# Rotation Measurements of 3C120 from ALMA Observations

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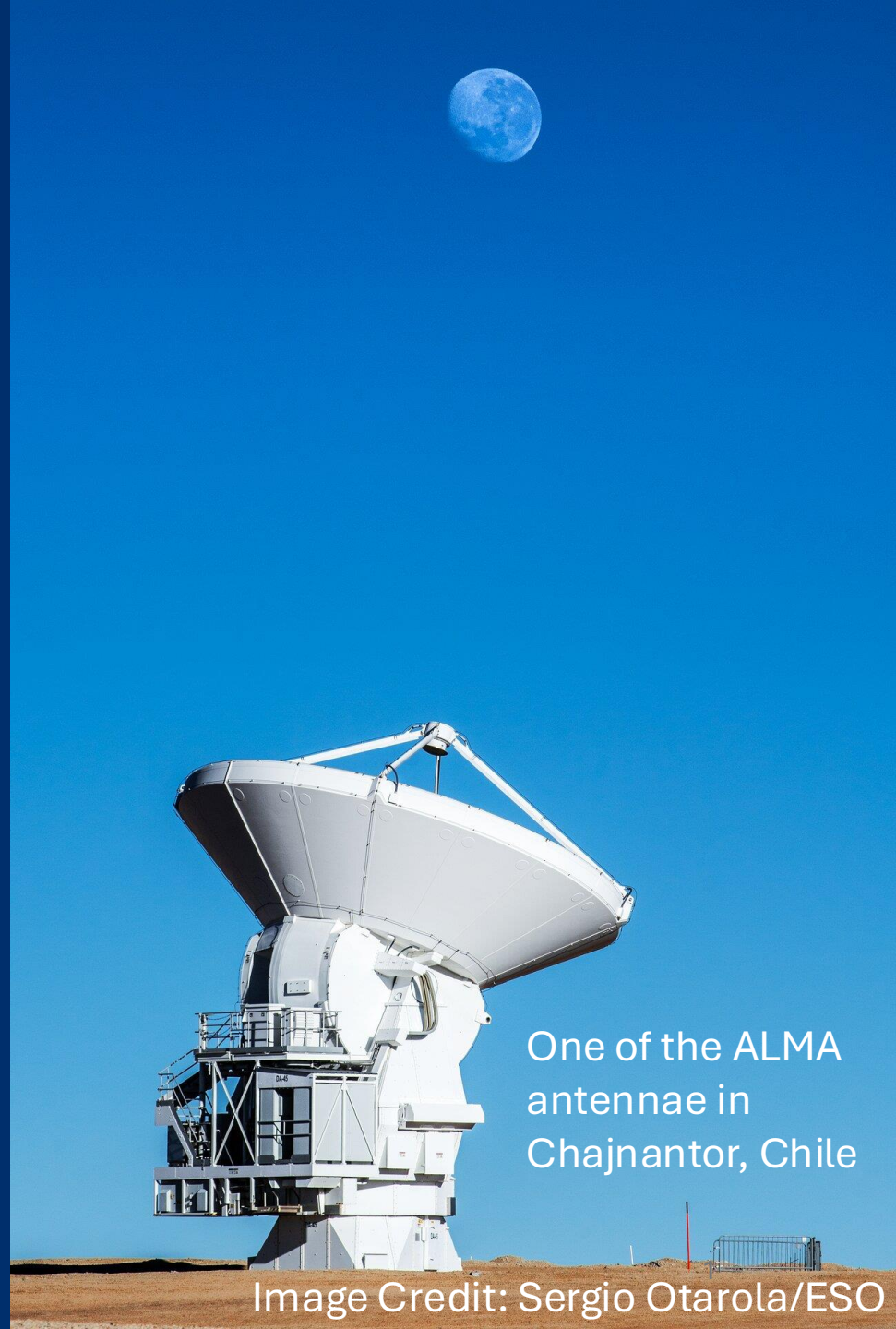

One of the ALMA antennae in Chajnantor, Chile

Image Credit: Sergio Otarola/ESO

# About Jet Systems

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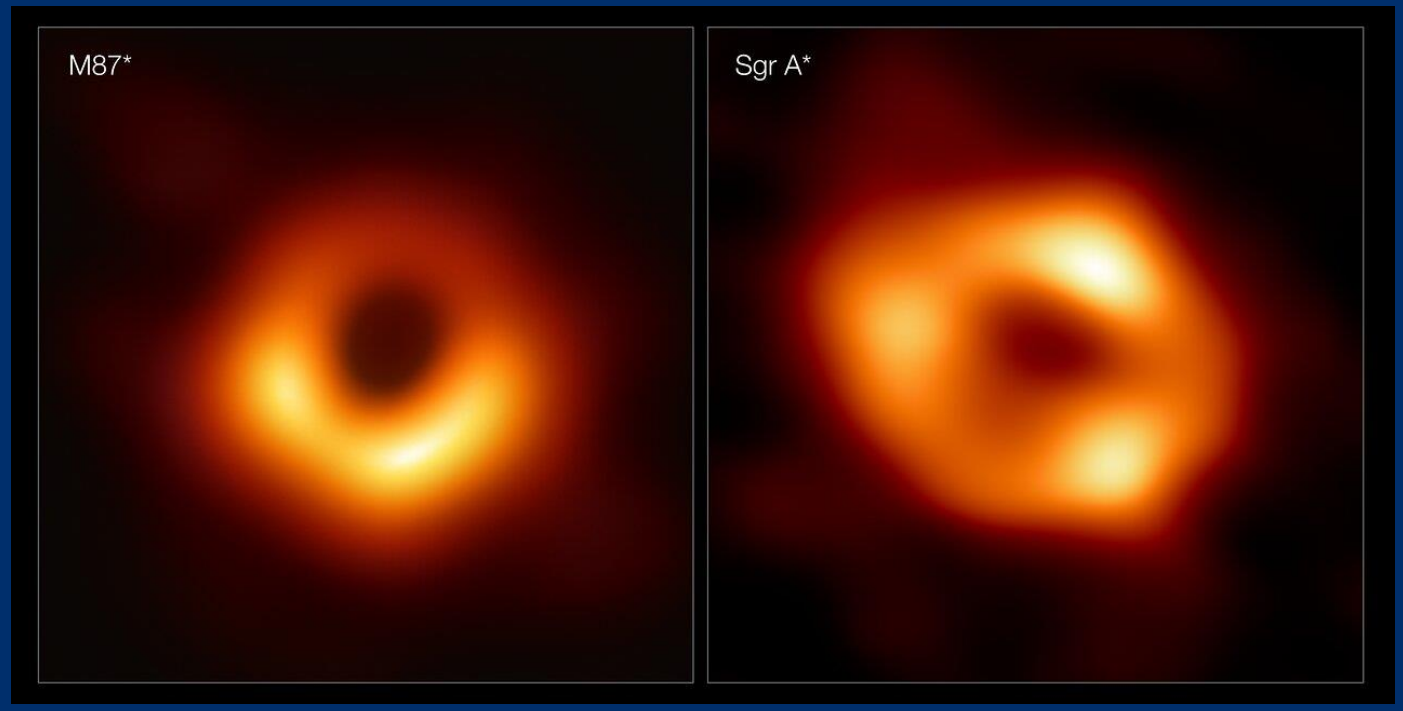
We know that

- Jets are powered by supermassive black holes (SMBHs)
- Jet systems radiate across the whole electromagnetic spectrum
- There are significant magnetic fields around SMBHs




The two resolved SMBHs at 230 GHz (ALMA Band 6)
Credits: Event Horizon Telescope Collaboration

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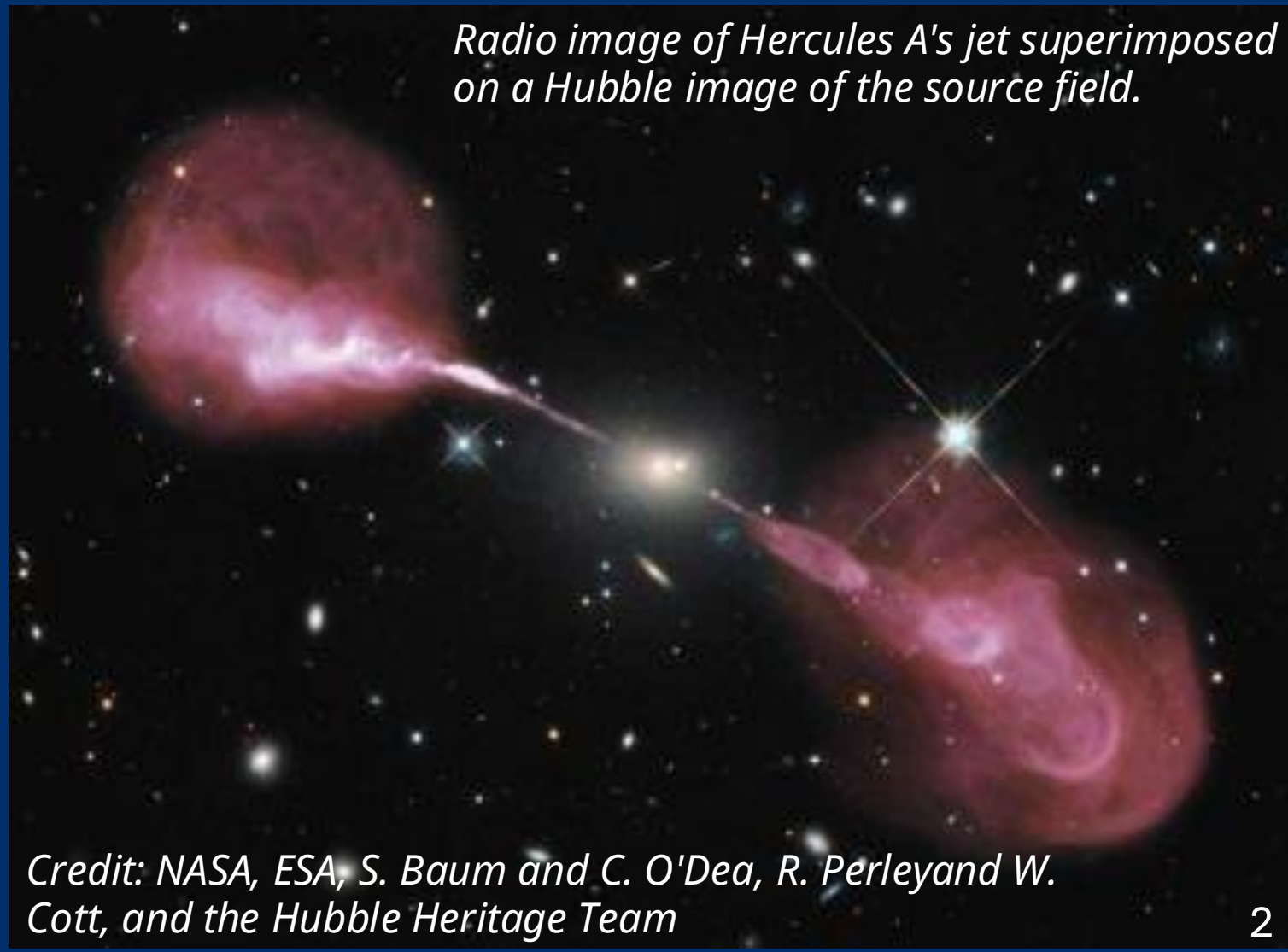

*Radio image of Hercules A's jet superimposed on a Hubble image of the source field.*

*Credit: NASA, ESA, S. Baum and C. O'Dea, R. Perleyand W. Cott, and the Hubble Heritage Team*

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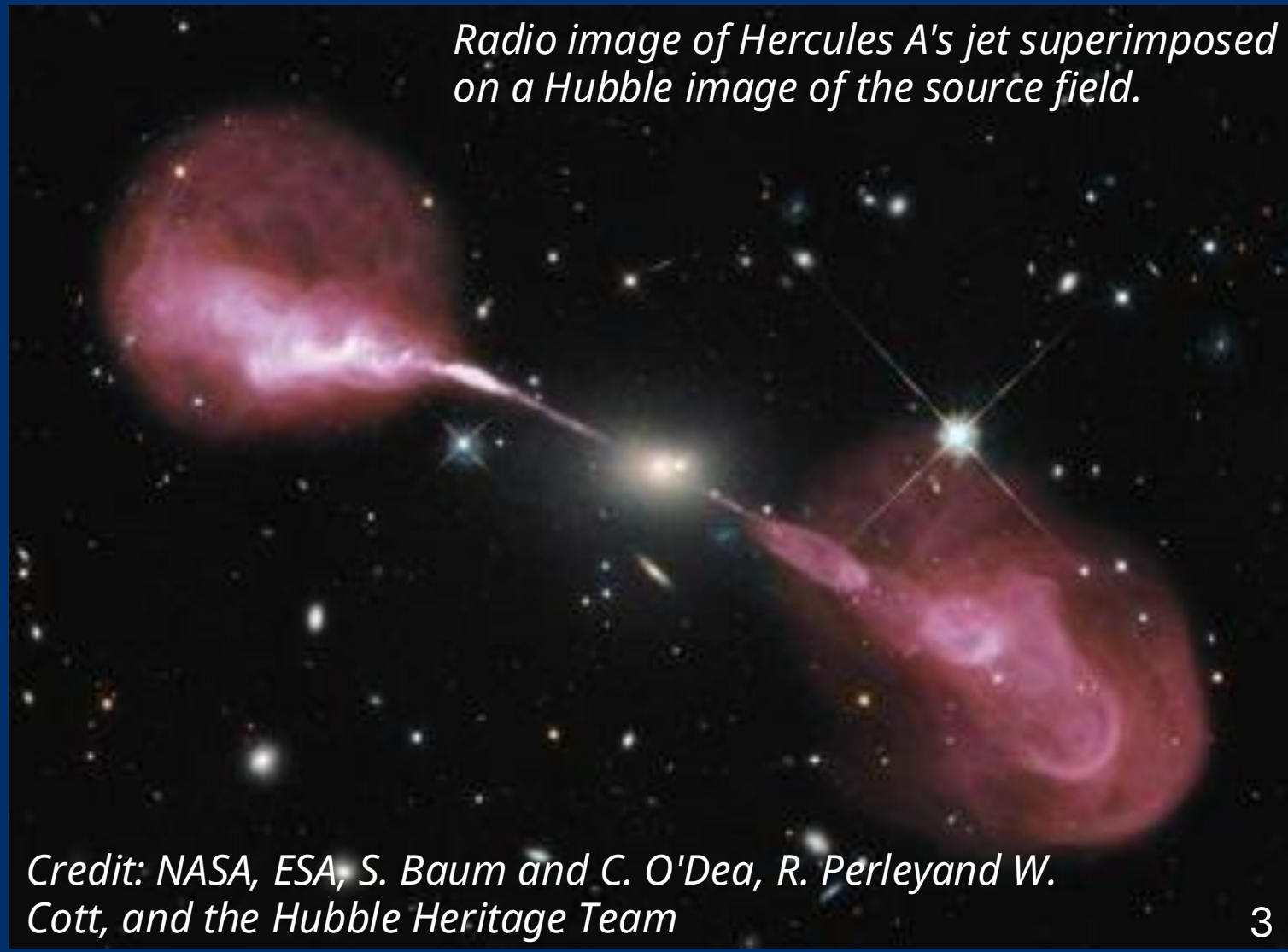
But we don't know

- How exactly the black holes launch the jets?
- Where does the extracted energy originate in the system?



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# Observations of Magnetic Fields

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- To study the region close to the jet base, we need high frequencies (> 100 GHz ; < 3 mm)
- We use Faraday Rotation Measure (RM) to estimate electron density (*n*) & magnetic field vector **B**:

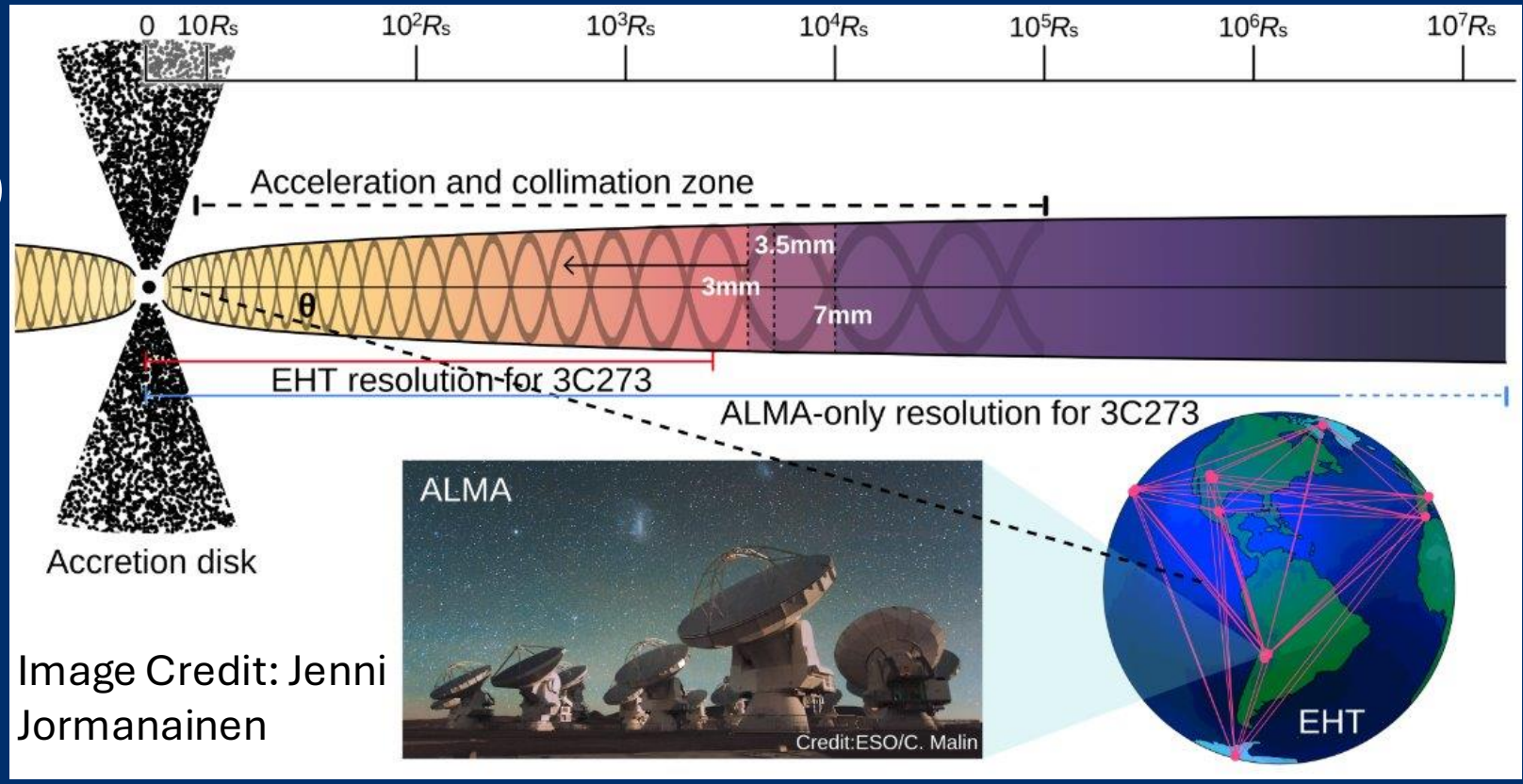


Image Credit: Jenni Jormanainen

*$R_s$ = Schwarzschild radius*
*EHT = Event Horizon Telescope*
*ALMA = Atacama Large Millimeter Array*

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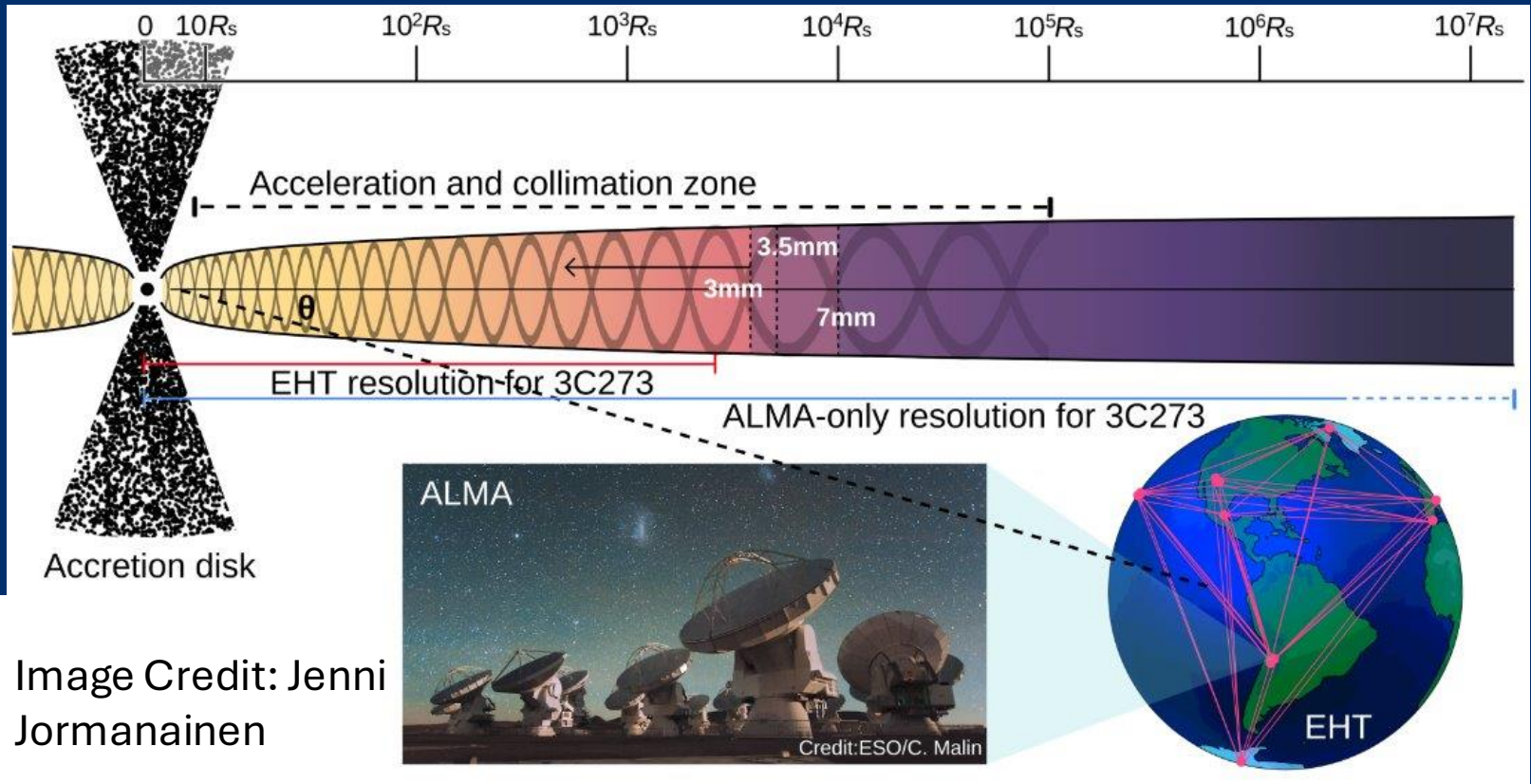
$$RM = \frac{e^3}{8\pi^2\epsilon_o m^2 c^3} \int n\mathbf{B} \cdot d\mathbf{l}$$

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# Faraday Rotation


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- Occurs if photons encounter a magnetized medium
- RM is observed with linear polarimetry

$$\mathrm{RM} = \frac{\Delta\chi}{\Delta\lambda^2}$$

$$\chi = \frac{1}{2}\arctan(U/Q)$$

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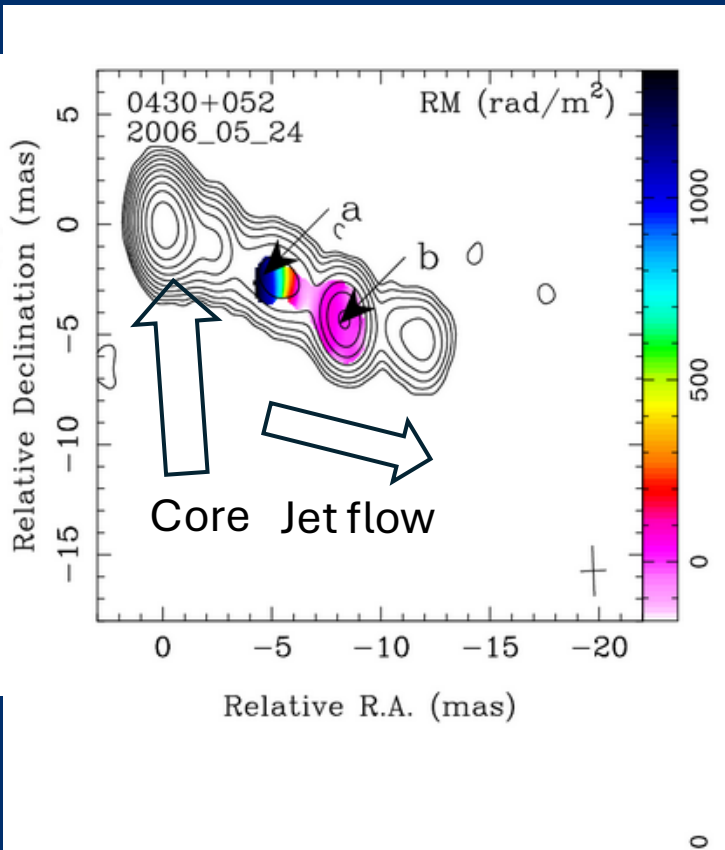
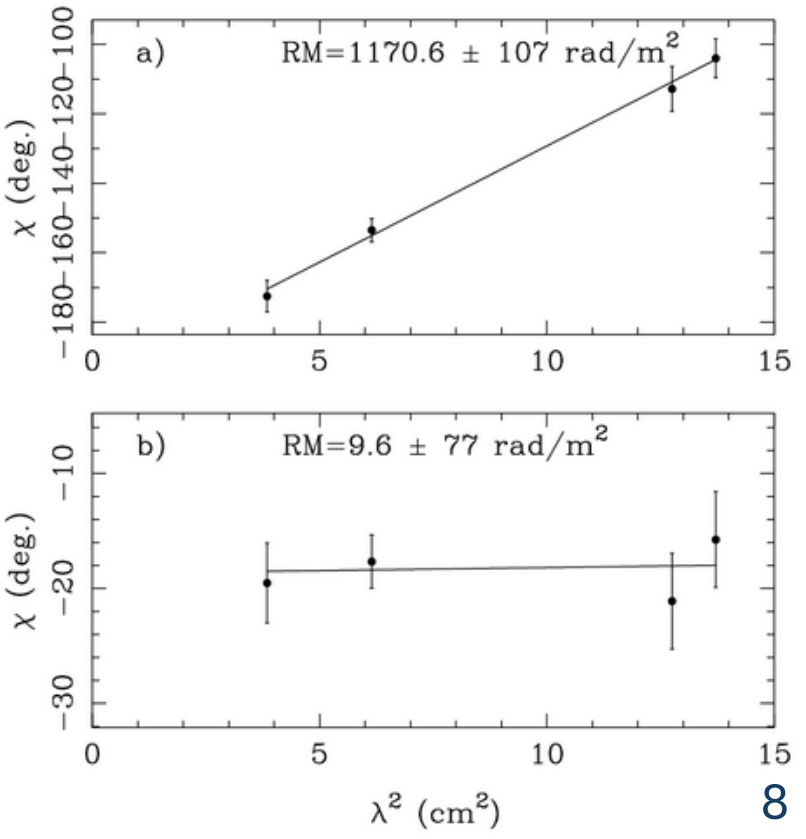
*Radio image and two Faraday rotation plots of 3C120 in four MOJAVE frequencies between 8 and 15 GHz (Hovatta et al. 2012)*

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# Data

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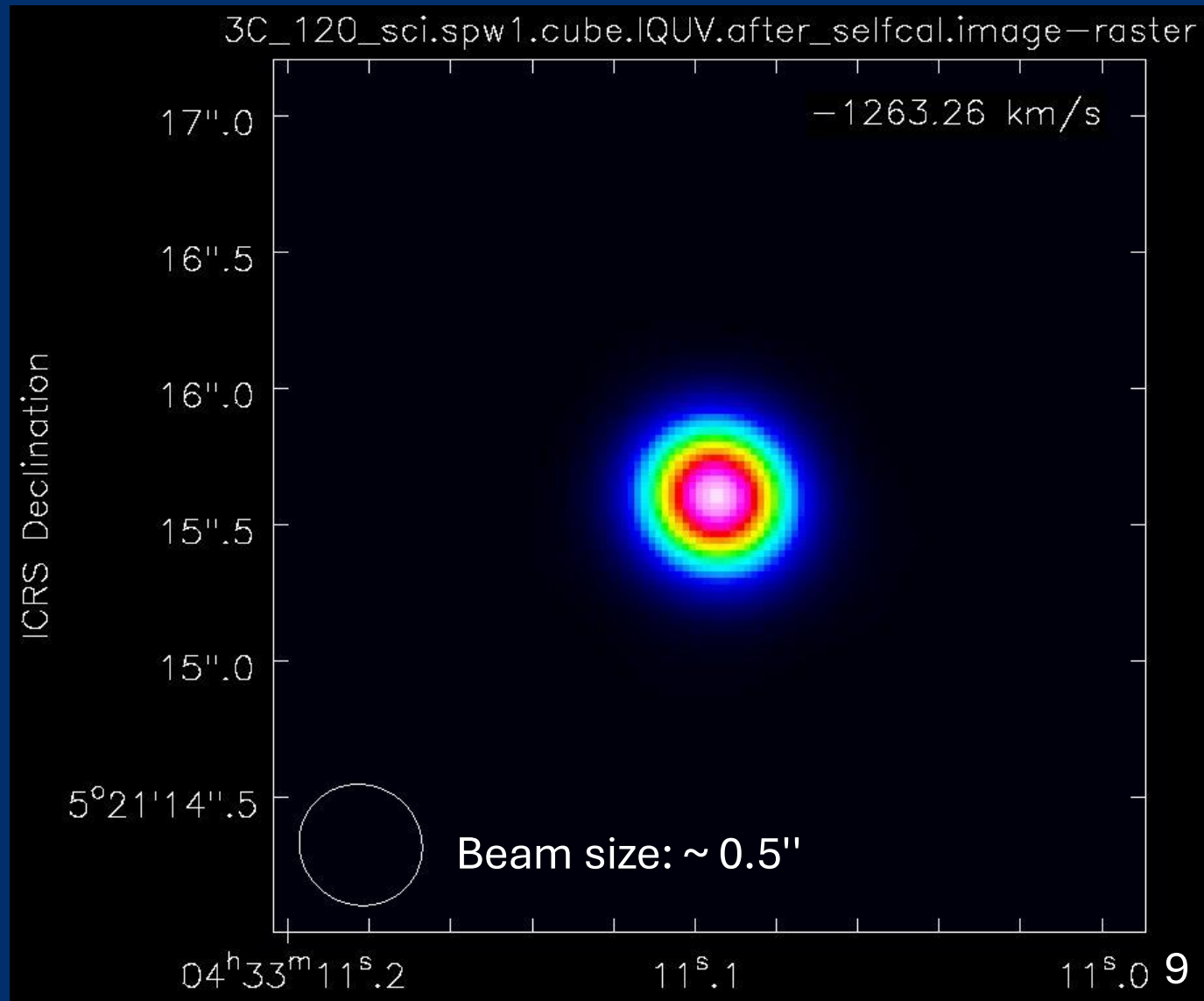
- In December 2024, I started analyzing ALMA data from proposal 2017.1.01425.S (PI: T. Savolainen)
- From the three science targets (3C120, 3C454.3, and CTA102), 3C120 turned out most interesting
- The fact that RM was high, was easy to spot but error propagation and perfecting calibration took months!

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# Results

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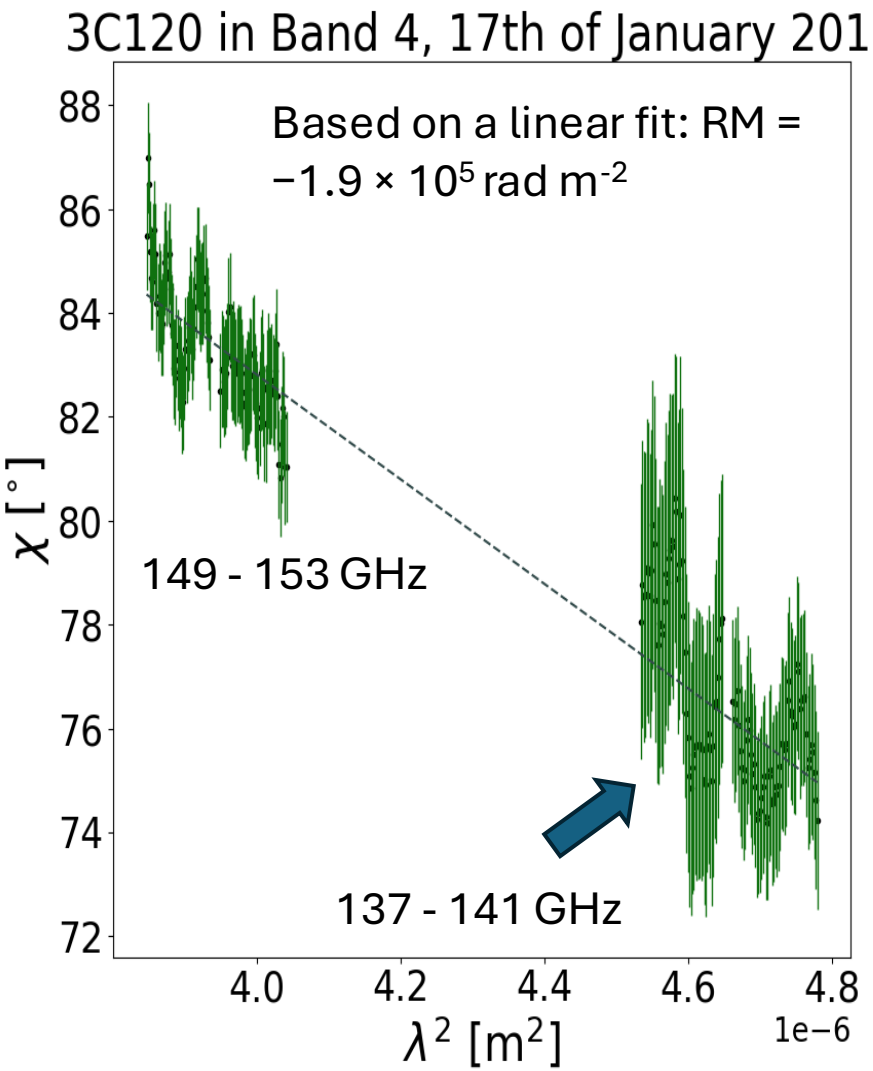
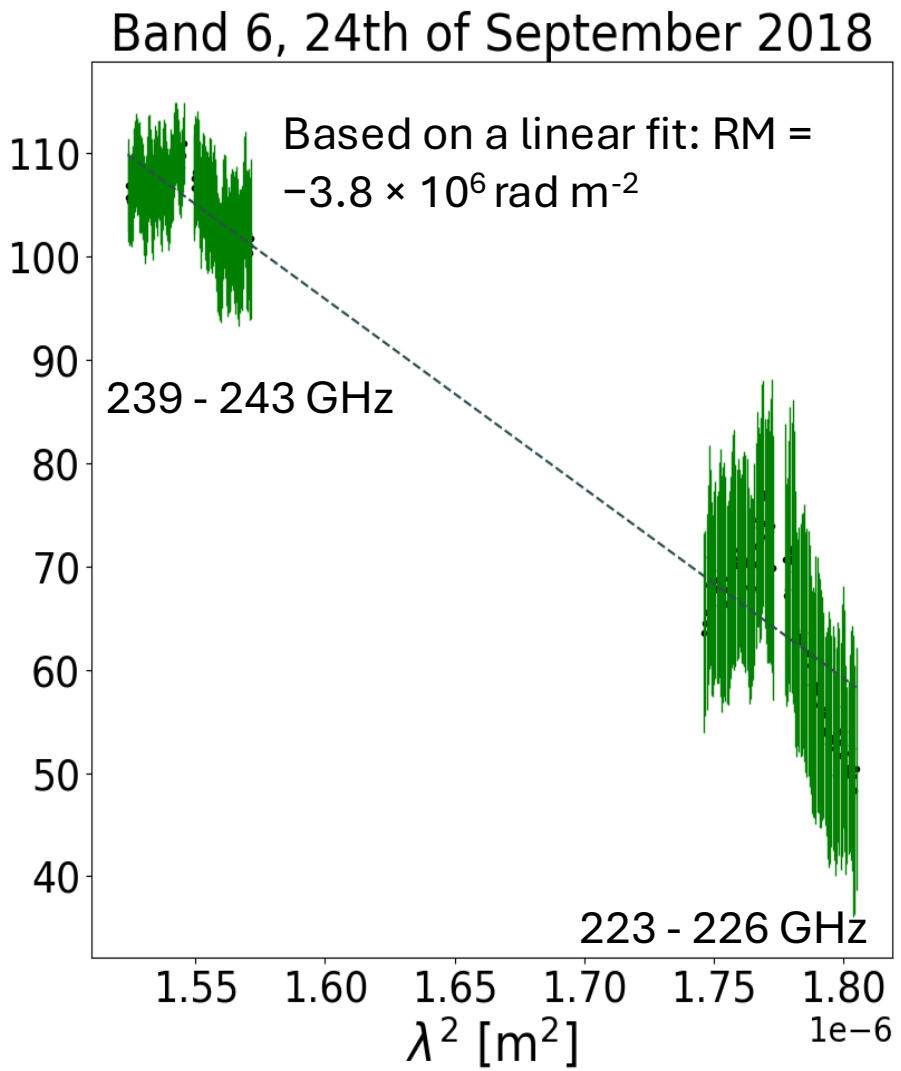
We detect high RMs in both Band 4 & 6 !

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# Results

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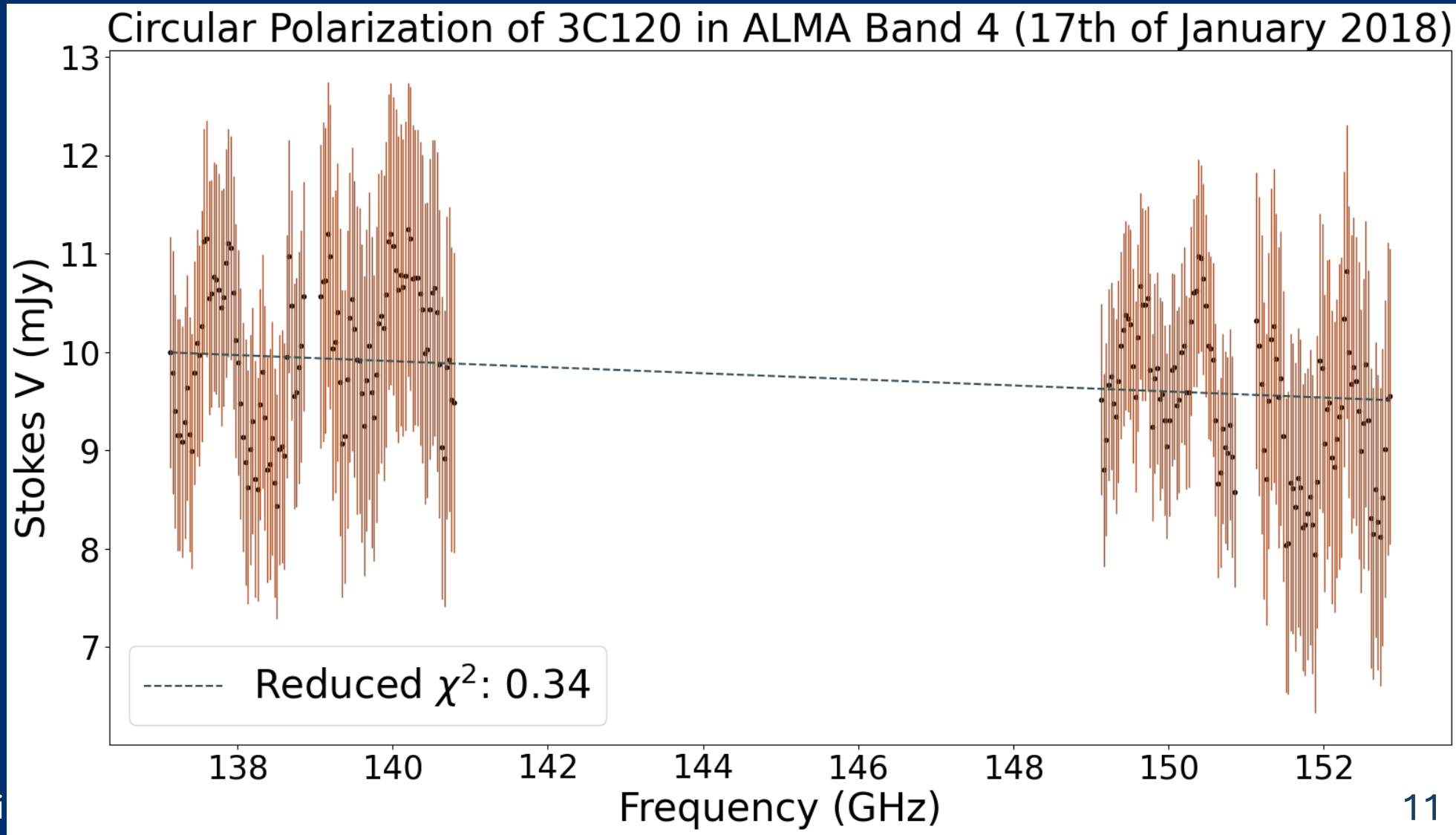
We detect significant circular polarization (0.4 %) in Band 4 !

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# Discussion

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ALMA observed the two bands 8 months apart but they should have observed them within a week :(


*Total intensity light curve of 3C120 at 37 & 43 GHz. Adapted from Kankkunen et al. 2025*

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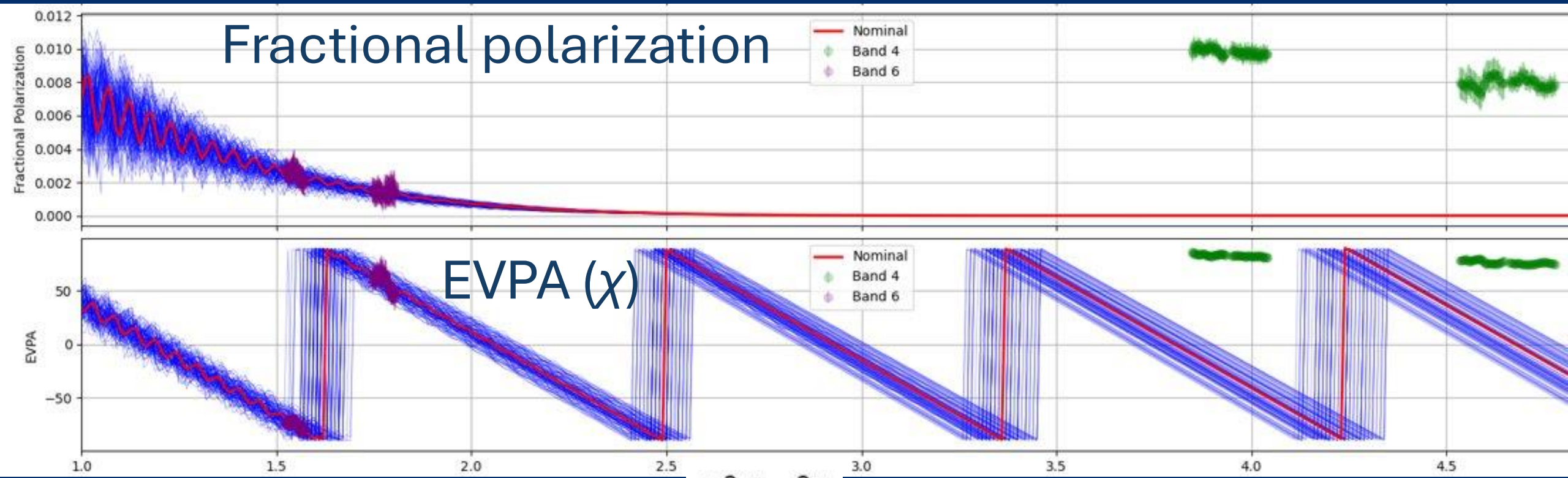
# Discussion

... but it's possible to rule the presence of a distant Faraday screen as a distant screen cannot cause changes in polarization we see below!



# Discussion

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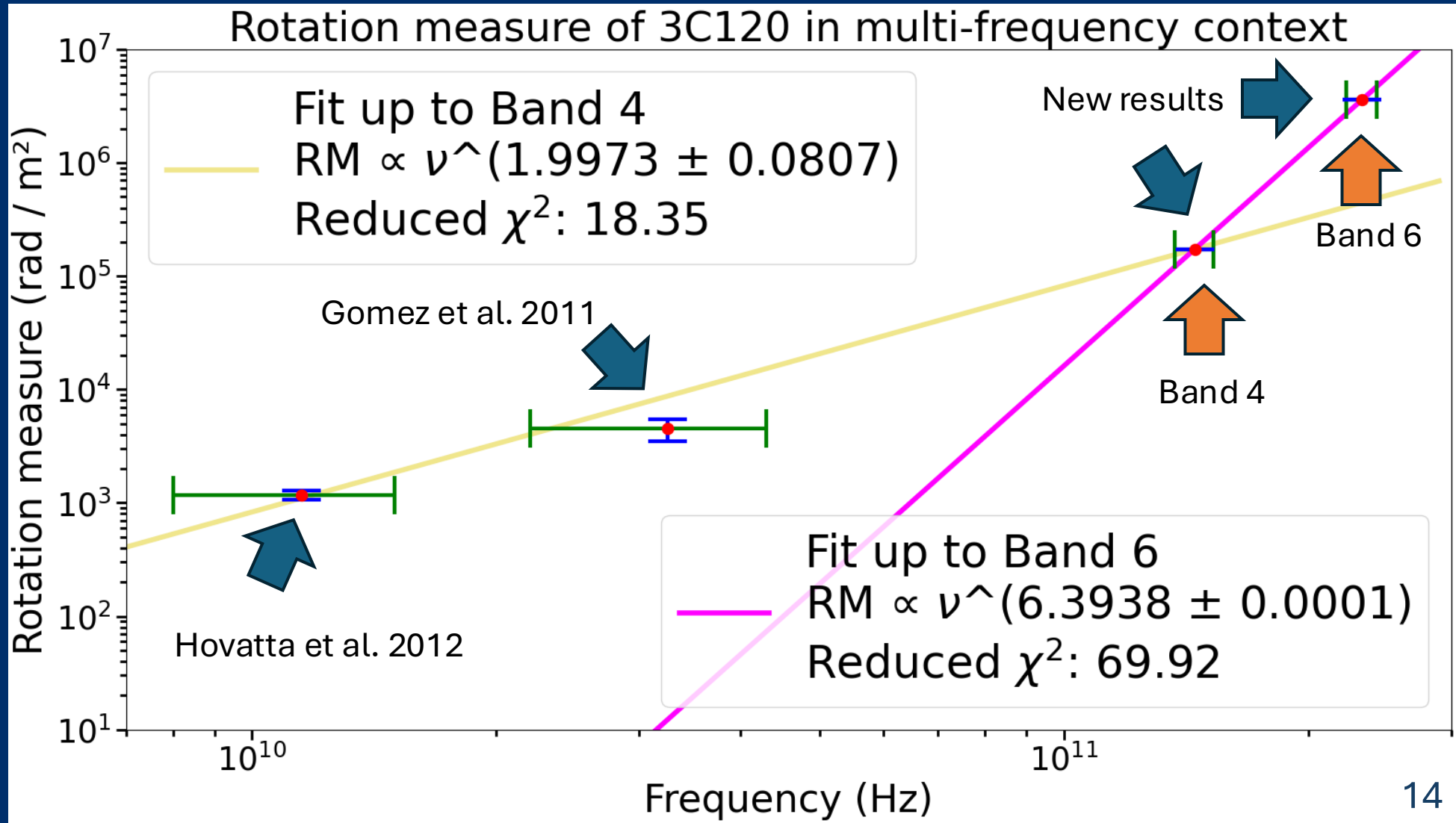
It's interesting that the common frequency relation between RM and frequency breaks after Band 4!

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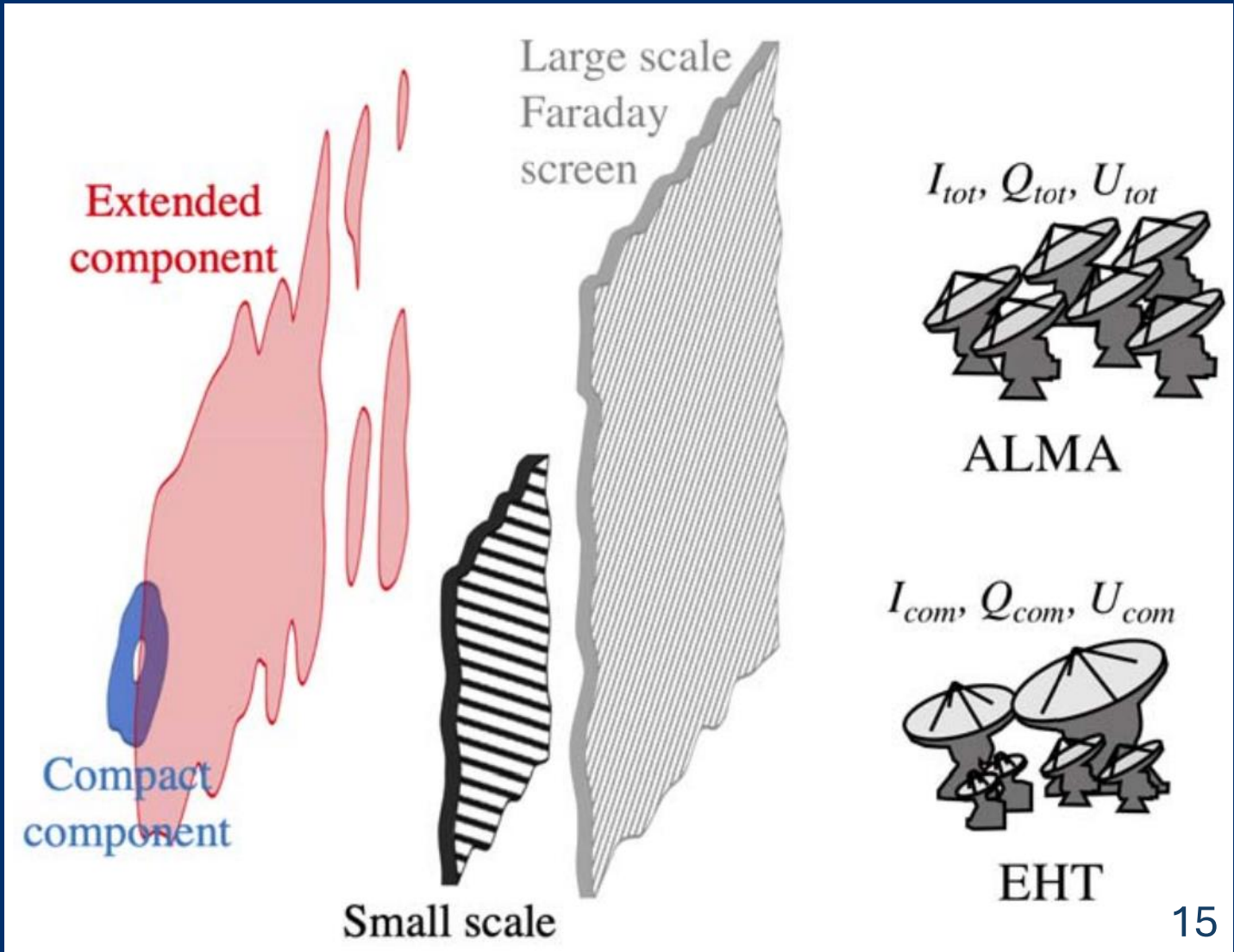
# Take home messages

- The paper will be submitted in the coming weeks!

The number of components in 3C120 is still open

No distant Faraday screen present but maybe there is a sheath?

*Illustration adapted from Goddi et al. 2021*

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# Take home messages

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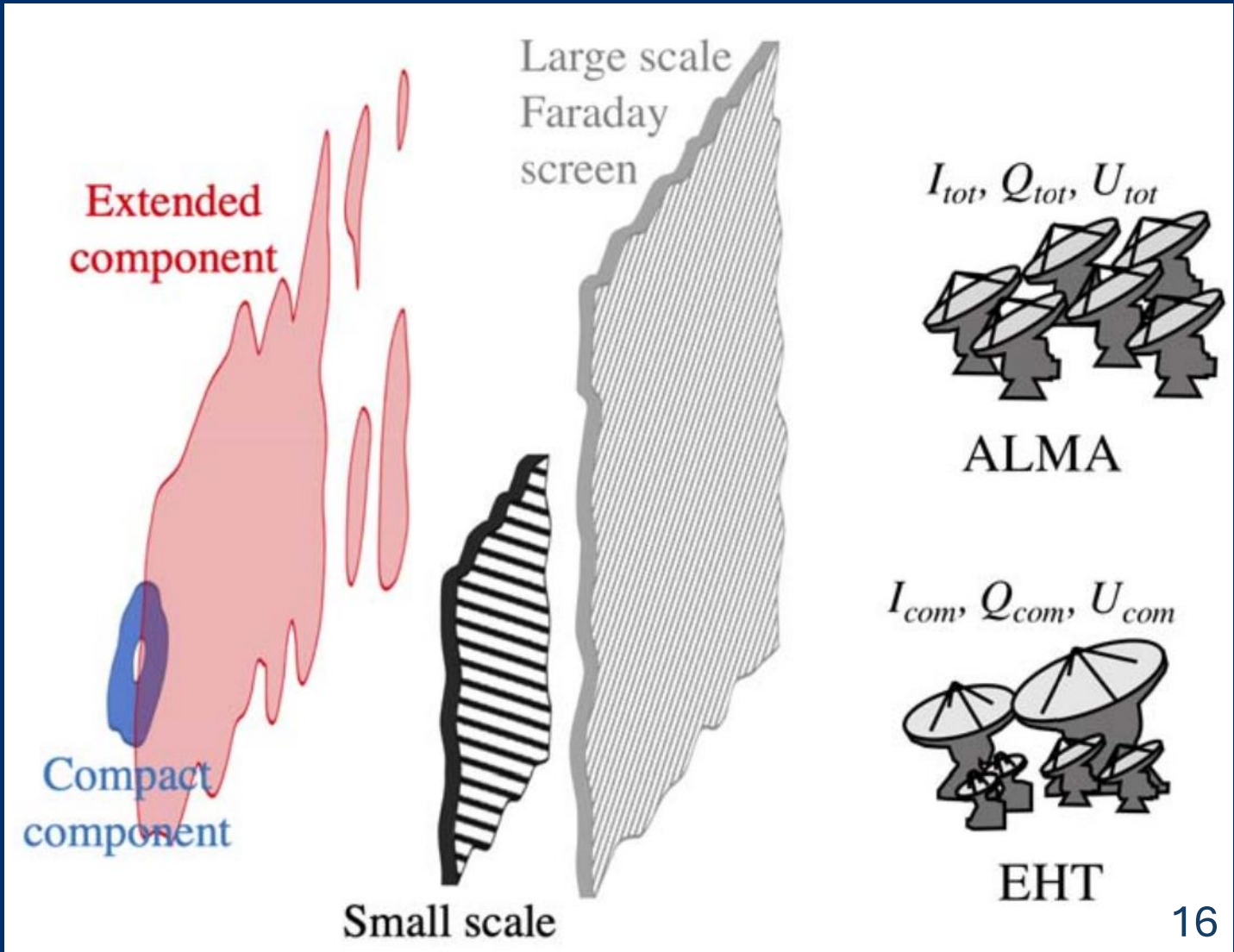
- The paper will be submitted in the coming weeks!
- Near-simultaneous observations of multiple frequency bands or VLBI (i.e. GMVA or EHT) would help to further constrain the depolarization mechanism
- I'll continue with other work related to polarization observations with ALMA, stay tuned!

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# Kiitos!

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