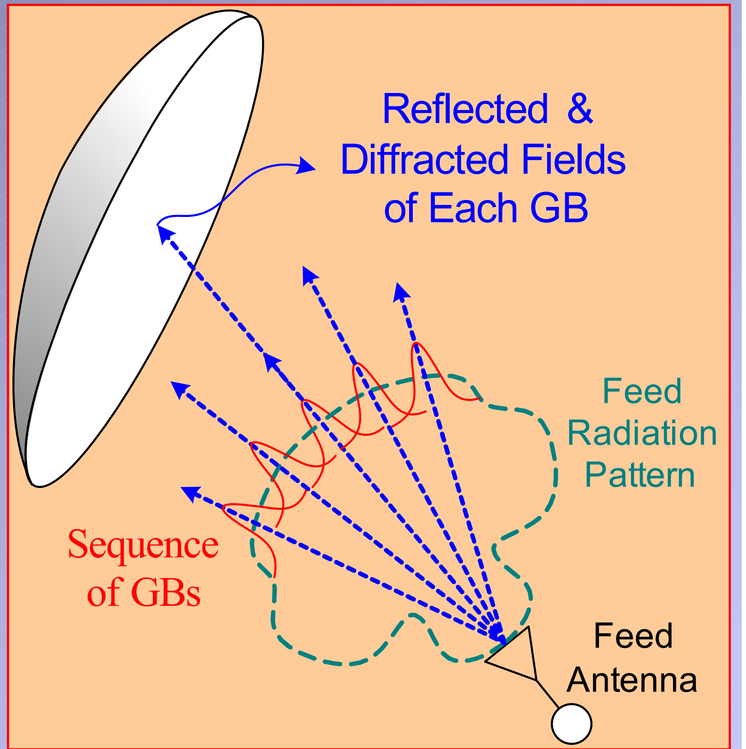
UTD Gaussian Beam Diffraction by an Edge

- H.-T. Chou, P. H. Pathak, and R. J. Burkholder , “Novel Gaussian Beam Method for the Rapid Analysis Large Reflector Antennas,” IEEE Trans. AP, June 2001.
- Previous work of Chou, Pathak, and Burkholder (June 2001) provides a <u>PO</u> based edge diffraction of GB.
- The PO-GB is more general in that it can handle <u>astigmatic</u> GB illumination of an edge.
- The PO-GB can be augmented by PTD correction if desired.
- The CSP method is more accurate since it yields a UTD-GB; however it is limited to <u>rotationally symmetric</u> GBs.

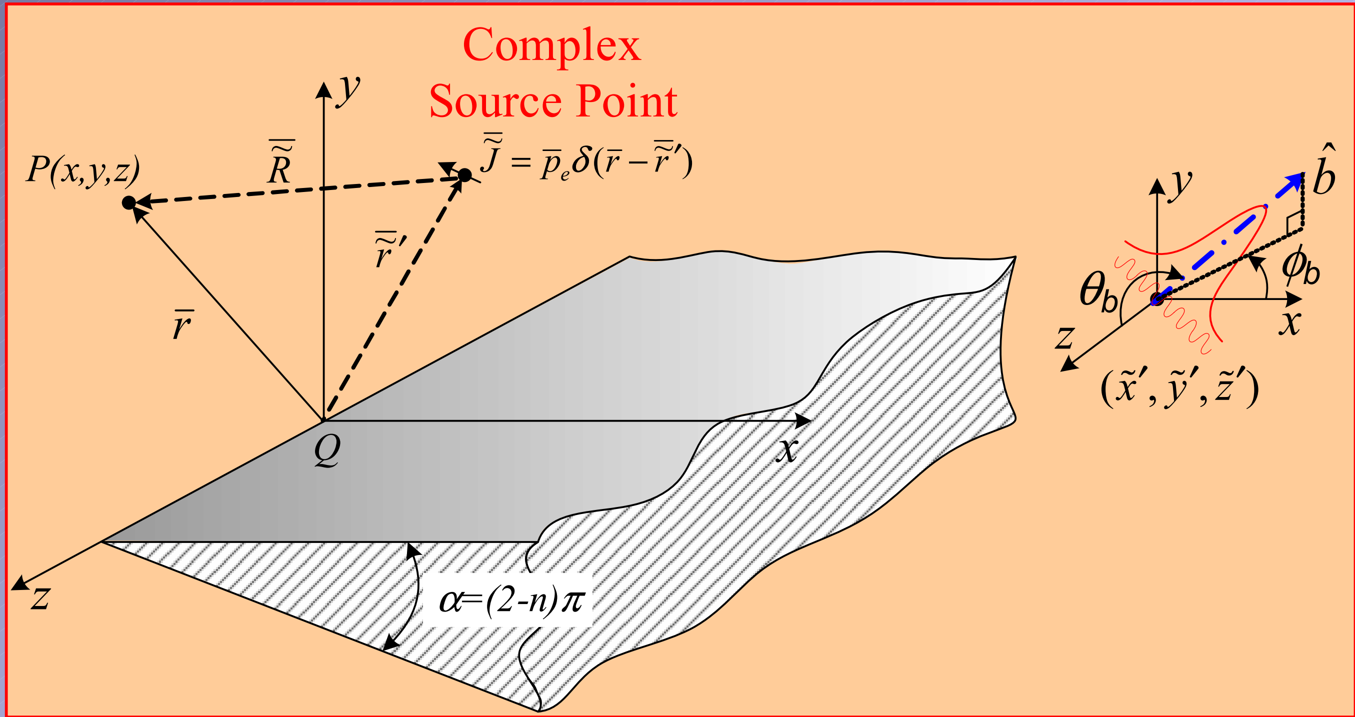


ElectroScience
LABORATORY

Formulation

- Extension of the Kouyoumjian-Pathak (K-P) UTD for a CSP excitation

$$\tilde{x}' = x' - jb\sin\theta_b\cos\phi_b$$
$$\tilde{y}' = y' - jb\sin\theta_b\sin\phi_b$$
$$\tilde{z}' = z' - jb\cos\theta_b$$



The ordinary K-P UTD for *E(P)* is analytically continued from a real to complex source location. The $\tilde{\bar{r}}'$ is complex for CSP

<u>*Note:*</u> *kb* is related to the waist of GB $\boxed{2w_0 = \sqrt{2b/k}}$ $b > 0$

Formulation

(CONTD.)

- For CSP, the *x*´, y´, and *z*´ in *r*´ becomes $\tilde{x}'$, $\tilde{y}'$ and $\tilde{z}'$ where

$$\tilde{r}' = \sqrt{\tilde{x}'^2 + \tilde{y}'^2 + \tilde{z}'^2}$$

$$\bar{\tilde{R}}_i = \bar{r} - \tilde{r}'$$

In the K-P UTD expression, the $F\left[kLa^{\pm}(\phi \pm \tilde{\phi}')\right]$ now becomes complex for a CSP because *L* and $\tilde{\phi}'$ are complex.

<u>Note:</u> $\tilde{L} = \dfrac{\tilde{s}_d \tilde{s}_i}{\tilde{s}_d + \tilde{s}_i} \sin^2 \tilde{\beta}_0$ and $\tilde{a}^{\pm} = 2\cos^2\left(\dfrac{2n\pi N^{\pm} - (\phi \pm \tilde{\phi}')}{2}\right)$

Complex Argument of Transition Function

$$\tilde{\chi} \equiv k\tilde{L}\tilde{a}^{\pm} \quad \Rightarrow \quad -\frac{3\pi}{4} < \arg\sqrt{\tilde{\chi}} < \frac{\pi}{4}$$

Formulation

(CONTD.)

- 3D K-P UTD for a wedge via CSP

$$\overline{\tilde{E}}_i(P) \approx j\frac{\omega\mu_0}{4\pi} p_e(\hat{R}\times\hat{R}\times\hat{p}_e)\frac{e^{-jk\tilde{R}_i}}{\tilde{R}_i} U_{si}(\phi_{si}-\phi)$$

$$\overline{\tilde{E}}_r(P) \approx j\frac{\omega\mu_0}{4\pi} p_e(\hat{R}\times\hat{R}\times\hat{p}_e)\cdot\overline{\overline{R}}\frac{e^{-jk\tilde{R}_r}}{\tilde{R}_r} U_{sr}(\phi_{sr}-\phi)$$

$$\overline{\tilde{E}}_d(P) \approx j\frac{\omega\mu_0}{4\pi} p_e(\hat{R}\times\hat{R}\times\hat{p}_e)\cdot\overline{\overline{D}}(\tilde{L},\tilde{a}^{\pm},\tilde{\beta}_0)\frac{e^{-jk(\tilde{s}_i+\tilde{s}_d)}}{\sqrt{\tilde{s}_i\tilde{s}_d(\tilde{s}_i+\tilde{s}_d)}}$$

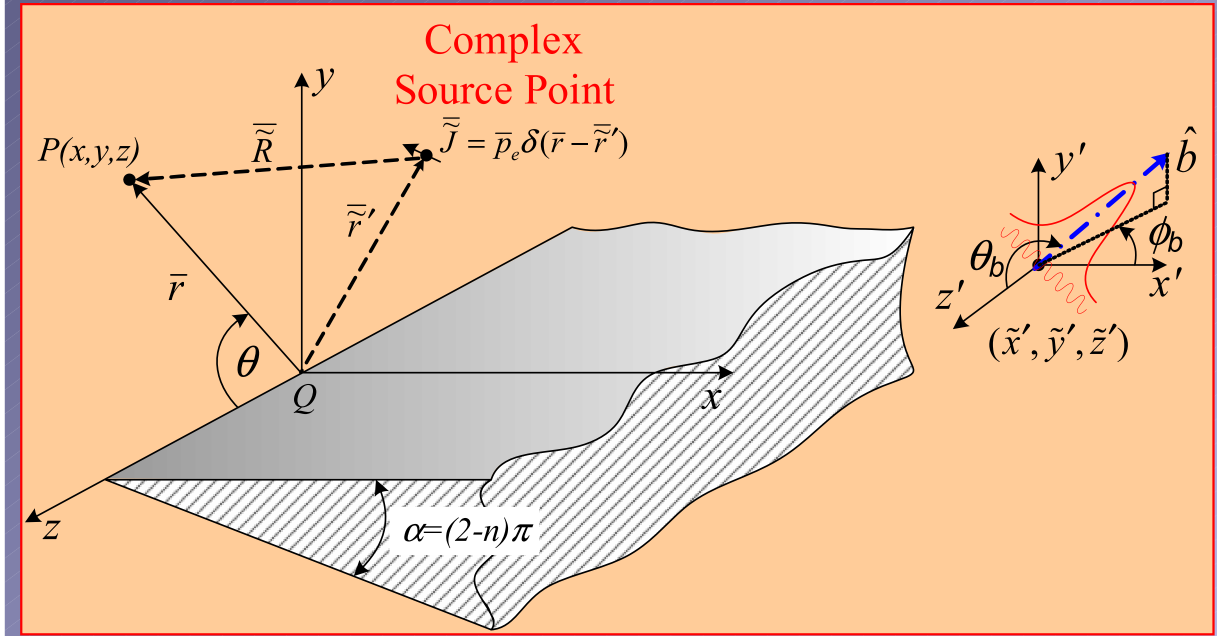
$$\overline{\tilde{E}}(P) \approx \overline{\tilde{E}}_i(P)+\overline{\tilde{E}}_{ru}(P)+\overline{\tilde{E}}_{rl}(P)+\overline{\tilde{E}}_d(P)$$

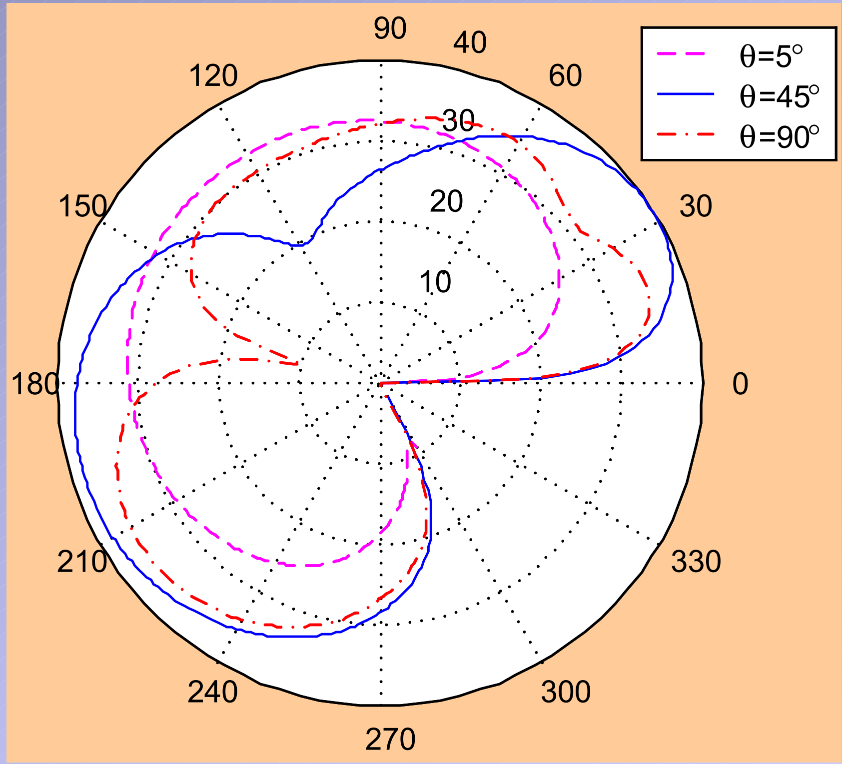
ϕ_{si} or ϕ_{sr} → $\mathrm{Re}[k\tilde{L}\tilde{a}^{\pm}]=0$, $\mathrm{Im}[k\tilde{L}\tilde{a}^{\pm}] \gtrless 0$

Incident and Reflection Shadow Boundary Angle

Numerical Results

- 3D Total Field from CSP excited PEC wedge with wedge angle α = 60 deg

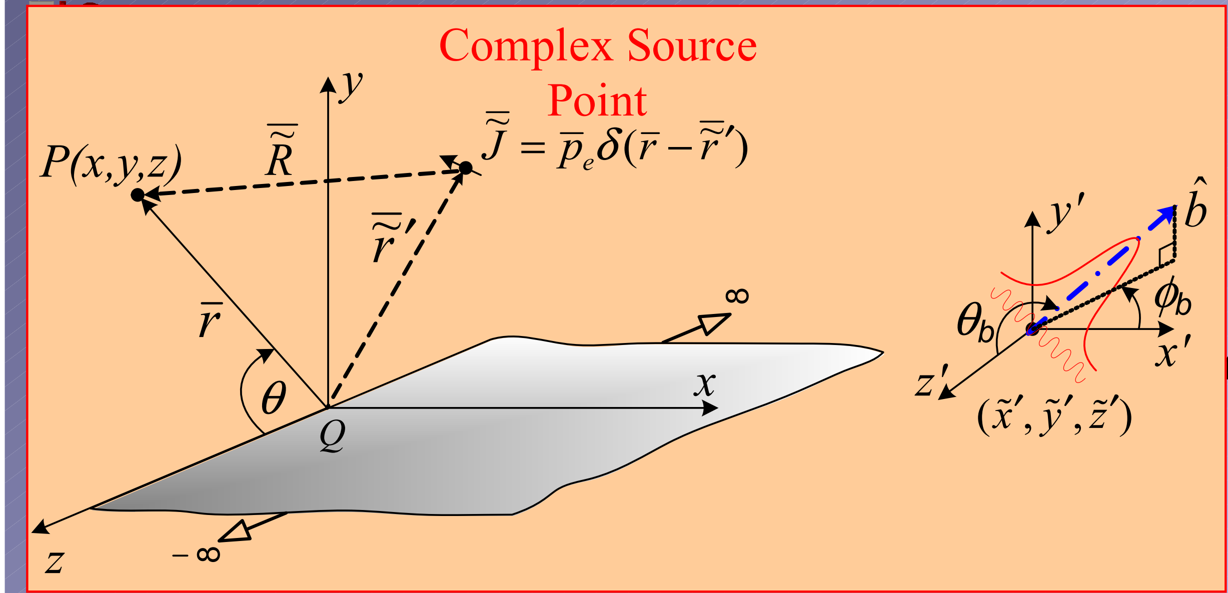


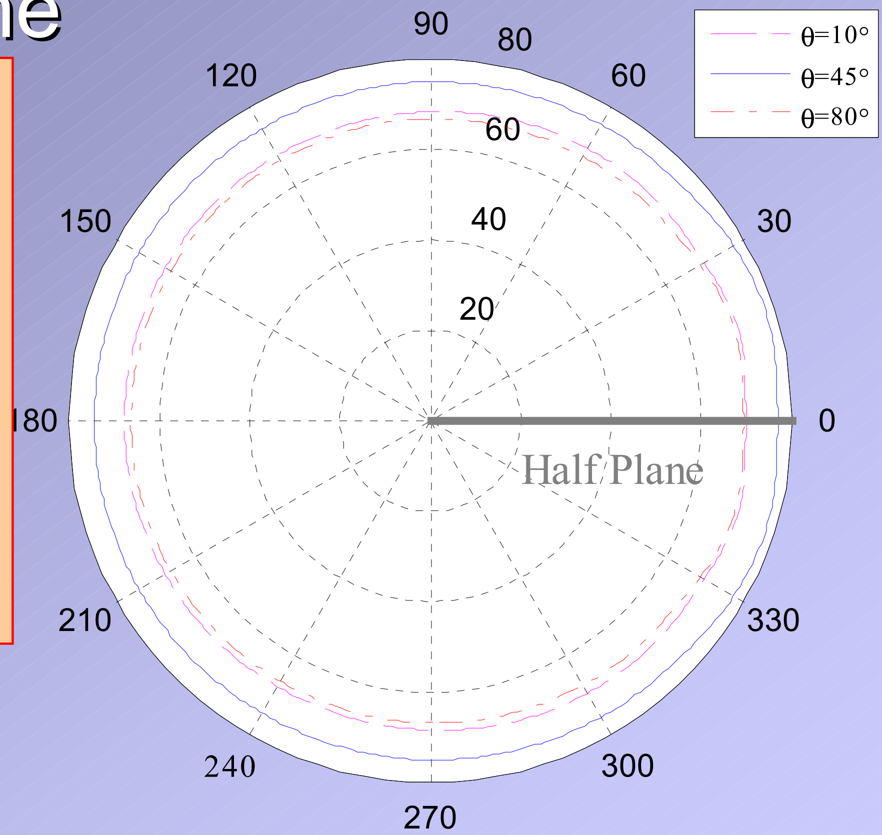


x′=0, y′=2λ, z′=-2λ, r=6λ, b=2/k,
w_o=0.38λ, ϕ_b=270 deg, and θ_b=45 deg

Numerical Results
(CONTD.)

- 3D Total Field from CSP excited PEC Half Plane Observed on the Keller Cone





$r=50\lambda$, $r'=5\lambda$, $b=30/k$, $w_0=0.6\lambda$, $\phi_b=0$ deg, $\theta_b=45$ deg

Numerical Results
(CONTD.)

- GB Edge Diffraction on the Keller Cone