Abstract English

Stars are responsible for creating heavy elements in the Universe both during their lifetime and at the moment of their death.
By studying metallicity (the abundance of heavy elements relative to hydrogen), we can infer information on the evolutionary history of galaxies.
The metallicity is affected by various processes, for example, the infall of pristine gas, the outflow of metal-rich gas, and stellar feedback.
These processes shape important relationships between the metallicity and other physical properties of galaxies.
An important relation is the so-called fundamental metallicity relation (FMR) which defines a 3D surface based on the stellar mass ($M_\star$), star formation rate (SFR), and metallicity for star-forming galaxies.

This Ph.D. work focuses on comparing FMR at different redshifts.
In this work, we used data from the Sloan Digital Sky Survey (SDSS) in the local Universe (at redshift $z \sim 0$) and the VIMOS Public Extragalactic Redshift Survey (VIPERS) up to redshift $z \sim 0.8$.
VIPERS allows us to increase significantly the statistical sample size with respect to the previous works, up to several thousand observations within redshift $0.48 < z < 0.8$.

In order to have consistent spectral measurements between the samples, we re-measured the VIPERS galaxy spectra with the Penalized PiXel-Fitting (pPXF) fitting code.
pPXF allows us to fit separately the stellar and gas component of the spectra to extract the stellar and gas kinematics, as well as the stellar population of stars and galaxies.
The separate fit of the stellar continuum and gas emission allows a better measure of the lines' properties.
We also paid particular attention to computing consistently all the properties defining the FMR in both samples taken into consideration.

Initially, we homogenized the sample by analyzing different biases that may arise from the data selection (method of selection of star-forming galaxies, signal-to-noise selection, selection on the quality of spectra) and observations (intrinsic luminosity evolution of galaxies, the fraction of blue galaxies).
We found that the analysis can be particularly biased by a high signal-to-noise threshold applied specifically on the emission line $\left[\ion{O}{iii} \right] \lambda 4959$.
However, projecting the FMR on planes defined by the combination of the $M_\star$ and SFR greatly reduces the effects of biases.
After correcting for the biases mentioned above, we reduce the difference of the FMR between the samples to ~ 0.1 dex, which is comparable to the average scatter in the metallicity of the populations of both samples.

We then proceed to study how different methods of comparison can affect the interpretation of the differences between the different datasets.
We compared the low and intermediate redshift samples via a set of parametric and non-parametric methods.
The parametric methods are based on studying the different projections of the FMR.
In order to compare specific physical properties at different redshifts, we build three control-

sample by cross-matching the VIPERS and the SDSS according to the physical properties of interest --- i.e. ($M_\star$-SFR), galaxy mass function, and relative distance from the star-forming main sequence.
The non-parametric method is based on studying the metallicity-relative sSFR (specific SFR, defined as the ratio SFR/$M_\star$) relation.
The relative sSFR is defined based on a normalization of the sSFR.
The choice of normalization allows for the comparison of specific properties between the samples.
Using both families of methods we find a statistically significant difference between the FMR and its projections for low and intermediate redshift, increasing with $M_\star$.
This study results in the first observational evidence for an evolution of the FMR up to median $z \sim 0.63$ with a significance of $\sim 3 \left< \sigma_\mathrm{med} \right>_\mathrm{VIPERS}$.

Finally, in the last part of the work (which will be a subject of future more detailed analysis), we try to select sub-populations and outliers based on the FMR by applying machine learning algorithms to the low and intermediate redshift samples.
The goal of this part is to look for footprints left by galaxy evolution or environmental effects on the surface of the FMR.
We initially apply the principal component analysis to reduce the dimensionality of the problem by projecting the data in a 2D space with the highest variance.
In this 2D space, we apply the K-means clustering algorithm to group galaxies into sub-populations, and the local outlier factor to find the outliers.
Despite the fact we do not observe big differences from the point of view of galaxy evolution between the sub-populations, the outliers can be divided into smaller groups according to their distance from the star-forming main sequence and having broad (equivalent width ratio $\left[\ion{O}{iii} \right]\lambda 5007/ \mathrm{H}\beta > 1$) or narrow (equivalent width ratio $\left[\ion{O}{iii} \right]\lambda 5007/ \mathrm{H}\beta \leq 1$) lines. These groups of outliers will be the subject of future more detailed analysis.