

NWS17-2017-000010

Abstract for an Invited Paper
for the NWS17 Meeting of
the American Physical Society

Large-scale Structure of the Universe in the Age of Digital Telescopes

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A powerful tool for understanding the Universe is the distribution of matter on scales much larger than galaxies. Observations of the large-scale structure will build on the legacy of cosmic microwave background, probing the Universe in three dimensions, mapping larger volumes, and thus yielding higher precisions. The structures we observe today grew from the gravitational collapse of seed structures laid down in the very early Universe, and that growth was affected by the physical processes that occur throughout its evolution. The detailed statistics of the structure thus contain information about the early Universe, fundamental physics, and the late-time acceleration of the Universe's expansion. The observationally dominant method for mapping large-scale structure is spectroscopic galaxy surveys, where the positions of millions of galaxies are catalogued and aggregated into a statistical sampling of the large-scale structure. However, there are now a number of surveys that will employ the new technique of hydrogen intensity mapping. Such surveys will use the 21 cm radio line from the hyperfine transition in neutral hydrogen to directly image the structure in three dimensions using radio telescopes. Aided by recent technological developments that have enabled a novel design of digital, rapid-survey radio telescope, hydrogen mapping will permit larger volumes to be surveyed, on a greater range of scales, and over many epochs of the Universe's evolution.