

Non-obvious controls:

- Grab the dial on the **angle** indicator to rotate the magnet.
- Select **up** or **down** for which spin the magnet lets through.
- **Spin orientation** controls the spin of the atoms coming out of the source.
- Turn on the **Sound** to hear the atoms popping out the source and through the magnets.

Important modeling notes / simplifications:

- The pie charts show the percentage of atoms that gone up and down so far. If you have only fired a few atoms, they may not match the expectation values.
- Increasing the speed of the atoms turns the stream of atoms from a series of discrete atoms to continuous beam.
- If you fire a single atom at a time, at high speeds it moves so fast you can't see it.

Insights into student use / thinking:

- In interviews, we found that even students with no science background were able to figure out the basics of nuclear physics by playing with this simulation. However, students were not able to make sense of the graphs without instruction.
- In the **Chain Reaction** tab, students quickly learn that **U-235** contributes to the chain reaction and **U-238** does not. They then wonder why we bother to include **U-238** in the simulation. Further instruction is needed to explain that Uranium in the real world is mostly **U-238**.
- Students can usually figure out what is happening in the **Nuclear Reactor** tab, but they may not realize that this represents a nuclear power plant unless you point it out.

Suggestions for sim use:

- For tips on using PhET sims with your students see: [Guidelines for Inquiry Contributions](#) and [Using PhET Sims](#)
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see [Teaching Physics using PhET Simulations](#)
- For activities and lesson plans written by the PhET team and other teachers, see: [Teacher Ideas & Activities](#)
- There are three key thought experiments typically taught with the Stern Gerlach experiment, all of which can be performed with this simulation:
 1. Send unpolarized beam of particles through a Stern-Gerlach magnet oriented in any direction and see that it is split into two and only two beams.
 2. Send unpolarized beam of particles through z magnet, then send +z beam through x magnet, see that it is again split into two beams.
 3. Send unpolarized beam of particles through z magnet, then send +z beam through x magnet, then send +x beam or -x beam through another z magnet, see that even though you started with a purely +z beam, after sending it through the x-beam, it contains both +z and -z components.
- Use this simulation in a lecture demo in conjunction with the simulation at <http://www.if.ufrgs.br/~betz/quantum/SGPeng.htm>, which allows you to see inside the magnets.