$$P_N(R_e) = 4\pi R_e^2 \left(\frac{3}{2\pi\langle R_e^2\rangle}\right)^{3/2} \exp\left(-\frac{3R_e^2}{2\langle R_e^2\rangle}\right) P_{\text{Gauss}}(r) = 4\pi r^2 \left(\frac{3}{2\pi}\right)^{3/2} \exp\left(-3r^2/2\langle r^2\rangle\right) \frac{-3r^2}{2\langle r^2\rangle}$$