Two channels of growth of supermassive black holes*

Davor Krajnović1, M. Cappellari2, R. M. McDermid3, E. Emsellem4, M. den Brok1, R. Marino5, K. B. Schmidt6, M. Steinmetz7, P. M. Weilbacher4

1 Leibniz-Institut für Astrophysik Potsdam (AIP), Germany; 2 University of Oxford, UK; 3 Macquarie University & AAO, AU; 4 ESO, Germany & CRAL-Obs/Univ, France; 5 ETH, Switzerland

Supermassive black holes on mass – size plane

Supermassive black holes (SMBH) follow tight scaling relations with global properties of host galaxies, implying a symbiotic growth of SMBHs and galaxies. The tightest relation is the relation between the SMBH mass ($M_{\text{BH}}$) and stellar velocity dispersion evaluated within half-light radius ($\sigma_\text{e}$). These relations, however, do not need to be universal, as at different epochs various assembly processes govern the growth of galaxies, and different feeding regimes influence the growth of SMBHs. For example, at high galaxy masses, mergers are predicted to be predominantly gas poor (Khochfar et al. 2009, MNRAS, 307, 506). Such dissipation-less mergers increase the size and the mass of the galaxy, but not its velocity dispersion (Bezanson et al. 2009, ApJ, 697, 1290). SMBHs in remnants of gas-poor mergers do not grow by accretion in an AGN/quasar phase, but through SMBH-SMBH mergers. The consequence is that the most massive galaxies should host SMBHs with masses that do not scale with the global velocity dispersion, but with the mass of the galaxy.

Two growth channels


How do the most massive galaxies grow?

The most massive galaxies are typically slow rotators (Emsellem et al. 2011), exhibiting complex kinematics and a low level of rotation. At the highest masses, about 50% of galaxies also show prolate-like rotation (see Fig. 3 top for an illustration). Most massive galaxies also have cored nuclear surface brightness profiles (Krajnovic et al. 2013, MNRAS, 433, 2812). The evidence point towards a growth channel specific for the most massive galaxies, which is dominated by major dissipation-less merging. There the SMBH growth is linked with mergers of SMBHs, which introduce a dependence on galaxy mass, and implies non-universal scaling relations.

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* Based on:  

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Evidence for dissipation-less merging. Left: Mass – size relation for galaxies from ATLAS$^3D$ and MGS surveys. The kinematics of MGS galaxies is dominated by prolate-like rotation, an indication of the strong influence of dissipation-less equal mass mergers. Shaded regions indicate locations of remnants of equal mass dissipation-less mergers, starting with $10^8 M_\odot$ progenitors. Top: examples of a rotation around the minor axis (typical of galaxies at all masses, and prolate-like rotation (often found in the most massive galaxies).