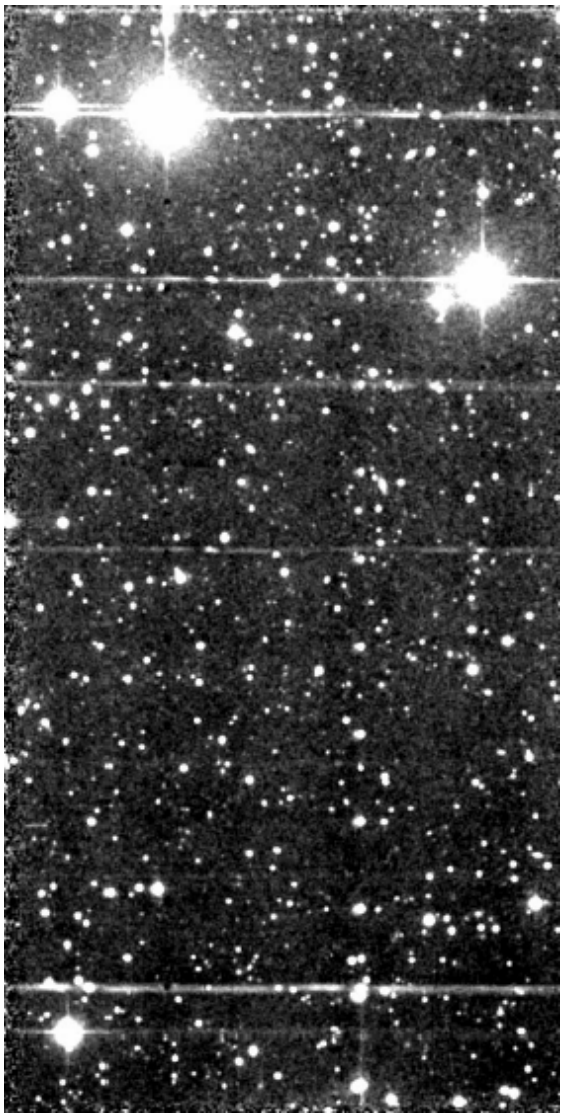
On a clear night in the city, you can see hundreds of stars across the sky. From a location in the distant countryside, you can see thousands of much fainter stars. With a telescope you can see millions of stars. In this activity, you will use a recent photograph of a small part of the sky to estimate how many stars could be seen by astronomers using a modern telescope to photograph the entire sky.

In 1999, the 2-Micron Astronomical Sky Survey (2MASS) photographed a small section of sky in the constellation Hercules. Follow the step-by-step procedure to estimate from this photograph about how many stars there are in the sky that are one million times fainter than what the human eye can detect.



1 – This image is 0.15 degrees wide and 0.29 degrees long. How many square degrees in size is this picture?

2 – The sky has an area of 41,260 square degrees. How many of these picture 'tiles' would be needed to cover the entire sky?

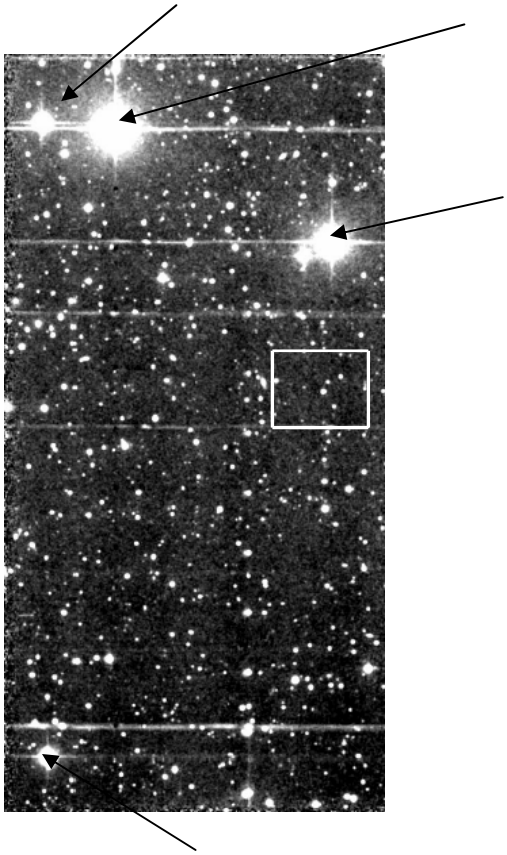
3 – How many bright stars do you see in the picture?

4 – How many faint stars do you see in the picture?

5 – If this picture were typical of the tiles in Question 2, about how many bright stars would you expect to find across the entire sky?

6 – How many of the faint stars you counted in Question 4 would you expect to see across the entire sky?

7 – The human eye should be able to see about 8,000 stars across the entire sky. Based on the numbers you estimated in questions 5 and 6, are any of the stars in the picture to the left likely to be visible to the eye?



1 – This image is 0.15 degrees wide and 0.29 degrees long. How many square degrees in size is this picture? **Answer:** 0.15 x 0.29 = 0.044 square degrees.

2 – The sky has an area of 41,260 square degrees. How many of these picture 'tiles' would be needed to cover the entire sky? **Answer:** 41,260/0.0435 = 948,500 tiles.

3 – How many bright stars do you see in the picture? **Answer:** Estimates may vary. The arrows indicate the four reasonable choices.

4 – How many faint stars do you see in the picture? **Answer:** Students will have to count by hand all of the 'spots' in this photograph. Answers may vary, but should be in the range from 500 to 600. Break the photograph into 4 x 8 equal-sized patches and count the number of stars in one of these, then multiply by the number of patches (32) to get an estimate. For example, in the patch I highlighted in the picture above, I counted 17 stars. There are 32 of these patches covering the picture, so I estimate that there are 32 x 17 = 544 stars in this picture.

5 – If this picture were typical of the tiles you estimated in Question 2, about how many bright stars would you expect to find across the entire sky? **Answer:** It the picture is typical, with 4 bright stars in its field of view, the number of similar stars would be 4 x 948,500 = 3.8 million.

6 – How many of the faint stars you counted in Question 4 would you expect to see across the entire sky? **Answer:** If we chose an average of 550 stars in this picture, then for 948,500 fields there would be about 550 x 948,500 = 521 million stars covering the entire sky.

7 – The human eye should be able to see about 8,000 stars across the entire sky. Based on the numbers you estimated in questions 5 and 6, are any of the stars in the picture to the left likely to be visible to the eye? **Answer:** No, because even the brightest stars seen in the photograph, if present across the sky, are far more common (there are 3.8 million of them!) than the stars you can see with the eye (about 8,000!), so they must be much fainter.