On the variable nature of low luminosity AGN*

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1. Introduction & Aims

Low ionization nuclear emission line regions (LINERs) are usually seen as scaled-down versions of Seyfert galaxies. However it is still under consideration how they fit into the AGN Unified Model (Antonucci 1993). Conversely to the variable nature of Seyferts (Peterson 1997), the first evidence on the variable nature of LINERs has been found by Maoz et al. (2005) at UV frequencies.

At X-rays different authors claim variability among the LINER family (Younes et al. 2011, Hernández-García et al. 2013), but the main driver of the changes is still an open question. We (Hernández-García et al. 2013, 2014, 2015, PhD thesis) have investigated in a systematic way the origin of the variations both in LINERs and Seyfert 2 (Sy2) galaxies with the goal of addressing this question. Here we report the comparison between both systems.

2. Data & Methodology

We have collected 13 LINERs (from Ho et al. 1997) and 25 Sy2 (Véron Cetty & Véron 2010) with available data at different epochs in the *Chandra* and/or *XMM-Newton public* archives. To study long term variations all the spectra from the same object are simultaneously fitted (see Fig. 1), and allowing different parameters to vary during the spectral fitting leads to isolate the parameter responsible for the variations. Short term variations have also been studied from the analysis of the light curves. Finally, when data are available from the optical monitor onboard *XMM-Newton* (see Fig. 2) UV data have also been analyzed.

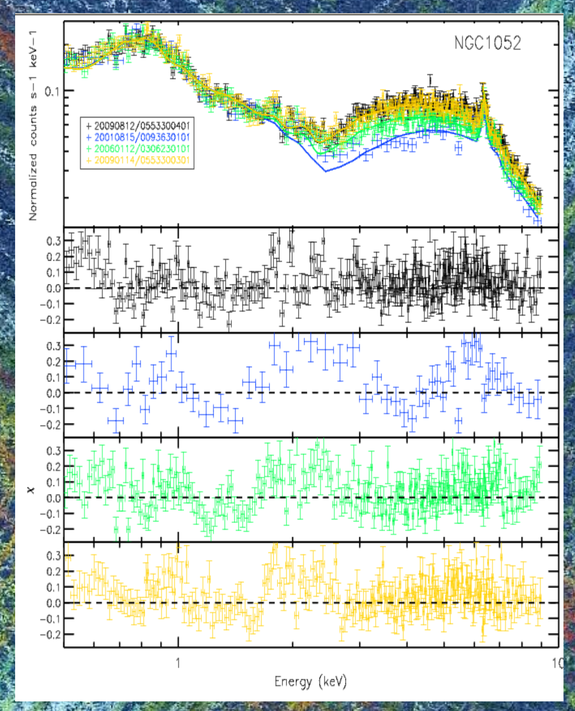

Figure 1. Simultaneous spectral fit for NGC 1052 in four different dates (top) and the corresponding residuals of each observation (see colors).

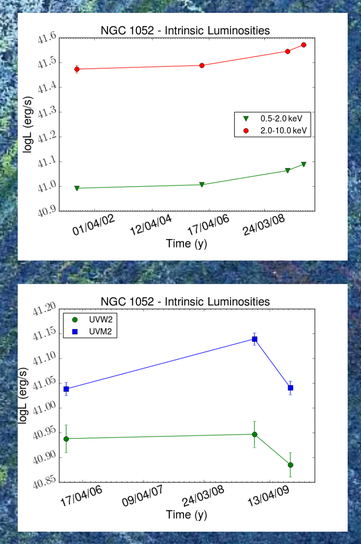

Figure 2. Top: X-ray luminosities in the 0.5-2 keV (green) and 2-10 keV (red) energy bands. Bottom: UV luminosities in the UVW2 (green) and UVM2 (blue) filters of NGC 1052.

3. Results

Spectral shape and X-ray parameters

- Sy2 need more complex models to fit their spectra than LINERs.
- Major differences are observed in the soft (0.5-2 keV) and hard (2-10 keV) X-ray luminosities, and the Eddington ratios, which are higher in Sy2 (Fig. 3).
- Differences are also observed in the hard column densities, temperatures, and black hole masses, although less significant.
- There are no differences in the slope of the power-law (Fig. 4).

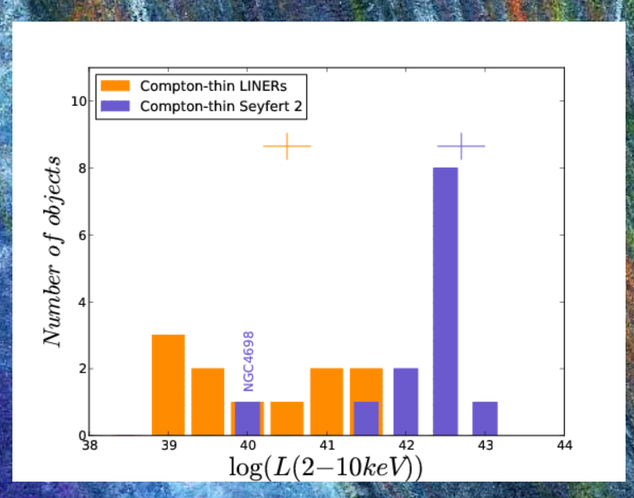

Figure 3. Histogram of the hard X-ray luminosities for the Compton-thin LINERs and Sy2.

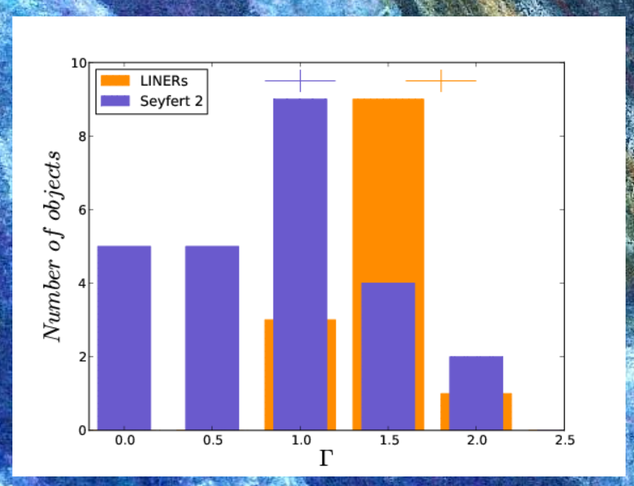

Figure 3. Histogram of the slope of the power-law for the Compton-thin LINERs and Sy2.

X-ray and UV variability

- Short-term (i.e., from hours to days) X-ray variations cannot be claimed, neither for Sy2 nor for LINERs.
- Long-term (i.e., from months to years) X-ray variability is very common in both families (seven out of 11 LINERs and 10 out of 13 Sy2). An exception is found for Compton-thick sources (two LINERs and 12 Sy2), which do not vary, most probably because the AGN is not accessible in the 0.5-10 keV energy band.
- X-ray variations are mostly related with variations in the nuclear continuum (i.e., the normalization of the power law), but other patterns of variability show that variations in the absorbers (more common in Sy2) and at soft energies can be present in a few cases (see Fig. 5).
- Variations at UV frequencies are observed only in LINER nuclei.
- Although variations occur similarly in both families, related to changes in the nuclear power, the accretion mechanism can be different. In Fig. 6 the index of the power law is plotted against the Eddintong ratio; as usually done for binary stars in different stages (Remillard et al. 2006). LINERs follow the results of Younes et al. (2011) and Sy2 do for those of Shemmer et al. (2006) for luminous AGN. This may suggest that LINERs are in the low accretion regime (ADAF) whereas Sy2 are efficient accretors.

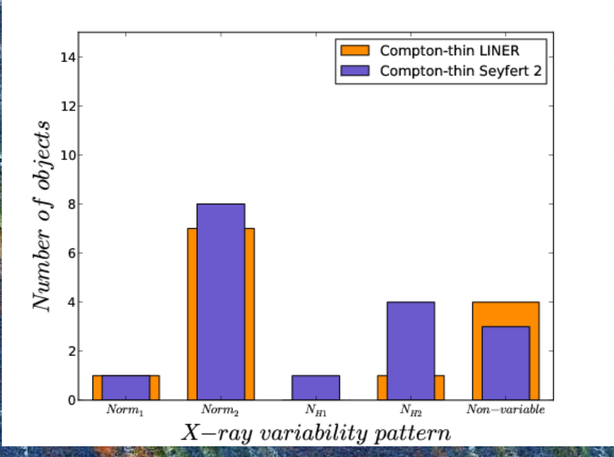

Figure 5. Histogram of the X-ray variability patterns of the Compton-thin LINERs and Seyfert 2s. In a few cases, two parameters vary together.

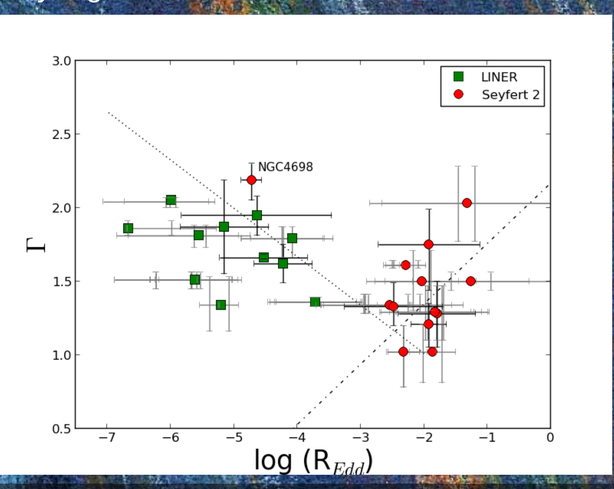

Figure 6. Slope of the power-law, Γ, vs. The Eddington ratio for the Compton-thin LINERs (green squares) and Seyfert 2s (red circles). The dot-dashed line represents the results by Shemmer et al. (2006), and the dotted line those by Younes et al. (2011).

4. Conclusions

The X-ray variations occur similarly in LINERs and Sy2. These variations might be related to viscous propagating fluctuations in the accretion disc flow (Lyubarskii et al. 1997), although the accretion mechanisms can be different, being more efficient in Sy2.

From the comparison of Sy2 and LINERs variability and based on the scarcity of absorption variations, the lack of changing-look candidates, and the fact that UV nuclear variations are found in LINERs and not in Sy2, we suggest that the broad line region and the torus might disappear in LINERs as predicted by theoretical models (Elitzur & Shlosman 2006).

5. References

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