

**Review Article**

Photometry Review from Some Constellations of Autumn in the Northern Hemisphere

S. Davood Sadatian

Department of Physics, Faculty of Basic Sciences, University of Neyshabur, Neyshabur, Iran

Email address:

sd-sadatian@um.ac.ir

To cite this article:

S. Davood Sadatian. Photometry Review from Some Constellations of Autumn in the Northern Hemisphere. *World Journal of Applied Physics*. Vol. 1, No. 2, 2016, pp. 37-43. doi: 10.11648/j.wjap.20160102.12

Received: October 21, 2016; **Accepted:** November 8, 2016; **Published:** November 29, 2016

Abstract: In this study, by using some tools available in optical observatory of Neyshabur University, consider some astronomy objects in the northern hemisphere (according the climate Neyshabur city). Then we analyze images (that taken by special filter) with some analyzer software and describe their component properties. Finally we compare some constellations in the northern hemisphere together.

Keywords: Photometry, Observatory, Nebula, Telescope

1. Introduction

Photometry is the measurement of the intensity of light or of relative illuminating power. Photometric measurements are made with instruments called photometers. The devices function by collecting light through some kind of input optics, passing it through a spectral modifying filter and then measuring the light with a photosensitive detector. The filter is carefully trimmed to modify the detector response. The detector converts the incoming light energy into an electrical signal, which is then amplified and displayed. Because the filter/detector combination approximates the eye response, the measured electrical signal is a true measure of the light as perceived by a human observer. [1-2].

CCD photometry: A CCD camera is essentially a grid of photometers, simultaneously measuring and recording the photons coming from all the sources in the field of view. Because each CCD image records the photometry of multiple objects at once, various forms of photometric extraction can be performed on the recorded data; typically relative, absolute, and differential. All three will require the extraction of the raw image magnitude of the target object, and a known comparison object. The observed signal from an object will typically cover many pixels according to the point spread function (PSF) of the system. This broadening is due to both the optics in the telescope and the astronomical seeing. When obtaining photometry from a point source, the flux is

measured by summing all the light recorded from the object and subtract the light due to the sky. The simplest technique, known as aperture photometry, consists of summing the pixel counts within an aperture centered on the object and subtracting the product of the nearby average sky count per pixel and the number of pixels within the aperture. [3-4]. This will result in the raw flux value of the target object. When doing photometry in a very crowded field, such as a globular cluster, where the profiles of stars overlap significantly, one must use de-blending techniques, such as PSF fitting to determine the individual flux values of the overlapping sources. [5]

Calibrations: After determining the flux of an object in counts, the flux is normally converted into instrumental magnitude. Then, the measurement is calibrated in some way. Which calibrations are used will depend in part on what type of photometry is being done. Typically, observations are processed for relative, or differential photometry. [6] Relative photometry is the measurement of the apparent brightness of multiple objects relative to each other. Absolute photometry is the measurement of the apparent brightness of an object on a standard photometric system; these measurements can be compared with other absolute photometric measurements obtained with different telescopes or instruments. Differential photometry is the measurement of the difference in brightness of two objects. In most cases, differential photometry can be done with the highest precision, while

absolute photometry is the most difficult to do with high precision. Also, accurate photometry is usually more difficult when the apparent brightness of the object is fainter.

Absolute photometry: To perform absolute photometry one must correct for differences between the effective passband through which an object is observed and the passband used to define the standard photometric system. This is often in addition to all of the other corrections discussed above. Typically this correction is done by observing the object (s) of interest through multiple filters and also observing a number of photometric standard stars. If the standard stars cannot be observed simultaneously with the target (s), this correction must be done under photometric conditions, when the sky is cloudless and the extinction is a simple function of the airmass.

Relative photometry: To perform relative photometry, one compares the instrument magnitude of the object to a known comparison object, and then corrects the measurements for spatial variations in the sensitivity of the instrument and the atmospheric extinction. This is often in addition to correcting for their temporal variations, particularly when the objects being compared are too far apart on the sky to be observed simultaneously. When doing the calibration from an image that contains both the target and comparison objects in close proximity, and using a photometric filter that matches the catalog magnitude of the comparison object most of the measurement variations decrease to null.

Differential photometry: Differential photometry is the simplest of the calibrations and most useful for time series observations. When using CCD photometry, both the target and comparison objects are observed at the same time, with the same filters, using the same instrument, and viewed through the same optical path. Most of the observational variables drop out and the differential magnitude is simply the difference between the instrument magnitude of the target object and the comparison object ($\Delta\text{Mag} = C\text{ Mag} - T\text{ Mag}$). This is very useful when plotting the change in magnitude over time of a target object, and is usually compiled into a light curve.

Applications: Photometric measurements can be combined with the inverse-square law to determine the luminosity of an object if its distance can be determined, or its distance if its luminosity is known. Other physical properties of an object, such as its temperature or chemical composition, may be determined via broad or narrow-band spectrophotometry. Typically photometric measurements of multiple objects obtained through two filters are plotted on a color-magnitude diagram, which for stars is the observed version of the Hertzsprung-Russell diagram. Photometry is also used to study the light variations of objects such as variable stars, [7] minor planets, active galactic nuclei and supernovae, or to detect transiting extrasolar planets. Measurements of these variations can be used, for example, to determine the orbital period and the radii of the members of an eclipsing binary star system, the rotation period of a minor planet or a star, or the total energy output of a supernova.

Software: A number of free computer programs are available

for synthetic aperture photometry and PSF-fitting photometry. SExtractor (www.astromatic.net/software/sextractor) and Aperture Photometry Tool (www.aperturephotometry.org) are popular examples for aperture photometry. The former is geared towards reduction of large scale galaxy-survey data, and the latter has a graphical user interface (GUI) suitable for studying individual images. DAOPHOT is recognized as the best software for PSF-fitting photometry. [5]

2. Spectrophotometry

Spectrophotometry is the quantitative measurement of the reflection or transmission properties of a material as a function of wavelength.[6] It is more specific than the general term electromagnetic spectroscopy in that spectrophotometry deals with visible light, near-ultraviolet, and near-infrared, but does not cover time-resolved spectroscopic techniques.

Spectrophotometry uses photometers that can measure a light beam's intensity as a function of its color (wavelength) known as spectrophotometers. Important features of spectrophotometers are spectral bandwidth (the range of colors it can transmit through the test sample), the percentage of sample-transmission, the logarithmic range of sample-absorption, and sometimes a percentage of reflectance measurement.

A spectrophotometer is commonly used for the measurement of transmittance or reflectance of solutions, transparent or opaque solids, such as polished glass, or gases. However they can also be designed to measure the diffusivity on any of the listed light ranges that usually cover around 200 nm - 2500 nm using different controls and calibrations. [6] Within these ranges of light, calibrations are needed on the machine using standards that vary in type depending on the wavelength of the photometric determination. [7]

An example of an experiment in which spectrophotometry is used is the determination of the equilibrium constant of a solution. A certain reaction within a solution may occur in a forward and reverse direction where reactants form products and products break down into reactants. At some point, this reaction will reach a point of balance called an equilibrium point. In order to determine the respective concentrations of reactants and products at this point, the light transmittance of the solution can be tested using spectrophotometry. The amount of light that passes through the solution is indicative of the concentration of certain reactions that do not allow light to pass through.

The use of spectrophotometers spans various scientific fields, such as physics, materials science, chemistry, biochemistry, and molecular biology. [8] They are widely used in many industries including semiconductors, laser and optical manufacturing, printing and forensic examination, as well in laboratories for the study of chemical substances. Ultimately, a spectrophotometer is able to determine, depending on the control or calibration, what substances are present in a target and exactly how much through calculations of observed wavelengths.

3. Applications of Spectroscopy in Astronomy

(1) Identify the elements

All spectral lines of the elements are different, no two

elements have the same spectral lines. Like human fingerprints all together different. So we can use this feature to identify the elements that shows spectral lines all the elements look. The image below shows the spectral lines of the elements.

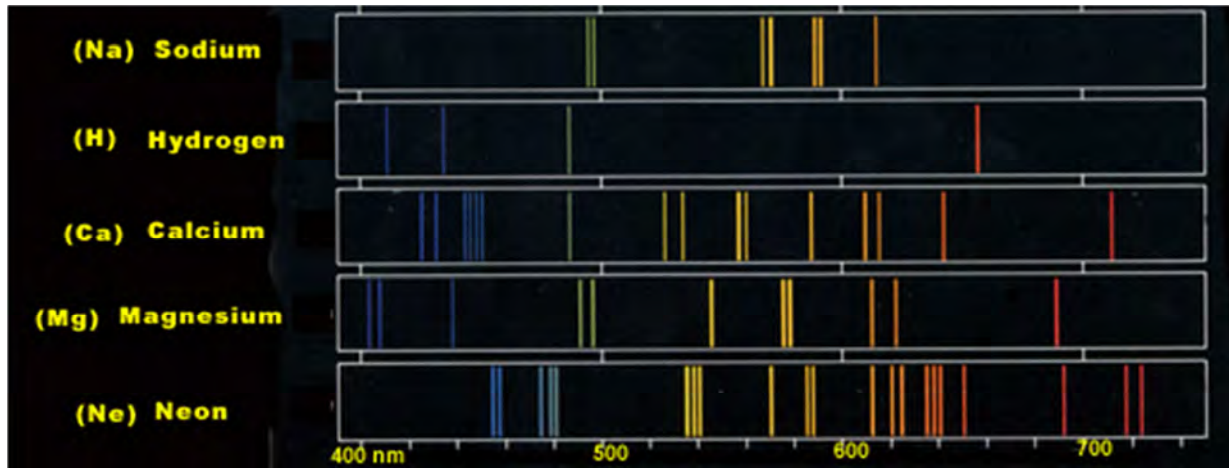


Figure 1. Spectrum of some elements.

(2) Discarding or Approaching celestial body

If an object is moving away from us a bit in the red spectral lines are displaced with redshift and If we approach it in the blue spectral lines are displaced with blueshift.

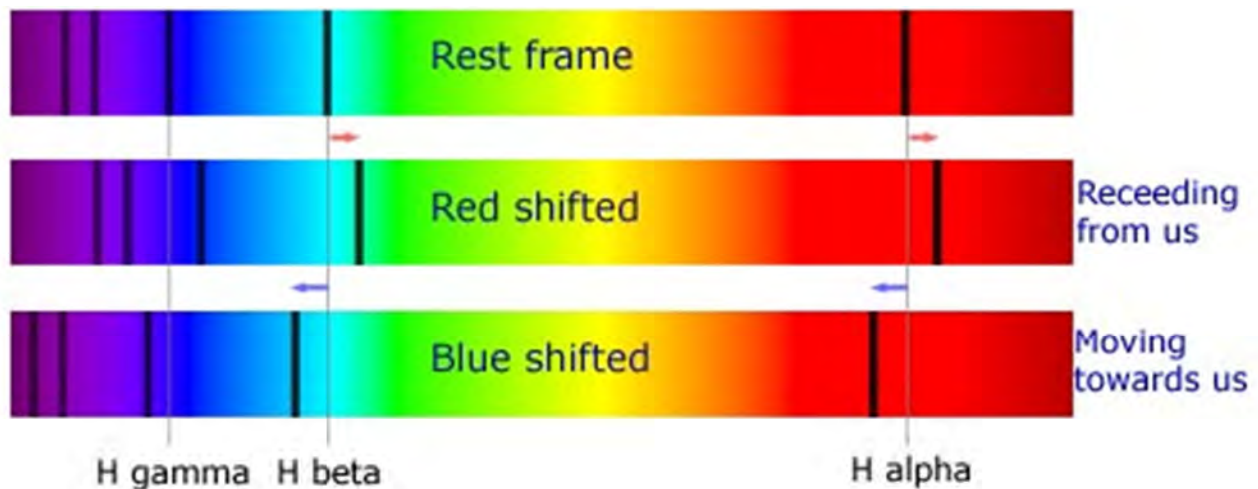


Figure 2. Doppler effect.

This feature is also called the Doppler effect, or Doppler transfer.

(3) Identify magnetic field (the Zeeman effect)

Such a situation is called to the fine structure of spectral lines by the Zeeman first time (in 1896) was observed is called the Zeeman effect. This can be used to detect magnetic fields. From the same sunspot magnetic fields have been discovered.

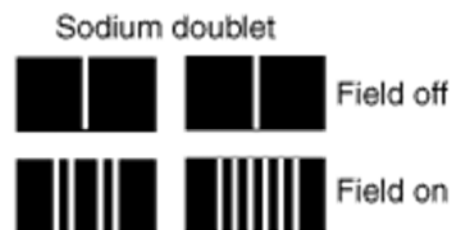


Figure 3. Zeeman effect.

This can be used to detect magnetic fields. From the same sunspot magnetic fields have been discovered.

(4) Measure the temperature of stars

Different elements at different temperatures aren't same. Intensity of spectral lines is very different in different stars, some stars have strong spectral lines of hydrogen and hydrogen lines are some strong lines instead of sodium and calcium. Is their ingredients differ? No. When scientists studied more about atomic physics discovered that the temperature of the photosphere of a star spectral lines pattern is determined. That's why we can not determine the temperature of the star's spectrum on the strong absorption lines.

4. Analyze two Constellations of Autumn in the Northern Hemisphere

A) Orion Nebula

The Orion Nebula (also known as Messier 42, M42, or NGC 1976) is a diffuse nebula situated in the Milky Way,

being south of Orion's Belt in the constellation of Orion. It is one of the brightest nebulae, and is visible to the naked eye in the night sky. M42 is located at a distance of $1,344 \pm 20$ light years [9, 10] and is the closest region of massive star formation to Earth. The M42 nebula is estimated to be 24 light years across. It has a mass of about 2000 times the mass of the Sun. Older texts frequently refer to the Orion Nebula as the Great Nebula in Orion or the Great Orion Nebula. [11]

The Orion Nebula is one of the most scrutinized and photographed objects in the night sky, and is among the most intensely studied celestial features. [12] The nebula has revealed much about the process of how stars and planetary systems are formed from collapsing clouds of gas and dust. Astronomers have directly observed protoplanetary disks, brown dwarfs, intense and turbulent motions of the gas, and the photo-ionizing effects of massive nearby stars in the nebula.



Figure 4. Orion Nebula (taken with S. Davood Sdatian, University of Neyshabur Observatory).

The nebula is visible with the naked eye even from areas affected by some light pollution. It is seen as the middle "star" in the "sword" of Orion, which are the three stars located south of Orion's Belt. The star appears fuzzy to sharp-eyed observers, and the nebulosity is obvious through binoculars or a small telescope. The peak surface brightness of the central region is about 17 Mag/arcsec² (about 14 millinits) and the outer bluish glow has a peak surface brightness of 21.3 Mag/arcsec² (about 0.27 millinits). [13] (In the photos shown here the brightness, or luminance, is enhanced by a large factor.)

The Orion Nebula contains a very young open cluster, known as the Trapezium due to the asterism of its primary four stars. Two of these can be resolved into their component

binary systems on nights with good seeing, giving a total of six stars. The stars of the Trapezium, along with many other stars, are still in their early years. The Trapezium is a component of the much larger Orion Nebula Cluster, an association of about 2,800 stars within a diameter of 20 light years. [14] Two million years ago this cluster may have been the home of the runaway stars AE Aurigae, 53 Arietis, and Mu Columbae, which are currently moving away from the nebula at velocities greater than 100 km/s. [15]

Observers have long noted a distinctive greenish tint to the nebula, in addition to regions of red and of blue-violet. The red hue is a result of the H α recombination line radiation at a wavelength of 656.3 nm. The blue-violet coloration is the reflected radiation from the massive O-class stars at the core

of the nebula.

The green hue was a puzzle for astronomers in the early part of the 20th century because none of the known spectral lines at that time could explain it. There was some speculation that the lines were caused by a new element, and the name nebulium was coined for this mysterious material. With better understanding of atomic physics, however, it was later determined that the green spectrum was caused by a low-probability electron transition in doubly ionized oxygen, a so-called "forbidden transition". This radiation was all but impossible to reproduce in the laboratory at the time, because it depended on the quiescent and nearly collision-free environment found in the high vacuum of deep space. [16]

Optical images reveal clouds of gas and dust in the Orion Nebula; an infrared image reveals the new stars shining within. The entirety of the Orion Nebula extends across a 1° region of the sky, and includes neutral clouds of gas and dust, associations of stars, ionized volumes of gas, and reflection nebulae.

The Nebula is part of a much larger nebula that is known as the Orion Molecular Cloud Complex. The Orion Molecular Cloud Complex extends throughout the constellation of Orion and includes Barnard's Loop, the Horsehead Nebula, M43, M78, and the Flame Nebula. Stars are forming throughout the entire Cloud Complex, but most of the young stars are concentrated in dense clusters like the one illuminating the Orion Nebula [17]

The current astronomical model for the nebula consists of an ionized (H II) region, roughly centered on Theta1 Orionis

C, which lies on the side of an elongated molecular cloud in a cavity formed by the massive young stars. [18] (Theta1 Orionis C emits 3-4 times as much photoionizing light as the next brightest star, Theta2 Orionis A.) The H II region has a temperature ranging up to 10,000 K, but this temperature falls dramatically near the edge of the nebula. The nebulous emission comes primarily from photoionized gas on the back surface of the cavity. The H II region is surrounded by an irregular, concave bay of more neutral, high-density cloud, with clumps of neutral gas lying outside the bay area. This in turn lies on the perimeter of the Orion Molecular Cloud. The gas in the molecular cloud displays a range of velocities and turbulence, particularly around the core region. Relative movements are up to 10 km/s (22,000 mi/h), with local variations of up to 50 km/s and possibly more. [19]

Observers have given names to various features in the Orion Nebula. The dark lane that extends from the north toward the bright region is called the "Fish's Mouth". The illuminated regions to both sides are called the "Wings". Other features include "The Sword", "The Thrust", and "The Sail".

Ring Nebula

The Ring Nebula (also catalogued as Messier 57, M57 or NGC 6720) is a planetary nebula in the northern constellation of Lyra. [20] Such objects are formed when a shell of ionized gas is expelled into the surrounding interstellar medium by a red giant star, which was passing through the last stage in its evolution before becoming a white dwarf.



Figure 5. Ring Nebula (taken with S. Davood Sdatian, University of Neyshabur Observatory).

Messier 57 is located south of the bright star Vega, which forms the northwestern vertex of the Summer Triangle asterism. The nebula lies about 40% of the distance from

Beta (β) to Gamma (γ) Lyrae, [22] making it an easy target for amateur astronomers to find. [21]

The nebula disk has an angular size of 1.5×1 arcminutes,

making it too small to be resolved with 10×50 binoculars. [22] It is best observed using a telescope with an aperture of at least 20 cm (8 in), but even a 7.5 cm (3 in) telescope will reveal its elliptical ring shape. [23] The interior hole can be resolved by a 10 cm (4 in) instrument at a magnification of 100×.[22] Larger instruments will show a few darker zones on the eastern and western edges of the ring, and some faint nebulosity inside the disk. The central star, at magnitude 14.8, is difficult to spot.[24]

M57 is 0.7 kpc (2,300 light-years) from Earth. [25] It has a visual magnitude of 8.8_v and photographic magnitude of 9.7_p. Photographs taken over a period of 50 years [26] show the rate of nebula expansion is roughly 1 arcsecond per century, which corresponds to spectroscopic observations as 20–30 km s⁻¹. M57 is illuminated by a central white dwarf or planetary nebula nucleus (PNN) of 15.75_v visual magnitude. [27]

All the interior parts of this nebula have a blue-green tinge that is caused by the doubly ionized oxygen emission lines at 495.7 and 500.7 nm. These observed so-called "forbidden lines" occur only in conditions of very low density containing a few atoms per cubic centimeter. In the outer region of the ring, part of the reddish hue is caused by hydrogen emission at 656.3 nm, forming part of the Balmer series of lines. Forbidden lines of ionized nitrogen or [N II] contributes to the reddishness at 654.8 and 658.3 nm. [28]

M57 is an example of the class of planetary nebulae known as bipolar nebulae, whose thick equatorial rings visibly extend the structure through its main axis of symmetry. It appears to be a prolate spheroid with strong concentrations of material along its equator. From Earth, the symmetrical axis is viewed at about 30°. Overall, the observed nebulosity has been currently estimated to be expanding for approximately 1610±240 years [29].

Structural studies find this planetary exhibits knots characterized by well developed symmetry. However, these are only silhouettes visible against the background emission of the nebula's equatorial ring. M57 may include internal N II emission lines located at the knots' tips that face the PNN; however, most of these knots are neutral and appear only in extinction lines. Their existence shows they are probably only located closer to the ionization front than those found in the Lupus planetary IC 4406. Some of the knots do exhibit well-developed tails which are often detectable in optical thickness from the visual spectrum [30].

5. Conclusion

Photometry, in astronomy, the measurement of the brightness of stars and other celestial objects (nebulae, galaxies, planets, etc.). Such measurements can yield large amounts of information on the objects' structure, temperature, distance, age, etc. Photometric work is always a compromise between the time taken for an observation and its complexity. A small number of broad-band measurements can be done quickly, but as more colors are used for a set of magnitude determinations for a star, more can be deduced about the

nature of that star. The simplest measurement is that of effective temperature, while data over a wider range allow the observer to separate giant from dwarf stars, to assess whether a star is metal-rich or deficient, to determine the surface gravity, and to estimate the effect of interstellar dust on a star's radiation. Finally, we should emphasize that the two nebulae are different in light intensity at each frequency spectrum and different mass structure. However, in this essay, we considered some property of two nebulae according nebula images taken in our observatory.

References

- [1] Sterken, Christiaan; Manfroid, J. (1992), *Astronomical photometry: a guide*, Astrophysics and space science library, 175, Springer, pp. 1–6, ISBN 0-7923- 1653-3.
- [2] Warner, Brian (2006). *A Practical Guide to Lightcurve Photometry and Analysis*, Springer, ISBN 0-3872-9365-5.
- [3] Mighell, Kenneth J. (1999). "Algorithms for CCD Stellar Photometry". *ASP Conference Series*. 172: 317–328.
- [4] Laher, Russ R.; et al. (2012). "Aperture Photometry Tool". *Publications of the Astronomical Society of the Pacific*. 124 (917): 737–763.
- [5] Stetson, Peter B. (1987). "DAOPHOT: A Computer Program for Crowded-Field. Stellar Photometry". *Publications of the Astronomical Society of the Pacific*. 99: 191–222.
- [6] Allen, D., Cooksey, C., & Tsai, B. (2010, October 5). *Spectrophotometry*. Retrieved from <http://www.nist.gov/pml/div685/grp03/spectrophotometry.cfm>
- [7] Schwedt, Georg. (1997). *The Essential Guide to Analytical Chemistry*. (Brooks Haderlie, trans.). Chichester, NY: Wiley. (Original Work Published 1943). 16- 17.
- [8] Rendina, George. *Experimental Methods in Modern Biochemistry* W. B. Saunders Company: Philadelphia, PA. 1976. pp. 46-55.
- [9] "SIMBAD Astronomical Database". Results for NGC 7538. Retrieved 2006-10- 20.
- [10] Gater, Will; Vamplew, Anton (2010). *The Practical Astronomer* (1st American ed.). London: DK Pub. p. 242. ISBN 9780756673246. Retrieved 4 March 2016.
- [11] Reid, M. J.; et al. (2009). "Trigonometric Parallaxes of Massive Star Forming Regions: VI. Galactic Structure, Fundamental Parameters and Non-Circular Motions". *Astrophysical Journal*. 700: 137. arXiv:0902.3913.
- [12] Hirota, Tomoya; et al. (2007). "Distance to Orion KL Measured with VERA". *Publications of the Astronomical Society of Japan*. 59 (5): 897–903.
- [13] Wikisource-logo.svg Ripley, George; Dana, Charles A., eds. (1879). "Nebula". *The American Cyclopædia*.
- [14] "Astronomers Spot The Great Orion Nebula's Successor", *Harvard-Smithsonian Center for Astrophysics*, 2006.
- [15] Clark, Roger (2004-03-28). "Surface Brightness of Deep Sky Objects". Retrieved 2013-06-29. The conversion to nits is based on 0 magnitude being 2.08 microlux.

- [16] Hillenbrand, L. A.; Hartmann, L. W. (1998). "Preliminary Study of the Orion Nebula Cluster Structure and Dynamics". *Astrophysical Journal*. 492: 540–553.
- [17] Blaauw, A.; et al. (1954). "The Space Motions of AE Aurigae and μ Columbae with Respect to the Orion Nebula". *Astrophysical Journal*. 119: 625.
- [18] Bowen, Ira Sprague (1927). "The Origin of the Nebulium Spectrum". *Nature*. 120 (3022): 473. Bibcode:1927Natur.120..473B. doi:10.1038/120473a0.
- [19] Carrasco, David, ed. (2001). *The Oxford Encyclopedia of Mesoamerican cultures the civilizations of Mexico and Central America*. Oxford [u. a.]: Oxford Univ. Press. p. 165. ISBN 9780195142570. Retrieved 4 March 2016.
- [20] "SIMBAD Astronomical Database". Results for Messier 57. Retrieved 2006-12-19.
- [21] O'Dell, C. R.; Balick, B.; Hajian, A. R.; Henney, W. J.; Burkert, A. (2002). "Knots in Nearby Planetary Nebulae". *Astronomical Journal*. 123 (6): 3329–3347.
- [22] Harris, Hugh C.; Dahn, Conrad C.; Canzian, Blaise; Guetter, Harry H.; Leggett, K.; Levine, Stephen E.; et al. (2007). "Trigonometric Parallaxes of Central Stars of Planetary Nebulae". *Astronomical Journal*. 133 (2): 631–638. arXiv: astro-ph/0611543 free to read.
- [23] Murdin, P. (2000). "Ring Nebula (M57, NGC 6720)". In Paul Murdin. *Encyclopedia of Astronomy and Astrophysics*. Institute of Physics Publishing.
- [24] Coe, Steven R. (2007). *Nebulae and how to observe them. Astronomers'. observing guides*. Springer. p. 111. ISBN 1-84628-482-1.
- [25] Garfinkle, Robert A. (1997). *Star-hopping: Your Visa to Viewing the Universe*. Cambridge University Press. ISBN 0-521-59889-3. OCLC 37355269.
- [26] Messier, Charles (1780). "Catalogue des Nébuleuses & des amas d'Étoiles". *Connaissance des Temps for 1783*. pp. 225–249.
- [27] Steinicke, Wolfgang (2010). *Observing and Cataloguing Nebulae and Star Clusters: From Herschel to Dreyer's New General Catalogue*. Cambridge. University Press. pp. 42–43. ISBN 0-521-19267-6.
- [28] Frommert, Hartmut; Kronberg, Christine. "William Huggins (February 7, 1824–May 12, 1910)". SEEDS. Archived from the original on 2008-04-21. Retrieve 2008-04-11.
- [29] Huggins, W.; Miller, W. A. (1863–1864). "On the Spectra of Some of the Nebulae. And On the Spectra of Some of the Fixed Stars". *Proceedings of the Royal Society of London*. 13 (0): 491–493.