Unified Description of X-ray Diffraction: Bragg, Laue, Reciprocal Lattice, and Ewald Methods

Aspect	Bragg's Law	Laue Equations	Reciprocal Lattice Condition	Ewald Construction
Main Equation	$2d\sin\theta = n\lambda$	$\Delta k \cdot a_i = 2\pi h_i$	$k' - k = G$	Geometric: the reciprocal point lies on the sphere
Space Used	Real space	Real space + phase condition	Reciprocal space	Reciprocal space (geometric)
View of Diffraction	Reflection from crystal planes	Phase matching from all lattice points	Momentum conservation condition	Geometric intersection condition
Dimensional Nature	Plane-by-plane (quasi 1D picture)	Fully 3D	Fully 3D	Fully 3D
Physical Meaning	Path difference between planes	Phase difference between lattice translations	The scattering vector equals the reciprocal vector	Diffraction occurs when geometry allows
Mathematical Rigor	Simple	More general	Most compact and fundamental	Visual/geometric
Generality	Works for any crystal but plane-based	Fully general	Fully general	Fully general
Shows Selection Rules?	Not explicitly	Yes	Yes	Yes (graphically)
Historical Context	1913	1912	Later formalism	1921