The Goto Spectroscope

The User Guide and a Few Notes about the Instrument And Amateur Astro-Spectroscopy

Barry D. Malpas – 09/03/2013

A Short Bit of Goto Spectroscope History

The Goto Optical Manufacturing Company was established in 1926 by Mr. Seizo Goto for the purpose of producing astronomical optical equipment for the educational market. The Goto Spectroscope was manufactured from the late 1940s through the 1980s and was sold in the United States by Edmund Scientific, Barrington, NJ, as well as Lafayette Radio Electronics, Syosset, NY, and by Efston Science, in Toronto, Canada.

Edmund originally sold it for about $40 in the 1950s, and as much as $400 by the late 1980s. Unfortunately, they did not sell the 6mm, 12.5mm, and other Goto Huygens eyepieces into which the spectroscope threads. Instead they sometimes sold an adapter separately to slide over the purchaser's own eyepiece which was inconvenient since the optics did not always match properly.

While the Lafayette version came with two eyepiece adapters allowing for different eyepiece thread sizes with .965 eyepiece barrels (shown above), their version to fit the standard 1¼ inch diameter focusing tube had its own machined 1¼ inch diameter barrel without optics. Since it did not include a "collimating" lens (eyepiece), it therefore produced some rather odd spectra as the incoming light was conical, and not parallel.

The Goto Spectroscopes were the first designed for use by amateurs and were excellently manufactured. I suspect that the subject of amateur astro-spectroscopy, at least in the United States, was not that well received early on because of the lack of understanding by the American marketing companies (i.e. Edmund and Lafayette) of the correct optical and use requirements by the Telescope-Spectroscope combination resulting in usually mediocre to bad performance.

Good "Seeing" is Very Important When Using Any "Slitless" Eyepiece Spectroscope

The most interesting and easiest stars to visually observe on a regular basis are the bright Type A stars (Sirius, Deneb, Altair, Vega) and Type M stars (Betelgeuse, Antares, Scheat) because of their dominant absorption lines.

The A Type stars show the very distinct Hydrogen Balmer lines, alpha, beta and gamma, at their maximum, while stars of Type M have broad absorption bands produced by many metals as well as molecules like Titanium Oxide.

Other Spectral Types, specifically F, G and K, because their absorption lines are of a finer structure, often require the "seeing" to be from very good to excellent. Since the absorption lines are produced by the "point source" of the star itself, the fine structure is blurred due to any unsteadiness of the atmosphere resulting in much less, or even no detail.

Goto Star Spectroscope User Guide with Notes

USER GUIDE
STAR SPECTROSCOPE

This is a handy star spectroscope of "Amici" type consisting of:

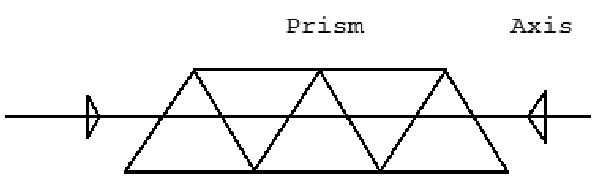
a. 5-Piece Prism Pipe
b. Eyepiece Mounting Screw Cap (adapter)
c. Cylindrical Lens caps (Each having 1, 2 or 3 dot engraved on it)

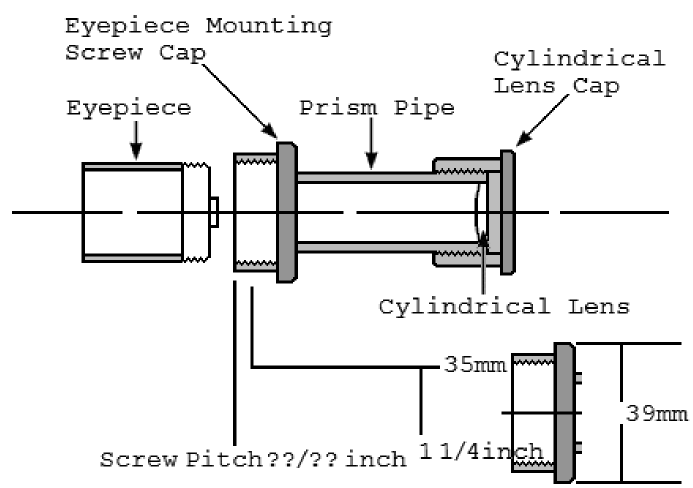
1 Dot (.) slow curvature
2 Dots (..) medium curvature
3 Dots (...) strong curvature

One and Two dotted cylindrical lenses are for use with small aperture telescopes (about 1-1/2" to 3") with low power eyepiece. In this case it is possible to obtain spectrum of 1-3 magnitude stars. If larger aperture telescope of 4" or more is used, spectrum of more faint stars can be observed. Three-dot lens is for telescopes with larger objective.

How to use:

1. Adjust your telescope and catch a star for observation.
2. Remove the eyepiece cap of telescope and mount the spectroscope by means of Eyepiece Mounting Screw Cap.
3. If the direction of prism dispersion and the axis of the cylindrical lens is in disorder, or not as illustrated below, adjust it by revolving the Cylindrical Lens Cap, or correct the position of Cylindrical Lens itself by loosening the lens pushing ring.





Notes:

1. Fraunhofer line ranges from C (wavelength 656.3 nm) to G' (wave length 434.0 nm). Dispersion between C and G' is 9°.
2. Resolution Power is 1 nm. Powerful enough to separate D double line.
3. This spectroscope is not intended for spectrum of sun and moon.

GOTO INC
4-16 Yazakicho, Fuchu-shi, Tokyo 183
8530, Japan
Tel +81-42-362-5312

My Notes:

To the right is the original scan of the user guide page. This is the only readable copy I have been able to locate on or off the Internet and is, unfortunately, a very small one. Following are a few possible errors that I may have made in trying to read it. However, I am quite sure that any errors are minor and will not affect the understanding of the use of the spectroscope guide. - *I've also included some extra comments that the reader may find useful.*

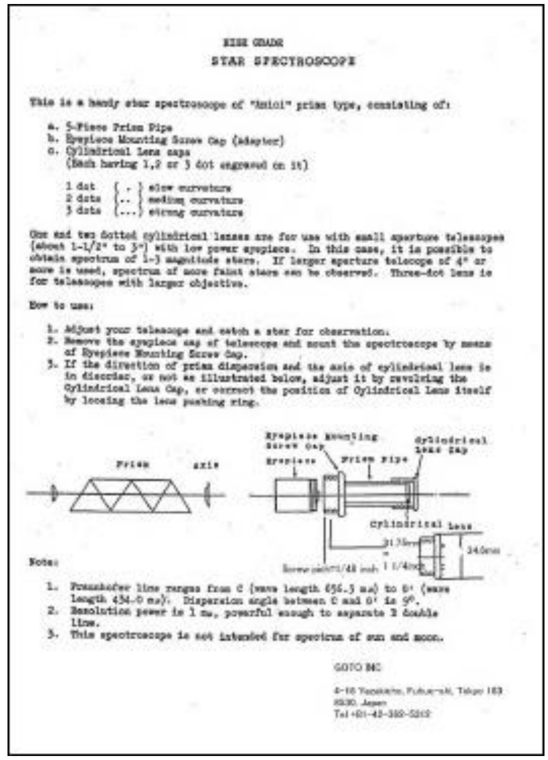
Title: Not sure of the first title line: User Guide, Nice Grade?

Notes Section:

1. The guide references the Fraunhofer designations of the Hydrogen Balmer series. The C wavelength refers to the first line of the Hydrogen series, Hydrogen Alpha (Hα – 656.3 nm, red), and G', the third line of the series, Hydrogen Gamma (Hγ – 434.0 nm, blue), spanning most of the visible spectrum. (Possible Errata: The guide appears to list Hα as 654.3 nm.)

2. The guide again makes reference to the Fraunhofer designation with the D doublet of Sodium (589.29 nm). D_1 is 589.592 nm, and D_2 is 588.995 nm. However, the dispersion difference between D_1 and D_2 is about 0.6 nm, less than the 1 nm resolution given.

3. In the illustration, I am not sure that the term "Screw Pitch" is correct, nor the characters following it, except "inch".



HIGH GRADE
STAR SPECTROSCOPE

This is a handy star spectroscope of "Amici" prism type, consisting of:

a. 5-Piece Prism Pipe
b. Eyepiece Mounting Screw Cap (Adapter)
c. Cylindrical Lens caps
(Each having 1,2 or 3 dot engraved on it)

1 dot (.) slow curvature
2 dots (..) medium curvature
3 dots (...) strong curvature

One and two dotted cylindrical lenses are for use with small aperture telescopes (about 1-1/2" to 3") with low power eyepiece. In this case, it is possible to obtain spectrum of 1-3 magnitude stars. If larger aperture telescope of 4" or more is used, spectrum of more faint stars can be observed. Three-dot lens is for telescopes with larger objective.

How to use:

1. Adjust your telescope and catch a star for observation.
2. Remove the eyepiece cap of telescope and mount the spectroscope by means of Eyepiece Mounting Screw Cap.
3. If the direction of prism dispersion and the axis of cylindrical lens is in disorder, or not as illustrated below, adjust it by revolving the Cylindrical Lens Cap, or correct the position of Cylindrical Lens itself by loosing the lens pushing ring.

Note:

1. Fraunhofer line ranges from C (wave length 656.3 mμ) to G' (wave length 434.0 mμ). Dispersion angle between C and G' is 9°.
2. Resolution power is 1 mμ, powerful enough to separate D double line.
3. This spectroscope is not intended for spectrum of sun and moon.

GOTO INC

Low Resolution Scan of
Original One Page User Guide

Edmund Scientific (Left) and Lafayette (Right) Versions
with Two Goto Eyepieces (12.5mm and 6mm, respectively)

Each spectroscope came with 3 cylindrical lens caps to stretch the spectrum at right angles to the dispersion in order to allow for better visual observing. However, the Lafayette model for .965 eyepieces came with two eyepiece adapters allowing for different eyepieces.

Goto Spectroscope (Edmund)
threaded onto the 6mm Huygens Eyepiece

Note that the top of the 6mm eyepiece (presented up-side-down, left) has been un-threaded and removed from the eyepiece barrel in order to allow the spectroscope to be connected.

Which is Better … Prism, or Diffraction Grating Spectroscopes?
Some Advantages and Disadvantages of Each

Prism Spectroscopes

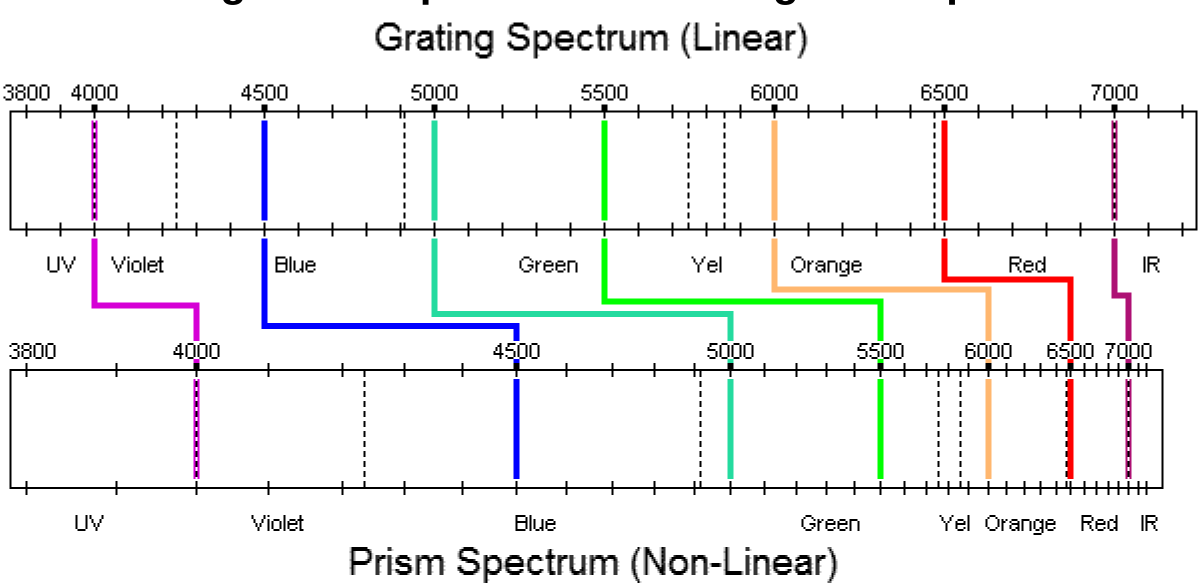
Eyepiece Prism Spectroscopes, such as the Goto Star Spectroscope, use an array of “Amici” prisms to “Refract” the incoming light to produce their spectra while maintaining a direct optical axis for viewing. For spectral light intensity when observing, a prism-based spectroscope will produce a higher efficiency spectrum (brighter) over one produced by diffraction because all of the light is “refracted” into a single spectrum. The main disadvantage of a prism spectroscope is the non-linearity of the wavelengths with the blue wavelengths being more spread out, while the red wavelengths are bunched up. This is a disadvantage if you plan on photographing and calibrating the spectra and measuring wavelength. However, it can also be an advantage if you plan to buy published photographs of comparison stellar spectra, as many were taken using prism spectrographs.

Diffraction Grating Spectroscopes

An example of an Eyepiece Diffraction Grating instrument is the Spectroscope made by Rainbow Optics which utilizes a Transmission Diffraction Grating as its light disperser. The primary advantage of a grating spectroscope is the wavelength linearity. That is to say, the dispersion angle between 400-500 nm is the same as from 600-700 nm (no red-end bunching as with a prism. See illustration below.) However, a grating produces a series of spectra and, even when “blazed”, may cumulatively lose 20%-35% of the light in the zeroth order (direct pass-thru), along with higher order spectra.

Note: Diffraction grating “Blaze” is the method of beveling the diffraction lines of a grating to direct most of the energy at a specific angle in the direction of the primary wavelength region of interest for analysis. For example: A standard lab grating will often place the Blaze in the 550 nm (midpoint of the visible) of the first order spectrum.

Grating-Prism Spectrum Wavelength Comparison



A Short Summary

Whether a prism or grating is used, the amount of light being collected is very important. The larger the telescope objective, the more light will be collected, and the more individual stars can be observed for their spectra. But, even a 12-inch has a visual limit of about fourth magnitude for observing any detail.