Building the Science Program for the Next Generation VLA

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Inspired by dramatic discoveries from the Jansky Very Large Array, and the Atacama Large Millimeter Array, the astronomy community is considering a future large area radio array: the 'Next Generation Very Large Array' (ngVLA). The design entails an interferometric array with 10 times larger effective collecting area and 10 times higher spatial resolution than the current VLA and ALMA, optimized for operation in the frequency range 10GHz to 50GHz, with reasonable performance over 1.2GHz to 115GHz.

The ngVLA is optimized for observations at wavelengths between the superb performance of ALMA at submm wavelengths, and the future SKA-1 at few centimeter and longer wavelengths. The ngVLA opens a new window on the Universe through ultra-sensitive imaging of thermal line and continuum emission down to milliarcecond resolution, as well as unprecedented broad band continuum polarimetric imaging of non-thermal processes. These capabilities are the only means with which to answer a broad range of paramount questions in modern astronomy, ranging from direct imaging of planet formation in the terrestrial-zone, to studies of dust-obscured star formation and the cosmic baryon cycle back to the first galaxies in the Universe. The ngVLA will implement novel techniques to explore temporal phenomena from milliseconds to years. The ngVLA covers a frequency range which may be optimal for finding the electromagnetic counterparts to gravity wave sources, and to search for pulsars orbiting the supermassive black hole in the Galactic center.

I will describe the science community process that has led to the current baseline design for the ngVLA. I will include a break-down of the key science programs, and how they drive eg. the configuration design. I will also highlight a few of the highest profile science goals, like making movies of terrestrial planet formation and tracing the dense gas history of the Universe.

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc. The work presented was the result of extensive efforts by the science and technical advisory committees, as well as broad participation by the community in the science and technical white papers and community studies. More details can be found at:

https://science.nrao.edu/futures/ngvla

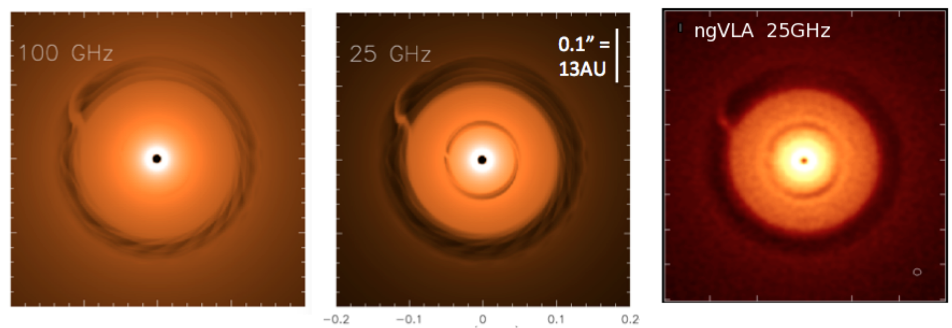

Figure 1: *Models and images of a* ~ 1*Myr old protoplanetary disk, comparable to HL Tau, at a distance of 130pc (ngVLA memo 5). The disk has a mass of 0.1*$M_{\odot}$*, orbiting a 1* $M_{\odot}$ *star. The model includes the formation of a Jupiter mass planet at 13AU radius, and Saturn at 6AU. The left frame shows the model emission at 100GHz, the center frame shows the 25GHz model, and the right shows the ngVLA image for a 100hour observation at 25GHz with 10mas resolution, with a noise of 0.1*μ*Jy, or* $\mathrm{T_B} = 1\mathrm{K}$.

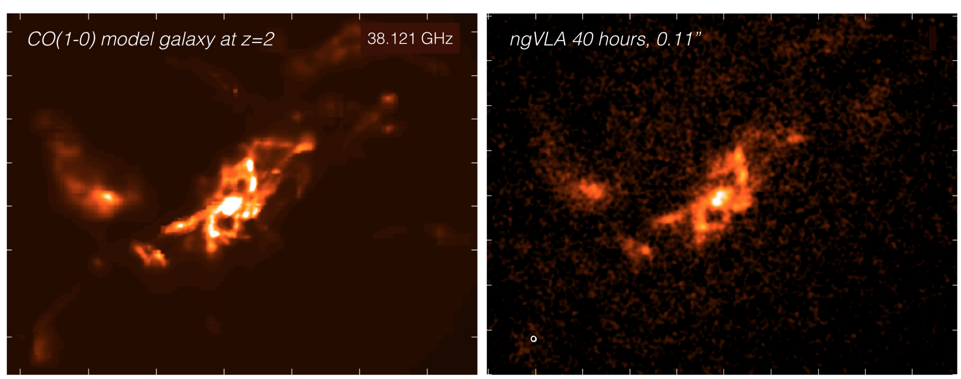

Figure 2: *Left: A model of the integrated CO 1-0 emission from a massive z=2 galaxy from the cosmological zoom simulations of Narayanan et al. (2015). The total SFR* $= 150$ $M_{\odot}$ *year*$^{-1}$*, and the stellar mass* $= 4 \times 10^{11}$ $M_{\odot}$*. The native resolution (pixel size) is 30mas, and the peak brightness temperature is 14K. The fainter regions have* $T_B \geq 0.1K$*. Right: the ngVLA image of the field assuming a 8 x 5hour synthesis using only antennas within a 15km radius (about 50% of the full array for the Clark/Conway configuration, and using Briggs weighting with R=0.5. The rms noise is 5*μ*Jy beam*$^{-1}$*, and the beam size is* 0.11"*. One tick mark = 1". The peak surface brightness is 0.18 mJy beam*$^{-1}$.