# WEAK RADIO GALAXIES: NARROW-BAND OPTICAL IMAGING

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## 1. Introduction

Previous studies show that: a) radio galaxies and radio-loud quasars have emission-line gas (ELG) which is extended on scales of tenths of kiloparsecs; b) there is convincing evidence that the kinematics and excitation of the very extended emission-line gas is governed by its interaction with the outflowing radio plasma; c) the evidence for an interaction is weaker in some radio galaxies. It is argued that the ionization of the ELG may be predominantly produced by the nuclear ultraviolet continuum and the kinematics of the gas due to the gravitational potential of the host galaxy, but it is not yet known whether there is a physical relationship between the ELG and the extended radio jets.

We have obtained optical narrow-band (isolating redshifted H$\alpha$+[NII], or [OIII]) images of a radio flux density selected sample of 26 radio galaxies. We also use data available in the literature to study the association between the extended emission-line gas and the radio structure.

The details of our study of extended emitting gas in weak radio galaxies are presented in Carrillo (1995), Carrillo, Cruz-González & Guichard (1995).

## 2. Observations and Data Reduction

The observations were carried out at the 2.12 m telescope of the Observatorio Astronómico Nacional at San Pedro Mártir, B.C., México. CCD images were taken through narrow-band filter centered on either H$\alpha$+[NII]$\lambda\lambda$6548,6583, or [OIII]$\lambda$5007. Two Thompson CCD detectors were used: 384×576 and 1024×1024, which with the f/7.5 secondary yield an image



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scale in the focal plane of 0.3"/pixel and 0.25"/pixel, respectively, so that the field of view is 1.93'×2.89', and 4.25'×4.25' in each case.

Typical observation times at H$\alpha$ were 30 min and at [O III] 1 hr. A set of standard stars from Oke's list, were acquired each night for photometric calibrations. The reduction of the two-dimensional CCD frames follows the standard procedures. The Image Reduction and Analysis Facility (IRAF) software was used.

## 3. Results

This work summarizes the results of a study of the optical properties and emitting-line gas nebulae of a representative sample of weak radio galaxies.

Our main results are:

- Spatially extended emission-line gas is quite common in weak radio galaxies. Line emission is detected in all the sources in the representative sample and 81% have resolved emission-line nebulae.
- The size of the emission-line nebulae is $\approx$ 4.6 kpc, and the emission-line luminosity in H$\alpha$+[NII] or [OIII] is $\approx 1.1\times10^{41}$ ergs $s^{-1}$. The latter is an order of magnitude the luminosity of emission-line nebulae in normal early-type galaxies, and similar to that found in powerful radio galaxies (Baum & Heckman, 1989a, 1989b).
- The emission-line nebulae have a wide range of sizes and morphology. In some sources we observed only small, centrally condensed, kpc scale regions, while in others we detect more extended filaments of line emitting gas at several kpc from the host galaxy nucleus.
- We find very strong correlations of the emission-line luminosity with both the total radio luminosity and the core radio power. WRGs showed to be consistent both in radio luminosity and line luminosity with less luminous sources than powerful radio galaxies or quasars.
- We estimate lower limits to the density of the emission-line gas of $\sim$ 0.02 to 0.26 $cm^{-3}$, and upper limits to the total mass in emission-line gas between $1.2\times10^{8}$ and $2.6\times10^{9}$ $M_{\odot}$.

## References

Baum, S.A., Heckman, T. (1989a) Extended Optical Line Emitting Gas in Powerful Radio Galaxies: Statistical Properties and Physical Conditions, *ApJ*, **336**, pp. 681-701.

Baum, S.A., Heckman, T. (1989b) Extended Optical Line Emitting Gas in Powerful Radio Galaxies: What is the Radio Emission-Line Connection?, *ApJ*, **336**, pp. 702-721.

Carrillo, R. (1995) Ph.D. Thesis, *Facultad de Ciencias*, UNAM.

Carrillo, R., Cruz-González, I., Guichard, J. (1995) in preparation.

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