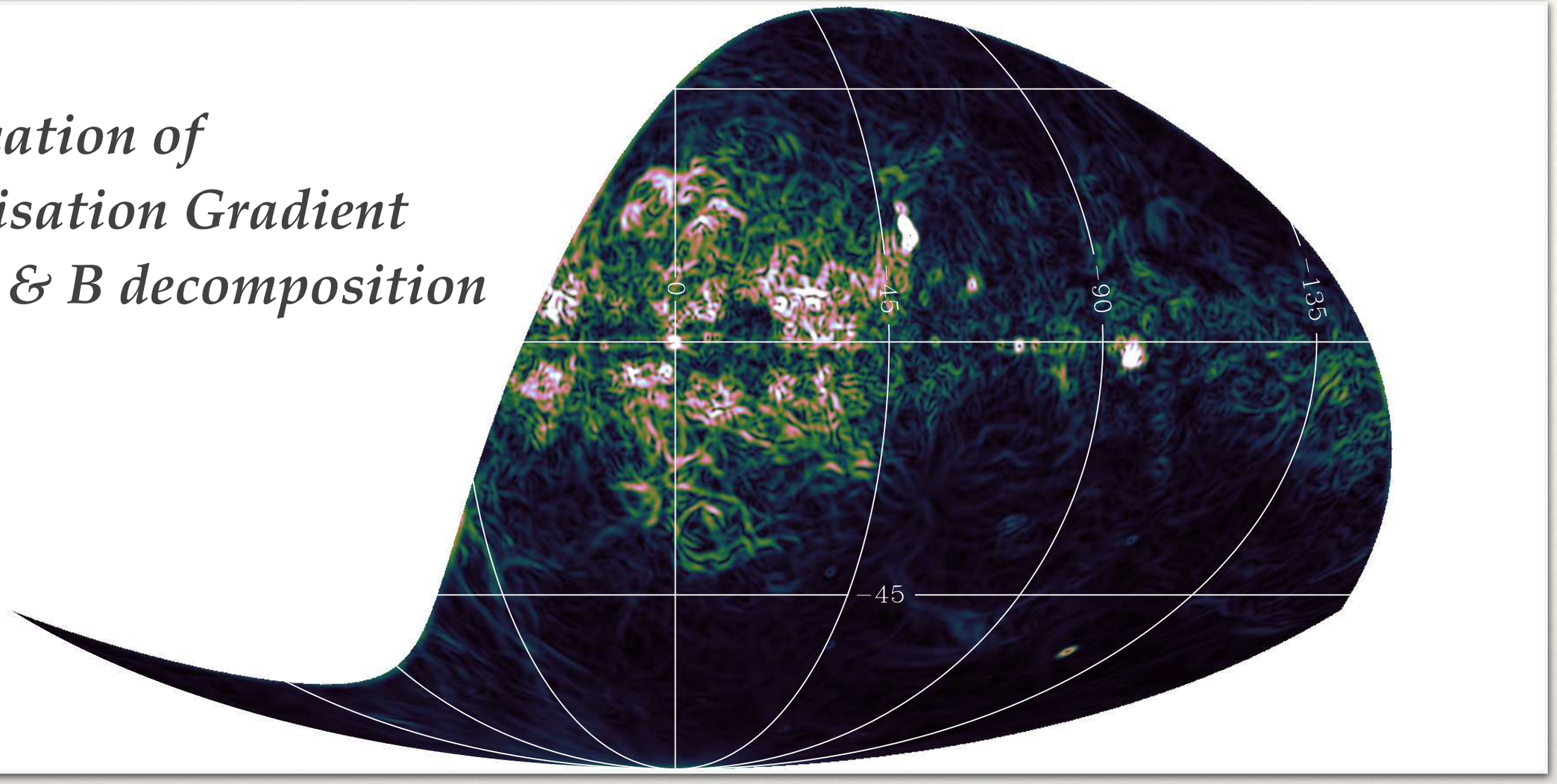
Unification of Polarisation Gradient and E & B decomposition



EWASS 2016

A second view on synchrotron linear polarisation fluctuations

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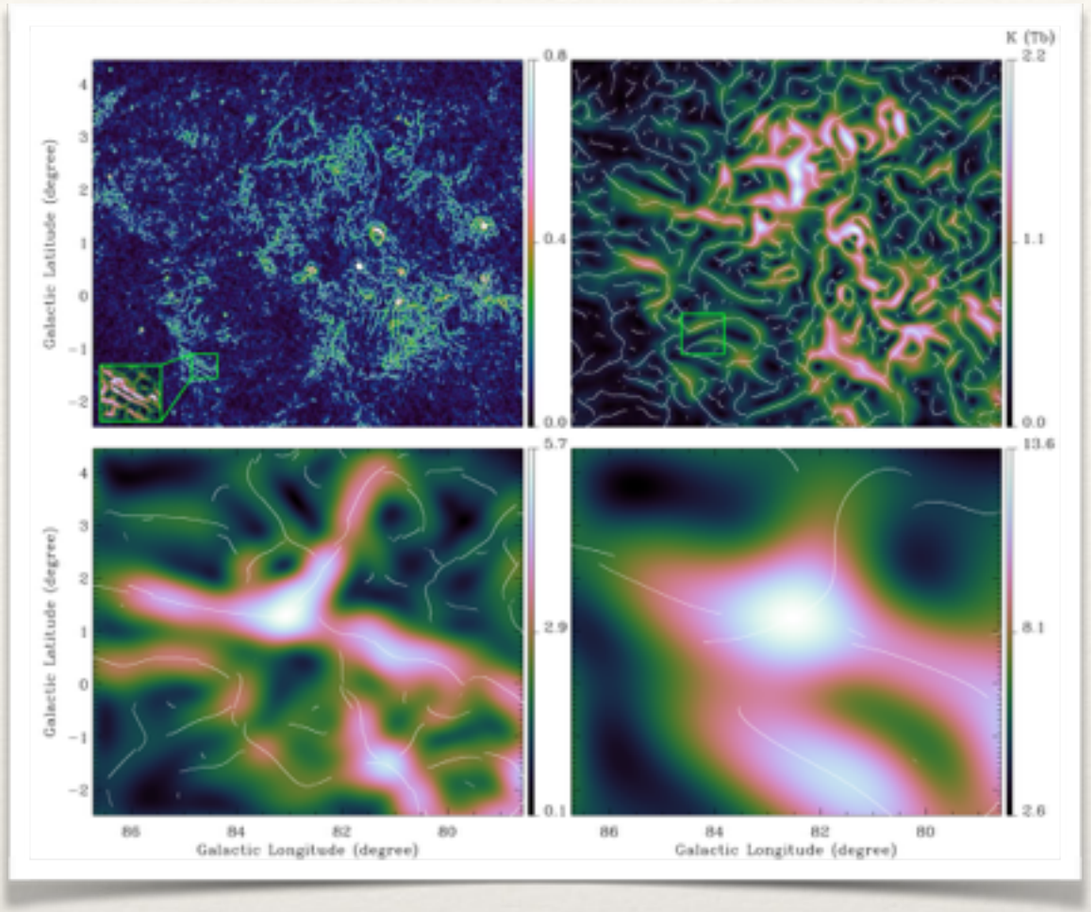
Polarisation gradient

Robitaille & Scaife 2015, MNRAS **451**.4891

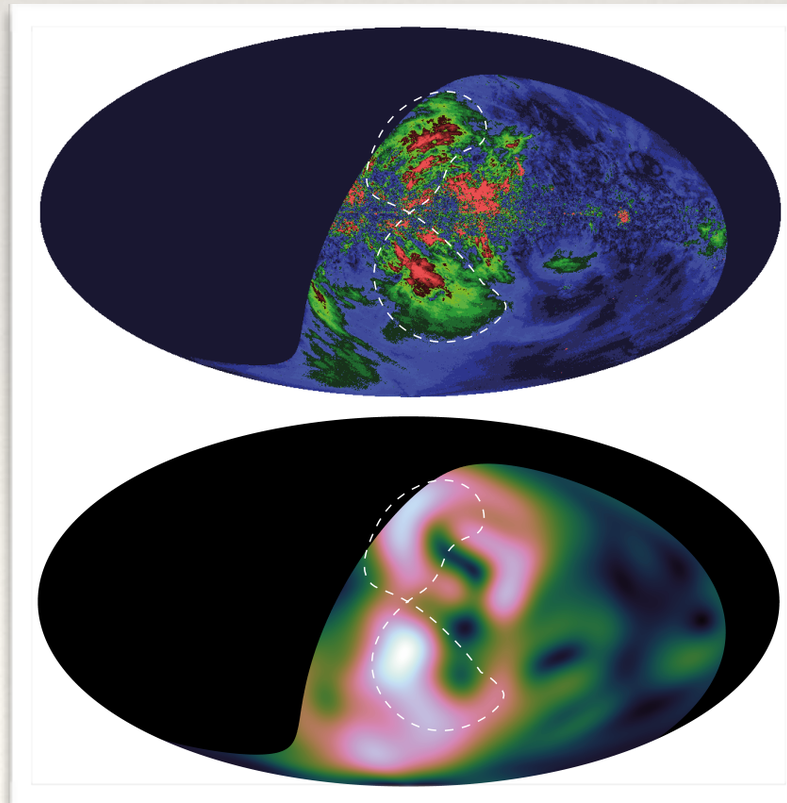
$$|\nabla \mathbf{P}| = \sqrt{\left(\frac{\partial Q}{\partial x}\right)^2 + \left(\frac{\partial U}{\partial x}\right)^2 + \left(\frac{\partial Q}{\partial y}\right)^2 + \left(\frac{\partial U}{\partial y}\right)^2}$$

- $|\nabla P|$ measures the rate at which the polarisation vector traces out a trajectory in the Q-U plane as a function of position on the sky.
- Invariant under rotation and translation of the Q-U plane.
- Using a wavelet formalism we extended the polarisation gradient analysis at multiple spatial scales.

Galactic Plane Survey



S-PASS (Parkes Telescope)



P

$|\nabla P|$

Spin-2 decomposition

$$(Q \pm iU)' = \exp(\mp 2i\theta)(Q \pm iU)$$

Rotationally invariant in "real space"
Zaldarriaga & Seljak 1997

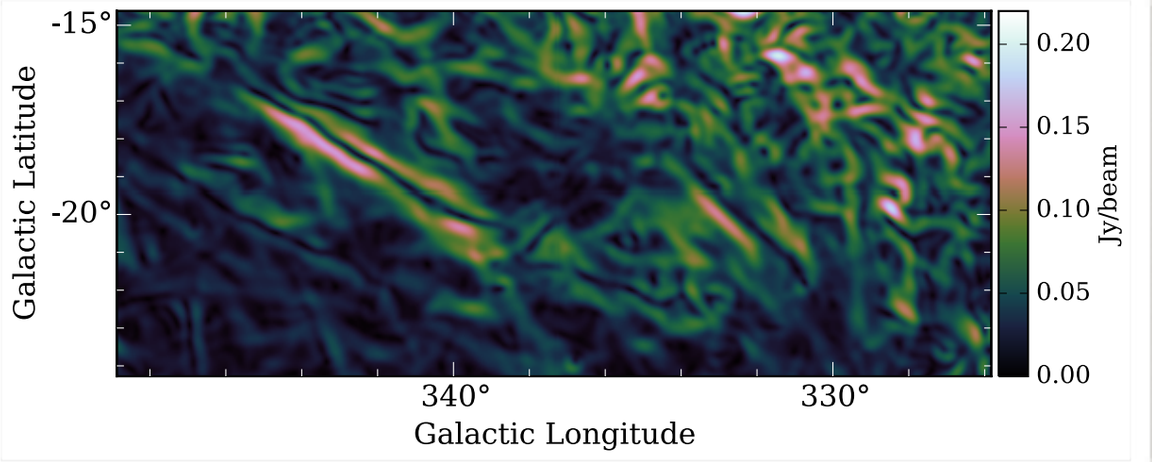
$$\tilde{E}(\hat{n}) \equiv -[\overline{\eth\eth}(Q + iU) + \eth\eth(Q - iU)]/2$$

$$\tilde{B}(\hat{n}) \equiv i[\overline{\eth\eth}(Q + iU) - \eth\eth(Q - iU)]/2$$

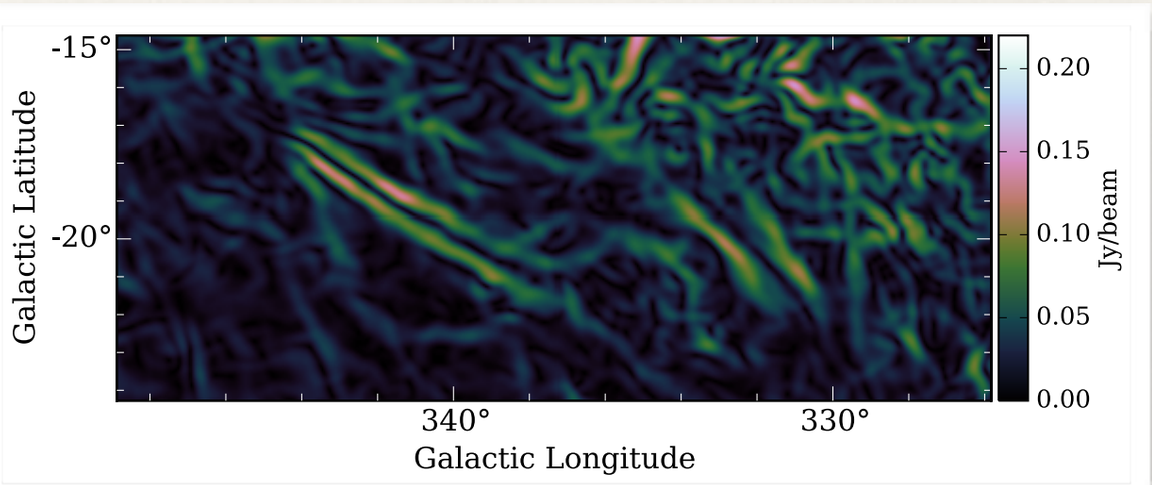
In the flat-sky approximation
Bunn et al. 2003

$$\nabla^2 E = \tilde{E}(\hat{n}) \qquad \nabla^2 B = \tilde{B}(\hat{n})$$

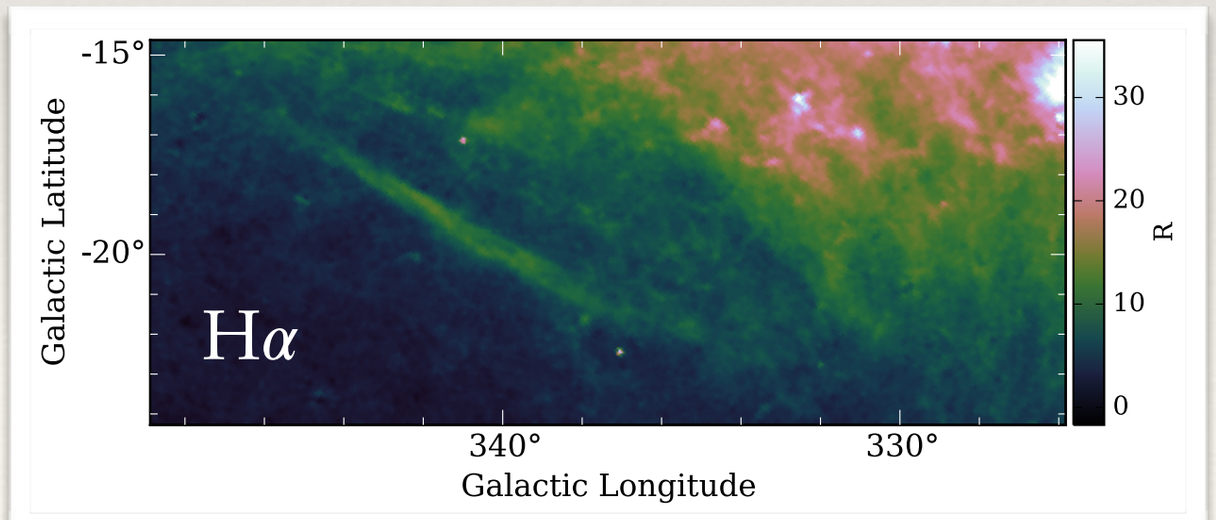
$|\nabla P|$

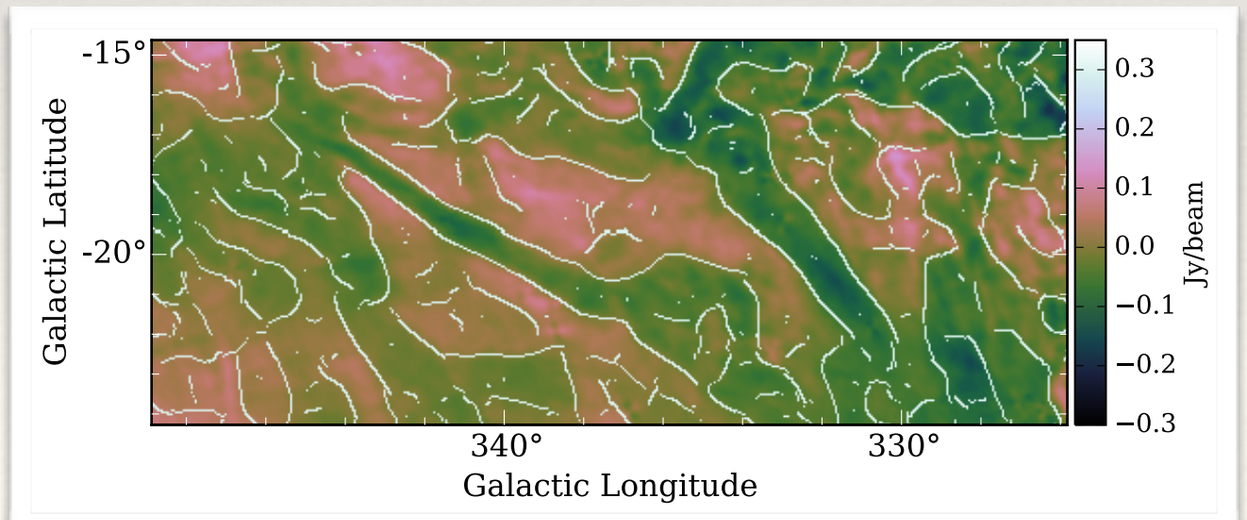


$|\nabla E|$



E mode & $|\nabla P|$ maxima chains



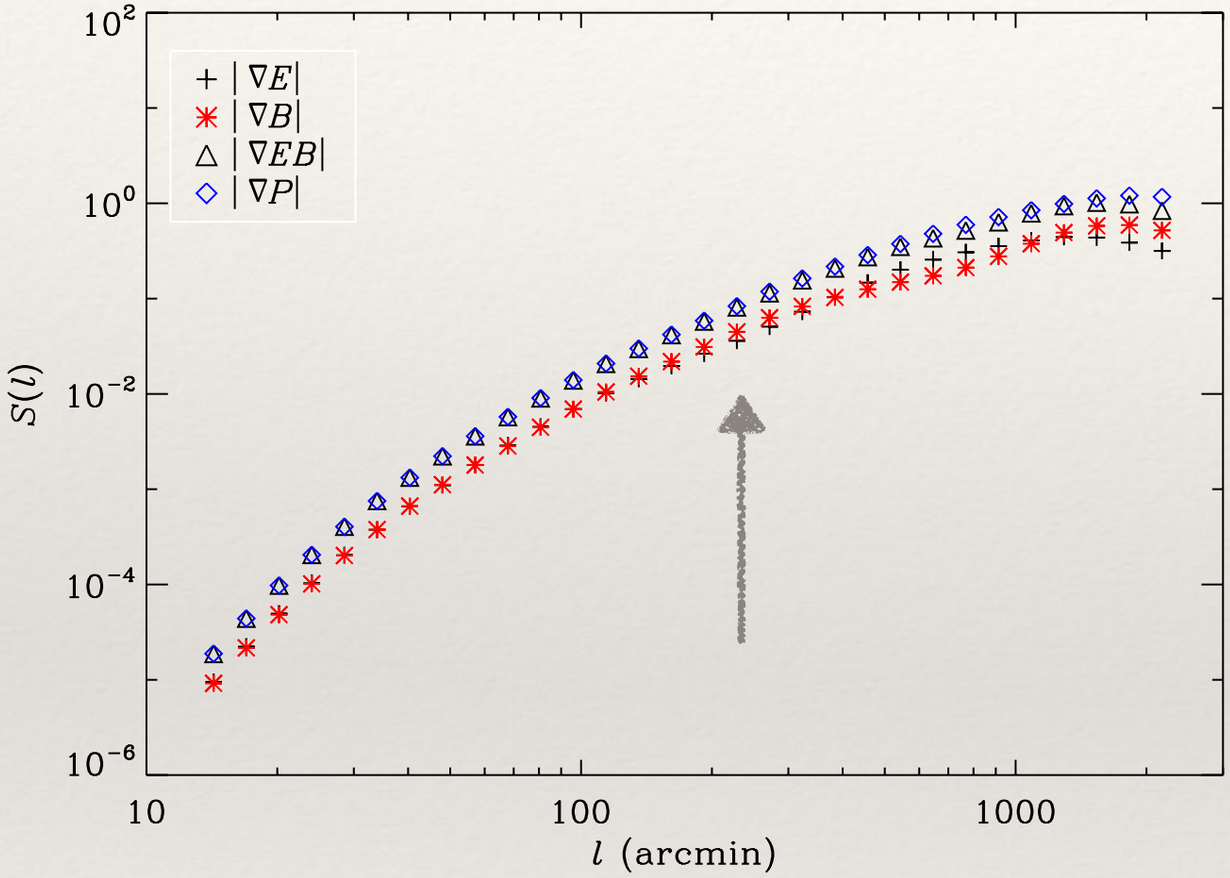


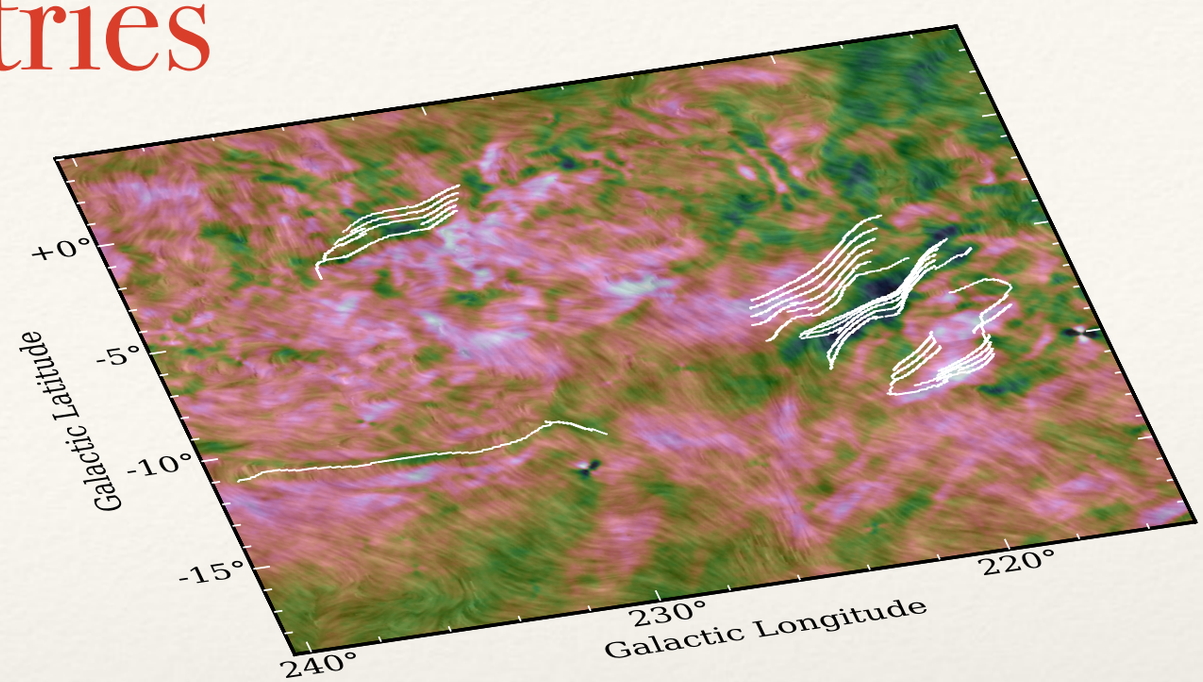
Localising E-B asymmetries

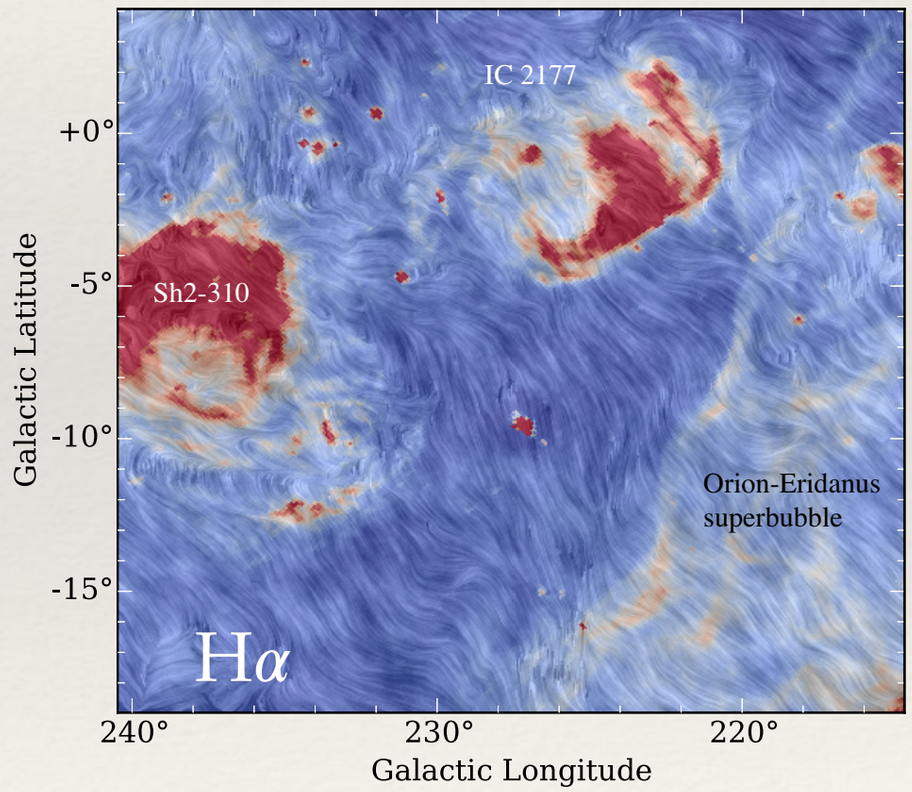
Wavelet power spectra

$$S_Y(l) = \langle |\nabla \tilde{Y}(l, \mathbf{x})|^2 \rangle_{\mathbf{x}}$$

Spatial scale







Multiscale analysis of the gradient of linear polarization

Robitaille & Scaife 2015, MNRAS **451**.4891

Unification of linear polarisation decomposition techniques

Robitaille & Scaife 2016, in preparation

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