WEAVE-QSO

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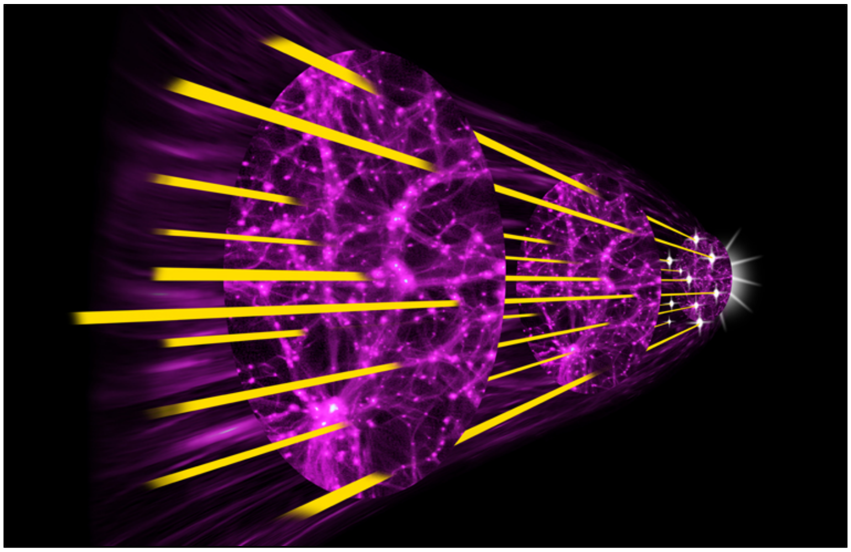
The WEAVE-QSO survey is designed to optimise quasar absorption science through the measurement of Lyman-alpha absorption and other intergalactic medium (IGM) absorbers. The science objectives form two pillars; probing large-scale structures in 3D that traverse lines-of-sight for the measurement of cosmological parameters and large-scale galaxy environments, and probing along the line-of-sight to measure the circumgalactic medium, thermal history and smaller-scale structure cosmology. The former is contingent on WEAVE-QSO's unrivalled number density of Lyman-alpha forest quasars, the latter rests on WEAVE's unprecedented resolution and signal-to-noise as a massive spectroscopic survey.

One of the challenges of our time is determining the cause of the acceleration in the expansion of the universe that we term 'dark energy'. One way to explore this phenomenon is to measure the expansion history of the Universe. There is a convenient standard ruler to achieve this, called Baryon Acoustic Oscillations (BAOs; e.g. Seo & Eisenstein 2003). Measuring the scale of BAOs in the distribution of large-scale structure at various epochs allows us to probe the expansion of the Universe.

Figure 1: Illustration of the expansion of the universe (from right to left) probed by a high number density of high redshift quasars (seen as white points).

In quasar absorption spectroscopy, we measure large-scale structure in skewers of density through the Universe. In this way we can measure the large-scale 3D distribution of gas in correlations between skewers, allowing a measurement of BAO and so expansion. This method was first demonstrated with the BOSS survey (e.g. Busca et al 2013) and further exploited with eBOSS (e.g du Mas des Bourboux et al 2020), with over 200,000 quasars with z>2. WEAVE-QSO will more than double the number density of sight-lines through the universe over several thousand square degrees. In this regard WEAVE-QSO will surpass all other surveys concurrent surveys producing competitive BAO constraints at z>2.5. This high density of quasars is extended to 2<z<2.5 in the HETDEX northern footprint. These high quasar densities will allow us to go beyond 2-point statistics and build structure maps using IGM tomography for a deeper understand of structure properties and galaxic environments (Kraljic et al 2022).



In addition, WEAVE-QSO will offer unparalleled spectral resolution (R~6000, but also R~20,000) as a large-scale spectroscopic survey of the IGM, and will provide very high signal-to-noise data through high levels of completeness to bright quasars. S uch data will be impactful for a wide range of science, including the measurement of neutrino masses, the amplitude of matter clustering, and possible effects of exotic forms of dark matter using the Lyman-alpha flux power spectrum. This rich dataset will be used to generate a catalogue absorbers in a cosmic web context to boost our understanding of intergalactic and circumgalactic media. IGM properties are sensitive to density, temperature, UV radiation, metallicity and abundance pattern and so quasar spectra constrains galaxy formation in a variety of ways. The WEAVE-QSO survey resolution and signal-to-noise will be uniquely capable of studying absorbers through a dynamic range spanning more than 8 orders of magnitude in hydrogen column density with thermal properties and accompanying narrow metal lines.