

# 1 Derivatives and Expectation Values

When calculating  $\frac{d\langle x^2 \rangle}{dt}$  why does the divergence under the integral cancel?

$$\int \int \int \text{Div}[(\bar{\psi} x^2)(\nabla \psi)] dx dy dz = 0$$

My professor stated in class something along the lines of: it is because the wavepacket is zero everywhere except the origin. Griffith uses a similar technique when using integration by parts and states that the boundary term (devergence in our case) tends to zero at infinity.

The other problem I am having is introducing known expectation values. After several pages of algebra and taking divergences I have come to the following.

$$\frac{d\langle x^2 \rangle}{dt} = \frac{i\hbar}{2m} \int \int \int x^2 (\psi \frac{\partial^2 \psi^*}{\partial x^2} - \psi^* \frac{\partial^2 \psi}{\partial x^2}) + 4x (\psi \frac{\partial \psi^*}{\partial x} - \psi^* \frac{\partial \psi}{\partial x}) dx dy dz$$

This has to equal the following, however I cannot seem to understand how it does.

$$\frac{d\langle x^2 \rangle}{dt} = \frac{1}{m} (\langle xp_x \rangle + \langle p_x x \rangle)$$