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High Spatial Resolution Integral Field Spectroscopy of extended Ionized Gas around three Quasars

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Observations and Data reduction

Three quasars, Ton 616, 4C 37.43 and PKS 2251+113 (Stockton and MacKenty 1987) were observed in 1992 at the 3.6 m CFH telescope with the Integral Field Spectrograph TIGER (Courtès et al. 1987, Pécontal 1991) under subarcsecond seeing (0.5 - 0.7"). The spatial sampling was 0.39" in a field 7 by 7 " , and the spectral resolution 8 ÅFWHM in the Hβ - [OIII]λ 5007 wavelength region (in the rest frame of the objects). The scaling is 4.5, 5.9 and 5.3 kpc.arcsec^{-1} for Ton 616, 4C 37.43 and PKS 2251+113 respectively (H_0 = 75 km.s^{-1}.Mpc^{-1}). The data were reduced with the software developed at Observatoire de Lyon by Rousset, Bacon and Pécontal (Rousset 1992). A detailed account of our results is reported in Durret et al. 1994.

Ton 616 = 4C 25.40 = 1223+25

Several blobs appear on the image deconvolved from seeing effects (Fig. 1a) showing no close association with the radio features. The [OIII]/Hβ narrow line intensity ratio is close to 7.6 in the central zone, and reaches values as high as 17 both NE and SW of the nucleus.

The velocity field of Ton 616 in the [OIII] lines is displayed in Fig. 1b. At large distances from the center it is well reproduced by a simple rotating disk model, but in more extended regions, particularly SE and SW of the nucleus, velocities are poorly accounted for, suggesting that there is no overall rotational pattern. Two regions can be singled out, one surrounding the nucleus, the other one in the W, consistent with the presence of two presumably interacting disks. The zone W of the nucleus presents double-peaked lines, with a velocity separation between the two peaks 240 km.s^{-1} (Boisson et al. 1994) The spatial evolution of the two component fit in this region shows that the red component is associated with the westernmost blob. The rotation velocity, diameter and ionized hydrogen mass estimates are consistent with the idea that this westernmost blob could be a galaxy, though its H mass would be rather high.

4C 37.43 = 1512+37

The [OIII] image of 4C 37.43 is displayed in Fig 2a, while the velocity field of the central region and east blob are shown in Fig. 2b. A velocity differnce of 235 km.s^{-1} is observed between the quasar and the east blob, in agreement with long slit spectroscopy by Bergeron and Durret (1987).

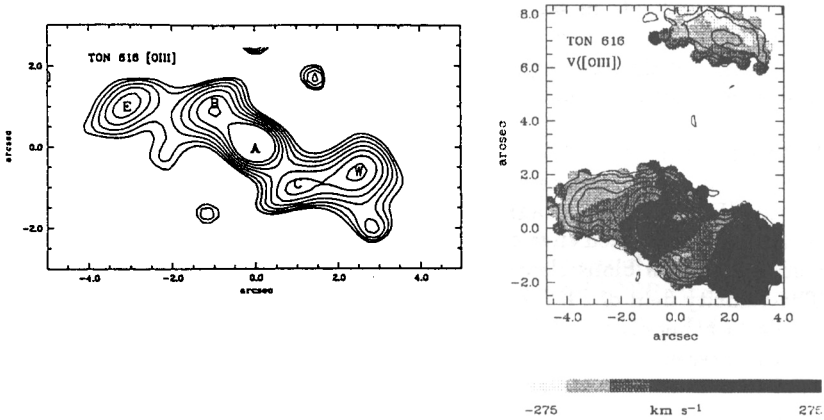

Figure 1. a)(left panel) [OIII] image of Ton 616 - b) (right panel) Velocity field of Ton 616 in the [OIII] lines

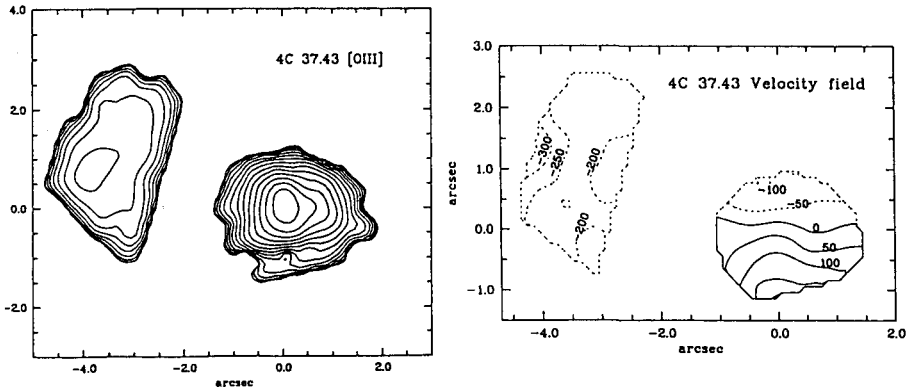

Figure 2. a) (left panel) [OIII] isophotes of 4C 37.43 - b) (right panel) [OIII] velocity field in 4C 37.43

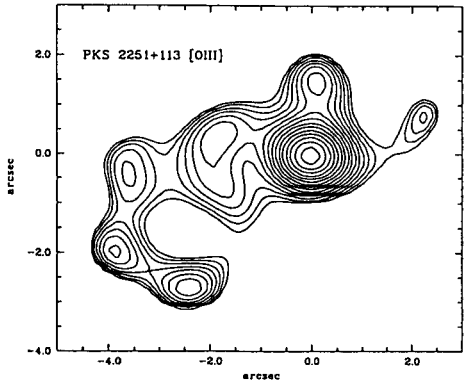

Figure 3. [OIII] image of PKS 2251+113

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The velocity fields of both regions cannot be fitted simultaneously by a single rotating disk, but each one can be fitted separately by a rotating disk.

The nature of the east region is not clear, since it has the size and possibly the mass of a galaxy, but no continuum is detected.

PKS 2251+113 = 4C 11.72

PKS 2251+113 shows a somewhat irregular shape, with an extension towards the E and SE. Its [OIII] image is given in Fig. 3 after deconvolution from seeing effects. The ionized envelope appears much more complex than previously reported, with seven blobs clearly visible.

The velocity field of PKS 2251+113 in [OIII] lines cannot be globally fitted by a single rotating disk model. The emission line morphology and velocity field suggest the presence of a main ionized nebulosity, consistent with a rotating disk, and several smaller blobs of ionized gas possibly interacting with the main envelope.

Conclusions

- the ionized gas in at least two of these objects (Ton 616 and PKS 2251+113) is very clumpy and shows chaotic velocity fields that cannot be simply accounted for by a single rotating disk, nor, in Ton 616, by two disks.

- the ionized gas in 4C 37.43 is smoothly distributed in two main blobs of comparable size, with totally decoupled velocity fields which can be separately fitted by single rotating disks.

- interactions must play an important role in the ionized nebulosities surrounding quasars.

- the ionized blobs may be galaxies interacting with the main envelopes surrounding the quasars, in agreement with the idea that interactions or mergers can trigger nuclear activity in quasars.

- integral field spectroscopy is a powerful technique for observing extended ionized gaseous envelopes in detail, particularly in sites with good seeing.

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