Search for Scattered Radio Transients in the Galactic Center using Archival VLA Data

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We discuss an ongoing search for radio transients in the Galactic center using over 20 years of archival imaging data from the Very Large Array (VLA). The Galactic center is expected to harbor a population of radio pulsars, some of which may produce the very luminous "giant pulses" observed in a subset of pulsars. This region also has a high stellar density with a central supermassive black hole, which provides a uniquely rich environment for stellar interactions, tidal disruption events, flares from neutron stars, and other classes of transient events.

The VLA has been used to study short-duration transients (such as giant pulses from the Crab pulsar), but usually only in phased-array mode. For imaging data, the typical correlator integration times are around 10 s while many interesting astrophysical transients have intrinsic durations of $\ll 1$ s. However, any short-duration radio transient produced in or beyond the Galactic center will be temporally broadened as a result of the multipath scattering of radio waves in a turbulent plasma. For a pulse emitted at Sgr A*, the scattering timescale is $\tau_{\rm sc} \approx 2300\nu_{\rm GHz}^{-4}$ s with $\nu_{\rm GHz}$ in GHz. At 5 GHz, this gives a pulse width of about 5 s, which roughly corresponds to the correlator integration time. Similar results are applicable for any pulse emitted within the hyperstrong scattering region of the inner Galaxy, which is about 30 arcmin in extent (projected distance of 75 pc at 8.5 kpc) and centered on Sgr A*.

Two independent processing approaches are currently being used to search for transients in the archival 5 GHz data sets. In the first approach, calibrated u-v data are taken directly from the archival data products produced by the VLA automated processing pipeline. From the u-v data, we divide up the observation into 10 s intervals and produce an image for each interval. Statistics are calculated for each 10 s snapshot and for the observation as a whole. Transients are identified as statistically significant deviations from the noise in each image.

In the second approach, raw u-v data from the VLA archive are calibrated and imaged and a source model is developed using CLEAN components from the entire image. The model-subtracted u-v data is imaged in 10 s intervals and transients are again identified as statistically significant deviations from the noise in each image. Although still preliminary, this second approach has produced a promising transient candidate that appears to be celestial.

Ultimately, we will determine the optimal analysis method and use it to search for transients in all of the archival VLA data of the Galactic center at 5 GHz. This search will then be extended to data sets at observing frequencies of 1.5 GHz and 8.5 GHz.