Proposition de stage M2

Location: Laboratoire d'Astrophysique de Marseille (LAM)
Period: 4 months
Supervisors: Carlo Schimd, Alessandro Boselli
Title: ***Morphometry of nearby galaxies: clustering of HII regions***

Can stochastic geometry help astrophysics? High-resolution imaging by WFC3 on Hubble Space Telescope (HST) or by MegaCam on Canada-France-Hawaii Telescope (CFHT) shows a very rich morphology of galaxies in the Local Universe. Going beyond the traditional Hubble classification (ellipticals, normal and barred spirals, irregulars) and phenomenological global indicators (ellipticity, Sersic index...), the currently available detailed images allow for challenging spatial statistical analyses. Grasha et al. (2017) recently studied the clustering of young stellar clusters in star-forming galaxies from the HST/LEGUS project using on the angular two-point correlation function, showing a clear trend of the clustering scale with the age of the stellar compounds and the global properties of the hosting galaxies (morphology, SFR surface density, stellar mass; see figure 1). These relations become however compelling when averaged across the few galaxies of the sample: the role of the galaxies' environment is unclear.

This project is intended to make the student familiar with these astrophysical problems and with several tools for statistical analysis widely used in cosmology. Working on real images from the CFHT/VESTIGE survey (Boselli et al. 2018; see figure 2), the student will measure the two-point correlation function as in Grasha et al. (2017) and then explore the Minkowski functionals as a new means to analyse the H-alpha images of galaxies, assessing the robustness and physical insight of these statistics. Basic knowledge of Python and C/C++ programming is a prerequisite. The student will be acquainted with professional software routinely used in astronomy and cosmology.

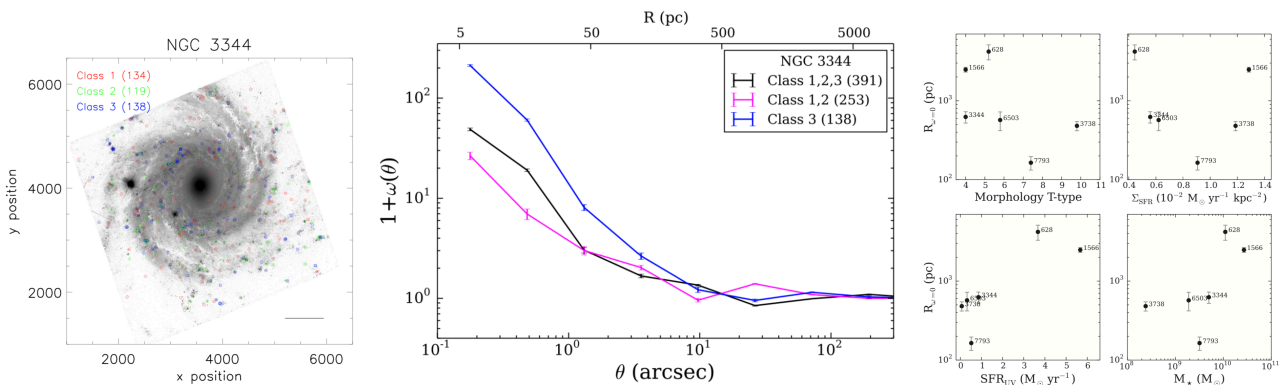A Ph.D. thesis on the same topic will be possible (grant: École Doctorale).

Figure 1 (from Grasha et al. 2017). *Left:* one of the 6 galaxies of the HST/LEGUS sample, with star forming regions marked by coloured circles according to their morphological classes. *Centre:* angular correlation function of the three morphological classes. *Right:* correlation length $R_{\omega=0}$ as function of the intrinsic properties of the 6 galaxies.
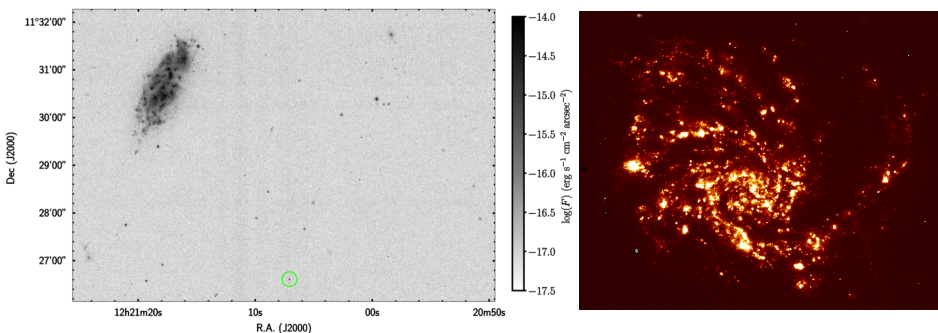

Figure 2. Continuum-subtracted $H\alpha$ image of NGC 4294 (left; Boselli et al. 2018) and NGC 4254 (right); note the details of HII regions. Images from the VESTIGE project, the narrow-band $H\alpha$+[NII] imaging survey covering the whole Virgo cluster region up to one virial radius (104 deg^2).