NOTA DE PRENSA

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Stars have found a new way to die

- **A peculiar burst detected on Christmas Day 2010 points to the merger of two stars, a neutron star and an evolved red giant, after going through a common-envelope stage.**

- **The event requires the addition of a new scenario to the two existing models for gamma-ray bursts.**

Granada, Nov. 30, 2011. On Christmas Day 2010, a gamma-ray burst (GRB) was discovered that put the existing models in question. In addition to an extraordinarily long duration, GRB 101225A – also named "The Christmas Burst" – showed an afterglow coming from a thermal source, different to other GRBs. An international group of astronomers lead by Christina Thöne and Antonio de Ugarte Postigo from the Instituto Astrofísica de Andalucía (IAA – CSIC) published an article in Nature where they propose a merger of two stars that underwent a common-envelope stage as explication of the event.

"All GRBs observed so far show an afterglow that is produced by the movement of very fast electrons in magnetic fields inside the jet coming from the GRB itself. In contrast, the afterglow of the Christmas Burst came from a thermal source, something really unprecendented", explains Christina Thöne (IAA-CSIC).

Until now, two mechanisms were proposed to explain GRBs, since they come in two different classes: the long GRBs (2 seconds or longer in gamma-rays) which are due to the collapse of a very massive star, while the short GRBs (less than 2 seconds) are produced by the merger of two compact objects such as two neutron stars. "The exotic character of this GRB forced us to invoke a third scenario and we investigated a large range of possibilities and models to explain this event", says Antonio de Ugarte (IAA-CSIC).

The study proposes that the Christmas Burst is the result of the merger between a neutron star (a degenerate star that contains the mass of the Sun in a radius of only a few tens of kilometers) and an evolved red giant star. This exotic binary system, placed at a distance of around 5.5 billion lightyears, experienced a common envelope phase when the neutron star plunged into the atmosphere of the giant star. During this stage, the giant star lost part of its evelope. Later when the two stars finally merged, the explosion produced two jets, similar to those created in normal GRBs, which got slowed down by the interaction with the previously ejected material. This interaction of the afterglow with the envelope gave rise to the observed radiation from hot material that was subsequently cooling down with time.

About 10 days after the GRB, a faint supernova explosion started to emerge, reaching its maximum about 40 days after the event. Long GRBs are usually accompanied by a bright supernova. The brightness of the supernova is usually connected to the amount of radioactive nickel produced in the explosion. "Our scenario predicts the production of only a small quantity of nickel which leads to a faint supernova, this makes it consistent with the observations", emphasizes Christina Thöne (IAA-CSIC). "However, there is also another model for this event, published in the same issue of Nature, suggesting that this burst came from the tidal disruption of a small body by a neutron star inside our Galaxy", adds the astronomer.

Gamma-ray bursts (GRBs)

Gamma-ray bursts (GRBs) are short, intese flashes of gamma-radiation which can happen anywhere in the sky and are always connected to catastrofic stellar events. The duration of the gamma-ray emission varies from milliseconds to more than half an hour and they are so energetic that they can be detected up to many thousands of millions of lightyears away. The Earth's atmosphere is opaque to gamma radiation, therefore GRBs can only be observed by detectors onboard spacecraft such as NASA's *Swift* satellite.

When *Swift* localizes a GRB it reacts and distributes the coordinates to research groups across the planet (mostly by internet) to give them the opportunity to follow the event up with ground-based telescopes. Those observations have shown that GRBs are followed by light emission at lower energies, the so-called afterglow, which comes from charged particles moving in magentic field at relativistic velocities (more than 99% of the speed of light).

"Despite several decades of GRB research, these objects still hold a lot of surprises for us. In the same way as supernovae of ever more different types have been found, we probably also have to expand our classification of GRBs. Stars seem to have many ways of how to die", concludes Christina Thöne.

REFERENCE:
C. Thöne et al. ***The unusual gamma-ray burst GRB 101225A from a helium star/neutron star merger at redshift 0.33*** Nature doi:10.1038/nature10611

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