Australia's National Science Agency

QUOCKAs and QUOLLs

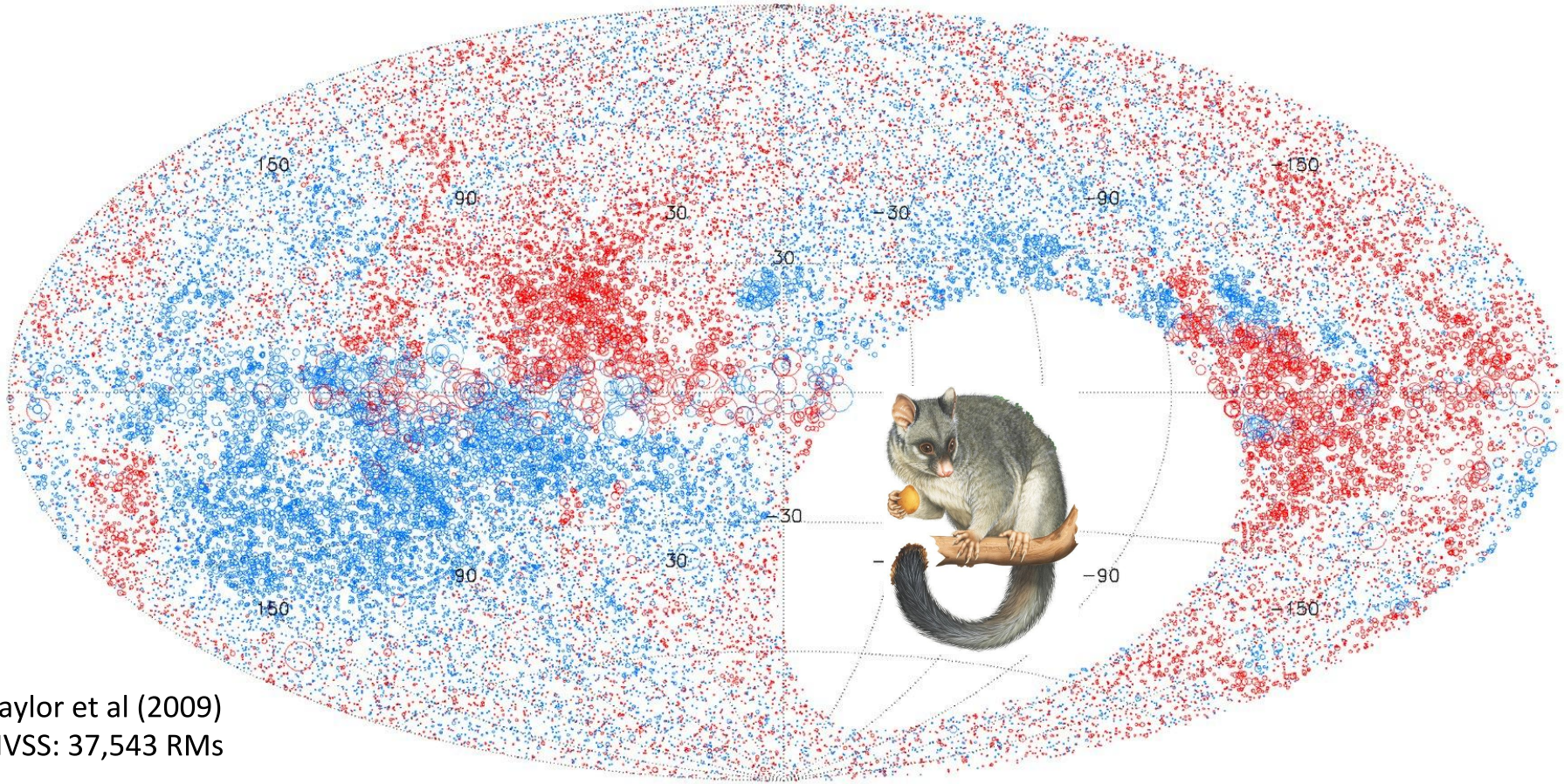
POSSUM/EMU Busy Week

George Heald | 18 December 2019

Overview

- Faraday complexity
- POSSUM (and VLASS)
- ATCA broadband polarization survey:
  QUOCKA
  (*QU Observations at Cm-wavelengths using Km-baselines with ATCA*)
- Proposed LBA polarization survey:
  QUOLL
  (*QU Observations Leveraging LBA; PI: Jane Kaczmarek*)
- Next steps

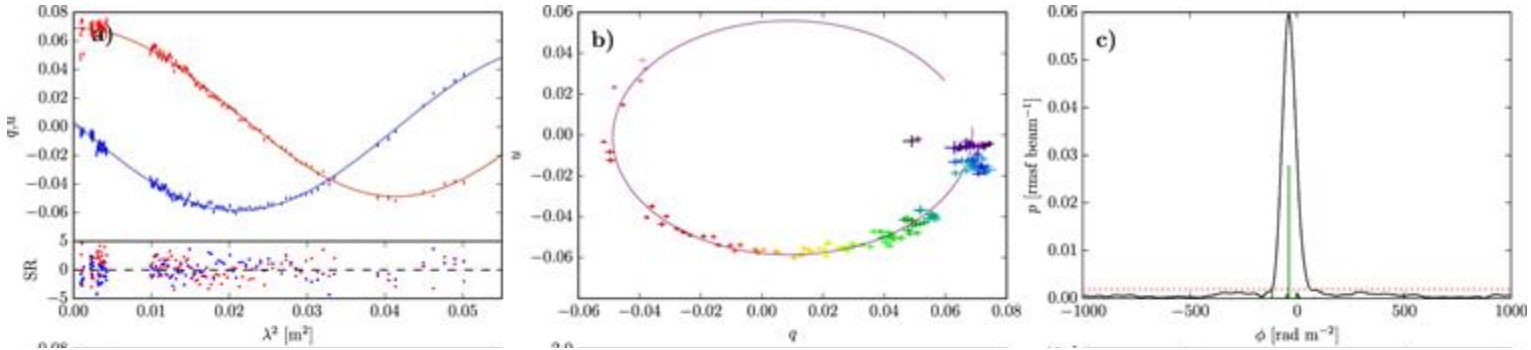
Our standard picture of the Faraday sky



Taylor et al (2009)
NVSS: 37,543 RMs

A “simple” polarized source ...

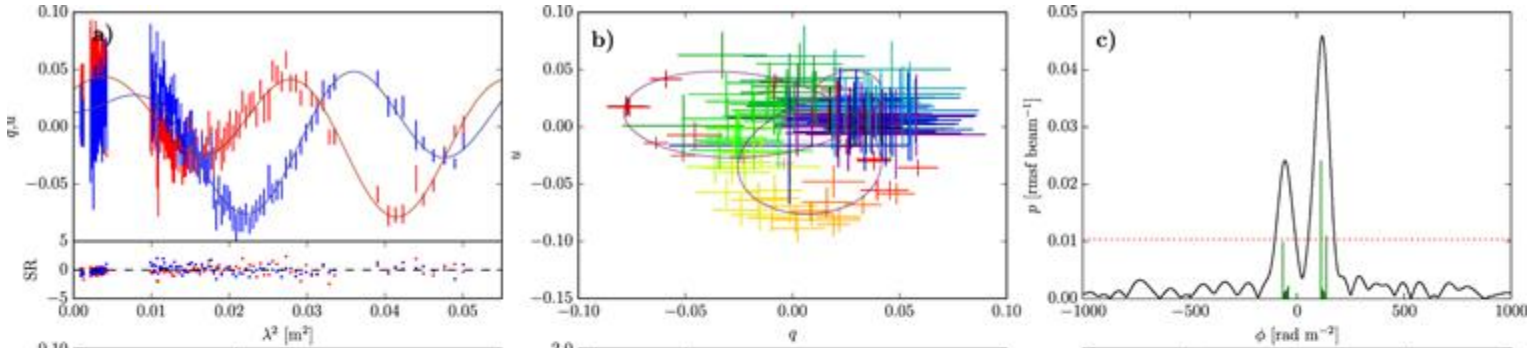
… shows sinusoidal variation in Q,U(λ^2) and a single Faraday peak



Anderson et al (2016)
ATCA, 1.3-10 GHz, 36 sources

A “complex” polarized source ...

… shows complicated variation in Q,U(λ^2) and multiple Faraday peaks

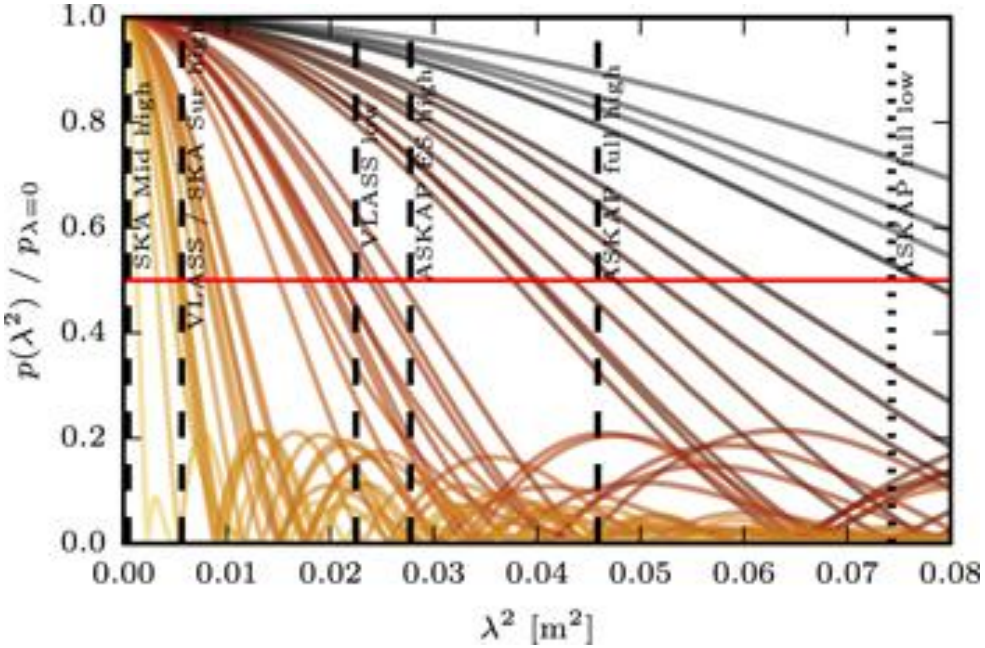


Anderson et al (2016)
ATCA, 1.3-10 GHz, 36 sources

POSSUM's frequency coverage

EMU: 800-1088 MHz + POSSUM: 1300-1440 MHz (excluding RFI)

(λ^2 = 0.076-0.14 m^2) (λ^2 = 0.043-0.053 m^2)



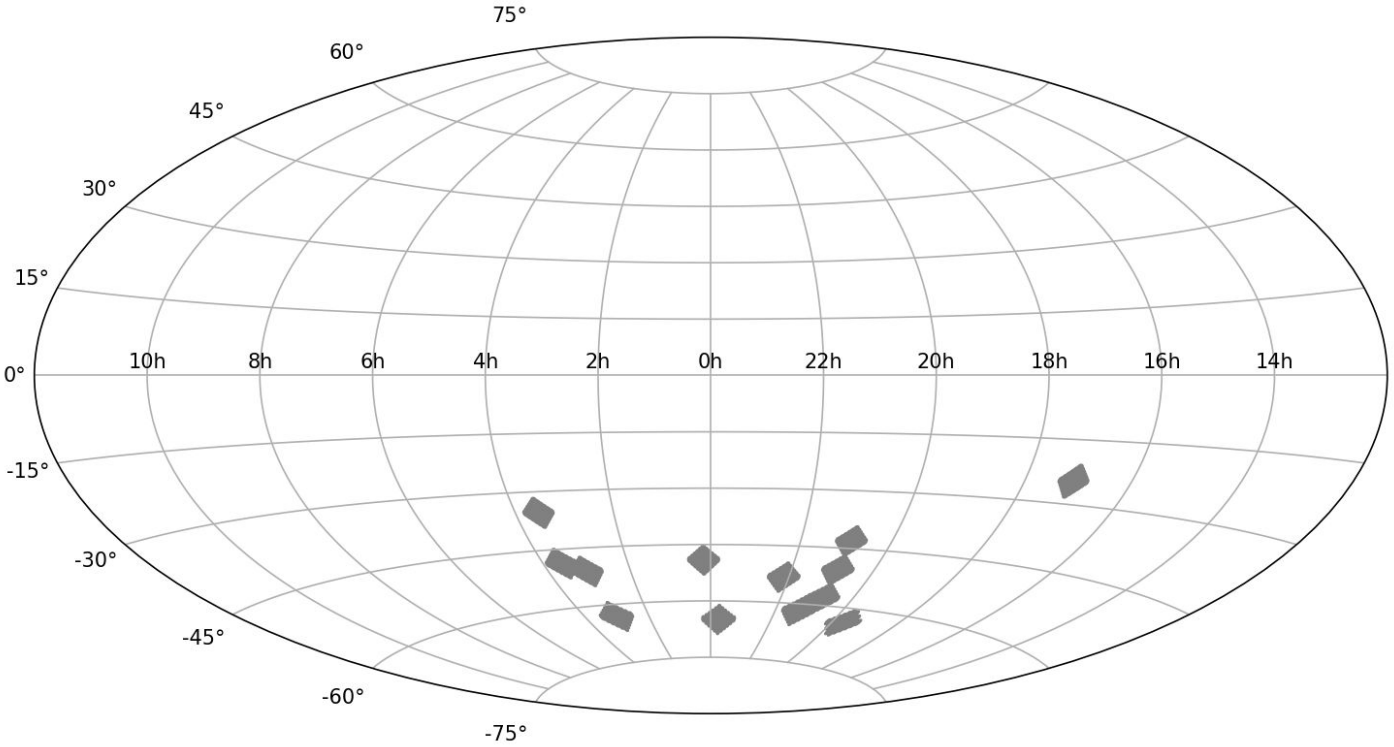
Quokka image: unknown/uncredited
Faraday image: Oppermann et al (2015)

QUOCKA survey description

- Targeted many (~500) AGN detected in polarization with ASKAP
  - Plus some extended DRAGNs - see Emma's talk
- Snapshot observations with ATCA (6x5min, spanning HA~12h)
- Two frequency bands: 1.1-3.1 GHz, and 4.5-8.5 GHz (λ^2 = 0.0012-0.074 m^2) - complementary to ASKAP POSSUM
- Standard calibration, plus high-quality polarization calibrators
  - Reduce V/I leakage to <~0.01%
- Primary science goals:
  - What is the intrinsic magnetoionic structure of AGN and its evolution?
    Develop better understanding of AGN structure through qu fitting
  - A broadband circular polarization survey
    Use complementary approach to study jet magnetic field structure

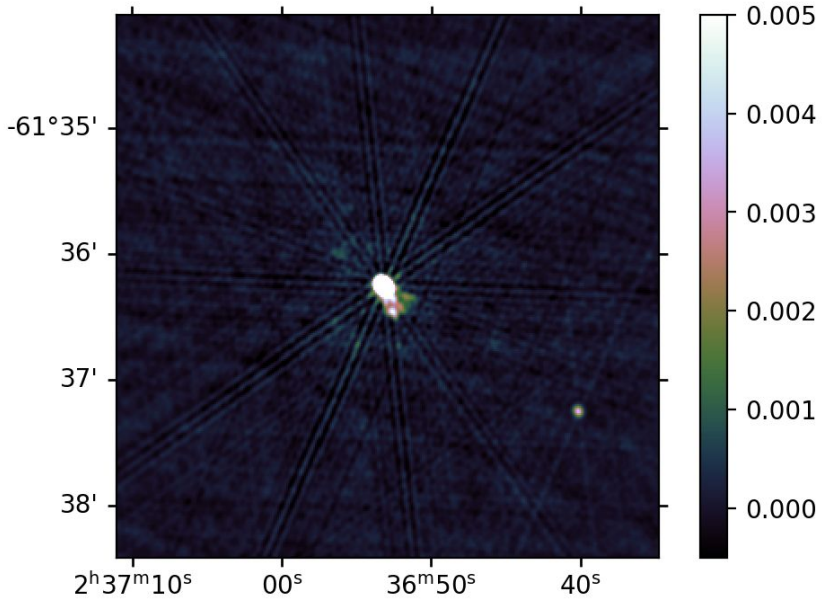
QUOCKA sky coverage

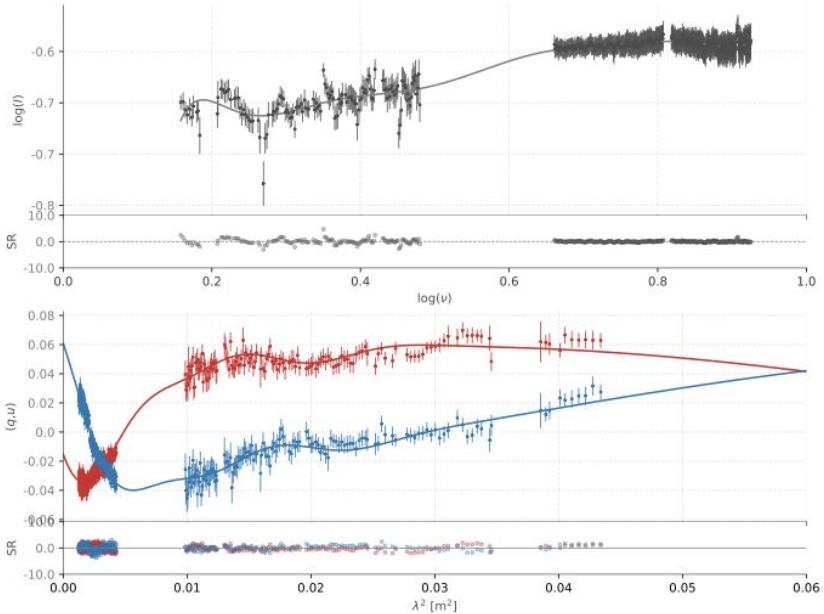
Sources selected from ASKAP Early Science fields



Typical QUOCKA source (0236-6136)

`miriad`-based data reduction pipeline (Zhang, Heald, et al)



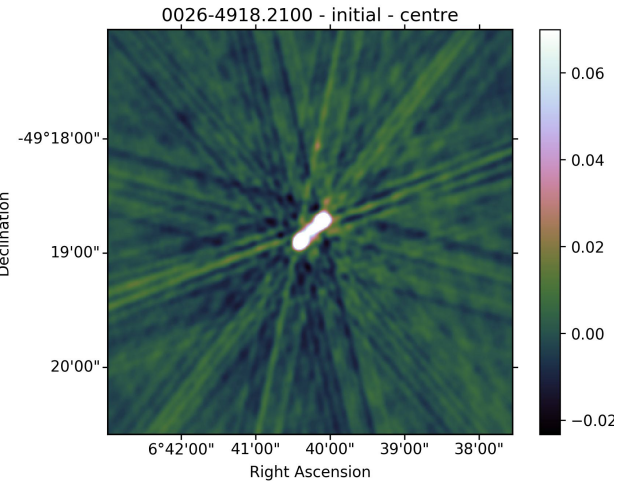


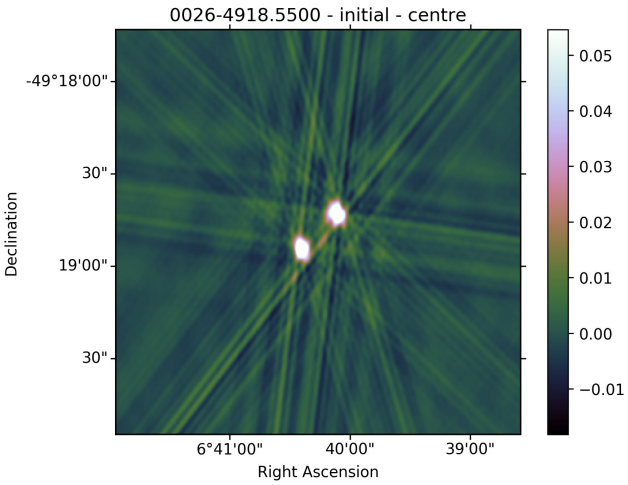
Plots: Xiang Zhang (CASS)

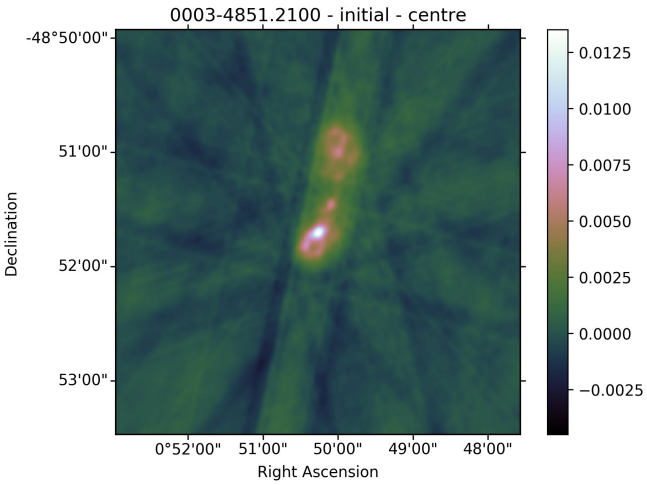
QUOCKA morphologies

Approximately 25% of QUOCKA sources are double / extended

Examples shown here after rudimentary calibration & imaging







Plots: Xiang Zhang (CASS)

QUOCKA: trends and future

Current plans:

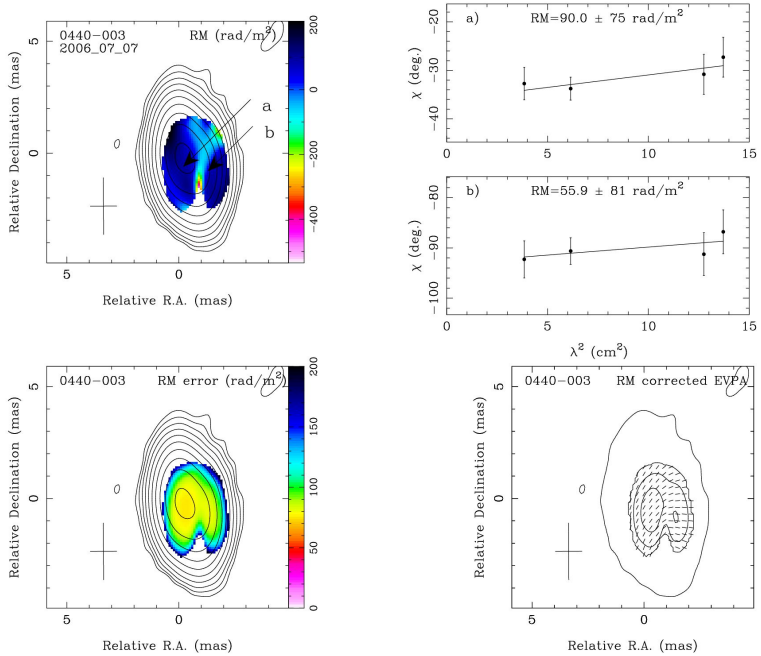
- Complete current project scope:
  - Finalise initial QUOCKA observations with ATCA
  - Refine data reduction (https://github.com/gheald/quocka)
  - Statistical breakdown of source population
  - First refereed publications and data release
- Develop extended QUOCKA sample based on SPICE-RACS catalog
- Draw connection between Faraday components and morphological structure through complementary VLBI
  - QUOLL: QU Observations Leveraging LBA (PI: Jane Kaczmarek)

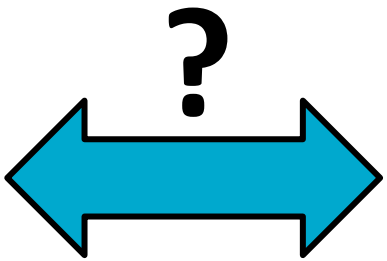
Original photo credit:
Photo Bruce Thomson

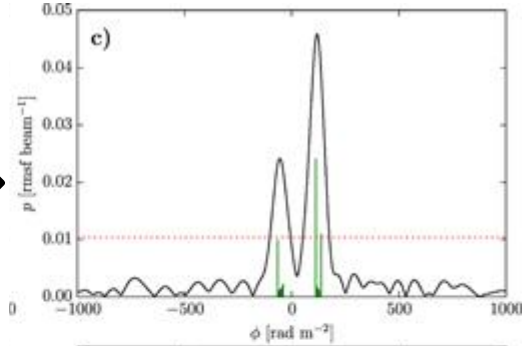
Polarized version:
Jane Kaczmarek

QUOLL: a proposed LBA survey

VLBI observations (e.g. MOJAVE) have shown extraordinary polarized structures on mas scales, within arcsec-scale radio sources







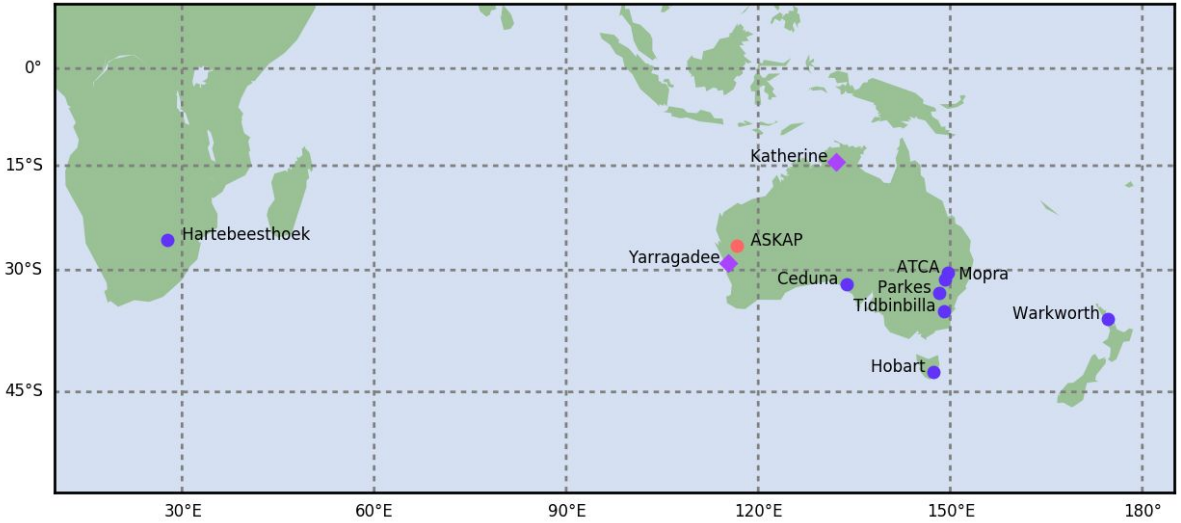
Anderson et al (2016)

Randomly selected example from MOJAVE webpage: https://www.physics.purdue.edu/MOJAVE/

QUOLL survey description

24h LBA request to observe 5 carefully selected QUOCKA sources

- Primary aim: associate Faraday components with mas structure
- L-band, 128 MHz bandwidth, full polarization
- Using polarization calibration techniques (Chanapote et al 2019)



Next steps

- Careful, exhaustive comparison of ATCA and ASKAP data
  - Completed ATCA data reduction
  - ASKAP Early Science - existing data products
  - ASKAP SPICE-RACS - further cross-checks
  - Additional ASKAP data as they become available
- Aim for expansion of QUOCKA to supplement SPICE-RACS
  - Build on the impact of the forthcoming densest radio polarimetry survey
  - Provide crucial connection between “narrow” ASKAP data and broadband reference sample
- Hoping to develop LBA programme to supplement QUOCKA
  - Establish morphological basis for Faraday modeling (“qu fitting”)
- Stay tuned for publications and data release(s)

CSIRO

QUestions?

Thank you

https://research.csiro.au/quocka/

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