

Caring for Optics

By Alan M. MacRobert



Big-time optical cleaning. The primary mirror for the 200-inch telescope on Palomar Mountain is washed (with special material) and realuminized every two or three years. Roger Ressmeyer / © Corbis

*When cleaning lenses and mirrors, the most important rule is the doctor's Hippocratic Oath:
"First, do no harm."*

Any telescope or binocular used for astronomy is a scientific instrument and should be treated as such. Even the humblest one deserves care, since you'll be using it right at the limit of its capabilities. When you're trying to see faint objects or fine detail, little problems can make a big difference.

Then again, an observer's life is full of imperfections, and there's no point fretting about them. The right attitude toward optics means knowing when to be vigilant about care and when to relax.

Every optical instrument gets dirty. Dirt on lenses or mirrors scatters light and reduces contrast. It makes dark skies less dark and bright objects less crisp.

The first tactic against dirt is defensive — and here's where to be vigilant. Keep the lens caps on when the instrument is not in use. If none are available, make your own. They don't have to be fancy: shower caps or cloth can cover the ends of a Newtonian reflector's tube. A plastic 35-mm film canister makes a convenient plug for a telescope's 1¼-inch eyepiece holder.

I store my two reflectors positioned so both their main and secondary mirrors face slightly down. That way dust can't settle on them. Eyepieces and Barlow lenses should be capped on both ends, or kept in plastic sandwich bags or small food containers.

Never touch the surface of a lens or mirror. The acids in skin oil can attack optical coatings over time. If you do leave a fingerprint on, say, a binocular objective, clean it off using the method described below.

So much for vigilance. Now to relax. Dirt happens, and in moderate amounts it has remarkably little effect on performance. In his book *Star Testing Astronomical Telescopes*, Harold Richard Suiter analyzes the effects of dirty optics mathematically. His conclusion? "The maximum amount of dirt [that a perfectionist] should tolerate on the optics is about 1/1000 of the surface area, [which is] the size of a single obstruction about 1/30 of the diameter." In other words, on a 10-inch telescope mirror this is the equivalent of a completely opaque dirt blot a third of an inch across. That's quite a pile of crud that can accumulate before detectably affecting contrast.

"Don't decide to clean mirrors on the basis of shining a light down the tube at night," advises Suiter. "All mirrors fail such a harsh inspection." After you've done what you can to prevent dust, ignore it.

Cleaning Optics

There's a good reason to ignore dirt aside from maintaining peace of mind. A dirty lens or mirror can always be made clean, but a scratched one is scratched forever. Cleaning causes tiny scratches ("sleeks") if you don't do it exactly right, and maybe even if you do. So clean optics rarely. I've washed the main mirror of my trusty 6-inch reflector twice in 30 years, and the mirror of my 12.5-inch reflector twice in nine years. I've never cleaned the secondary mirrors at all, aside from blowing off dust, and they still look fine — because I've been careful about the telescopes' storage.

Actually, the surface you are cleaning is usually not glass but an optical coating that is softer and more vulnerable. The basic antireflection lens coating is magnesium fluoride, which can be very soft if the manufacturer applied it at too low a temperature. Good magnesium fluoride coatings are usually made quite

hard. The newer, better multicoatings tend to be softer but are also being hardened up by manufacturers.

Cleaning a mirror. Ordinary house dust contains bits of rock powder carried in on the wind. Sleeks are caused by rubbing this stuff against glass. So when a cleaning finally must be done, the first and most important step is to remove all grit.

Mirrors can be completely immersed in water for thorough cleaning. You'll need the kitchen sink, two towels, liquid detergent, a bottle of distilled or demineralized (deionized) water (available in drugstores), and a package of sterile cotton. (If it's sterile it's more likely to be grit-free.)



Washing a 12-inch telescope mirror. The safest way to remove grit is to blast the surface with tap water. That may be all you need to do. If dirt remains, swish the surface very lightly with clean cotton in lukewarm water and detergent. Rinse with tap water, do a final rinse with distilled water, and set up on edge to dry. *Sky & Telescope / Chuck Baker*

Wash out the sink, rinse it well, and lay a folded towel on the bottom. Take off any jewelry from your hands and wrists. Put the mirror face-up on the towel, and with the drain open, blast the mirror's surface with room-temperature water for a few minutes. This will remove most dust and grit safely. Do not shock a mirror's metal coating with hot or cold water.

Turn off the tap and give the mirror a final rinse with distilled or demineralized water. This will leave no mineral deposits when it dries. Stand the mirror on edge (on a folded towel to prevent slipping) and let it dry completely. You can draw off stubborn water droplets carefully with the corner of a paper towel.

If the mirror looks reasonably clean, quit while you're ahead! You can't scratch a mirror you haven't touched.

If it's still cruddy, plug the sink, put the mirror back in on the towel, and fill the sink half full with lukewarm water. Add a teaspoon of liquid detergent and let the mirror soak for 10 minutes. Then, holding it underwater, swirl it around for a last chance at rinsing off remaining grit.

Take a wad of cotton and, starting at one edge, swab the mirror in one direction, applying no pressure beyond the weight of the cotton itself. Grit is less abrasive wet than dry, so do this underwater.

Turn the cotton over in a backward-rolling motion as you go, so that as soon as a part of it rubs the surface, that part is carried up and away from the glass. Throw out the wad when it has been turned completely. The job may take a lot of cotton.

It's a good idea to work in complete silence. If you make sleeks, you may actually hear them! If so, stop and proceed to the rinse.

Drain the sink and run lukewarm water over the mirror for at least a minute. Finish with a rinse of distilled water and tilt the mirror on edge to dry.

Eyepieces and Lenses

For dusting eyepieces, a quick and safe first step is to lay a finger across the eye end (without touching the glass!) and suck air under your finger past the lens while flipping your finger away. The sudden pulse of air removes much dust. This takes about one second at the telescope.

The traditional method for dusting optics is to brush very lightly with a camel's-hair brush. Sold in camera shops, these brushes have soft bristles with minimum tendency to scrape grit against a lens. The bristles should be untrimmed ("natural end"). Brush very lightly in one direction, while turning the brush in a

backward-rolling movement so that as bristles pick up dust they are flicked away from the glass. Seal the brush in its container or in a plastic bag when not in use.

Camera shops also sell cans of compressed gas for blowing dust off lenses. Be careful with the kind that use liquid propellants; these can spit onto the glass and leaving a residue, if the can is tipped or shaken in use.

Your own breath is also likely to leave spit.



One convenient lens cleaner is the E-wipe, a lint-free pad soaked with methanol. You drape the wipe on the glass, pull it across once, and discard. The methanol dries in moments, leaving a clean surface free of dirt, oils, or grease. *S&T / Chuck Baker*

For tougher dirt or stains on a lens, various lens-cleaning solutions are available. Among the simplest and most effective are pure isopropyl alcohol or methyl alcohol (methanol), available in drug stores and hardware stores, respectively. Standard isopropyl rubbing alcohol works well too and is easier to find, but avoid alcohol preparations with other ingredients that may leave stains. If you dilute a cleaning solution, use distilled or demineralized water. Camera shops sell lens-cleaning fluids such as Crystal Clear, which is pure methanol (which will be cheaper in a hardware store).

You'll need a soft, grit-free wipe. A well-washed piece of pure cotton cloth works well. So does a cotton swab or piece of clean cotton. Moisten it with the fluid and swirl the fluid gently across the lens, applying no pressure. If necessary, rub dry very gently with a fresh piece.

Don't drop liquid directly onto the glass. It's liable to seep into the edge of the lens cell and carry dissolved grime onto interior surfaces, staining them.

Eyelash and fingerprint oil will stain coatings permanently if left on long enough. So will moisture sealed in after observing sessions. (Blow-dry your eyepieces if necessary before capping them.) But such stains are only cosmetic, eyepiece manufacturers insist. They should have no noticeable effect on performance.

An eyepiece's field lens (the one farthest from your eye) will probably stay clean by itself. Leave it alone except perhaps for an occasional air blast or camel's-hair dusting. If problems develop *inside* the eyepiece, don't try to take it apart. You are almost certain to tilt and jam ("cock") a lens element. Send the eyepiece back to the manufacturer for disassembly and cleaning, which some makers will do for little or no cost.

Refractor objectives and the corrector plates of catadioptric telescopes should not be taken out of their cells except by an expert. (If you ever do take a refractor lens apart, make sure you will be able to collimate it after putting it back together — an art known to few. Make sure that on the outside rim of each element is a penciled indication of which sides face each other, which side faces the sky, and the orientation with which the elements are to be reassembled so that the same points around their edges match up again.)

These can be cleaned the same way as small lenses by using more time and fluid. It's okay to put drops of fluid directly onto the glass as long as none gets into the edge of the cell. Resist any urge to hurry the job.

The deluxe way to clean mirrors and lenses is with a syrupy substance called collodion, sold in camera and drug stores. Dab it on, and it dries to a thin plastic film. Peel off the film (using a bit of sticky tape) and everything you don't want — dirt, fingerprints, the works — should come off with it. This way you may not have to wash at all.

Dew Hazards

When a lens or mirror gets colder than the dew point of the surrounding air, water or frost will condense on it. A dirty surface will dew up much faster than a clean one. Never wipe a dewed lens or it may sleek — and more dew will immediately condense on it anyway. Instead, warm the glass slightly with an electric hair dryer. An eyepiece can be warmed in your hand, then dried by sucking air in across the eye lens or by waving your hand just in front of it (this actually works).

Dewing can be reduced or stopped by shielding the glass from exposure to most of the open sky. Exposure to the chill of space is usually what causes things to dew up at night. If a basic dewcap doesn't do the job, you can

add commercial or homemade antidew heaters.

If you get rid of dew reasonably soon, it has no effect on the optics. Stains and worse problems arise when dampness remains, or forms, on optics in storage.

A cold telescope can become dripping wet on being brought into a warm house. Don't cover or seal the telescope until it's completely dry. One school of thought says that sealing is a bad idea altogether. Even while a telescope is in storage, the humidity in the air sealed in can condense onto the optics if the temperature of the glass drops. Dust covers should probably "breathe" a little to let water vapor out during changes of temperature. Cloth might be a better cover than plastic, at least over the eyepiece tube. Of course, avoid any storage site that actually shows signs of being prone to dampness.

Be vigilant to prevent dirty lenses and mirrors — and then forget about them. Perfectionists are never happy, but astronomy should be fun. After all, what matters is not what you see *on* your telescope, but what you see *through* it.

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