ASTRONOMY AND ARTIFICIAL INTELLIGENCE
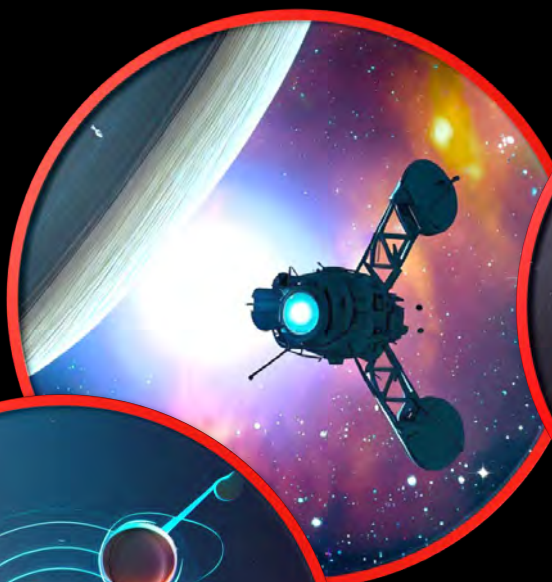
THE STORY OF
OUR SUMMER SCHOOL

YOUR GUIDES

Professor Berry Billingsley
Dr Nqobile Nkala
Mina Cullimore

Canterbury
Christ Church
University

DAY 1

Using AI in your research, data visualisation and Archeoastronomy

DAY 2

Visit school observatory, Engineering and Astronomy, Chatbots and a Lightening Tour of AI

DAY 3

Current and future uses of AI including keynote on data visualisation

DAY 4

Applications of AI, Communicating science through outreach and public engagement

AIMS

Participants of this year's summer school came from multiple universities and brought different levels of experience with AI and were at different points in their PhD studies. Our four-day programme aimed to provide each of them with a launch pad to using AI more creatively and more expertly than they currently are. That meant helping some students to find AI solutions for the problems they are tackling now and it also meant offering all participants an insight into the future of AI.

DAY 3 GROUP PROJECT:

ALGORITHMS IN SPACE

Here's the scene.

You are a space telescope and you are millions of miles from Earth – journeying through space and moving ever further from the home planet. Your task? Well of course it's to solve the big puzzles of life, the universe and everything. Are we alone? Is there meaning in the universe beyond our own planet? Do the laws of nature that we experience here – extend across the universe? … We have similar questions we ask in biology – where increasingly remote subs hunt the ocean floors. In other words, science is now turning to autonomous and semi-autonomous AI to roam the ocean depths and travel through space … on our behalf to ask Big Questions about life, the universe and everything. In other words, the scope to extend the conclusions we drew beyond our immediate focus of 'astronomy and AI' begins by noticing how many other situations exist, where we will be sending autonomous or semi-autonomous AI.

These ideas were presented to a cohort of PhD astronomy students and experts in a range of disciplines from oceanography, artificial intelligence, astronomy … and even the culinary arts (!!) to 'think' about the future of astronomy … now that we have AI.

Is there something uniquely human about how we engage with our experiences of perceiving these images of the stars? How can we say – with any certainty – what curiosity might look like when working with AI, and what questions we will ask and investigate?

Is there something uniquely human about the way we engage with these images?

WELCOME

Thank you for joining us at the Astronomy and AI Summer School. We are delighted to have you. Here is all the information that you need for the event.

KEY CONTACTS

Contact person 1
Nqobile Nkala
nqobile.nkala@canterbury.ac.uk
Mobile: 07718971370

Contact person 2
Professor Berry Billingsley
berry.billingsley@canterbury.ac.uk

ARRIVAL AND ACCOMMODATION

PETROS COURT

AUGUSTINE HOUSE

- Check is between 10:00-11:00.
- Please arrive at Petros Court on the morning of the 11th July. You will be welcomed by Ethan Basso who will direct you to your flat. The nearest train station is Canterbury East, which is a 5 min walk away.
- Once you have checked in, proceed to Augustine House where the Summer school events will be based.

CELEBRATION DINNER

On Thursday 13th at 7pm, we will hold a celebration dinner at a Thai themed restaurant: Bangkok-House - The Unique Taste of Thailand
Please get back to us should you feel that this will be unsuitable for you and if you have any special requirements that you have not told us about.

TECHNOLOGY

Please bring a laptop/other internet capable device as activities will require access to the internet. Internet access will be available through the Eduroam facility.

SUMMER SCHOOL EVENT BASE

The Summer School events are based in **AH 1.21** *(Augustine House, First floor, room 21)*

Breakfast and Lunch will be served in the canteen area on the Ground floor Augustine House.

KEY SPEAKERS

Professor Chris Lintott

Chris will deliver a Keynote address on Day 3 of the Summer School (Thursday 13th July).

- Professor of Astrophysics and Citizen Science Lead at Oxford University
- Chris describes himself as 'a distractible astronomer who specialises in galaxy formation, machine learning including anomaly detection, and occasional planet hunting'
- projects usually make use of the Zooniverse citizen science platform, working in collaboration with more than two million volunteers around the world
- a proud and excited member of the collaboration building the Vera Rubin Observatory, which will power the next astronomical revolution
- an author, a broadcaster for the BBC's long-running Sky at Night program, and is involved in all sorts of public engagement and outreach projects.
  www.physics.ox.ac.uk/our-people/lintott

Professor Berry Billingsley

- Professor of Science Education
- leads the LASAR (Learning about Science and Religion) Research Centre and the Epistemic Insight Initiative based at Canterbury Christ Church University
- worked with the BBC where she produced and presented television and radio programmes including BBC World Service's 'Science in Action', BBC TV's 'Tomorrow's World' and BBC Education's 'Search out Science'
- research interests include artificial intelligence, machine learning, and NLP

Dr Nqobile Nkala: *Organiser*

- Senior lecturer in science education for Secondary and Post-16 ITE
- research interests include science pedagogy, critical pedagogy, decoloniality and identity
- interests in this project are the implications of AI, machine and cross disciplinary learning on 'How Science Works', and the attendant consequences for science teacher and secondary school science education.

Professor Kevin Walsh

- Astronomer-in-Residence at The Westminster School
- an Adjunct Professor of Physics Education at Shaanxi Normal University, Xi'An, PRC
- editor of the Bulletin of the Society of the History of Astronomy
- a Fellow of both the Royal Astronomical Society and the Institute of Physics
- research area for his talk - the burgeoning field of Archaeoastronomy and the interdisciplinary approach it entails, including examples of how celestial phenomena may have influenced structures in ancient civilisations.

Dr Hellen Ward

- a Principal Lecturer at the Faculty of Sciences, Engineering and Social Sciences at Canterbury Christ Church University
- leads STEM education
- the director of the STEM Hub and a regional partner of STEM Learning.

Dr Marc Sarzi

- PhD in Astronomy at the University of Padua while also working at the Max-Plank Institute for Astronomie in Heidelberg on the detection supermassive black holes at the centre of galaxies using data from the Hubble Space Telescope
- post-doctoral positions in universities of Durham, Oxford, and Hertfordshire (became Reader in Astrophysics)
- expert in the use of Integral-Field Spectroscopy - a data-intensive technique that allows to map galaxies at different wavelengths and to extract a variety of key characterizing properties linking to their formation and evolution
- an STFC public engagement fellow and always maintained a strong commitment to communicating science to the general public
- current position - Head of Research of the Armagh Observatory & Planetarium.

Dr Anne Nortcliffe

- the Founding Head of the School of Engineering, Technology and Design at Canterbury Christ Church University
- over 25 years experience of engineering and computing education and research, including senior roles in Higher Education
- is passionate about educating next generation of engineering and computing graduates through an equal, diverse and inclusive learning environment and curriculum.

Professor Phillippe de Wilde

- Professor of AI based at the University of Kent in Canterbury
- promotes the use of artificial intelligence and machine learning in Biosciences, Pharmacy, Sports and Exercise Sciences, Physics, Chemistry, Forensics, and the Medical School
- research interests are in Artificial Intelligence, Machine Learning, Statistical Learning, Neural Networks.

Professor Konstantinos Sirlantzis

- Professor of Applied Artificial Intelligence at the School of Engineering, Technology and Design at Canterbury Christ Church University
- has been Associate Professor of Intelligent Systems at the School of Engineering, University of Kent, Head of the Robotics and Assistive Technologies Research Group, and Founding Director of KAROL (Kent Assistive RObotics Laboratory)
- research includes artificial intelligence and neural networks for image analysis and understanding, robotic systems with emphasis in assistive technologies, and pattern recognition for biometrics-based security applications
- has organized and chaired a range of international conferences and workshops, and has authored over 150 peer-reviewed articles in journals and conferences.

Thursday's Round Table Discussion Leads

Martin Watts

- Senior Lecturer and Course Director Foundation Year for Faculty of Arts, Humanities and Education at Canterbury Christ Church University
- Principal Research Fellow at Centre for Kent History and Heritage (CCCU)
- current working on the Whitstable Maritime project
- Historical Advisor to National Trust Dover
- research interests include the history of seafaring and the development of navigation technology

Ioanna Giorgi

- Lecturer in Artificial Intelligence at University of Kent
- PhD in Computer Science from University of Manchester, then Research Fellow in Computational Intelligence and Robotics at University of Plymouth
- specialises in brain-inspired architectures to explore the role of human language for high-level cognitive modeling in developmental and cognitive robots
- research interests include human-language-facilitated neuro-robotics, NLP and NLU, multilingual cognition, socially assistive robotics, socio-technical aspects of security in AI and Robotic applications.

Aryn Litchfield

- Research Fellow at the LASAR centre at Canterbury Christ Church University, leading work relating to search engines and artificial intelligence
- holds a first-class BA in Philosophy, Religion and Ethics from CCCU, and an MA (distinction) in Philosophy from the University of Kent
- research interests include virtue epistemology, philosophy of science, philosophy of religion, and artificial intelligence.

Paul Babra

- culinary expert in Indian cuisine
- facilitates multidisciplinary, cultural education and taste experiences in the UK and EU
- recently been nominated for 'The Game Changer, Entrepreneur of the Year' award for the British Chambers of Congress

Dr Aga Gordon

- Senior Lecturer in Entrepreneurship and Innovation in Christ Church Business School at CCCU
- PhD in Physical and Theoretical Chemistry, an MBA (Open) and is a fully qualified chemistry specialist teacher
- an Associate Professor in Quantum Chemistry at the University of Wroclaw for twelve years and has published over 40 peer reviewed research papers in international journals
- roles in the LASAR centre; as Project Manager to oversees the Epistemic Insight Initiative strands and associated projects, and as Research Fellow she leads the consortium of eight collaborating HE Institutions, supporting ITE tutors in embedding epistemic insight into their teacher education programmes.

Dr Elisabetta Canetta

- graduated from the Universita' di Bologna, Bologna (Italy) with an MPhys in Theoretical Nuclear Physics, followed by PhD in Experimental Biophysics Universite' Joseph Fourier, Grenoble (France)
- universities of Abertay Dundee as a Post Doctoral Research Assistant (PDRA), Surrey as a Post Doctoral Research Fellow (PDRF)
- joined the Optical Trapping Group at the School of Physics and Astronomy of the University of St Andrews as a PDRF, then to the School of Biosciences of Cardiff University as a Lecturer in Biophotonics
- currently Senior Lecturer in Physics, Programme Director of the BSc (Hons) Applied Physics course and the Course Lead of the Master by Research (MRes) Sport, Health and Applied Science at St Mary's

Sherry Simpson: Organiser

- Research Fellow at the LASAR centre at CCCU
- experienced FE lecturer and a registered Careers Development professional, currently studying for a Doctorate in Education at CCCU
- leads the Essential Experiences in Science and Investigating Big Questions (Covid-recovery) projects collaborating with primary school teachers to support development of pupils' Epistemic Insight, implemented through the Discovery Bags investigations
- oversees the financial position of research activities, supporting business planning across the suite of LASAR research projects.

Mina Cullimore: Organiser

- Research Fellow at the LASAR centre at CCCU, developing opportunities for knowledge exchange through co-creative research-engaged projects
- Recent projects include STFC funded 'The Power of Light' (with scientists at Diamond Light Source) and a Big Questions in Classrooms Epistemic Insight project with leads of science and RE in secondary schools
- analogue and digital visual artist (U/G & P/G universities of Kent and Falmouth), exhibiting work, lecturing on philosophy of art, and facilitating art classes and workshops, module lead and tutor Introduction to Arts in Education
- QTS with extensive teaching, leadership, and curriculum development experience in secondary schools

The **BIG QUESTIONS** of life, the universe and everything belong to everyone

Across our planet and across time, people have gazed at the night sky and felt a sense of awe and wonder at the scale of what we see.

We know that on the cosmic scale of things we are vanishingly small and yet we recognise a story where we have significance beyond our size.

Why do we feel drawn to study aspects of reality that we do not - or cannot - or do not yet - understand?

Is it because we are delighted by the intellectual journey as we try to fathom out how reality works?

Or do we feel a need to explore because there's a possibility that maybe we're alone...

Can it be that our planet is the only place we'll ever find where sentient, creative, compassionate and intelligent life exists?.

Oh lucky, lucky astronomers

Your lab is the universe, your materials the stars. Surely of all the disciplines that have buildings in a typical university or science park, astronomy runs rings around the others in its capacity to inspire our imaginations.

INVENTION
AND APPLICATIONS

For some people their curiosity and interest in all things astronomical is focused on the practical and technological.

There are engineers and entrepreneurs who are developing new types of instruments that work in conditions beyond our Earth's.

There are many inventions that were developed and produced to support astronomy and the space industry.

Memory foam is of the most widely recognised NASA spinoffs. It was invented as a material that can help to cushion test pilots during flights.

ASTRONOMY AND ARTIFICIAL INTELLIGENCE

And now like every other discipline we wonder at this new technology and what it means for us. We're up for building partnerships, or seeing it as a tool. We think it will expand and accelerate the work we do.

So here's the thing …

How should we conceptualise the part that an AI plays if, for example, it is on board a space telescope and making decisions for us?
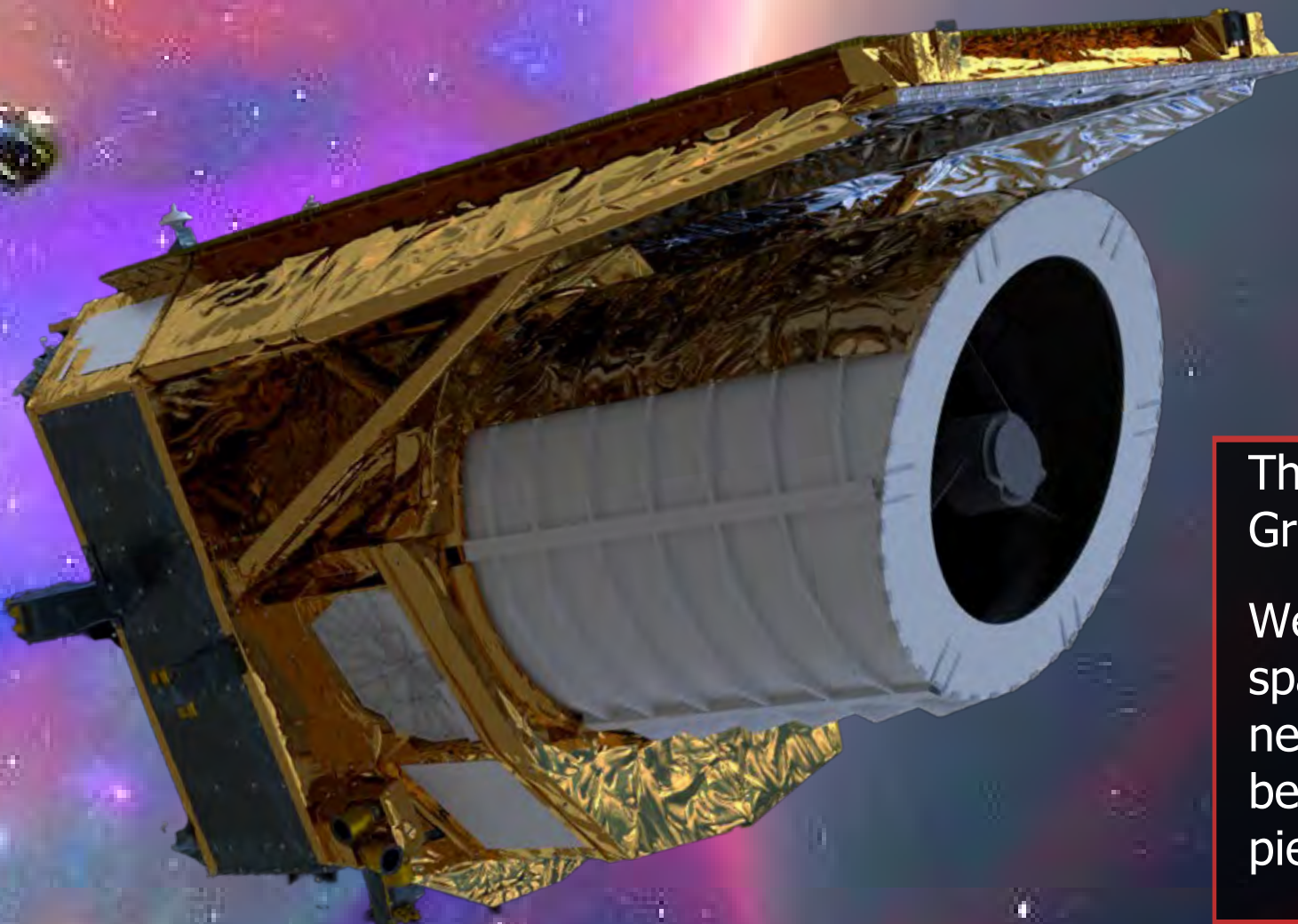
It will be useful to draw on some current case studies, such as the Euclid and James Webb telescopes, to find out what's already possible.
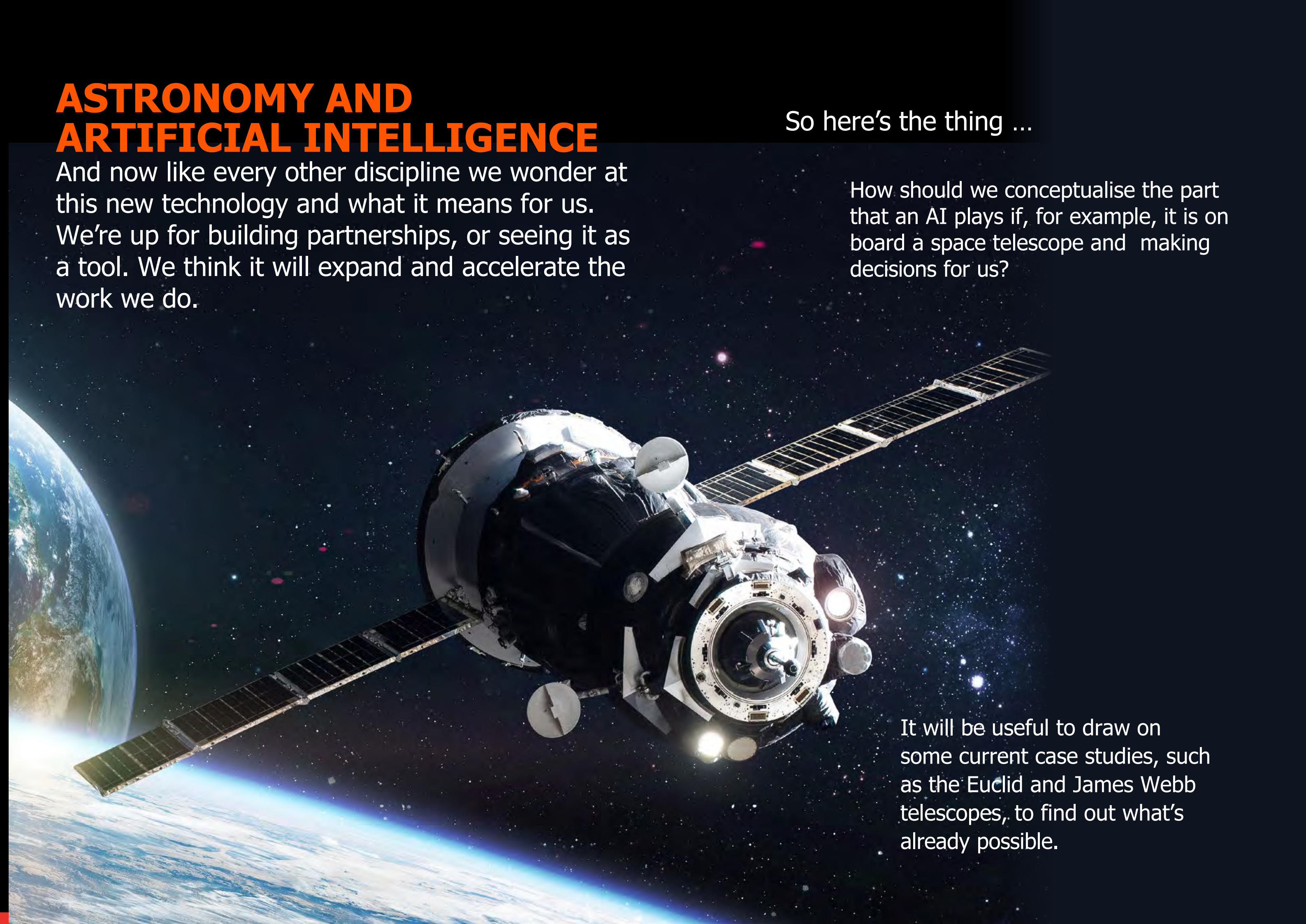
EUCLID

The Euclid mission aims to provide insight into how the dark universe affects the geometry of the cosmos.

By observing back through time to distant reaches of space, Euclid will reveal new knowledge of what expansion looks like, and how structure has taken form. From this astronomers hope to infer the prop rties of dark energy, dark matter and gravity.
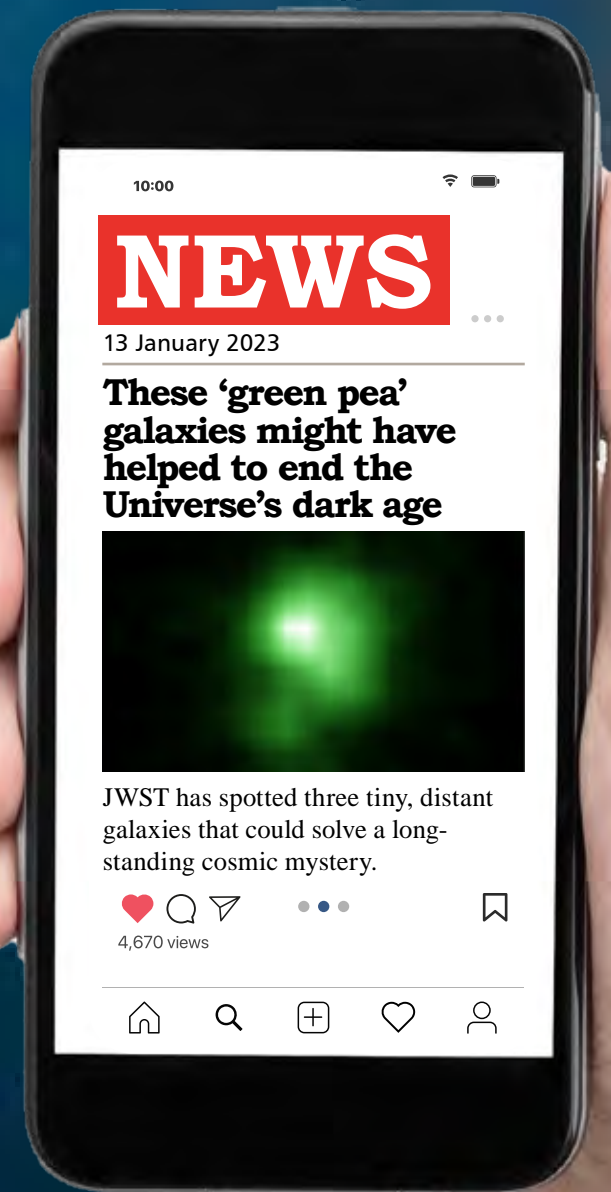
GREEN PEA GALAXIES

So-called 'green pea' galaxies were spotted by citizen scientists as they poured over images of space, tasked with identifying different types of known galaxy.

Someone on a discusison forum called the mysterious blobs 'green peas.' And before long, more people spotted them among the galaxies and speckles they were studying.

Thanks to their discoveries and information-sharing, astronomers published a paper in Nature – about the 'green pea galaxies'. And these cosmic wonders are continuing to make the news today.

NEWS

13 January 2023

These 'green pea' galaxies might have helped to end the Universe's dark age

JWST has spotted three tiny, distant galaxies that could solve a long-standing cosmic mystery.

4,670 views

The Euclid telescope is named after an ancient Greek mathematician.

We wonder what the next big discovery in space might be? It could be a new object, or a new mathematical pattern. Or perhaps it will be more like a harmony and the chords in piece of music.

CASE STUDY
WHAT CAN WE LEARN FROM OTHER REMOTE AIS?

The questions we are asking in astronomy are similar to those asked by oceanographers as they ponder upon the designs of autonomous subs...

How do we design an AI that can explore the depths of the oceans (in conditions where humans cannot directly make observations), with the capacity to make decisions for us about what data to discard and what data to keep?.

Suppose we are going to put an AI on board a remote telescope. Its role will be to filter the data that the instruments receive to manage the limitations of how much can be sent to earth.

What's the best way to imagine the AI?

- Is the AI a tool following the instructions of astronomers?

- Do we want it to 'think like an astronomer and ask new questions?

- Since astronomy is a discipline that seeks to help humanity to understand our place in space ... should it have the (wider) curiosity that humans experience when we look into space?

- As it is an AI, perhaps it should have a type of curiosity that we have yet to understand – in which case how do we communicate with this?

We will want to put questions like these to philosophers and psychologists as well as engineers.

WHERE TO FROM HERE?

So here are some challenges for us to address:

How do we prepare an AI to see and respond to puzzles that we haven't yet imagined ourselves?
Perhaps it will detect an unfamiliar object. but perhaps it's not an object but rather an unusual pattern, or flavour, or harmony as yet unknown to us.

And suppose we solve this then how will the AI communicate with us to explain the mysteries it selects?
When citizen scientists reached into their repertoire of metaphors and analogies, they found the term 'green peas'. But what kinds of language and metaphors will serve us best when we are communicating with an AI and it is communicating with us? Perhaps a scholar in linguistics has an answer.

And in the end, how far can and should we stretch our understanding of what it means to be curious? Might the sensible limit be to equip it with the questions that astronomers are asking (and no more)? Should it have the curiosity of a person, and is that possible for an AI?

Who should be in our think tank - to help us to address these questions?

Perhaps as well as astronomers, mathematicians, philosophers, linguists, engineers and theologians, we should be calling on chefs and artists and musicians. Working with these specialists might give our AI a more complete idea of what curiosity and creativity look like. If you were to design the 'think tank' to advise us at the start of the project, who would you choose and why?

Canterbury
Christ Church
University