Blog

Make a Comet

Posted by admin on January 28, 2013

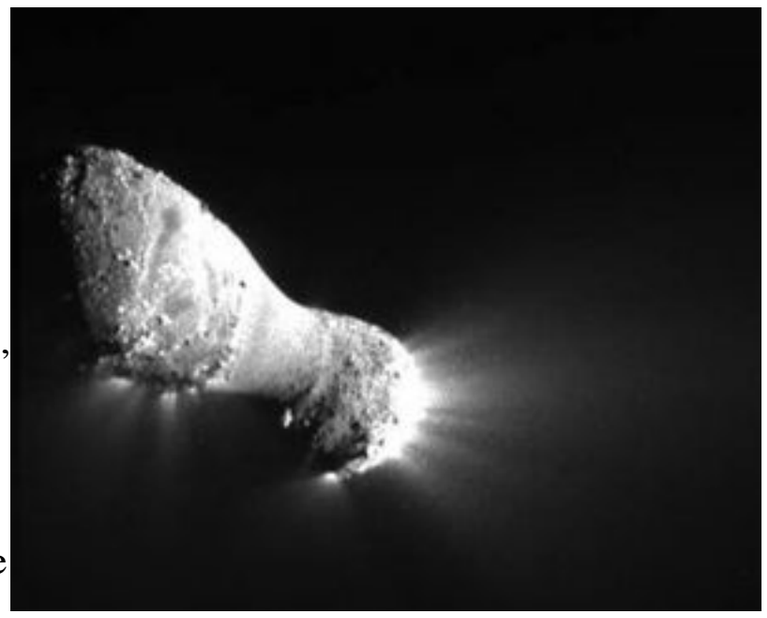
New comets are approaching the sun in 2013, and astronomers are cautiously suggesting one of them, dubbed Comet ISON, could be a gorgeous apparition for the public to see around Thanksgiving. The majesty and mystery of these solar system interlopers appeal greatly to even the most casual skywatchers. My favorite activity to prepare the public for "hairy stars", as ancient Chinese observers called them, is to make a simulated comet from dirt, water, and dry ice.

The comet recipe first formulated by Dennis Schatz is tried and true--a messy frothing stew that is always a crowd pleaser. I encourage you to try making one on your own, then take your show on the road to share with others. Here are some of my tips for crafting the haute of celestial cuisine. Bon appetit!

Background

In June 2011, astronomers announced comet C/2011 L4 (also known by the discovering party's acronym "Comet PANSTARRS"), which would make its nearest pass to the sun, called perihelion, around March 10, 2013. Then, in September 2012 another deep space itinerant was discovered, comet C/2012 S1 or "Comet ISON". It would be zooming over 40 times closer to the sun than PANSTARRS--a mere million miles--on November 28, 2013. If Comet ISON survives its close encounter, some have predicted it may be a dazzling spectacle. Comets are fickle and have a history of frustrating astronomers. Whether these two comets are inspiring phenomena or are visual duds, the celestial denizens will certainly be in the news.

In the early 1950's, astronomer Fred Whipple pegged comets as "dirty snowballs", recognizing they were conglomerations of dirt and ice and other material from the primordial solar system. However, after modern spacecraft visited some comets, the objects were found to be more like "snowy dirtballs" that had extremely dark surfaces, darker than asphalt.



Astronomers have found interesting complex organic compounds in the mix. As the comet approaches the sun from deep space, the dark organic stuff absorbs solar energy and revs up the melting process. After outgassing lessens the amount of ice, a crusty surface of solids remain. Some comets are in elliptical orbits, bringing them repeatedly near the sun. Hence, these recurring visitors may ultimately end up devoid of much ice, a dark finish to their previous careers as visible spectacles.

I believe Comet PANSTARRs may have a parabolic orbit, suggesting this may be its first encounter with the sun and its heat. If so, some of the more volatile compounds in the comet could outgas early during the inaugural warm-up, while it's still out by, say, the orbit of Jupiter. If it poofs away a lot of the volatiles then, PANSTARRS may look prematurely bright and later sputter out. Observers are hoping it instead keeps ramping up in brightness and never lets up. Again, that's the fickle nature of comets that encourages caution rather than hyperbole when predicting ensuing brightness.

Messy Fun

Follow the comet-making activity instructions from *Astronomy From the Ground Up*, in which audience members help you mix cometary ingredients and flash freeze them with dry ice. It is certainly easiest and most manageable if you only make one yourself with the aid of others. However, if you can acquire the supplies and get permission for each person to make his/her own, I encourage you to make a whole batch of them. The fun is too good to keep to yourself. Recently I tried the latter approach with kids from an after-school program at Prairie Vista Elementary School in Granger, IN.

I purchase dry ice either at Meijer's or at a dry ice purveyor found in the phone directory. Remember how rapidly it melts, so your most economical bet is to buy it the same day you intend to use it. When the kids are safely prepared (see Caveat below) it's fun for them to bash the slabs of dry ice with a mallet into a mixture of powder and chunks of ice smaller than golf balls. However, for expediency you may want to do your own smashing in advance and have the prepared ice in a cooler.

With safety always in mind, an efficient method is to have an assembly line with small teams of students at their own mixing bowls. As a group they all mix the solids and water together, stirring often. Then you, the instructor, step in to pour in the dry ice and squeeze the bag, serving only one team at a time while the others watch and wait their turn.

One ingredient at a time, they guess what we were putting into the mix. Make it fun throughout. Rather than say, "This is dirt...", have them put a bare hand into an unlabeled bag and squeeze the contents tightly. Ask, "What is it?", even if it's obvious. To support the "snowy dirtball" findings, I like to have them grab two handfuls of dirt.

Keeping a crowd of kids focused while you're compressing someone else's comet can be challenging. Be ever wary of where the dry ice is stored, for curiosity is a wonderful but hazardous trait. It helps to have an assistant herd the kids so you can focus on the comet literally at-hand.

Though I alone scoop and pour the dry ice, I always have the kids stir the mixture. The subsequent fog spewing from the bag conjures up all kinds of mad-scientist images. Here's a great time to bring out your best Macbeth performance:

Double, double toil and trouble;
Fire burn, and caldron bubble.
Fillet of a fenny snake,
In the caldron boil and bake;
Eye of newt, and toe of frog,
Wool of bat, and tongue of dog...

For safety, I alone squeeze the bag and form the comet's shape until it's reasonably firm. Be prepared to splash some more water into the bag if the mixture is crumbly. Once I sense the comet is well solidified, I call in the participant to help squeeze it further with me. By then, most of the freezing action is done, but it gives them more ownership in the process.

When it's time to reveal the comet, I remind them that a comet is named informally after its discoverer. (More formal names refer to the year and the number of the discovery. Again, Comet ISON is actually C/2012 S1.) I ask the student his/her name, and as they peek inside, grab the glob, and pull it out, I announce with great fanfare, "Ladies and gentlemen, I present to you Comet (Kid's Name)!"

If the comet seems to be a failure with multiple fractured pieces, don't despair. Suggest that's what may happen to comets in reality as they sometimes break up. A stunning example was Comet Shoemaker-Levy 9, which broke into a "string of pearls" that sequentially smashed into Jupiter in 1994. The resulting splotch marks on Jupiter were one of the most impressive sites I've ever seen with my telescope. Perhaps Comet ISON will be torn apart by the sun's gravity during its close encounter. We don't know.

Comets Are Deceiving

If your audience is large, a good way to show the outgassing is to place the comet on an overhead projector. (To prevent issues of cold ice on heated glass, you may want to insert an intervening base for the comet that raises it off the surface, like a petri dish.) The projected vapor will look dark and wispy, but you can blow gently to simulate solar wind making a tail.

That solar wind is an outpouring of charged particles from the sun, which can be simulated with a fan around which you walk your homemade comet. It's important to note the tail is always blown back away from the sun; hence, you can never really tell from a picture what direction the comet is traveling. While the comet is inbound toward the sun, the tail streams out behind its direction of travel. However, as it rounds the sun and travels back out into deep space, the comet actually leads with its tail, like a person with long hair walking with the wind to her back. You can preface this notion with a photo of a comet and ask, "Which way is this comet traveling?" It's admittedly a trick question. Without reference to the direction of the sun, you cannot tell the direction of motion, only the direction to the sun.

As mentioned, comets are notoriously fickle. Astronomers heralded Comet Kohoutek in 1973 as the comet of the century, but it never brightened enough

to meet public expectations and was a major letdown. Frankly, we don't know how PANSTARRS or ISON will pan out. To convey the unccertainty, give each participant a 3x5 card with "Good" written on one side and "Not Good" printed on the other (or use your choice of words). Ask them, based on what little they really know about the predicted comet, whether they think the comet will be visibly a good show or not. Have everyone place their cards on the table with their prediction face-up, and tally results. Next, have everyone hold their card at shoulder height and drop them to the floor on the count of three. Again tally the results. Suggest the odds of a good sighting for the two big comets of 2013 are somewhere between their best guess and the random drop. Basically you want them to know it's not a certainty.

Caveats

Creating a comet in the classrom is a fun, messy, hands-on affair, but it does require safety precautions. Rather than being a cause not to do engaging science, the hazards are a great teaching opportunity.

For example, before introducing the ingredient ammonia, we discuss the issue of how to smell mixtures in a chemistry class. You never want to put your nose over a liquid and sniff hard. Ask them to suggest alternative techniques. I show the students how to wave a hand gently over the container to get a waft of the compound, and one by one we pass the container down the line and practice. The ammonia I use is blue window cleaner, whose odor I have them describe and guess what it is.

Of course, the activity opens with a description of the hazards of dry ice, which is carbon dioxide that is frozen to a temperature below -109 degrees Fahrenheit. Anyone near or handling dry ice needs gloves to prevent rapid freezer burn. When it comes time for mixing the dry ice in water, I prefer to choose students wearing long sleeves, if possible, just to minimize skin exposure.

All participants need eye protection, for dry ice compressed in a bag of water tends to spatter unpredictably. That volatile tendency is also why the instructor should be the one to squeeze the freezing mixture initially. Make enough comets and you'll see you sometimes have only frosted vapor pouring out of the bag, but other times bits of ice, dirt, and water will unexpectedly spill out onto the table. It's good theater, but a mess.

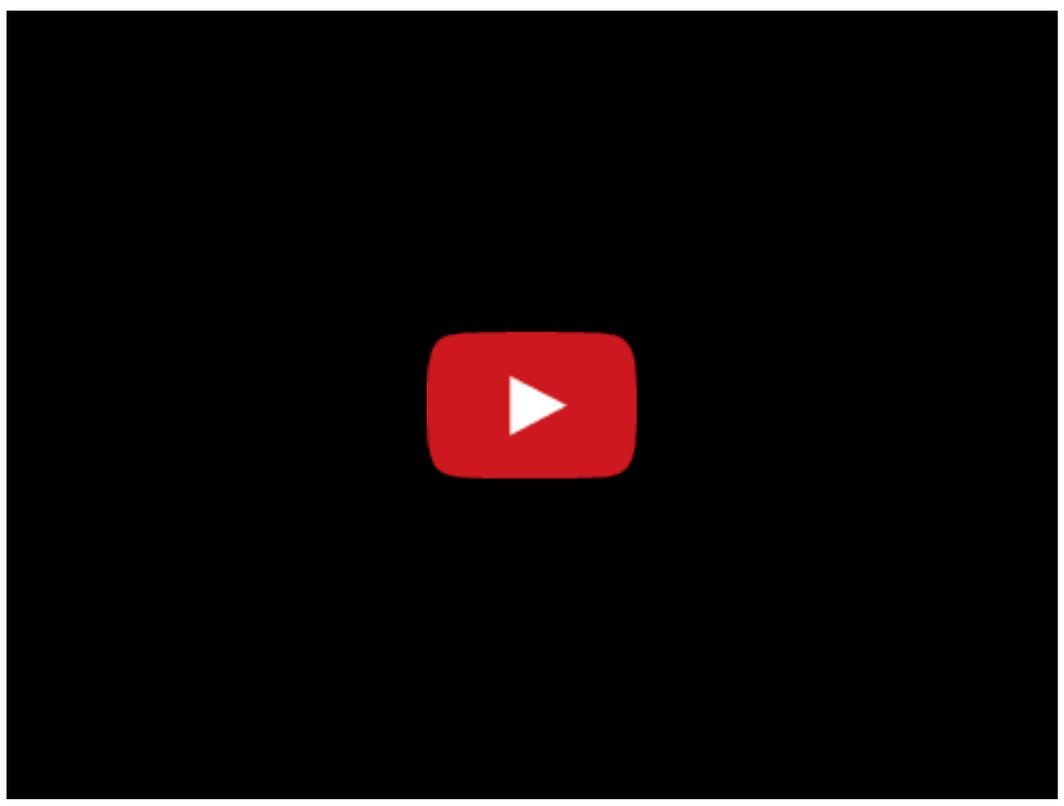
After the comet is made, the instructor can rolll the finished product around in his/her hands to show how the extreme dry ice and relatively warm water have become a very cold but manageable piece of water ice. That said, there may be some chunks of unmixed dry ice in the cometary amalgam, so I don't let kids handle the finished product with bare hands.

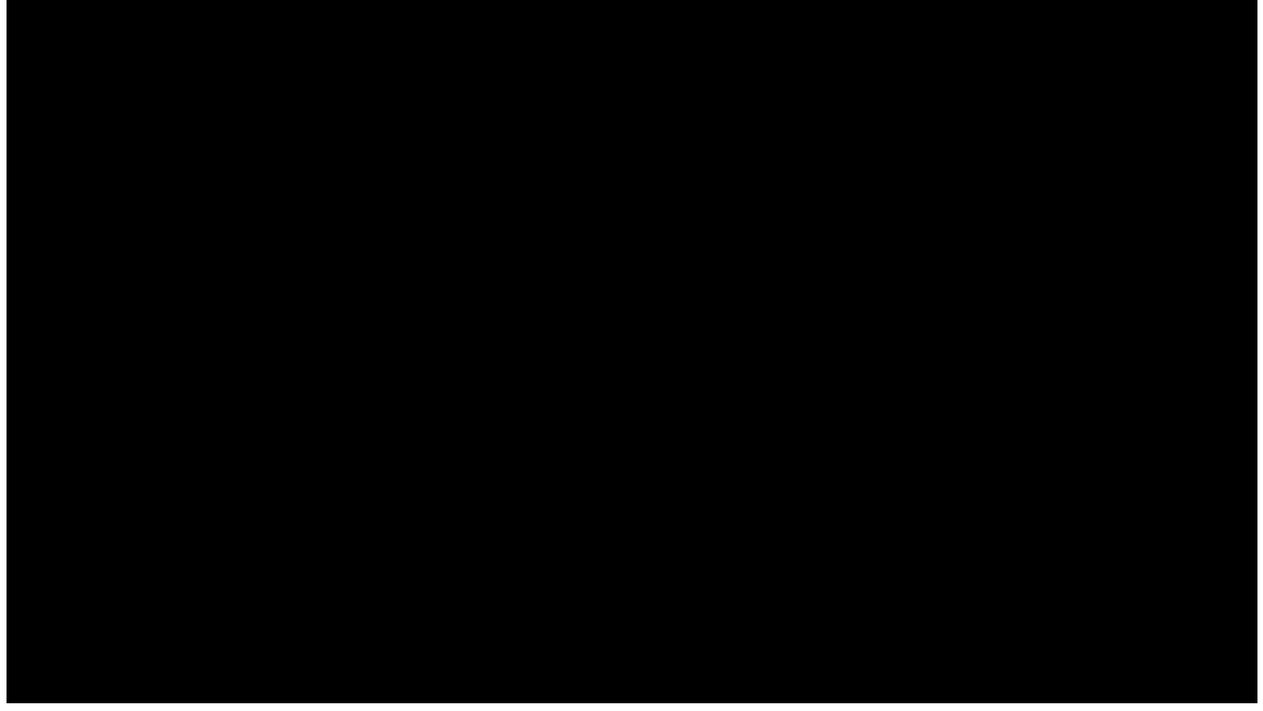
If you put the outgassing comet in a freezer bag for the student to take home, do not zip it up completely. You can, briefly, to show how the outgassing inflates the bag, but the bag may fully expand and loudly pop if you seal it.

Go forth and enjoy making your own comets. Our next solar system recipe will be primordial soup.

Two videos, below, were added to this article in September 2013. First, host Gordy Young of Experience Michiana makes a dry ice comet on a YouTube video provided courtesy of WNIT Public Television.

The second video shows a rare plume of vapor outgassing from a dry ice comet during a demonstration with teachers from the South Bend Community School Corporation. Very cool feature, comparable to what may happen on real comets.





Outgassing Plume Observed on Dry Ice Comet from Chuck Bueter on Vimeo.

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