

# Transition (LINER/HII) nuclei as evolved Composite (Seyfert 2/Starburst) nuclei

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**Abstract.** We compare the circumnuclear stellar population and environmental properties of Seyfert and Composite (Seyfert + Starburst) nuclei with those of LINERs and LINER/HII transition galaxies (TOs), and discuss evidence for evolution from Seyfert/Composite to LINER/TO nuclei.

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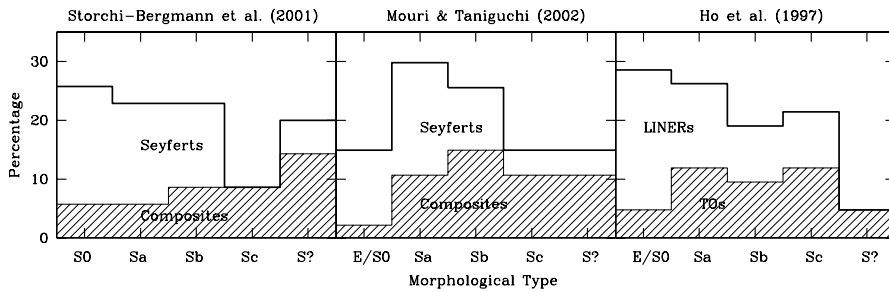
## 1. Introduction

Many contributions to these Proceedings discuss signatures of the feeding process of AGN. Our group, in particular, has been looking for peculiarities in the circumnuclear stellar population in these galaxies. We have concluded that about 40% of nearby Seyferts seem to have circumnuclear starbursts (Cid Fernandes et al. 2001), which is significantly more than what is found in a sample of non-active galaxies with similar Hubble types, arguing for a relation between the presence of a starburst and an active nucleus. We have called the Seyfert galaxies with luminous circumnuclear starbursts of Composites.

In Storchi-Bergmann et al. (2001) we proposed an evolutionary scenario for the activity in Seyferts in which interactions with companion galaxies could be the triggers of both nuclear activity and circumnuclear starbursts. In this scenario the age of the last generation of stars could be used to date the onset of nuclear activity, if the active nucleus and circumnuclear starburst are triggered together. If, in addition, they evolve together, we should find weak active nuclei as evolved Seyfert 2 and old starbursts around weak active nuclei as the evolved Composite nuclei. These evolved nuclei could be LINERs and TOs (Ho et al. 1997). In this contribution we discuss evidence pointing in this direction.

## 2. Stellar population *vs.* galaxy morphology and environment

We first summarize the results found by Storchi-Bergmann et al. (2001), which motivated the proposed evolutionary scenario: (1) there is a larger incidence of Composites in late-type galaxies; (2) the inner morphology of Composites is also “late-type” (Malkan et al. 1998); (3) the age of the starbursts in the Composites is in the range  $10^6 - 10^8$  yrs; (4) there is a larger incidence of close companions among Composites. It is interesting to point out that these conclusions are similar to those reached by Mouri & Taniguchi (2002) for a sample of 48 CfA Seyfert galaxies, in particular the larger incidence of younger stellar population in later type galaxies and in galaxies with close companions. In the evolutionary scenario the Composite nuclei would be the youngest Seyferts, in which signatures of the interaction could still be clearly visible, as well as there would be plenty of gas and dust, which would lead to the late-type morphology.



**Figure 1.** Distribution of Hubble types of: Seyfert 2s from Storchi-Bergmann *et al.* (2001) (left), CfA Seyferts from Mouri & Taniguchi (2002) (middle), and LINERs from Cid Fernandes *et al.* 2004 and González Delgado *et al.* 2004 (right). Open histograms represent the distributions of the complete samples, while hatched ones represent the distribution of galaxies with large contribution from young (first two samples) and intermediate age stars (last sample).

Recently, we extended the stellar population study to a sample of 51 LINERs and TO's (Cid Fernandes *et al.* 2004; González Delgado *et al.* 2004). Investigating the relation between the stellar population and environmental properties, we find that: (1) the stellar population of most TO's is characterized by a significant contribution from intermediate age stars; (2) there is a larger incidence of TOs in late-type galaxies; (3) the age of the starbursts is mostly around  $10^9$  yrs; (4) there is no excess of companions among TOs (Schmitt 2001).

### 3. Conclusions

In figure 1 we compare the distribution of Hubble types for the Seyfert and LINER samples discussed above, and the corresponding subsamples of Composites and TO's. This figure shows that both Composites and TO's present a larger incidence in later-type galaxies, although the distributions are not exactly the same, with the Seyfert samples having a larger proportion of distorted galaxies (S?).

We quantified the contribution from young and intermediate age stars to the spectra, and find that the contribution in luminosity of the young stars in the Composites and of the intermediate age stars to the TO's correspond to similar mass contributions to the total mass of their bulges.

We thus conclude that at least part of the TO's may be evolved Composites; in this case, the Seyfert 2 nucleus should have evolved and faded to a LINER together with the Starburst. This conclusion is also consistent with non-Composite Seyfert nuclei evolving to LINER nuclei (Corbin, 2000). Our results also support that interactions may be the triggers of starburst activity, once the interaction signatures are gone after  $10^9$  yrs.

### References

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