Emission Line Galaxies

The Data Set
The Sloan Digital Sky Survey (http://www.sdss.org, also http://skyserver.sdss.org) has taken spectra of roughly 800,000 galaxies. Galaxy spectra can be divided into two, types: those with emission lines and those without. We will be visualizing a catalog of more than 400,000 emission line galaxies. By studying the strength and shape of various emission lines we can classify these galaxies into different types, and also get a handle on the composition, temperature and density of the emitting gas, as well as global properties of the galaxy such as star-formation rate, or mass of the central black hole.

Background:
The emission lines seen in galaxy spectra, are produced by two sources: de-excitation of hot gas throughout the galaxy, or by excited gas near the central black hole. In the former case the emission lines tell us about the star formation rate of the galaxy, because the gas photo-excited by ultraviolet light which is produced by hot stars with short lifetimes. In the latter case the emission lines tell us both about the strength and orientation angle of the active galactic nucleus.

Nomenclature:
These emission lines all arise from atomic transitions. A particular line may be denoted as: [OII] 3727, where O refers to the element (Oxygen), II indicates that it is a transition in singly ionized Oxygen (Neutral Oxygen is OI), and the brackets denote that is a forbidden transition. Forbidden transitions are those that violate one of the quantum selection rules – these transitions are not seen in the laboratory, but are common in the rarefied environment of space. 3727 is the wavelength of the emitted photon in Angstroms (10^{-10}m).

Plots and Classifications:
Traditionally astronomers will make Log-Log scatterplots of the ratios of intensities of lines. Plotting the ratio of intensities accomplishes two things: it removes the dependence of brightness on distances, and if the lines are of similar wavelengths we are insensitive to reddening (which will change the shape of the spectrum, so that what we measure is not the true intrinsic shape).

One common plot is the BPT diagram (see the attached 1 page conference proceeding paper) which is used to separate starforming galaxies from galaxies with active galactic nuclei(AGN). This is a plot and classifier we would like to reproduce in our tool.

Some things that would be desired of a visual analytics tool for studying this data set:

1. The ability to make scatterplots and histograms of simple arithmetic combinations of the intensities and widths.
2. The ability to paint or otherwise mark regions in these plots, and to carry anlong these markings to other plots (and the ability to output them).
3. The ability to click on a point and bring up the image of the galaxy, or other catalog information – and to search for it in other surveys.

The Table Schema:
He table consists of object identifier information (specObjID, objID, plate, mjd, fiberID), positions: RA, Dec (right ascension and declination in decimal degrees): and distances z (redshift, and distance (in co-moving megaparsecs).

The line information is stored in four numbers per line. They are the parameters of a fitted Gaussian (height and sigma). The height is in units of 10-19 ergs s^{-1} cm^{-2} A^{-1}, and sigma is in units of Angstroms.

We will be interested in plotting derived quantities based on these, namely the line Intensity: I = 1.7724*height*sigma, and the full-width, half-maximum of the line FWHM = c*2.354 *sigma/(central wavelength)/(1+z), where c is the speed of light in km/sec (299792km/s), and z is the redshift.

Linking to Other Resources:
Images: Use the SDSS image query Service, and the RA and DEC values in the table:
http://cas.sdss.org/astro/en/tools/chart/chart.asp
Here is an example:
http://casjobs.sdss.org/ImgCutoutDR7/getjpeg.aspx?ra=18.87667&dec=-0.86083&scale=0.39612&width=512&height=512&opt=&query=

Get the catalog info from the SDSS image explorer using the ObjID identifier:
http://cas.sdss.org/astro/en/tools/explore/obj.asp?objid=%20587731511532060697
This page also has links to other catalogs

Some References:
Stasinska et. al.: attached
Bill Keel's webpage: http://www.astr.ua.edu/keel/galaxies/emission.html
Tim Heckman's LINER paper: http://adsabs.harvard.edu/abs/1980A&A....87..152H
If you are really interested in the Physics: The Physics of Gaseous Nebulae by Donald Osterbrook

Galaxy Evolution across the Hubble Time
Proceedings IAU Symposium No. 235, 2006
F. Combes & J. Palouš, eds.

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Star Forming Galaxies and AGN Hosts: The Seagull Wings

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Abstract. Using photoionization models applied to the data from the Sloan Digital Sky Survey (SDSS) we propose a physically motivated dividing line in the [OIII]/H vs [NII]/H (BPT) diagram between normal star forming (NSF) galaxies and AGN hosts. We also propose a new diagnostic diagram which can be used for optical spectra of galaxies with redshifts up to z = 1.3.

Keywords. galaxies: active — galaxies: starburst — emission lines: surveys

1. Introduction

In the BPT diagram, NSF galaxies and AGN hosts from the SDSS form two sequences, which look like the wings of a seagull. The Kewley et al. (2001) and Kau man et al. (2003) lines to distinguish both classes are too "generous" for NSF galaxies. We propose a better dividing line, given by: $y = (-30.787 + 1.1358x + 0.27297x^2)\tanh(5.7409x) - 31.093$, where $y = \log$ [OIII]/H , and $x = \log$ [NII]/H .

We then propose a new diagnostic diagram, where NSF galaxies and AGN hosts are divided by the line: $D_n(4000) = -0.15(\log x + 1) + 1.7$, where $x = \max(EW[OII], EW[NeIII])$.

See Stasińska et al. (2006) for more details.

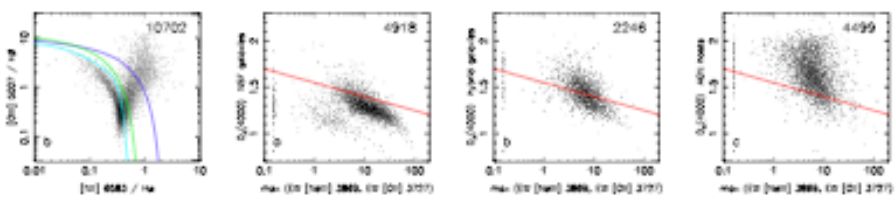

Figure 1. a: The BPT diagram for 10702 galaxies from the SDSS DR2 (Abazadjian et al. 2002). The Kewley line, the Kau mann line and our line are shown from top to bottom. b, c, d: $D_n(4000)$ versus max(EW[OII], EW[NeIII]) for NSF galaxies, hybrid galaxies and AGN galaxies respectively. The red line is the adopted boundary between NSF and AGN galaxies.

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References

Abazajian, K., et al., 2004, AJ, 128, 502
Kau mann, G. et al., 2003, MNRAS, 346, 1055
Kewley, L. J. et al., 2001, ApJ, 556, 121
Stasińska, G., Cid Fernandes, R., Mateus, A., et al., 2006, MNRAS, 371, 972