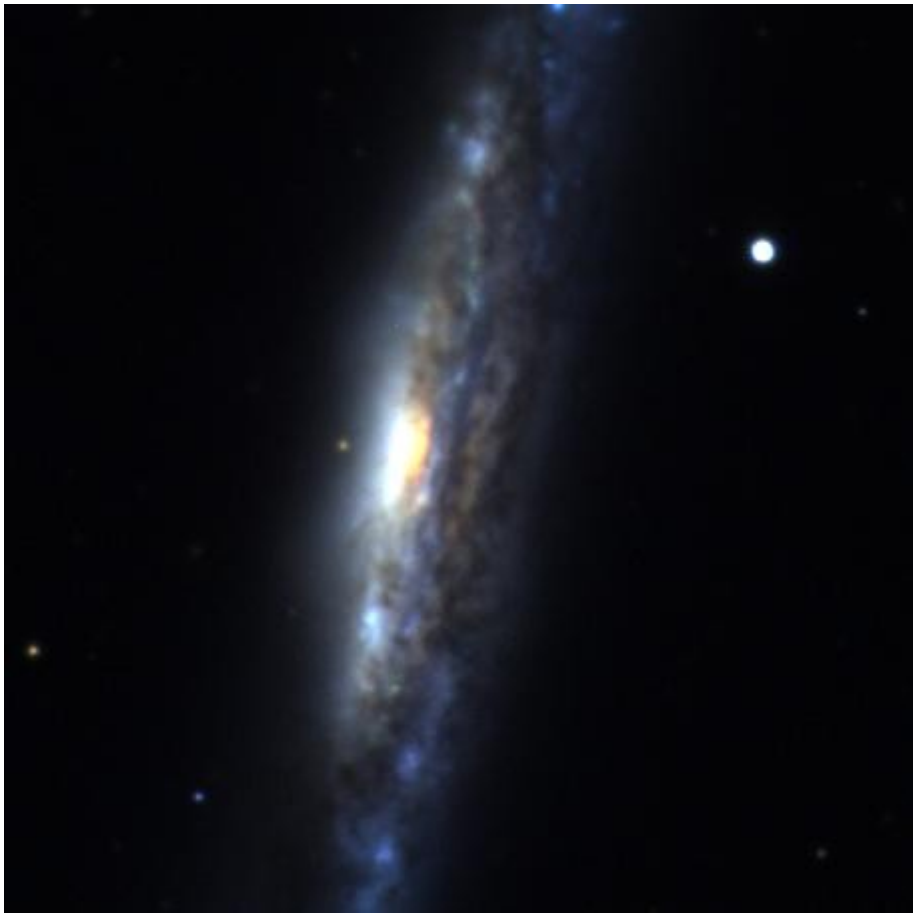
Polarization detection in NGC 3079 at 22cm



SDSS

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Polarization detection in NGC 3079 at 22cm

OUTLINE :

- Detail about the galaxy and the observation.
- Calibration.
- RM Synthesis.
- Polarization detection.
- Conclusions and future work.

Details of NGC 3079

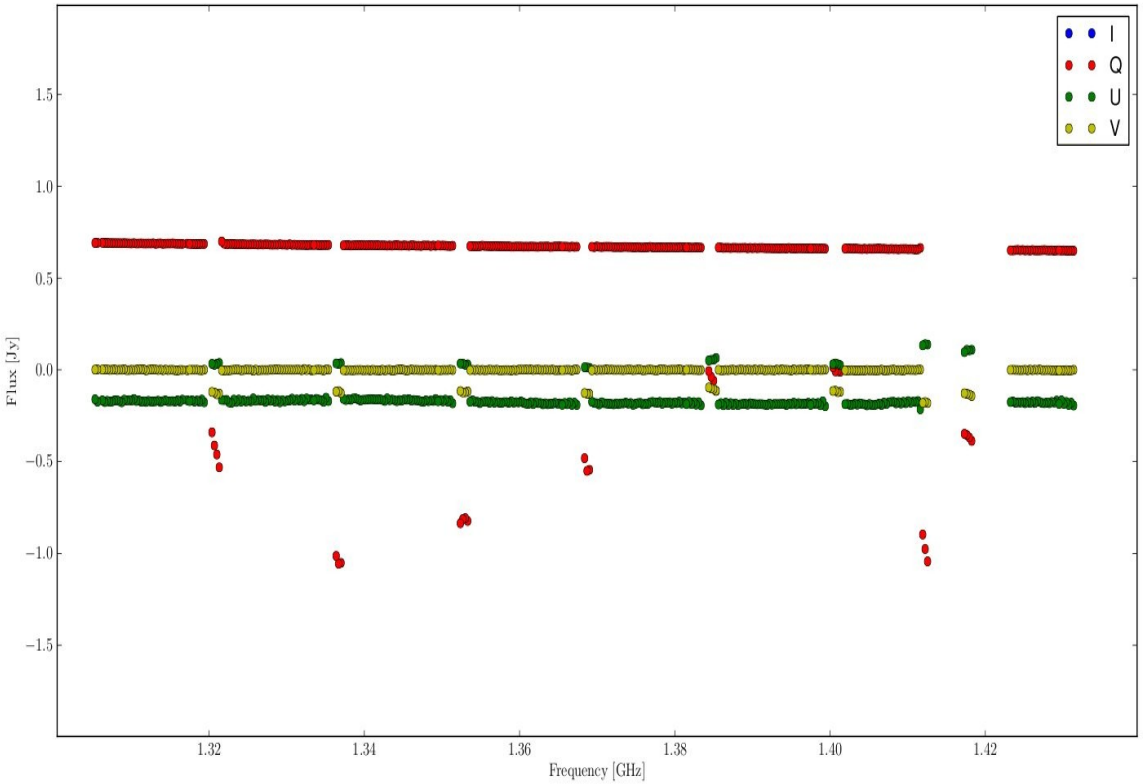
- Edge-on starburst galaxy.
- Inclination angle of 84°
- Galactic longitude: 157.81º ; galactic latitude: 48.36º
- Located at a distance of 20 Mpc

Specifications of the observation

- Observed with the WSRT at 22cm
- 8 IFs, each IF comprised of 64 channels and a bandwidth per IF of 20 MHz
- Data originally published in the SINGS survey (Braun et al. 2007) only in total intensity (Stokes I). In this work the uncalibrated data was retrieved from the WSRT archive and re-reduced.

Calibration of the data

- Flux calibrator CTD93
- Polarization calibrator 3C138



3C138 Stokes (Q,U,V) = (0.63,-0.17,0.00) Jy

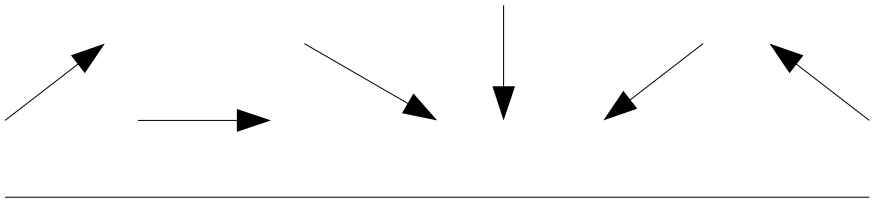
- Flagging due to RFI in calibrators and target was carried out using AOFlagger (Offringa et al. 2011)
- Channel by channel calibration for high DR purposes.
- Some channels present calibration errors or undetected RFI.

Detecting polarization

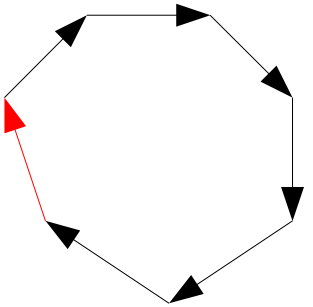
Previous works (Cecil et al 2001; Duric et al 1983) have been unable to detect polarization at 1.4 GHz.

This is attributed to the low degree of polarization at this frequency but also due to bandwidth depolarization.

Avoiding bandwidth depolarization and recovering any existent polarized signal: RM Synthesis

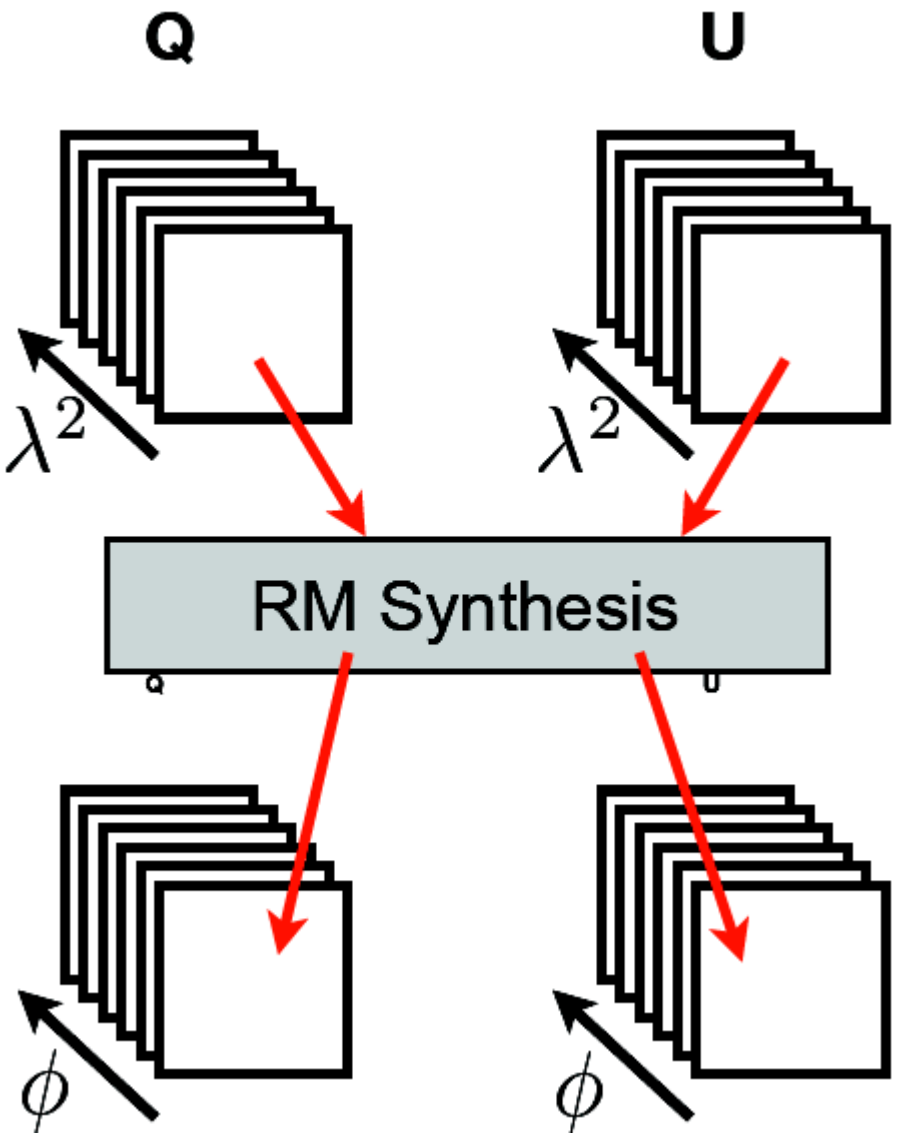


Wide bandwidth.

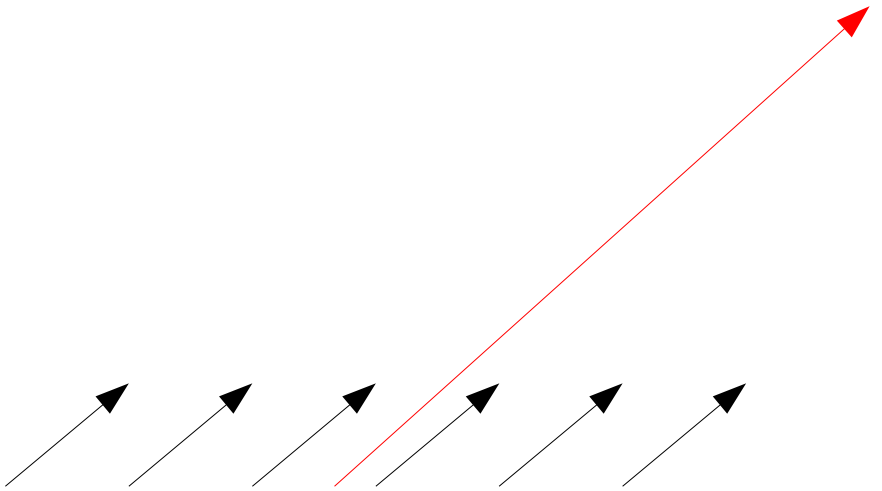


Loss of polarized signal after imaging of Q and U using the entire band

RM Synthesis



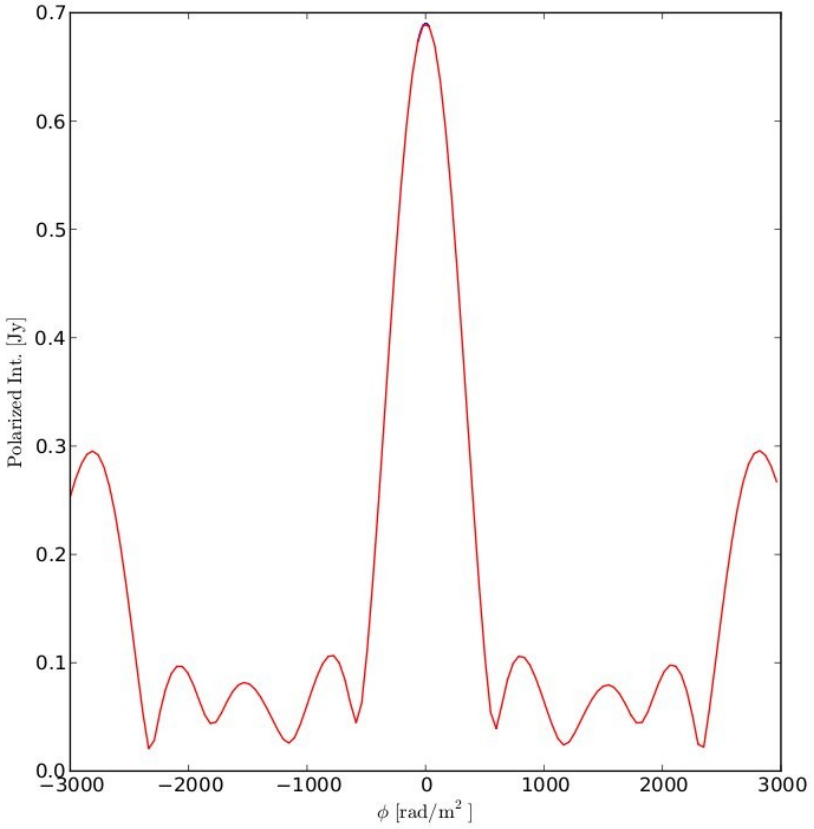
$$\tilde{F}(\phi) = K \sum_{c=1}^{N} \tilde{P}_c e^{-2i\phi(\lambda_c^2 - \lambda_0^2)}$$

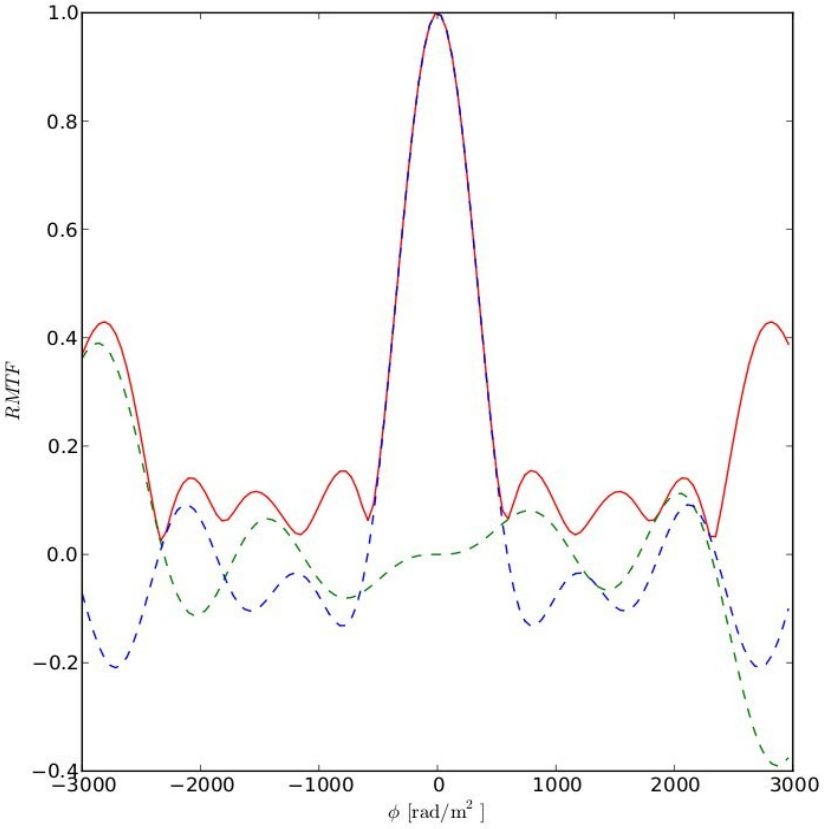


Recovering polarized signal after RM Synthesis.

RM Synthesis on 3C138

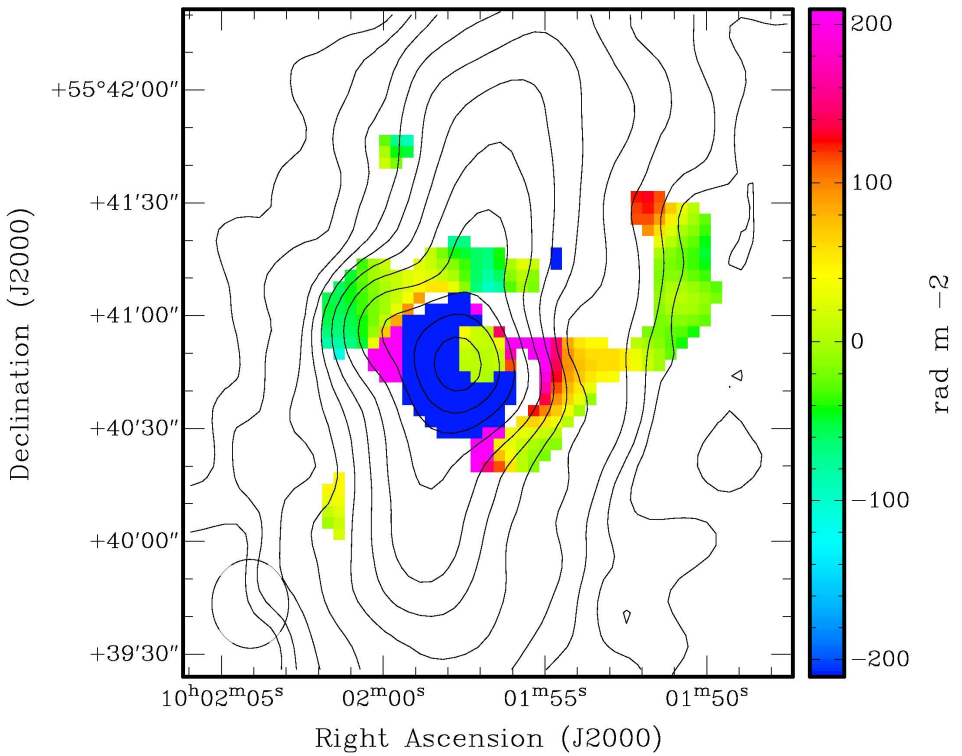
- RM = -2.1 rad/m^2 (Cotton et al. 1997)
- Faraday Depth = -2.7 rad/m^2 (by fitting a parabola to the peak)





- Resolution in Faraday space: 389.5 rad m^{-2}

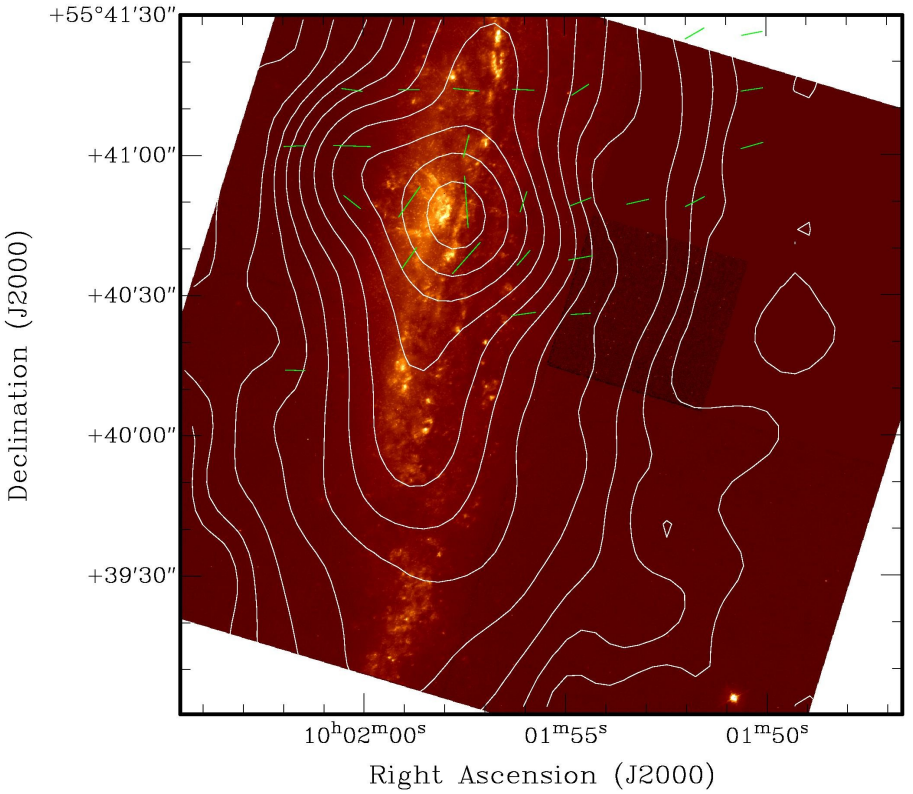
RM map of NGC3079 at high resolution



Black contours represent the total intensity map. Lowest contour level at 0.21 mJy (3σ). Beam size of 17" x 14.5"

- RM map produced by selecting the peaks in every line-of-sight Faraday spectrum of the RM-Cube generated.
- In order to have negligible contribution of the Ricean bias pixels were blanked below a cutoff of $5\sigma_{Q,U}$

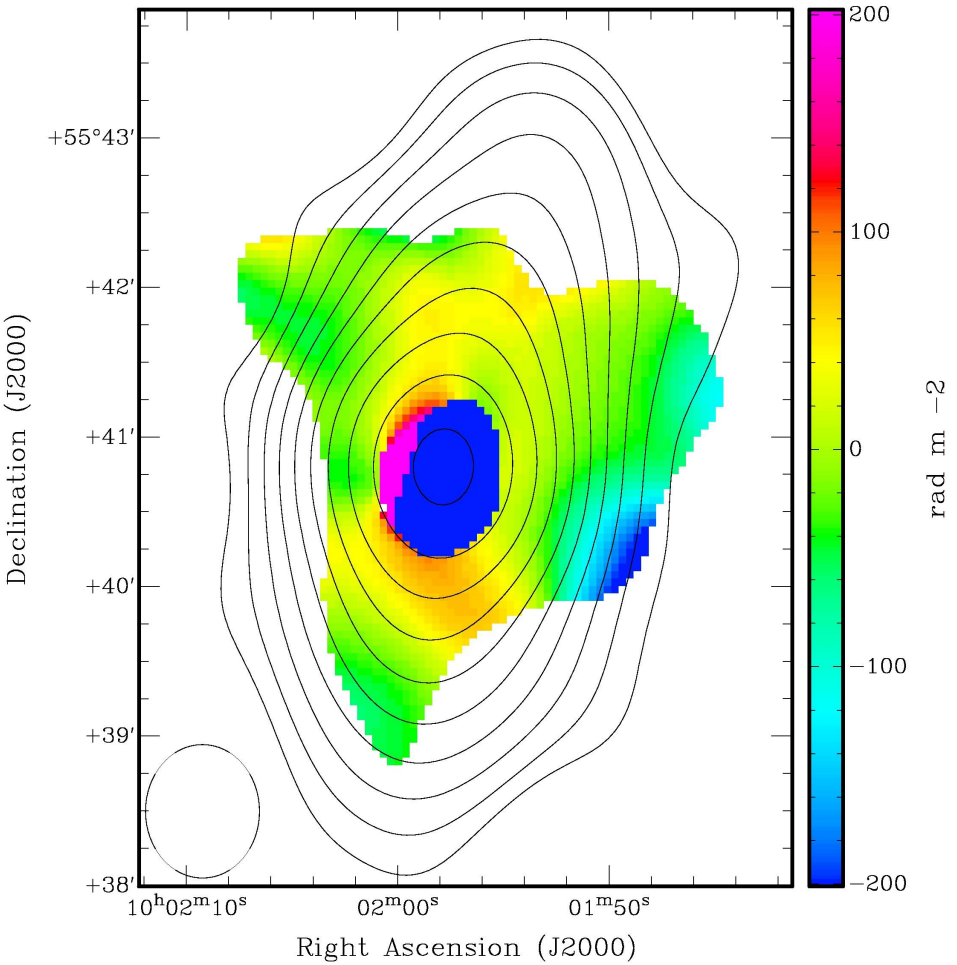
B-fields at high resolution



H-alpha image from the HST

- Polarization vectors de-rotated to $\lambda = 0$ rad m^{-2}
- Vertical magnetic fields in the halo following the direction of the ionized supperbubble

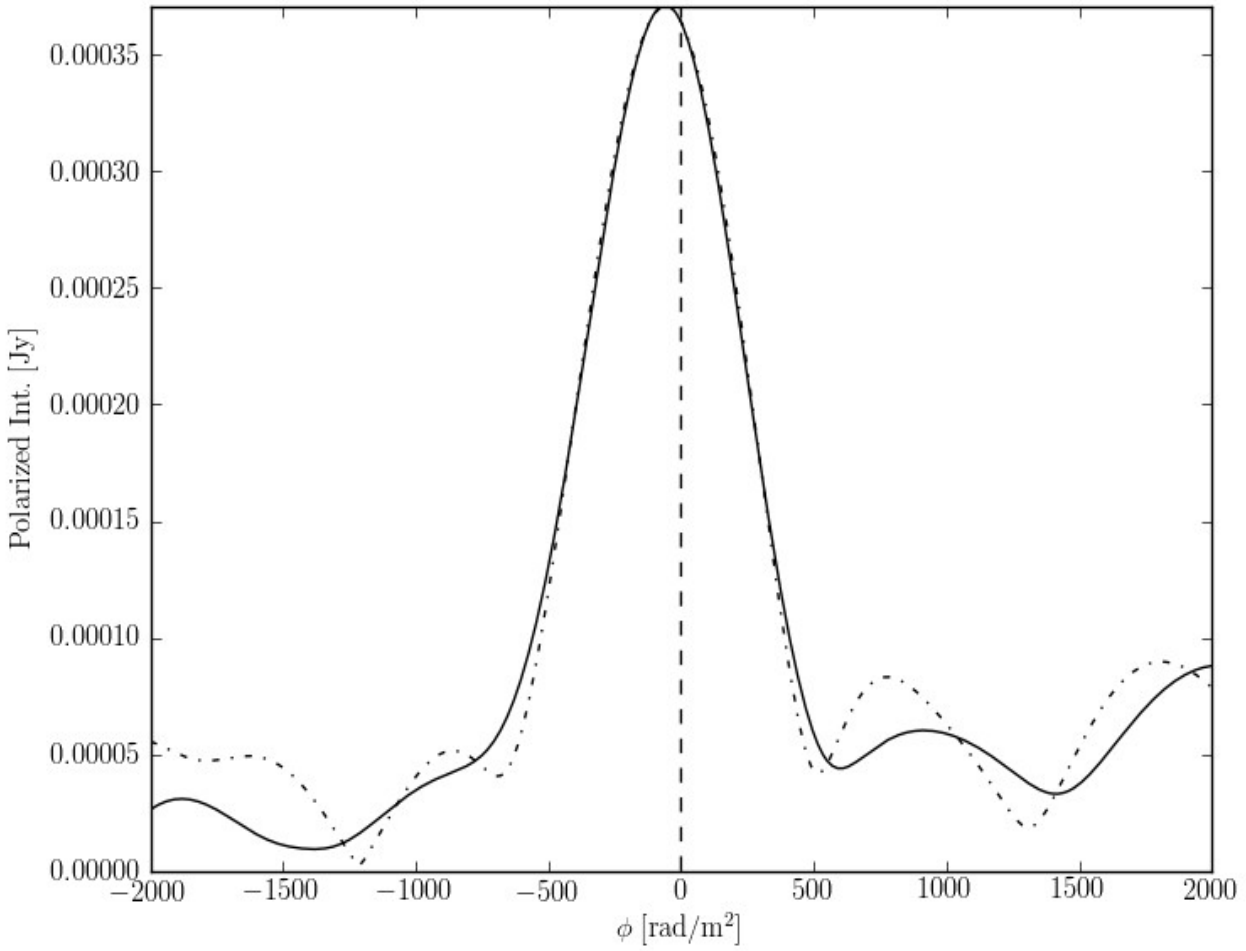
RM map of NGC3079 at low resolution



Black contours represent the total intensity map at three times the original resolution. Lowest contour level at 0.9 mJy (3σ).

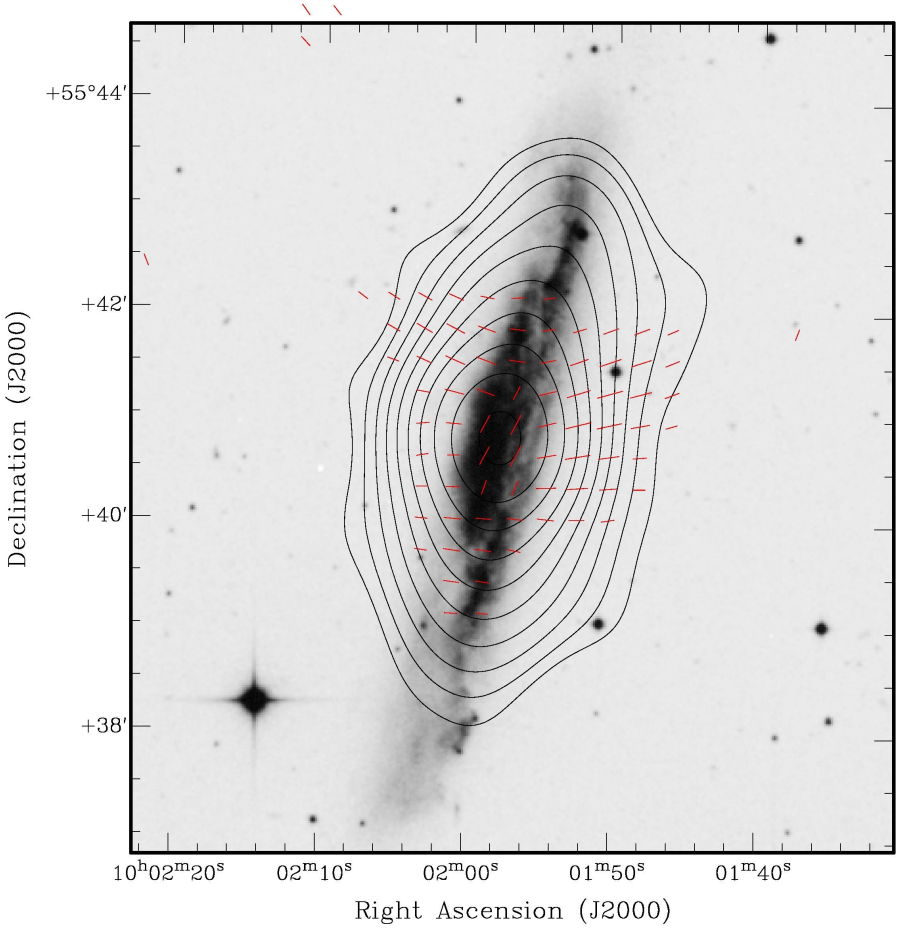
- Polarized extended emission; present in the short baselines.
- All Q and U channel-maps where convolved with a beam size of 51" x 43.5".

Faraday spectra along a halo line-of-sight



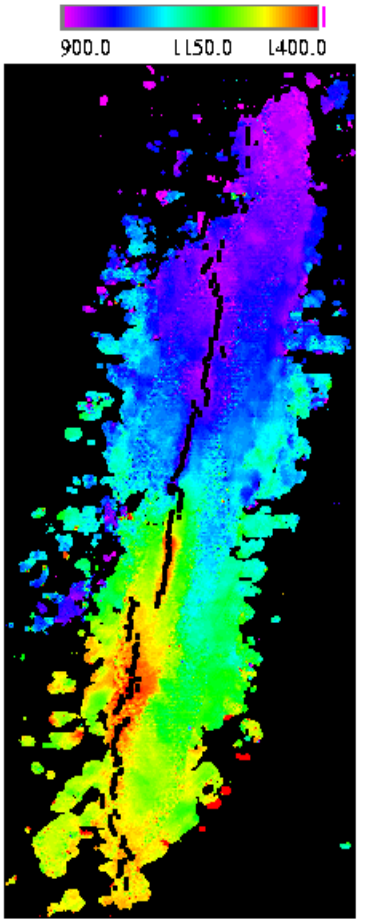
- Φ ~ -60 rad m-2
- σ_{Φ} = 28.4 rad m-2
- In worst case Faraday depth equals to ~ -32 rad m-2
- Foreground RM from NVSS is 4.8 (Taylor et al. 2009)
- Emission from the halo.

B-fields at low resolution



Grey scale image from the DSS

- Depolarization in the southern side of the galaxy due to the longer line-of-sight path.
- B -fields forming the well know X-shaped pattern.
- Indication of galactic wind.



H-alpha velocity field map (Veilleux et al. 1999)

Conclusions and future work:

- Vertical large scale B-fields in the halo.
- Calculation of scale height and synchrotron lifetime in order to estimate the cosmic ray bulk velocity. Indication of galactic disk wind?
- EVLA observations at 20 and 6 cm already available. With unprecedent resolution and sensitivity the magnetic field structure can be study in great depth in this starburst galaxy. EVLA resolution will allow to circumvent beam depolarization
- 23 hrs at 90 cm will be available in 2012/2013? as part of the LEGACY survey. Trace cosmic ray propagation further out into the halo.