Coma Wastes Light

This article, a result of a talk on collimation by Dr. Barry Spletzer at the TAAS General Meeting on May 2, 2015, also could be titled as the more simplistic, non-argumentative "Coma Correctors Concentrate Light."

Observers using reflectors have not referred to "wasted light" when discussing comatic views, but maybe they should (using "wasted" as meaning: *to be consumed, spent, or employed uselessly or without giving full value or being fully utilized or appreciated*).

This is a hobby and there are many, many ways to enjoy it, but just because coma is not seen or is not bothersome does not mean it is not present and it does not optically affect the view. **Coma wastes light from an object by spreading or blurring it, especially near the edges of the view, making brighter objects less defined and making the dimmest objects invisible.** Coma is one result of a reflector's inherent design.

Think about this example: a 6-in/150mm mirror with a 1500mm focal length (an f/10 focal ratio). Many observers do **not** use a coma corrector for this reflector because the blurring from coma is quite minor and not too bothersome.

Now, keep the same mirror curvature (i.e., same focal length of 1500mm), but double the size to 12-in/300mm, which costs significantly more than a 6-in mirror and results in an f/5 focal ratio. Here the coma is more pronounced, with much of it (but not all) generated by the more expensive outer radius of the larger mirror. Many observers spend money for a larger mirror to see fainter objects, and others just want to better enjoy bright objects, yet all large, fast mirrors **will** produce more blurring (wasted light) from coma. However, some hobbyists choose **not** to incur the added cost of using a coma corrector with larger sizes of f/5 (or less) mirrors.

Some people like to calculate the effects of coma. For the 6-inch f/10 mirror, and using a diffraction-limited reflector formula from Roger Sinnott (*Sky and Telescope* magazine, May 1991, page 528, "Focus and Collimation: How Critical?", `the circular diameter where coma diameter < Airy disk = 0.01778mm x (focal ratio)^3`), an 18mm diameter circle at the focal plane (i.e., the eyepiece field stop) is free of visible coma even to the most sensitive of eyes. Or using an approximate formula for average eyeballs (as described on the CloudyNights forum on 12/11/2014 by Ernest Shekalyan of the Russian Astro-talks forum, `where the field of view in degrees for decent views is roughly the square of the telescope focal ratio`),

well-designed 100 degree (apparent) field of view eyepieces should not show a degraded view from coma with an f/10 mirror. And using the above diffraction-limited reflector formula for the 12-inch f/5 mirror, only a 1.1mm diameter circle is free of visible coma, and for average eyeballs, only 25-degree (apparent) field of view eyepieces will provide views without much comatic degradation. These calculated values **suggest** that coma is a significant concern with the f/5 mirror, but not with the f/10 mirror.

During my observing of very dim objects at a dark site, a coma corrector allows me to routinely view a field with magnitude 16 galaxies (mostly as small, faint, fuzzy blobs of light), and sometimes a field with magnitude 17 stars and tiny galaxies, using a 14.5-in f/4 reflector. **On the other hand**, using only an inexpensive 17mm Plössl (no coma corrector, 50 degree field of view) on the Great Orion Nebula also seems to be enjoyable, filling the field of view and showing six Trapezium stars, with many wisps of light and various dark regions. Both approaches show wonderful views of the skies, yet there are tradeoffs for each; the choice depends on the esthetic and budgetary desires of the observer. Viewing small, bright objects at/near the center of the field (or larger, nebulous ones), is probably just fine without a coma corrector for the majority of observers, especially if the skies are not very dark, which can hide some of the wasted light from comatic blurring; or if the field of view is "small" (less than perhaps 65 degrees), because coma increases linearly from the center of the eyepiece view (and is also independent of magnification).

There are no firm rules on which reflector should use a coma corrector; there are only some differing opinions. An easy visual test (without using a coma corrector) is to place a faint star in the center of view, then slowly move that star to the edge of the view, watching how it changes brightness (and probably shape). Most of any change will be from coma, with a smaller contribution from astigmatism (of various items, assuming the eyepiece itself is well-designed) and even less from partial illumination by the secondary mirror. If the viewing results seem okay, then that's all that matters, and a coma corrector is probably not worth the cost or effort.

This idea of "waste" can be applied to many things: vehicle engines, video/audio gear, homes, clothing, yet each variation of intentional "waste" generally provides enjoyment or value to the person. Coma **does** waste light per optical physics, but it does not always bother an observer, as evidenced by the many who say "a coma corrector didn't make a difference for me" and/or "I don't see any coma."

Observing sessions with my reflector **will** include a coma corrector to concentrate the light from a 14.5-inch f/4 mirror. Your viewing and financial preferences regarding wasted light from coma may vary.

Source: Jim Kaminski, February 2018