Lecture 8 Highlights

The Stern-Gerlach (SG) device uses an inhomogeneous magnetic field to exert a force on neutral atoms in a manner that depends on the sign and magnitude of the "z-component" of magnetic moment (anti-parallel to the spin of the electron) of the atom. The z-direction is defined by the direction of the gradient in magnetic field of the SG device (see Griffiths page 181). The SG takes un-polarized atoms as input and produces spin-polarized beams as output. Atoms in these beams are in S_z eigenstates.

We then discussed the "thought experiment" on pages 176 and 177 concerning the impossibility of precisely determining two components of the spin vector $\vec{S}$. This is a re-statement of the fact that one cannot form simultaneous eigenfunctions of incompatible operators (recall that the components of $\vec{S}$ do not commute, e.g. $[S_z, S_x] = i\hbar S_y$). We also derived the eigenvalues and eigenfunctions of S_x in terms of the S_z basis. This exercise showed directly that the S_x eigenstates are made up of an equal superposition of S_z "up" and S_z "down" states. Hence a determination of S_x forces a "minimal information" condition for S_z, or we could say that our knowledge of S_z is in a "state of maximum ignorance."

We also discussed the question of what happens to a spin state after the wavefunction has been collapsed into a particular eigen-spinor, and then is left alone. See the file "Does a Measured Spin State Smear Out into Other Spin States?" on the Supplementary Material part of the class web site.