Simultaneous Water and Class I methanol maser Surveys of Class II methanol maser sources

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Abstract

We have conducted simultaneous surveys of 22GHz water maser and Class I 44GHz and 95GHz methanol masers toward 148 Class II 6.7GHz methanol maser sources using KVN (Korean VLBI Network) 21m telescopes. The sample consists of 77 sources of the Arecibo methanol maser Galactic plane survey (AMGPS, Pandian et al. 2007) and 71 sources of the Methanol multibeam (MMB) survey (Caswell et al. 2010; Green et al., 2010). We detected water maser emission in 85 sources (57%), 44GHz methanol maser emission in 81 sources (55%), 95GHz methanol maser emission in 72 sources (49%). Forty nine sources (33%) show both water and 44GHz methanol masers. 95GHz methanol maser emission was almost detected in 44GHz methanol maser-detected sources. The two Class I methanol masers have strong correlations with each other in velocity, flux density, and line shape, while they do not show any significant correlation with water and 6.7GHz Class II methanol masers. In this poster we will present the main results of our surveys and discuss the implications.

Observation Information

We selected 77 AMGPS sources(Pandian et al.,2007; Pandian et al., 2011) and 71 MMB survey(Caswell et al. 2010; Green et al., 2010) sources to observe 22GHz water maser, 44GHz class I methanol maser and 95GHz class I methanol maser. Two survey were blind survey results, 148 sources were selected from limit of sidelobe effects(Lee et al., 2011), elevation limits on KVN sites and avoidance of overlapping sources with other KVN projects - EGO, HMPO, IRDC and UCHII observations. Observation were done during the 2011-2012 seasons. KVN Yonsei, Ulsan and Tamna single dish telescopes were used for totally 36 days. We found signals over than 3 sigma rms noise, σ_{rms}~ 0.02K and dV ~ 0.2 Km/s.

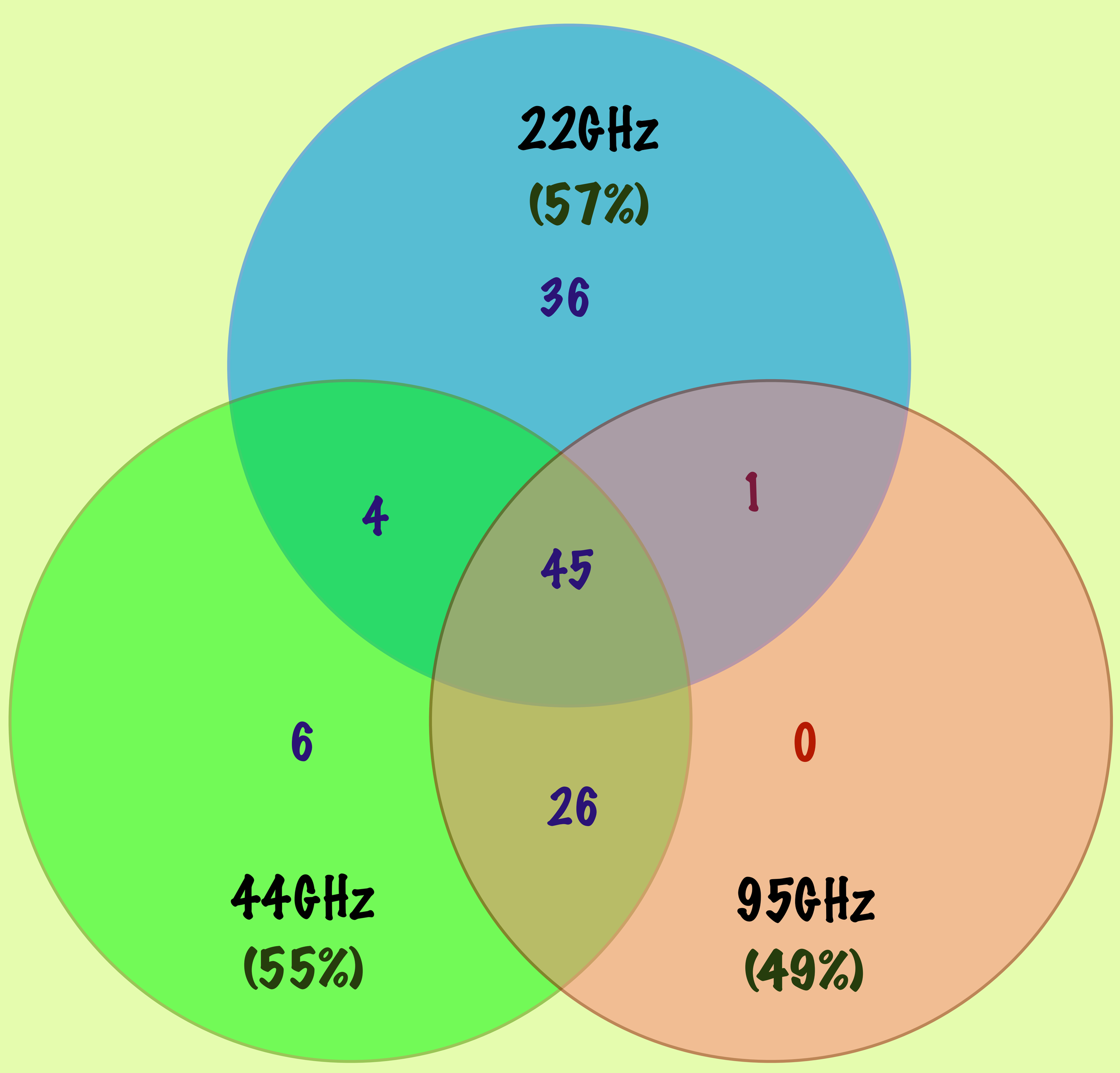
V_{LSR} of 77 sources were from NH_3 observations of Pandian et al.(2012), and HCO^+(1-0) & $H^{13}CO^+$(1-0) observation were done with KVN to verify molecular V_{LSR} of 71 sources, and at weak HCO^+ sources, ^{13}CO(1-0) with TRAO were observed.

Antenna Beam Size & Aperture Efficiency
(http://kvn-web.kasi.re.kr/obs_information.php)

Site	Band (GHz)	HPBW (arcsec)	Aperture Efficiency (%)	Beam Efficiency (%)
KVN Yonsei	22	119	65	46
	44	61.5	63	47
	86	31.5	48	36
	129	23.4	30	28
KVN Ulsan	22	120	62	44
	44	61.6	62	47
	86	32.5	49	39
	129	22.9	32	29
KVN Tamna	22	123	59	44
	44	62.1	62	48
	86	31.5	52	39
	129	21.9	40	33

Results

We detected 22GHz, 44GHz and 95GHz maser emissions in 85(57%), 81(55%) and 72(49%) sources.



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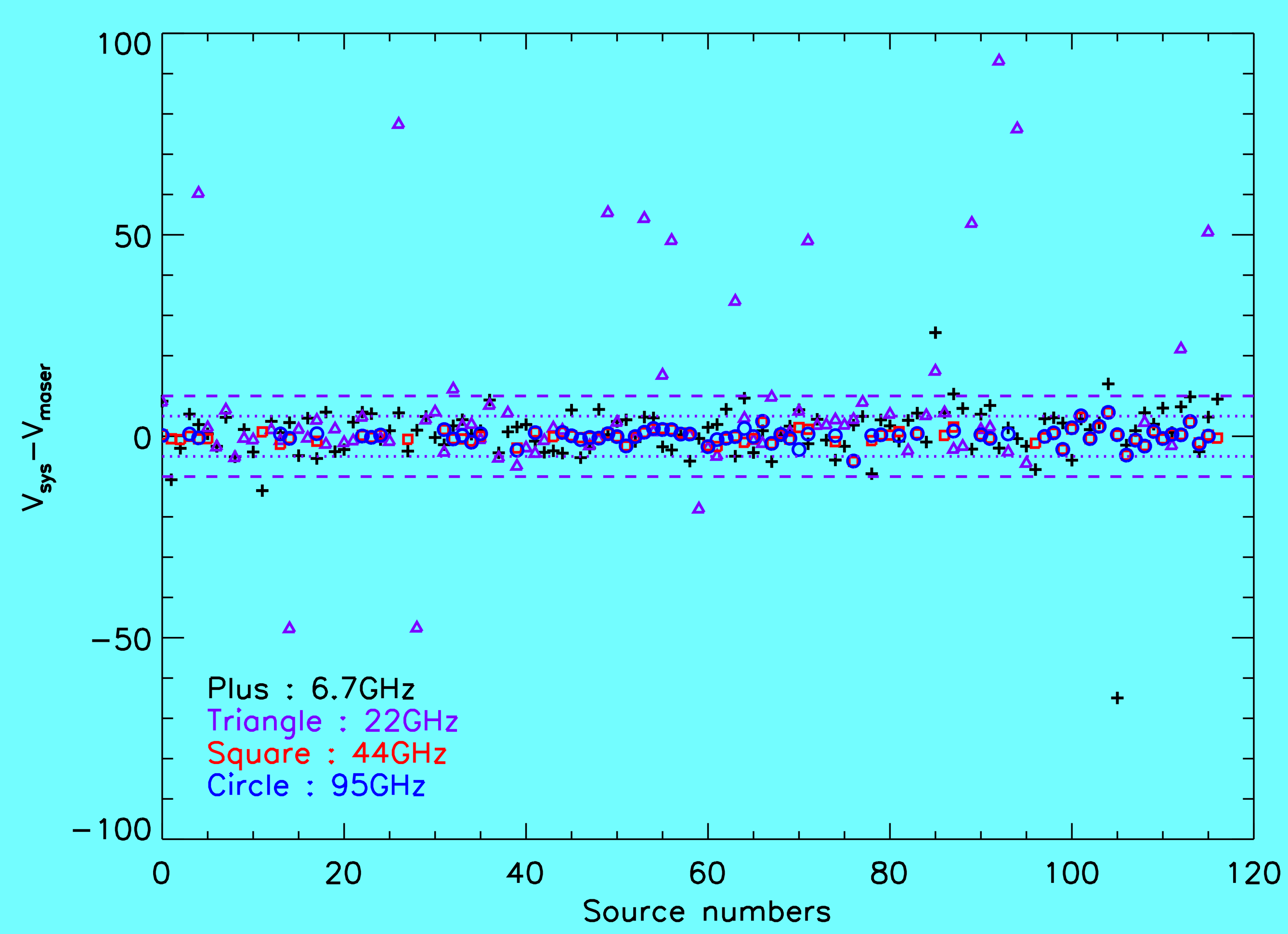
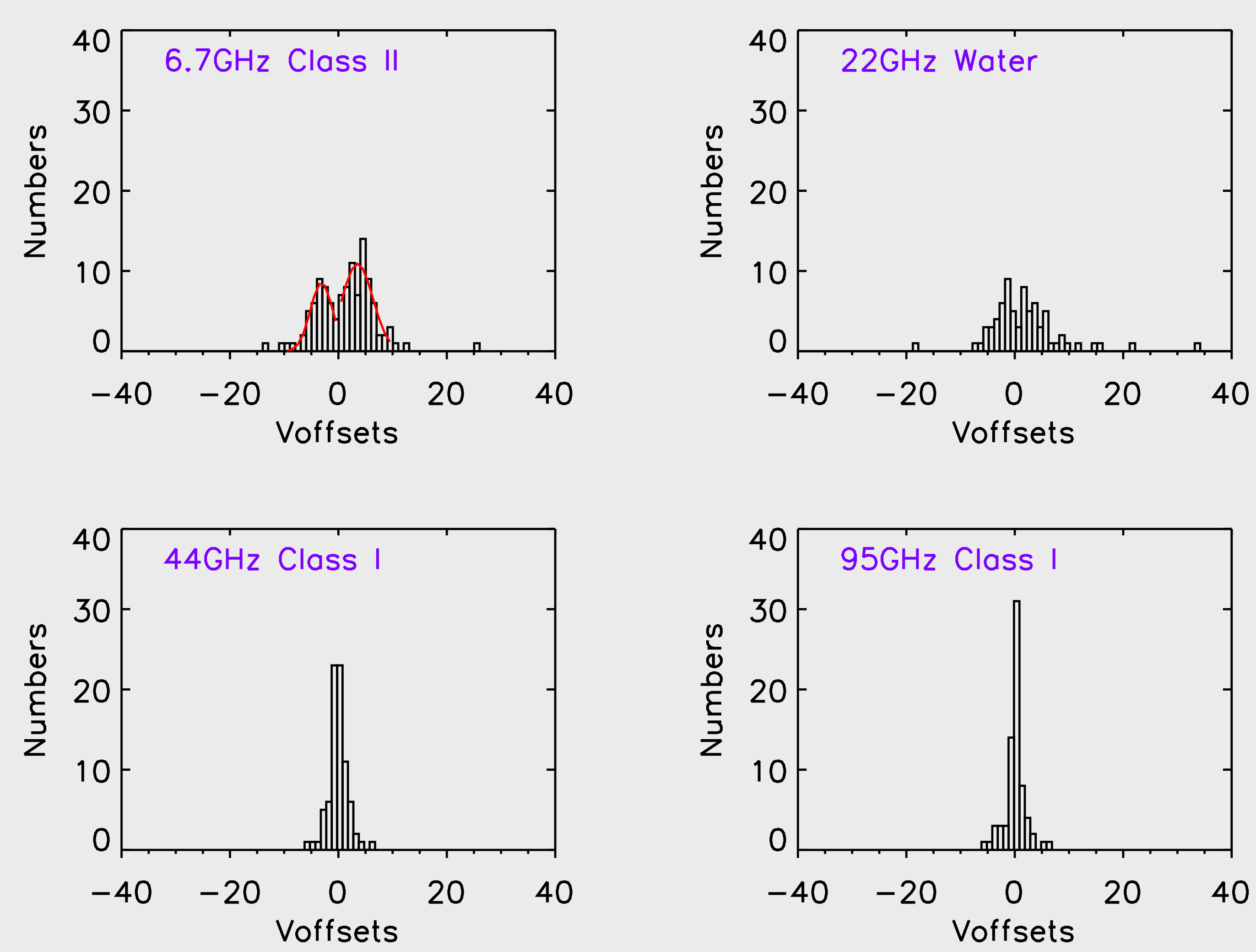
Analysis

Velocities offsets



Velocities of 44GHz and 95GHz class I methanol masers are almost aligned within 5Km/s. Water maser shows various dispersion and class II methanol maser velocity also show aligned shape but not same with class I methanol masers.

Histogram of velocities offsets



44GHz and 95GHz class I methanol masers are aligned V_{sys} well, almost within 5km/s. Specially, 6.7GHz class II methanol maser velocity offset shows double peak. Class II methanol maser seems related with circumstellar disc or torus(Bartkiewicz et al. 2008) and the shapes were also seen at Byun et al. (2012). Peak positions of two gaussian profiles are at -3.1 and 3.5. Also, water maser is related with outflows and the histogram show weak two peaks, but more detail can be known via interferometry observations toward the related sources.

Comparisons between 44GHz and 95GHz class I methanol masers

44GHz and 95GHz class I methanol maser shows strong correlations between themselves. Even peak velocity positions are very close, mean V_{peak} offset is -0.1km/s with 1.0 standard deviation.

Peak flux comparison shows,

$S_{peak}(95) = 0.67\ S_{peak}(44) + 1.0$ (r=0.91)

and,

integrated flux comparison shows,

$S_{int}(95) = 0.90\ S_{int}(44) + 1.7$ (r=0.97)

Slopes are higher than 0.32 and 0.52(Val'tts et al.(2000)), respectively.