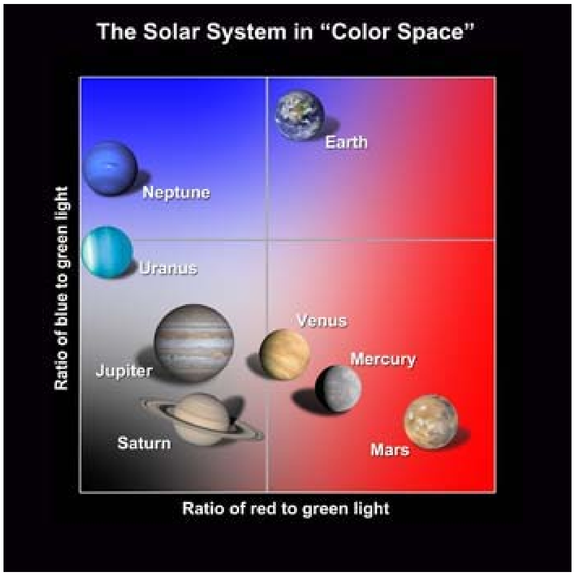

Earth is invitingly blue. Mars is angry red. Venus is brilliant white. NASA astronomer Lucy McFadden, and UCLA research assistant in geochemistry Carolyn Crow, have now discovered that a planet's "true colors" can reveal important details.

Mars is red because its soil contains rusty red stuff called iron oxide. Our planet, the "blue marble" has an atmosphere that scatters blue light rays more strongly than red ones. This suggests that astronomers could use color information to identify Earth-like worlds. Their colors will tell us which ones to study in more detail.

As NASA's Deep Impact spacecraft cruised through space, its High Resolution Instrument (HRI) measured the intensity of Earth's light. HRI is a 30-cm telescope that feeds light through seven different color filters. Each filter samples the incoming light at a different portion of the visible-light spectrum, from ultraviolet and blue to near-infrared. A table showing the reflectivity of each body is shown below. The numbers indicate the percentage of light reflected by the planet at 350, 550 and 850 nanometers (nm). For example, compared to the light that it reflects at 550 nm, Venus reflects 116% more light at 850 nm.

Object	350 nm	550 nm	850nm	Object	350nm	550nm	850nm
Mercury	47	100	142	Jupiter	60	100	64
Venus	58	100	109	Saturn	45	100	78
Earth	152	100	110	Titan	34	100	88
Moon	67	100	169	Uranus	98	100	15
Mars	34	100	203	Neptune	125	100	13

Note: Table based upon data published by the astronomers in the Astrophysical Journal (March 10, 2011).

Problem 1 – One way to plot this data so that the planets can be easily separated and identified is to plot the ratio of the reflectivities for each planet where X = R(850)/R(550) and X = R(350)/R(550). For example, for the Moon, where R(350) = 61% , R(550) = 100%, and R(850) = 155% we have X = 155/100 = 1.55, and Y = 61/100 = 0.61. Using this method, calculate X and Y for each object and then plot the (X,Y) points on a graph.

Problem 2 – The planetary data in the table can be written as an ordered triplet. For example, for Mercury the reflectivities in the table above would be written as (56, 100, 177). Using the definition for X and Y in Problem 1, which of the planets below would you classify as Earth-like, Jupiter-like, or Moon-like, if the planetary reflectivities are: Planet A (61, 82, 156), Planet B (45, 35, 56), Planet C (90, 120, 67).

Problem 3 – Can you create a different plot for the planets that makes their differences stand out even more?

Problem 1 – One way to plot this data so that the planets can be easily separated and identified is to plot the ratio of the reflectivities for each planet where X = R(850)/R(550) and X = R(350)/R(550). For example, for the Moon, where R(350) = 61% , R(550) = 100%, and R(850) = 155% we have X = 155/100 = 1.55, and Y = 61/100 = 0.61. Using this method, calculate X and Y for each object and then plot the (X,Y) points on a graph. See graph below.

Object	350 nm	550 nm	850nm	X	Y
Mercury	47	100	142	**1.42**	**0.47**
Venus	58	100	109	**1.09**	**0.58**
Earth	152	100	110	**1.10**	**1.52**
Moon	67	100	169	**1.69**	**0.67**
Mars	34	100	203	**2.03**	**0.34**
Jupiter	60	100	64	**0.64**	**0.60**
Saturn	45	100	78	**0.78**	**0.45**
Titan	34	100	88	**0.88**	**0.34**
Uranus	98	100	15	**0.15**	**0.98**
Neptune	125	100	13	**0.13**	**1.25**

Problem 2 – The planetary data in the table can be written as an ordered triplet. For example, for Mercury the reflectivities in the table above would be written as (56, 100, 177). Using the definition for X and Y in Problem 1, which of the planets below would you classify as Earth-like, Jupiter-like, or Moon-like, if the planetary reflectivities are: Planet A (61, 82, 156), Planet B (45, 35, 56), Planet C (90, 120, 67). Answer: **Planet A has X and Y values similar to the moon; Planet B is more like Earth; and Planet C is more like Jupiter.**

Problem 3 – Can you create a different plot for the planets that makes their differences stand out even more? Answer: **There are more than 100 different ways in which students may decide to create new definitions for X and Y such as X = R(350) – R(850); Y = R(850)/R(350) and so on. Some will not visually let you see a big difference between the planet 'colors' while other may. Astronomers try many different combinations, usually with some idea of the underlying physics and how to enhance what they are looking for. There is no right or wrong answer, only ones that make the analysis easier or harder!**