Status of VLBI in Korea

Bong Won Sohn
Korea Astronomy and Space Science Institute

Contents

- History
- Current status of KVN
- Future plan
- AGN WG activities


KVN HISTORY

KVN Ulsan Observatory

KVN Yonsei Observatory

KVN Tamna Observatory

Korean VLBI Network

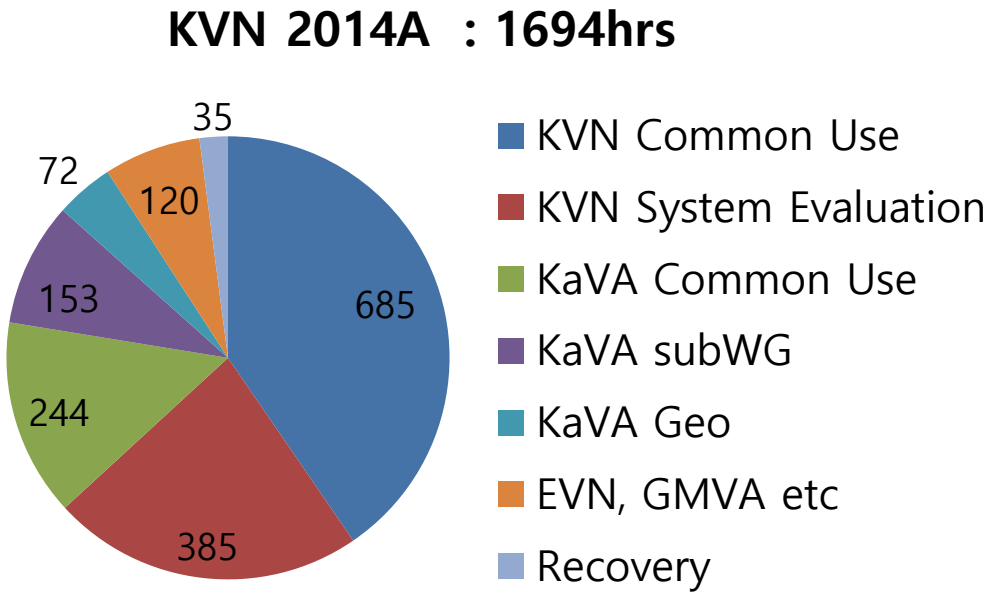
- Dedicated mm-VLBI facility
  - 3, 21m telescopes (Yonsei(Seoul), Ulsan, and Tamna(Jeju))
  - Shaped Cassegrain type
  - Surface accuracy: RMS < 150μm
  - Fast slewing: 3°/sec, 3°/sec^2
- *Simultaneous* multi-frequency observation from 22GHz up to 129GHz
  - Multi-frequency Phase referencing
  - Simultaneous or fast position switching observation
- Construction: 2001-2008
  - 6 GHz receiver at Ulsan
  - 22 and 43 GHz receivers in stage (2009)
  - 86 and 129 GHz receivers in 2nd stage (completed)

Sejong Gedesic VLBI Obsevatory

안테나 직경	22M (Cassegrain)
수신 주파수	2/8, 22, 43 GHz
포인팅 정확도	0.0131° (RMS)
반사경면 정확도	120μm
구동범위	AZ: +-270 ° EL: 0~90 °
구동속도	AZ & EL 5° /sec
운영제어sw	FS9(NASA/GSFC)
기록기	K5 (NICT)
수소메이저	Vremeya-CH(Russia)
구축비용	123억

CURRENT STATUS OF KVN

Operation Time of 2014A



- KVN Common Use
  - ***685h for 12 proposals***
- System Evaluation
  - 385h for Astrometry, Multi-Freq PR, RTS and Sampler, Pol, etc
- KaVA Common Use
  - ***244h, 1Gpbs Operation***
- KaVA K-band Geodetic VLBI with 2 month interval
- EVN Associate Member (22/43GHz Session)
- Single Dish ~ 500h for 7 proposals

KVN Common Use 2014A : VLBI

1	Polarization Properties of Radio-loud AGNs - 1. Compact Sources	Bong Won Sohn	KASI	AGN/Pol
2	Investigation of Development of Bipolar Outflows from AGB to Post-AGB Stars II	Se-Hyung Cho	KASI	Evolved star
3	The Plasma Physics of Active Galactic Nuclei II	Sascha Trippe	SNU	AGN/Pol
4	Flares and Relativistic Jets in Microquasar Cygnus X-3	Soon-Wook Kim	KASI	Galactic/ ToO
5	Probing Early-Time Evolution of Core-Collapse SNe using KVN	Jae-Joon Lee	KASI	Extragalactic/ SNe/ToO
6	Four Frequency KVN Observations of the Polar Cap sources	Richard Dodson	KASI	AGN/ Astrometry
7	VLBI multi-frequencies observations of Sgr A* with KVN	Atsushi Miyazaki	KASI	Galactic center
8	44 and 95GHz Methanol Maser Fringe Survey toward Massive Star Forming Region	Kee-Tae Kim	KASI	Star Formation
9	The core-shift effect in the jets of 3C 66A and 3C 66B	Guang-Yao Zhao	KASI	AGN/ Astrometry
10	The radio structure of radio quasars at high z	Minfeng Gu	SHAO	AGN
11	High Frequency Weak AGN Survey using the KVN's Multi-Frequency Phase	Taehyun Jung	KASI	AGN
12	Interferometric Monitoring of Gamma-ray Bright AGNs at 22-129 GHz	Sang-Sung Lee	KASI	AGN

KVN Common Use 2014A : Single Dish

1	Short-spaced Monitoring of SiO and H2O Masers toward Water Fountain Sources	Jaeheon Kim	KASI	Evolved Star
2	Monitoring Microquasar Cyg X-3 to Trigger Target-of Opportunity (ToO) VLBI Obs.	Soon-Wook Kim	KASI	Galactic/ ToO
3	HCN and HNC abundance ratio toward three different phases of massive SF	Mi-Hwa Jin	KHU	Star Formation
4	Spectroscopic Obs. of comets C/2012 S1 (ISON) and C/2013 R1 (Lovejoy)	Young-Jun Choi	KASI	Comet
5	Intra-day variability in polarization of Blazars at 22/43/86GHz (POLIDV)	Sang-Sung Lee	KASI	AGN/ Pol
6	Simultaneous multi-frequency flux monitoring of S5 0716+714 with KVN radio telescope	Jee won Lee	KASI	AGN
7	Time Monitoring Obs. of SiO and H2O Masers toward Stellar Maser Sources II	Se-Hyung Cho	KASI	Evolved Star

Total ~ 500 hr +α

2014B Operation

- VLBI

Type	hour
KVN Common Use	300 -> 500
KVN Key Science	500 -> 300
KaVA Common Use	200
KaVA Science WG	300
EVN/GMVA/EAVN	150
System Evaluation (Director's Time)	350
Total	1800

- Single Dish Total : 300h x 3 sites

2015A Call for Proposal

- Yet, regional calls
  - International cooperation encouraged!
- VLBI (East Asia) >300 hrs/yr (<100hr/project)
- Single Dish (Korea) <3x300 hrs /yr
- Key Science (Korea) ~ 300hrs/project/ys
  - 3~4 projects will be selected in early 2015
- Visit KVN webpage
  - http://kvn.kasi.re.kr/

- 2015B First Global CfP will be announced

- EVN, GMVA, RadioAstron participation

PLANS

2015A Common Use

- KVN Common Use : 300-500h
  - Open to East Asia
  - Deadline : early Nov
- More KSP time
- KaVA Common Use : 250h
  - Open to East Asia
  - Single Frequency Imaging at 22GHz or 43GHz
  - Deadline : early Nov
- EVN
  - Deadline : Feb / June / Oct

Upgrade Activity

- Multi-Frequency Inst. Phase-Cal for 22/43/86GHz
  - end of 2014
- Astrometry
  - Annual Parallax of Orion, BX-Cam
    - Zenith Wet Delay Correction using GPS data
  - Improving station coordinate accuracy through KVN+VERA Geodetic VLBI : 2month interval, 4cm -> 1cm
- Network Connection
  - 1Gbps -> 2Gbps
  - e-VLBI (with KISTI)
- Wideband recording system
  - KVN : Mark5B+(2Gbps) , **Mark6(4 x 2Gbps)**

  cf) VERA : OctaDisk(2 x 2Gbps)

Long-term Plans

- Extended-KVN
  - One or two more KVN type telescope(s)
  - Locations TBD
  - One in Korea, one abroad?
    - Shorter baseline (< 100km)?
    - North Korea? ASEAN country?

- SKA
  - Cosmic magnetism, HI science, SKA-VLBI
  - Industry Participation
    - Smart Energy Management, Antenna construction, Electronics

- For major funding (> 10^11 Won ~ 74M Euro) in 2017/18, Preparatory report should be submitted late 2015 or 2016.

AGN TEAM ACTIVITIES

AGN team contribution

- Large contribution to KVN/KaVA commissioning
  - System verification observation
  - Fringe test, Imaging test
  - Phase referencing development
  - Phase referencing calibrator survey (J. Lee+ → Jung's talk)
- International Cooperation
  - EVN participation
  - KaVA collaboration (Kino's talk;)
  - GMVA, RadioAstron participation
- Cooperation with Korean Universities
  - Yonsei: AGN-Host(Yi)/Cluster(Chung) environment
  - SNU: Jet physics(Trippe), Black Hole Properties(Woo)
- *KVN Key Science Candidates*
  - *New Faint Sources (Sohn+)*
  - *Gamma-ray bright AGNs (S. Lee+)*
- *KVN legacy program**
  - *KVN mutli-frequency survey (Jung+)*
  - *Observe all the 22GHz detected sources(e.g. J. Lee+) up to 130GHz*
  - *Definition of KVN Legacy program is in discussion*

Discussions on Large AGN program (KSP, Legacy)

- Key Science Program Candidates

  "The KSP should aim at a clear scientific goal, which may manifest the strength and power of KVN."

  "The KSP is recommended to request less than 300 hours of observing time a year (for up to about 3 years), and it should not be a combination of small programs."

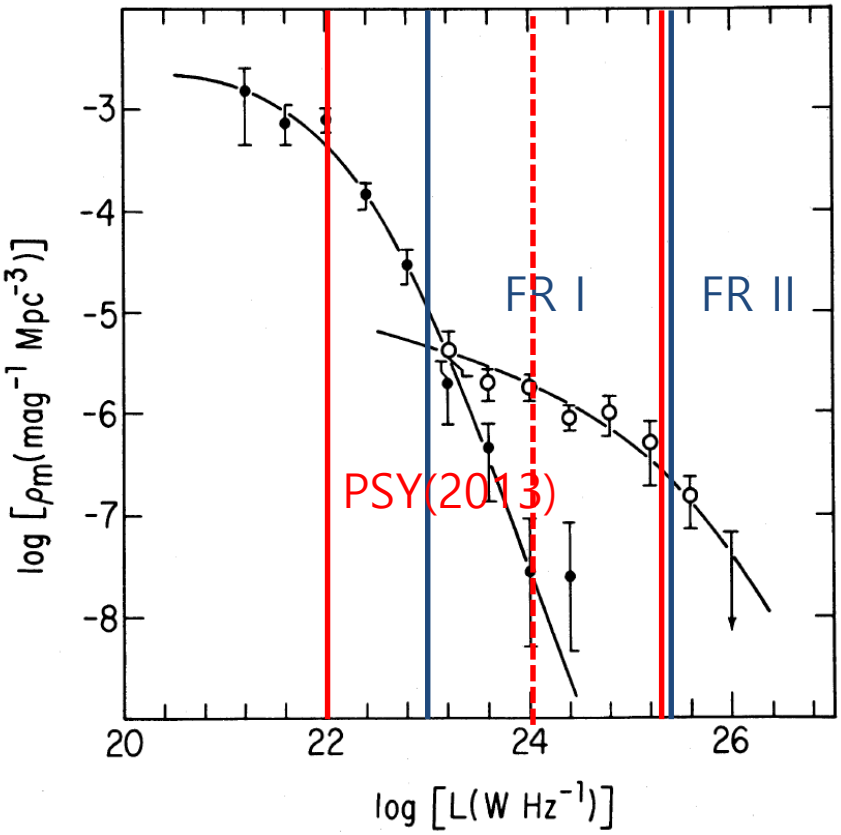
- 'the strength and power of KVN'
  - See the unseen (MFPR (Jung+))
  - Positional accuracy (SFPR (Rioja+))

- 'the weakness of KVN'
  - Small number of telescopes
  - Baseline length (< 500km)

➢ Looking for 'proper' objects – 'clear scientific goal'
  - 'unique' scientific cases (input from 'Eating VLBI'?)
  - Yet unexplored sources (Faint AGNs, new sources)
  - e.g. **PSY(2013)**, ***Mantovani+(2011), Righini+(2012) & Ricci+(2013)***

➢ Better UV coverage, higher resolution
  - via international cooperation (VERA, Yebes, ….???)

Faint Radio Sources with Elliptical hosts



Local(z<0.05) radio luminosity function
1.4GHz Survey(Condon(1989))

- Physics of low power (low γ) jets
- Most Ellipticals are here (although # of star burst > # of them)
- Probably important to understand the evolution of Elliptical galaxies and the role of AGN (feedback)

- Blue lines FR I & II
- Red lines (Park+2013)
- Sources turned out to be brighter at 22GHz than expected

22/43GHz Survey (Park+, 2013)

- Source selection
  - Volume limited (0.01<z<0.06)
    - z=0.05, 1pc ~ 1mas
  - SDSS images and spectroscopy survey
    - Black Hole mass 7.3..8.7 log($M_\odot$)
    - Accretion rate
  - Narrow emission line
  - FIRST survey
  - Elliptical shape (neither recent merger nor G-G interaction)
  - BPT diagram
    - 305 Ellipticals with AGN activities
  - No Spiral AGNs(Seyferts), no Starburst included
- To build volume limited sample of Non-beaming, AGN activity, but Elliptical

- Radio
  - Most of them turn out to be compact sources in FIRST Survey (81%)
  - Constituent with Ivezic+ (2002)
  - With KVN 22 & 43GHz, we observed 86 sources
  - Detection
    - 37%(32)@22GHz
    - 19%(19)@43GHz
  - Park, Sohn, Yi (2013, PSY2013)

Results

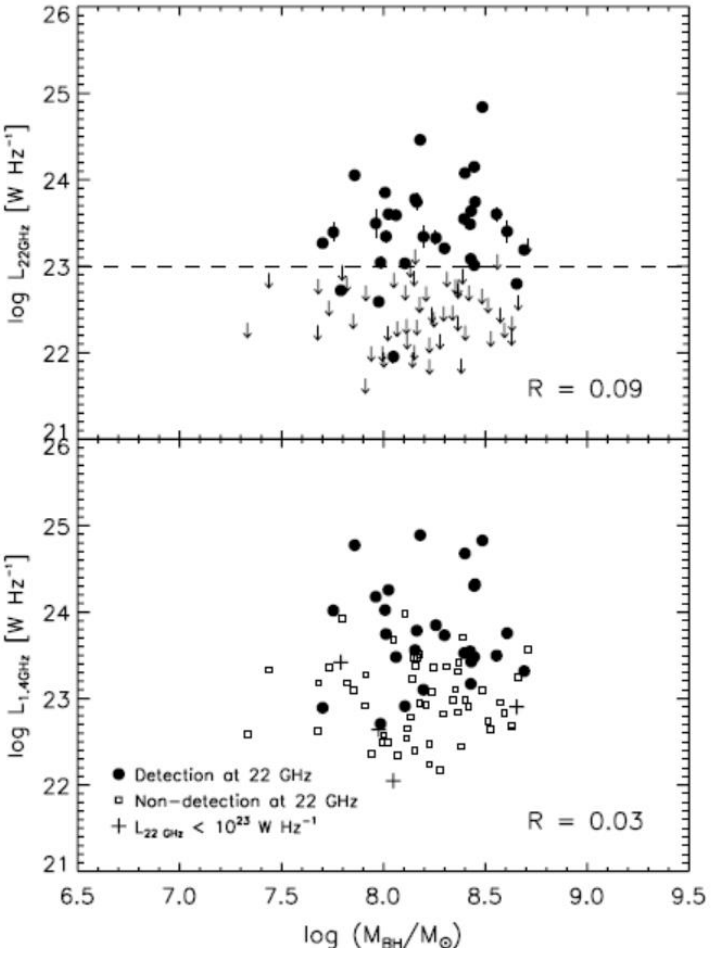
- Flat to inverted spectra dominated
  - Optically thick at 1.4GHz? And confined by ISM?
- Weak or no relation with Black Hole mass
- Eddington ratio ([OIII]/δ^4; Kaufman & Heckman 2009), approximation of accretion rate and 22/43GHz power shows much higher correlation
- Probably jets with low γ, large viewing angle, but optically thick at cm

✓ mm-VLBI essential ← optically thinner

✓ Phase referencing necessary ← sources are weak, atmospheric delay

✓ SFPR desirable ← accurate spectral index, polarization property

➢ good to explore Host-AGN connection



PSY(2013)

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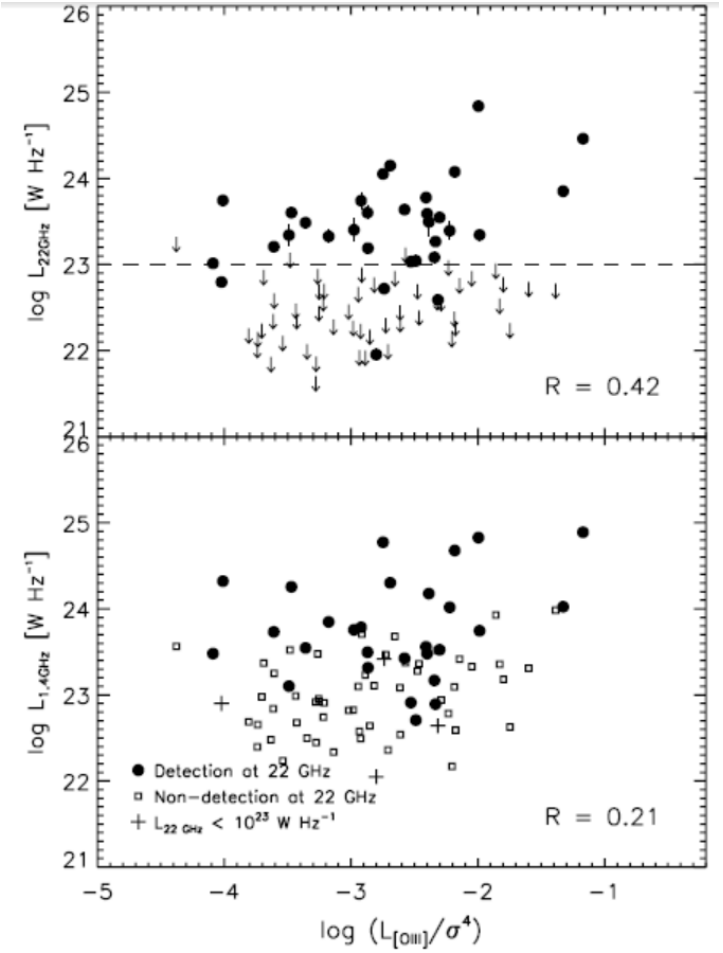

PSY(2013)

Summary

- History
- Current status of KVN
  - open use > 1000 hrs
- Future plan
  - Soon global CfP, preparation of next steps
- AGN WG activities
  - Looking for and developing unique scientific cases

THANK YOU