Current status of KVN-VERA o bservation of Sgr A*

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Sgr A* at high radio frequency

- Flux variation with various time scale
 - sub-hr QPOs@7mm (Miyoshi et al. 2009); VLBA
 - slit-modulation-imaging (SMI) method
 - P = 31.4 min, a rotating 3-arm structure
 - At the central 50 μ as the P = 56.4min a double amplitude variation
 - IDV@3mm (Li et al.(2009)); ATCA
 - 20~ 33% fractional variation in 2 ~ 4 hrs
 - 1.3mm flares (Zhao et al(2004)) ~ weeks; SMA
 - > 3days delay with 1.3 cm VLA flux
 - spectral break at 3mm
 - ✓ Mostly (if not all) based on single frequency observations

Sgr A* radio structures

- Compact unresolved
 - VLBI at 7 mm and 3 mm wavelen gths (Rogers et al. 1994; Krichba um et al. 1998;Doeleman et al. 2 001; Bower et al. 2004; Shen et a I. 2005)
 - intrinsic size of Sgr A* to be < 2 A
 U and < 1 AU respectively
 - VLBI at these wavelengths is infl uenced by scattering effects
 - Mostly (if not all) based on single frequency observations at certai n epochs





structural variability

- Possible structural variation seen @7mm on 31 May 1999
- Larger (than usual) deviations
- 3 sigma along the minor axis
- Intrinsic sizes derived
 - 0.334 +/- 0.042 mas (EW)
 - 0.359 +/- 0.095 mas (NS)
- First detection of intrinsic size along minor axis of 2.87 AU
- Intrinsically symmetric
- Increased (cf. 0.268+/- 0.025 mas) by ~25% to ~34%
- Relation with total intensity variation (not clear)



Shen et al.(2006)

Motivations

- Sgr A*
 - sub-hrs to weeks of time scale flux variation
 - Li et al., (2009)
 - the expanding plasmon model or the sub-Keplerian rotating hot spot model
 - simultaneous multi-wavelength monitoring asked
 - Jets? (Markoff et al. 2007)
 - KVN + VERA observation
 - First scientific observation in commissioning phase
 - Spectral/polarization information with high temporal resolution
 - Absolute position : VERA dual beam @43GHz
 - Frequency dependant position : KVN 22-43GHz
 - Imaging KVN+VERA 43GHz

Rioja et al.(2010)

Conventional PR

SFPR with multi-channel receiver



Dodson et al.(2010)

HYBRID MAPPING:

3C345 structure: Two components detectable 22 GHz: 3.8 mas sep. 43 GHz: 3.0 mas sep



Jung et al. (2009) Images



NRAO512 (22GHz) phase model

3C345 (43GHz) original

Right Ascension (mas)

Contours %: -0.632 0.632 1.26 2.53 5.05 10.1 20.2

Beam FWHM: 0.628 × 0.39 (mas) at -42°

Clean LL map. Array: VERA

Û

Map peak: 1.42 Jy/beam

Contours %: 40.4 BO.8

3C345 at 43.058 GHz 2005 Apr 15

The FIRST phase referenced image from the 22 & 43 GHz simultaneous dual-frequency observation



3C345 (43GHz) phase referenced





Korean VLBI Network

- Dedicated mm-VLBI facility
 - 3 x 21m telescopes (Seoul, Ulsan, and Jeju)
 - Shaped Cassegrain type
 - Surface accuracy: RMS < 150μm
 - Fast slewing: 3°/sec, 3°/sec²
- *Simultaneous* multi-frequency observation from 22G Hz up to 129GHz
 - Multi-frequency Phase referencing
 - Simultaneous or fast position switching observation
- Construction: 2001-2010

 - 2/8 GHz receivers (TBD)
 22 and 43 GHz receivers in 1st stage (2008/2009)
 86 and 129 GHz receivers in 2nd stage (2011)





KVN in Madrid



KVN Yonsei Observatory



KVN in Madrid



East Asian VLBI Network @ 22, 43GHz

VERA 22GHz : 1.5mas 43GHz : 0.8mas

KVN 22GHz : 7.2mas 43GHz : 3.7mas 86GHz : 1.8mas 129GHz : 1.2mas

Image © 2005 EarthSat

KVN & VERA Network

VERA

SEOUL

KVN

Shen et al.(2006)

East Asia Mm-VLBI array is good for monitoring SgrA* structural variability



Observations

LST			20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
UT			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
JST			9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8
2011/3/28	月	87									XMM-	-newt	on													
			三鷹	計画	亭電						三鷹	計画例	亭電											三鷹	計画傳	電
2011/3/29	火	88												Chan	dra											
								三鷹	計画係	亭電									KVN+	-VER/	ł					
2011/3/30	水	89									XMM-	-newt	on													
												三鷹	計画傳	宇電					KVN+	-VER/	ł					
2011/3/31	木	90												Chan	dra											
									三鷹	計画傳	宇電								KVN+	-VER/	ł					
2011/4/1	金	91									XMM-	-newt	on													
						三鷹	計画	亭電											KVN+	-VER/	ł					
2011/4/2	Ħ	92																								
			三鷹	計画	亭電						三鷹	計画傳	事電											三鷹	計画傳	電
2011/4/3	H	93									XMM	-newt	on													
								三鷹	計画傳	亭電									KVN+	-VER/	Ą					
2011/4/4	月	94																								
												三鷹	計画的	宇電						VED						
2011/4/5	火	95									XMM-	-newt	on													
									三鷹	計画例	亭電								KVN+	VERA	ł					

回停電 power down at Mitaka Sgr A* XMM-newton Chandra

- Triggered by XMM/Chandra obs.(Dolemann et al.)
- KVN 22 & 43GHz simultaneous obs.
- VERA 43GHz dual beam obs.
 Honma(VERA) and Sohn (KVN) et al.

Outlook

- Multi-frequency phase referenced observations
 - High temporal resolution
 - Accurate Relative position
 - λ Astrometric Positional accuracy
 - factor of ten better than imaging resolution (Lee et al.(2008), Rioja et al.(2010))
 - Full polarization mode KVN+(VERA)+...
 - Probing electron density and magnetic field of variable components in Sgr A*
- Full polarization mode only at KVN yet
 - VERA will install soon (22, 43GHz)
- Imaging resolution is still marginal
 - Unresolved structure increase the uncertainty of positional accuracy
 - Will be improved with CVN (22GHz) and VLBA (22, 43, 86GHz)
 - 130GHz collaboration?
- Correlation delayed (due to scheduled black out in Tokyo area);
 - correlation at KJJVC(KVN)?
 - Commissioning phase will end this June