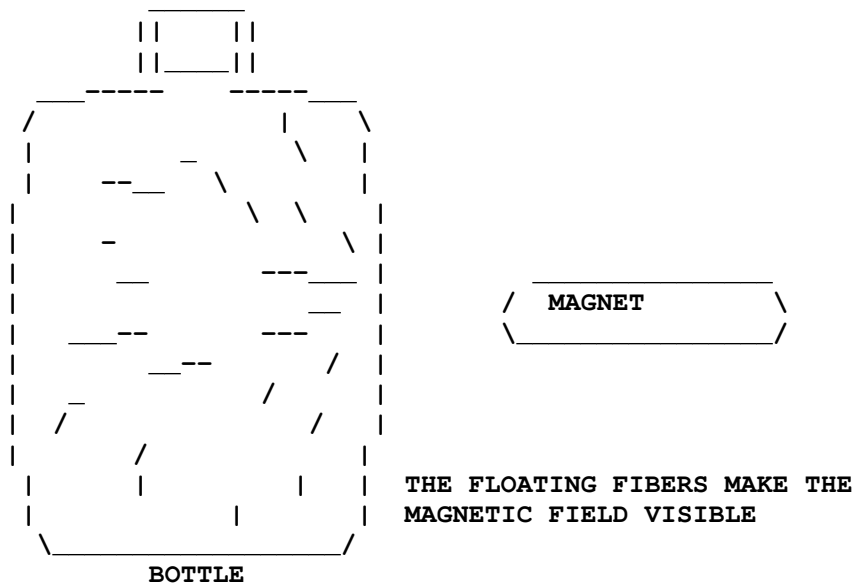


SEEING MAGNETIC FIELD PATTERNS IN 3D

A simple science project

1988 [William Beaty](#), Museum of Science, Boston

Iron filings align themselves in strong magnetic fields. This reveals the shape of the field patterns. A similar thing happens with the electric fields created by high voltage and by "static electricity." If small fibers are exposed to a very strong electric or magnetic field, they will align with the field and make it visible.



3D MAGNETIC AND ELECTRIC FIELD VIEWING BOTTLE

MATERIALS:

- Magnet
- Extra-fine steel wool (type 000 or 0000, hardware store)
- Plastic bottle full of baby oil with paper label
- Scissors
- OPTIONAL:

- rubbing alcohol to remove label
- pan or shallow dish for the alcohol
- White spray-paint, if desired

REMOVE THE LABEL

Make sure to buy baby oil with a removable paper label, NOT the kind with a permanent, painted-on label. Even better, try to find a bottle that has a label only on one side.

If your bottle has labels on both sides, peel the label from one side of the oil bottle. You can do this by picking at the paper label with fingernails while running warm water on it. An easier way is to soak one side of the bottle in a shallow dish of rubbing alcohol for about 10 or 15 minutes. Peel off the gooey label. Use a bit of alcohol and a paper towel to clean off the remaining glue. (It really is easier to find a bottle at the store that only has a label on one side!)

MAKE THE STEEL FIBERS

Obtain extra fine steel wool. This is the kind that looks like a rolled-up wad of grey hair, NOT the kind that looks like a coppery coarse net used for scrubbing dishes. Any grade of wool will work, but extra-fine wool will settle more slowly, so you don't have to shake the bottle so often.

Find the end of the roll, and unroll the steel wool part way. We will use the scissors to make cuts ACROSS the wool. First trim the wool straight across to remove the frayed fibers, then repeatedly cut across the wool to make many very narrow strips, narrower than 1/8 inch. Try to cut them 1/16 inch if you can. This will give you thousands of short steel fibers. Cut up about a heaping teaspoon of fibers, or about one square inch of unrolled steel wool. Don't pack them down too much if you can help it. If you use a really tiny bottle of baby oil, use less than a teaspoon of fibers. If you use too large an amount of fibers, the fibers will clump and settle to the bottom of the bottle too fast. If you use too

small an amount, the fibers will be hard to see.

MIX THE FIBERS INTO THE OIL

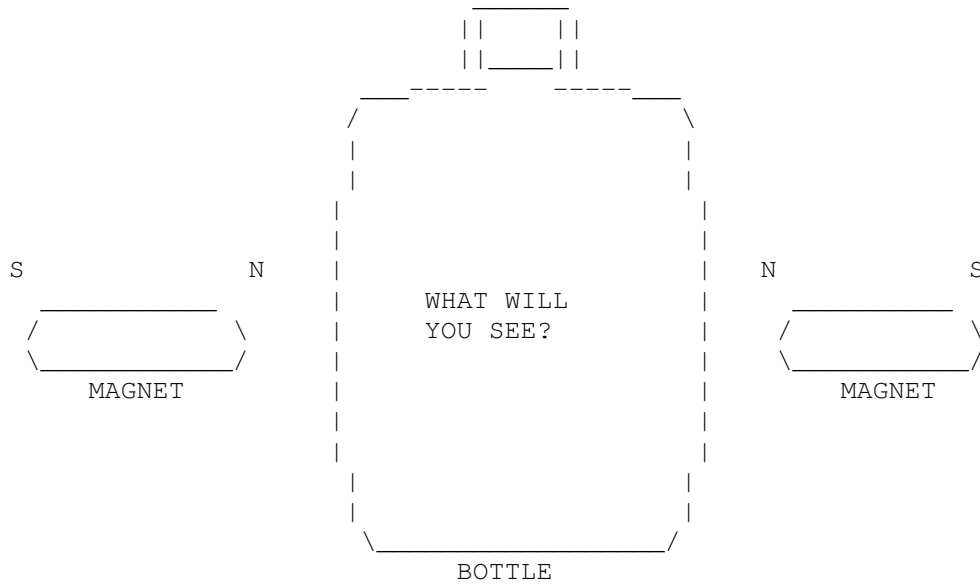
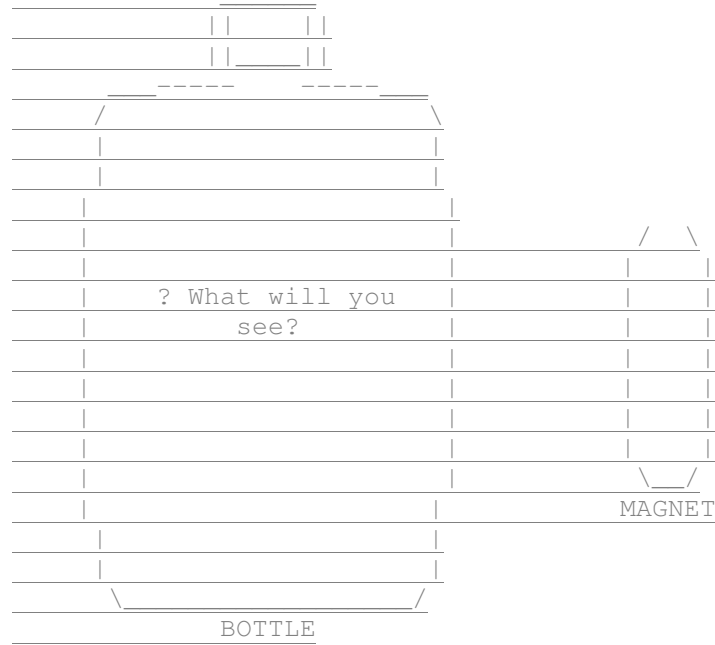
Gently wad up the fibers, drop the wad into the bottle of baby oil, cap it securely and shake the bottle. Shake until the wad of fibers is spread evenly throughout the oil. It helps to shake the bottle with a violent rotating wrist motion rather than just shaking straight up and down. Up-and-down shaking only works if there is a large bubble, rotation-shaking works good even with no bubble at all

If you have difficulty finding a magnet, try Radio Shack stores. They sell small disk magnets which can be stacked up to form bar magnets. A few dollars worth of their 1-inch "donut" disk magnets will be enough to make several big stacks. These can be used in other future science projects. You'll also wind up with a lifetime supply of refrigerator magnets! Don't forget to keep magnets away from credit cards, computer disks and video tapes, magnets can erase these. Keep them away from color TV and computer screens, since they can create permanent color blotches which can only be removed with a TV repair "degausser" coil or a cassette tape bulk eraser. (Hint: wave your magnets around an old Black&White TV screen, see what happens to the picture!)

While the fibers are still mixed into the oil, hold a magnet near one side of the bottle and watch the tiny fibers. They will all align themselves and reveal the three-dimensional magnetic field pattern. It helps to have the bottle in bright light so you can see the tiny fibers against the white label on the back of the clear bottle. The fibers start to settle to the bottom in 10 or 15 seconds, so you'll have to shake the bottle every so often if you want to keep experimenting.

When the fibers settle out, shake them up again. If the fibers clump against the magnet, then you are holding the magnet too close to the bottle. Hold it about 1/2 inch or 1 inch away. Try holding the magnet sideways as shown above. Also try it up and down. Also try holding one magnet pole near each

side of the bottle. Try an "N" pole with an "N" pole (the poles which repel each other.) Also try an "N" pole facing an "S" pole (the poles which attract.)

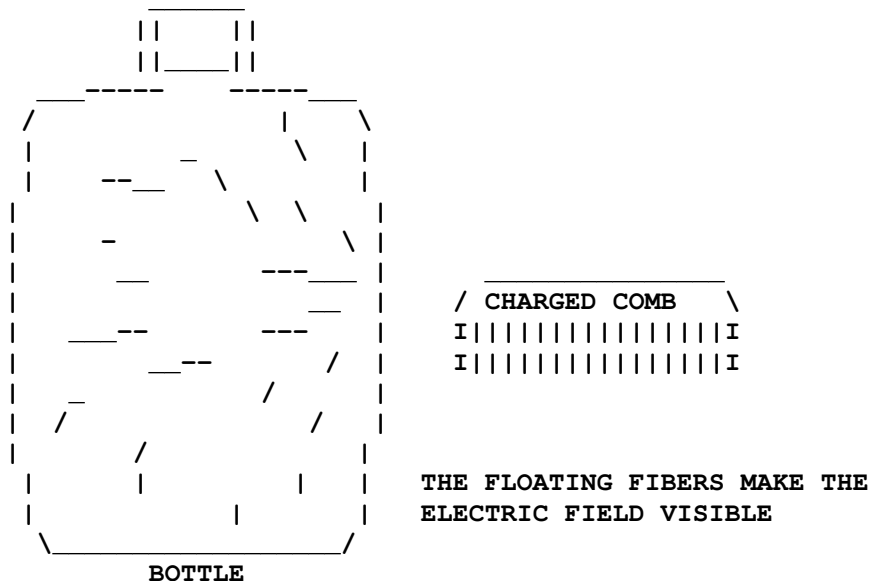


You can improve your bottle by removing all labels and painting one side of the bottle with white spray paint. This gives you a smooth white background against which to

view the floating dark fibers.

ELECTRIC FIELD VIEWING BOTTLE

Magnetic fields can be seen by using steel or iron fibers. Did you know that there is another kind of field besides the magnetic kind? These are called Electric Fields, or e-fields, or electrostatic fields, or voltage-fields. Electric fields exist around any object having an imbalance of electric charge. Rub a balloon on your arm and then use the balloon to make your arm hair stand on end. When you do this, the imbalanced charge remains on your hairs and on the balloon surface. What reaches out from the surfaces and makes the hairs stand up? Electric fields! And while iron and steel can be used to make a Magnetic Field Viewing Bottle, you can use hair to make an Electric Field Viewing Bottle.



Follow the instructions above for making a magnetic field viewing bottle, but instead of using steel wool, use hair! Straight black hair works best. If you don't want to cut chunks out of your hairdo, you can also use the artificial hair from a halloween mask, from an old doll, etc. Use black hair so the fibers are easily seen. Gather a hank of hair, trim the end straight across with scissors, then cut across the hair repeatedly to create thousands of short fibers. Try to make them shorter than 1/8 inch. 1/16 inch fibers are best. Make about one teaspoon of hair fibers, then dump them into a new bottle of baby oil and shake them up.

The E-Field viewing bottle works best with small charged objects like balloons, combs, pieces of cloth attached to plastic rulers, etc. Try combing your hair with a black plastic comb, then hold the comb near the bottle and watch the fibers slowly line up with the spreading field created by

the comb. As usual, charging by contact (friction) only works when the humidity in the room is low.

I've tried the bottle on VandeGraaff machines, but the field from these generators is so powerful that the fibers can become charged if the bottle is held too close. This causes the fibers to stick to the inside of the bottle. There's no way to get the fibers loose again, but if you wait several days they will become discharged and float free.