Title: "Observing the cold gas surrounding AGN-host galaxies with MUSE"

Recent observations taken at the VLT-MUSE have revealed ubiquitous Lyman-alpha (Lya) nebulae around bright QSOs at z~3-4, extending up to hundreds of kpc. Such extended Lya emission is mainly produced through circumgalactic gas 'fluorescence' powered by the AGN-triggered UV radiation. The MUSE IFU allows to study the morphology and the kinematics of the cold gas distribution around bright QSOs, providing precious tools for studying the interplay between QSOs and their surrounding environment. After briefly reviewing previous and current research on this topic, I will present new deep MUSE observations of a Broad Absorption Line (BAL) QSO at z~5, revealing a Lya nebula with a maximum projected linear size of ~60 kpc around the QSO (Ginolfi et al. 2018, MNRAS, 476, 242). After correcting for the cosmological surface brightness dimming, we find that our nebula, at z~5, has an intrinsically less extended Lya emission than nebulae at lower redshift. However, such a discrepancy is greatly reduced when referring to comoving distances, which take into account the cosmological growth of dark matter (DM) haloes, suggesting an interesting positive correlation between the size of Lya nebulae and the sizes of DM haloes/ structures around QSOs. This conjecture is supported by a qualitative analysis of other observations of Lya nebulae in a larger redshift range (z~2-7). Differently from typical nebulae around radio- quiet non-BAL QSOs, in the inner regions (~10 kpc) of our nebula, the velocity dispersion of the Lya emission is very high (FWHM>1000 km/s), suggesting that in our case the Lya emission may trace outflowing material (associated with the BAL nature of the QSO) on ~10 kpc-scales.