

# THE EXTENDED IONIZED NEBULOSITIES SURROUNDING THE ACTIVE GALAXIES NGC 6215, A 0945-30 AND MCG-2-58-22

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## OBSERVATIONAL RESULTS

*The following results are fully described in Durret and Bergeron (1988).*

NGC 6215 is a radio-loud spiral galaxy at a distance of 31.3 Mpc (with  $H_0 = 50 \text{ km s}^{-1} \text{ Mpc}^{-1}$  throughout), located 165 kpc away from the Seyfert 2 NGC 6221 and embedded in an ionized nebulosity of diameter 8.3 kpc along PA=340°. This gaseous envelope is three times more extended towards the South than towards the North. The nucleus of NGC 6215 has characteristics of a weak LINER (Low Ionization Nuclear Emitting Region, see Heckman, 1980), with [OI]λ6300 detected at a 3σ level. The extranuclear spectra are indistinguishable from HII region type, and all the zones, including the nucleus, have very similar excitation levels. The ionized gas shows no velocity gradient along PA=340°:  $\Delta v < 50 \text{ km s}^{-1}$ , suggesting that the minor axis of the nebulosity is close to the photometric minor axis.

A 0945-30 (=MCG-5-23-16) is an S0/a galaxy, located at a distance of 50.8 Mpc; it is variable in X-rays but is not a radio source. The ionized envelope around this galaxy has a diameter of 8.5 kpc along PA=232°, and is symmetrically distributed on either side of the nucleus. Its nuclear spectrum is that of a high excitation narrow line Seyfert, with [OIII]λ5007/Hβ ≈ 17, [NeV]λ3426/[NeIII]λ3869 ≈ 1 and HeIIλ4686 present, together with [OI]λ6300. A synthesis analysis of the Hα-[NII] blend shows the existence of a weak broad component in Hα, implying that this galaxy is in fact a Seyfert 1.9. The extranuclear regions are of lower excitation than the nucleus, particularly to the south-west. This extended nebulosity is one of the few examples where [OII]λ3727 is detected further away from the nucleus than [OIII]λ5007. The velocity field of the ionized gas is consistent with solid body rotation throughout, with a maximum amplitude of 450 km s<sup>-1</sup> and a velocity gradient of 68 km s<sup>-1</sup> kpc<sup>-1</sup>.

MCG-2-58-22 (= Mkn 926) is a Seyfert 1 located at a distance of 277 Mpc, with extremely broad Balmer lines, a very high X-ray luminosity and a barely resolved central radio source. It is surrounded by a very large ionized nebulosity of diameter 47 kpc along PA=270°, one of the largest detected around Seyfert 1s. As in A 0945-30, the gas is of rather unusually low excitation outside the nucleus, with I([OII]λ3727) notably larger than I([OIII]λ5007). The velocity field of the ionized gas has an extremely large amplitude of about 800 km s<sup>-1</sup>. Solid body rotation is observed over the central 28 kpc, with a gradient of 24 km s<sup>-1</sup> kpc<sup>-1</sup>, and a flattening of the rotation curve in the easternmost region.

## DISCUSSION

**By what kind of radiation is the gas ionized in the nuclear and extranuclear regions?**

The emission line intensities of the nuclear and extranuclear regions of NGC 6215 cannot be simultaneously fitted by HII region models (e.g. Stasinska, 1980). On the other hand, they are consistent with those predicted for LINERs by Binette (1985), where the gas of density  $400 \text{ cm}^{-3}$  is photoionized by a power-law continuum  $F_\nu \propto \nu^{-2.0}$ , and has an average ionization parameter  $U \simeq 10^{-4}$  (within a factor of 2). The gas in NGC 6215 therefore does seem to be ionized by a weak active nucleus, whose UV radiation is responsible for the ionization of the nuclear and possibly also extranuclear regions.

The nuclear spectrum of A 0945-30 is that of a high excitation Seyfert 1.9, which we believe to be an obscured Seyfert 1. A comparison of its nuclear emission line intensities with photoionization models by Stasinska (1984) gives a satisfactory fit for a blackbody ionizing radiation of effective temperature  $2 \cdot 10^5 \text{ K}$ , an ionization parameter  $U=(1-2)10^{-3}$ , a gas density  $n=(1-2)10^4 \text{ cm}^{-3}$  and abundances close to solar. The gas north-east of the nucleus is probably photoionized by a similar UV radiation of somewhat smaller effective temperature  $1.5 \cdot 10^5 \text{ K}$ , and has a lower value of  $U=(2-4)10^{-4}$ . The gas south-west of the nucleus seems of lower excitation and redder, implying the presence of dust which could prevent the nuclear ionizing continuum from reaching this zone; the gas could in that region be photoionized either by partially obscured UV radiation coming from the nucleus, or by nearby hot stars.

The nuclear spectrum of the Seyfert 1 galaxy MCG-2-58-22 is of notably lower excitation than that of A 0945-30. Since only [OII] $\lambda$ 3727 and sometimes H $\beta$  are detected outside the nucleus, we cannot discuss the ionization mechanism and physical properties of the extranuclear gas.

**Are there correlations between the ionized nebulosity extent and other properties?**

Very large ionized nebulosities (of diameter larger than 20-30 kpc) seem to have been until now preferably found (see e.g. Fosbury, 1986) around :

- Seyfert galaxies or quasars rather than LINERs
- radio loud objects
- intrinsically bright active galactic nuclei, particularly in the UV

The analysis of a catalogue of 157 ionized nebulosities found in the literature (Durret, unpublished) confirms that :

- few gaseous envelopes are found around LINERs (10 out of 157, or 6%)

AGN, but no clear correlation is found between the diameter of the ionized gas and the radio flux

- ionized envelopes do tend to be larger around AGN with bright absolute magnitudes, but this is a trend rather than a correlation.

## REFERENCES

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