

$$\begin{aligned}
 \tilde{E}_0^{(1)} &= \langle E_0 | H' | E_0 \rangle \\
 &= \int_{-\infty}^{+\infty} dx \psi_0^2(x) x^2 e^{-\gamma x^2} dx \\
 &= \sqrt{\frac{m\omega}{\pi\hbar}} \int_{-\infty}^{+\infty} x^2 e^{-x^2 \left(\gamma + \frac{m\omega}{\hbar}\right)} dx \\
 &= \sqrt{\frac{m\omega}{\pi\hbar}} \sqrt{\frac{1}{\gamma + \frac{m\omega}{\hbar}}} \frac{1}{\gamma + \frac{m\omega}{\hbar}} \frac{\sqrt{\pi}}{2} \\
 &= \sqrt{\frac{m\omega}{\gamma\hbar + m\omega}} \frac{\hbar/2}{\gamma\hbar + m\omega} \\
 &= \sqrt{m\omega} (\lambda\hbar + m\omega)^{-3/2} \frac{1}{\omega} \frac{\hbar\omega}{2}
 \end{aligned}$$

$$\begin{aligned}
 y &= ax & y^2 &= a^2 x^2 \\
 dx &= \frac{1}{a} dy & x^2 &= \frac{y^2}{a^2}
 \end{aligned}$$

Piccolezza:

$$\frac{\lambda\sqrt{m\omega}}{\omega} (\lambda\hbar + m\omega)^{-3/2} \ll 1$$