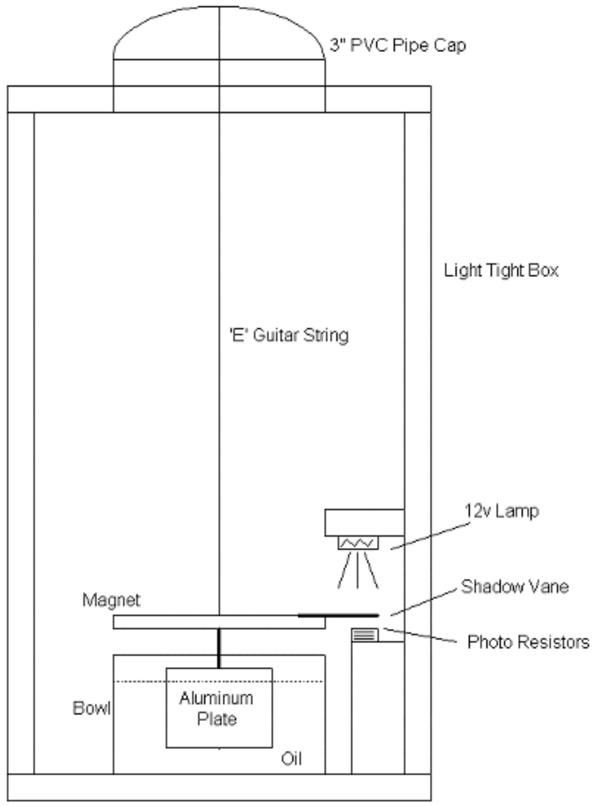
A Simple Homemade Magnetometer for Geomagnetic & Solar Studies
John Blackwell

What amazes me about amateur astronomy is that there is always some project that one can do to keep from being bored on a rainy day! For many years I had been counting sunspots, but it was only recently that I started to actually send the data in to a scientific group. The American Association of Variable Star Observers (AAVSO) has a Solar Division. This group collect sunspot data from over 100 amateurs located around the world. They also publish a monthly newsletter, and it was one of these that caught my eye. In it was a plot of magnetic field changes of the Earth throughout a geomagnetic storm. Even more interesting is that this data was collected using very simple technology, as you will see later on in this article.

Geomagnetic storms are the things responsible for aurorae, magnetic disturbances, and even blackouts. They cause huge amounts of electrical flow through pipelines, the ground, and the various electrical networks that supply power throughout the world. It was one such storm that in March 1989 blew out a transformer in New Jersey, brought down a power station in Quebec and left millions of people without power! Radio communications can be disrupted and satellites can be shorted out or even can be made to fall from their orbits due to the increased drag effects caused by the added density of the solar wind stream. In short, this phenomena should not be taken too lightly in this technological age.

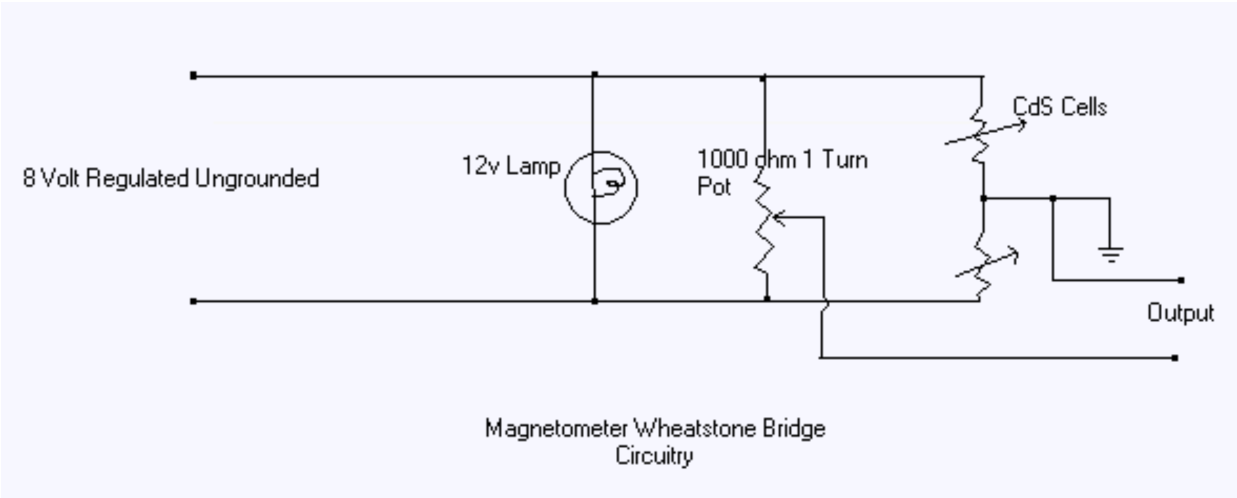
What causes these geomagnetic storms? The Solar Wind. This is a stream of charged particles (electrons and protons) sent through the Solar System by the Sun. Events such as large solar flares and Coronal Mass Ejections send tons of solar wind material into the Earths magnetosphere. With this collision, the Earth's magnetic field changes. These changes, though minute in scale, can be easily picked up by a simple device called a magnetometer.

A magnetometer is basically a very sensitive compass with the ability to capture the amount of magnetic field changes over time. Here is a sketch of the basic layout for the device first mentioned in the AAVSO Solar Bulletin, designed by Jim Mandaville.



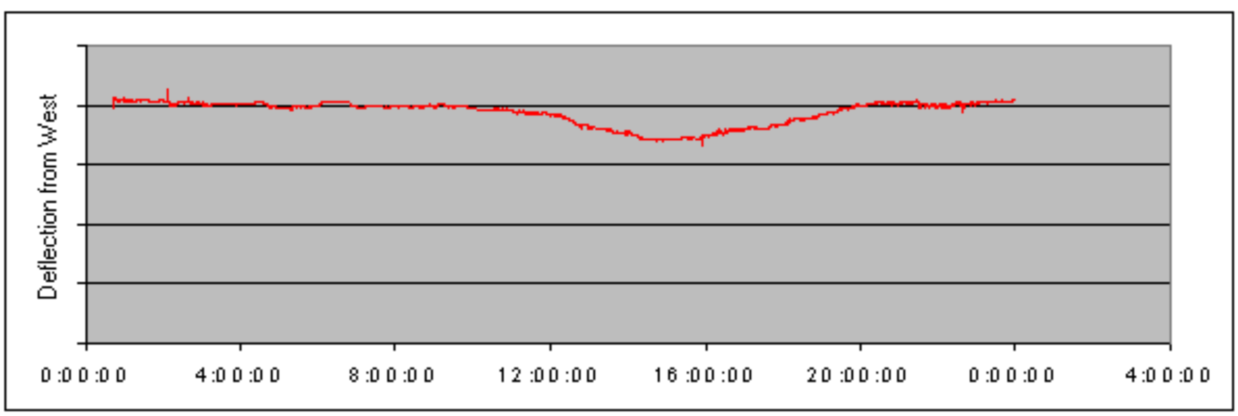
Magnetometer Design

As you can see it is nothing more than a bar magnet suspended by a fine wire. Attached to the bottom of the magnet is a stiff piece of coat hanger wire that has a rectangular piece of soda can aluminum hot melt glued to it. This plate is placed into a bowl of mineral oil. The bowl of mineral oil helps to dampen any wind or vibrational movement in the system. Attached to the magnet is a 1 cm. wide strip of balsa wood that, in combination with a 12v lamp above, casts a shadow upon two Cadmium Sulfide photo resistor cells. These CdS cells are a part of a simple Wheatstone bridge circuit:

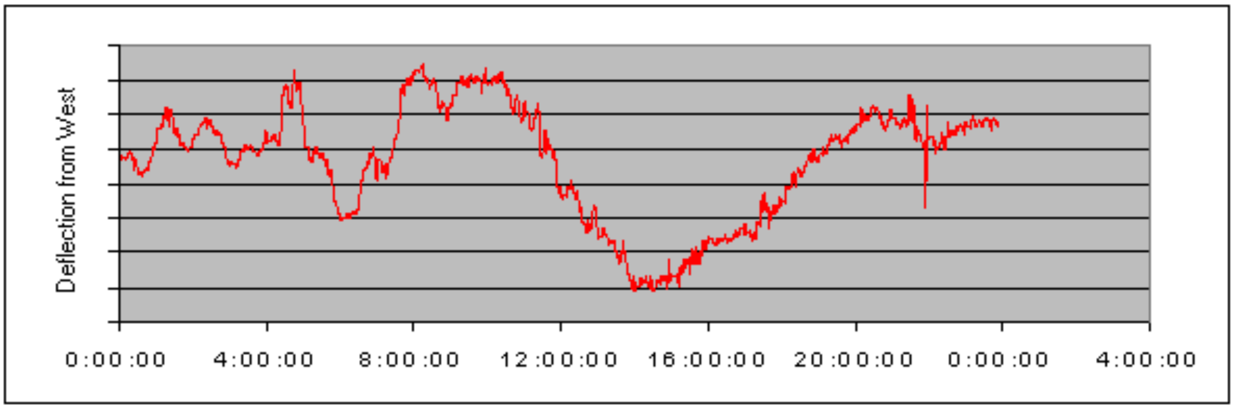


Voltage changes in the circuit originate when the amount of light striking one CdS cell changes relative to the other. The imbalance sends an analog signal out to either a strip chart recorder or to an analog-to-digital converter unit and then onto a computer hard disk. The best way to operate this device has been to place just enough tension in the guitar wire such that the magnet points east-west instead of north-south. This makes it act like a torsion balance, and makes it quite sensitive. Also, if using an A/D converter to capture the data, I have found that taking data off of the circuit every 30 seconds is more than enough. This rate tends to allow for sensitive enough observing and also allows cars to drive by without really effecting the plots.

The results are remarkable, either way. I was able to detect cars more than 200 yards away, which makes for interesting magnetograms. Here is an example from March 18, 1999, a quiet day magnetically speaking. The horizontal axis is Universal Time in hours, and the vertical axis is the amount of magnet deflection from west:



And here is another from March 15, 1999. This chart shows a little more activity. It was snowing very hard that day, and the large spike in the chart at about 2200 UT is due to a snow plow plowing our driveway:



Obviously there is a need to be a bit more scientific about the data being collected. To finish the design, one would have to do further work to calibrate the actual deflection values such that different days can be compared correctly.

Where to Go from Here:

If you are interested in continuing research along these lines, I suggest working with more advanced instrumentation once work with this has exhausted your interest. One can seek out affordable magnetometer kits to build that provide calibratable measurement in one, two or even three axes at once. At this stage, one could begin to predict auroral activity and solar storms.