   Follows the lectures on Bose-Einstein condensation

2. Griffiths, 2nd Edition, Problem 5.16
   Fermiology

of the 3D harmonic oscillator you have to answer the question: “How many ways can we add three non-negative integers to get a particular sum $n$?”

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1. **Macroscopic quantum model of superfluidity.** To described the condensed phase of superfluid $^4$He, we posit the existence of a single quantum wavefunction that describes the collective behavior of all the atoms in the ground state: $\psi_0(\vec{r}) \equiv n_0(\vec{r}) \, e^{i\theta(\vec{r})}$, where $n_0(\vec{r}) = |\psi_0(\vec{r})|^2$ is the local density of condensed particles, and $\theta(\vec{r})$ is the spatially varying phase. Using the definition of probability current (Eq. [4.193]), and re-interpreting it as the mass current, find the superfluid velocity $\vec{v}_s$ in the expression $\vec{J} = n_0 \vec{v}_s$. 
2. When superfluid $^4$He is constrained to flow in a circular channel, the circulation maintains itself with no dissipation. Show that the values of the circulation $\kappa$ are restricted to the discrete quantum values $\kappa = \oint \vec{v}_s \cdot d\vec{l} = n \frac{h}{m}$, where $n = 0, \pm 1, \pm 2, \ldots$