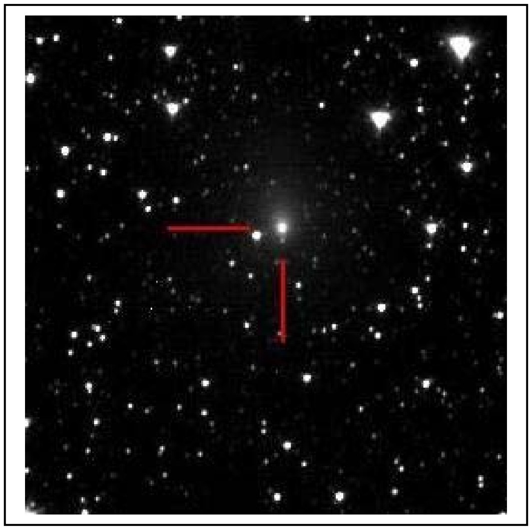

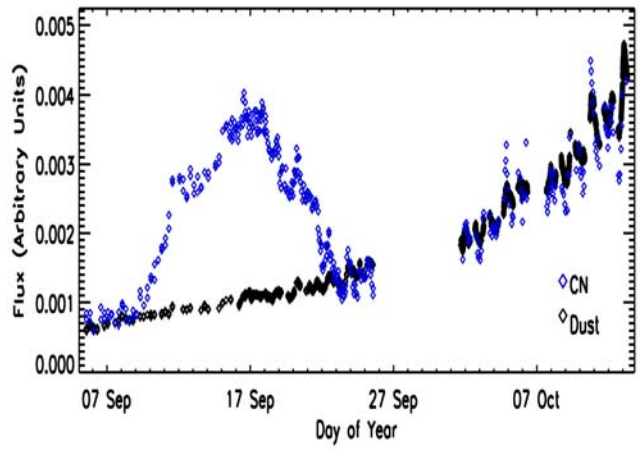

On September 25, 2010 at a distance of 41 million km, the spacecraft Deep Impact took this image of the comet Hartley 2 about 40 days before closest approach on November 4. The graph to the right indicates the brightness of the comet as measured by the spacecraft between 5 September and 13 October. There are two curves plotted, one that depicts dust (black) released from the nucleus and one taken with the cyanogen-gas filter, sensitive to both the dust continuum and CN gas (blue), The gap in data from 25 September through 1 October was due to a scheduled break in the observations for calibration observations.

Problem 1 - From the graph, A) how long did the ejection burst of cyanogen gas last, B) on what date did it reach its maximum brightness, and C) in terms of its flux, by what factor did the burst increase the brightness of the comet compared to its dust intensity?

Problem 2 - The distance to the comet is given by the table below:

Date	Day Number	Distance (km)
September 5	0	60 million
September 20	15	46 million
September 25	20	41 million
September 29	24	37 million
October 27	52	9 million

Write a linear equation that gives the distance to the comet in terms of the day number. What is the average speed of the comet in millions of km/day?

Problem 3 - Assume that the brightness of the comet follows the inverse-square law so that if you halve the distance to the comet, its brightness will be 4-times greater. If the comet's brightness was B = 0.0006 units on September 5, and the physical conditions in the comet did not change, what would you predict its brightness would be on October 13?

Problem 1 - From the graph, A) how long did the ejection burst of cyanogen gas last, B) on what date did it reach its maximum brightness, and C) in terms of its flux, by what factor did the burst increase the brightness of the comet compared to its dust intensity?

Answer: A) The ejection lasted between September 9 and 23 for a total of **14 days**.
B) The maximum brightness occurred on about **September 17th**.
C) The dust brightness on Sept 17 was 0.0012 .The total brightness was 0.0039, so the cyanogen outburst increased the comet's brightness by a factor of 0.0039/0.0012 = **3.25 times**.

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Write a linear equation that gives the distance to the comet in terms of the day number. What is the average speed of the comet in millions of km/day?

Answer: From the tabulated data, the slope over the time interval is m = (9-60)/(52) = -1.0, so the linear equation would be **D(t) = -1.0(T) + 60** where D(t) is in millions of kilometers and T is the number of days since September 5. The average approach speed is **1 million km/day**.

Problem 3 - Assume that the brightness of the comet follows the inverse-square law so that if you half the distance to the comet, its brightness will be 4-times greater. If the comet's brightness was B = 0.0006 units on September 5, and the physical conditions in the comet did not change, what would you predict its brightness would be on October 13?

Answer: October 13 occurs at T = 38 days, so its distance is D = -1.0(38) + 60 = 22 million km. On September 5 its distance was 60 million km, so the factor of its distance change is 38/60 = 0.63 .The comet's brightness from the inverse-square law is just

$$B = 0.0006 \frac{1}{(0.63)^2}$$

so the brightness on October 13 is just **B=0.0015 flux units**.

Note: Students will notice from the light curve graph that the actual comet brightness on October 13 was B = 0.0042 units because the comet ejected a cloud of dust, which increased its brightness significantly - by 0.0042/0.0015 = 2.8 times its normal brightness without the dust and cyanogen eruption.