

Using the newly available SINFONI instrument at the VLT, we will measure the central kinematics of pseudobulges and bulgeless galaxies, to study the properties of their supermassive black holes.

Studies of the dynamics of stars and gas in the nuclei of nearby galaxies during the last few years have established that all galaxies with a massive (classical) bulge component contain a central supermassive black hole (SMBH) [1]. The mass M_{\bullet} of SMBHs is closely correlated with their bulge luminosity/mass and with the bulge velocity dispersion σ [2], which indicates a close link between bulge evolution and BH growth. Do these relations remain valid when galaxies with pseudobulges—grown via secular evolution and not via mergers as classical bulges—are consid-

ered? The few BH masses determined in pseudobulges seem to follow the $M_{\bullet} - \sigma$ relation, but much better statistics is required to draw any robust conclusions. Furthermore the knowledge about central black holes in bulgeless galaxies is still scarce. Do they contain black holes at all, and if, what is their mass? Bulgeless galaxies have not experienced major merger episodes and secular evolution processes have not yet become significant, so these galaxies might be the hosts of seed black holes in their earliest evolutionary stage.

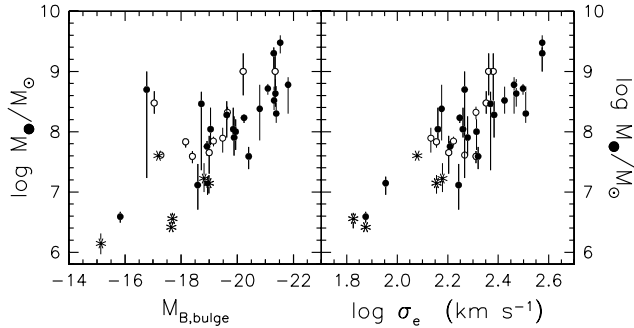


Fig. 1: The $M_{\bullet} - M_{B,\text{bulge}}$ (left) and $M_{\bullet} - \sigma_e$ (right) correlations for elliptical galaxies (filled circles), bulges (open circles) and pseudobulges (stars) (from [3])



Fig. 2: NGC 4826 is a galaxy with a pseudobulge. Pseudobulges are mostly found in late-type galaxies and are physically unrelated to ellipticals. The pseudobulge of NGC 4826 shows a rapid rotation V . V/σ is well above the oblate line describing rotationally flattened isotropic spheroids in the $V/\sigma - \epsilon$ diagram (see [6] for a review).

References

- [1] Richstone et al. 1998, Nature, 395, A14.
- [2] Gebhardt et al. 2000, ApJ, 539, L13.
- [3] Kormendy&Gebhardt 2001, AIPC, 586, 363.



Fig. 3: NGC 300 is a bulgeless Sd galaxy located in the Sculptor group. In the center there is a bright nucleus, i.e. a compact star cluster.

We will observe the central regions of a number of bulgeless and pseudobulge galaxies using SINFONI (SINGLE FAINT OBJECT NEAR-IR INVESTIGATION) at ESO VLT. This recently commissioned instrument consists of the NIR ($1 - 2.5 \mu\text{m}$) integral field spectrograph SPIFFI [4], the adaptive optics (AO) module MACAO, and the laser guidestar PARSEC and provides ideal means to measure stellar kinematics and therewith the BH mass in galaxy centers. Compared to STIS this new spectrograph has a larger collecting power, a higher resolution ($R \leq 4500$) and is able to penetrate dust, which makes it particularly suitable to observe late-type spiral galaxies. The preoptics of SINFONI allows to choose a field of view of $8'' \times 8''$, $3'' \times 3''$ or $0.8'' \times 0.8''$, which is sliced into 32 slitlets of 64 pixels each, resulting in 32×64 spectra.

We will derive the line-of-sight velocity distributions with the FCQ program [5] and perform the dynamical modelling based on the Schwarzschild orbit superposition method (see the poster “Orbital mapping of early-type galaxy dynamics”).

[4] <http://www.mpe.mpg.de/SPIFFI/>.

[5] Bender 1990, A&A, 229, 441.

[6] Kormendy&Kennicutt 2004, ARA&A, 42, in press.