VLBI at MHz frequencies Why is it worth the effort?

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UK Research and Innovation



The effort it takes ...

The effort it takes ...

The International LOFAR Telescope (ILT)



Why do we call it VLBI?

- **<u>Clocks</u>**: remote and international stations on individual clocks
- **Ionosphere**: dispersive delay, and requires directional dependent calibration
- **<u>Calibrators</u>**: need 'Goldilocks' calibrators for resolution / frequency
- Source characteristics: low-frequency absorption, source structure



Why do we call it VLBI?



The effort it takes ...



The effort it takes ...

Dynamic range of spatial scales



Physically meaningful spectral modelling



Paradigm shift: small samples to statistical surveys



LOFAR / EVN survey comparison

GOODS-N EVN - 32.5 hours Central field + targeted wider area total area covered: 0.05 deg² $31 T_b AGN$ identifications

ELAIS-N1 LOFAR-VLBI - 32 hours

4 x continuous observations FoV: 5.14 deg² 1575 T_b AGN identifications

Large enough samples for radio luminosity functions



contribution of AGN 50% more than expected

... and wide enough to find rare objects

LoTSS High Resolution (LoTSS-HR) is underway!



Sensitivity at 144 MHz [mJy/bm] for $\alpha = -0.7$

comparison with other surveys

		LoTSS	LoTSS-HR	VLASS
resolution		6"	0.3"	2.5"
Area [deg ²]		20,000	20,000	33,885
noise		70 µJy/bm	~50 µJy/bm	69 µJy/bm
Sources / deg ²		780	~30	~148
	driven by selection of sources > 10 mJy			

Matched resolution (or better) with optical/NIR etc.



<u>Arp299</u>

LOFAR @ 150 MHz

Fell

H₂

Lots of excellent instruments in the Southern hemisphere!

Take home messages

• The combination of field of view, resolution, and observing frequency is unique and enables a major step forward in terms of blind surveys

• High resolution at low frequencies is absolutely crucial for anchoring spectral modelling

• LABMDA will be in the Southern hemisphere, with overlap in sky coverage with premiere instruments (eg. MUSE) - this will be an incredible opportunity to provide spatially matched information!