

Astrowatch

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

Gamma-ray bursts are a real threat to life

A new study confirms the potential hazard of nearby gamma-ray bursts (GRBs), and quantifies the probability of an event on Earth and more generally in the Milky Way and other galaxies. The authors find a 50% chance that a nearby GRB powerful enough to cause a major life extinction on the planet took place during the past 500 million years (Myr). They further estimate that GRBs prevent complex life like that on Earth in 90% of the galaxies.

GRBs occur about once a day from random directions in the sky. Their origin remained a mystery until about a decade ago, when it became clear that at least some long GRBs are associated with supernova explosions (*CERN Courier* September 2003 p15). When nuclear fuel is exhausted at the centre of a massive star, thermal pressure can no longer sustain gravity and the core collapses on itself. If this process leads to the formation of a rapidly spinning black hole, accreted matter can be funnelled into a pair of powerful relativistic jets that drill their way through the outer layers of the dying star. If such a jet is pointing towards Earth, its high-energy emission appears as a GRB.

The luminosity of long GRBs – the most powerful ones – is so intense that they are observed throughout the universe (*CERN Courier* April 2009 p12). If one were to happen nearby, the intense flash of gamma rays illuminating the Earth for tens of seconds could severely damage the thin ozone layer that absorbs ultraviolet radiation from the



Artist's rendering of a GRB, where life-damaging gamma rays are produced by two relativistic jets powered by a new-born black hole at the heart of an exploding massive star. (Image credit: ESO/A Roquette.)

Sun. Calculations suggest that a fluence of 100 kJ/m² would create a depletion of 91% of this life-protecting layer on a timescale of a month, via a chain of chemical reactions in the atmosphere. This would be enough to cause a massive life-extinction event. Some scientists have proposed that a GRB could have been at the origin of the Ordovician extinction some 450 Myr ago, which wiped out 80% of the species on Earth.

With increasing statistics on GRBs, a new study now confirms a 50% likelihood of a devastating GRB event on Earth in the past 500 Myr. The authors, Tsvi Piran from the Hebrew University of Jerusalem and Raul Jimenez from the University of Barcelona in Spain, further show that the risk of life extinction on extra-solar planets increases towards the denser central regions of the Milky Way. Their estimate is based on the rate of GRBs of different luminosity and the properties of their host galaxies. Indeed, the authors found previously that GRBs are more frequent in low-mass galaxies such as the Small Magellanic Cloud with a small

fraction of elements heavier than hydrogen and helium. This reduces the GRB hazard in the Milky Way by a factor of 10 compared with the overall rate.

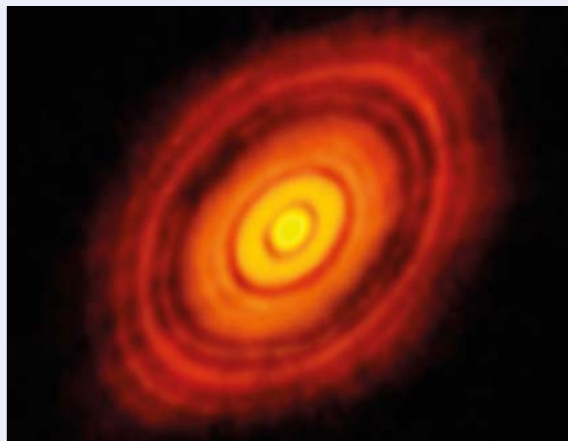
The Milky Way would therefore be among only 10% of all galaxies in the universe – the larger ones – that can sustain complex life in the long-term. The two theoretical astrophysicists also claim that GRBs prevent evolved life as it exists on Earth in almost every galaxy that formed earlier than about five-thousand-million years after the Big Bang (at a redshift $z > 0.5$). Despite obvious, necessary approximations in the analysis, these results show the severe limitations set by GRBs on the location and cosmic epoch when complex life like that on Earth could arise and evolve across thousands of millions of years. This could help explain Enrico Fermi's paradox on the absence of evidence for an extraterrestrial civilization.

● Further reading

T Piran and R Jimenez 2014 *Phys. Rev. Lett.* **113** 231102.

Picture of the month

This image from the Atacama Large Millimeter/submillimeter Array (ALMA), located high in the Chilean Andes, reveals an unprecedented view of a planet-forming disc around a young star. The major systems of ALMA, which consists of 54 antennas with 12-m dishes and 12 smaller 7-m dishes, were completed in early 2013 (*CERN Courier* May 2013 p43). This first-released image from ALMA with the antennas in the near-final configuration is the sharpest picture ever made at submillimetre wavelengths, and even exceeds the resolution achieved with the Hubble Space Telescope (Picture of the month, *CERN Courier* November 2011 p13). By showing concentric bright rings separated by gaps around the star HL Tauri, the image suggests that ALMA is witnessing the formation of planet-like bodies in this stellar disc, about 450 light-years away. Seeing such features in a star that is only one-million years old has astounded ALMA's scientists, and could revolutionize theories of planetary formation. (Image credit: ALMA (ESO/NAOJ/NRAO).)



AEROPAK®

Mineral Insulated (MI) Cable
SiO₂ Coax and Triax cables suitable for microwave signals

We were among the first pioneering companies to manufacture mineral-insulated cable to improve product performance and reliability.



Temperature is our business | www.okazaki-mfg.com

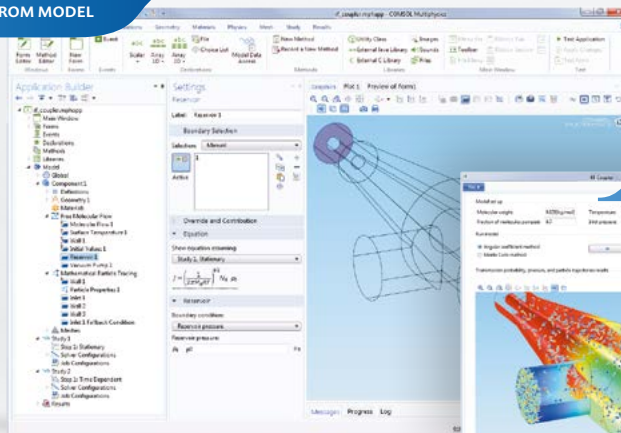
Verify and Optimize your Designs with COMSOL Multiphysics®

NOW FEATURING THE APPLICATION BUILDER

The Application Builder provides you with tools to easily design a custom interface for your multiphysics models. Use COMSOL Server to distribute your apps to colleagues and customers worldwide.

Visit comsol.com/release/5.0

FROM MODEL



TO APP

