The Interplay among Black Holes, Stars and ISM in Galactic Nuclei
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The [L - σ] relation for local HII galaxies

Vinicius Bordalo[1] **and Eduardo Telles**[1]

[1]Observatório Nacional/MCT, Rio de Janeiro, Brazil
email: vschmidt@on.br, etelles@on.br

Abstract. Local HII galaxies present a Fundamental Plane of [L-σ] where either the equivalent width of Hβ or the oxygen abundance O/H act as a second parameter. These relations are powerful cosmological distance indicators since emission line galaxies may be found to high redshifts, though some caution must be taken till systematic effects are better understood.

HII galaxies present empirical parametric relations of size and luminosity versus their supersonic line widths (Melnick *et al.* 1988; Telles & Terlevich 1993). However, contrary to normal Hubble type galaxies, the origin of the internal motions, evidenced by their supersonic emission line widths, are not as clear. The two more popular competing models are the gravitational model and the effect of massive star evolution through winds and supernova explosions. In any case the existence of the empirical relations by themselves justify their calibration and possible use as a powerful distance indicator of cosmological interest, since HII galaxies are easy to find at great distances (Melnick, Terlevich & Terlevich 2000).

Telles, Muñoz-Tuñón & Tenorio-Tagle (2001) have shown that HII galaxies are very "blobby" and that the intrinsic properties (luminosity, velocity dispersion) of a galaxy are dominated by the central (core) component. The latter point was the primary motivation to observe HII galaxies using the FEROS Echelle spectrograph on the 1.52m ESO telescope. We have pursued a more detailed investigation of the [L - σ] relation for a homogeneous sample of about one hundred local HII galaxies ($z < 0.1$). Emission line profiles were classified as: Gaussian – regular lines, very well represented by a single gaussian fit; Irregular – showing wings, generally sharp and asymmetric; Profile with Components – showing two or more components, possibly suggesting systematic motions, or multiplicity.

We have also measured widths for the lines of the ions of hydrogen (Hα, Hβ) and oxygen ([OIII]$\lambda\lambda$4959, 5007) and compared their derived σ values. We have found that hydrogen line widths are marginally greater than oxygen line widths (Figure 1). This difference favors turbulence as the interpretation for the motions, similar to what is found for giant HII regions (Hippelein 1986).

Another important topic in our study is the possible existence of a second parameter in the [L - σ] relation. Using the method of Principal Component Analysis with spectrophotometric data from Kehrig *et al.* (2004) we have found that either the equivalent width of Hβ (EW(Hβ)) or the metallicity (O/H) contributes to about 30% of the variance as a second principal component. This means that either parameter may be responsible for the scatter in the [L - σ] relation (Figure 2), indicating that the [L - σ] relation may be sensitive to evolution and that O/H or EW(Hβ) is the independent second parameter. We will improve this analysis with the inclusion of more objects, for which the spectrophotometry is being derived now.

There are still remaining issues to be cautious, for instance, the different emission line profiles, shown by our high resolution spectroscopy, indicate that different broadening

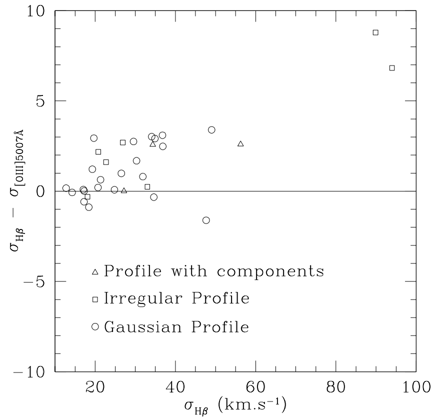

Figure 1. Line width systematic difference σ(HII) - σ[OIII] $\approx$ 1.6 km s^{-1}. These galaxies have emission lines with S/N > 20 and $\delta\sigma$ < 1 km s^{-1}.

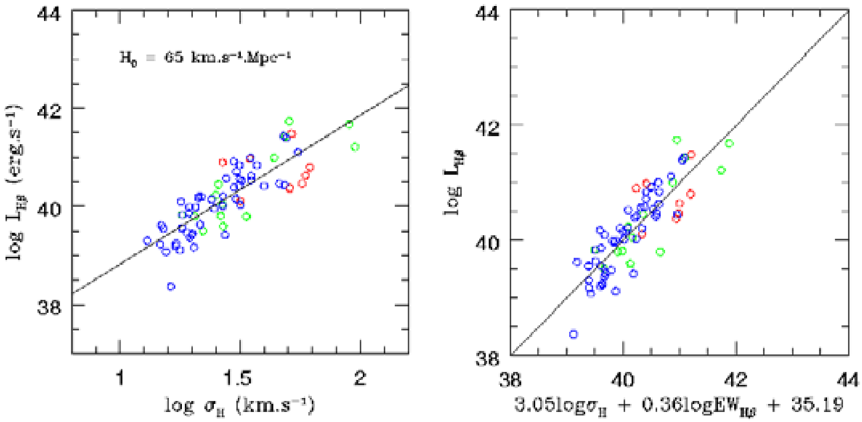

Figure 2. Left graph shows the [L - σ] relation for 71 galaxies for which we have fluxes and equivalent widths of Hβ from Kehrig et al. (2004) spectrophotometry. The solid line represents a linear least square fit without error weights: **log L(Hβ) = (3.03$\pm$0.25)logσ + (35.79$\pm$0.37); RMS = 0.41**. **Right graph** shows the [L - σ - EW(Hβ)] relation for the same 71 galaxies. The RMS is reduced to 0.36.

mechanisms may be at play and may be also a source of scatter in the [L - σ] relation. One needs to identify precisely for what kind of objects the relation holds and whether it applies for the distant Universe before it can be used as a cosmological distance indicator. A full analysis of our data will appear in a forthcoming paper.

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