Stellar Populations and Kinematics in Seyfert Galaxies

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Abstract. Our aim is to study the stellar kinematics in hosts of AGN. We do so by measuring nuclear stellar velocity dispersions ($\sigma_\star$). Our sample comprises spectra of 78 objects, 69 of which are Seyfert galaxies, in the region around the $\lambda\lambda 8498.02, 8542.09, 8662.14$ Calcium triplet (CaT). We investigate two methods to measure $\sigma_\star$: (1) the direct fitting method (DFM), which makes use of our stellar population synthesis code Starlight, and (2) the cross-correlation method (CCM), for which we use the fxcor package in IRAF. Both methods yield velocity dispersions consistent to within 19 km/s on-average. We have also measured the CaT equivalent width (W_{CaT}) and the $\lambda 3933$ CaII K equivalent width (W_K) for the objects in our sample. Other studies have shown that W_K is a powerful tracer of starbursts in Seyfert nuclei, so we check if W_{CaT} can be used in the same way. We have also analysed a sub-sample of 34 spatially resolved objects with reasonably good off-nuclear signal-to-noise. We study the spatial variations of both $\sigma_\star$ and W_{CaT}. We see no dilution in W_{CaT} for composite starburst + Seyfert 2 galaxies, in contrast to the dilution in the W_K (studied by other authors) for the same objects.

Keywords. Galaxies: active, galaxies: kinematics and dynamics, galaxies: Seyfert, galaxies: statistics, galaxies: stellar content
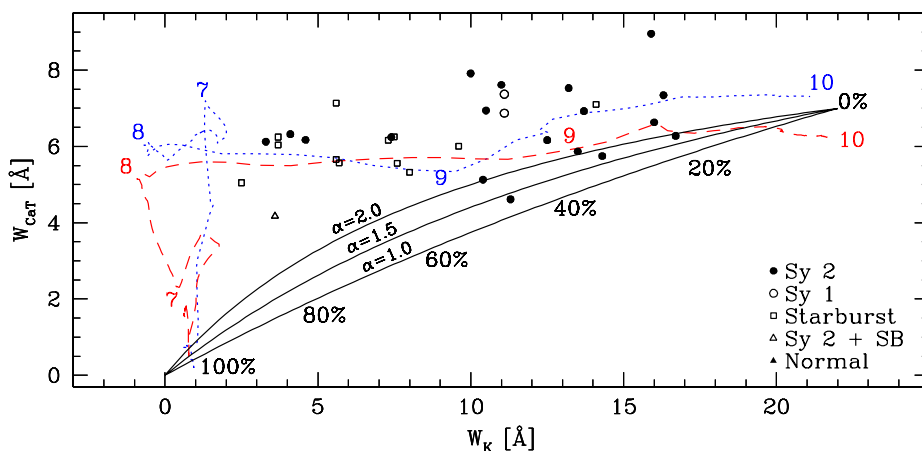
Figure 1. Comparison between nuclear W_{CaT} and W_K for our objects. We show the evolutive paths for simple stellar populations with two metallicities: 1 (dotted line) and 2.5 $Z_\odot$ (dashed line). The numbers at those lines indicate log(age). The solid curves show the dilution of the equivalent widths due to a featureless power-law $F_\nu \propto \nu^{-\alpha}$. We found that W_{CaT} is nearly constant, thus it cannot be directly used as a stellar population diagnostic tool. We also show that the combination of W_{CaT} and W_K is inconsistent with a non-stellar featureless continuum. Purely stellar models, on the other hand, reproduce the observed values quite well.

1. Appendix

We have studied in detail two methods to measure stellar velocity dispersions: the direct fitting method (DFM) and the cross-correlation method (CCM). Some examples of fits for the DFM can be seen in Figure 2. These two methods they are in an extremely good agreement with one another (Figure 3; Garcia-Rissmann *et al.* 2005).

We have also shown that stellar population models reproduce W_K and W_{CaT} for Seyfert 2 galaxies without any need for an additional non-stellar featureless continuum component (Figure 1).

In our spatial analysis, we see that W_{CaT} for composite starburst + Seyfert 2 galaxies is not diluted, in contrast to the dilution in the W_K for the same objects (Figure 4).

As a future step, we can use $\sigma_\star$ to study the activity of AGN, through the black hole mass and $\sigma_\star$ relation (Ferrarese & Merritt 2000; Gebhardt *et al.* 2000). We also emphasize the use $\sigma_\star$ as a diagnostic of stellar populations and starbursts, through the stellar mass and mass-to-light ratio that can derived from it. This is especially important for Seyfert 1 galaxies, for which other stellar population diagnostic tools fail.

References

Ferrarese, L. & Merritt, D. 2000, *ApJ*, 539, L9

Garcia-Rissmann, A., Vega, L. R., Asari, N. V., Fernandes, R. C., Schmitt, H., González Delgado, R. M., & Storchi-Bergmann, T. 2005, *MNRAS*, 359, 765

Gebhardt, K., Bender, R., Bower, G., Dressler, A., Faber, S. M., Filippenko, A. V., Green, R., Grillmair, C. *et al.* 2000, *ApJ*, 539, L13
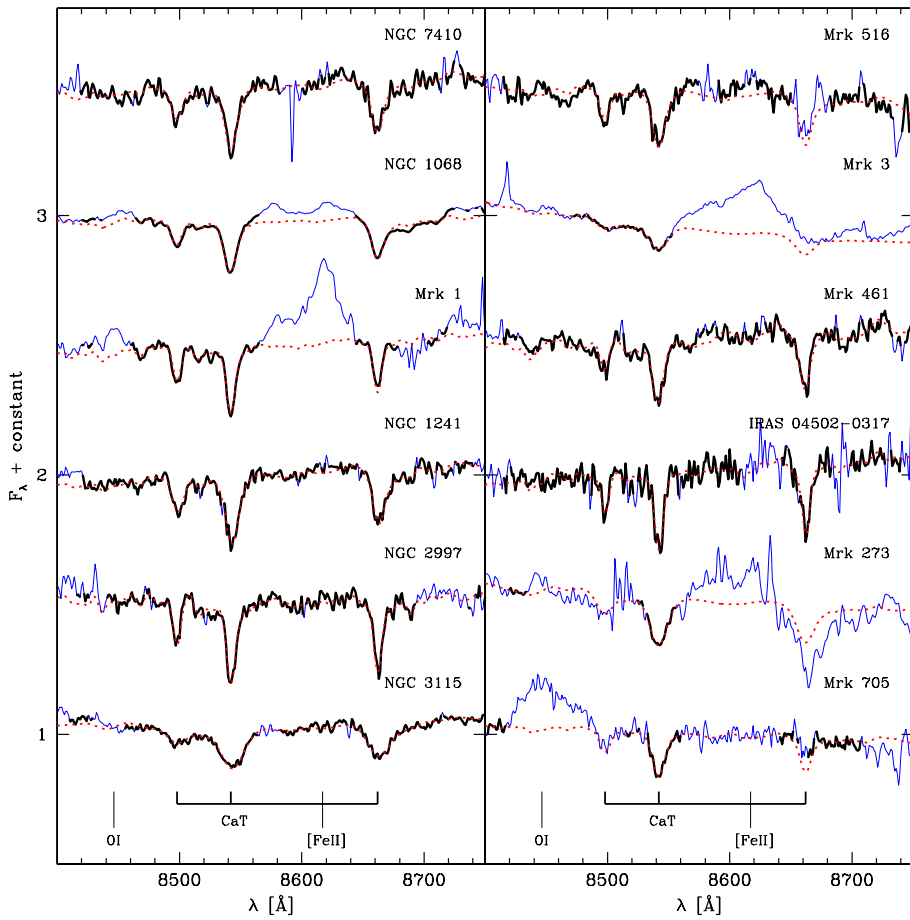
Figure 2. Examples of direct fits to the galaxy spectra. The solid line (black and blue) shows the observed spectrum, while the dotted line (red) shows the spectral fits obtained with the DFM. A thicker line (in black) is used to mark the region actually used in the fits.
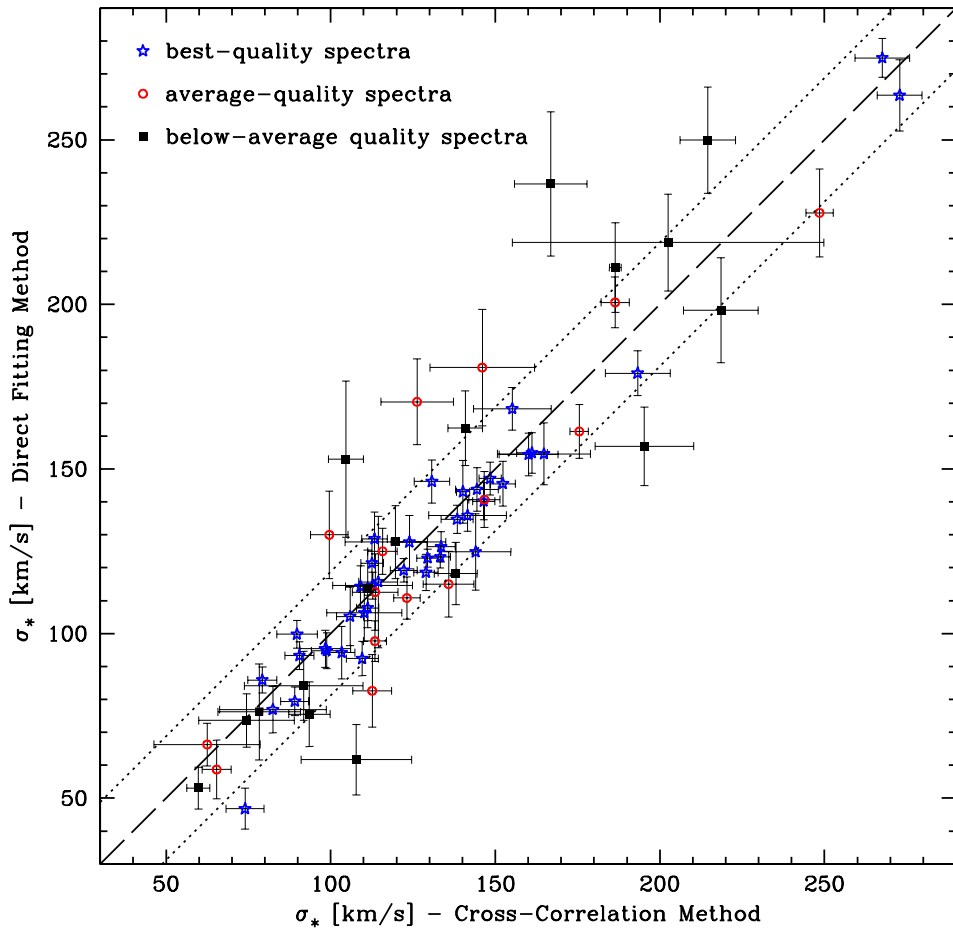
Figure 3. Nuclear analysis. We find that the DFM and the CCM yield velocity dispersions consistent to within 19 km/s on-average. The dashed line is the identity line, the dotted lines indicate $\pm$ 1 sigma. The uncertainties for the CCM are simply the template mismatch; for the DFM, they were calculated by rescaling χ^2.
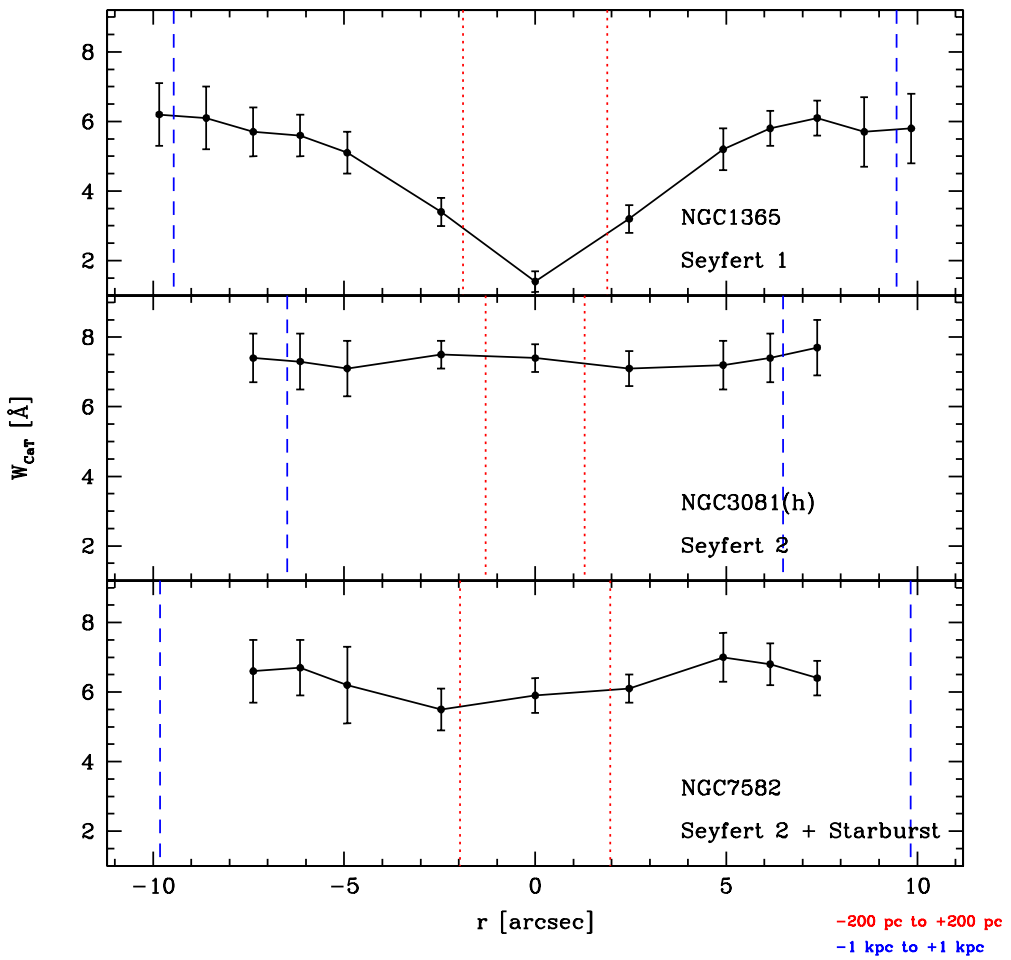
Figure 4. Spatial analysis. Spatial variations of W_{CaT} for some of our objects. Even though our spatial resolution does not allow very detailed studies, we find an interesting result: we see **no dilution** in W_{CaT} for composite starburst + Seyfert 2 galaxies, in contrast to the dilution in the W_K (studied by other authors) for the same objects.