Science with wide spectroscopic surveys

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Abstract

Since the early 2000s, wide spectroscopic surveys, particularly multi-fibre experiments, have yielded significant insights into the three-dimensional distribution of galaxies and quasars in the Universe. These surveys have played a crucial role in constraining cosmological parameters through precise measurements of the baryon acoustic oscillation (BAO) scale and the non-linear growth rate of structure from redshift space distortions (RSD). Pioneering experiments like the 2-degree field galaxy redshift survey (2dFGRS; [5, 4]), and the Sloan Digital Sky Survey (SDSS; [7]) have successfully measured hundreds of thousands of spectra, marking the first detection of Baryonic Acoustic Oscillations and enabling constraints on cosmology with large-scale structures. Over the past two decades, ground-based spectroscopic surveys, notably the SDSS [18, 1, 8, 3], have extended these efforts, accumulating over 3.5 million spectra, including those of luminous red galaxies (LRGs), emission line galaxies (ELGs), and quasi-stellar objects (QSOs) providing constraints on the expansion history of the Universe and the growth rate of structure up to redshift 2.2 [9, 14, 17, 2, 10, 20]. Continuing this trajectory, ongoing and future large multi-fibre experiments, such as the Dark Energy Spectroscopic Instrument (DESI; [6]), the 4-meter Multi-Object Spectroscopic Telescope (4MOST; [19, 15]), and the Subaru Prime Focus Spectrograph (PFS; [16]), are willing to observe an order of magnitude more galaxy and quasar spectra. Their main goals are to constrain the expansion history of the Universe and the growth rate of structure with sub-percent precision over a broad redshift range of $0.1 < z < 3.5$. In addition, these experiments offer opportunities to probe primordial physics, including the constraints on neutrino mass or primordial non-Gaussianity. This talk aims to provide an overview of the ongoing and future experiments of the Stage-IV cosmological spectroscopic surveys, with a particular focus on the scientific objectives of DESI and 4MOST. We will present the results of the first year of DESI observations and the status of 4MOST, which is scheduled to start in early 2025. In addition, we will highlight the synergies between large spectroscopic and photometric surveys, such as *Rubin LSST* [11] or *Euclid* [12], to further improve our understanding of the Universe. Finally, we will present the design and science cases for future Stage-V spectroscopic experiments, such as the Wide-Field Spectrocopic Telescope (WST; [13]).

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