

Astrowatch

COMPILED BY MARC TÜRLE, ISDC AND OBSERVATORY OF THE UNIVERSITY OF GENEVA, AND CHIPP, UNIVERSITY OF ZÜRICH

Fast radio bursts reveal unexpected properties

Two studies show that fast radio bursts (FRBs) have a richer phenomenology than initially thought and might originate in two different classes. While a group could, for the first time, pinpoint the location of a FRB and constrain baryon density in the intergalactic medium, a second study has found repeated FRBs from the same source, which cannot be of cataclysmic origin.

FRBs are very brief flashes of radio emission lasting just a few milliseconds. Although the first FRB was recorded in 2001, it was detected and recognised as a new class of astronomical events only six years later (*CERN Courier* November 2007 p10). It has been overlooked until re-analysis of the data searching for very short radio pulses. Since then, more than 10 other FRBs have been detected, and they all suggest very powerful events occurring at cosmological distances (*CERN Courier* September 2013 p14). Unlike for gamma-ray bursts (GRBs), there is a way to infer the distance via the time delay of the pulse observed at different radio frequencies. This delay increases towards lower radio frequencies and is proportional to the dispersion measure (DM), which refers to the integrated density of free electrons along the line of sight from the source to Earth.

The real-time detection of a FRB at the Parkes radio telescope has now made it possible, for the first time, to quickly search for afterglow emission, which has routinely been done for GRBs for more than a decade (*CERN Courier* June 2003 p12). Only two hours after the burst, the Australia Telescope



Artistic rendering of repeating fast radio bursts from a distant source with, in front, the suspended support platform of radio receivers of the 305 m Arecibo telescope in Puerto Rico.

Compact Array (ATCA) observed the field and identified two variable compact sources. One of them was rapidly fading and is very likely the counterpart of the FRB. This achievement is reported in *Nature* by a collaboration led by Evan Keane of Swinburne University of Technology in Australia and project scientist of the Square Kilometre Array Organisation.

What makes the study so interesting is that the precise localisation of the afterglow allowed identification of the FRB's host galaxy and, therefore, via its redshift of $z=0.492\pm0.008$, the precise distance to the event. With this information, the DM can

be used to measure the density of ionised baryons in the intergalactic medium. The obtained value of $\Omega_{\text{GM}}=4.9\pm1.3$, expressed in per cent of the critical density of the universe, is in good agreement with the cosmological determinations by the WMAP and Planck satellites.

The second paper, also published in *Nature*, reports the discovery of a series of FRBs from the same source. A total of 10 new bursts were recorded in May and June 2015, and correspond in location and DM to a FRB first detected in 2012. This unexpected behaviour was found by Paul Scholz, a PhD student at McGill University in Montreal, Canada, sifting through data from the Arecibo radio telescope in Puerto Rico. The recurrence of bursts on minute-long timescales cannot come from a cataclysmic event, but is likely to be from a young, highly magnetised neutron star, according to lead author Laura Spitler of the Max Planck Institute for Radioastronomy in Bonn, Germany. It is likely that this FRB is of a different nature to other FRBs.

The status of the field is reminiscent of that of GRBs in the 1990s, with the first afterglow detections and redshift determinations in 1997, and the earlier understanding that soft gamma repeaters are distinct from genuine extragalactic GRBs, which are cataclysmic events like supernova explosions and neutron star mergers.

● Further reading

EF Keane *et al.* 2016 *Nature* **530** 453.
LG Spitler *et al.* 2016 *Nature* **531** 202.

Picture of the month

This stunning image by the Hubble Space Telescope shows the central region of the Tarantula Nebula in the Large Magellanic Cloud (Picture of the Month, *CERN Courier* June 2012 p12). The young dense star cluster R136 is only a few million years old, and contains hundreds of young blue stars. In addition to this image by the Wide Field Camera 3, astronomers used the ultraviolet-imaging spectrograph STIS – installed by astronauts in 2009 – to identify nine monster stars with masses more than 100 times that of the Sun. One of them is the previously identified record-holder R136a1, which keeps its place as the most massive star known in the universe, at more than 250 solar masses. These hefty stars are destined to explode as supernovas in a few million years.

NASA, ESA, P. Crowther (University of Sheffield)

