University of Waterloo

PHYS 437A Assignment 1

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1. The Sloan Digital Sky Survey (SDSS; York et al. 2000) is a massive endeavour that began in 2000 to provide imaging and spectroscopic surveys of a large swath of the night sky. It is imaging an area of π sr about Galactic latitude 30° to a depth of $g' \sim 23$ mag in the Northern and Southern Galactic Caps. It employs the use of a 2.5m f/5 modified Ritchey-Chrétien wide-field altitude-azimuth telescope located at the Apache Point Observatory, as well as a 0.5m photometric telescope, equipped with a large-format mosaic CCD camera and two spectrographs to take observations of the night sky in five optical bands (u', g', r', i', and z') as well as obtain spectra of approximately 1 million of the brightest galaxies and 100,000 of the brightest quasars from the imaging survey. The goal of the survey is to provide data for studies of the distribution of luminous and nonluminous matter in the universe to support investigations of the large-scale structure of the universe. It is believed that it will detect $\sim 5 \times 10^7$ galaxies, $\sim 10^4$ quasars, and $\sim 8 \times 10^6$ stars.

2. Ryan Speller retrieved objects in the photometric catalog of SDSS data release 8 that were within a projected distance (calculated from SDSS photometric redshifts and from the distances of the primaries from the Atlas3D catalog) of 1 Mpc from the primary galaxies of his sample and had a photometric redshift of ≤ 0.15 (as photometric redshifts of the SDSS survey are imprecise) by performing an SQL query of the SDSS Catalogue Archive Server. His primaries were chosen to be within the SDSS survey area and to contain enough surrounding galaxies in the SDSS survey to obtain reasonable statistics. He recorded r-band magnitudes (where possible), cmodel magnitudes and sizes of each of the objects. He then identified the boundaries of masked regions of the SDSS DR8 to ensure he could obtain reasonable background statistics from the data. He then performed cuts by magnitude (the most important cut), color, and size on the SDSS data to reduce the background of distant galaxies near the primaries. From this, he searched for excess clustering of those galaxies around those primaries to measure the clustering signal and carry out the investigations of his paper (ie. explore the possible dependence of the clustering signal on primary luminosity and morphology and find the relative luminosity function per primary).

3. The Atlas3D survey (Cappellari et al. 2011) is a multiwavelength survey of 260 bright early-type (E and S0) galaxies. The goal of the survey is to study the galaxy formation of ETGs by obtaining observations of stellar population and kinematics, as well as the kinematics and distribution of HI, CO, and ionized gas, of a sample of ETGs. The sample was chosen (based off a morphology selection criteria) from a parent sample of 871 primaries that were within 42 Mpc of us, had $|\delta$ - $29°| < 35°$, $|b| > 15°$, and were brighter than $M_K <$ -21.5 mag. The survey covers 37% of the night sky out to a distance of 42 Mpc, corresponding to a volume of 1.16×10^5 Mpc^3. The parent sample was put together using the K_S-band magnitudes from the Two Micron All Sky Survey (2MASS; Skrutskie et al. 2006) (to calculate M_K) as well as distance estimates from literature. The Atlas3D survey is a part of the Atlas3D project which combines the survey data with theoretical models and simulations of galaxy formation in the hope of studying galaxy formation and evolution of ETG galaxies. The project will compare the survey data with model predictions to test the models. It was from the Atlas3D parent sample that Ryan's sample of primaries were constructed.

4. Ryan built his sample of primaries from the Atlas3D parent sample as it was a survey of nearby galaxies (within 42 Mpc), which enabled Ryan to discern satellites around the primaries as they were close enough to be resolved, and it overlapped with a large-area survey (the SDSS), which Ryan could use to identify satellites and retrieve data (such as r-band magnitude, cmodel magnitude, and size) about them. He applied an isolation criterion to the parent sample to pick out systems that were analogous to the Local Group. This involved removing members that were within 1.5 Mpc of another member, removing objects that were not within the SDSS survey area, were in regions of incomplete coverage, or were in badly masked regions, and removing galaxies that were within 5° of the center of the Virgo cluster or 3° of the center of the Coma or Leo clusters. This left him with 274 primaries to study. He then obtained distances, morphological T-types, and (2MASS) K_S magnitudes for the sample. This allowed him to investigate the dependence of the clustering signal on primary morphology and luminosity.

5. The SDSS survey is a long-term project to survey the night sky. From it's inception in the year 2000 to the present day, it has gone through improvements and updates. To accommodate for this continuously

changing environment and the need of more and new data, the project is broken up into data releases, each building on the previous release by adding new data from the instruments. From 2000-2008, the first survey (SDSS-I, 2000-2005) was carried out which provided imaging of over 8000 sq. degrees and spectra of over 700,000 objects through Data Release 1-5. SDSS-II (2005-2008) introduced three subprojects (Legacy, SEGUE, and a Supernova survey). It produced 3D maps containing about 1 million galaxies and 100,000 quasars. Data Release 6-7 were released in this timeframe. Data Release 6 (like DR2) saw significant changes to the processing software, adding different data products on top of the SDSS-II data. SDSS-III (2008-2014) was carried out after upgrades to the spectrographs and addition of two new instruments to carry out four surveys (BOSS, SEGUE-2, APOGEE, and MARVELS) to supplement studies of the Milky Way, planetary systems, and dark energy and cosmological parameters, while surveying the night sky. Data Release 8-12 were released in this timeframe. Data Release 8 contains the full imaging survey from SDSS as well as measurements for about 500 million stars and galaxies and spectra of two million objects. Data Release 9 contains the first release of BOSS spectroscopy and updates to the cumulative SDSS archive. Data Release 10 contains the first release of APOGEE and updates to the archive. Data Release 11 and 12 were release simultaneously and served as the final release for SDSS-III, containing all the data taken by SDSS-III throughout its operation, including the complete dataset of BOSS and APOGEE. Currently, SDSS-IV (2014-present) is in operation, which added more data, brought updates to previous surveys (eBOSS, APOGEE-2), and introduced new surveys (MaNGA) to supplement studies. Data Release 13 is the latest release which contains all the data from previous surveys as well as new data for the updated and new surveys that are taking place in SDSS-IV. Ryan Speller worked with Data Release 8.

6. To query for data in the SDSS archive catalog, you have to perform an SQL query. For this, I will follow the SkyServer SQL tutorial. SkyServer holds all information on the objects catalogued by SDSS in a database. The database is divided into 63 tables which contain relevant data (eg. the “specObj” table contains data of objects’ spectra). These tables are broken further down into columns which contain only one attribute of the table (eg. “class” column in “specObj” table). The Schema Browser provides a way to view and search through the tables and columns and find where data is located on the database. To request data from the database you must perform a query. SkyServer uses SQL to communicate with the database to return data based on your search criteria. Knowing what the tables and columns are enables you to perform a typical SQL query to the SkyServer database to retrieve the data you want from SDSS. This can all be done on the SkyServer website. The table from the query can be outputted in a variety of formats: HTML, XML, CSV, JSON, VOTable, Fits, and MyDB.

References

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