URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Fast Radio Bursts with the Deep Synoptic Array

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Despite the accumulation of over 100 fast radio burst (FRB) detections[1], the nature of these bright, ms-duration flashes of radio emission originating from beyond the Milky Way remains uncertain. The most compelling clues come from the handful of bursts associated with host galaxies, but FRB hosts and local environments present a complex picture. While the first FRB to be localized is found in a star-forming dwarf galaxy [1], others have been localized to much more massive galaxies [2, 3]. With limited localizations available, the conclusions of statistical comparisons of FRB hosts and environments to other extragalactic transients remain in debate. Furthermore, the exploitation of FRBs as probes of ionized matter in order to study the interstellar media and halos of distant galaxies and constrain the distribution of baryons within the Universe rely on more than tens to hundreds of localized bursts with redshift determinations.

Although the first FRB localizations were achieved through detections of repeat bursts during interferometric follow-up campaigns, localizing non-repeating FRB sources is possible only through interferometric FRB searches. To date only six sources have been discovered by interferometers and localized to arcsecond precision. The Deep Synoptic Array (DSA, Fig. 1) will detect over one hundred fast radio bursts each year, and localize them to better than ± 1.5-arcsecond precision. Constructed at the Owens Valley Radio Observatory in California, the DSA will consist of 110 4.65-m dishes observing at 1.4 GHz. The 11.3 deg^2 field of view is searched coherently using the core 95 dishes of the array. After detection, localizations are derived from images generated using all baselines in the 2.5-km region. The DSA will deliver accurate FRB localizations to the community within 60 seconds to enable rapid multi-wavelength follow-up, host galaxy associations and redshift determinations. Retaining full-polarization voltages for each candidate burst will allow detailed analysis of intrinsic burst properties and propagation effects. Commissioning and early science with a 25-antenna array began in late 2020. Early characterization of the system shows above-expected performance, with system temperatures < 30 K. Construction to a 63-element array, and the full 110-element array are ongoing.

Figure 1. Four antennas of the deep synoptic array during construction in July 2020.

References

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