# MULTI-WAVELENGTH VLBA MAPPING OF SGR A*

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## 1. Introduction

Sgr A*, the enigmatic compact nonthermal radio source located at the center of the Galaxy for many years has been considered as the signpost of a massive black hole (Rees 1982; Lo 1986; Falcke *et al.* 1997). Its properties are unique in the Galaxy, but it resembles other nuclear radio sources (Lo 1993). Efforts to delineate the source structure of Sgr A*, in order to constraint the nature of the underlying energy source, have been ongoing since 1975 (Lo *et al.* 1975).

Recent proper motion and radial velocity measurements of the stars in the immediate neighbourhood of Sgr A* have provided very convincing evidence for the existence of a compact dark mass of $2.5 \times 10^6$ $M_\odot$ near Sgr A* (Eckart & Genzel 1997) and that Sgr A* is at least as massive as $10^5$ $M_\odot$. Since the scale size of Sgr A* is between $10^{12}$ and $10^{13}$ cm, it is even more compelling to determine the radio source structure of Sgr A*. Higher angular resolution VLBI imaging study of Sgr A* is the only way to probe directly the region between 1 to 10 times the Schwarzschild radius of a $3 \times 10^6$ $M_\odot$ black hole.

## 2. VLBA maps of Sgr A* at 6, 3.6, 2.0, 1.35 and 0.7 cm

Multi-wavelength (6, 3.6, 2.0, 1.35 and 0.7 cm) VLBA+Y1 observations of Sgr A* were carried out near simultaneously in February 1997. All the post-correlation data reduction (edition, opacity correction, calibration, fringefitting and imaging) were carried out at NRAO AOC, Socorro. Figure 1 (left) is a "map" of Sgr A* at 0.7 cm. It shows an elongated source with little apparent structure. The jet structure claimed by Krichbaum *et al.* (1993) is not confirmed. The maps at the other wavelengths can all be described by an elongated source with similar axial ratio and position angle of the



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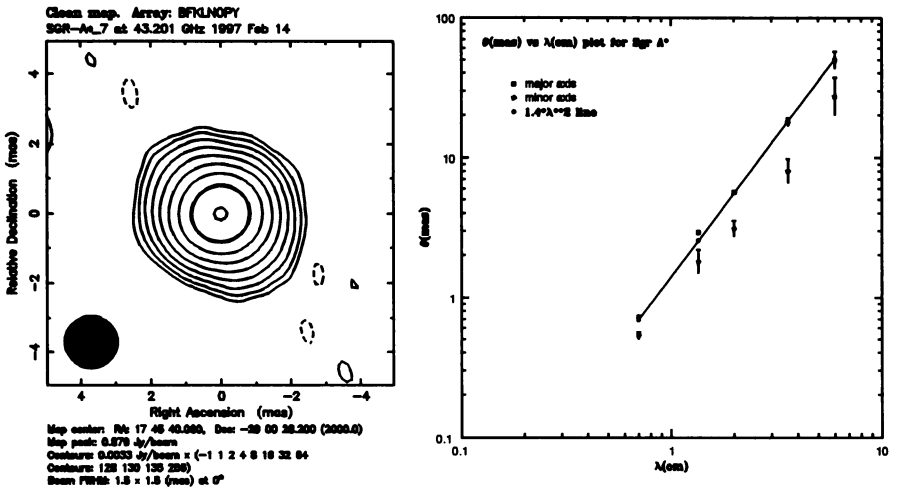


*Figure 1.* (left): the image of Sgr A* at 0.7 cm. (right): the plot of measured angular size of Sgr A* versus wavelength.

major axis. In figure 1 (right), the major and minor axes of Sgr A* are plotted as a function of observing wavelength, and is compared to a curve representing 1.4 $\lambda^2$ (Rogers *et al.* 1994). A fit of the minor axes may show a dependence deviating from $\lambda^2$.

The accepted interpretation of the $\lambda^2$ dependence is that the observed source structure is due to interstellar scattering of an unresolved source. The minor axis of the observed 7 mm map is about twice the upper limit to the intrinsic source size of Sgr A*. This upper limit is 0.2 mas or $2.6 \times 10^{13}$ cm (Rogers *et al.* 1994). Note that the size is 35 times the Schwarzschild radius of a $2.5 \times 10^6$ $M_\odot$ black hole.

Future observations of Sgr A* include: (1) mapping at shorter wavelength (e.g. 3 mm) is needed to reach the intrinsic structure, (2) structure variation of Sgr A* with time and possible correlation with outbursts, (3) astrometry of Sgr A* at various wavelengths, and (4) polarization search.

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