NATURE

100 YEARS AGO

The appearance on clear evenings of the zodiacal light after sunset at this season of the year in this latitude is usual, and it has been frequent and beautiful to observe in this district for many nights. It would be interesting if the readers of NATURE could detect any definite movement of the arm of light, for much yet remains to be discovered about this phenomenon, and any observer can make this point a study… The very remarkable sunset of March 6 has probably been observed by many readers of NATURE. The "fire-finger" left in a perfectly perpendicular position for upwards of fifty minutes after sunset was visibly withdrawn, without losing colour or size or changing from the perpendicular, and was a vivid and beautiful adjunct to a sunset afterglow strangely reminding one of the "Krakatoa sunsets" of years ago. This finger of fire the writer has only observed once before, after a similar-coloured sunset over the estuaries of the Medway and Thames last summer, but London smoke dimmed the effect.

From *Nature* 13 March 1902.

50 YEARS AGO

A conference was held during January 19–20 in London of the organization Science for Peace, which was attended by 180 scientific workers… After lengthy discussion, a statement of principles was adopted. Recognizing the danger of a third world war the statement runs... "We think it our duty to ensure that science is used solely to improve the conditions of life and to advance the arts of peace". It is the scientist's duty "to inform and enlighten the public both about the benefits that science can bring, and about the destructiveness and misery of modern war". ... What people want to hear about is not the horrors of atomic warfare, not the A.B.C. of atomic energy, but dispassionate analysis of present deadlocks, and expert suggestions as to what can be done… In so far as we contribute to the release of tension among the nations, we contribute not only to the safety and independence of our country, but also to the support and sustenance of the great scientific tradition in which we have been fostered and to removal of the suspicion that scientists are indifferent to the often revolutionary consequences of their own discoveries.

From *Nature* 15 March 1952.

It will be fascinating to see how the neuronal properties and synaptic connectivity of the circuits that control movement in these genetically altered animals compare with those that develop normally. We can also look forward to genetic manipulations in other organisms that are better suited to the study of reflex pathways in the control of movement, so that we can discover in detail the developmental consequences of altered sensory signalling. ■

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Cosmology

Maintaining the standard

George F. R. Ellis

Cosmologists continue to probe for weaknesses in the 'standard model' for explaining the structure of the Universe. Happily, the model passes the latest observational test of its consistency.

There might seem to be a paradox at the heart of cosmology. On the scales of stars, galaxies and clusters of galaxies, the structure of the Universe is complex, but cosmologists claim that at larger scales it becomes very simple. The standard model of cosmology assumes that the structure of the Universe is extremely smooth at the largest observable scales, but there are other models that could account for the uniformity we see in observations made at such scales. Fortunately, there are various observational tests that can investigate the consistency of the standard model — and the results of one such test are reported by Blake and Wall[1] on page 150 of this issue.

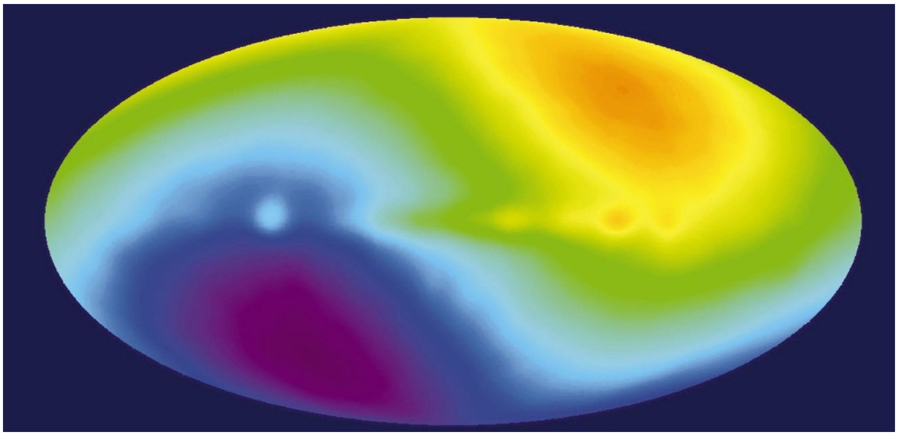
At large scales, such as the Hubble scale (about 10^{10} light years), which is estimated using the rate of expansion of the Universe since the Big Bang, the structure of the Universe seems to follow the model codified by Robertson and Walker[2,3]. In this model, space is everywhere isotropic (there are no preferred directions) and homogeneous (all physical and geometrical properties are the same everywhere at a given instant). So, apart from a possible uniform curvature, the model contains no spatial structure at all; things only vary with time. It is hard to get simpler than that.

One might be excused for being a mite cynical about the claim that everything is so simple at these scales. In fact, on the largest scales (beyond those that are observable), cosmologists believe that the Universe might again be complex, having a fractal structure, that is, one that has similar structure on all scales. This is a consequence of popular models[4,5] that describe the Universe as chaotic and inflationary — that at one stage in its evolution it underwent exponential expansion and that this might still be occurring in some regions today. So might cosmologists be deceiving themselves when they embrace such idealized models for the observable region of the Universe?

But there is evidence for this simplicity — it is the extraordinary large-scale isotropy of the Universe around us. The distributions of very distant galaxies and radio sources are isotropic to a high degree of accuracy, as is the cosmic microwave background (CMB). This is the radiation that is believed to have originated at the moment, 300,000 years after the Big Bang, when the Universe had cooled sufficiently for matter and radiation to become decoupled — electrons and protons began to combine to form atoms, and radiation could propagate freely.

Today, we can detect this relic of the Big Bang, but there is in fact a simple, detectable anisotropy — the temperature of the CMB is 2.7 K, but, when the whole sky is observed, the CMB seems slightly hotter in one direction and slightly cooler in the opposite direction (Fig. 1). The difference is only one part in 1,000, but it creates a dipole structure in the CMB[6]. This anisotropy can be removed by factoring in a change of velocity: the dipole is interpreted as being due to the Earth moving at a speed of about 370 km s^{-1} relative to the 'rest frame' of the CMB. Once this velocity dipole is removed, the radiation becomes astonishingly isotropic[7] — to one part in 100,000.

Much effort is now going into measuring and analysing this tiny residual anisotropy in the CMB, for it is the signature of seed perturbations that existed at the time of the matter–radiation decoupling, from which



NASA/COBE

Figure 1 **The all-sky map of the cosmic microwave background radiation reveals a dipole structure. Radiation in the direction of the Earth's motion appears bluer and hotter, and radiation in the other half of the sky appears redder and cooler. Blake and Wall[1] have found a corresponding dipole in the distribution of distant radio sources. This supports the belief that the microwave background is a cosmic, not a local, phenomenon and is a relic of the Big Bang.**

galaxies and clusters of galaxies would eventually grow. But the point here is not what the CMB anisotropy represents, but that it is so small. The simplest explanation is that the Universe is indeed extraordinarily smooth on the largest scales — that it is a Robertson–Walker model, with tiny fluctuations superimposed.

This is not the only possible interpretation, but it is supported by a physical model. The inflationary-universe theory[4,5,8] suggests that such a high degree of smoothness would necessarily result from a vast exponential expansion of the Universe at very early times. It also provides a mechanism for the formation of structure that predicts anisotropies in the CMB of the kind recently confirmed[7].

But other possible explanations exist. The observed dipole anisotropy could, for example, be caused by a genuine inhomogeneity of the Universe at large scales. Or the whole picture could be wrong — the 2.7-K radiation might not be a property of the whole Universe at all, but could instead be generated locally and become isotropic in the neighbourhood of the Sun[9].

There are two crucial tests that the CMB must pass if its interpretation as a Big Bang relic is correct. First, the radiation would have cooled as the Universe expanded; thus, for radiation that has travelled very large distances to us (equivalent to looking far back in time), we should see evidence of increasing temperature, up to a limit of 3,000 K — the temperature at the time of decoupling. This can be tested by detecting the effect of the CMB temperature on intergalactic molecules, and, so far, the CMB has passed this test with flying colours[10].

The second test is that number counts of distant objects (galaxies, radio sources and quasistellar objects) must also show a dipole anisotropy that is in the same direction as that of the CMB, at about the 2% level[11]. This imbalance should appear because, as the observer on Earth moves towards the sources, their surface brightness will appear enhanced, so that previously undetectable sources will be raised above the detection limit. The reverse should happen as the observer moves away from sources in the other half of the sky. If this anisotropy were not found, it would spell disaster for the standard model — either the background radiation could not be of cosmological origin, or the Universe would not fit the Robertson–Walker model.

This crucial test has now been carried out by Blake and Wall[1]. They have analysed data from the sky survey of distant radio sources[12] performed by the National Radio Astronomy Observatory's Very Large Array in New Mexico, USA. The Y-shaped array of 27 radio antennas (each 25 m in diameter) achieves the resolution of a telescope several kilometres in diameter. Blake and Wall find that there is indeed a dipole, in the same direction as the temperature anisotropy and close to the expected amplitude, after experimental effects and local clustering have been taken into account.

The result is not unexpected, but it is important nevertheless. The seemingly unlikely standard model, with its simple behaviour at large scales, has passed yet another critical consistency test. It is vital that we carry out all such tests, checking every potential weakness in the standard picture. With yet another observational success behind them, theoretical cosmologists can be pleased that their basic model remains intact. ■

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Signal transduction

Molecular ticket to enter cells

Shlomo Oved and Yosef Yarden

Just as important as starting cellular signalling pathways is switching them off again. It seems that the Cbl protein has a dual function in accelerating the degradation of certain signalling molecules.

The cells that make up our bodies live in tight-knit communities and communicate with each other almost constantly. They often do so by using messenger molecules such as growth factors; when these molecules bind to receptors on the cell surface, they activate a plethora of cellular processes that set specific gene programmes in motion. The receptors must then be inactivated so that signalling can be stopped, and breakdown of the deactivation mechanisms often leads to cancer. One of the main inactivation mechanisms entails rapid clearance of the receptor from the surface — a process termed receptor-mediated endocytosis — and degradation of messenger–receptor complexes in an acidic cellular compartment, the lysosome. Receptors may spend hours to days at the cell surface, but they are removed within seconds after messenger binding. On pages 183 and 187 of this issue, Soubeyran and colleagues[1] and Petrelli and co-workers[2] shed light on the rapid sequence of events that take place in this critical window of time (Fig. 1, overleaf).

A major source of information on receptor-mediated endocytosis is the equally rapid recycling of membranes at synapses, the specialized junctions between nerve cells. When nerves are stimulated, neuro-