CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

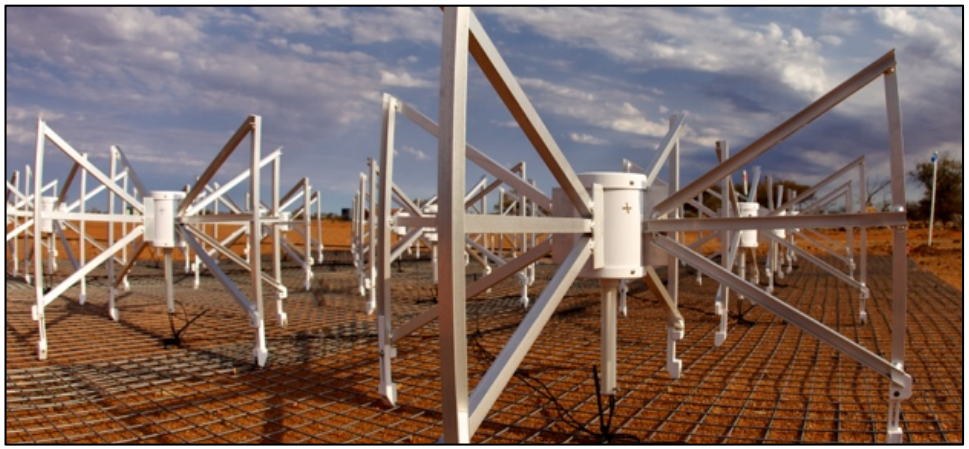
GLEAM

Searching for the Synchrotron Cosmic Web with the Murchison Widefield Array

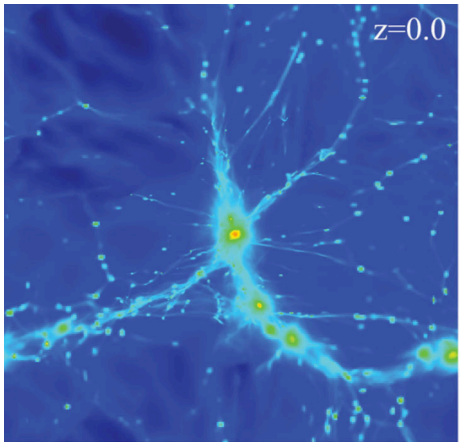
Bryan Gaensler, Emil Lenc and the GLEAM Team

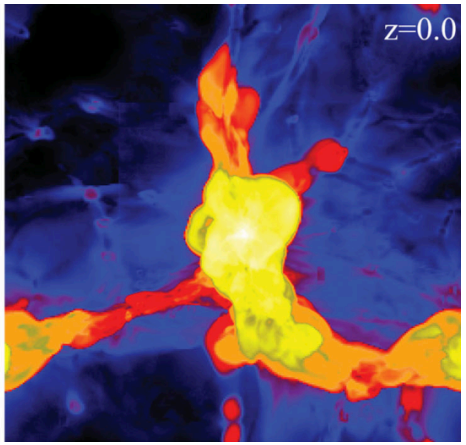
CAASTRO / The University of Sydney

#OzMWA2014



Natasha Hurley-Walker

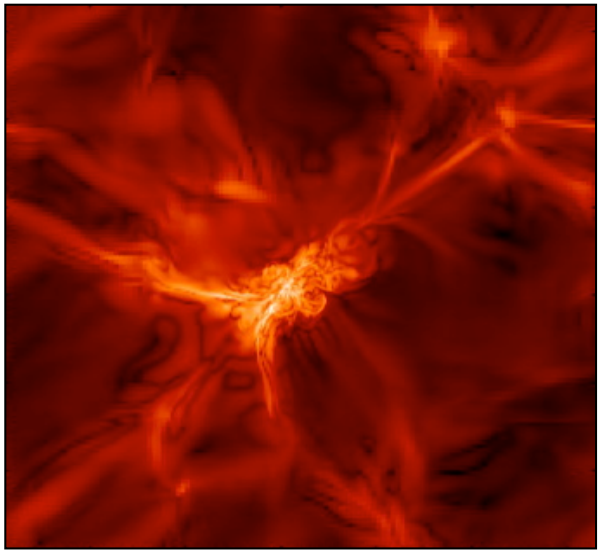




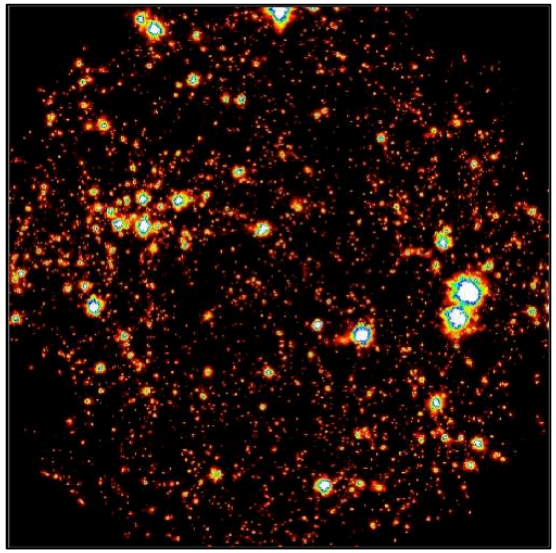
Planelles & Quillis (2013)

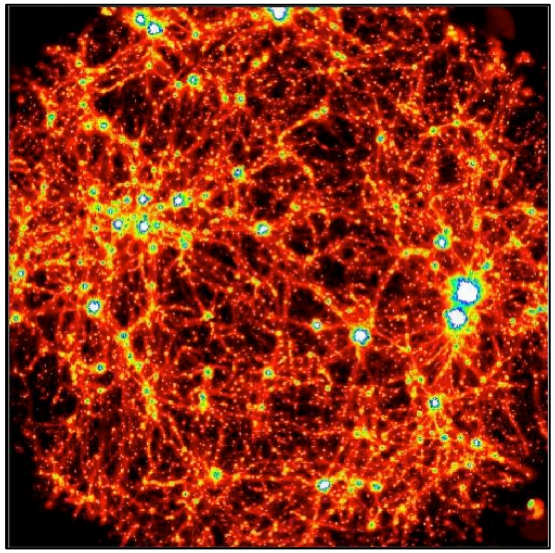
The Synchrotron Cosmic Web

- Intergalactic shocks accelerate electrons and amplify magnetic fields
  (Keshet et al. 2004; Hoeft & Brüggen 2007; Battaglia et al. 2009; Araya-Melo et al. 2012)
  - faint synchrotron radiation should trace large-scale structure and cosmic filaments
  - → direct image of large-scale structure of the Universe
  - → laboratory for studying particle acceleration in low-density shocks
  - → magnetic field strength of the intergalactic medium
  - → direct discriminant on competing models for origin of cosmic magnetism
- Signal should dominate other radio signals on scales ~ 10′ to 1° at frequencies ~100 MHz



MHD simulation of magnetised large-scale structure (Brüggen et al. 2005)

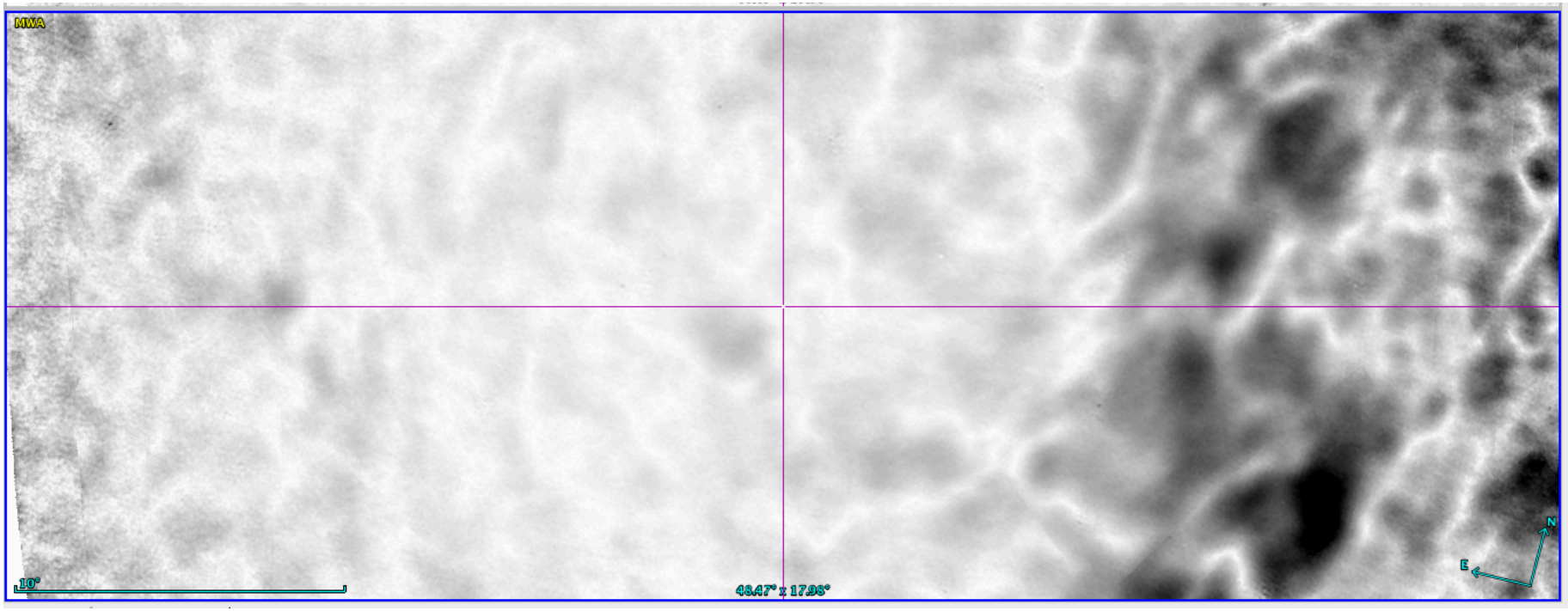




Injected fields vs primordial fields (Donnert, Dolag et al. 2008)

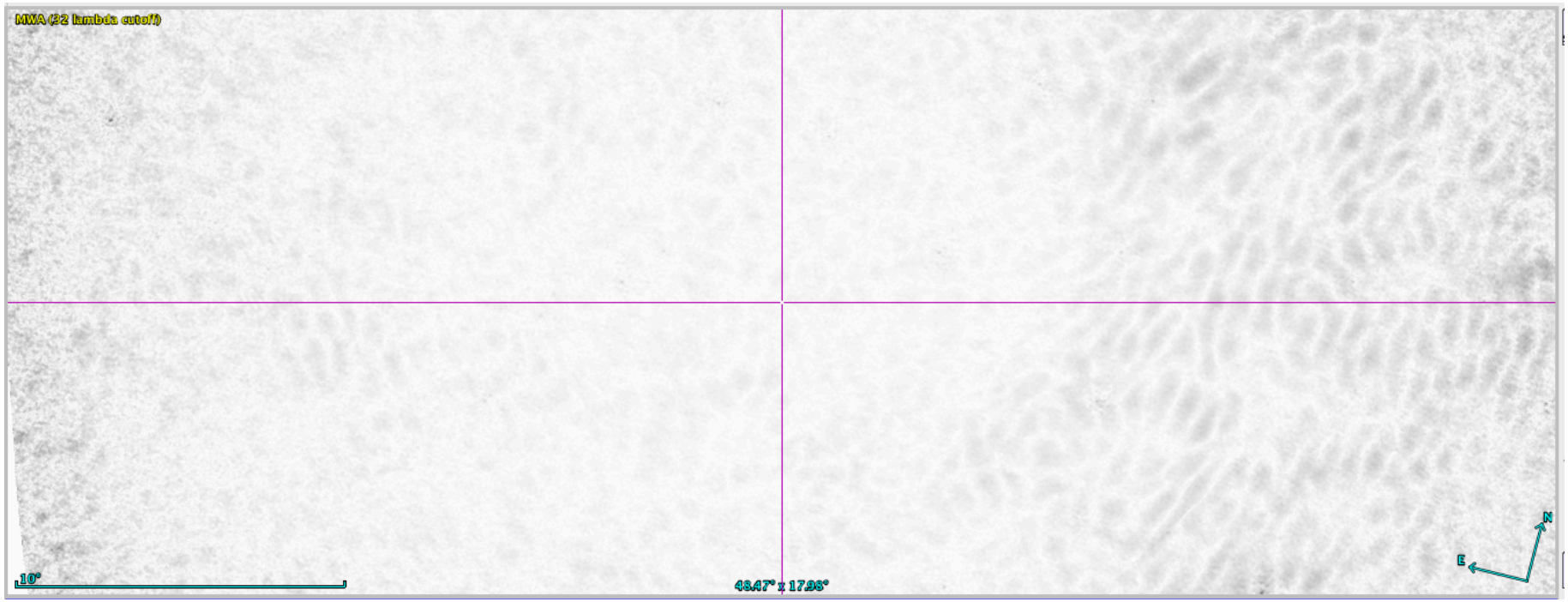
Diffuse Emission: MWA vs LOFAR

Diffuse polarisation with the MWA – all baselines



Diffuse Emission: MWA vs LOFAR

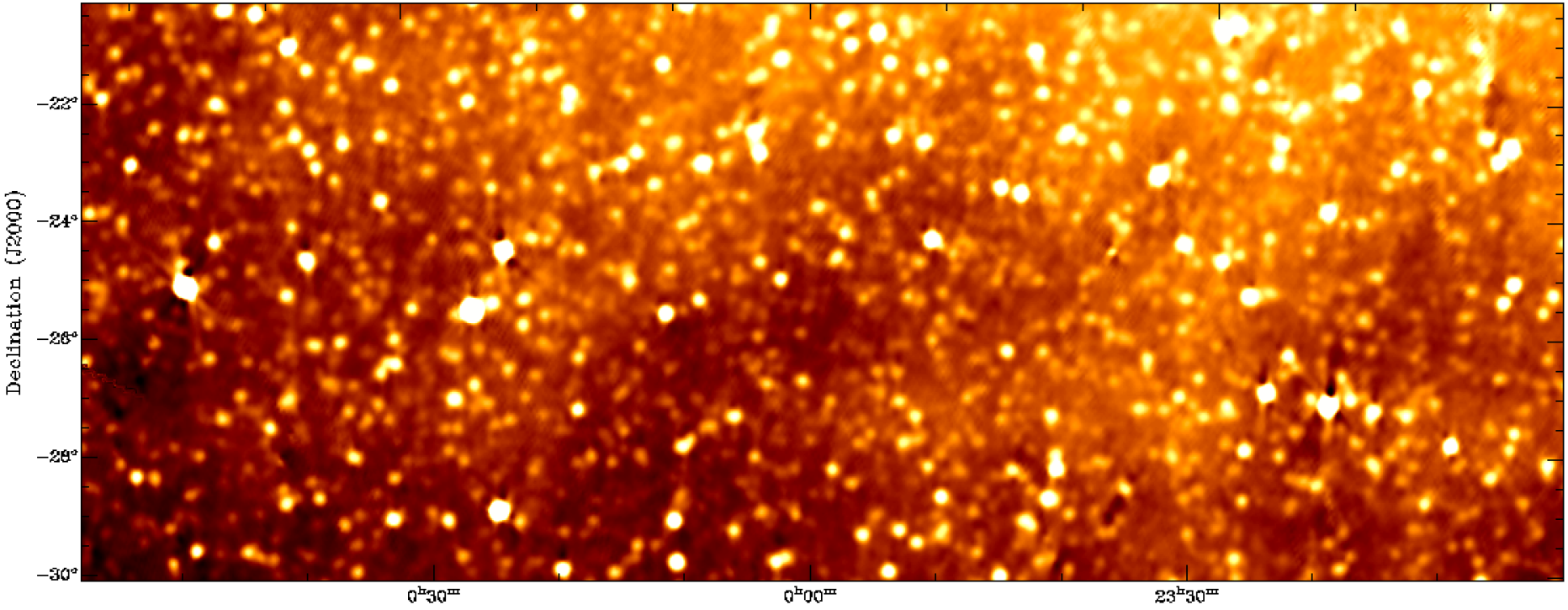
Diffuse polarisation with the MWA – discarding B < 32λ



Emil Lenc

Diffuse Emission: MWA vs Parkes

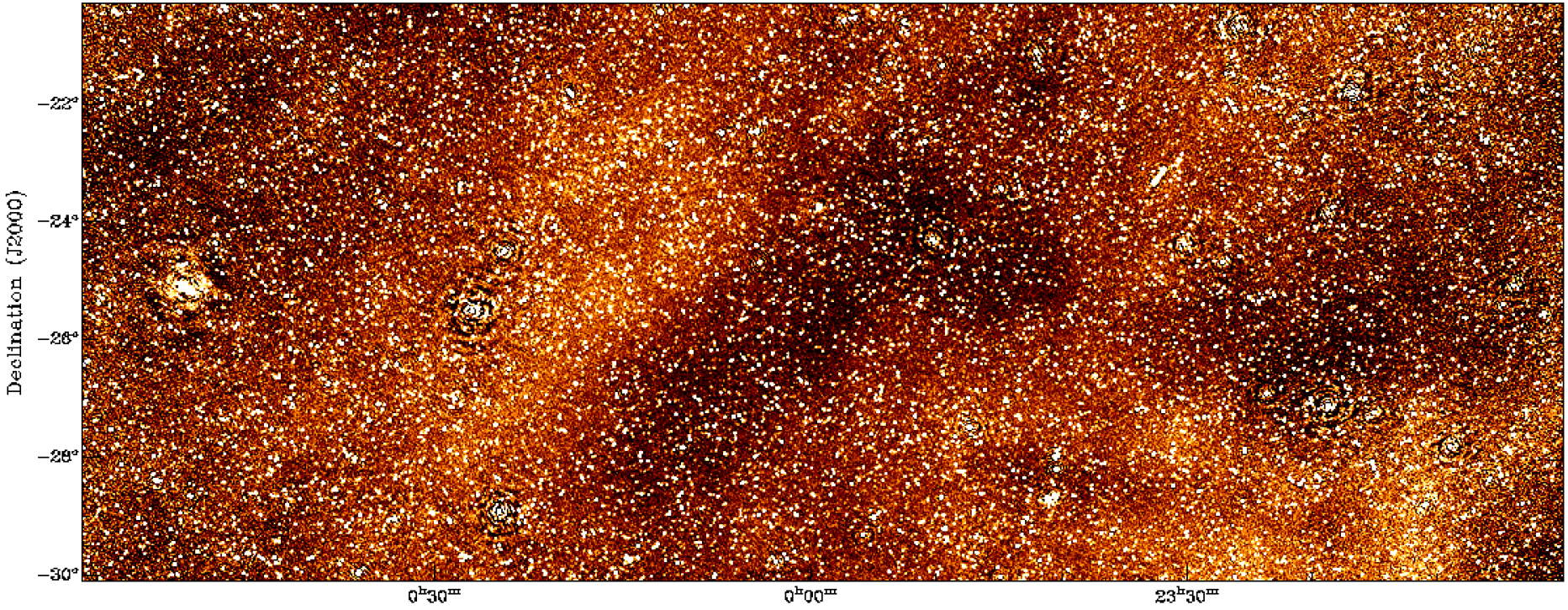
S-PASS survey at 2.3 GHz (Carretti et al. 2011)



CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

Diffuse Emission: MWA vs Parkes

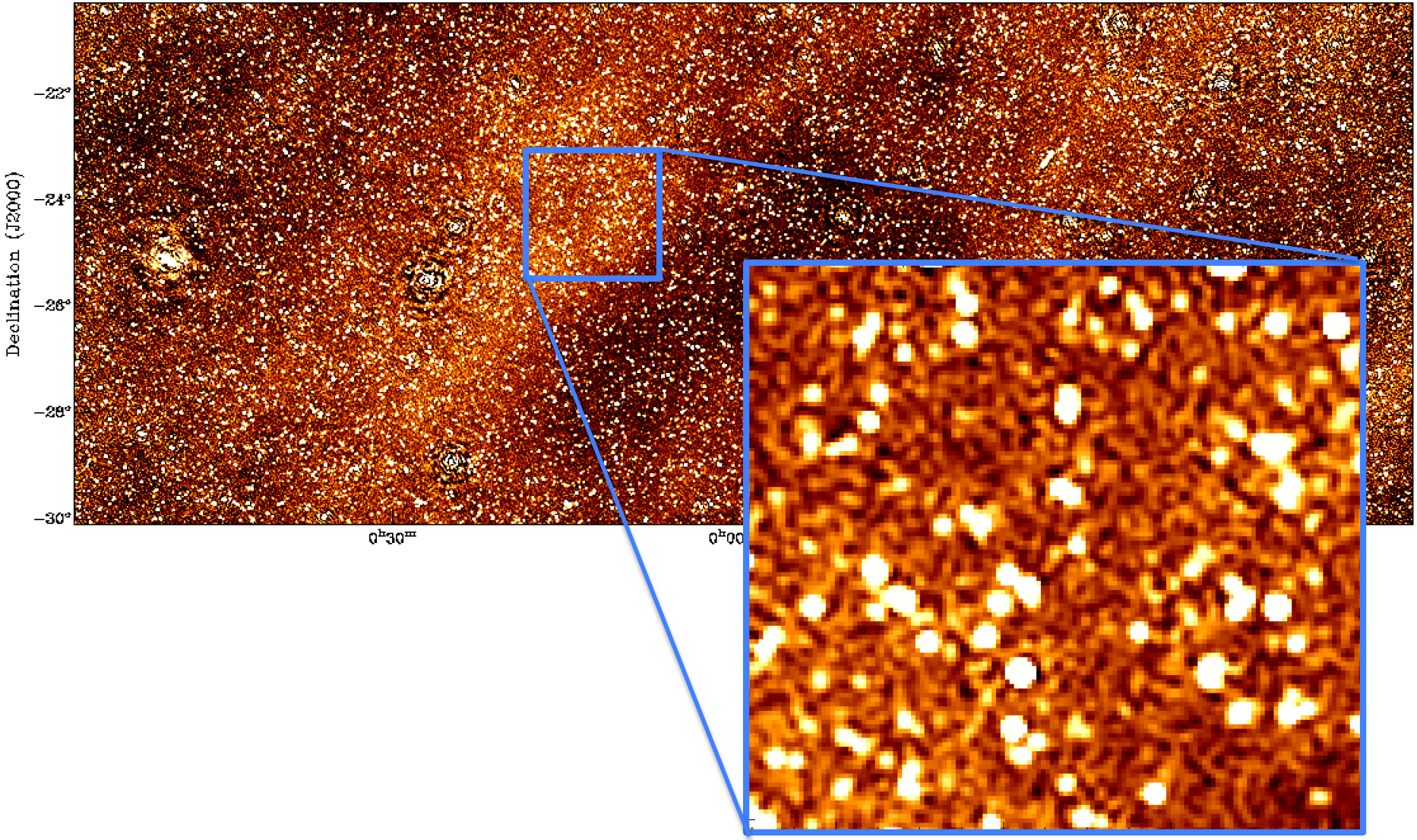
MWA at 150 MHz (André Offringa)



CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

Diffuse Emission: MWA vs Parkes

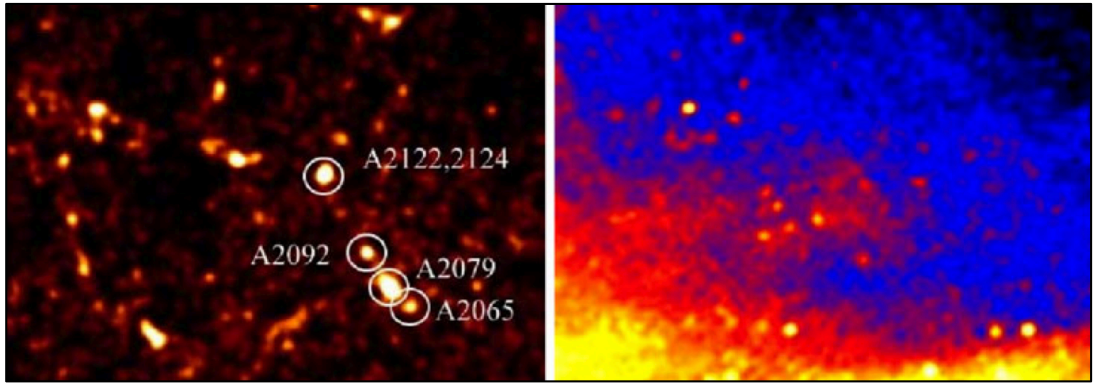
MWA at 150 MHz (André Offringa)



CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

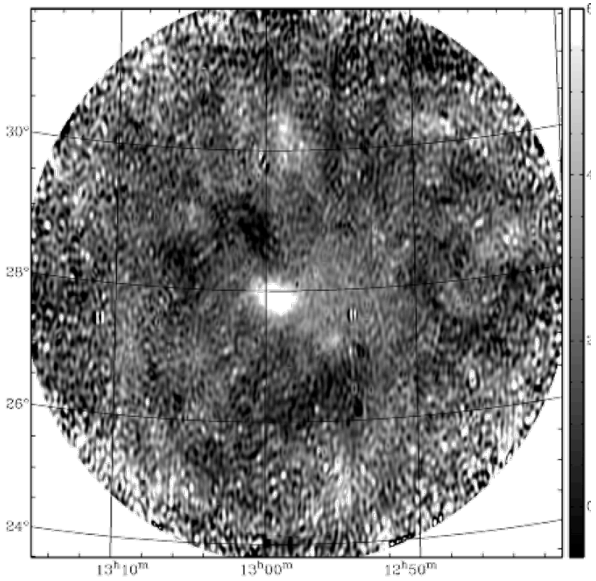
Detecting the Synchrotron Cosmic Web

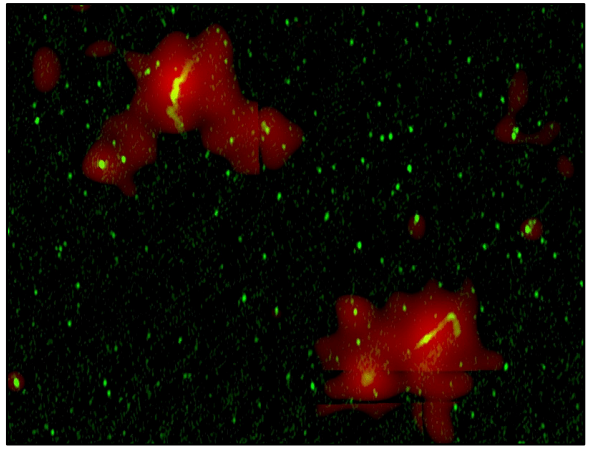
- Direct detection (Bagchi et al. 2002; Wilcots 2004; Vazza et al. 2014)
  - predicted brightness ~1.8 mJy/arcmin^2 at 150 MHz
  - faint emission, Galactic foregrounds, point-source confusion
  - MWA GLEAM: confusion limit ~1.5 mJy/arcmin^2 at 150 MHz
  - increasing the baselines: improvement to ~0.5 mJy/arcmin^2
- Polarisation (Rudnick & Brown 2008)
  - higher sensitivity due to greatly reduced confusion
  - fainter signals, complex foregrounds, depolarisation
- Statistical detection (Brown et al. 2010, 2011)
  - stacking at peripheries of clusters
  - cross-correlation with tracers of large-scale structure



2MASS galaxy distribution vs 1.4 GHz radio emission (Brown 2011)

Coma field at 400 MHz (Kronberg et al. 2007)



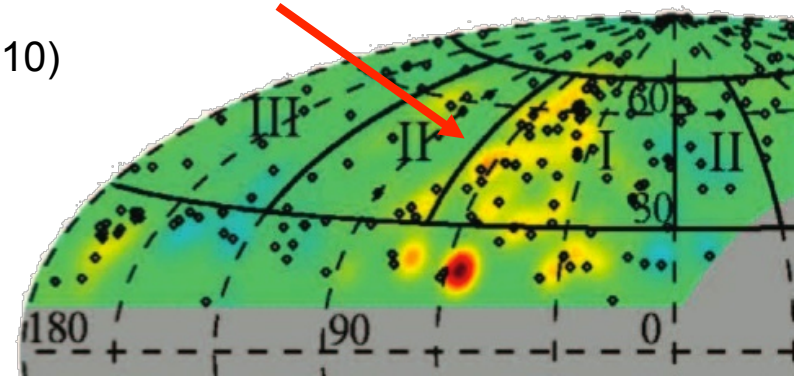


3C 31 and NGC 315: **total intensity** and **diffuse polarisation** (Rudnick & Brown 2008)

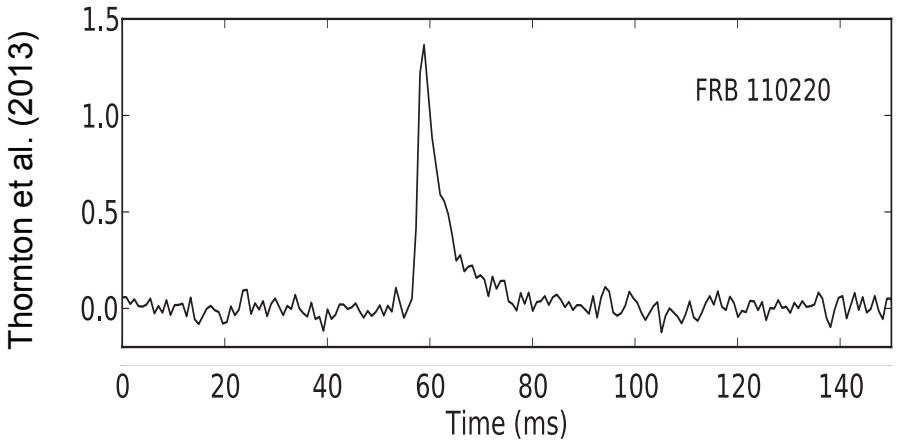
CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

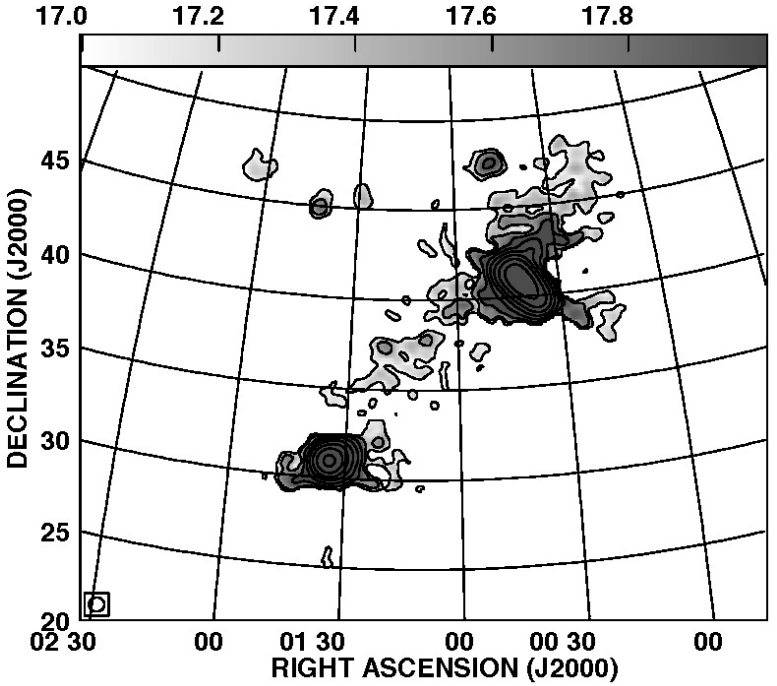
Radio Probes of the Thermal Cosmic Web

- Faraday rotation from background AGN
  (Xu et al. 2006; Akahori & Ryu 2010; Stasyzsyn et al. 2010)
  - need to correct for foreground Galactic Faraday rotation
- 21cm emission from the WHIM
  (Popping & Braun 2007; Popping et al. 2014)
  - requires sensitivity to $N_{HI} < 10^{18}$ cm^{-2}
- Dispersion of fast radio bursts
  (Thornton et al. 2013; McQuinn 2014)
  - need localisations and redshifts



Xu et al. (2006)



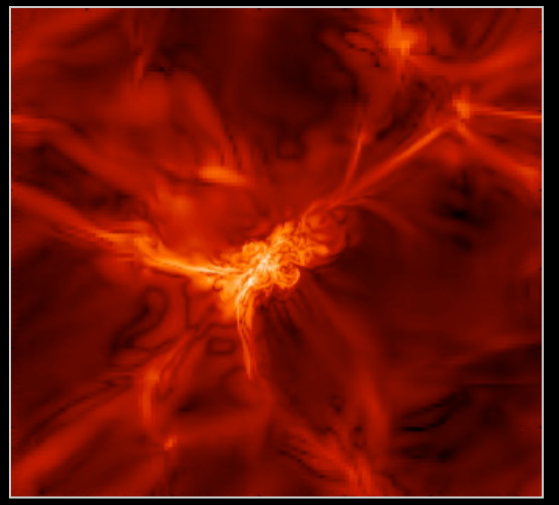


Braun et al. (2004)

CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

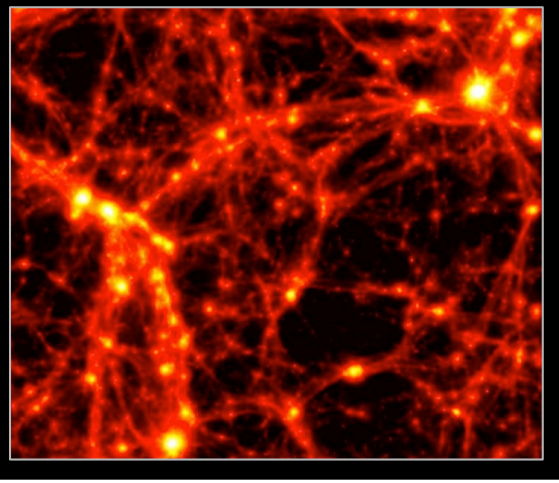
Summary

- Radio synchrotron: a key diagnostic of the cosmic web
- Upgraded MWA should have required sensitivity
- Will require substantial effort on processing, simulations, source subtraction and multi-wavelength correlations



Brüggen et al. (2005)

MWA / Hurley-Walker



Popping et al. (2009)