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The Fresnel Connection

Particles versus Waves

> … neither the corpuscular nor the undulatory … will furnish that complete and satisfactory explanation of all the phenomena of light which is desirable.[1]
>
> John Herschel, *Treatise on Light* (1830)

Particles and waves are the yin and yang of physics. Throughout its history, physics has grappled to reconcile these two extreme views of dynamical systems. On the one hand, individual particles execute trajectories impelled by invisible forces, colliding sometimes with other particles at discrete points in space and time. On the other hand, continuous media like ocean waters move collectively in great undulations that spread out across vast distances. Particles are intrinsically local—waves are intrinsically non-local. Yet from the earliest days of physical thought, beginning with Democritus and continuing through Aristotle to the Enlightenment, it was suspected by some that the two were somehow linked—that waves emerge from media composed of unseen particles whose mutual small actions and reactions against each other combine to form the greater motions.

The conflict between particles and waves has always been most acute in the physics of light. A succession of wave-particle debates

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