Non-obvious controls:
- Be sure to try all the different tabs at the top of the simulation.
- You can change the sample atom. Each type of atomic nucleus has a different magnetic moment and thus a different energy splitting between the spin down and spin up state for the same magnetic field.
- To excite the nuclei, you must turn on the radio wave source and tune the frequency of the radio waves to match the excitation frequency between the spin down and spin up states. This excitation frequency depends on the magnetic field.
- In the second tab, you can excite the nuclei in one small region by adjusting the horizontal and vertical gradients.
- You can Pause the sim and then use Step to incrementally analyze.
- If you are doing a lecture demonstration, set your screen resolution to 1024x768 so the simulation will fill the screen and be seen easily.

Important modeling notes / simplifications:
- This simulation is based on the model of MRI presented in Louis Bloomfield’s textbook, *How Things Work*.1

Insights into student use / thinking:
- We recommend starting with the first tab to help students learn the basic ideas of how to excite nuclei with a constant magnetic field. The second tab can be overwhelming if it is the first thing students see.
- In interviews, we found that even students with no science background were able to figure out the basics of how an MRI works by playing with this simulation.

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
- Use MRI as a context for helping students understand magnetic moments, spin, and energy splitting between spin states.
- Ask students to calculate what frequency should excite the nuclei for a given magnetic field or vice versa, and use the simulation to check their calculations.
- Give students a table of magnetic moments for different atoms, and ask them to use the simulation to determine the mystery sample atom (marked “???”).
- Turn off Show atomic nuclei, then add tumor, and ask students to determine where the tumor is by tuning the frequency to match the energy splitting and seeing where the most photons are emitted.

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