# 8.E: Rotation (Exercises)

## Q1

In the 1925 Michelson-Gale-Pearson experiment, the physicists measured the Sagnac effect due to the earth's rotation. They laid out a rectangle of sewer pipes with length $x = 613\ m$ and width $y = 339\ m$, and pumped out the air. The latitude of the site in Illinois was $41^\circ 46'$, so that the effective area was equal to the projection of the rectangle into the plane perpendicular to the earth's axis. Light was provided by a sodium discharge with $\lambda = 570\ nm$. The light was sent in both directions around the rectangle and interfered, effectively doubling the area. Clever techniques were required in order to calibrate the apparatus, since it was not possible to change its orientation. Calculate the number of wavelengths by which the relative phase of the two beams was expected to shift due to the Sagnac effect, and compare with the experimentally measured result of $0.230 \pm 0.005$ cycles.

## Q2

The relativistic heavy ion collider RHIC collides counter-rotating beams of gold nuclei at $9\ \mathrm{GeV/nucleon}$. If a gold nucleus is approximately a sphere with radius $6 \times 10^{-15}\ m$, find the maximum angular momentum, in units of $\hbar$, about the center of mass for a sideswiping collision. Answer: $\sim 10^5$.

## Q3

Show, as claimed section 8.2, that the time-space components of the tensor ${}^\star L$ equal the angular momentum three-vector.