Early Polarisation Science with ASKAP

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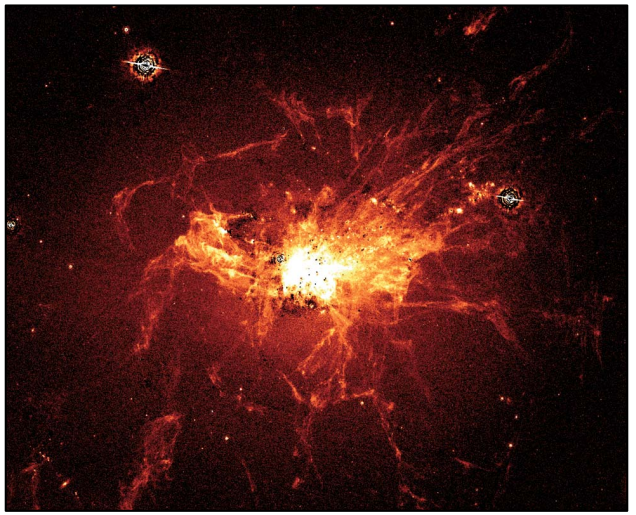
askap.org/possum

New Discovery Space with ASKAP-12

- Radio polarimetry: a highly sensitive probe of density, magnetic field and turbulence at all redshifts

  → ***Cosmic Magnetism:*** a fundamental unsolved problem and one of five SKA Key Science Projects

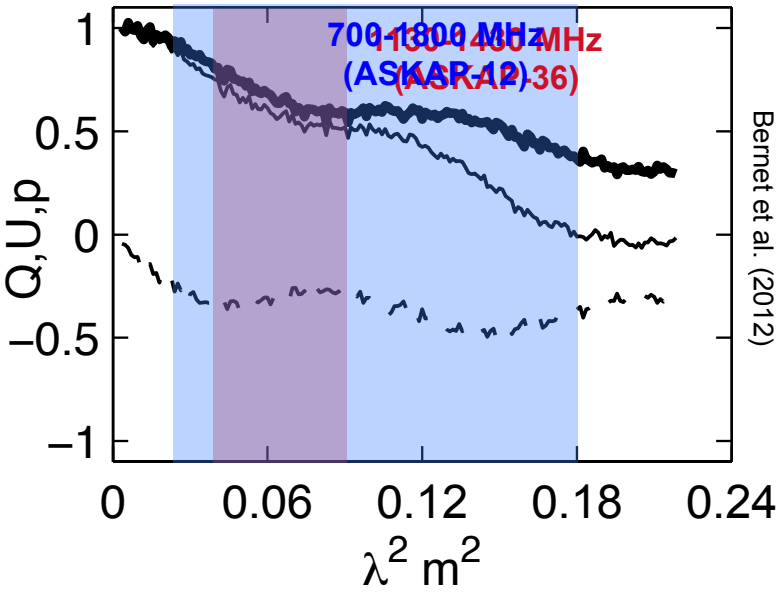


Fabian et al. (2008)

- *What is the relationship between supermassive black holes and their environments?*
  - broadband depolarisation → thermal environment of radio galaxies & AGN (e.g. O'Sullivan et al. 2013)

- *How have galaxies evolved over cosmic time?*
  - broadband polarisation → physical properties of central engine (e.g. Farnes et al. 2013)

- *What are the physical properties of absorbing systems?*
  - broadband Faraday rotation → covering fraction and turbulence (e.g. Bernet et al. 2012)

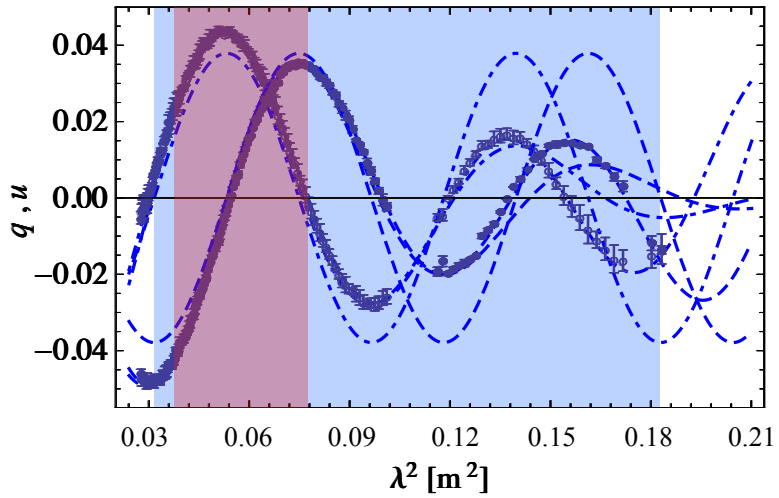


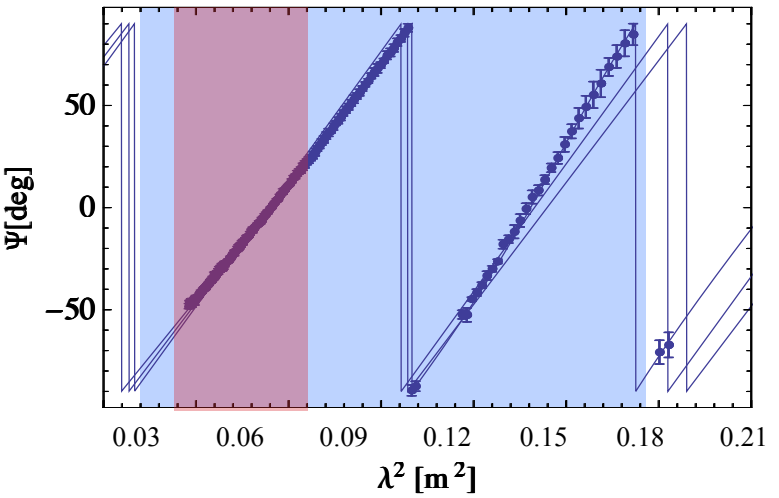
Bernet et al. (2012)

- Narrow bandwidth ($\Delta\nu/\nu \sim 0.25$) : rotation measures
- Broad bandwidth ($\Delta\nu/\nu \sim 1$) : Faraday tomography

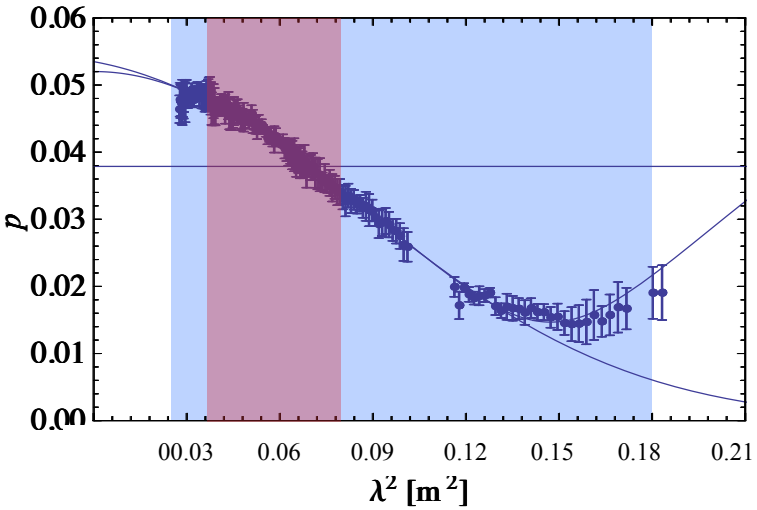
Broadband Polarimetry: A Unique Physical Probe

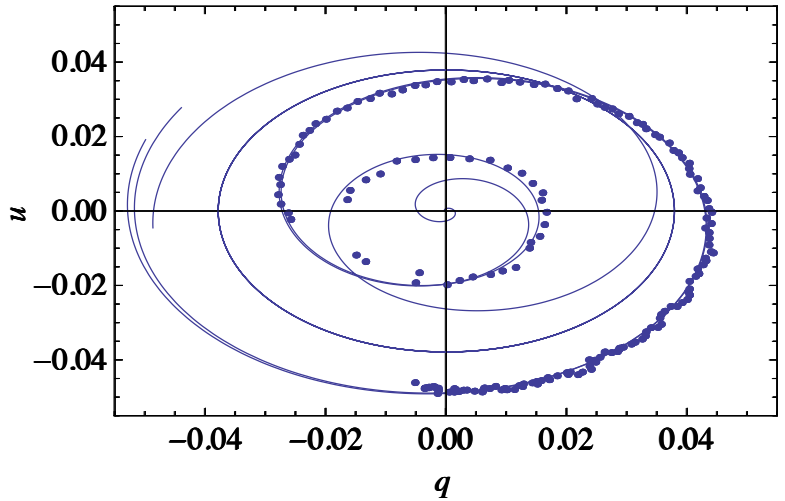
1130-1430 MHz (ASKAP-36)





700-1800 MHz (ASKAP-12)





Polarimetry of PKS B1610-771 (O'Sullivan et al. 2012) : Simple Faraday rotation with lobes

Survey Specifications & Fallback Options

- **Frequency coverage:** 700-1800 MHz, for large $\Delta\nu/\nu$
  - *fallback: 700-1000 MHz, for unique phase space*

- **Correlator / data products:** full polarisation at 1 MHz resolution
  - *fallback: I/Q/U only at 10 MHz resolution*

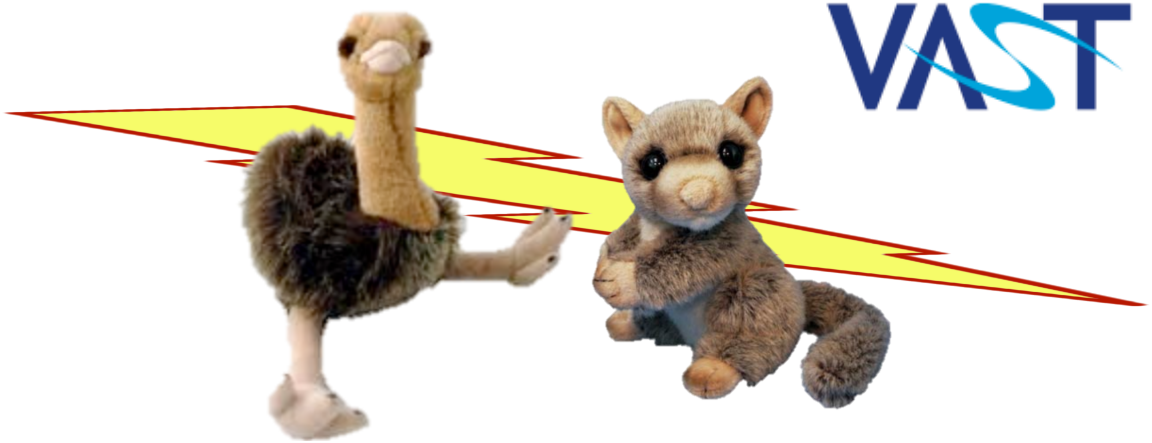
- **FoV & Sky Coverage:** 30 deg^2 x 100 = 3000 deg^2, for NVSS-level statistics
  - *fallback: 20 deg^2 x 25 = 500 deg^2, for useful statistics*

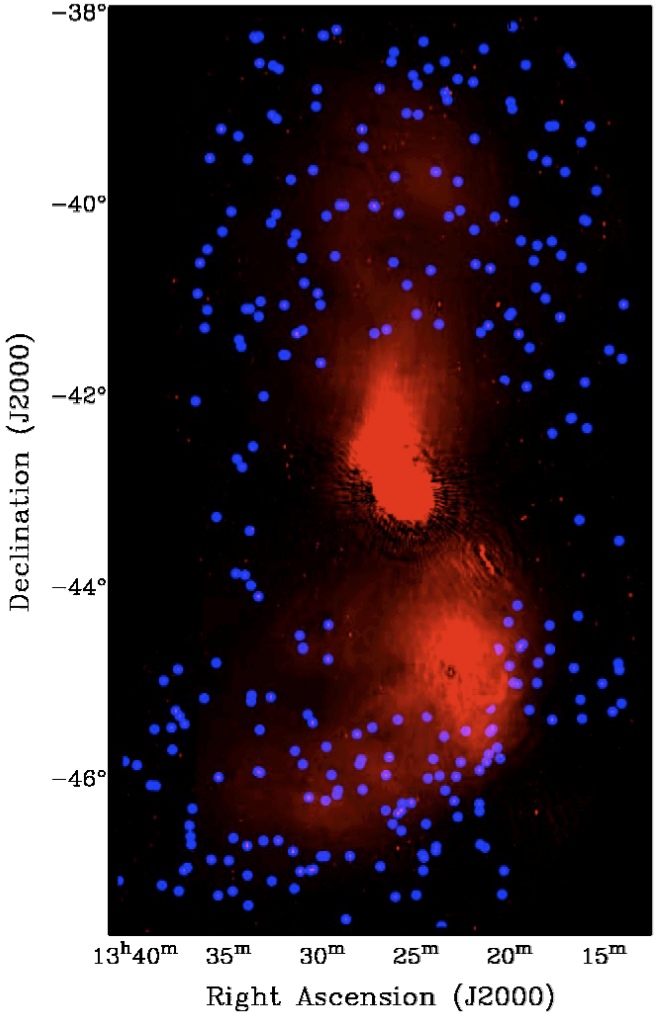
- **Survey Fields :** extragalactic, with multi-wavelength coverage for photo-z's

- **Observing time:** 2 hrs/band/pointing (600 hours), for 10-25 pol src's per deg^2
  → sensitivity ≈ 40 μJy/beam (ASKAP-12), ≈ 27 μJy/beam (ASKAP-18)
  - *fallback: 2 hrs/pointing (50 hours), for 4-6 polarised sources per deg^2*
    → *sensitivity ≈ 70 μJy/beam (ASKAP-12), ≈ 50 μJy/beam (ASKAP-18)*

Short Science Topics & Commensality

- Rotation measure grids toward specific objects/fields
  - Centaurus A (Shane O'Sullivan)
  - Galactic caps (Takuya Akahori)
  - Magellanic Clouds / Bridge / Stream
  - Gum Nebula, Orion, high-velocity clouds …
- Complete commensality w baby-EMU, baby-FLASH
  - solid overlap with baby-VAST

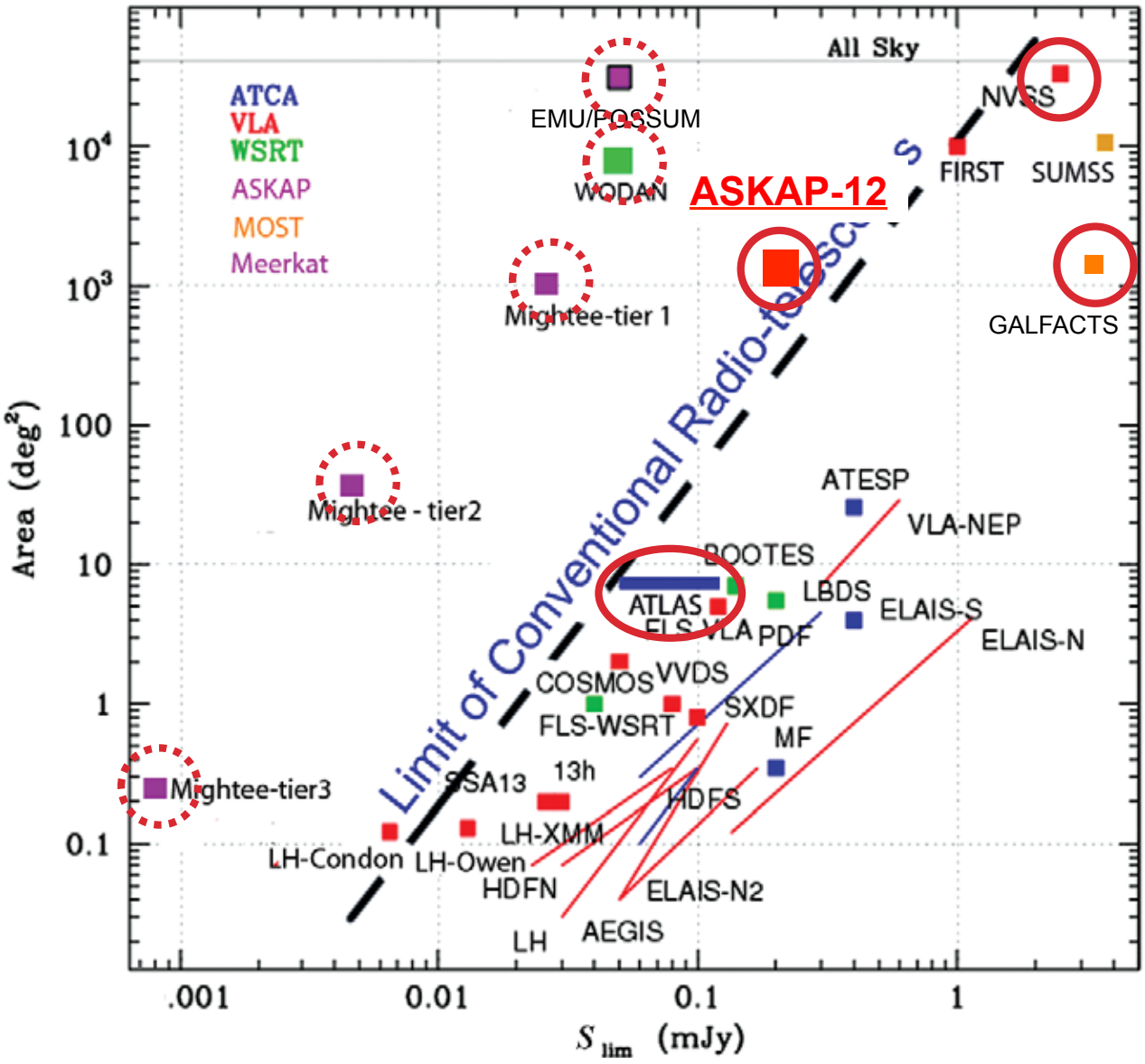




Feain et al. (2009)

Gifthunger / babywebsite.us / clipartpal.com

Comparison with Other Surveys



polarisation

$\Delta\nu/\nu > 0.25$

Norris et al. (2013)

ASKAP-12 vs ASKAP-36

Keith Allison / Flickr

Pro Sports Extra

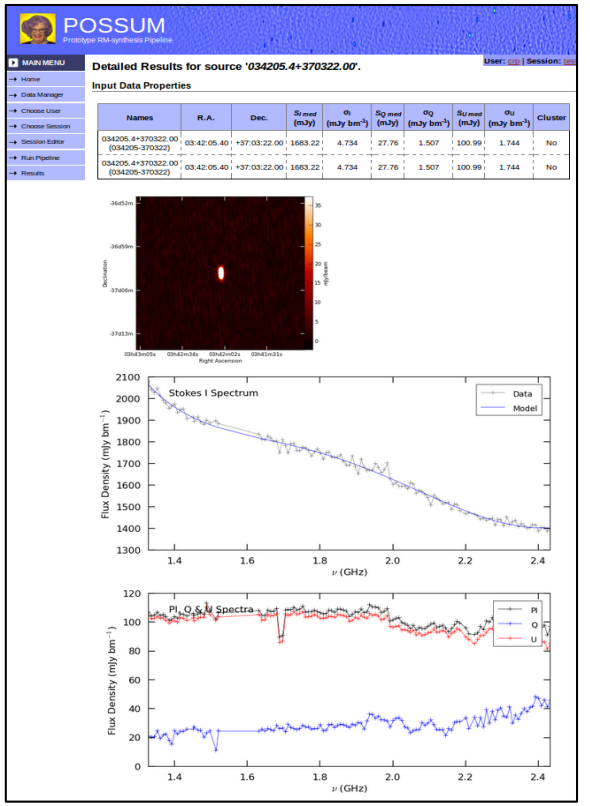
- ASKAP-12 survey is distinct & complementary to 1130-1430 MHz surveys on ASKAP-36
  - ASKAP-12: intrinsic/targeted magnetic fields; ASKAP-36: global/foreground *B* fields
  - large band will let us interpret POSSUM & many other upcoming ~300-MHz surveys
  - a broadband survey is needed to test and commission ASKAP's full frequency range

What we propose for ASKAP-12 will not be surpassed until the SKA

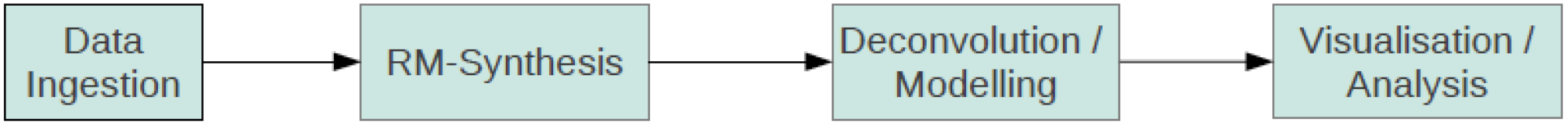
Risks & Special Requirements

- There are requirements beyond those specified for full SSPs
  - can we get good, thermal-noise-limited images in a 2-hour observation?
  - what are the imaging challenges & overheads of frequency switching?
  - what are the calibration challenges & overheads of frequency switching?

- Polarisation has unique additional specifications
  - need to establish polarisation capabilities of ASKAP-12 and of the ADEs
  - special requirements for off-axis calibration and beam-weighting
  - distinct multi-dimensional data products



Cormac Purcell



Unique & Ground-Breaking Science

- A ***broadband*** (700-1800 MHz) continuum polarisation survey of 1000-3000 deg^2
  - 6 hours per pointing (2 hours per frequency band x 3 bands)
  - total observing time $\lesssim$ 600 hours ($\lesssim$ 100 nights)
  - rms sensitivity $\approx$ 40 μJy/beam (ASKAP-12), $\approx$ 27 μJy/beam (ASKAP-18)
  - 10 to 25 polarised sources per deg^2

- ***Unique questions addressed by unique broadband observations***
  - what is the relationship between SMBHs and their environments?
  - how have galaxies evolved over cosmic time?
  - what are the physical properties of absorbing systems?

- Extremely strong synergy & commensality with other early science programs
- Area of phase space never previously explored, will not be surpassed until SKA
- Highly complementary to 1130-1430 MHz POSSUM survey on ASKAP-36
- Tests ASKAP's full frequency range; allows us to interpret 300-MHz surveys