Stern-Gerlach August 18

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1 Introduction

The Stern-Gerlach experiment was first devised by Otto Stern and Walther Gerlach. This experiment results in an observable phenomena that can not be explained classically.

2 The Experiment

In line with the original experiment, we will hypothetically take silver atoms and pass them through a gradient magnetic field of strength $B(x)$. Silver atoms have one unpaired electron (check this with the periodic table if you like) so the atoms will have a magnetic moment

$$\mu = \mu_b$$

where μ_b is the Bohr magneton. It then follows

$$\vec{V} = -\vec{\mu} \cdot \vec{B}$$

$$\vec{F} = -\nabla \vec{V}$$

since μ is a constant, we can say

$$\vec{F} = -\vec{\mu} \cdot \nabla \vec{B}$$

For simplicity, we will say that the magnetic field only changes in the z direction and at a constant rate b [1]. The force then becomes

$$\vec{F} = -\vec{\mu} \cdot b\hat{z}$$

If we interpret this classically, the direction of μ is arbitrary, it can point in any direction, we will expect to see the atoms coming out of the experiment to be smeared out.

[1] It isn't actually possible to create such a field, but as we will see later, the procession of the x and y magnetic moments shall cancel out much of the x and y force