



BRIEF

CCD IMAGING

Seeing





CCD IMAGING - Seeing

Overview

In a continuing series on CCD Imaging, this lesson focuses on a concept called Seeing.

In short, Seeing describes how clear your image is (ex. Star, planet, etc) when being viewed through the Earth's atmosphere.



CCD IMAGING - Seeing

What is Seeing

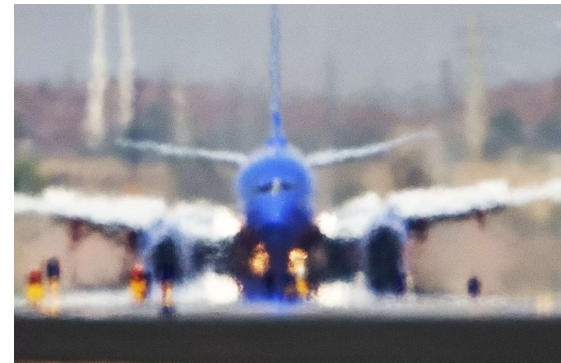
To astronomers, Seeing is a measurement of atmospheric turbulence usually associated with temperature changes and/or the Jetstream.

It is an image smearing and not the loss of light.

You may have seen a similar effect when you see far away objects shimmer if they are viewed through turbulent air, or through air parcels of different temperatures over a hot parking lot or roadway.

In the images on the right, the air near the ground is heated, expands, and rises, causing temperature variations along the line of sight and turbulence.

Light rays are bent by the passage through parcels of air with different temperatures, as the index of refraction of air varies slightly with temperature.

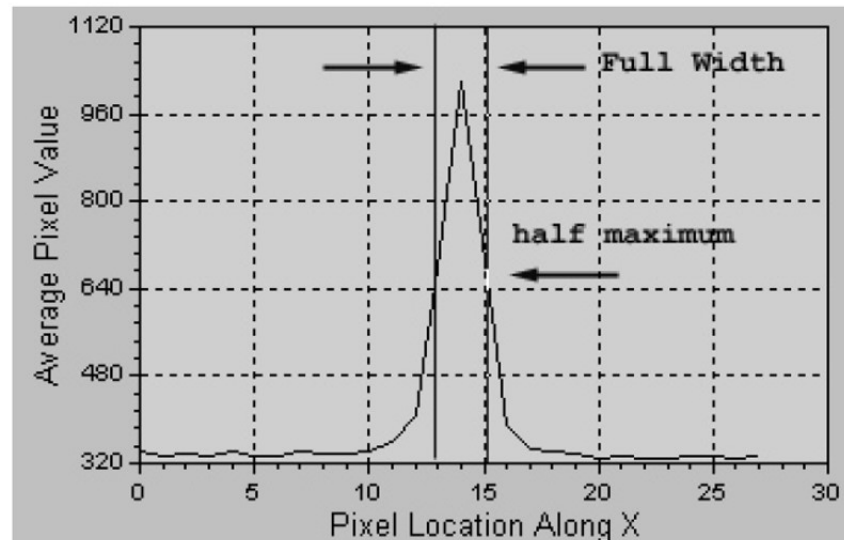




What is Seeing

Seeing is a term used in Astronomy to describe the quality of the atmosphere. This varies from night to night, even within a single night, and from location to location.

Its value is expressed in arcseconds based on the FWHM (Full Width at Half Maximum) of an image of a star.



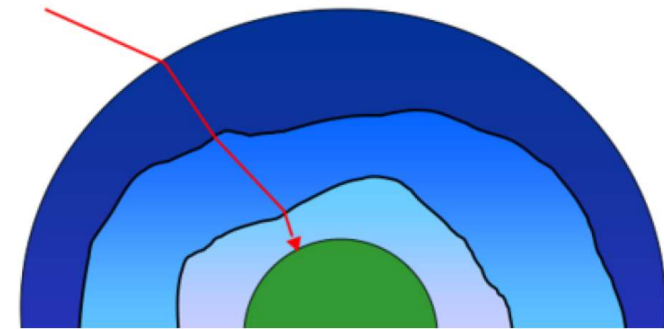
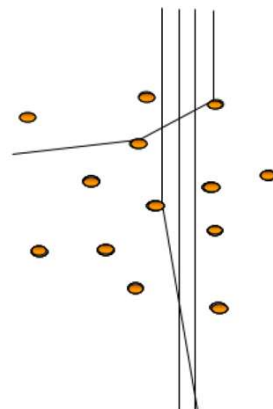
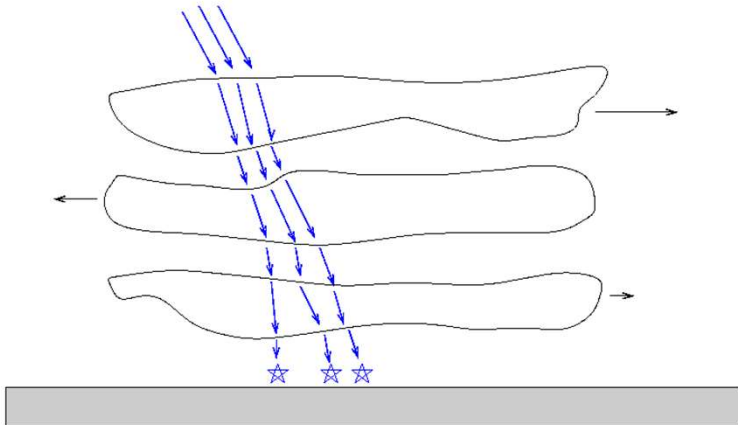
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What is Seeing

Large temperature differences between layers of air are the cause of poor seeing meaning the visible disc of a star is enlarged (distorted) thus covering a greater number of pixels as the refractive index of each layer is different and so incoming light is distorted from its parallel path before it gets to the observer.

Additionally, light passing through the Earth's atmosphere is scattered slightly making them no longer exactly parallel, and thus a little blurry as the direction of the rays is being continuously changed. The result is an image of a star that appears as a wandering blurry object rather than a nice sharp image.



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What is Seeing

Seeing is the term astronomers use for this smearing and shimmering of light from celestial objects due to its passage through the Earth's atmosphere.

It makes the images of stars, and other objects, appear much larger than normal, and makes the images of extended objects (e.g. planets) appear "fuzzy".



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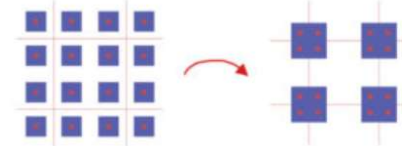


CCD IMAGING - Seeing

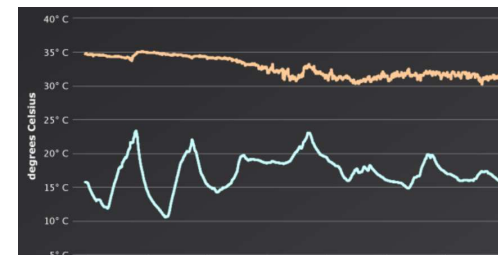
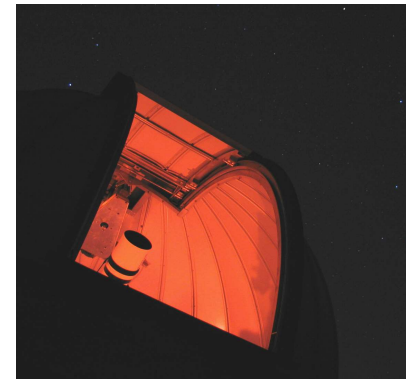
Methods to mitigate Seeing Issues

Better Seeing can be obtained by:

- Higher altitudes for the telescope since there is less air to look through the higher one goes
- Letting the mirror adjust to the local temperature. If the mirror is warmer than the air in the dome, there will be turbulence and temperature inhomogeneities as the hot air rises above the mirror
 - Turbulence near the dome slit can be caused if the dome air is warmer than the air surrounding the dome
- Binning: This does not, of course, change the total size or field of view of the CCD, but does decrease the number of pixels in the image



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Summary

Seeing, in short, is the blurring of an image due to atmospheric effects such as air turbulence and significant temperature differentials.

In some cases this can be mitigated through high altitude observatories and/or letting the observatory and telescope adapt to the evening temperature, and binning.

There are some times when Seeing cannot be mitigated. In these cases, CCD imaging be not be satisfactory on those nights.



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Questions?