

UNANTICIPATED JETS

from the MeerKAT
Galaxy Cluster Legacy Survey

L. Rudnick, University of Minnesota

with support from US. NSF AST17-14205

MCGLS Collaboration:

Including Kenda Knowles, Bill Cotton, Fernando Camillo

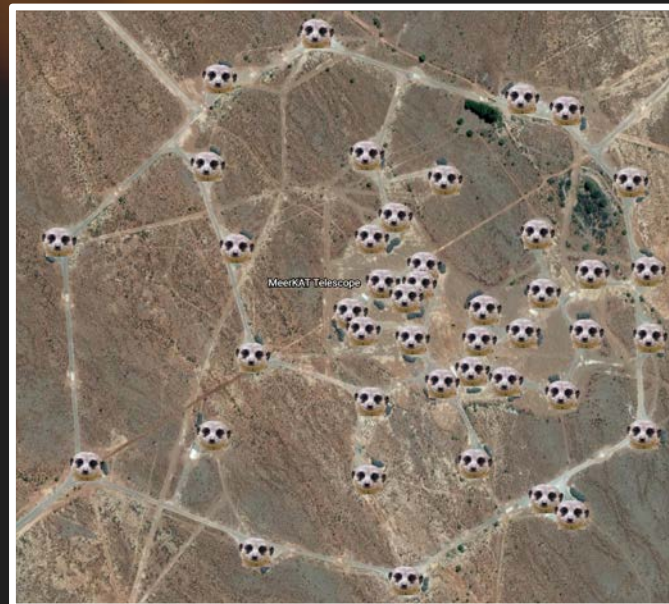


MeerKAT : SKA precursor

Karoo, Northern Cape, SA



- 64 dishes @13.5m
- 8 km full array
- 1 km dense core



Galaxy Cluster Legacy Survey

115 targets, radio & X-ray selected

L-band (900-1670 MHz), 6 – 10 h

4-7 $\mu\text{Jy}/\text{bm}$ rms

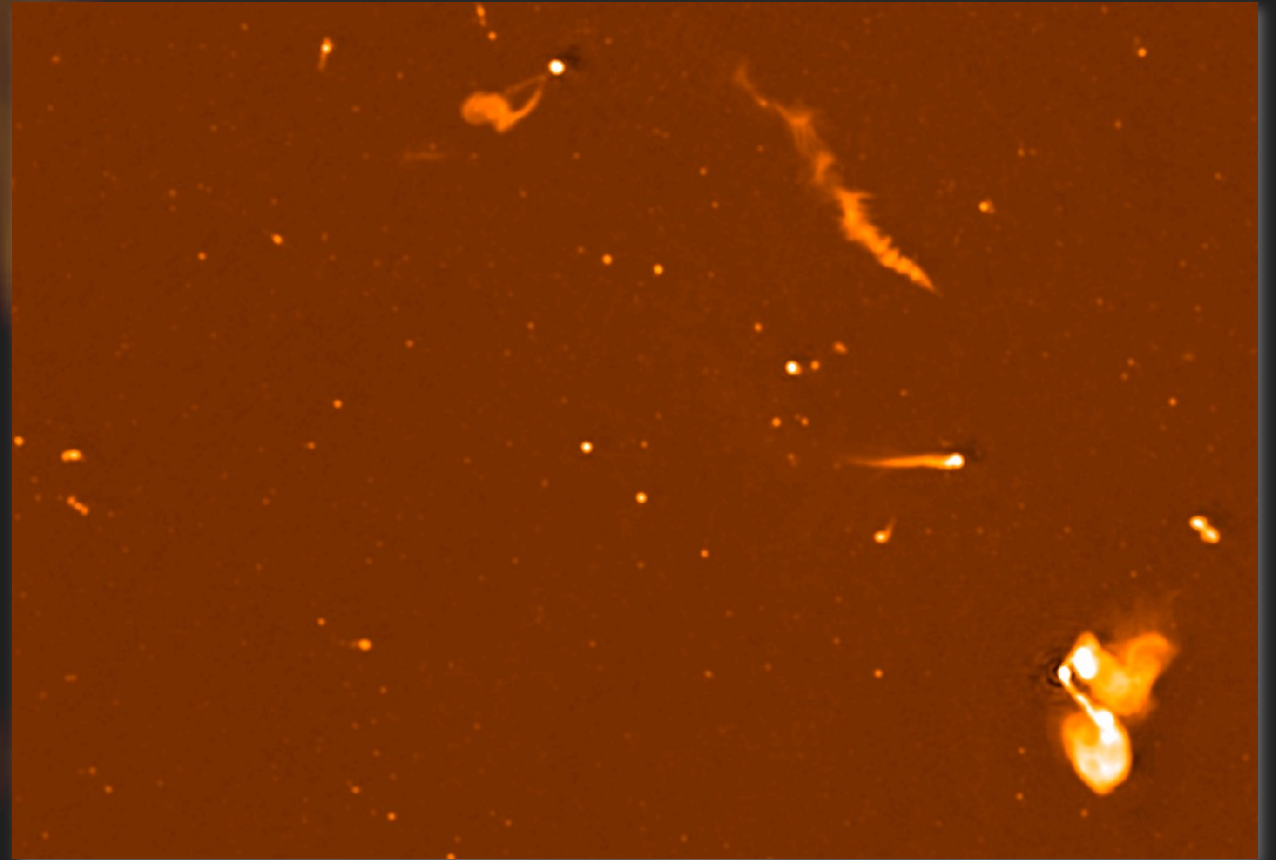
8" \rightarrow 10' sensitivity

in-band spectral index

polarization

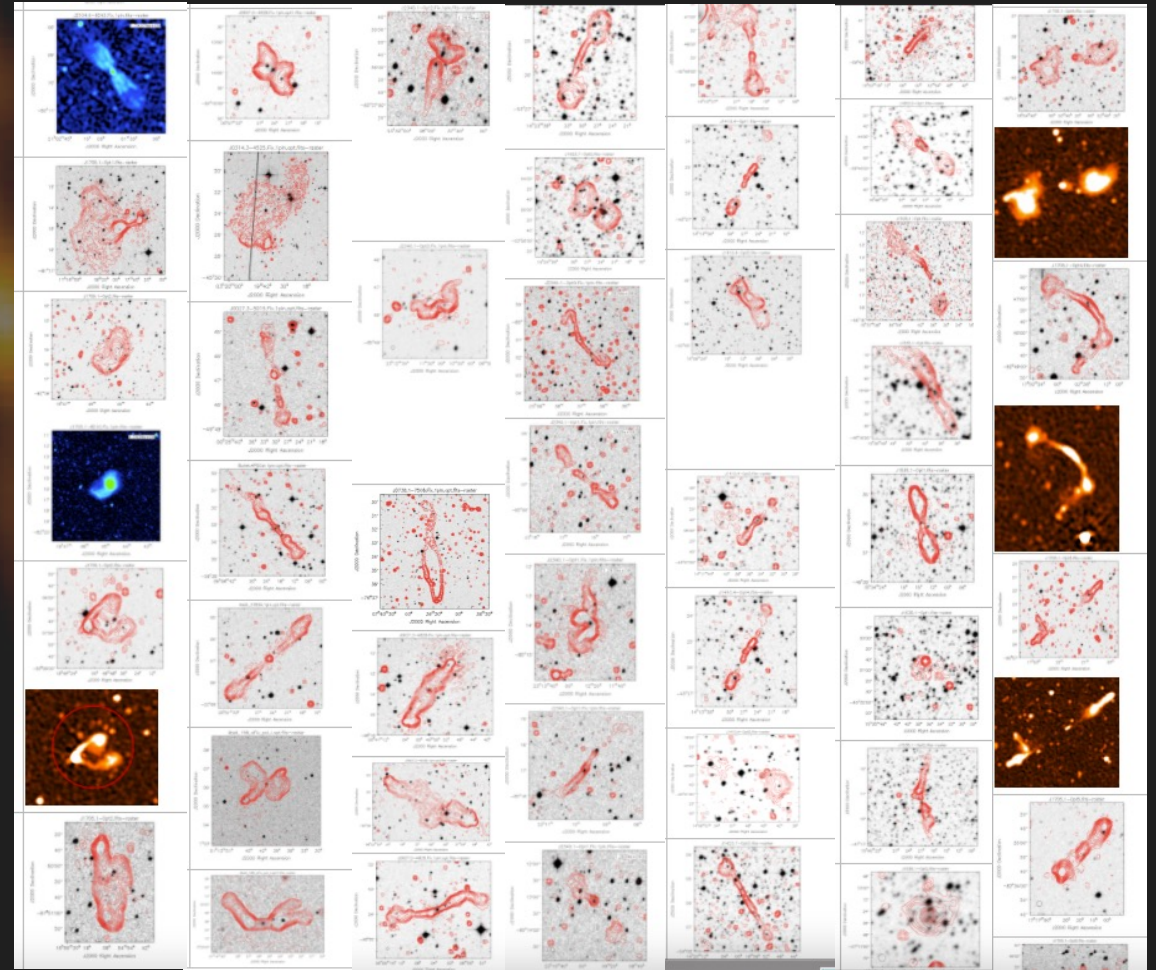
2° x 2° full field

1° x 1° primary beam corrected

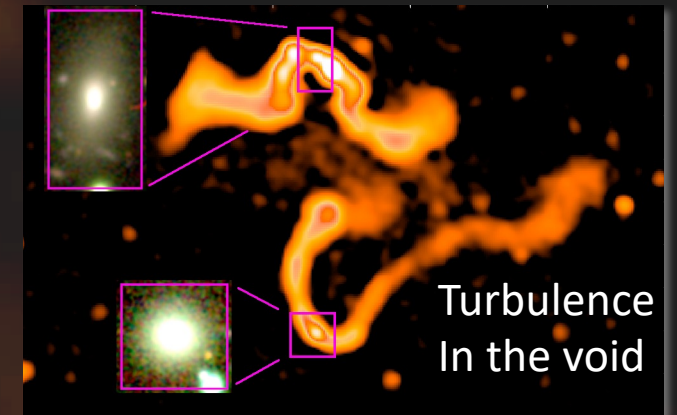
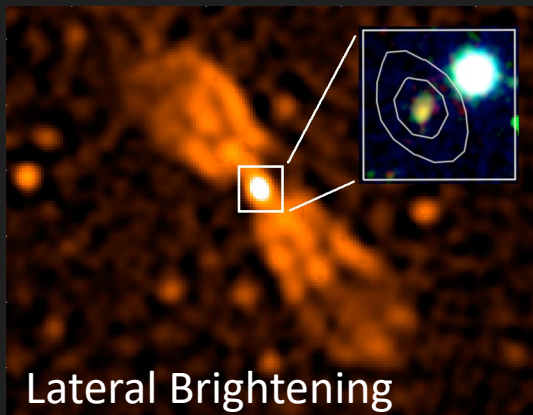
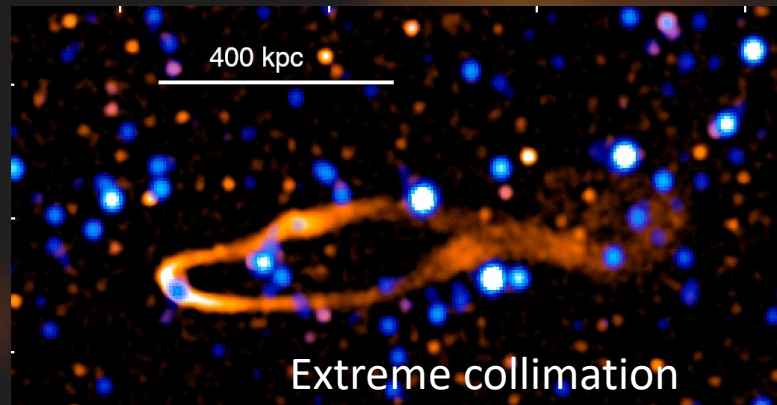
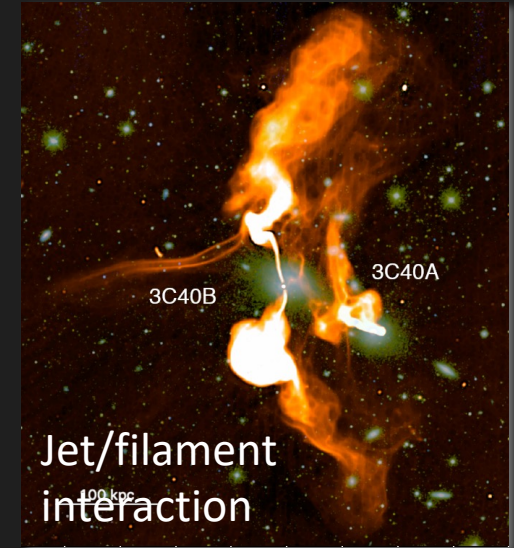
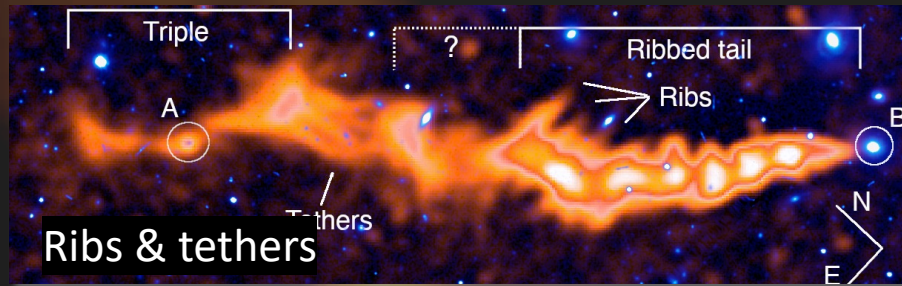


Hundreds of potentially interesting sources

- Special shout out to spotters
 - Nadeem Ozeer
 - SRAO
 - Konstantinos Kolokythos
 - North-West Univ., SA
- And stimulating chats with
 - Chris Nolting, Tom W. Jones, Chika Onubogu, Avery Garon, Alex Reineck, Tanzid Sultan, Tiziana Venturi, Viral Parekh, Tracy Clarke



selected UNANTICIPATED JETS

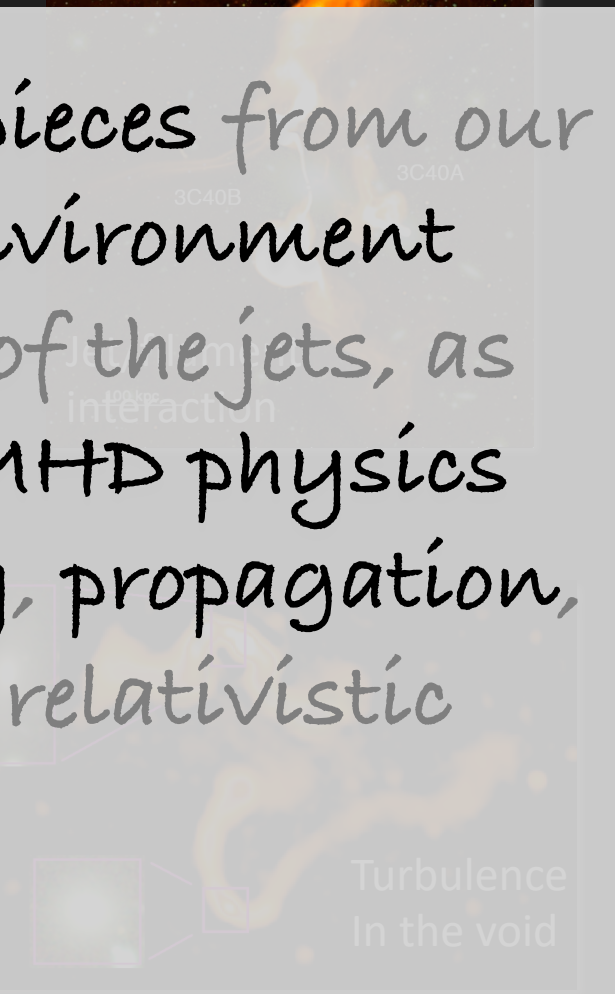
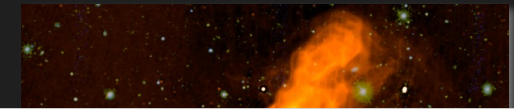


selected UNANTICIPATED JETS

What are we missing?



There are missing pieces from our knowledge of the environment and physical state of the jets, as well as their basic MHD physics including stability, propagation, and acceleration of relativistic particles.



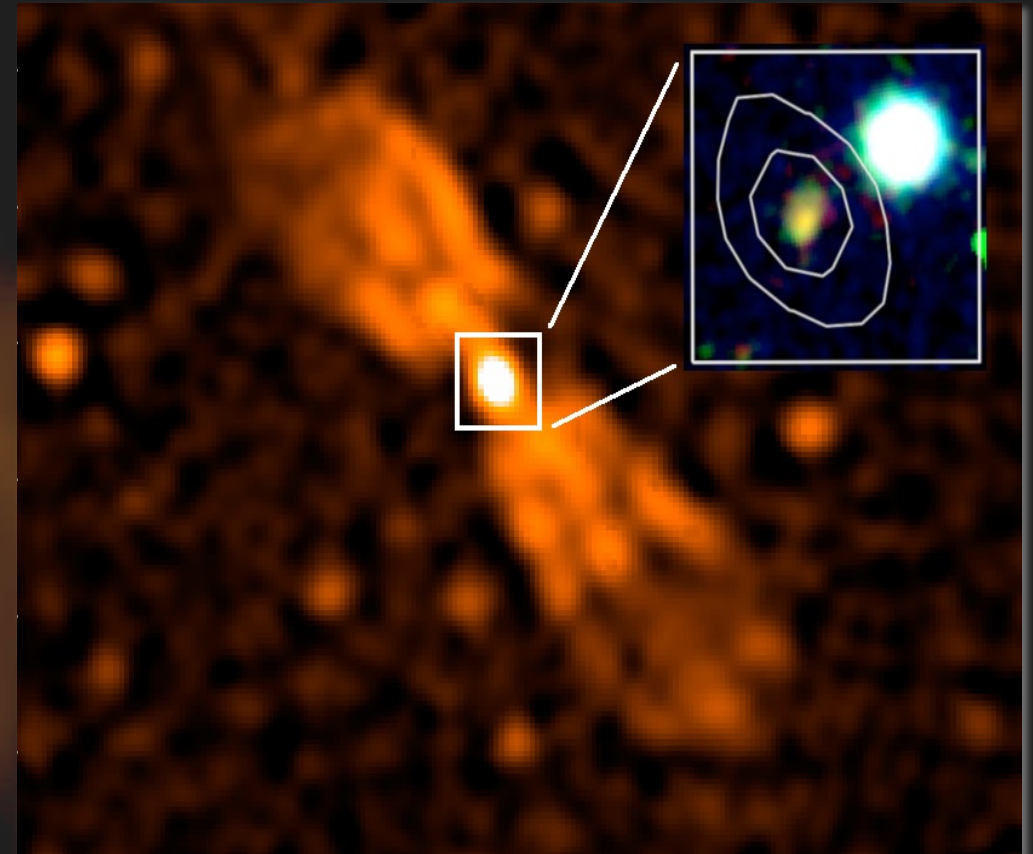
selected UNANTICIPATED JETS: Lateral Brightening



- 4.5' long, no redshift
- Edge brightened lobes
- Jets at origin, edges develop
- Jets and edges fade together



- **How make bright edges?**
- **Outflow? Backflow?**
- **Jets fade, but if backflow, lobes brighter at end**
- **Surrounding magnetic fields? But why jet & lobes together?**



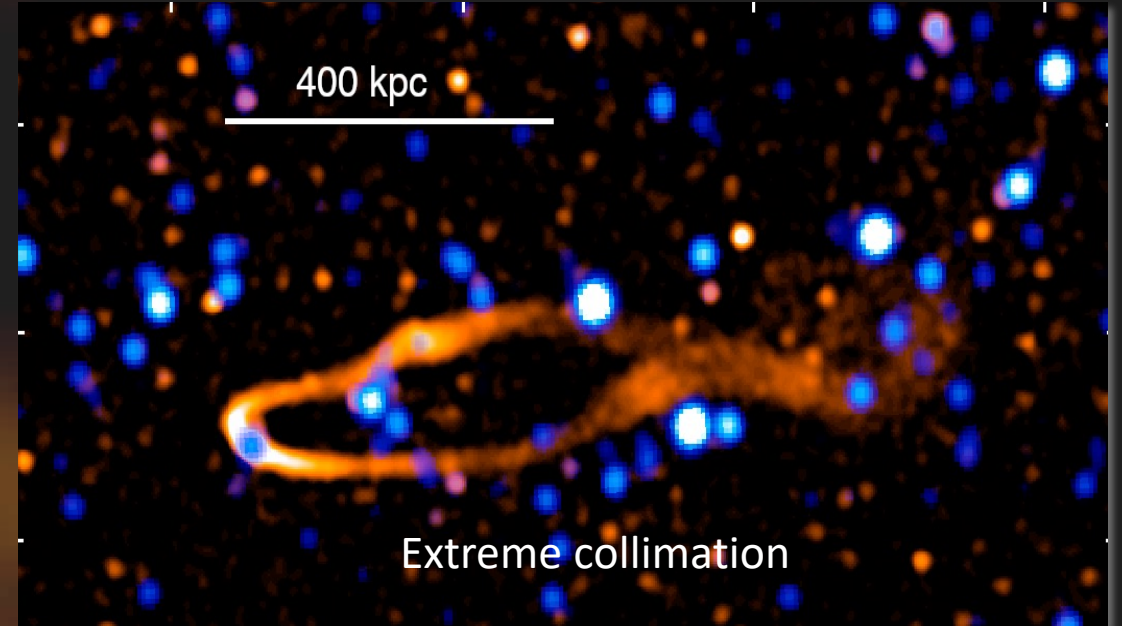
selected UNANTICIPATED JETS: Extraordinary Collimation



- Narrow for 400 kpc,
>10x bending radius



- How avoid flapping,
mixing?
- Projection makes it
worse



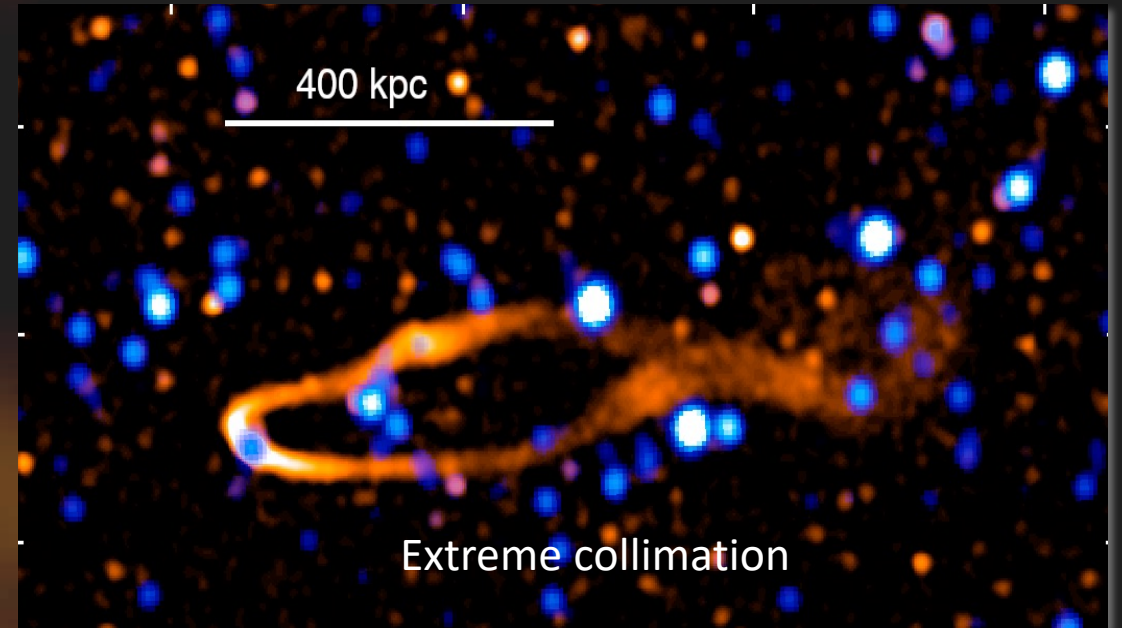
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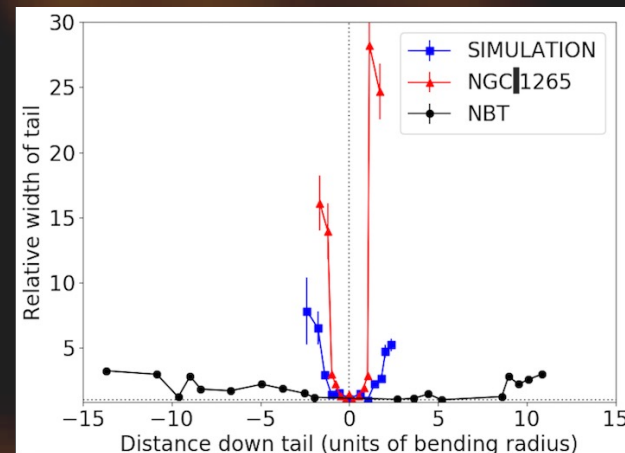
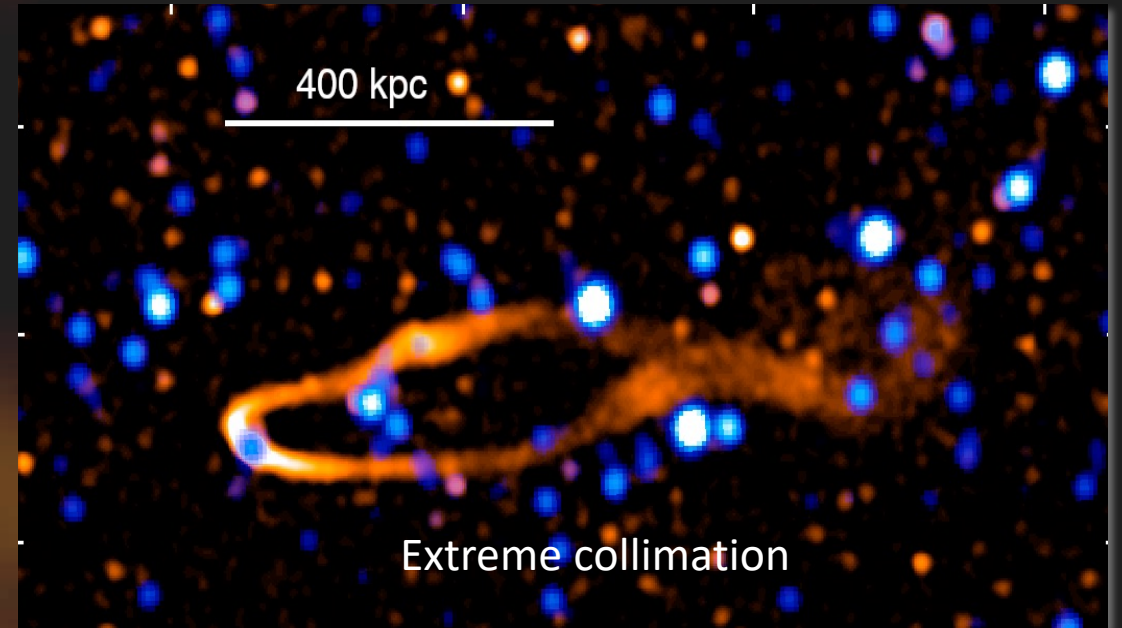
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NGC 1265

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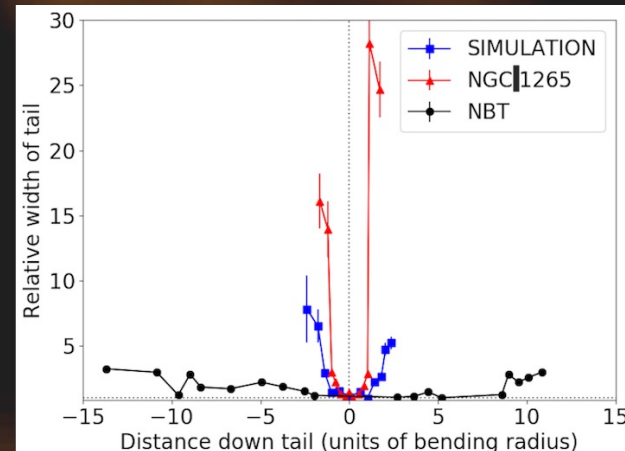
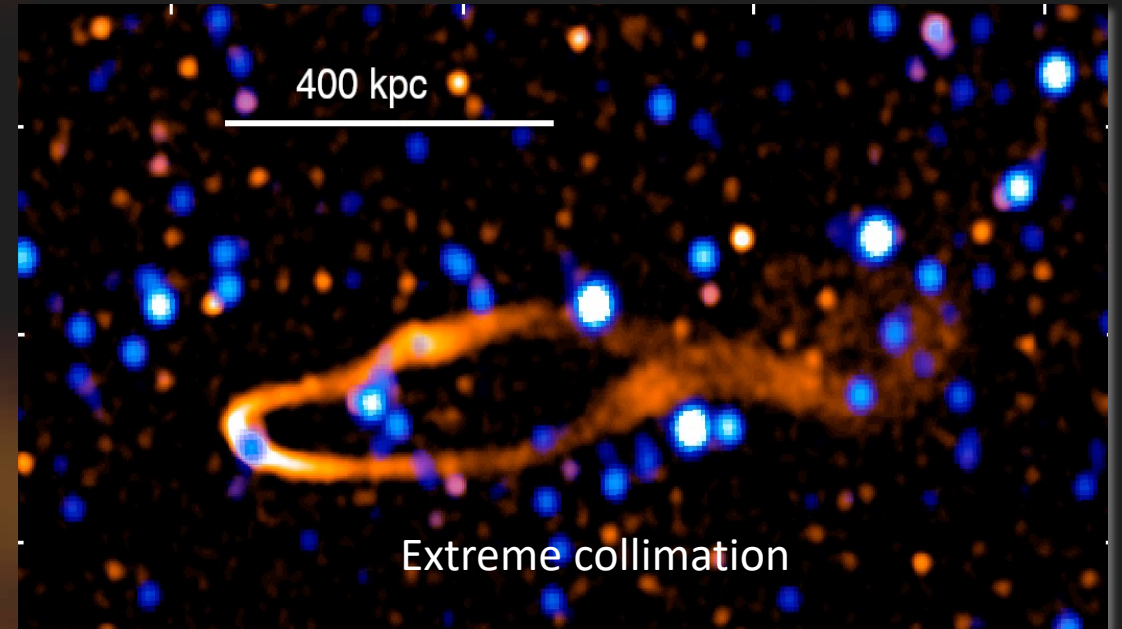
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Simulation:
Brian O'Neill
T.W. Jones, C. Nolting
P. Mendygral
[2019ApJ...884...120](#)

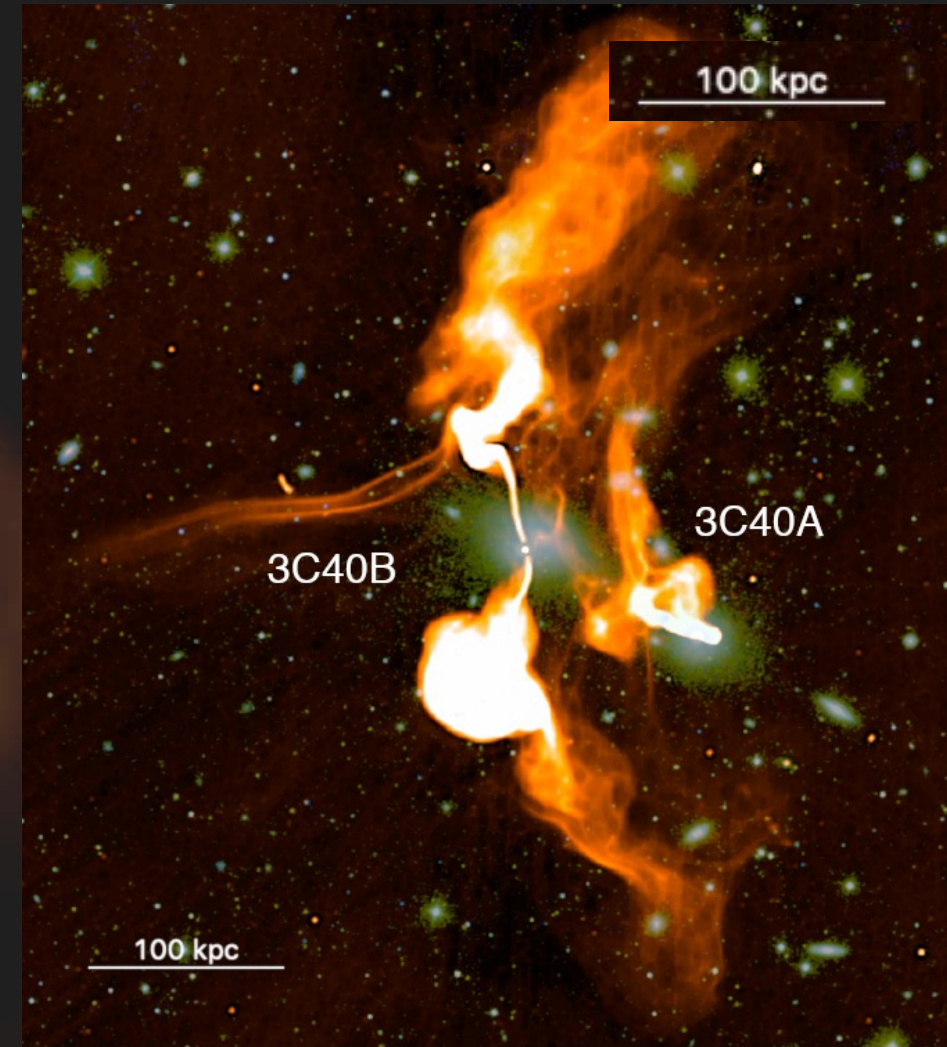


selected UNANTICIPATED JETS: Jet/Filament Interaction

- Filament “draped” over bend in jet
- Spectral index steeper and steepening away from jet – same shape!
- RM discontinuity
- Compact X-ray patch!



- ICM magnetic filaments?
- Distorted/stretched by jet?
- Electrons from jet?
- Reacceleration?



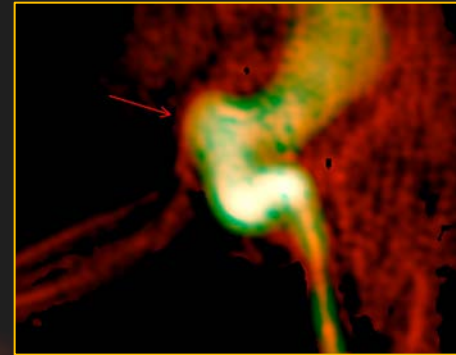
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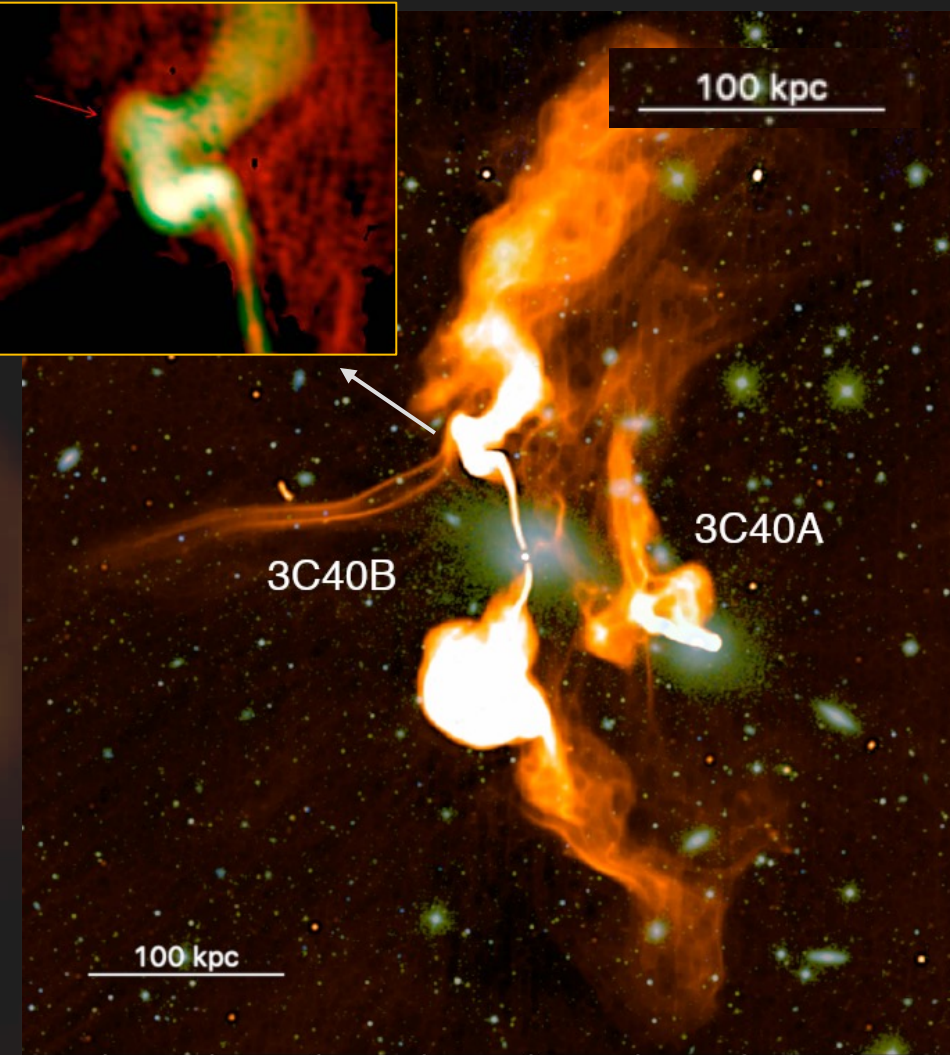


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Spectral index
Red = Steep



Compact
X-rays!



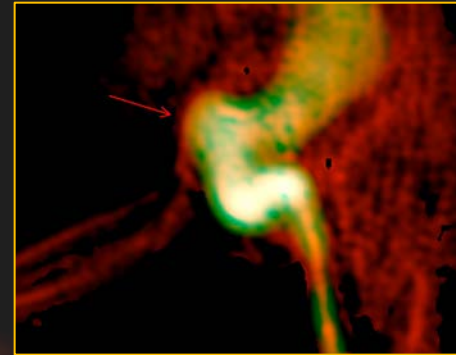
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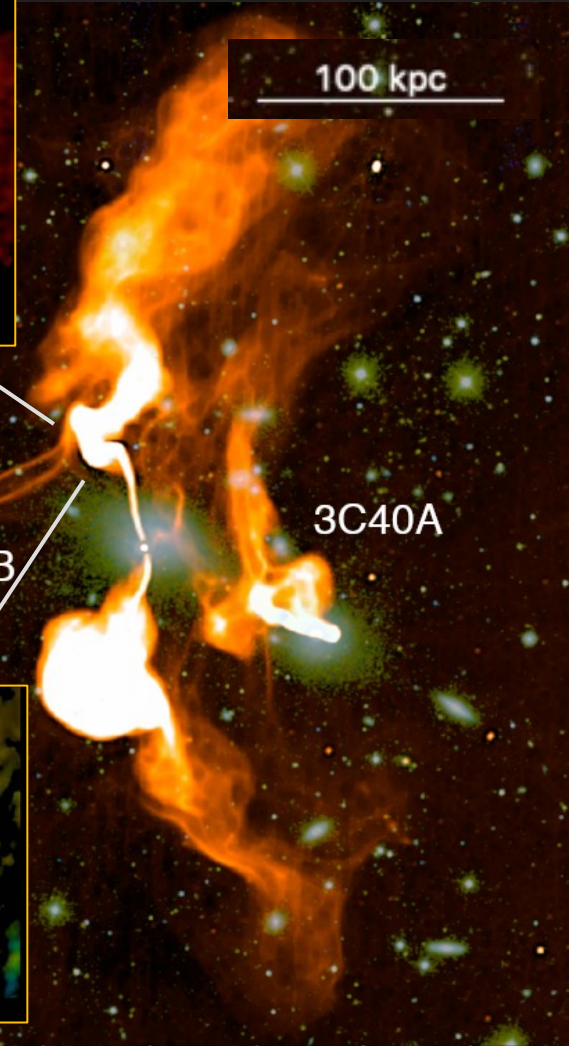
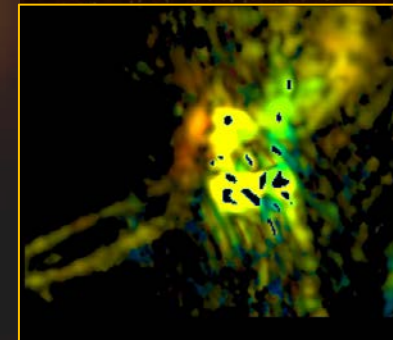


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Spectral index
Red = Steep



Rotation measure
Jump by 50 rad/m²

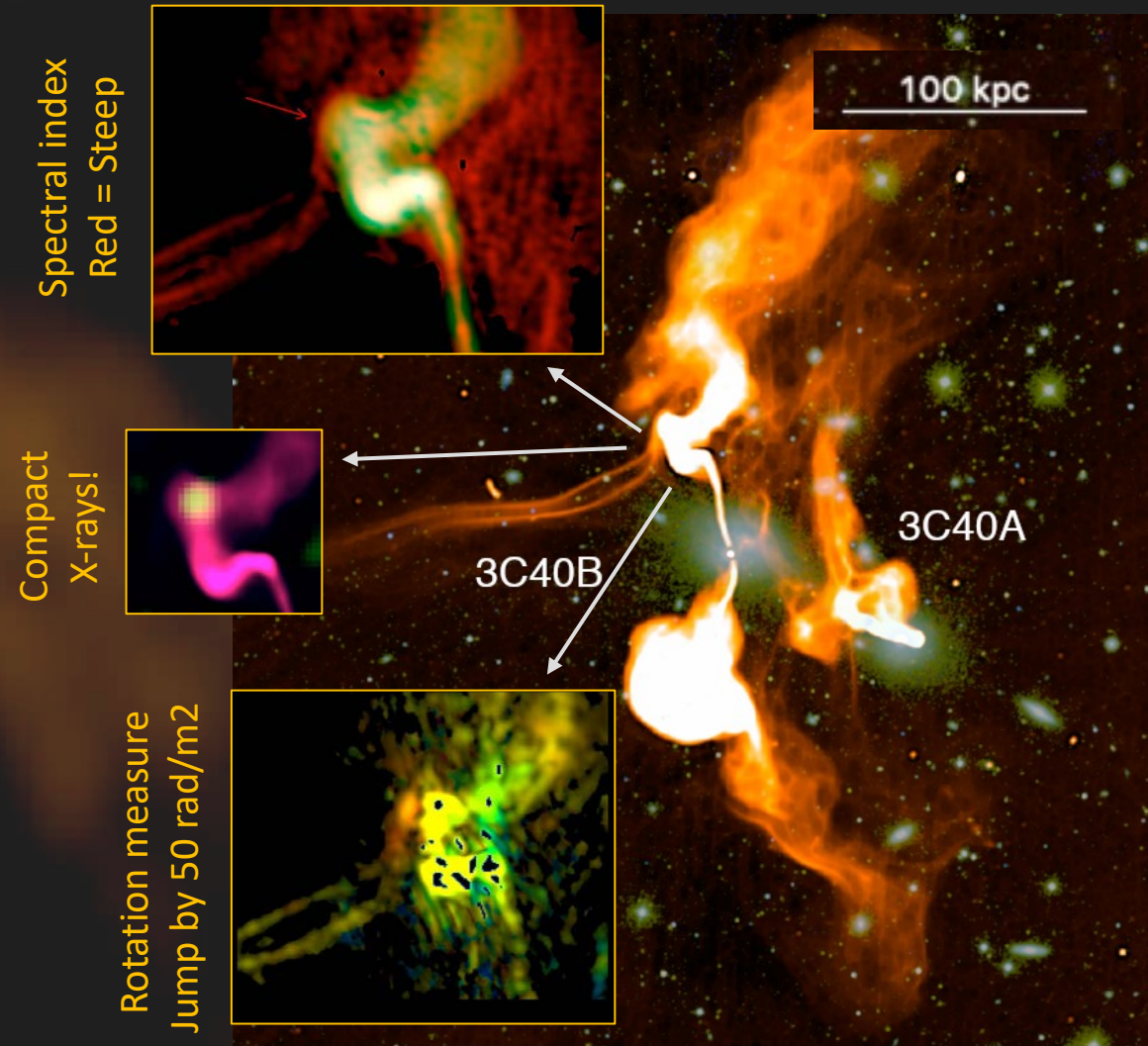


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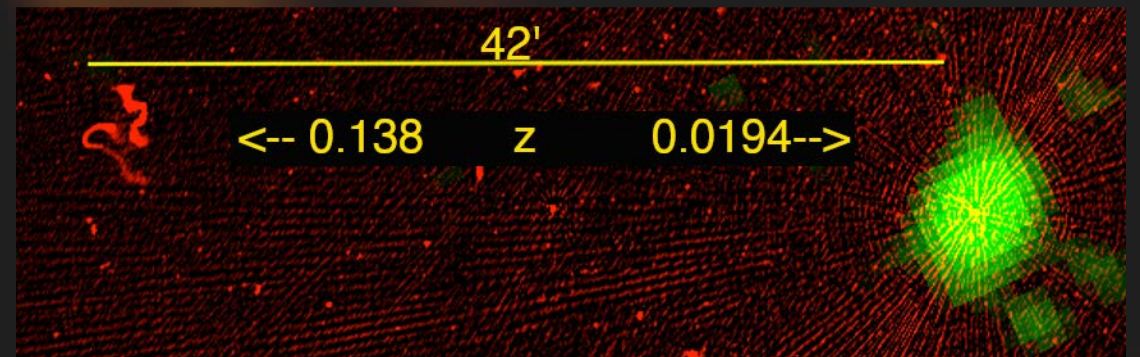
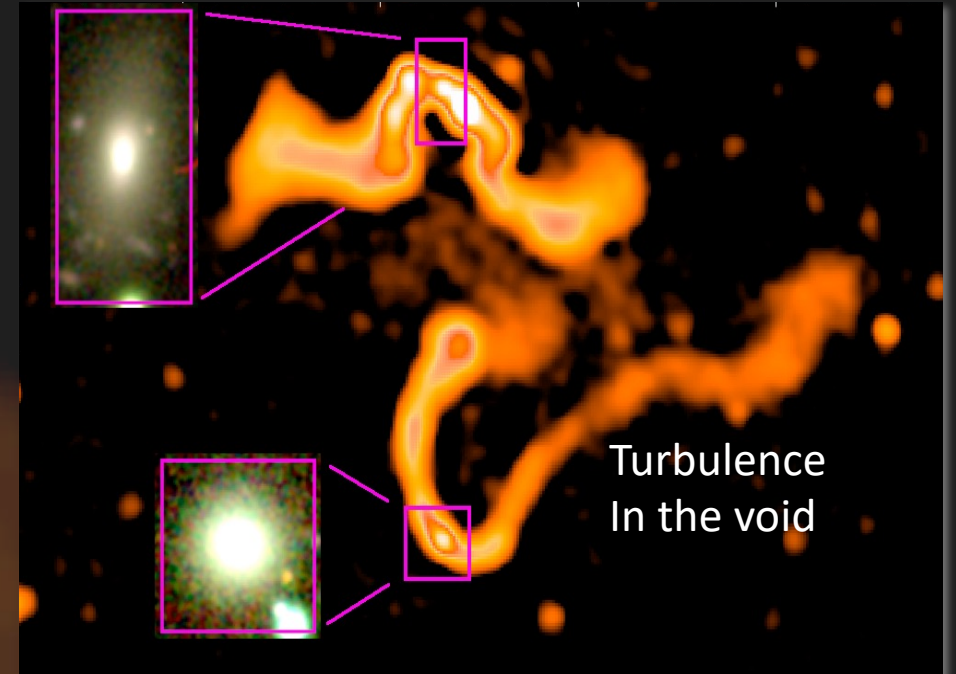
selected UNANTICIPATED JETS: Turbulence in the Void



- Multiple bends → surrounding turbulence
- No nearby X-ray or optical clusters



- Is there sufficient turbulence and pressure in very low density regions?

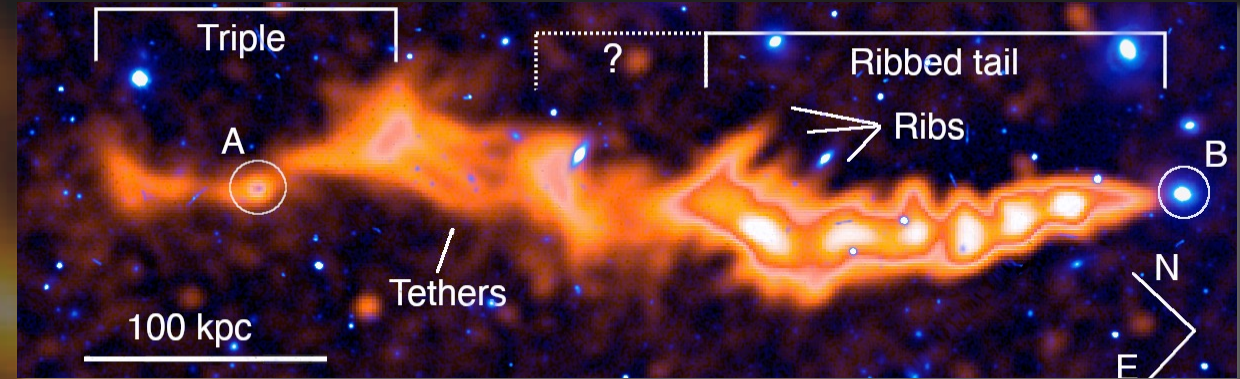


selected UNANTICIPATED JETS: Ribs and Tethers



- Edge of X-rays, Abell 3266

- Quasi-periodic knots with transverse "ribs", up to 90 kpc!
- "Normal" spectral steepening until ... connection by "tethers" with triple ($z=0.78$); similar spectra, edge of X-rays



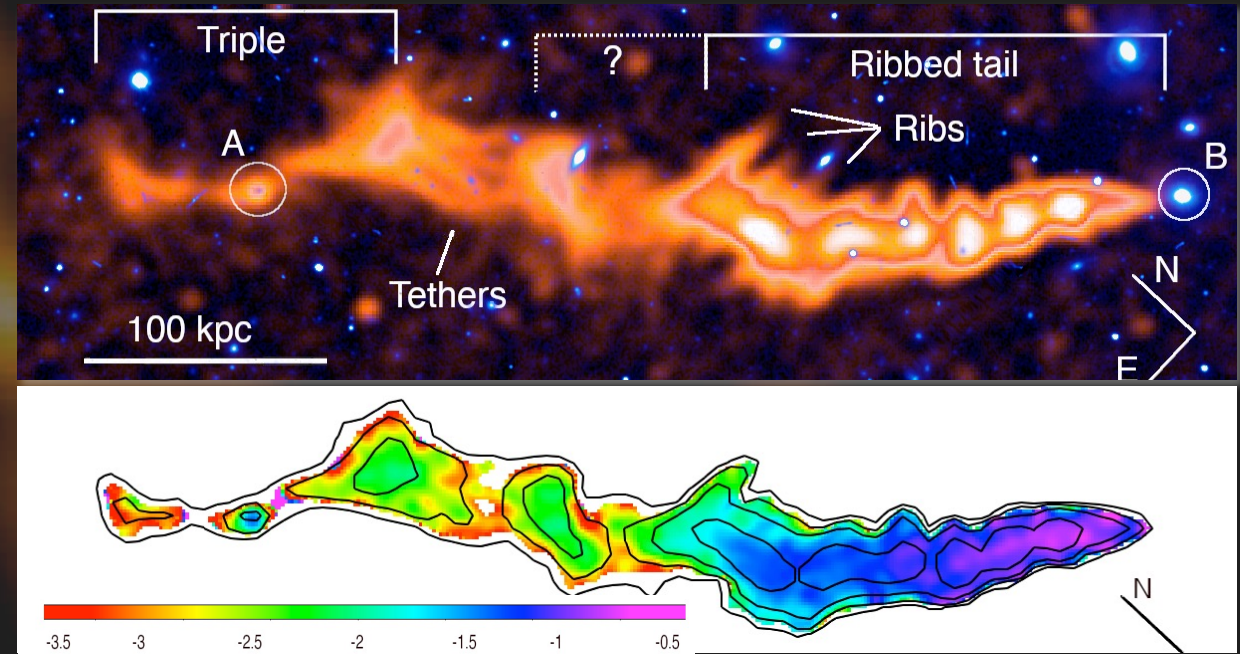
- Quasi-periodic: recollimation shocks? Instabilities? But why ribs?
- One source or two? Tethers??

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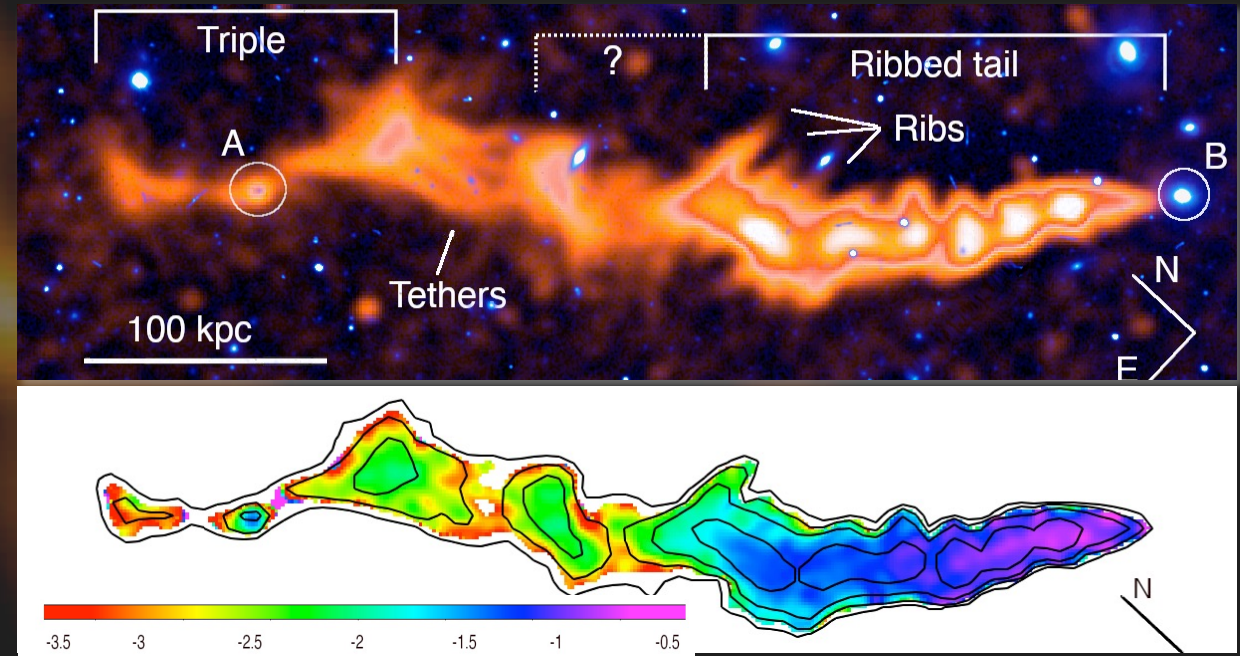
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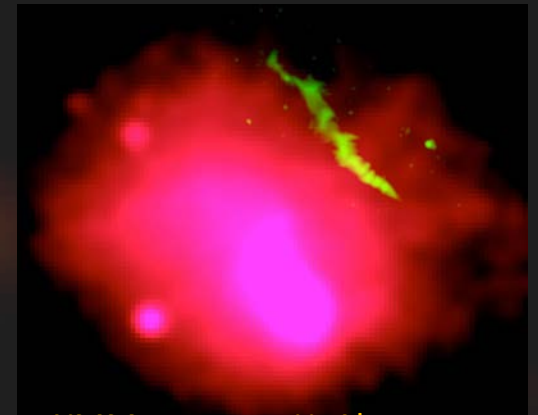


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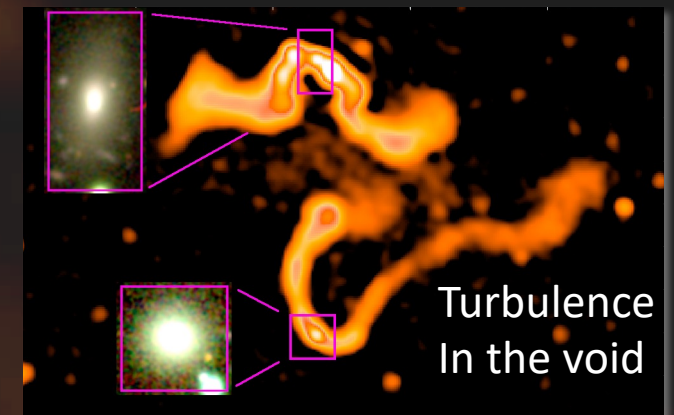
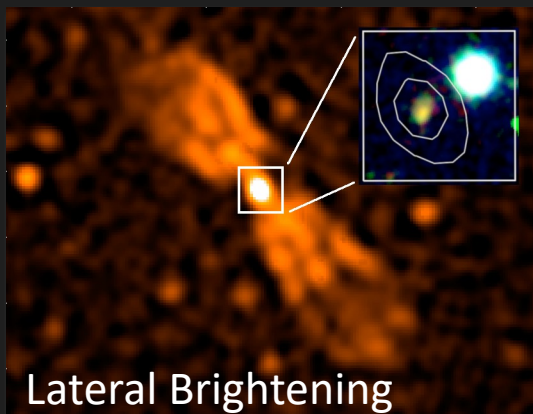
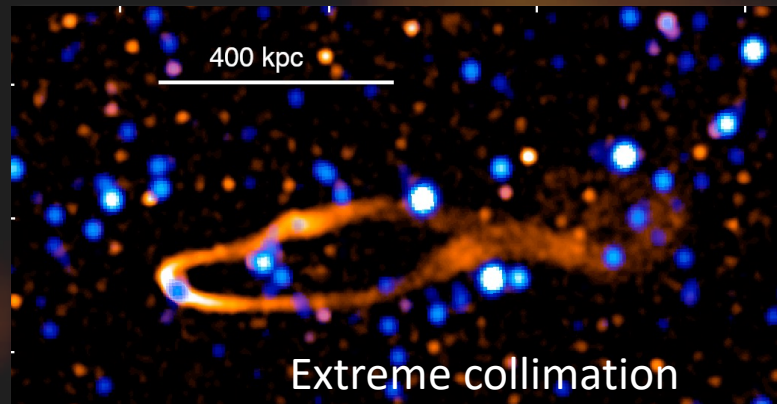
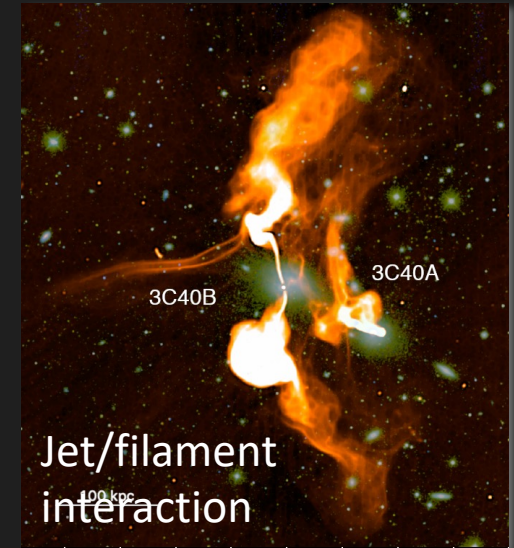
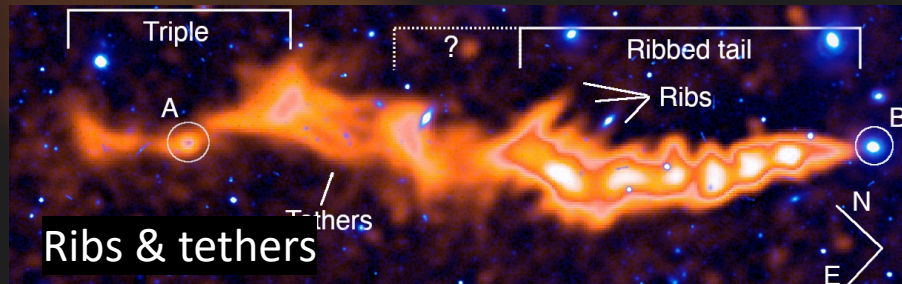
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XMM, courtesy H. Akamatsu

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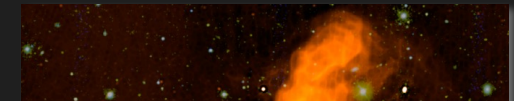


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Turbulence
In the void