



International
Centre for
Radio
Astronomy
Research



UWA Master of Physics (Astronomy and Astrophysics)

Intro session to 2027 degree

Luca Cortese (he/his/him)

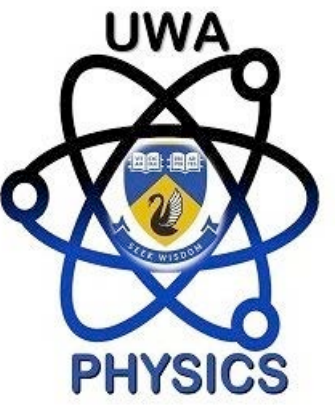
ICRAR-UWA Science Director



ICRAR is a joint venture between Curtin University and The University of Western Australia and receives support from the Western Australian and Australian Governments.



Welcome to the University of Western Australia

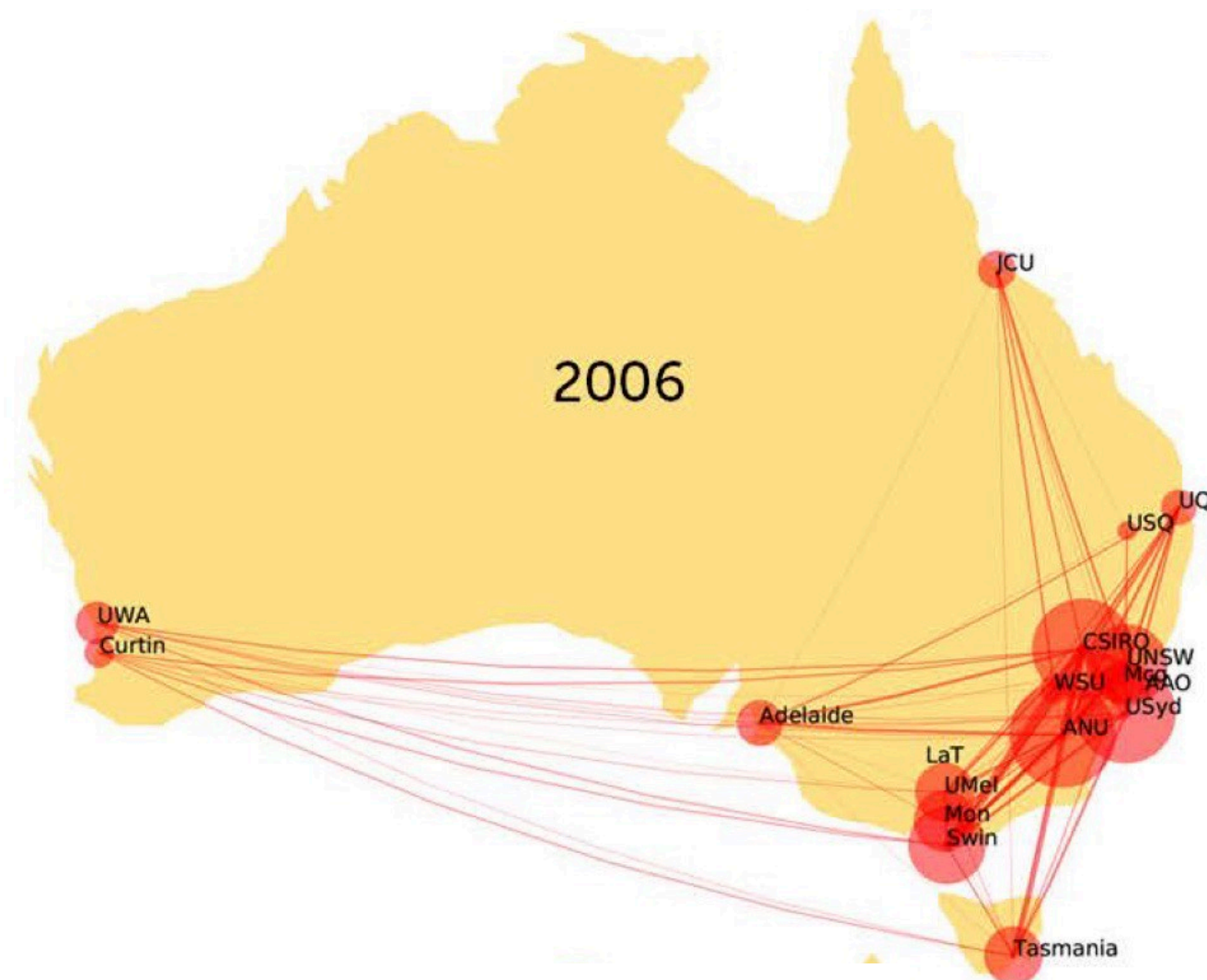


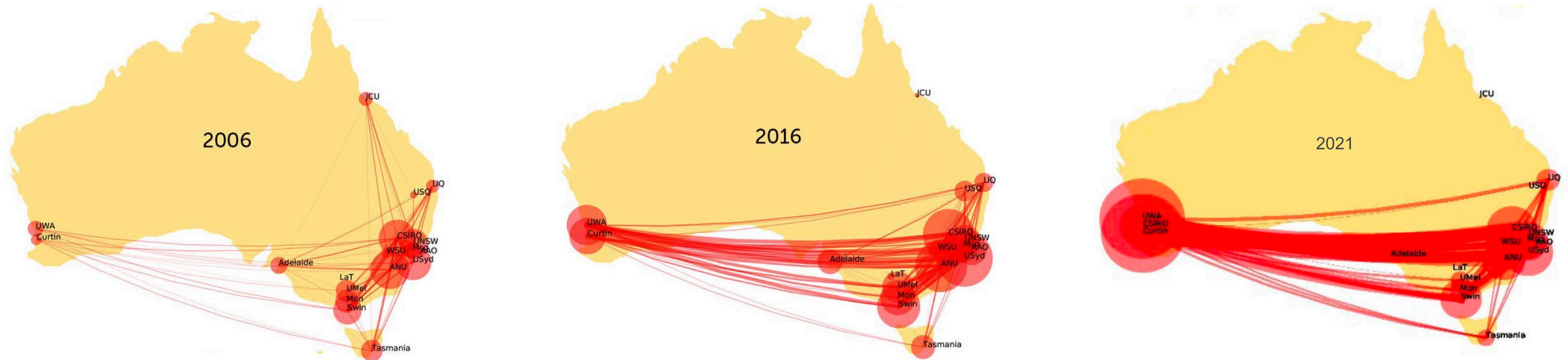
Member of the prestigious
Group of Eight universities



Ranked **77th in the world** in
the QS World University
Rankings 2027







Significant growth (investment and people!) in the astronomy sector in WA in the last ~15 years

Roughly one third of the Australian astronomy community is now based in WA

The Square Kilometre Array



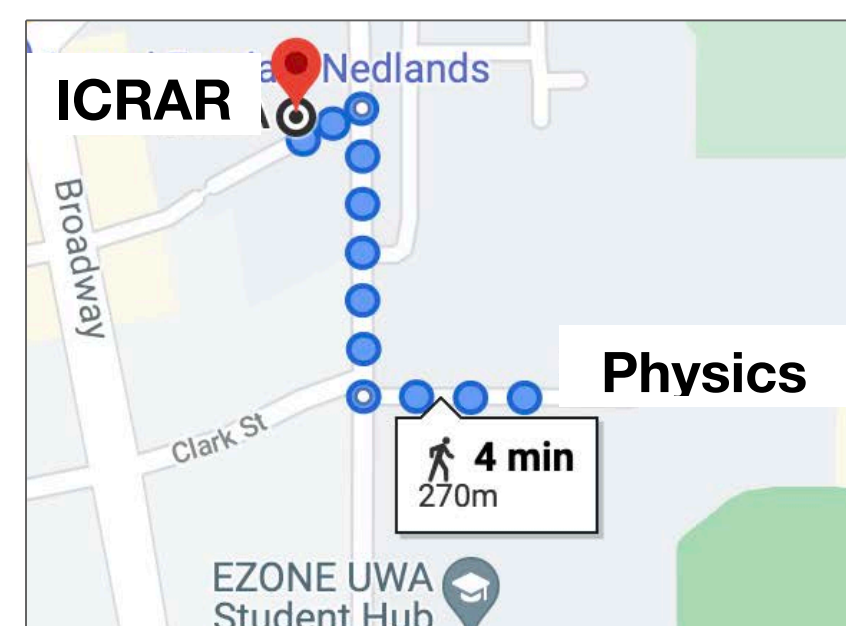


The SKA as the driver of a revolution in WA's astronomy landscape

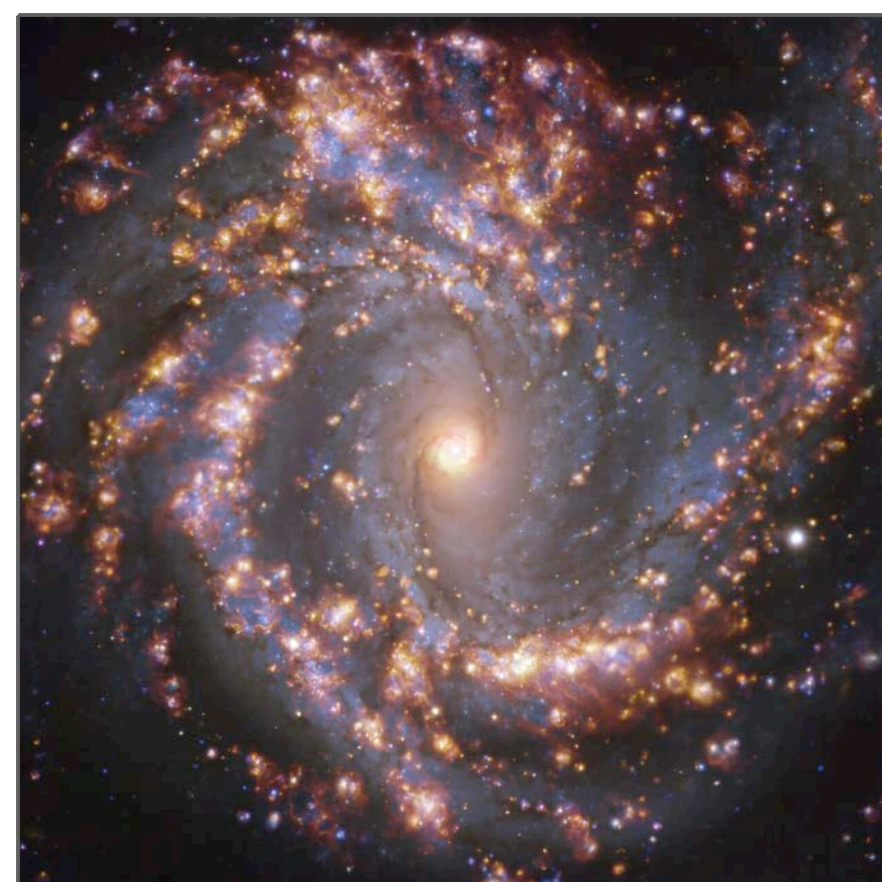


**The International Centre
for Radio Astronomy Research**

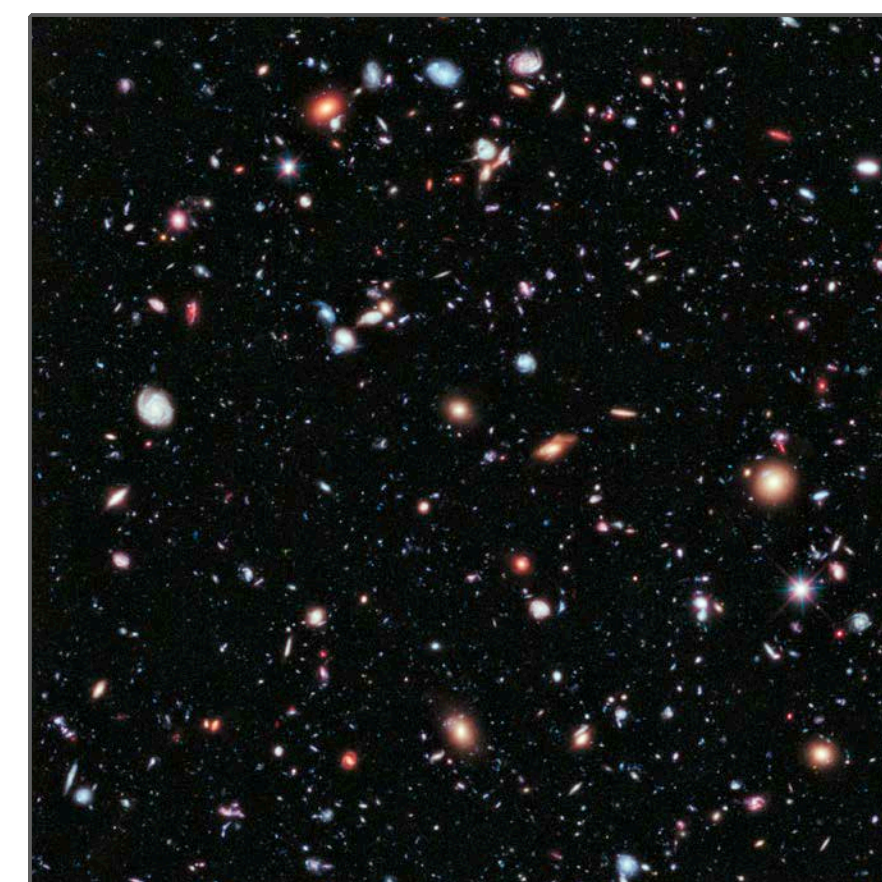
Department of Physics



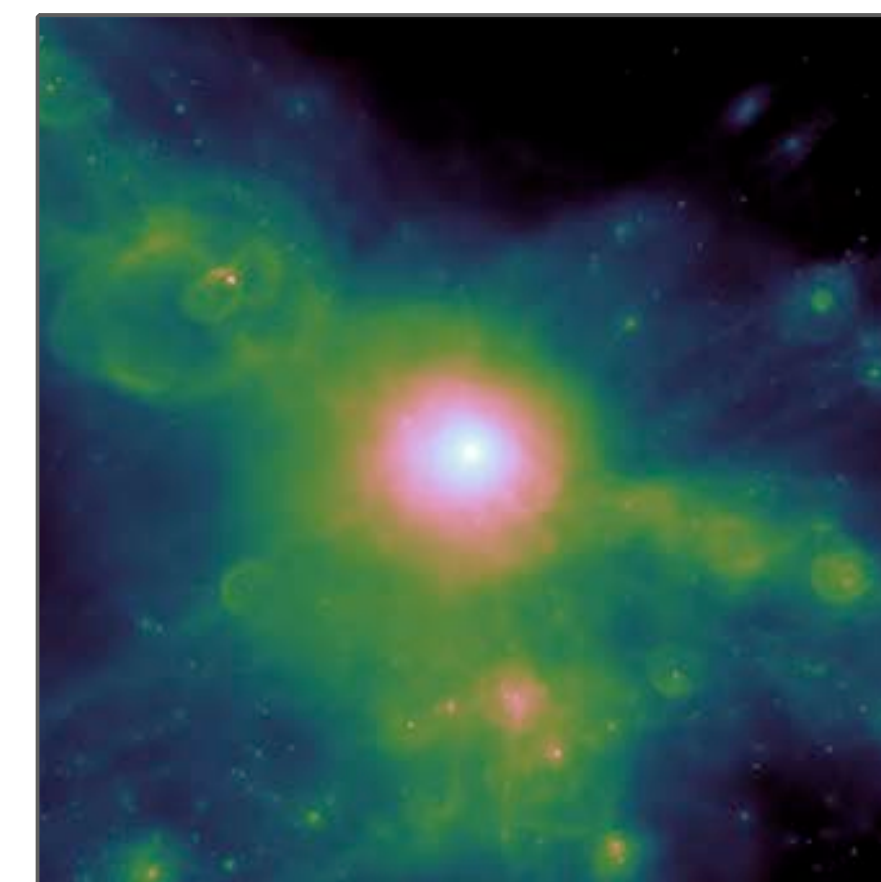
**Physics of the diffuse
Universe**



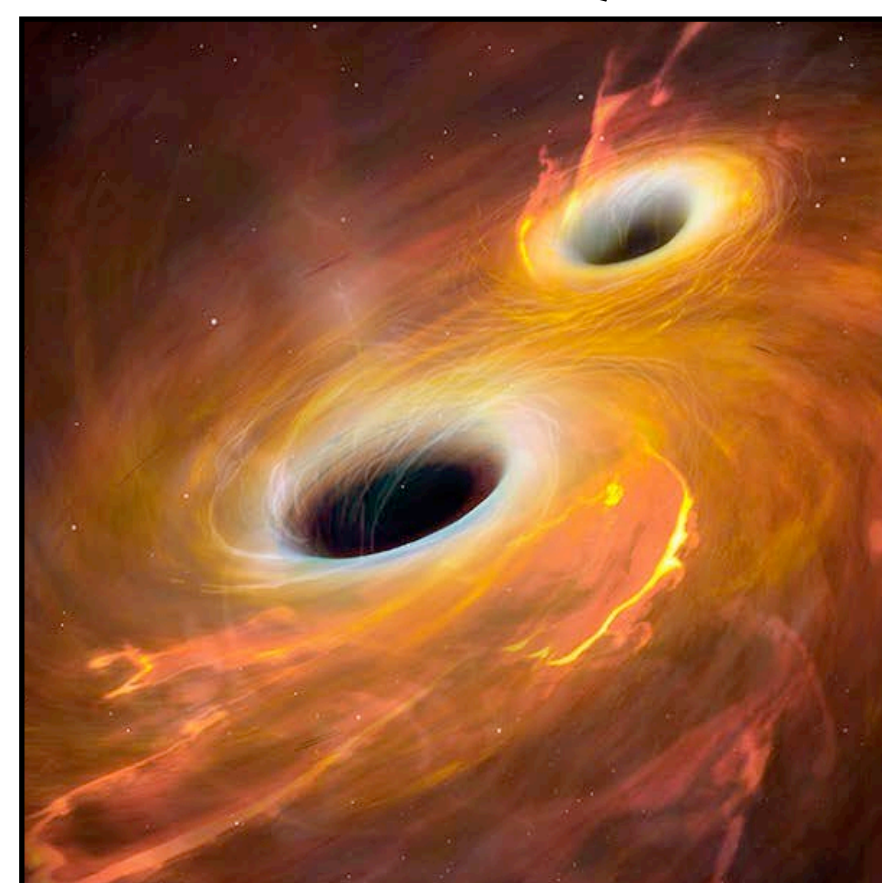
The evolving Universe



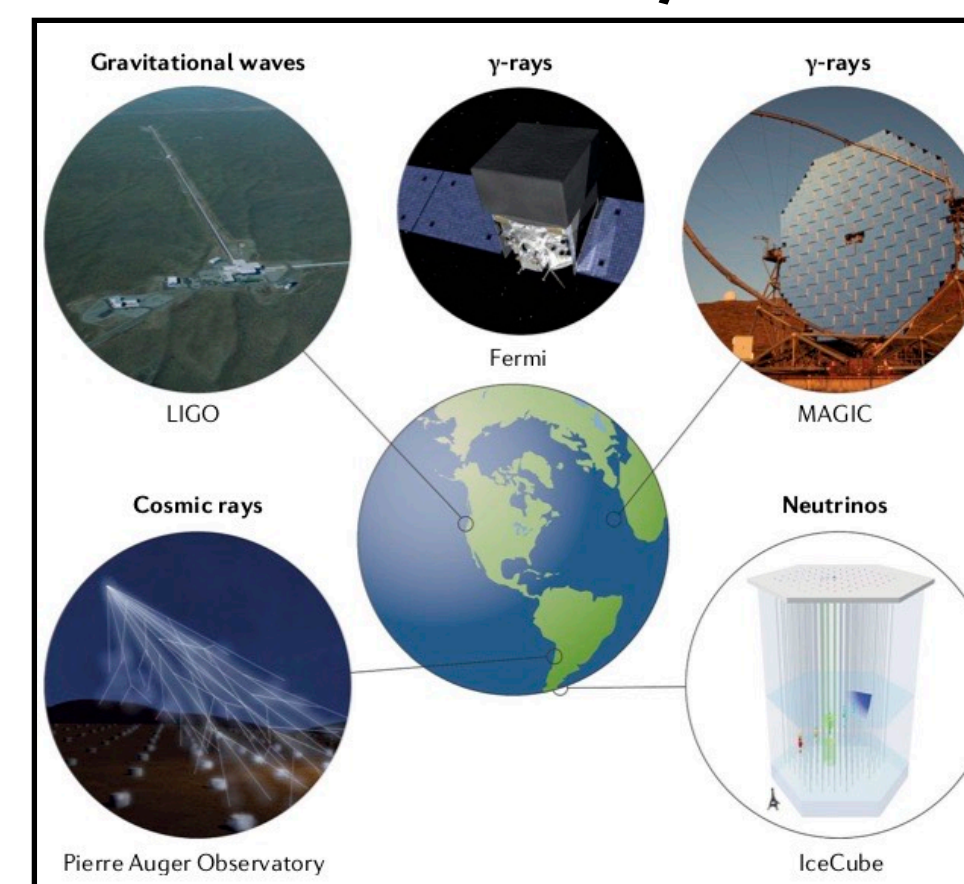
Cosmological Theory



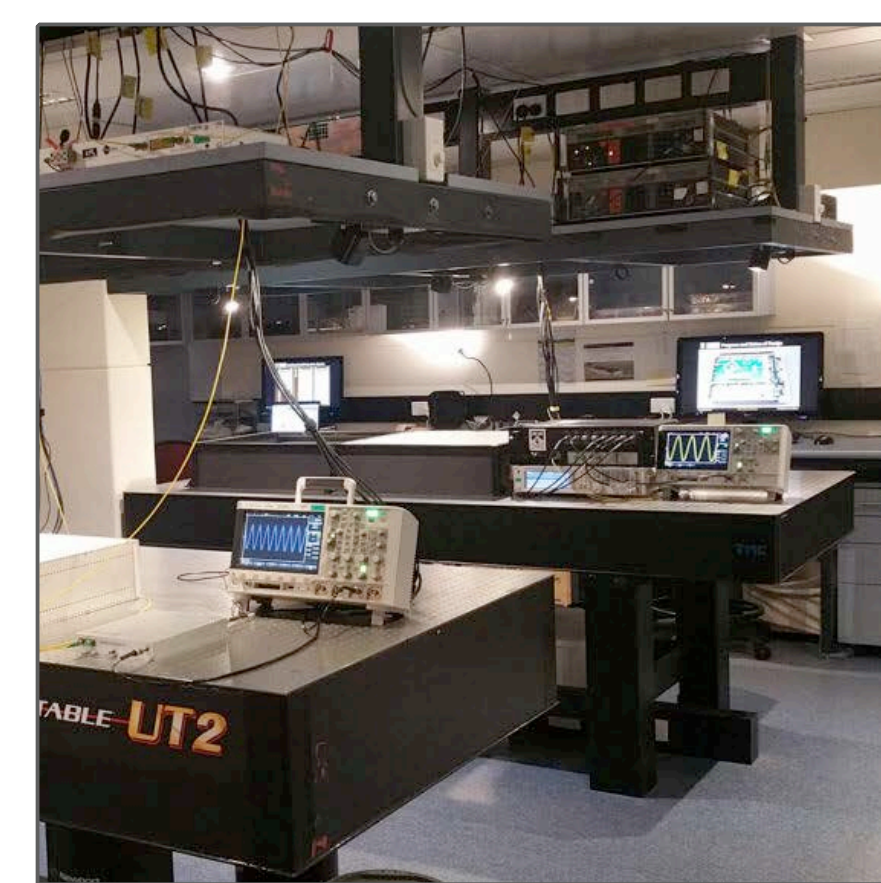
**Gravitational Wave
Astronomy**



**Multimessenger
Astronomy**



Astrophotonics



Advanced Coursework Units

Galaxies and Galactic Dynamics

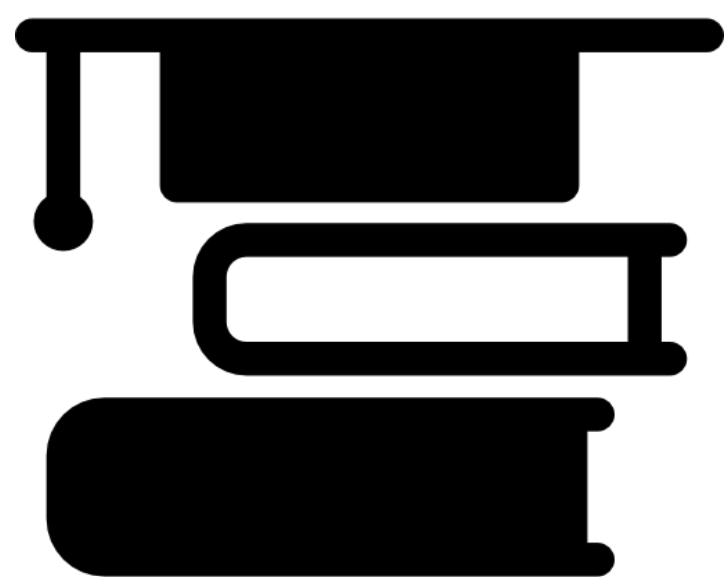
Radio Astronomy and the Interstellar Medium

Gravitational Wave and Multi-messenger Astronomy

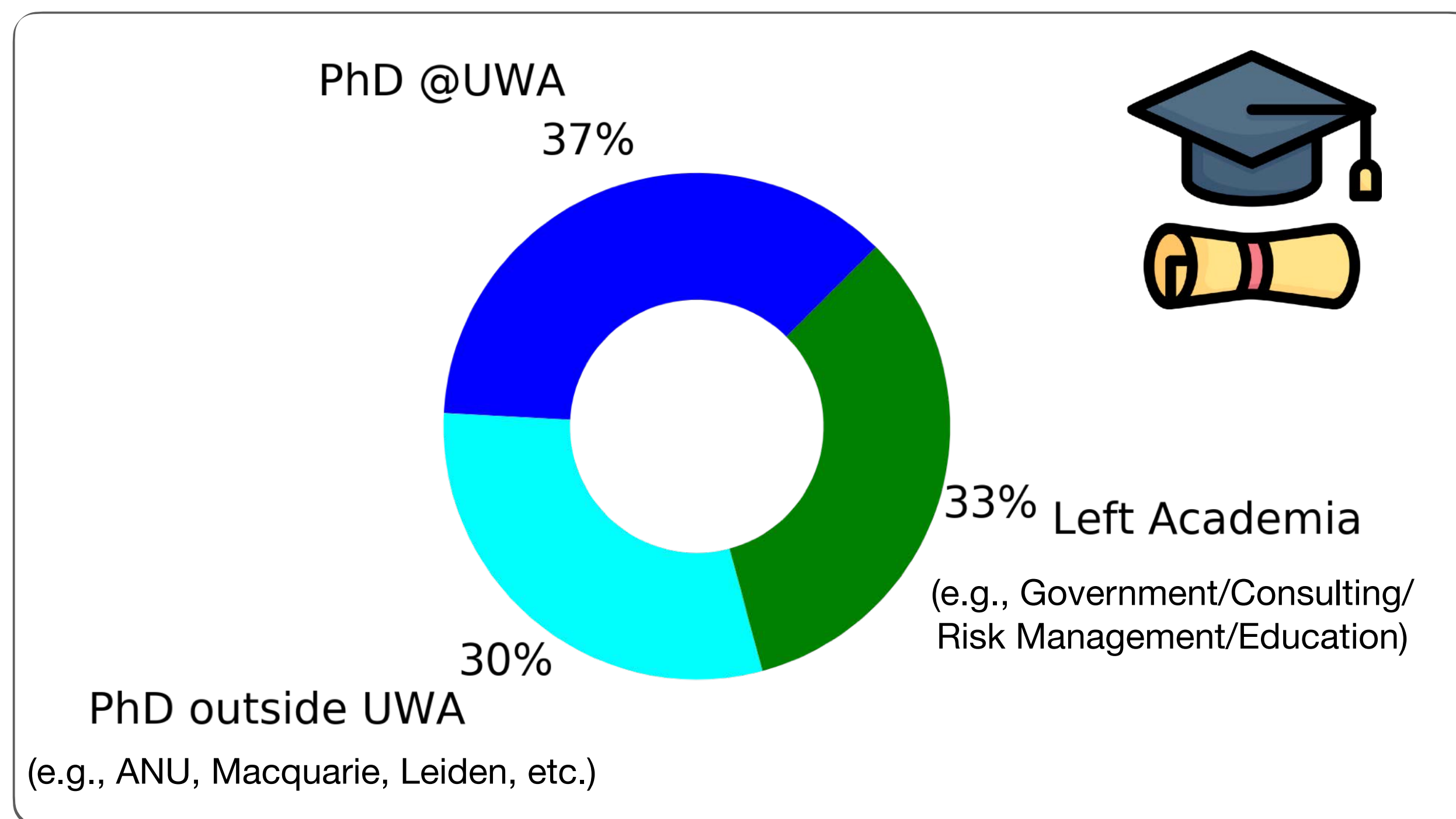
Cosmological Physics

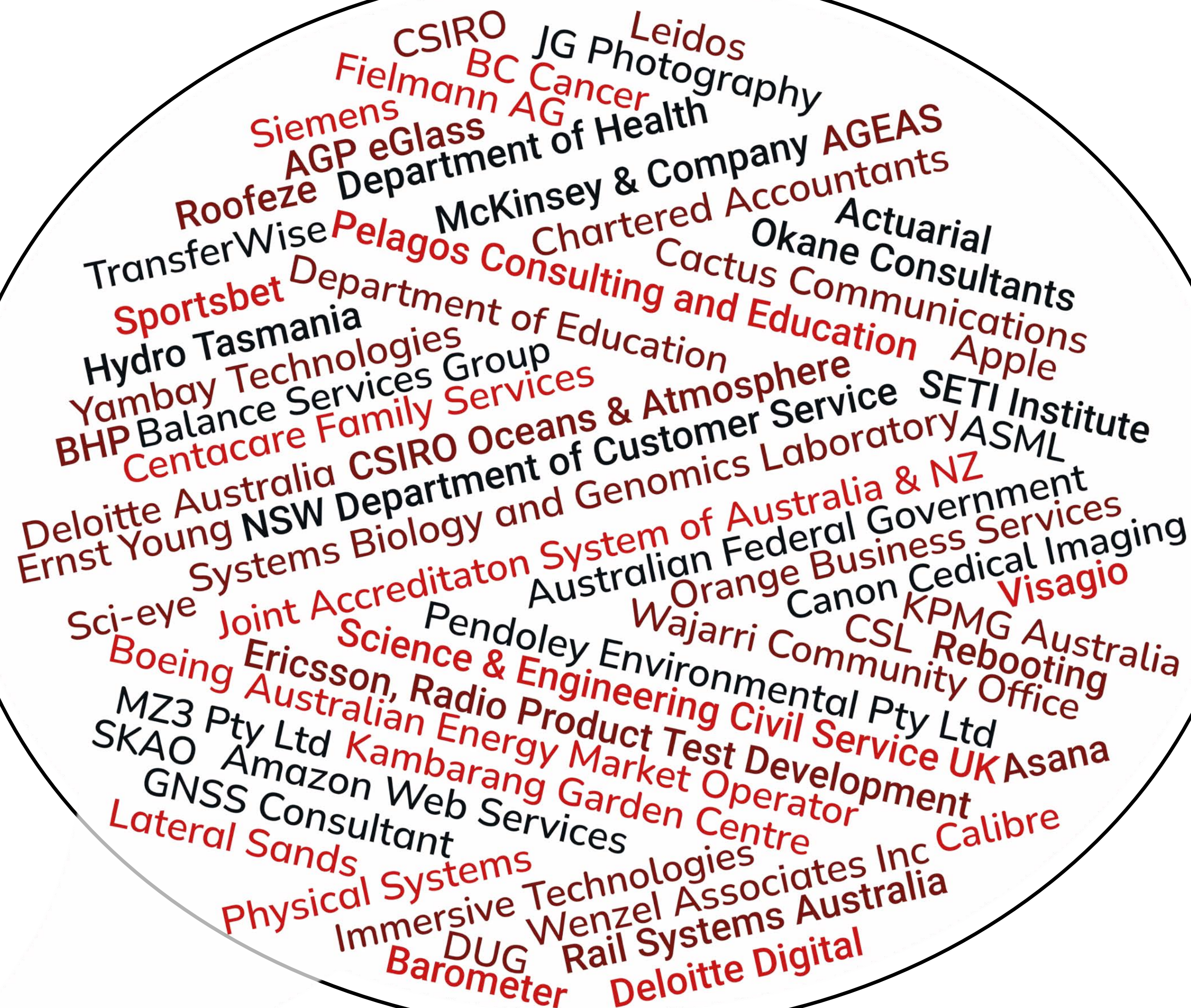
Computational Statistics for Physics

and more...!

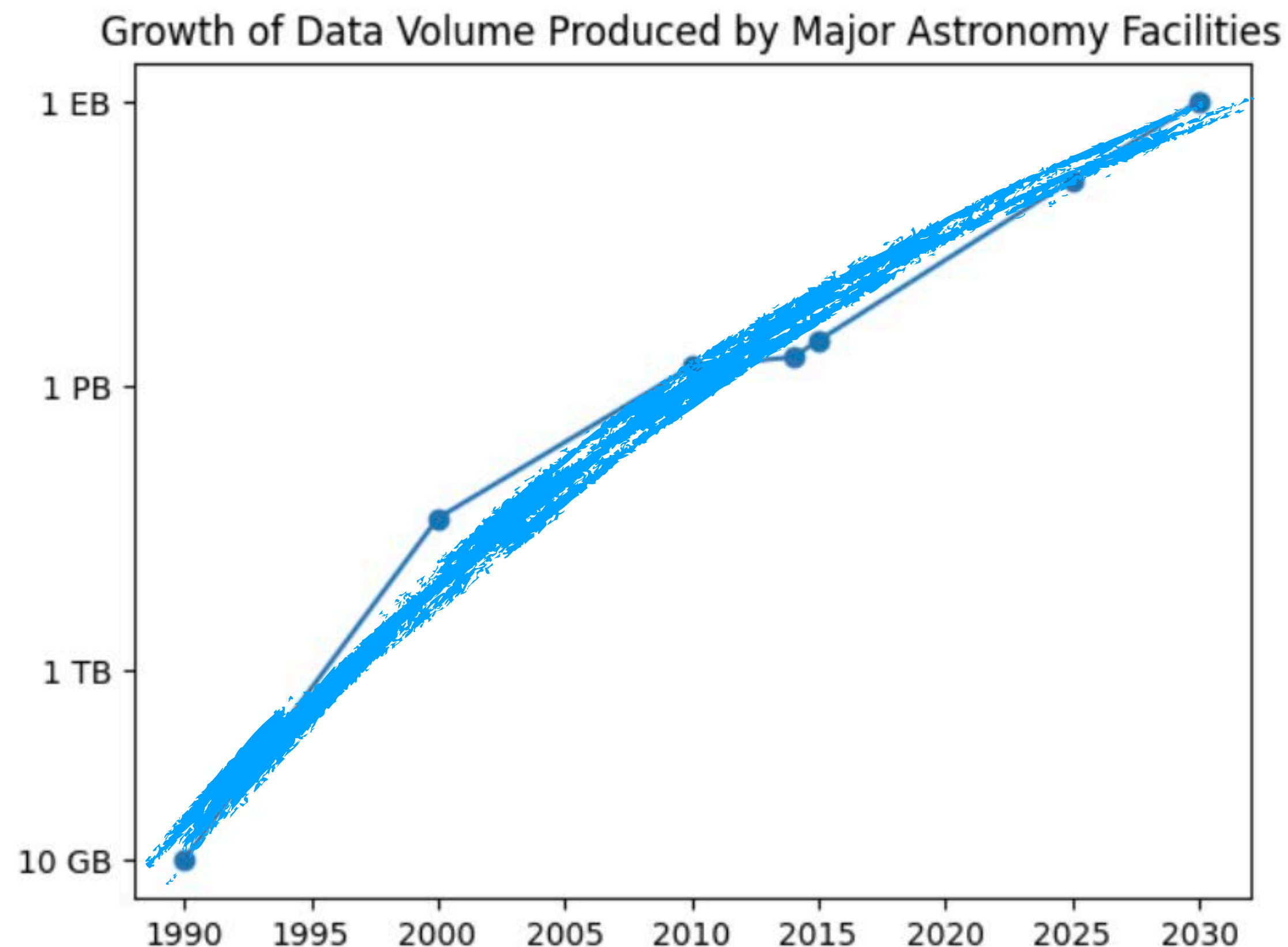


Transferrable skills!





Avalanche of data requires modern ways to tackle the key questions in the field



Astrophysics is one of the most advanced areas of data science. We extract a lot of info from data with low signal and high noise



Make the most of what UWA offers to postgraduate students!

Research/Coursework

- **Desk/Desktop**
Your place where to study, do research and interact with staff and students
- **Research group meetings**
Discuss with your supervisor
- **Seminars/Journal Club**
Hear the latest about the research work done
At UWA and/or world-wide
- **Student's Plot of the Week**
Students-only event to discuss research and socialise

Training/Support Network

- **Mentors**
PhD student/ECR/Staff to provide one-on-one support and expand network
- **Development, Equity and Inclusion Initiatives**
Training (Mental Health, Resilience, Writing workshops, etc)
Wards - support network in case of confidential issues
Anonymous feedback (on-line form or pigeon-hole)

One of the most supportive environments in Australia!



Master of Physics Astronomy & Astrophysics

Information for Commencing Students

Matthew Young



THE UNIVERSITY OF
WESTERN
AUSTRALIA

Our Programme

**Programme
Chair**

Specializations

**Specialization
Coordinators**

Our Programme

**Programme
Chair**

Specializations

**Specialization
Coordinators**

Prof Ju Li



Master of Physics

Our Programme

**Programme
Chair**

Prof Ju Li



Master of Physics

Specializations

Astrophysics

Computational

Experimental

Quantum
Technology & Computing

Medical

Theoretical

**Specialization
Coordinators**

Our Programme

Programme Chair

Prof Ju Li



Master of Physics

Specializations

- Astrophysics
- Computational
- Experimental
- Quantum
Technology & Computing
- Medical
- Theoretical

Specialization Coordinators



Matthew Young



Jingbo Wang



Ju Li



Mike Tobar



Pejman
Rowshan Farzad



Darren Grasso

Master of Physics

Astronomy & Astrophysics Specialisation

Webpages

- How to [Study the Master of Physics at UWA](#)
- UWA Handbook Entry - [Master of Physics](#)
- [Specific Information](#) on the Astronomy & Astrophysics specialisation

Master of Physics

Fees

Master of Physics at UWA has Commonwealth Supported Places (CSP) for Domestic Students.

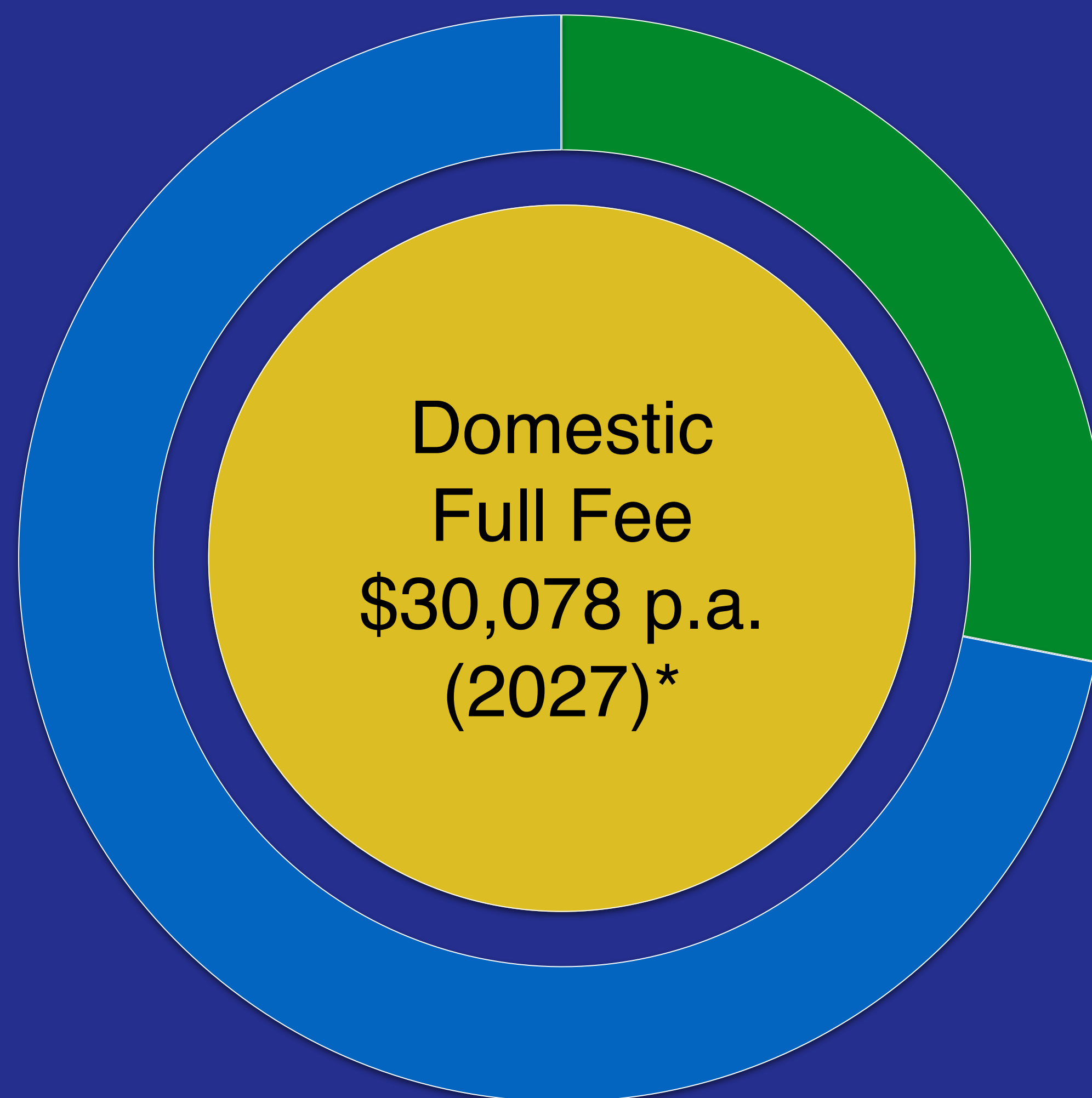
Master of Physics - Domestic Student Fees



Domestic
Full Fee
\$30,078 p.a.
(2027)*

* Indicative. See education.gov.au - 2027 Allocation of units of study to funding clusters

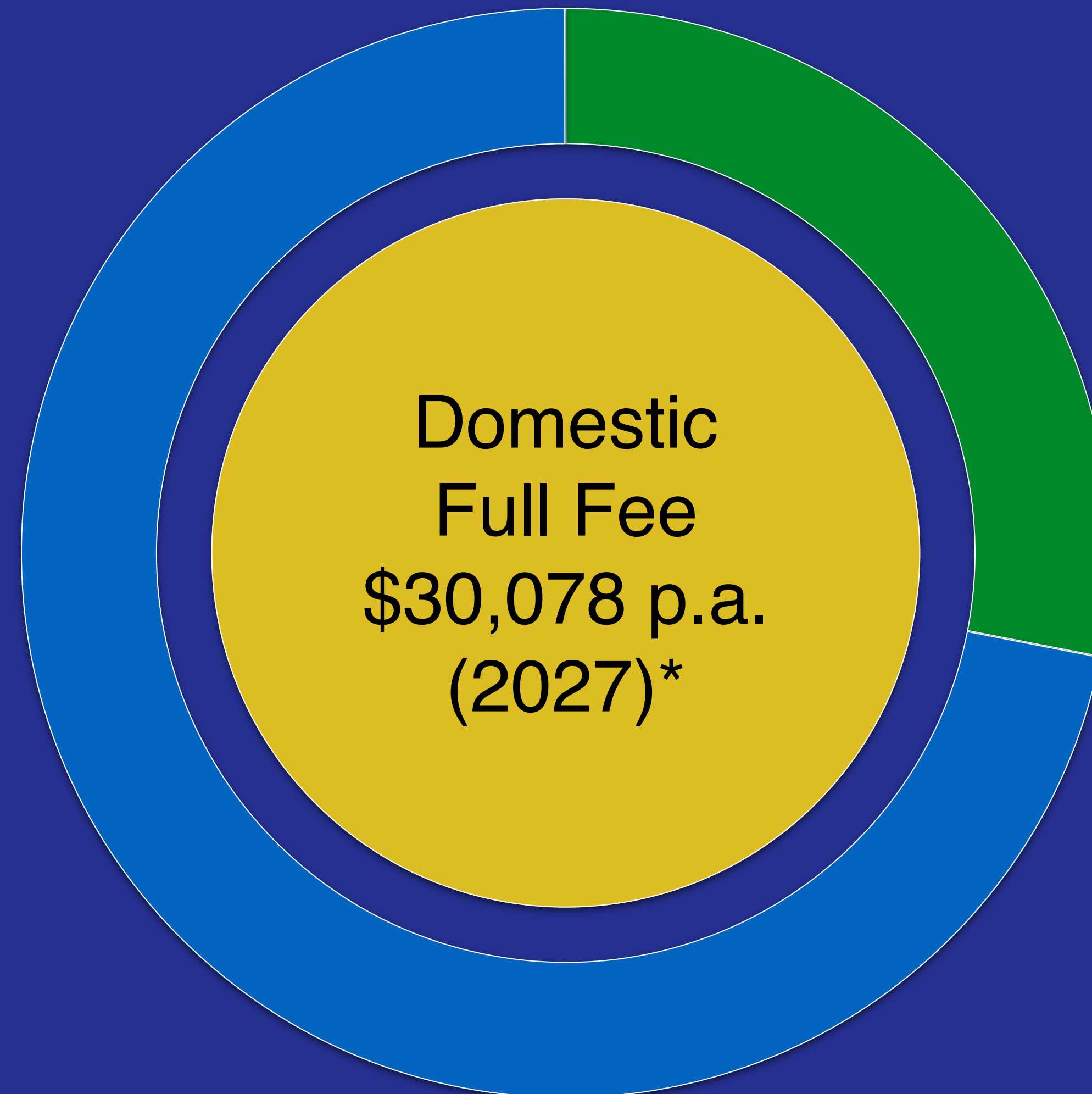
Master of Physics - Domestic Student Fees



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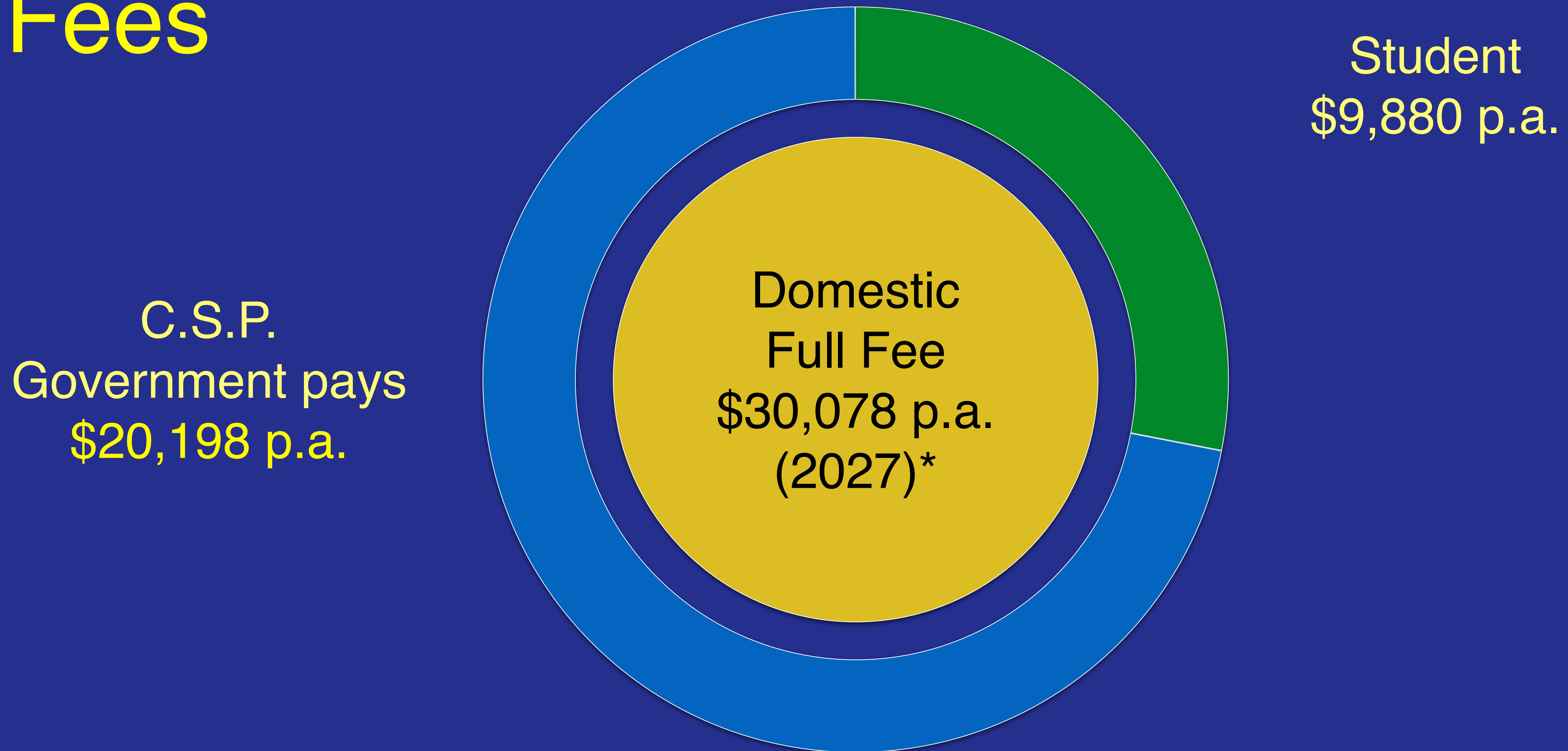
Master of Physics - Domestic Student Fees

C.S.P.
Government pays
\$20,198 p.a.



* Indicative. See education.gov.au - 2027 Allocation of units of study to funding clusters

Master of Physics - Domestic Student Fees



* Indicative. See education.gov.au - 2027 Allocation of units of study to funding clusters

Master of Physics

Fees:

Master of Physics at UWA has Commonwealth Supported Places (CSP) for Domestic Students.

Few Australian Universities have CSPs for Physics/Astrophysics Masters courses!

Master of Physics - International Student Fees



International
\$53,500 p.a.
(2026)

Master of Physics - International Student Fees



International
\$53,500 p.a.
(2026)

Some Scholarships

Master of Physics - Scholarships

Master of Physics - Scholarships

Examples:

Master of Physics - Scholarships

Examples:

Master of Physics - Scholarships

Examples:

- The [Renu Sharma Scholarship](#) in Astronomy and Astrophysics

Master of Physics - Scholarships

Examples:

- The [Renu Sharma Scholarship](#) in Astronomy and Astrophysics
- Muriel & Colin Ramm Postgraduate [Scholarship in Physics](#)

Master of Physics - Scholarships

Examples:

- The [Renu Sharma Scholarship](#) in Astronomy and Astrophysics
- Muriel & Colin Ramm Postgraduate [Scholarship in Physics](#)
- Global Excellence [Scholarships](#)

Master of Physics - Scholarships

Examples:

- The [Renu Sharma Scholarship](#) in Astronomy and Astrophysics
- Muriel & Colin Ramm Postgraduate [Scholarship in Physics](#)
- Global Excellence [Scholarships](#)
- Search [UWA Fees & Scholarships](#)

Structure

Structure

Year 1

Semester 1

Semester 2

Year 2

Semester 3

Semester 4

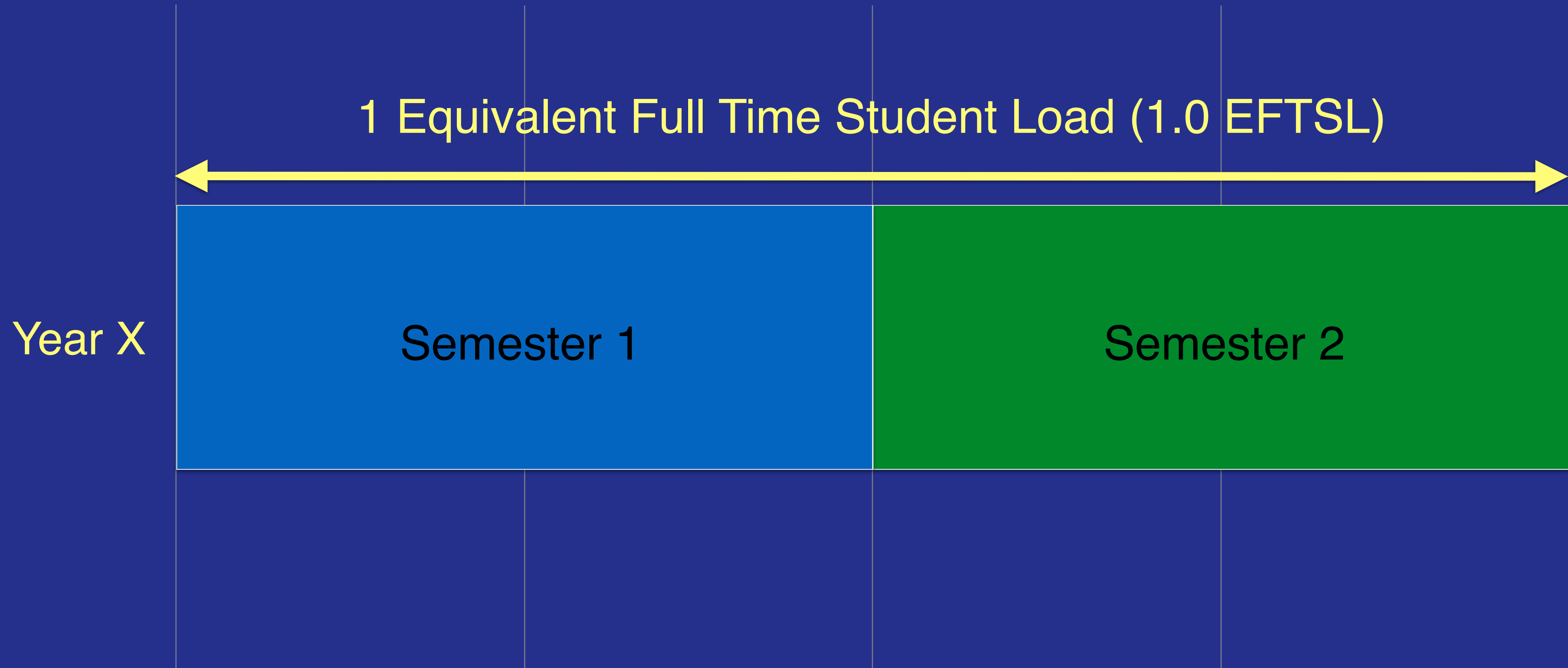
Structure

Year X

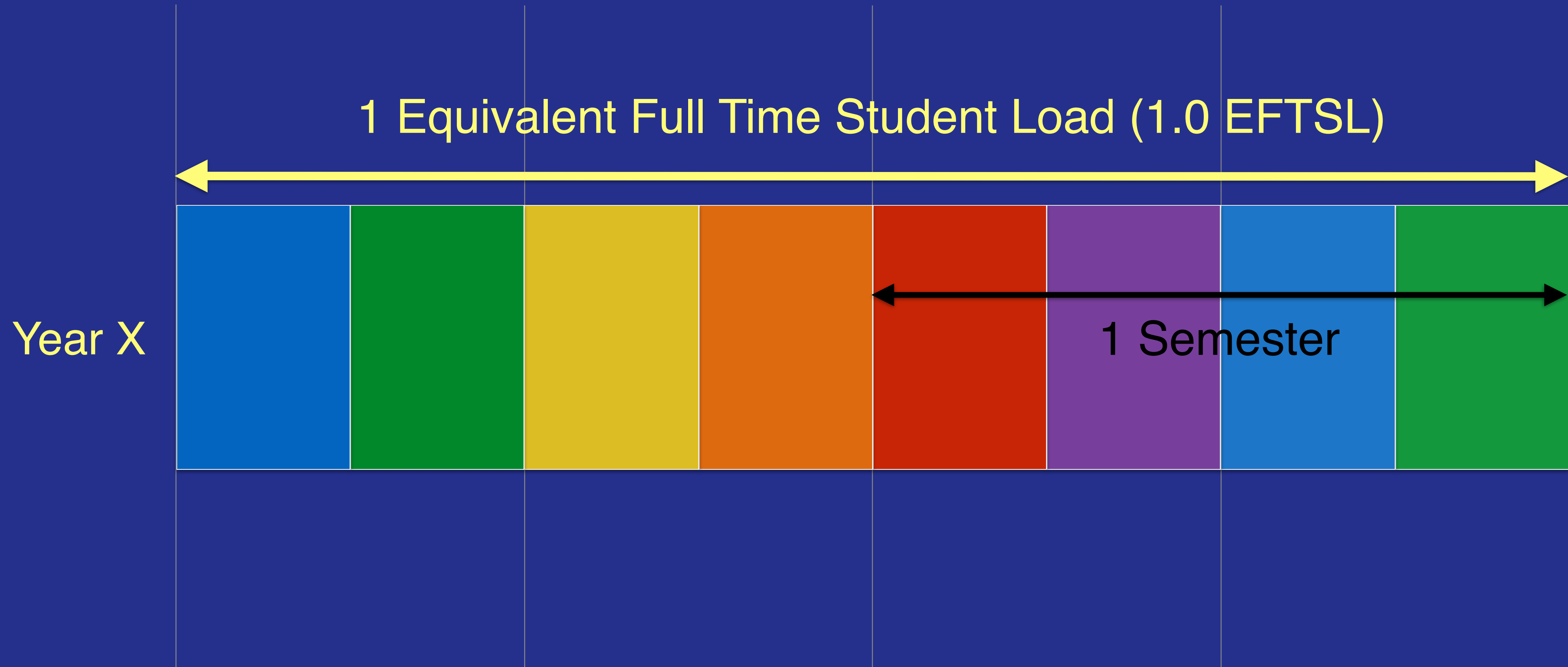
Semester 1

Semester 2

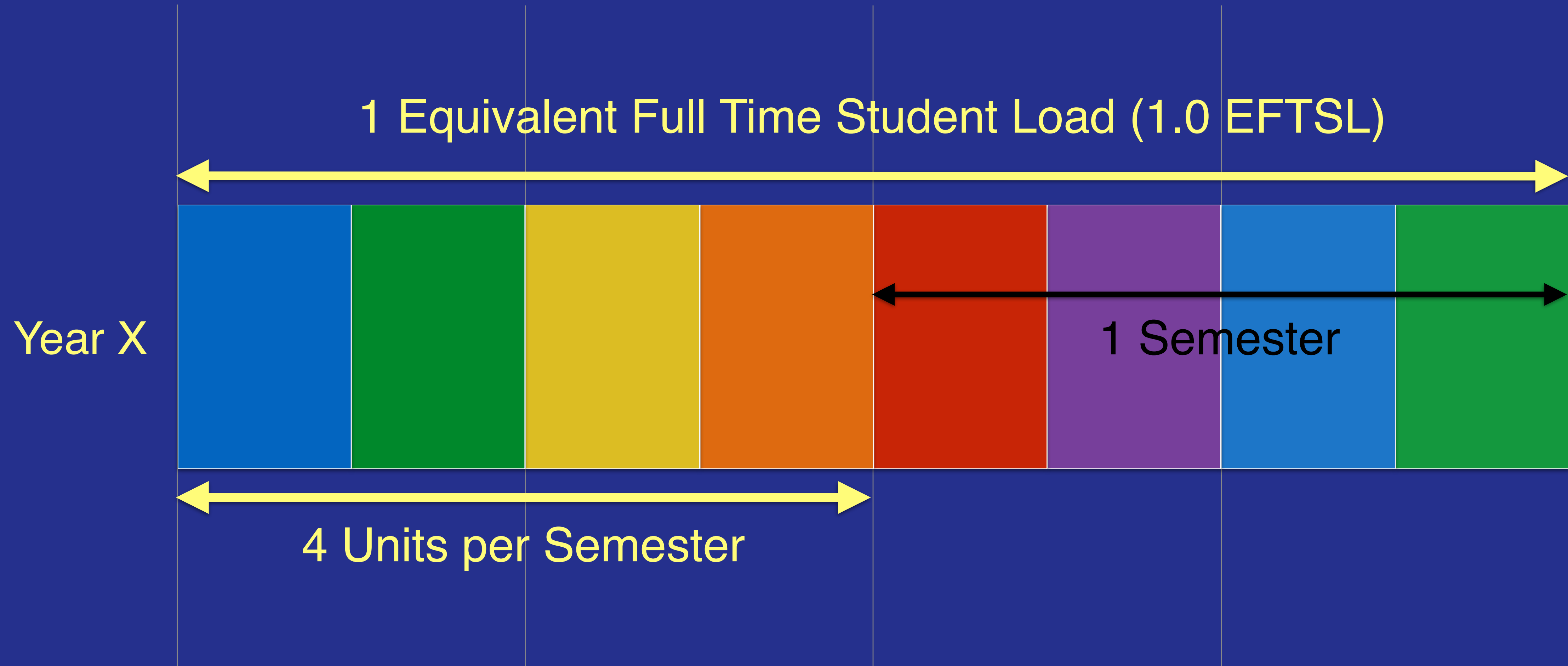
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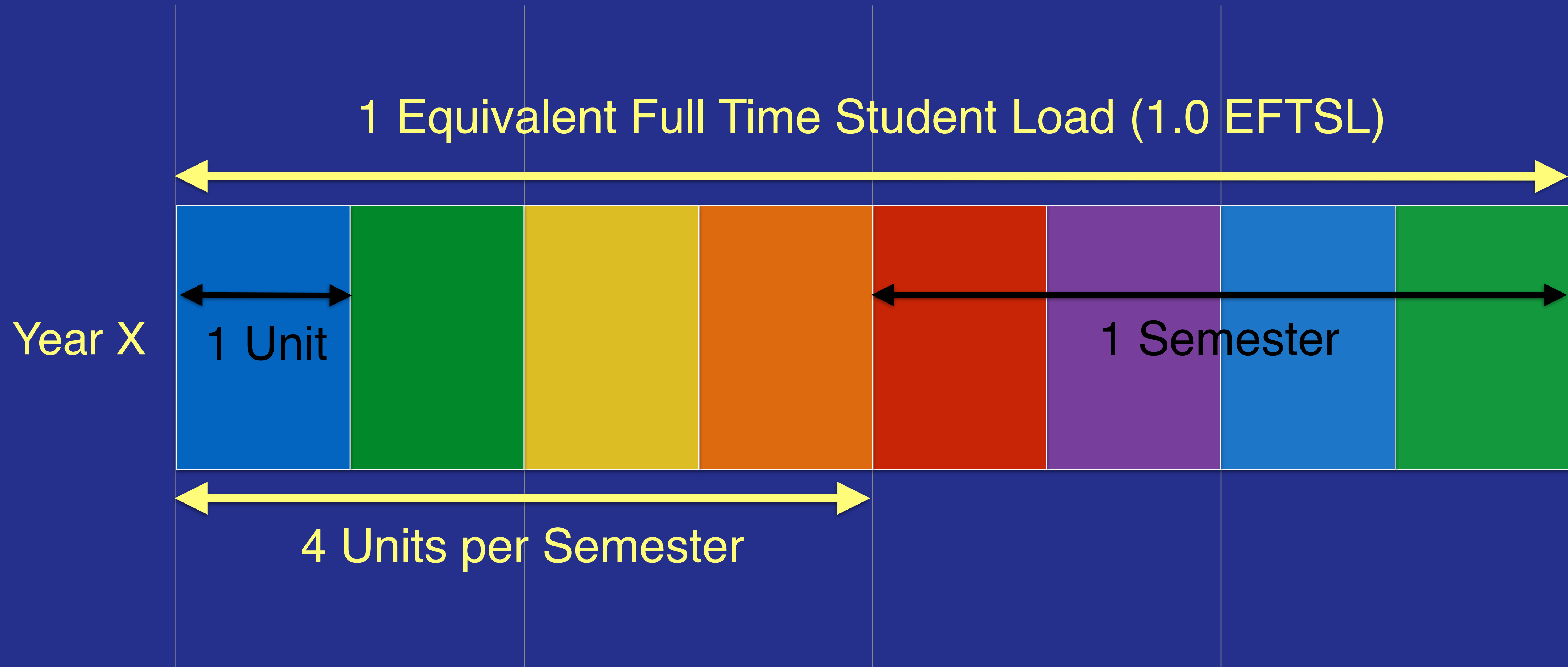
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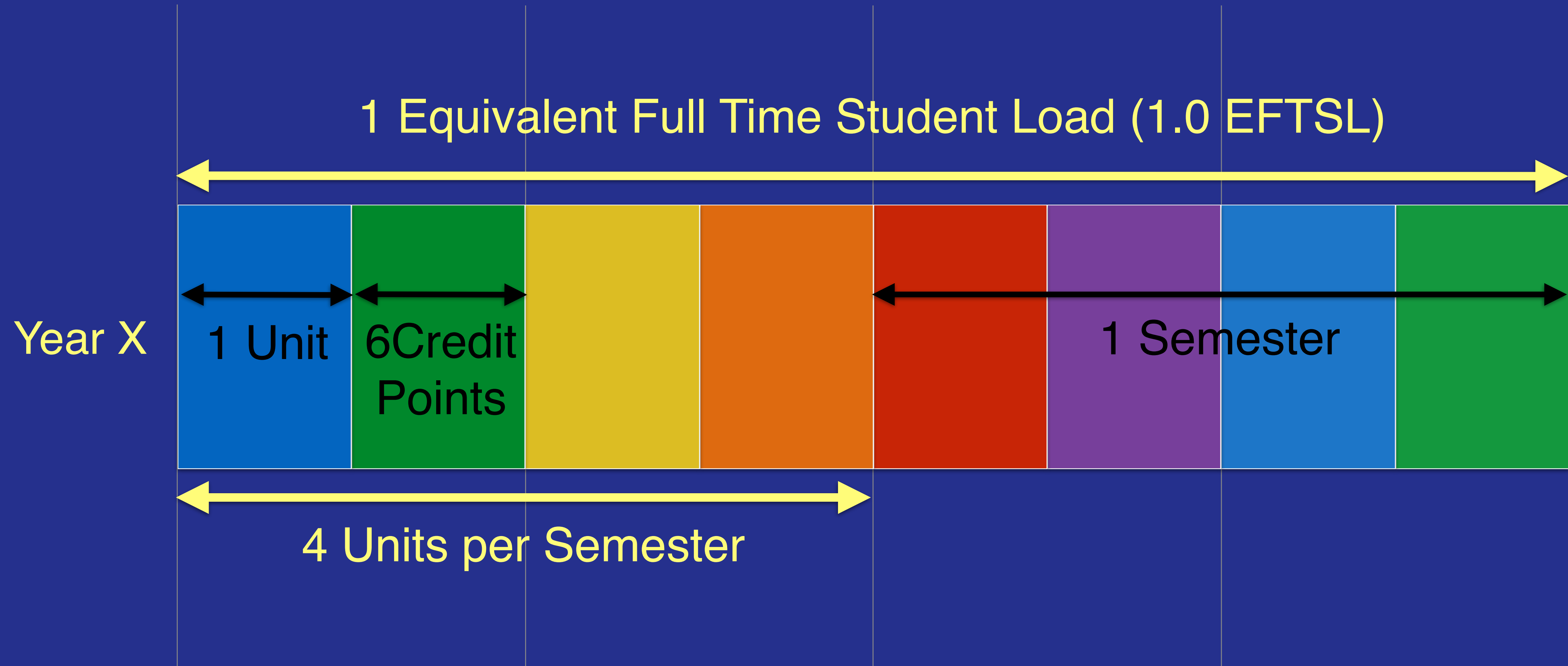
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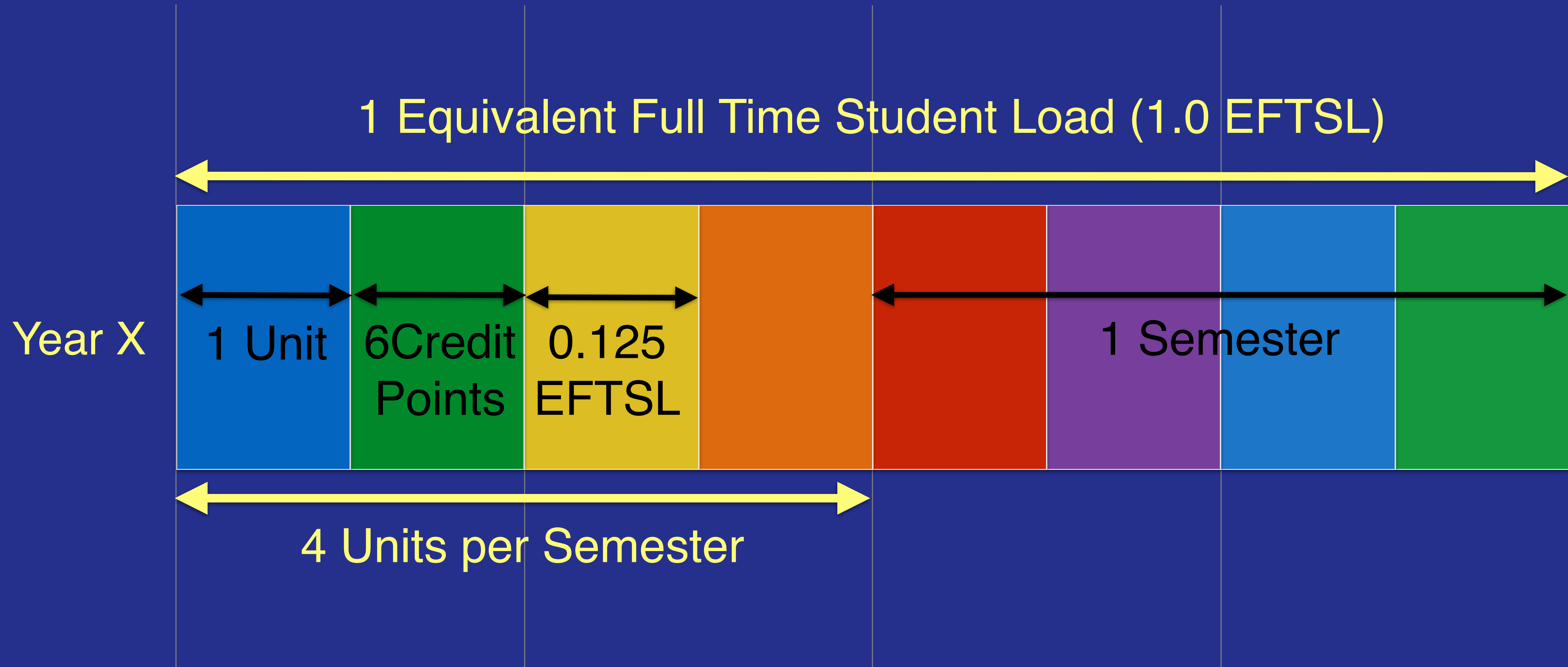
Structure



Structure



Structure



Structure

Year 1

Semester 1

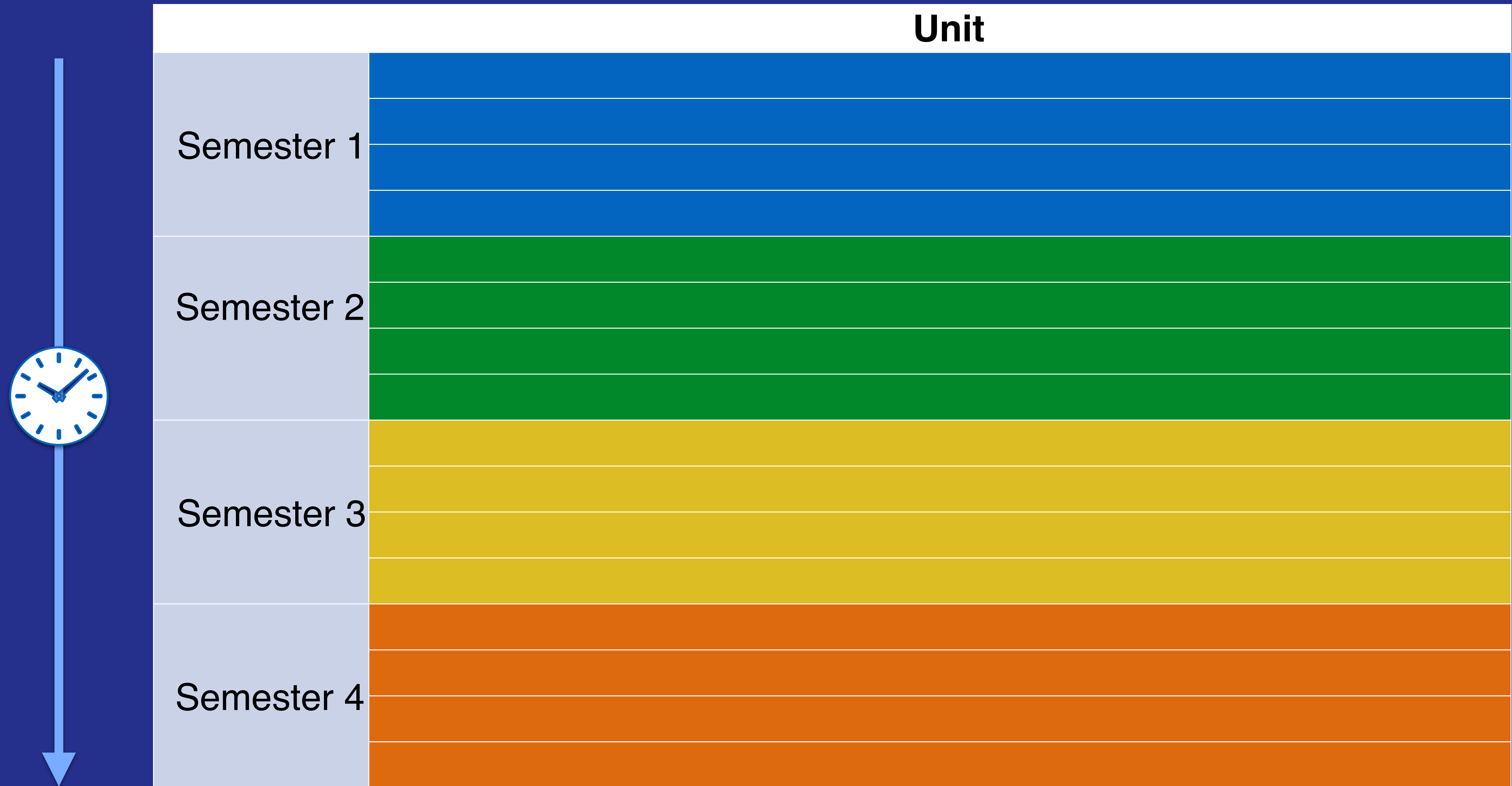
Semester 2

Year 2

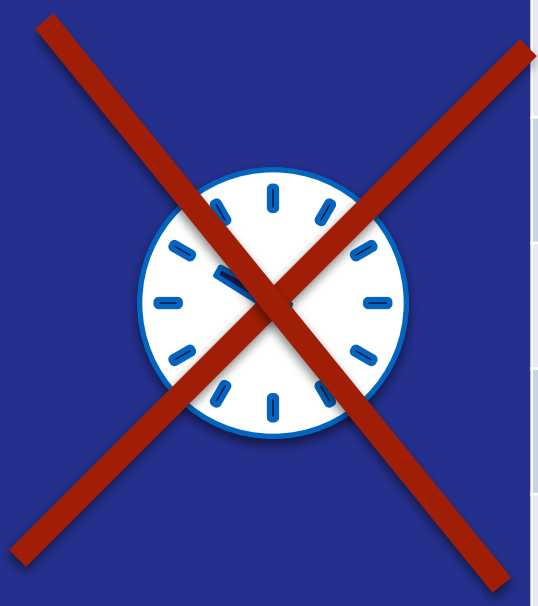
Semester 3

Semester 4

Structure



Structure



Unit	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Structure

Unit	
1	10 Coursework Units
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	6 Research Units
12	
13	
14	
15	
16	

Structure

Unit	
1	6 Coursework Units (Non-Core)
2	
3	
4	
5	
6	
7	4 Coursework Units (Core)
8	
9	
10	
11	6 Research Units (Core)
12	
13	
14	
15	
16	

Structure

Unit	
1	6 Coursework Units (Non-Core)
2	
3	
4	
5	
6	
7	Radio Astronomy & the Interstellar Medium
8	Galaxies & Galactic Dynamics
9	Cosmological Physics
10	Computational Statistics for Physics
11	6 Research Units (Core)
12	
13	
14	
15	
16	

Structure

Unit	
1	
2	
3	6 Coursework Units (Non-Core)
4	
5	
6	
7	Radio Astronomy & the Interstellar Medium
8	Galaxies & Galactic Dynamics
9	Cosmological Physics
10	Computational Statistics for Physics
11	Research Proposal in Astronomy & Astrophysics
12	Physics Research Project Part 1
13	Physics Research Project Part 2
14	Physics Research Project Part 3
15	Physics Research Project Part 4
16	Dissertation in Astronomy & Astrophysics

Structure

Unit	
1	Required Conversion Units OR Coursework Units (Option)
2	OR
3	Advance Standing
4	
5	2 Coursework Units (Option)
6	
7	Radio Astronomy & the Interstellar Medium
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Structure

Up to 4 Required Conversion Units	
CITS1401	Computational Thinking with Python
MATH2501	Advanced Mathematical Methods
PHYS2001	Quantum Physics & Electromagnetism
PHYS2002	Many-Particle Systems
PHYS2003	Physics for Electrical Engineers
PHYS3001	Quantum Mechanics & Atomic Physics
PHYS3002	Electrodynamics & Relativity
PHYS3003	Astrophysics & Space Science
PHYS3005	Quantum Computation
PHYS3011	Mathematical Physics
PHYS3012	Topics in Contemporary Physics (Astro Stream)
PHYS3101	Quantum Field Theory & Quantum Technology

See the [UWA Handbook](#) for up-to-date information

Structure

Unit	
1	Required Conversion Units OR Coursework Units (Option)
2	OR
3	Advance Standing
4	
5	2 Coursework Units (Option)
6	
7	Radio Astronomy & the Interstellar Medium
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Structure

Available	Take 2 — 6 Option Units
Sem 2	Gravitational-Wave and High-Energy Astronomy
Sem 1	Frontiers in Experimental Physics
Sem 1	Computational Methods for Physics
Sem 1	Quantum Information & Computing
Sem 2	Differential Geometry & General Relativity
Sem 1	Advanced Mathematical Physics & Relativistic Electrodynamics
Sem 1	Symmetry Principles in Physics
Sem 2	Advanced Statistical & Condensed Matter Physics
Sem 2	Quantum Measurement & Technology
Sem 2	Quantum Field Theory
Sem 1,2	Physics Reading Unit

See the [UWA Handbook](#) for up-to-date information

Example Study Plans

- 🔄 Kim has completed an undergraduate degree at UWA
- 🔄 Sam is a domestic student who has completed an undergraduate degree in Physics, and requires some conversion units prior to commencing research..
- 🔄 Avery is a domestic student who has completed an undergraduate degree in Physics, and requires some conversion units for coursework, but is otherwise ready to commence some research.
- 🔄 Ash is an international student commencing in Semester 2, and requires some conversion units
- 🔄 Jo is an international student commencing in Semester 2, with a strong background in physics and astrophysics
- 🔄 Jay is a domestic student who completed an undergraduate degree in Physics two years ago, with a strong focus on quantum mechanics
- 🔄 Cam is a domestic student who completed an undergraduate degree in Physics four years ago
- 🔄 Jackie has completed an undergraduate degree at UWA, and does not want to take optional units

Link to [Example Study Plans](#)

Example Study Plans: “Kim”

Example Study Plans: “Kim”

- BSc Physics + Mathematics & Statistics = UWA Physics
- Statistics
- Basic programming in R
- Offered 24 points of advance standing (4 units), but decides to take 4 additional option units instead to make the most of the MPhys
- Completing the degree over four semesters
- Keen to start research early in the course

Example Study Plans: “Kim”

	Unit	Type
Semester 1	Radio Astronomy & the Interstellar Medium	
	Galaxies & Galactic Dynamics	
	Frontiers in Experimental Physics (Astro Stream)	Option
	Research Proposal in Astronomy & Astrophysics	
Semester 2	Cosmological Physics	
	Computational Statistics for Physics	
	Gravitational-Wave and High-Energy Astrophysics	Option
	Physics Research Project Part 1	
Semester 3	Physics Research Project Part 2	
	Physics Research Project Part 3	
	Computational Methods for Physics	Option
	Advanced Mathematical Physics & Relativistic Electrodynamics	Option
Semester 4	Physics Research Project Part 4	
	Dissertation in Astronomy & Astrophysics	
	Differential Geometry & General Relativity	Option
	Frontiers in Quantum Computation	Option

Example Study Plans: “Sam”

- BSc Physics < UWA Physics
- No astronomy or astrophysics units
- No programming experience
- Takes 4 Conversion Units
- Delays commencing Research Units until completed more coursework
- Completing the degree over four semesters

Example Study Plans: “Sam”

	Unit	Type
Semester 1	Computational Thinking with Python	Conv
	Astrophysics & Space Science	Conv
	Radio Astronomy & the Interstellar Medium	
	Galaxies & Galactic Dynamics	
Semester 2	Electrodynamics & Relativity	Conv
	Frontiers in Modern Physics (Astro Stream)	Conv
	Cosmological Physics	
	Computational Statistics for Physics	
Semester 3	Research Proposal in Astronomy & Astrophysics	
	Physics Research Project Part 1	
	Physics Research Project Part 2	
	Frontiers in Experimental Physics (Astro Stream)	Option
Semester 4	Physics Research Project Part 3	
	Physics Research Project Part 4	
	Dissertation in Astronomy & Astrophysics	
	Gravitational-Wave & High-Energy Astrophysics	Option

Example Study Plans: “Avery”

- BSc Physics < UWA Physics
- No astronomy or astrophysics units
- No programming Experience
- Takes 4 Conversion Units
- Doing an experimental project & is ready to commence research
- Completing the degree over four semesters

Example Study Plans: “Avery”

	Unit	Type
Semester 1	Computational Thinking with Python	Conv
	Astrophysics & Space Science	Conv
	Radio Astronomy & the Interstellar Medium	
	Research Proposal in Astronomy & Astrophysics	
Semester 2	Electrodynamics & Relativity	Conv
	Frontiers in Modern Physics (Astro Stream)	Conv
	Computational Statistics for Physics	
	Physics Research Project Part 1	
Semester 3	Galaxies & Galactic Dynamics	
	Frontiers in Experimental Physics	Option
	Physics Research Project Part 2	
	Physics Research Project Part 3	
Semester 4	Cosmological Physics	
	Gravitational-Wave & High-Energy Astrophysics	Option
	Physics Research Project Part 4	
	Dissertation in Astronomy & Astrophysics	

Example Study Plans: “Jackie”

- BSc (Physics & Computer Science) = UWA Physics + Comp Sci
- Although a domestic student offered a Commonwealth Supported Place, Jackie is keen to get into workforce as soon as possible.
- Therefore takes 4 units of advance standing on offer
- Completing the degree over three semesters

Example Study Plans: “Jackie”

	Unit	Type
Semester 1	Radio Astronomy & the Interstellar Medium	
	Galaxies & Galactic Dynamics	
	Frontiers in Experimental Physics (Astro Stream)	Option
	Research Proposal in Astronomy & Astrophysics	
Semester 2	Cosmological Physics	
	Computational Statistics for Physics	
	Gravitational-Wave and High-Energy Astrophysics	Option
	Physics Research Project Part 1	
Semester 3	Physics Research Project Part 2	
	Physics Research Project Part 3	
	Physics Research Project Part 4	
	Dissertation in Astronomy & Astrophysics	

Questions?



THE UNIVERSITY OF
WESTERN
AUSTRALIA

UWA space surveillance hub

Partnering with industry and international space agencies

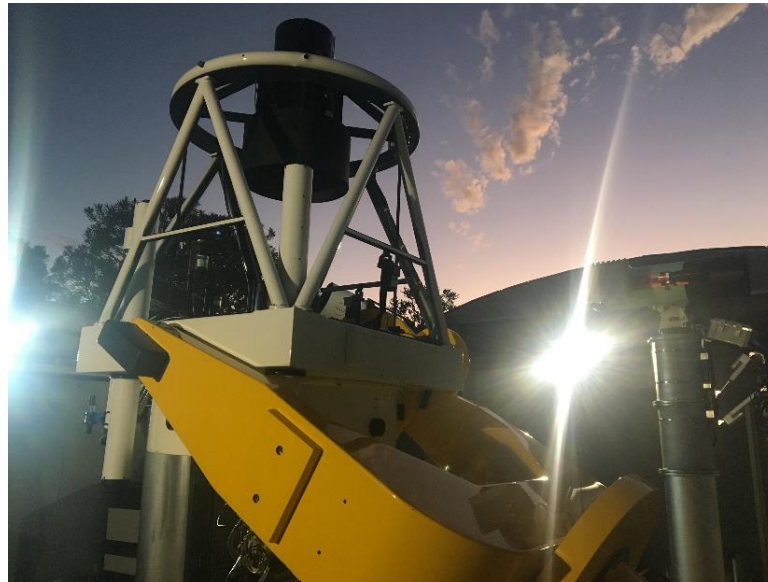
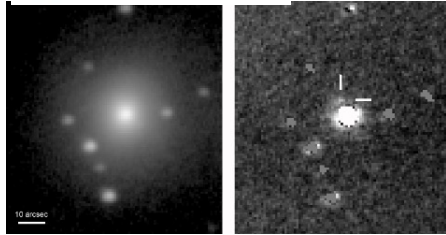


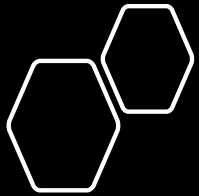
Key personnel include:

Ass. Prof. David Coward

Dorota Mieczkowska, John Moore

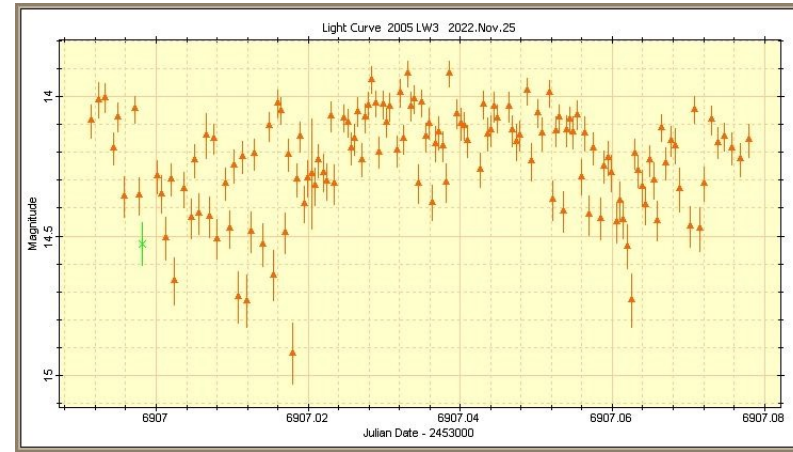
Dr John Kennewell, Evan Dilley, Fiona Panther





PLANETARY DEFENCE

Planetary Defence: As a key member of the Southern Hemisphere Asteroid Research Consortium (*SHARC*), the Zadko Observatory team is contributing to the Australian southern hemisphere bistatic radar and optical program, to detect near-Earth asteroids and objects (*NEO's*) exhibiting an Earth orbit crossing nature. **UWA is now a member of the NASA subcommittee "International Asteroid Warning Network."**



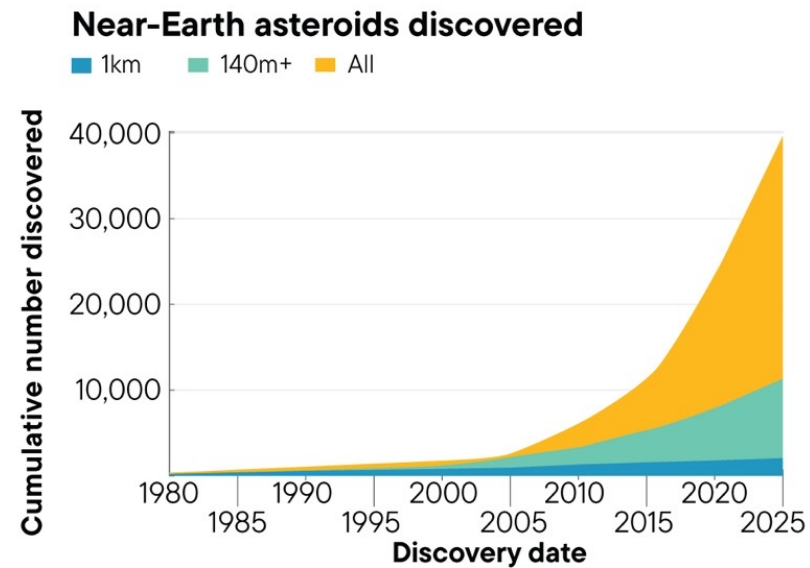
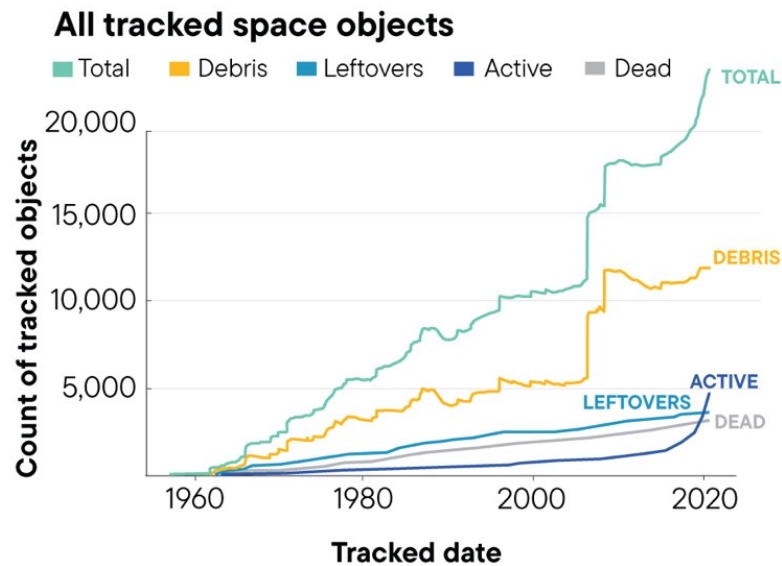
<https://web.sharc-scheduler.net/>



"Wow... a winning lottery ticket! What are the odds?"

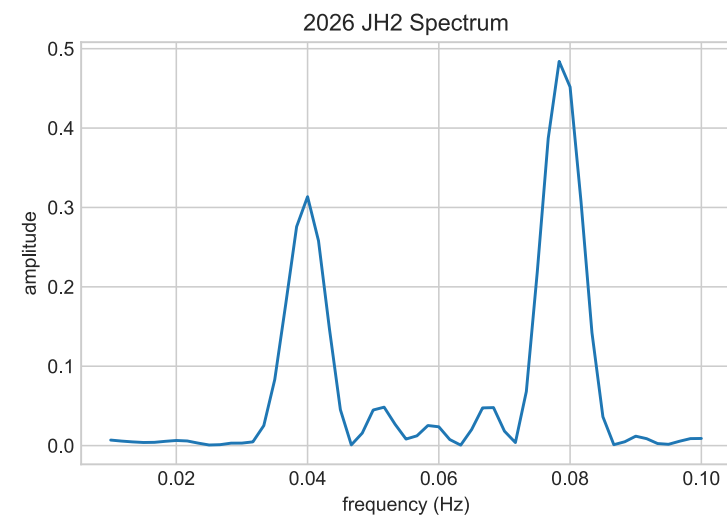
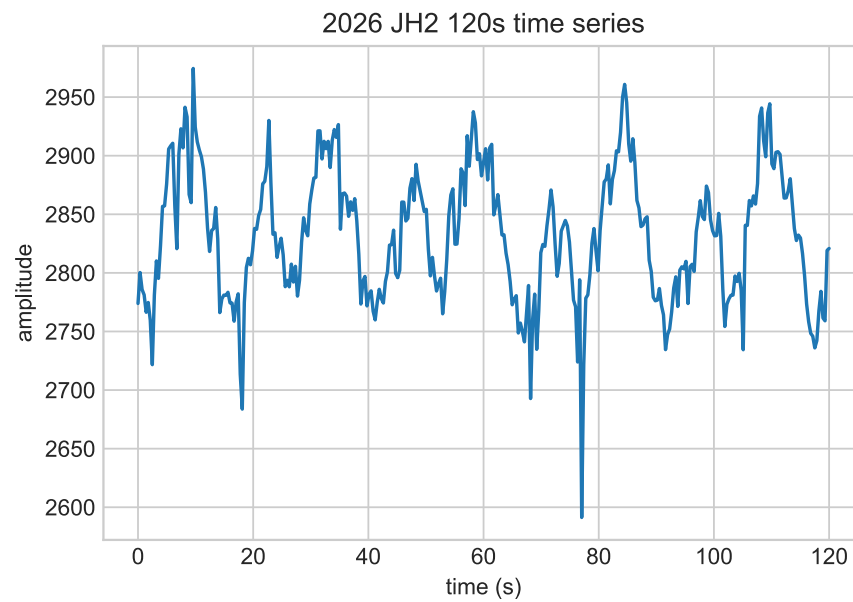
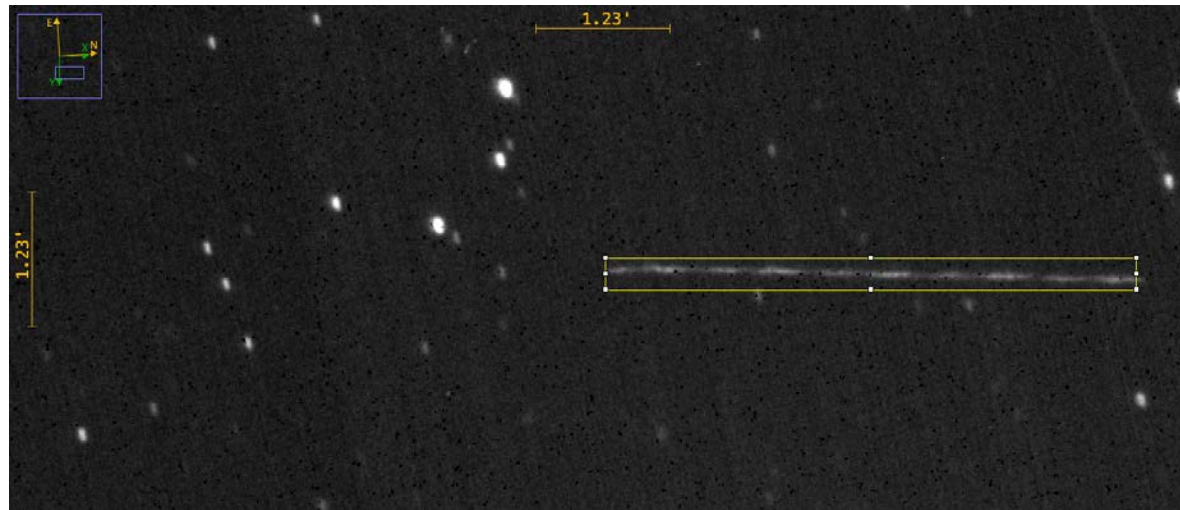


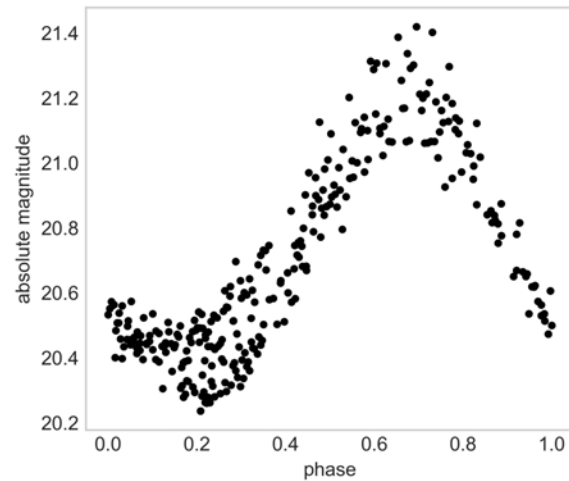
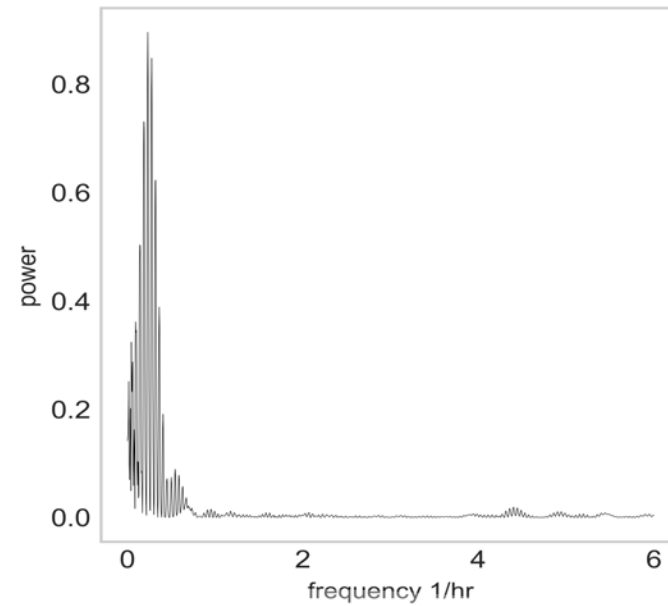
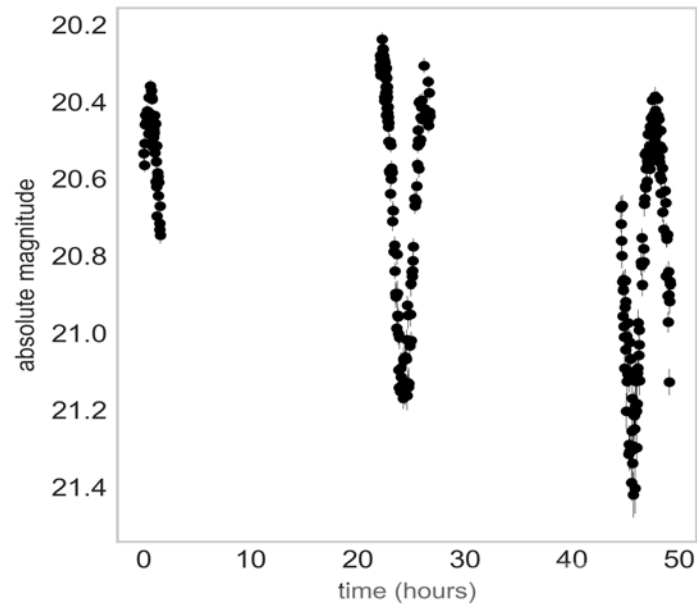
Some NEAs discovered only weeks before close approach
some there are no warnings



2013 event, 1000s injuries, Air blast, 20 m small asteroid, No warning

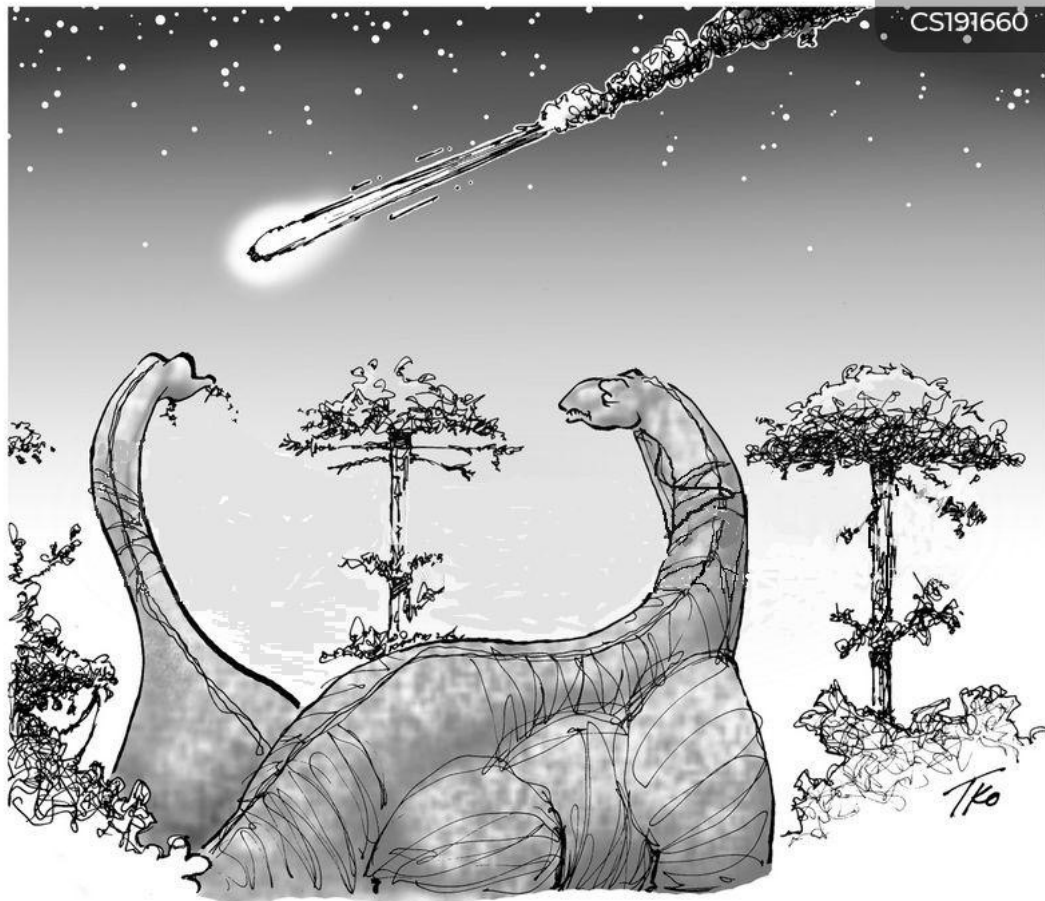
2026 Masters project – 30 -200 m class asteroid rapid response and characterization





PROJECTS

Light curve inversion → shape reconstruction
Joint optical & radar tracking
Impact modelling



*“Hey, Arthur...Arthur, check it out - a shooting star.
That’s a sure sign of good luck, my friend.”*

The United Nations has declared 2029 as the International Year of Asteroid Awareness, coinciding with the historic close approach of asteroid 99942 Apophis.

This 370-metre asteroid will pass within 31,000 km of Earth on April 13, 2029 –

closer than geostationary satellites - providing an unprecedented opportunity for asteroid research and public awareness.

Gravitational Wave Astronomy @ UWA Physics

Linqing Wen

Contact: linqing.wen@uwa.edu.au

Group Members



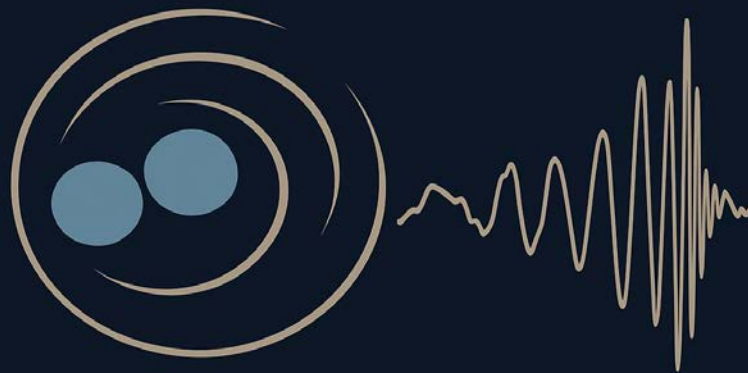
An Exciting time for GW Astronomy



- 2015: First detection of GWs from a binary black hole merger of $30 + 35 M_{\odot}$
- 2017: Nobel Prize in Physics
- 2017: First detection of GWs and EM radiation from a binary neutron star merger
- Four science runs completed: > 200 detections of NS-NS, NS-BH, BH-BH binary coalescences discovered
- Our team SPIIR contributed to 80% of confirmed O3 online detections and public alerts
 - 1 of 5 teams in the world, detect GWs within seconds
- Oct 2026: IR1 run
- ~ 2028: O5 run with all 4 GW detectors @design sensitivity

Project: GW Online Detection & Public Alerts

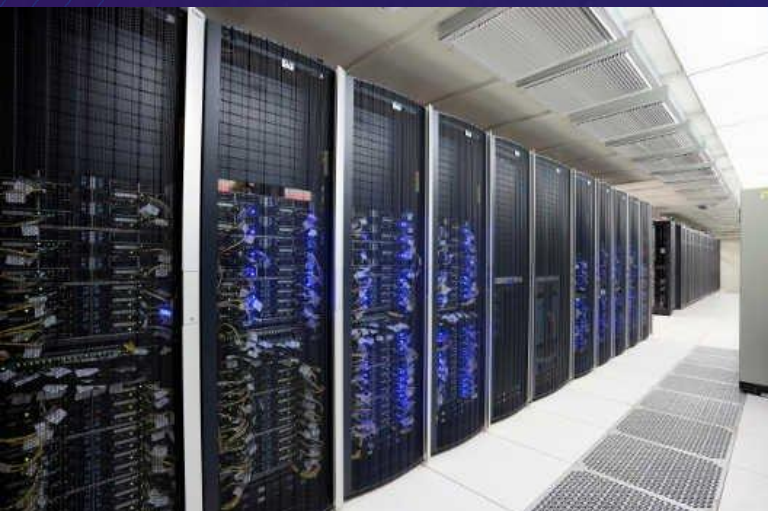
- Search for new GW events on detector data using improved techniques
- Signal Processing technique for O5 public alerts with 5 detectors



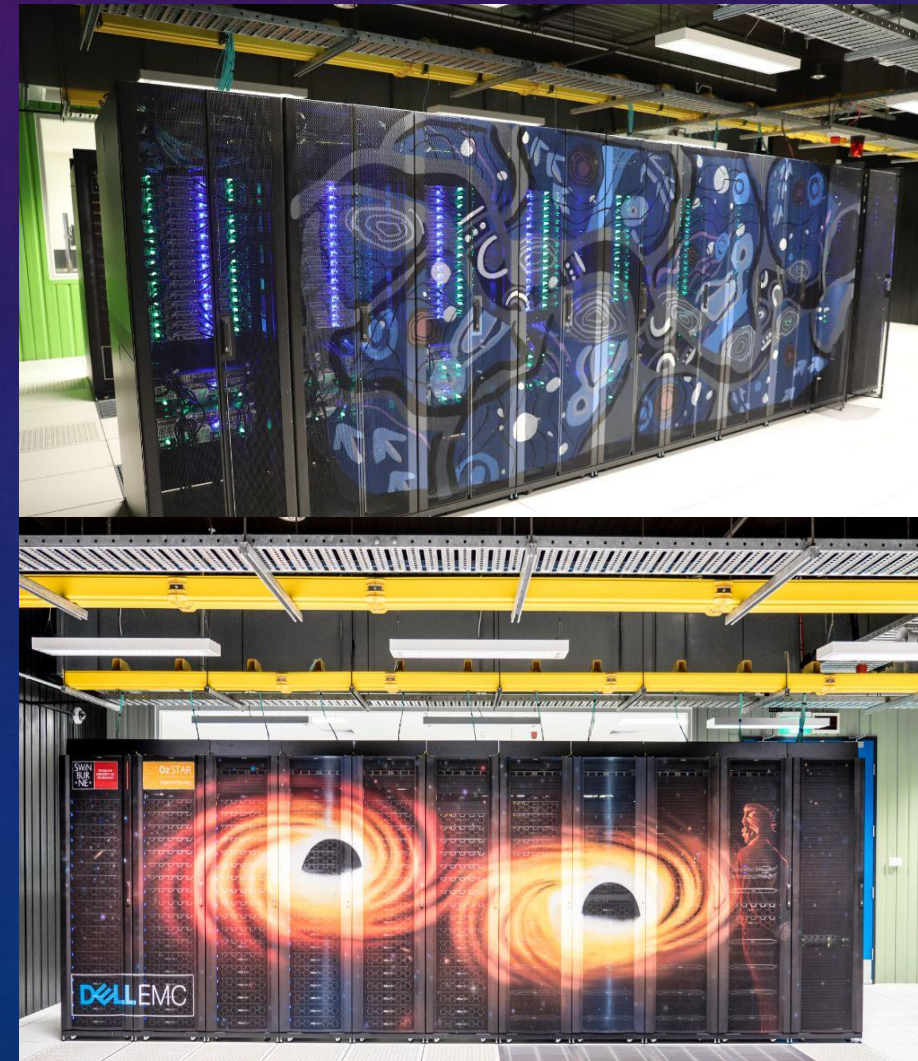
SPIIR
LISTENING TO THE
SPACETIME RIPPLES

Project: Machine Learning for Rapid GW Discovery

- ML to detect GWs: from eccentric, sub-solar mass binaries, hierarchical search
- ML for GW early warning
- Online (low-latency) ML implementation



(Use OzStar, Caltech LIGO Computing and a global supercomputer network)

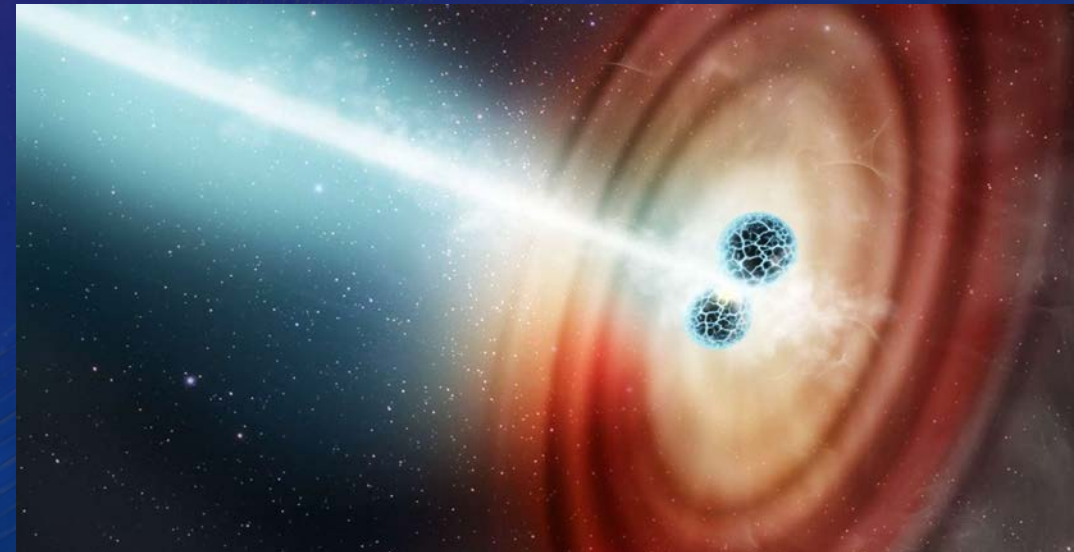


Project: EM Counterparts to GW Events



Use these telescopes to
look for EM counterparts!

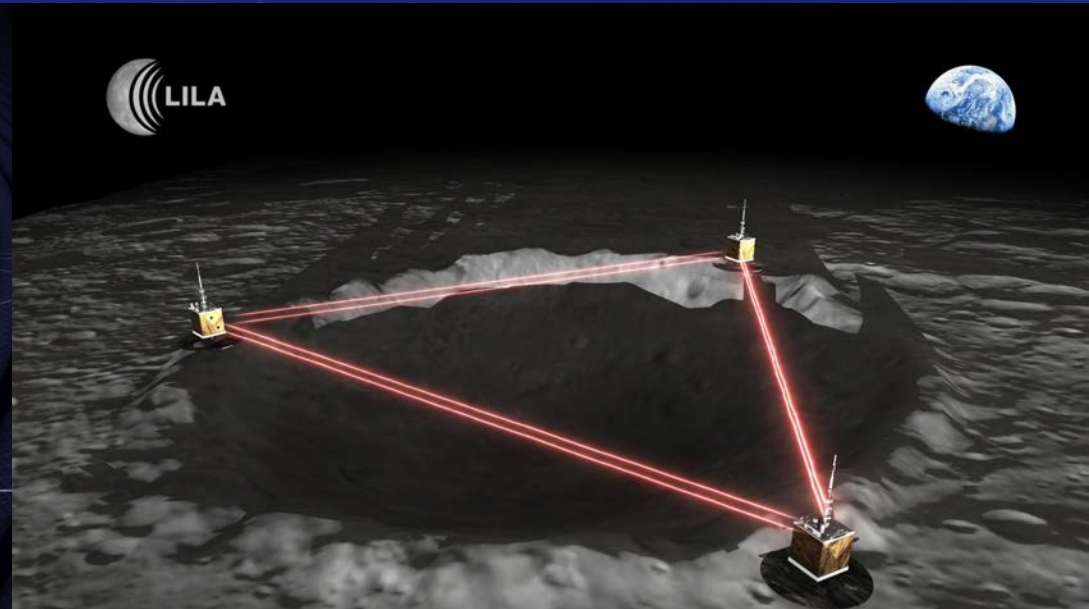
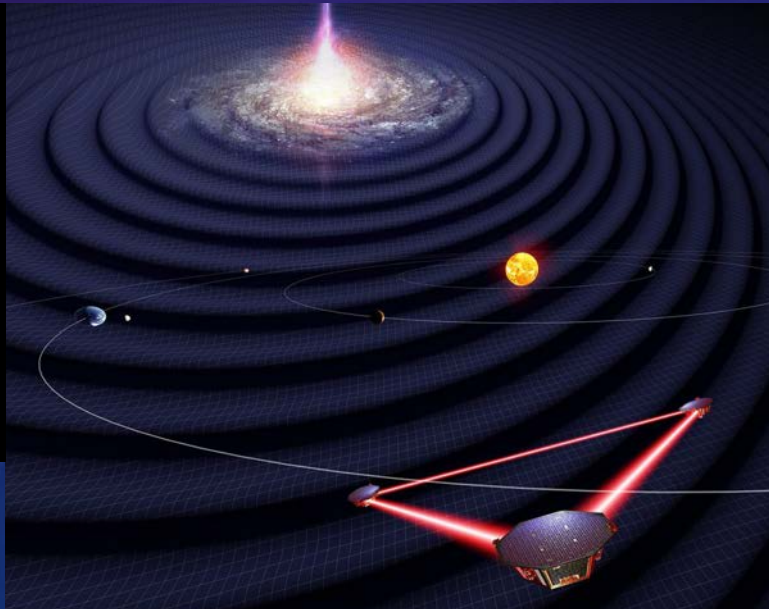
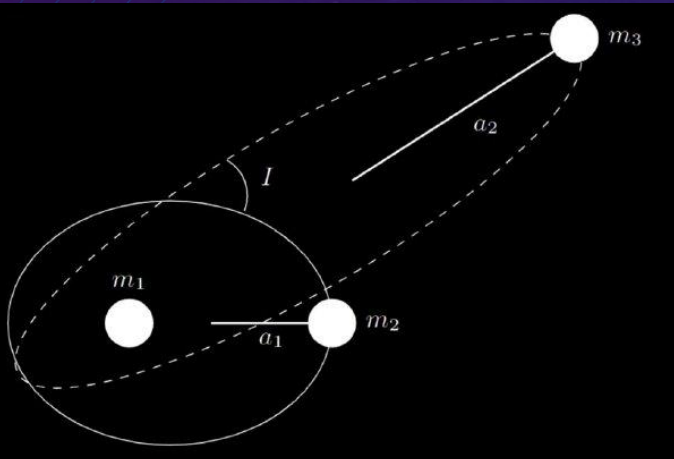
- Coincident detections across GW, LSST (optical transients), CHIME (fast radio bursts) and Fermi (gamma ray bursts) using multi-modal ML
- Rapid spectroscopic follow up with the ANU 2.3m telescope



Project: Triple System Dynamics & Space Detectors

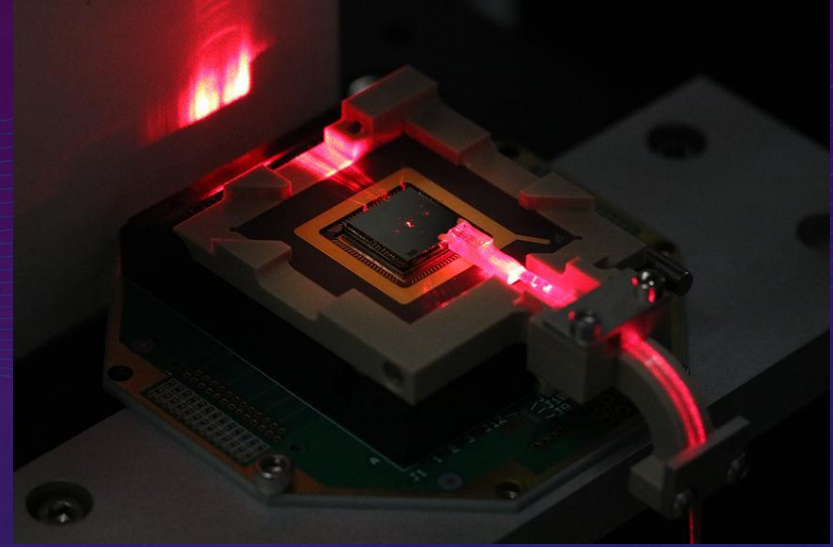
LISA/LILA

- Investigate analytically and numerically BBH mergers with triple black hole systems
- Detecting signatures of a 3-body system using next-generation interferometers from space: LISA (space) & LILA (on the Moon)



Project: Quantum Computing for GW Discovery

- Speed up GW matched filtering technique using quantum computing
- Joint project with QUISA $\langle \text{QUISA} \rangle$



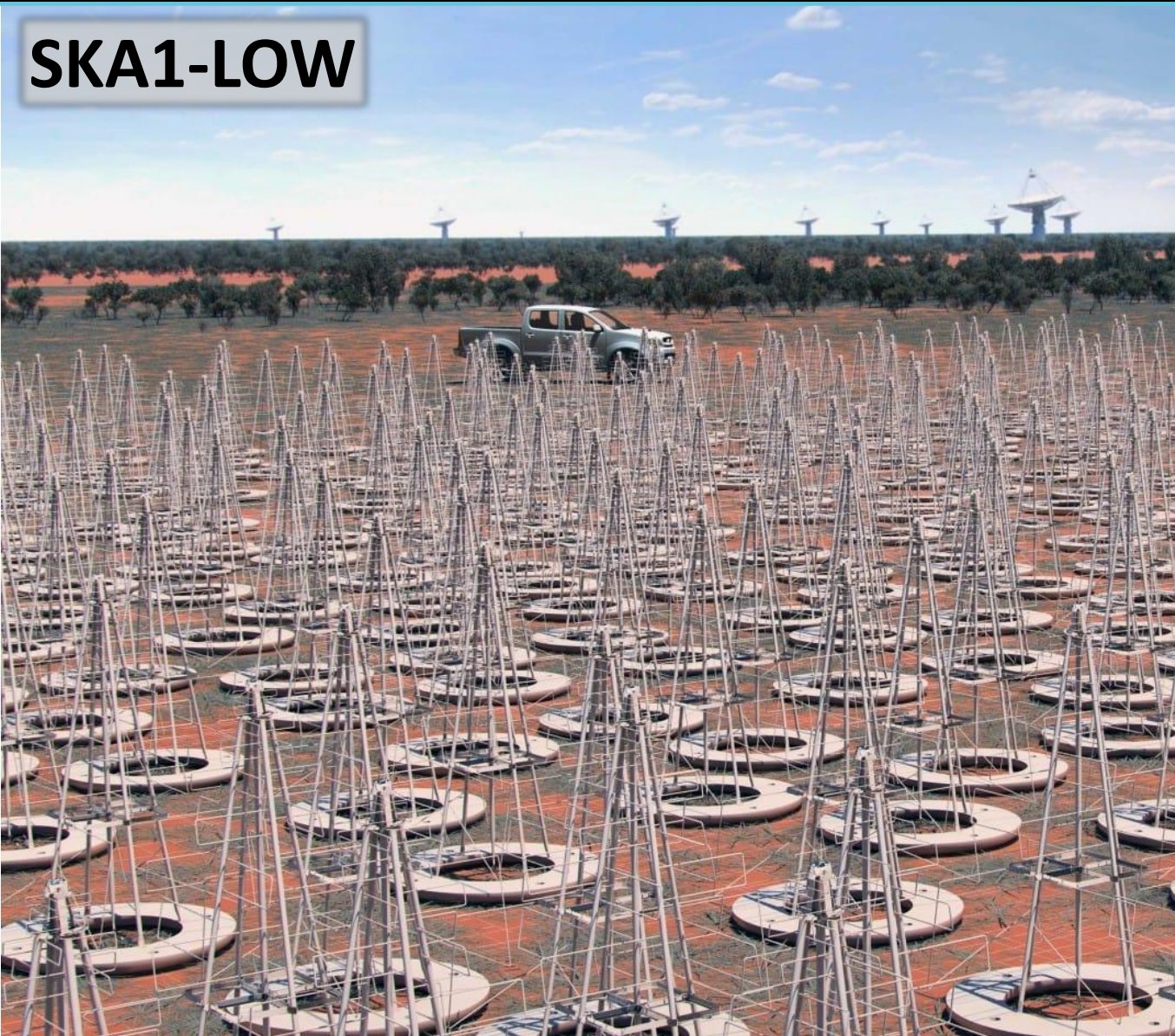
Project Summary

- Computational/signal processing:
 - Online GW detection and early warning
 - Machine learning for rapid GW discovery
 - Quantum computing
- Astronomy / observations:
 - EM counterparts
- Theoretical:
 - Triple BH systems
 - Detection using Space GW detectors

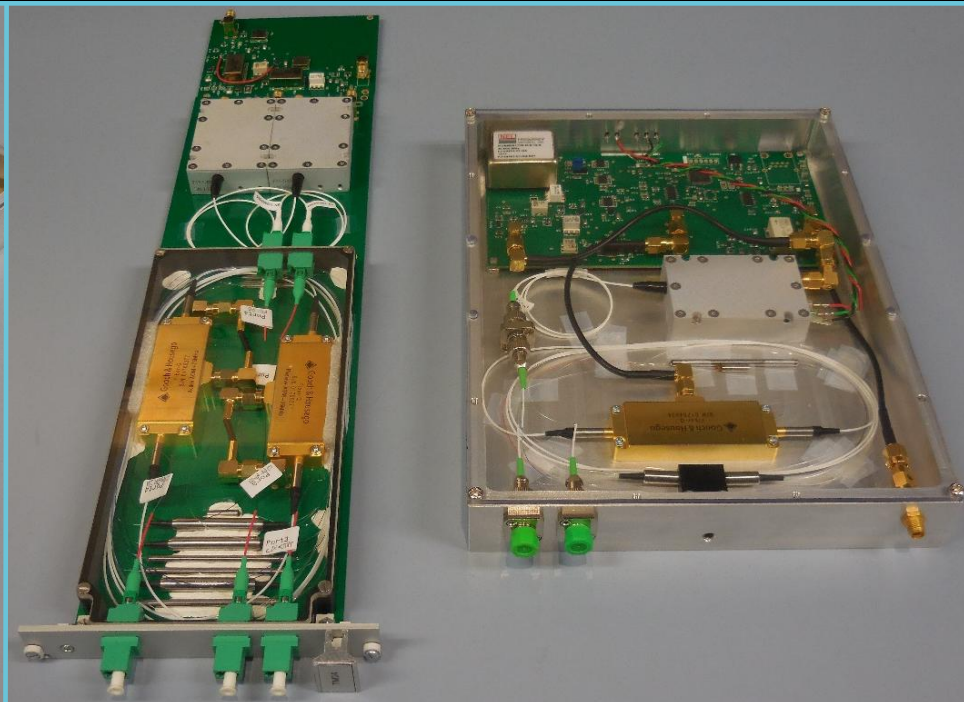
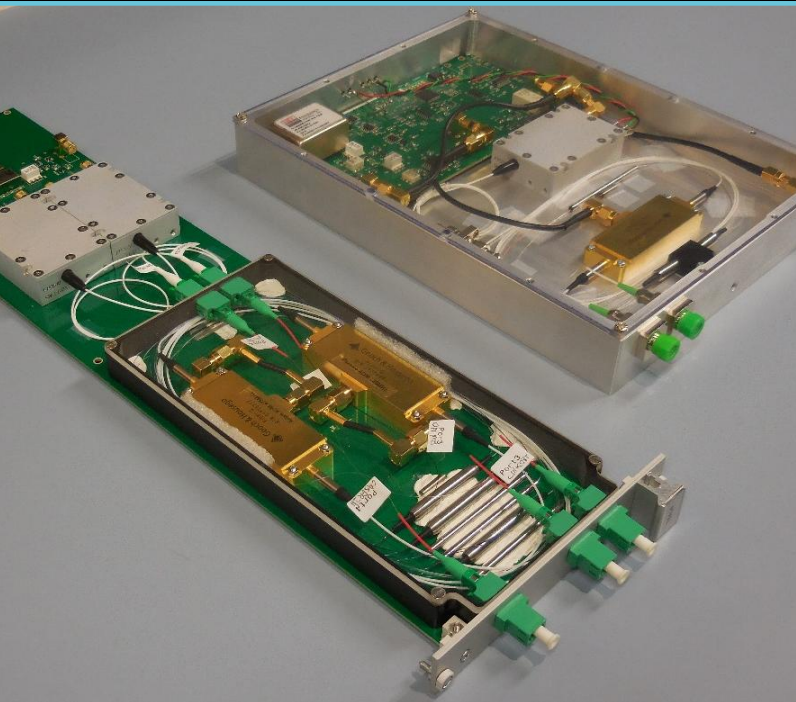
Astrophotonics

icrar.org/astrophotonics

Radio Astronomy Instrumentation



Radio Astronomy Instrumentation



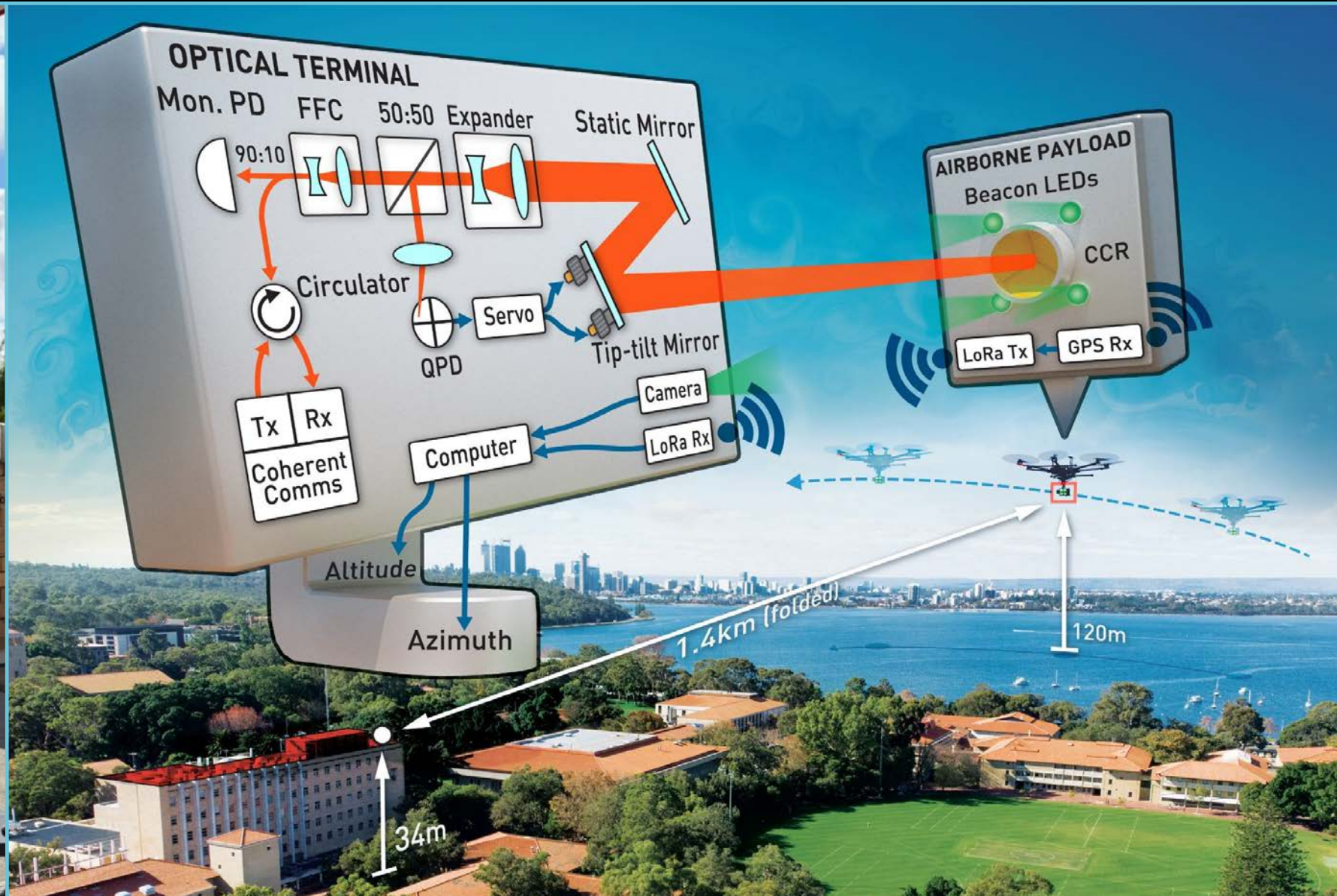
Projects

- Next-gen stabilization
 - Lab work
 - Programming
 - Electronics
- Fast imaging backend

Contact

- mike.kriele@uwa.edu.au
- sascha.schediwy@uwa.edu.au

Free-space laser links

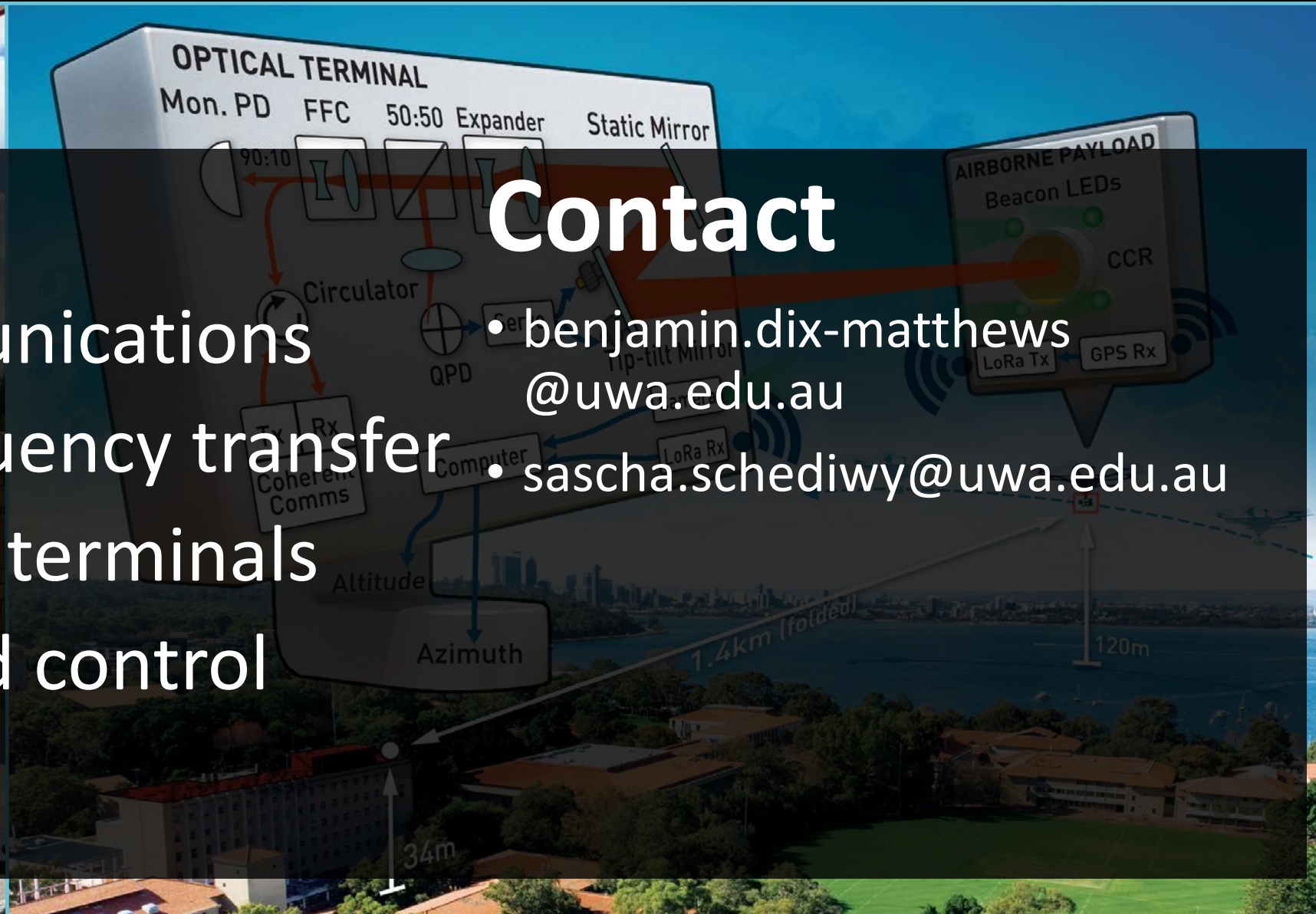


Projects

- Optical communications
- Time and frequency transfer
- Mobile optical terminals
- Electronics and control software

Contact

- benjamin.dix-matthews@uwa.edu.au
- sascha.schediwy@uwa.edu.au



Ground to space laser links



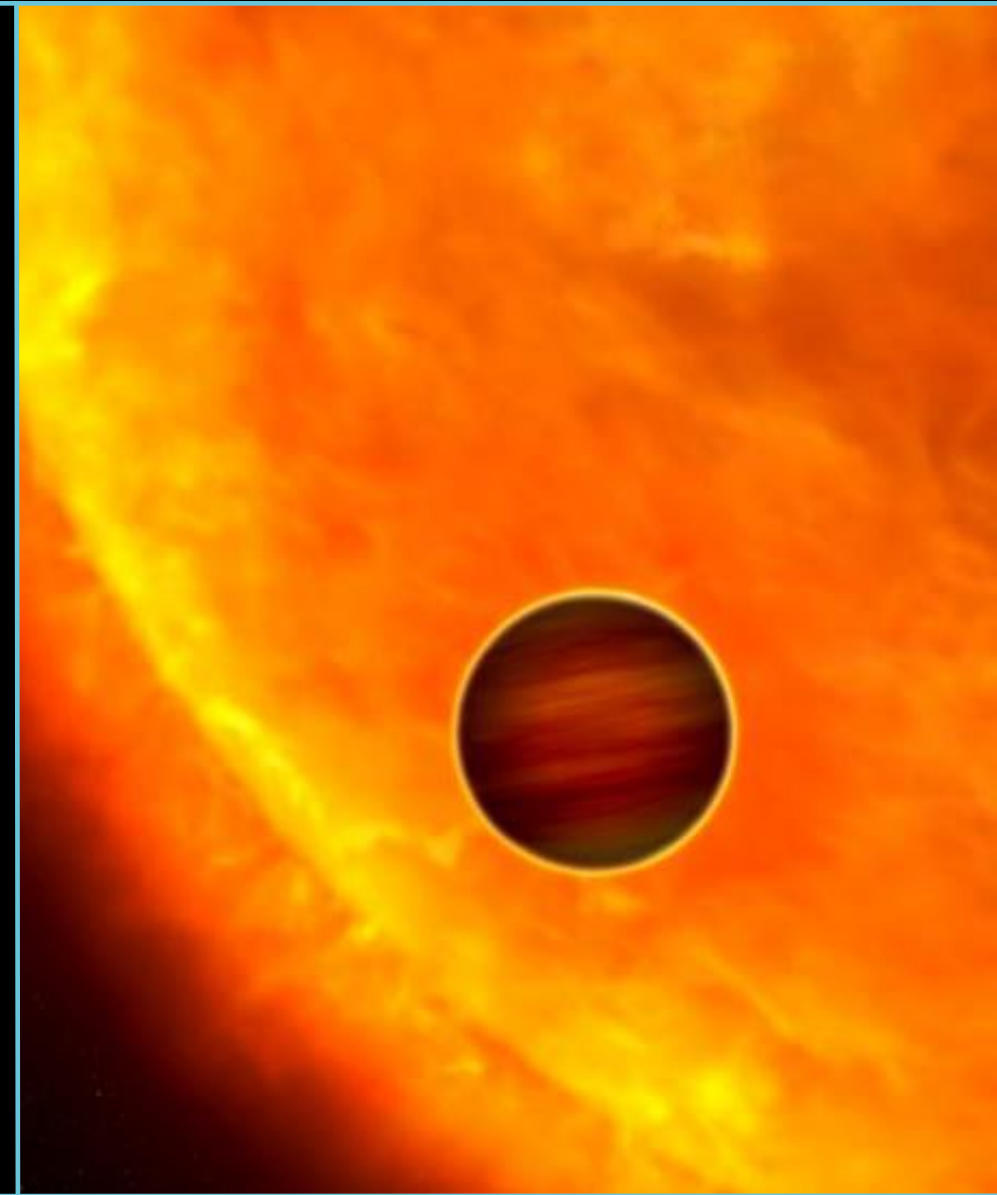
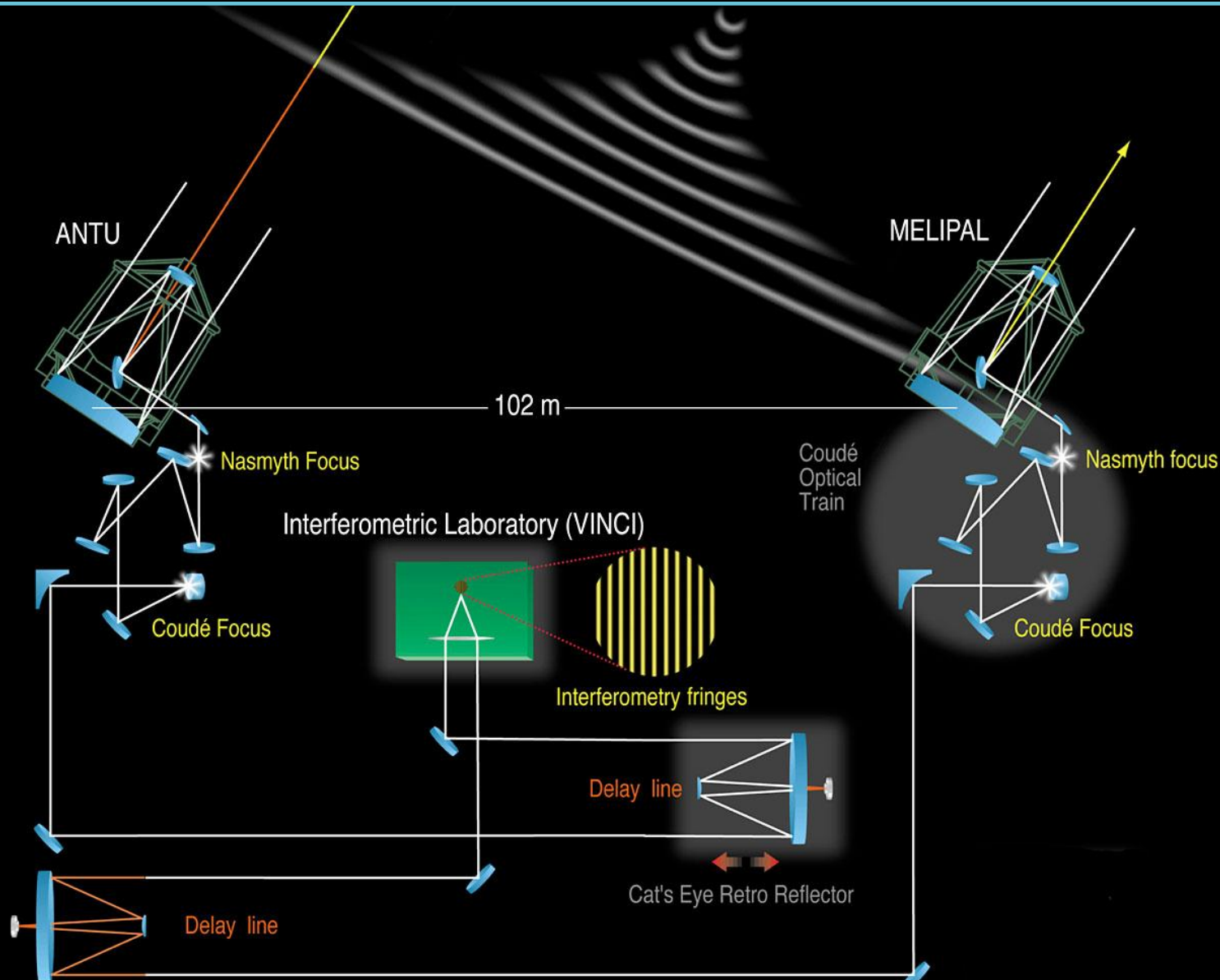
Projects

- Time and frequency transfer, time-of-flight ranging and related photonic applications
- Design, model, build and test optical links between ground stations and satellite platforms

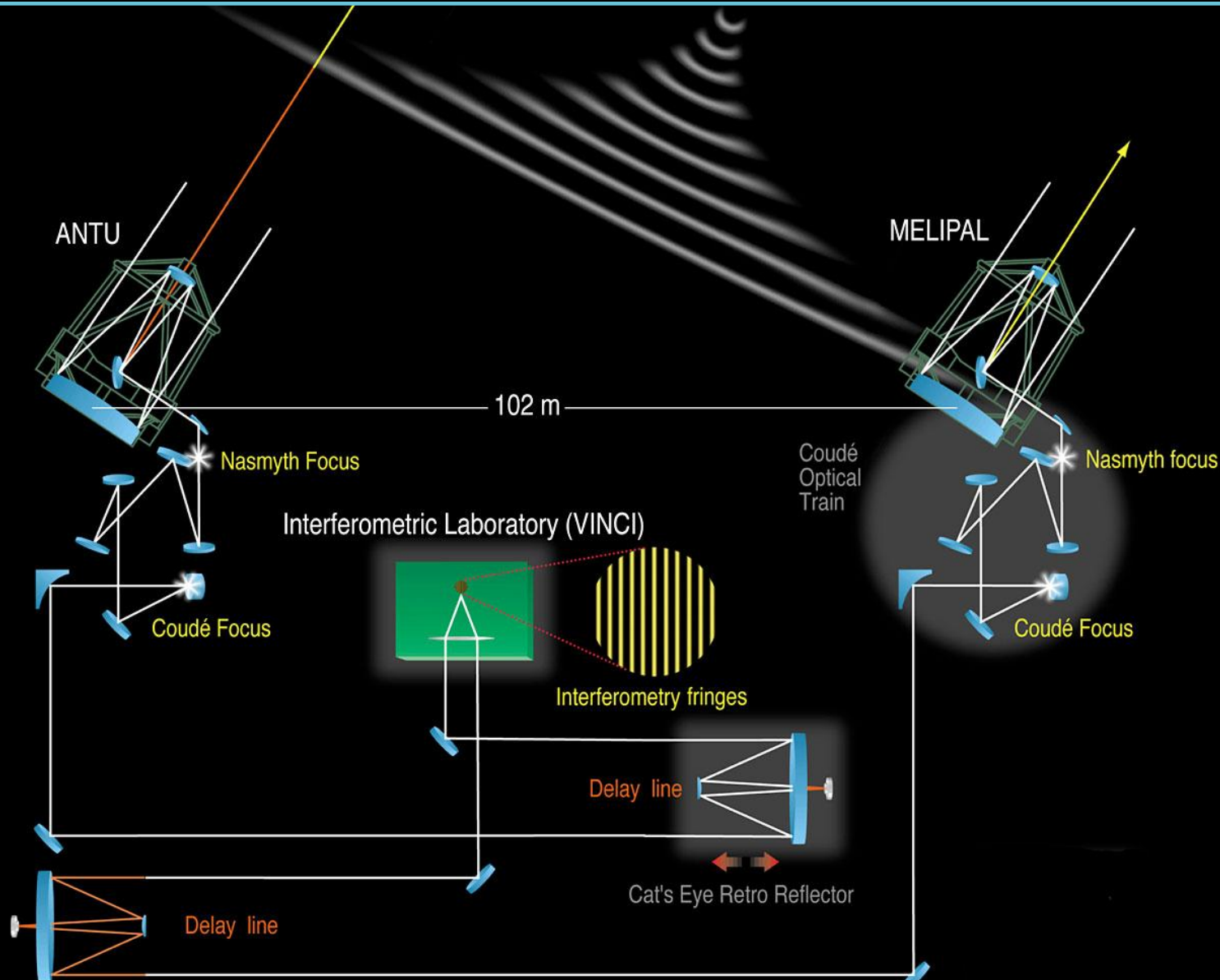
Contact

- lyra.walsh@uwa.edu.au
- andrew.lance@uwa.edu.au

Quantum Technologies for Astronomy



Quantum Technologies for Astronomy



Projects

- Quantum telescope
 - Theory
 - Experiment
- Space domain awareness

Contact

- david.gozzard@uwa.edu.au

Projects

- Radio astronomy instrumentation
- Laser communications
- Satellite laser communications
- Quantum telescopes

Students

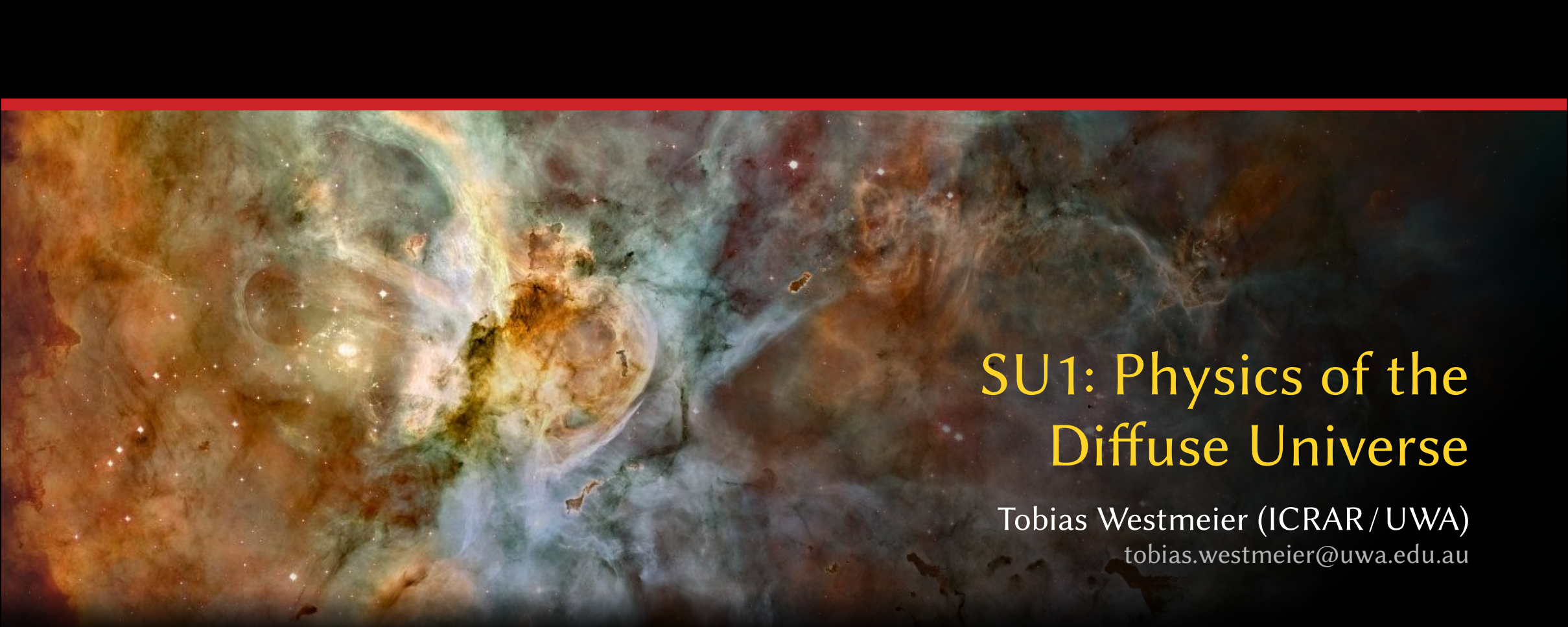
- Masters or PhD
- Physics/Astrophysics
- Engineering
 - Electrical/Electronics
 - Mechanical
 - Software



icrar.org/astrophotonics

sascha.schediwy@uwa.edu.au

david.gozzard@uwa.edu.au



SU1: Physics of the Diffuse Universe

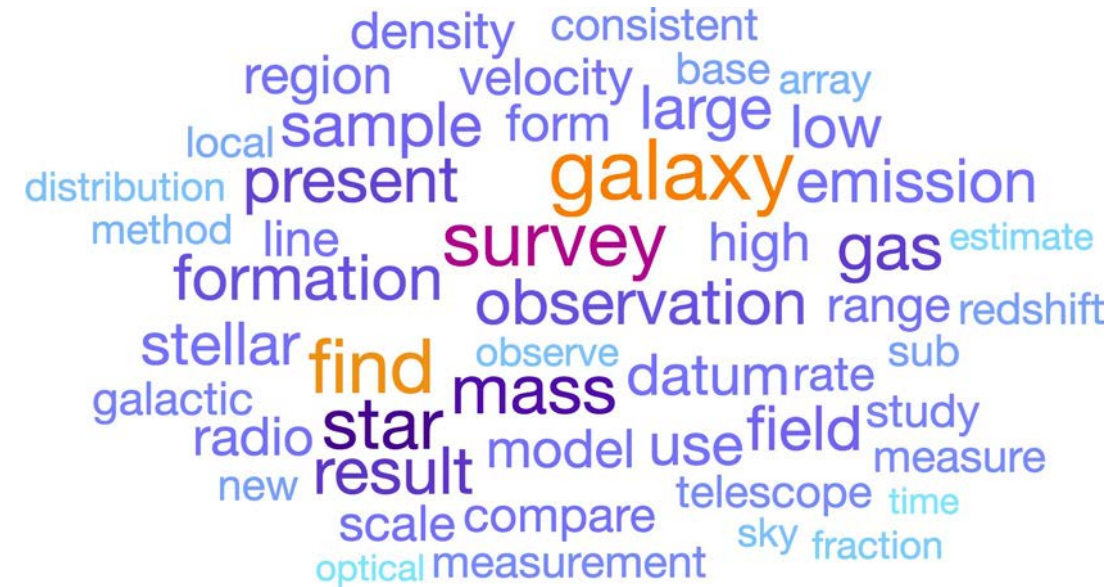
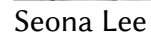
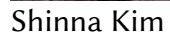
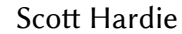
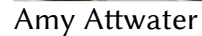
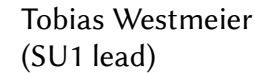
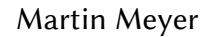
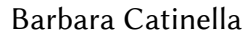
Tobias Westmeier (ICRAR / UWA)
tobias.westmeier@uwa.edu.au



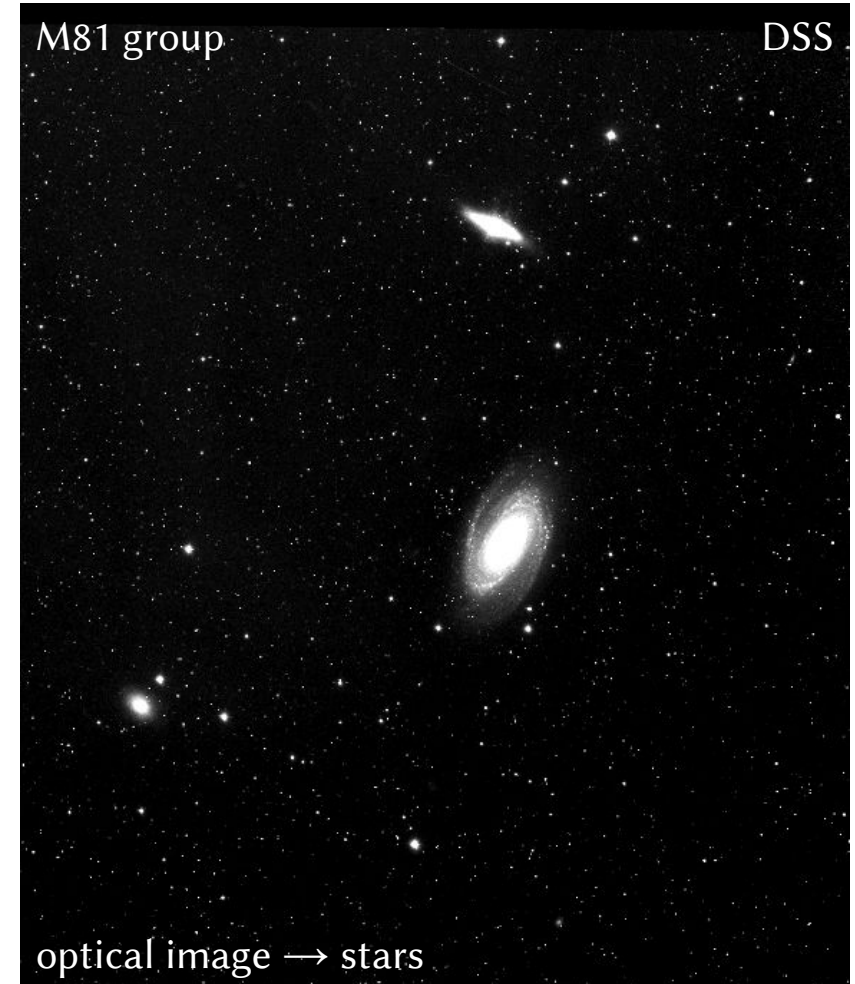
International
Centre for
Radio
Astronomy
Research



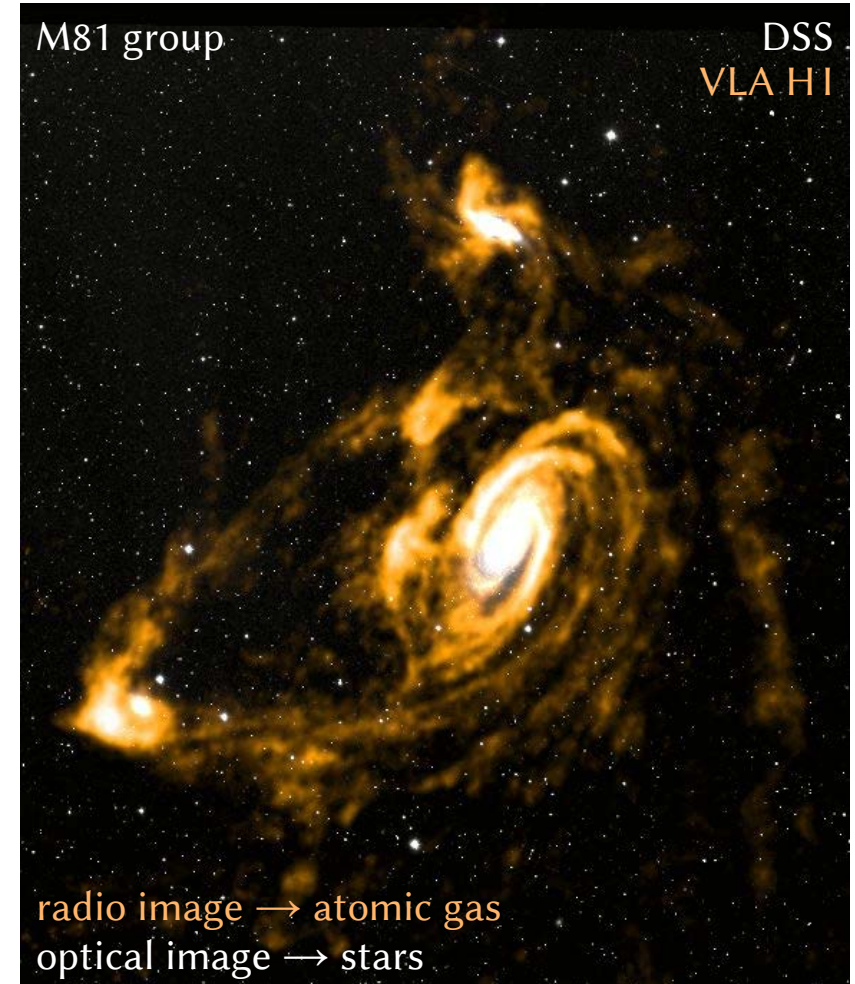
ICRAR is a joint venture between Curtin University and The University of Western Australia and receives support from the Western Australian and Australian Governments.



- ★ We use the **best telescopes in the world** to study how galaxies use their gas to form stars, and what physical processes determine the properties of galaxies.
- ★ This requires **multi-wavelength observations** to trace all baryonic components (atomic and molecular gas, stars, dust...) and comparison with models/theory.



- ★ We use the **best telescopes in the world** to study how galaxies use their gas to form stars, and what physical processes determine the properties of galaxies.
- ★ This requires **multi-wavelength observations** to trace all baryonic components (atomic and molecular gas, stars, dust...) and comparison with models/theory.



Discovering Galaxies with Radio (+ other) Telescopes

★ We lead **cutting-edge radio & multi-wavelength surveys** to answer key open questions:

- ▶ How efficiently can gas form new stars in different galaxies?
- ▶ How does the environment affect galaxy properties?
- ▶ How does gas accrete onto galaxies?
- ▶ Why are some galaxies running out of gas?



ASKAP

Credit: T. Westmeier



ALMA

Credit: ESO / C. Malin

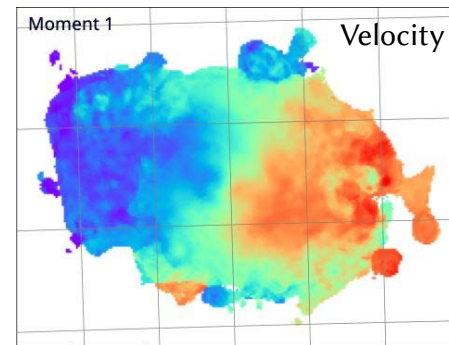
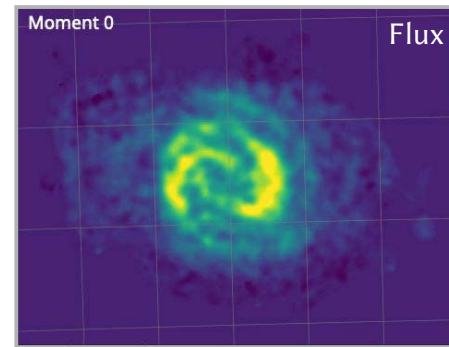


VLT

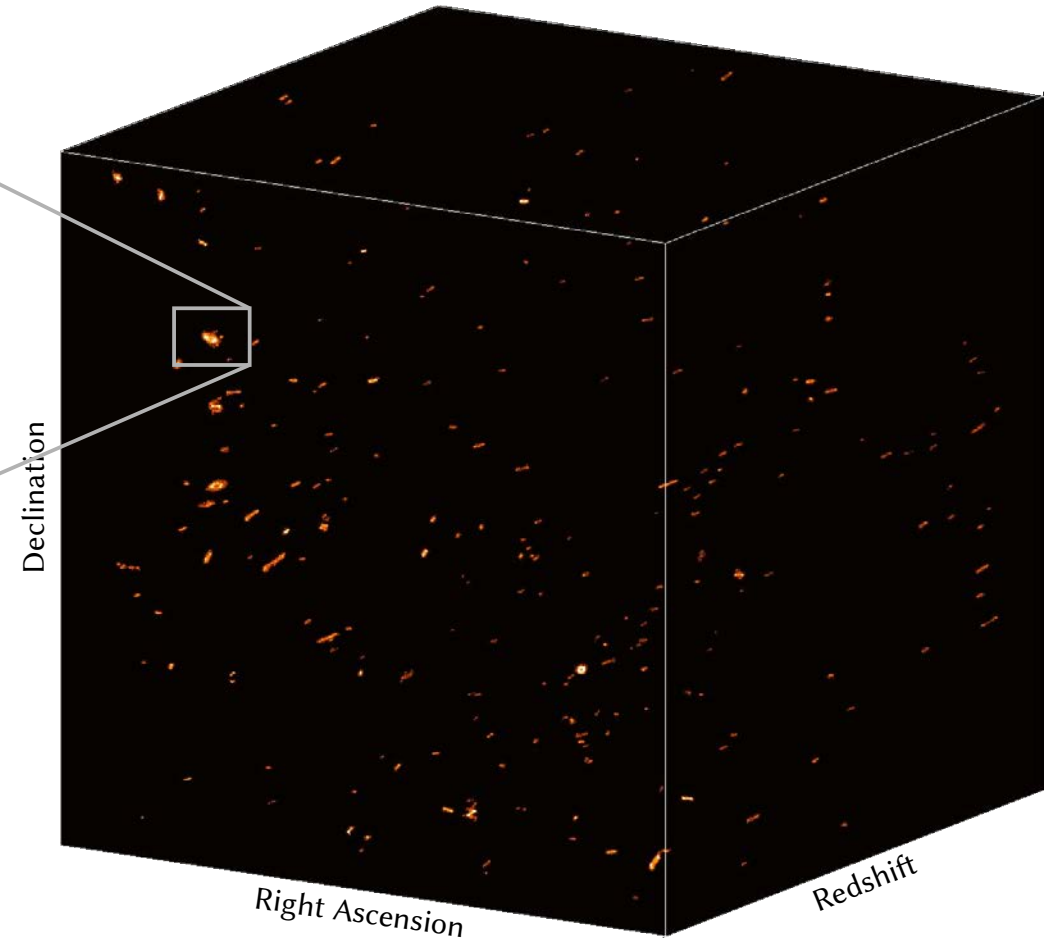
Credit: ESO / G. Hühdepohl

★ WALLABY

- ▶ $\approx 200,000$ galaxies out to $z \lesssim 0.1$ (1.3 billion years look-back time)
- ▶ Largest ever census of atomic hydrogen
- ▶ Thousands of galaxies well-resolved



Westmeier et al. (2022)



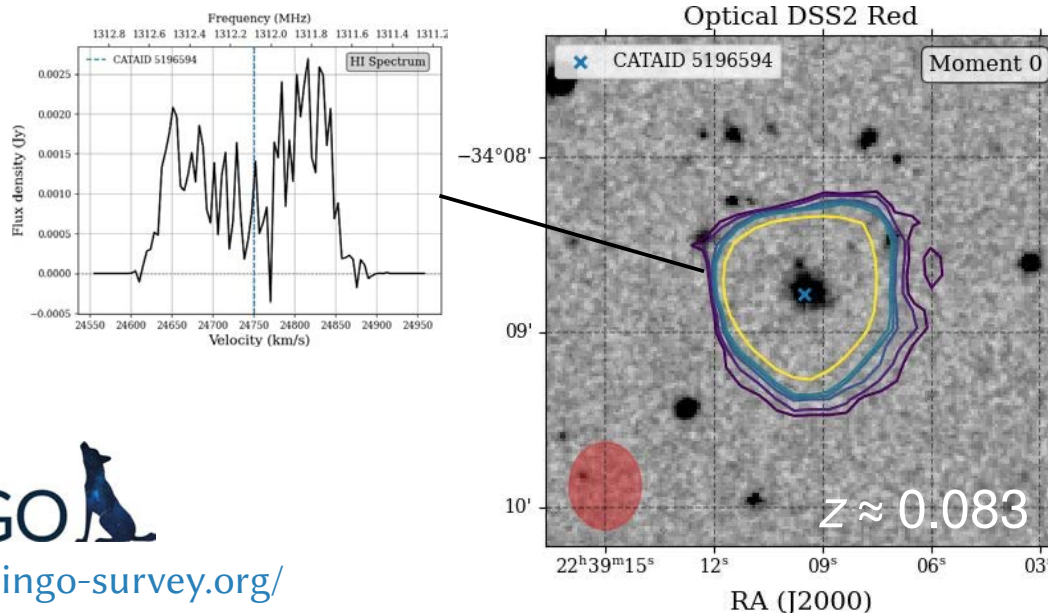
3D visualisation of galaxies in WALLABY data cube



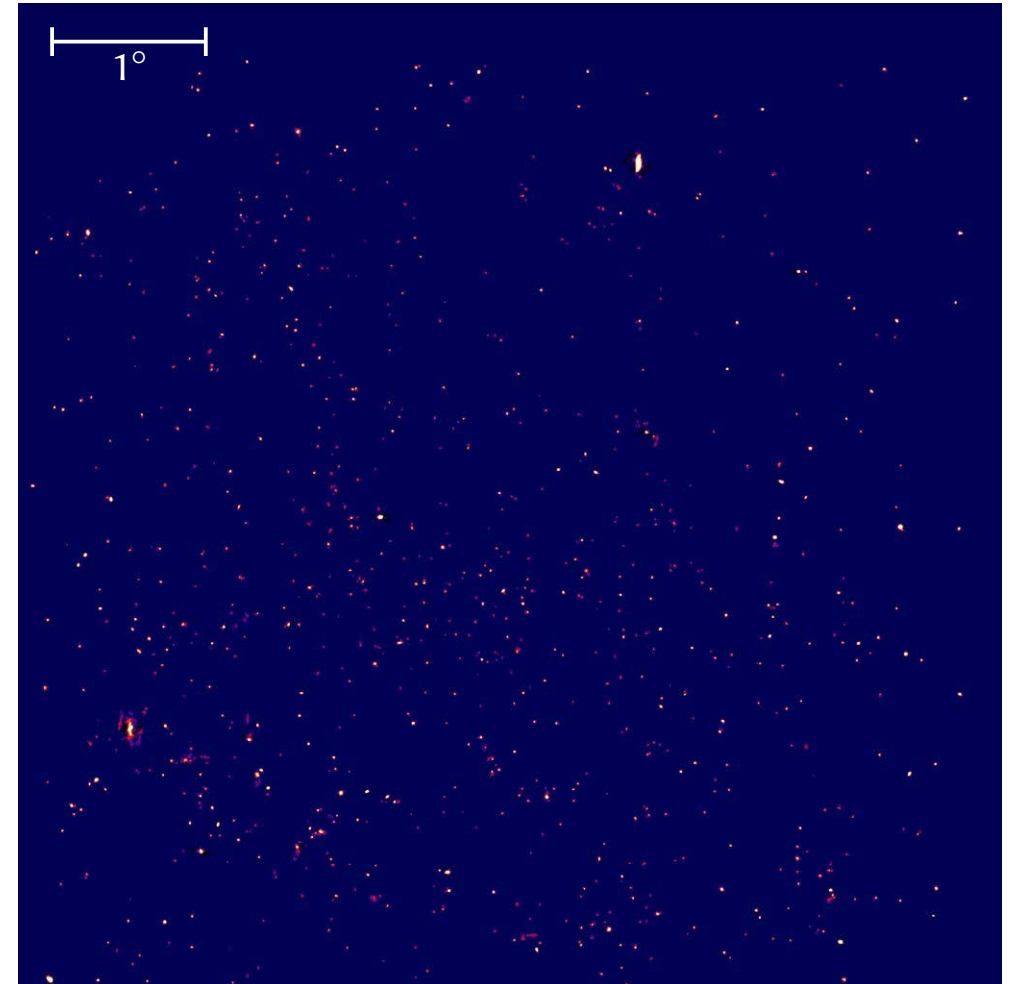
<https://wallaby-survey.org/>

★ DINGO

- ▶ Deep 800 h HI survey of G23 region with ASKAP
- ▶ Evolution of gas content of Universe out to $z \lesssim 0.43$ (4.5 billion years)

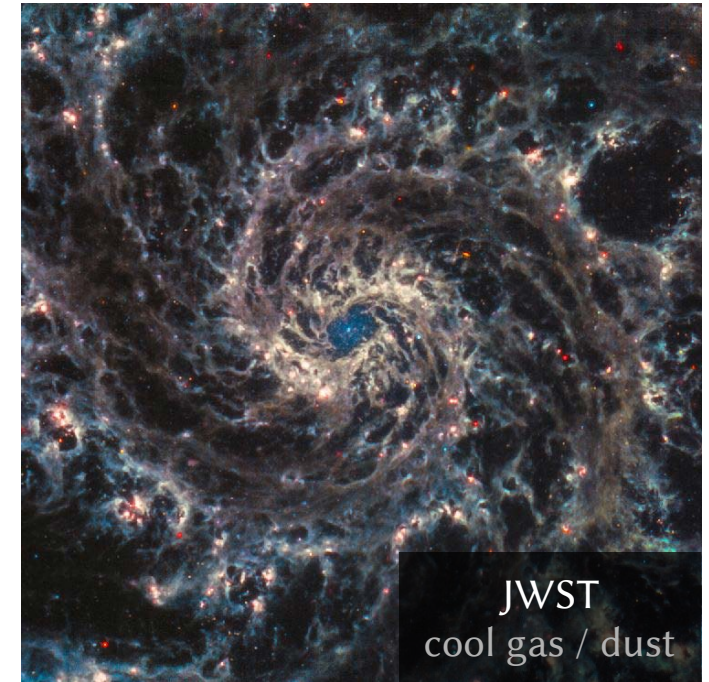
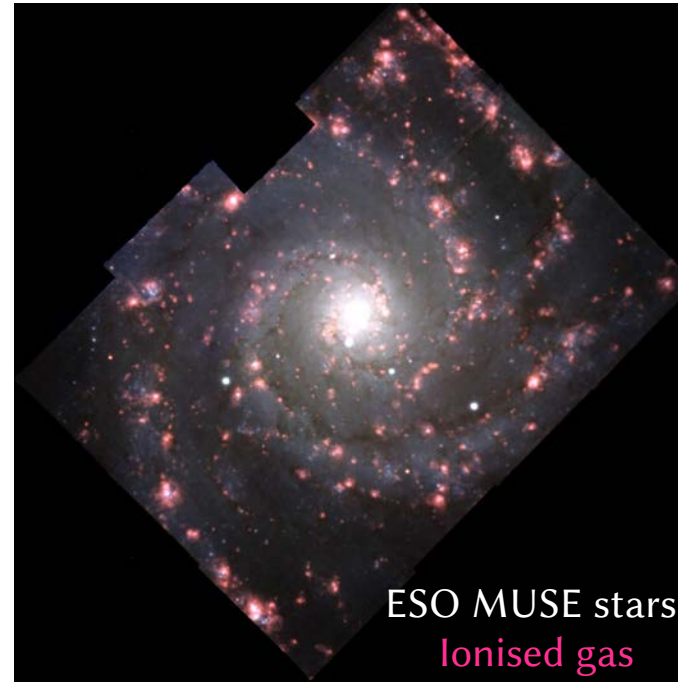
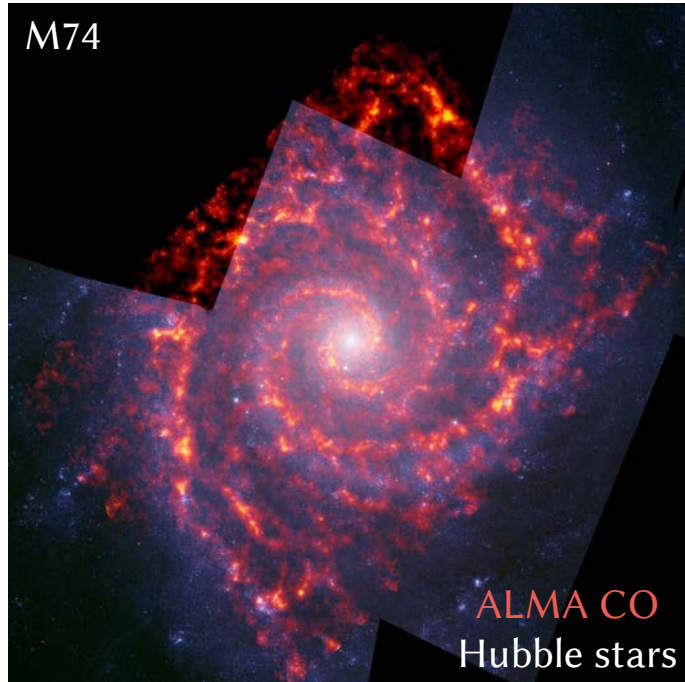


<https://dingo-survey.org/>



DINGO full survey (350 h)

MAUVE – Star Formation in Exquisite Detail



- ▶ **MAUVE** (*Multiphase Astrophysics to Unveil the Virgo Environment*)
- ▶ Ongoing **large program** with the **ESO Very Large Telescope**
- ▶ What regulates **star formation** in nearby galaxies?
- ▶ Why are some galaxies actively forming stars and others not at all?



<https://mauve.icrar.org/>

- ▶ **Exciting science** – we lead some of the most cutting-edge galaxy surveys in the world
- ▶ Learn how to take and analyse **data from the world's best telescopes**
- ▶ Acquire **strong problem solving and analytic skills**
- ▶ Develop your **computational skills**
- ▶ **Become a leader** in Square Kilometre Array and galaxy evolution science
- ▶ Join a **fantastic & supportive working environment**



**Get in touch to discuss
project opportunities!**

Tobias Westmeier
ICRAR room 151 (1st floor)
tobias.westmeier@uwa.edu.au





International
Centre for
Radio
Astronomy
Research

The Evolving Universe

A/Prof Elisabete da Cunha
(on behalf of SU2)

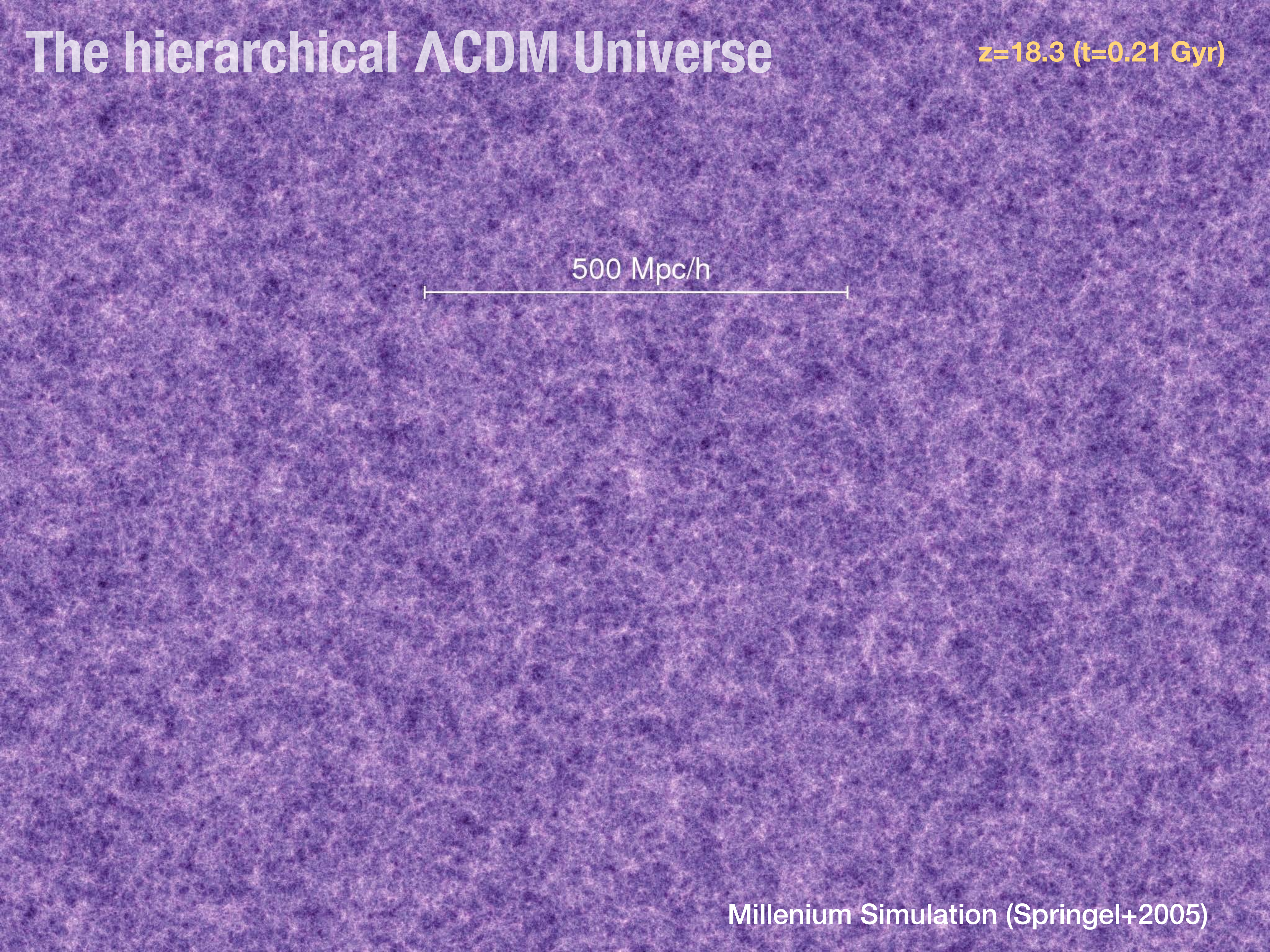
elisabete.dacunha@uwa.edu.au



The hierarchical Λ CDM Universe

$z=18.3$ ($t=0.21$ Gyr)

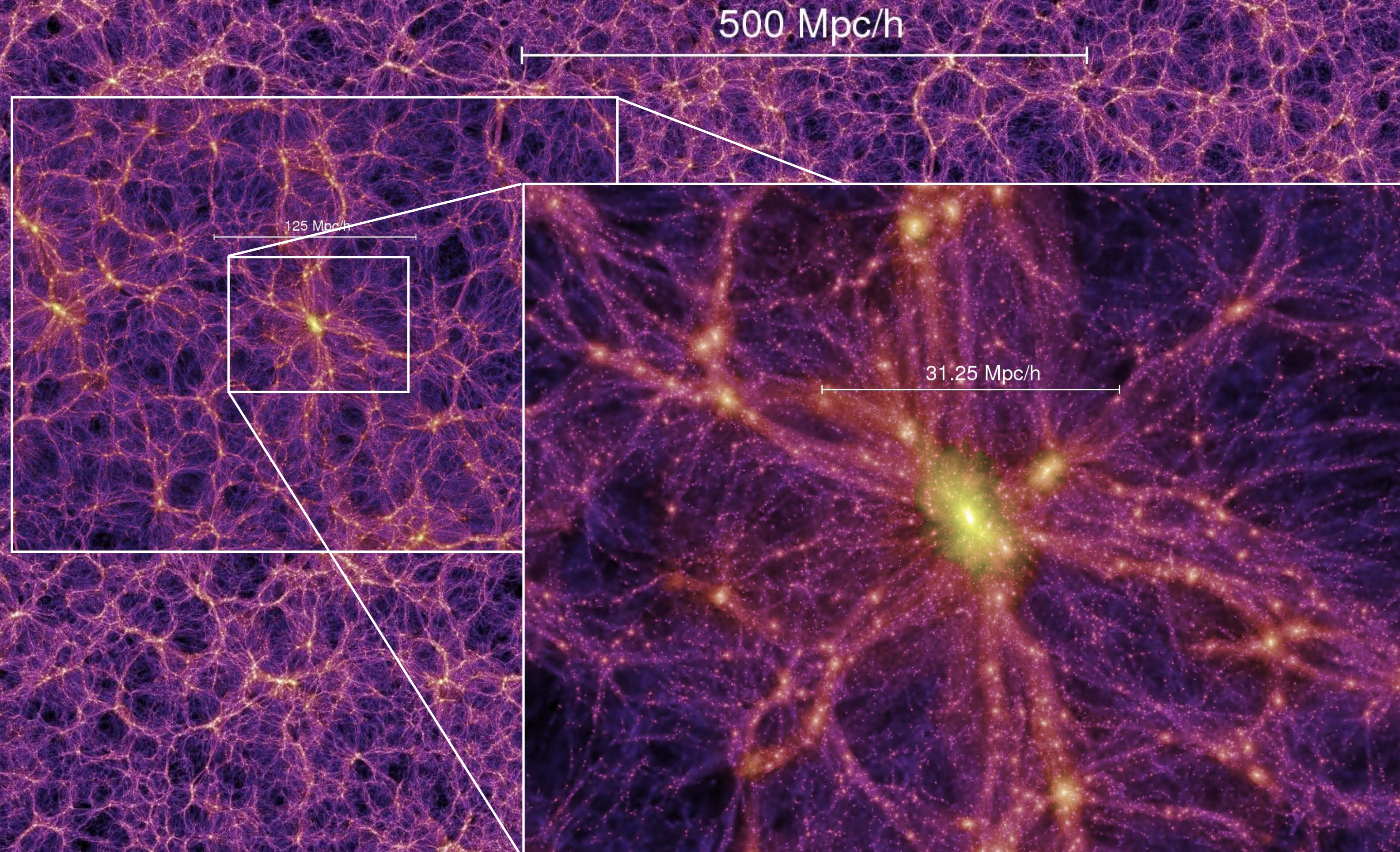
500 Mpc/h



Millenium Simulation (Springel+2005)

The hierarchical Λ CDM Universe

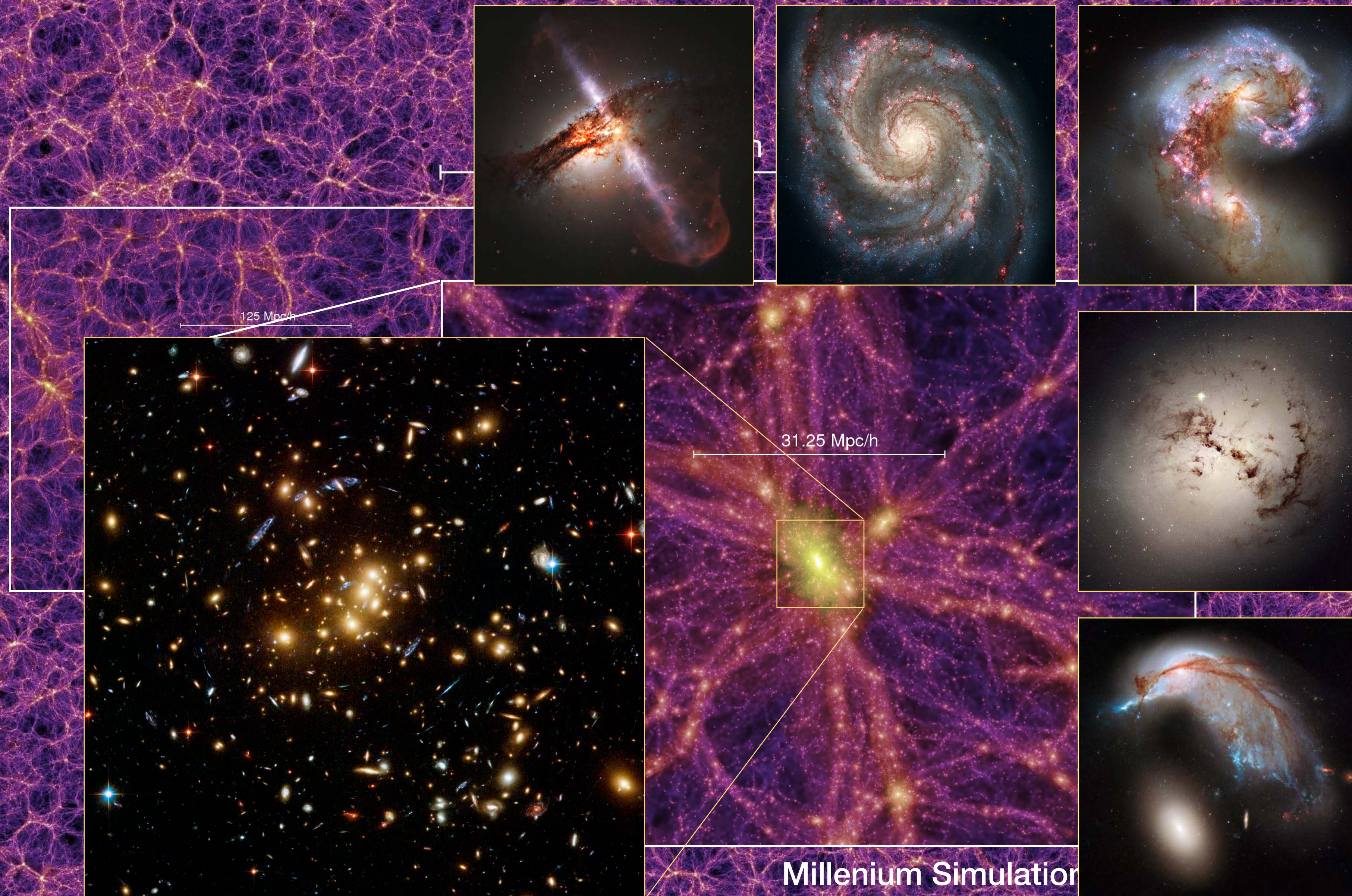
$z=0$ ($t=13.6$ Gyr)

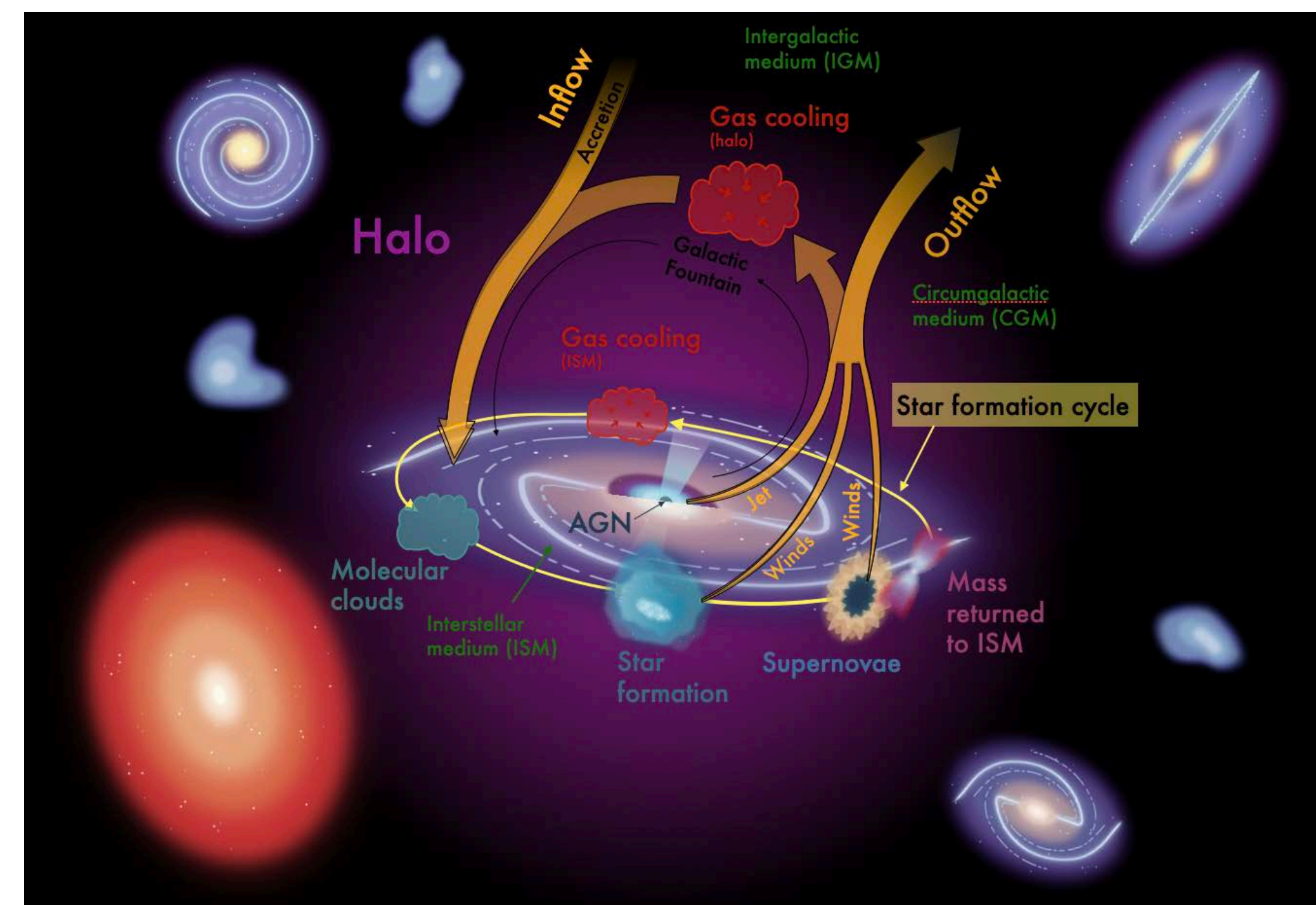


Millenium Simulation (Springel+2005)

The hierarchical Λ CDM Universe

$z=0$ ($t=13.6$ Gyr)







Galaxy evolution is a complex problem

We try to measure all properties of statistically-significant **samples of galaxies**, the light they produce and their environments...

Across all times → How things are changing with time

Across all wavelengths → All galaxy components: dark matter, stars, gas, dust, AGN

Across all scales → From large-scale structure down to the sub-regions of galaxies

...and use these to determine the **dominant processes** that form the Universe we see today.



Across all times



Across all times



Across all times



+



+



Properties of the first galaxies in the Universe





+



+



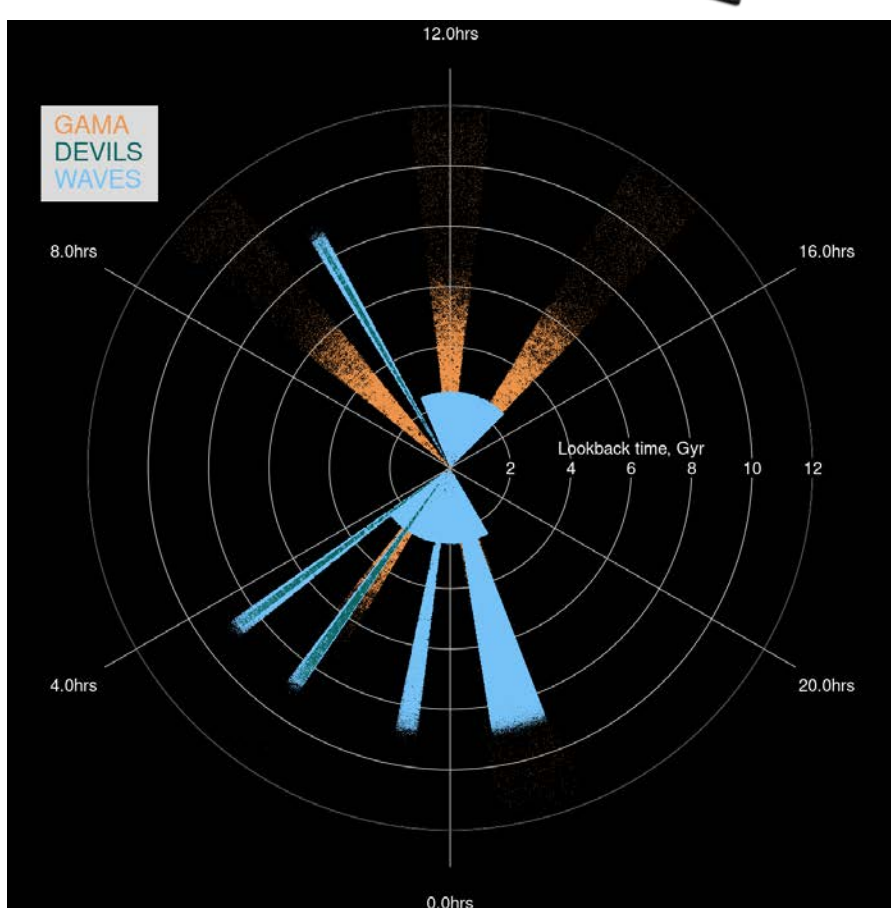
Properties of the first galaxies in the Universe



+



+



Evolution of galaxies and environments at intermediate to low redshift



Across all times



+



+



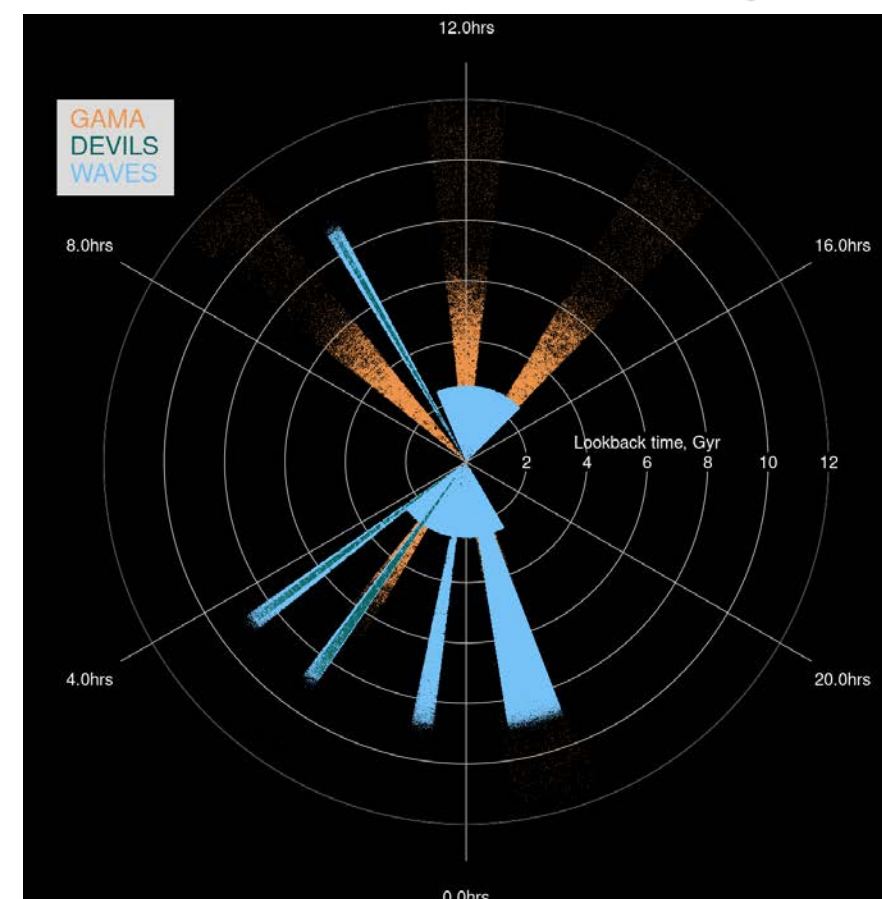
Properties of the first galaxies in the Universe



+



+



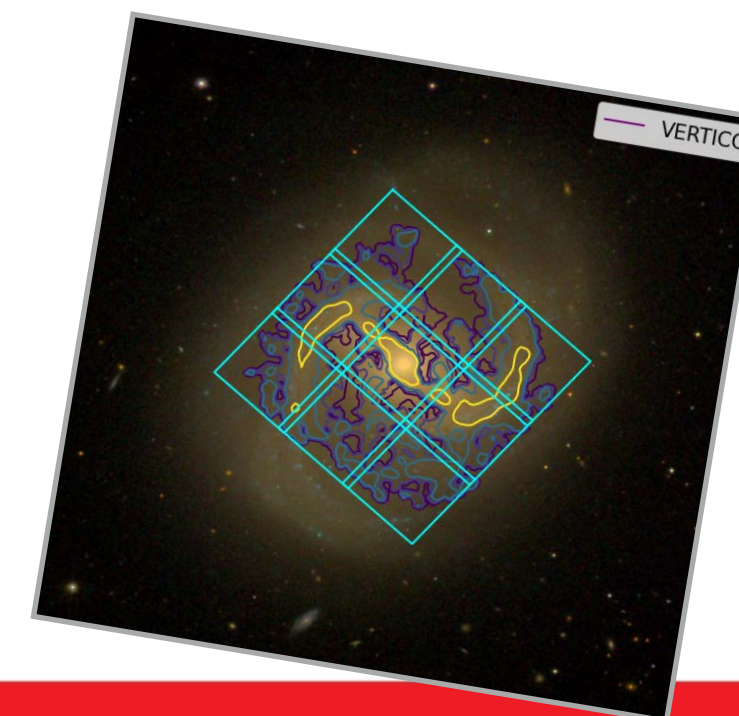
Evolution of galaxies and environments at intermediate to low redshift



+



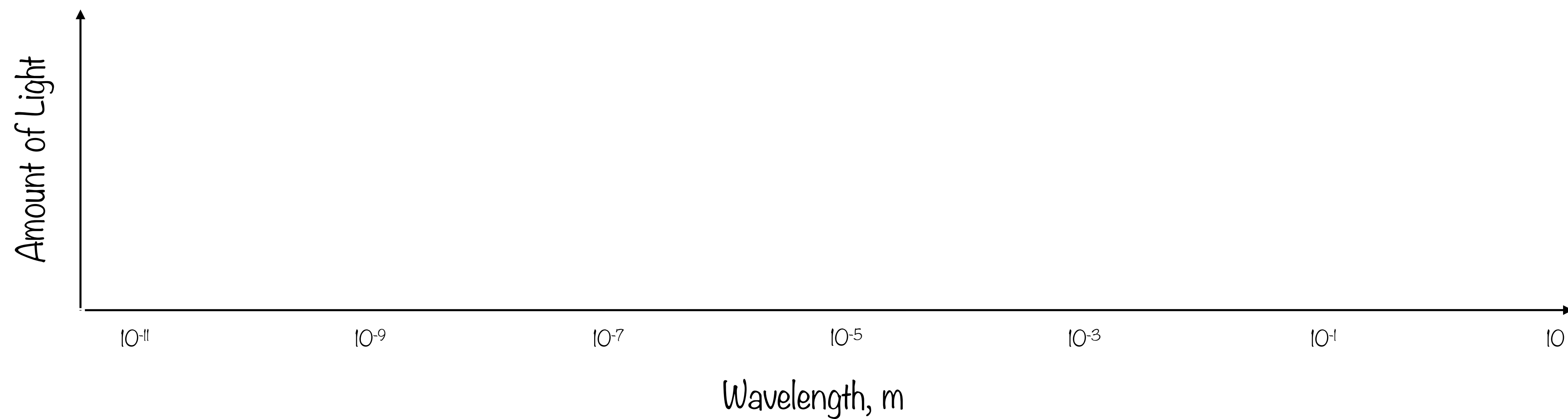
+



Evolution of galaxies and environments right now!

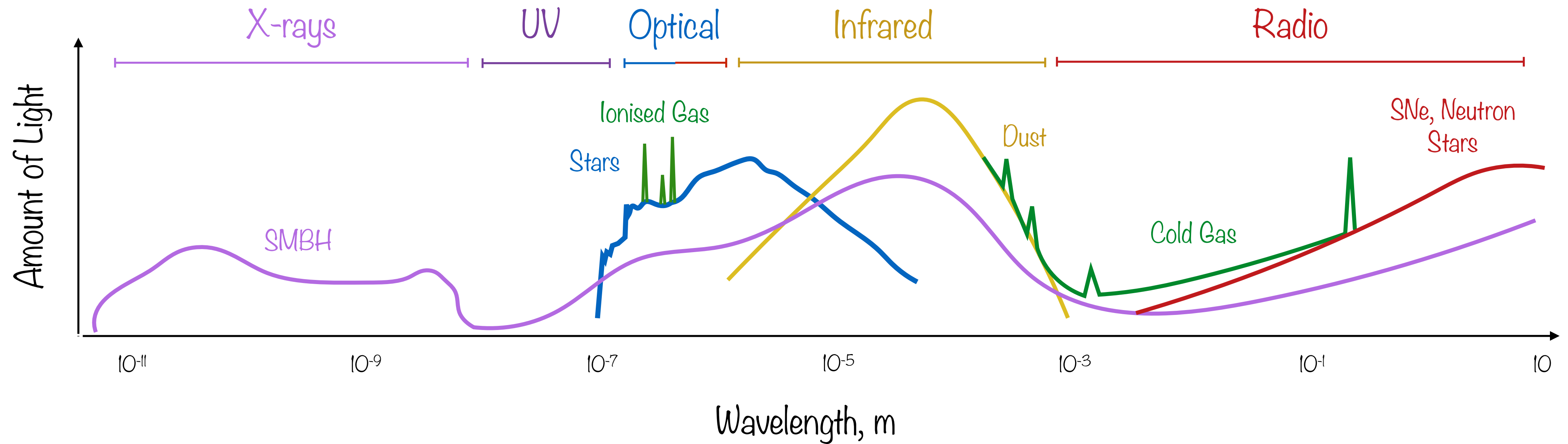


Across all wavelengths





Across all wavelengths



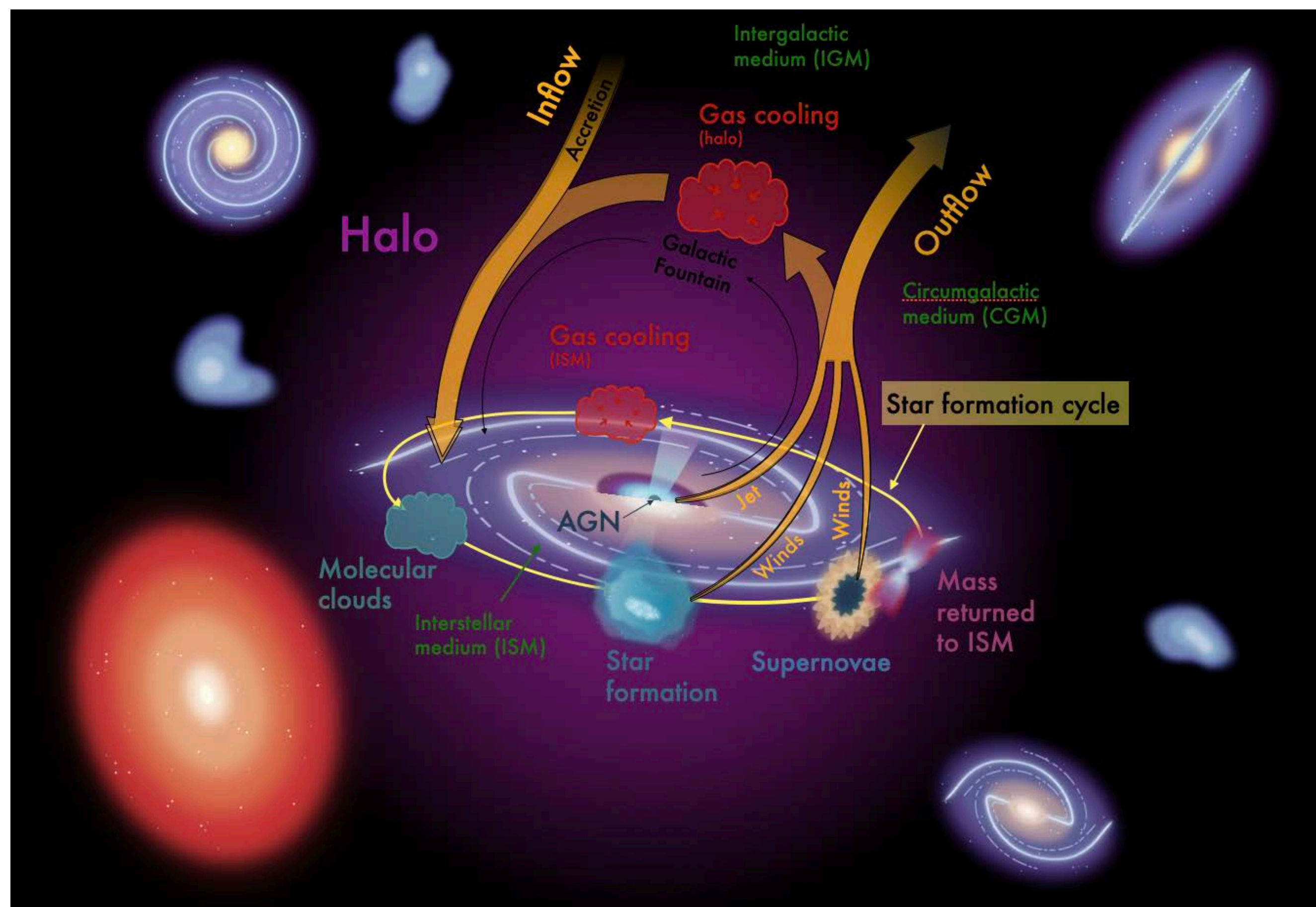
Physical components of galaxies

stars gas dust AGN

Census of baryons and photons in the Universe

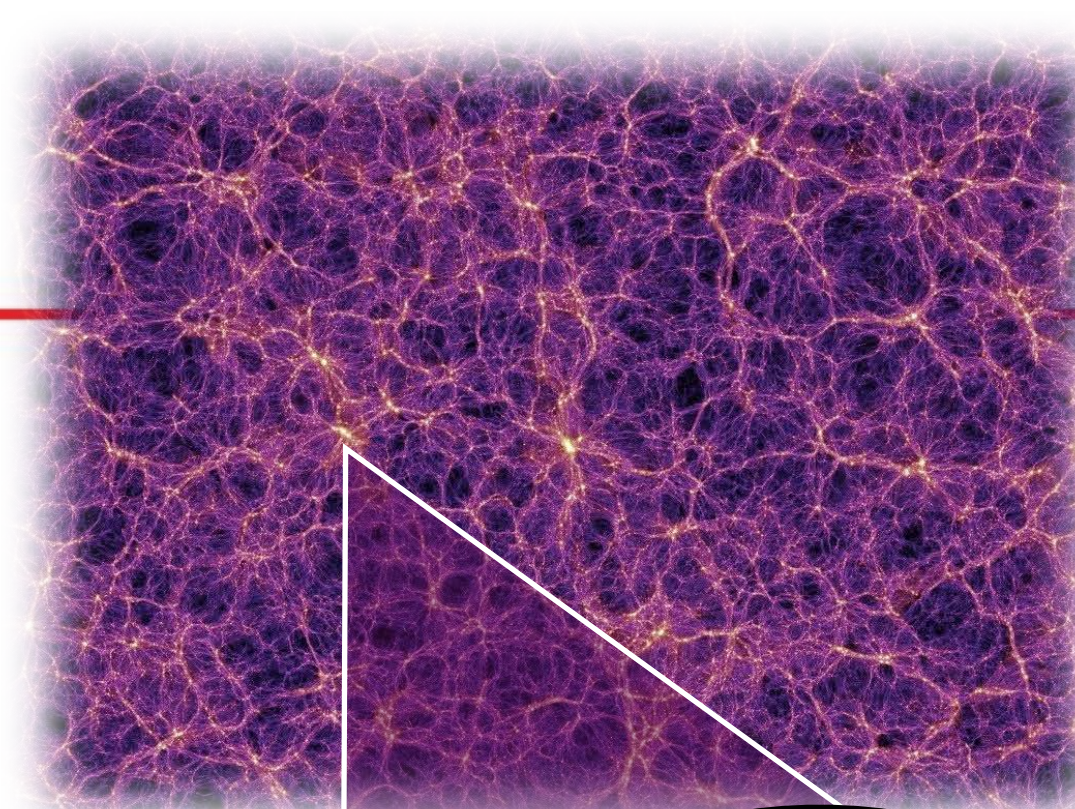
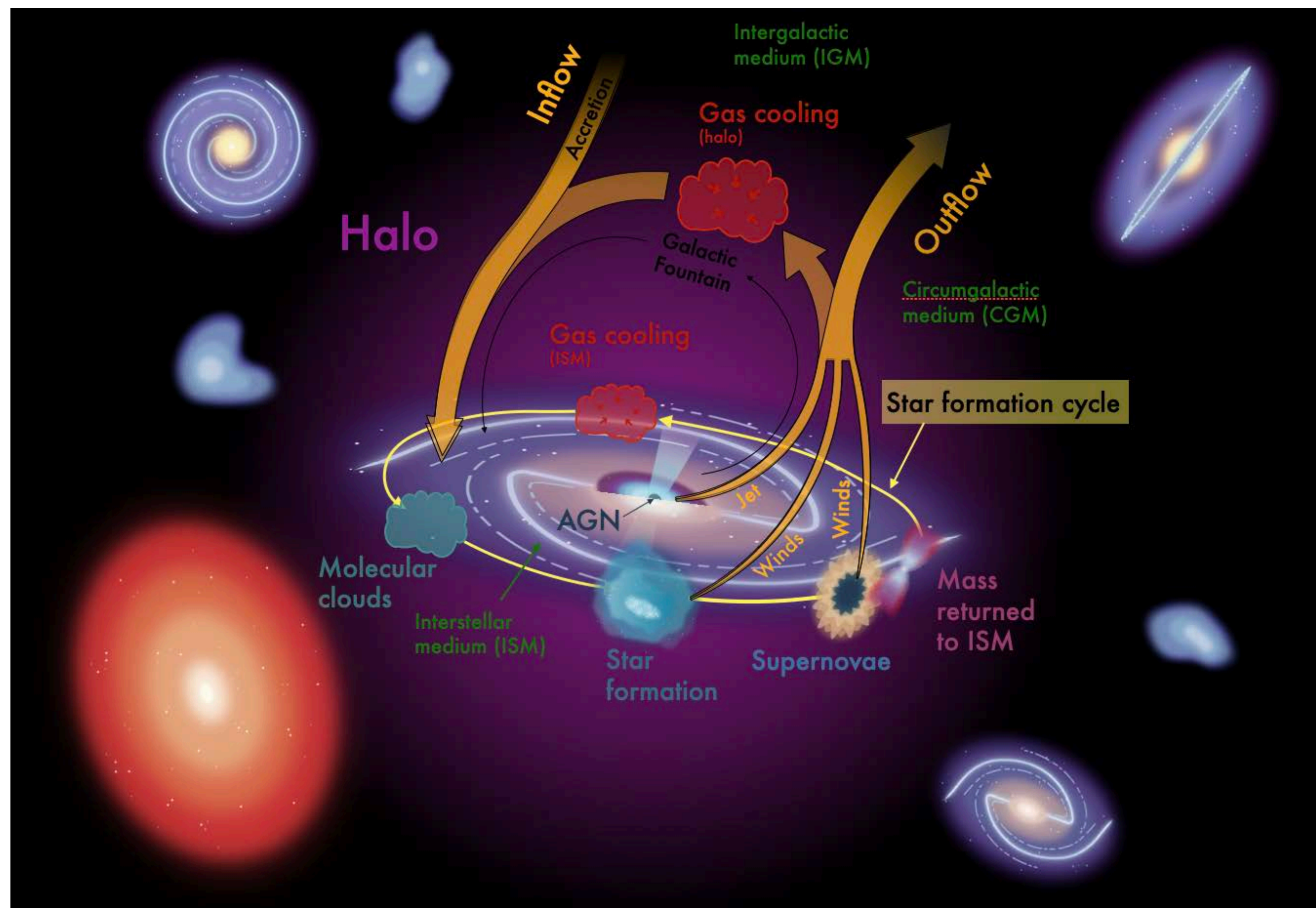
Galaxy morphology, structure and dynamics

Across all scales





Across all scales



Elisabete da Cunha



Multi-wavelength SEDs, dust, gas and star formation at high redshift

Simon Driver



Baryon and photon census, dark matter maps

Aaron Robotham



Multi-wavelength SEDs, galaxy environments, software tools

Luke Davies

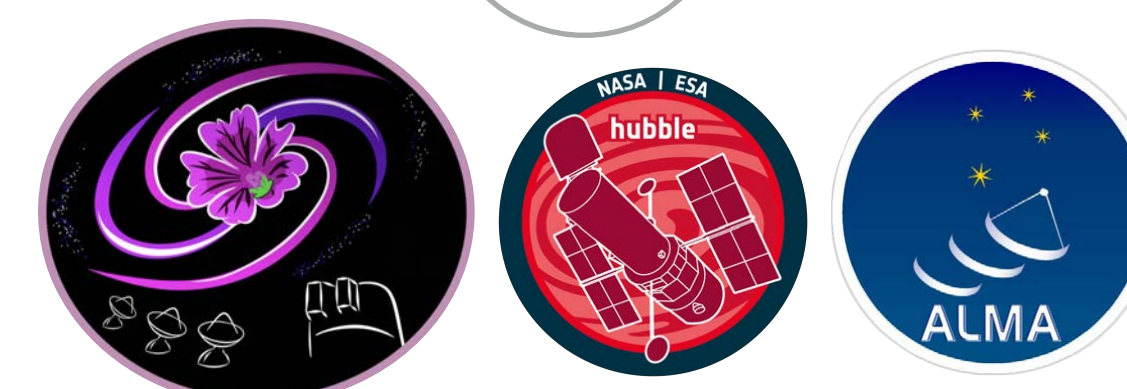


Star-formation, impact of environment, galaxy quenching

Luca Cortese



Resolved properties, galaxy dynamics, impact of environment, gas properties





Who to talk to...



Elisabete da Cunha



Luca Cortese



Aaron Robotham



Luke Davies



Simon Driver



Who to talk to...

Faculty



Elisabete da Cunha



Luca Cortese



Aaron Robotham



Luke Davies



Simon Driver

Post-docs



Andrew Battisti



Uroš Meštrić



Sabine Bellstedt



Trystan Lambert



Adam Marshall



Dior Etherton

PhD



+ Masters students...

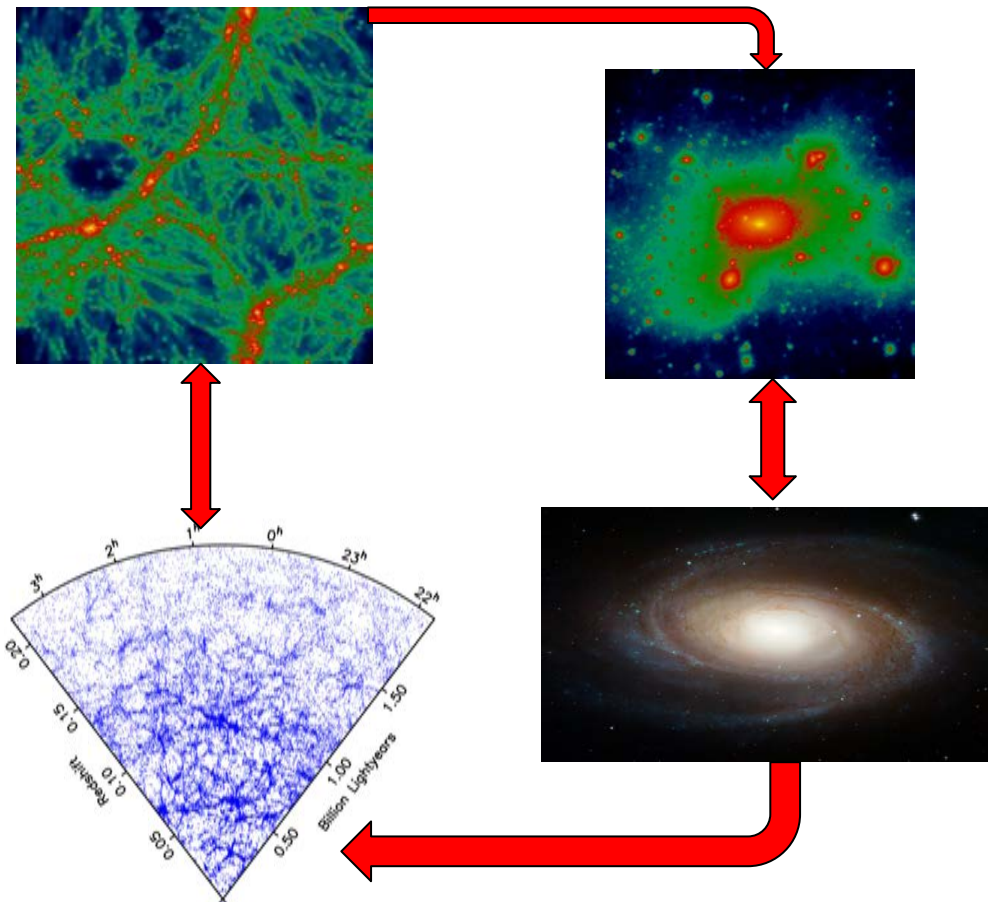


Computational, modelling and theoretical astrophysics group

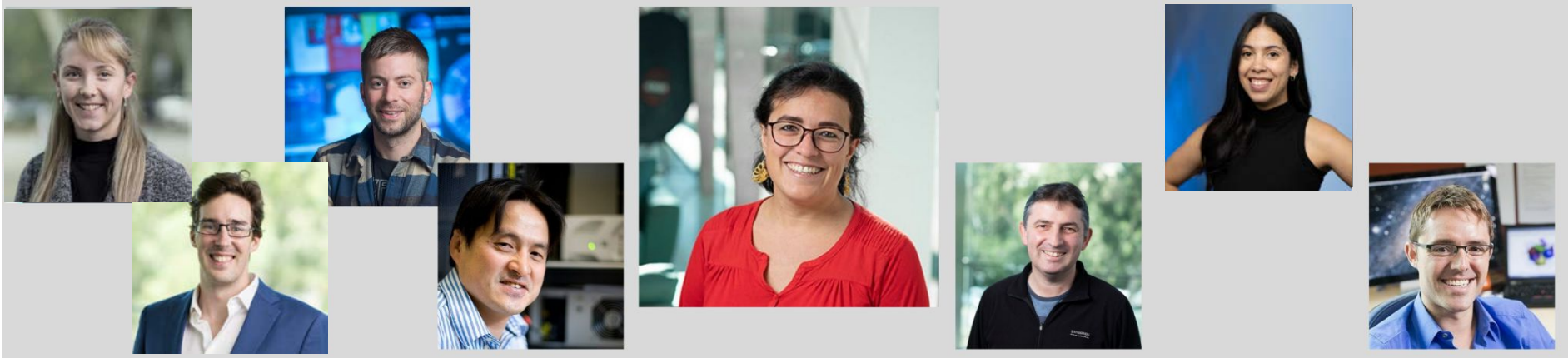
Modelling Dark Matter & Galaxy Formation

Prof Chris Power, on behalf of SU3 Team

What do we do?



- Explore theories of **cosmology**, **dark matter**, and **galaxy formation**...
- ... using state-of-the-art **supercomputer simulations** and sophisticated **theoretical models**.
- Create mock observables to test model predictions and support **galaxy survey science**
- Develop **novel algorithms** and **statistical tools** to analyse and interpret data

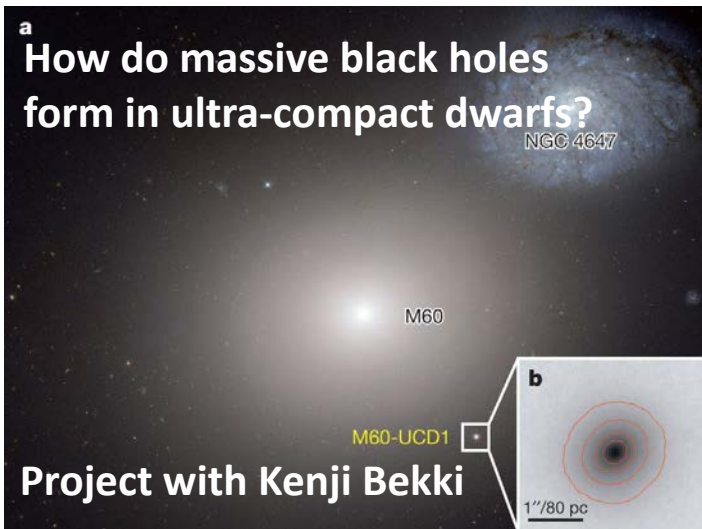


SU3 Computational, Modelling, Theory





Problems in Galaxy Formation



Do **super-massive black holes** grow in galaxies, or do galaxies grow around super-massive black holes?

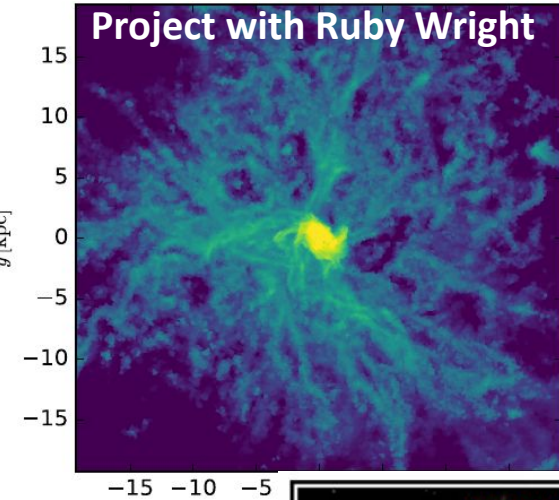
Is **galaxy morphology** a product of nature or nurture?





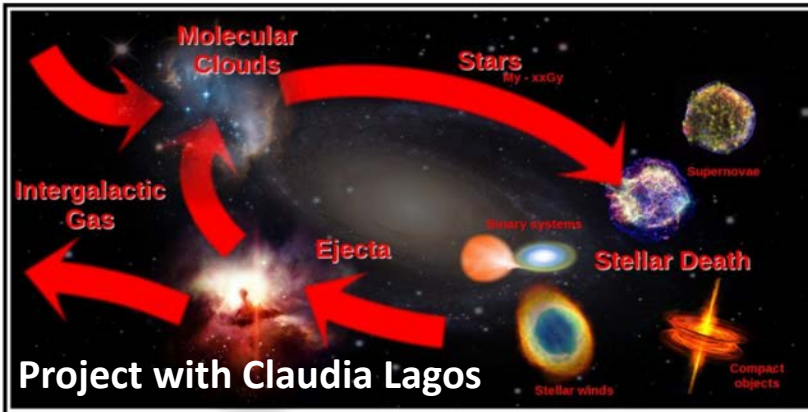
Problems in Galaxy Evolution

Project with Ruby Wright



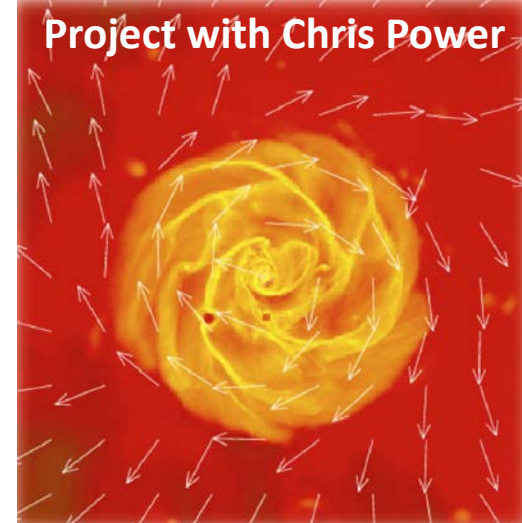
How can we probe the baryon cycle in galaxies using current and future observatories?

How do the **chemical elements**, yielded by the stars that forge them in their interiors, **enrich their host galaxies**?



Project with Claudia Lagos

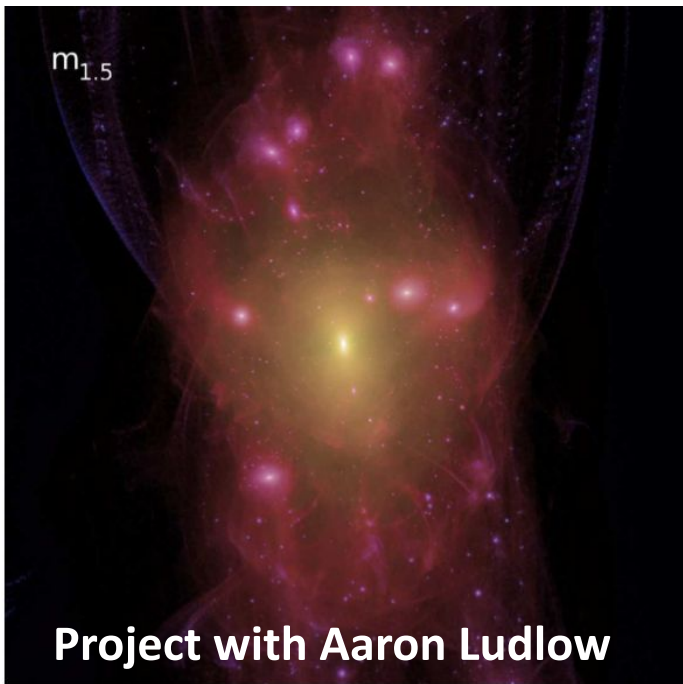
Project with Chris Power



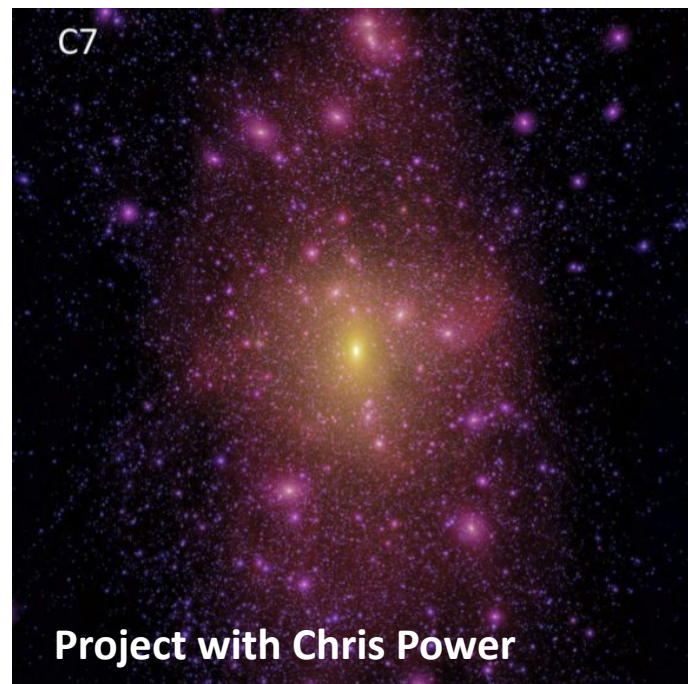


Problems in Dark Matter

How does **dark matter** influence the **observable properties of galaxies**?



Can we use the stars around galaxies to **test our theories of dark matter**?

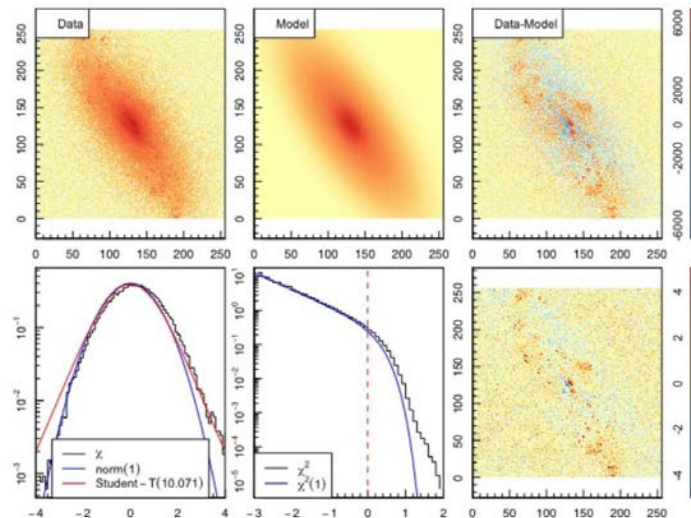




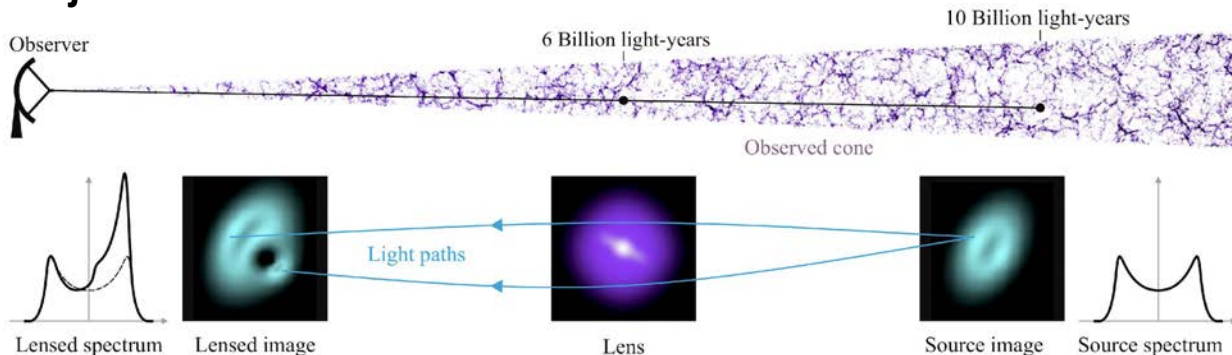
Problems in Modelling

Project with Claudia Lagos & Aaron Robotham

What can **galaxy structure** tell us about the **physics of galaxy formation**?



Project with Danail Obreschkow



How can we explore **dark matter** and **distant galaxies** through **gravitationally lensed radio signals**?

Gravitation, cosmology and extreme transients!

Dr Fiona Panther
fiona.panther@uwa.edu.au



Waveform graphic: Mac Button



FORREST
RESEARCH
FOUNDATION

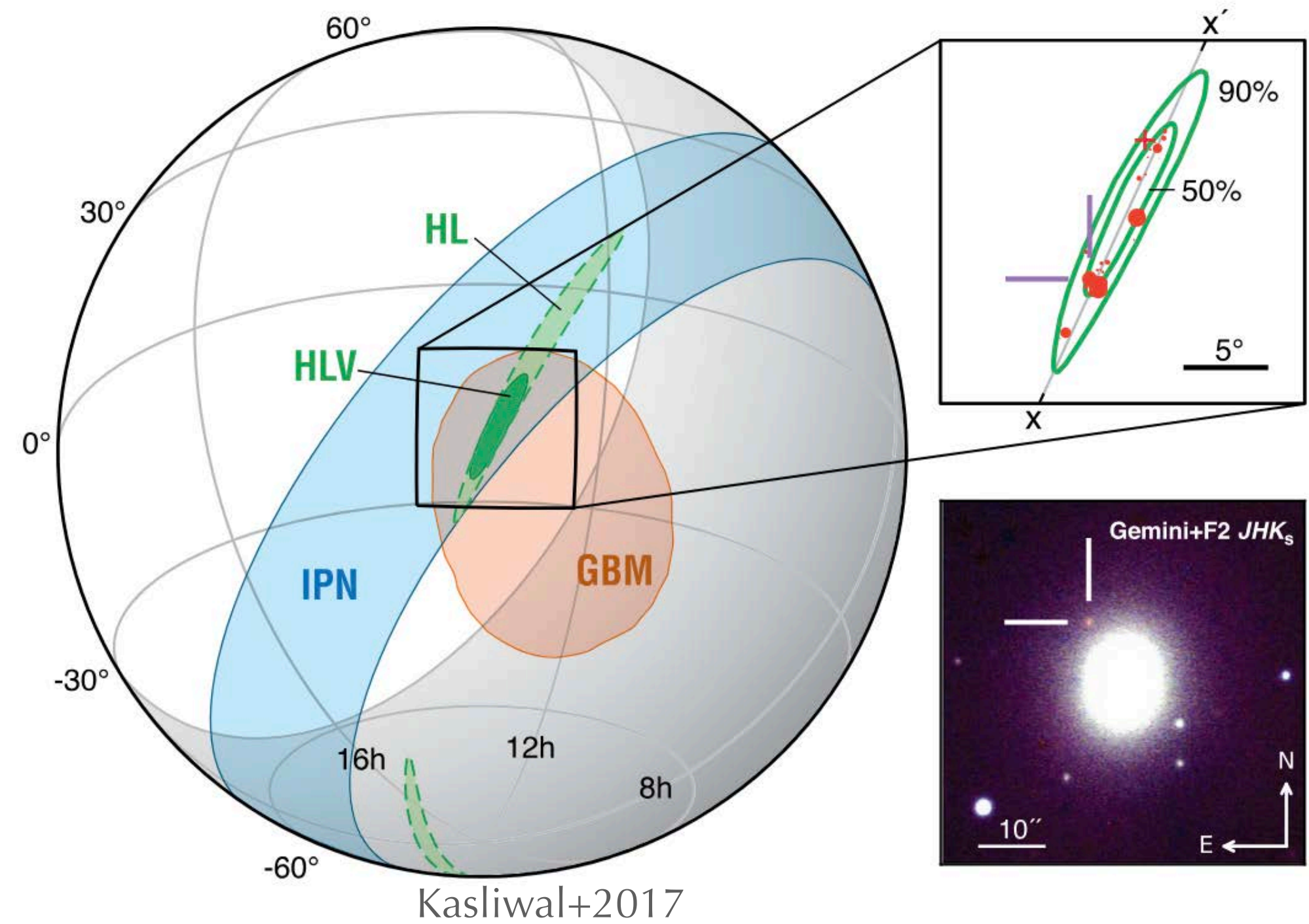


UWA
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OzGrav
ARC CENTRE OF EXCELLENCE FOR
GRAVITATIONAL WAVE DISCOVERY

Our work, in one slide.

How do the most extreme compact objects form, evolve and interact over cosmic time?

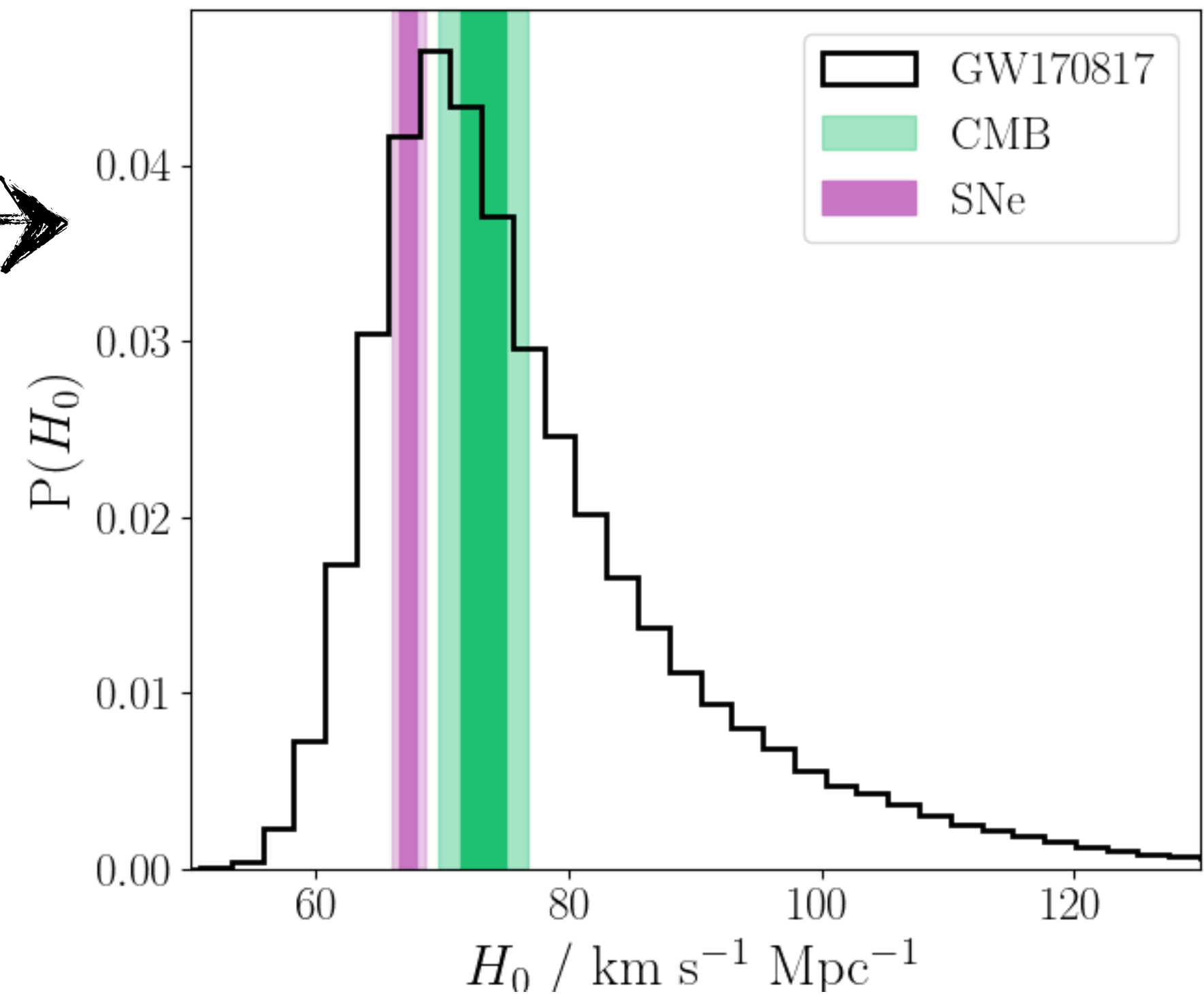


How do we measure things? And how can we get the maximum amount of information out of our observations?

Panther+2026 (New Astro. Rev.)



Can we use gravitational waves and light to understand Dark Energy



Who are we?

Jordan Moncrieff, PhD Student



+ Andrew McKenzie (BPhil)



Fiona Panther (Forrest Research Fellow)

Photographs: National Science Week @ Forrest Research Foundation 2026



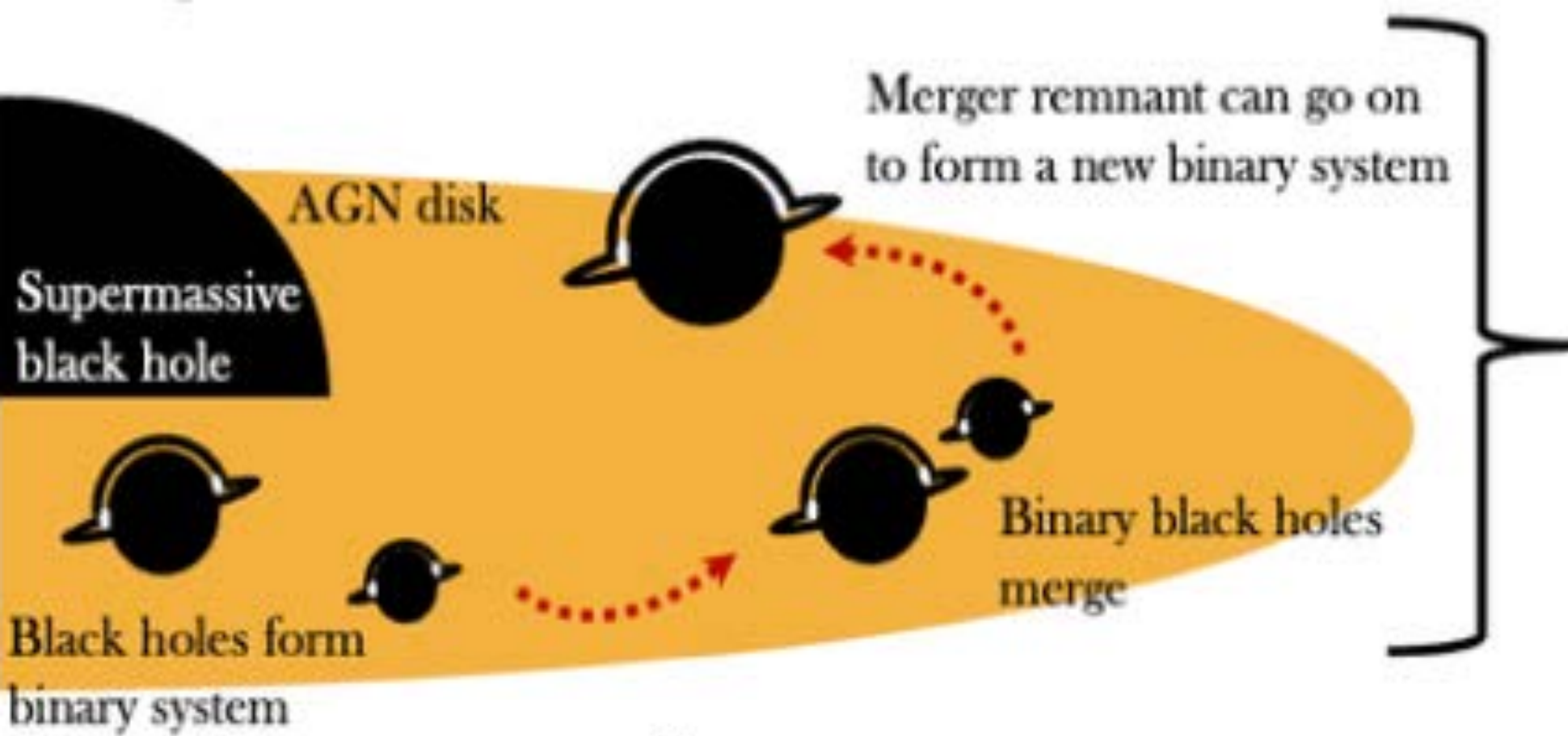
Mac Button (Masters Frontier Physics)



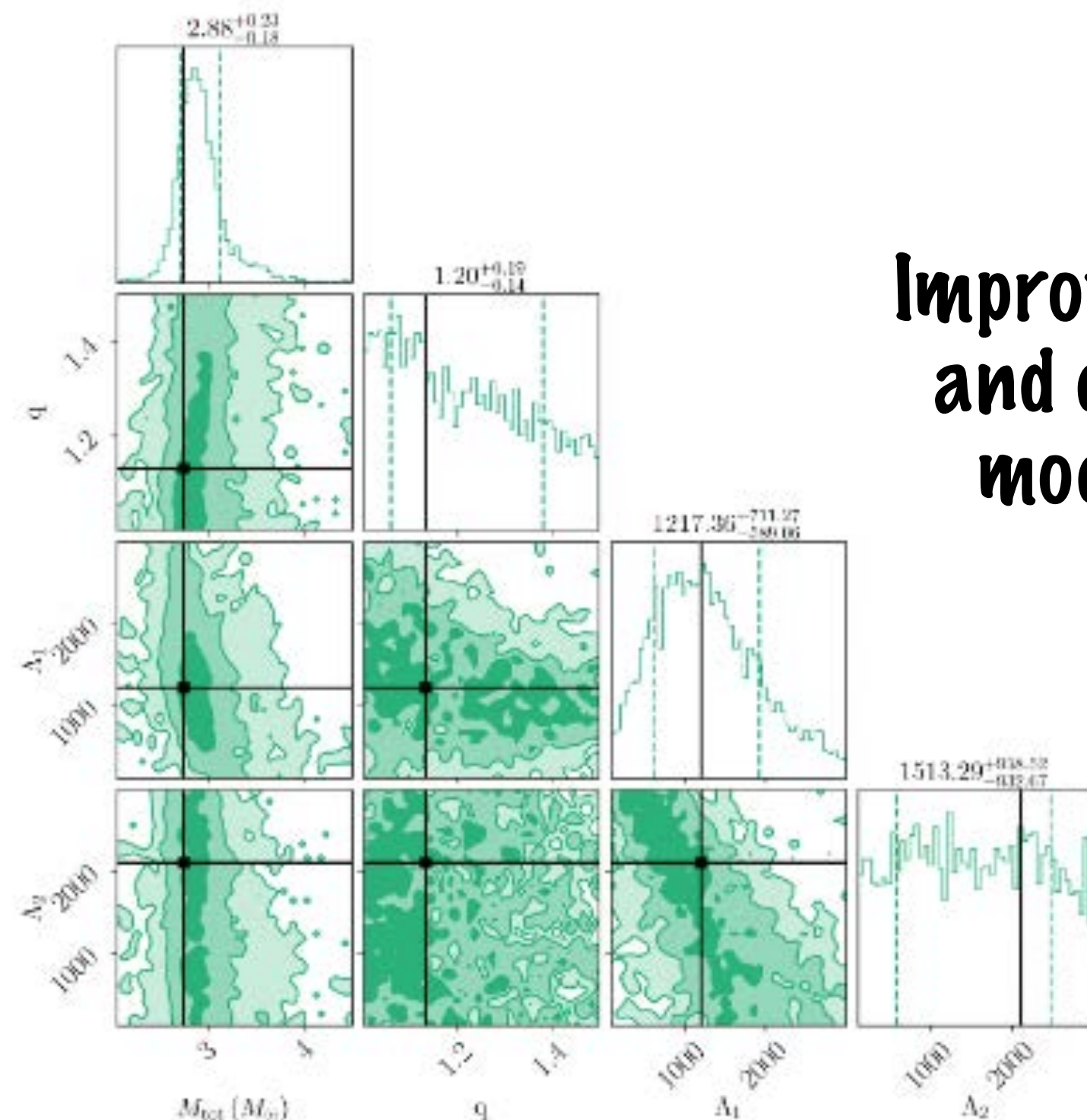
Collaborators include

- Paul Lasky, Eric Thrane & Evgeni Grishin (Monash)
- Christian Wolf, Liana Rauf, Chris Lidman (ANU)
- Nikhil Sarin (Cambridge)
- Thomas Siebert (U. Würzburg)
- Alessandro Trani (U. De Concepcion)
- Nick Stone (U. Wisconsin-Madison)

What problems do we work on?

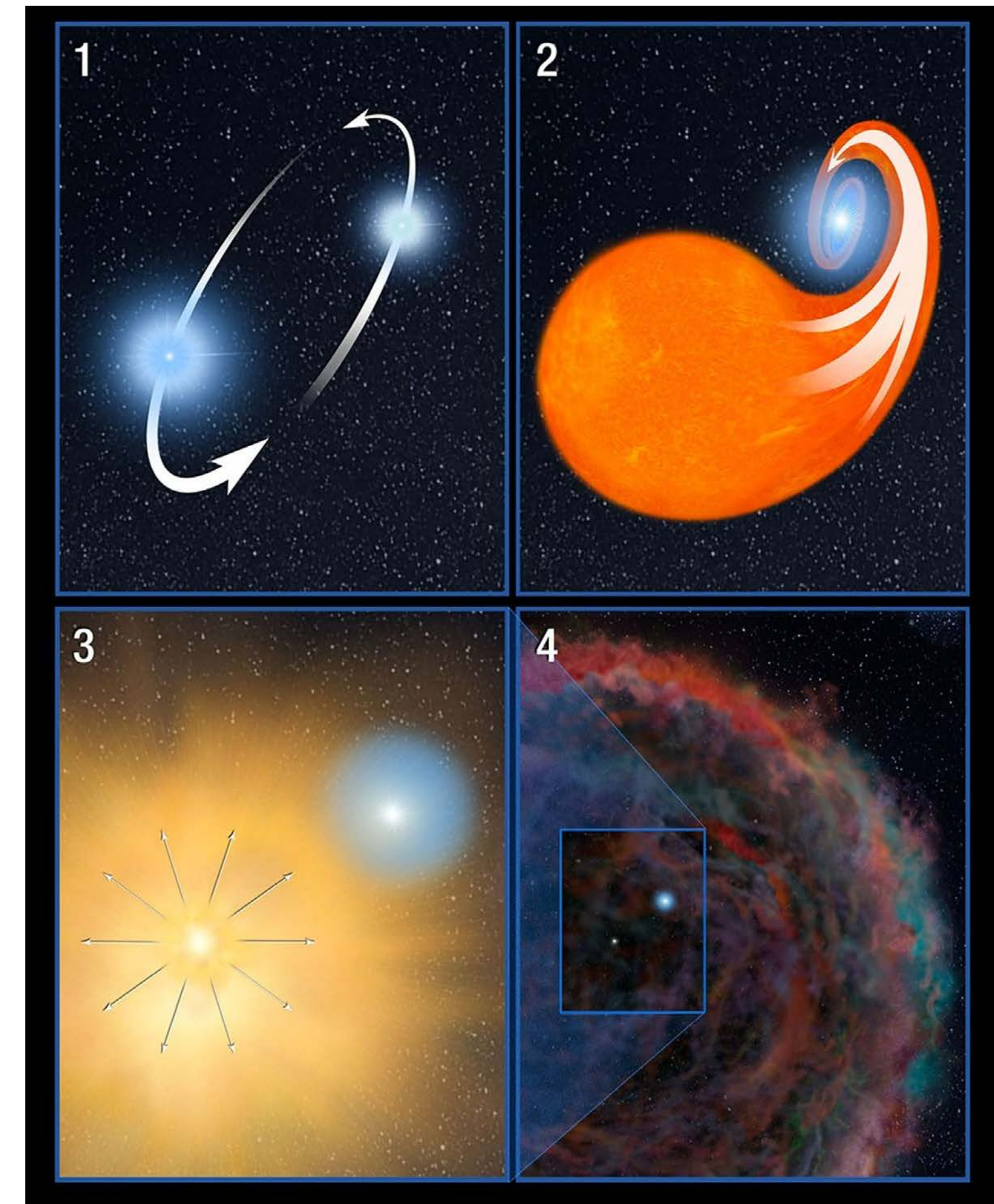


What role do AGN have in the evolution of merging black hole binaries?



Improving data analysis and developing better models for physical systems

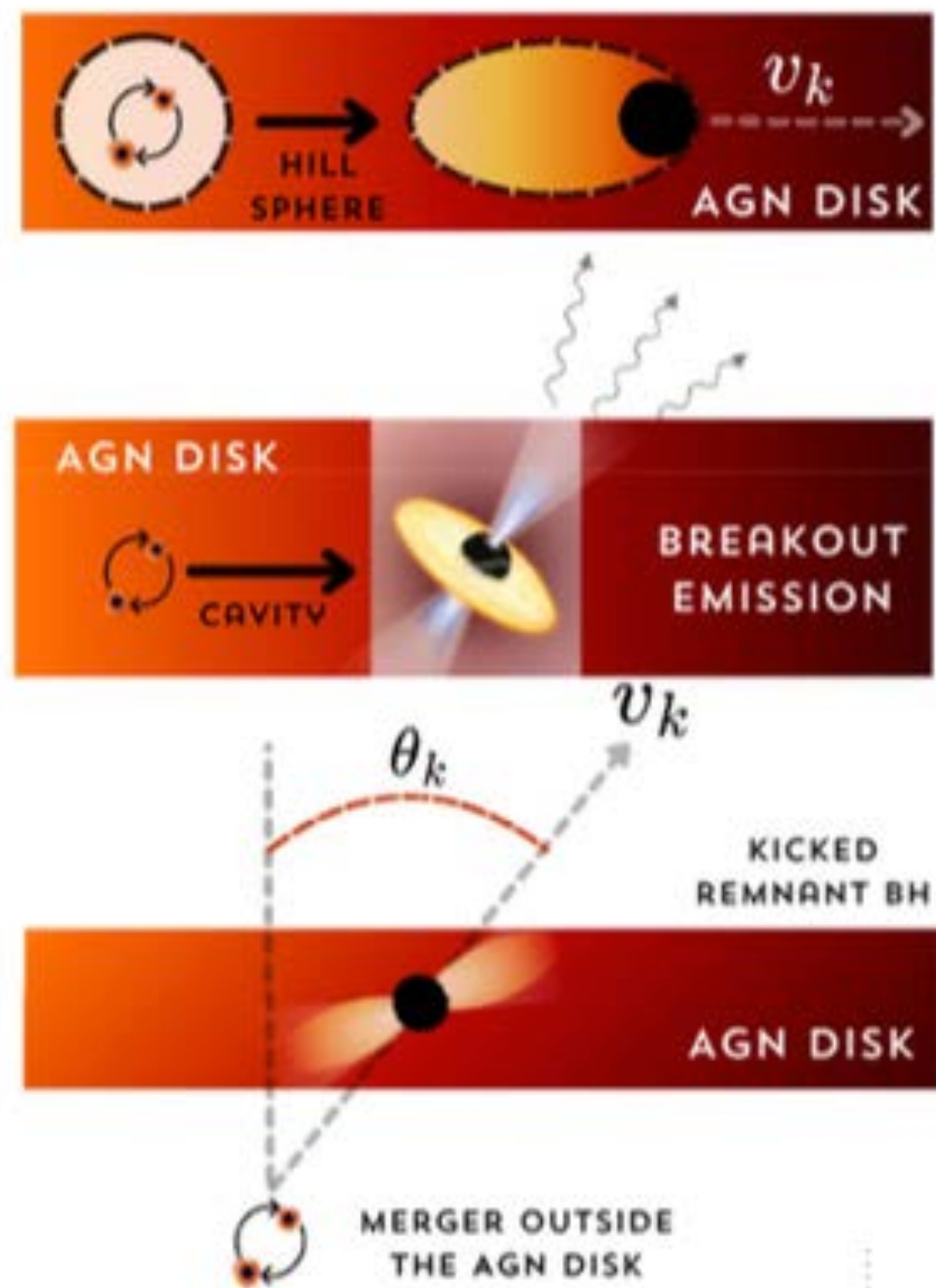
LHS figures: Panther
RHS figure: NASA



What sort of stars end their lives as extreme transients?

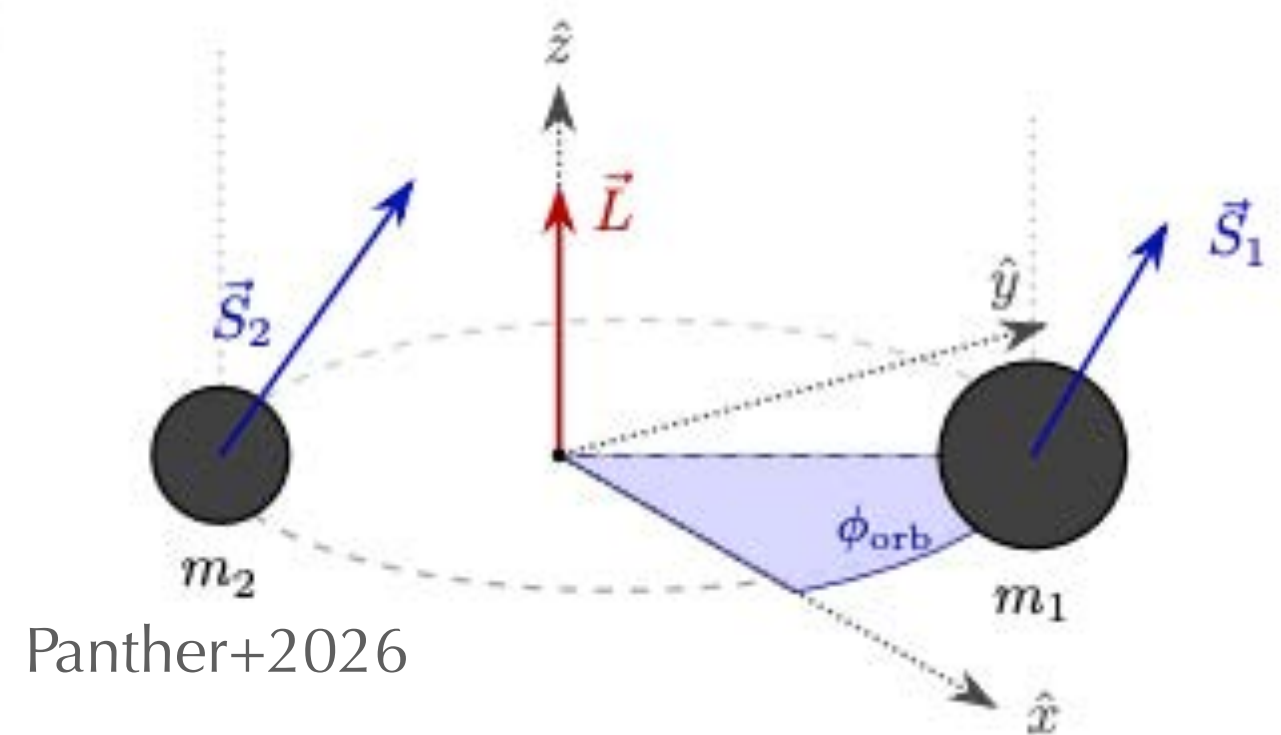
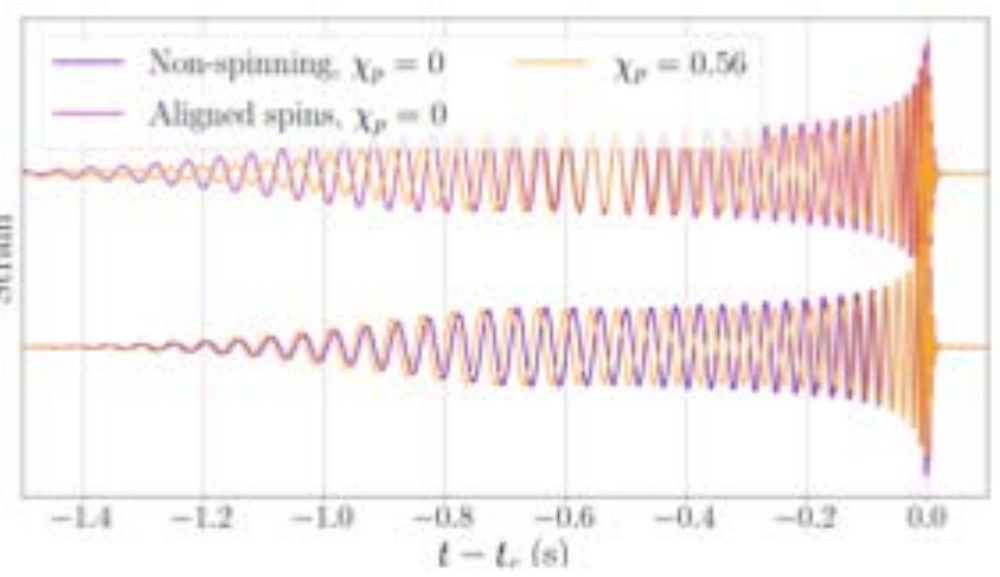
Which question are you going to answer?

Darc+2025

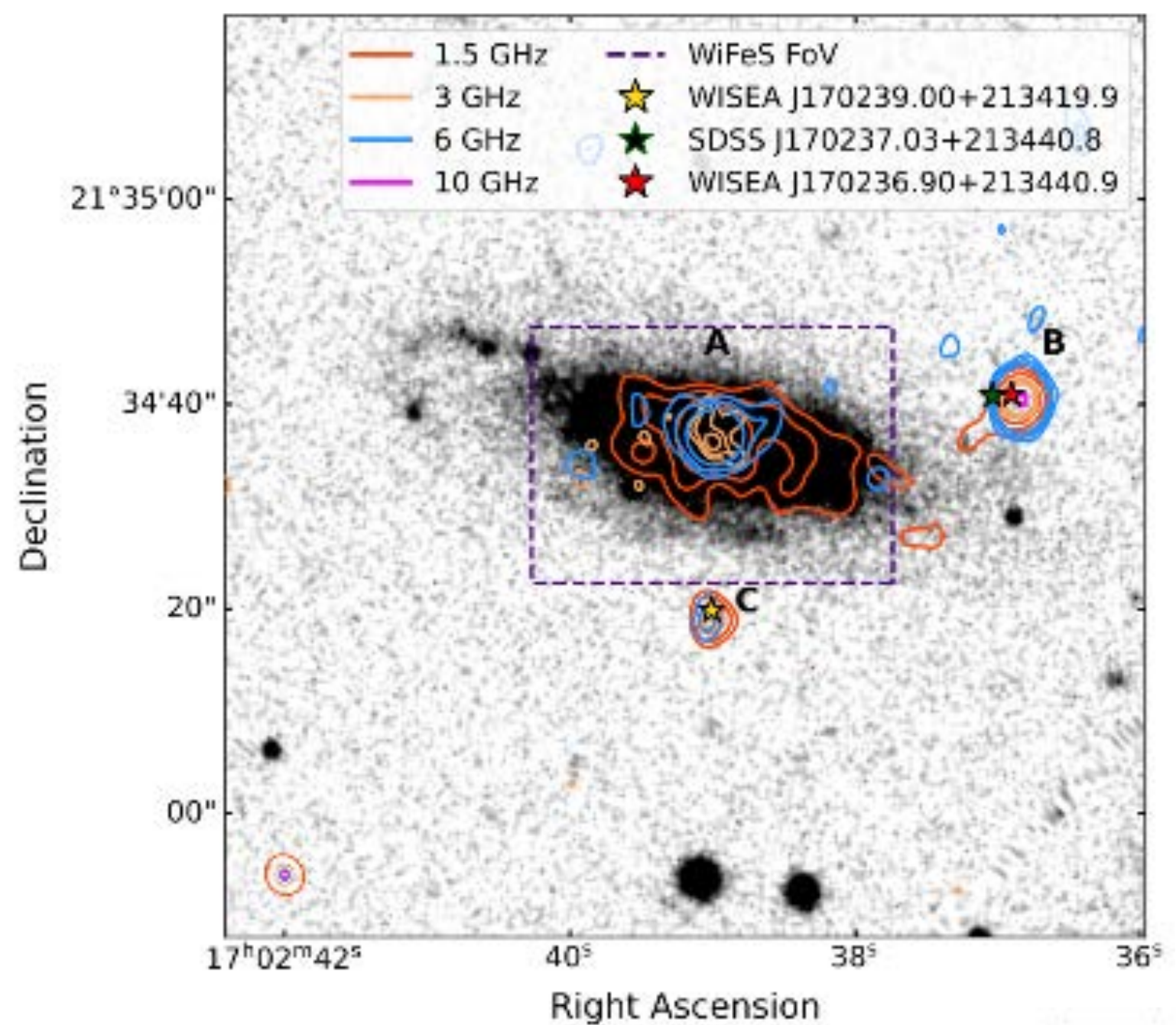


‘Illuminated’ dark sirens for GW cosmology

Model the electromagnetic and GW emission from binary black hole mergers in AGN, and use these models to search for BBH that are ‘illuminated’ by their environments.



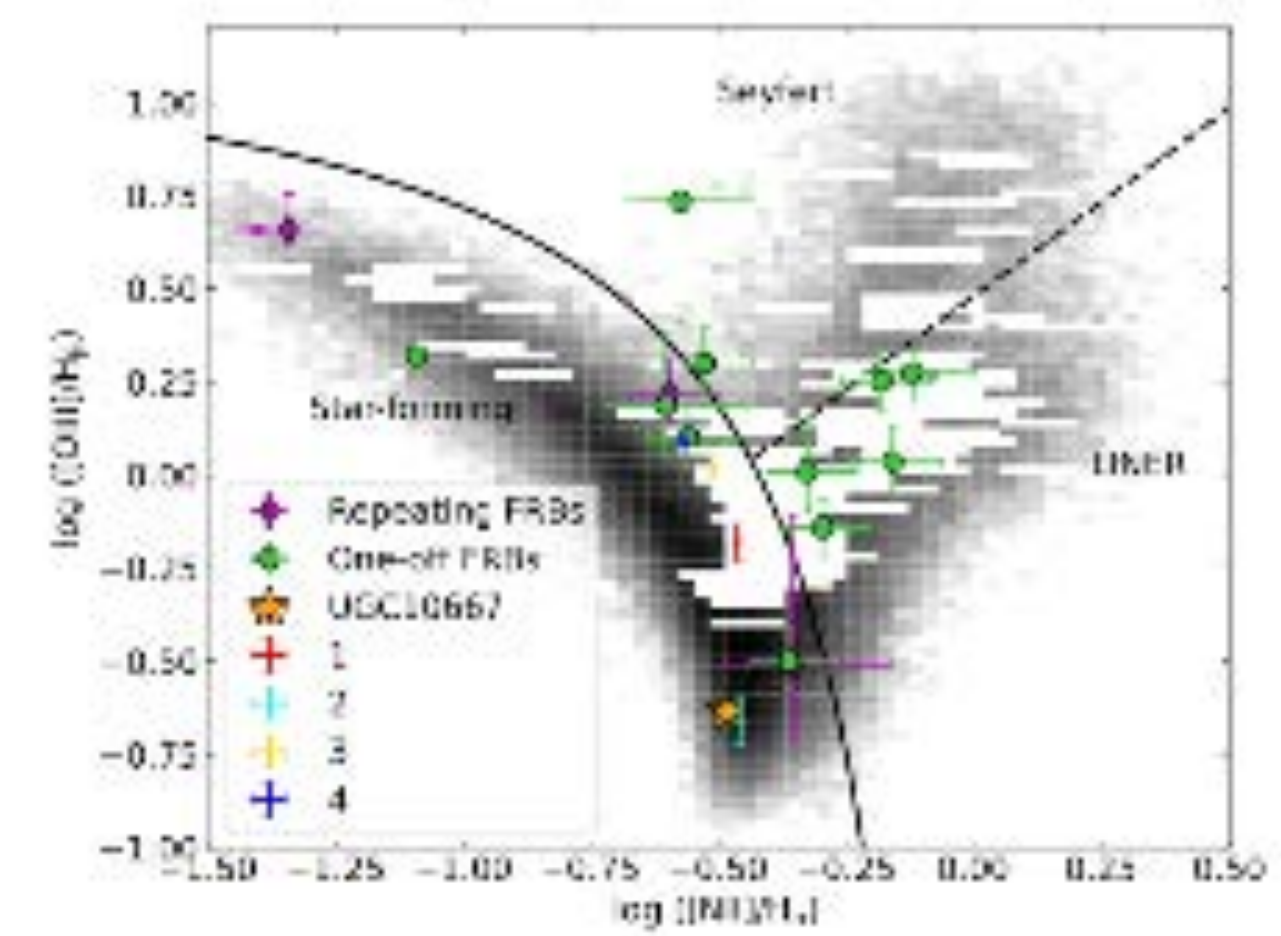
Panther+2026



Understanding the stellar populations that host extreme transients

Panther+2023

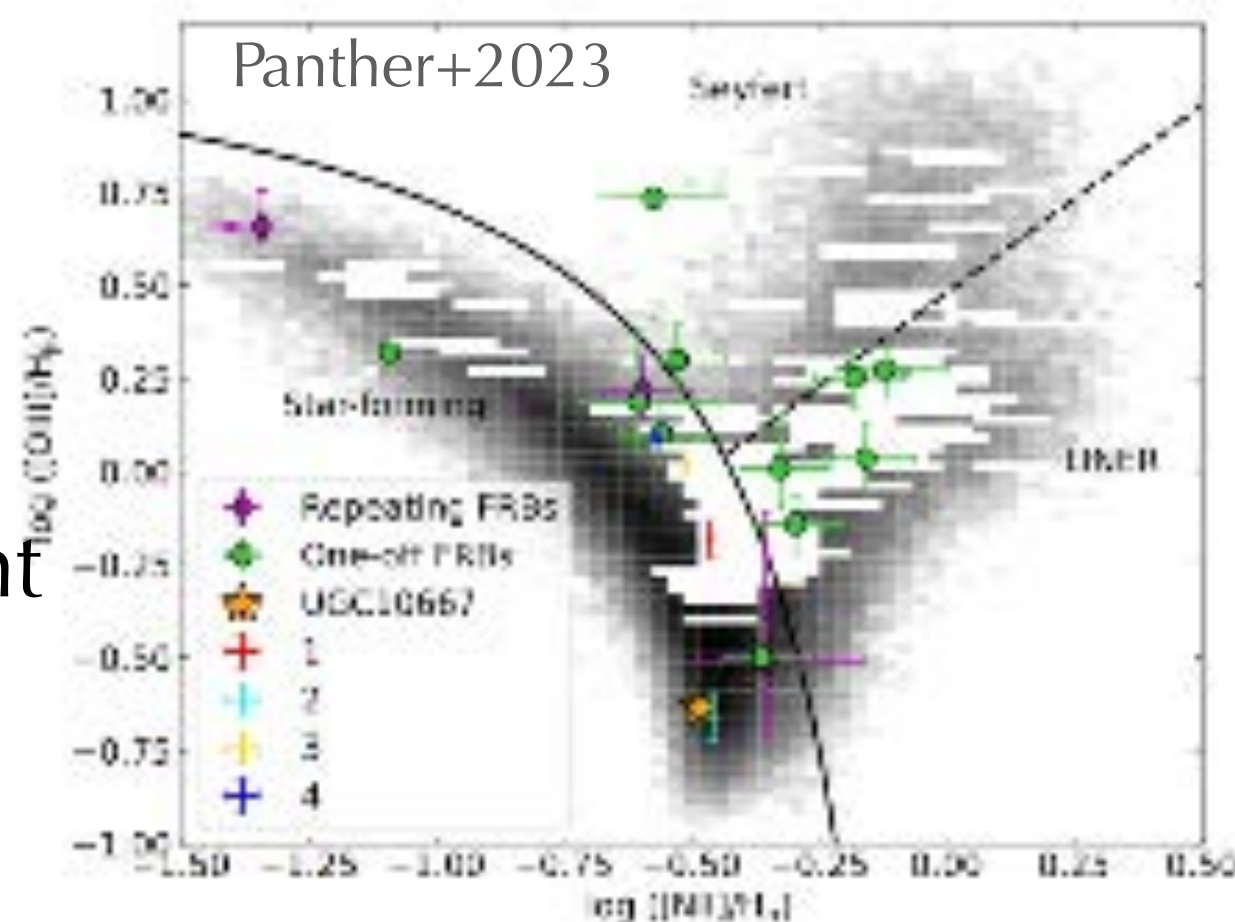
Use spectroscopic observations of transient host galaxies to understand the progenitors of extreme transients



Which question are you going to answer?

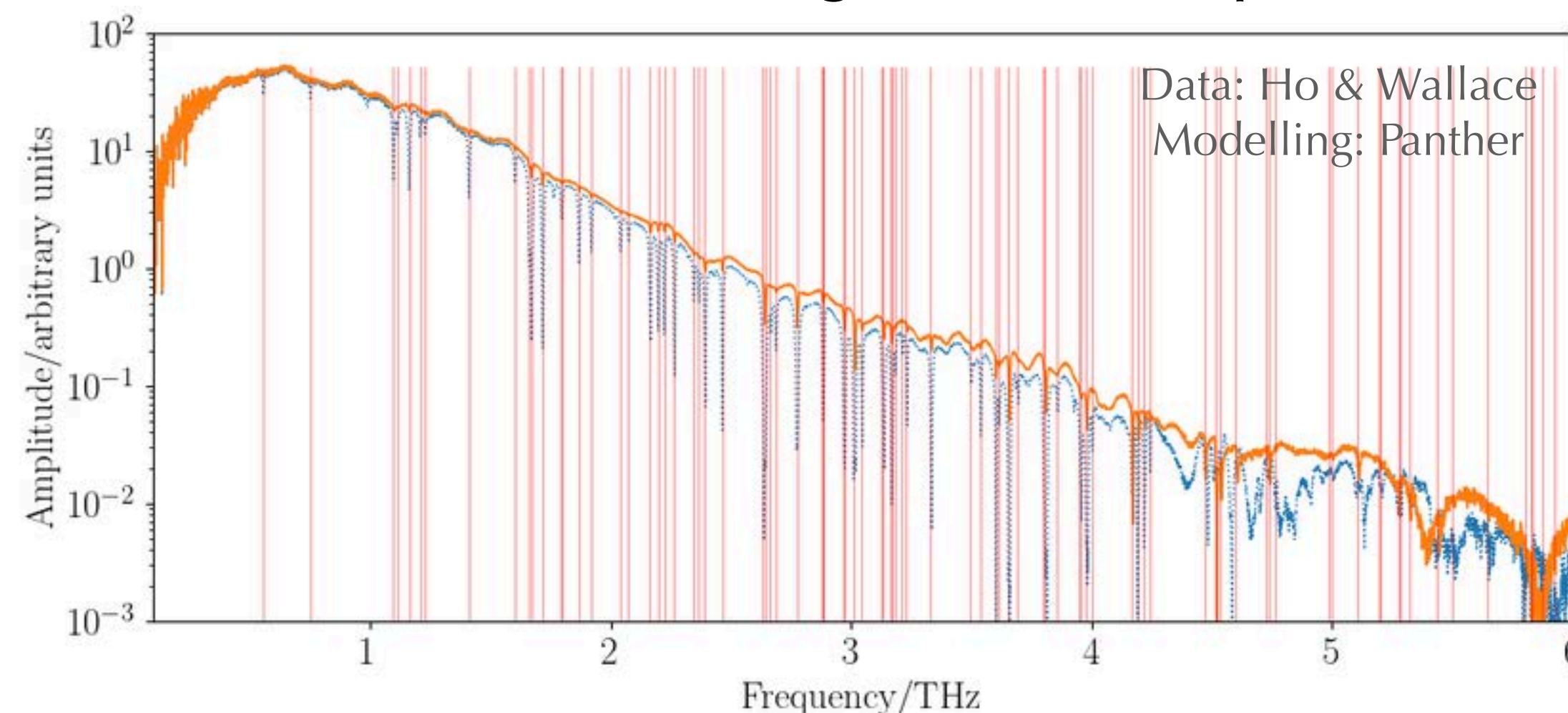
An extreme deconvolution (XD) approach to classifying emission line galaxies

Develop and apply new methods to classifying emission line galaxies that factors in measurement uncertainties in faint objects, and study the 'gap' between Seyfert and LINER galaxies



Removal of water vapor interference from spectroscopic observations

Use transdimensional inference to remove OH transitions from astronomical spectra in post-processing, and study applications to medical and industrial sensing at THz frequencies



Phase transitions in postmerger neutron star remnants

Mac Button

Investigate coherent methods to determine if phase transitions between nucleonic matter and quark-gluon plasmas occur in hypermassive neutron stars

More information?

About projects:

email
fiona.panther@uwa.edu.au to
organize a meeting time

To find out more:

Contact Jordan Moncrieff or Mac Button (current students).

You can also contact my past students: Eloise Moore (U. Potsdam) or Jamie McGregor (ANU)



Thank you



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