Stern-Gerlach Shutters

— The Problem —

1. The Stern-Gerlach Scientific Contraption Company makes a device called a Stern-Gerlach Shutter. One of these is depicted in Figure 1.

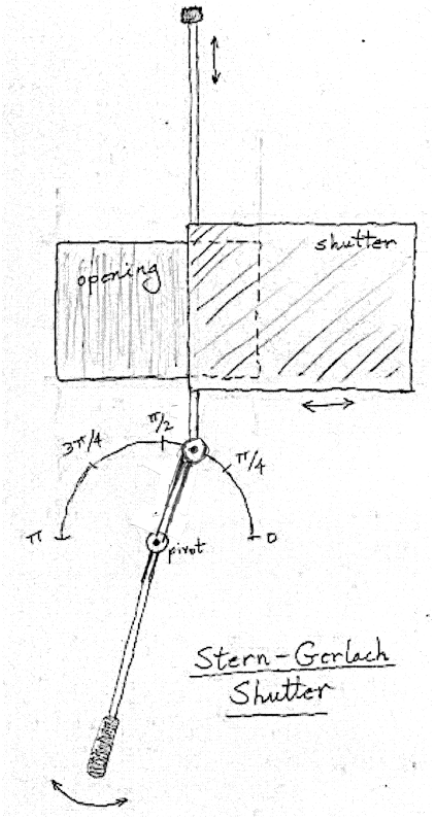

Figure 1
Stern-Gerlach Shutter

2. The settings gauge at the bottom of the device is set at a desired angle between zero and π. The shutter sheet slides horizontally, guided by a long bar that is connected to the rotating handle, and which can slide vertically through a tube at the left edge of the shutter sheet.

3. The shutter sheet is used to cover a rectangular opening that is centered over the settings gauge's pivot. The width of the opening is equal to the diameter of the semicircle swept out by the settings gauge.

4. We have two of these Stern-Gerlach Shutters, and for each one a corresponding Stern-Gerlach Shutter Shooter. A Stern-Gerlach Shutter Shooter fires a pellet at a random point inside the boundaries of the opening of a Stern-Gerlach Shutter. The pellet may either pass through the opening or bounce off the shutter sheet. The Shutter Shooter may fire either a black pellet or a white pellet, at the discretion of the experimenter.

5. Shutter 1 is set to ϕ_1 and Shutter 2 is set to ϕ_2.

6. According to the flip of a fair coin, we shoot either a black pellet at Shutter 1 and a white pellet at Shutter 2, or the other way around.

7. Let $+1$ represent either a black pellet passing through an opening or a white pellet bouncing off a shutter sheet. Let -1 represent pellets doing it the other way around.

8. Compute, for the two Stern-Gerlach shutters, the correlation coefficient ρ as a function of $\phi_1 - \phi_2$.

— The Solution —

Figure 2

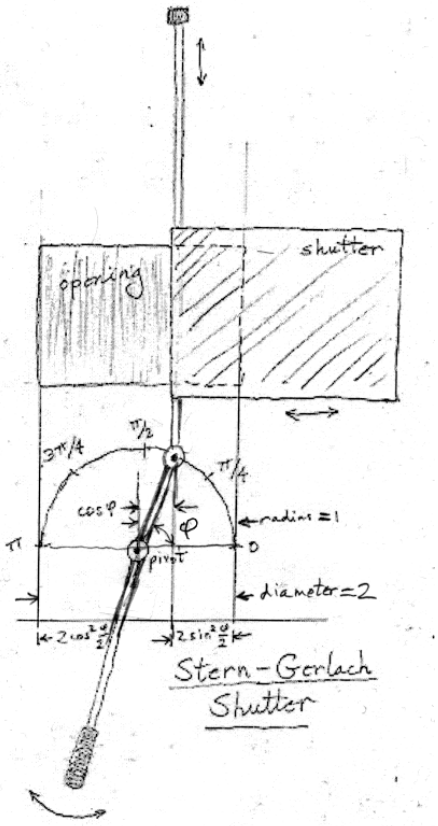

Figure 2 Dimensions of a Stern-Gerlach Shutter