Radar Equation for Distributed Targets

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

$$P_r = \frac{G^2 l^2 P_t s}{64 p^3 R^4}$$

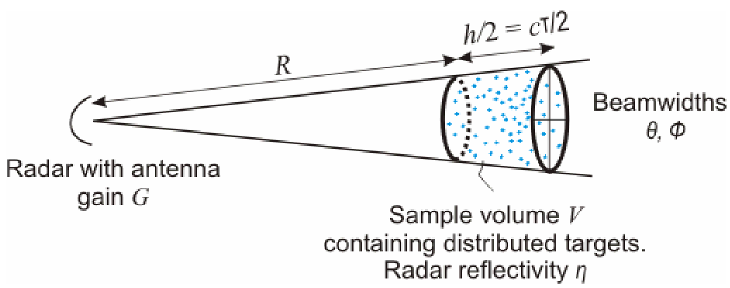
Consider many point targets evenly distributed in the sample volume, and assume that the pulse length h is much smaller than the distance R. Let s_i be the cross sectional area per unit volume (for some important targets we can compute this). The total backscatter cross sectional area from the sampling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

$$s_t = V \sum_{Unit\,Volume} s_i = Vh$$

where h 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:

$$P_r = \frac{G^2 l^2 P_t V h}{64 p^3 R^4} \qquad 1$$

Consider the pulse volume:



$$V_1 = p \frac{Rq}{2}\frac{Rf}{2}\frac{h}{2} \text{ (general)}$$

$$V_2 = \frac{pR^2 q^2 h}{8} \text{ (symetric } q = j\text{)}$$

$$V_3 = \frac{pR^2 q j}{8\ln(2)}\frac{h}{2} \text{ (symectric, Gaussian)}$$

Substitute V_3 and $h = ct$ into Equation 1 to find

$$P_r = \frac{G^2 l^2 P_t q f h h}{1024 \ln(2) p^2 R^2} = \frac{G^2 l^2 P_t q f h c t}{1024 \ln(2) p^2 R^2}$$

For a given radar G, l, P_t, t, q, and f are constant and one can group these and the numerical constants in a constant called the radar constant, and the expression becomes

$$P_r = \left(\frac{G^2 l^2 P_t q f c t}{1024 \ln(2) p^2}\right)\frac{h}{R^2} = C\frac{h}{R^2}$$

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