PHYS 811: Assignment 4

1. A finite rotation can be obtained from an infinitesimal one by solving an appropriate differential equation as done in the classical mechanics section. Show that, alternatively, the same task can be performed by relating the transformed coordinates, $x'$ and $y'$, to the original ones, $x$ and $y$, by the infinite string of Poisson brackets.

2. Prove that if $[\Pi, H] = 0$, where $\Pi$ is the parity operator and $H$ is a Hamiltonian (possibly dependent on time), a system that starts out in a state of even/odd parity maintains its parity.

3. A particle is in a potential $V(x) = V_0 \sin(2\pi x/a)$ which is invariant under the translations $x \to x + ma$, where $m$ is an integer. Is momentum conserved? Why yes or not?

4. In a certain nuclear decay, the electron comes out with its linear momentum always parallel to nuclear spin. Argue that parity is violated.

5. Parity in one dimension can be treated as a mirror reflection. In three dimensions, parity is defined as $\Pi |r\rangle = | - r\rangle$, so that it is not a mirror reflection. Show that a reflection on a mirror in the $x - y$ plane is the same as parity transformation followed by 180° rotation about the $z$ axis. Discuss implication of this relation on (non)invariance properties of weak interactions.