Pulsar Timing and Searching with the Janksy VLA

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The nearly-completed Karl G. Jansky Very Large Array (VLA) represents an order-of-magnitude improvement over the “old” VLA, with sensitive octave-bandwidth receivers and a new correlator capable of processing up to 8 GHz total bandwidth. Due to these improvements and a total collecting area approximately equivalent to a 130-m diameter single dish, the VLA now has potential to be a world-class pulsar instrument. Here, we will present the scientific motivations, design and initial results from a flexible software-based pulsar observing system currently being installed using pre-existing computing resources at the VLA.

To date, radio pulsar science has been dominated by observations performed using large single-dish radio telescopes. Due primarily to computational constraints for these kinds of observations, interferometers have previously not been competitive with the wide bandwidths available from modern receivers and digital pulsar backends on single-dish telescopes. However, the situation is now changing, and nearly all future large-area radio telescopes (e.g. SKA) are expected to be array instruments. In addition to its immediate use for pulsar studies, our work on the VLA will be important for building experience routinely observing pulsars with a large array instrument.

Our initial system targets “phased array” style observations, in which the signals from each antenna are coherently added to form a single beam on the sky. This is ideal for timing observations in which pulsars with accurately known positions are monitored for years or decades in order to study their binary properties, explore the nature of dense neutron star matter, test general relativity, and possibly directly detect gravitational radiation. Phased array observing can also be used for targeted searches for pulsars in locations such as the galactic center. In our system, the phased data from the correlator are sent over ethernet to a computer cluster that performs filterbank, coherent dedispersion, and/or pulse period folding in real time software. The software architecture is a combination of flexible data aquisition code developed for the GUPPI pulsar instrument and the community-developed DSPSR pulsar signal processing library, both publicly-available open-source software packages. In the final configuration we expect to process up to 2 GHz of radio bandwidth in real time, primarily limited by data transfer rates over the network.