A Giant Step: from Milli- to Micro-arcsecond Astrometry
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# The 3-mm flux density monitoring of Sagittarius A* with the ATCA

**J. Li[1,3], Z. Q. Shen[1,2], A. Miyazaki[4], M. Miyoshi[4], T. Tsutsumi[4], M. Tsuboi[5], L. Huang[1,3], and B. Sault[6]**

[1]Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai 200030, China
email: lijuan@shao.ac.cn

[2]Joint Institute for Galaxy and Cosmology of ShAO and USTC, Shanghai 200030, China

[3] Graduate School of the Chinese Academy of Sciences, Beijing 100039, China

[4] National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

[5] Institute of Space and Astronautical Science, Sagamihara, Kanagawa 229-8510, Japan

[6] University of Melbourne, School of Physics, Parkville, Victoria 3052, Australia

**Abstract.** We have performed monitoring observations of the 3-mm flux density toward the Galactic center compact radio source Sgr A* with the ATCA since 2005 October. It has been found that during several observing epochs Sgr A* was quite active, showing significant intraday variation. Here we report the detection of an IDV in Sgr A* on 2006 August 13, which exhibits a 27% fractional variation in about 2 hrs.

**Keywords.** Galaxy: center, techniques: interferometric

## 1. Introduction

There is compelling evidence that Sagittarius A* (Sgr A*), the extremely compact radio source at the dynamical center of the Galaxy, is associated with a massive black hole of $4 \times 10^6$ solar masses. Since its discovery in 1974, Sgr A* has been observed with radio telescopes in the northern hemisphere, and temporal flux variations were reported (see, e.g., 7- and 13-mm VLA observations by Yusef-Zadeh *et al.* 2006, 3-mm OVRO by Mauerhan *et al.* 2005, 2-mm NMA by Miyazaki *et al.* 2004, 0.8-mm SMA by Marrone *et al.* 2006). On the other hand, X-ray and infrared flares have also been detected (Genzel *et al.* 2003, Baganoff *et al.* 2001), indicating very short timescales and violent intensity increases. Since Sgr A* is embedded in thick thermal material, it is particularly difficult to observe its structure, thus IDV observation can give indirect constraints on the source emission geometry and emission mechanisms.

Since 2005 October we have performed several epochs of flux density monitoring toward Sgr A* at 3-mm using the ATCA, a five 22-m dish interferometer at Narrabri, Australia where Sgr A* passes almost overhead, allowing a longer observing window ($>$ 8 hr with elevation higher than 40°). Thus, the ATCA calibrations and flux measurements of Sgr A* are expected to be more accurate. Here we present preliminary result obtained from the observation on 2006 August 13.

## 2. Observations

On 2006 August 13, we used upper sideband (88.896 GHz) with a bandwidth of 128 MHz for the observation of Sgr A* and other continuum calibrators, and the lower sideband (86.243 GHz) of 32 MHz for SiO maser sources. Quasar 3C 279 was observed as a bandpass calibrator. The instrumental gain and phase were calibrated by alternating

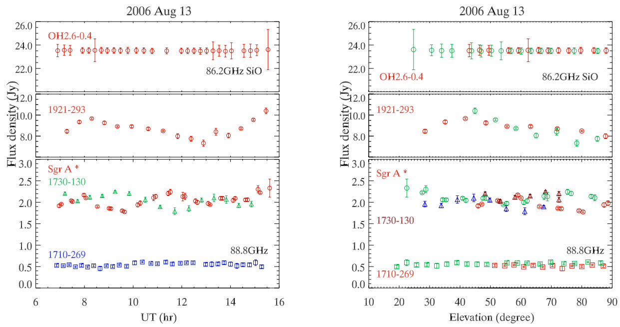

**Figure 1.** Left: ATCA 3-mm light-curves of Sgr A* ('○' in the lower panel), control source OH2.6−0.4 and other calibrators like PKS 1921−293, PKS 1730−130 ('△' in the lower panel), PKS 1710−269 ('□' in the lower panel) on 2006 August 13. Right: the same plot for flux density as a function of elevation angle. Note that different amplitude scales in different panels.

observations of Sgr A* and calibrators (OH2.6−0.4, PKS 1710−269 and PKS 1730−130). The pointing accuracy was checked by observing VX Sgr every half an hour.

## 3. Data analysis and preliminary results

All the data processing was conducted using the MIRIAD package. For the amplitude calibration, we first applied the nominal elevation-dependent gains and then used calibrators to determine the necessary corrections. However, calibrators are, in general, variable sources which will cause uncertainties in the gain correction. Therefore, different secondary calibrators (as control sources) were tried to check the consistency of the gain calibrations. Later, we further compare the fractional gain correction for each antenna with the fractional variation in Sgr A* to make sure that the detected variation is real. The calibrated data were then averaged in a 5-minute bins to search for a shorter timescale variability. The flux measurements of Sgr A* were estimated by fitting a point source model to visibility data on the projected baselines longer than 25k$\lambda$ (or 85 m at 3-mm) to suppress the contamination from the surrounding extended components. Both the fitting error and the rms of the residual were used to get the error estimate.

As a result, we show light-curves of Sgr A* and calibrators on 2006 August 13 at 3-mm in Figure 1. It can be clearly seen that Sgr A* has undergone a flux density variation with a fractional variability of 27% in a timescale of about 2 hrs. This timescale for the rise and fall is consistent with the previous observations at 3-mm (Mauerhan *et al.* 2005).

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