Below is an equation from Roger J. Sullivan, Microwave Radar: Imaging and Advanced Processing, p. 67 eq 3.8. It is used here to display the radar cross section of a perfectly conducting sphere. Three regions can be seen in the following plot. Beginning on the left-side of the plot and moving toward the right-side, in regions where the sphere is much smaller than the radar wavelength, Rayleigh scattering occurs, Mie scattering occurs in the region where the radar wavelength and the size of the sphere are comparable and optical scattering occurs when the size of the sphere is much larger than the wavelength. In the plot below, optical scattering is beginning to occur off to the right-side of the plot as the fluctuations associated with Mie scattering begin to become smaller and smaller.

In the plot, on the vertical axis the RCS of the sphere is normalized to the area of the sphere and on the horizontal axis the circumference of the sphere is normalized by the wavelength of the radar.

The relatively compact form of the *Mathematica* statements shown below to produce the graph demonstrates the value of using *Mathematica* in this

example.

```
(* Sullivan's equation page 67, eg 3.8 is as follows:
```

$$\frac{\sigma}{\pi\ a^2} = \frac{1}{\rho^2}\ \left|\sum_{n=1}^{\infty} (-1)^n\ (2n+1)\,(a_n+b_n)\right|^2$$

$$a_n = \frac{j_n(\rho)}{h_n^{(2)}(\rho)}\quad ;\quad b_n = \frac{-[\rho j_n(\rho)]'}{[\rho\ h_n^{(2)}(\rho)]'}$$

```
*)
```

```
In[1]:= -D[ρ SphericalBesselJ[n, ρ], ρ];
        D[ρ SphericalHankelH2[n, ρ], ρ];

In[3]:= -SphericalBesselJ[n, ρ] - ρ (-SphericalBesselJ[n, ρ]/(2 ρ) +
          1/2 (SphericalBesselJ[-1 + n, ρ] - SphericalBesselJ[1 + n, ρ]));

In[4]:= SphericalHankelH2[n, ρ] + ρ (-SphericalHankelH2[n, ρ]/(2 ρ) +
          1/2 (SphericalHankelH2[-1 + n, ρ] - SphericalHankelH2[1 + n, ρ]));
```

In[5]:=

```
FinalSullivan = LogLogPlot[
  1/ρ^2 Abs[Sum[(-1)^n (2 n + 1) ((SphericalBesselJ[n, ρ]/SphericalHankelH2[n, ρ]) + ((-SphericalBesselJ[n, ρ] -
        ρ (-SphericalBesselJ[n, ρ]/(2 ρ) + 1/2 (SphericalBesselJ[
              -1 + n, ρ] - SphericalBesselJ[1 + n, ρ])))/
       (SphericalHankelH2[n, ρ] + ρ (-SphericalHankelH2[n, ρ]/(2 ρ) +
            1/2 (SphericalHankelH2[-1 + n, ρ] - SphericalHankelH2[1 + n, ρ]))))), {n, 1, 30}]]^2
  ,
  {ρ, .1, 20}, PlotRange → All, Frame → True,
  FrameLabel → {"Circumference of Sphere/Wavelength: 2πa/λ",
    "RCS of Sphere/ Area of Sphere:σ Sphere/πa^2"}, PlotLabel → Sphere,
  Axes → False, ImageSize → 72 × 7, LabelStyle → Directive[Black, Bold],
  Frame → True, BaseStyle -> {FontWeight -> "Bold", FontSize → 14}]
```

Out[5]=