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# CO-EVOLUTION OF SUPERMASSIVE BLACK HOLES AND GALAXIES IN THE NEAR UNIVERSE

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**Although the bulk of the supermassive black hole (SMBH) growth has occurred at redshifts higher than 2, the feeding processes cannot be resolved at the corresponding distances. It is in the near Universe that these processes – which take place within the inner few hundred parsecs of active galaxies – can be probed down to ∼10 pc spatial resolution. We discuss integral field spectroscopic observations of the inner kiloparsec of nearby active galaxies which reveal the presence of gas reservoirs and inflows along nuclear spirals and filaments.**

In the last 8 years we have been using optical and near-IR integral field spectroscopy of the central regions of nearby active galaxies in order to map and quantify gas inflows (Fig. 1) and outflows from the nucleus (e.g. Riffel et al. 2008; Riffel & Storchi-Bergmann 2011; Riffel, Storchi-Bergmann & Winge 2013; Schnorr Müller et al. 2011; Storchi-Bergmann et al. 2010).

The gas inflows are usually seen in association with nuclear spirals (as for Mrk 79, see Fig. 1) or bars in scales of a few tens of pc, being observed in low ionization gas in the optical and in hot molecular gas in the near-IR. The velocities of the inflowing gas are in the range from 50 to ∼200 km s$^{-1}$ and the mass-inflow rates are $10^{-2}$–10 $M_\odot$ yr$^{-1}$. The derived mass inflow rates are larger than the mass accretion rate to the SMBH ($10^{-3}$–$10^{-2}$ $M_\odot$ yr$^{-1}$) and can lead, during an activity cycle, to the accumulation of enough gas in the inner few hundred parsecs to trigger the formation of new stars. Stellar population synthesis show that new and intermediate age stars are indeed observed in the central region of AGNs (e.g. Storchi-Bergmann et al. 2012).This result suggests that co-evolution of SMBH and galaxies is still occurring in the near Universe.

Outflows from the active nucleus are observed in ionized gas with velocities of 100 – 800 km s$^{-1}$, usually within a biconical/hourglass shape, with a mass-outflow rate of 0.1–10 $M_\odot$ yr$^{-1}$, being much larger than the accretion rate to the AGN and thus, suggesting an interaction of the nuclear outflow with the Narrow-Line Region gas.

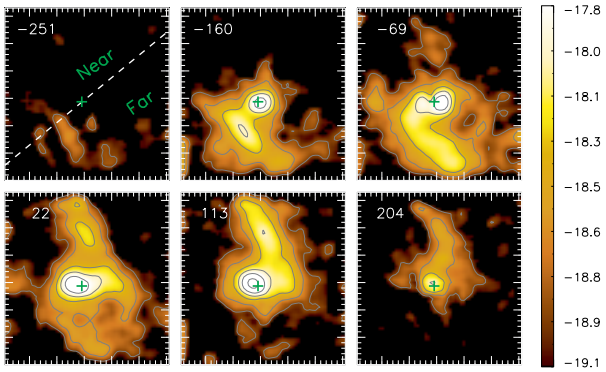


Fig. 1. Channel maps along the $H_2$ $\lambda$2.1218$\mu$m emission-line profile for Mrk 79 observed with NIFS. The major tick marks show increments of 0.″5, North is up and East is left. The blueshifts and redshifts observed along spiral arms in the far and near side of the galaxy, respectively, were attributed to inflows of gas towards the nucleus of Mrk 79. See Riffel, Storchi-Bergmann & Winge (2013) for more details.

The observed inflow and outflow rates are similar, although the inflows are best seen around LINER nuclei and the outflows around Seyfert nuclei, what may imply evolution between these two types of activity.

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