**Unit: 6.1**

**Introduction to Spectroscopy**

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**1.3. Mechanism of interaction of EMR with matter:**

Energy can occur in different forms—for example, kinetic, potential, mechanical, chemical, electrical, and thermal energy. Ocean waves make themselves manifest by their way of propagation. The waves are because of a disturbance at the air–water interface. They are transverse that is the vibration of the particles is perpendicular to the direction of the propagation. A number of aspects connected with wave motion become visible when observing these waves, such as direction, wavelength, amplitude, velocity, and frequency.

Electromagnetic radiation (EMR) is energy that propagates through vacuum (free space) or through material media in the form of an advancing interaction between electric and magnetic fields. It can make itself manifest by its interaction with matter. Light and thermal energy are examples of EMR.

In addition to by radiation, thermal energy may travel by conduction and convection. The interaction process is of great importance to the remote sensing specialist.

Matter can reflect, transmit, or absorb electromagnetic (radiant) energy. If matter is transparent to radiant energy, the energy will pass through it unchanged. If matter is a perfect reflector, the energy will not be changed except to change the direction in which it is moving. If electromagnetic radiation is absorbed by matter, then there is a transfer of energy from the radiant energy to the medium that is doing the absorbing. This may result in an increase in the vibrational energy of the molecules of the absorbing medium if it is a solid, or increased molecular velocities if the medium is a gas, or chemical change if the radiant energy is of sufficiently high energy (high frequency) to break chemical bonds or change the energy level of electrons. In general all of these types of absorption results in a rise in temperature of the absorbing medium.

Thus, Bohr’s frequency condition indicates that a system can experiment on a transition between two states 1 and 2 if the energy of the electromagnetic radiation **absorbed** equals the energy difference between the two states

Δ*E*1→2 = *E*2 − *E*1 = *h*ν

On the other hand, **emission**of radiation is due to the return of an atomic or molecular system from an excited state to a lower energy state, and the energy of the emitted radiation also corresponds to the energy difference between the states involved in the transition (Figure 1).

*E*2

*E*2

*hν*

*E*1

*hν*

*E*1

**Figure 1** Absorption and emission between quantized energy levels.

The probability of a transition and the amount of radiation absorbed or emitted depends on the nature of the interaction between the molecular system and the radiation.

The mechanism of interaction between electromagnetic radiation and matter relies on the interaction between the oscillating electric and magnetic ﬁelds of the radiation with the electric or magnetic dipole moment of an atom or molecule. Thus, a molecular system can experience a force as a consequence of the electro- static interaction between its electric dipole moment and the oscillating electric ﬁeld of the electromagnetic radiation. On the other hand, the interaction between the permanent magnetic moment of a nucleus or an electron and the magnetic ﬁeld of the electromagnetic radiation is the foundation of nuclear magnetic reso- nance, electron spin resonance, and related spectroscopic techniques. According to this, the interaction between atoms or molecules and the electromagnetic radi- ation requires the existence of a permanent electric or magnetic dipole or the instantaneous creation of an electric dipole due to internal motions.

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