

# College of San Mateo Observatory

## Stellar Spectra Catalog



Spectra taken from CSM observatory using  
SBIG Self Guiding Spectrograph (SGS)

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A work in progress compiled by faculty, staff, and students.

## Stellar Spectroscopy

Stars are divided into different spectral types, which result from varying atomic-level activity on the star, due to its surface temperature. In spectroscopy, we measure this activity via a spectrograph/CCD combination, attached to a moderately sized telescope. The resultant data are converted to graphical format for further analysis.

The main spectral types are characterized by the letters O, B, A, F, G, K, & M. Stars of O type are the hottest, as well as the rarest. Stars of M type are the coolest, and by far, the most abundant. Each spectral type is also divided into ten subtypes, ranging from 0 to 9, further delineating temperature differences.

Type	Temperature	Color
O	30,000 - 60,000 K	Blue
B	10,000 - 30,000 K	Blue-white
A	7,500 - 10,000 K	White
F	6,000 - 7,500 K	Yellow-white
G	5,000 - 6,000 K	Yellow
K	3,500 - 5,000 K	Yellow-orange
M	>3,500 K	Red

### Class Spectral Lines

**O** -Weak neutral and ionized Helium, weak Hydrogen, a relatively smooth continuum with very few absorption lines

**B** -Weak neutral Helium, stronger Hydrogen, an otherwise relatively smooth continuum

**A** -No Helium, very strong Hydrogen, weak CaII, the continuum is less smooth because of weak ionized metal lines

**F** -Strong Hydrogen, strong CaII, weak NaI, G-band, the continuum is rougher because of many ionized metal lines

**G** -Weaker Hydrogen, strong CaII, stronger NaI, many ionized and neutral metals, G-band is present

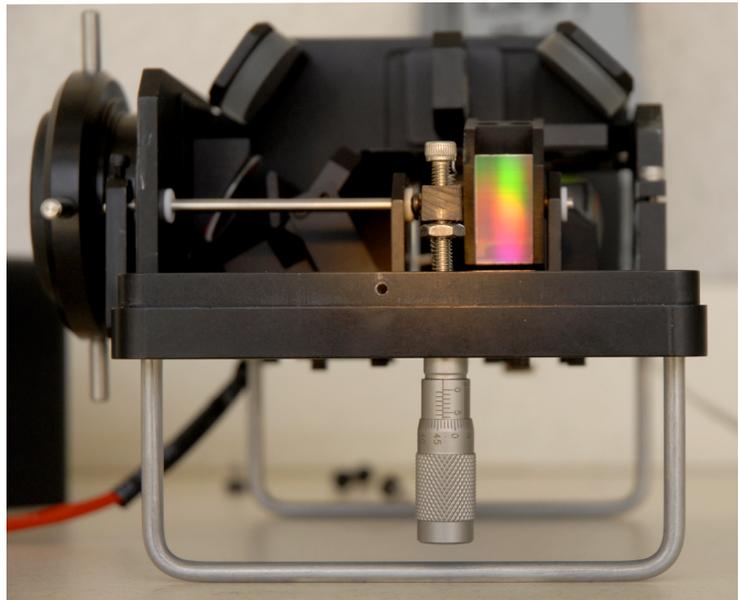
**K** -Very weak Hydrogen, strong CaII, strong NaI and many metals G-band is present

**M** -Strong TiO molecular bands, strongest NaI, weak CaII very weak Hydrogen absorption. (Note: Hydrogen may be *emission* lines.)

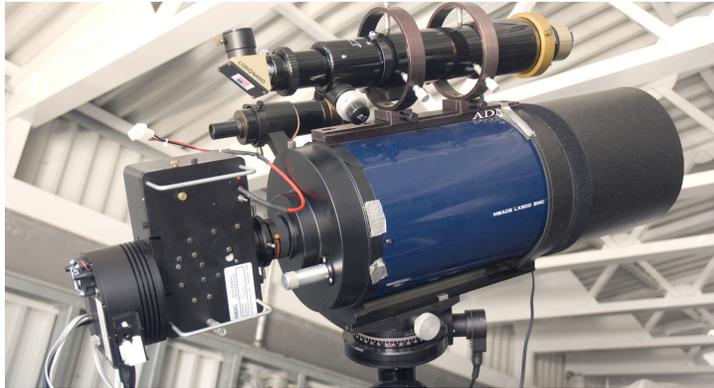
In addition, a star's luminosity class can be expressed in Roman numerals, ranging from I to V. As an example, a B8V Type star indicates a blue-white star, leaning toward white with a temperature  $\sim 2600\text{K}$ , and a luminosity class of V. Luminosity class V stars are main-sequence stars, fusing hydrogen to helium in their cores. Our sun is classified as a G2V star. (yellow, main sequence) A star's luminosity is a function of its surface area and temperature.

Luminosity Class	Description
I	Supergiants
II	Bright giants
III	Giants
IV	Subgiants
V	Main-sequence stars

For recording stellar spectra, we use an SBIG SGS spectrograph attached to the telescope. Starlight passes through the telescope optics, into the spectrograph, and through a slit. A blazed reflective diffraction grating, a fine ruled surface, then splits the incoming light into a spectrum. The spectral image is focused onto the CCD (charge-coupled device) camera, and recorded.

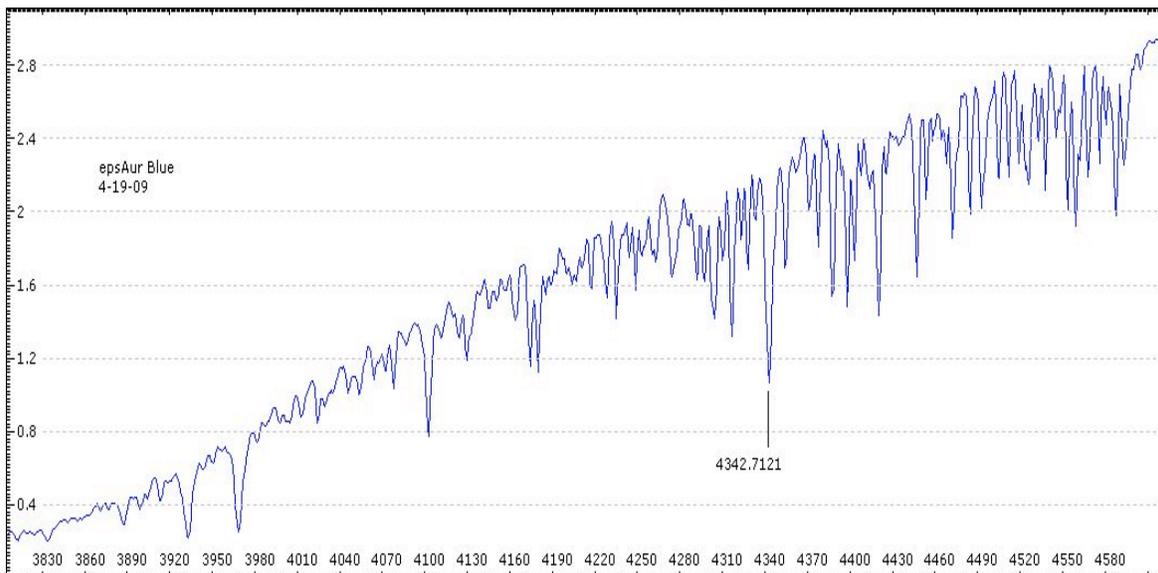


SGS side view w/ micrometer, diffraction grating.



Setup for taking stellar spectra. -CSM observatory

The camera's X axis represents wavelength, or location in the spectrum. Y axis represents intensity or signal strength. Looking at stellar spectra, we see gaps or absorption lines, representing different elements and differences in energy levels of the particular atoms within that element. The amount of a particular element affects the strength of that element's absorption line. The analysis of spectral lines can also be used to determine a star's rotational velocity and chromospheric activity.



Epsilon Aurigae in blue, 4-19-09 Line 4342=H gamma. -CSM observatory

## Equipment:

**Losmandy G-11** equatorial mount w/Gemini. The mount takes goto commands from the computer to provide accurate tracking, via camera control software.

**Meade 8" SCT** telescope with f/6.3 focal reducer. The faster f/ratio allows shorter exposure times, and imaging of fainter stars. FL=1270mm. Focusing is done manually.



**SBIG SGS** spectrograph with 600 lines per mm, with hi res. grating. Dispersion=1.064/pixel. Stars are imaged in blue and/or red end of the spectrum. A mercury lamp provides blue calibration spectra, and a neon lamp, the red calibration spectra. We've added a cable to the SGS, to allow computer room control of the LED slit illumination.

**SBIG ST-7XME** CCD camera is design-specific to the SGS and "non anti blooming" for good linear response. Most images are taken with the imaging chip cooled to -10C, greatly reducing electronic noise.

## Software:

**TheSky6** -with the G-11 for object location and mount control. Sky6 also provides spectral, and other information.



**CCDSOFT** -for image acquisition and all camera control including focus, temperature, and autoguiding.

**Maxim DL** -image reduction tools for "dark frame" subtraction.

**Iris** -for horizontal adjustment of the spectra, and vertical adjustment of absorption lines.

**Vspec** -spectra processing, including flux calibration, heliocentric speed calculation, and line identification.

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## Contents

**O stars:**

**B stars:** Spica B1Ib Alkaid B3V

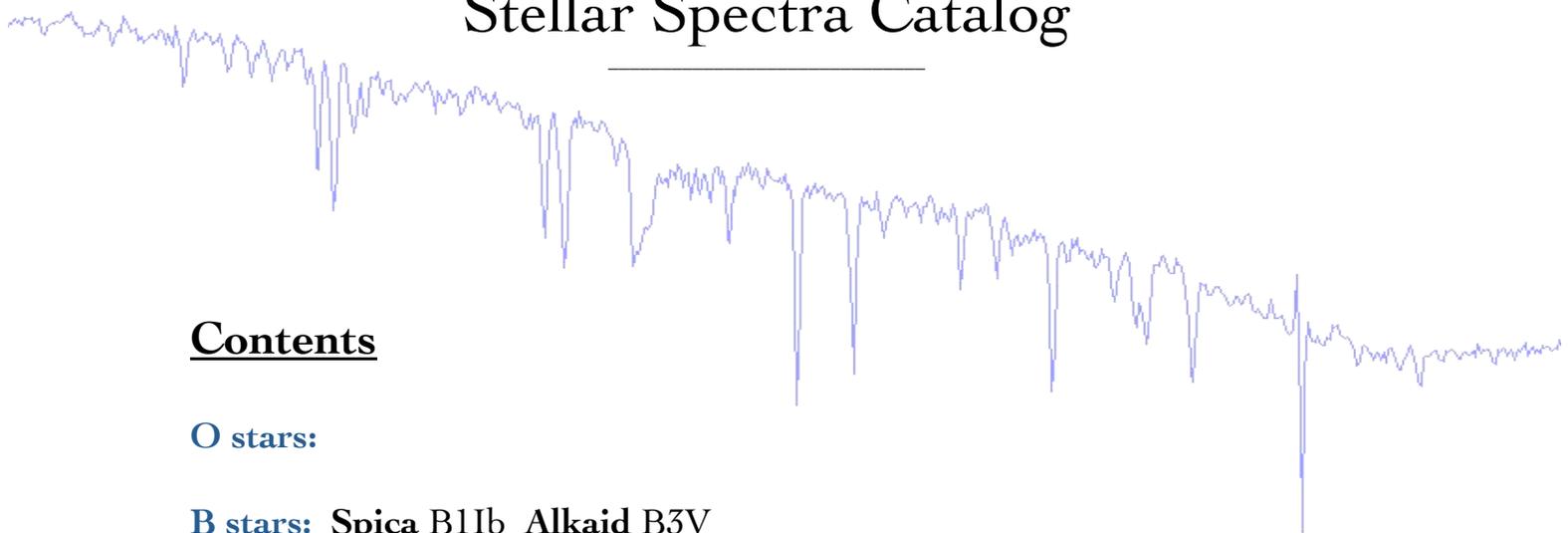
**A stars:**

**F stars:** Almaaz F01b

**G stars:** Nekkar G8III

**K stars:** Arcturus K1III Eltanin K5II

**M stars:**

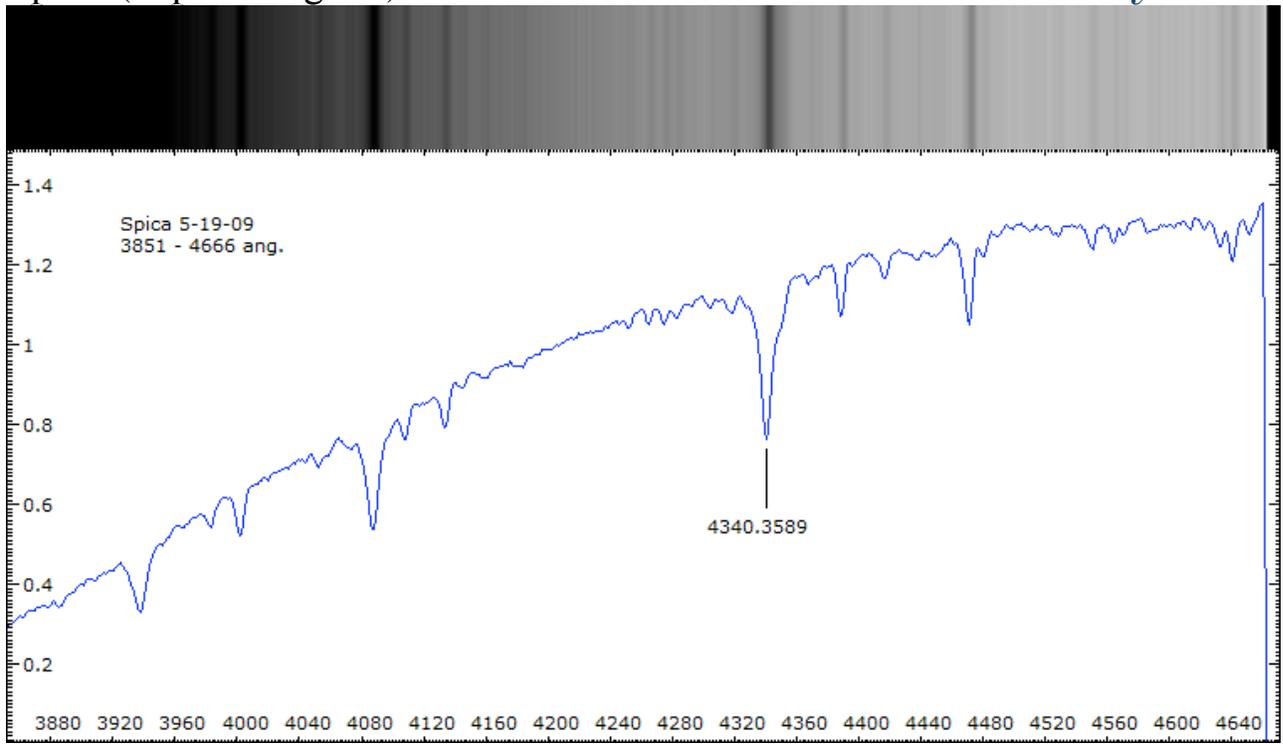


All spectra: X=Wavelength Y=Intensity

## B Stars

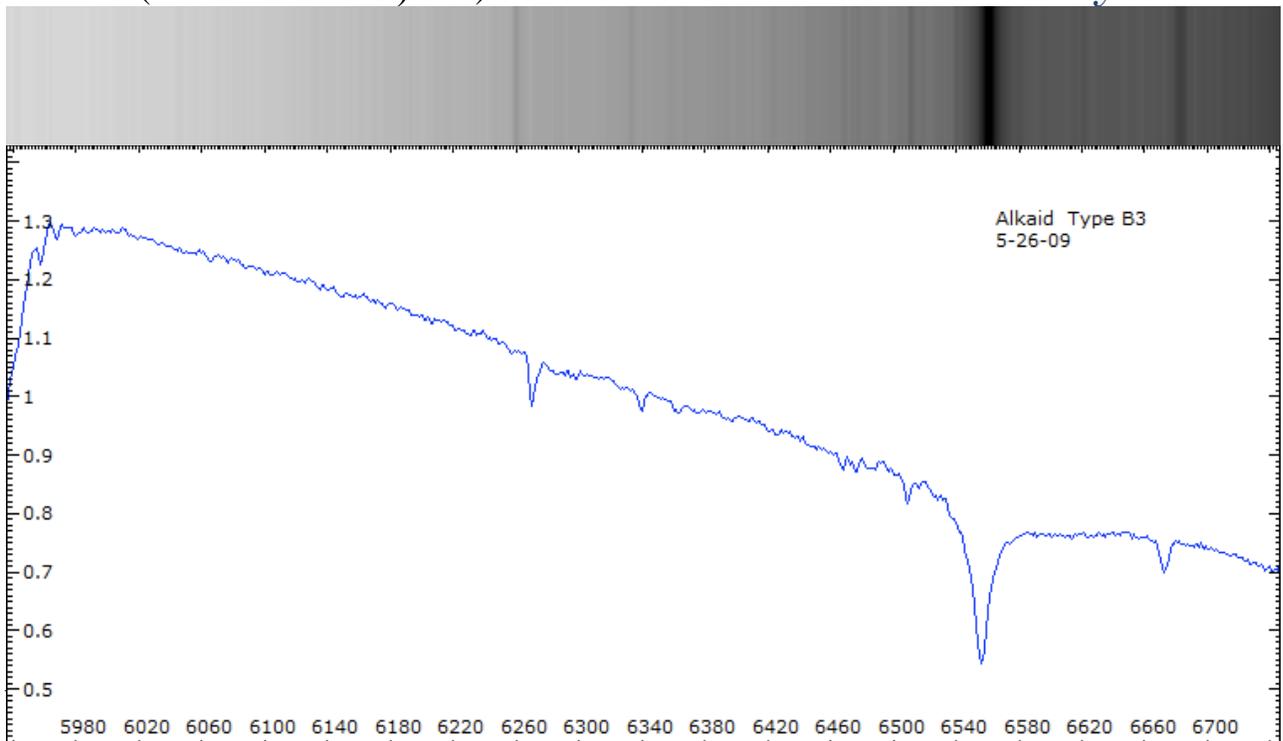
Spica (Alpha Virginis) B1Ib

-CSM Observatory



Alkaid (Eta Ursae Majoris) B3V

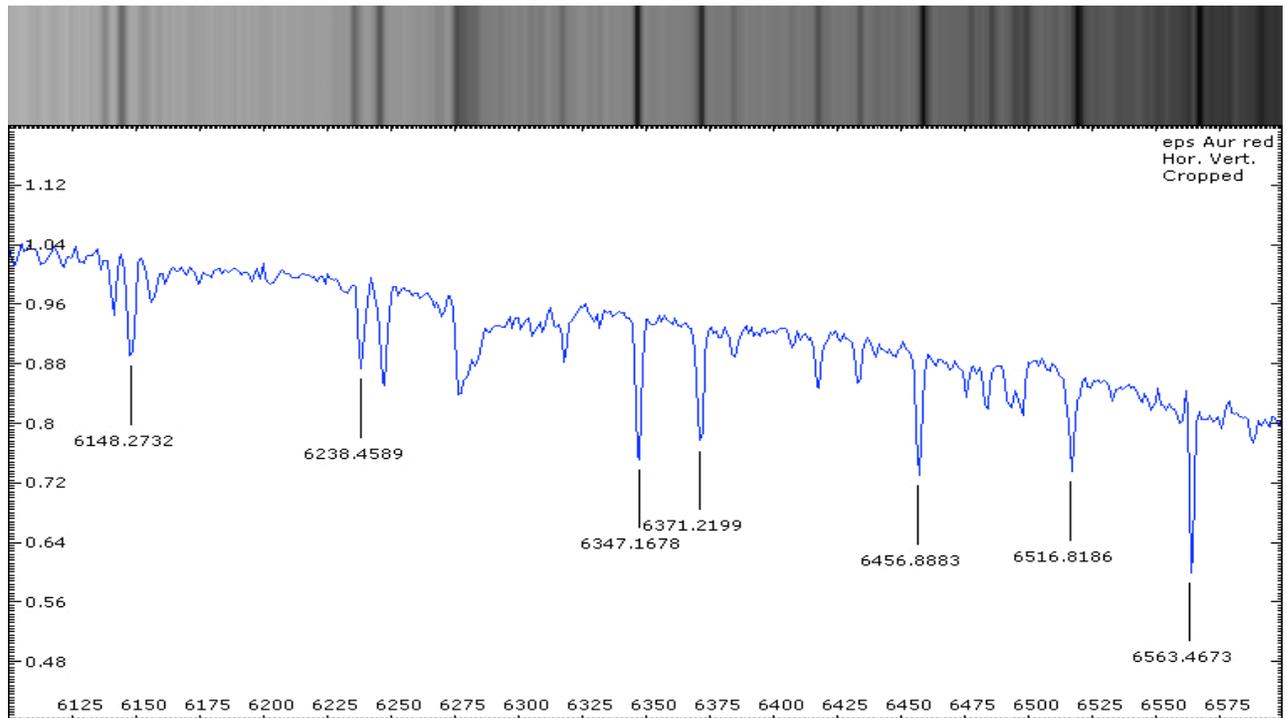
-CSM Observatory



## F Stars

Almaaz (Epsilon Aurigae) F01b

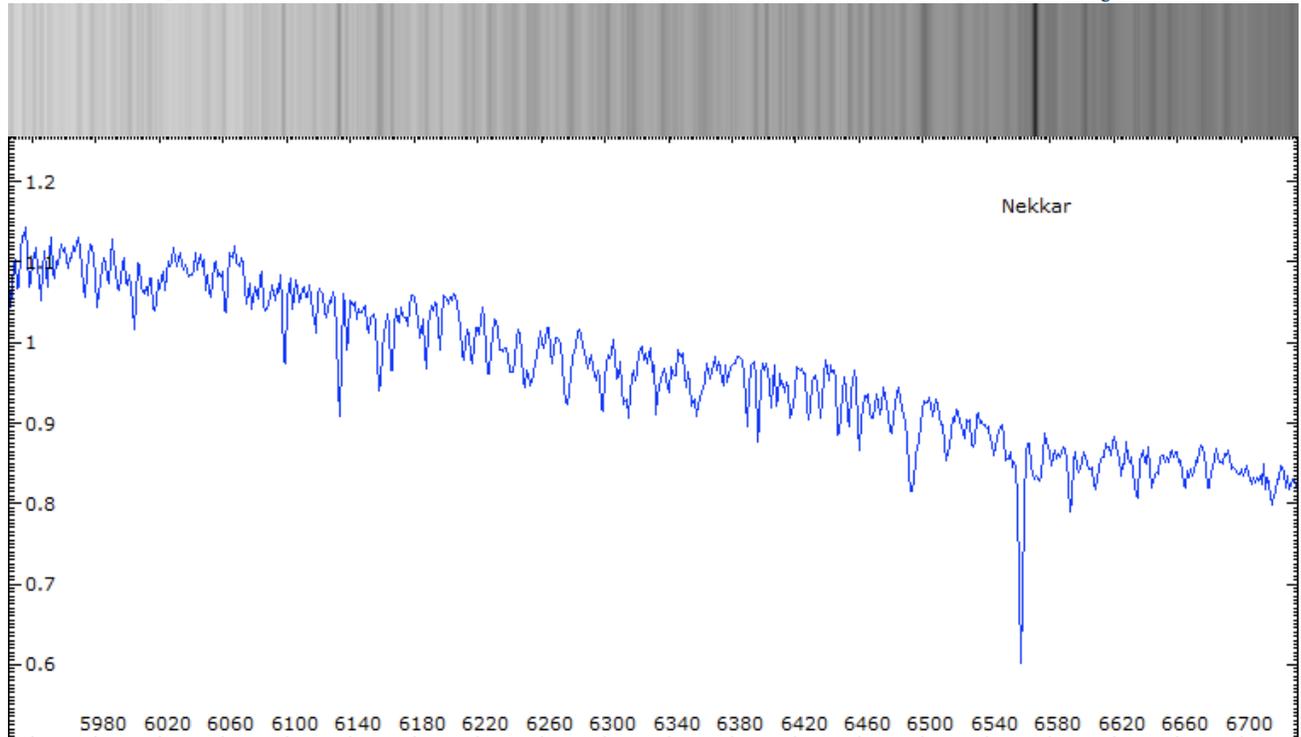
-CSM Observatory



## G Stars

Nekkar (Beta Bootis) G8III

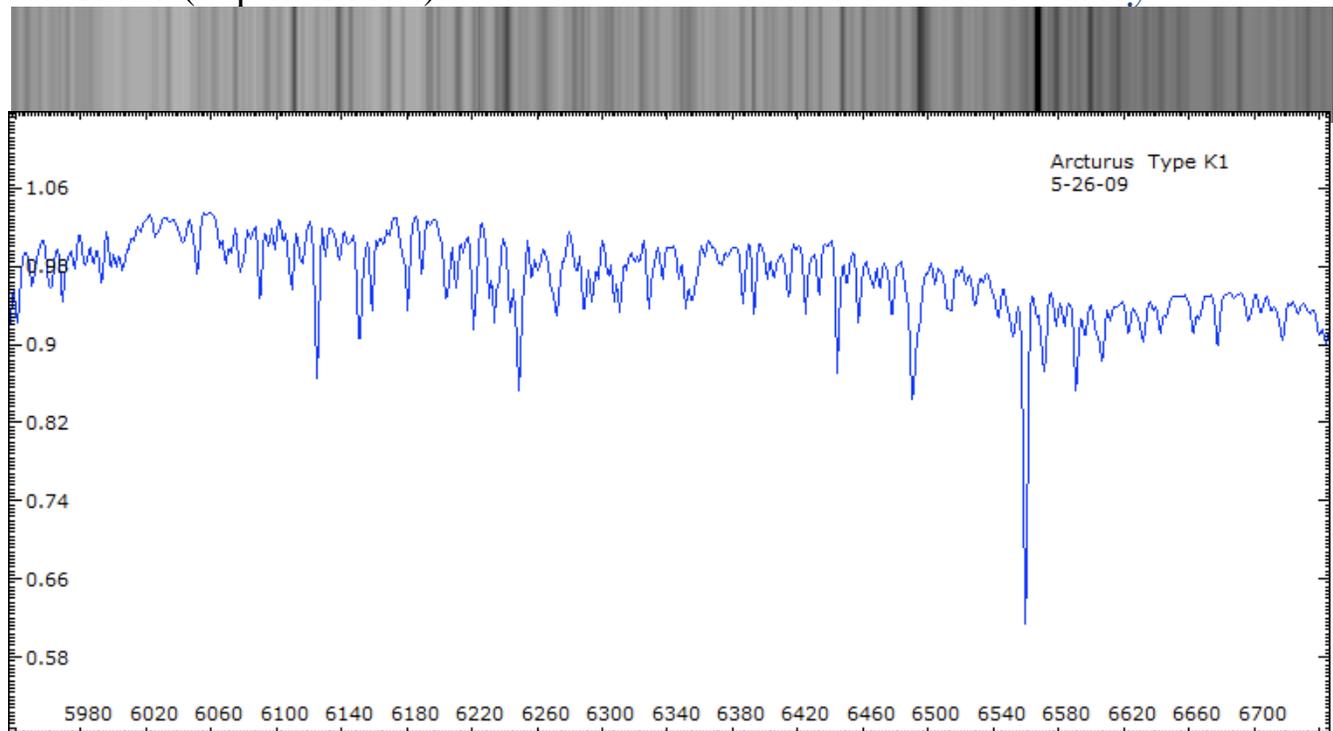
-CSM Observatory



# K Stars

Arcutus (Alpha Bootis) K1III

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Eltanin (Gamma Draconis) K5II

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