**Recession Velocities**

The radial velocity of a galaxy is measured using the Doppler effect and is given by:

v = c \* (

where **v** is the radial velocity in km/sec, **c** is the speed of light (300,000 km/sec), is the laboratory or rest wavelength of the radiation, and  is the shift in wavelength shift towards longer wavelengths ( = the observed wavelength minus the rest wavelength). For these spectra, wavelengths are measured in Angstroms (Å) (an Angstrom is 1/10 of a nanometer, 10-10 meters). The red-ward shift of a spectral line relative to its rest wavelength, **** is known as the *redshift*, and is often denoted by the letter *z*. Radial velocity is motion directly toward or away from an observer.

We can determine the velocity and redshift of a galaxy from its spectrum: we measure the wavelength shift of a known absorption line and solve for the velocity.

**Example**: *An absorption line that is found at 5000Å in the lab is found at 5050Å when analyzing the spectrum of a particular galaxy. Therefore this galaxy is moving away from us with a velocity*

*v = (50/5000) \* c = 3,000 km/sec*

Using the same website as above, click on “spectrum” for the two galaxies whose distances you measured. The full optical spectrum of the galaxy is shown at the top of the spectrum page. Shown are many different spectral features, including absorption lines and emission lines, superimposed on continuum emission from the galaxy, over the entire visible-light spectrum. Below the full optical spectrum are enlarged portions of the same spectrum, in the vicinity of the spectral features of calcium and hydrogen.

The small dark bars near the lower left corner of the sub-spectrum indicate the rest positions of particular lines as measured in the laboratory. Measure the “rest” position of two absorption lines of calcium (Ca K and Ca H) and measure the observed position in each galaxy by clicking at the rest position and at the center of the spectral line in the galaxy's spectrum. Record the difference in the two positions. Measurements for NGC 1357 have been entered as an example.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Galaxy | Ca K shift | Ca H shift | Average Line Shift | Average Velocity of the Galaxy |
| NGC 1357 | 194-158=36 | 239-203=36 | 36 | 2135 km/s |
|  |  |  |  |  |
|  |  |  |  |  |

The galaxies’ velocities can be calculated from the positions of the spectral lines as follows:

 km/sec

Or you can use the chart below to convert pixel shift to galaxy velocity.