Radar Equation for Distributed Targets

The radar equation for point targets (targets occupy a very small part of the sample volume) is:

$$P_r = \frac{G^2 \lambda^2 P_t \sigma}{64 \pi^3 R^4}$$

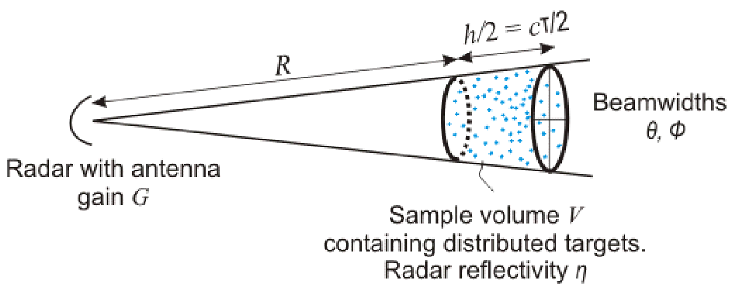
Consider many point targets evenly distributed in the sample volume, and assume that the pulse length h is much smaller than the distance R. Let σ_i be the cross sectional area per unit volume (for some important targets we can compute this). The total backscatter cross sectional area from the sampling volume is then

$$\sigma_t = V \sum_{Unit\ Volume} \sigma_i = V\eta$$

where η is defined as the *radar reflectivity*. Its units are $m^2\ m^{-3}$ or m^{-1} or cm^{-1}. Substitute this into the radar equation for point targets to find:

$$P_r = \frac{G^2 \lambda^2 P_t V \eta}{64 \pi^3 R^4} \qquad 1$$

Consider the pulse volume:



$$V_1 = \pi \frac{R\theta}{2} \frac{R\phi}{2} \frac{h}{2} \text{ (general)}$$

$$V_2 = \frac{\pi R^2 \theta^2 h}{8} \text{ (symetric } \theta = \varphi\text{)}$$

$$V_3 = \frac{\pi R^2 \theta \varphi}{8 \ln(2)} \frac{h}{2} \text{ (symectric, Gaussian)}$$

Substitute V_3 and $h = c\tau$ into Equation 1 to find

$$P_r = \frac{G^2 \lambda^2 P_t \theta \phi \eta h}{1024 \ln(2) \pi^2 R^2} = \frac{G^2 \lambda^2 P_t \theta \phi \eta c \tau}{1024 \ln(2) \pi^2 R^2}$$

For a given radar G, λ, P_t, τ, θ, and ϕ are constant and one can group these and the numerical constants in a constant called the radar constant, and the expression becomes

$$P_r = \left(\frac{G^2 \lambda^2 P_t \theta \phi c \tau}{1024 \ln(2) \pi^2} \right) \frac{\eta}{R^2} = C \frac{\eta}{R^2}$$