GAS DISKS IN RADIO GALAXIES

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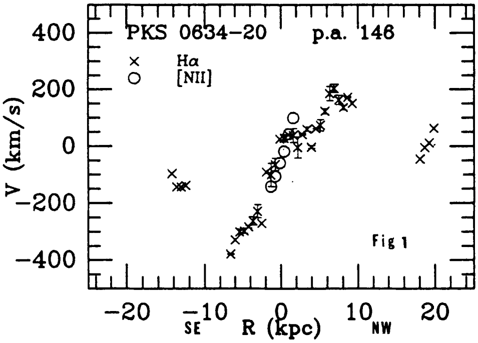
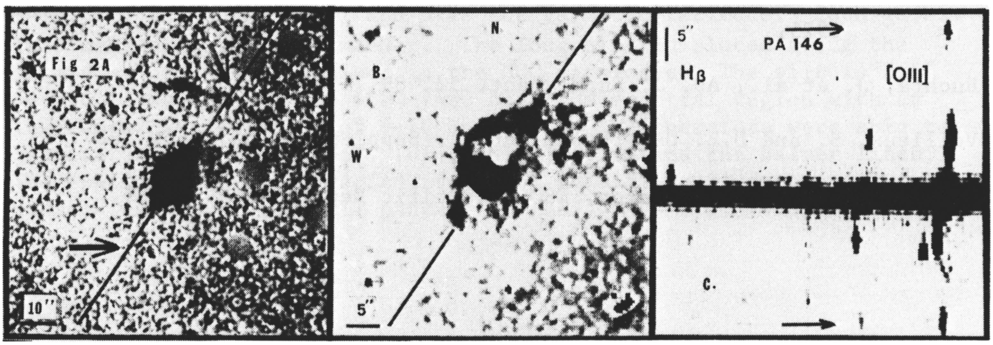
Spectroscopic observations have shown that strong radio galaxies contain extra–nuclear gas which is rapidly rotating (Simkin 1979, Heckman *et al.* 1985). In addition, weak spiral–like structure has been observed in the inner regions of several strong radio galaxies classified as DE or E (Simkin and Michel 1986, Beichman *et al.* 1985, Hansen *et al.* 1987, Baum *et al.* 1988).

To study these extra–nuclear gas disks in more detail, we have made spectroscopic and photometric observations of ten of the most powerful southern radio galaxies ($P > 10^{24}$ W/Hz, $z < 0.08$). Our aim was to see whether gas disks like that observed in 3C33 were a common feature of radio galaxies, and if so, whether such

Figure 1 (right) shows the rotation curve for PKS 0634-20 at p.a. 146^o. The scale assumes H_o=100 km/s/Mpc.

Figure 2 (below) shows (a) the distribution of ionized gas in PKS 0634-20, (b) an expanded view of the inner gas ring, and (c) a blue spectrum of the extended emission. Arrows show the position of the outer ring in (a) and (c).





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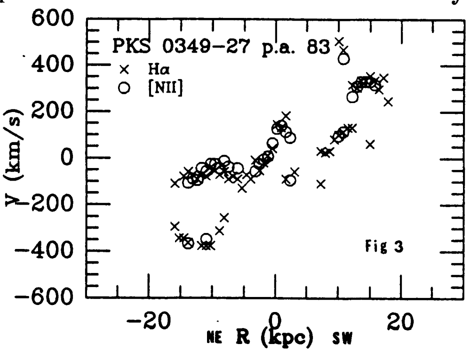
galaxies might represent a hybrid class between ellipticals and supergiant spirals.

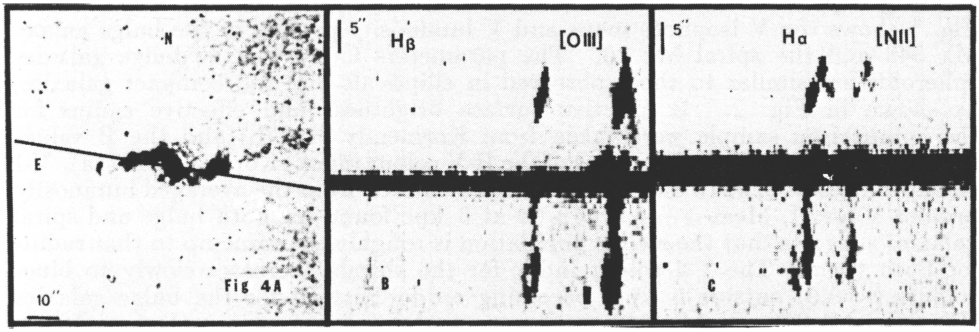
Our observations included narrow-band CCD images in the Hα/[NII] lines and broad-band g, r and i images, with a scale of 0.3"/pixel and 1–1.5" seeing. All the galaxies observed showed gaseous arcs or loops, similar to those seen in barred or interacting spiral galaxies. The morphology of the gas falls into three broad classes: sharply-defined rings (e.g. PKS 0634−20; fig. 2), S-shaped structures (e.g. PKS 0349−27; fig. 4) and amorphous emission, (e.g. Hydra A).

Spectra at Hα/[NII] and Hβ/[OIII] confirm the ionized gas distribution seen in the narrow-band images. Several objects have projected rotation velocities which approach or exceed those seen in massive Sa galaxies (Rubin *et al.* 1985), but the velocity structure is generally complex. Most galaxies show two or more distinct velocity components, sometimes spatially separated (as in the inner and outer rings of PKS 0634−20; fig. 1), but often overlapping and distinguishable only by the presence of line-splitting, as in PKS 0349−27 (fig. 3). The ring structures may be indicative of global angular momentum transfer in the gas, with some gas clouds falling towards the nucleus while others are swept out into a ring. If so, the gas morphology may be a visible tracer of the process which feeds the nuclear activity.

Figure 3 (right) shows the rotation curve for PKS 0329-27 at p.a. 83^o. Again, the scale is for H_o=100 km/s/Mpc.

Figure 4 (below) shows (a) the distribution of ionized gas in PKS 0349-27, (b) the blue spectrum at p.a. 83^o (marked in 4a), showing line-splitting on both sides of the nucleus, and (c) a red spectrum in the Hα/[NII] region at the same position.





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REFERENCES

Baum, S.A. et al. 1988. Ap. J. Suppl., in press.
Beichman, C. et al. 1985. Ap. J. **293**,148.
Hansen, L., Norgaard-Nielsen, H.U., Jorgensen, H.E., 1987. Astr. Ap. Suppl. **71**,465.
Heckman, T.M., Illingworth, G.D., Miley, G.K. & van Breughel, W.J.M. 1985. Ap. J. **299**,41.
Rubin, V.C., Burstein, D., Ford, W.K. & Thonnard, N. 1985. Ap. J. **289**,81.
Simkin, S.M. & Michel, A. 1986. Ap. J. **300**,L5.