The MUSE Hubble Ultra Deep Field Survey: Evolution of galaxy major merger fraction since $z \sim 6$

Emmy Ventou, IRAP, Toulouse-France

With T. Contini & the MUSE-GTO collaboration
How do galaxies grow over cosmic time?
Role of mergers vs gas accretion?
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This analysis is based on MUSE observations over one medium deep (10 hr) mosaic covering the entire HUDF, and two deep fields, the UDF10 and HDF-S with an average in exposure time of 30hr.

Parent sample of 1801 galaxies with spectroscopic redshift.
Detection of close pairs in MUSE data cubes

Close pair: \( 5 < r_p \leq 30 \text{ kpc} \) and \( D_V \leq 500 \text{ km s}^{-1} \)
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- \( r_p \approx 7 \text{ kpc} \)
- \( D_v \approx 8 \text{ km/s} \)
Detection of close pairs in MUSE data cubes

Close pair: $5 < r_p \leq 30 \text{kpc}$ and $D_v \leq 500 \text{km s}^{-1}$

- $r_p \sim 7 \text{kpc}$
  - $D_v \sim 8 \text{km/s}$

- $r_p \sim 15 \text{kpc}$
  - $D_v \sim 9 \text{km/s}$
Detection of close pairs in MUSE data cubes

Close pair: $5 < r_p \leq 30 \text{kpc}$ and $D_v \leq 500 \text{km s}^{-1}$

- ID 4, $z=0.76$
  - $r_p \sim 7 \text{kpc}$
  - $D_v \sim 8 \text{km/s}$

- ID 35, $z=2.54$
  - $r_p \sim 15 \text{kpc}$
  - $D_v \sim 9 \text{km/s}$

- ID 7283, $z=3.43$
  - $r_p \sim 21 \text{kpc}$
  - $D_v \sim 50 \text{km/s}$

- ID 577, $z=5.76$
  - $r_p \sim 19 \text{kpc}$
  - $D_v \sim 120 \text{km/s}$
Results

We identified 113 close pairs of galaxies spread over a large redshift range (0.2<z<6) and stellar masses ($10^7$-$10^{11}$ Msun).

Defining major mergers as having a mass ratio of 1:1-1:6, we found 56 major close pairs, among this sample, 23 pairs are identified at high redshift (z>3).
Estimation of the major merger fraction

Where \( N_g \) and \( N_p \) is the number of galaxies in the parent sample and the number of major close pairs

\[
F_{MM} = \frac{N_p^{corr}}{N_g^{corr}} = C_1 \sum_{k=1}^{N_p} \frac{W_c}{C_2^k} \frac{W_c}{C_2^k} W_A
\]

\[
= C_1 \sum_{i=1}^{N_g} \frac{W_c}{C_2} W_A
\]

- \( C_1 \) accounts for the **missing companions** due to our limit in spatial resolution,
- \( W_c \) takes into account the **confidence** in the \( z \) measurement,
- \( W_A \) takes into account that some galaxies are located on the border of the MUSE field-of-view,

and finally \( C_2 \) is a correction term for the **redshift incompleteness**.
Evolution of the galaxy major merger fraction up to z~6

The major merger fractions estimated in the MUSE fields are in good agreement with those derived from previous studies at similar redshifts, with a constant increase of the merger fraction with look-back time up to z~2-3.

At higher redshift, we show for the first time that the fraction slowly decreases or flattens down to about 10% at z~6.
The trend of our major merger fraction evolution is in agreement with the trend of recent predictions from hydrodynamic simulations, HORIZON-AGN (Kaviraj et al. 2015), EAGLE (Qu et al. 2017) and ILLUSTRIS (Snyder et al. 2017), with a slow increase of the merger fraction up to \( z \sim 3 \) and then a decrease toward higher redshift.
Extend such analysis to other MUSE fields, to obtain even more statistically robust results and decrease the cosmic variance effect.

Use simulations to refined the close pairs criteria. Convert the merger fraction into a merger rate.
Thank you for your attention
Estimation of the major merger fraction

C\textsubscript{2} is a correction term for the redshift incompleteness, defined in each fields and z bins as:

\[
\text{Number of spectroscopic } z / \text{Number of photometric } z
\]

From Inami +17
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