Deep Impact

Your Comet Catcher Guide

Observing Tempel 1 and Deep Impact

WHERE CAN DEEP IMPACT BE SEEN FROM?

For observers in North America, Comet Tempel 1 is currently visible with a telescope soon after dark on any clear evening. It looms low in the southwestern sky in the constellation Virgo.

For skywatchers in North America, only those in the far western reaches will be positioned to see the comet during impact. For everyone else, it will have sunk below the horizon and out of view by then. Viewers in Los Angeles and San Francisco will see the comet 25 degrees above the horizon at impact time. Residents of Tucson will see it 22 degrees high. (For reference, the width of your fist at arm's length from your face spans about 10 degrees of sky.) NASA predicts impact will occur around 10:52 p.m. Pacific Daylight Time on July 3rd, or 1:52 a.m. Eastern Daylight Time on July 4th.

Folks that don't have a ringside seat for the main event will be able to observe the comet on subsequent evenings. And there's a good possibility that the "aftermath" -- the sunlit brightening of the ejected debris -- will continue for some time. It could be days, weeks, or longer, nobody knows for sure.

Introduction and Preparation for Viewing

NASA's historic Deep Impact mission is set to climax on July 3rd/4th with the planned collision of a man-made projectile with a comet called 9P/Tempel 1. The 820-pound, washing-machine-sized "impactor" launched from the Deep Impact spacecraft will smash into the comet's nucleus at 23,000 miles per hour, expelling ice and dust debris and gouging out a crater a couple of football fields wide and some 50 yards deep, experts predict. By analyzing the blown-out debris and the freshly excavated crater itself, scientists expect to learn more about what comets are made of. And from that they hope to gain new insights into how the solar system was formed.

For us non-rocket scientists, Deep Impact presents an opportunity, though challenging, to witness a cosmic event befitting of a sci-fi novel through backyard telescopes, and even capture some pictures for posterity. While the *visual* impact for amateur sky watchers will fall short of a fireworks display, despite the July 4th date, the impact is expected to cause the faint comet to brighten noticeably, from a faint 9th magnitude to 6th or even 5th magnitude, which is right on the cusp of naked-eye visibility. (In the magnitude scale used by astronomers, a lower number denotes a brighter star). And in space, anytime an object changes noticeably in appearance over a time span of less than several million years, that's something to get excited about!

Comet Tempel 1 Near its closest point to Earth. Image obtained by Dr. Tony Farnham and Matthew Knight of the University of Maryland.

Finding Comet Tempel 1 in the Evening Sky

Tempel 1 is a relatively small and faint comet, and without a pronounced "tail" like the famous comets Hyakutake or Hale-Bopp, two naked-eye comets that put on dazzling sky shows in recent years. Before impact, Tempel 1 will look like a dim, fuzzy star in a telescope, which will make locating it amid a sea of stars somewhat tricky.

But you can do it! Here's what you'll need: a telescope (more on telescopes later, in Part II); a star map or two which you can access here;

First image of Tempel 1 taken by the Impactor spacecraft after launch. 30 images composited from MRI camera.

and an observing location away from streetlights and city glow. You will improve your chances of seeing the comet on evenings when the Moon is thin or below the horizon, as moonglow washes out faint celestial objects. Fortunately, the Moon will be out of the way on the night of the impact. Leading up to then, your best comet-viewing opportunities will be in late May and late June, when the Moon does not interfere.

During May through most of July, Comet Tempel 1 will reside in the constellation Virgo. To see where Virgo is in the sky, refer to the monthly all-sky chart in this guide. At the time of impact on July 3-4, the comet will loom about 3.5 degrees from the bright star Spica, or Alpha Virginis. (One finger width at arm's length spans about 1 degree of sky. So 3.5 degrees is about three and a half finger widths.) Spica is easy to get to from the Big Dipper, if you can find that. If you follow the arc of the Dipper's handle away from the "pan," the first bright star you'll come to is Arcturus in the constellation Bootes (you "arc to Arcturus"). Then just continue that arc and the next bright star you'll land on is Spica.

The accompanying detailed star chart shows the path Comet Tempel 1 will follow in the days leading up to the impact event and beyond. Print it out and use it at the telescope to zero in on the comet, using Spica and the other bright stars shown as visual guideposts.

Take the opportunity well before the July impact to practice locating the comet. Although it is dim, it will have a fuzzier appearance than the surrounding stars, so you should be able to pick it out of the crowd if your telescope is pointed in the right place. And the more familiar you become with how Tempel 1 looks *before* the impact, the better you will appreciate the extent to which it changes *after* impact.

TIPS AND TRICKS FOR VIEWING COMET TEMPEL 1

Allow Time for Your Eyes to Dark Adapt

Anytime you stargaze, whether you're using a telescope, binoculars, or just your eyes, be sure to allow some time beforehand for your eyes to adapt to the darkness. After 20 minutes or so in the dark, you'll notice that you can see many more stars than when you first stepped outside and looked up. For viewing Comet Tempel 1, good dark adaptation will be important for seeing the "fuzziness" around what might otherwise look like a plain-old star.

Once your eyes are dark-adapted, avoid looking at bright light sources as they will instantly spoil your night vision. To see what you're doing at the telescope or to read your star map, use a flashlight that emits red light, the dimmer the better. A flashlight with a red LED and adjustable illumination is ideal. Red light interferes less with the eyes' dark adaptation than white light.

Use Averted Vision and the Jiggle Technique

For faint objects like Comet Tempel 1 (at least before the impact), sometimes you can see them better using averted vision. That is, instead of looking directly at the comet, look off a little to one side in the eyepiece's field of view. The reason this works is that the edge of the eye's retina is more sensitive to dim light than the center. Another trick for spotting difficult objects is to tap the side of the telescope tube lightly, just enough to jiggle the field of view.

Viewing Deep Impact With a Telescope or Binoculars

While all manner of professional observatory telescopes and orbiting instruments such as the Hubble Space Telescope will be trained on Comet Tempel 1 before, during, and after the big crash, backyard skywatchers can get a first-hand look for themselves.

As for what gear you'll need to witness the event, there are basically three options: eyes alone, binoculars, or a telescope. Let's explore each of these options.

WILL THE EYES HAVE IT?

If you don't have a pair of binoculars stashed in a closet somewhere and don't want to spring for a telescope, you can try going "naked" -- taking a naked-eye viewing approach, that is. Unfortunately, with just your eyes you will not be able to see the comet before impact, because at 10^{th} magnitude it's about 40 times dimmer than they can detect. But after impact, when the comet brightens to the expected 6th magnitude or so, it may become visible without optical aid, barely. But you would have to be an experienced observer to pick it out from among the thicket of stars surrounding it. Can you say needle in a haystack? So, no, the eyes really won't have it. This is an event best observed with the aid of an optical instrument.

IS IT A SIGHT FOR *FOUR* EYES?

With a good pair of full- or giant-sized binoculars, you should be able to spot the comet. We'll define full-size binoculars as those having front lenses of 40mm to 50mm diameter. Giant-size binocs sport lenses measuring 60mm or larger. The bigger the lenses the better, because bigger lenses take in more light, so you get a brighter image.

Before impact Tempel 1 may be hard to discern in binoculars, but upon brightening after the impact it should be easy to spot. Your best bet is to mount the binoculars on a tripod to steady the image and reduce arm fatigue. Most binoculars have a threaded socket in between the optical barrels that accepts an optional "L-adapter" (available from Orion), which couples the binocular to a standard camera tripod.

If you don't have a tripod, brace the binocular against something solid like a wall or a car door to hold it steady.

Observe from as dark a site as possible and make sure your eyes are fully dark-adapted (see Tips and Tricks at left). Using a planisphere or the attached all-sky map, find the constellation Virgo in the west-southwest part of the sky. Locate the bright star Spica and sweep the area immediately around it. When you see a fuzzy patch, you've spotted Tempel 1! On the date of impact, it will be about 3-1/2 degrees (about a third of a fist-width at arm's length) to the east-northeast (left) of

The eye is good at detecting motion, and when you set the whole starfield in motion this way, the comet's fuzzy form may emerge from the surrounding stellar pinpoints.

Drape a Dark Cloth Over your Head

Any extraneous light from nearby houses or street lights will interfere with your ability to see the faint comet through a telescope or binoculars. You can block such light from entering your eye by draping a dark cloth such as a towel over your head and the eyepiece(s). Or at the least, cup your hand around your eye and the eyepiece -- without touching the eyepiece -- to block stray light. You'll be amazed what a difference it can make.

Spica. Refer to the attached map of Virgo to determine the comet's exact position relative to Spica.

A Telescope's the Ticket

To get a good look at Comet Tempel 1, a telescope is the way to go. Any telescope design will do -- refractor, reflector, or Cassegrain, but the bigger its optics, the more vivid the image will be. From a dark-sky site, a telescope with 4" optics should begin to reveal the comet's hazy glow (if you have a smaller telescope, go ahead and give it a try. You just might get lucky.). You'll have better luck with an 8" or larger telescope, which will be a reflector or Schmidt-Cassegrain. Remember that moonlight will wash out the comet from June 8 to 23, so plan on starting your observations on the 24th, if you haven't already, when the Moon comes up later in the evening.

Your telescope should be equipped with a finder scope to help locate the comet, and a sturdy mount. An "equatorial" mount is desirable, since it allows you easily to follow the east-to-west motion of celestial objects in the sky by making manual adjustments with one slow-motion control, or by use of an optional electronic tracking drive. If your telescope is coupled to a simpler, "altazimuth" mount, not to worry. You can still track the comet by making occasional tweaks to both the vertical and horizontal positions of the scope. Plan on having at least a couple of eyepieces at the ready, one for low-power viewing and another for higher magnification.

Start by making sure the finder scope is aligned with the main telescope. The procedure for this should be covered in the telescope's instruction manual. Then do a quick polar alignment of the equatorial mount (if that's what you have); that's also covered in the manual. Put a low-power eyepiece in the telescope's focuser. Low power (less than 50x) is best for locating objects and for getting maximum contrast between objects and the background sky. Now you're ready to go comet-catching! To get the telescope pointed in the right direction, locate Spica in the finder scope and use your telescope's slow-motion controls to center it on the finder's crosshairs. Remember that the view in a typical finder scope will be upside-down compared to a normal view. If you're using a star chart, rotate it 180 degrees to match the view in the finder scope. It's also important to know how the image in the main telescope's eyepiece compares to the star chart. In a reflector telescope the image will be upside-down. In a refractor or Cassegrain used with a "star diagonal" in front of the eyepiece, the view will be mirror-reversed, so you will have to mentally flip it back or else turn your star chart over and read it from behind to match the eyepiece view! From Spica, move the telescope a few degrees in the direction of the comet using the mount's slow-motion controls. Refer to the detailed star chart to determine where the comet should be relative to Spica. With a low-power eyepiece in the telescope's focuser, see if you can identify the comet's fuzzy glow. If you can't, sweep the area a little with the slow-motion controls until you find it.

Once you have Tempel 1 in the eyepiece's field of view, study its appearance for a while. Can you detect any shape to its diffuse tail? Now insert a higher-power eyepiece, one that provides 100x magnification or so. The view will be dimmer but you may resolve more structure. Try other magnifications using other eyepieces, too, if you have them.

Of course, after the impactor slams into the comet on July 3/4, it should become much easier to see. Will the blown-off debris cloud cause the comet to look any bigger, or just brighter? How soon after impact will its appearance start to change? And how long will the "extreme makeover" persist? Nobody has the answers to these questions right now. But with a good telescope, a good eye, and patient observation, you can have fun finding out!

Photographing Comet Tempel 1 and Deep Impact

A great way to document the historic collision of the NASA-fired projectile with Comet 9P/Tempel 1 would be to capture "before and after" pictures of the comet. There are a number of different ways to photograph celestial objects, but not all of them can be employed to photograph Tempel 1 because of its faintness.

For example, a simple camera-and-tripod setup will not be enough to reveal the comet, except maybe after impact when it brightens. But with this setup you are limited to very short exposures, since the Earth's rotation will result in "trailing" of star images after as little as 15 or 20 seconds. And that's not enough time to burn in much of an image on the film. Nor will the comet be bright enough to allow telescope owners to hold a camera up to the scope's eyepiece and snap a keepsake, as can be done for, say, the Moon.

Go Piggyback

Probably the simplest method for photographing Comet Tempel 1 is to "piggyback" a camera on a telescope equipped with a motorized tracking mount, or on the tracking mount itself, without the telescope. In this method, the motor drive, or "clock" drive, moves the mount in lock-step with the motion of celestial objects as they drift from east to west in the sky. This allows you to take longer exposures, which will record dimmer objects and keep the stars from trailing.

For basic, unguided piggyback photography you will need a camera that permits the shutter to remain open for an extended exposure, and a cable release. We recommend using a telephoto lens – something longer than a typical 50mm lens – to zero in on a smaller area of sky. This comet ain't big! But if a 50mm is all you have, by all means give it a try! For film, go with something fast but not too grainy. Kodak EliteChrome 200 is good, or any slide or print film with an ISO rating of 400. If you have one of the new digital SLR cameras, you won't need film, of course. Couple your camera to the equatorial mount or atop your equatorially mounted telescope tube with a sturdy ¼"-20 adapter such as a ball-type adapter.

Before beginning to snap pictures, it will be important to polar-align the telescope mount. The procedure should be covered in your telescope's instruction manual. A good polar alignment will keep stars from trailing during long exposures. A rough "eyeball" polar alignment may allow you to take exposures lasting a minute or so without seeing evidence of trailing in the resulting pictures. But for longer exposures, a more accurate alignment will be needed. Just how accurate depends on the focal length of the lens you're using and the length of the exposures you plan to take. Short lenses and short exposures are more forgiving of inaccurate alignments.

Set your camera lens one f-stop down from wide open, and set the focus to infinity. With the scope's motor drive running and the camera aimed at the constellation Virgo, try taking exposures of different length: 30 seconds, 1 minute, 2 minutes, 4 minutes, and 8 minutes, for starters. When you get the film developed you will see at what point evidence of trailing appears. If stars are smeared even in the shortest exposures, you may need a better mount and drive, or at least better polar alignment. If the stars are pinpoint perfect even at the longer exposures – congratulations! Try going even longer next time.

If you get some wide-field piggyback shots of the area where the comet is located (in Virgo) both before and after the July 3/4 impact, then by comparing them side-by-side you should be able to see any changes in brightness that occurred.

Prime-Focus Photography

The best method for photographing the Deep Impact event involves coupling a camera body directly to a telescope, using the telescope as the camera lens. This

method is called prime-focus photography, and is ideal for shooting faint deep-sky objects such as nebulas and galaxies, or, in this case, Comet Tempel 1.

Unfortunately, prime-focus astrophotography is extremely involved and requires a top-notch telescope and equatorial mount with sophisticated electronic drive controls, plus knowledge of advanced techniques for polar-alignment, guiding during long exposures, and focusing. It's not something anyone dare try that hasn't already logged some experience with simpler methods of skyshooting such as camera-and-tripod or piggyback.

So we won't go into the prime-focus method here, except to note that the advent of sensitive but relatively inexpensive CCD cameras designed for use with telescopes over the last couple of years has made getting good deep-sky images a little easier by requiring shorter exposure times (because a CCD chip is more sensitive than film). One such camera is the SAC Mintron CCD Imager. When attached to a telescope's focuser, it beams real-time video images of the target object to a computer or television screen. The longest exposure it can take is 2.2 seconds, but it comes with software that lets you digitally "stack" multiple exposures, which has an effect similar to taking a longer single exposure: you see more detail. You'll still need to accurately polar-align your telescope mount and use an electronic drive, but for 2.2-second exposures you will not have to "guide" the telescope by making electronic adjustments during the exposure, as you would with a conventional camera requiring longer exposures.

So if you have a good telescope and the technical wherewithal to take on CCD imaging, the SAC Mintron CCD Imager should provide the means for capturing revealing shots of Comet Tempel 1's smashing transformation. Good luck!

For an excellent overview of the different types of astrophotography, check out the *Backyard Astronomer's Guide* by Dickinson and Dyer.

Share your before and after photos of Comet Tempel 1 at http://www.space.com/amazingimages.

This SkyView Pro 8 EQ Reflector telescope package with SAC Mintron CCD camera is available at http://www.telescope.com.