Can retired galaxies mimic active galaxies?

A study of LINERs in the SDSS

Natalia Vale Asari
UFSC, Brazil
Observatoire de Paris, France
natalia@astro.ufsc.br

Grażyna Stasińska
Observatoire de Paris, France

Roberto Cid Fernandes Jr., Jean Michel Gomes, Marielli Schlickmann & William Schoenell
UFSC, Brazil

Abilio Mateus
LAM, France

Larte Sodré Jr.
USP, Brazil

More details in: **Can retired galaxies mimic active galaxies? Clues from the Sloan Digital Sky Survey.** Stasińska, G.; Asari, N. V.; Cid Fernandes, R.; Gomes, J. M.; Schlickmann, M.; Mateus, A.; Schoenell, W.; Sodré, L., Jr., 2008, MNRAS, in press (arXiv:0809.1341)

1 Background

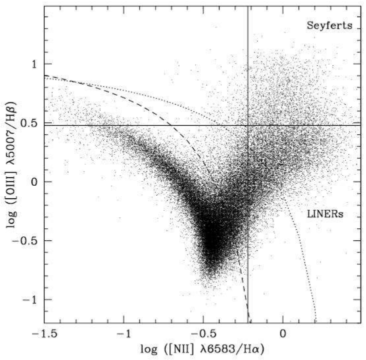

Figure 1: The [N II]/Hα vs. [O III]/Hβ diagram (BPT, after Baldwin, Philips & Terlevich 1981) as revealed by the Sloan Digital Sky Survey (SDSS). Star-forming (SF) galaxies lie on the left wing and hosts of active nuclei in the right wing. Figure from Kauffmann et al. (2003).

Kewley et al. (2006) showed the SDSS right wing is in fact composed of two branches, identified as Seyfert and LINERs (Ionization Nuclear Emission Regions).

But do all LINERs really have an active nucleus? We explore this open question by studying the stellar populations of SDSS galaxies.

2 Data processing

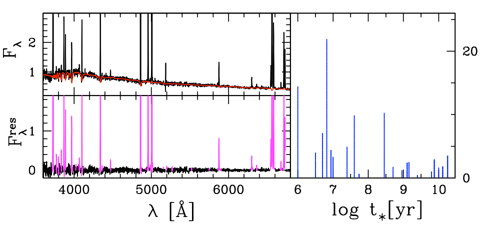

Figure 2: We infer the **stellar populations** that compose a galaxy by a pixel-by-pixel model of its spectral continuum with our code STARLIGHT, using a base of simple stellar populations from Bruzual & Charlot (2003). Top panel shows an example of observed (black) and model (red) spectra. The panel on the right shows the light fraction associated with populations of different ages for this model. We then measure **emission lines** by fitting gaussians to the residual spectrum (bottom panel).

3 Sample

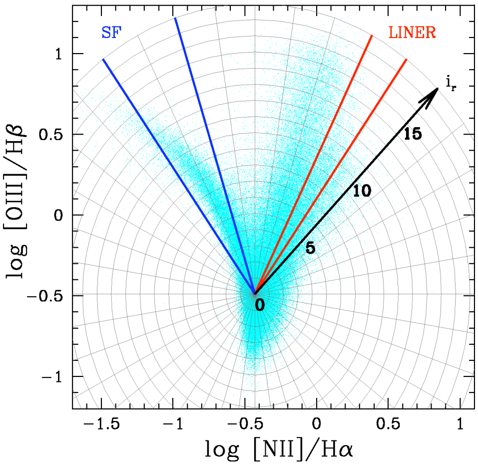

Figure 3: Sample of **131287** SDSS galaxies in the BPT diagram. We chopped the diagram into polar coordinates (r, θ), with the center defined at the point of inflection of the median curve of the distribution of [O III]/Hβ as a function of [N II]/Hα. The **SF** and **LINER** branches were defined as ranges in θ. We study variations of properties in the r coordinate by using the i_r index.

4 Results

4.1 Ionizing photons

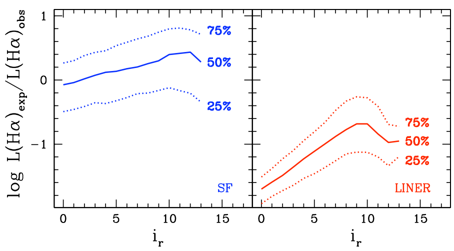

Figure 4: For each galaxy, we compute $Q_{\rm HI}$, the number of stellar ionizing photons with energy above 13.6 eV arising from the populations uncovered by STARLIGHT. We consider only the old stellar populations for estimates in the LINER branch. We then predict the luminosity in Hα due to the stellar populations, $L(\mathrm{H}\alpha)_{\rm exp}$, assuming all these photons are absorbed, and compare it to the observed value $L(\mathrm{H}\alpha)_{\rm obs}$. The $L(\mathrm{H}\alpha)_{\rm obs}$ for SF branch is quite well explained by the populations recovered by STARLIGHT. We can explain the observed $L(\mathrm{H}\alpha)$ for about **25% of the LINER branch** in our sample by only using the ionization of **old stellar populations**.

4.2 Radiation hardness

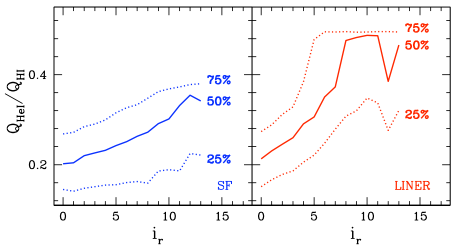

Figure 5: The ratio $Q_{\rm HeI}/Q_{\rm HI}$ of He to H ionizing photons (expressing the hardness of the radiation field) for the SF and LINER branches. The stars in LINER branch have much **harder radiation** than the ones in the SF branch. This could explain why the [O III] and [N II] lines are stronger (with respect to hydrogen lines) in LINERs than in SF galaxies.

4.3 Photoionization models

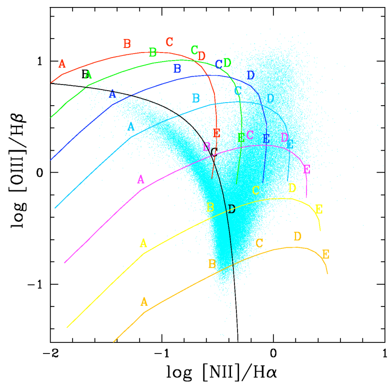

Figure 6: Photoionization models confirm that the **ionization from old stars** can account for the emission line ratios in the LINER branch. This plot shows photoionization models for given values of nebular metallicity (different colours) and ionization parameter (A–E). Metal-rich models (twice the solar metallicity) are the ones which best cover the LINER region.

5 Conclusions

A fraction of the galaxies in the SDSS that are thought to have nuclear activity could actually be composed galaxies which **stopped forming stars**. The ionization in these **retired** galaxies is produced by hot post-AGB stars and white dwarfs, which can account for LINER-like emission line ratios.

Acknowledgements: We acknowledge the support from the CAPES-COFECUB program, CAPES, CNPq, FAPESP, Observatoire de Paris and the SDSS team.