

Superposition Is Not A Rule, It Is A Consequence

Review of *Introduction to Modern Optics* (166 pp.) — the short one, and the one that explains why

TLDR / 80-20

Waves add because Maxwell's equations are linear. That is the whole foundation.

The book states it plainly: the superposition principle is a consequence of the vacuum equations being linear differential equations. Everything else follows.

The Keys

- **It supplies the missing "why".** Other texts assert superposition and move on. This one traces it to linearity in the underlying differential equations.
- **That single fact licenses the rest of optics.** If waves add, they can be decomposed; if they can be decomposed, Fourier methods apply; if those apply, systems have transfer functions.
- **Coherence length is the practical measure.** The distance over which a wave keeps its phase relationship. Exceed it with a path difference and the fringes disappear.
- **Interference is engineered, not found.** Young's double slit works because a single pinhole is used to illuminate the aperture, forcing the two paths to stay related.
- **Real light is random.** In actual interference the amplitudes and phases of the waves vary with time in a random fashion — the clean sinusoid is an idealisation.
- **Diffraction gets a proper treatment.** Fresnel and Fraunhofer cases, with the Fresnel-Kirchhoff formula and the obliquity factor correcting for propagation angle.
- **Aperture size against wavelength sets the pattern.** Wider apertures give narrower, brighter patterns — the relationship that becomes the resolution limit.
- **The Van Cittert-Zernike theorem connects source to coherence,** explaining how an extended, incoherent source can still produce spatially coherent light at a distance.

AI's Take

- **At 166 pages it is the most efficient of the three optics books,** and the one to read first despite being the least comprehensive.
- **Its one contribution is causal ordering.** Linearity causes superposition causes decomposition causes Fourier optics. Knowing that chain makes the other books navigable.
- **The honesty about randomness matters.** Admitting that real amplitudes and phases fluctuate is what makes coherence a measurable quantity rather than a yes-or-no property.
- **The transferable idea: find the linearity.** Wherever a system's governing equations are linear, components add independently — and that is what makes analysis possible at all.
- **Use it as the map and Hecht as the territory.** This book explains the structure; Hecht supplies the detail that structure organises.