The high-z AGN and galaxies into the Reionization epoch with LSST

Scientific Objectives:

1-Use the unique combination of wide and deep LSST Imaging to study galaxy and AGN populations at high Redshift ($4<z<7.5$).
2-Assess the role of galaxies and AGN in driving the Reionization process in the early Universe.
3-Improve our understanding of the growth of SMBHs at high-z.
4-Detailed description of the mass assembly history of high-z galaxies.
5-Comparison of our results with state-of-the-art theoretical models of galaxy/AGN formation and evolution in the Early Universe.

Scientific Objectives 2

In particular, we will study:
1) the mass function of SMBHs at z>6, for both radio loud and radio quiet AGN;
2) the luminosity function of galaxies and AGN at z>4 and their contribution to the HI ionizing emissivity;
3) the Lyman Continuum (LyC) escape fraction of faint galaxies and AGN at z>4 by stacking a large number of LSST images in the rest frame UV to beat down the IGM absorption variance;
4) the fraction of neutral hydrogen close to Reionization from the fraction of high-z galaxies with Lyman-alpha line in emission and from deep UV spectra of high-z AGN.

We will extend at z>4 our knowledge on the galaxy and AGN clustering aimed at measuring the properties of their host dark matter halos; the BH-galaxy scaling relation; the evolution of the ISM/gas mass with sub-mm data; the bright end of the GSMF, and the fraction of red and dead galaxies versus extremely dusty starbursts; the formation of the seeds of the first SMBHs at z>6; the low-mass end of the GSMF at z>4.

The results based on LSST observations will be complemented by theoretical studies. The prediction of the assembly history and emission properties of AGN and galaxies is crucial to study the evolution of the radiation backgrounds (both UV and X), the nature of the first SMBH seeds and the BH-host galaxy co-evolution, before and during the Reionization epoch.

Participants and responsibilities/scientific interests

PIs: A. Bongiorno, A. Caccianiga, A. Grazian, A. Moretti
Spokeperson: A. Grazian (rotation between PIs every 1-2 years)

Research Team:
L. A. Antonelli, S. Cristiani, R. Della Ceca, F. Fiore, F. Fontanot, G. Ghisellini, E. Giallongo, F. Haardt, F. La Franca, M. Magliocchetti, N. Menci, L. Pentericci, E. Piconcelli, G. Polenta, R. Salvaterra, R. Scaramella, R. Schneider, P. Severgnini, E. Vanzella, G. Zamorani.

PostDocs:
L. Ballo, A. Bonchi, M. Castellano, C. Cicone, F. Faustini, L. Graziani, M. Landoni, E. Merlin, S. Pilo, P. Santini, T. Sbarrato, R. Valiante, L. Zappacosta.

1PhD will start next year at Universita' dell'Insubria (Como) and INAF/OA-Brera.

LSST Affilates for 2017:
A. Grazian (PI Scientist): Galaxies
C. Cicone (Jr. Researcher): Active Galactic Nuclei
M. Landoni (Jr. Researcher): Active Galactic Nuclei
E. Merlin (Jr. Researcher): Galaxies

Connection with other observational facilities

AGN and galaxy candidates at z>4 will be selected through several techniques: color-color selection, photometric redshifts, morphology, variability, lack of proper motion, cross-correlation of LSST photometry with Radio (FIRST, CLASS, ASKAP), X-ray (e-Rosita) and InfraRed (FLAMEX, UKIDSS, VISTA, WISE, Euclid) data.

Spectroscopic follow-up of high-z candidates for redshift determination will be carried out with VLT-MOONS, VISTA-4MOST, WHT-Weave. Dedicated follow-up could be carried out with TNG, LBT, VLT, ALMA and in the future with JWST, ELTs, SKA.

Synergy with other LSST projects: only few percent of the targets observed by VLT-MOONS, VISTA-4MOST, WHT-Weave will be galaxy and AGN candidates at z>4 from LSST. This program can share time with other follow-up spectroscopic programs of LSST sources.

Foreseen Data Analysis, software development and Time cadence

Software development: we plan to develop and test our software using LSST simulated data and existing data from other surveys (SDSS, UKIDSS, VST, VISTA, HyperSuprimeCam).

As soon as the first LSST data will be available, it is fundamental to test our software on the real LSST images and multicolor catalogs.

As soon as there will be major improvements in the LSST database (depth or area), the following data analysis is foreseen:1-access the LSST multicolor catalog; 2-search for galaxies and AGNs at z>4 with color-color selections; 3-derive photometric redshifts; 4-select additional candidates from photo-z; 5-cross-correlation with databases in Radio, X-Ray, Near Infrared to search for additional candidates; 6-check images of candidates in different bands for visual check of a fraction of candidates; 7-follow-up spectroscopy of a fraction of candidates for redshift determination and selection validation; 8-determination of physical and statistical properties of galaxies and AGN from photometry and redshift (spectroscopic or photometric).

With multi-epoch LSST data: select AGN at z>4 from variability.

When Euclid data will be available: apply state-of-the-art software to obtain a multicolor catalog from U to H band and extend the search of galaxies and AGN at z>7.5 into the Reionization Epoch.