Supplementary Material

APPENDIX

The initialization wavevectors $\boldsymbol{k}'$ are specified by us in the simulation frame. The reference frame is rotated from frame S' (simulation frame) to frame S (Hollweg frame) by angle ϕ about z-axis such that the wavevector k_x becomes 0 in new reference frame, Figure S1. The rotation matrix for wave-vectors, for

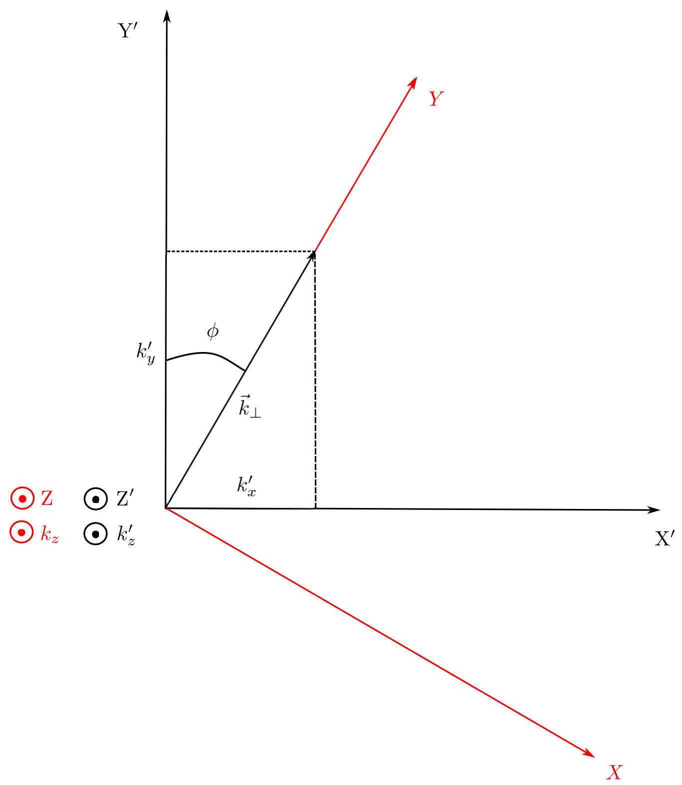

Figure S1. Rotation of reference frame from X', Y', Z' to X, Y, Z by angle ϕ about the z-axis such that k_x becomes 0.

rotation of reference frame, is given by,

$$k_x = k'_x \cos\phi - k'_y \sin\phi$$

$$k_y = k'_x \sin\phi + k'_y \cos\phi$$

$$k_z = k'_z$$

where,

$$\cos\phi = \frac{k'_y}{k'} \text{ and } \sin\phi = \frac{k'_x}{k'}$$

Since k_x is zero in the new reference frame, we can now obtain eigenvector relations for $\boldsymbol{\delta E}$, $\boldsymbol{\delta B}$ and $\boldsymbol{\delta v}$ using Hollweg relations. Now, eigenvector relations in the simulation frame S', i.e., in 3D, can be obtained using the inverse rotation matrix. The electric field polarization in the simulation reference frame (S') using the rotation matrix is given by,

$$\delta E'_x = \delta E_x \cos\phi + \delta E_y \sin\phi,$$

$$\delta E'_y = -\delta E_x \sin\phi + \delta E_y \cos\phi,$$

$$\delta E'_z = \delta E_z.$$