3.5: The Bottom Line- Geometric Optics and Wave Optics

In geometric optics, mirrors, lenses, telescopes and so on are analyzed by tracking narrow rays of light through the system, applying the standard rules of reflection and refraction. Despite Huygens' picture, most people using this well-established technique before 1800 thought the rays were streams of particles. Fermat's Principle of Least Time was an elegant formulation of the laws of motion of this stream -- it reduced all observed deflections, etc., to a single statement. It even included phenomena caused by a variable refractive index, and consequent curved paths for light rays, such as mirages, reflections of distant mountains in the middle-distance ground on hot days caused by a layer of hotter air close to the ground.

But despite its elegance, no theoretical explanation of Fermat's Principle was forthcoming until it was established that light was a wave -- then it became clear. The waves went out over all possible paths, but phase differences caused almost perfect cancellation except for paths in the vicinity of the shortest possible.

We shall find a similar connection between classical mechanics and quantum mechanics.