Search for Extreme Rotation Measures in CSS Sources

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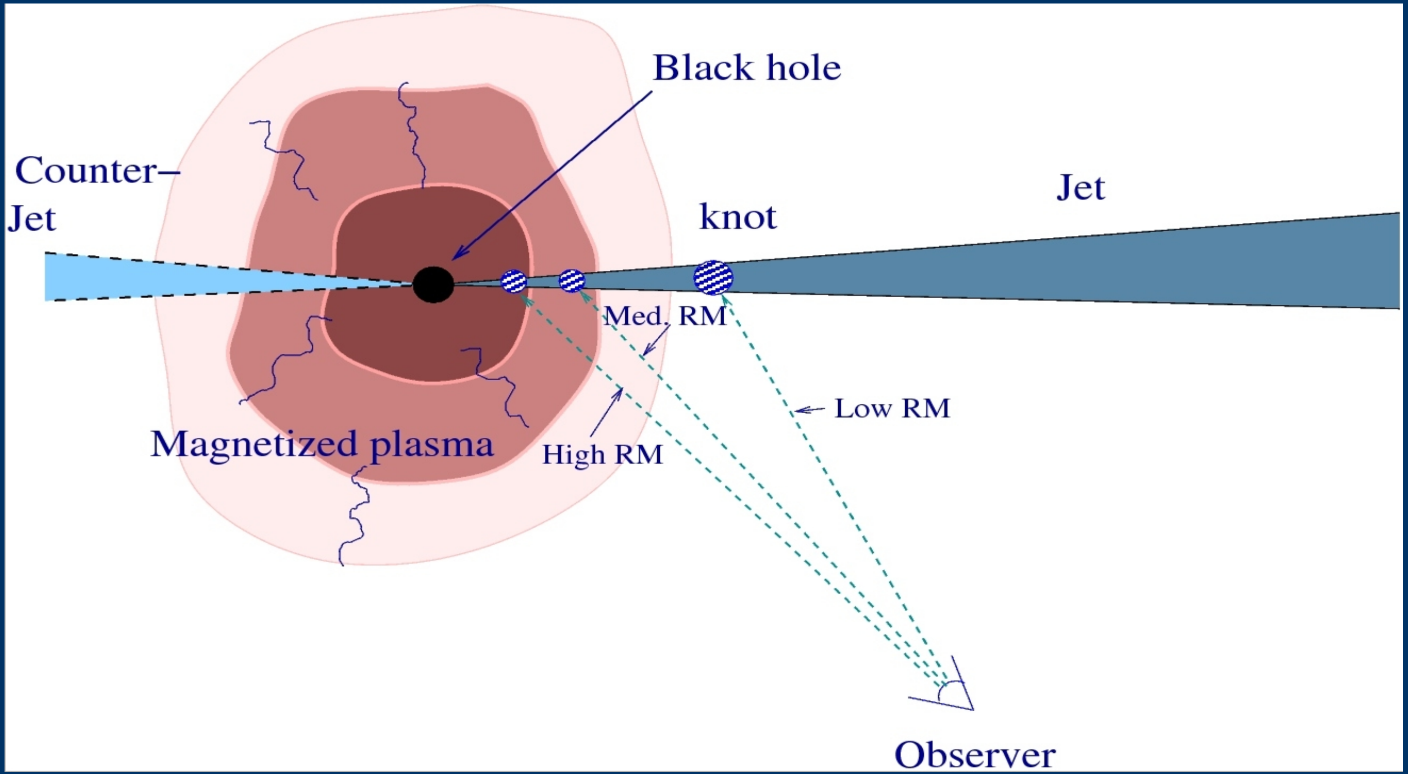

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Motivation

- High plasma densities and strong magnetic fields are expected near BH at core of AGN nuclei
- Magnetized plasma is birefringent, rotating the polarization angle of linear polarization.
- Faraday rotation:

$$\chi = \chi_0 + \mathrm{RM} \cdot \lambda^2$$

Polarization angle, χ , rotates with wavelength squared
RM = Rotation measure

Faraday Rotation

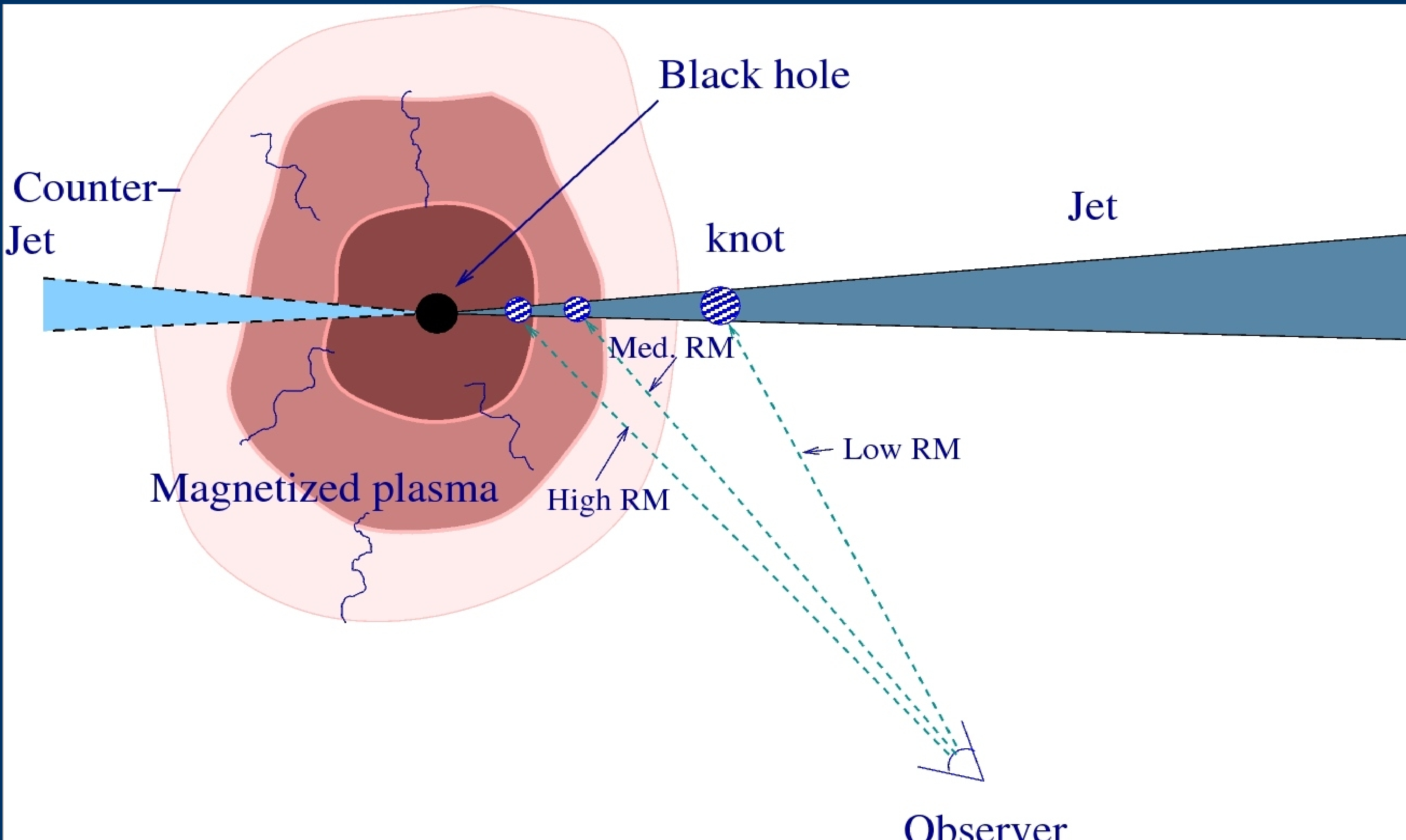
- Rotation measure is integral of electron density times component of magnetic field along LOS.

$$\mathrm{RM} = \frac{e^3}{8\pi^2\epsilon_0 m^2 c^3} \int n_e \boldsymbol{B}_{||} d\boldsymbol{l}.$$

Faraday rotation in AGN nuclei

- Background radiation will be Faraday rotated passing through dense magnetized plasma.
- Varying Faraday rotation can depolarize.
- Sgr A* strongly depolarized at cm wavelengths.
- Sgr A* has RM ~ ½ million, could be more in more active nuclei.

Cartoon AGN nuclei



Detection of Dense Magnetized Plasma

- Polarimetric measurements can detect Faraday Rotation near nuclei of AGN.
- Multiple LOSs with different RM may depolarize, low fractional polarization may indicate dense screen.
- Need emission embedded in or behind screen.

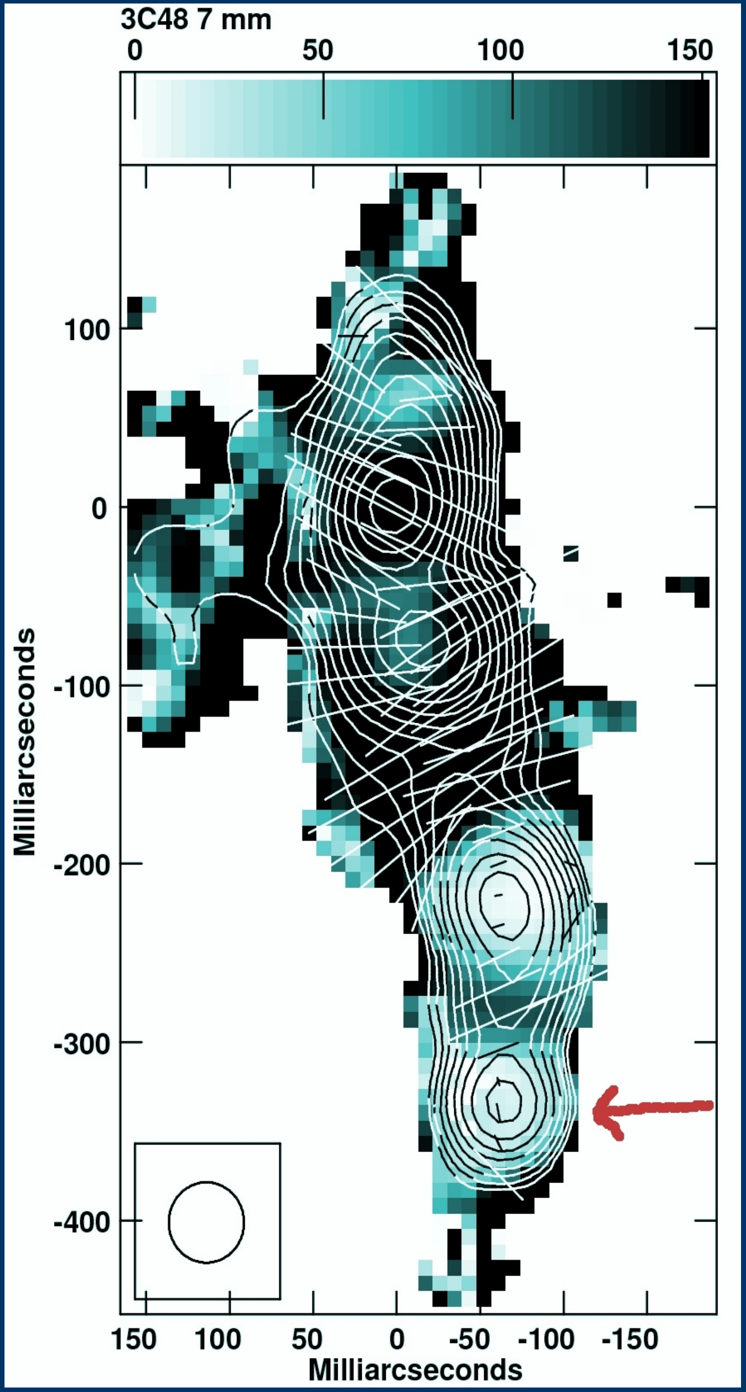
CSS Nuclei

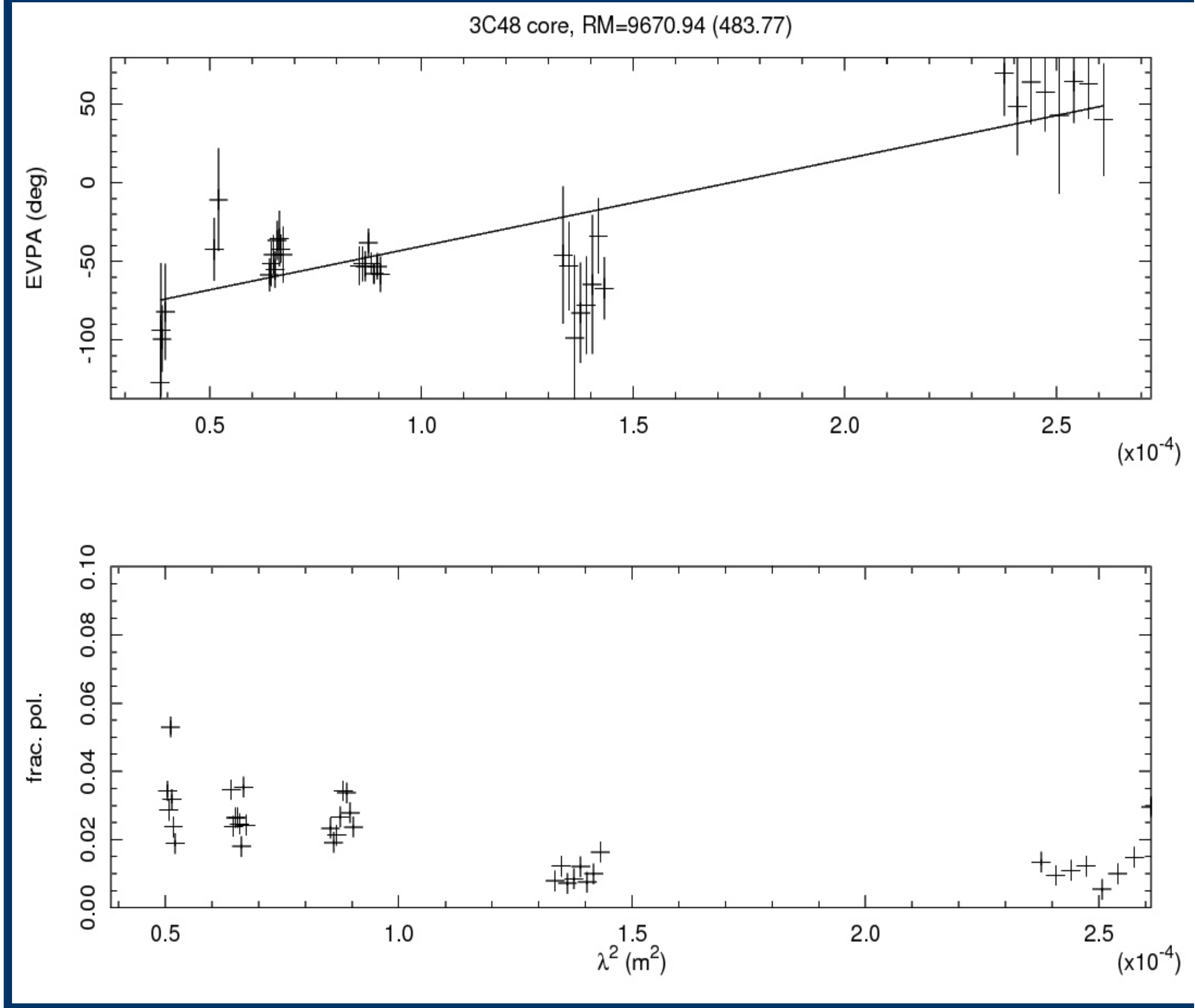
- Many are weakly polarized at cm λ
- Possibly depolarized by dense screen
- Better observed at short λ :
  - Faraday effects are less
  - Opacity is less ➡ see closer to nucleus
- but CSS sources are faint at short λ.
- EVLA has good sensitivity 20 – 45 GHz

EVLA Observation of CSS Sources

- 3C48, 3C138, 3C147, (3C286) in standard calibrator observations (public).
- 6 × 1 GHz bands   20 – 45 GHz
- A configuration, ~60 mas resolution
- Image at common resolution
- Pixel by pixel fitting of RM
- Examine nucleus

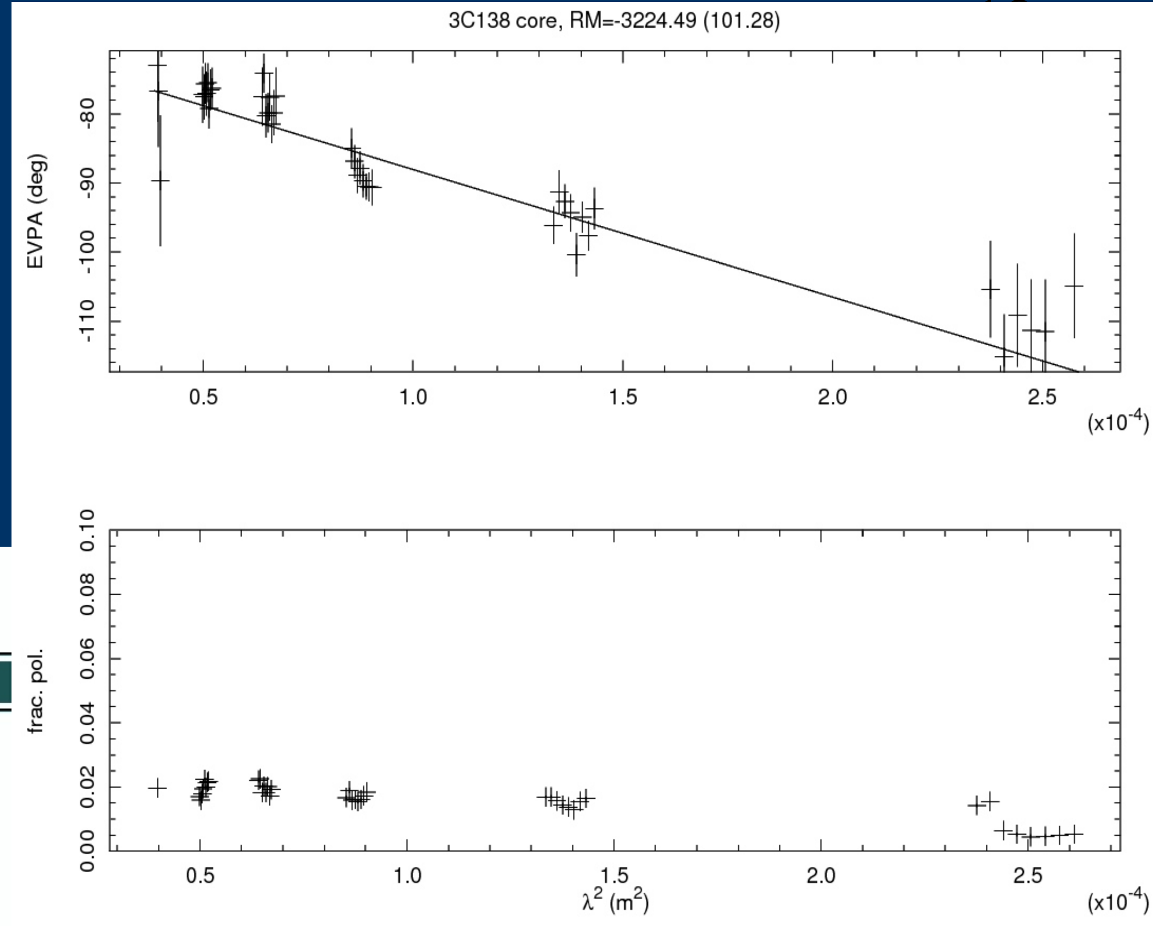
3C48

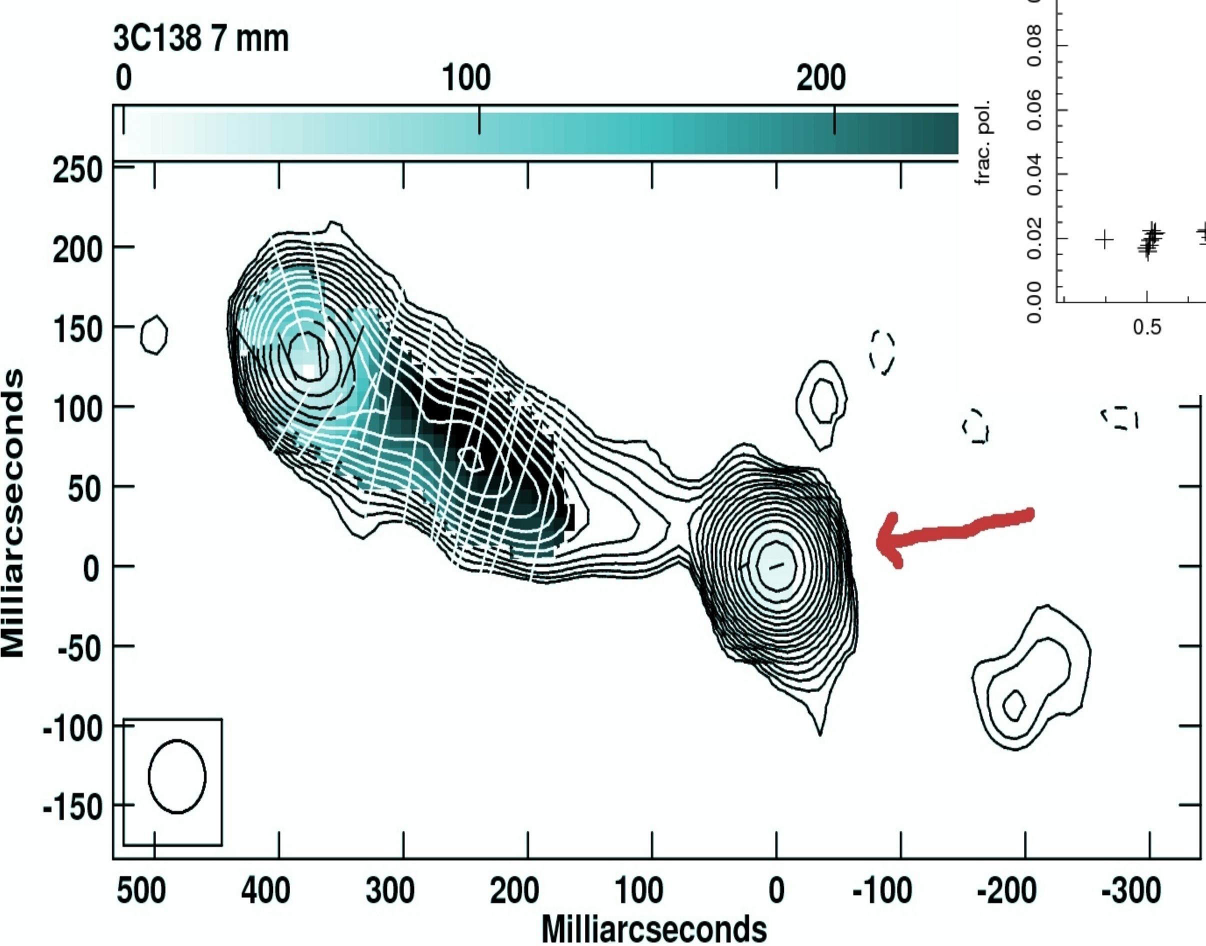




I Pol contours, Fpol color, EVPA vectors

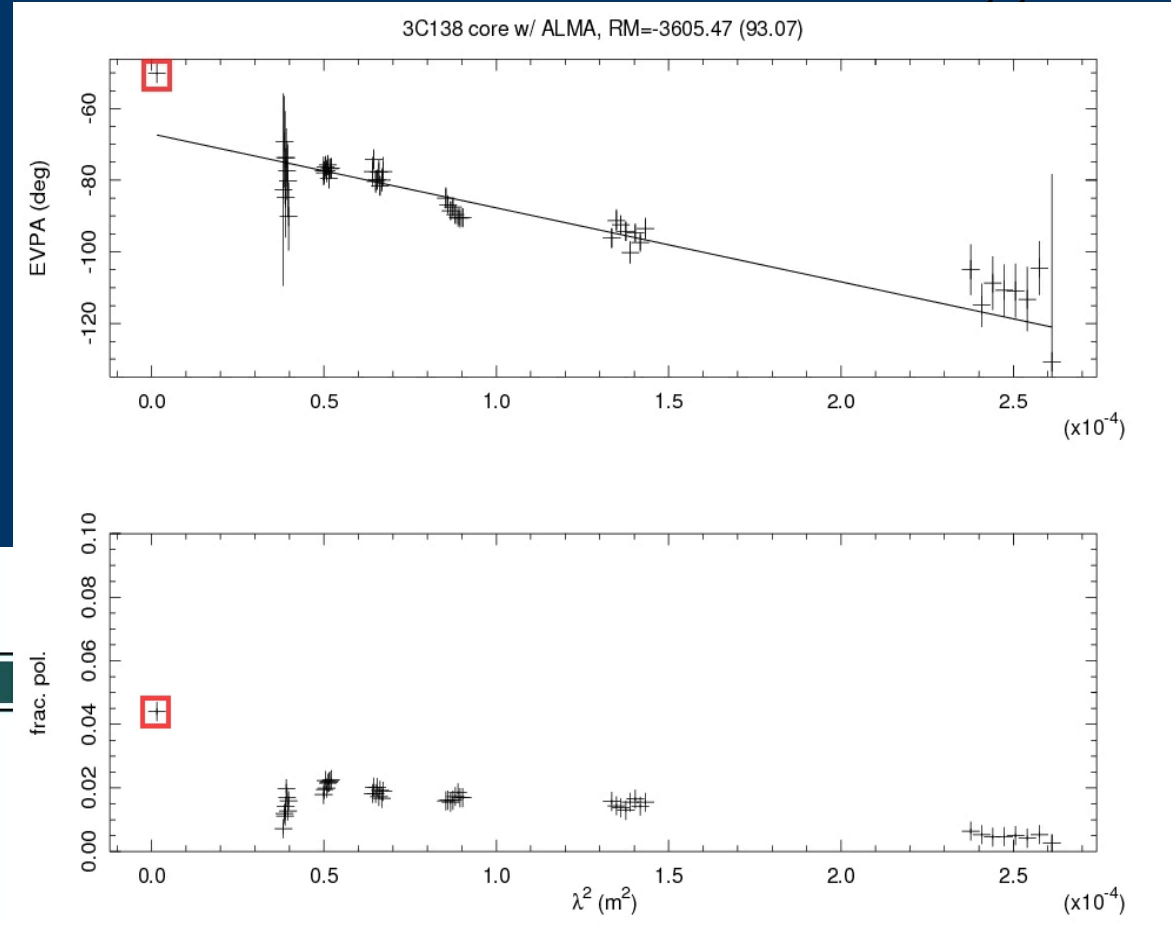
3C138

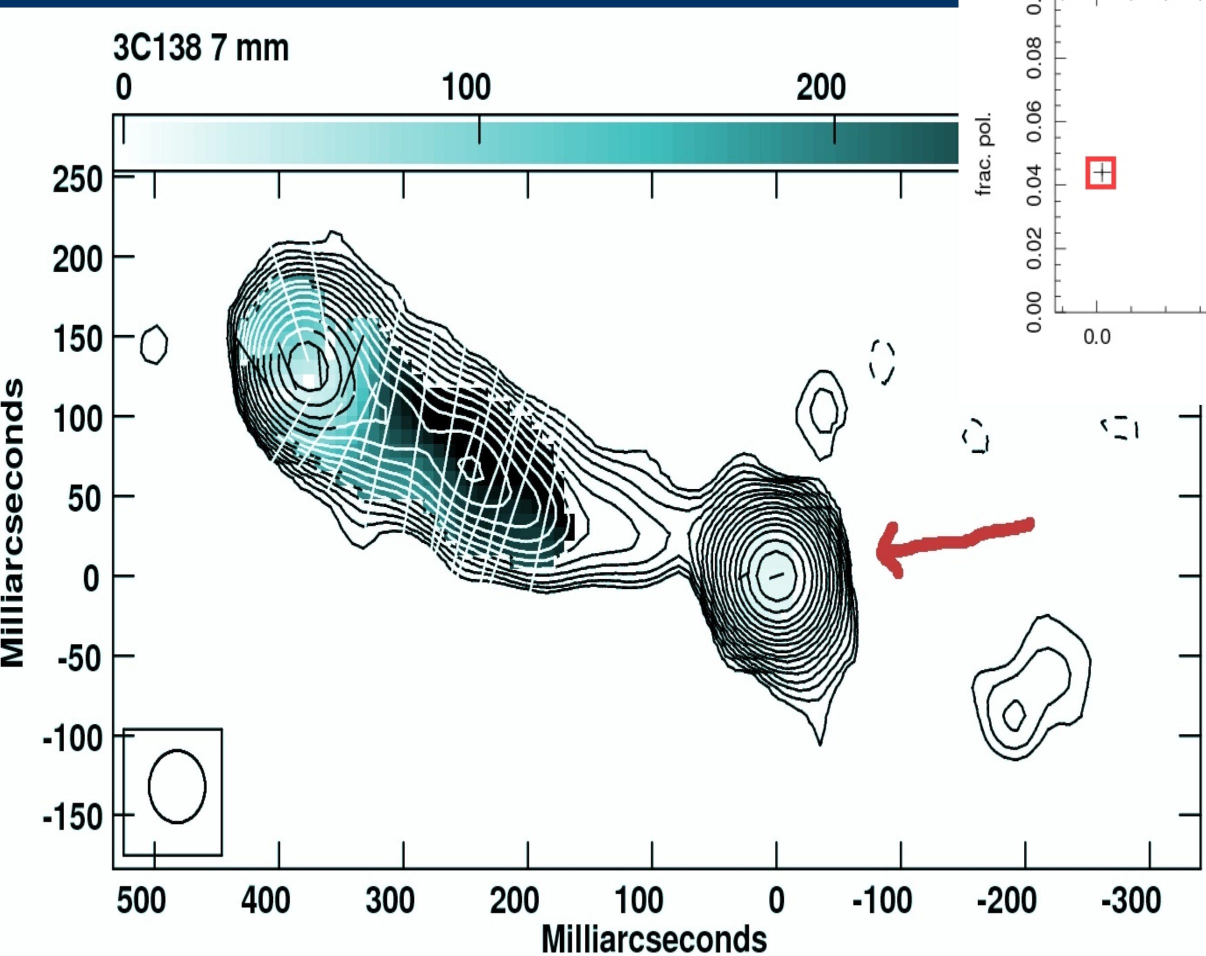




I Pol contours, Fpol color, EVPA vectors

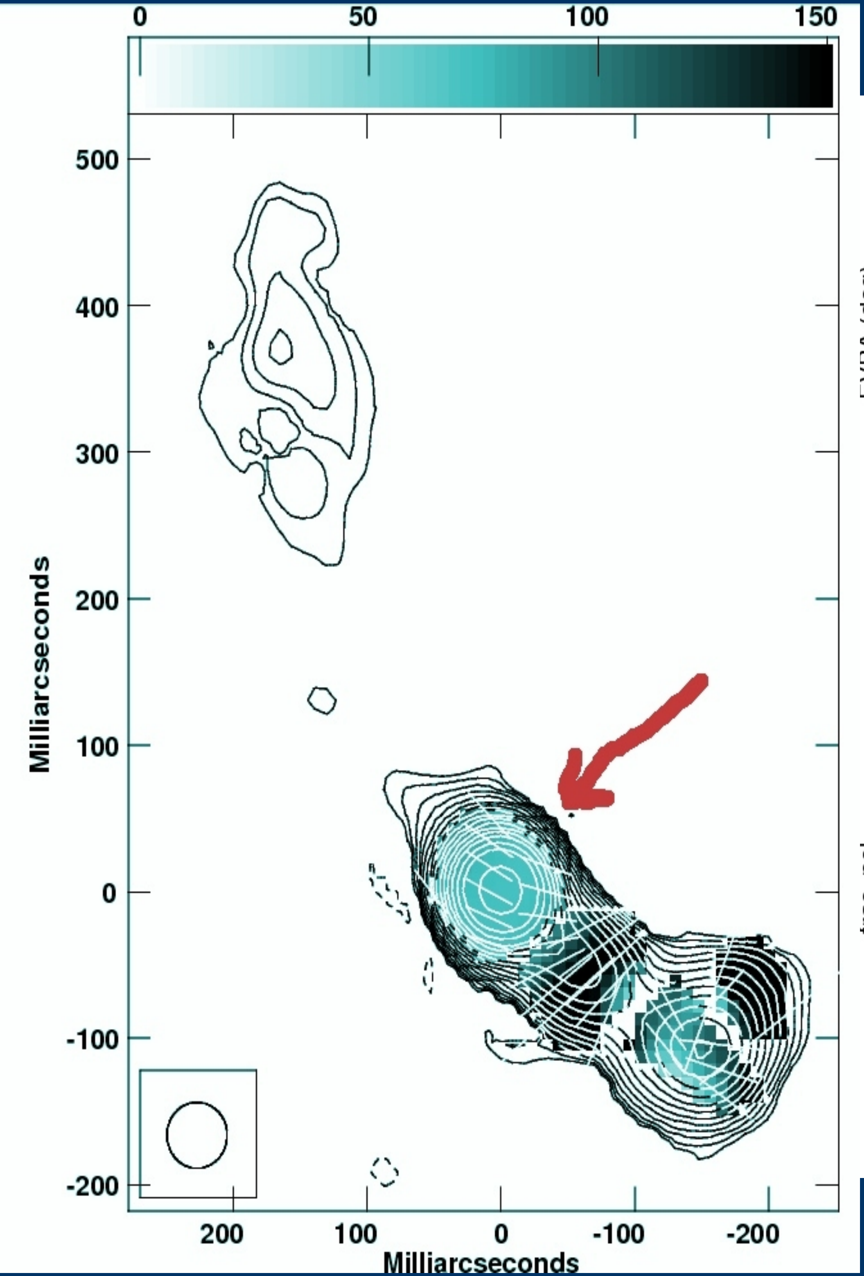
3C138
with ALMA band 6
240 GHz

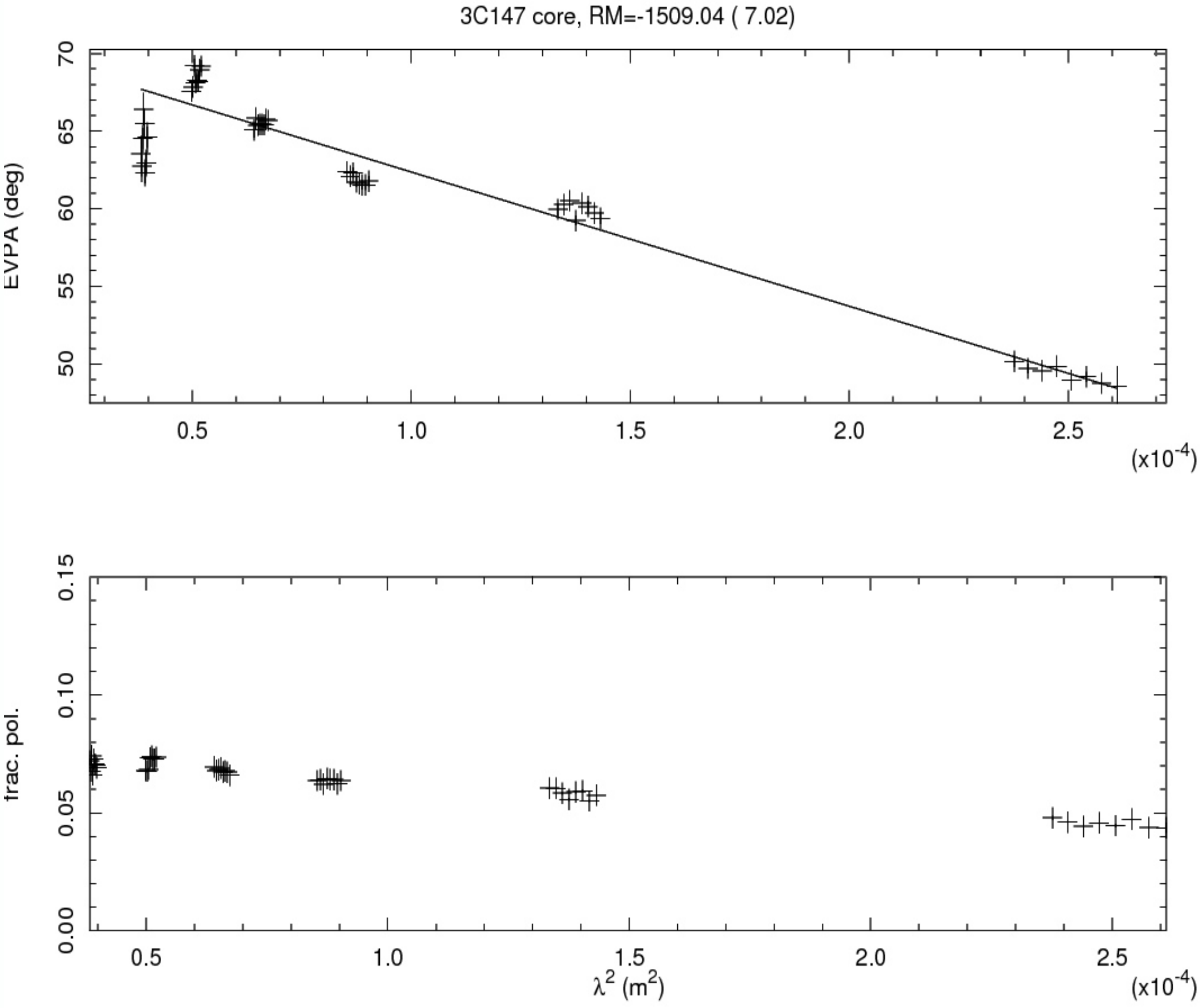




I Pol contours, Fpol color, EVPA vectors

3C147





I Pol contours, Fpol color, EVPA vectors

Results

- 3C48 fpol low but increases with frequency, RM ~ 10,000
- 3C138, low fpol, core RM ~-3000
  - < cm value (Cotton+ 2003 RM ~-5000)
  - seen through holes in apparently dense Faraday screen.
  - ALMA result supports
- 3C147, low RM, high Fpol
- High RM components possibly masked by low RM components, need denser λ^2 coverage.
- Need higher frequencies to get closer to the BH

Faraday Analysis

- Multiple RM/complex structures can be revealed by Faraday Analysis
- Fourier Transforms data in λ^2 space.
- Separate RM components seen as peaks.
- Need dense coverage to get good transfer function.
- Allows detection of high RM component in the presence of low RM.

Further observations

- EVLA measure nearly complete 20-48 GHz on a selection of sources – in progress.
- ALMA Cycle 3 proposal for several sources at 350 GHz.

Summary

- Low fpol, moderate RM seem in 3C48, 3C138 up to 45 GHz
- 3C147, high fpol, low RM
- Continuing observations to do Faraday analysis
- Higher frequencies?