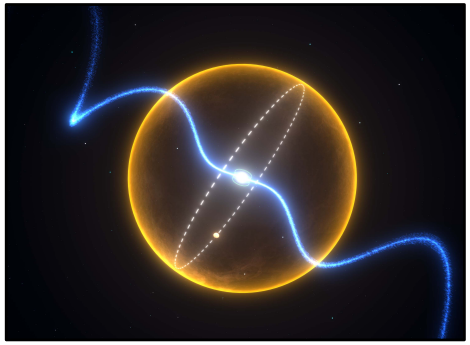
CAASTRO
ARC CENTRE OF EXCELLENCE
FOR ALL-SKY ASTROPHYSICS

THE UNIVERSITY OF SYDNEY

ARC Centre of Excellence for All-Sky Astrophysics: A New Way of Looking at the Sky

Sean Farrell
The University of Sydney

www.caastro.org



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An Opportunity …

Google Earth; CSIRO / Swinburne; MWA; USyd; iVEC/CSIRO; AAO; ANU

- Aust government has designated astronomy a "Super Science":
  - critical area of scientific endeavour; area of world-leading capability in which Australian researchers have consistently punched above weight
  - ***Square Kilometre Array (SKA)***, largest telescope ever conceived
- Australian SKA Pathfinder (ASKAP)
- Murchison Widefield Array (MWA)
- SKA Molonglo Prototype (SKAMP)
- Aust Astronomical Observatory (AAO)
- SkyMapper
- Pawsey High Performance Computing Centre for Square Kilometre Array Science

$420M of public investment in astronomy infrastructure →

A window of opportunity to make Australia a world leader in all-sky astrophysics

The Centre for All-sky Astrophysics

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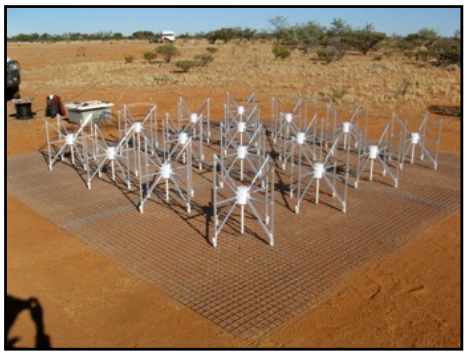
The CAASTRO Vision: To be the international leader in wide-field astronomy, positioning Australia to address fundamental unsolved questions about the Universe with the dramatic capabilities of next-generation telescopes and advanced instrumentation.

- → **DISCOVER:** Ground-breaking advances in understanding the Universe
- → **INNOVATE:** New ways of processing & visualising complex data sets
- → **PERFORM:** High-impact discoveries using SKA pathfinders
- → **UNITE:** A new network of talented researchers
- → **EDUCATE:** Exciting opportunities for students and young researchers



CAASTRO Investigators

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ASKAP/POSSUM

ASKAP/FLASH

ASKAP/VAST

ASKAP/WALLABY

SkyMapper

AAO Director

CSIRO SKA Director

ASKAP/EMU

› **The University of Sy**
- Bryan Gaensler (Director)
- Kate Gunn (COO
- Scott Croom (CI)
- Elaine Sadler (CI)
- Tara Murphy (AI)

› **Swinburne University**
- Matthew Bailes (CI)
- Warrick Couch (CI)
- Jeremy Mould (CI)
- Emma Ryan-Weber (AI)
- Chris Blake (AI)

› **ANU**
- Brian Schmidt (CI)
- Frank Briggs (CI)
- Stuart Sim (AI)

› **University of Melbourne**
- Stuart Wyithe (CI)
- Rachel Webster (CI)
- Jamie Bolton (AI)

› **UWA / ICRAR**
- Lister Staveley-Smith (CI)
- Martin Meyer (AI)
- Chris Power (AI)

Curtin University / ICRAR
- Steven Tingay (CI)
- JP Macquart (AI)
- Randall Wayth (AI)

› University of Queensland
- Tamara Davis (AI)

AAO
- Matthew Colless (PI)
- Andrew Hopkins (PI)
- Chris Lidman (

› CSIRO
- Brian Boyle (PI)
- Robert Braun (PI)
- Ray Norris (PI)

› Max-Planck Society
- Michael Kramer (PI)
- Guinevere Kauffmann (PI)

› Durham University
- Carlos Frenk (PI)

› Caltech
- Shri Kulkarni (PI)

› University of Oxford
- Steve Rawlings (PI)

› University of Arizona
- Xiaohui Fan (PI)

› University of Toronto
- Ue-Li Pen (PI)

› CNRS
- Reynald Pain (PI)

› RRI
- Ravi Subrahmanyan (PI)

› NCI

› iVEC

› NSW I&I

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Big Questions …

20th century : we discovered our place in the Universe

21st century : we seek to understand the Universe we inhabit

› **THE EVOLVING UNIVERSE**

- When did the first galaxies form, and how have they then evolved?

› **THE DYNAMIC UNIVERSE**

- What is the extreme physics that drives change in the Universe?

› **THE DARK UNIVERSE**

- What are the Dark Energy and Dark Matter that dominate the cosmos?

(Australian Astronomy Decadal Plan 2006-2010;
European Science Vision for Astronomy 2010;
US Decadal Review 2001-2010)

NASA / ESA / S. Beckwith / STScI

oneroundtable.com

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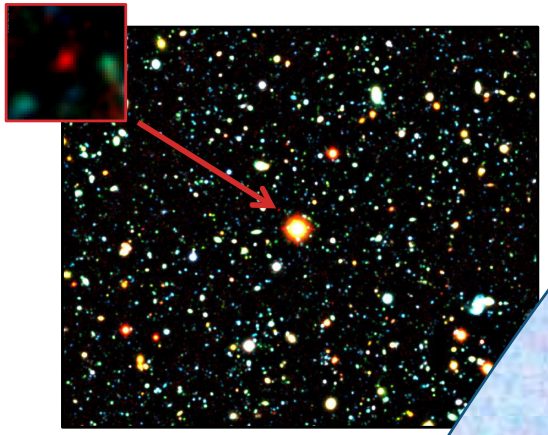
… and

EVOLVING



© Subaru Telescope / NAOJ

- Rare populatio
- Brief signals
- Weak stati

› Further pro

- teles
- data
- alg

MWA

ASKAP

eROSITA

Hubble Space Telescope

SkyMapper

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A World-Class Team

- Director: Bryan Gaensler (U Sydney)
- Deputy Director: Lister Staveley-Smith (UWA)
- Eight Fellows of the Academy, 11 ARC Fellows, eight Directors of national observatories/institutes
- Australia's highest profile astronomers
  - Brian Schmidt: ***2011 Nobel Prize in Physics***
  - Bryan Gaensler: 2011 Pawsey Medal
  - Stuart Wyithe: 2011 Malcolm McIntosh Prize
  - Current CAASTRO complement: 82 people
- Full involvement of national facilities
- World-class partners: Caltech, Oxford, Toronto, Durham, Max-Planck, Arizona, CNRS, RRI




ICC

PALOMAR TRANSIENT FACTORY

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Membership Categories

Category	Funding?	Examples
Chief Investigators	Travel, computing	Node directors, theme leaders, postdoc supervisors
Partner Investigators	-	AAO/CSIRO staff, international partners
Associate Investigators	$15,000/year	Survey leaders; early/mid career scientists
CAASTRO Affiliates	-	Super Science Fellows, senior scientists w. minor involvement
CAASTRO Research Staff	Salary, travel, computing	Postdocs, research coordinators, software developers
CAASTRO Professional Staff	As needed	COO, outreach officer, admin support
CAASTRO Students	Top-ups, travel, computing	Postgraduate students supervised by Chief Investigators
CAASTRO Visitors	$15,000/year	Includes Partner Investigators
“Friends of CAASTRO”	-	General public

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Research Themes & Highlights

› **EVOLVING: When did the first galaxies form, & how have they evolved?**

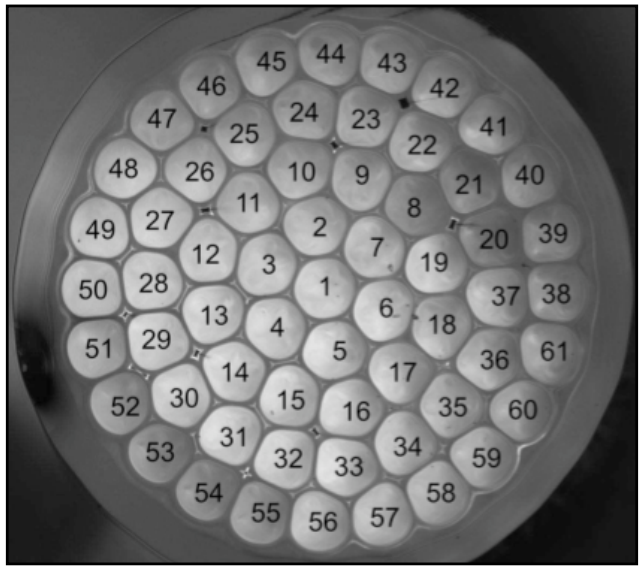
- A new way of studying galaxies using hexabundles (Croom et al. 2011)

› **DYNAMIC: What is the extreme physics driving change in the Universe?**

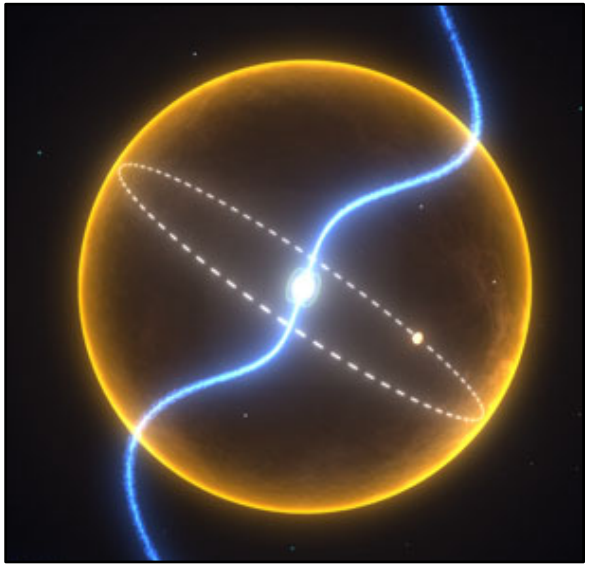
- A planet made of diamond (Bailes et al. 2011)
- A new candidate magnetar outside the Galactic plane (Callingham et al. 2011)

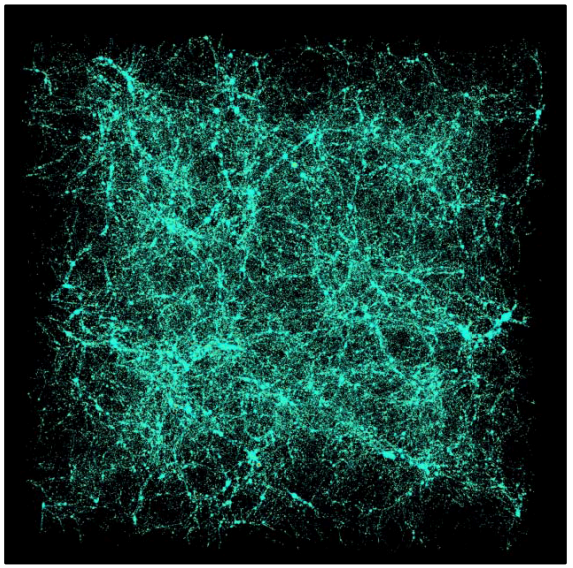
› **DARK: What are the Dark Energy/Matter that dominate the Universe?**

- Simulating the cosmos on a laptop (Greig et al. 2011)

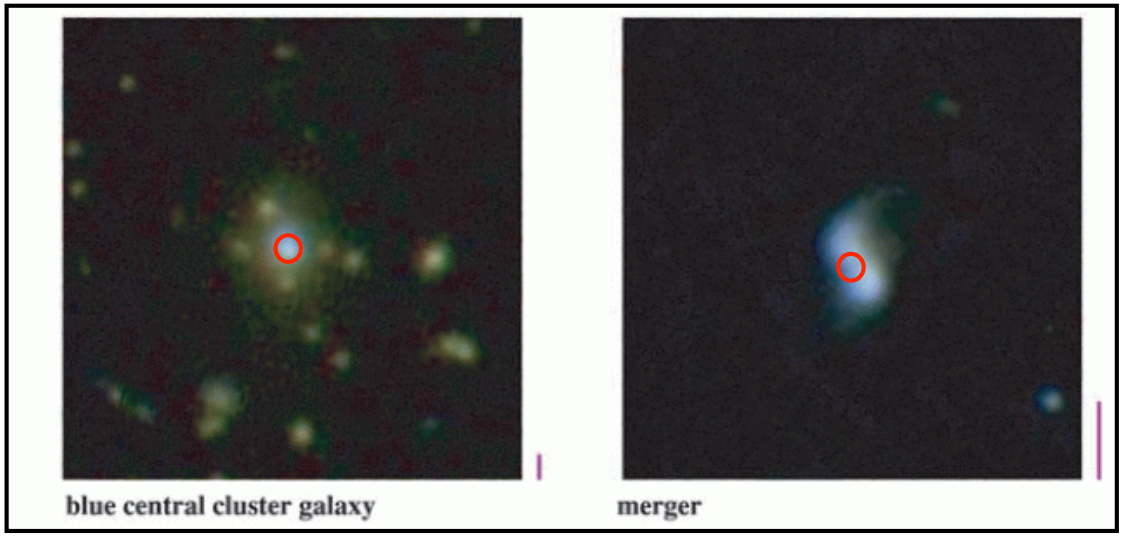


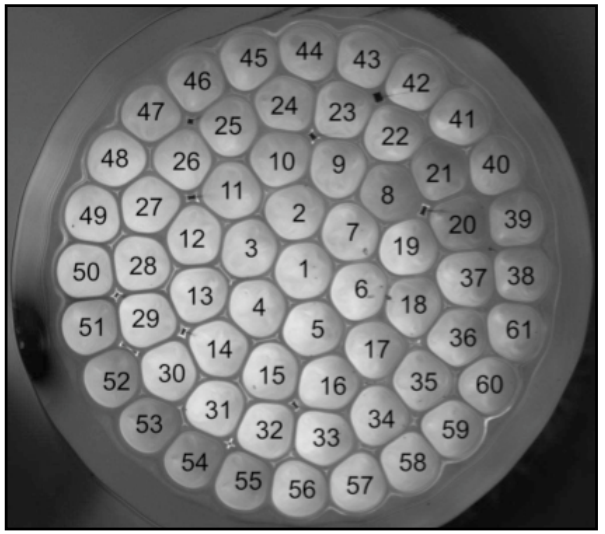
Bland-Hawthorn et al. (2008)


Bailes et al. (2011)

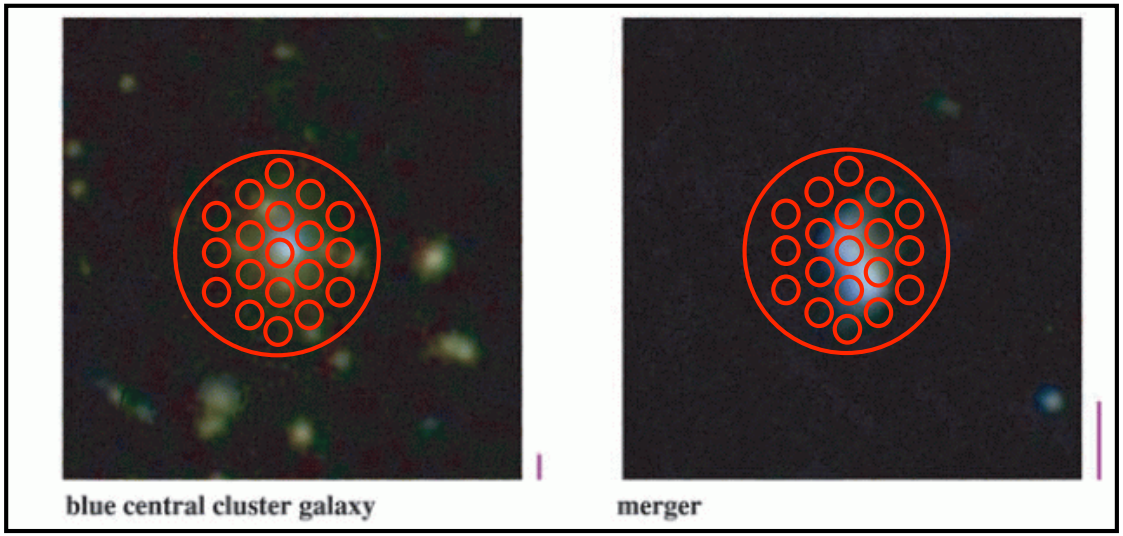

Norman et al. (2009)

Hexabundles (Croom et al.)

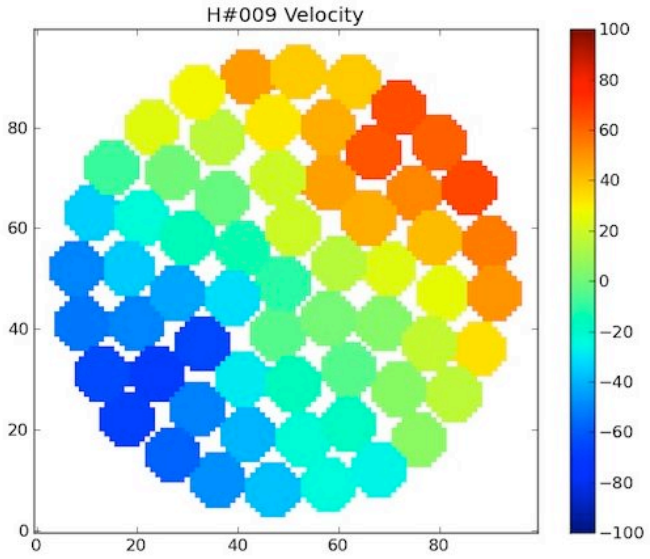




Bland-Hawthorn et al. (2008)



Kauffmann et al. (2005)



Croom et al. (2011)

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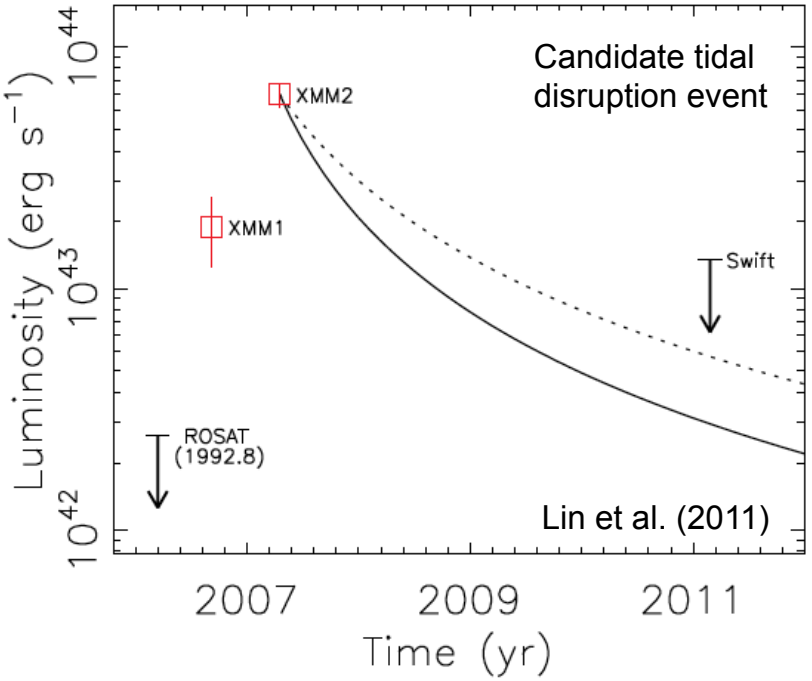
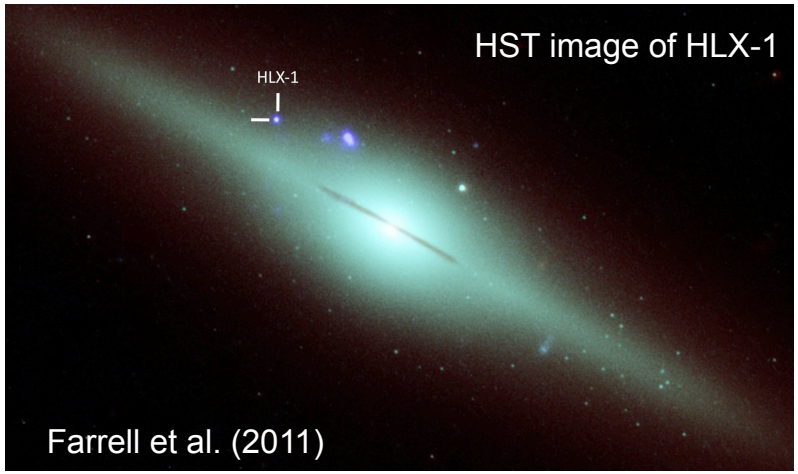
Synergies with eROSITA





- X-ray/radio studies of galaxy clusters (talk by T. Repirich)
- Detection and study of tidal disruption events (talk by R. Saxton)
- Identification and characterisation of environments around ULXs (talk by C. Motch)
- Study of jets across the whole gamut of black hole masses
- Many other overlaps particularly for transient events (e.g. novae, supernovae, GRBs etc.)
- Broad-band characterisation of new populations of extreme objects

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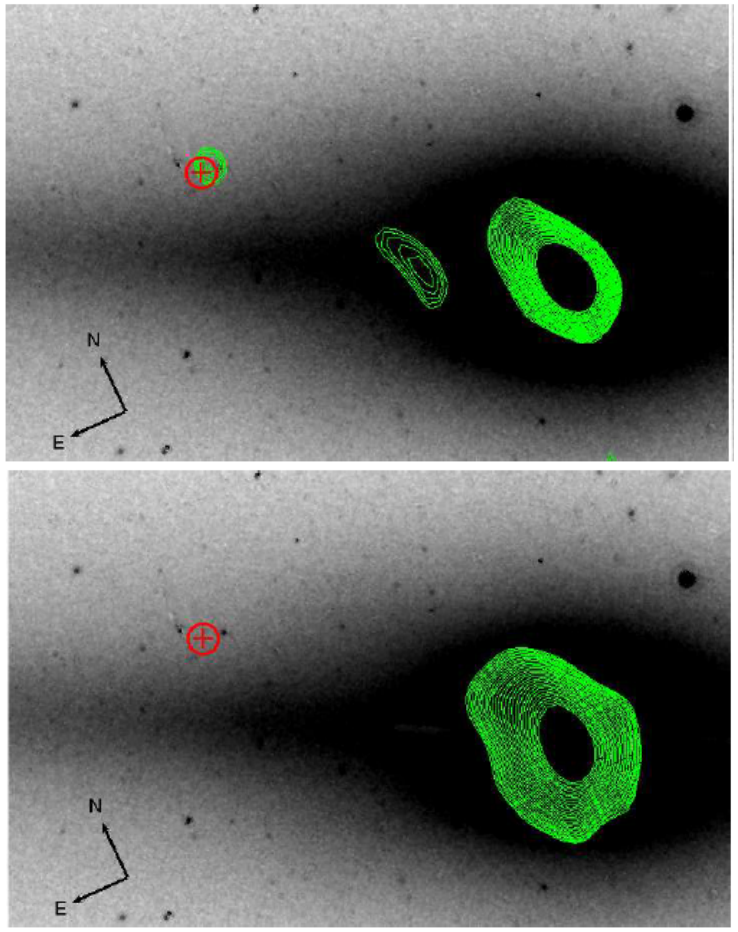
Jets from IMBHs



Radio detection with ATCA
Webb et al. (2011)

- First detection of transient jet emission from a ULX (ESO 243-49 HLX-1), with luminosities consistent with IMBH (Webb et al. 2011)
- Using ASKAP expect to detect steady jets from >100 M_{sun} BH out to 1 Mpc
- Steady jets from 10,000 M_{sun} BH out to 10 Mpc
- Jet ejection events from all IMBHs out to ~10 – 50 Mpc
- X-ray matches will be crucial to confirm nature of source → eROSITA is perfect
- Will be able to test scale invariance of black holes over all mass scales

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Summary

- CAASTRO is a one-stop-shop for ASKAP/MWA/SkyMapper/SKAMP data and expertise
- Aiming to pursue cutting-edge advances in galaxy evolution, extreme physics, Dark Matter/Energy
- Obvious strong overlap between CAASTRO and eROSITA science goals
- Associated multi-wavelength surveys are highly complementary → unique science opportunities possible through combined efforts
- Partner organisations and investigators being sought (KPIs require this!)
- Funding available to support collaborative visits to Australia