An X-Ray, Infrared, and Submillimeter Flare of Sagittarius A*

D. P. Marrone, F. K. Baganoff, M. R. Morris, J. M. Moran, A. M. Ghez, S. D. Hornstein, C. D. Dowell, D. J. Muñoz, M. W. Bautz, G. R. Ricker, W. N. Brandt, G. P. Garmire, J. R. Lu, K. Matthews, J.-H. Zhao, R. Rao, and G. C. Bower

Astrophysical Journal, **682**, 373–383 (2008)

Abstract.

Energetic flares are observed in the Galactic supermassive black hole Sagittarius A* from radio to X-ray wavelengths. On a few occasions, simultaneous flares have been detected in IR and X-ray observations, but clear counterparts at longer wavelengths have not been seen. We present a flare observed over several hours on 2006 July 17 with the Chandra X-Ray Observatory, the Keck II telescope, the Caltech Submillimeter Observatory, and the Submillimeter Array. All telescopes observed strong flare events, but the submillimeter peak is found to occur nearly 100 minutes after the X-ray peak. Submillimeter polarization data show linear polarization in the excess flare emission, increasing from 9% to 17% as the flare passes through its peak, consistent with a transition from optically thick to thin synchrotron emission. The temporal and spectral behaviors of the flare require that the energetic electrons responsible for the emission cool faster than expected from their radiative output. This is consistent with adiabatic cooling in an expanding emission region, with X-rays produced through self-Compton scattering, although not consistent with the simplest model of such expansion. We also present a submillimeter flare that followed a bright IR flare on 2005 July 31. Compared to 2006, this event had a larger peak IR flux and similar submillimeter flux, but it lacked measurable X-ray emission. It also showed a shorter delay between the IR and submillimeter peaks. Based on these events, we propose a synchrotron and self-Compton model to relate the submillimeter lag and the variable IR/X-ray luminosity ratio.

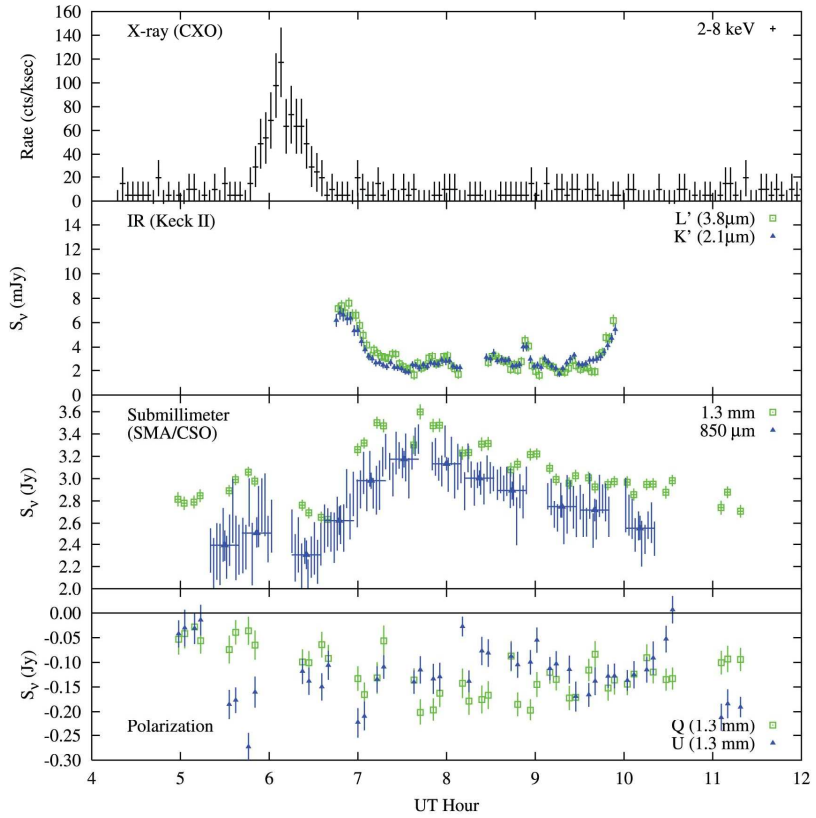

FIG. 3.—Flux density observed during the 2006 July 17 flare in all three bands. For the CSO 850 μm data the flux density measurements are shown at their full temporal resolution (*vertical bars*) and rebinned into 10 minute averages. The zero point of the 850 μm flux density scale is uncertain by 1 Jy due to confusion with the surrounding dust emission. The 1.3 mm polarization measured by the SMA is shown in the bottom panel.