Spatially resolved spectroscopy of Active Galactic Nuclei: the impact on their host galaxies

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Active Galactic Nuclei (AGN) are astrophysical sources located at the centres of galaxies whose observational properties cannot arise from stellar processes: they are explained only by accretion of matter onto supermassive (10^6 - 10^{10} $M_\odot$) black holes (BH) in galaxy nuclei.
The scaling relations existing between BH mass and mass, luminosity and stellar velocity dispersion of the host spheroid (Ferrarese & Merritt 2000, Gebhardt et al. 2000) cannot have a gravitational origin, as the BH gravitational sphere of influence is negligible with respect to the size of the spheroid. The so-called "feedback" is the interaction mechanism between the BH and the rest of the galaxy thought to be responsible for these relations: outflows and jets accelerated by the AGN radiation pressure, as well as the radiation itself, inhibit gas accretion and quench star formation (negative feedback, Fabian et al. 2012) but may also induce it (positive feedback, Silk et al. 2013, Zubovas & King 2014).

In my thesis project, I am studying this interaction mechanism in detail in a sample of local active galaxies taking advantage of the new-generation optical and near-IR integral field spectrograph MUSE (located at VLT) which has an unprecedented spatial coverage of 1'×1' on 300×300 spatial pixels (Bacon et al. 2010).
From the Doppler shift of gas emission lines, I obtain kinematical maps of the outflows originating from the active nucleus. Diagnostic diagrams making use of gas line ratios ([OIII]/Hβ, [NII]/Hα, [SII]/Hα and [OI]/Hα) are employed to spatially sort out the dominant contribution to the photoionization of the gas between the emission of OB stars in star formation regions and the more energetic AGN continuum (Baldwin et al. 1981, Kewley et al. 2006). The density of the gas can be directly obtained from the [SII] line doublet, while more detailed information on the physical state of the gas can be acquired using photoionization models. As barred galaxies sometimes also show inflow motions towards the centre, I can inspect the possibility that the refueling of material for the BH accretion is carried on through this inflow along the bar.
From the spatially resolved spectroscopic analysis of the X-ray data from the Chandra space telescope I study the highly ionized phase of the gas, which is less dense and hotter with respect to the optical emitting one ($T \sim 10^6$ - 10^7 K against $T \sim 10^4$ K). This allows to compare distribution and properties of the cold gas observed with MUSE with the ones held by the hot gas emitting in the soft X-rays (≲1-2 keV), as well as with the possible reflection components seen in the hard X-rays (≳1-2 keV).
Moreover, the emission of the molecular gas can be studied using the mm interferometer ALMA, so as to investigate the presence of outflows and compare their properties with those detected in ionized gas. The presence and the effects of AGN feedback can then be searched in the relative distribution of outflows and star formation indicators.

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