Introduction

In the era of large area surveys (e.g., SDSS, CFHTLS, DES, and LSST), the automatic computation of a large number of galaxy clusters with a well-defined selection function is an important aspect in the probing of large-scale structure. Galaxy clusters play a key role in constraining cosmological parameters (and hence dark energy) via the redshift–distance relation and the growth rate of cosmic structure formation.

Presented in this poster are preliminary results of an on-going effort to extract galaxy clusters from several large area surveys (e.g., SDSS DR7, CFHTLS, and UKIDSS) using the red sequence Voronoi tessellation and percolation method (see, for example, Ramella et al. 2001; Barkhouse et al. 2006). Cluster candidates are cross-correlated with overlapping X-ray data, and cluster richness estimates are provided.

Voronoi Tessellation and Percolation Technique

The detection of galaxy clusters is based on the overdensity of galaxies selected via their location in the color-magnitude plane. The early-type cluster red sequence occupies a unique position in the cluster color-magnitude diagram as the 4000 Å break shifts to longer observed wavelengths with increasing cluster redshift. Clusters are detected by searching for spatial over-densities by applying the VTP technique to galaxy catalogs derived from overlapping red sequence slices (widths ± 0.1 mag). The VTP algorithm partitions the galaxy spatial plane into polyhedral cells, each containing a unique galaxy. The cell size is determined by the distance between nearest neighbors and encloses the maximum area nearest to a given galaxy. Clusters are detected as over-densities in the number of cells per unit area. Selecting galaxies relative to the red sequence slices provides an estimate of the cluster redshift. Due to degeneracy in the colors of galaxies at higher redshift, r−i and r−z colors are required to sample red sequences for 0 < z < 1.3.

Figure 1. Voronoi tessellation on a galaxy distribution satisfying the color cut sequence for a cluster red sequence at z=0.475. Area enclosed within the circle is a previously unknown cluster that is detected as an extended Chandra X-ray source (Barkhouse et al. 2006).

Figure 2. Red sequences (RS) for the early-type cluster galaxies based on passive evolution models and a formation at z=5. Top: r+RS for clusters from 0.05 < z < 0.7. Bottom: r+RS for 0.4 < z < 1.05. Solid points represent m* for each depicted redshift interval.

Figure 3. Aligned equatorial projection in Galactic coordinates of approximately 150,000 cluster/group candidates detected from the SDSS DR7 data.

Figure 4. Redshift distribution of cluster/group candidates detected from DR7 using the VTP method (green histograms). The red histogram depicts the red sequence galaxy population (e.g., Yee & Ellington 2003; Barkhouse et al. 2006). The X-ray luminosities are taken from the 400 square degree ROSAT PSPC survey (Bullock et al. 2007).

Figure 5. X-ray luminosity (0.5–2 keV) vs. the optical richness parameter Bgc for a subset of matched objects. The Bgc richness measurement is defined as the amplitude of the correlation function between the cluster center and its red sequence galaxy population (e.g., Yee & Ellington 2003; Barkhouse et al. 2006). The X-ray luminosities are taken from the 400 square degree ROSAT PSPC survey (Bullock et al. 2007).

Figure 6. Redshift distribution of cluster/group candidates detected from the CFHTLS Deep fields (release T0005). The deep magnitude depths of these fields (e.g., I-band luminosity magnitude 26.5) will help to uncover poor systems at high redshifts.

Acknowledgments

The authors acknowledge the use of data from the Sloan Digital Sky Survey DR7, the Canada France Hawaii Telescope Legacy Survey, and the UKIRT Infrared Deep Sky Survey.