

## Air and Space this Week Item of the Week

### Phaethon and the Geminids

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**KEY WORDS: 3200 Phaethon Geminids Parent body Active Comet**

No, I'm not promoting a new musical sensation! This week's Item is about the Geminid meteor shower, usually the second-best of the year (after August's Perseids), and their parent body, the unusual *asteroid* 3200 Phaethon. The Geminids are occurring now (the shower has a very broad peak), with the maximum ZHR (potentially as high as 120 or so) the nights of December 13/14 and 14/15.

#### Phaethon, the object

A year ago, I used the cleaning out of my garage (which, alas, I must do again soon) as an analogy for Pluto's "demotion" and the possible (still-pending?) "promotion of asteroid 10 Hygeia from "asteroid" to "dwarf planet." ***I will include it as the last item in the archived version of this Item if you want to be reminded of my garage.*** **Docents/Teachers:** The garage/nomenclature analogy is a good way of demonstrating how this thing we call "Science" is iteratively self-correcting.

In the same way, 3200 Phaethon is a good example of how astronomical definitions are forced to evolve over time as more knowledge is gained.

3200 Phaethon is relatively-large object, on the order of 5 miles across. It is an Apollo class asteroid, meaning that its perihelion is inside Earth's orbit and its aphelion is outside Earth's orbit. Not all Apollos are dangerous, but, since they cross Earth's orbit, some are. Including Phaethon. It's listed as a "Potentially Hazardous Object," but its orbit is quite well-known and Earth is safe for a number of centuries to come.

3200 Phaethon looks like an asteroid and its reflectance spectra contains some elements consistent with it being a relatively normal F-type chondritic body. It has a very elliptical orbit, and it approaches the Sun closer than any other known natural object (0.14 AU – half of the Sun-Mercury distance!). The fact it passes so close to the Sun at times earned it the name it bears. In Greek mythology, Phaethon was the son of the Sun god, Helios. Phaethon got to drive the Chariot of the Sun, with rather disastrous consequences (see section below).

However, 3200 Phaethon has some characteristics more common to comets than asteroids. Its highly-elliptical orbit is not diagnostic, because both comets and some asteroids have them. But 3200 Phaethon is quite blue in color, unlike almost every other asteroid. Its spectrum also reveals ammonia, a somewhat volatile substance, especially when close to the Sun. More tellingly, NASA's *STEREO* satellite images of Phaethon showed it to have a faint "tail" of dust when near the Sun, leading it to be called a "rock comet" when the tail was first discovered.

3200 Phaethon reached perihelion on December 7, only 0.14 AU from the Sun, but it is much too faint and too close to the Sun in the sky to be seen. Interestingly, the excellent comet information website, [aerith.net](http://www.aerith.net), treats 3200 Phaethon like it does comets; see: <http://www.aerith.net/comet/catalog/A03200/2020.html>.

Fred Whipple, of recent mention here for his research, including the “Whipple Shield” and “Dirty Snowball” model of comets. He was the one that was able to link 3200 Phaethon with the Geminid meteor shower. It was the last of the larger annual meteor showers to have its parent body identified; all of the others are comets.

So, if a comet can be likened to a “dirty snowball,” I wonder if Whipple would liken Phaethon to a “snowy dirtball.” It is likely a comet that has lost most of its volatile component during its close passages to the Sun.

3200 Phaethon does not fit the traditional view of asteroids and comets well, so a new term was needed. It is the largest of what are now termed “[active](#)” asteroids. [133P/Elst-Pizarro](#) (a cometary designation, unlike Phaethon’s, is another. A total of 39 active asteroids have been discovered so far.

Phaethon’s orbit does not intersect Earth’s, but “[close](#)” approaches are possible. The next such will be on 12/11/2050, when it will pass about 6 million miles away. The closest approach for the next 200 years is on 12/14, 2093, at ~2 million miles. Incoming speed would be on the order of 20-25 miles *per second*... Five miles across and much faster than a speeding bullet; that’d leave a bruise somewhat larger than the one received by Mrs. Hodges of Sylacauga!

### **The Geminids Meteor Shower**

Meteors can appear sporadically, impossible to predict. But meteor showers are a different matter. Meteoroids comprising the “showers” we see are bits of rocky debris shed by comets as their more volatile components sublime away when they are near the Sun. They slowly spread along the orbit of their parent comet (or in this case, “active” asteroid). If the Earth intersects the meteoroid stream, it gets hit by a large numbers of ex-comet particles. Since the particles are in essentially-parallel trajectories, they appear to radiate from a specific point in the sky (perspective is responsible for the radial pattern; their apparent paths more-or-less align with a central “vanishing point.” In this case, the radiant lies in the constellation Gemini, hence, meteors of this shower are called “Geminids.”

The Geminids shower rivals the Perseids as the year’s best. The Moon interfered somewhat with the Perseids last August, but is in perfect position (total solar eclipse) for unimpeded Geminids viewing now.

The ideal viewing time is during the wee hours of tomorrow morning. Imagine the Earth and Sun as viewed from over the North Pole. The Earth is spinning counter-clockwise, and is orbiting the Sun counter-clockwise. That means that in the first half of the night, one would be looking away from the Earth’s motion around the Sun. Any meteoroid coming in is in a “stern chase,” having to catch up to hit us. After midnight, the Earth rotates the observer onto the

leading hemisphere of the Earth's motion. Meteoroids coming in are coming at us. You get more bugs on the windshield than on the rear window....

So, if the weather is good, be a night owl for once and go out **TONIGHT** around 2 AM or so. You ought to be able to find Orion, marked by his three-star belt. Look above him to see two bright stars close to one another, Pollux and Castor in Gemini. Find a comfortable spot, lie back, and watch that part of the sky. You can realistically expect to see a meteor every four minutes or so. Because of the orbit of their parent, 3200 Phaethon, Geminids have a fairly-high speed of approach, making them move across the sky more quickly than with other showers.

### **Phaethon, the Namesake**

Phaethon was the son of Helios, the Sun God, and Clymene, one of the Oceanids, daughters of the Titans Oceanus and Tethys. He lived in the court of King Merops, Clymene's husband. He got teased a lot about having only a step-father, so Clymene confided to him that Helios was his actual father. Her admission did not raise Phaethon's low self-image, but it did increase his already-staggering over-confidence in all things.

Phaethon sought out Helios to ask for proof he could show his friends that he was, in fact, the son of Helios. He explained his feelings to dear old dad, who felt a small and brief amount of guilt about being an absent parent. But that was enough for him to blurt out without thinking that he would, by the River Styx, give Phaethon "anything" as proof of his parentage.

Big mistake. Zeus was glad to delegate to Helios the driving of the Chariot of the Sun. Good choice, because Helios was the only god, including Zeus, to be able to handle the extremely-difficult Solar Horses that drew the Chariot. But the over-confident and under-loved Phaethon immediately responded that he wanted to drive the Chariot for one day. Helios was honor-bound by his oath to Styx to comply. He tried to talk Phaethon into something less dangerous, but to no avail.

There was room for only one in the Chariot, so young Phaethon would be on his own. Not even Zeus himself could control these Horses. What could go wrong?

The Horses were particularly rambunctious on the fateful morning. Phaethon impulsively grabbed the reins, and the Horses were off. Phaethon was barely hanging on, and the Horses, feeling no firm hand on the reins, ran wild. They soared much higher above the Earth than normal, freezing large areas of the Earth below. They dove steeply and flew fast and low, searing the Earth and creating the Sahara Desert, still standing, er, sanding, today. "Great cities perished" and "whole nations with their people were consumed to ashes." Quotes from [here](#).

Zeus was observing from Olympus, and realized that Phaethon's erratic flight must be stopped immediately. Helios could do nothing, nor could any of the other Gods. Zeus had no choice. He unleashed a thunderbolt, knocking Phaethon off the Chariot to fall to his death in the River Eridanus (Po) below.

The Horses, feeling the loss of weight in the Chariot, headed for the barn, and the main threat to the Earth and its people abated. Terrible damage had been done, and was compounded

when a distraught Helios refused to drive the Chariot for several days. The other Olympians pleaded with Helios to reconsider, and he eventually went back to his daily routine.

Phaethon was cursed by many survivors of his folly, no doubt. But there were some that mourned him. His significant other, [Cycnus of Liguria](#), was one; he was turned into a swan and placed into the sky as the constellation Cygnus. Phaethon's seven sisters, aka [the Heliades](#) (not the Pleiades) did, too. They mourned so hard and so long that they were turned into a grove of poplar trees. Amber, well-known to the Greeks, were the tears his sisters shed.

One of the brighter stars in our sky is Capella, the lucida of the constellation of Auriga, the "Charioteer." Like Pollux and Castor in Gemini, Capella lies near Orion; find it by extending ahead a line across the top of the bowl of the Big Dipper.

But who is this "Charioteer?"

One story is that the constellation represents one of the sons of Hermes, Myrtilus, a pretty [rotten guy](#) who, in one story, is claimed to be Clymene's son, thereby Phaethon's half-brother. Another says the Charioteer is [King Erichthonius](#) of Athens, another not-so-nice guy. And yet another story says the constellation honors Orsilochus of Argo ([Trochilus](#)), the inventor of the four-horse chariot.

And one story, the one I like, says the Auriga *is really Phaethon*. The theme of the whole story is about the peril of hubris.... And perhaps the danger of a promise.

Phaethon may or may not be commemorated in the sky, but he certainly is in art and literature. For example:

- "The Fall of Phaethon" statue by Dominique; Lefevre Wikimedia [here](#)
- Phaethon and the Heliades Roman History Books webpage [here](#)
- "Then Phaethon beheld the world on fire, and felt the heat intolerable. The air he breathed was like the air of a furnace, and full of burning ashes, and the smoke was of a pitchy darkness..." [Bulfinch, 1897](#)
- More [here](#)

Some story, huh? It accounts for the constellations of Eridanus (where Phaethon fell), Cygnus, and perhaps, Auriga.

Below is a repeat of the Didja Know segment (A+StW, December 2-15, 2019 installment) I cited above, about how cleaning out one's garage is a good example of the self-correcting nature of scientific inquiry:

Sometimes I use this segment to have a little fun with obscure facts and connections. However, this week, I want to expand on the role of classification in the process of scientific inquiry, in light of the likely upcoming change in status of asteroid 10 Hygiea to "dwarf planet."

I'm inspired by my messy garage. That's right, my garage.

Moving into this home recently required lots of re-arrangement of stuff, and I am dreading taking on the task of getting my new garage in shape. Things have been tossed in somewhat

haphazardly, and I have a difficult time finding things. I'll wait until spring cleaning time to take this task on, but let's think for a moment about how I'll need to go about it.

My first step will be to remove all of the stuff from the garage, so I can clean the basic place properly. While doing so, I'll put like things in separate piles, so re-loading them can be done in an organized way. Going in, I know ahead of time that some items will go in the "lawn/garden tools" pile, some will go in the "other tools" pile, and a lot will go in the "books and rocks my wife won't let me keep in the house" pile.

I imagine that, as the unloading process progresses, I'll find some items I'll want to save that do not fall into one of my pre-conceived categories. I'll have to establish new piles to accommodate such discoveries. Then I can finish up by loading each pile to its new and proper place in my imagined all-clean garage.

Classification of Solar System bodies has proceeded similarly. Back in the day, all we knew of was "planets," objects that wander in the sky relative to the "fixed" background stars. When the telescope was invented in 1608 and turned to the skies by Galileo, Jupiter's four large moons were quickly discovered. Now we had to add a new category, "moons," to accommodate all known bodies. Not long after that, objects much smaller than known planets and moons were discovered, mostly lying between Mars and Jupiter, so we had to add yet another category, "asteroids" to have a logical place for all known Solar System objects ("asteroids," aka "little stars" was a lousy term, as they are definitely NOT stellar!).

***So, adding categories to one's classification scheme as new items are discovered is the natural consequences of both garage cleaning and Solar System study, and indeed, of all classifications, one of the first steps in the process of inquiry.***

Pluto had always been an "odd duck" among planets. It was quite small, its orbit is inclined from the Plane of the Ecliptic by a large amount, and its orbit was elliptical enough for Pluto to be closer to the Sun than Neptune over part of its orbit. But when other objects were found in Pluto's neck of the woods, it became clear that yet another class of objects was needed to accommodate them, now called "dwarf planets." No rational scheme of classification could keep Pluto as a planet and yet not include its other Kuiper Belt companions. Worse, no classification scheme could keep Pluto a planet and not include the (former) asteroid 1 Ceres. So nine planets was not an option; it had to be either eight or "many." The [IAU chose](#) to make the new classification, and Pluto got "demoted" as the natural consequence of our learning more about the diversity of objects in the Solar System, not some diabolical plot to deny Mickey's dog his rightful place in the heavens. [Hey, just change "My Very Educated Mother Just Served Us Nine Pizzas" to "Most Very Economical Misers Just Serve Us Nothing."]

Hygiea's change in status is for similar reasons. And thus, Science Marches On!

Alas, I still gotta get to that messy garage...

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