



On March 28, Swift's Burst Alert Telescope discovered the source in the constellation Draco when it erupted with the first in a series of powerful X-ray blasts. The satellite determined a position for the explosion, now cataloged as gamma-ray burst (GRB) 110328A, and informed astronomers worldwide. As dozens of telescopes turned to study the spot, astronomers quickly noticed that a small, distant galaxy appeared very near the Swift position. A deep image taken by Hubble on April 4 pinpoints the source of the explosion at the center of this galaxy, which lies 3.8 billion light-years away.

That same day, astronomers used NASA's Chandra X-ray Observatory to make a four-hour-long exposure of the puzzling source. The image, which locates the object 10 times more precisely than Swift can, shows that it lies at the center of the galaxy Hubble imaged.

The duration of the x-ray bursts tells astronomers approximately how large the emitting region is, and since the source is a black hole, it gives the approximate diameter of the black hole. The radius of a black hole is related to its mass by the simple formula $R = 3 M$, where M is the mass of the black hole in units of the sun's mass, and R is the radius of the Event Horizon in kilometers.

Problem 1 - What is the average duration of the three flare events seen in the X-ray plot above?

Problem 2 - Light travels at a speed of 300,000 km/s. How many kilometers across is the x-ray emitting region based on the average time of the three x-ray flares?

Problem 3 - The size of the x-ray emitting region from Problem 2 is a crude estimate for the diameter of the black hole. For reasons having to do with relativity, a better black hole size estimate will be 100 times smaller than your answer for Problem 2. From this better-estimate, about what is the mass of the black hole GRB110328A in solar masses?