Death Stars

Artist rendering courtesy NASA/G. Bacon (STScI)

Our sun is an active star that produces a variety of storms, such as solar flares and coronal mass ejections. Typically, these explosions of matter and radiation are harmless to Earth and its living systems, thanks to our great distance from the sun, a thick atmosphere, and a strong magnetic field. The most intense solar flares rarely exceed about 10^{21} Watts and last for an hour, which is small compared to the sun's luminosity of 3.8×10^{26} Watts.

A long-term survey with the Hubble Space Telescope of 215,000 red dwarf stars for 7 days each revealed 100 'solar' flares during this time. Red dwarf stars are about 1/20000 times as luminous as our sun. Average flare durations were about 15 minutes, and occasionally exceeded 2.0×10^{21} Watts.

Problem 1 - By what percentage does a solar flare on our sun increase the brightness of our sun?

Problem 2 - By what percentage does a stellar flare on an average red dwarf increase the brightness of the red dwarf star?

Problem 3 - Suppose that searches for planets orbiting red dwarf stars have studied 1000 stars for a total of 480 hours each. How many flares should we expect to see in this survey?

Problem 4 - Suppose that during the course of the survey in Problem 3, 5 exoplanets were discovered orbiting 5 of the surveyed red dwarf stars. To two significant figures, about how many years would inhabitants on each planet have to wait between solar flares?

Problem 1 - By what percentage does a solar flare on our sun increase the brightness of our sun?

Answer: $P = 100\% \times (1.0 \times 10^{21} \text{ Watts})/(3.8 \times 10^{26} \text{ Watts})$

P = 0.00026 %

Problem 2 - By what percentage does a stellar flare on an average red dwarf increase the brightness of the red dwarf star?

Answer: The average luminosity of a red dwarf star is stated as 1/20000 times our sun's luminosity, which is 3.8×10^{26} Watts, so the red dwarf star luminosity is about 1.9×10^{22} Watts.

$P = 100\% \times (2.0 \times 10^{21} \text{ Watts})/(1.9 \times 10^{22} \text{ Watts})$

P = 10 %

Problem 3 - Suppose that searches for planets orbiting red dwarf stars have studied 1000 stars for a total of 480 hours each. How many flares should we expect to see in this survey?

Answer: We have two samples: N1 = 215,000 stars for 7 days each producing 100 flares. N2 = 1000 stars for 480 hours each, producing x flares.

From the first survey, we calculate a rate of flaring per star per day:

Rate = 100 flares x (1/215,000 stars) x (1 / 7days)

= 0.000066 flares/star/day

Now we multiply this rate by the size of our current sample to get the number of flares to be seen in the 480-hour (20-day) period.

N = 0.000066 flares/star/day) x (1000 stars) x (20 days)

= 1.32 or **1 flare event**.

Problem 4 - Suppose that during the course of the survey in Problem 3, 5 exoplanets were discovered orbiting 5 of the surveyed red dwarf stars. To two significant figures, about how long would inhabitants on each planet have to wait between solar flares?

Answer: The Flare rate was 0.000066 flares/star/day. For 1 star, we have T = 0.000066 flares/star/day x (1 star) = 0.000066 flares/day so the time between flares (days/flare) is just T = 1/0.000066 = 15,151 days. Since there are 365 days/year, this is about **42 years between flares on the average**.