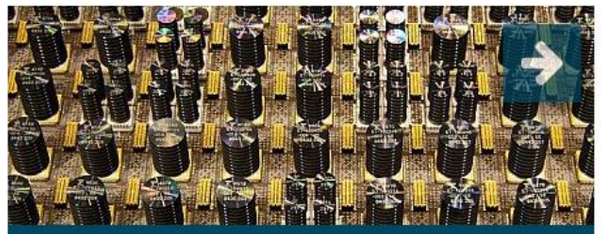
DISCUS

Data Intensive Science Centre
University of Sussex

About us

The team



Case studies

Contact us

DISCUS is the Data Intensive Science Centre at the University of Sussex, a research unit built to address real social and economic challenges by applying data interpretation techniques developed by a cross-disciplinary team over a number of years.

DISCUS aims to support the UK's public and private sector organisations as they seek to make better use of their largest and most complex data sets, delivering better outcomes for the general public, and staying competitive on the international stage.

Funded by:

Science & Technology Facilities Council

EPSRC
Engineering and Physical Sciences Research Council

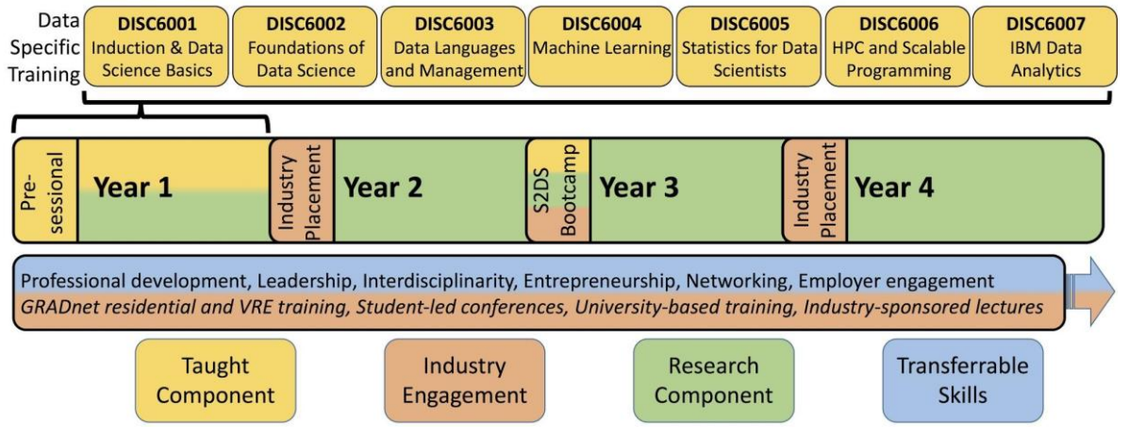
wellcome

brighton and sussex medical school

DISC*net:* Data Intensive Science Centre in SEPnet South East Physics Network

- STFC Data Intensive Science Centre call October 2016
- Sussex, Soton, QMUL, OU, Portsmouth, building on GRADnet
- 9% of all STFC activity in UK
- Leveraging 44 PhD years of STFC → 228 PhD years Training
- Data intensive training e.g. from IBM
- 132 months of commercial placements in 27 companies
- 5-week commercial transfer with pivigo
- Not just STFC. Sussex DISCUS interdisciplinary e.g. linking to GCRF
- Director Prof. Seb Oliver, University of Sussex (Also STFC ETCC Chair)
- Ranked 2nd in STFC competition
- **DISC***net* pilot being developed 56 PhD students and postdocs registered interest

UNIVERSITY OF SUSSEX



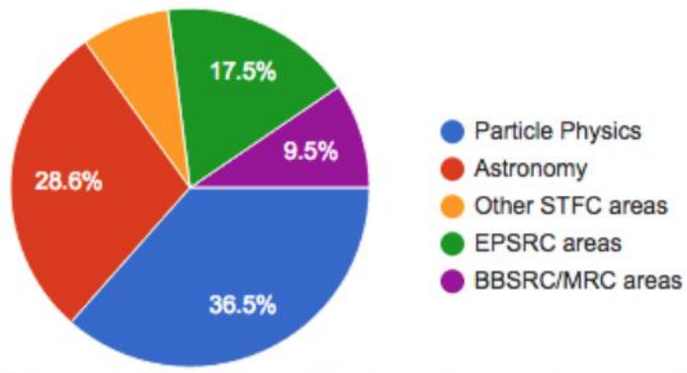


Figure 1: Breakdown of the broad research areas for 77 projects proposed for DISCnet

Partner
Ageas
Adler Planetarium
Ambiental
CCFE
Critical
DEIMOS Space
HMRC
IBM UK
IEA
Kent CC
Knownow
Lein
MeVitae
MP Capital
NAOC
National Crime Agency
NPL
Ordnance Survey
Pivigo
PRDICT
Rank
SAC
Senseye
STFC-SCD
Thales
TUI
Viridan

Faculty members

Chris Byrnes

Ilian Iliev

Antony Lewis

Jon Loveday

Seb Oliver

Kathy Romer

Mark Sargent

David Seery

Robert Smith

Peter Thomas

Stephen Wilkins

4MOST

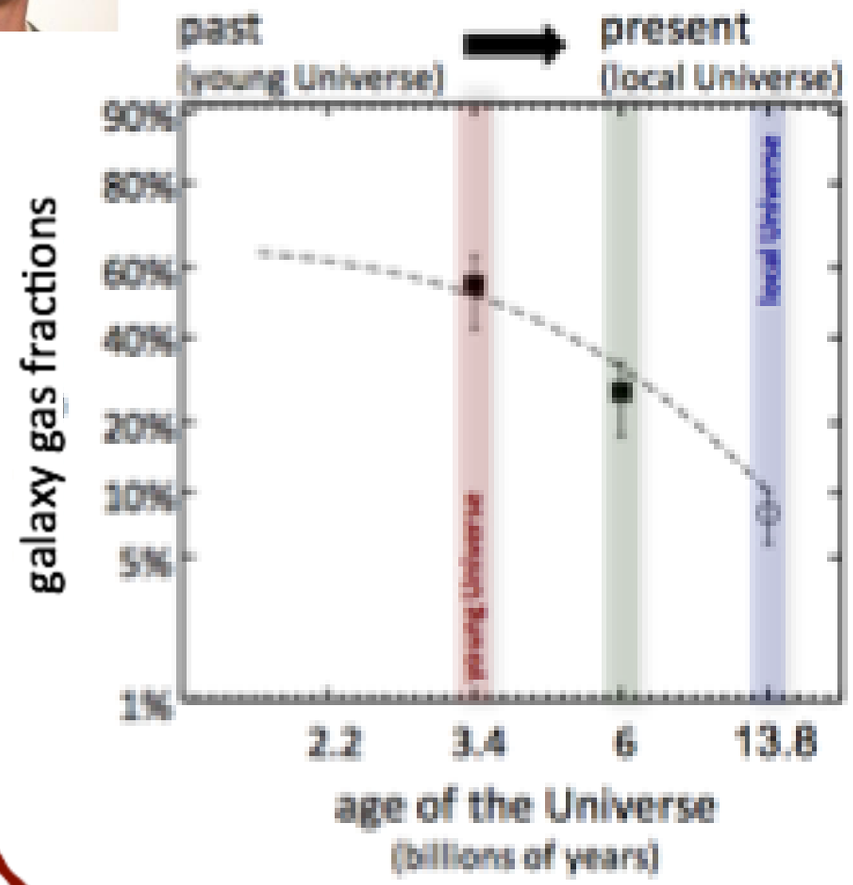
- Sussex is a member of the 4-metre Multi-Object Spectroscopic Telescope (4MOST)
- The premier spectroscopic facility in the southern hemisphere
- Most new PhD students will be involved in 4MOST survey planning
- Ideally positioned for postdoc positions when 4MOST starts in 2021

Gas and star formation in galaxies through cosmic time

(supervisor: Mark Sargent)

Gradual gas consumption in spiral galaxies?

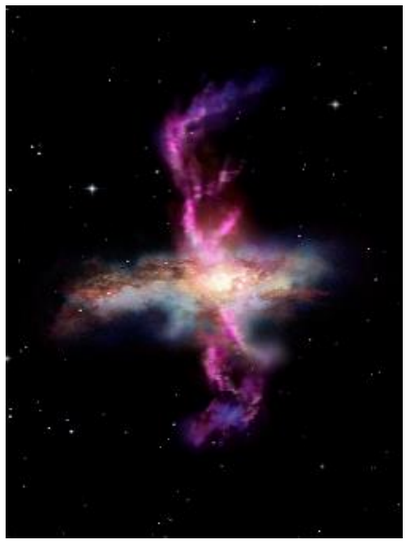
Central question: *How did it come to this…?*

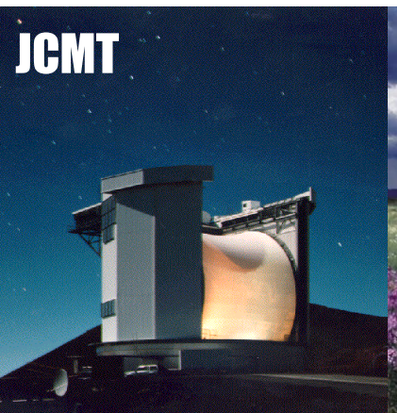


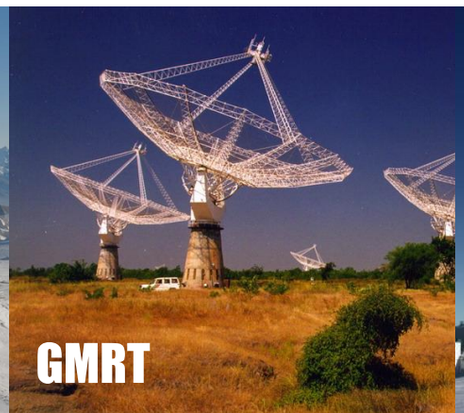
Rapid/efficient gas consumption in merger-induced starbursts?

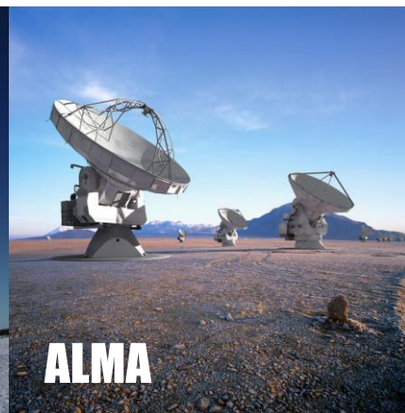
Stripping of gas reservoirs in dense environments, e.g. in galaxy groups?

Removal of gas by feedback, e.g. from AGN or star-formation?









STEPHEN WILKINS

UNDERSTANDING THE FIRST GALAXIES

A visualization of the MassiveBlack Simulation - one of the largest (in both volume and number of particles) hydro-dynamical simulations ever run.

The Hubble eXtreme Deep Field: our most sensitive view of the Universe.

6 Extreme Emission Line Sources discovered at low-redshift.

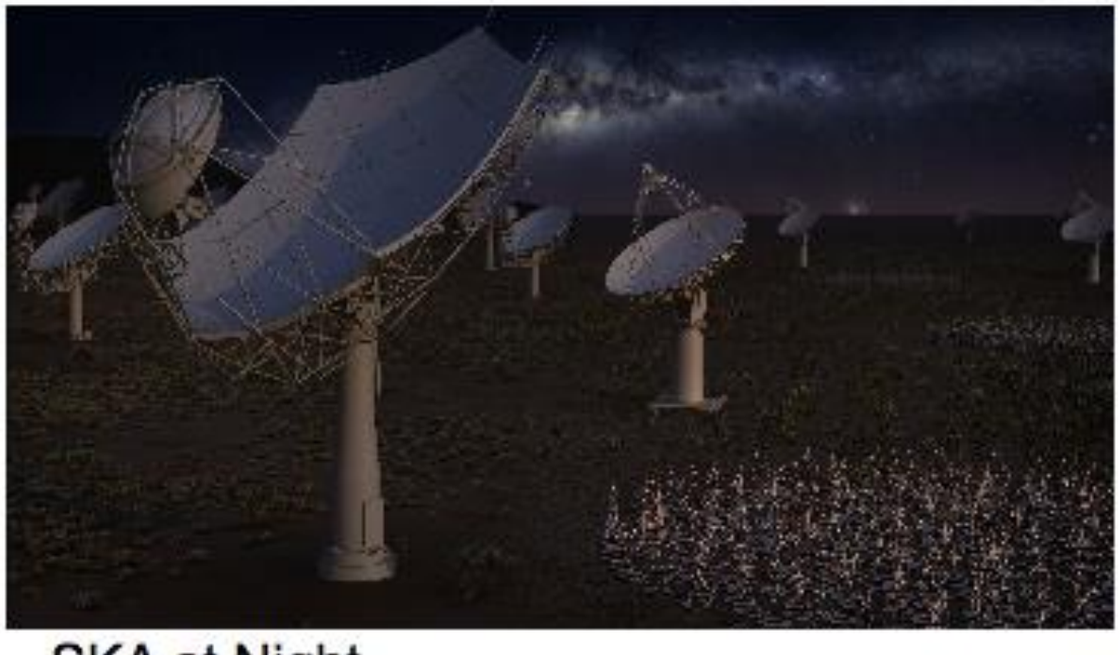
EXTREME EMISSION LINE SOURCES

The Dawn of the Universe: Dr. Ilian Iliev

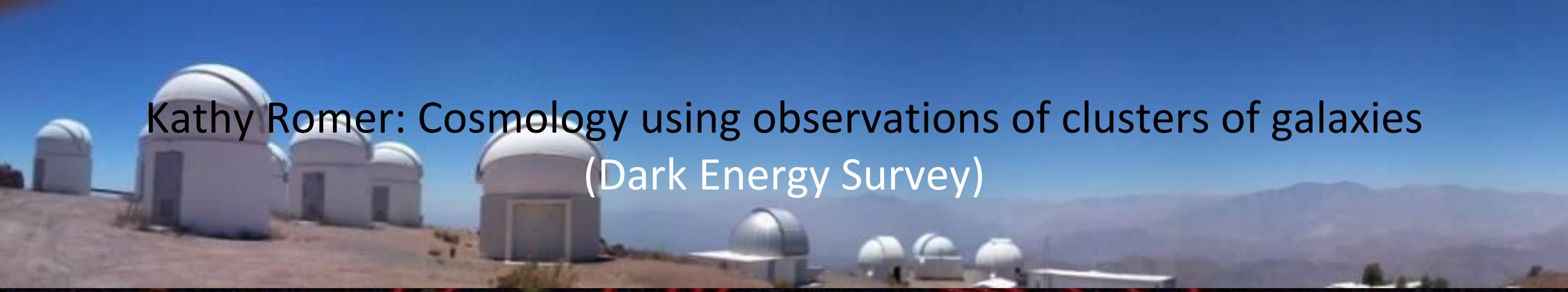
In this project you will:

- Participate in active, front-line research
- Be part of important international collaborations (LOFAR,SKA)
- Learn parallel computing, use the best worldwide computing facilities

Titan supercomputer, Oak Ridge



SKA at Night



Kathy Romer: Cosmology using observations of clusters of galaxies (Dark Energy Survey)

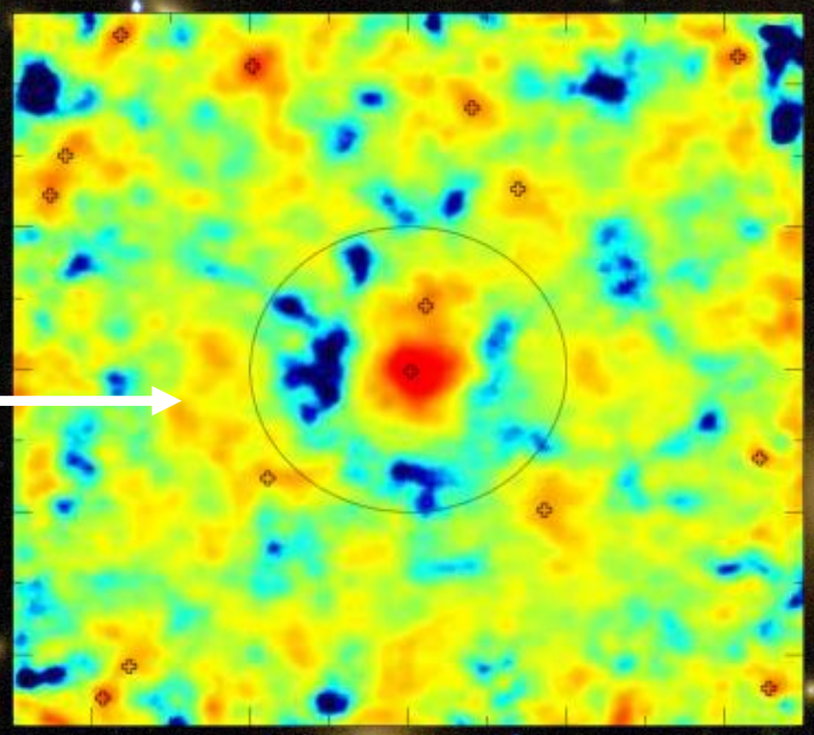
- DES is the leading Dark Energy experiment in world
- 5000 square degrees of deep imaging (optical and near IR)
- Season 2 (of 5) has just finished, so it is a great time for students to get involved
- Kathy is the only DES member at Sussex
- You will be working with X-ray and optical observations of clusters
- You will attend collaboration meetings in USA, Europe and South America (and you will be able to go observing to Chile)

Combining cosmic shear and large-scale structure data to constrain the acceleration of the Universe. Supervisor: Dr Robert E. Smith

We will explore how the combination of weak lensing aperture mass statistics and redshift space distortions can help shed light on this great mystery.

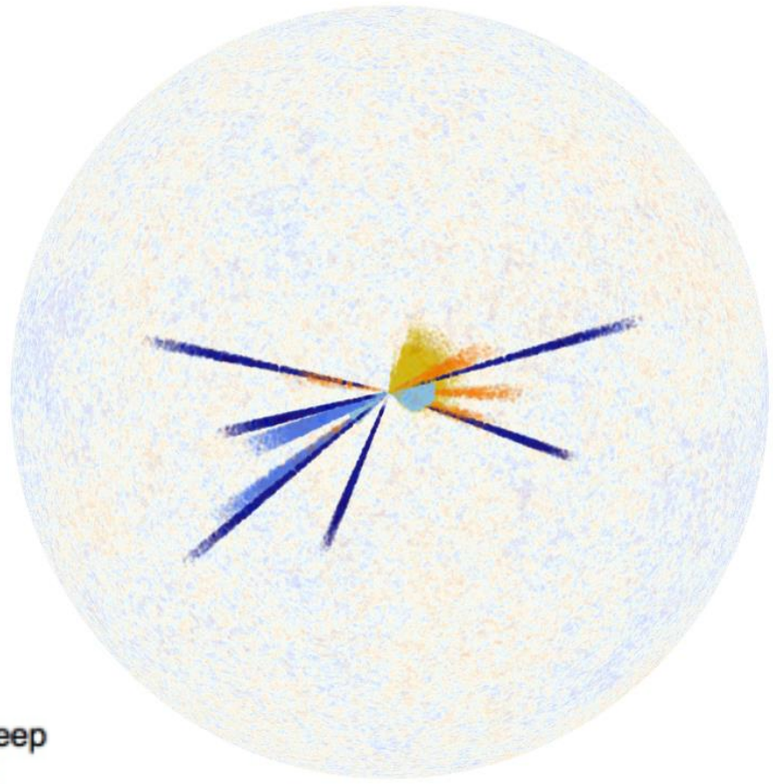
Is Dark Energy quantum vacuum, scalar field or a modification to General Relativity?

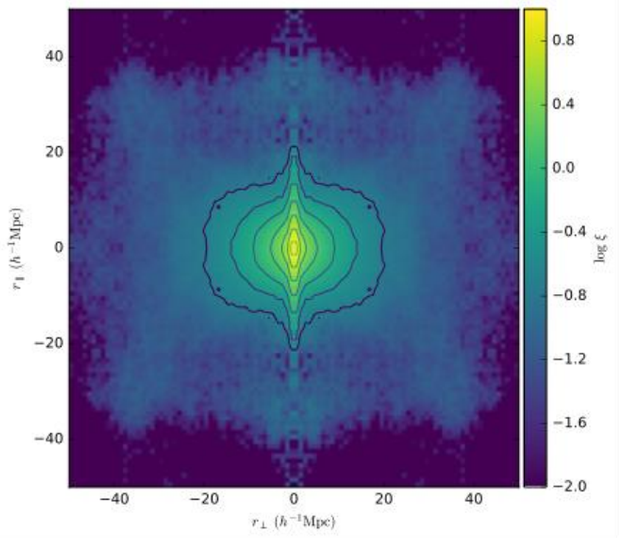
Aperture mass map showing the presence of a cluster in the mock CFHTLens data



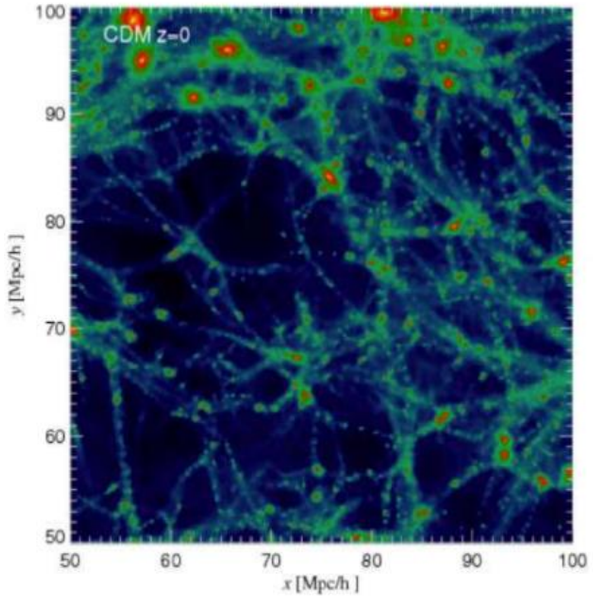
Project will involve analytic calculations, numerical simulations and data analysis.

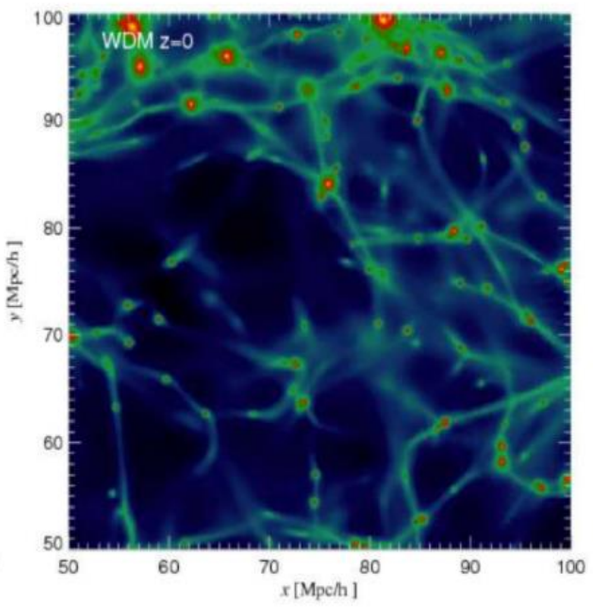
Observational constraints on modified gravity and dark matter - Jon Loveday

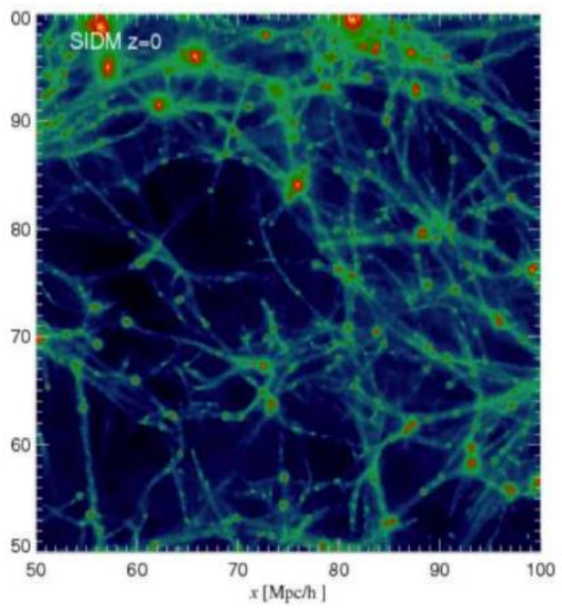




- Utilise existing GAMA data to measure galaxy pairwise velocity dispersion and infall into galaxy groups
- Sensitive test of modified gravity and dark matter
- Optimise future surveys with 4MOST





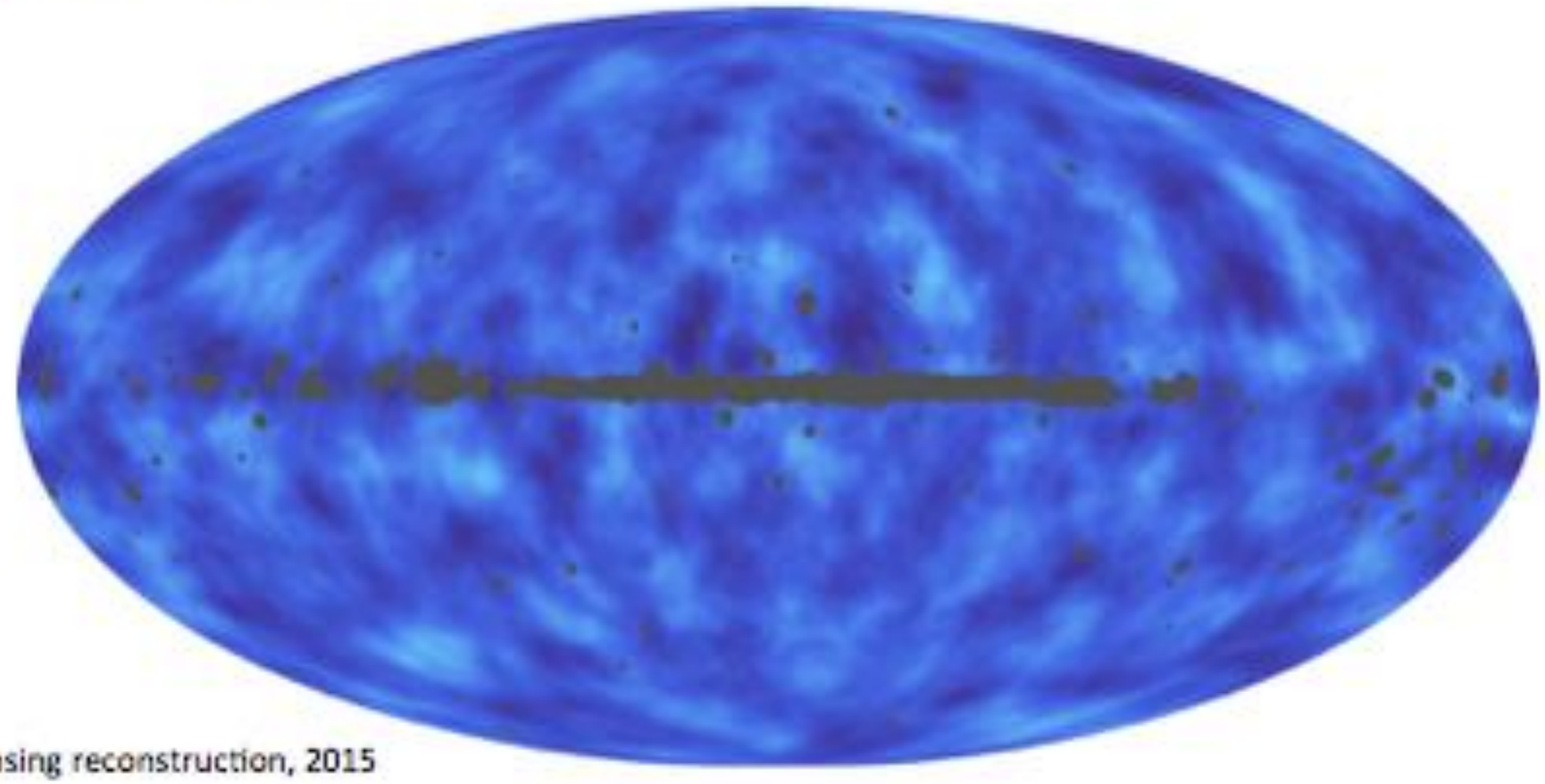


Cosmology after Planck: the theory of cosmological observables

Supervisor: Antony Lewis

- CMB Lensing
- Spectral distortions
- B-modes from gravity wave and separation from lensing signal/foregrounds
- Large-scale structure and correlations
- Sampling algorithms for complex parameter spaces

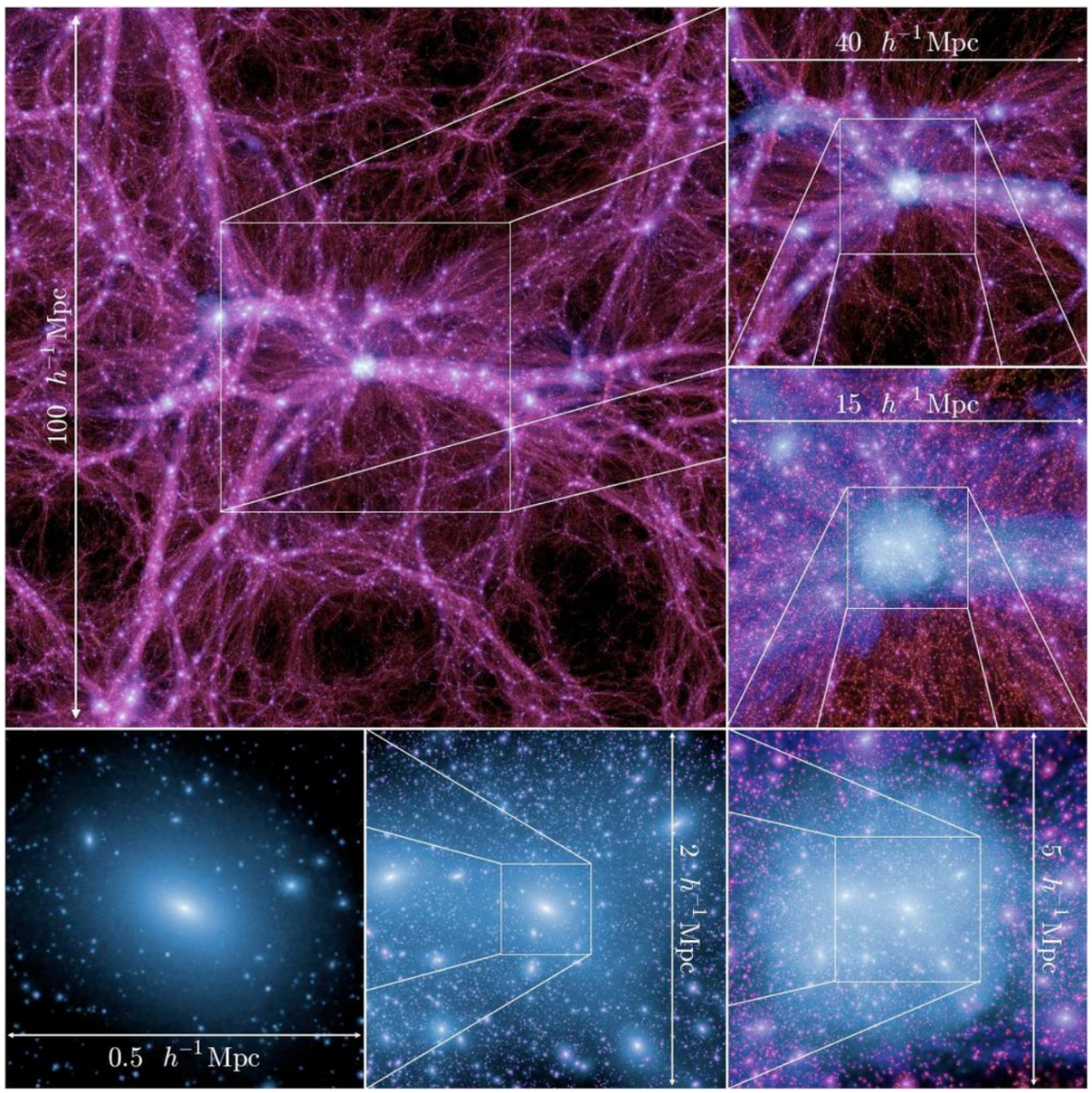
CMB lensing can map the integrated density of almost the entire observable universe

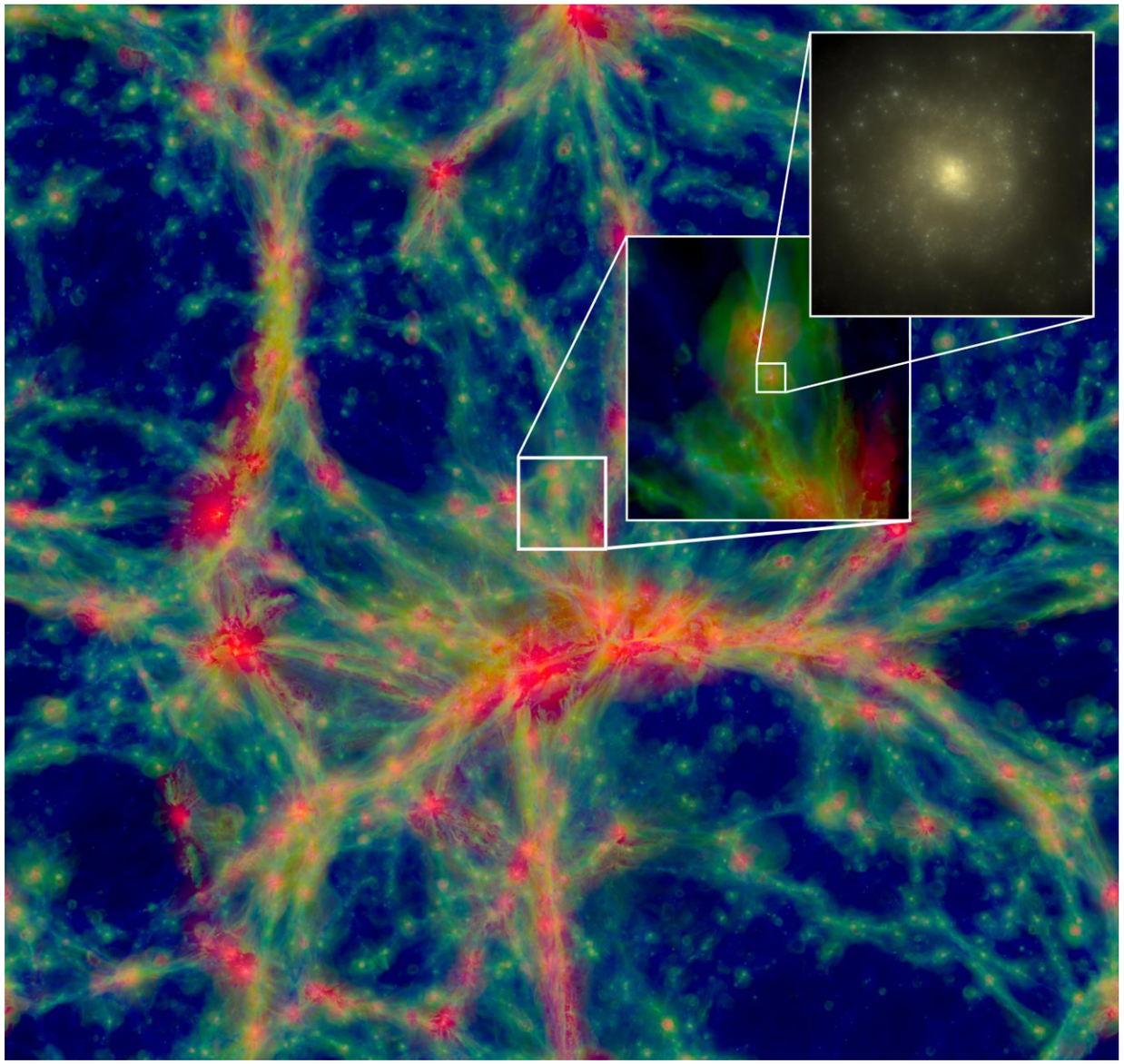


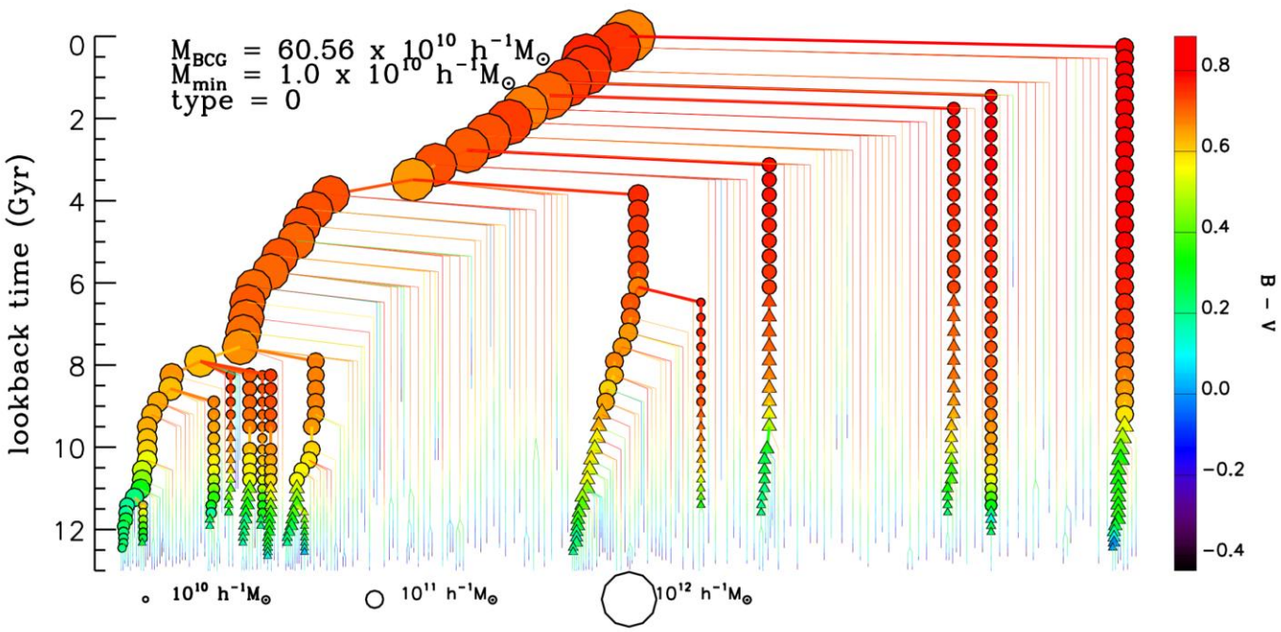
Planck lensing reconstruction, 2015

Making galaxies:

- semi-analytics
- simulation







Astronomy key skills

- Used to handling very big data sets
- Cradle to grave
- Raw data processing
- Image analysis
- Object detection
- Object classification
- Machine learning for classification and regression
- Application of statistics to research problems
- Bayesian methodologies for
  - model parameter estimation
  - Hierarchical probabilistic modelling
  - Model selection
- Numerical simulation on massive scales
- In general highly numerate and computationally skilled with access to a vast “toolkit” of methods and experienced in applying these methods to real research problems

Quantum Dots

Star gazers find familiar patterns in molecules

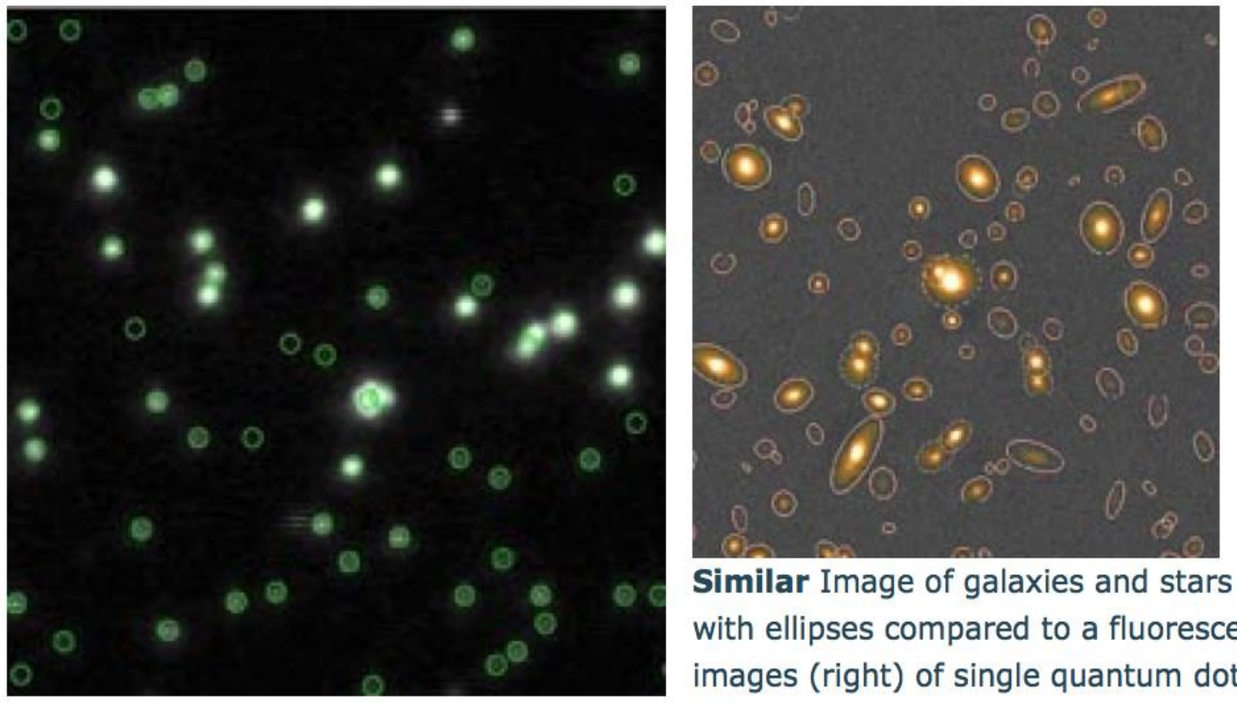
Scientists will use the techniques for mapping entire galaxies to map single molecules in microscopic images.

Chemists Dr Mark Osborne and Steven Lee will apply astronomical concepts to try to shed some light on the properties of single molecules.

Mark came up with the idea when he noticed significant similarities between the sky maps on show in the Astronomy Centre and the images his team were trying to decipher.

He said: "I was wondering how astronomers decided whether a really faint star was real, an aberration or noise - and figured they must have some well-established algorithms for sorting the wheat from the chaff."

Single molecules, like distant galaxies, are extremely difficult to map as their appearance and intensity changes over time, due to "chemical noise" from their surroundings.



Similar Image of galaxies and stars (left) with ellipses compared to a fluorescence images (right) of single quantum dots with circles.

Astronomers Dr Seb Oliver and Dr Rupert Ward aim to develop their galaxy-mapping software to not only locate single molecules, but also to track their intensities as they interact with their nanoenvironments.

This research will ultimately provide the tools for a more powerful analysis of complex processes such as the immune response, DNA repair and protein misfolding, at the molecular level.

Mark said: "I guess it was the extreme scales that appealed, from mapping galaxies across the Universe to single molecules under a microscope."

In initial tests, the techniques have been applied with some success and the team hopes to deliver bespoke algorithms within six months.

"Bayesian Methods of Astronomical Source Extraction"
Savage & Oliver 2007ApJ...661.1339S

Cross identification in Extragalactic Astronomy:

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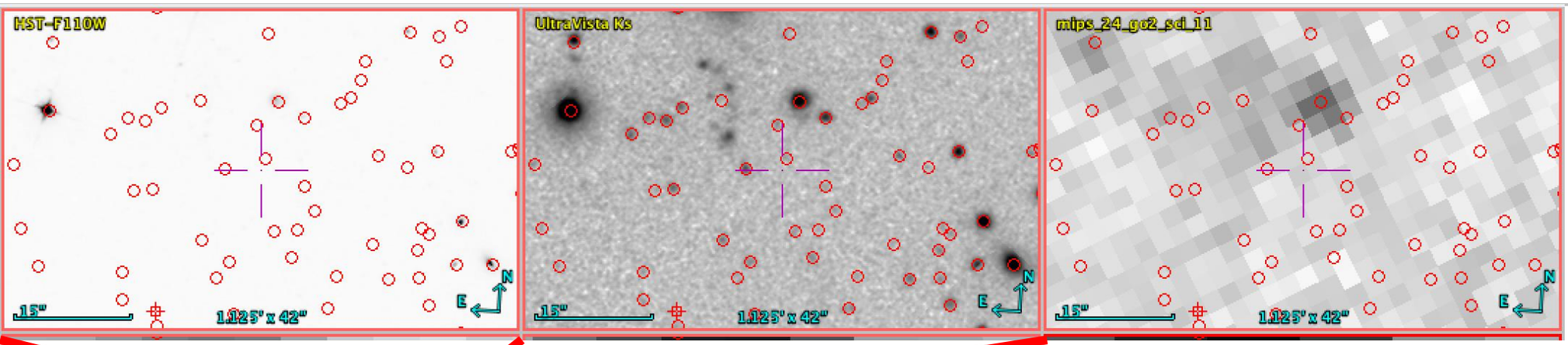

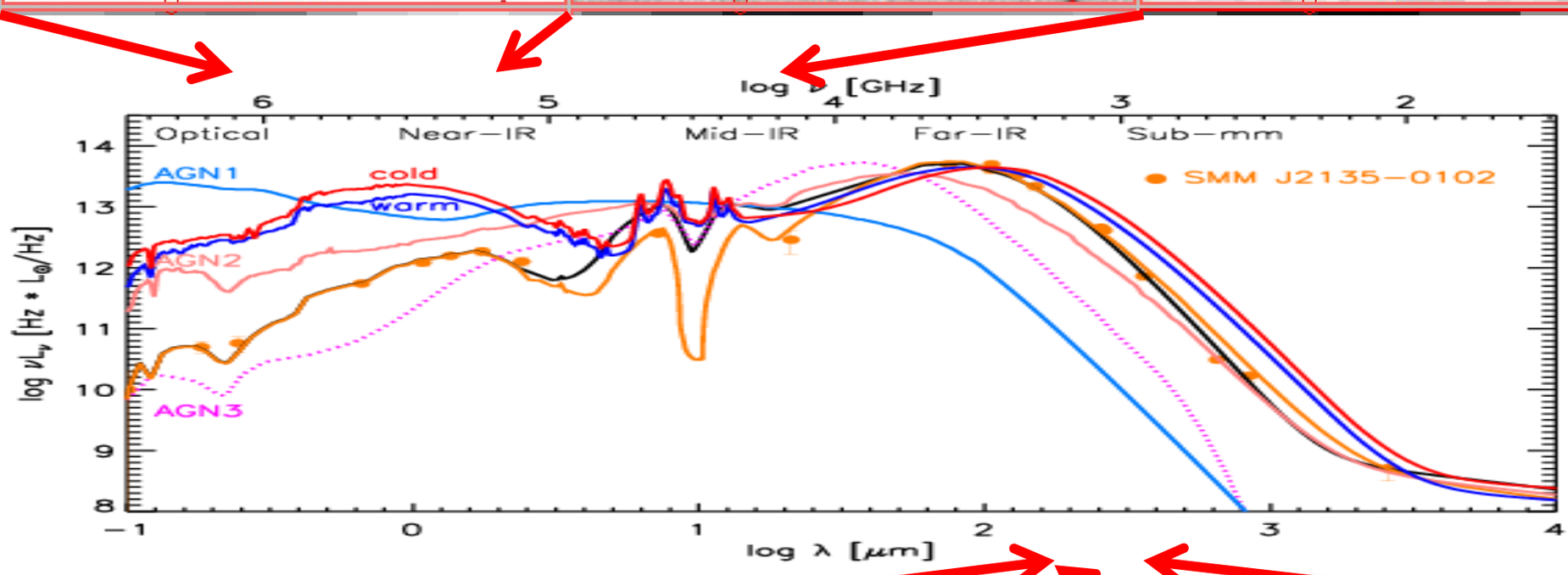

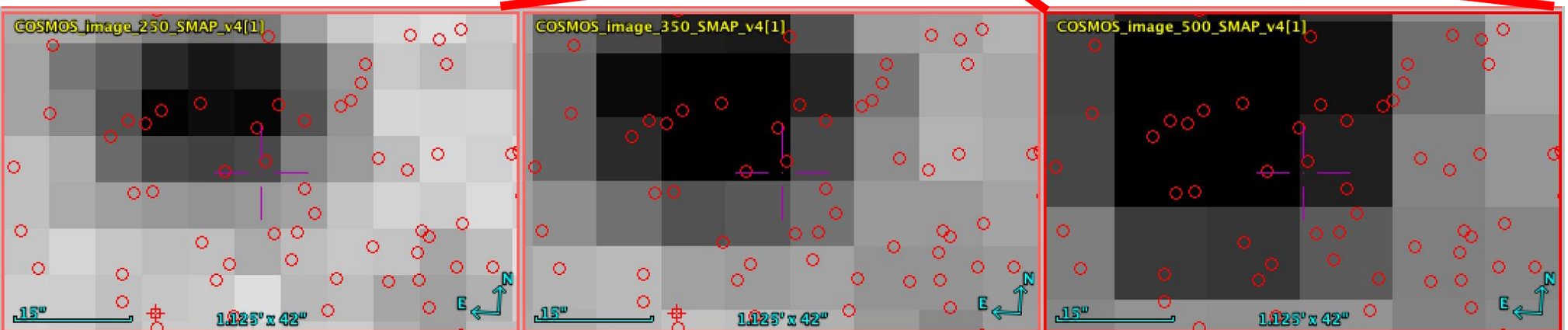

Astronomy – ECFSPR
The analogy

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Galaxies	⟶	Patient
Wavelength	⟶	Time
Redshift	⟶	Age
Position	⟶	e.g. Gender, Genotype, Age
Intensity	⟶	e.g. BMI

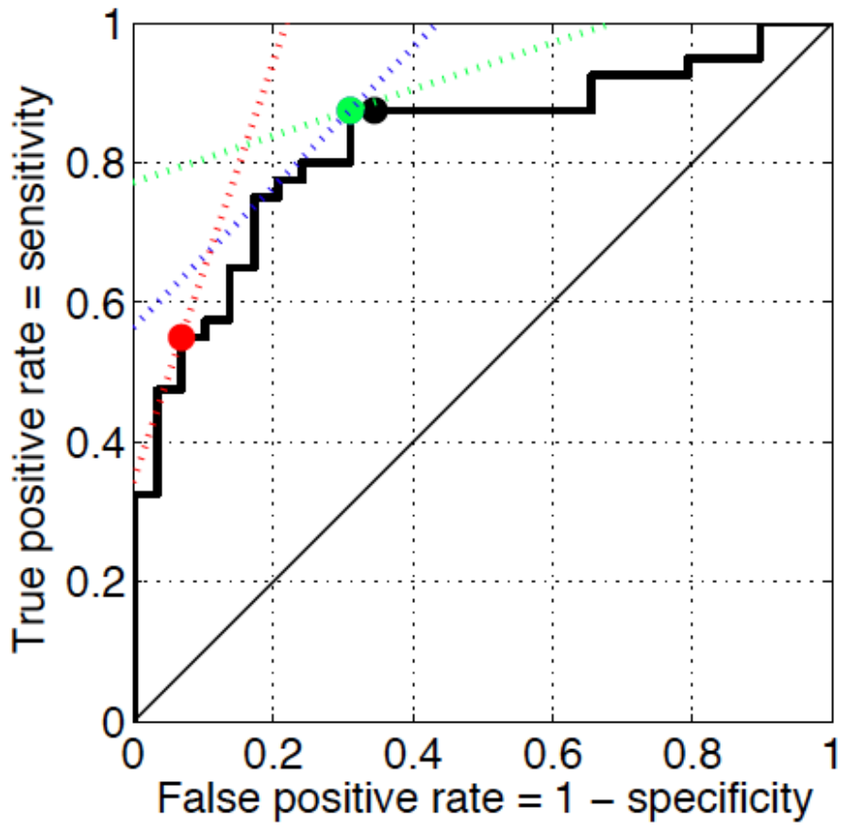
Gaussian process classification of Alzheimer's disease and mild cognitive impairment from resting state fMRI

University of Sussex

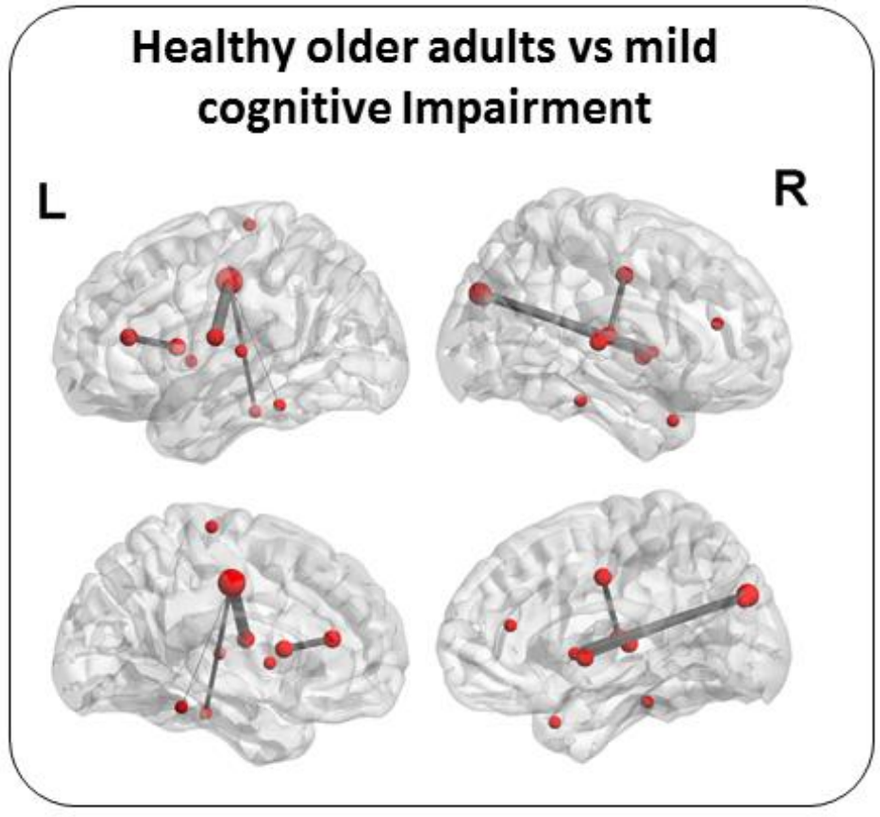
Challis E, Hurley P,
Serra L, Bozzali M,
Oliver S, Cercignani M
Neuroimaging, 2014

Tunable, e.g.

- Sensitivity = 88%
- Specificity = 69%
- Sensitivity = 55%
- Specificity = 93%



(a) NC vs a-MCI



Science & Technology Facilities Council

Global Challenge Concepts fund

ASTRODEM

Finding Early Indicators of Dementia Using Astronomical Techniques

- Medical researchers and astrophysicists have been awarded £94,000 by the Wellcome Trust to improve the early diagnosis of dementia.
- Astrophysicists will swap galaxies for general practice and analyse 96,000 anonymous GP records and identify common, early indicators of dementia.
- Only 50-60% of patients with dementia currently receive a diagnosis, and the UK government has prioritised increasing diagnosis rates.
- Timely diagnosis allows patients to maximise their quality of life, benefit from treatments and plan for the future
- Researchers will create probabilistic models to predict each patient's risk of having dementia from their GP records
- Novel analysis techniques will accounting for errors in diagnosis to better understand the correlations between underlying conditions.

Science & Technology Facilities Council

wellcome trust

brighton and sussex medical school

University of Sussex