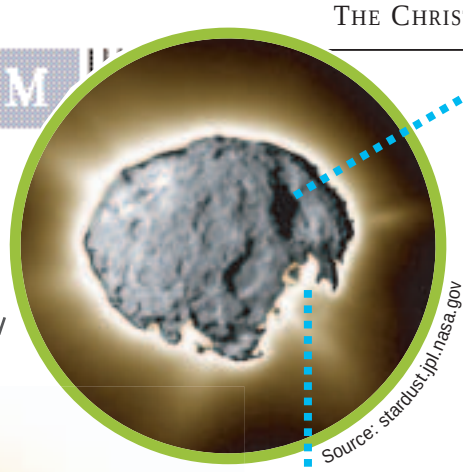
The comets are coming!



Source: stardust.jpl.nasa.gov

Up close
NASA's Stardust spacecraft took this composite picture of the nucleus of Comet Wild 2 in January as the comet overtook the craft and streaked past. Note the pitted surface of the comet's three-mile-wide nucleus and the jets of gas (mostly water vapor) emerging.

Unsteady ground
As a comet approaches the sun, the sun heats it up. Ice and frozen gases underground turn to gas. Pressure builds, weak areas of the surface give way, and the gas shoots out in jets, taking dust with it.

SCOTT WALLACE – STAFF

Two comets are swinging by Earth's neighborhood this month – visitors from beyond Pluto. They may be leftovers from when our solar system first formed.

A PAIR OF "dirty snowballs" are about to appear in a twilight sky near you.

Over the next month, our solar system is treating us to two visits from comets. Both may be visible to the naked eye – and surely with binoculars.

And that's not all the comet news. Last January, a small United States spacecraft named Stardust swept through a comet's cloak of dust and gas to collect samples of this material. Stardust – now working its way through the asteroid belt between Jupiter and Mars – is speeding back to Earth carrying comet dust for scientists to study. It's expected to drop its package of samples into the Utah desert in two years.

Meanwhile, scientists in Europe are tracking a comet-chasing spacecraft named Rosetta. They launched it in March. It won't meet up with a comet until 2014. But if everything works as planned, Rosetta will orbit the comet for about a year to study it. It also will send a lander to the comet's surface. This will give astronomers a rare look at a comet's core, or nucleus.

Why all the high-tech, high-priced interest in comets? These hefty clumps of dust and ice are thought to be the leftover material from which the planets formed some 4.6 billion years ago. By studying them, scientists hope to learn more about the huge disk of dust and gas that surrounded the sun before the planets began to assemble themselves – a bit like cosmic dust bunnies – from this material.

Examining solar system 'leftovers'

Studying comets in our solar system also is helping astronomers understand what they see when they look at nearby solar systems. (So far, planets the size of Jupiter or larger have been detected in orbit around some 60 nearby stars.)

Three years ago, for example, astronomers in the US found that a red giant star 500 light-years from Earth was surrounded by water vapor. What was the water vapor doing there? The star was too rich in the wrong kinds of elements to generate an envelope of water vapor. The astronomers concluded that the vapor must have come from comets and other icy objects. (As the star matured and expanded into a red giant, the astronomers theorized, it vaporized the comets. Our sun will expand into a red giant, too – in about 5 billion years.)

In our solar system, comets buzz around the sun, starting from two vast regions. One is the Oort cloud, named for a Dutch astronomer who first suggested that such a cloud existed. This "cloud" surrounds the sun in the farthest frontiers of the solar system. Its inner limit lies far beyond Pluto – some 50,000 Astronomical Units (AU) away. (Astronomers use AUs to measure some distances in space. One AU is the distance between Earth and the sun, or 93 million miles.) Nobody knows for sure how many objects the Oort cloud contains. It's too far away and the objects are too faint and small to see.

Astronomers figure that these Oort-cloud objects probably formed near Neptune and Uranus. The gravity from these planets probably kicked the "planetesimals" (planetary building blocks) out of the neighborhood. Some theorize that the Oort cloud represents only from 1 to 10 percent of the planetesimals ejected by Neptune and Uranus. The rest hurtled into deep space.

Comets that enter the inner solar system from the Oort cloud originate in the cloud's farthest reaches, where the sun's gravity is weaker and the comets may be tugged by the gravity of passing stars or the vast clouds of gas and dust that move between the stars. These comets can take from 200 to several thousand years to make just one round trip around the sun. David Jewitt, an astronomer at the University of Hawaii, says the best estimate astronomers have is that the Oort cloud contains around 1 trillion objects. The comets visible this month are thought to have come from the Oort cloud.

A second "home" for comets is the Kuiper belt. It's named for another Dutch astronomer (what is it with the Dutch and comets?), who deduced its existence. It lies like a flattened doughnut at a distance of from 30 to 50 AU. Here, at least 100 million objects larger than .6 mile in diameter are thought to orbit the sun. Halley's comet, one of the most famous, originates here.

These close-in comets, which orbit the sun once every 200 years or less, include Stardust's target: Comet Wild 2. During the craft's comet encounter in January, it snapped some great photos of Wild 2's nucleus. "The images are quite spectacular," says Thomas Duxbury, the mission's project manager at Cal Tech's Jet Propulsion Laboratory in Pasadena, Calif. (We've reproduced one of them above.)

The nucleus, he says, looks like a hamburger patty with a bite or two taken out of it. It's a big oblong burger – measuring about 3.4 miles long, about 2.5 miles wide, and 1.9 miles thick. The comet overtook Stardust from behind, coming to within about 148 miles of it.

A close encounter, a close call

It was a wild ride. Dust particles and spacecraft collided at bulletlike speeds. Stardust gave its earthbound handlers a few tense moments during its closest encounter, which lasted tens of minutes.

The spacecraft is shielded with three layers of material, each acting like a bullet-proof vest. Each layer has its own dust counter so engineers can see how well the shields are performing. Roughly a dozen particles about an inch across punched through to the second shield. The systems that help keep the craft stable and the shields pointed toward the oncoming stream of dust worked extra

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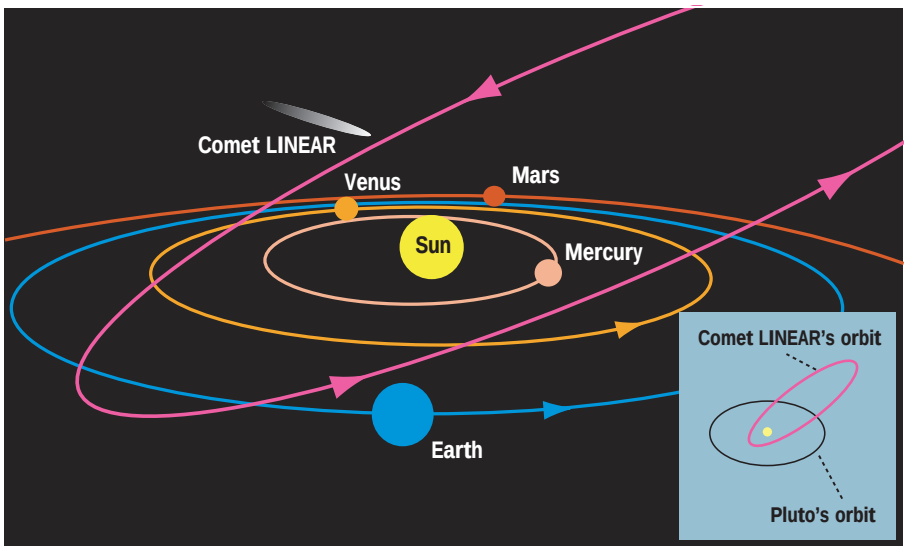
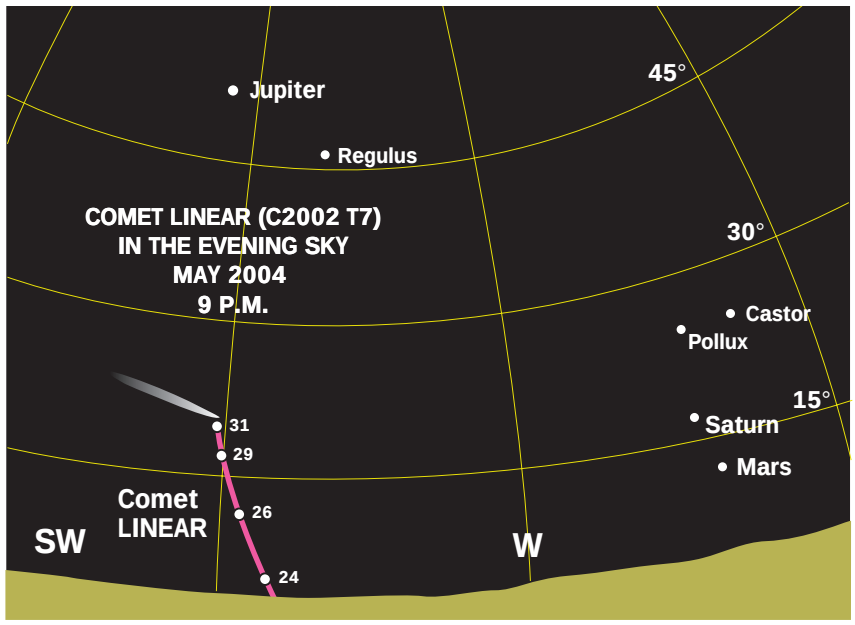
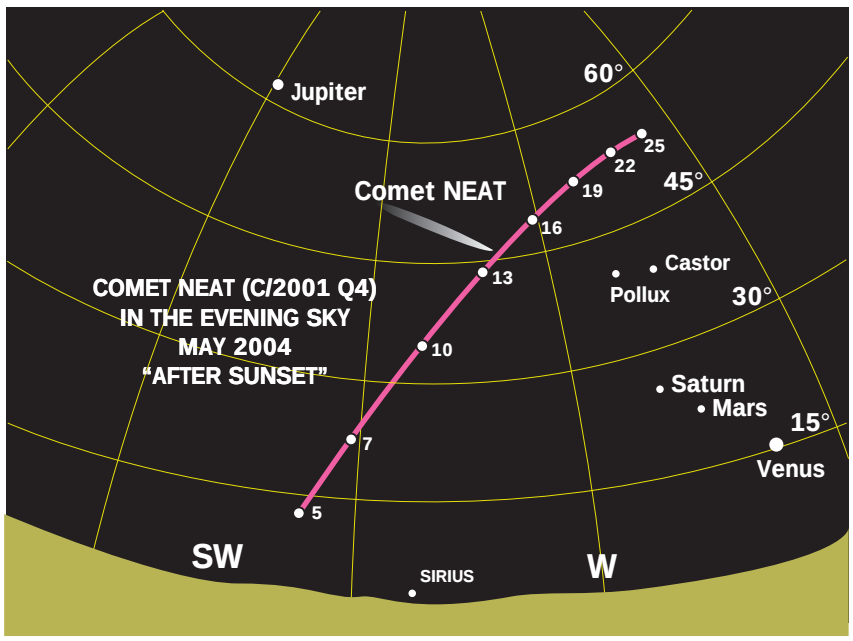


Source: Chandra.harvard.edu

SCOTT WALLACE – STAFF

WILD RIDE: Unlike comets LINEAR and NEAT, the Wild 2 comet encountered by the Stardust spacecraft originated near Jupiter, in the Kuiper belt. Stardust got to within 150 miles of Wild 2 and was pummeled with debris, but its shields held.





Source: Griffithobs.org SCOTT WALLACE – STAFF

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hard to keep the craft from becoming a tumbling hunk of hardware.

"We did hold our breath a little bit," Mr. Duxbury says. But once the craft had passed safely through the coma – the halo of dust and gas around the nucleus – "of course we told everybody we knew it would work all the time."

Special gel-filled collectors swept up some of the comet dust while the spacecraft's camera snapped away. Where movies like "Armageddon" (1998) show a nucleus with jets of gas erupting all over the place, Stardust found only a couple of dozen. Even that was a surprise, since the team only expected one or two. As the sun heats the nucleus, subsurface ice and frozen gases vaporize, spewing through the surface. The gas and dust form the coma and tail. Wild 2's surface was remarkable, Duxbury says. "We were seeing bedrock – the actual solid surface."

They also saw stair-step formations on the surface, as well as spires that appear to be from jets of dust and gas that long since have shut down.

If Comet Churyumov-Gerasimenko, Rosetta's target, is like Wild 2, the European probe should have no trouble finding a landing spot.

Peter N. Spotts

How and where to look

IF YOU want to watch this spring's cometary extravaganza, grab a pair of binoculars. Binoculars will help you see the comets if they don't get bright enough to spot with the naked eye.

Try to find an observing spot with a low horizon. If that's your backyard, great! Otherwise, look for a nearby hilltop or a big park where the treetops appear low in the distance.

Set your alarm clock to see LINEAR. In early May, that comet should appear about an hour before sunrise just above the eastern horizon. If you miss it, don't despair: LINEAR will reappear in the southwestern sky at twilight in late May (as shown on the chart above).

You can watch comet NEAT in the evenings, starting around May 5 or 6. It should appear at the end of twilight, just to the left of Sirius, the "dog star."

Use the sky charts above to find out where to look for the comets on a given date. (Charts are also available at: **skyandtelescope.com/observing/objects/comets/article_1229_1.asp**.)

Scan the indicated part of the sky slowly to spot the comet. If the comet appears faint, shift your eyeballs (not your binoculars!) slightly to one side. This should give you a brighter view.

P.N.S.