

What Fires In All Four Brains

Convergence analysis across Hecht's *Optics*, Goodman's *Fourier Optics*, *Introduction to Modern Optics*, and *Foundations of Computer Vision* · 1,758 corpus chunks

One mechanism fires in every book: linearity → superposition → decomposition → convolution.

Four authors, four vocabularies, one chain. Two of them call it physics and one calls it a filter kernel, but it is the same operation.

The method

- **Treat each book as a brain.** Probe all four with identical queries and see which concepts light up everywhere. What fires across more sources is load-bearing.
- **Why this beats summarising.** A single author's emphasis reflects their taste. A concept four independent authors all reach for is structural.
- **The probes were the same for each.** Wave behaviour, linear systems, convolution and filtering, coherence and resolution — asked identically of all four collections.

What fired in all four

- **Linearity, and it is the root.** *Modern Optics* supplies the reason the others assume: superposition holds because Maxwell's vacuum equations are linear differential equations.
- **Superposition.** Hecht names it explicitly as the shared basis of polarization, interference and diffraction — three chapters that are one phenomenon.
- **Decomposition.** If components add independently, any complicated input can be broken into simple ones, solved separately, and recombined. Goodman makes this the method.
- **Convolution.** Goodman convolves an impulse response across a field; *Computer Vision* convolves a kernel across an image. Same operation, different substrate.
- **The chain is causal, not thematic.** Linear equations permit superposition, superposition permits decomposition, decomposition produces convolution and transfer functions.

What fired in three of four

- **Coherence and phase.** Central to all three optics books, largely absent from *Computer Vision* — because a camera records intensity and discards phase.
- **Aperture and the resolution limit.** Wider apertures give narrower, brighter patterns. The optics books derive it; the vision book inherits it as a constraint.
- **Frequency-domain thinking.** Explicit in *Fourier Optics*, present in the other optics texts through diffraction, and present in vision as filtering.

What fired in only one

- **Polarization — Hecht alone.** It matters where the wave's vector nature matters, and nowhere else in this set.

- **Computational geometry — vision alone.** Pixels as points with neighbourhoods and adjacency is a framing no optics text needs.
- **Historical argument — Hecht alone.** Four centuries of wave-versus-particle, which none of the others spend pages on.
- **These outliers are the specialisation.** What fires in one book tells you what that book is *for*, once you already know what all four share.

What the convergence means

- **The optics/vision boundary is not where it looks.** The split is not physics versus software. It is *phase kept* versus *phase discarded* — everything else carries across.
- **Fourier optics is the hinge.** It describes a lens as a transform, which is exactly what an image filter is. The same equation is hardware in one book and code in another.
- **A lens and a convolution kernel do the same job.** One performs the operation in glass at the speed of light; the other performs it in software, slowly and adjustably.
- **The reason vision can borrow from optics at all** is that both systems are linear and shift-invariant, and every such system is fully described by its response to a single point.
- **Practical consequence.** Learning the chain once buys all four books. Learning four books separately buys the chain four times, at four times the price.
- **The limit of the method.** Convergence shows what these four authors agree on, not what is true. Four textbooks in adjacent traditions can inherit the same error together.