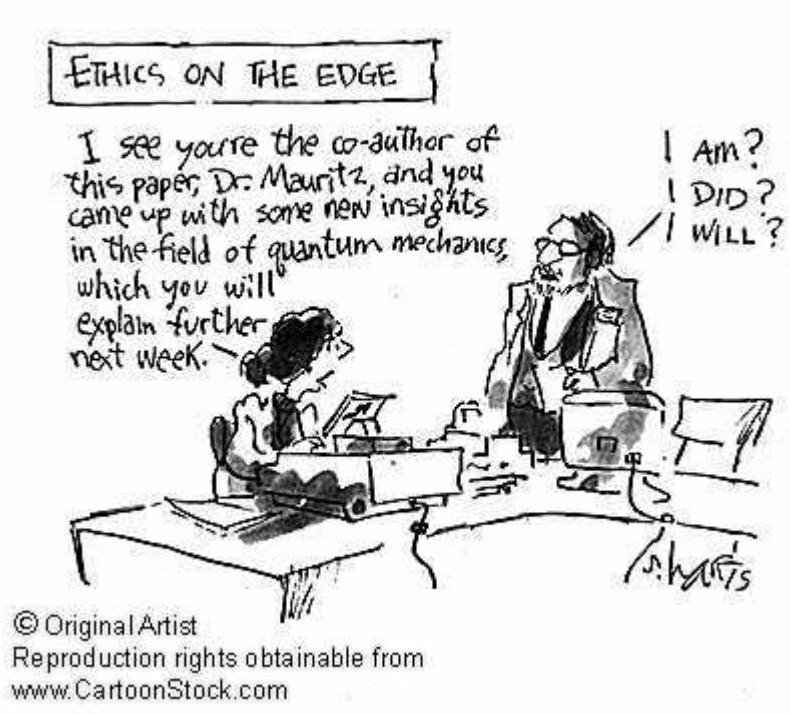
Phys 402
Spring 2009
Homework 9
Due Friday, May 1, 2009 @ 9 AM

1. Griffiths, 2nd Edition, Problem 5.29 **Follows the lectures on Bose-Einstein condensation**

2. Griffiths, 2nd Edition, Problem 5.16 **Fermiology**

3. Griffiths, 2nd Edition, Problem 5.37. **Hint: To calculate the degeneracy of state E_n 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?"**



Physics 402
Spring 2009
Prof. Anlage
Discussion Worksheet for April 29, 2009

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: $\psi_0(\vec{r}) = \sqrt{n_0(\vec{r})}\, e^{i\theta(\vec{r})}$, 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 κ are restricted to the discrete quantum values $\kappa = \oint \vec{v}_s \bullet d\vec{l} = n\frac{h}{m}$, where $n = 0, \pm 1, \pm 2, \ldots$