burton and Geballe could not understand the presence of such weak lines in the Gemini spectra. Yet, their detection provides clear evidence that the molecular gas must be dissociating, which led to the speculation that the very existence of ultra-hot, 5,000-degree molecular gas implies the constant formation of freshly formed hydrogen molecules.

This work is also close to the research of AOP's Öpik fellow, Dr David Eden who, by using the data from multiple James Clerk Maxwell Telescope (JCMT) Large Programs (a facility that AOP is a partner of), is investigating the

causes of star formation in the Milky Way and across the entire Universe. The first step to this is to determine on what scale the regulation of the star formation process is occurring. Previous work by Eden has identified that the regulation is on the scales of individual molecular clouds. As a result, the focus was placed on the individual molecular clouds in a large sample obtained from CHIMPS (CO Heterodyne Inner Milky Way Plane Survey). In *Rani, Moore, Eden & Rigby (2022)*, the star-formation efficiency was compared to the mode of turbulence, i.e., the driving force of the movement of the gas in these clouds, and it was determined that the star-formation efficiency increased if the turbulence was more compressive or collapsing, as opposed to solenoidal or swirling. The ramifications of this result are that simulations of astronomical systems need to take this into account when modelling star formation and shifts the focus on to the molecular cloud formation mechanisms as where the star-formation efficiency of a system is set.

### *The role of SALT*

The South African Large Telescope (SALT) is the largest telescope in the Southern Hemisphere, providing unparalleled access to the skies for its shareholders, of whom AOP through its membership of the UK SALT consortium is one. Participation in this major international facility brings visibility throughout the worldwide research community and allows AOP and just a few other UK universities to engage in collaborations with other SALT international partners. In turn, through such partnerships, AOP receives a return in terms of telescope time allocation that is equivalent to roughly 10 times its contribution. In 2022 alone, over 230 AOP unique astronomical observations have been made, targeting some of the most exotic stars in the Universe. These contribute to a growing series of discovery papers and to the training of postgraduate research students at AOP. Participation in SALT also allows AOP to explore opportunities through the SALT Collateral Benefits Programme to develop links between local schools in Northern Ireland and in South Africa. AOP carries out the administration function for the UK SALT consortium, which includes four other academic partners – Keele University, Open University, University of Central Lancashire and University of Southampton.



The 10-metre diameter South African Large Telescope (SALT), in the semi-desert region of the Karoo, South Africa.

Using SALT, Simon Jeffery leads a survey of chemically peculiar subdwarf stars in the southern sky. These are stars that are in the final stages of their lives but their histories from birth to the present are very diverse. By exploring the abundances of key elements such as hydrogen, helium, carbon, oxygen, and iron, and of exotic elements such as lead and zirconium, these histories and internal physics can be explored. These AOP-led SALT observations have already led to a first data-release and are now building towards the second data-release, including classifications, coarse analyses and kinematics for nearly 400 hydrogen-deficient hot subdwarfs. A treasure trove of data for exotic stars is yielding exciting new discoveries. For instance, the hot subdwarfs BPS CS 22940-0009 and EC 20187-4939 are linked objects connecting extreme helium stars with hot subdwarfs (*Snowdon et al. 2022, Scott et al. 2023*). The survey has also discovered even more exotic stars – eight super-hot white dwarfs and pre-white dwarfs with surface temperatures between 100,000 and 200,000 degrees (*Jeffery et al. 2023*). Jorick Vink and a team of international astronomers are using SALT to study the long-term polarised light from the most famous Luminous Blue Variable Eta Carina, which is quite possibly the most massive star in the Milky Way. Thanks also to AOP's contribution SALT will continue to develop its instrumentation, and the introduction of a new near-infrared spectrograph will facilitate the study of star formation processes in nearby galaxies, with Sarzi already obtaining time to study star-forming galaxies in Fornax later in 2023. SALT has also proved essential in determining the nature of several short period binaries identified in the OmegaWhite Survey of the Galactic plane which set out to discover AM CVn binaries which can have orbital periods as short as 5 mins. Many were found to be short period pulsators, including four of the newly discovered class of Blue Luminous Variables (BLAPS), but one object was found to be a rare binary with an orbital period of 74 min containing a hot sdB star and a white dwarf (*Ramsay et al 2022*).

## Transient and Periodic Variable Stars

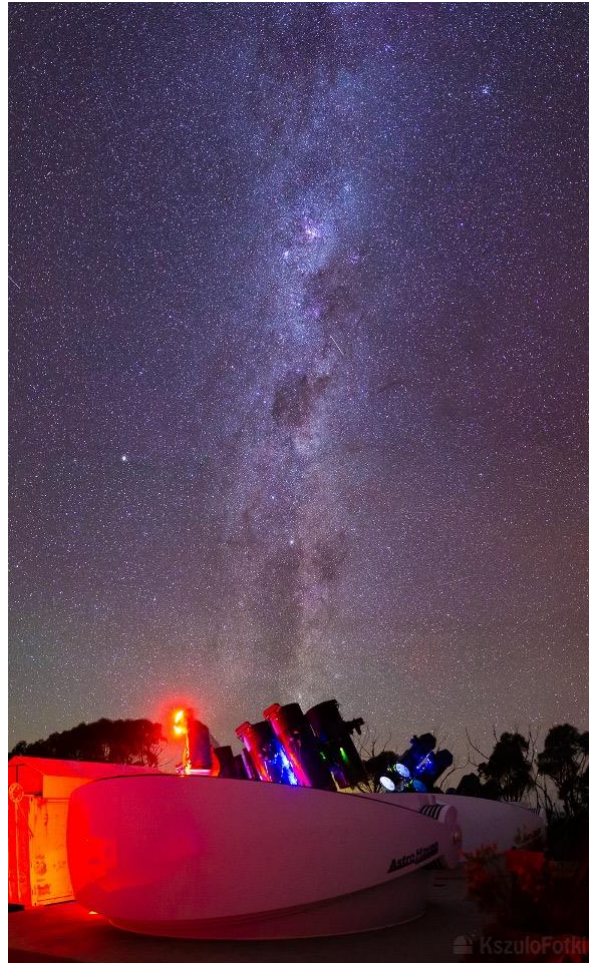
### *Introduction*

Apart from the bright planets and the occasional comet, the night sky might appear to be unchanging, with stars being the same brightness and in the same place as they always are. However, astronomers from the ancient world detected new stars, “novae” or “supernovae”, which suddenly appeared in the night sky and then gradually faded from view over weeks or months. We now know that these “transient” events occur when one star circling a companion star unloads enough matter through the process of “accretion” to its companion to make it explode. Supernovae have now been used to show the universe is expanding. Other “variable stars” were first detected in the early 17th century when a star now called “Mira” was observed to change in its brightness on a timescale of nearly a year. We now know that Mira is a star several hundred times as large as the Sun, and contracts and expands in size over this “period” of one year. In fact, practically all stars are variable at some level. However, in many cases its only recently astronomers have been able to detect this variability.

By studying the brightness of stars in detail we can test physical models which are put forward to explain the observed behaviour. However, the diversity of variable stars requires different observing strategies. Explosive events can be extremely rare and short-lived, so that in order just to catch their initial rise to outburst it is necessary to observe the entire sky every night. On the other hand, targeted monitoring lasting many months is necessary to unravel the minute vibrations of Sun-like stars. Simon Jeffery and Gavin Ramsay have been using data from the Kepler and TESS satellites to better understand both the interior of stars and the accretion process. Further, Armagh astronomers have access to the GOTO and BlackGem telescopes (more of which below) which are used for many research areas especially transient sources.

### *Recent results*

In the study of periodic phenomena, long continuous monitoring with extremely high accuracy has proved necessary to discover the signals due to exoplanets, star spots and gentle vibrations present in or around many stars. For these, space craft are essential to overcome poor weather and day light, with Kepler/K2 (NASA 2000-2018), TESS (NASA 2018-ongoing) and Plato (ESA, from 2026) being pivotal missions. Using TESS has discovered that the unseen companion stars in the four known hydrogen-deficient binaries all show a similar signature, either of a surface inhomogeneity or a low-order non-radial pulsation (*Jeffery 2023*). Using TESS data, Gavin Ramsay analysed optical data of 23 High Mass X-ray Binaries which contain a giant star and either a neutron star or Black Hole. His team found that all showed quasi-periodic behaviour on a timescale shorter than 1 day which typical of giant stars which are not in a binary. They also found evidence of two rare outbursts and showed the pulsation behaviour changed over the outburst (*Ramsay, Hakala & Charles 2022*). In another paper using TESS data the accretion flow in the magnetic accreting binary BY Cam was mapped as the flow rotated around the magnetic field of the white dwarf (*Mason et al 2022*). V652 Herculis is a large-amplitude pulsating extreme helium with a period of 0.1d and a significant shock at minimum radius (*Jeffery et al. 2015*). Simon Jeffery has developed new non-linear hydrodynamic models of the interior to show that a shock is generated whenever the pulsation amplitude is sufficiently large, and this is related to the luminosity of the star and its internal opacity (*Jeffery et al. 2022*). He has combined these hydro models with a radiative transfer code to model the time-varying spectrum of V652 Herculis, and to demonstrate how different parts of the star’s spectrum can be used to explore the behaviour of the shock as it travels through the stellar atmosphere (*Jeffery 2022*).



The new southern node of the Gravitational-wave Optical Transient Observer (GOTO) at Siding Spring Observatory, Australia (credit: Krzysztof Ulaczyk, University of Warwick).

AOP became a founding partner of the international project the *Gravitational-wave Optical Transient Observer* (GOTO) through a successful bid for funds from the Department of Culture, Arts and Leisure in January 2015. Its prime goal is to detect the optical counterpart of gravitational wave events such as the neutron star binary merger GW170817. The prototype GOTO node of telescopes was built in 2017 on the summit of the island of La Palma in the Canaries, which is one of the world's best sites to observe the night sky (Steeghs et al 2022). Early in 2020 GOTO was awarded £3.2m by STFC to allow a second node to be built on La Palma and two nodes in Australia which were installed in the first quarter of 2023. GOTO is now able to image the whole observable sky every few nights and is ready for the next gravitational wave observation run made by Ligo, Virgo and Kagara which is due to start late April 2023.

Using GOTO and other all-sky optical survey data, PhD student Chris Duffy investigated the long-term optical behaviour of a group of strongly magnetic cataclysmic variables called polars (Duffy et al 2022). Some of these systems can experience rapid fades in brightness which is due to the flow from the low mass star onto the more massive white dwarf. Different scenarios for why this happens were examined. This is just one example of the science which will be done using GOTO data over the years ahead which will include transients such as supernovae; galactic accreting binaries; pulsating variable stars and stars showing activity. Gavin Ramsay chairs the GOTO Executive Board that oversees and manages the project, including the development of the Australian node and the preparation of the next funding bid to STFC.

## Solar Physics and Stellar Flares

### Introduction

Aurora, or Northern Lights in the northern hemisphere, were seen over much of the UK and Ireland in the first few months of 2023. The link between aurora and flares from the Sun date back to Richard Carrington who observed a white light flare on the Sun from England in 1859, which was followed by aurora only 18 hours later that were recorded in Armagh. We now know that flares are caused by regions of strong magnetic activity on the Sun whose intensity

varies over the course of around 12 years. Although one of the wonders of the natural world, these auroral storms can also cause disruption to human activity: in 1989 the electricity grid in Canada was disrupted by a flare causing widespread blackouts. More recently, in February 2022, a solar storm caused 40 newly launched Starlink satellites to prematurely enter the Earth's atmosphere costing up to \$20m. The first flares from stars other than the Sun were seen from low-mass dwarf stars nearly a century ago. With space missions such as Kepler and TESS which can study many stars continuously for many days or months, we can now study flares from many types of stars which can be used to help us determine how often the Sun can release intense flares.

### Solar Physics

Solar Physics at AOP is led by Leverhulme Emeritus Fellow Gerry Doyle who supervises final year PhD student Nived Vilangot Nhalii. In recent work, they report on properties of rapidly moving jets of plasma (called spicules) above the Sun's photosphere (its visible 'surface') with observations obtained with the highest time resolution using the CRisp Imaging Spectro-Polarimeter (CRISP) mounted on the Swedish 1m Solar Telescope on La Palma together with simultaneous observations made using Solar Dynamics Observatory satellite (*Nived et al 2022*). Nived found that at any one moment in time, there are nearly a million of these spicules on the Sun. It remains to be seen whether they are a significant heating source for the outer atmosphere of the Sun (the corona).

### Stellar Flares

Gavin Ramsay and Gerry Doyle continue to study flares from low-mass stars and Solar type stars. We now know that many stars can produce flares which can be hundreds of times greater than events from the Sun. Over the last few years, we have found a population of very rapidly rotating low mass stars which appear to be flare inactive. Since we expect rapidly rotating stars to be very active this is a great surprise. Areas which we are pursuing include examining their emission in the ultra-violet; making more sensitive and rapid observations in the blue and examining specific spectral features. For instance, observations of a sample using the SAAO 1.9m telescope in South Africa revealed that one star show evidence of emission lines which appear to come and go. However, further investigations are continuing. Observations of the active star YZ CMi using Ultraspec on the Thai 2.4m national telescope revealed quasi periodic pulsations which allowed us to determine the size of the coronal loops which produced the flares. This gives insight to how flares are generated more generally.

### The role of I-LOFAR



The Irish LOW Frequency ARray station (I-LOFAR) in Birr Castle, County Offaly (left) and a map of Europe showing all the various nodes of the LOFAR network (right).

The LOFAR (LOW Frequency ARray) array observes the sky at low frequency radio waves and is therefore complementary with the Square Kilometre Array being built in South Africa and Australia which observes at higher radio frequencies. In 2016 AOP joined I-LOFAR, the Irish consortium which now includes nine partners, through capital funding from DCAL. The Irish station at Birr Castle links up with stations in ten European countries and strengthens Irish North-South collaboration and the more recent formal links made between AOP, Dunsink Observatory and Birr. It is a prime example of 'big-data' science with all stations in Europe being recently upgraded to LOFAR 2.0 which allows faster data transfer and more rapid data reduction.

In collaboration with colleagues in Dublin Institute for Advanced Studies (DIAS), Gavin Ramsay and Gerry Doyle supervise Jeremy Rigney (the Lindsay studentship) who is using data from I-LOFAR and the full LOFAR array to study flares and outbursts from low mass stars and intense radio storms from the Sun. Rigney used radio observations made using the ASKAP array in Australia to study stars which were also being observed at the same time using the TESS satellite. By making the radio and optical observations simultaneously can reveal the physical processes at work. The resulting paper, *Rigney et al (2022)*, showed that four low mass stars were detected at radio wavelengths with two of them having shown very strong circular polarisation. These results give insight to what

causes the radio emission and the physical nature of their environment. Rigney is now analysing radio data obtained using I-LOFAR of an intense solar storm in May 2022.

## Solar System Studies

### *Introduction*

Our Solar System is an extraordinary natural laboratory to study the formation and evolution of planetary systems around the Sun and other stars. Our work here feeds into fundamental questions about how the Solar System and the Earth formed and the development of life in the Universe. Our study of comets, asteroids and planets impacts on models of solar system formation, the ever-present hazard to civilization if asteroids or comets hit our planet and on the origin of water and organic compounds necessary for life to exist. The space industry benefits from improved detailed knowledge and understanding of the near-Earth and interplanetary environment.

### *Recent results*

Apostolos Christou reports on the ongoing investigation of small asteroids in Earth-like orbits, the so-called co-orbitals. These are among the most accessible targets for deep space exploration with some being easier to reach than the Moon, yet very little is otherwise known about them. Christou has been collaborating with Dr Galin Borisov, formerly a PDRA at AOP and now an Associate Professor at the Bulgarian National Astronomical Observatory (NAO), to observe the co-orbitals at every available opportunity and ascertain their physical properties. This programme continues to benefit from a standing agreement between AOP and NAO that grants Armagh researchers access to the 2m RCC telescope at Rozhen. A recent paper (*Borisov et al., 2023*) reports on observations of four co-orbital targets, monitoring their brightness over time to constrain their shape and spin rate. The largest asteroid in the study was Minor Planet (138175), an object smaller than a kilometre across. Our analysis shows a rotation period of ~14 hours during which the asteroid brightness changes by more than 50%, suggesting an elongated or bi-lobed "dumbbell" shape. Another asteroid, 2017 SL16, is roughly similar in size to the Observatory or Planetarium main buildings. Our observations show an extremely short rotation period of only 19 minutes, suggesting an internally cohesive asteroid like solid rock, as a strengthless agglomerate held together by gravity alone would have readily spun itself apart.

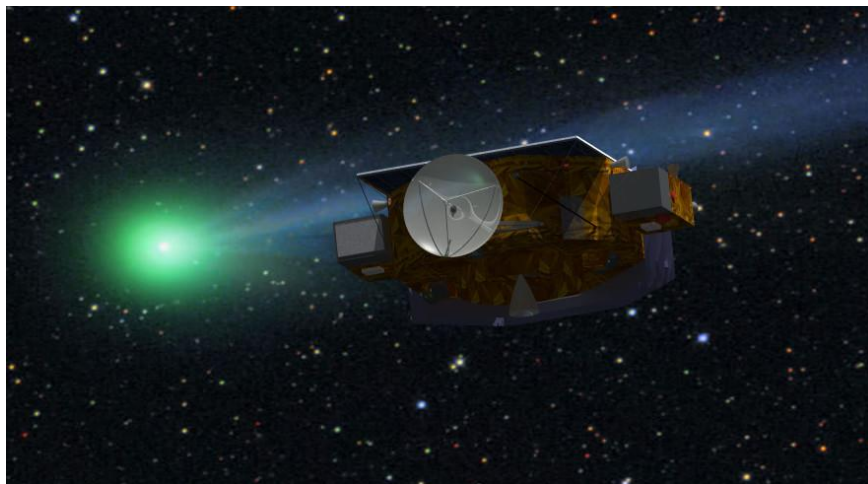
Christou is collaborating with Prof Stanley Dermott (U. Florida at Gainesville, FL, USA) and Dr Dan Li (NSF NOIRLab, Tucson, AZ, USA) to determine the origin of meteorites such as those currently on display in the Planetarium building exhibition area. Scientists examine meteorites in the laboratory to understand how planets like the Earth came together 4 billion years ago. Most meteorites arrive on our planet from a belt of asteroids between Mars and Jupiter. The processes that remove them from the belt and deliver them to Earth are still active today and can be studied through the current distribution of asteroids as a starting point. A recent paper in MNRAS (*Christou et al, 2022*) describes a new numerical method to precisely measure the meteorite removal rate at a given location. Mapping this quantity across the belt in future work will allow us to identify the most likely parent asteroids and source regions of meteorites.

Christou further reports the completion of a term of service within the Vera C. Rubin Early Career Prize selection committee under the Division of Dynamical Astronomy (or DDA) of the American Astronomical Society. Named after one of the most influential figures in 20<sup>th</sup> century astronomy and a strong advocate for the participation of women in science, this prestigious award recognises work by outstanding and impactful early career international researchers in Dynamical Astronomy or closely related fields. The roster of Rubin prize candidates is considered the "Top Gun" equivalent of Dynamical Astronomy professionals worldwide and, with only one Prize winner to select from a cadre of excellent candidates, the selection committee usually has their work cut out for them. Christou began his three-year term of service in the Spring of 2021 as the world was slowly coming out of lockdown conditions in response to the COVID pandemic. In 2023 Christou assumed the duties of committee Chair, being responsible for co-ordinating the work of committee members in selecting the winning nomination. With the selection process now successfully completed, the 2023 Rubin Prize winner is to be announced during the 54<sup>th</sup> Annual Meeting of the DDA to be held between 8-12 May at Michigan State University, USA.

Stefano Bagnulo and his PhD student Zuri Gray secured telescope time at the ESO VLT to study the consequences of the impact of Double Asteroid Redirection Test (DART), a planetary defence mission to test a method of deflecting an asteroid on course to hit Earth. DART arrived at near-Earth asteroid Didymos on September 26 2022. The spacecraft crashed into the asteroid's small moon Dimorphos, testing whether the kinetic impactor technique works. Because of the impact, dust clouds were ejected from Dimorphos, which was studied by Bagnulo and Gray from ground-based telescopes using polarimetric techniques (*Bagnulo, Gray & Granvik 2023*). Their work formulated two distinct scenarios for the formation of the dust on the surface of the impacted asteroid and has attracted international interest including through an official ESO press release.

Finally, AOP work on our Solar system links also to extra-solar planetary systems and in particular to the ESA's Plato mission, which is due to be launched towards the end of 2026, has a prime goal of identifying Earth sized planets around Solar type stars in its habitable zone. Gavin Ramsay is one of two ESA Plato Community Scientists and member of the Science Working Team. At the start of the mission, Plato will point at one particular area of the sky covering 2,250 square degrees for at least two years. Identifying the location of this field will be critical to the success of the mission and a final decision will be decided by the Science Working Team in June 2023.

### *The COMET INTERCEPTOR Space Mission*



*Artist impression of COMET INTERCEPTOR Space Mission*

The European Space Agency (ESA) recently approved a space mission to encounter a comet coming from the edge of our Solar System; the launch is expected in 2028. A novel idea sets this mission apart. So far, spacecraft have approached comets that are already well known and have gone around the Sun already several times. Therefore, it is very likely that the comet material has been “processed” by solar radiation and the space environment, and it is no longer in pristine condition. By contrast, here we are interested in comets on their first trip around the Sun, made of unprocessed material preserved in the cold outer parts of the solar system. To achieve the goal of visiting such a new comet, the spacecraft will be launched before the comet is found and will wait in deep space for instructions. Once a suitable target comet is found, instructions will be sent from the ground to guide the spacecraft to the comet (hence the name **Comet Interceptor**). Studying the material brought for the first time to the heat and light of the Sun will give us the opportunity to look at the solar system as it was when it formed. AOP is contributing to the development of the instrument that will send to Earth comet images (including polarimetric images) obtained with a fish-eye lens. Stefano Bagnulo is an expert in polarimetric observations and is one of the co-Investigators of the project, and his PhD student Zuri Gray is also involved in the mission team. Most recently, Bagnulo has officially become co-I of the EnVisS instrument on-board Comet Interceptor, and member of the Comet Interceptor “Near Environment” working group. He has participated to the second CI Working Group meeting at the European Space Research and Technology Centre in March 2023.

## **Education and Community Outreach**

### **Planetarium**

AOP is a special place that brings together fundamental research and public curiosity about the nature of the cosmos, all within a heritage environment that is rich in scientific history. Four pillars underlie and support the public programme of AOP - education, inspiration, entertainment and outreach. The Planetarium was established in 1968 and is world-renowned as an innovative centre of excellence in promoting the public understanding of science.

At the Planetarium, the primary activity is the education and the dissemination of scientific and astronomical knowledge. The Planetarium also promotes an understanding of astronomy and science to a large audience base of all ages, from nursery to seniors via a school's educational programme and science offering to the wider public through both onsite and outreach means.

This year we achieved record-breaking numbers of 72,000 visitors to AOP. This was largely due to a very successful summer event “Brickosaurs” which consisted of an exhibition of a range of large-scale LEGO brick dinosaur models. The models were housed in an outdoor marquee during June/July 2022 with dinosaur activities and dome shows themed around the event. Credit to the education team who worked tirelessly to ensure that this was a success, each playing their role with Senior Education Officer Ria Mee overseeing the logistics of the event.

This year has seen us experiment with live music in the dome through orchestras which are detailed in the highlights

section below. This is a new use for the dome, and one in which provides a very unique venue and indeed selling point. We also utilised the dome to livestream the Artemis rocket launch. Although the first launch was abandoned, we had a full dome audience ready to witness history in Fulldome format. The second planned launch was set for 5.30am, and thus we ran a staff event where we streamed the live launch. This was a very unique and historic event, and one in which shows the power of Planetarium technology for a full immersion experience.

During 2021-22 we had changed our operational model to reflect the growing need to open at the weekends and our hours of opening changed from Monday-Saturday to Tuesday-Sunday and this has continued into 2022-23. This has also helped our non-school audience grow.

Towards the end of the 2022-23 financial year our school visitors reached the same level as they had been at pre-pandemic which is very encouraging, and our school bookings are very healthy going forward. Careers events continued with a partnership with School Employer Connections with Operations Manager Helen McLoughlin continuing to drive and deliver this element of our outreach.

Half-way through the year we changed our focus on outreach and with a dedicated Tours and Outreach Officer we explored the demand for offsite dome visits. This has proved to be a popular and worthwhile venture with Dr. Rok Nežič leading the delivery of the programme. Included were visits to schools, youth group organisations, Ulster University, Marble Arch Caves event, special schools and council festivals. With a new electric van, Rok has been increasing our outreach visibility which is having a positive impact on our bricks and mortar visitors with customers coming back for a fulldome show visit. We also partnered with the Royal Institution (RI) to conduct outreach on their behalf to secondary schools which has been a popular and worthwhile partnership, opening more opportunities to work with the RI and it has increased our outreach visibility.

Accessibility was a focus in 2022-23 ensuring that we have a place that is a "space for all". We introduced Makaton inclusion this year at the Planetarium as well as having Level 1 British Sign Language (BSL) and Irish Sign Language (ISL) translators. Our popular dome show "CapCom Go" was filmed in both BSL and ISL as well as Irish and Ulster Scots with the help of the DfC translation department. We also provided a BSL and ISL translation of our live Christmas experience "Mission Santa". Monthly relaxed-dome show sessions are now standard in our programme as well as relaxed event sessions for workshops. We have also renewed our JAM (Just A Minute) Card registration with all front-line staff JAM Card trained. This year we also set up a youth forum giving children with autism the opportunity to lead and show us what they need in order to make a successful visit to AOP. They have been driving change and they have been working on developing ideas for items such as sensory bags, sensory maps and increasing awareness of our accessibility through our website. This was made possible through an Association of Science and Discovery Centres (ASDC) Bold Futures fund for which we also set a target to increase our reach of special schools through outreach. We were getting an engagement level of 8% of special schools in previous years. By the end of March 2023, we had already increased that to a 35% engagement level.

During this year we were successful in some education and outreach funding bids as well as advertising bids. To note are the Tourism NI (TNI) marketing bids in which we received funding per season to help promote AOP. This funding has helped us to reach different audiences and grow our annual visitor figures. We also applied and were successful in an Association of Science and Discovery Centre's (ADSC) bid through "Bold Futures" for which the programme is listed above. Through the IAU we got seed funding to pilot an afterschool's programme which Education Officer Nick Parke is taking the lead to organise. Missions and Mindsets was a small funding bid that resulted in AOP joining a fully funded learning programme with the opportunity next year to apply for further programme funding.

Through our marketing activities we have produced a steady stream of good news stories from AOP, including highlighting the research we conduct, job roles throughout the organisation and promoting a visit to AOP.

We also participated in providing work experience for a Stranmillis College student which was a rich and valued learning experience.

Towards the end of the year, we installed two Astropark trails after successfully applying for TNI Experience funding. Following a successful tendering exercise, we developed a new kids Eco trail with a workbook, sculptures, clues and an augmented reality (AR) app around the grounds. There is also an adult app focusing on a tour of the grounds and Observatory. A lot of work across the organisation went into this new experience over the last year and these outdoor trails have already increased dwell time and been popular with visitors and locals. We aim to officially launch these trails in the new financial year.

### **Highlights from AOP's Programme of Events in 2022-23**

In April we had our first official live music event in the new dome when the Southern Regional College music department performed a live musical rendition of the "Our Place in the Cosmos" soundtrack.

In May, Helen McLoughlin and Ria Mee brought the outreach dome to the Slieve Russell Hotel in county Cavan for the Massive Stars IAU conference and held both a schools and public event, our first outreach event since the start of the pandemic. A new climate temporary exhibition was launched this month also in Copernicus Hall.

June 2022 saw the introduction of Brickosaurs, after a two-year wait due to the pandemic. The install took place on week beginning 6 June with a marquee erected to house the dinosaurs. The exhibition opened to the public on June 11.

July was all about Brickosaurs. Over 17,000 people came to see the exhibition in July which surpasses any previous month's visitors on record. Adrian Dunbar came by for a visit to film for his new Channel 5 show as well.

In August we began presentations in our new Digital Visualisation Lab (DVL) which were very well received. Armagh Library held story time at AOP and we went to the library with our experiments from the Big Book of Experiments and Bright Ideas. The big event was the Artemis live streaming event in the dome - a first in terms of a live launch screened in the dome around the world. Although the launch was scrubbed, AOP received positive PR from the event through numerous BBC Newsline pieces and both online and newspaper articles. We also held our first concert in the dome with the Sligo Baroque Orchestra "The Music and Astronomy of William Herschel - Celebrating 200 years". The event was fully booked and we will want to replicate the success again in the future, merging live music with imagery on our dome.

In September, Rushmere Shopping Centre hired our outreach dome to give shoppers a unique experience. We also had stands at four local Southern Regional College campuses for freshers week. Members of the team attended the British Association of Planetaria (BAP) conference in Leicester and ASDC conference in Glasgow. The big event this month was the Observatories Network Conference which was a huge success and showcased the organisation using both the Planetarium and Observatory for conferencing opportunities.

October kicked off with a PhD Saturday where students planned workshops and delivered talks in our hall. For Space Week we delivered afternoon visual reality sessions where visitors got the chance to put on a headset and learn about climate change. An online careers event saw 340 secondary school pupils learn all about astronomy as a career. Interesting events that month also included a Bat Walk, the Partial Solar Eclipse event, the return of Startrackers. We had Tall Tales and Terror in the Observatory, Spooky Space in the Planetarium with some potions and explosions, DVL demos and Infrared talks.

November saw the Armaghi People of the Year Awards launch event. Rok Nežič visited Cavan, Laois and Dublin, and began outreach visits as part of the Royal Institution partnership. We had sold-out tours of the Observatory as part of the Georgian Day events in Armagh. "Our Place in the Cosmos" was featured at the Fulldome Film Festival in Plymouth. For Mission Santa, we held accessible sessions this month in BSL which were well received. Our second orchestra concert in the dome took place "Thus she shall go to the stars" featuring the work of astronomer Agnes Clerke. AOP's Erin Higgins worked with Senior Education Officer Ria Mee to put together some of the event which was screened on the dome.

December continued with sold-out Mission Santa dates and a trial of providing sessions for schools. We included sensory sessions, BSL and ISL interpreted events and engaged with community groups and special units in schools. We were involved with the Royal Institution Christmas Lectures and hope to build upon this for next year.

February half-term was very successful for AOP with sold-out dome shows and events. Events included DVL sessions, careers events and Lego Brick workshops. A GCSE Day was held this month where multiple schools came to enjoy a dome show, workshop and walk to the Observatory. The Armaghi Awards were held in the Copernicus Hall this month with 100 people in attendance.

March brought the launch of the Irish language translated "CapCom Go" with the help of the DfC translation department, Southern Regional College in Armagh, National Space Centre Leicester and Aonach Mhacha. We began our Bold Futures project which has been funded by ASDC. Outreach has been taking place at special schools and our youth forum met at the end of March to give us feedback and ideas on our programming and to create sensory bags and maps for us. Two trails have been installed around the grounds - a kids Eco trail with workbook and AR app and a more adult tour of the Astropark and Observatory.

## History and Heritage

### History & Heritage Policy

AOP boasts a collection of over thirty-one thousand historic documents, rare and antiquarian books, scientific instruments and photographs. This collection is unique on the Island of Ireland and one of the best-preserved observatory collections in the United Kingdom. The heritage policies that have been implemented ensure that the collection is cared for in accordance with best practice and has allowed ongoing historical research.

During 2022-23 the Observatory has continued to be open to the public for the 'Legendary Telescope Tour' package, which has been well received. The eMuseum has 485 objects available for public viewing on the Armagh.space website, with a goal of making 7,000 objects available by summer 2024. Since 2021-22, four new temporary exhibition cases have been filled in the Planetarium, with rotating displays. In addition, two new cases have been filled in the Planetarium Board Room.

In accordance with AOP's policy of making our collection available for the public and researchers to use we have continued to facilitate public information requests. The 2022-23 financial year brought 21 requests which were facilitated by the Museum Collections Officer. This is an increase of 7 requests over the 2021-22 year. In addition, AOP was host to the Observatory Networks Workshop Four, which was held in September 2022. This workshop saw the premier academics in the field of astronomical history gather in Armagh, and included sessions delivered by staff and students of AOP.

2022-23 introduced the second successful project supported by the National Lottery Heritage Fund. This project, 'Wisdom Begins With Wonder' is funded to run from May 2022 to June 2024 and has seen the successful implementation of a volunteer program. Since launching, the volunteer program has facilitated over one hundred hours of voluntary work in AOP, with more volunteers awaiting projects. The project has also funded the position of Museum Collections Officer from June 2022-May 2024, on a part time basis. This position is responsible for ongoing volunteer coordination, museum policy development, cataloguing and the facilitation of research requests.

In 2022-23 AOP was awarded Museum Accreditation by the Northern Ireland Museum Council and the Arts Council. This has been an objective of the Living Space Committee since 2019 and was successful thanks to the buy-in from across the organisation and the assistance of our Museum Mentor, Sean Barden, from the Armagh County Museum. The accreditation lasts for five years, at which point it will be reassessed. AOP has also been consulting with the Northern Ireland Museum Council on a wide range of ongoing challenges to the sector, and staff have attended four consultations and two training sessions. Since achieving Museum Accreditation, AOP has hosted visits from the Director of the Northern Ireland Museum Council twice.

AOP has also continued to publish historical research, and staff have been involved in a project to publish a book in conjunction with the International Planetarium Society. The team have also continued to provide access to the operated collection of historic scientific instruments. Over the winter observation period, four successful observation sessions were held with the Grubb 10-Inch telescope, and five staff and students were trained in its use. The Grubb 10-Inch and Calver telescopes have also undergone successful preventative conservation including the rebalancing of the Calver telescope and the removal and reattachment of the finder scopes.

### **Library & Archives**

AOP's suite of technical equipment is complemented by a Library and Archives which, together, represent one of the premier specialist collections of their kind in the world. The Library, Archives and Historic Scientific Instruments collection contains a unique variety of historic books and manuscripts, images, photographic plates, scientific instruments, clocks and other artefacts concerning the development of modern astronomy from the Age of Enlightenment up to the present day with specific reference to the important discoveries and scientific contributions made by the international research community here at Armagh. The library also provides an essential reference resource for AOP research, and especially for its student and young researcher cohort. It contains approximately 3,400 textbooks, monographs, special reports, and conference proceedings covering nearly all disciplines in astronomy. Some 17,000 volumes from nearly 200 scientific journal titles include nearly complete runs of all the major astronomy journals, as well as journals of significant historical interest.

During 2022-23 the collection has been supplemented by approximately 20 new books on topics relevant to AOP research. Work continues on binding the backlog of unbound journals. Attention has been given to some of the more historical items, including the volumes of Nature from the 1890's and Popular Astronomy from the 1930's. A scoping audit of the remaining backlog has been carried out to inform future funding requirements.

Whilst still under enormous pressure for space, the AOP library is now an attractive space and a more effective research tool, with potential for further development and revenue generation, and increasingly demonstrating its potential for historical discovery as well as astronomical research.

### **Meteorological Record**

As part of AOP's primary research role, staff and students take daily readings of a wide range of meteorological parameters at Armagh and maintain the Observatory's unique 228-year long meteorological record and databank. This is believed to be the longest daily climate series in the UK and Ireland from a single site (though the log book for the period June 1825 to December 1832 appears to have been lost), as well as being one of the longest in the world. The climate station has been continuously maintained since July 1795 with readings currently taken

every day at 09:00 (GMT). The World Meteorological Organisation (WMO) has recognised Armagh with Centennial Station status for its longevity and importance in contributing to the climate record.

Calibration of these data has enabled researchers and government agencies to use the Armagh series for reports and research into global warming. The data contributes to the UK Meteorological Office's main climate database and are released to the general public on a monthly basis through press releases and on our climate website (<http://www.climate.armagh.ac.uk/archives.html>) whilst also contributing to the UK Meteorological Office's main climate database.

Climate change is a subject of strategic importance for Northern Ireland as we move into an era of rapid climate variability, and the Armagh's unique climate record provides an exceptionally long historical baseline, enabling better informed judgements to be made as to how Northern Ireland's climate has responded and is responding to climate change world-wide. In order to inform the public about the impacts of climate change, AOP has introduced a movable exhibition on the subject into the Planetarium exhibition area in the Copernicus Hall. This is centred around an interactive Puffersphere presentation on climate change, together with supporting exhibits around the room which expand on local impacts. The exhibition has been designed to be readily mounted / demounted so that it can be moved and reassembled quickly when the Copernicus Hall is being used for other activities and events.

An automated weather station (AWS) was installed by the Met Office in 2019, sampling the weather every minute. This now provides the primary source of weather data in the Met Office records (e.g., temperature, pressure, rain fall, windspeed) since it is automatically uploaded to the Met Office. However, manual collection still continues, and provides the only source for some of the data collected (e.g. sunshine, grass temperature) at Armagh. We have now placed the measuring instruments inside a second Stevenson Screen within an expanded meteorological enclosure. This is to ensure that the AWS enclosure is identical to those used by the Met Office in their UK-wide network. In doing this we also changed the fencing around the weather station to make it less visually intrusive.

We developed a series of python scripts to store, analyse and provide access to the weather data base via the weather webpages. This includes both the manual data as well as the (recent) automated weather station data. Research Assistant Tom Watts wrote the necessary code. This takes the monthly observers log, provides a means of entering the information via an online log, and in addition automatically downloads the data received from the automated station, to ingest these data sets into a new database. Analysis scripts then allow this database to be interrogated, e.g. to find climate extrema over any date range of interest. This can then be examined from the website: <https://weather.armagh.space>. This includes enquiring about weather on any single day (as might be used in a visitor display in the Planetarium), as well as examining the data set over any period of interest and searching for climate records (extrema) over a period of interest. The automated weather station data is now also available to inspect online, in addition to the manual data. Plotting tools allow the user to see the weather over any time period, as well as to find when extrema in the various measured parameters occurred.

The Met Office changed their method of provision of data from the automated station to us in April. It is no longer sent it via a daily email digest. We have developed code to access this data direct from the Met Office repository. This has had the added benefit of AOP now being able to provide real time weather data (including conditions for the past 24 hours) for Armagh via our web pages (see <https://weather.armagh.space/aws-live.php>), including for visitors to the Planetarium.

The three new PhD students were trained in weather observations (Andrew Marshall-Lee, Asish Monai, Saskia Schlagenhauf), and then accredited as Level 1 Met Observers by the Director. This forms part of their PhD training in the techniques of scientific data measurement and analysis.

Information about the weather record in Armagh has now been transferred from the previous climate website ([climate.armagh.ac.uk](http://climate.armagh.ac.uk)), updated, and had extensive new material added; see [armagh.space/weather](https://armagh.space/weather). This includes information about the history of the weather record, on the instruments used, the log book, and on publications. Rok Nežič has primarily compiled the material for these web pages.

On 18 July 2022 our manual station recorded a maximum temperature of at 31.2°C, the second hottest ever measured in Armagh (only exceeded by the 31.3°C on 22 July of the previous year). Record temperatures were measured across the UK during this period, notably exceeding 40°C in some locations in England on 19 July. The average temperature on 18 July in Armagh (the average of max and min values) was the highest ever recorded here, i.e. since 1844 when we starting recording min/max temperatures. Overall, 2022 was the warmest year ever recorded, with a mean daily temperature of 10.8°C (average of all max & min values across the year). The next two most-warmest years are 2007 (10.6°C) and 2021 (10.5°C).

In March 2023 our Met Station measured 140.5mm of precipitation, the highest March figure ever recorded since rainfall records began in 1838. November 2022 was also the sunniest November in Armagh for 98 years with 89.8 hours of sunshine, 50% higher than the long-term average.

## Support

AOP is committed to ensuring fit for purpose governance and support services to support the delivery of organisational objectives.

### Information and Communications Technology (ICT)

The comprehensive research computer facilities are used primarily for numerical analysis, computer modelling and data reduction. The computers and peripherals are largely funded by DfC, but occasionally by external research grants. Staff require access to high-end Apple Mac and Linux workstations. In addition to this, Corporate and Education is serviced within a Windows and Office 365 environment.

An ICT Strategy was approved in October 2022 and progress against the Action Plan's ongoing support commitments, continuous focus and short, medium and long-term activities are considered by the Audit and Risk Assurance Committee (ARAC) each quarter.

AOP continues to modernise and improved its centralised ICT hub. In 2022-23 all primary MacBook laptops and six compute servers were replaced.

AOP is continually implementing measures to improve its resilience against cyber security measures without disproportionately inhibiting the ICT requirements of researchers. An ICT Risk Assessment is reviewed quarterly and considered at ARAC. ARAC also receives received quarterly updates on implementation of patching and software updates.

### Finance

AOP has a well-established finance function. Financial policies and procedures are continually being enhanced to ensure that the organisation meets the governance standards required. This includes the application of public sector procurement controls, meeting prompt payment targets and providing regular and ad hoc financial information within the organisation and to the Department.

AOP continues to experience significant cost pressures within a core budget that has remained static for 6 years. In 2022-23 it was able to mitigate this through an additional resource allocation and exceptional income from admissions and trading sales which greatly exceeded expectations.

### Human Resources

A Human Resources Action Plan 2022-23 has been implemented to include:

- Maintaining a Fit for Purpose Organisation Structure – recruitment of 4 new staff; maintaining a pool of casual employees; preparation of new skills-gap paper; inclusion of succession planning questions in appraisal cycle; preparation of organisational planning report for 2023-24 Business Plan and budgeting process; identification of short term opportunities to plug skills gaps with short term projects or engagements and recruitment activity as required in-year;
- Continual review of Operating Models – implementation of formal hybrid working arrangements; monitoring and reporting on new arrangements; supporting Education Team Officers with employee working arrangements; review of staffing needs in context of budgets and affordability;
- Employing and Investing in Motivated and Engaged Staff – agree and implement actions arising from Staff Survey and engagement event; consideration of Concordat to support the career development of Researchers; supporting annual appraisal process; completing/revising a rolling training plan; review implementation of training plans in the context of available budget; prepare business case for special bonus scheme; conduct annual staff engagement survey; development of internal engagement plan; preparation for two significant engagement events; supporting the Health and Wellbeing of PhD students;
- Fair and Equitable Employment Policies and Procedures – completion of annual Fair Employment return; achievement of Bronze Diversity Mark Award; preparation of Project Juno Champion application; review of policies and induction and refresher training in policies.

A Human Resources Strategy 2022-26 has been developed and approved along with the Q1 Action Plan for 2023-24.

### Diversity and Inclusion

AOP has an obligation under Section 75 of the Northern Ireland Act to ensure that equality of opportunity and good relations are central to policy making, policy implementation and review as well as service delivery. AOP monitor the composition of their workforce in terms of community background and sex and use an equal opportunities monitoring form questionnaire. AOP complete an annual Fair Employment Monitoring return to the Equality Commission detailing staff composition and that of job applicants to AOP posts.

In the AOP Strategic Plan 2021-26 we state that having Fair and Equitable Employment Policies and Procedures is one of our key elements in delivering high standards. AOP have a number of policies in place including an Equal Opportunities Policy.

AOP signed up for Diversity Mark Accreditation in December 2021, formally applied for the Bronze Award in July 2022 and was awarded the Bronze Award in November 2022. Three Equality, Diversity and Inclusion targets have been set as follows:

- To develop an Equality, Diversity and Inclusion Strategy;
- To increase the number of female research staff at AOP from 2 to 4; and
- To increase female representation on the AOP Management Committee from 3 to 5.

AOP achieved Juno Practitioner status in June 2019. This is an award scheme that recognises and rewards university physics departments, schools of physics, and related institutes and organisations that can demonstrate they have taken action to address gender equality at all levels and to foster a more inclusive working environment. We applied for Juno Champion status in April 2023. This application will involve satisfying the following 6 Juno Principles:

- Principle (1) Robust organisational framework - A robust organisational framework to deliver equality of opportunity and reward;
- Principle (2) Appointment and Selection - Appointment and selection processes and procedures that encourage men and women to apply for academic posts at all levels;
- Principle (3) Career Progression and Promotion - Departmental structures and systems that support and encourage the career progression and promotion of all staff and enable everyone to progress and continue in their careers;
- Principle (4) Open and Inclusive Culture - Departmental organisation, structure, management arrangements and culture that are open, inclusive and transparent, and encourage the participation of all staff;
- Principle (5) Flexible Working - Flexible approaches and provisions that enable individuals, at all career and life stages, to optimise their contribution to their department, their institution and to science, engineering and technology; and
- Principle (6) Professional Conduct - An environment where professional conduct is embedded into departmental culture and behaviour.

## **Governance**

Governance and accountability continue to be strengthened and improved and risks reduced as demonstrated by external and internal audit reviews. Actions arising from effectiveness reviews undertaken by both ARAC and the Management Committee have also resulted in enhanced arrangements.

One outstanding Internal Audit recommendation, relating to Record Management, is currently being addressed. A retention and disposal schedule is awaiting consideration by the Public Record Office of Northern Ireland (PRONI). The organisation has moved towards paperless record management systems which will be easier to manage and control in accordance with the approved Retention and Disposal policy.

## **Estates Management**

AOP manages an extensive estate which includes 9 separate buildings, including the Grade A listed Observatory and a circa 20-acre historic estate. There are also several leases associated with land and property.

During the year AOP has prepared an Outline Business Case (OBC) for redevelopment. AOP views this project as imperative to future proof its role into the next generation. The case for change is predicated by an estate that is outdated and misaligned to expectations of modern-day visitors and future opportunities. The OBC was approved by the Board of Governors in May 2023, and submitted to the Department for consideration.

## **NetZero**

AOP's international research standing, and unique record of uninterrupted meteorological observations has allowed AOP to effectively communicate on the issue of climate change (CC) to the general public, in particular since the design and installation of a temporary exhibition in the Planetarium and through AOP's participation in 2021 at the COP26 conference in Glasgow. This has also prompted AOP to lead by example in the CC arena, in particular by joining the UK Government SME Climate Hub by committing to reduce by 50% its CO2 emission 2030.

As an initial step in this direction, DfC funding was granted to facilitate a carbon baselining exercise to capture both the present carbon footprint of AOP and to indicate a set of emission reduction measures (ERMs) that could

eventually half such a carbon footprint. This study indicated that the Planetarium building and its operation are the main source of both direct (e.g. through heating oil consumption) and indirect (e.g. by consuming electricity generated elsewhere) CO2 emission. Trying to reduce or optimise emission in the Planetarium should therefore be a priority, although in the long term a new and energy efficient building would be desirable. Meanwhile, it is the AOP grounds that offer the wider scope for reducing AOP's footprint either through green energy generation or the carbon offsetting through the planting of trees.

Moving in this direction, in the last financial year Department for the Economy (DfE) capital funding was obtained to change the internal lighting of the Bell building and the Planetarium based on more efficient LED technology and to install two green energy power generation stations based on wind and solar power on AOP grounds. While the latter will certainly not generate sufficient power to cover the need of the Planetarium, they will serve to illustrate the role that new technologies will play in harnessing even more efficiently the energy from winds and our Sun, thus adding to AOP's education offering. Finally, a NetZero committee with representative from all of AOP's main team, including also students, has been meeting regularly to discuss and implement additional ERMs and more generally good practice in terms of ecological sustainability.

## Achievements and Performance

The targets set for AOP in the 2022-23 Business Plan are shown in the following table. Actual performance achieved is shown along with the corresponding achievement in the previous financial year, where applicable.

Targets were achieved or exceeded in many areas; however, there were 6 targets not met. Failure to meet a number of the missed targets is beyond AOP's control in that they are reliant upon external factors. In particular, capital funding is required to achieve Urban Night Sky Place accreditation; the joint development Masterplan project was dissolved in-year and it was anticipated that a major funding stream would be live to make application in pursuance of AOP's future development. Targets relating to school visitors and cosmic classroom events were not achieved due to a combination of the level of schools returning post-Covid and an increase in dome outreach. The objective of submitting an OBC for AOP's future development within one year was ambitious. Significant progress has been made, however, there has been slight slippage in the timeline.

KPI	Description	Target	As at 31 March 2023	As at 31 March 2022 (where applicable)	Comments
1	Attract 55,000 visitors (to include 43,000 public visitors and 12,000 school visitors)	55,000	Public 62,793	37,345	Bookings overall exceeding pre-pandemic levels. 2021-22 target affected by Covid-19.
			School 9,381	n/a	Total 72,174 visitors - School visitor target unachievable due to the level of schools returning.
2	Achieve £486,000 income from admissions and sales	£486,000	£570,851	£364,553	2021-22 target affected by Covid-19.
3	Achieve an 80% satisfaction rating of 4 or above out of 5	80%+ evaluation ratings $\geq$ 4	88.67%	93%	
4	Achieve 75 number bed nights from a collaboration with local accommodation providers	75	182	New KPI	
5	Deliver 2 new school programmes (ecology and GCSE)	2	2	New KPI	
6	Deliver 4 events focused on the work of astronomers and PhD students	4	7	New KPI	
7	Deliver 20 cosmic classroom events (10 paid and 10 free for schools with low educational achievement in STEM)	20	Paid 2	Paid 20	Paid - unachievable due to level of schools visiting and increase in dome outreach
			Free 11	Free 7	

KPI	Description	Target	As at 31 March 2023	As at 31 March 2022 (where applicable)	Comments
8	Press coverage: 15 positive press releases for print media 3 broadcast TV coverage	15 3	68 6	New KPI	
9	Deliver one pilot event to raise awareness of the Armagh-Birr-Dunsink partnership	1	1	New KPI	
10	Achieve recognition as an Urban Dark Sky Place			Unachievable	Capital funding required to deliver
11	Publish 50 articles in referenced scientific journals	50	85	67	
12	Scientific Outreach: 12 scientific talks at international conferences 12 public talks by scientists	12 12	39 43	New KPI	
13	Admit 3 new PhD students in October 2022	3	3	2	
14	Attract 8 number of external bookings for events or seminars	8	14	New KPI	
15	Facilitate 6 onsite scientific visits	6	26	New KPI	
16	Develop one non-astronomy partnership in the use of DVL facilities	1	1	New KPI	
17	Create 1 externally funded non-astronomy PhD	1	1	New KPI	
18	Create 2 new Puffersphere applications in house	2	2	New KPI	
19	Develop one new educational workshop using VR	1	1	New KPI	
20	Submit an OBC for AOP future development			New KPI	Slight slippage in the timeline. Submitted May 2023.
21	Secure outline planning approval for a joint development Masterplan in partnership with ABC Council			New KPI	KPI obsolete as joint development Masterplan project dissolved
22	Submit one major funding application in pursuance of AOP future development	1		12	It had been anticipated that PEACE PLUS would be live. An expression of interest was submitted.
23	Deliver 1 community/schools climate change event	1	3	9	
24	Achieve £320,000 funding from scientific sources to support AOP research	£320,815	£359,339	£420,000	Reduction in Covid-19 supplementary funding

Progress Key: Complete, Not Achieved

## Financial Review

### Operating Results

In the financial year to 31 March 2023, the value of charity funds increased by £2,111m, summarised below.

		2023	2022
		£	£
Total incoming resources		3,730,874	4,041,109
Total outgoing resources		(4,285,869)	(4,034,081)
<b>Net income / (expenditure)</b>		<b>(554,995)</b>	<b>7,028</b>
Gains on the revaluation of fixed assets		255,242	422,885
Actuarial gains on defined benefit pension scheme		2,411,000	1,534,000
<b>Net movement in funds for the year</b>		<b>2,111,247</b>	<b>1,963,913</b>
<b>Movement in Unusable Funds</b>			
Capital financing			
Capital grants received		549,000	1,254,000
Government grant fund		(858,746)	(828,152)
Revaluation reserve		1,904	185,428
Pension reserve		2,035,000	1,098,000
<b>Movement in Usable Funds</b>			
Restricted		(26,080)	(14,346)
Unrestricted		410,169	268,983
		<b>2,111,247</b>	<b>1,963,913</b>

The total income for the year was £3.731m, a decrease of £0.310m from 2021-22, mainly due to a decrease in DfC capital grant income of £0.705m, offset by increases in DfC Recurrent grant-in-aid of £0.160m, operating income of £0.163m and trading income of £0.065m.

Expenditure was £4.286m, an increase of £0.252m from the previous year. Staff costs continue to be the largest component of operational expenditure, comprising 62% of all direct costs.

Unrestricted operating costs are funded primarily by DfC grant-in-aid. The balance of such unrestricted operating costs is funded by contributions from external grants, operating income, trading activities and miscellaneous income. We continue to seek other funding streams to maintain this important source of funds. In 2022-23 the Department provided 71% of the total income through recurrent and capital grant allocations (2021-22: 79%).

#### Net Assets

Net assets at 31 March 2023 were £12.720m (31 March 2022: £10.609m).

#### Reserves

The AOP reserves policy is included in note 1 of the accounts. Total accumulated funds are as follows:

<b>Funds at 31st March</b>	<b>2023</b>	<b>2022</b>
	£	£
Restricted funds	148,028	174,108
Unrestricted funds	5,010,569	4,910,146
Revaluation Reserve	7,403,874	7,401,970
Pension Reserve	158,000	(1,877,000)
<b>Total Charity Funds</b>	<b>12,720,471</b>	<b>10,609,224</b>

## Going Concern

The Trustees are satisfied that the organisation is a going concern on the basis that it has a reasonable expectation that it will continue in operation for the foreseeable future. The financial statements are therefore prepared on a going concern basis.

## Pension Reserve

AOP is a member of Northern Ireland Local Government Officers' Superannuation Committee (NILGOSC) which manages Local Government Pension Scheme (LGPS) Northern Ireland, which in turn provides a defined benefits pension to employees. The scheme moved into surplus during the year and at 31 March 2023 the surplus was calculated by independent actuaries at £158,000 (2022: deficit £1,877,000). The assets, defined benefit obligation and current service cost shown in note 19 to the accounts have been calculated based on the data and results of the 2022 triennial actuarial valuation. AOP is able to recognise the surplus in full at this accounting date because we can gain an economic benefit from payment of reduced contributions below the cost of the expected FRS102 service costs in the future.

## Key Risks and Uncertainties

At year end, the key risks were identified as:

- Reputation – loss of confidence in AOP's ability to deliver acceptable level of research of international value;
- Engagement:
  - Visitors – failure to provide experiences that attract new and returning visitors and/or failure to engage local pride in AOP as a cherished asset;
  - Partners and collaborators – failure to attract support and commitment from key stakeholders to be able to deliver future vision;
- Resources:
  - Staff - failure to maintain an appropriately skilled, highly motivated and engaged workforce of sufficient capacity to satisfactorily deliver AOP objectives;
  - Budget – insufficient or poor management of budget could result in objectives not being met and/or value for money not being achieved;
- Asset Management:
  - Buildings and Heritage – failure to plan for the long term development needs of the estate and assets resulting in increasing reliance on remedial intervention and failure to protect heritage assets from irreparable decline;
  - Other physical assets including ICT – failure to plan for the upkeep and renewal of plant and equipment resulting in reduced service delivery; and
- Governance and Planning:
  - Failure to embed best practice approaches to corporate governance and risk management resulting in loss of confidence and reputational damage and/or legal challenge;
  - Inadequate information/data security measures resulting in information breaches and/or cyber security breaches.

As part of the Risk Management Strategy, management regularly review the inherent level of risk for each of the above and how the risk is currently managed. An Action Plan is documented to reduce the level of risk, mindful of the risk appetite of the organisation. This Risk Register is reviewed on a quarterly basis by the Audit and Risk Assurance Committee and approved by the Management Committee. Many of the above risks derive from the uncertainty around funding. Until AOP has both a budget appropriate to its needs and long-term security of funding, this situation is likely to continue. In managing these funding risks, the organisation has developed and maintained close communication links with the Department and submitted in-year monitoring bids for additional funding while carefully monitoring spend and budgets. For many of the above risks all reasonable steps within AOP's control are being taken to manage the risk.

The above risks also take account of recommendations from internal and external audit investigations and reports. Significant progress has been made in addressing the weaknesses identified in previous years and considerable effort has been put into the management of these risks going forward.

## Plans for Future Periods

In October 2021, AOP published a new Strategy for 2021-26 with four key themes of Enduring Relevance, National and International Standing, Offering More and Pursuing our Priorities.

Leading on from this AOP has prepared a Business Plan for 2023-24 for consideration by the Department. The business plan has been developed in the context of an unclear and uncertain, political and financial environment, however AOP remains focused and optimistic towards continued achievements within its key priority areas.

AOP, in conjunction with Dublin Institute of Advanced Studies, Dunsink Observatory, and Birr Science and Heritage Foundation, have embarked since September 2022 on a formal strategic process to develop an inter-institutional partnership for mutual benefit. This takes place in acknowledgement of the potential for strengthening the partner institutions' collaborative working capacity and for wider impact on a transboundary basis. This also includes taking into account a context of emerging opportunities for strengthening the long-standing north-south connections between Armagh, Dunsink and Birr in a way which maintains the integrity of each partner's core mission, and promotes the intrinsic value of scientific knowledge and heritage represented by the body of work carried out over the three sites since their establishment and ongoing. This will continue to be a key area of work in 2023-24 and will include submission of an application for consideration to be included in the Republic of Ireland Tentative List for UNESCO World Heritage Status as a transnational bid.

Following on from completion of a draft Outline Business Case for future development AOP will continue to work with partners and stakeholders to identify funding opportunities and other resources to move the project forward to the next phase of planning.

## Structure, Governance and Management

Armagh Observatory and Planetarium is a single statutory corporation and arms-length body (ALB). ‘The Governors of The Armagh Observatory and Planetarium’ are as described in *The Armagh Observatory and Planetarium (Northern Ireland) Order 1995*.

This 1995 Order superseded the original 1791 Act of the Irish Parliament entitled ‘*An Act for Settling and Preserving a Public Observatory and Museum in the City of Armagh For Ever*’, and an Amendment of 1938 (‘The University and Collegiate and Scientific Institutions Act [Northern Ireland], 1938’).

AOP is a registered charity under the title “The Armagh Observatory And Planetarium”.

### Board of Governors

AOP is governed by a Board of Governors. Membership of the Board of Governors consists of:

- the Church of Ireland Archbishop of Armagh;
- the Dean of the Church of Ireland Cathedral of Armagh;
- the other members of the Chapter of the Church of Ireland Cathedral of Armagh;
- one Department nominee;
- one Queen’s University Belfast (QUB) nominee; and
- up to three additional members nominated by the Board of Governors.

The Armagh Observatory and Planetarium (Northern Ireland) Order 1995 (the Order) places a statutory duty on “the Governors of Armagh Observatory and Planetarium” to maintain and manage AOP with the purpose of “developing and improving the knowledge, appreciation and practice of astronomy and related sciences.”

The Board of Governors (the Board) has retained a role to ensure that the culture and character, history and patrimony embodied in AOP are protected and preserved and that the institution is managed in line with the statutory purpose outlined in the Order. This role will normally be fulfilled through an Annual Review meeting (visitation) where the Board will receive assurance as to the management and performance of AOP from the Management Committee.

### Management Committee of Armagh Observatory and Planetarium

The Board has delegated primary responsibility for the governance and management of AOP to a Management Committee. The Management Committee has corporate responsibility for ensuring that AOP fulfils the aims and objectives set by the Department and approved by the Minister and for promoting the efficient, economic and effective use of resources. The Management Committee provides leadership, challenge, oversight, support and encouragement to the Director and staff.

The Management Committee comprises:

- three nominees from the Board of Governors;
- six nominees from the Department appointed through open competition;
- one nominee of Queen’s University, Belfast;
- one nominee of the Science and Technology Facilities Council (STFC);
- one nominee of the Dublin Institute for Advanced Studies (DIAS);
- a Chair appointed through open competition; and
- up to three additional members co-opted by the Board of Governors. This is by exception and subject to Departmental approval.

The following committees are established as sub-committees of the Management Committee.

### Audit and Risk Assurance Committee (ARAC)

The ARAC is a sub-committee of the Management Committee established in accordance with DAO (DFP) 06/13 - Corporate governance in central government departments: Code of Good Practice NI 2013, and in line with the HM Treasury Audit and Risk Assurance Committee Handbook (DoF 03/18) to advise the Board of Governors, the Management Committee and the Director of AOP as Accounting Officer and to support them in their responsibilities for issues of organisational risks, internal control, governance and their associated assurances and in reviewing the reliability and integrity of these assurances.

### Staffing Policy and Remuneration Committee

The Staffing Policy and Remuneration Committee is a sub-committee of the Management Committee and provides advice and recommendations to the Management Committee on employment issues.

### Research and Education Advisory Committee

The Research and Education Advisory Committee is a sub-committee of the Management Committee and advises it on research and education issues.

### Redevelopment Committee

The Redevelopment Committee is a sub-committee of the Management Committee and was established to develop an Outline Business Case for redevelopment proposals.

Further details on the membership of these Committees are set out in the Governance Statement on pages 30 to 39.

## **Reference and Administrative Details**

### **Name of the Charity**

The charity is registered and operates under the title of The Armagh Observatory And Planetarium.

### **Charity number**

Registered with the Charity Commission for Northern Ireland 103948.

### **Principal Office**

College Hill, Armagh, BT61 9DG

### **Trustees (and Board of Governors)**

Archbishop J McDowell, (Chair)  
The Very Revd Dean S Forster  
The Venerable Archdeacon T Scott (to 30 January 2023)  
The Venerable Archdeacon E Cairns  
The Venerable Archdeacon Dr P Thompson  
Revd Canon W M Adair  
Revd Canon W J A Dawson  
Revd Canon M Hagan\* (from 23 April 2023)  
Revd Canon D Hilliard  
Revd Canon J Moore (to 22 February 2023)  
Revd Canon B Paine  
Revd Canon R J N Porteus  
Mr G Cox  
Professor A Fitzsimmons  
Mr R Wilson  
Archbishop E Martin  
Ms S Leslie\*

*\*Pending the outcome of ongoing discussions with CCNI, Ms Leslie and Revd Canon Hagan have not been registered as a Charity Trustees.*

### **Director and Accounting Officer**

Professor Michael Burton

## **Auditors**

Northern Ireland Audit Office, 106 University Street, BELFAST, BT7 1EU

## **Internal Auditors**

Cavanagh Kelly, 36-38 Northland Row, Dungannon, BT71 6AP

## **Bankers**

Danske Bank, Donegal Square West, Belfast, BT1 6JS

## **Register of Interests**

A Register of Interests is maintained for Board and Committee Members and the Executive Team and is available for inspection at the Principal Address. Declared Interests by Board and Committee Members and the Director are available on the AOP website – [www.armagh.space](http://www.armagh.space).

Related party transactions are shown in note 23 of the accounts.

## **Gifts**

AOP adheres to the limits and rules laid out in its Management Statement approved by the Department and the guidance in Managing Public Money Northern Ireland (MPMNI). There were no gifts made or accepted during the 2022-23 financial year that exceeded these limits.

## **Personal data related incidents**

AOP has considered the requirement to report personal data related incidents. It is content that there were no such incidents in the year ended 31 March 2023.

## **Disclosure of Audit Information**

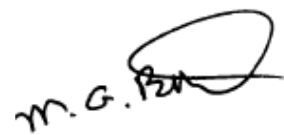
So far as the Accounting Officer is aware, there is no relevant audit information of which AOP's auditors are unaware. The Accounting Officer has taken all necessary steps to make himself aware of any relevant audit information and to establish that AOP's auditors are aware of that information.

## **Events after the end of the reporting period**

There have been no events since the end of the financial year requiring disclosure.



**Archbishop John McDowell**  
Chair of the Board of Trustees  
Date: 2 October 2023



**Professor Michael Burton**  
Director  
Date: 2 October 2023

# Remuneration and Staff Report

The remuneration and staff report sets out AOP's remuneration policy for Board members and senior managers, reports on how that policy has been implemented and sets out the amounts awarded to the Director. In addition, the report provides details on remuneration and staff that users see as key to accountability.

## Remuneration Policy

The pay remit for the Northern Ireland (NI) public sector, including senior civil servants (SCS) in the NICS, is normally approved by the Minister of Finance. In the absence of a functioning Executive, the 2022-23 NI public sector pay award was announced by the Permanent Secretary, Department of Finance in April 2023.

Annual AOP pay awards are made in the context of the wider Northern Ireland public sector pay policy. The pay awards for 2022-23 were paid in May 2023. The pay of staff (other than post-doctoral research assistants who are paid in accordance with academic scales in use by Queens University, Belfast) is based on a system of pay scales for each grade, including SCS, containing a number of pay points from minimum to maximum, allowing progression towards the maximum based on performance.

## Board Members

Board members do not receive any remuneration. They receive travel and subsistence allowances at rates and on conditions determined by AOP, subject to Departmental approval. No Board member receives pension benefits or makes pension contributions in their capacity as a Board member.

## Service Contracts

The Director of AOP, Professor Michael G. Burton, is the person in a senior position having authority and responsibility for directing and controlling the activities of the organisation. The service contract of the Director commenced on 1 August 2016.

Current terms and conditions for staff are those set out in various policies and individual employment contracts. Senior staff are permanent employees of AOP. The notice period for senior staff is three months. Termination payments are in accordance with contractual terms and those of the principal Civil Service Pension Scheme (NI).

## Director's Remuneration (including Salary and Pension Entitlements) (Audited Information)

The following tables provide details of the remuneration and pension entitlements of the Director of the organisation.

Single Total Figure of Remuneration of Director							
	Salary (£'000)		Pension Benefits* (£'000)		Total (£'000)		Percentage Change
Official	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	
M.G. Burton	80-85	85-90	14	23	95-100	105-110	(9.7%)

\*The value of pension benefits accrued during the year is calculated as (the real increase in pension multiplied by 20) plus (the real increase in any lump sum) less (the contributions made by the individual). The real increases exclude increases due to inflation and any increase or decrease due to a transfer of pension rights.

'Salary' includes gross salary to the extent that it is subject to UK taxation. There was no overtime, benefit-in-kind, bonus or other allowances. The salary of the Director shown above is based on the Northern Ireland Senior Civil Service Grade 5 pay scale.

## Compensation on early retirement or for loss of office

No payment for compensation on early retirement or for loss of office has been made (2021-22: £nil).

## AOP Fair Pay Disclosures

AOP is required to disclose the relationship between the remuneration of the Director and the lower quartile, median and upper quartile remuneration of the organisation's workforce. The banded remuneration of the Director in the financial year 2022-23 was £80,000 - £85,000 (2021-22: £85,000 - £90,000). The relationship between the mid-point of this band and the remuneration of AOP's workforce is disclosed below.

2022-23	25 <sup>th</sup> percentile	Median	75 <sup>th</sup> percentile
Total remuneration	£18,783	£29,731	£37,373
Pay ratio	4.4:1	2.8:1	2.2:1

2021-22	25 <sup>th</sup> percentile	Median	75 <sup>th</sup> percentile
Total remuneration	£18,783	£29,307	£39,324
Pay ratio	4.7:1	3.0:1	2.2:1

Total remuneration includes salary, overtime and performance related bonuses. It does not include severance payments, employer pension contributions and the cash equivalent transfer value of pensions. Remuneration ranged from £18,783 to £82,500.

The percentage changes in respect of AOP are shown in the following table. It should be noted that the calculation for the Director is based on the mid-point of the band within which their remuneration fell in each year.

Percentage change for:	2022-23 v 2021-22	2021-22 v 2020-21
Average employee salary and allowances	2.4%	-2.9%
Director's salary and allowances	-5.7%	6.1%
Average employee performance pay and bonuses	14.9%	-24.0%

No performance pay or bonus was payable to the Director in these years.

### Pension Entitlements (Audited Information)

Official	Accrued pension at pension age as at 31/03/23	Real increase in pension at pension age	Accrued Lump Sum at 31/03/23	Real Increase in Lump Sum	CETV at 31/03/23	CETV at 31/03/22	Real Increase in CETV
	£'000	£'000	£'000	£'000	£'000	£'000	£'000
M.G. Burton	12	1	-	-	179	144	13

The CETVs above have been calculated in accordance with guidance from the Department of Finance in Employer Pension Notice EPN 12-2022. When calculating the real increase in CETV and the pension benefits accrued during the year 2022-23 for the single total figure of remuneration, NILGOSC takes account of inflation. The CPI increase for September 2022 was 10.1%. The in-service revaluation rate for the Career Average Revalued Earnings Scheme was also 10.1%.

### Pension Scheme

Pension benefits are provided through the Northern Ireland Local Government Officers' Superannuation Committee Pension Scheme (NILGOSC). Retirement pension will be based on 1/49<sup>th</sup> of salary paid in year and pension is based on career average earnings. Details can be obtained at <http://www.nilgosc.org.uk>.

Active members of the pension scheme will receive an Annual Benefit Statement. The accrued pension quoted is the pension the member is entitled to receive when they reach their scheme pension age, or immediately on ceasing to be an active member of the scheme if they are at or over pension age.

Employee contribution rates for all members for the period covering 1 April 2022 to 31 March 2023 are as follows:

Pensionable Pay	Contribution Rate
£0 to £15,400	5.5%
£15,401 to £23,700	5.8%
£23,701 to £39,500	6.5%
£39,501 to £48,000	6.8%
£48,001 to £95,100	8.5%
More than £95,100	10.5%

Employer contribution rates are determined by the Scheme's actuary every three years. Following the results of the 2022 actuarial valuation, the Committee agreed with its actuary the employer contributions and deficit recovery contributions for the following three years, effective from 1 April 2023. The next valuation is due as at 31 March 2025.

## Cash Equivalent Transfer Values

A Cash Equivalent Transfer Value (CETV) is the actuarially assessed capitalised value of the pension scheme benefits accrued by a member at a particular point in time. The benefits valued are the member's accrued benefits and any contingent spouse's pension payable from the scheme. A CETV is a payment made by a pension scheme or arrangement to secure pension benefits in another pension scheme or arrangement when the member leaves a scheme and chooses to transfer the benefits accrued in their former scheme. The pension figures shown relate to the benefits that the individual has accrued as a consequence of their total membership of the pension scheme, not just their service in a senior capacity to which disclosure applies. The CETV figures include the value of any pension benefit in another scheme or arrangement which the individual has transferred to the NICS pension arrangements. They also include any additional pension benefit accrued to the member as a result of their purchasing additional years of pension service in the scheme at their own cost. CETVs are calculated in accordance with The Occupational Pension Schemes (Transfer Values) (Amendment) Regulations 2015 and do not take account of any actual or potential benefits resulting from Lifetime Allowance Tax which may be due when pension benefits are taken.

### Real increase in CETV

This reflects the increase in CETV effectively funded by the employer. It does not include the increase in accrued pension due to inflation, contributions paid by the employee (including the value of any benefits transferred from another pension scheme or arrangement) and uses common market valuation factors for the start and end of the period. However, the real increase calculation uses common actuarial factors at the start and end of the period so that it disregards the effect of any changes in factors and focuses only on the increase that is funded by the employer.

### Total Permanently Employed Staff Costs (Audited Information)

	Permanent staff £	Others <sup>1</sup> £	2022-23 £	2021-22 £
Wages and salaries	1,172,056	169,562	1,341,618	1,298,400
Social security costs	125,302	16,806	142,108	132,074
Employer's pension contributions	218,849	31,956	250,805	238,763
Defined benefit pension additional service cost	327,000	-	327,000	376,000
	1,843,207	218,324	2,061,531	2,045,237

<sup>1</sup> "Others" includes £13,501 for agency staff

### Average staff numbers (Audited Information)

	Permanent staff	Others <sup>2</sup>	2022-23 Total Number	2021-22 Total Number
Average staff numbers	27.4	7.9	35.3	34.9

<sup>2</sup> "Others" includes 5.4 fixed term, 2.2 casuals and 0.3 agency staff

### Staff Composition – permanent employees (full time equivalent)

	Male	Female
Directors/senior managers	2.6	2.0
Other employees	8.9	13.9

### Staff Turnover

	2022-23	2021-22
Leavers as a percentage of average staff in post	3.1%	8.9%

### Sickness Absence (Audited Information)

Staff sickness for the period 1 April 2021 to 31 March 2023 totalled 126 days (2022: 101 days) which equates to an average per FTE of 1.66% (2022: 1.37%).

### Expenditure on External Consultancy (Audited Information)

Expenditure on external consultancy during the year was £nil (2021-22: £nil).

**Off-payroll Engagements (Audited Information)**

There were no “off-payroll” engagements in place as at 31 March 2023, nor were any arrangements entered into between 1 April 2022 and 31 March 2023.

**Exit Packages (Audited Information)**

Exit package cost band	No of compulsory redundancies	No of other departures agreed	Total no. of exit packages by cost band	Total no. of exit packages by cost band
	2022-23	2022-23	2022-23	2021-22
Total no. of exit packages	-	-	-	-
Total resource cost	Nil	Nil	Nil	Nil

## Statement of the Responsibilities of the Governors and Accounting Officer

Under the Audit and Accountability (Northern Ireland) Order 2003, the Governors are responsible for preparing for each financial year and for preparing a statement of accounts in the form and on the basis set out as the Department for Communities, with the approval of the Department of Finance, shall direct. The accounts are prepared on an accruals basis and must give a true and fair view of the state of affairs of AOP and of its income and expenditure, Statement of Financial Activities and cash flows for the financial year.

In preparing the accounts, the Accounting Officer is required to comply with the requirements of the Government Financial Reporting Manual and in particular to:

- observe the accounts direction issued by the Department of Finance, including the relevant accounting and disclosure requirements, and apply suitable accounting policies on a consistent basis;
- make judgements and estimates on a reasonable basis;
- state whether applicable accounting standards as set out in the Government Financial Reporting Manual have been followed, and disclose and explain any material departures in the accounts;
- prepare the accounts on a going concern basis; and
- confirm that the Annual Report and Accounts as a whole is fair, balanced and understandable and take personal responsibility for the Annual Report and Accounts and the judgements required for determining that it is fair, balanced and understandable.

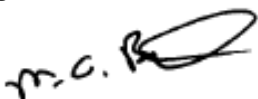
The Department for Communities has appointed Professor M.G. Burton as Accounting Officer of AOP. The responsibilities of an Accounting Officer, including responsibility for the propriety and regularity of the public finances for which the Accounting Officer is answerable, for keeping proper records and for safeguarding AOP's assets, are set out in Managing Public Money Northern Ireland.

## Statement of Disclosure of Information to the Auditors

So far as the Accounting Officer of Armagh Observatory and Planetarium, in office at the date of the approval of these financial statements, is aware:

- there is no relevant audit information relating to these respective charitable organisations of which the auditors are unaware;
- he has taken all the steps that he ought to have taken as Accounting Officer in order to make himself aware of any relevant audit information relating to these charitable organisations and to establish that the auditors are aware of that information;
- he confirms that the Annual Report and Accounts as a whole is fair, balanced and understandable; and
- he confirms that he takes personal responsibility for the Annual Report and Accounts and the judgements required for determining that it is fair, balanced and understandable.

Signed:



**Professor Michael Burton**  
**Accounting Officer for Armagh Observatory and Planetarium**

**Date: 2 October 2023**

# Governance Statement

AOP is a Non-Departmental Public Body established under The Armagh Observatory and Planetarium (Northern Ireland) Order 1995.

## 1. Compliance with Corporate Governance Code

In 2013 the Department of Finance and Personnel published Corporate Governance in Central Government Departments: Code of Good Practice NI. The Code draws on best practice in the public, private and charity sectors by: reinforcing the importance of corporate governance as a pre-requisite to achieving good financial management; reflecting changes in governance best practice, including increased emphasis on good leadership; and promoting better governance arrangements within departmental families.

The Code is written for departments, concentrating throughout on key principles which will have wider application for other parts of the public sector. Such bodies (including arms-length bodies (ALBs)) are encouraged to consider and adopt the practices set out in the Code wherever it is relevant and practical and suits their business needs.

AOP in so far as they are relevant for an arms-length body, complies with the principles of good practice in the Corporate Governance Code.

## 2. Governance Framework

### Accounting Officer

Name	Accounting Officer
Professor Michael Burton – Director and Chief Executive	From 1 September 2016 onwards

### Board of Governors

AOP is governed by a Board of Governors. Membership of the Board of Governors consists of:

- the Church of Ireland Archbishop of Armagh;
- the Dean of the Church of Ireland Cathedral of Armagh;
- the other members of the Chapter of the Church of Ireland Cathedral of Armagh;
- one DfC nominee;
- one Queen’s University Belfast (QUB) nominee; and
- up to three additional members nominated by the Board of Governors.

During 2022-23 two Members of the Chapter of the Church of Ireland Cathedral of Armagh retired. Revd Canon M Hagan was appointed in 2023-24 to one of these positions and the second currently remains vacant.

<b>BOARD OF GOVERNORS</b>			
<b>GOVERNOR</b>	<b>DATE OF APPOINTMENT</b>	<b>DATE OF EXPIRY</b>	<b>MEETINGS ATTENDED (max. 1)</b>
Archbishop J McDowell (Chair)	28 April 2020	None	1
The Dean Very Revd S Forster	14 February 2021	None	1
The Venerable Archdeacon T Scott	9 November 2006	30 January 2023 (Retired)	1
The Venerable Archdeacon E Cairns	13 December 2020	None	0
The Venerable Archdeacon Dr P Thompson	13 January 2019	None	0
Revd Canon W M Adair	10 September 2008	None	0
Revd Canon W J A Dawson	1998	None	0
Revd Canon M Hagan	From 23 April 2023	None	0
Revd Canon D Hilliard	13 March 2016	None	1
Revd Canon J Moore	13 March 2016	22 February 2023 (Retired)	1
Revd Canon W B Paine	7 May 2017	None	0
Revd Canon R J N Porteus	1998	None	0
Professor A Fitzsimmons	18 April 2019	1 May 2024	0
Mr R Wilson	1 December 2019	30 November 2024	1
Archbishop E Martin	1 January 2021	31 December 2025	1
Ms S Leslie	From 1 June 2021	31 May 2026	1
Mr G Cox	1 March 2021	28 February 2026	1

At the annual meeting on 26 April 2022, the Board of Governors endorsed the continuing membership of Revd Canon Adair, Mr Cox and Mr Wilson as its nominees on the Management Committee and agreed to extend the Chair of the Management Committee's appointment for a further 5 year term.

The Board received an update on a confidential land matter; the appointment of a Management Committee Sub-Group relating to the matter and established the parameters for convening a Special Meeting.

The Board formally resolved to change the registered charity name and to delegate the role of Trustee to the members of the Management Committee, once the process of name change had been concluded.

The Board approved the draft Partnership Agreement with DfC and delegated authority to the Chair to sign it and to the Management Committee to approve the necessary changes required as a result of its implementation. It also granted the Management Committee authority to delegate some of its activities to its Sub-Committees and to approve the necessary changes required to Terms of Reference as a result.

The Board reviewed a written report from the Chair of the Management Committee and the minutes from the Management Committee and the Audit and Risk Assurance Committee meetings between June 2022 and March 2023 (draft).

The Board formally retrospectively approved the Annual Report and Accounts 2020-21 and approved the 2021-22 draft Annual Report and Accounts, subject to minor amendments and delegated authority to the Management Committee to approve the accounts and to the Archbishop to sign them off on its behalf when completed. The Board noted the Management Report for 2021-22 which included the Director's Report, Corporate Plan Objectives, Key Performance Indicators and the Risk Register as at April 2022.

The Board approved the draft 2022-23 Business Plan.

The Board is satisfied that comprehensive arrangements are in place to ensure that high-quality information is received to enable it to make informed decisions. Internal controls are in place to validate the accuracy and completeness of information presented to the Board.

## Management Committee of Armagh Observatory and Planetarium

There were no changes to the Management Committee membership during 2022-23. The term of appointment for the Chair of the Management Committee was extended for a further 5 years and the term of appointment for both Professor Harra and Mr Brown extended by one year, from 30 April 2023 to 30 April 2024. Mr McGurgan's term of appointment ended on 30 April 2023, leaving one public appointment vacancy which will not be filled until March 2024.

<b>MANAGEMENT COMMITTEE</b>			
<b>MEMBER</b>	<b>DATE OF APPOINTMENT</b>	<b>DATE OF EXPIRY</b>	<b>MEETINGS ATTENDED (max. 4)</b>
Mr J Briggs (Chair)	1 January 2018	31 December 2027	4
Professor L Harra	1 November 2014	30 April 2024	3
Mr S Brown	1 November 2014	30 April 2024	3
Mr P McGurgan (to 30 April 2023)	1 November 2014	To 30 April 2023	1
Professor M Mathioudakis	11 November 2016	10 November 2026	3
Mr R Wilson	1 December 2019	30 November 2024	2
Dr C Jackman	1 January 2021	31 December 2025	2
Dr M Darnley	1 January 2021	31 December 2025	2
Mr P Kennedy	1 March 2021	28 February 2026	3
Dr K Lemon	1 March 2021	28 February 2026	4
Mr E Rooney	1 March 2021	28 February 2026	4
Mr G Cox	19 May 2021	18 May 2026	3
Rev Canon W M Adair	15 September 2021	14 September 2026	0
VACANT (from 1 May 2023)			

During 2022-23 the Management Committee considered a wide range of business. The Management Committee held their first full in-person meeting in June 2022, which was the first such meeting for over two years.

In June 2022 the Management Committee reviewed AOP's draft Operating Framework, an operational document developed as part of the Partnership Agreement. Coinciding with the June meeting, a number of engagement activities were held over a two-day period.

At its October 2022 meeting the Management Committee noted that the 2022-23 Business Plan had been approved by Minister Deirdre Hargey MLA on 23 September 2022.

A 'task and finish' working group to consider issues arising from the Management Committee Effectiveness review was established in June 2022. It met in August and November 2022 and in December 2022 the Management Committee approved its recommendations to approve a Policy Approval Process Paper, and implementation of its recommendations, and to establish a principle for meeting dates for 2024 and beyond.

In December 2022 the Committee agreed to further engagement with the Charity Commission in relation to a proposed name change to the Registered Charity.

A Special Meeting of the Management Committee took place in March 2023 to consider a draft Outline Business Case for AOP's redevelopment project, prior to consideration by the Board of Governors.

At each of its meetings throughout the year the Committee received a report from the Director, updates from its sub-committees and approved relevant reports. Regular governance reports such as the Bi-Annual Assurance Statement, the Risk Register, Key Performance Indicators and Finance monitoring reports were reviewed and approved. The Committee considered and noted amendments to policies that had been reviewed in line with the policy review process and approved new policies as appropriate.

During the year the Armagh Leisure Village Development Proposal was withdrawn and the Management Committee's attention was re-focused on AOP's Vision and redevelopment. The Committee received regular updates on progress from its Redevelopment Sub-Committee.

Internal controls are in place to validate the accuracy and completeness of information presented to the Management Committee.

## Audit and Risk Assurance Committee

The Audit and Risk Assurance Committee is drawn from the Management Committee and comprises a minimum of four and maximum of five members.

<b>AUDIT AND RISK ASSURANCE COMMITTEE</b>	
<b>MEMBER</b>	<b>MEETINGS ATTENDED (max. 3)</b>
Mr S Brown Chair (from June 2021)	2
Professor L Harra	3
Mr P Kennedy	2
Dr K Lemon (from 4 May 2023)	0
Mr P McGurgan (to 30 April 2023)	1
Mr E Rooney	3

During 2022-23 the Audit and Risk Assurance Committee considered reports from Internal Audit on progress against the audit plan and progress on outstanding recommendations; reports from external audits on the 2021-22 Annual Report and Accounts; the 2022-23 external audit strategy; review of the Accounting Officer's Assurance Statement and review of the Risk Register. Throughout the year particular attention was given to ICT related risks, including data and cyber security.

The Committee is satisfied that the integrated approach, the frequency of meetings, the breadth of the business undertaken, the skills of Members and the range of attendees at meetings of the Committee has allowed the Committee to meet the governance requirements of the organisation and assisted the Management Committee to demonstrate its stewardship of the public resources with which it is charged.

The Committee is satisfied that the organisation has robust risk management arrangements in place which are in line with the good practice in the HM Treasury 'Orange Book' and are reviewed regularly by the Management Committee.

There were 6 Internal Audit recommendations from prior years outstanding, 5 of which have been completed. The Committee is satisfied that the remaining outstanding recommendation has been implemented by AOP as far as possible, but that its completion is beyond AOP's control. There were 11 new internal audit recommendations in 2022-23, of which 3 remain outstanding, having not reached the date of implementation during the financial year.

## Staffing Policy and Remuneration Committee

The Staffing Policy and Remuneration Committee's membership is drawn from the Management Committee and comprises a minimum of four and maximum of five members.

<b>STAFFING POLICY AND REMUNERATION COMMITTEE</b>	
<b>MEMBER</b>	<b>MEETINGS ATTENDED (max. 4)</b>
Mr E Rooney (Chair)	4
Mr S Brown	3
Mr J Briggs	4
Dr K Lemon	4
M P Kennedy	3

In 2022-23, amongst other matters, the Committee considered:

- staffing and recruitment, including Skills Gaps Analysis and Strategic Workforce Planning;
- staff related policies, including new Hybrid Working and Volunteer Policies;
- staff survey and engagement; and
- updates on a range of Human Resources issues including progress against the Human Resources Strategy and Action Plan.

AOP's application for the Diversity Mark (Bronze Award) was successful.

## Research and Education Advisory Committee

The Research and Education Advisory Committee's membership is drawn from the Management Committee and comprises a minimum of four and maximum of five members.

RESEARCH AND EDUCATION ADVISORY COMMITTEE	
MEMBER	MEETINGS ATTENDED (max. 3)
Prof L Harra (Chair)	3
Prof M Darnley	3
Dr K Lemon	3
Prof M Mathioudakis	2

In 2022-23, amongst other matters, the Committee considered:

- education and outreach;
- concordat to support the career development of researchers;
- Research Excellence Framework (REF);
- funding opportunities; and
- new STFC Consolidated Grants.

## Redevelopment Sub-Committee

The Redevelopment Sub-Committee's membership is drawn from the Management Committee and comprises of six members.

REDEVELOPMENT SUB-COMMITTEE	
MEMBER	MEETINGS ATTENDED (max. 11)
Mr S Brown (Chair)	11
Mr J Briggs	5
Mr G Cox	4
Mr P Kennedy	9
Dr K Lemon	4
Mr E Rooney	10

The primary purpose of the Sub-Committee was to drive the 'Development of AOP Science and Education Park' Project forward, and oversee the delivery of the outcomes and benefits, most notably initially an Outline Business Case (OBC) by March 2023. In doing so, its primary functions included:

- Providing leadership and direction - championing the project as appropriate within AOP and with stakeholders, and supporting the SRO.
- Taking decisions – members must have the authority to take / recommend decisions to the SRO
- Challenging and scrutiny - all aspects of Project and project delivery.

It was a very ambitious and challenging timetable and there was a little slippage in the completion of the OBC.

This is a 'task and finish' sub-committee which will continue until the OBC is approved, following which appropriate governance for the next stage of the project will be considered.

## Conflicts of Interest

The organisation maintains a register of interests to ensure that potential conflicts of interest can be identified and addressed in advance of Board, Management Committee and other Committee discussions. The register is formally revisited on an annual basis. Where conflicts exist, they are recorded in the Committee minutes and the Chair of the meeting decides the most appropriate way of managing the conflict. This may include that member not taking part in discussions or making decisions on certain matters or being excluded for part or all of that meeting.

The Register of Interests for Board of Governors, Management Committee and senior staff is published on the AOP website in accordance with central government guidance.

## Directors and Secretary

Professor Michael Burton, Director and Accounting Officer.

The Corporate Manager provides a range of secretarial support services to the Board of Governors, Management Committee and Audit and Risk Assurance Committee, the HR and Policy Officer provides secretarial support to the Staffing Policy and Remuneration Committee and the Executive Officer to the Research and Education Advisory Committee.

### 3. Business Planning and Risk Management

#### Business Planning

*'Our mission is the pursuit of knowledge and understanding of the cosmos, and the sharing of that knowledge in order to inspire future generations and enrich the intellectual, economic, social and cultural life of all.'*

*'Our vision is to be recognised as an international centre of scientific excellence for the pursuit of astronomy and the public understanding of science, for our capacity for innovation and our extraordinary heritage, a place our community can be proud of.'*

The pillars that support us are – Knowledge, Legacy, People and Engagement.

The five year strategy is built around four strategic themes - Enduring Relevance, National and International Standing, Offering More and Pursuing our Priorities.

The Strategic Plan aligns closely with the aims and objectives of AOP's sponsor branch, the Department for Communities, and with the broader aims and objectives of the Northern Ireland Executive's Programme for Government. The organisation's Strategic Plan 2021-26 received Departmental approval on 17 August 2021.

The work of the Observatory encompasses both internationally acclaimed research and a unique cultural heritage - scientific, historical, architectural - as well as maintaining the unique daily climate series (the longest daily series from a single site in the UK and Ireland) and undertaking a world-class programme of science in the community, which complements the Planetarium's main business of education.

The Planetarium's main business is education, and all age and social groups are welcome to visit. The educational programmes and demonstrations are designed to include participation by children of pre-nursery age up to senior citizens and all age groups in between. The primary educational aim of the Planetarium is to endorse and promote the Science, Technology, Engineering, Arts and Mathematics (STEAM) agenda which promotes scientific careers to young people. All of the ancillary activities support the primary aim, with the additional target of offering excellent value for money, both to the visitors taking part and to the public purse. The Planetarium maintains a focus on being inclusive so that all children can enjoy the Planetarium experience.

Full details of all AOP's activities are provided in comprehensive Annual Reports which are available online at: [www.armagh.space](http://www.armagh.space)

No Ministerial Directions have been issued regarding the work of AOP.

#### Risk Management

Risk Management is an essential element of AOP's corporate governance framework and is closely linked to the system of internal control and business planning process. A robust risk management process assists AOP in identifying and managing issues which may hinder the achievement of objectives. The arrangements are regularly reviewed.

As well as ensuring that there is an effective system in place to deal with threats to AOP's aims and objectives, the organisation encourages a proactive approach to innovation and well-managed risk taking where there is potential to realise sustainable improvements in the organisation's research and educational services. For this reason, the organisation's Risk Appetite is 'Open'.

The Management Committee sets the risk appetite for AOP. The Accounting Officer, Senior Management Team and other staff are responsible for ensuring that residual risks are reduced to a level as low as reasonably practicable and wherever possible consistent with the level of risk appetite established by the Management Committee.

Updates are provided to the Audit and Risk Assurance Committee on the development and implementation of the risk management process across AOP. The Audit and Risk Assurance Committee provides the Accounting Officer with objective advice on issues concerning the risk, control and governance of the organisation and the associated assurances. An update on the main points considered by the Audit and Risk Assurance Committee is provided to the Management Committee following each meeting and the Management Committee has access to all papers for the Audit and Risk Assurance Committee.

#### **4. Fraud and Information Risk**

The Accounting Officer has overall responsibility for managing the risk of fraud including:

- developing a fraud risk profile and undertaking a regular review of the fraud risks associated with each of the key organisational objectives in order to keep the profile current;
- establishing an effective fraud prevention policy and fraud response plan, commensurate with the level of fraud risk identified in the fraud risk profile;
- designing an effective control environment to prevent fraud commensurate with the fraud risk profile;
- operating appropriate pre-employment screening measures;
- establishing appropriate mechanisms for reporting fraud risk issues, reporting significant incidents of fraud, and coordinating assurances about the effectiveness of fraud prevention policies to support the Governance Statement;
- liaising with the Audit and Risk Assurance Committee;
- ensuring that all staff are aware of the organisation's fraud prevention policy and know what their responsibilities are in relation to combating fraud;
- ensuring fraud awareness training is provided as appropriate and, if necessary, more specific fraud prevention training and development is provided to relevant staff;
- ensuring that vigorous and prompt investigations are carried out if fraud occurs, is attempted or is suspected by the establishment of a Fraud Investigation Oversight Group;
- ensuring, where appropriate, legal and/or disciplinary action against perpetrators of fraud;
- ensuring, where appropriate, disciplinary action against supervisors where supervisory failures have contributed to the commission of fraud;
- ensuring, where appropriate, disciplinary action against staff who fail to report fraud;
- taking appropriate action to recover assets and losses;
- ensuring that appropriate action is taken to minimise the risk of similar frauds occurring in future; and
- ensuring that an anti-fraud culture is promoted throughout the organisation in line with the seven Nolan Principles of Public Life.

Risks to data and information held by the organisation are owned and managed by individuals designated as information asset owners. The Executive Officer responds to requests for information under the Data Protection and Freedom of Information Acts following consultation with the Accounting Officer and the organisation's governing committees, as appropriate.

AOP operates a Raising a Concern (Whistleblowing) Policy which informs all members of the organisation of the standards of behaviour expected of them in carrying out their duties, and to provide information on the procedures to follow if a situation arises in which they are required to act in a way which is believed by them to be illegal, improper, or in breach of the Nolan Principles.

#### **5. Governance and Accountability**

AOP seeks to achieve excellence in good governance, in particular the precepts: (1) leadership; (2) effectiveness; (3) accountability and (4) sustainability.

The Chair of the Board of Governors has a particular leadership responsibility for securing the sustainability and vitality of the organisation in the long term; giving advice and direction in formulating AOP's forward look and overall strategy; ensuring that account is taken of guidance provided by the Minister or the Department; promoting the efficient and effective use of staff and other resources; encouraging high standards of probity amongst staff and Board and committee members alike; and ensuring that the Board and its committees meet at regular intervals throughout the year and that the Minutes of meetings accurately record the decisions taken and, where appropriate, the views of individual Board members.

Within AOP, leadership is exercised by the Director and his Senior Management Team who are responsible for the management and effective operation of their organisation. Their operational responsibilities include:

- developing, implementing and monitoring the strategic and operational plans;
- undertaking financial management and Accounting Officer responsibilities;
- managing and developing a team of highly qualified professional and administrative staff;
- identifying and attracting sources of external income;
- promoting their respective organisations in relevant local, national and international arenas; and
- promoting Public Understanding of Science with the objective of improving the level of scientific literacy in the community and to ensure a strong link with government policy and the STEM agenda.

Members of the Board of Governors and of the Management Committee and their various sub-committees exercise an effective challenge function on the leadership team in accord with their respective roles in the organisation. They also provide guidance and advice on strategic and operational matters such as Human Resource issues, accountability and relationships with stakeholders.

The members of these committees are drawn from a wide community background within, and beyond, Northern Ireland, and provide the organisation with a correspondingly wide range of expert knowledge and advice. All the committees of AOP operate with full transparency and accountability, and over the last year have proved effective in the discharge of their duties and responsibilities.

It was agreed by the Board of Governors and the Management Committee that the governance arrangements in place, in line with guidance, removed the need for the current Board of Governors to complete an internal self-assessment of its effectiveness.

The Board of Governors and supporting Committees receive assurances from the Director and his Senior Management Team and Internal Audit that the governance and accountability processes are being managed effectively.

## 6. Sources of Independent Assurance

### Internal Audit

CavanaghKelly was appointed as Internal Auditors for the 3 years 2020-21 to 2022-23. Their work was carried out in accordance with the Public Sector Internal Audit Standards.

During the year, the Audit and Risk Assurance Committee considered reports on the following areas:

Audit Assignment	Assurance Rating
Education and Community Outreach	Satisfactory
HR, including performance management	Satisfactory
Purchasing and Procurement	Satisfactory
Internal Audit Follow Up 2022-23	N/A

An overall 'satisfactory' internal audit assurance opinion has been provided.

Of the new issues identified by internal audit during 2022-23 there were no priority one issues.

The Internal Audit Charter; Internal Audit Strategy 2023-2026 and Annual Internal Audit Plan 2023-24 will be considered at a future meeting when the new internal audit contract has been awarded.

### External Audit

The Comptroller and Auditor General (C&AG) is required to audit the financial statements under *The Armagh Observatory and Planetarium (Northern Ireland) Order 1995*. The C&AG is responsible for reporting whether in their opinion the financial statements give a true and fair view of the state of the Armagh Observatory and Planetarium's affairs and of its income and expenditure, and whether they and the part of the Remuneration Report to be audited have been properly prepared in accordance with *The Armagh Observatory and Planetarium (Northern Ireland) Order*

1995 and DfC directions made thereunder. The C&AG is required to report whether, in her opinion, in light of the knowledge and understanding of AOP and its environment obtained in the course of the audit, she has identified any material misstatements in the Trustees' Annual Report and whether the information which comprises the Statement of the Responsibilities of the Governors and Accounting Officers and Governance Statement, as included within the Annual Report, is consistent with the financial statements. She also reports on whether, in her opinion, in all material respects, the expenditure and income presented in the financial statements have been applied to the purposes intended by the Assembly and whether the financial transactions conform to the authorities which govern them.

A representative from the Northern Ireland Audit Office is invited to all Audit and Risk Assurance Committee meetings.

## **7. Review of the Effectiveness of the System of Internal Governance**

The system of internal governance is designed to manage risk to a reasonable level, rather than to eliminate all risk of failure to achieve certain policies, aims and objectives; it can therefore only provide reasonable and not absolute assurance of effectiveness. The system of internal governance is based on an ongoing process designed to identify and prioritise risks to the achievement of the AOP policies, aims and objectives; to assess the likelihood of the events occurring and the impact should they be realised; and to manage the risks effectively, efficiently and economically. The system of internal governance has been in place in AOP for the year ended 31 March 2023 and up to the date of approval of the annual accounts, and accords with Department of Finance guidance.

As previously detailed in Section 2, the responsibilities of the Accounting Officer include the need to maintain a sound system of internal control which supports the achievement of the organisation's policies, aims and objectives. The review of the effectiveness of the system of internal governance has been informed by the assurances provided by relevant parties such as: Internal Audit and the Senior Management Team. Where weaknesses have been identified these have been promptly drawn, through normal reporting mechanisms, to the attention of the Audit and Risk Assurance Committee, Management Committee and/or Board of Governors, as appropriate.

The main procedures in place to monitor the effectiveness of the system of internal governance are as follows:

- ongoing independent assessment of the Observatory's research outputs;
- regular reports by financial staff on progress against principal financial targets and the projected financial outcome for the year and progress reports by staff responsible for major projects;
- detailed progress reports to the Management Committee and Board of Governors at their regular meetings and inclusion of performance measures and results against targets in the annual operating plan;
- annual reports on the system of internal control from internal auditors to the Audit and Risk Assurance Committee;
- regular Accountability meetings with officials from the Sponsor Department to consider operational and strategic issues and matters relating to the system of internal control;
- Bi-Annual Assurance Statements submitted to the Sponsor Department;
- periodic review of the AOP Risk Register by the Audit and Risk Assurance Committee, the Management Committee, the Accounting Officer and Senior Management Team and the Sponsor Department;
- continuous assessment of the quality of research through peer review of grant applications, applications for telescope time, and the submission of scientific papers to academic journals of international standing by Armagh Observatory staff;
- peer review of the research quality, capability and output of the Observatory, and through participation in an objective external Assurance Committee, which provide an opinion on the adequacy and effectiveness of the system and contain recommendations for improvement; and
- annual reports from Northern Ireland Audit Office to the Audit and Risk Assurance Committee, the Management Committee and the Board of Governors on the annual accounts, providing an opinion on the state of affairs of the organisation and its total incoming resources and expenditure of resources.

All reports based on the internal and external audits include opinions on the adequacy and effectiveness of risk management and the control framework in place. These matters are considered by the Audit and Risk Assurance Committee and are reported by the Audit and Risk Assurance Committee Chair to the Management Committee and the Board of Governors.

Weaknesses identified in AOP's control systems and internal governances are set out within the next section. Upon identification, plans were immediately put into place to addresses these issues.

## 8. Internal Governance Divergences

There is currently one outstanding internal audit recommendation from prior years, which has been partially implemented:

Recommendation	Priority	Status
GDPR – the draft Records Management Policy and Retention and Disposal Schedules should be finalised as soon as possible.	Medium	Draft policy and schedules with PRONI for consideration. Completion pending confirmation by PRONI.

During its audit for 2022-23, NIAO identified three priority 1 issues to be addressed by management in their areas of responsibility, with recommendations as follows:

- (i) Recommended that AOP seek to put in place an appropriate contract arrangement to cover the cloud services being provided by Microsoft Azure beyond the 2023-24 year close.

Management Response:

AOP are named on the NICS collaborative agreement ID 3095831 Collaborative Call Off Contract for Microsoft Licensing Solutions Partner (LSP). With the assistance of the contractor, AOP is actively progressing the transfer of Microsoft Azure services to the Collaborative Contract, with an expected completion no later than 31 October 2023. No material cost savings are anticipated through use of the Collaborative Contract.

- (ii) Recommended AOP seek to put measures in place to ensure that appropriate checks on expenditure and purchase orders are carried out to ascertain whether or not a contract is in place for the services required, so that appropriate approval can be sought either through the normal procurement process or a Direct Award Contract (if required) before any expenditure is incurred.

Management Response:

With immediate effect, AOP will intensify its financial procedures relating to procurement of goods and services valued in the range of £5,000-£30,000 to ensure that Financial Policies are complied with. Additional training will be provided for staff.

- (iii) Recommended that AOP only drawdown funds as they are needed and seek departmental approval if this is not going to be the case.

Management Response:

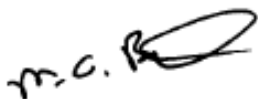
When dome shows are purchased at year end, it is inevitable that they will not be used until the new financial year. In this instance, an opportunity was taken to delay the first showing in order to extend the end date of the license. AOP will ensure such extension does not occur in future if it will breach drawdown rules.

## 9. Conclusion

Armagh Observatory and Planetarium has an effective governance structure and is operating to a high standard of integrity and probity.

In signing this report, I have taken assurances, where available, from the Audit and Risk Assurance Committee and I will continue to monitor the Internal Audit and Northern Ireland Audit Office recommendations to ensure that all issues are appropriately addressed.

To the best of my knowledge this report provides a fair and accurate reflection of the business of AOP and of the status of the controls and checks that have been put in place to regulate and inform the organisation's committees.



Signed:

Date: 2 October 2023

**Professor Michael Burton**  
Accounting Officer  
Armagh Observatory and Planetarium

## Refereed Journal Publications: April 2022– March 2023

Aharonian F., et al., inc. **Burton M. G., Çubuk K.**, 2022, A deep spectromorphological study of the  $\gamma$ -ray emission surrounding the young massive stellar cluster Westerlund 1, *Astronomy & Astrophysics*, 666, A124, doi:10.1051/0004-6361/202244323, <https://ui.adsabs.harvard.edu/abs/2022AA...666A.124A>

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**Vink J. S.**, 2022, Theory and Diagnostics of Hot Star Mass Loss, *Annual Reviews of Astronomy & Astrophysics*, 60, 203, doi:10.1146/annurev-astro-052920-094949, <https://ui.adsabs.harvard.edu/abs/2022ARAA..60..203V>

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<https://ui.adsabs.harvard.edu/abs/2022MNRAS.516.4245W>

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<https://ui.adsabs.harvard.edu/abs/2022ApSS.367..117U>

## Non-Refereed Journal Publications: April 2022 – March 2023

Bagnulo S., et al., inc. **Borisov G., Christou A.**, 2022, in European Planetary Science Congress. Unusual polarimetric properties for interstellar comet 2I/Borisov. pp EPSC2022–1111, doi:10.5194/epsc2022-1111

**Burton M.**, 2023, Where past meets future, *Astronomy and Geophysics*, 64, 1.25, doi:10.1093/astrogeo/atac094, <https://ui.adsabs.harvard.edu/abs/2023AG....64.1.25B>

**Burton, M.**, 2023, Colour in Astronomy and the Infrared Revolution, *Planetarian*, 52, p18

**Christou A.**, Georgakarakos N., 2022, in European Planetary Science Congress. High-inclination NEAs as meteor stream parent bodies. pp EPSC2022–708, doi:10.5194/epsc2022-708

Dermott S., Li D., **Christou A.**, 2022, in AAS/Division of Dynamical Astronomy Meeting. A new method of searching for ghost families in the asteroid belt. p. 401.01

Dorsch M., Heber U., **Jeffery C. S., Scott L.**, 2022, From atomic physics to stellar evolution: decoding the heavy-metal subdwarfs with HST, HST Proposal. Cycle 30, ID. #17072

Dyer M. J., et al., inc. **Ramsay G.**, 2022, in Marshall H. K., Spyromilio J., Usuda T., eds, *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series Vol. 12182, Ground-based and Airborne Telescopes IX. The Gravitational-wave Optical Transient Observer (GOTO)*. p. 121821Y (arXiv:2208.14901), doi:10.1117/12.2629369

Geballe T., **Burton M.**, Roueff E., Abgrall H., 2023, in American Astronomical Society Meeting Abstracts. Infrared Line Emission in the Herbig-Haro 7 Bowshock from 5,000 K Molecular Hydrogen in Quasi-bound States. p. 213.01

Gomez Martin J. C., Martikainen J., **Gray Z.**, Peiteado M., Jardiel T., Muñoz O., 2022, in European Planetary Science Congress. Experimental scattering matrices of Martian dust analogues for radiative modelling and remote sensing applications.. pp EPSC2022–66, doi:10.5194/epsc2022-66

**Gray Z.**, et al., 2022, in European Planetary Science Congress. The Return of Rosetta's Comet: Photometric and Polarimetric Observations of Comet 67P/Churyumov-Gerasimenko in its 2021-22 Apparition.. pp EPSC2022–1094, doi:10.5194/epsc2022-1094

Heras A. M., et al., inc. **Ramsay G.**, 2022, in *Bulletin of the American Astronomical Society*. ESA's PLATO mission: Development status and upcoming milestones. p. 504.01

Lu A., et al., inc. **Sarzi M.**, 2022, in American Astronomical Society Meeting #240. Star Formation Efficiency in the Bulge of the AGN-host Galaxy NGC 3169 with SHELLE and ALMA. p. 228.03

**McMahon M.**, 2023, in *The Journal of the Herschel Society Vol 22, No. 1, 'Herschel Family Papers held at Armagh Observatory and Planetarium'*

Rauer H., et al., inc. **Ramsay G.**, 2022, in European Planetary Science Congress. The PLATO Mission. pp EPSC2022–453, doi:10.5194/epsc2022-453

Rebolledo D., Green A. J., **Burton M.**, Garay G., 2023, in *Physics and Chemistry of Star Formation: The Dynamical ISM Across Time and Spatial Scales. Proceedings of the 7th Chile-Cologne-Bonn Symposium. Multi-phase view of the ISM in the Carina Nebula*. p. 66

**Sarzi M.**, Iodice E., Fornax3D Collaboration 2022, The Fornax3D Survey — A Magnitude-Limited Study of Galaxies in the Fornax Cluster with MUSE, *The Messenger*, 189, 9, doi:10.18727/0722-6691/5284, <https://ui.adsabs.harvard.edu/abs/2022Msngr.189....9S>

Singer N., Reed M., **Jeffery S.**, 2023, in American Astronomical Society Meeting Abstracts. Masses and Radii of Subdwarf B Stars from Gaia Parallaxes and Spectral Energy Distribution Fitting. p. 401.09

## **Books and Other Publications Not Listed Above: April 2022 – March 2023**

Produced by AOP, 2022, Armagh Observatory and Planetarium Souvenir Guidebook, p. 1–29

## Presentations: April 2022 – March 2023

Date	AOP Speaker	Title	Location/Mode	Category
05 Apr 2022	S. Bagnulo	Introduction to Polarimetry	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
06 Apr 2022	D. Eden	What Causes Stars to Form?	Seminar, Astrophysics Research Institute, Liverpool John Moores University, Liverpool	Research
07 Apr 2022	M. Sarzi	How to Get Observing Time on the Largest Ground and Space Telescopes in the World	Astrobytes, AOP	Internal Outreach
12 Apr 2022	G. Ramsay	Super-flares on the Sun and Solar Type Stars	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
24 Apr 2022	J. Rigney	Low Mass Stars at Radio Wavelengths	Dunsink Observatory, Dublin Institute for Advanced Studies, Dublin	Outreach
22 Apr 2022	A. Christou	The Three Body Problem in Action: A Guided Tour of the Coorbital Zoo	Seminar, Grupo de Dynamical Orbital e Planetologia (GDOP) - Faculdade de Engenharia de Guaratinguetá, UNESP, Sao Paolo, Brazil (online)	Research
25 Apr 2022	E. Higgins	Constraining Physical Processes in Pre-Supernova Massive Star Evolution	Lorentz Workshop: 'Bridging Stellar Evolution and Feedback Together', Lorentz Center, Leiden, The Netherlands	Research
27 Apr 2022	D. Eden	SKA: Current Status and Pathfinder Science	Astrobytes, AOP	Internal Outreach
28 Apr 2022	H. Dalglish	The Nature of the Night	The Nature of the Night Event, AOP	Outreach
28 Apr 2022	C.S. Jeffery	Guts, Bangs, Branes, Strings and Multiverse	Astrobytes, AOP	Internal Outreach
28 Apr 2022	A. Sander	The Dependencies of Wolf-Rayet-Type Mass-Loss and the Consequences for their Ionizing Feedback	Workshop, Bringing Stellar Evolution and Feedback Together, Lorentz Center, Leiden, The Netherlands	Research
05 May 2022	M. Burton	Our Place in the Cosmos 2/27	Astrobytes, AOP	Internal Outreach
10 May 2022	G. Sabhahit	The Metallicity (in) Dependence of the Humphreys-Davidson Limit	International Astronomical Union Symposium 361, Ballyconnell, Co Cavan, Ireland	Research
11 May 2022	G. Ramsay	What Does An Astronomer Do	Astrobytes, AOP	Internal Outreach
11 May 2022	M. McMahon	The Grounds of Armagh Observatory	Armagh and District History Group Meeting, AOP	Outreach
16 May 2022	C. Duffy	CV in ZTF and Other All Sky Surveys	ZTF Consortium Meeting, University of Warwick, England	Research
17 May 2022	H. Dalglish	Globular Clusters Young and Old	IOP Three Minute Wonder Competition, Royal Institution, London	Outreach
17 May 2022	C.S. Jeffery	Project Sirius: High Performance Computing @ AOP	Discussion Seminar, AOP	Research/AOP Training
19 May 2022	M. Burton	Our Place in the Cosmos 3/27	Astrobytes, AOP	Internal Outreach
19 May 2022	H. Dalglish	Dark Skies	Armagh Place Plan Launch Event, Armagh City Hotel, Armagh	Outreach

19 May 2022	J.S. Vink	Radiative Transfer and Massive Stars	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
23 May 2022	S. Bagnulo	New Insight into the Magnetism of Isolated White Dwarfs	Institute of Astrophysics of Andalusia, Spain	Research
24 May 2022	M. Burton with D. Eden	Our Galaxy – Molecular Clouds and Star Formation	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
24 May 2022	J.S. Vink	Introduction to Massive Stars	The Massive Star Research Group Discussion Meeting, AOP	Research
25 May 2022	H. Dalglish	Rewilding the Night: Dark Skies for People and Planet	Seminar, Queen's University Belfast	Research
26 May 2022	M. Burton	Our Place in the Cosmos 4/27	Astrobytes, AOP	Internal Outreach
09 Jun 2022	S. Bagnulo	A Night at the Telescopes	Astrobytes, AOP	Internal Outreach
13 Jun 2022	A. Christou	High-inclination NEAs as Meteor Stream Parent Bodies	Meteoroids 2022 Virtual Meeting	Research
13 Jun 2022	A. Humpage	Simulating the Evolution of Large, Near-Earth Meteoroid Streams and Their Properties	Meteoroids 2022 Virtual Meeting	Research
13 Jun 2022	C.S. Jeffery	The SALT Survey of Chemically-Peculiar Subdwarfs	sdOB10 - The 10th International Workshop on Hot Subdwarfs and Related Objects, University of Liege, Belgium	Research
13 Jun 2022	L. Scott	The SALT Survey of Helium-Rich Hot Subdwarfs: The Neon-Rich Binary EC20817-4939"	sdOB10 - The 10th International Workshop on Hot Subdwarfs and Related Objects, University of Liege, Belgium	Research
16 Jun 2022	M. Burton	Our Place in the Cosmos 5/27	Astrobytes, AOP	Internal Outreach
17 Jun 2022	M. Burton	"Our Place in the Cosmos" – Behind the Scenes	Seminar Programme, Department for Communities NI (via Zoom)	Outreach
17 Jun 2022	H. Dalglish	Dark Skies in Namibia: Celebrating Stars and Stories	Women in Dark Skies Web Talks, Mayo Dark Sky Park, Ballycroy, Co. Mayo, Ireland	Outreach
20 Jun 2022	M. Burton	Wisdom Begins With Wonder – A Vision for the Armagh Observatory and Planetarium	Stakeholder Event, AOP	Outreach
22 Jun 2022	E. Higgins	Very Massive Stars: Mass Loss Implementation and the Upper Initial Mass"	VFTS Meeting, Heidelberg, Germany	Research
23 Jun 2022	M. Burton	Our Place in the Cosmos 5/27	Astrobytes, AOP	Internal Outreach
28 Jun 2022	H. Dalglish	Light Pollution	House of Lords, London	Policy
28 Jun 2022	E. Wince	Black Holes Where They Shouldn't Be	Seminar, AOP	Research
29 Jun 2022	S. Bagnulo	Comet Polarimetry	Comet Interceptor, EnVisS Workshop (Online)	Research
30 Jun 2022	H. Dalglish	Dark Skies and Climate Action	Dark Skies and Climate Action Workshop, AOP	Outreach
04 Jul 2022	J. Rigney	Searching for Stellar Flares from Low Mass Stars Using ASKAP and TESS	Cool Stars 21, Toulouse, France	Research
11 Jul 2022	K. O. Çubuk	3D Molecular Cloud Distribution in the Southern Galactic Plane	National Astronomy Meeting, University of Warwick, England	Research
13 Jul 2022	C. Duffy	The New Robotic Telescope and Accreting Binaries	National Astronomy Meeting, University of Warwick, England	Research
13 Jul 2022	M. McMahon	Observatory Networking - Professional and Personal Relationships Over Four Centuries	Discovering Collections Discovering Communities (DCDC22) History Day Conference (online)	Outreach

14 Jul 2022	M. Sarzi	Fornax 3D: A Survey of Fornax with MUSE	VEGAS Collaboration Meeting, Naples, Italy	Research
02 Aug 2022	S. Bagnulo	Two (or more) Mechanisms for the Onset of Magnetism in White Dwarfs	Discussion Seminar, AOP	Research/AOP Training
02 Aug 2022	J.S. Vink	X-Shooting ULLYSES	Focus Meeting 4, IAU General Assembly, Busan, Korea (virtual)	Research
04 Aug 2022	M. Burton	Public Demonstration of Astronomy with a Data Visualisation Laboratory	AOP	Outreach
04 Aug 2022	J.G. Doyle	Simultaneous TESS and ASKAP Observations of Low Mass Stars	Solar-Stellar Connections, Flares, and Superflares, International Workshop, hosted by VIRAC, Latvia (online)	Research
04 Aug 2022	G. Ramsay	Super-Flares from Solar-Type and Low Mass Stars	Solar-Stellar Connections, Flares, and Superflares, International Workshop, hosted by VIRAC, Latvia (online)	Research
08 Aug 2022	M. Burton	Ireland's Historic Observatories: Their Intersection with Science, Culture and Politics	Division C (Education, Outreach & Heritage) meeting – via Zoom, IAU General Assembly, Busan, Korea	Research
10 Aug 2022	A. Sander	The Driving of Hot Star Winds	IAU Symposium 370 - Winds of stars and exoplanets, IAU General Assembly, Busan, Korea	Research
10 Aug 2022	J.S. Vink	Theory and Diagnostics of Hot Star Mass Loss	IAU Symposium 370, IAU General Assembly, Busan, Korea (virtual)	Research
11 Aug 2022	M. Burton	Public Demonstration of Astronomy with a Data Visualisation Laboratory	AOP	Outreach
15 Aug 2022	S. Bagnulo	A Volume Limited Spectropolarimetric Survey of White Dwarfs	22nd European Workshop on White Dwarfs, Universität Tübingen, Germany	Research
15 Aug 2022	C.S. Jeffery	Hot White Dwarfs from the SALT Survey of Helium-Rich Hot Subdwarfs	22nd European Workshop on White Dwarfs, Universität Tübingen, Germany	Research
6 Aug 2022	J. Landstreet	Rotation Periods and Surface Magnetic Field Structures of Young Weak-Field Magnetic White Dwarfs	22nd European Workshop on White Dwarfs, Universität Tübingen, Germany	Research
16 Aug 2022	J.S. Vink	Stellar Winds (Invited Review)	Stars 2020, Institute of Astronomy, University of Cambridge, England	Research
18 Aug 2022	M. Burton	Public Demonstration of Astronomy with a Data Visualisation Laboratory	AOP	Outreach
19 Aug 2022	M. Burton	The Music and Astronomy of William Herschel – Celebrating 200 Years	AOP	Outreach
23 Aug 2022	M. Burton	Public Demonstration of Astronomy with a Data Visualisation Laboratory	AOP	Outreach
25 Aug 2022	A. Humpage	Dispersion Rates of Resonant and Non-Resonant Near-Earth Families	CELTA ASI Summer School, University of Highlands & Islands (UHI), Sabhal Mòr Ostaig, Skye and UHI Inverness, Scotland	Research
30 Aug 2022	C. Duffy	Diverse Outbursting Behaviour in AM CVn System	AM CVn 4.5 (online)	Research

01 Sep 2022	D. Eden	MAJORS: Massive, Active, JCMT-Observed Regions of Star Formation	Irish National Astronomy Meeting, Dunsink Observatory, Dublin	Research
01 Sep 2022	M. Sarzi with C. Clarke	Detecting Planetary Nebulae with Adaptive Optics	Irish National Astronomy Meeting, Dunsink Observatory, Dublin	Research
02 Sep 2022	J. Rigney	Searching for Stellar Flares from Low Mass Stars Using ASKAP and TESS	Irish National Astronomy Meeting, Dunsink Observatory, Dublin	Research
02 Sep 2022	E. Wince	Black Holes Where They Shouldn't Be	Irish National Astronomy Meeting, Dunsink Observatory, Dublin	Research
09 Sep 2022	H. Alexander	Interpretation of Armagh Observatory and Planetarium History in the Planetarium Display Space	Contemporary Observatory Networks, Observatory Networks Conference, AOP	Research
09 Sep 2022	A. Black	Considering the Historic Architecture of the Observatory	Contemporary Observatory Networks, Observatory Networks Conference, AOP	Research
09 Sep 2022	M. Burton	Introduction to Armagh Observatory and Planetarium	Contemporary Observatory Networks, Observatory Networks Conference, AOP	Research
09 Sep 2022	M. McMahon	Oral History at Armagh Observatory and Planetarium	Contemporary Observatory Networks, Observatory Networks Conference, AOP	Research
09 Sep 2022	R. Nežič	Blending History and Science for the Public	Contemporary Observatory Networks, Observatory Networks Conference, AOP	Research
11 Sep 2022	A. Christou	Extra-Terrestrial Occultations: The Beagle 2 Experiment	41st European Symposium on Occultation Projects, Granada, Spain (virtual)	Research
11 Sep 2022	A. Christou	A Proposal to Hold ESOP XLII in the City of Armagh, Northern Ireland, on 15-19 September 2023	41st European Symposium on Occultation Projects, Granada, Spain (virtual)	Research
23 Sep 2022	A. Christou	High-Inclination NEAs as Meteor Stream Parent Bodies	Europlanet Science Congress 2022, Granada, Spain	Research
23 Sep 2022	Z. Gray	The Return of Rosetta's Comet: Photometric and Polarimetric Observations of Comet 67P/CG in its 2021-22 Apparition	Europlanet Science Congress 2022, Granada, Spain	Research
23 Sep 2022	R. Nežič	Unusual Polarimetric Properties for Interstellar Comet 2I/Borisov	Europlanet Science Congress 2022, Granada, Spain	Research
25 Sep 2022	M. Burton	The Music and Astronomy of William Herschel (with Rod Alston)	Sligo Baroque Music Festival, The Model, Sligo, Co. Sligo, Ireland	Outreach
27 Sep 2022	J. Rigney	Low Frequency Radio Emission Associated with an Impulsive Flare and CME	Planetary, Solar, and Heliospheric Radio Emission Conference, Dublin	Research
30 Sep 2022	A. Christou	Prospects for Meteor Astronomy on Venus	Venus Science Conference, Ahmedabad, India (virtual)	Research
01 Oct 2022	Z. Gray, A. Humpage, E. Winch	Armagh-geddon	AOP	Outreach
04 Oct 2022	K.O. Çubuk	Nuffield Research Placements at Armagh Observatory and Planetarium	Nuffield Research Placement Celebration Event, The Long Gallery, Stormont, Belfast	Outreach
10 Oct 2022	M. Burton and M. McMahon	Armagh Dunsink Harvard Telescope Event	Dunsink Observatory, Dublin	Outreach
12 Oct 2022	C. Duffy	Gravitational Waves and the Gravitational Wave Optical Observer	Group Visit, AOP	Outreach
14 Oct 2022	J. Rigney	Searching for Stellar Flares from Low Mass Stars Using ASKAP and TESS	TESS Science Meeting #29	Research

18 Oct 2022	C. Duffy	VY Scl Systems	GOTO Science Meeting (online)	Research
19 Oct 2022	M. Sarzi	Planetary Nebulae and Their Role in the Cosmic Distance Ladder	Irish Astronomical Association Lecture, Queen's University Belfast	Outreach
27 Oct 2022	M. Burton	AOP Science & Education Park Redevelopment Project	Armagh, Banbridge & Craigavon Councillors and Officers Visit, AOP	Outreach Internal
27 Oct 2022	R. Nežič	Creepy Comets	Star Tracker Evening, AOP	Outreach Internal
28 Oct 2022	M.E. Bailey	The Human Orrery: Ground-Based Astronomy for All. PhD and Postdoc Training. Part 1	AOP	Teaching Internal
28 Oct 2022	M. Burton	Measuring the Heavens from Armagh	QUB Geography Field Trip, AOP	Teaching Internal
31 Oct 2022	M.E. Bailey	The Human Orrery: Ground-Based Astronomy for All. PhD and Postdoc Training. Part 2	AOP	Teaching Internal
07 Nov 2022	A. Christou	According to an Astronomer: What Apollo Taught us About the Moon	Astrobytes, AOP	Internal Outreach
07 Nov 2022	R. Nežič	Armagh Observatory: Astronomical Past, Present and Future	Sydney City Skywatchers (online)	Outreach
08 Nov 2022	S. Bagnulo, Z. Gray	Update from the VLT	Hybrid Observation Working Group Session, DART IT Meeting (online)	Research
10 Nov 2022	S. Bagnulo	Magnetism in Isolated White Dwarfs	Hybrid Solar Polarisation Workshop 10, Kyoto, Japan (online)	Research
11 Nov 2022	A. Sander	Organisation of the XShootU Collaboration	ULLYSES New Horizons Workshop, Lorentz Centre, University of Leiden, The Netherlands	Research
11 Nov 2022	J.S. Vink	Workshop Summary X-Shooting ULLYSES	ULLYSES New Horizons Workshop, Lorentz Centre, University of Leiden, The Netherlands	Research
14 Nov 2022	J. Rigney	The Sun and the (Low Mass) Stars: Searching for Stellar Flares and CMES on M Dwarfs	Seminar, STELLAR Consortium, Bulgaria Academy of Sciences (online)	Research
14 Nov 2022	M. Sarzi	Fornax 3D: A Survey of Fornax with MUSE	Seminar, Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brazil (online)	Research
15 Nov 2022	S. Bagnulo	The Origin of Magnetism in Isolated White Dwarfs: Observational Constraints	White Dwarfs from Physics to Astrophysics Conference, Kavli Institute for Theoretical Physics, UC Santa Barbara, USA	Research
16 Nov 2022	G. Ramsay	Super-Flares on the Sun and Other Stars. Multi-Messenger Astronomy and Wide-Field Optical Surveys.	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
17 Nov 2022	C.S. Jeffery	Project Sirius: High Performance Computing @ AOP	Discussion Seminar, AOP	Research/AOP Training
17 Nov 2022	R. Nežič	Telescopes: What They Are and How to Use Them	Johnston Central Library, Cavan, Co. Cavan, Ireland	Outreach
17 Nov 2022	J. Rigney	What are M dwarfs?	Open Night, Dunsink Observatory, DIAS, Dublin	Outreach
18 Nov 2022	M. Sarzi	Fornax 3D: A Survey of Fornax with MUSE	Seminar, Institute of Astronomy, University of Cambridge, England	Research
21 Nov 2022	C.S. Jeffery	According to an Astronomer: Ten Hottest Objects in the Universe	Astrobytes, AOP	AOP Training/Internal Outreach

22 Nov 2022	C.S.Jeffery	SALT White Dwarfs and Pre-White Dwarfs	Discussion Seminar, AOP	Research
24 Nov 2022	A.P. Monai	Star Families	Star Tracker Evening, AOP	Outreach
25 Nov 2022	E. Higgins	Torch Bearing Women in Astronomy	West Cork Music Festival Event, AOP	Outreach
30 Nov 2022	J.S. Vink	First Science with JWST	Irish Astronomical Association Lecture, Queen's University Belfast	Outreach
02 Dec 2022	Z. Gray	Astronomer's Guide to Polarimetric Observations	Nordic Optical Telescope & Isaac Newton Group of Telescopes Seminar Series, Santa Cruz de La Palma, Spain	Research
05 Dec 2022	K.O. Çubuk	Artemis Mission and Permanent Moon Base	Astrobytes, AOP	Internal Outreach
14 Dec 2022	J.G. Doyle	50 Telescopes and Counting	Irish Astronomical Association Lecture, Queen's University Belfast	Outreach
19 Dec 2022	M. McMahon	History of Astronomy in Ireland and Globally	Astrobytes, AOP	Internal Outreach
02 Dec 2022	Z. Gray	Astronomer's Guide to Polarimetric Observations	Nordic Optical Telescope & Isaac Newton Group of Telescopes Seminar Series, Santa Cruz de La Palma, Spain	Research
05 Dec 2022	M.E. Bailey	Education and Public Outreach at Armagh Observatory: Using Kinesthetic Learning to Bring Heaven Down to Earth in a Practical Way	Causeway U3A, Portstewart, Co. Antrim	Outreach
05 Dec 2022	K.O. Çubuk	Artemis Mission and Permanent Moon Base	Astrobytes, AOP	Internal Outreach
08 Dec 2022	L. Scott, A. Loni	Careers in Astronomy	Banbridge Academy, Banbridge, Co. Armagh	Outreach
19 Dec 2022	M. McMahon	History of Astronomy in Ireland and Globally	Astrobytes, AOP	Internal Outreach
09 Jan 2023	M. Burton	World Heritage and Astronomy	Northern Ireland Amateur Astronomy Society, Ballyclare High School, Co. Antrim	Outreach
10 Jan 2023	J.S. Vink	How Heavy is the Most Massive Star?	Heidelberg Joint Astronomical Colloquium, University of Heidelberg, Germany	Research
16 Jan 2023	C. Duffy	The Accretion Behaviour of Cataclysmic Variables Under Differing Magnetic Environments	Accretion and Magnetism Conference, Cape Town, South Africa	Research
18 Jan 2023	S. Bagnulo	Two (or more) Channels for the Onset of Magnetic Fields in White Dwarfs	Accretion and Magnetism Conference, Cape Town, South Africa (online)	Research
23 Jan 2023	S. Bagnulo	Becoming an Astronomer: For Those People Who Come In and Want to Have an Idea of What it Takes to Become a Full-Time Astronomer	Astrobytes, AOP	Outreach Internal
26 Jan 2023	C. Duffy	Big Telescopes of the World	Star Tracker Evening, AOP	Outreach
28 Jan 2023	J. Rigney	Radio Astronomy in Ireland	Astrofest 2023, Galway Astronomy Club, Menlo Park Hotel, Galway, Ireland	Outreach
02 Feb 2023	M. Burton	Measuring the Heavens – A Short History of Armagh Observatory	Isle of Man Astronomy Society, The Observatory, Foxdale, Isle of Man (via Zoom)	Outreach
03 Feb 2023	M. Burton	Ireland and the Herschels – Some Surprising Connections.	Herschel Society, Bath, England (Hybrid via Zoom)	Outreach
06 Feb 2023	M. Burton	Understanding the Stars and Where They Are in Our Sky and in the Galaxy	Astrobytes, DVL, AOP	Internal Outreach

09 Feb 2023	M. Burton	Ultra-hot Molecular Hydrogen in the Interstellar Medium ("emission from quasi-bound molecular hydrogen")	Seminar, AOP	Research
13 Feb 2023	J.S. Vink	Hot Star Winds	Munich Institute for Astro- and Particle Physics, Munich, Germany	Research
14 Feb 2023	M. Burton	Our Galaxy: Gas, Dust and Surveys	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
20 Feb 2023	S. Schlagenhauf	Exoplanets in the Habitability Zones of Stars: Finding Them and Learning Anything	Astrobytes, AOP	Internal Outreach
23 Feb 2023	C.S. Jeffery	Eight Super-Hot White Dwarfs	Seminar, AOP	Research
25 Feb 2023	M. McMahon, A. Marshall Lee, S. Schlagenhauf	Cosmic Conservation	AOP	Outreach
27 Feb 2023	M. McMahon	The Troughton Equatorial Telescope Network	Centre for Fusion, Space and Astrophysics, University of Warwick, England (online)	Outreach
27 Feb 2023	H. Alexander	A Brief Overview of the History of Armagh Observatory and Planetarium	Portadown Rotary Club, Seagoe Hotel, Portadown, Co. Armagh	Outreach
01 Mar 2023	S. Bagnulo	Introduction to Night Time Polarimetry	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
06 Mar 2023	D. Eden	Star Formation in the Milky Way...and Beyond	Northern Ireland Amateur Astronomy Society, Ballyclare High School, Co. Antrim	Outreach
07 Mar 2023	D. Eden	High-Mass Star Formation	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
15 Mar 2023	J. Rigney	Diving Deeper into the Radio Sky	Irish Astronomical Association Lecture, Queen's University Belfast	Outreach
21 Mar 2023	A.P. Monai	Population Studies of Exotic Hot Subdwarfs	Discussion Seminar, AOP	Research
22 Feb 2023	J.S. Vink	Radiative Transfer and the Most Massive Stars	QUB/AOP PGR Lecture Series, Queen's University Belfast	Research
23 Mar 2023	J. Rigney	Life Around Other Stars	Open Night, Dunsink Observatory, Dublin Institute for Advanced Studies, Dublin	Outreach
24 Mar 2023	Z. Gray	A Day in the Life of an Astronomer (video presentation)	Staring into Space - PhD Afternoon, AOP	Outreach
24 Mar 2023	A. Marshall Lee, A.P. Monai, S. Schlagenhauf, A. Humpage, Ethin Wince, Z. Gray	Staring into Space - PhD Afternoon	Staring into Space - PhD Afternoon, AOP	Outreach
27 Mar 2023	J. Rigney	Diving Deeper Into the Radio Sky	University College Dublin, Dublin	Outreach
29 Mar 2023	C.S. Jeffery	SALT and the Super-Hot Zombie Stars	Irish Astronomical Association Lecture, Queen's University Belfast	Outreach

## Education and Outreach: April 2022 – March 2023

Date	Event Description
Apr 2022 – Mar 2023	The Legendary Telescope Tours at Armagh Observatory
20 Apr 2022	Wee Critters – Interactive Animal Experience
28 Apr 2022	The Nature of the Night – See The Astropark Like Never Before
11 May 2022	IAU Conference 361: Massive Stars Near and Far, Slieve Russell Hotel, Ballyconnell, Co Cavan. Live Interactive Sessions in the Inflatable Star Dome
8 Jun 2022	Astropark Infinity Walks to Celebrate the launch of Disney and Pixar's Lightyear Movie
11 Jun to 31 Jul 2022	Brickosaurs Experience
30 Jun 2022	Dark Skies and Climate Action Workshop
1 Jul 2022	Story Time with Armagh City Library
7, 14, 21, 28 and 2, 20 Aug 2022	Jurassic Ark Encounters NI Workshop
4, 11, and 18 Aug 2022	Drop In Data Visualisation Laboratory Demonstrations
19 August 2022	Music and Astronomy of William Herschel, Celebrate 200 Years of William Herschel, Live Performance by the Sligo Baroque Orchestra
10 – 11 Sep 2022	European Heritage Open Days – Astropark Tours
Sep 2022 – Jan 2023	Temporary Exhibition "Like Gold to Airy Thinness Beat", Art on the International Space Station with The Moon Gallery
1 Oct 2022	Armagh-Geddon PhD Day
5 – 7 Oct 2022	Space Week, Space and Sustainability, Special Screening of Our Place in the Cosmos
20 Oct 2022	Bat Walk Around the Astropark with Northern Ireland Bat Group
27 Oct 2022	Spooky Star Tracker, An Evening of Stargazing and Planet Spotting with Our Experts
29/30 Oct 2022	Potions & Explosions Live Science Show with Scientific Sue
29/30 Oct 2022	Tall Tales and Terror at Armagh Observatory
31 Oct – 4 Nov 2022	Drop In Data Visualisation Laboratory Demonstrations
16 Nov 2022	Artemis I Mission Launch
16 Nov 2022	Cavan Monaghan Science Festival Event: The Night Sky Through The Telescope, Johnston Central Library Cavan
19 Nov – 23 Dec 2022	Mission Santa, An Immersive Christmas Experience
24 Nov 2022	Star Tracker, An Evening of Stargazing and Planet Spotting with Our Experts
25 Nov 2022	Thus She Shall Go To The Stars ... A Live Musical Performance in the Dome, Jessie Kennedy with The Celestial Strings. In association with The West Cork History Festival
26 Nov 2022	Armagh Georgian Day, Observatory Tour with Dr Rok Nežič
13 and 15 Dec 2022	Royal Institution Christmas Lecture Series. Live Stream. Professor Dame Sue Black will reveal the secrets of forensic science
14 Dec 2022	Star Tracker, An Evening of Stargazing and Planet Spotting with Our Experts. Apollo 17 Anniversary Special
26 Jan 2023	Star Tracker, An Evening of Stargazing and Planet Spotting with Our Experts
16 Feb 2023	NI Science Festival 2023 Event: Shoot for the Stars, Astronomy Careers
18 – 19 Feb 2023	NI Science Festival 2023 Event: Bricks 4 Kidz Workshop
17 Feb 2023	NI Science Festival 2023 Event: Astropark Walking Tours
22 Feb 2023	NI Science Festival 2023 Event: Climate Tour in collaboration with the Northern Ireland Museums.
23 Feb 2023	NI Science Festival 2023 Event: Star Tracker Special – From Mercury with Love
24 Feb 2023	NI Science Festival 2023 Event: Little Astronomers
25 Feb 2023	NI Science Festival 2023 Event: Cosmic Conservation, Astronomy and Antiques
08 Mar 2023	Irish Week Event: CapCom Go As Gaeilge.

21 Mar 2023	Irish Astronomy Week Event: Introduction to Astrophotography with Paul Evans
22 Mar 2023	Irish Astronomy Week Event: Observatory Library Open Afternoon
23 Mar 2023	Irish Astronomy Week Event: Star Tracker, An Evening of Stargazing and Planet Spotting with Our Experts
24 Mar 2023	Irish Astronomy Week Event: Look Up Dome Show
24 Mar 2023	Irish Astronomy Week Event: Staring into Space, PhD Day at Armagh Observatory and Planetarium

## Intergalactic Craic Podcasts: April 2022 – March 2023

Date	Podcast Title
23 Jan 2023	S3 – What's the craic?
27 Jan 2023	S3Ep1 – Wee Bitta Craic: Welcome Ethan, Alice and Zuri!
10 Mar 2023	S3Ep2 – Wee Bitta Craic: Bout Ye Zuri?

Presenters: H Alexander, E Winch, A Humpage and Z Gray  
All published via [anchor.fm/intergalacticraic](https://anchor.fm/intergalacticraic)

## THE ARMAGH OBSERVATORY AND PLANETARIUM

### THE CERTIFICATE AND REPORT OF THE COMPTROLLER AND AUDITOR GENERAL TO THE NORTHERN IRELAND ASSEMBLY

#### Opinion on financial statements

I certify that I have audited the financial statements of the Armagh Observatory and Planetarium for the year ended 31 March 2023 under the Armagh Observatory Planetarium (Northern Ireland) Order 1995. The financial statements comprise: the Statement of Financial Activities, the Balance Sheet, the Cash Flow Statement; and the related notes including significant accounting policies. The financial reporting framework that has been applied in their preparation is applicable law and United Kingdom accounting standards including Financial Reporting Standard (FRS) 102, the Financial Reporting Standard applicable in the UK and Republic of Ireland (United Kingdom Generally Accepted Accounting Practice).

I have also audited the information in the Trustees' Annual Report that is described in that report as having been audited.

In my opinion the financial statements:

- give a true and fair view of the state of Armagh Observatory and Planetarium's affairs as at 31 March 2023 and of its total incoming resources and expenditure of resources for the year then ended;
- have been properly prepared in accordance with the Financial Reporting Standard applicable in the UK and Republic of Ireland (FRS 102); and
- have been properly prepared in accordance with the Armagh Observatory Planetarium (Northern Ireland) Order 1995 and Department for Communities directions issued thereunder.

#### Opinion on regularity

In my opinion, in all material respects the expenditure and income recorded in the financial statements have been applied to the purposes intended by the Assembly and the financial transactions recorded in the financial statements conform to the authorities which govern them.

#### Basis for opinion

I conducted my audit in accordance with International Standards on Auditing (ISAs) (UK), applicable law and Practice Note 10 'Audit of Financial Statements and Regularity of Public Sector Bodies in the United Kingdom'. My responsibilities under those standards are further described in the Auditor's responsibilities for the audit of the financial statements section of this certificate.

My staff and I are independent of Armagh Observatory Planetarium in accordance with the ethical requirements that are relevant to my audit of the financial statements in the UK, including the Financial Reporting Council's Ethical Standard, and have fulfilled our other ethical responsibilities in accordance with these requirements.

I believe that the audit evidence obtained is sufficient and appropriate to provide a basis for my opinions.

## **Conclusions relating to going concern**

In auditing the financial statements, I have concluded that Armagh Observatory Planetarium's use of the going concern basis of accounting in the preparation of the financial statements is appropriate.

Based on the work I have performed, I have not identified any material uncertainties relating to events or conditions that, individually or collectively, may cast significant doubt on the Armagh Observatory Planetarium's ability to continue as a going concern for a period of at least twelve months from when the financial statements are authorised for issue.

The going concern basis of accounting for Armagh Observatory Planetarium is adopted in consideration of the requirements set out in the Government Financial Reporting Manual, which require entities to adopt the going concern basis of accounting in the preparation of the financial statements where it anticipated that the services which they provide will continue into the future.

My responsibilities and the responsibilities of the Trustees and the Accounting Officer with respect to going concern are described in the relevant sections of this report.

## **Other Information**

The other information comprises the information included in the Trustees' annual report other than the financial statements, the parts of the Trustees' described in that report as having been audited, and my audit certificate and report. The Trustees and the Accounting Officer are responsible for the other information included in the annual report. My opinion on the financial statements does not cover the other information and except to the extent otherwise explicitly stated in my report, I do not express any form of assurance conclusion thereon.

My responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements, or my knowledge obtained in the audit or otherwise appears to be materially misstated. If I identify such material inconsistencies or apparent material misstatements, I am required to determine whether this gives rise to a material misstatement in the financial statements themselves. If, based on the work I have performed, I conclude that there is a material misstatement of this other information, I am required to report that fact.

I have nothing to report in this regard.

## **Opinion on other matters**

In my opinion based on the work undertaken in the course of the audit:

- the parts of the Trustees' to be audited have been properly prepared in accordance with Department for Communities directions made under the Armagh Observatory Planetarium (Northern Ireland) Order 1995; and
- the information given in the Trustees' Annual Report the financial year for which the financial statements are prepared is consistent with the financial statements.

## **Matters on which I report by exception**

In the light of the knowledge and understanding of the Armagh Observatory Planetarium and its environment obtained in the course of the audit, I have not identified material misstatements in the Trustees' Annual Report.

I have nothing to report in respect of the following matters which I report to you if, in my opinion:

- adequate accounting records have not been kept; or
- the financial statements and the parts of the Trustees Report to be audited are not in agreement with the accounting records; or
- certain disclosures of remuneration specified by the Government Financial Report Manual are not made; or
- I have not received all of the information and explanations I require for my audit; or
- the Governance Statement does not reflect compliance with the Department of Finance's guidance.

### **Responsibilities of the Board of Governors and Accounting Officer for the financial statements**

As explained more fully in the Statement of the Responsibilities of the Governors and Accounting Officer the Governors and the Accounting Officer are responsible for:

- the preparation of the financial statements and for being satisfied that they give a true and fair view;
- such internal controls as the Trustees Accounting Officer determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error;
- ensuring the Trustees' Annual Report, which includes the Remuneration and Staff Report, is prepared in accordance with the Government Financial Reporting Manual;
- assessing the Armagh Observatory Planetarium's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Trustees and Accounting Officer anticipates that the services provided by Armagh Observatory Planetarium's will not continue to be provided in the future.

### **Auditor's responsibilities for the audit of the financial statements**

My responsibility is to examine, certify and report on the financial statements in accordance with the Armagh Observatory Planetarium (Northern Ireland) Order 1995.

My objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error and to issue a certificate that includes my opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with ISAs (UK) will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

I design procedures in line with my responsibilities, outlined above, to detect material misstatements in respect of non-compliance with laws and regulation, including fraud.

## My procedures included:

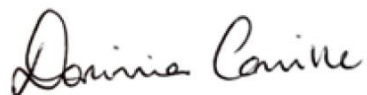
- obtaining an understanding of the legal and regulatory framework applicable to the Armagh Observatory Planetarium through discussion with management and application of extensive public sector accountability knowledge. The key laws and regulations I considered included Armagh Observatory Planetarium (Northern Ireland) Order 1995.
- making enquires of management and those charged with governance on Armagh Observatory Planetarium's compliance with laws and regulations;
- making enquiries of internal audit, management and those charged with governance as to susceptibility to irregularity and fraud, their assessment of the risk of material misstatement due to fraud and irregularity, and their knowledge of actual, suspected, and alleged fraud and irregularity;
- completing risk assessment procedures to assess the susceptibility of Armagh Observatory Planetarium's financial statements to material misstatement, including how fraud might occur. This included, but was not limited to, an engagement director led engagement team discussion on fraud to identify particular areas, transaction streams and business practices that may be susceptible to material misstatement due to fraud. As part of this discussion, I identified potential for fraud in the following areas: revenue recognition, expenditure recognition, and posting of unusual journals;
- engagement director oversight to ensure the engagement team collectively had the appropriate competence, capabilities, and skills to identify or recognise non-compliance with the applicable legal and regulatory framework throughout the audit;
- documenting and evaluating the design and implementation of internal controls in place to mitigate risk of material misstatement due to fraud and non-compliance with laws and regulations;
- designing audit procedures to address specific laws and regulations which the engagement team considered to have a direct material effect on the financial statements in terms of misstatement and irregularity, including fraud. These audit procedures included, but were not limited to, reading board and committee minutes, and agreeing financial statement disclosures to underlying supporting documentation and approvals as appropriate; and
- addressing the risk of fraud as a result of management override of controls by:
  - performing analytical procedures to identify unusual or unexpected relationships or movements;
  - testing journal entries to identify potential anomalies, and inappropriate or unauthorised adjustments;
  - assessing whether judgements and other assumptions made in determining accounting estimates were indicative of potential bias; and
  - investigating significant or unusual transactions made outside of the normal course of business.

A further description of my responsibilities for the audit of the financial statements is located on the Financial Reporting Council's website [www.frc.org.uk/auditorsresponsibilities](http://www.frc.org.uk/auditorsresponsibilities). This description forms part of my certificate.

In addition, I am required to obtain evidence sufficient to give reasonable assurance that the expenditure and income recorded in the financial statements have been applied to the purposes intended by the Assembly and the financial transactions recorded in the financial statements conform to the authorities which govern them.

## **Report**

I have no observations to make on these financial statements.



Dorinnia Carville  
Comptroller and Auditor General  
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11 October 2023