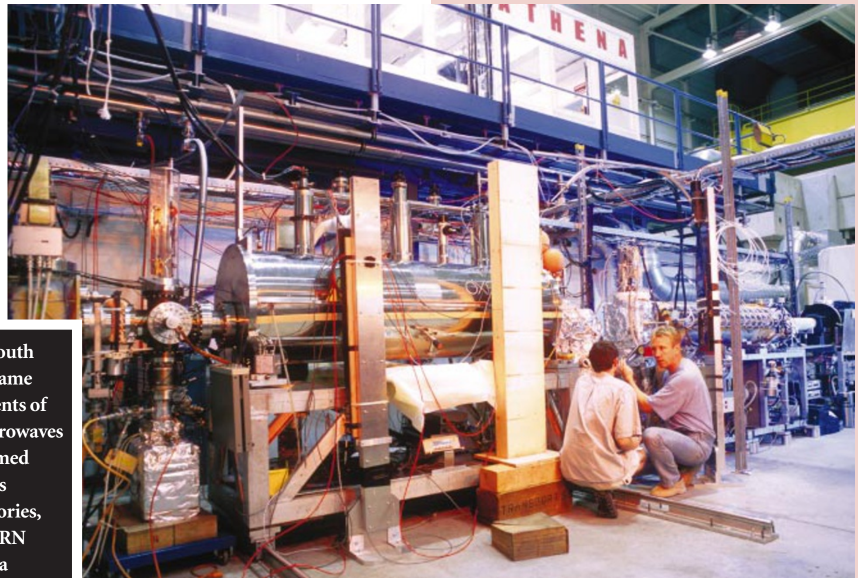
E. LEITCH

CERN



From the South Pole (left) came measurements of cosmic microwaves that confirmed cosmology's leading theories, while at CERN near Geneva (right), two teams captured atoms of antihydrogen.

derived from GM grain imported illegally from Argentina. And unapproved GM cotton varieties have reportedly been widely planted in India, hampering attempts to monitor the environmental and economic impact of the officially sanctioned crops. ■

Peter Aldhous

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Cosmology

It all adds up

The embers of the Universe's primordial fire continue to provide cosmologists with data against which to test their ideas. And the most reassuring news this year has been that their favourite theories seem up to the job.

September saw the release of new results on the cosmic microwave background (CMB), the blanket of microwave radiation that pervades the Universe. The microwave photons that make up the CMB date from just 300,000 years after the Big Bang. By analysing enough of them, cosmologists can detect faint records of conditions in the youthful Universe.

For 271 days over the past two years, researchers used the Degree Angular Scale Interferometer (DASI), an observatory at the US Amundsen-Scott South Pole Station, to study microwave photons coming from two small patches of the Antarctic winter sky. The images from each day were combined into a single super-high-resolution picture, which revealed a slight polarization in the microwave background.

The polarization was created by electrons surfing the waves of energy that swept through the early Universe, says John Carlstrom, an astronomer at the University of Chicago and leader of the DASI project, who announced the news at the International Workshop on Particle Physics and the Early Universe, held in Chicago. The results are published in this issue of *Nature*[1–3]. As electrons sped along the front of the wave, they reflected photons in a preferential direction, causing the radiation in certain areas of the Universe to become polarized. When the electrons eventually fell into orbit around protons, the radiation escaped, taking with it a record of the energy waves.

The polarization data back up other results to come from studies of the CMB. During the early 1990s, temperature differences in the CMB were detected[4]. Cosmologists suspect the differences were caused by clumps of matter in the early Universe, which seeded the growth of the web of galaxies we see today. According to the leading theory, these clumps of matter were created by the energy waves — so detecting evidence of the waves was important. "The polarization is a unique signature," says Carlstrom. "If it wasn't there, we'd have to throw out this theory of waves, which means we'd have to throw out all of our recent interpretations of the CMB."

NASA's Microwave Anisotropy Probe satellite, launched in June 2001, will provide a more detailed all-sky picture of the polar-

Highlight: Antihydrogen

Holding up a mirror to physics' world view

Atoms from the mirror world of antimatter were captured and analysed for the first time this year. Two teams at CERN, the European Laboratory for Particle Physics near Geneva, have created large numbers of long-lived antihydrogen atoms, which can be used to test fundamental theories about the Universe.

In total, the teams produced thousands of antihydrogen atoms by using magnetic fields to bring together antiprotons and anti-electrons. This was a considerable technical achievement in itself, but the real interest lies in studying the properties of antihydrogen. Theory suggests that it should mirror the properties of hydrogen, but no one knows for sure, says Rolf Landua, spokesman for the ATHENA collaboration, which announced its results in September[1].

The standard model of fundamental particles and forces holds that hydrogen and antihydrogen should have the same properties and obey the same rules, but it can't predict why the Universe is almost devoid of antimatter. Finding a difference between matter and antimatter could lead to an explanation, and perhaps force physicists to reformulate the standard model.

A second CERN team, called ATRAP, has also captured antihydrogen atoms[2], and has subsequently made preliminary measurements of their most excited energy states[3]. "There's still a lot of work to do," says Gerald Gabrielse of Harvard University, spokesman for ATRAP.

"This is just the start," agrees Landua. "Everything is fresh; we haven't exploited all of our potential."

Geoff Brumfiel

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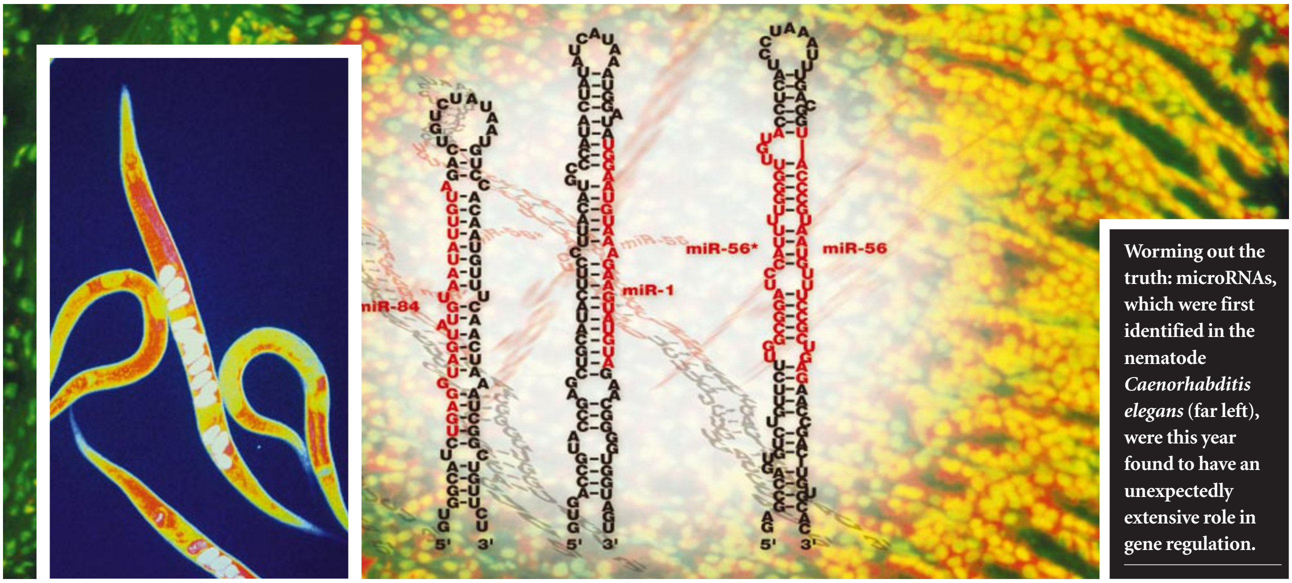
J. KING-HOLMES/SPL; INSET, M. XERIDAT/SPL



Worming out the truth: microRNAs, which were first identified in the nematode *Caenorhabditis elegans* (far left), were this year found to have an unexpectedly extensive role in gene regulation.

ization sometime early next year. But the polarization may retain a secret. The energy waves are thought to have been triggered by a rapid enlargement of the early Universe, known as inflation. This would also have created gravity waves, which would lead to tiny whirlpools in the CMB polarization. Detecting these whirlpools would provide the best evidence yet for inflation. Measuring such vortices will require more sensitive instruments, however. "No one knows for sure exactly how to do it — yet," says Lyman Page, a cosmologist at Princeton University in New Jersey. ■

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Small RNAs

The genome's guiding hand?

They can be thought of as biology's 'dark matter': tiny RNAs that don't encode any protein. But 2002 has seen an avalanche of discoveries about their roles in influencing gene activity — lending some credence to the radical idea that small RNAs hover 'above' the genome, providing a matrix of regulatory control.

MicroRNAs (miRNAs) are about 22 nucleotides long, and were first identified in the nematode *Caenorhabditis elegans*[1,2]. In *C. elegans*, they regulate the activity of specific genes by binding to messenger RNAs (mRNAs) and preventing their translation to proteins.

Until recently, many experts thought that such examples were interesting anomalies. But they are now realizing that miRNAs are involved in gene regulation in a wide variety of organisms, and researchers are finding links between miRNAs and the phenomenon of RNA interference (RNAi). The latter mechanism, which is exploited by biologists for gene-silencing studies, is thought to be a natural defence against invading viruses. It uses an enzyme called Dicer to cut double-stranded viral RNA into small interfering RNAs (siRNAs), again about 22 nucleotides long. These then bind to other viral RNA, targeting it for destruction.

Dicer also creates miRNAs, by cutting them from longer, hairpin-shaped RNAs transcribed from the genome, but that was where the similarity was thought to stop. In August, however, it emerged that miRNAs can also function in the RNAi pathway and cause their target mRNAs to be degraded, if they perfectly match its target sequence[3].

Speculation was mounting that miRNAs represented an unexplored layer of gene regulation but, without knowing the identity of their targets, their role remained unclear. This again changed in the summer, when the mRNA targets of miRNAs were identified in the weed *Arabidopsis thaliana* — most of those studied seem to be involved in early plant development[4,5]. This was remarkable progress, given that miRNAs were only identified in plants a few months earlier[6,7].

At the same time, new functions for small RNAs were being found. Tiny RNAs now appear to do a whole lot more than just target mRNAs. They seem to be associated with various 'epigenetic' phenomena — the inheritance of features that do not involve genetic sequence changes. For instance, a startling connection has been made between small RNAs and the silencing of gene activity in tightly packed regions of the genome: deleting genes that encode components of the RNAi pathway led to a loss of gene silencing in the fission yeast *Schizosaccharomyces pombe*[8,9].

Small RNAs also seem to be capable of reshaping the genome. The ciliated protozoan *Tetrahymena thermophila* possesses two nuclei, the larger of which loses roughly 15% of its DNA during the cell's development — and this seems to be guided by small RNAs[10].

Finally, some researchers are taking a lead from the presumed natural function of RNAi by exploring the use of small RNAs as anti-viral agents. siRNAs targeted at viral genes can inhibit the replication of HIV-1 or polio-virus in cultured cells[11–13]. What's more, siRNAs targeted at the host receptors used by HIV to enter the cell can also block infection[13].

Of course, results in cultured cells don't always translate to the clinic. "The challenge will be in the delivery," says Andy Fire of the Carnegie Institution of Washington in Baltimore, co-discoverer of RNAi in *C. elegans*. But there are early signs that siRNAs targeted at human hepatitis C virus can function when injected into mice[14]. These small nucleotide strings could yet be big news for medicine. ■

Carina Dennis

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