AOW 4

1. Mark your confusion…
2. Show evidence of close reading; mark up the text with questions and/or comments
3. Be a skeptic!
4. Write a one-page reflection on your own sheet of paper.

Detecting a single proton

Technology uses a diamond detector to sense the presence of a single proton

BY **STEPHEN ORNES**
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This magnetic resonance imaging machine uses magnetic fields to peer inside living tissue. Scientists have now found a way to use the same approach to detect the presence of a tiny building block of atoms

A proton may be incredibly small, but the subatomic size of this particle makes it ideal for researchers trying to peer into the nano-world. Scientists have just built a tiny magnetic-resonance-imaging detector out of diamond. It has now scanned a single proton. It detected that proton, even though it could not actually make an image of it.

One day, such a device might make it possible to “see” far bigger — but still quite tiny — biological features, such as viruses and proteins.

“It's a really nice milestone,” Daniel Rugar told *Science News*. A physicist at the IBM Almaden Research Center in San Jose, Calif., he did not work on the device.

The new scanner is a micro-scale version of the giant magnetic resonance imaging (MRI) machines used in hospitals and labs. But it works much the same way they do.

In a hospital MRI machine, the body part to be scanned is placed in a strong magnetic field. This aligns the magnetic fields of individual protons in molecules throughout that body part being scanned. The fields of these protons will now point in the same direction. Then, the MRI directs radio waves at the body part. Those protons absorb these waves and send them back out — but at a different frequency. (Frequency is measured

as the number of waves per second.) When the radio waves shut off, the protons' magnetic fields return to normal. The scanner uses the shifts in frequencies to create a detailed map of the tissues that had been scanned.

Protons are found in the nucleus of all atoms. But in hydrogen they're special. The nucleus of each hydrogen atom consists of a single proton. Hydrogen atoms can be found in water molecules. The human body contains so much water that it contains trillions of hydrogen atoms. This makes MRI a powerful tool for peering inside the ocean of atoms comprising our cells and tissues.

Scientists have been trying for more than 20 years to use the same approach to scan even smaller things.

"We want to apply MRI tricks to studying viruses, cells and individual molecules," Christian Degen told *Science News*. He is a solid state physicist at ETH Zurich in Switzerland. Degen is no stranger to the field. In 2009, he and a team of scientists used a magnetic sensor to image a virus. The virus contained about 10,000 hydrogen atoms.

To build a sensor that could identify a single proton, his team used diamond. This crystalline mineral is made of a rigid array of carbon atoms. The researchers removed two carbon atoms from the surface of the crystal. In that space, they substituted an atom of nitrogen. Now, when the researchers shone a green light on the crystal, the nitrogen atom sent out bright red light.

Degen's team placed a thin slice of the material that contained hydrogen just above the diamond crystal's surface. When they turned on the magnetic field, they observed that the brightness of the red light changed due to a change in magnetic fields. That highlighted the presence of a single proton nearby. Degen's team reported its findings October 16 in *Science.*

The red light acts like a flashlight. And it serves as a sensor that points to a changing magnetic field, such as the one in the proton, Rugar says. The red light brightens or dims in response to how strong that magnetic field is. Scientists are "still discovering all the things that can be done with it," Rugar said.

Technologies already exist to scan molecules — items made of many atoms, which are themselves made of subatomic particles. The new magnetic sensor suggests it is possible to detect those subatomic building blocks, one by one. And that may help show scientists how proteins, viruses, and other tiny objects behave.