50 & 100 YEARS AGO

50 YEARS AGO

Life, the Great Adventure. By Jean Rostand. (Discussions with Paul Bodin.) — An admirable guide for those who wish to explore some of the broader paths in the field of current biology... With Rostand's general point of view few modern readers would quarrel, although his explanation of reasons for superfluous hair in the male is nonsense... These, however, are trivial criticisms of a book which could reach many readers. Many of them will be shocked to learn that... in a country like France, whose people are so proud of their ability to behave rationally, there are still about 3,460 astrologer-palmists in Paris alone... One of the lessons from this book is that the mass of people are still prepared to believe anything, particularly if the new cult is served persuasively with the right amount of scientific jargon. Rostand and Bodin deserve praise for their efforts to remove some of the superstitions of 1955.
From *Nature* 20 August 1955.

100 YEARS AGO

The *Academy* directs attention to a curious poetical tribute — composed by a French mathematician — to Archimedes, referring to the evaluation of π, which, set out in thirty places of decimals, is 3.14159265358979323846264 3383279. It will be observed that each of the thirty-one words in this quatrain contains the number of letters corresponding with the successive numbers in the numerical expression:— *Que j'aime à faire apprendre un nombre utile aux sages/Immortel Archimède, artiste ingénieur!/Qui de ton jugement peut priser la valeur?/Pour moi ton problème eut de pareils avantages.*

The *Frankfurter Zeitung*... adds a similar effort emanating from a German poet and geometrician:— *Dir, o Held, o alter Philosoph, Du Riesen-Genie!/Wie viele Tausende bewundern Geister/himmlisch wie Du und göttlich!/Noch reiner in Aeonen/wird das uns strahlen/wie im lichten Morgenrot!*

The *Academy* asks for English parallels to these efforts.
From *Nature* 17 August 1905.

directed along the axis of rotation, this energy breaks through the surface of the star at almost the speed of light. This high-energy radiation shockwave is sent out along a narrow jet and can be spotted by detectors — if the jet is pointing the right way.

According to the collapsar model, the prompt energetic structure of a long GRB is the result of dissipation by internal, relativistic shocks, which may last seconds or minutes, at a radius of about 10^{14} cm from the centre of the collapsed star[9]. At this point, much of the energy remains in storage as kinetic energy and is tapped later[10], at a radius of about 10^{16} cm, when the outflow collides with the interstellar medium or the particle wind from the progenitor star. This two-stage model, known as the internal–external model[11], predicts a transition from an erratic, prompt γ-ray outburst to a smoother X-ray afterglow (Fig. 1). Late bumps in the light curves that are observed from long GRBs, as well as directly observed spectral features, are reminiscent of features from stellar explosions — supernovae — and provide evidence in support of the collapsar model.

Tagliaferri and colleagues observed[3] two long bursts, GRB050126 and GRB050219a, which lasted about 20–30 seconds and were detected initially by Swift's Burst Alert Telescope (BAT) at γ-ray frequencies. True to its name, Swift rapidly — in 129 seconds in the first case and 87 seconds in the second — slewed its X-Ray Telescope (XRT) into the line of the burst to allow unprecedented monitoring, at low X-ray frequencies, of the afterglow. The Swift data show that, as the prompt emission fades, an initial afterglow appears that declines very rapidly over a few hundred seconds. This early afterglow is, however, distinct from the later afterglow familiar from pre-Swift data — with the high sensitivity and excellent time coverage of Swift, we are now witnessing the X-ray light curves in the transition period from prompt emission to afterglow.

Although the Swift data broadly support the notion of two components to GRB emission, the decay of the burst's prompt brightness within the first few minutes is unexpectedly steep, falling with the inverse cube of time, t^{-3}. How should we interpret this? The authors cite several possibilities[3], but most of these are undermined by the 'non-thermal' spectrum of the radiation that follows a power law, rather than the 'blackbody' form assumed in the models. The most intriguing option that would provide such a rapid decay is 'inverse Compton' scattering of low-energy photons by high-energy electrons in the reverse shock of the burst. (Blast waves lead to two shocks, one propagating ahead into the external medium, and another propagating back through the ejected material of the jet.) If the inverse Compton mechanism dominates — which would be true if the outflow contained a very large abundance of electron–positron pairs — prompt 'optical' flashes that are also not observed might be suppressed[12]. Robotic telescopes on the ground with swift responses should soon constrain these speculations.

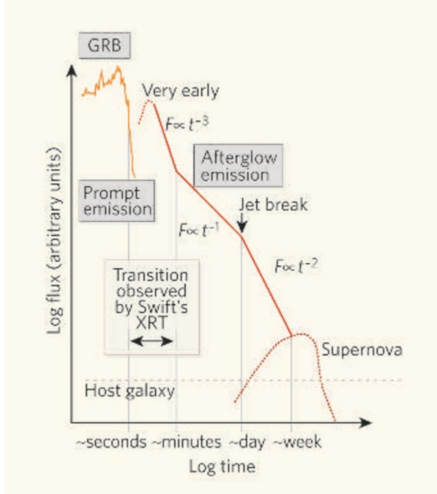

Figure 1 | Staged burst. The flux F of a γ-ray burst (GRB) over time t, as recorded by the Swift satellite and reported by Tagliaferri *et al.*[1]. The prompt γ-ray emission usually lasts for a only few seconds, and is believed to originate from shocks within the relativistic jet. The longer-lasting afterglow, in the X-ray to optical and infrared bands and typically outshining the GRB's host galaxy, decays following a power law, with the flux falling as t^{-1} during the first 24 hours, and faster (t^{-2}) thereafter. In the transition region between prompt emission and afterglow, the gradient is even steeper (t^{-3}). A bump in the light curves sometimes observed a few weeks after the trigger is predicted by the collapsar model for long GRBs, and is believed to be light from an associated supernova.

The standard model used to explain GRB afterglows is known as the fireball model and is based on a few main ingredients. First, the extreme brightness of the GRB, in conjunction with the large distances involved, implies a huge energy release. Second, the brevity of the bursts indicates a small volume in which this energy is released. Taken together, these seem to imply the existence of a dense, opaque fireball driving the burst to relativistic speeds.

If there really were a fireball, this would imply emission in all directions, and the observed GRB energies would be difficult to explain within the confines of conventional astrophysics. But commonly observed breaks in the afterglow suggest that the outflow is indeed jetted and is thereby limited to a small solid angle, reducing the energy required. After correcting for this effect, the bursts seem to behave approximately as 'standard candles'[13] — objects whose observed brightness depends only on how far away they are — making them useful measures of cosmological distance[14].

Continued monitoring of the sky with Swift, with other detectors such as HETE-2 and INTEGRAL, and with the future missions GLAST-GBM, Agile and EXIST, will further expand our understanding of GRBs. They will remain a source of amazement and wonder for some time to come. ■