Finding AGN With Wide-field VLBI observations

First results from a new observational technique

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Collaborators:
Alef, Bach, Brisken, Deller, Lenc, Morgan, Norris, Rottmann, Tingay
Wide-field VLBI observations
Applications and problems

- VLBI surveys are expensive
- $T_B > 10^6$ K is great AGN filter (if $z > \sim 0.1$)
- Long baselines
  - high fringe rates
  - tiny FOV
  - no „blind“ surveys
- Workaround: higher resolution
  - data volume $>>$ TB/day
  - cumbersome/impossible

Large circle: VLBA primary beams at 1.4GHz; small circle: VLBA FOV at 1.4GHz
Wide-field VLBI observations
Applications and problems

Garrett+ 2005: 1024 channels, 0.5s integrations (120GB of data), FOV of few arcmin

Averaging losses on 5000km baseline with 64kHz channels and 0.5s integrations (as in Garrett+ 2005)
Wide-field VLBI observations
New methods: multiple phase centres in DiFX2
(Deller+ 2010, in prep)

- Fourier transform data
- Calculate delay towards N phase centres
- Phase-rotate spectra
- Correlate and average
- Result: N normal VLBI data sets

Radio sources from Norris+ (2006) indicated with pluses, large circle is VLBA FWHM at 1.4GHz, small circle is CDFS (Luo+ 2008), rectangle is ECDFS (Lehmer+ 2005)
Wide-field VLBI observations

The pilot project – observations

(Middelberg+ 2010, submitted)

- CDFS observed at 1.4GHz in July 2007
- Expected sensitivity 50μJy – 100μJy
- Batch-calibration – thank you, ParselTongue
- First project to use multi-phase centre capability of DiFX2, with N=96

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- Primary beam correction scheme developed

*Does not require equal telescopes* → EVN
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Target S393: z=1.07, $S_{\text{ATCA}} = 49.1\text{mJy}$, $S_{\text{VLBI}} = 2.5\text{mJy}$
Target S519: z=0.69, $S_{\text{ATCA}} = 0.9\text{mJy}$, $S_{\text{VLBI}} = 1.1\text{mJy}$

Left: natural weighting, right: uniform weighting
Wide-field VLBI observations
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- Detected 21% of sources (=AGN)
- Identified 8 previously unknown AGN
- Every X-ray type 1 QSO is detected
- 1 starburst/elliptical galaxy detected
- 1 potential radio SN

Wide-field VLBI now practical and easy
(but see Morgan+ 2010 and Wucknitz+ for a different approach)

Next step: Lockman Hole East (Ibar+ 2009), use mosaicing of three pointings
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(Middelberg+ 2010, not even in prep)

- bm332b: 12h @ 512Mbps
- 347 targets
- Phase-referencing only
- 28 targets with SNR>7
- Brightest has SNR=88
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- Wide-field VLBI:
  
  Astonishing new capabilities, easy to use!