Gas kinematics in the inner kiloparsec of NGC 1386: a new clue to the torus-galaxy connection?

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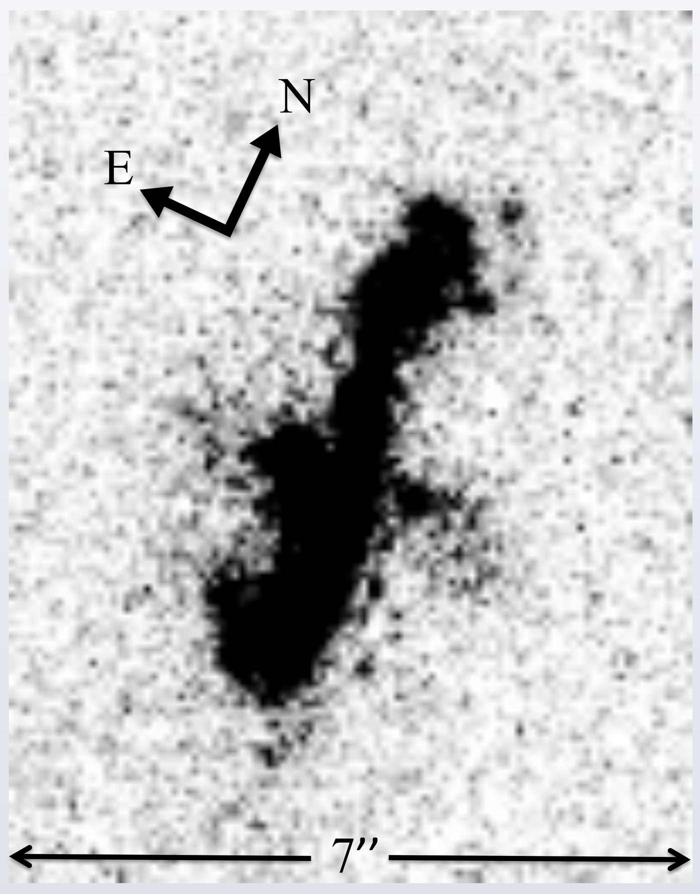
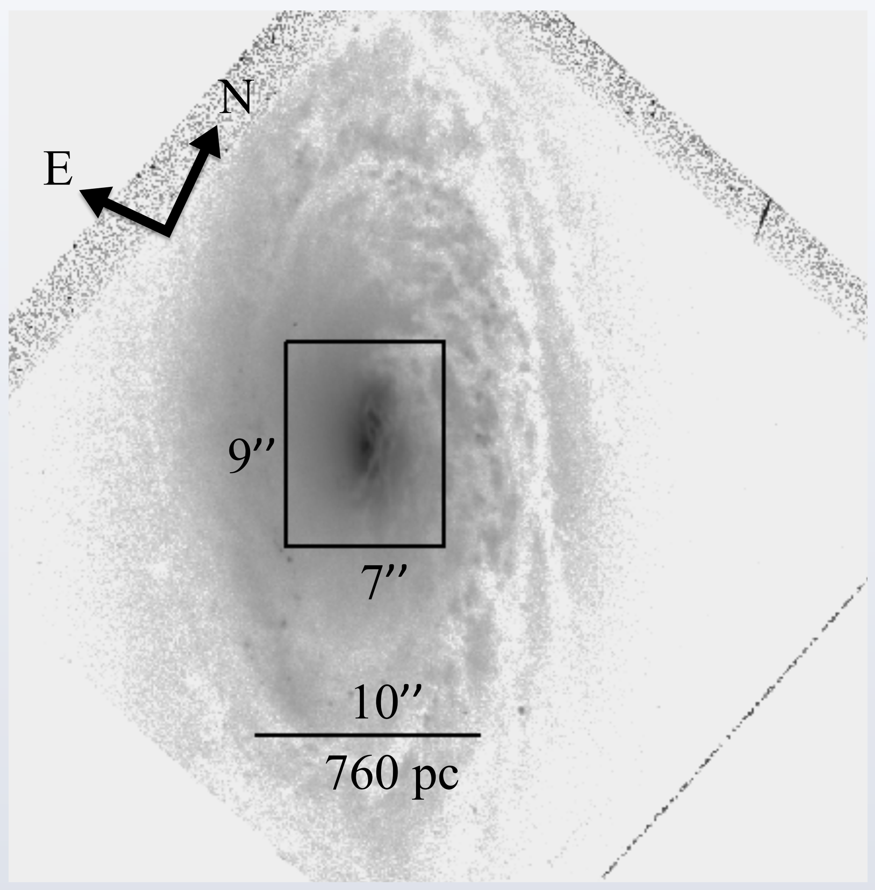
A peculiar feature in NGC 1386

To further our understanding of the processes of AGN feeding and feedback, we are using integral field spectroscopy to probe the inner kiloparsec of a sample of nearby Seyfert galaxies. One of these is NGC 1386, a Seyfert 2 located in the Fornax cluster (16 Mpc). Early studies showed complex gas kinematics and interesting features, e.g. Storchi-Bergmann and Pastoriza 1989, Weaver et al 1991, Ferruit et al 2000, Schulz and Henkel 2003, Rodriguez-Ardila et al 2006. Image above taken from the MAST archive (DSS sky survey).

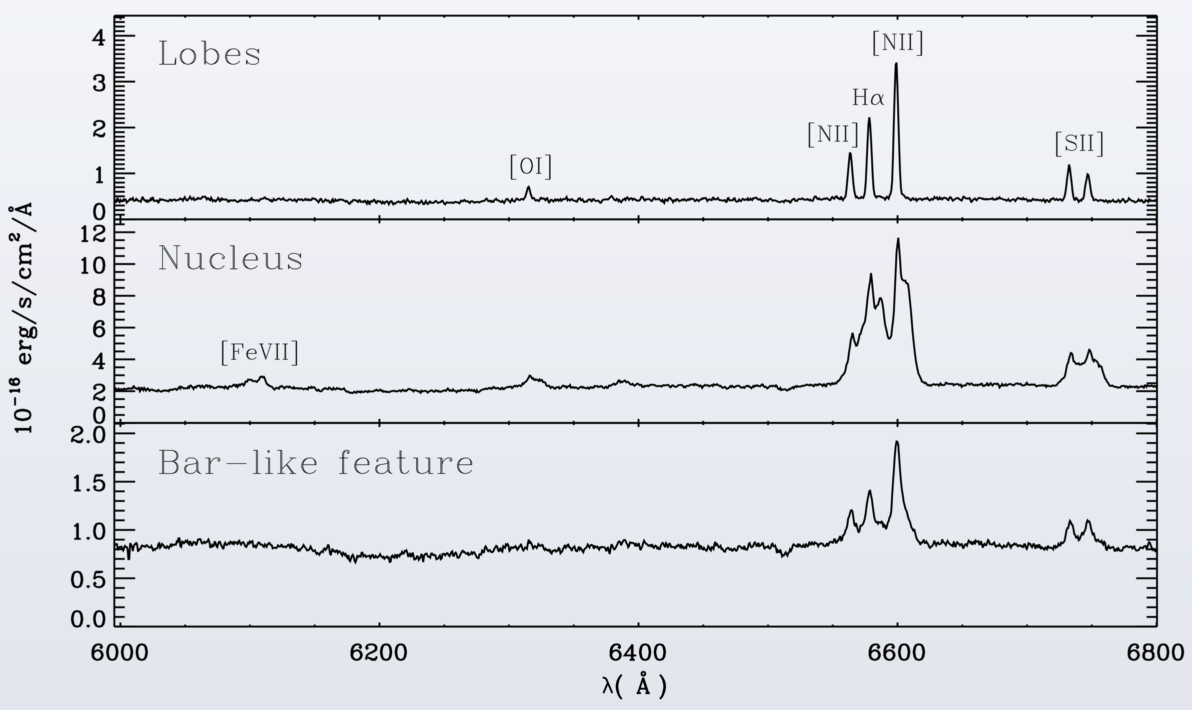


Hubble Space Telescope images reveal the presence of two extended lobes and a faint bar-like feature in [OIII]5007 emission (Ferruit et al.2000).

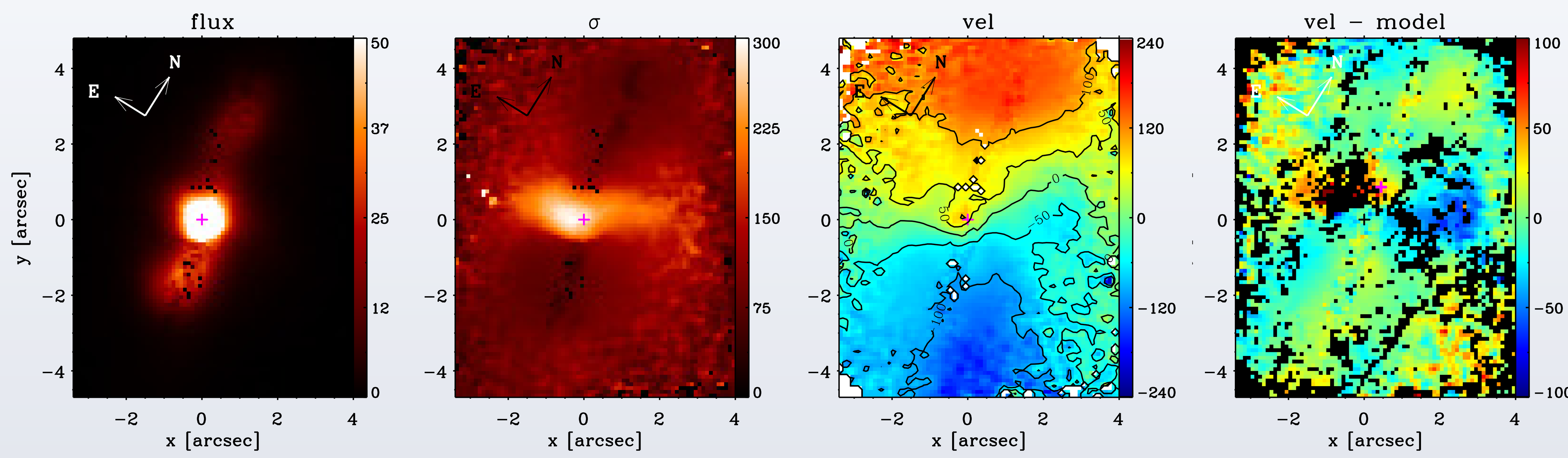


We used the GMOS Integral Field Unit to investigate the kinematics of the ionized gas in the nuclear region of NGC 1386 (field-of-view, hereafter FoV, highlighted by the box in the HST image reproduced above).

New clues from integral field spectroscopy



Representative examples of spectra extracted from locations in the lobes (top), the nucleus (center), and the bar-like feature (bottom). Multiple components were required to achieve good fits to the line profiles. A narrow component (velocity dispersion σ ~ 90 km/s) consistent with rotation extends over the whole FoV. In the nucleus, two red- and blue shifted broader components (σ ~ 200 km/s) consistent with an outflow are present, and have counterparts in the HST [OIII] image.

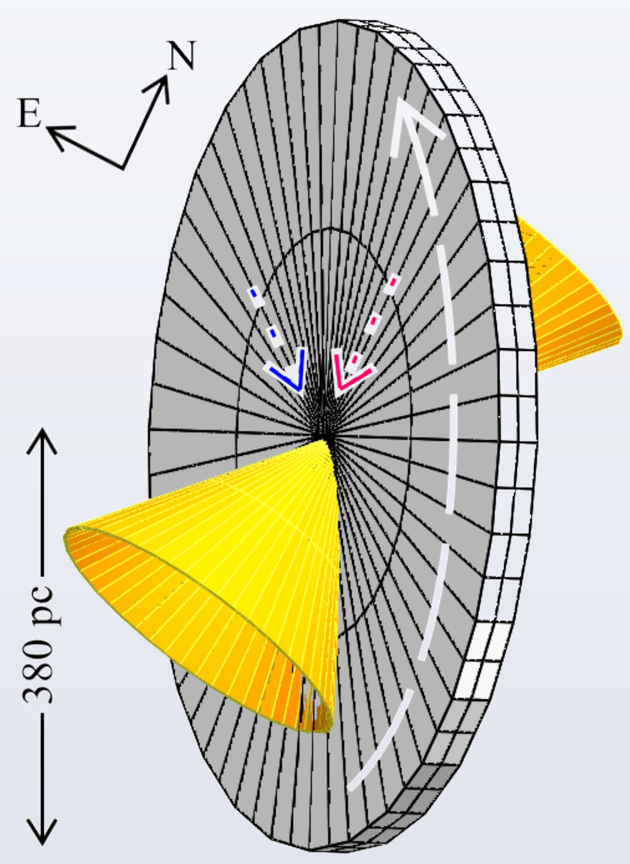


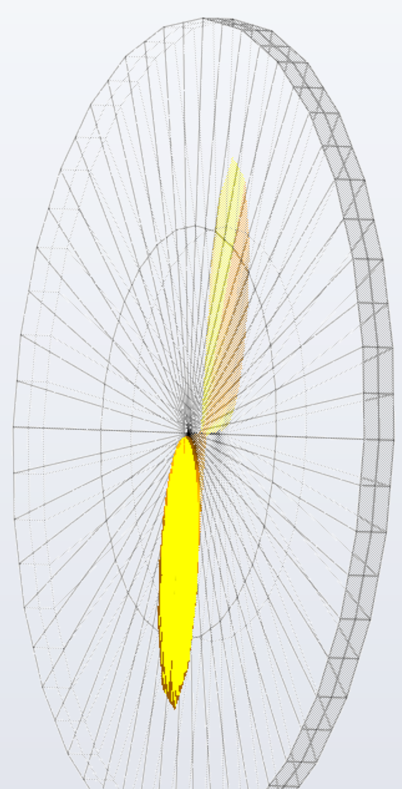
Flux, velocity dispersion and velocity maps were derived from the fits (here we show results for a single-component fit; see **Lena et al. 2015** for details on the multi-component fitting). Our maps show that the faint bar-like feature observed by Ferruit et al. is associated with a clear increase in the line width (the velocity dispersion).

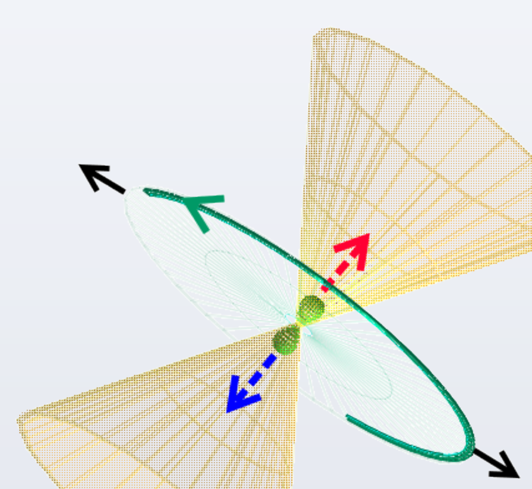
To isolate distortions in the velocity field, we fitted the velocity derived from the narrow component with a model representing gas moving along circular orbits. The residual map, shown on the right, reveals that the bar-like feature is also associated with a velocity residual suggestive of rotation or outflow.

Additional velocity residuals in the outer part of the FoV might be due to gas inflows along nuclear dusty spirals.

Our model







We propose the model represented above: the narrow component is due to gas rotating in the large-scale disk of the galaxy (long dashed arrow). However, inflows along dusty spirals might be present (short dashed arrows). The bright lobes visible in the flux maps are regions of the disk intersected by the AGN radiation cones (center, in yellow). The broad spectral component is due to outflowing blobs (right) which are resolved in HST [OIII] maps. The bar-like feature is associated with a kinematical component suggestive of rotation and/or outflow in a plane approximately coincident with the plane of the torus, with the combination of blue/redshifted velocity residuals and increased velocity dispersion along the [OIII] bar favoring an outflow. The torus has an opening angle of 34° (a similar value was found by Brightman et al. 2015), with the axis oriented at 76° with respect to the line of sight, intercepting the galaxy disk at an angle of 38°. Cartoon made with *Shape* (Steffen et al. 2010).

References

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