Realfast All the Time with the Very Large Array

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1. Extended Abstract

Fast radio bursts (FRBs) are millisecond-duration radio transients that are uniquely tuned to probing extragalactic media. Their rapid flashes are inherent to dynamic, spatially coherent processes from small emission regions, while their radio waves are strongly influenced by the ionized gas that pervades galaxies and the space between them. Information about these plasmas is encoded into the bursts' scattering, dispersion, scintillation, and polarization, all of which are which are directly measurable by radio telescopes. These measurements alone tell us some information about the burst source and location. However, when an FRB can be *precisely localized* (i.e. to better than ~arcsecond precision; Fig. 1), a host can be identified and these measurements can be used to infer densities, measure sizes, and study structure and magnetic fields of the intervening media.

Using FRBs for this science and uncovering FRB progenitors (i.e. studying their host galaxy properties, offsets from host galaxies, distribution with distance, and identifying multi-wavelength counterparts) are most directly achieved by localizing FRB detections to a host galaxy. However, past efforts have largely focused on FRB detection with single-dish antennae, whose localization capabilities are limited to a few arcminutes on the sky. In Figure 1, we show that for confident localization to a single galactic host, approximately arcsecond or better localization precision must be achieved; this limits host identification as something that requires interferometric detection of FRBs to be performed.

The *Realfast* FRB detection system on the Very Large Array is being designed to 1) perform fast imaging of dedispersed data on the VLA; 2) detect and precisely localize FRBs in real time; and 3) ultimately run as a commensal program, performing FRB searches at a diverse range of frequencies and target fields. A prototype CPU-based system has been commissioned and has thus far taken approximately 400 hours of FRB search data [1, 2], and has been successfully demonstrated by detecting and localizing several pulsars and RRATs [3]. In late 2016, *Realfast* performed the first FRB localization, pinning down the repeating FRB121102 to a precision of 0.2", which enabled the identification of its host: a dwarf galaxy at redshift z = 0.193.

Our presentation will review the development of the *Realfast* system, its status and plans for commensal observing, and demonstrate its scientific successes thus far, including an exploration of FRB relationship to star formation rate, and results related to the localization of FRB121102.

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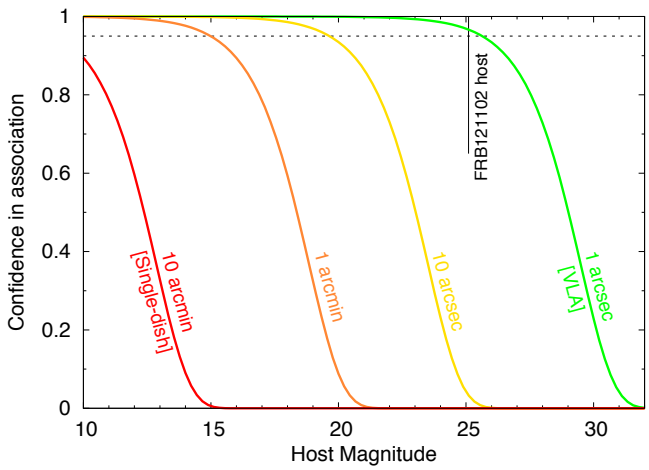

Figure 1. Following from past formulations of occurrence rates of galaxies with optical magnitude [ref], here we show the confidence in association of an FRB as a function of typical host magnitude. To securely tie an FRB to an individual host galaxy, sub-arcsecond localization precision should be performed. This is highlighted by the relatively nearby but faint dwarf galaxy host of FRB121102.

4. References

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