KVN/VERA fringe survey at 43GHz as a VSOP-2 pre-launch survey

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Collaboration

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Motivations

- Only a few 100 sources have been observed at 43 GHz for geodetic/astrometric purpose (VLBA, Lanyi et al).
- A KVN/VERA fringe survey at 43 GHz should be considered for VERA, KVN, VSOP-2, etc.
  - **VERA**: needs a full list of extragalactic calibrators at 22/43 GHz for dual-beam Galactic astrometry (e.g., VERA fringe survey at 22 GHz; Petrov et al 2007).
    - 549 sources detected out of 2494 sources observed
    - Focused on Galactic plane/center and known water masers
    - On-going follow-up imaging survey using VLBA (GaPS) at 22 GHz
  - **KVN**: needs the list of calibrators at 22/43 GHz for multi-freq. phase-referencing observation at 22/43/86/129 GHz
  - **VSOP-2**: needs preparatory surveys for identifying suitable radio sources for phase referencing observation at 8/22/43 GHz (VSOP-2 pre-launch survey at 43 GHz)
- A follow-up VLBI imaging survey at 43 GHz with a complete sample of compact radio sources is required to study compact AGN jets.
EAVN-Array43:
- KVN(3x21m) + VERA(4x20m) + Nobeyama(45m) + Kashima(34m)

0.7 mas@43GHz
In Dec. 2009, KVN will be ready to operate at 22/43 GHz.

<table>
<thead>
<tr>
<th>Station</th>
<th>Longitude (°″E)</th>
<th>Latitude (°″N)</th>
<th>Height (m)</th>
<th>Baseline length (km)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yonsei</td>
</tr>
<tr>
<td>Yonsei</td>
<td>126 56 35</td>
<td>37 33 44</td>
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<tr>
<td>Ulsan</td>
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<td>35 32 33</td>
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<td>Tamna</td>
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<td>33 17 18</td>
<td>320</td>
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<table>
<thead>
<tr>
<th>Receiver</th>
<th>22 GHz</th>
<th>43 GHz</th>
<th>86 GHz</th>
<th>129 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq[GHz]</td>
<td>21.25~23.25</td>
<td>42.1~44.1</td>
<td>85~87</td>
<td>128~130</td>
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<tr>
<td>Polarization</td>
<td>RCP/LCP</td>
<td>RCP/LCP</td>
<td>RCP/LCP</td>
<td>RCP/LCP</td>
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<tr>
<td>1st IF Freq. [GHz]</td>
<td>8~10</td>
<td>8~10</td>
<td>8~10</td>
<td>8~10</td>
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<tr>
<td>IF Pout [dBm]</td>
<td>-25</td>
<td>-25</td>
<td>-25</td>
<td>-25</td>
</tr>
<tr>
<td>Trx [K]</td>
<td>25</td>
<td>80 -&gt;</td>
<td>&lt; 100</td>
<td>&lt; 150</td>
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<tr>
<td>Down Converter Frequency [MHz]</td>
<td>512-1024</td>
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</tbody>
</table>

KVN : Korean VLBI Network
VERA: VLBI Exploration of Radio Astrometry

Main aim: Galaxy-scale maser astrometry.
New aspect: dual-beam for phase-referencing

Construction completed in 2002
Regular observations from 2004

Ishigaki-jima Ogasawara
Mizusawa
Iriki

Ishigaki-jima
Ogasawara
Fringe Survey at 43 GHz (FS43)

- **Phase I (2008)**: A 24-hr pilot observation of ~ 550 compact radio sources only with VERA.
  - To test baseline sensitivity of VERA at 43 GHz: \( S_{\text{VERA}} \).
    - Expected value \( S_{\text{VERA}} \sim 150 \text{ mJy} \) (VERA team, priv. comm.)
  - To demonstrate a feasibility of FS43 with dynamic scheduling.
  - Source selection criteria:
    - Correlated flux density of \( S_c \sim 300 \text{ mJy} \) on baselines of 170 ~ 250 M. at 8 GHz based on the catalogs of VCS1-5 and ICRF
    - Compactness of \( S_c/S_{\text{VLBA}} \sim 0.4 \) at 8 GHz
    - Detected sources in 3mm VLBI survey (Lee et al. 2008)
    - Correlated flux density of \( S_{22} \sim 500 \text{ mJy} \) on baselines of 100 ~ 200 M. at 22 GHz based on the VERA Fringe survey at 22 GHz (Petrov et al. 2007)
  - Each source will be observed for one scan of a 1-min duration.
550 objects selected for the pilot observations

- **Group1 (205)**: $S_c > 500$ mJy, $S_c/S_{VLBA} < 0.4$
- **Group2 (299)**: $500$ mJy $\leq S_c \leq 300$ mJy, $S_c/S_{VLBA} < 0.4$
- **Group3 (46)**: $S_c < 300$ mJy, $S_c/S_{VLBA} < 0.4$
Fringe Survey at 43 GHz (FS43)

- **Phase II (2009-2010)**: Survey observations with EAVN-Array43 (VERA, KVN, Nobeyama, Kashima)
  - Sources with expected $S_{43} > S_{VERA}$
  - Each source observed for one or two scans.
  - The first whole-sky fringe survey at 43 GHz in Northern hemisphere.
  - Spectral index (at 22-43GHz) obtained from KVN data.

- **Phase III (2011-2012)**: A follow-up imaging survey with a complete sample using EAVN-Array43 (+ VLBA?)
  - A complete sample based on the results of FS43
  - Improve the data base of AGN VLBI images at 43 GHz
  - Statistical study of intrinsic properties of relativistic jets.
Expected results from the survey

- Providing a full list of calibrators for KVN, VERA, and VSOP-2 (as a pre-launch survey).
- Triggering a follow-up VLBI imaging survey at 43 GHz with a complete sample of compact radio sources.
  - Resolution of the VLBI survey at 43 GHz will be matched with that of VSOP-2 at 22 GHz
  - Comparison of structural information and morphology at matched resolution
  - Comparison of $T_b$ distribution at 22/43 GHz
    - To see if there is any difference.
    - To see if the difference is coming from jet stratification or opacity effect.
Statistical studies of compact jets

- **Surveys at various frequencies (ref. Yuri’s talk)**
  - VCSs (Kovalev et al. 2007) and ICRF (Ojha et al. 2004) at 2/8 GHz
  - 2cm VLBA Survey (Kovalev et al. 2005) at 15 GHz
  - GMVA 3mm VLBI survey at 86 GHz (Lee et al. 2008)
    - Resolution of 0.04 mas
    - 127 sources observed
    - 121 sources detected (~100 % detection rate)
    - 109 sources imaged (dynamic range ~ 100)

- **$T_b$ change of core comp. for a sub-sample of jets**
Change of $T_b$ in a jet $\Rightarrow$ acceleration/deceleration of relativistic jets

$T_b$ increases up to 20 GHz and then starts to decrease at 86 GHz. $T_b$ are systematically low.

A VLBI survey at 43 GHz is required to fill this gap to confirm the possible trend of $T_b$. 
Change of $T_b$ in a jet

Compact jets may be accelerated by magnetohydrodynamic (MHD) forces.
A KVN/VERA fringe survey at 43 GHz will be supporting VSOP-2 as a pre-launch survey.

A VLBI imaging survey at 43 GHz based on the results from the fringe survey should be considered in order to enable the statistical studies of compact radio jets.
**EAVN-Array22**: KVN + stations with a highest freq. of 22 GHz (e.g., Shanghai, Urumqi, Tsukuba, Yamaguchi, Usuda, Tomakomai, Gifu, Takahagi)

0.7 mas@22GHz
Suggestion of EAVN-Array22/43

- EAVN-Array43:
  - KVN + VERA + Nobeyama + Kashima

0.7 mas@43GHz