Images, Colors, and Filters

A. Using filters to study galaxies, stars, and nebulae

Color filters will be used to observe slides of a variety of astronomical objects, including stars, star-forming regions, planetary nebulae, supernova remnants, and galaxies. Students will compare and discuss how different objects look through the different filters.

Most high-sensitivity electronic cameras used by astronomers to image planets, stars, nebulae, and galaxies are essentially black and white cameras. To learn about the colors of objects, different color filters are placed in front of the camera, so that the light from the object passes through the filter before entering the camera.

Color filters block some wavelengths of light and let others pass through. A green filter, for example, allows green light to pass through, and blocks all other wavelengths. Thus when you look at a white light source (which contains all the colors of the rainbow) through a green filter, the light appears green. Similarly, a red filter lets red light pass through and blocks other colors.

Directions: In this exercise, you will observe a variety of astronomical objects through colored filters, and see how the filters can help to bring out certain features in each object. The instructor will project several images of astronomical object on the screen. Your job is to observe each image through the red and blue portions of the 3D glasses and answer the questions about each slide found on the answer sheet. Please do not touch the filters with your fingers. We will also get a refresher on how to use the star wheels.

Slide 1: The Visible Spectrum

Q1: On your answer sheet, make a table listing with three columns labeled “Filter”, “Colors Absorbed” and “Colors Visible.” Each row under the “Filter” column should be filled in with the color of the filter, and the rest of the row should list which colors are absorbed and transmitted for that filter. For the colors that are transmitted, describe how bright they appear through the filter.

Q2: How might these "real world" filters make it more difficult to interpret photos?

Q3: We’ve learned about many general properties of stars that can be judged by their color. If we were only able to compare star colors as being red or blue, list as many general properties as you can think of to apply to each group of stars. (Hint: think in opposites)
Slides 2-4: Star Clusters

(2) The Pleiades

Q4: Locate the Pleiades on your star wheel and find its right ascension and declination:

Q5: Describe the view of the cluster through each of the filters.

Q6: Which filter best shows the gas between the stars? Why do you think this is so?

(3) Cluster NGC 6656

Q7: This cluster has an RA of 18hr 35min, and a Dec of -25°. Use your star wheel to locate this cluster, and give its Messier catalog number. What constellation is this cluster closest to? Is it a globular cluster or an open cluster?

Q8: Describe the view of the cluster through the red and blue filters.

(4) Open cluster NGC 884

Q9: Without using the filters, take a look at the image. On your answer sheet, draw a rectangle representing the field of view of the image. Next, indicate in the rectangle which stars will appear brightest in the red or blue filters. Mark the stars that will appear brightest in the red filter with small circles, and the stars that will appear brightest in the blue filter with small squares.

Q10: If you had red and blue filters and a black and white camera, how could you tell which stars were older in this picture? Describe what pictures you would take, and what they would tell you in detail.

Slides 5-7: Nebulae & Clusters

(5) Wide View Orion Nebula

Q11: Which filter best shows the gas best in this picture?

Q12: Emission nebulae are typically found near hot stars and are reddish-pink in color, while reflection nebulae are found near cooler stars and are bluish in color. Draw another rectangle to represent the field of view, and sketch the areas where you can see emission nebulae and reflection nebulae, and label them.

Q13: Describe the overall color of the nebulae, without looking through the filters. Specifically, which areas appear blue, red, or purplish?

Q14: Do you think these are reflection nebulae, emission nebulae, both, or something else? Explain your reasoning.

(7) NGC 3603: An H-II region

Q15: Describe the view through each filter. Which filter shows the gas best? Which one shows the stars in the central region best?

Q16: The name “H-II” (pronounced h-two) is referring to the ionized hydrogen present in the nebula. Based on this and your answers to Q15, what can you conclude about the temperatures and ages of the stars in this cluster?

Slides 8-9: Planetary Nebulae

(8) The Crab Nebula

Q17: Through which filter do the thin filaments show up best? Explain why you think this is so.

Q18: Through which filter does the central gas show up best? Explain why you think this is so.

(9) The Cat’s Eye Nebula

This is a false color image, where the different colors represent different elements:

- Red represents hydrogen (recall that H has a red line in its spectrum)
- Green represents nitrogen
- Blue represents oxygen

Q19: How does the image change when viewed through the red vs. blue filters? Carefully describe the view through each filter, explaining which features are visible through each filter.

Q20: Through what filter does the nitrogen gas show up best? On your answer sheet, sketch the view through that filter.
Slides 10-12: Galaxies

(10) M31: The Andromeda Galaxy

Q21: Use your star wheel to look up the RA and Dec of this galaxy. What time will it rise tonight?

Q22: Which filter shows the structure of the spiral arms best? Which filter shows the central bulge best?

Q23: Based on your answers to Q3 and Q22, where do you think most star formation is happening in this galaxy? Explain your reasoning.

(11) M74: A Large Spiral Galaxy

Q24: This galaxy has an RA of 1hr 35min and a Dec of +15°. What constellation is this galaxy located in?

Q25: Notice the bright red spots in the spiral arms of the galaxy. What do you think these are? How does that fit in with your answer to Q23?

(12) The Mice: Two Interacting Galaxies

Q26: Observe the image through the red and blue filters. If you were an astronomer searching for supernovae to study in this galaxy, where would you focus your attention? Explain your reasoning.

(13) And (14) Young galaxies in the early Universe

Q27: Almost all of the points of light in this image are galaxies; there are only a few stars. How many stars can you count? How did you know they were stars and not galaxies?

Q28: Imagine you were taking pictures of this galaxy field with black and white film. If you had red and blue filters available that you could take the pictures through, how could you determine which galaxies were reddest without actually taking a color image?