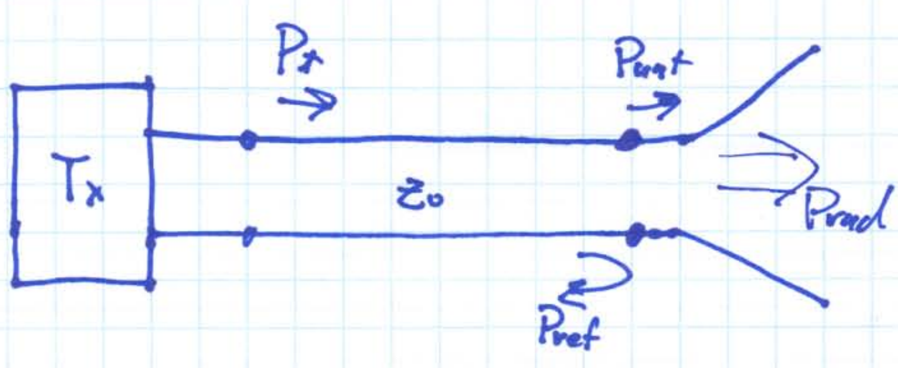
Antenna Gain

Recall that directivity pattern is:

$$D(\theta,\phi) = \frac{4\pi\, U(\theta,\phi)}{P_{rad}}$$

Yet, because of ohmic and return losses, we find that:

$$P_t \geq P_{ant} \geq P_{rad}$$



We find that P_{rad} is difficult to <u>measure</u>, whereas P_t and/or P_{ant} is not.

So We define a new parameter, called antenna <u>gain</u> $G(\theta,\phi)$

$$\text{Gain } G(\theta,\phi) = \frac{4\pi\, U(\theta,\phi)}{P_t}$$

or, assuming the antenna is matched:

$$G(\theta,\phi) = \frac{4\pi\, U(\theta,\phi)}{P_{ant}}$$

Note this means that

$$\frac{G(\theta,\phi)}{D(\theta,\phi)} = \frac{P_{rad}}{P_{ant}}$$

But recall that $P_{rad} = eP_{ant}$, whe e is antenna efficiency.

In other words,

$$\frac{G(\theta,\phi)}{D(\theta,\phi)} = e$$

So

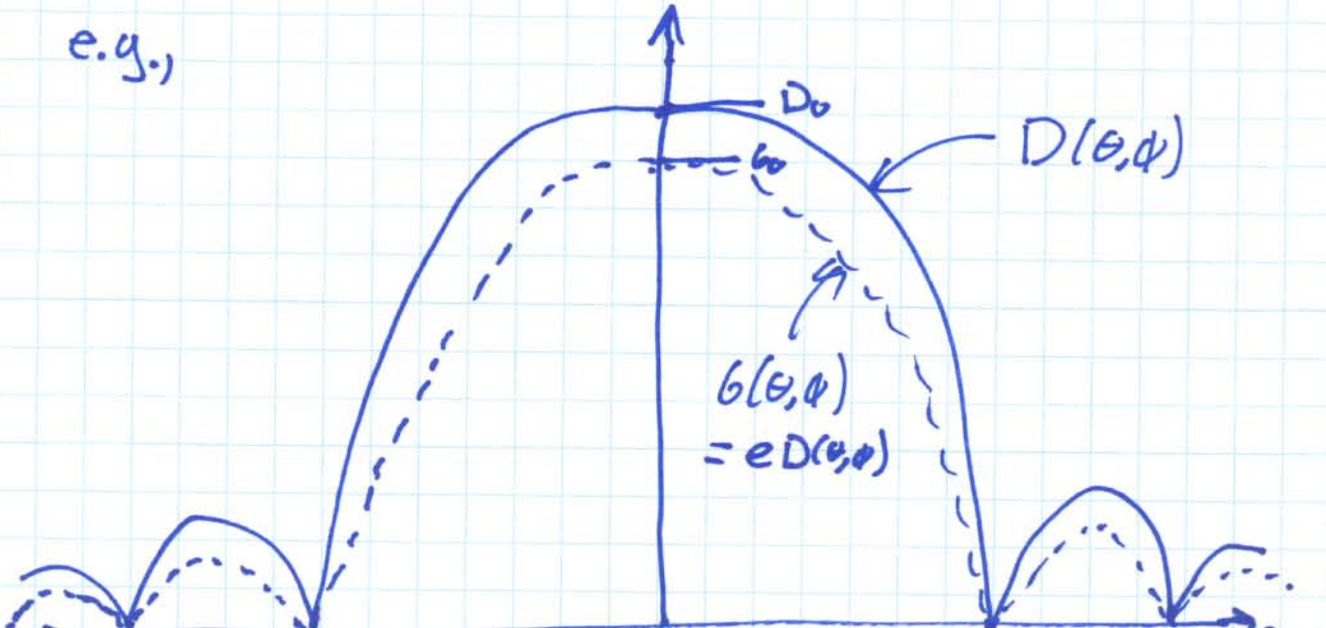
$$G(\theta,\phi) = e\, D(\theta,\phi)$$

and since $e \leq 1$, we find

$$G(\theta,\phi) \leq D(\theta,\phi).$$

Note since e is a constant (with respect to θ and ϕ) we find that the patterns $G(\theta,\phi)$ and $D(\theta,\phi)$ are the same, only gain $G(\theta,\phi)$ is slightly smaller than $D(\theta,\phi)$ at every direction.

e.g.,



As a result, we find that the <u>maximum</u> value of the gain pattern $G(\theta,\phi)$ is:

$$G_0 = e\, D_0$$