No Microwave Flare of Sgr A* around the G2 Periastron Passing

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Sagittarius A* (Sgr A*) is a compact source from radio to X-ray associated with the Galactic center super massive black hole (GCBH), which is located just at the dynamical center of the Galaxy (Reid & Brunthaler 2004) and has the mass of 4 x10^6 M☉ (Ghez et al. 2009, Gillessen et al. 2010). The observed size of Sgr A* is proportional to inverse square of observation frequency ∆θ[mas]= 1.3λ⁻² (Lo et al. 1985). The relation indicates that the real picture of Sgr A* has been hidden by electron scattering around Sgr A* although submillimeter VLBI is now developing quickly (Doeleman et al. 2008). Recently it is found by IR precision astrometry observation that a small gas cloud is approaching Sgr A* (Gillessen et al. 2012). The cloud, called “G2”, has the estimated mass of 3 M☉. And the G2 will come closer the periastron distance of ~2000 Rs in the spring of 2014 (Gillessen et al. 2013, Phifer et al. 2013). The approaching of the G2 cloud to Sgr A* is a golden opportunity to explore the vicinity of the GCBH using a test probe. There are some predictions of increase in emission from Sgr A* induced by the interaction of the G2 with the prior existing accretion disk (e.g. Narayan et al. 2012, Sadowski et al. 2013). The G2 is expected to be a gas cloud or a star with dusty envelop (e.g. Scoville,N & Burkert, 2012). Although the nature of the G2 is still in controversy, it is understandable that the G2 may give some perturbation to the accretion disk around the GCBH because the G2 is somewhat extended. If any increase begins, it is very important for study of the mechanism of the event to observe the initial raising phase by ourself and to alert world-wide community to observe it. After the event, jet eruptions might occur from Sgr A*.

We have been daily monitoring Sgr A* at 22 GHz since Feb. 2013 with a sub-array of Japanese VLBI Network (JVN) (ATEL#4923, #5013) in order to explore the flux density variability with the G2 cloud approaching. The sub-array consists of Mizusawa 10-m RT, Takahagi /Hitachi 32-m RT, and Gifu 11-m RT. Tsukuba 32-m RT and Kashima 34-m RT have joined it sometimes. A software correlator at ISAS, which was originally developed in NICT (Kondo et al. 2012), is used to deal with the daily data in the day. The system noise temperatures of these are 100-200 K except summer season. At least three quasars including
NRAO530 are observed as flux calibrators in the monitor. The integration time is 10 minute for an object in a day. NRAO530 is a bright QSO and located nearby Sgr A*, but certainly variable in the timescale of several months. Unfortunately, all antennas of the subset don’t have a beam switch system for measurement of total flux density. Their flux densities are calibrated by the comparison with NGC7027 with the Nobeyama 45-m telescope in order to guarantee the absolute flux density accuracy during the periastron passing. NGC7027 is a bright young planetary nebula with the flux density of 5.5 Jy at 22 GHz.

The flux density at 22 GHz of Sgr A* had been monitored for 3 years with VLA (Herrnstein et al. 2004); \( S_v = 0.93^{+0.16}_{-0.09} \) Jy Sgr A* seems to be in quiescent phase at the frequency in the observation duration. The standard deviation of the measured flux densities is only \( 1\sigma = 17\% \). The variability within \( 5\sigma = 86\% \) cannot be distinguished from the ordinary activity of Sgr A*. Therefore we set twice increase as our criterion for the alert.

The angular size of Sgr A* is expected to be 2 mas by the relation mentioned above. Because the sub-array has projected baselines of 90-140 km or the beam size (fringe spacing) is about 25 mas, we can observe the flux density of Sgr A* avoiding the decrease by partially resolved-out. On the other hand, Sgr A* is embedded in the strong extended emission surrounding it. The high spatial resolution can selectively observe the flux density of Sgr A* itself suppressing the contamination from the extended structure. Because we don’t know when the increase will occur fundamentally, continuous monitor is valuable. In addition, the observation frequency of 22 GHz is expected to be fairly available even in summer of Japan although there is a large year-to-year variation in the weather condition. Therefore, the sub-array is suitable for the daily flux density monitor of Sgr A*.

\[ S_v = 0.93^{+0.16}_{-0.09} \] Jy

\[ 1\sigma = 17\% \]

\[ 5\sigma = 86\% \]

\[ SgrA*MONITOR \]

\[ \text{Flux density at 22 GHz (Jy)} \]

\[ \text{DOY(from 2013 Jan. 1)} \]

\[ \text{PRELIMINARY} \]

Fig.1 Light curve of Sgr A* at 22 GHz
The radio flux of Sgr A* must be emitted just around the GCBH, although the origin of the flux have remained controversial. On the other hand, an induced synchrotron flux with the G2 cloud approaching must be centered at the contact point between the G2 gas cloud and the accretion disk around the GCBH. The angular separation between Sgr A* itself and the possible bright spot is expected to be up to 25 mas at the G2 periastron assuming that the Galactic center distance is 8 kpc. The two spots may be detected separately by the sub-array. If so, this proves that such electron acceleration is occurred by the interaction.

Figure 1 shows the result of this monitor up to July 4, the elapsed days of 550 days from 1 Jan, 2013. The average flux density in DOY (210) = 40—505 day is $S_\nu = 1.17 +/- 0.30$ Jy. The number in the parenthesis is number of observation epochs in the observation period. The error shows the standard deviation of the observed flux densities. Although the average and the standard deviation are slightly larger than previously observed values (Herrnstein et al. 2004), they are still consistent with them. Then we conclude that Sgr A* at 22 GHz had been in quiescent phase around the G2 periastron passing.

References
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