High Resolution Near UV Imaging of Seyfert Galaxies

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Abstract: We present the preliminary results of a near ultraviolet HST imaging survey of 73 nearby Seyfert galaxies. These images are used to study the structure and frequency of circumnuclear star formation in these objects. We find a wide range of morphologies in these images, from Seyfert 1’s where only a single point source was detected, to galaxies with a large number of circumnuclear star clusters, as well as objects where only diffuse emission could be seen. We find that circumnuclear star formation can be found around both Seyfert types, and not only around Seyfert 2’s, as suggested by previous studies. We confirm previous ground based results, which indicate that circumnuclear star formation is common in Seyfert galaxies.

Sample and Data: Our observations were done with the HST ACS/HRC using the filter F330W, which has a bandwidth of ~400A centered around 3300A. The observations were done in snapshot mode, with 73 of the 101 galaxies in the original sample being observed. Each galaxy was integrated for 20 minutes, split into 2 exposures. We used the F330W filter, and not a shorter wavelength one, because it has one of the best throughputs and negligible red leak, allowing us to efficiently detect circumnuclear star clusters. The original sample was composed of Seyfert galaxies with either HST or ground-based data available at other wavebands (optical and infrared imaging and spectroscopy, narrow band [OIII] and radio imaging), which will help the interpretation of the near-UV images.

Figure 1: One of the main results of this survey is the detection of a wide range of near-UV structures in these galaxies. The above figure (left) presents some examples of Seyfert 2 galaxies where we could detect circumnuclear star clusters. These structures were detected in ~50% of the galaxies in our sample. This includes some of the galaxies already known to have circumnuclear starbursts, like NGC7130, NGC7674 and NGC5135 (Gonzalez Delgado et al. 1998, 2001; Schmitt et al. 1999), as well as a few previously unknown sources, like NGC7496 and NGC5674. The solid line, in the bottom left corner of each panel has 250pc.

Figures 2 and 3: In the case of Seyfert 1 galaxies, ground based observations by Oliva et al. (1999) did not find circumnuclear star formation, suggesting that they have stellar populations different from Seyfert 2’s. However, the above figures (center and right) show that the detection of circumnuclear star formation in Seyfert 1’s, based on ground based studies, was probably hampered by the glare of the nucleus. We still have several cases, like NGC6814 and NGC5940, where we can only detect a nuclear point source, but we also find a significant portion of sources (e.g. MRK42, NGC7469) where circumnuclear star clusters can clearly be seen. The percentage of Seyfert 1’s with such star clusters is similar to that of Seyfert 2’s.

Figure 5: An interesting result of this survey was the fact that ~30% of the galaxies show diffuse emission. We are not certain about the nature of this emission. It could be due to intermediate age stars, old enough that the original star clusters have been destroyed by interactions with the bulge gravitational potential. In other cases, like NGC3393 and MRK573, this diffuse emission is aligned with the radio emission, and coincident with the extended [OIII] emission. In these cases the diffuse emission can be attributed to several factors: reflected nuclear continuum, [NeV]/[NeIII]/[OIII] emission, or recombination continuum. It will be necessary to use imaging polarimetry and high sensitivity, high spatial resolution spectroscopy to differentiate between these mechanisms.

Figure 4: The above figure shows an additional use of our images, the study of the structure and the properties of star clusters in the spiral arms of galaxies. Several of the galaxies in the sample are close enough, and have sufficiently strong star formation along their spiral arms, that it will be possible to characterize the properties of individual star clusters and associations.

Summary: We found that at least 50% of our Seyfert galaxies have circumnuclear star formation. However, this is only a lower limit, given that there is a large number of galaxies, the ones with diffuse emission, for which the presence of young stars uncertain and has to be verified. We are currently combining all information available for our galaxies to characterise their circumnuclear star clusters and diffuse UV emission.