PhD Thesis Project Proposal
INAF – Osservatorio Astrofisico di Arcetri

TITLE:

UNVEILING THE STAR-FORMATION AND ASSEMBLY HISTORY OF GALAXIES VIA JOINT STELLAR POPULATION AND DYNAMICAL ANALYSIS.

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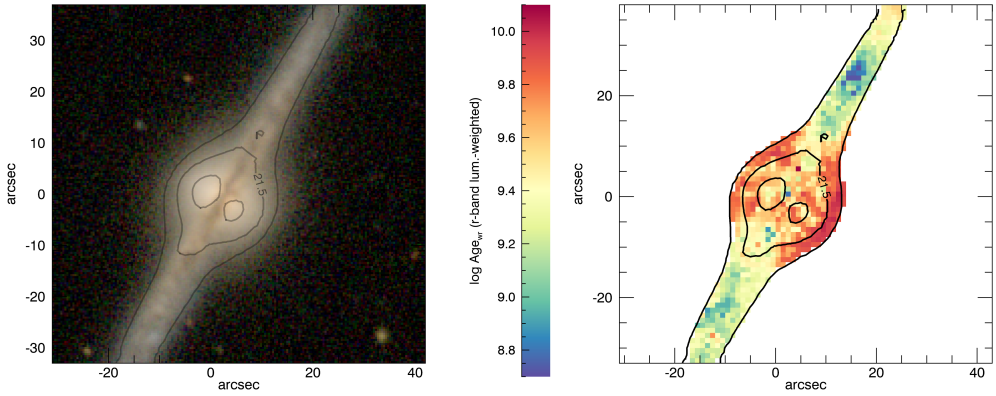
SUMMARY: Galaxies build up their structure and stellar mass across cosmic time via conversion of gas into stars and via accretion of stars through merging with satellite galaxies. All generations of stars contribute to the optical spectrum of a galaxy with the signature of their age and chemical composition at their formation epoch, which appears as a fossil record of the galaxy's star formation history (SFH). Also, due to the long dynamical relaxation times, the kinematic properties of a galaxy can be connected to the dynamical processes through which it has been assembled. Therefore, it is in principle possible to decipher the whole galaxy SFH and dynamical assembly history based on its spectrum or, better, on the spatially resolved spectral information obtained via Integral Field Spectroscopy (IFS).

Currently a number of available techniques work separately on the SFH reconstruction and on the dynamical decomposition of galaxies, for which the accuracy and details of the results are limited by observations, by theoretical understanding and also by computing power. Nevertheless, time is ripe to attempt solving simultaneously for the star formation history and the dynamical assembly history, by considering together stellar population properties and dynamical structure, as demonstrated by a number of pilot studies (Poci et al. 2019, 2021, Zhu et al. 2020).

In addition to already available datasets of IFS of nearby galaxies (e.g. CALIFA, Fornax3D, TIMER, GECKOS), the data from the **new generation IFS WEAVE-Apertif survey** (starting mid 2023 at the 4.2m William Herschel telescope, aiming at a final simple of a few hundreds gas rich galaxies) make up a majestic observational dataset for such an experiment. **Along with its superb spectral coverage and both spatial and spectral resolution for the *optical IFS*, WEAVE-Apertif leverages the *spatially resolved HI* observations obtained from the Apertif focal-plane array system on the Westerbork Synthesis Radio Telescope, one of the SKA pathfinder instruments.** Such a ***unique optical-radio synergy*** will be the key for a comprehensive description of the dynamics and of the gravitational potential of these galaxies, thus making unprecendented accuracy attainable in the dynamical modelling. On the other hand, the deep, high-resolution, spatially-resolved spectroscopic observations together with the state-of-the-art stellar population modelling developed by our group will provide reliable maps of stellar population propeties and star-formation histories. By combining these two pieces of information the different dynamical components will be characterized in terms of their formation epoch and chemical enrichment. This tesis will constitute a key step toward building a comprehensive picture of galaxy star formation and assembly, spanning the full variety of masses and morphology.



- Example of mean age map (*to the right*) of an edge-on spiral galaxy (in "true" colors in the *left-side image*), with a young disk characterized by circular orbits and an old bulge characterized by low angular momentum orbits (data from CALIFA, Zibetti et al. 2017).

The expertise gained in the project will open the PhD candidate the opportunity to start a successful research career in this field, yet it may constitute a great asset also for non-academic jobs.

The Project will develop in the context of a rich collaboration, including international experts in all aspects of the involved science: stellar populations (Zibetti [INAF-OAArcetri, supervisor], Gallazzi [INAF-OAArcetri, co-supervisor], Falcon-Barroso [IAC, Spain]), stellar orbit decomposition (van de Ven [Uni Wien], Di Cintio [CNR Firenze]), kinematic and dynamic analysis (Falcon-Barroso [IAC, Spain], Lyubenova [ESO], Zibetti [INAF-OAArcetri]).