New probes of fundamental physics: Utilising small-scale signatures in the Universe

In the upcoming years, the field of cosmology will see a wealth of new and high quality data from the current Stage-3 (and the forthcoming Stage-4) surveys of cosmic microwave background (CMB) and large-scale structure (LSS). In particular, there is overwhelming evidence that measuring the late time effects on the CMB photons (secondaries) will provide new and valuable information for cosmological inference upon cross-correlating with LSS surveys. Simultaneously, surveys of the 21cm hydrogen line will achieve sufficient accuracy for cosmological inference for the first time. In this talk, I will describe how these new cosmological probes will provide opportunities to study fundamental problems. I will focus on a novel probe, the so-called `moving lens effect', a CMB modulation due to changing gravitational potentials as a result of cosmological structure moving transverse to the line of sight (Hotinli 2019, PRL). I will also discuss prospects of utilising velocity acoustic oscillations (`so-called' VAOs) in the 21cm hydrogen. I will describe how these observables can be used to constrain various classes of early Universe models beyond the standard LCDM.