Probing the large scale structures of massive galaxies with dwarfs/GC/UCDs in a variety of environments

Faint objects around galaxies - low-surface brightness dwarfs, globular clusters and ultra compact dwarf galaxies - are used to probe the external structural properties of their massive host and thus provide insight on their formation mechanism. In particular they may trace their outer kinematics up to large galactocentric distances, provided that their redshift is known. While on-going and planned deep imaging surveys (e.g. NGVS, MATLAS, LSST, Euclid) have the sensitivity to detect these faint tracers, their spectroscopic follow-up proves to be particularly time consuming and inefficient with current spectroscopic facilities. MSE will be the ideal instrument to carry out this crucial task.

The main science drivers of the science case presented here are:

- probing the kinematics of galaxies at large galactocentric distances using globular clusters.
Among the parameters defining the structural properties of galaxies, the dynamical status is likely the most widely used. Integral field spectroscopy has become instrumental to derive the kinematics of galaxies, but has so far been mainly applied to the inner regions up to 1-2 effective radius (Re) (see the Sauron, Atlas3D surveys). Attempts to go further out (with MUSE, Califa, MANGA etc…) are on going but will never reach distances beyond 10 Re. At such distances, the only tracers are dwarf galaxy satellites (with stacking techniques compensating for the lack of objects), and the numerous globular clusters (GCs). Recent surveys using GCs revealed complex links between the small and large scale kinematics of massive galaxies that should be understood.
So far most of such studies have been carried out in the Virgo cluster, where dwarfs and GC satellites not only interact with their host but with the whole cluster. Future deep imaging surveys will soon provide catalogs of GC candidates in less dense and more simple laboratories like groups and the field.
Besides, how the environment shapes the large scale structure of galaxies, including their dark matter halo, is still largely unknown. A dedicated spectrograph on a 10-meter class telescope offering a large field (at least 1 degree) is most needed to make the spectroscopy follow-up of the hundreds of faint GC candidates surrounding massive galaxies. The instruments currently available on the Keck, Magellan, or VLT do not have the requested multiplex capabilities and/or field of view to perform this task in an efficient way.

- probing the kinematics of fine structures
Fine structures, i.e. collisional debris like tails, streams and shells, keep the memory of past mass accretion events. Deep images can detect them and reveal their shape. However, their surface brightness is too low (> 28 mag.arcsec-2), for direct spectrophotometry. Thus their kinematics, which constrains the nature of the mergers at their origin and the orbits of the colliding galaxies, cannot be determined unless they are resolved into stars. A way around this limitation is to use GCs presumably associated with the collisional debris. **This technique pushes galactic archeology outside the Local and most nearby Groups, with GCs playing the same role as stars**. It has been tested on the tidal tails around a couple of nearby massive ellipticals but the method is time consuming as it requires the spectroscopic observations of a large number of GCs to ensure that at least some of them are physically linked with the tidal debris. The development of the method absolutely needs an instrument like MSE.

- probing satellite-satellite mergers, satellite destruction and production

In the extended halos of galaxies, satellite galaxies are tidally threshed, interact with each other, even merge before eventually being accreted by the host. Alternatively, major mergers may induce the birth of new satellites, such as Tidal Dwarf galaxies (TDGs), that may be responsible for the intriguing shape of the so called disk of satellites found in the Local Group spiral galaxies.

Such activity is predicted by simulations, but has so far been studied in only a few nearby galaxies.

Simple imaging is not enough to disentangle between the different classes of satellites. Spectroscopy provides the missing kinematical information and metallicity: it tells whether the satellite candidates are indeed physically associated with the system, are preexisting (metal poor) objects or recently born (metal rich) TDGs and helps to make a census of dwarf-dwarf mergers. The importance of the latter is the matter of a growing debate.

- probing the physical link between, nucleated dwarfs, TDGs, GCs and UCDs

The extragalactic bestiary has recently been enriched with new species such as the Ultra Compact Dwarf Galaxies (UCDs).

The link between UCDs and other known classes of stellar objects like dwarfs or globular clusters is currently unknown. Are UCDs the high mass end of GCs or remnants of nucleated dwarf spheroidals? Could UCDs have been born in major mergers, like TDGs? Studying the respective spatial and kinematical distribution of these various classes of objects is key to understand their parental connection, if any. MSE would allow to extend current studies on this topic so far mostly done in the Virgo cluster to a variety of environments and distances.