Consider a Gaussian profile

$$\rho(r) = e^{-\alpha r^2}. \tag{1}$$

The total mass is

$$M = 4\pi \int_0^\infty r^2 \rho(r)\,\mathrm{d}r = \left(\frac{\pi}{\alpha}\right)^{3/2}. \tag{2}$$

The gravitational potential at a radius a from the origin can be written as

$$\begin{aligned}
\Phi(a) &= \Phi_{\mathrm{in}} + \Phi_{\mathrm{out}} \\
&= -\frac{GM_{\mathrm{in}}}{a} - 4\pi G \int_a^\infty r'\rho(r')\,\mathrm{d}r' \\
&= -4\pi G \left\{ \frac{1}{a} \int_0^a r'^2 \rho(r')\,\mathrm{d}r' + \int_a^\infty r'\rho(r')\,\mathrm{d}r' \right\} \\
&= -4\pi G \left\{ \frac{1}{a} \left[-\frac{a e^{-\alpha a^2}}{2\alpha} + \frac{\sqrt{\pi}\cdot \mathrm{erf}(a\sqrt{\alpha})}{4\alpha^{3/2}} \right] + \frac{e^{-\alpha a^2}}{2\alpha} \right\} \\
&= -4\pi G \left(\frac{\sqrt{\pi}\cdot \mathrm{erf}(a\sqrt{\alpha})}{4a\alpha^{3/2}} \right).
\end{aligned} \tag{3}$$