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Science Synergies with a next-generation Very Large Array in the 2030's

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The National Radio Astronomy Observatory (NRAO) has engaged the broad scientific and technical communities in the design of a next-generation Very Large Array (ngVLA), a large-scale research infrastructure project under development for the National Science Foundation Astronomical Sciences Division (NSF-AST) through a cooperative agreement with Associated Universities, Inc. Building on the superb cm/mm observing conditions and existing infrastructure of the VLA site, the ngVLA is envisaged as an interferometric array with ten times greater sensitivity and spatial resolution than the current VLA and ALMA, operating in the frequency range of 1.2 – 116 GHz. The ngVLA will also greatly expand current U.S. VLBI capabilities by both replacing existing VLBI antennas/infrastructure with ngVLA technology and adding additional stations on 1000 km baselines to bridge the gap between baselines across the U.S. Southwest and present VLBA baselines.

The ngVLA will be a transformative, multi-disciplinary scientific instrument capable of opening a new window on the Universe through ultra-sensitive imaging of thermal line and continuum emission down to milliarcsecond-scale resolution, as well as unprecedented broad-band continuum polarimetric imaging of non-thermal processes (e.g., the formation and evolution of stellar and supermassive blackholes in the era of multi-messenger astronomy). The ngVLA will be optimized for observations in the spectral region between the superb performance of ALMA at sub-mm wavelengths, and the future Phase I Square Kilometer Array (SKA-1) at decimeter and longer wavelengths, thus lending itself to be highly complementary with these facilities and act as a final piece in a global suite of transformational radio capabilities to be utilized by the entire astronomical community.

The telescope will tackle a vast range of key, outstanding questions in modern astrophysics by simultaneously delivering the capability to: unveil the formation of Solar System analogs on terrestrial scales; probe the initial conditions for planetary systems and life with astrochemistry; chart the assembly, structure, and evolution of galaxies from the first billion years to the present; use pulsars in the Galactic Center as fundamental tests of gravity; and understand the formation and evolution of stellar and supermassive black holes in the era of multi-messenger astronomy. Being highly synergistic with its contemporary facilities in space, on the ground, or underground, the ngVLA will maximize the scientific returns on additional investments made by funding agencies in the U.S. and abroad. In this talk we provide an overview of the broad ngVLA science case, and discuss its complementarity with other instruments and facilities anticipated in the coming two decades.