Morphology of AGN host galaxies with VST-KIDS: a pilot analysis with the SDSS

Mario Radovich[1], Anna Romano[2,3]

[1]*INAF-Osservatorio Astronomico di Capodimonte,* [2]*INAF-VST Center*
[3]*Dipartimento di Astronomia - Università di Padova*

email: radovich@na.astro.it

Introduction

The Kilo-Degree Survey (KIDS) is one of the core public surveys to be done with VST/Omegacam: it will provide the *ugriz* follow-up of the NGP ($10^h < \alpha < 15^h$, $-7.5° < \delta < 2.5°$) and SGP ($22^h < \alpha < 4^h$, $-37° < \delta < -22°$) strips in the 2dFGRS. The total covered area will be 1500 sq. deg. (NGP: 780 sq. deg., SGP: 720 sq. deg.). In addition, YJHK photometry will be obtained from the on-going UKIDSS survey (NGP) and from VISTA (NGP, SGP) with VIKING, a near-infrared public survey (submitted to ESO) parallel to KIDS. Among the several scientific topics which will be addressed by KIDS (e.g. weak lensing, search for high-z QSOs, environment and morphology of galaxies), we describe here a project aimed at studying the morphology and environment of galaxies hosting an AGN. On large scales (> 1 Mpc) there is no evidence for a difference in the environment of AGN compared to normal galaxies (see e.g. Sorrentino et al. 2006); however, it is still an open issue if there is an excess in AGN of galaxies with close neighbours or showing traces of past merging events (tidal tails, disturbed morphology, etc.) which could have triggered the activity. In preparation of KIDS, we started a pilot analysis using the SDSS data available for the NGP strip to prepare and test the tools which will be then applied to the KIDS data. In particular, SDSS data allow: (i) a spectroscopic selection of the sample complementary to the 2dF and (ii) a first morphological analysis, even if the quality of the SDSS images is ~ a factor 2 lower than that expected for KIDS.

Definition of the sample

The SDSS contains ~ 35000 galaxies with spectra ($z < 0.2$) in the NGP strip. Galaxies with no emission lines were classified as passive galaxies. The residual galaxies were classified as: AGN-1 if FWHM(Hα) > 1200 km/s and FWHM([OIII] λ5007) < 800 km/s; AGN-2 or star-forming galaxies (SFG) according to the Veilleux-Osterbrock (VO) diagrams (Veilleux & Osterbrock 1987), as parametrized by Kewley (2001). In a first approximation, this can be done using line fluxes from the SDSS data-base. However, as the fiber aperture diameters are 2" in the 2dFGRS and 3" in the SDSS, the intensity of Balmer lines is underestimated if no template subtraction is done to remove the absorption from the underlying galaxy. To this end, we used a spectro-photometric code (Fritz & Poggianti 2006) which allows to find for each spectrum the linear combination of simple stellar populations fitting the observed continuum and absorption-line features (see Fig. 1). After the subtraction of the template, emission lines were fitted again using multiple Gaussians, now using a code that was developed by us. Figure 2 shows the so-obtained VO plots: it can be seen how in several cases the classification changes from AGN-2 to SFG after template subtraction. Figure 3 shows the spatial distribution of SFG (~5600), AGN-1 (~250) and AGN-2 (~480).

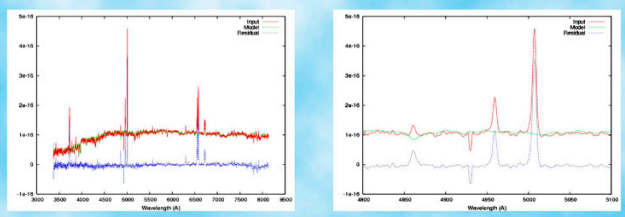

Fig. 1: Example of template subtraction for an AGN-2 spectrum

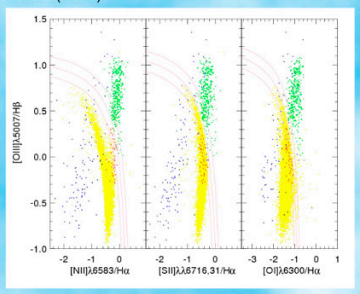

Fig. 2: Diagnostic diagrams for AGN-1, AGN-2 and SFG. Red points are galaxies classified as AGN-2 before template subtraction. The curves (+/- 0.1 dex) are from Kewley (2001).

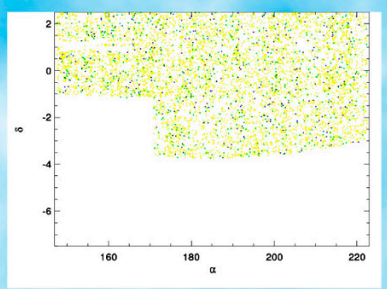

Fig. 3: Spatial distribution of AGN-1, AGN-2 and star forming galaxies (colors are as in Fig. 2) from the SDSS catalog, in the NGP strip.

The NYU Value-Added Galaxy Catalog (Blanton et al. 2005, http://sdss.physics.nyu.edu/vagc) is a cross-matched collection of galaxy catalogs (SDSS-DR4, 2dF, SWIRE, GALEX-DR1, 2MASS, IRAS, etc.) which is particularly useful for our analysis: in addition to the cross-correlation of catalogs, it provides a more reliable photometric calibration of the SDSS and has been more carefully cleaned from contaminations (bad deblending, stars misidentified as galaxies, etc.). Absolute magnitudes (ugrizJHK), K-corrections and Sersic fits are also provided. For these reasons, SDSS galaxies are extracted from this catalog rather than from the main Archive Server.

Morphological analysis

The morphological analysis is done using two different approaches:
1) Evaluating the Sersic index by model fitting of the galaxy: to this end we use the GALFIT code (Peng et al. 2002). As discussed e.g. by Cassata et al. (2005), this alone does not allow a reliable morphological classification.
2) Computing the CAS indexes (concentration, asymmetry and clumpiness) defined by Conselice (2003):

$$C = 5\log\left(\frac{r_{80}}{r_{20}}\right) \qquad A = \frac{\sum|I_0 - I_{180}|}{2\sum|I_0|} \qquad S = \frac{\sum(I - I_s)}{\sum I}$$

where r_{80} and r_{20} are the apertures containing 80% and 20% of the total flux; I_{180} is the image rotated by 180 deg. around a center computed so that it minimizes *A*; I_s is the image smoothed to remove large-scale structures.
We are trying to perform these steps in a way as much automatic as possible. For each image containing the target galaxy, SExtractor is run: a star-galaxy separation is done from the flux-radius diagram, and the PSF is obtained from a bright star close to the galaxy. SExtractor parameters for the galaxy are used as inital parameters in GALFIT, thus allowing a faster and more robust fit. If close neighbours are found, they are included in the fit. At the same time, a smaller image section is extracted around the galaxy and CAS parameters are computed using a tool developed by us in C++, which is currently being tested.
Very preliminary results are displayed in Fig. 4: the displayed Sersic indexes are those given in the NYU catalogs and will be compared with those computed from GALFIT when our analysis will be completed. We are also comparing the CAS parameters obtained using different approaches and algorithms (e.g. for masking, smoothing, etc.), to derive the most reliable procedure.

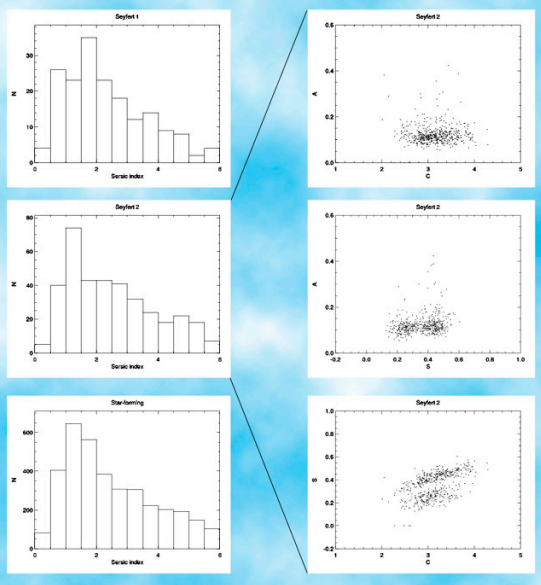

Figure 4: Distribution of Sersic indexes (from the NYU catalogs) and CAS parameters (AGN-2 only, preliminary results), in the r band.

Near-infrared morphology

As the UKIDSS (and later VISTA) data will become progressively available, we'll extend the morphological analysis from the optical to the near-infrared data.

References

Blanton M., et al., 2005, AJ, 129, 2562
Cassata P., et al. 2005, MNRAS, 357, 903
Conselice C.J. 2003, ApJS, 147,1
Fritz J., Poggianti B.M. 2006, *in preparation*
Peng et al. 2002, AJ, 124, 266
Sorrentino G., Radovich M., Rifatto A. 2006, accepted by A&A
Kewley L.J., Dopita M.A., Sutherland R.S. et al. 2001, ApJ, 556,121
Veilleux S., Osterbrock D.E. 1987, ApJS, 63, 295

KIDS: KiloDegree Survey with VST/Omegacam

PI: Konrad Kuijken, Leiden Observatory, the Netherlands
CoIs: R. Bender, H. Bohringer,M. Capaccioli, T. Erben, U. Hopp, Y. Mellier, M. Neeser, J. Peacock, M. Radovich, R. Saglia, P. Schneider, P. Schuecker, S. Seitz, R. Silvotti, W. Sutherland, A. Taylor, E. Valentijn, S. Warren

VIKING: VISTA KiloDegree Infrared Galaxy Survey

PI: Will Sutherland, Institute of Astronomy, Cambridge, UK
CoIs: R. Bender, H. Bohringer, M. Bremer, M. Capaccioli, L. Clewley, G. Dalton, S. Driver, A. Edge, J. Emerson, T. Erben, P. Hearaudeau, U. Hopp, M. Jarvis, K. Kuijken, J. Liske, R. McMahon, Y. Mellier, M. Neeser, J. Peacock, C. Pearson, S. Phillips, M. Radovich, K. Romer, R. Saglia, P. Schneider, P. Schuecker, S. Seitz, R. Silvotti, A. Taylor, E. Valentijn, B. Venemans

Institutes: Leiden, Groningen, Munchen, Bonn, Paris, Naples, London, Edinburgh, Cambridge