

## Astronomical Seeing and Transparency Scales

*Seeing is the quality of observing conditions induced by turbulence in Earth's atmosphere, which blurs the images of astronomical objects. — Astronomy magazine*

### ASTRONOMICAL SEEING

- I - Severely disturbed skies:** Even low power\* views are uselessly shaky. Go read a good book.
- II - Poor seeing:** Low power images are pretty steady, but medium powers are not.
- III - Good seeing:** You can use about half the useful magnification of your scope.  
High powers\*\* produce fidgety planets.
- IV - Excellent seeing:** Medium-powers are crisp and stable. High-powers are good, but a little soft.
- V - Superb seeing:** Any power eyepiece produces a good crisp image.



\* The **PRACTICAL LOWEST power** magnification for any telescope is approximately 7 times for each inch of aperture. Example: 28X for a 4-inch (100mm) diameter telescope.

\*\* The **PRACTICAL HIGHEST power** magnification for any telescope is approximately 50 times for each inch of aperture. Example: 200X for a 4-inch (100mm) diameter telescope.

### ANTONIADI SCALE - Eugène Michel Antoniadi (1870-1944)

Used by visual planetary observers

- I - Perfect seeing,** without a quiver.
- II - Slight undulations,** with moments of calm lasting several seconds.
- III - Moderate seeing,** with larger air tremors.
- IV - Poor seeing,** with constant troublesome undulations.
- V - Very bad seeing,** scarcely allowing the makings of a rough sketch.

### PICKERING SEEING SCALE - William H. Pickering (1858-1938)

- 1** - Star image is usually about twice the diameter of the third diffraction ring if the ring could be seen; star image 13 arcseconds (13") in diameter.
- 2** - Image occasionally twice the diameter of the third ring (13").
- 3** - Image about the same diameter as the third ring (6.7"), and brighter at the center.
- 4** - The central Airy diffraction disk often visible; arcs of diffraction rings sometimes seen on brighter stars.
- 5** - Airy disk always visible; arcs frequently seen on brighter stars.
- 6** - Airy disk always visible; short arcs constantly seen.
- 7** - Disk sometimes sharply defined; diffraction rings seen as long arcs or complete circles.
- 8** - Disk always sharply defined; rings seen as long arcs or complete circles, but always in motion.
- 9** - The inner diffraction ring is stationary. Outer rings momentarily stationary.
- 10** - The complete diffraction pattern is stationary.

(On this scale 1 to 3 is considered very bad, 4 to 5 poor, 6 to 7 good, and 8 to 10 excellent.)

## **TRANSPARENCY SCALE** (American Association of Amateur Astronomers)

Sky transparency varies with clouds, altitude, moisture content of the airmass, industrial pollutants, aerosols ( e.g. volcanic ash, pollen, smoke from wildfires, etc.) and auroras.

- 0 - Do Not Observe** - Completely cloudy or precipitating. (why are you out?)
- 1 - Very Poor** - Mostly Cloudy.
- 2 - Poor** - Partly cloudy or heavy haze. 1 or 2 Little Dipper stars visible.
- 3 - Somewhat Clear** - Cirrus or moderate haze. 3 or 4 Little Dipper stars visible.
- 4 - Partly Clear** - Slight haze. 4 or 5 Little Dipper stars visible.
- 5 - Clear** - No clouds. Milky Way visible with averted vision. 6 Little Dipper stars visible.
- 6 - Very Clear** - Milky Way and M31 visible. stars fainter than mag 6.0 are just seen and fainter parts of the Milky Way are more obvious
- 7 - Extremely Clear** - overwhelming profusion of stars, Zodiacal light and the gegenschein form continuous band across the sky, the Milky Way is very wide and bright throughout

## **DANJON SCALE**

This scale was devised by André Danjon (1890-1967) for rating the overall darkness of lunar eclipses

- L=0** Very dark eclipse.  
(Moon almost invisible, especially at mid-totality)
- L=1** Dark eclipse, grey or brownish in coloration.  
(details distinguishable only with difficulty)
- L=2** Deep red or rust-coloured eclipse.  
(very dark central shadow, while outer umbra is relatively bright)
- L=3** Brick-red eclipse.  
(umbral shadow usually has a bright or yellow rim)
- L=4** Very bright copper-red or orange eclipse.  
(umbral shadow has a bluish, very bright rim)

## THE BEAUFORT SCALE

The following table includes both the traditional maritime observations and terrestrial observations. With a little practice, you can learn to estimate the wind speed around you. This in turn can help you to better judge seeing conditions, or explain why the seeing is as good, or poor, as you experience.

Force	Description	On Land	On Sea	Speed (knots)
0	Calm	Smoke rises vertically	Sea like a mirror	0
1	Light air	Smoke drifts. Wind vane still	Small ripples	1-3
2	Light Breeze	Wind felt on face. Leaves rustle; vane moves	Small wavelets. Crests break. Glassy foam.	4-6
3	Gentle Breeze	Leaves and small twigs in constant motion. Light flag extended.	Large wavelets. Crests break. Glassy foam.	7-10
4	Moderate Breeze	Raises dust; moves small branches	Small waves but fairly frequent 'white horses'	11-16
5	Fresh Breeze	Small trees in leaf begin to sway	Moderate waves, more pronounced long form. Many white horses.	17-21
6	Strong Breeze	Large branches in motion	Large waves. Extensive foam crests. Probably some spray.	22-27
7	Near gale	Whole trees in motion	Sea heaps up. White foam streaks along wind.	28-33
8	Gale	Breaks twigs off trees. Impedes progress.	Moderately high waves of greater strength; edges of waves begin to break into spindrift. Foam blown in well-marked streaks along wind.	34-40
9	Severe Gale	Slight structural damage possible. Tree branches may break.	High waves. Dense foam streaks along wind. Wave crests begin to topple and roll over. Spray may affect visibility.	41-47
10	Storm	Seldom experienced inland. Considerable structural damage. Trees uprooted.	Very high waves with long overhanging crests. Dense large patches of foam blown along wind. Sea surface white. Visibility reduced.	48-55
11	Violent Storm	Rarely experienced. Widespread damage.	Exceptionally high waves. Sea covered with long white patches of foam along wind. Everywhere edges of wave crests blown into froth. Visibility much reduced.	56-63
12	Hurricane or Cyclone	Widespread severe damage.	Air filled with foam and spray. Sea completely white with driving spray. Visibility seriously affected.	64+

## BRIGHTNESS SCALE

Magnitude*	Comments
very bright stars	
-4	Venus at its brightest
-3	Jupiter at its brightest
-2	Sirius in Canis Major, the brightest star in the sky
-1	Betelgeuse in Orion
0	Vega in Lyra
+1	Spica in Virgo, Deneb in Cygnus, Pollux in Gemini
+2	Polaris, the North Star
+3	Megrez, the faintest star in the Big Dipper
+4	
+5	Probable naked eye limit in the suburbs
+6	Probable naked eye limit in the country
+7	
+8	Neptune
+9	Approximate limit of typical binoculars
+10	Approximate limit of a 60-mm telescope
+11	Approximate limit of a 3-inch telescope
+12	Approximate limit of a 4-inch telescope
+13	Approximate limit of a 6-inch telescope
+14	Approximate limit of an 8-inch telescope
very dim stars	

- Magnitudes are approximate  
The difference in brightness between any successive two magnitudes is a ratio of 2.5

## FILTERS FOR VISUAL OBSERVATION

A good resource at the telescope is a set of colored filters. Filters can be acquired from various sources. Consult your astronomy magazines. Kodak's Wratten series can be purchased in over a hundred colors and densities, and can be mounted in slide mounts and simply be held between the eyepiece and the eye. For longer observations, as when sketching, screw-in filters are available for both 1-1/4 and 2-inch eyepieces. You don't need to choose between dozens of colors, though; only a few will do.

Filters can reduce glare, improve image definition, and enhance tonal contrast. Here are some suggestions.

- A **BLUE** filter, such as a Wratten #44A, 47B or 80A, can be used for the detection of high altitude clouds on Mars, white ovals and spots in the belts of Jupiter, and the zones of the clouds of Saturn. It can also be used to cut down glare on a bright Moon.
- A **GREEN** filter, such as a Wratten #58, allows you to see more clearly the edges of the Martian polar caps, and enhances the belts and Great Red Spot in the clouds of Jupiter.
- A **YELLOW** filter, such as a Wratten #8, 12, or 15, can improve markings in the clouds of Venus and enhance Martian dust storms.
- An **ORANGE** filter, such as a Wratten #21, is one of the more useful ones you can have. It is used for bringing out detail on Mars, and enhancing some of the zonal detail on Jupiter. An orange filter also darkens the blue sky, so daytime observations of Jupiter, Venus, and the Moon are much improved.
- A **RED** filter, such as a Wratten #23A, 25, or 25A, can also be used to enhance contrast on Mars, Jupiter, and Saturn. A red filter, however, is fairly dark, so it works best on larger aperture telescopes which give brighter images. Flipping back and forth between red and blue filters can sometimes bring out subtle colorations on the Moon.
- A **POLARIZING** filter can cut down glare when observing a nearly full Moon, making it easier to see ray structure. It will also cut down day-time glare.
- **LIGHT POLLUTION** and **O-III** filters are good for planetary and emission nebulae.