Joint Spectroscopic and Photometric Analysis of Low-Redshift Galaxies

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Spectroscopic Data

Astro Data Lab hosts the following spectroscopic data (current and future):

- Copy of all SDSS files:
  - catalogs, spectra, images
- Selected SDSS catalogs - specobj* tables and value-added catalogs (VACs)
  - SDSS DR16, DR14, DR13, DR12
- Gemini GOGREEN:
  - catalogs, spectra, images
- DESI: catalogs and images (current), spectra (future)
- More Gemini Large & Long Programs (future)
- Maunakea Spectroscopic Explorer (MSE) (future?)

GOAL: *Single set of user-friendly tools and services for all datasets*

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Spectroscopic Services

Astro Data Lab currently hosts the following spectroscopic services:

- Spectroscopic Catalog Access:
  - Querying, saving, joining, or cross-matching with other catalogs
  - Direct analysis in jupyter notebooks
- Spectral Access Service:
  - New, fast service to access large number of spectra
- Spectral Visualization:
  - Static plots of the spectra
  - Grid Preview Plot of multiple spectra
  - Interactive tool PROSPECT from DESI team adapted to work at Data Lab
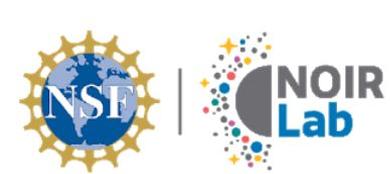
New Spectral Access Service

Credit: Mike Fitzpatrick

specClient

- QUERY INTERFACE - Returns an array of identifies matching the query
  id_list = query (<region> | <coord, size> | <ra, dec, size>,
  constraint = <sql_where_clause>, **kw)

- DATA ACCESS INTERFACE - Returns an array of spectrum objects
  spec | list = getSpec (<id> | <id_list>, fmt = 'numpy', out = None, align = False,
  cutout = None, context = 'default', profile = 'default', **kw)

- PLOT INTERFACE - Plots the spectra or Grid spectra or stacked image
  plot (<id> | <spec>, context = context, profile = profile, **kw)
  plotGrid (<id_list>, nx, ny, page = <N>, context = context, profile = profile, **kw)
  stackedImage (<id_list>, fmt = 'png|numpy', align = False, yflip = False,
  context = context, profile = profile, **kw)

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# Spectral Visualization

Credit: Mike Fitzpatrick

Two Jupyter Notebooks available that shows how to query, retrieve, and visualize spectra:

1. Getting Started with Spectral Data
2. How to use the Spectral Data Services

Static Spectrum Plot

Grid Preview Plot

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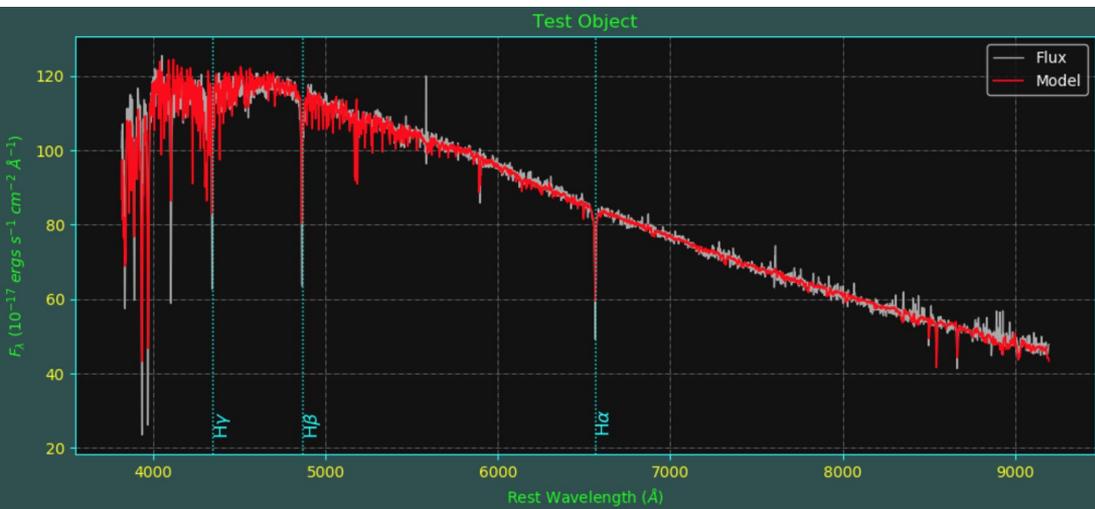
Stacked Image Plot
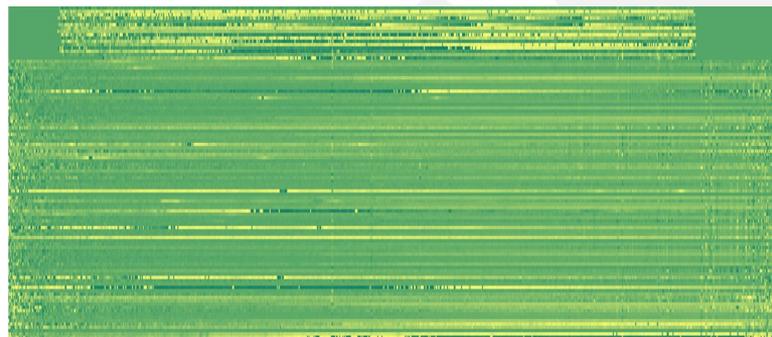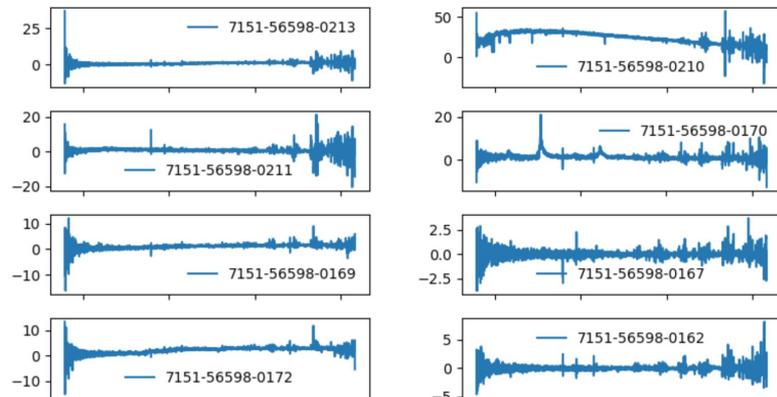
PROSPECT Interactive Viewer

Credit: Benjamin Weaver (and Stephen Bailey for DESI version)

Interactive: zoom & pan

Coming soon

Target info

Navigation

redshift info

Zoom box

to Sky Viewer

legacysurvey.org/viewer

github.com/desihub/prospect

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Example Science Notebook
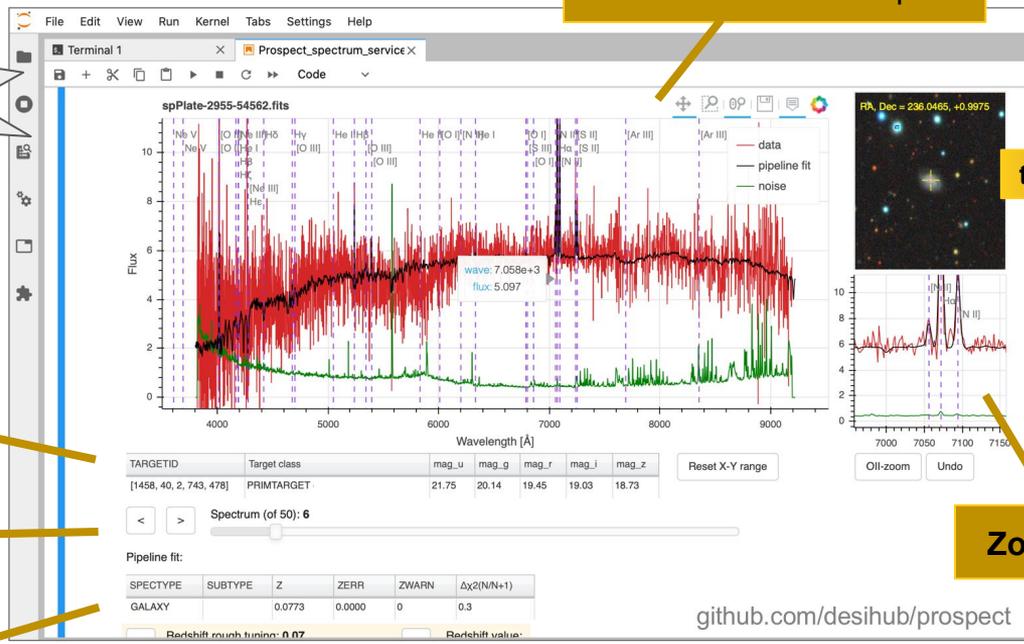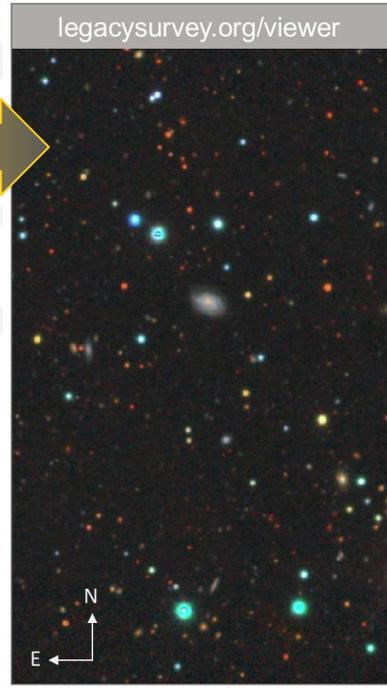
Stacking SDSS Spectra of Galaxies Selected from the BPT Diagram

1. Query SDSS DR12 value-added catalog with emission-line measurements.
2. Construct the BPT diagram (emission-line ratios) and select 100 random galaxies in each box from each class.

3. Stack the spectra of galaxies in each box
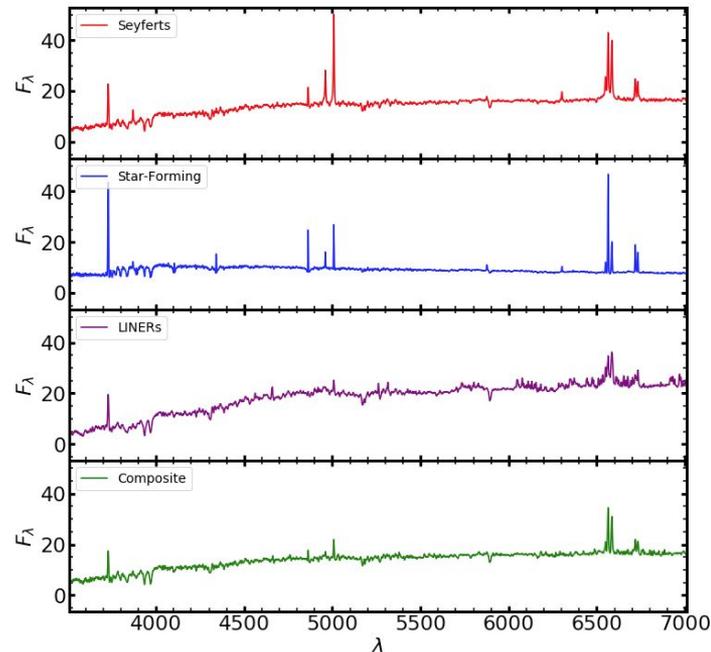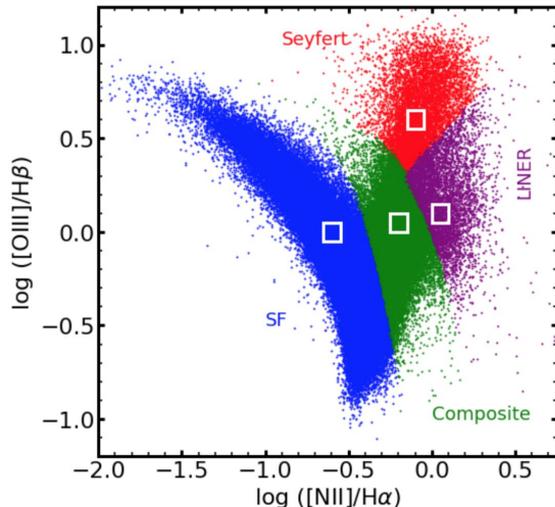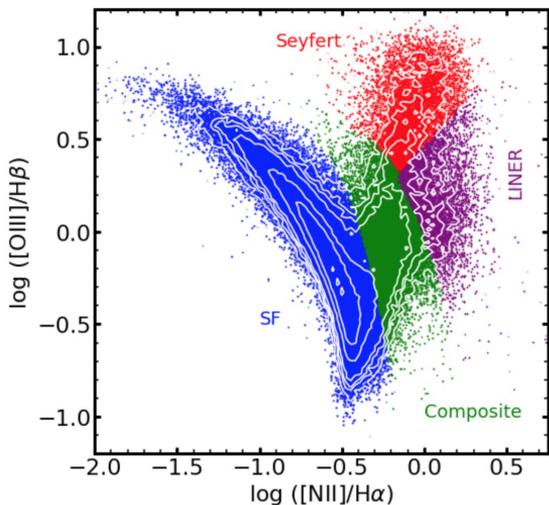
Photometric Properties of Emission Line Galaxies

1. Cross-match SDSS DR12 emission line measurement catalog with DESI Imaging Tractor catalog.

2. Construct the BPT diagram using emission line ratios from the spectroscopic catalog and separate the galaxies into different classes.

3. Study optical colors of the galaxies in different classes:
→ AGN and composites have redder *r-z* & *g-r* colors
→ Star-forming galaxies reach bluer colors

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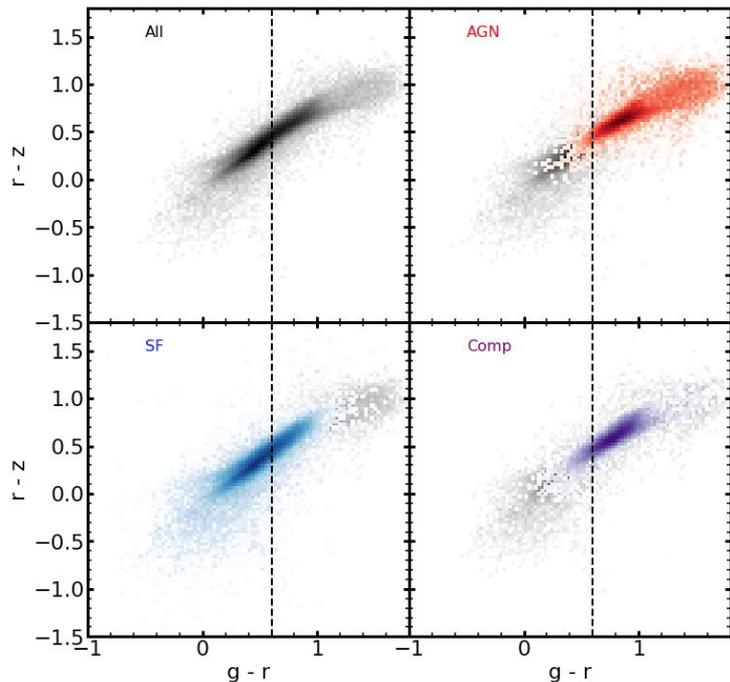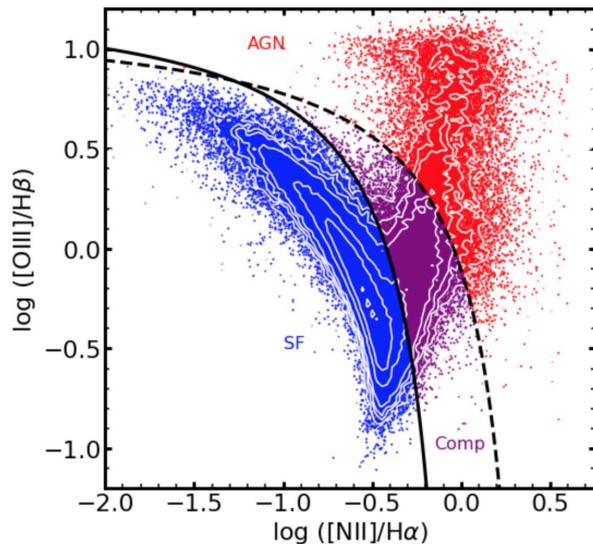
Future Directions

- Spectroscopic Data Access & Analysis
  - Spectral access tools to include GOGREEN, DESI and other spectroscopic data
  - Compatibility with Astropy specutils

- Spectroscopic Data Type
  - Expand to include Spectral Cubes (e.g., MaNGA)

- Future Large Spectroscopic and Photometric Surveys
  - Get ready for upcoming large spectroscopic (DESI-2, SDSS-V, WEAVE, 4MOST, MSE etc), and photometric (VRO/LSST) datasets.

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