The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus
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Flux monitoring observations of Sgr A* at 8 GHz and 2 GHz with the NICT Kashima–Koganei VLBI System

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Abstract. We have been conducting flux monitoring observations of Sgr A* at 8 GHz and 2 GHz using the NICT Kashima-Koganei VLBI system (109 km baseline) since mid-February 2013. The primary objective of the monitoring is a search for flux variation which is expected to be caused by the interaction between the G2 cloud and the accretion disk. Until 2013 September 22, we observed Sgr A* for 39 days, five hours on each day. Four quasars (NRAO 530, PKS 1622−253, PKS 1622−297, PKS 1921−293) were also observed as flux calibrators every 6 minutes. No significant change nor variation has been detected in the 8 GHz flux density of Sgr A*. The 8 GHz flux density was 0.81 ± 0.07 Jy (preliminary), while no significant 2 GHz emission was detected by our system. We will continue monitoring as often as possible until at least 2014 May.

Keywords. Galaxy: center — Galaxy: nucleus — radio continuum: galaxies

1. Introduction

The Milky Way Galaxy has a $4 \times 10^6 M_\odot$ SMBH at its center, which is recognized as a compact radio source Sgr A*. Despite its huge mass, Sgr A* is extremely dim and quiet. This extreme dimness suggests a very low mass accretion rate ($< 10^{-5} M_\odot$ yr^{-1}), and thereby a low radiation efficiency. On the other hand, the widespread ($\sim$ 200 pc) distribution of Fe 6.4 keV fluorescent line emission implies that Sgr A* was far brighter ($\sim 10^{39}$ erg s^{-1}) than now about several hundred years ago (Ryu *et al.* 2012). It is possible that currently inactive Sgr A* may be active sometimes. Such variations may be caused by intermittent accretion of interstellar gas onto the central SMBH. Recently, the Max-Plank-Institut für extraterrestrische Physik (MPE) group has reported the discovery of a dense gas cloud, G2, which is on its way toward Sgr A* (Gillessen *et al.* 2012). This cloud's mass is approximately three times as the mass of the Earth. The G2 cloud is on the elliptical orbit with high eccentricity and thought to reach the pericenter, $\sim$ 2400 Schwarzschild radii from the nucleus, in spring 2014 (Gillessen *et al.* 2013; Phifer *et al.* 2013). The G2 cloud has been stretched and will be disrupted by the strong tidal force from the central SMBH. The tidal disruption of the G2 cloud will increase mass accretion rate onto the central SMBH, causing a flare in multi-wavelengths. The interaction between hot plasma around Sgr A* and the G2 cloud may cause a bow shock, accelerating electrons, which emit synchrotron radiation in centimeter wavelength (Narayan *et al.* 2012; Crumley & Kumar 2013).

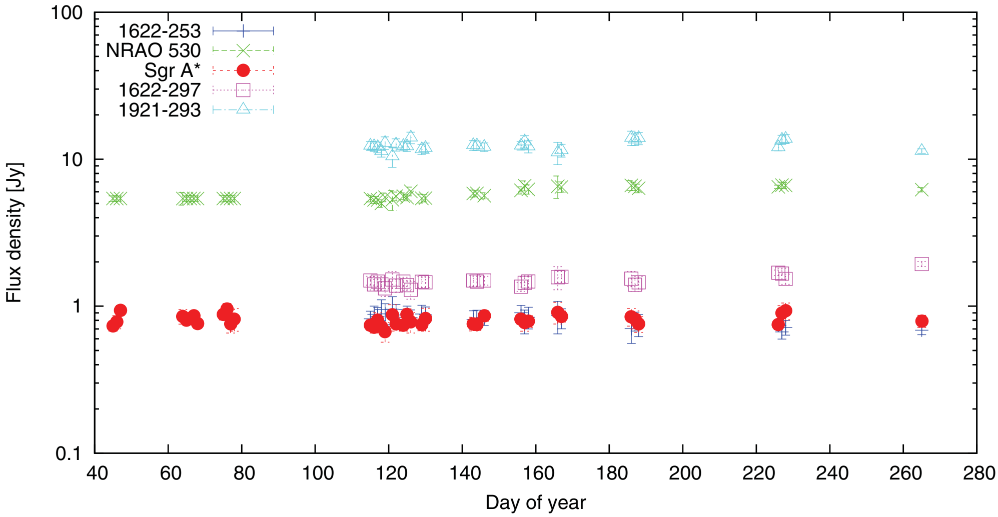

Figure 1. Flux densities at 8 GHz. These fluxes are values averaged over each observing day. Error bars show 1σ standard deviation for each day. [A COLOR VERSION IS AVAILABLE ONLINE.]

2. Observations and preliminary results

In order to search for cm-wave flux variations caused by the G2 event, we have conducted flux monitoring observations of Sgr A* at 8 GHz and 2 GHz using the NICT Kashima–Koganei VLBI system since mid-February 2013. This VLBI system consists of two 11-m diameter antennas which are located at Kashima and Koganei in Japan, and K5/VSSP32 samplers. The baseline length is 109.1 km. Observing frequencies are 2.21-2.29 GHz and 8.2-8.5 GHz. The spatial resolutions of this VLBI system are $\simeq$ 250 mas and $\simeq$ 70 mas at 2 GHz and 8 GHz, respectively. Until 2013 September 22, we observed Sgr A* for 39 days in total, about five hours ($EL > 15°$) each day. From day-of-year (DOY) 78, four quasars (NRAO 530, PKS 1622−253, PKS 1622−297, PKS 1921−293) are observed as flux calibrators, while only NRAO 530 had been used before DOY 78. The integration times are, 300s, 30s, 240s, 240s, and 30s, for Sgr A*, NRAO 530, PKS 1622−253, PKS 1622−297 and PKS 1921−293, respectively, in each observing sequence. All the sources were observed by turns in the five hours observing.

Figure 1 shows a plot of flux densities of Sgr A* and the calibrators at 8 GHz. No significant emission at 2 GHz was detected. We determined Sgr A*'s flux by using the correlation amplitudes of calibrators, and NRAO 530's 8 GHz flux of 5.4 Jy (Healey *et al.* 2007). Note that quasars are variable in every wavelength, thus the flux calibration method employed here is a bit controversial. Nevertheless, the 8 GHz flux of Sgr A* is really stable, exhibiting no significant flares or variations. We obtained the average 8 GHz Sgr A* flux to be 0.81 ± 0.07 Jy as a preliminary value. We plan to continue the monitoring as often as possible until at least 2014 May.

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