

Characteristics

HII regions are mainly composed of clouds of ionized hydrogen (that is, protons and electrons). In these clouds, sometimes one proton and one electron will recombine to form an atom of neutral hydrogen. When this happens, the electron starts at a high energy level in the newly-formed atom, then jumps down to a lower energy level. When the electron jumps, it releases a photon, as the animation to the right shows.

The exact series of energy level jumps is governed by quantum mechanical probability. One electron might be captured in the fifth energy level, jump to the third energy level, and then to the first energy level. Another electron might be captured in the fourth energy level, jump down to the third, then to the second, and finally to the first energy level.

The most important energy level transitions are the ones that give off photons with wavelengths that we can observe with the SDSS. One of these jumps is the transition from the $n = 3$ to $n = 2$ energy levels, which gives off light with a wavelength of about 6560 Angstroms, which is in the red part of the spectrum. Because this jump is fairly common, HII regions give off a lot of red light. In a tri-color image using red, green and blue filters, HII regions appear pink. (BUT: SDSS tri-color images use the green, red, and near infrared filters to make color images - confusing, no? In SDSS images, HII regions appear light blue instead of pink.) Transitions from $n = 4$ to $n = 2$ and $n = 5$ to $n = 2$ levels also produce lines in the visible spectrum.

HII regions also give off a lot of ultraviolet light due to photons from the transitions where electrons jump into the $n = 1$ energy level. Since SDSS uses a filter in the near ultraviolet, the effects of this transition show up as well.



The Whirlpool Galaxy, M51. Notice the pink HII regions.

Click on the image for a larger view.

Courtesy of [The Hubble Heritage Project](#).

Question 1. Given the wavelengths of photons emitted by HII regions, how could you use astronomical colors (g-r, etc.) to distinguish HII regions misclassified by Photo from true separate galaxies?