

CHAPTER OVERVIEW

29: Spectroscopy

The primary method of measuring the energy levels of a material is through the use of electromagnetic radiation. Experiments involving electromagnetic radiation—matter interaction are called spectroscopies. Since the energy levels of atoms and molecules are discontinuous, they absorb or emit light only at specific energies. These specific values correspond to the energy level difference between the initial and final states and they can be measured as signals in spectroscopic experiments. The intensity of the experimental signals depends on the population of the initial state involved in the transition.

Depending on the type of radiation, as well as the shape of the molecules and the inner details of the instrument that is used, some transition might be visible by the experiment (allowed), while others might not be (forbidden). The analysis of allowed and forbidden transition for each type of spectroscopy results into some mathematical formula that are called **selection rules**.

To summarize, spectroscopy is mainly the result of the following three effects:

- The energy levels of the atoms or molecules (determining the position of the signals).
- The population of the energy levels (determining the intensity of the signals).
- The selection rules that account for the symmetry and the interaction with the instrument.

Spectroscopy is the most important experimental verification of quantum mechanics, since we can use it to validate its theoretical results on the energy levels of atoms and molecules.

[29.1: Rotational Spectroscopy](#)

[29.2: Vibrational Spectroscopy](#)

[29.3: Electronic Spectroscopy](#)

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