ngLOBO High Resolution, Low-Frequency Imaging and High-z HI Cosmology: The Long View Towards Instrumental Convergence

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The field of low-frequency radio astronomy is experiencing a wonderful renaissance, that has led to many new and planned aperture array-based instruments, ranging in size from small and medium (e.g. LWA, MWA) to large (e.g. LOFAR, ngLOBO, LFAA). At the same time, existing instruments are undergoing major upgrades (e.g. uGMRT) and commensal modifications (e.g. VLITE on the JVLA). The reemergence of this long-neglected field, in which radio astronomy was born, is driven by two distinct scientific themes. One is spectral line cosmology, linked predominantly to the search for high redshift hydrogen. While predictions go back decades, the seminal paper by Shaver et al. (1999) significantly rekindled interest. Coincidentally at about the same time, self-calibration on the VLA demonstrated that the severe confusion limit blinding low frequency interferometry could be overcome, opening a path to sub-arcminute resolution imaging comparable to that pioneered by the VLA at cm-wavelengths a decade earlier.

Influenced partly by political considerations, the two scientific themes have often been packaged together into the push for a single instrumental concept. This is problematic, since the cosmology requires the high surface brightness of a condensed aperture (< 3 km), while high angular resolution imaging requires a much larger one (> 300 km). Progress on the cosmology front currently benefits from an experimental approach to instrument design, while high angular resolution imaging already fits into a more traditional, observatory-class user facility, such as planned for the ngVLA. An efficient realization of the latter is ngLOBO, a planned suite of low frequency detectors embedded in the ngVLA infrastructure and operating commensally. Trying to achieve both the cosmology and imaging concepts too early in a single instrument, barring unlimited funding, risks fragmenting critical scientific advocacy groups.

Instrumental convergence across cosmology and imaging makes more sense in the longer term, after two key mid-term goals are achieved. First, the field needs to be explored at high resolution by an ngLOBO-class imaging instrument achieving wide-field, angle-variant ionospheric calibration. Equally or more important, the EOR and/or Dark Ages signature must be detected from the ground (e.g. by HERA) or from space (e.g. by DARE). With more precise knowledge to limit the design options, it is conceivable both themes could merge. ngLOBO could benefit from a condensed core for increased surface brightness sensitivity. From the other direction, once global HI is detected, low frequency cosmology will need a more extended aperture for imaging. At this future stage, the two instrumental approaches could converge.