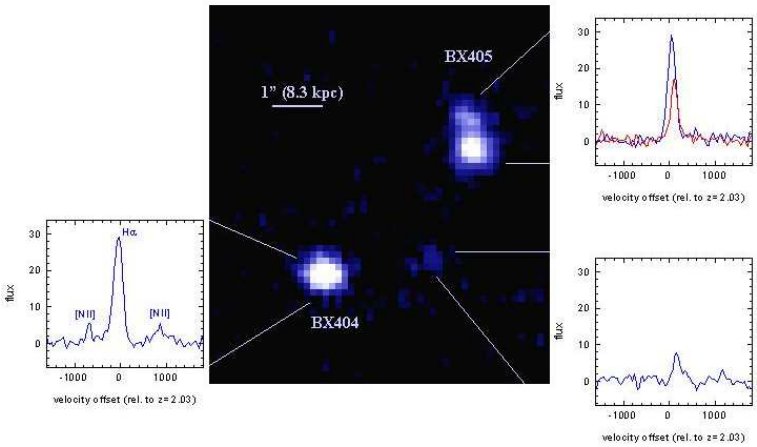
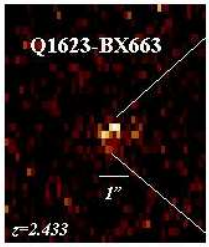
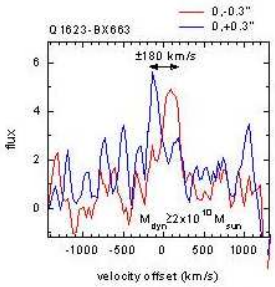
The High Redshift Galaxy Spectroscopic Imaging Survey in the Near-Infrared with SINFONI (SINS)

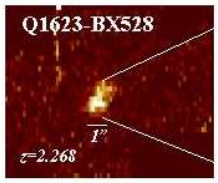
It is becoming increasingly clear that most of the baryonic mass in galaxies was put in place between z≈1–3. However, the real test of our understanding of galaxy formation and evolution is not just when the mass accumulated, but rather: How did it accumulate? Was the mass accumulation rate mass-dependent so that more massive galaxies formed earlier in the history of the Universe? Why do some galaxies have large amounts of angular momentum, while others do not?
We have developed an ambitious program to determine the spatially resolved dynamics, ionization, and metallicity of a large sample of high redshift galaxies with SINFONI at the VLT. This survey constitutes a majority (60% or ∼50 nights) of our entire GTO program. Our sample is chosen to be a representative subsample of several samples with well-defined selection criteria such as the "BM/BX" of Steidel, Shapley, et al. (see below), LBGs at z∼3, bright K-band selected (e.g., K20), (sub)mm, infrared, narrow-band H-alpha and Ly-alpha, and other optical/near-IR color (R-K/J-K) selected galaxies in the redshift range of 1-3.5. Through this imaging spectroscopy study, we will determine: the growth/merger rate of galaxies, metallicities, frequency of superwinds, and the relationship between various classes of high redshift objects – e.g., what are the relative masses, metallicities, and evolutionary state/star-formation history of objects across all of these selection criteria? Below are two examples of what we can learn through SINFONI observations.

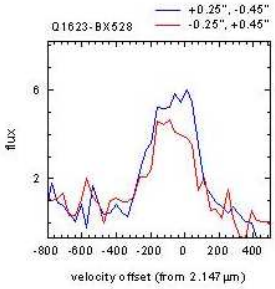
SINFONI images of the galaxy pair BX404/405 constructed by combining all the K-band spectral elements and inset spectra of the reion near Hα at z=2.03 of each component. The relative velocity of BX 404 and 405 is ∼150 km s^{-1} and a projected separation of 30 kpc. The emission line object to the south and west of BX404/405 has a velocity of 150 and 300 km s^{-1} relative to BX405 and BX404 respectively. The two components of BX405 have velocities that differ by about 70 km s^{-1} over about 6 kpc. The velocity and size allow a roughly dynamical mass estimate of ∼10^{10} M$_\odot$ for BX405. If BX 404/405 are part of a larger gravitationally bound structure, their relative velocities and projected distances suggest M$_{dyn}$≈ 10^{11} M$_\odot$. The ratio of [NII]/Hα crudely implies that BX 404 has roughly solar metallicity,











SINFONI K-band images of two galaxies Q1623-BX663 and BX528 and inset 1D-spectra of the region around Hα at z=2.433 and 2.268 for each galaxy. The SINFONI data of BX663 reveals a velocity shear of 180km s^{-1}. With a projected separation of about 0.6 arc seconds or about 5 kpc, the velocity offset suggests M$_{dyn}$>2 ×10^{10} M$_\odot$. The SINFONI data of BX528 reveals only a small velocity offset across the galaxy (≈50km s^{-1}). The 2 components have FWHMs of ≈350 and ≈250 km s^{-1} with each component separated by about 8 kpc in projection. The relatively broad lines of the individual regions compared to the small shear suggests that these are two interacting/merging galaxies. Assuming the line widths are due to virialized motions in each galaxies we can crudely estimate 1 and 3×10^{11} M$_\odot$ each component respectively.

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