Friday, August 31, 2018

Optical Transfer -Function.

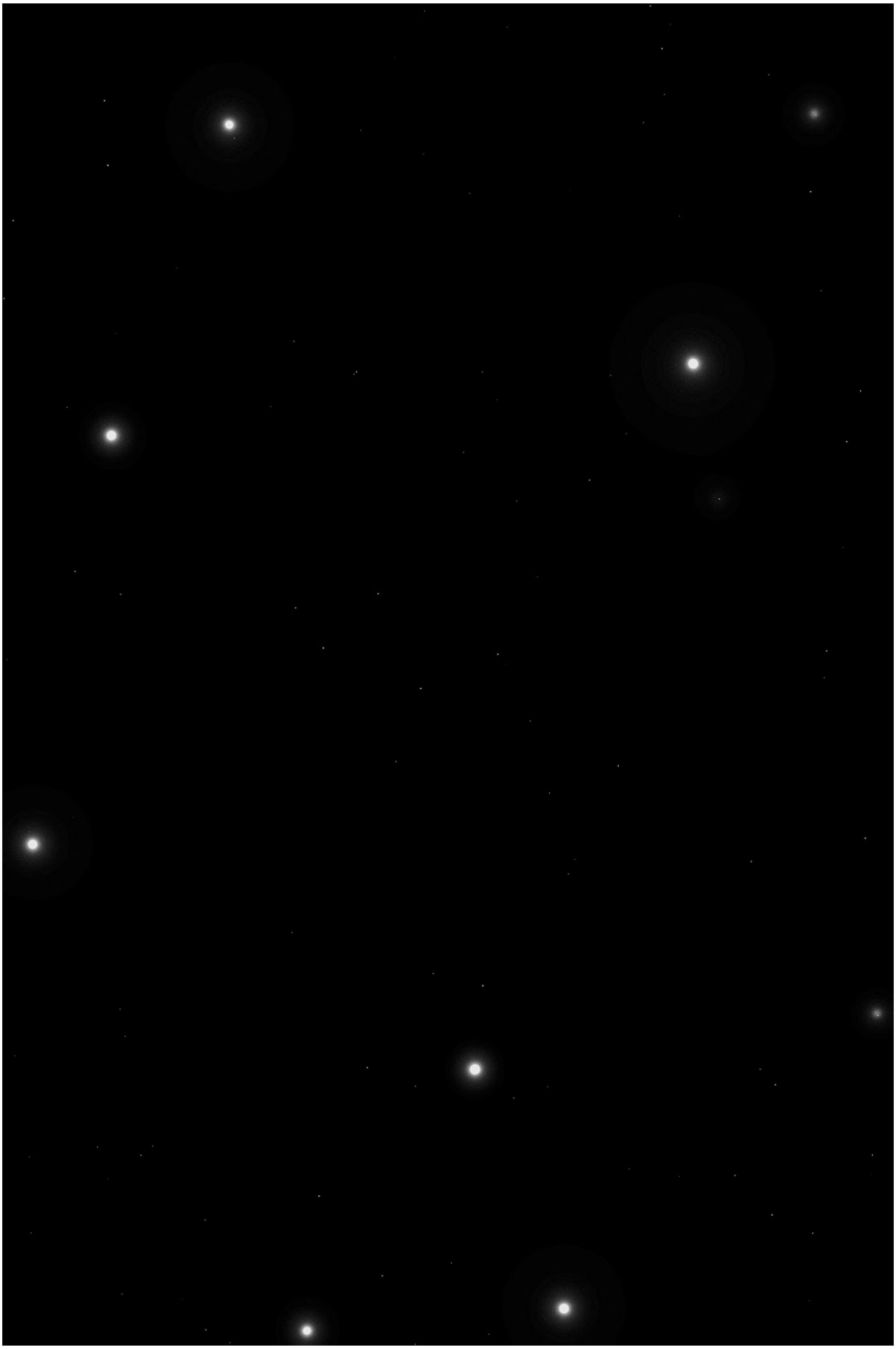
Spatial frequency is a characteristic quantity of a structure that reproduces identically at regularly spaced positions.

It is the measure of the number of repetitions per unit of length or per unit of angle.

The concept of spatial frequency finds its main applications in optics, especially in photography, video and Astronomy.

Part of Asto zine 3 in preparation: Delinquent optics.

Will be added: more details in the magazine.



Stars with old fisheye And brightness treatment +1

It allows to characterize the fineness of the details of a pattern or an image formed on a sensor: it is often expressed in cycles per millimeter (cy-mm)

When the dimension of the objects is inaccessible, the spatial frequency is the number of times that a light structure can be repeated in a given angle, for example in cycle by radian (cy-rad)

It is especially used to provide an assessment of the quality of optical systems: the resolving power of an optical device is often summarized at the maximum spatial frequency that the system can satisfactorily restore.

The Modulation Transfer Function indicates the contrast attenuation restored by the system for a given spatial frequency.

The notion of spatial frequency is common only in certain domains:

The wave-number or repetition refers to the number of cycles of a monochromatic wave per unit length.

It's the opposite of the wavelength.

In printing, the number of screen-dots is called the number of screen-halves per unit length.

In digital imaging, the number of pixels per unit-length is called resolution.

From the point of view of mathematics, it does not matter whether a variable represents a temporal or spatial magnitude.

The methods of spectral analysis apply to spaces, if the structures respect the fundamental hypothesis of the linearity of the quantities involved.

The surface of an object, whether it is bright (primary source) or illuminated (secondary source), can be decomposed into a set of elementary surfaces forming a multitude of source points.

Each of its source points constitutes an object point that can be studied independently of the others.

An object point is the point of intersection of the incident rays that meet the optical system.

It is at the top of the incident cone beam.

If it is located before the entrance surface of the optical system, it is called real, it actually emits light rays in the form of a divergent beam.

If it is after, it is called virtual, it is the point of convergence of virtual rays Insofar as we consider that the optical system forms a conical emerging beam, the vertex of the cone is an image point, it is the point of intersection of the rays emerging from the optical system.

The image-point is said to be real if it is situated downstream of the exit face with respect to the propagation direction of the light at the output of the optical system.

The emerging rays then converge, the image point is at the intersection of real rays.

The image point is said to be virtual if it is located upstream of the output face of the optical system.

In this case, the emerging rays diverge and the image point is at the intersection of virtual rays.

An object located at infinity is a source emitting parallel light rays, an image is formed at infinity when the light rays that form it are parallel.

An optical system is a set of optical elements, such as mirrors, lenses, diffraction gratings, and so on allowing to modify the trajectory of the light rays or the properties of the light.

The light undergoes reflections, refractions, diffusions, diffractions, filtering, etc. according to the level of analysis of the journeys.

The light rays only undergo refractions:

They enter through the entrance face and exit through the exit face. Dioptric systems consist only of diopters (prisms, lenses, parallel-faced blades, etc.)

Some optical instruments are dioptric systems such as the Galilean telescope , some telescopes or most photographic lenses.

Catoptric systems:

The optical condenser which allows uniform illumination of the field observed in an optical instrument, is an optical system (specific to the design of the whole but individually unsuitable as an instrument)

catadioptric systems:

Light rays undergo only reflections, whether they are specular reflection phenomena (planar, spherical, parabolic or elliptical mirrors) or total reflection (prisms)

The Optical Transfer Function, or FTO, of an optical system is a complex function that links the luminance of the object space to the illumination of the image space.

It allows to model the influence of the optical system on the distribution of light energy in the image space.

The optical transfer function is often considered only in the plane objects and conjugated images but is three-dimensional in the general case.

This complex function is decomposed into an amplitude called: Modulation Transfer Function and a so-called Phase Transfer Function.

The Modulation Transfer Function, or FTM, is a function that makes it possible to characterize the capacity of the optical system to restore contrast as a function of the fineness of the details of the object.

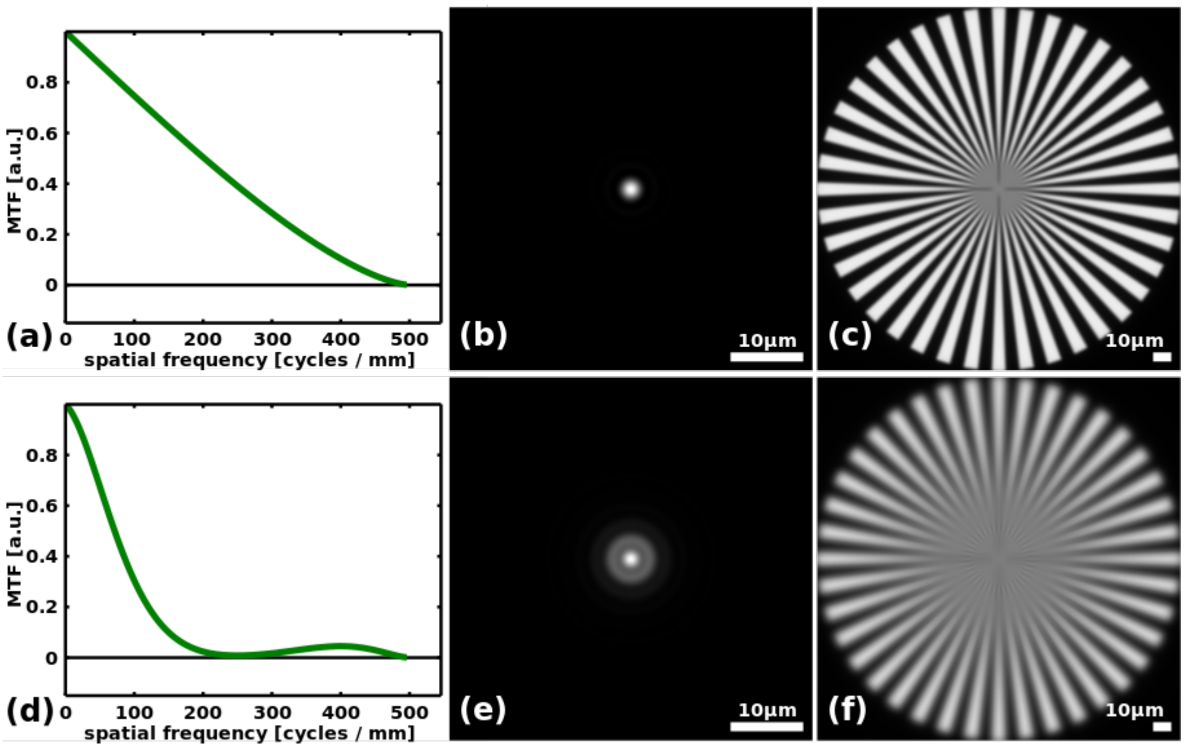
In other words: its ability to transmit the spatial frequencies of the object.

It is used to evaluate the quality of the optical system, especially in photography and cinematography.

The phase transfer function characterizes the phase shifts introduced by the optical system.

It intervenes mainly in the near field, in the hypothesis of a diffraction of Fresnel.

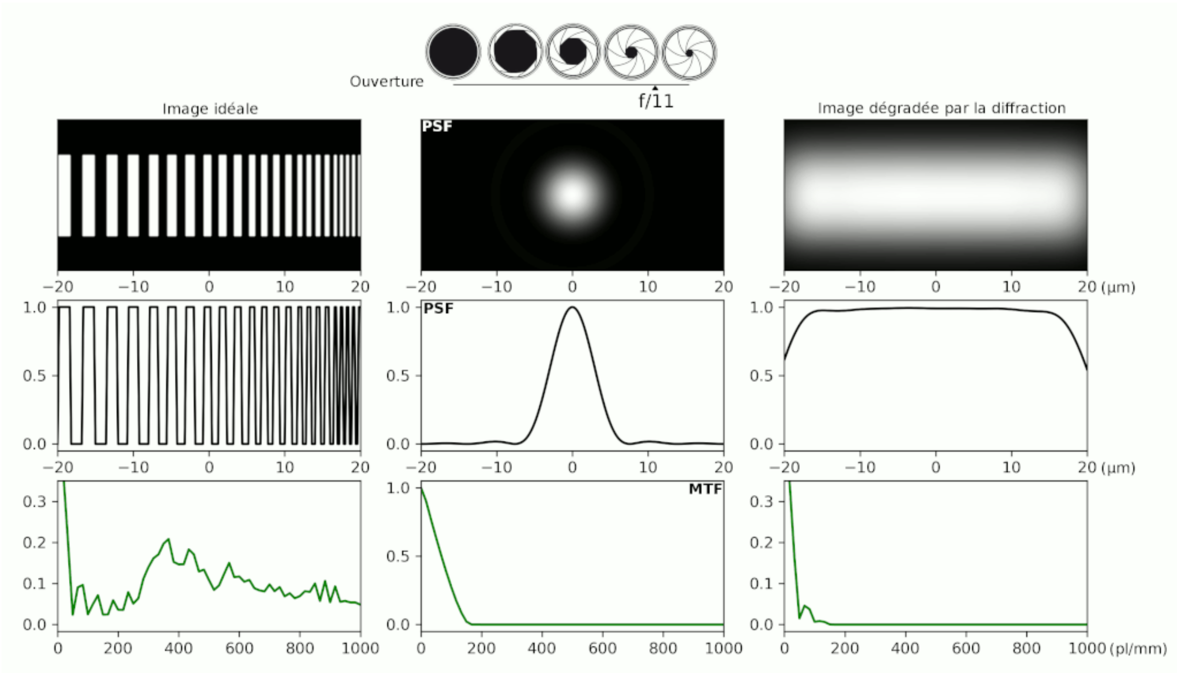
The notion of optical transfer function has analogues in other areas of physics, notably in electronics and acoustics.



It is useful to know the behavior of an ideal optical system, in the sense that it is devoid of aberration, in order to compare it to a real Optical

System.

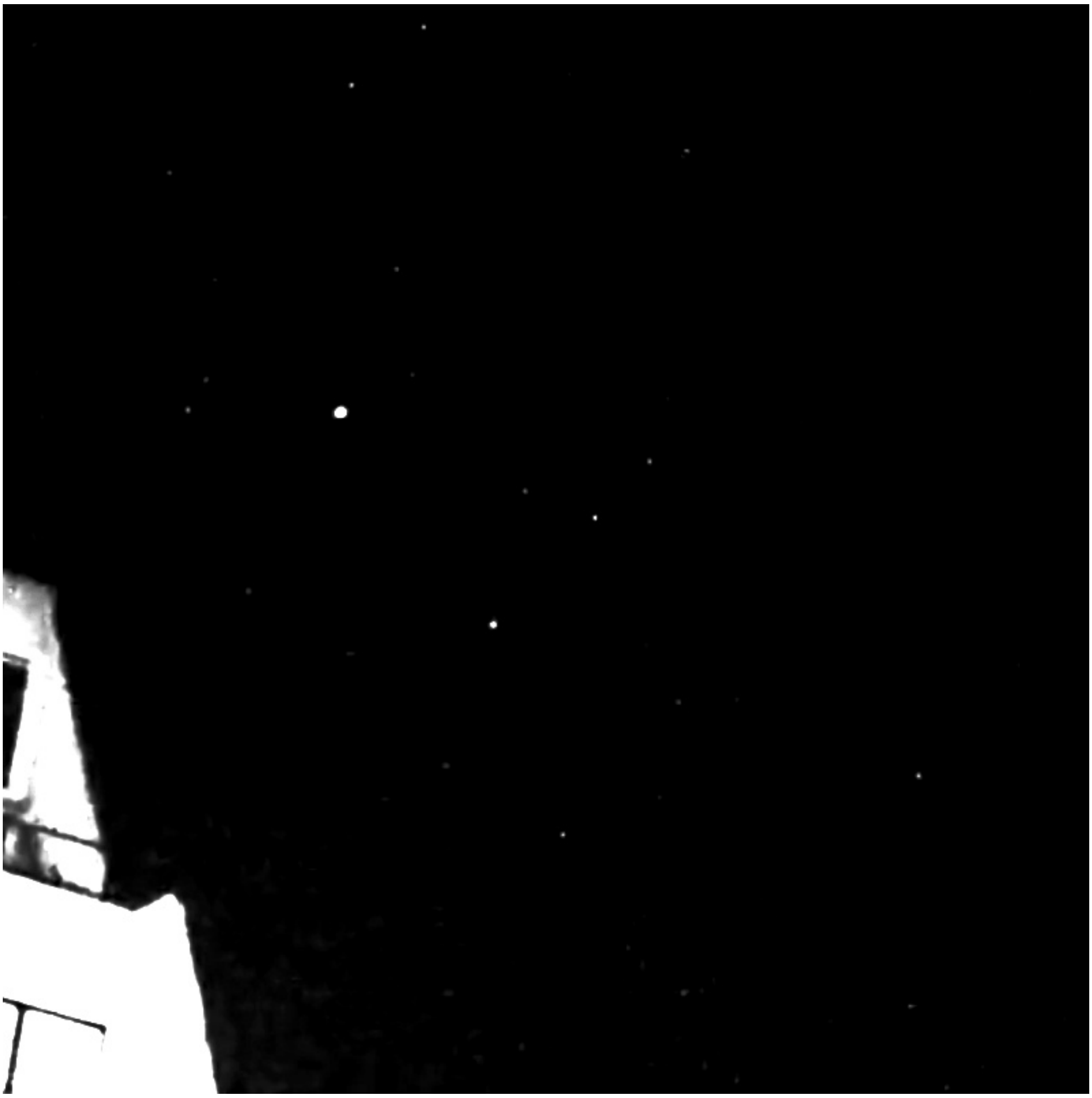
In practice, a system is said to be limited by diffraction if the aberrations that affect it have a function of spreading the point smaller than the Airy-Spot created by diffraction.



The spreading function of the point is obtained, corresponding to a change of variable, to the Fourier Transform in two dimensions of the shape of the opening.

The Airy spot is the diffraction pattern resulting from the crossing of a circular hole by the light.

We speak of Airy's task in the case of optical systems to qualify the best possible image of a source point by this system.

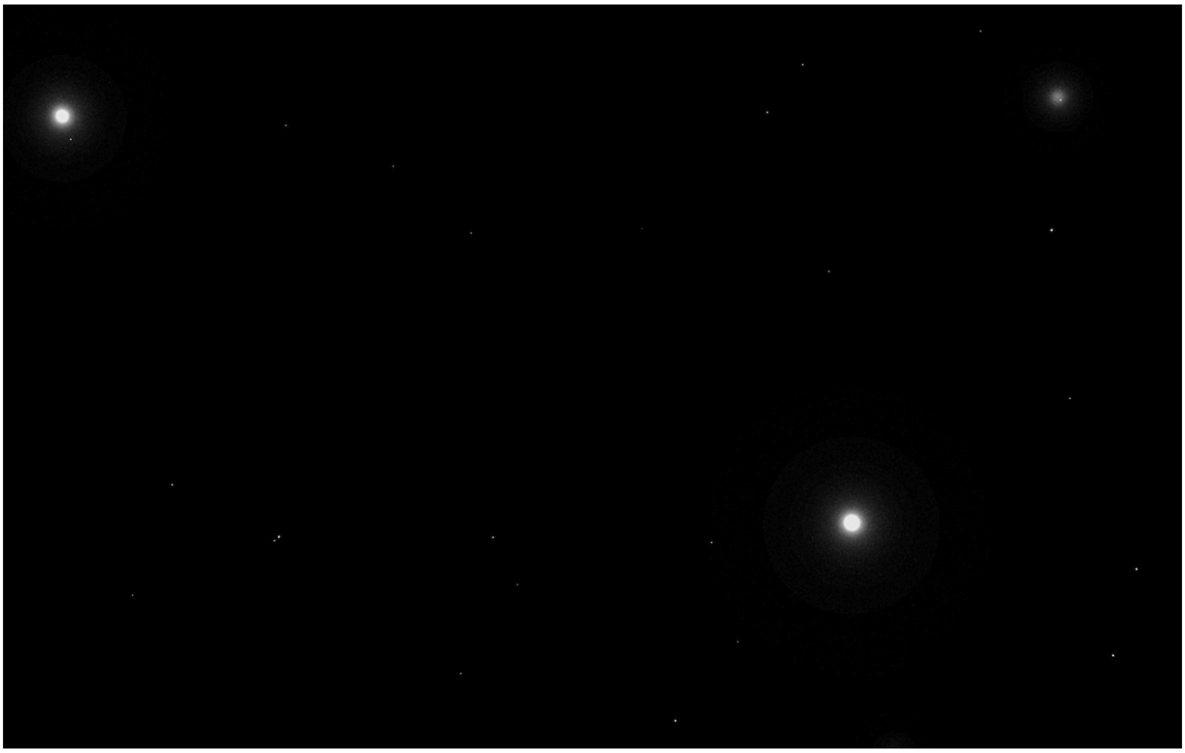


Ufo capture and post treatment + 1

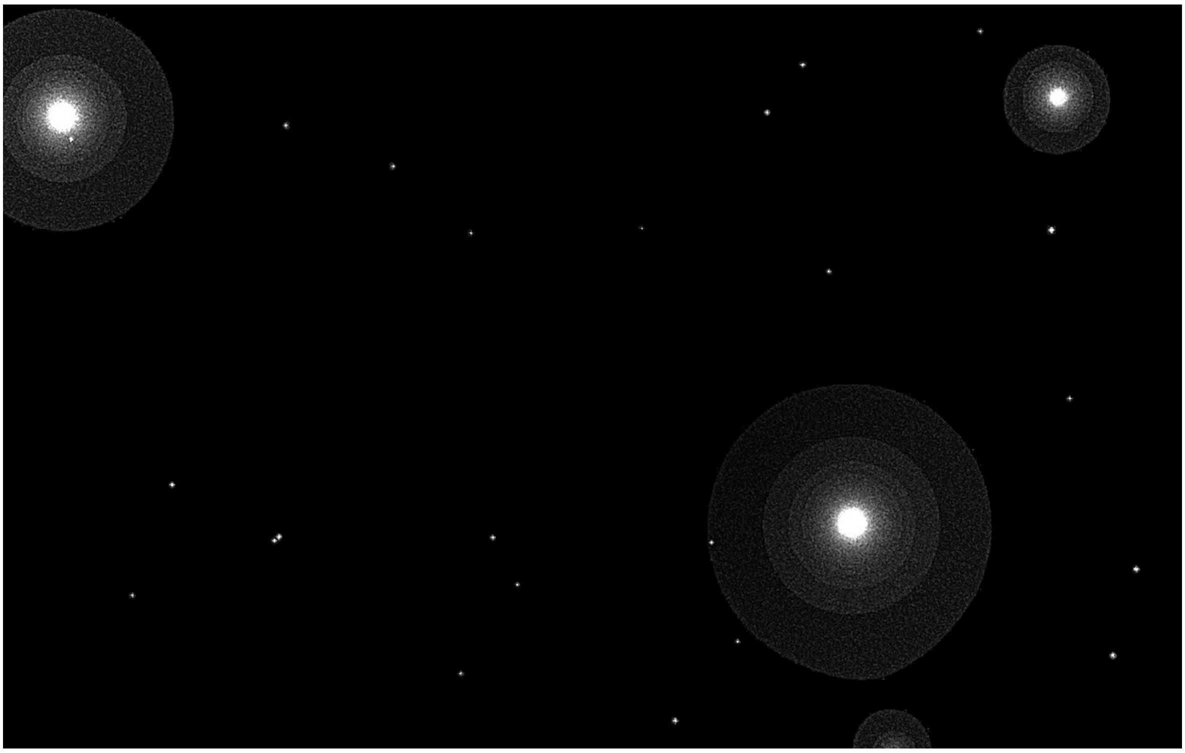
A system whose impulse response gives a Spot of Airy is said to be limited by diffraction.

The name of this figure comes from George Biddell Airy, English scientist who discovered and described the phenomenon in 1835 in: On the Diffraction of an Object-glass with Circular Aperture.

The figure shows a symmetry of revolution and takes the form of a bright spot haloed concentric circles of lower brightness.



The Airy spots capture 1 original (we see two)



Airy spots well visible!

Excerpt from the Airy spots mini poster in the Astro zine 3.

Resolution Power, or Separation Power, or Spatial Resolution, expresses the capacity of an optical measurement or Observation System.

Microscopes, telescopes or the eyes, but also some detectors, especially those used in imaging to distinguish the details..

It can be characterized by the minimum angle or distance (e) that must separate two contiguous points so that they are correctly discerned
It can, in an equivalent way, be characterized by the maximum spatial frequency that the system can measure or restore: it is then expressed in cycles per millimeter (cy-mm) or in pairs of lines per millimeter (pl-mm)

The definition of resolving power can equally well be applied to a spatial, spectral and even temporal resolution capacity.

Posted by Veronica IN DREAM at 6:12 PM