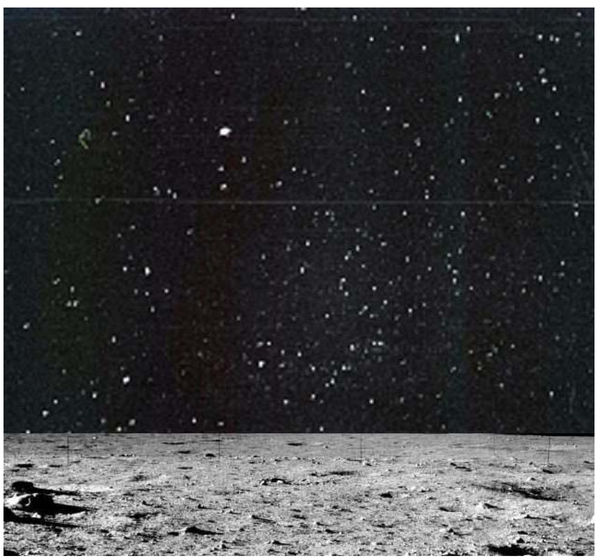
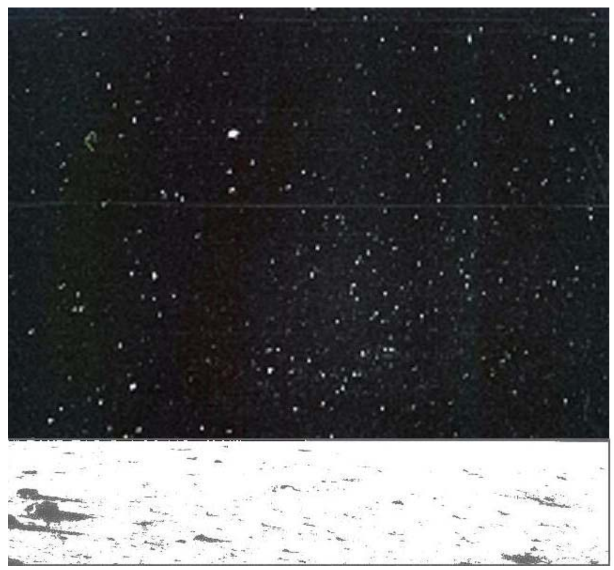
Where Did All the Stars Go?

Have you ever looked closely at NASA photographs from space and wondered where the stars went?

To the left is an Apollo-11 photo taken by astronauts on the surface of the moon. Notice the sky has no stars! The re-touched photo on the bottom-left gives an impression of the stars that a simple $100 camera would see if it used a 'timed exposure' of about 20 seconds. So why did the very expensive camera used by the Apollo-11 astronauts show not a single star?

The re-touched photo below shows what might happen to the lunar surface detail with a 20-second exposure.





A camera light meter measures the brightness of an object. Let's indicate brightness by the unit 'cents/second'. For example, a faint object might have a brightness of 10 cents/second while a bright object has 10,000 cents/second.

Problem 1 - If the stars in the Apollo photo have a brightness of 2.5 cents/sec, how many cents will be collected in a 20-second time-exposure?

Problem 2 - If the lunar surface has a brightness of 500 cents/second, how many cents will be collected in a 20-second exposure?

Problem 3 - If the lunar surface is scaled to a camera contrast setting of 100%, A) How bright, in cents, is a 1% contrast change? B) What contrast change do the stars represent?

Problem 4 - If the image is set to only record contrast changes of 1% or greater to bring out detail on the lunar surface, will the stars be visible? Explain.

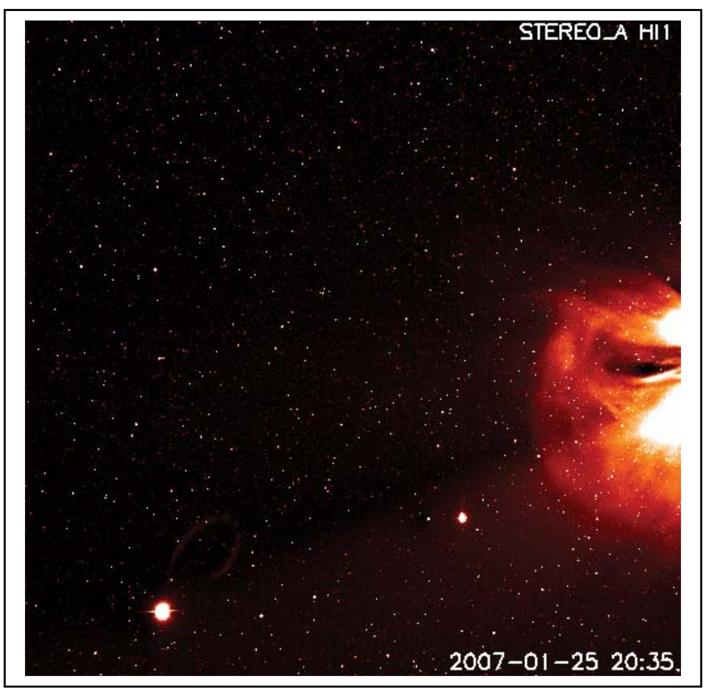
Answer Key

Problem 1 - If the stars in the Apollo photo have a brightness of 2.5 cents/sec, how many cents will be collected in a 20-second time-exposure? Answer: Multiply the rate at which the cents are accumulated (2.5 cents/sec) by the elapsed time (20 sec) to get 2.5 cents/sec x 20 sec **= 50 cents**.

Problem 2 - If the lunar surface has a brightness of 500 cents/second, how many cents will be collected in a 20-second exposure? Answer: Multiply the rate at which the cents are accumulated (500 cents/sec) by the elapsed time (20 sec) to get 500 cents/sec x 20 sec = **10,000 cents**.

Problem 3 - If the lunar surface is scaled to a camera contrast setting of 100%, A) how bright, in cents, is a 1% contrast change? Answer: Since 10,000 cents = 100%, that means that 1% will equal 10,000 cents/100 = 100 cents. B) What contrast change do the stars represent? Answer: The stars produce 50 cents, but in the same amount of time (20 seconds) the lunar landscape produces 10,000 cents, so the stars represent a contrast change of only (50 cents/10000 cents) x 100% **= 0.5 %.**

Problem 4 - If the image is set to only record contrast changes of 1% or greater to bring out detail on the lunar surface, will the stars be visible? Explain. Answer: **If 0% represents black and 100% represents white, the smallest intensity in the image (1%) will correspond to 100 cents, but the stars represent a contrast change of 0.5% or 50 cents, which is smaller than the 100 cents (1%) contrast that the image can register on this camera setting (20 seconds with 10,000 cents = 100%). So the stars will be replaced by 'black' and will be eliminated from the image so that scientists can study the landscape details on the lunar surface instead.**



This is an image taken by NASA's STEREO satellite of a coronal mass ejection (CME) from the sun. The gas is very faint, so the camera had to be designed to detect only faint light, rather than bright sources. Notice that the CME image has plenty of background stars that can in some cases be seen through the translucent gases. Had the camera been designed differently, there would have been no stars in the picture, and only the brightest portions of the CME would have been visible in the photograph.