The Interplay among Black Holes, Stars and ISM in Galactic Nuclei
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MUSYC

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Abstract. We describe MUSYC, a 1 square degree multiwavelength survey that will make unique contributions in several areas and is particularly well suited for the study of high redshift AGN.

1. Introduction

Active Galactic Nuclei are signposts for supermassive black holes (BH) and, because they are visible at very high redshifts, allow us to probe the earliest collapsed objects.

Furthermore, galaxy formation – specifically, the collapse of the bulge and the initial burst of star formation – appears to be connected to the most intense phase of BH accretion (Kormendy & Gebhardt 2001). Essentially all galaxies with a bulge harbor supermassive BHs (Gebhardt et al. 2000, Kormendy & Gebhardt 2001), making the study of high-redshift AGN important for understanding galaxy formation as well as the BH–galaxy connection. Different scenarios have been proposed that could explain the observed link: the simultaneous hierarchical growth of galaxies and their central black holes through mergers (Haehnelt & Kauffmann 2000) or a strong coupling between BH accretion and star formation in proto-disks at high redshift (Burkert & Silk 2001).

Yet a potentially large fraction of AGN are not detected in the traditional blue-excess or broad-emission-line surveys. Now in the new era of deep surveys, it is possible to find all the AGN, whether obscured or not. Combining multiwavelength data, especially in the IR and X-rays, enables a complete census of accreting supermassive BHs, as well as the measurement of the redshift distribution and evolution of the full population.

2. Survey Design

A number of multiwavelength surveys aim to address these scientific goals by exploiting the unprecedented combination of ground-based observatories and space missions available today. Very deep, pencil-beam IR/optical/X-ray surveys such as GOODS will probe the faint end of the luminosity function of AGN. However, they are subject to cosmic variance and the probability of actually observing objects as rare as $z \sim 6$ AGN is extremely low. Shallow, wide surveys such as NOAO Deep/Wide, EIS Deep Public Survey, the Las Campanas Infra-Red Survey (LCIRS), and ESO's K20 survey will cover larger areas to higher flux limits in order to find large samples of AGN. Going too wide, however, makes it difficult to obtain full coverage of high-quality multiwavelength imaging, particularly in the near-infrared (JHK), which is critically important for studying obscured AGN and where detectors are smaller than optical CCDs.

The MUSYC (Multiwavelength Survey by Yale-Chile) project is a public survey that comprises about 1 square degree of sky imaged to AB depths of U,B,V,R=26.5 and K(AB)=22.5 for a 5σ point source detection, and is unique in its combination of depth and total area. The survey covers four fields of $\sim 30' \times 30'$ each, chosen to leverage existing

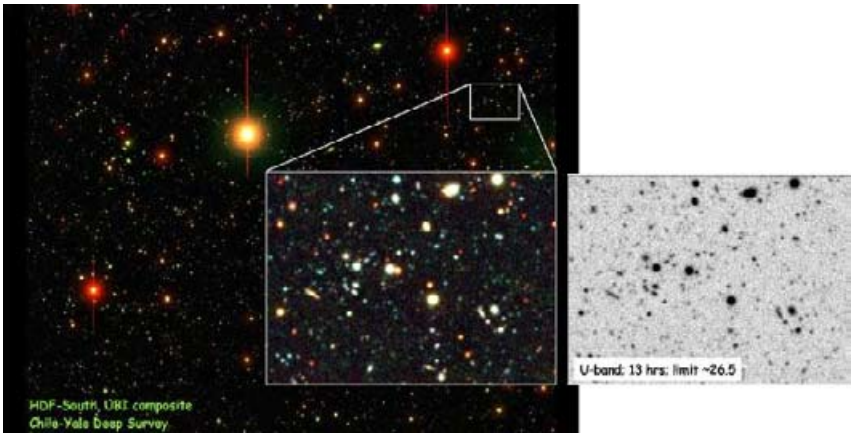

Figure 1. UBI image of the $34' \times 34'$ Extended HDF-S. A zoom on a $3' \times 2'$ region shows a UBI composite and the U-band image which is the deepest public wide-field U-band data available."

data and to enable flexible scheduling of observing time during the year. Each field will be imaged from the ground in the optical and near-infrared, and with space-based observatories in the optical (ACS on HST), X-rays (Chandra, XMM), and mid/far-infrared (Spitzer). Follow-up spectroscopy will be done mostly with multi-object spectrographs (VIMOS, IMACS, GMOS). The survey fields will be a natural choice for future observations with ALMA.

Fields were chosen to meet the following criteria: (a) Previous (long) observations with space telescopes; (b) Low 100 micron emission, reddening, and N_H columns; (c) No (or few) bright sources known in the optical/radio; (d) High Galactic latitude ($|b| > 30°$) to reduce stellar density; (e) Southern accessibility ($\delta \leqslant 5°$). The chosen fields are the Extended CDF-South, Extended HDF-South (see Fig. 1), SDSS 1030+05 (around a z=6.3 SDSS quasar), and the 1256+01 'Castander Window'.

3. AGNs in MUSYC

The main goal is to set constraints on the fraction of obscured AGN at the $z \sim 2$ QSO era. Understanding the evolution of BHs in the early universe requires an increased sample of AGN at $z > 1$. We will look into the interplay between the growth of galaxies and their embedded BHs by correlating the occurrence of AGN with host morphologies. We will also estimate the cosmic growth of BH mass by converting AGN luminosity to accreted mass. AGN are particularly likely to be obscured by dust in a torus or warped disk around the central black hole, but very few obscured AGN have been found. We will determine if obscured AGN are actually rare or if they have been missed due to biases in previous surveys. An unbiased AGN survey requires multiwavelength data of the precise sort provided by MUSYC; the best approach is to combine deep infrared and hard X-ray surveys with optical or NIR spectra to measure redshifts.

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