Faster / simpler →

Helmholtz Wave Equation

$$\left[\nabla^2 + k_0^2\, n^2(\mathbf{r})\right] \; u(\mathbf{r}) \;=\; 0$$

Full wave equation solver

WPM (Wide-angle, local n)

$$u(z+\Delta z) = \mathcal{F}^{-1}\left[e^{ik_z^{(m)}\Delta z}\mathcal{F}\{u(z)\}\right]$$

$$k_z^{(m)} \;=\; \sqrt{(k_0 n_m)^2 - k_x^2 - k_y^2}$$

Wide-angle propagator in potential (refractive index) between slices

Angular Spectrum (Non-Paraxial)

$$u(z+\Delta z) \;=\; \mathcal{F}^{-1}\left[e^{ik_z\Delta z}\mathcal{F}\{u(z)\}\right]$$

$$k_z \;=\; \sqrt{k^2 - k_x^2 - k_y^2}$$

Wide-angle propagator in free space between slices

Fresnel (Paraxial)

$$u(z+\Delta z) = \mathcal{F}^{-1}\left[e^{-i\pi\lambda\Delta z k_\perp^2}\mathcal{F}\{u(z)\}\right]$$

$$k_\perp^2 \;=\; k_x^2 \,+\, k_y^2$$

Small-angle propagator in free space between slices

← More accurate / more general