Physical Science 21

Laboratory

Lab 9: The Hunt for Micrometeorites

Before coming to lab tonight: Read Chapter 6 of Discovering the Essential Universe (3rd ed.), by Neil Comins, especially sections 6-7, 6-8, and 6-9.

Objective: This lab will show that you have a close connection to the Universe, by demonstrating that small amounts of material from space are falling on you all the time, and that this material is quite easy to collect.

On a clear, dark night, far from city lights and with no Moon in the sky, one can see about 6 meteors per hour. Meteors are often called "falling stars" or "shooting stars," because that's what they look like. They are not stars: they are rocks from space, heating up as they plunge into Earth's atmosphere, often at speeds of over 100,000 miles per hour. (A rifle bullet travels at about 3,000 miles per hour.)

During *meteor showers*, the hourly rate can be much greater. Meteor showers happen when Earth crosses the path of where a comet orbits the Sun. Comets are big, dirty snowballs: they spend most of their time in the Outer Solar System. Every so often, a comet comes in close to the Sun. When they do, the ice melts (actually sublimates, or turns directly into gas). This makes the long, gaseous tails for which comets are famous. Comets leave behind plenty of debris, the dust particles and rocks that used to be in the ice. When Earth crosses one of these trails of debris, we get a meteor shower, as the dust particles and rocks plunge into Earth's atmosphere.

Meteor showers appear to come from one point in the sky, called the *radiant*. Meteor showers are named after the constellations in which their radiants appear. For example, the Perseid shower appears to come from the constellation Perseus. The Perseids happen every year, in August: their average rate is about 60 meteors per hour. This may be too slow for some people, but watching meteors under a dark sky is a delight. The best time to see a meteor shower is after midnight, as Earth moves into the stream. Most people, therefore, aren't impressed by meteor showers, because they often do exactly the wrong things when trying to observe them: they try observing them in the early evening, which is the wrong time of night, and under the glare of city lights, which never helps.

Meteor showers can turn into meteor storms, with much higher hourly rates. The highest this author has seen is 3,000 meteors per hour, in the 2001 Leonids. (The Leonids happen

in November, although they won't peak again for another 33 years.) The 2001 Leonids looked like a good Fourth-of-July show. The 1966 and 1833 Leonid showers had over 100,000 meteors per hour: some people who saw them thought the world was ending!

Bits of meteors that survive the passage through Earth's atmosphere and hit Earth are called *meteorites*. Meteors may be common, but meteorites are quite rare. What happens to the materials that make up the bulk of the observed meteors? As early as the 19th century some people speculated that the smaller objects left behind small, microscopic materials that came to be known as micrometeorites These small particles are worn off (or ablated from) larger meteors, which plunge through the atmosphere and melt as a result of the heat generated when the meteors are slowed by Earth's atmosphere. These small pieces quickly cool into spherical shapes and, over a few days, slowly settle to Earth. You can collect your own micrometeorites, and examine them with a microscope.

COLLECTING MICROMETEORITES

In order to increase your chances of finding any micrometeorites, you need to collect material which is likely to have a higher than average concentration of micrometeorites. The roof of a house or building makes a good collector of micrometeorites, since they are continuously falling from the sky. When it rains, the dust, pollen, micrometeorites, and other debris will be washed from the roof and carried to the rain gutters and downspouts by the rushing water. If you check these areas, you will find a very fine powdery material. This fine dust is likely to be rich in micrometeorites. Ordinary dirt does not work as well: it should be fine dust.

Follow the instructions of your lab supervisor in collecting the dust. You can look around the downspouts, in the cracks of the sidewalks, or on the roof of McLane Hall. Use a magnet to pick up this fine dust, to collect any micrometeorites that are high in iron. Smear this dust onto the sticky part of a sticky-note card. Once back in the lab, use a microscope to examine the on the sticky-note card. The micrometeorites will be shiny and spherical, because they were once melted. Other than in meteors, few processes in nature (volcanoes or lightning) are hot enough for long enough to vaporize iron. Any naturally occurring spheres of iron are therefore micrometeorites. Once you find one, try to separate it from the other material using a straight pin or tweezers. Look for more micrometeorites in your sample.

The micrometeorites collected with a magnet are high in iron. A significant fraction of micrometeorites are stony and are therefore not magnetic, so we can't collect them reliably with this method.

(From The Observer, newsletter of the Central Valley Astronomers)

Micro Meteorite Madness at the May Meeting

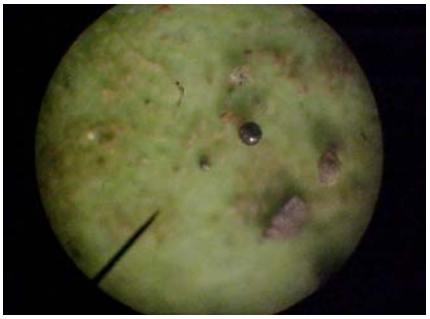
Brian Bellis dazzles a packed meeting with
Miraculous Microscopic Marble-like Meteorite Marvels

Step one:
Get dirt from under a rainspout (a roof acts as a giant collector for micrometeorites)

Step two:
Collect all magnetic particles with a magnet (Note: only the elements iron, nickel, and cobalt are naturally magnetic)

Step three:
Scrape particles from the magnet onto the sticky part of Post-It Notes and examine under low power (10x to 40x)

Step four:
Use lots of light and look for little marble-like spheres

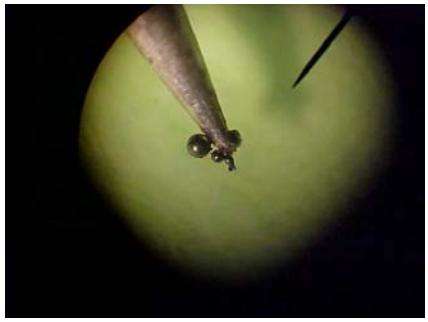


Step Five:
Ignore anything that is not perfectly spherical (40x)

Step Five and a half:
Calmly keep looking…"holy cow look at this cluster"

Step six:
Take a good hard look before telling everybody that you have found some. (Hint: sit close to Don Miller …the micrometeorite King!)

Step seven:
For goodness sake go to higher power (100x)



Step eight:
Play with them, here seen on Paul Lake's needle probe tip.

Step nine:
Slap Brain Bellis on the back and thank him profusely for his great presentation and fun-filled activity.

Lab 9: The Hunt for Micrometeorites

Photos taken with a SONY digital FDMavica MVC-FD75 camera.

Micrometeorites Worksheet

Name: _____ Your lab day: Mon Tues (Circle one)

Lab Instructor: _____ Time: 5:30 p.m. 7:30 p.m. (Circle one)

Number of meteorites found:

Precise places (Where exactly?) where the dust was collected:

Describe, in 2 or more complete sentences, the method for finding the meteorites:
Include Microscope + other tools

What kind are they (Stony or Iron)?

Describe:

-color

-shape

-sizes (use a clear plastic ruler, under the microscope)

-unusual features (e.g. clustering)