Active Galactic Nuclei (AGN)

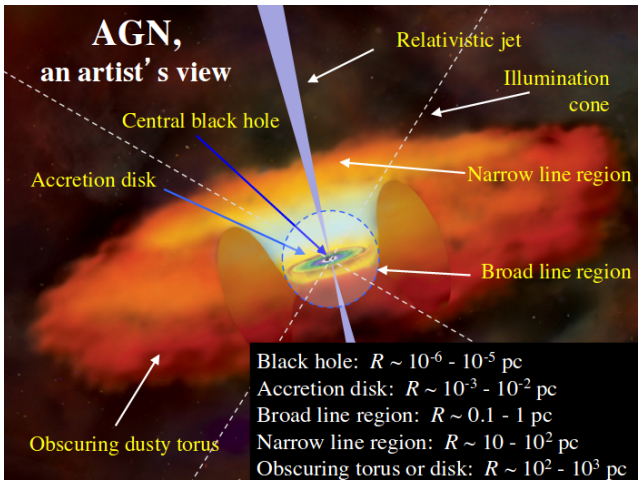
- What are they?

  In the 1970s, astronomers became aware of a compact radio source at the center of the Milky Way Galaxy which they named Sagittarius A. After many decades of observation and mounting evidence, it was theorized that the source of these radio emissions was in fact a supermassive black hole (SMBH). Since that time, astronomers have come to theorize that SMBHs at the heart of every large galaxy in the Universe.
  Most of the time, these black holes are quiet and invisible, thus being impossible to observe directly. But during the times when material is falling into their massive maws, they blaze with radiation, putting out more light than the rest of the galaxy combined. These bright centers are what is known as Active Galactic Nuclei, and are the strongest proof for the existence of SMBHs.

- Properties

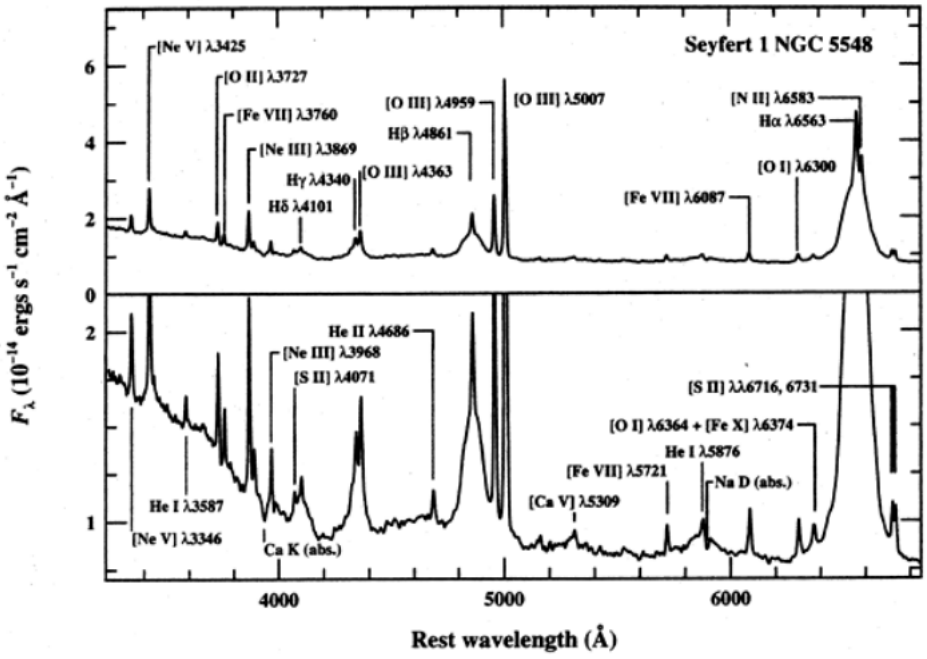
  1. They have broad spectral energy disribution (SED):-
  i) Nonthermal radio emission
  ii) Generally bluer spectra than stars
  2. Presence of strong, broad emission lines
  3. Luminosities upto $10^{15} L_o$
  4. Strong variability in brightness across SED which has higher period for lower wavelengths
  5. Central engines are unresolved
  6. Zero proper motions due to large distances
  7. Powerful magnetic jets that fire material above and below the black hole at relativistic speeds
  8. Velocity dispersions of order of 1000 km/s

  Below is a visual represenation of its features,



- Spectra and SED

  Typical Spectra of an AGN is as shown below (continuum part due to stellar population):-



  Thermal broadening?
  From FWHM of spectra, we can calculate velocity dispersion. Assuming temperature as the driving factor for the broadening, we can equate thermal energy and kinetic energy of the particles to estimate the temperature. This temperature comes out to be approximately 10^{10}K.
  1. At such temperatures, high amount of ionization is expected which means we should not observe peaks like balmer lines and [OI].
  2. Since the broadening is inversely proportional to sqaure root of mass of species, lines of heavy elements should have smaller widths.
  Hence, we can conclude that broadening is not driven by temperature and the emission is non-thermal.

SEDs are usually used to represent energy distribution. This is done in order to compensate for the lower no. of photons at higher energies thereby avoiding perception of lower energy output at higher frequencies (which is possible if spectra is used for representation). Typical SED is as follows,