APPLICATIONS OF OUT-OF-FOCUS IMAGES IN AMATEUR ASTRONOMY

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Abstract

The use of out-of-focus images for telescope alignment and image evaluation is briefly described.

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1. Introduction

Out-of-focus (OF) images are usually considered undesirable, but they can be used in a variety of applications where sharp images would not be informative. The following sections treat these applications.

2. Alignment of Optical Systems

Even after their initial adjustment, reflector optics occasionally require realignment, and the OF method is quick and handy. A Newtonian reflector requires the alignment of both the primary and the secondary mirrors.

a. Primary mirror out of alignment

If the telescope is pointed at a bright star, medium to high magnification will show the dark image of the secondary off-center in the round star image. See Figure 1. The cure consists of turning the appropriate adjustment screws on the primary mirror cell until the image of the secondary is centered. Only then will the star image shrink to a virtual point during focusing.

b. Secondary mirror out of alignment

Misalignment of the secondary mirror (the elliptical flat in a Newtonian reflector) reveals itself through a non-circular OF image of a bright star. See Figure 2. The remedy consists of shifting the secondary along the optical axis of the telescope and adjusting its tilt until the star image is round.

It may be necessary to readjust the primary after this, and it will be necessary to readjust the alignment of the finder scope as well.

3. Visualizing Atmospheric Turbulence

If there are thermal currents inside the telescope, or if the atmosphere is very turbulent and the "seeing" is bad, faint stars will be very difficult to estimate. The OF method can save time and frustration by alerting the observer to such conditions. The trick is to observe shadow bands on the primary mirror. Currents inside the telescope will show up as a stationary pattern, while the atmosphere will produce rapidly moving bands about four to six inches across. (Hence they cannot ordinarily be seen in telescopes less than ten or twelve inches in diameter.)

When the shadow bands have high contrast and are easy to see, the "seeing" will be bad; when they are relatively faint, the atmosphere is calm and the sky is astronomically good.

4. Detecting Obstructions in the Optical Path

The OF image will at once reveal even minor obstructions in the optical path of the telescope, such as wires and thin tree branches, which can affect observations.

5. Variable Star Observing

The OF method is a help in estimating the relative brightness of variable stars. Observers will find that it is less difficult to compare circular OF images than sharp images, particularly when the stars are bright.

Faint stars, of course, will require precise focus and excellent optical alignment to make them visible. However, a magnitude-13 star with a ten-inch telescope in a dark sky may qualify for slight OF comparison.

There are two reasons for improved accuracy. First, the variable and its comparison stars will be nearer the limit of visibility. Thus, the accuracy of visual estimates can be improved. When the variable and a comparison star are nearly the same magnitude, the focuser can be driven so far that one or both of the stars will vanish. The star vanishing first must be the fainter one.

Second, the colors of star images are more easily seen when they are slightly out of focus. It is no secret that any comparison of brightness is more accurate when stars of similar color are used. If stars of different color are being compared and one of them is red, the quick-glance method should be used. This practice is the norm when observing long period or semiregular variables and for R Coronae Borealis-type stars.

The size of OF images is limited by the angular distance between the two images being compared. Overlap of the circles should be avoided; on the other hand, the use of higher magnification will enlarge the circles without causing overlap.

The accuracy of the OF method can be tested with suitable comparison stars of nearly equal magnitude, and there are many advantages in training oneself to estimate differences as small as 0.1 magnitude.

In a way, the conscious use of out-of-focus images is like turning a vice into a virtue!

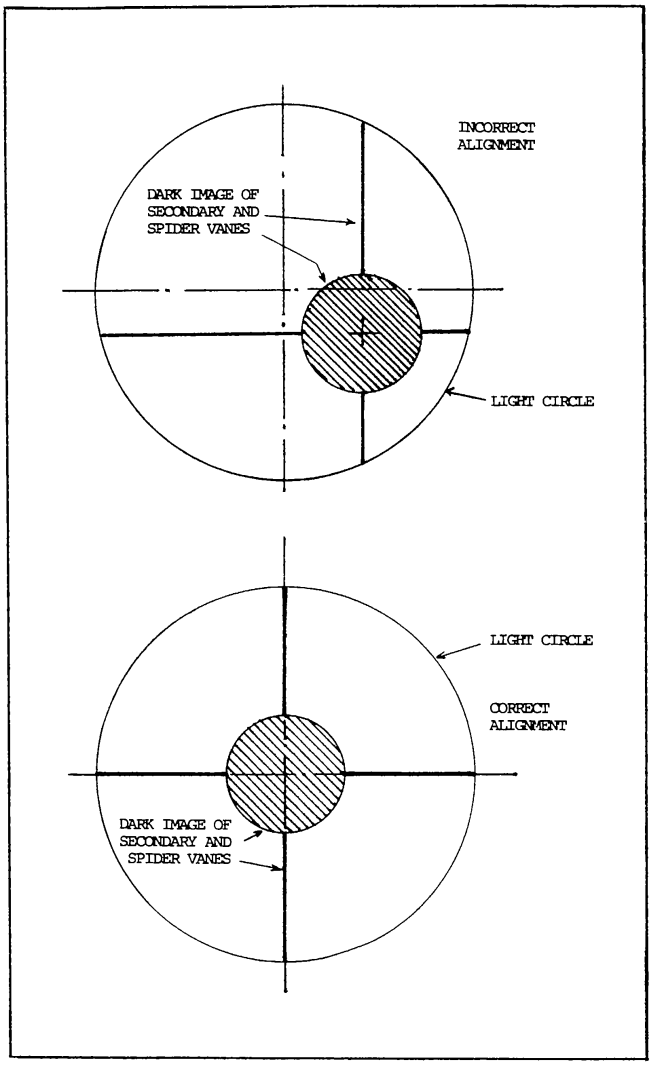

Figure 1. Primary mirror out of alignment.

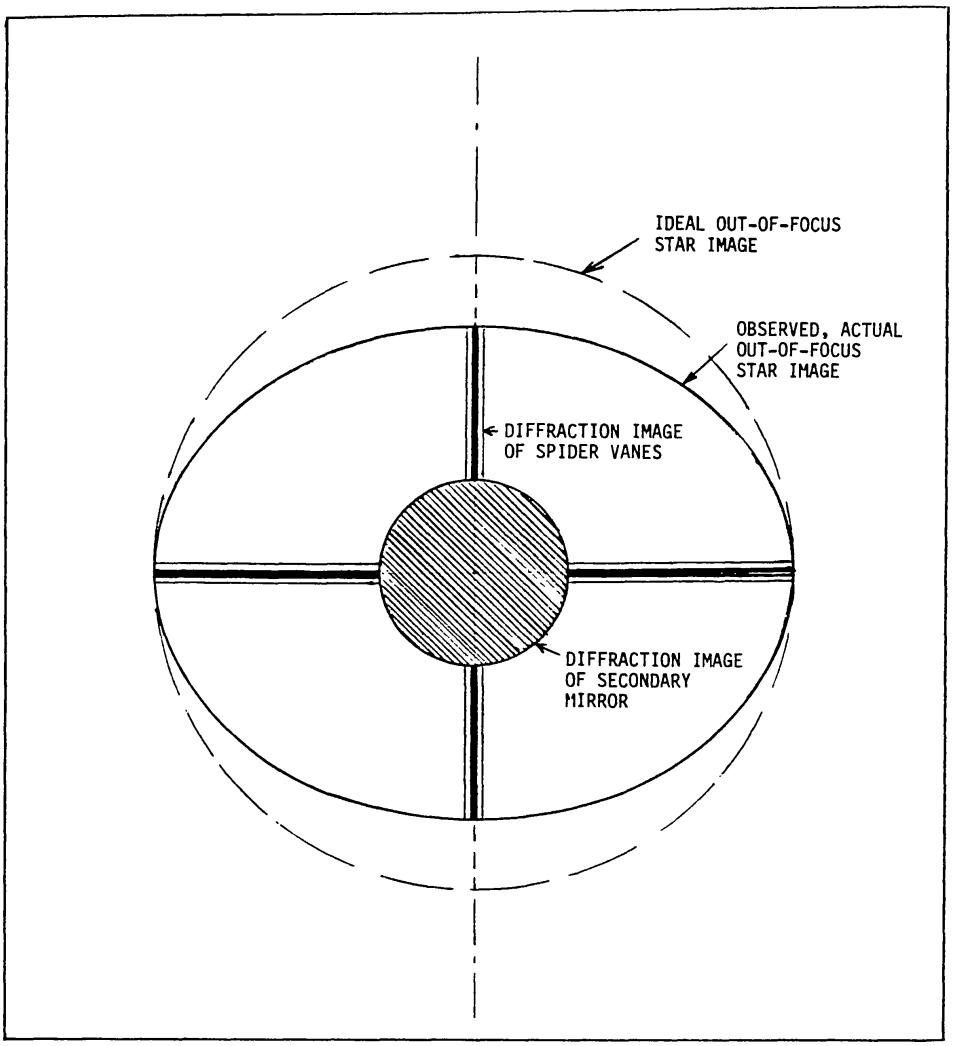

Figure 2. Secondary mirror out of alignment.