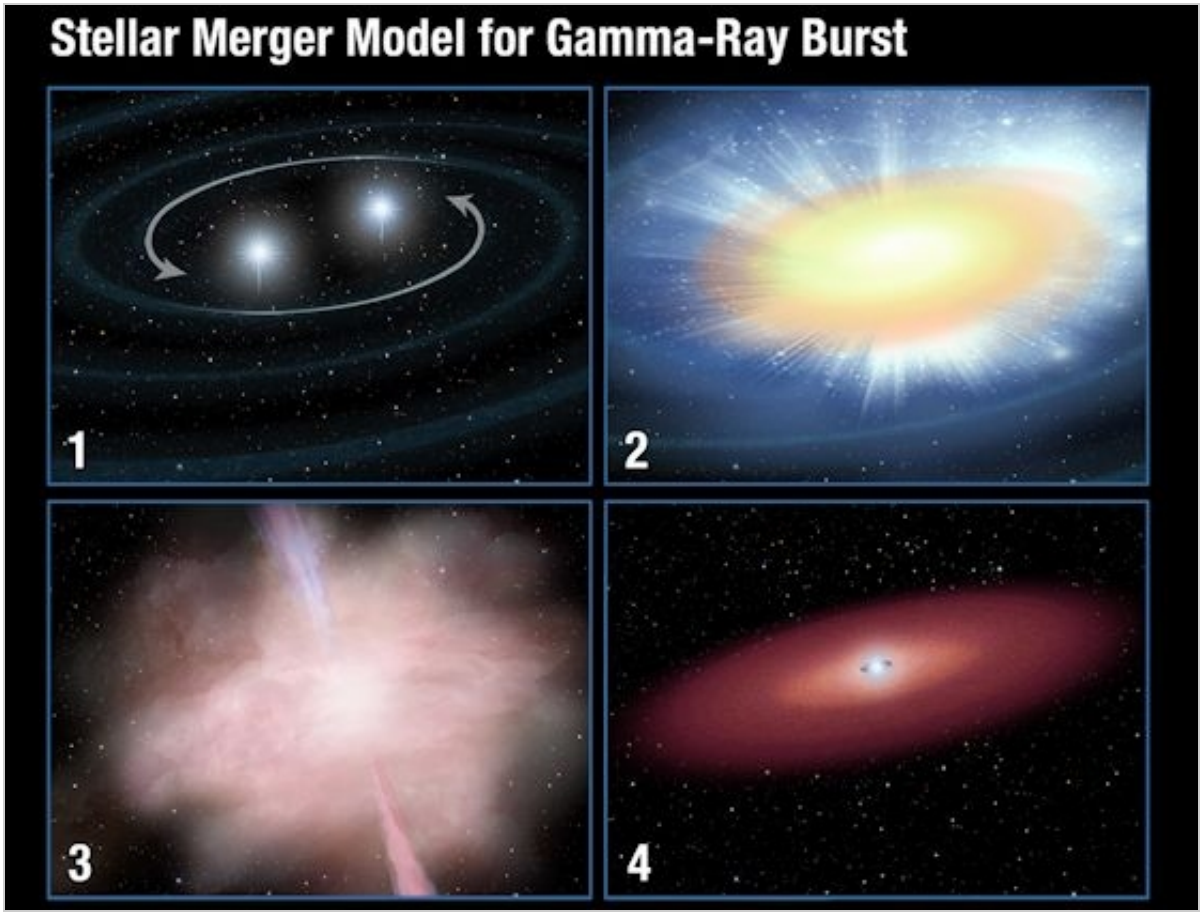
Hubble Sees the Fireball from a "Kilonova"

August 3, 2013: NASA's Hubble Space Telescope has detected a new kind of stellar blast called a kilonova, which happens when a pair of compact objects such as neutron stars crash together. Hubble observed the fading fireball from a kilonova last month, following a short gamma ray burst (GRB) in a galaxy almost 4 billion light-years from Earth.

"This observation finally solves the mystery of short gamma ray bursts," says Nial Tanvir of the University of Leicester in the United Kingdom, who led a team of researchers conducting this research.



This sequence illustrates the kilonova model for the formation of a short-duration gamma-ray

burst. 1. A pair of neutron stars in a binary system spiral together. 2. In the final milliseconds, as the two objects merge, they kick out highly radioactive material. This material heats up and expands, emitting a burst of light called a kilonova. 3. The fading fireball blocks visible light but radiates in infrared light. 4. A remnant disk of debris surrounds the merged object, which may have collapsed to form a black hole. More

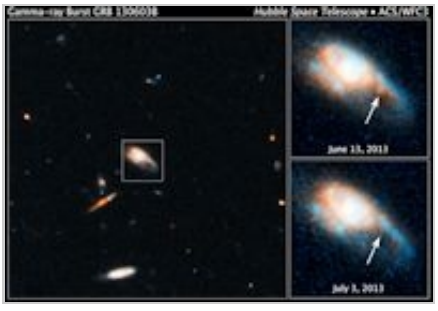
Gamma ray bursts are flashes of intense high-energy radiation that appear from random directions in space. They come in two flavors--long and short. "Many astronomers, including our group, have already provided a great deal of evidence that long-duration gamma ray bursts (those lasting more than two seconds) are produced by the collapse of extremely massive stars," explains Tanvir.

The short bursts, however, were more mysterious.

"We only had weak circumstantial evidence that short bursts [might be] produced by the merger of compact objects," he adds. "This result now appears to provide definitive proof."

Astrophysicists have predicted short-duration GRBs are created when a pair of super-dense neutron stars in a binary system spiral together. This event happens as the system emits gravitational radiation, creating tiny waves in the fabric of space-time. The energy dissipated by the waves causes the two stars to sweep closer together. In the final milliseconds before the explosion, the two stars merge into a death spiral that kicks out highly radioactive material. This material heats up and expands, emitting a burst of light.

The resulting "kilonova" is about 1,000 times brighter than a regular nova, which is caused by the eruption of a white dwarf.



These Hubble images show the fireball afterglow of Gamma-ray Burst 130603B. More

In a recent science paper Jennifer Barnes and Daniel Kasen of the University of California at Berkeley and the Lawrence Berkeley National Laboratory presented new calculations predicting how kilonovas should look. They predicted the same hot plasma producing the radiation also will block the visible light, causing the gusher of energy from the kilonova to flood out in near-infrared light over several days.

An unexpected opportunity to test this model came June 3 when NASA' s Swift space telescope picked up the extremely bright gamma ray burst, cataloged as GRB

130603B. Although the initial blast of gamma rays lasted just one-tenth of a second, it was roughly 100 billion times brighter than the subsequent kilonova flash.

From June 12-13, Hubble searched the location of the initial burst, spotting a faint red object. An independent analysis of the data from another research team confirmed the detection. Subsequent Hubble observations on July 3 revealed the source had faded away, therefore providing the key evidence the infrared glow was from an explosion accompanying the merger of two objects.

The team's results appeared Aug. 3 in a special online publication of the journal Nature.

Credits:

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More information:

For images and more information on the kilonova, visit:
http://hubblesite.org/news/2013/29

For more information about the Hubble Space Telescope, visit:
http://www.nasa.gov/hubble