Introduction to SDSS
-instruments, survey strategy, etc

(materials from http://www.sdss.org/)

Shan Huang

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<table>
<thead>
<tr>
<th>Basic Facts</th>
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<tr>
<td>Survey type</td>
<td>Imaging and Spectroscopy</td>
</tr>
<tr>
<td>Status</td>
<td>SDSS-II completed, SDSS-III on-going</td>
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<tr>
<td>Coverage</td>
<td>more than a quarter of the sky</td>
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<tr>
<td>Telescope</td>
<td>2.5-meter telescope at Apache Point Observatory</td>
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<tr>
<td>Wavelength rang</td>
<td>• Imaging: u(3551Å), g(4686Å), r(6165Å), i(7481Å), z(8931Å)</td>
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<td></td>
<td>• Spectra: 3800-6150Å (blue), 5800-9200Å (red)</td>
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<tr>
<td>Major instruments</td>
<td>• 120-megapixel camera</td>
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<td></td>
<td>• a pair of spectrographs fed by optical fibers</td>
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<td>Target type</td>
<td>more than 930,000 galaxies, 120,000 quasars, and more than 225,000 stars (Legacy), galactic stars, supernova, etc.</td>
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<tr>
<td>Basic observing</td>
<td>map one-quarter of the entire sky and perform a redshift survey of galaxies, quasars and stars (Legacy)</td>
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<tr>
<td>strategy</td>
<td></td>
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<tr>
<td>Basic data products</td>
<td>• Data archive server: fits images, spectra and catalog table</td>
</tr>
<tr>
<td></td>
<td>• Catalog archive server: search and brows all catalogs and jpeg images</td>
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<tr>
<td>Status of public</td>
<td>DR7 is the final data release of SDSS-II, the first release of SDSS-III is scheduled for December 2010</td>
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<td>data</td>
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Major Instruments

 Telescope
  - 2.5 modified Ritchey-Chretien telescope, 3° foV, Apache Point Observatory, New Mexico

 Imaging camera
  - Photometric CCDs:
    - 30 2048x2048 square CCDs
  - Pixel size and scale:
    - 24 micron, 0.396 arcsec/pixel
  - Operating mode: drift scan (2p)
  - Integration times: 54s
  - Image frame size: 2048x1361 pixels (13.51x8.98 arcmins)
  - Flux calibration, astrometric CCDs
  - Average wave length of filters
    - u-3551Å, g-4686Å, r- 6165Å
    - i-7481Å, z-8931Å
Major Instruments

- **Spectrograph**
  - Number of fibers: 320x2
  - Spectra of 640 objects at a time
  - Fiber diameter: 3”
  - CCDs: 4, 2048 × 2048, square
  - Channels: 3800-6150Å (blue), 5800-9200Å (red)
  - Pixel size: 69 km/s
  - Spectral resolution: 1850 - 2200
  - Typical integration time:
    - 3 exposures of 15 minutes each

- **Photometric telescope**
  - A separate telescope with a 20" aperture
  - FoV: almost a full degree
  - CCD: 2048x2048 pixel
  - Pixel scale: 1.15 arcsec/pixel
SDSS-I

- First phase of operation (2000-2005)
  - EDR-DR?
  - imaged more than 8,000 square degrees of the sky in five optical bands
  - obtained spectra of galaxies and quasars selected from 5,700 square degrees of that imaging
  - obtained repeated imaging (roughly 30 scans) of a 300 square degree stripe in the southern Galactic cap
SDSS-II

- Time frame: 2005 – 2008 (final data release: DR7)

- Main surveys:
  - Sloan Legacy Survey
  - SEGUE (the Sloan Extension for Galactic Understanding and Exploration)
  - Sloan Supernova Survey

- Additional supplementary imaging:
  - M31 / Perseus / Sgr / SGP scans (46 deg$^2$)
  - Low Galactic latitude fields “Orion runs” (832 deg$^2$)
Sloan Legacy Survey

- Sky Coverage: 8,423 deg² of imaging and spectra
  - 7,646 deg² of North Galactic Cap
  - 740 deg² of three stripes in the South Galactic Cap
    - 300 deg² central stripe scanned multiple times

- Target: 930,000 galaxies, 120,000 quasars, and 225,000 stars

- Imaging data are available as FITS files
  - Calibrated astrometric and photometric parameters and classifications

- Spectra
  - Main: a magnitude-limited sample of galaxies
  - Luminous Red Galaxies (LRG):
    - a near-volume-limited sample
      - 0.2 < z < 0.38 (down to r_Petrosian = 19.2)
  - A magnitude-limited sample of quasars
Sloan Legacy Survey

- SDSS galaxy map and quasar spectra

Large scale structure in the northern equatorial slice of the SDSS main galaxy redshift sample

\[ r_{\text{PSF}} - r_{\text{model}} \geq 0.3, \quad r_p < 17.77 \]
\[ \mu_{50} \leq 23.0 \text{ mag arcsec}^{-2} \text{ in } r, \]
median redshift: 0.104
SEGUE

- Sky coverage: new imaging of 3250 deg$^2$ at lower Galactic latitudes

- Spectra target: 240,000 stars in a variety of categories in selected fields, from white dwarfs to giants

- Science objective: explore the structure, formation history, kinematics, dynamical evolution, chemical evolution, dark matter distribution of the Milky Way.

SEGUE scan - note the open (reddened) cluster.
Sloan Supernova Survey

- Science motivation: detect and measure light curves for several hundred supernovae

- Survey strategy: repeat imaging of the same region of sky every other night (SDSS Southern equatorial stripe 82, about 2.5° wide by 120° long repeated ~80 scans)


- Detections
  - multi-band lightcurves for ~500 spectroscopically confirmed Type Ia supernovae (z=0.05-0.4)
  - a few hundred light curves for SNe Ia not confirmed
  - 80 spectroscopically confirmed core-collapse supernovae
SDSS-III

- Main surveys:
  - Baryon Oscillation Spectroscopic Survey (BOSS)
    - Measure the cosmic distance scale via clustering in the large-scale galaxy distribution and the Lyman-$\alpha$ forest
  - SEGUE-2
    - Map the structure, kinematics, and chemical evolution of the outer Milky Way disk and halo (double the sample of SEGUE)
  - APOGEE
    - Use high-resolution infrared spectroscopy to see through the dust to the inner Galaxy
  - MARVELS
    - probe the population of giant planets via radial velocity monitoring of 11,000 stars
SDSS Science Objectives

- The properties of galaxies
- The evolution of quasars
- The structure and stellar populations of the Milky Way
- Dwarf galaxy companions of the Milky Way and M31
- Asteroids and other small bodies in the solar system,
- The large scale structure and matter and energy contents of the universe