Questions and answers for Module 4

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1 Questions

1. What is the basic concept of a photon ?
2. How best can the presence of a photon detected ?
3. Define an exciton.
4. Differentiate a Frenkel exciton from a Wannier-Mott exciton.
5. Write the Wannier equation representation of exciton-polariton.

2 Answers

1. The basic notion of a photon came into being during the process of quantizing a free electromagnetic field. It corresponds to elementary discrete excitations of electromagnetic modes in a virtual cavity. To put it in a simple way, photons are elementary excitations of the quantized free field. The most important concept of a photon is that it is impossible to construct a wave function for the photons in the coordinate representation and thereby, one cannot represent the photon picture as a spatially localized point particle as an electron.

2. If the photon is present in an area whose spatial dimensions happen to be much smaller than the wavelength of light and also if a detector such as an atom is present to absorb the photon in the above mentioned area, it would be possible to detect the energy of the photon with the same accuracy as the detector size.

3. The bound electron-hole pair inside a given semiconductor is called an exciton.

4. For the former, the electron and the hole are tightly bound to each other, thereby resulting in a strong electron-hole interaction. Attractions of such types are found in conic crystals. For the latter the electron-hole pair is weakly bound. This is due to the fact that the Coulomb interaction becomes strongly screened by the valence electrons through the large dielectric constant for most of the semiconductors.

5. $$-\left[\frac{\hbar^2}{2M}\nabla^2_{\mathbf{R}}+\frac{\hbar^2}{2m_r}\nabla^2_{\mathbf{r}}+V(r)\right]\psi(\mathbf{Rr})=E\,\psi(\mathbf{R},\mathbf{r}),$$