

# LIV.INNO

## Research & Development



# UK Research and Development Roadmap (July 2020)

- UK is internationally recognised for leadership in research.
- Record increase in public spending on R&D, reaching £22 billion per year by 2024 and 2025 (more than double previous spending)
- The aim is to fuel the UK's transformation into a scientific superpower
- A “once-in-a-generation opportunity” to pursue ambitious new goals, the ‘moonshots’ that will define the next decade and beyond.

UK universities may need to rethink their R&D strategies, including a new approach to partnerships with industry and the private sector.



# STFC Centres of Doctoral Training (CDTs)

- Highly skilled staff and students, with the right mindset for disruptive innovation (curious, tackling fundamental questions, thinking 'out-of-the-box')
- Bespoke training in data science, physics and astronomy, R&I
- Research generates extremely large data sets (e.g. from CERN or space telescopes), pushing the limits of data science techniques
- Contribute to the local economy (e.g., skills, innovation)



# University of Liverpool & Liverpool John Moores University

- Both recognized as research intensive universities
- Research in Physics at both UoL and LJMU is >90% 'world leading' or 'internationally-excellent', as judged by Research Excellence Framework (REF 2021), a national audit of university quality.
- Our research is recognized as creating real world impact.
- The two universities have developed strong collaborations (e.g., joint undergrad teaching in Physics & Astronomy, CDTs).



# LIV.INNO CDT in Data Intensive Science

## University of Liverpool & Liverpool John Moores University

- One of 5 new CDTs in Data Intensive Science established across the UK. LIV.INNO is an investment of £1.3M to the two Liverpool universities.
- Three cohorts of PhD students, first starting in Oct. 2022. Financial support from STFC and match-funds from the two universities + external partners.
- Builds off our successful previous CDT, 
- A much more extensive collaboration across departments

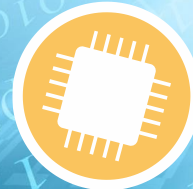
LJMU: Astrophysics Research Institute + School of Computer Science and Mathematics

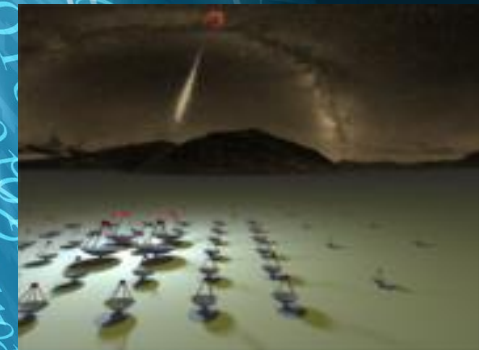
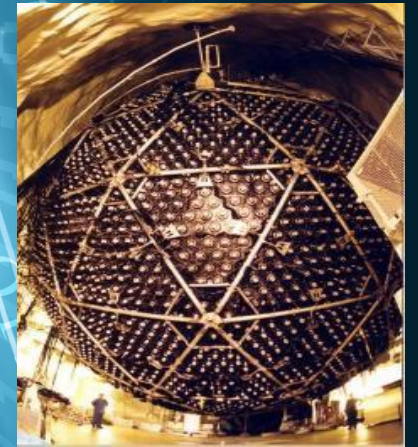
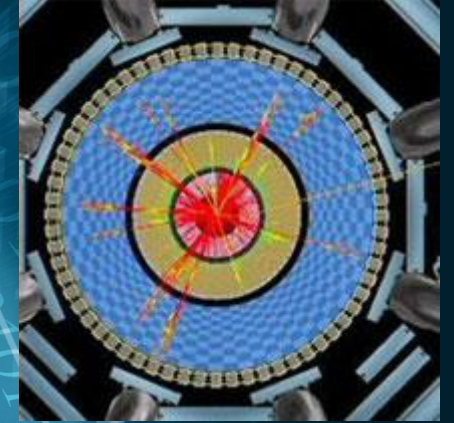
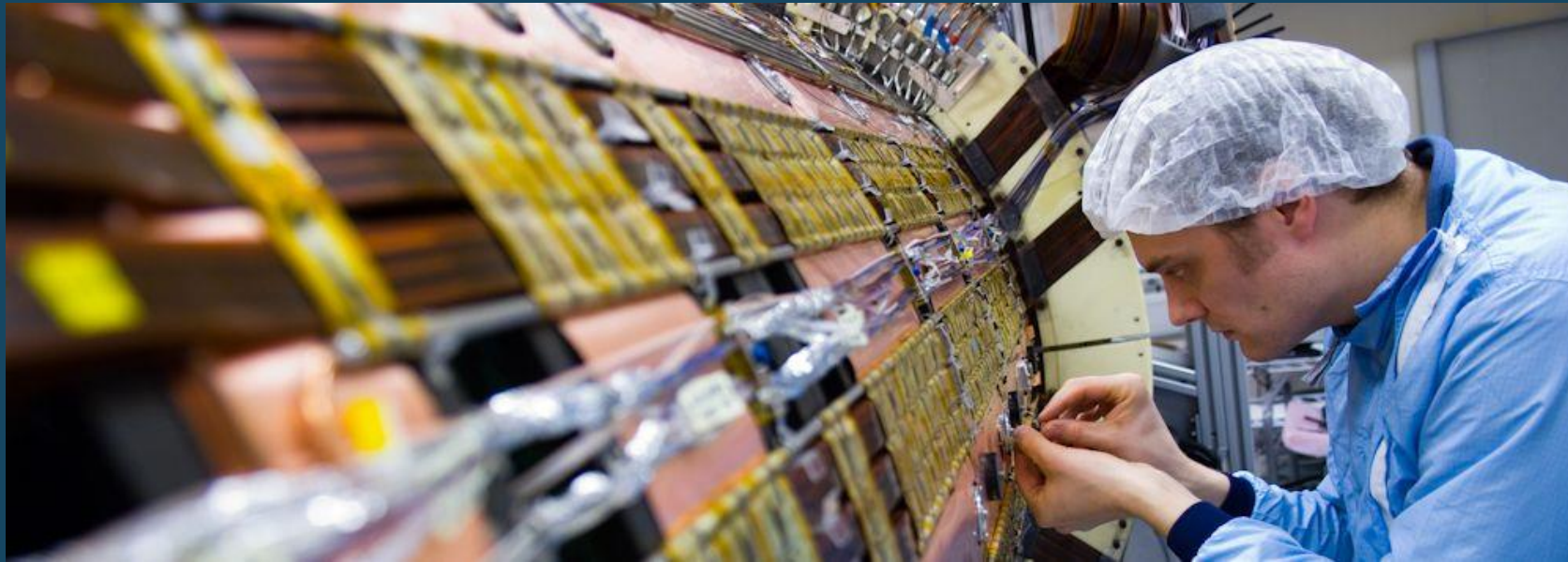
UoL: Department of Physics, Computer Science

# Research areas

**LIV.INNO covers the entire STFC remit:**

- Physics (UoL): e.g., nuclear, theoretical, particle and accelerator physics.
- Astronomy (ARI, LJMU): e.g., theoretical and computational astrophysics, stellar physics, time-domain, instrumentation.





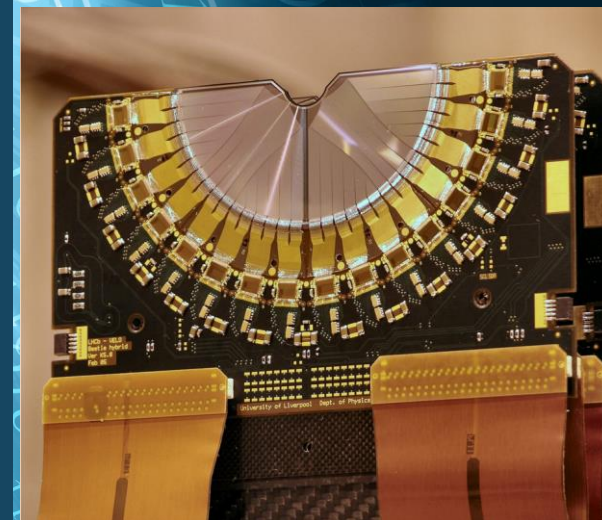
## Particle physics (UoL):

- is one of the largest groups in the UK
- conducts research at international research facilities on three continents (e.g., LHC at CERN, SNO+, LZ, CTA)
- research into the fundamental particles and forces of nature: Higgs, neutrinos, ... & probing the nature of dark matter and dark energy.



## Accelerator physics (UoL):

- is amongst the world-leaders in beam diagnostics development, accelerator and light source design and optimization.
- makes key contributions to many of the global accelerator flagship projects (e.g., LHC, ELENA, AWAKE, EuPRAXIA)
- Broad spectrum: from fundamental research antimatter to developing accelerator applications for medical sector








## Nuclear physics (UoL):

- fundamental questions concerning the properties of atomic nuclei and their nature
- applications to medical treatment and preservation of the environment.



# Astrophysics at ARI (LJMU)



Galaxy Formation and Evolution



Computational Galaxy Formation




Time Domain Astrophysics



Star Formation and Stellar Populations



Astronomical Instrumentation



Astro-ecology



The  
Liverpool Telescope  
Observing robotically since 2004



New Robotic Telescope

LIV.INNO

# Research projects

The Centre focusses on addressing the data challenges presented by STFC research.

R&D is structured across three main Work Packages (WP):

1. [Monte Carlo and high performance computing \(WP1\)](#)
2. [Artificial intelligence and machine learning \(WP2\)](#)
3. [Data analysis \(WP3\)](#)



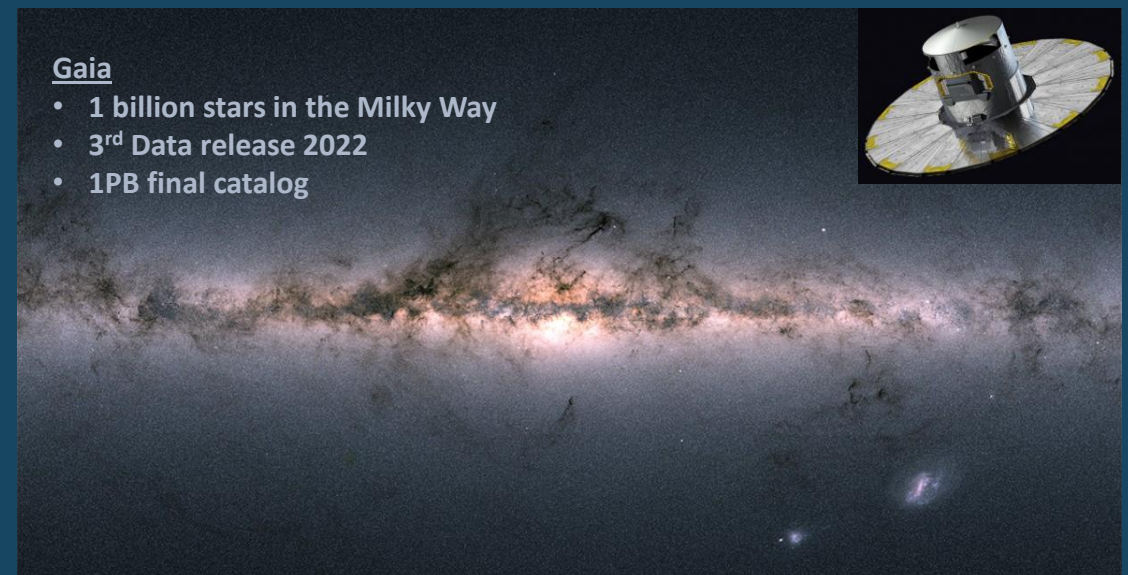
# Big Data in Astronomy

-rich data sets for ML & AI

Billions galaxies in the Universe:

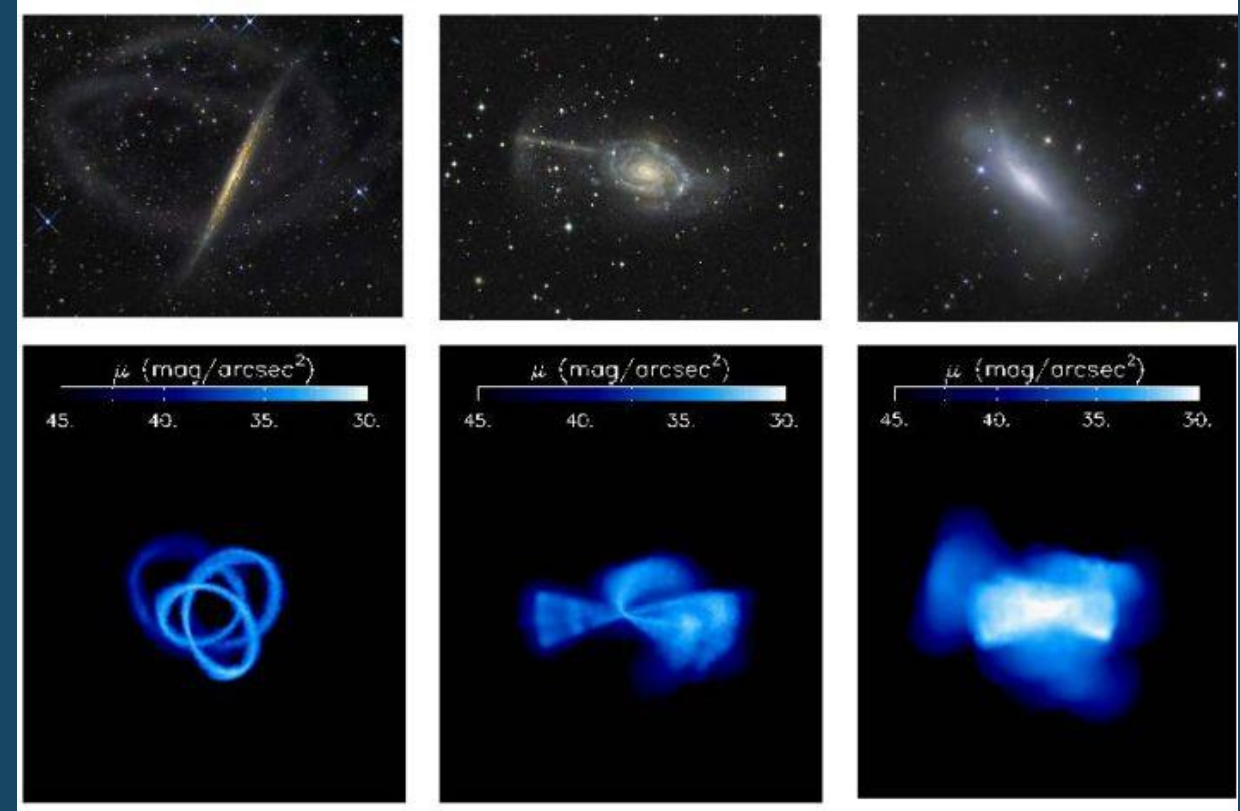
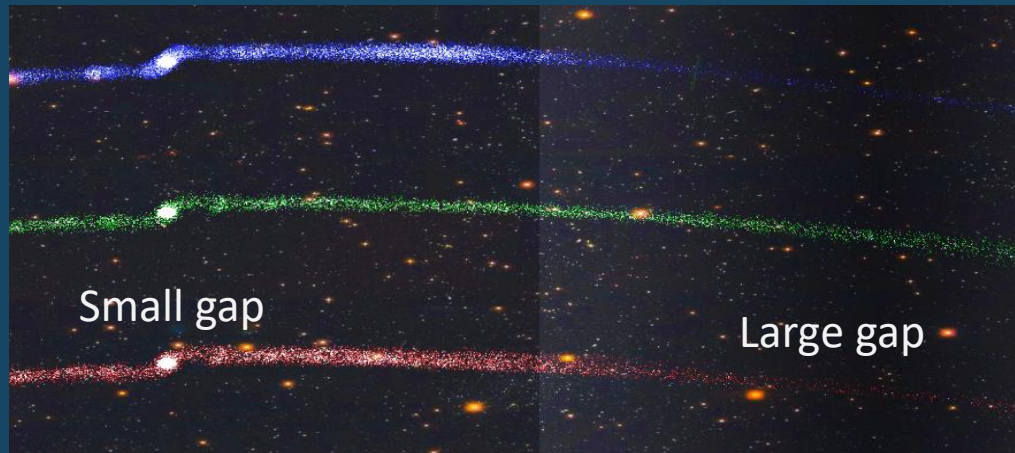


Billions of stars in the Milky Way:



## Example:

- ML techniques can detect debris from galaxy collisions & help categorize them
- Each pattern of debris structure is a piece of the puzzle in the process of galaxy formation
- Some 'gaps' in the data can be signatures of dark matter.

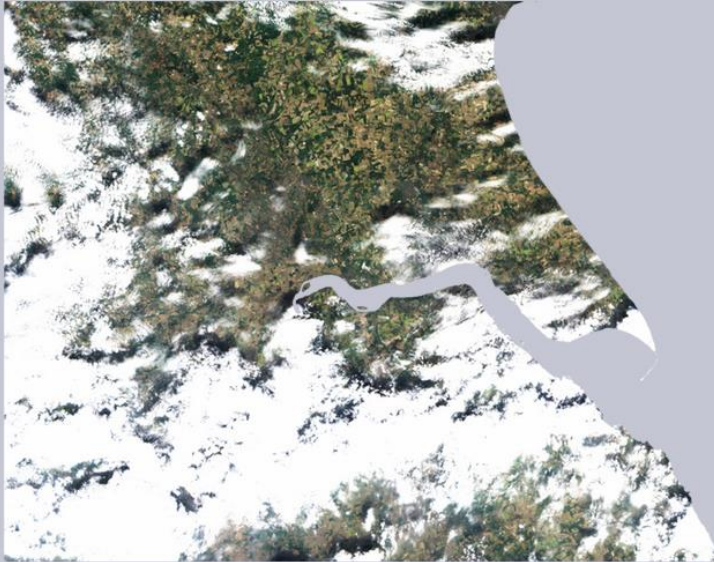


Example  
of partner:



'Real world' similarities: missing data due to cloud coverage. Fill in the 'gaps' with a physical model

### Direct view via Sentinel-2 satellite



26 April 2020

### Cloud-free view with ClearSky



26 April 2020

Method combines  
hyperspectral image  
analysis rooted in  
observational  
astrophysics with  
machine learning/AI  
tools.



# Some of our partners

(potential internship placements, bespoke training)

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- Adaptix
- AIMES
- Art Recognition
- Clatterbridge Cancer Centre
- CERN
- Cockcroft Institute
- CIVIDEC
- D-Beam Ltd
- DiRAC
- The Football Association (FA)
- Fermilab
- Fistral
- First Light Fusion
- FOTON
- STFC Hartree Centre
- Hewlett Packard Enterprise (HPE)
- IBM
- Liverpool Centre for Cardiovascular Science
- Mirion Technologies
- Naimuri
- Pilkington Technology Management
- NVIDIA
- Royal Liverpool University Hospital
- STFC Daresbury Laboratory
- ViBo Health

**We are open to more  
partner collaborations!**