

# *University of Wyoming*

## *AstroCamp*

### *Light Spectrum and Spectrometers*

#### *Applications of Spectroscopy in H-Alpha*

**Purpose:** To introduce students to the physics concepts of light and what the light spectrum is.  
To demonstrate what a spectroscope is and how it is used.  
To identify various gas elements through a spectroscope.  
To demonstrate Optical technology to the students by looking at the sun through a telescope fitted with an H-Alpha filter.

### **Wyoming State Science Standards Addressed:**

#### **Standard 1:**

In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

#### ***Benchmark 12:***

##### **Forms and uses of Energy.**

Students investigate energy as a property of substances in a variety of forms with a range of uses.

#### ***Benchmark 13:***

##### **The Conservation of Matter and Energy.**

Students identify supporting evidence to explain conservation of matter and energy, indicating that matter or energy can neither be created nor destroyed, but is transferred from one object to another.

#### **Standard 2:**

Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

#### ***Benchmark 2:***

Students use inquiry to conduct scientific investigations.

Ask questions that lead to conducting an investigation.

Collect, organize, and analyze and appropriately represent data.

Draw conclusions based on evidence and make connections to applied scientific concepts.

#### ***Benchmark 4:***

Students recognize the relationship between science and technology in meeting human needs.

### *Goals:*

Students will use fine motor skills to build a spectroscope.  
Students will use reading skills to follow directions.  
Students will use listening skills to follow directions.  
Students will use logic to come to meaningful conclusions about the spectrum of the light they view.  
Students will use comparative skills to find the match of the real spectrum of the element.  
Students will demonstrate their understanding of the spectrum of light through verbal interaction with staff and through realization that H-Alpha light is a piece of the spectrum of light in the red portion.  
Students will use inquiry to come to meaningful conclusions about the light spectrum.  
Students will understand that light is energy.

### *Entry Level:*

Students will need an introduction to light and its basic properties and what a spectrum is.  
Students will need an introduction on how light is created and that it is not created from nothing, but a changing of mass into energy.  
Students will need clarification about what a diffraction grating is and how it works.  
Students will need to understand what an element is and why that is important to astronomers.  
Students will need to be introduced to the light spectrum poster and how to read it for comparison.  
Students will need to understand what H-Alpha is and why it is important to have this filter on the telescope when looking at the sun.  
Students will need an explanation of the atomic theory of H-Alpha.  
Students will need an introduction to the sun and its features including sunspots, filaments, granulation, and solar flares.

### *Premise:*

The premise of this lesson is to introduce students to the spectrum of and enable them to understand what it is, how it works and why it is important to astronomers and other scientists. Students will work individually building a spectroscope, look at different elements through the spectroscope, compare them to a poster of the different elements' spectra, and identify them. Students will then be exposed to an H-Alpha telescope filter to look at the different solar features available at that time. This should take approximately two (2) hours from beginning to end.

### *Supplies:*

Spectroscope kits (1 per student)  
Variety of illuminated gas tubes (Hydrogen, Helium, Argon, Oxygen)  
Scissors  
Spectrum of Elements Poster  
Scotch Tape  
Spectral Line Estimation Hand out  
H-Alpha Filter and Telescope(s)

*Activities:*

Light Spectrum and Spectroscopes

Introduce: Introduce the students to the concept of light by asking them what light is. Allow ample time for questions.

Instruct: Light is packets or waves of energy produced from stars, light bulbs, fire (heat), radios, microwaves, radar, etc. Some light is visible and some light is not visible. The light that the human eye can see is called visible light. All other light is categorized by its wavelength (some shorter and some longer). Shorter wavelengths of light are classified as gamma rays, x-rays, and Ultra-Violet light. Longer wavelengths of light are categorized as Infrared, microwaves, and radio waves. All of these are invisible to the human eye. However, some insects can see Ultra Violet light and snakes, cats, dogs, and many other animals can see in Infrared. Humans call this night vision.

Talk to the students about conservation of energy and how that applies to light.

Instruct: The energy that produces the light that comes from stars is produced in the core of the star through a process called nuclear fusion. It can take a million years or more for one photon of light that is produced in the core of the sun to reach your eye. This energy required to produce the light is transferred from Hydrogen atoms that are crushed through the effects of gravity. The result is a Helium atom, light, heat, and other forms of radiation and particles. This supports the Law of Conservation of Energy and Matter.

Additions/Modifications to Instruction:

Introduce: Spectroscopes are devices used by astronomers and other scientists to break apart or divide a wave of light into its different light components or colors. The light that you see coming from any light source is not just made of that color, but is a combination of many colors or wavelengths of light. To see these wavelengths you must use a spectroscope. Astronomers use spectroscopes to determine what far away stars, dust clouds, or planets are made of by comparing the spectra that is taken from a telescope to known spectra taken on earth of the different elements.

Activity: Hand out one spectroscope kit to each student. Each student should also have access to scissors, scotch tape, and the diffraction grating provided in the kit. Have a kit prepared to demonstrate what one should look like when they are finished. Have students read the instructions carefully. Make sure to reinforce any important instructions such as cutting, taping

and folding instructions. Having more volunteers available to help out is a good idea.

When the students are done with their spectrosopes, turn the lights off and give them the spectra worksheet to copy their spectra for comparison to the spectrum poster. Students should view each element carefully and draw in the corresponding spectra lines. When they are finished they will compare their drawings to the poster and make predictions of what each element is.

#### Additions/Modifications to Activity:

##### Activity:

##### H-Alpha Filter

Students then will go to the roof and have an opportunity to look through an H-Alpha Filter and view the features on the sun as they appear on that day.

Introduce: Introduce students to the telescope and the H-Alpha filter. Explain why it is important not to look at the sun through a telescope. (Ask Gallileo) Explain the relationship between the lab the students just completed and the H-Alpha filter. H-Alpha is a state of Hydrogen that shows up as a red line on the spectrum of light.

Instruct: The sun is the closest star to our planet and was called Sol by the Romans and Helios by the Greeks.  
It is a large super-heated ball of fusing hydrogen. By mass it is 76% Hydrogen and 28% Helium. The remaining 2% is metals. Its outer layer is approximately 6000 degrees Celcius. A layer around the sun that is visible only during total solar eclipse is called the corona. The corona is approximately 1-2 million degrees Celcius. The features that will be seen today are called sun spots, solar filaments, solar flares, and granulation.

Sun spots are local electromagnetic disturbances that are made visible. Almost always sunspots are found in pairs, one having a North polarity and the other a South polarity. They may look small when you look at them, but they are generally as large or larger than the earth. Sunspots are also cooler than the photosphere. That is why they appear darker.

Solar Flares are also related to the electromagnetic properties of the sun. Solar Flares are enormous explosions of super-heated gas that extend hundreds of thousands of miles above the sun's photosphere.

Solar Filaments are Solar Flares seen straight on. They look like fine, dark threads of twisting fire when viewed through the telescope.

Granulation is a phenomenon on the surface of the sun that has the appearance of geometric shapes all closely fitted together. The edges are all darker because they are cooler. The inside portion of each granule is brighter and sometimes has shades of yellow, orange, and red.

Additions/Modifications to Instruction:

Observation:

Students then can observe sunspots, solar flares, solar filaments, and granulation. Allow plenty of time for students to view multiple times as solar flares evolve over time. Possibly consider multi-day observations to demonstrate the motion of sun spots due to solar rotation.

Additions/Modifications to Observation:

*Questions:*

- What is light?
- What is the light spectrum?
- What is a spectroscope?
- Why does an astronomer use a spectroscope?
- What are stars?

*Teaching Strategy: Conceptual Change Model (Constructivism)*

Strengths: The teaching strategy used in this activity is conceptual change model. The conceptual change model is used to challenge students to confront their beliefs about the properties of light, make predictions about these properties, and then challenge those predictions by performing a variety of activities. Each activity within the lesson is based upon a teaching philosophy called Constructivism, and allows for hands on/minds on interaction by the students. This philosophy tends to engage the most students because it is student-driven and student-focused. Hopefully any misconceptions about the properties of light will be confronted, addressed, and corrected during the lesson. It is important to assess understanding as frequently as possible by using effective inquiry skills.

Weaknesses:

It is easy for students to get lost and not know what is going on depending on the level of instruction and the abilities of the students to follow written and verbal directions. Follow the K.I.S.S. Philosophy and Keep It Simple Stupid. It is important to ensure that each student has the required materials and understands what is happening and what they should be doing. Provide as many adult supervisors as possible to aid with the construction of the spectrometers.