

3.11 Kirchhoff's Laws Explained

PRE-LECTURE READING 3.11

- *Astronomy Today*, 8th Edition (Chaisson & McMillan)
- *Astronomy Today*, 7th Edition (Chaisson & McMillan)
- *Astronomy Today*, 6th Edition (Chaisson & McMillan)

VIDEO LECTURE

- Kirchhoff's Laws Explained¹ (4:54)

SUPPLEMENTARY NOTES

Elements Other Than Hydrogen

- Every element has different absorption and emission lines, and series of lines, because:
 - Every element has a different number of protons in its nucleus, which pull on the electrons differently, resulting in different orbitals and different energies between orbitals.
 - Elements have different numbers of electrons.
 - Inner electrons partially shield the charge of the nucleus from outer electrons, again resulting in different orbitals and different energies between orbitals.
 - Each electron can transition between orbitals, resulting in different numbers of absorption and emission lines.
 - Partial ionization (losing some but not all electrons) changes both the amount of shielding and the number of lines.

Absorption Line Spectra

- Absorption line spectra are caused by atoms with electrons in lower energy states transitioning to higher energy states.
- This requires that the gas be **transparent** (for the rest of the light to pass through) and **cool** (for the electrons to be in the lower energy states, and not collisionally excited to higher energy states or ionized).
- This is Kirchhoff's Third Law.

¹<http://youtu.be/IiLJYN2jduA>

Emission Line Spectra

- Emission line spectra are caused by atoms with electrons in higher energy states transitioning to lower energy states (or by ionized atoms recombining).
- This requires that the gas be **transparent** (for the light to pass through, without being thermalized into a continuous spectrum) and **hot or heated** (for the electrons to have gotten into the higher energy states or ionized, via either collisional excitation or absorption of light).
- This is Kirchhoff's Second Law.