Formation and evolution of stellar populations based on the red passive galaxies observed up to the redshift z~1

Despite all the nowadays knowledge, the origin and evolution of galaxies are widely regarded as one of the greatest challenges in modern astronomy. A detailed and robust description of the process of galaxy formation and evolution - a process leading to the formation of spiral and elliptical galaxies is still missing.

This dissertation follows the build up of stellar content in red passive galaxies over the last 8 billion years ($0 < z < 1$) in a consistent way by merging spectroscopic information from large galaxy surveys ($z \sim 0$: SDSS survey; $z \sim 1$: VIPERS). The aim of this dissertation is to constrain evolutionary paths, by:

(1) constraining star formation epoch in red passive galaxies from spectral features as a function of redshift and stellar mass (Siudek et al., 2017a), and by

(2) considering red passive galaxies as a heterogeneous population with different evolutionary phases, i.e., estimating actual galaxy types at $z \sim 1$ (Siudek et al., 2017b).

For a reliable estimation of star formation history of red passive galaxies, I performed a robust analysis of U-V color and two spectral indices (4000Å break and Hδ[4102Å] line) on stacked spectra of unique, non-contaminated sample of 3,991 VIPERS red passive galaxies. These spectral features, together with a grid of synthetic spectra, are used to trace the evolution of red passive galaxies over the last 8 billion years and characterize the formation redshift-stellar mass relation for intermediate-redshift passive red galaxies. Assuming a single burst formation, I found that high-mass passive red galaxies formed their stars at $z_{form} \sim 1.7$, while low-mass galaxies formed their main stellar populations more recently, at $z_{form} \sim 1$. The consistency of these results, which were obtained using two independent estimators of the formation redshift, further strengthens a scenario in which star formation proceeds from higher to lower mass systems as time passes, i.e., what has become known as the downsizing.

To constrain evolutionary paths leading to the formation of red passive galaxies and blue star-forming populations I proposed a new approach to galaxy classification. Nowadays, it becomes clear that the classification based on a small number of parameters, even carefully chosen, is far too simple to reflect the real zoo of different cosmic objects. Therefore, the aim of this dissertation is to develop a new method for galaxy classification based on the multidimensional space of VIPERS absolute magnitudes (observations in 12 different filters and spectroscopic redshift). An unsupervised classifier blindly separated VIPERS galaxies into three main groups: blue star-forming, intermediate, and red passive. Each group can be further separated into additional subclasses (4, 3, 4 for blue, intermediate, and red, respectively, and class 12 which includes active galactic nuclei, AGNs). The physical properties of derived classes change gradually from blue star-forming to red and passive galaxies. This separation cannot be obtained using traditional methods, as on single two-dimensional color-color diagrams different classes overlap. This blind separation may reveal different evolutionary phases of galaxies and lead to the creation of a more detailed picture of galaxy evolution.

Siudek, M., Małek, K., Scodeggio, M., et al. 2017a, A&A, 597, A107
Siudek, M., Małek, K., Krakowiak, T., et al. 2017b, in prep.