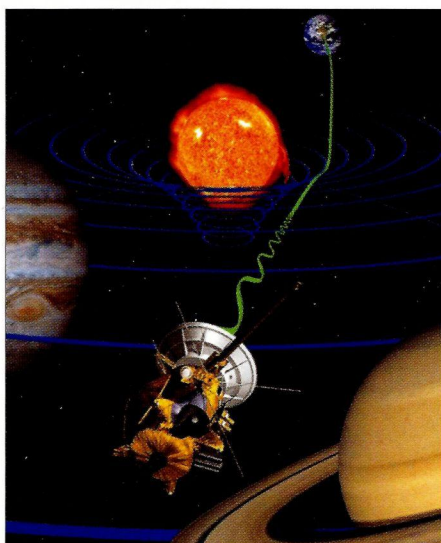


Compiled by Steve Reucroft and John Swain

Cassini gives general relativity a good test...

While most physicists are convinced that Einstein's theory of gravity in terms of a curved space-time geometry is basically correct, it is always good to check. Now researchers in Italy have made a new, more stringent test of general relativity using measurements of the frequency shift of radio signals to and from the Cassini spacecraft as it passed on the opposite side of the Sun from Earth. Bruno Bertotti of the University of Pavia and colleagues measured the parameter γ , which is unity in general relativity and zero in Newton's theory, and therefore indicates the degree to which gravity can be explained purely in terms of geometry without any additional forces.

The team found that $\gamma - 1 = 2.1 \pm 2.3 \times 10^{-5}$, which is a dramatic improvement over previous measurements that gave results at the 0.1% level, and strongly supports the idea that gravity is of purely geometrical origin, at least over distance scales of the order of our solar system. The improved accuracy is due to technological improvements implemented on the spacecraft's communication system and at NASA's ground station at Goldstone, California. Meanwhile, Cassini, a joint NASA/ESA



This artist's impression shows the concept of the general relativity experiment. (Jet Propulsion Laboratory.)

mission, continues its journey towards Saturn, which it will begin orbiting on 1 July 2004.

Further reading

B Bertotti et al. 2003 *Nature* **425** 374.

...while relativity makes entropy more confused

Entropy is turning out to be more subtle than ever. As a measure of the number of microstates accessible to a system, entropy is clearly Lorentz-invariant, but now Donald Marolf of the University of California in Santa Barbara, Djordje Minic of Virginia Tech, and Simon Ross of Durham University have had a close look at what happens in transformations to non-inertial (accelerated) frames, and have found that things can become very tricky.

As with Hawking radiation, the Unruh effect predicts that the vacuum of an inertial observer

will have particles in it as seen by an accelerated observer. It is not immediately obvious then what can be said about the corresponding entropies, and a great deal of careful rethinking about statistical thermodynamics may be in order. With luck, when the dust settles, the results may be comparable to those after it was realized that the second law had to be revised if black holes were to be accounted for properly.

Further reading

<http://xxx.lanl.gov/abs/hep-th/0310022>.

Single molecule able to store memories

A new approach to memory devices stores ones and zeros on individual molecules. Fraser Stoddart and collaborators at the University of California in Los Angeles have shown that individual organic molecules called catenanes, held between carbon nanotubes and metal electrodes, can be used to store data. Each catenane molecule has two linked rings that can rotate relative to each other depending on an applied voltage. The nanotubes act as incredibly thin wires, and also bond chemically to the catenanes. These memory elements can be very small – a gramme of organic molecules could, in principle, be enough to make all the memories for all the new computers worldwide for several years.

Further reading

A Goho 2003 *Science News* **164** 182.

New display device creates E-paper

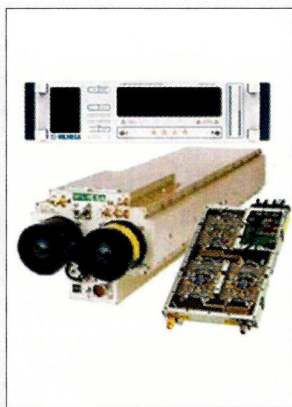
Paperless offices, paperless journals – and now paperless paper? Robert Hayes and B J Feenstra of Philips Research Eindhoven in the Netherlands have developed a new display device that acts like a sheet of paper, but can display images fast enough to be used for video. The idea is to use an applied voltage to control the degree to which a droplet of coloured oil mixed with water in a tiny pixel wets a white reflective surface. Contrast and reflectivity are far higher than can be obtained with liquid-crystal displays, so this looks like a technology that might really take off quickly.

Further reading

R A Hayes and B J Feenstra et al. 2003 *Nature* **425** 383.

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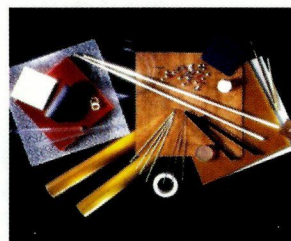


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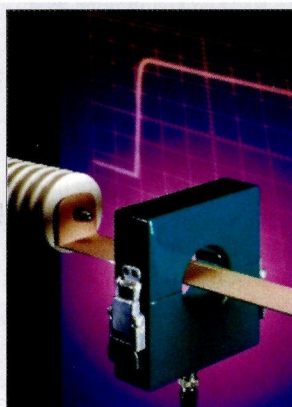


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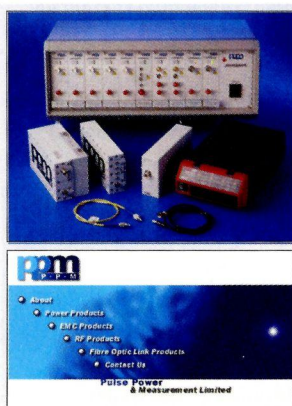
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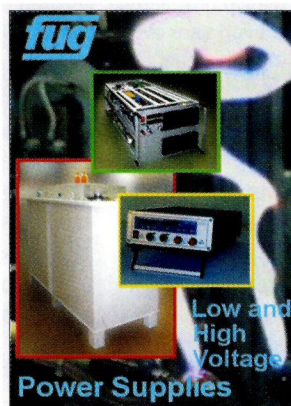


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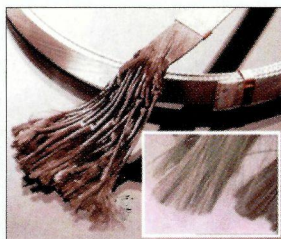


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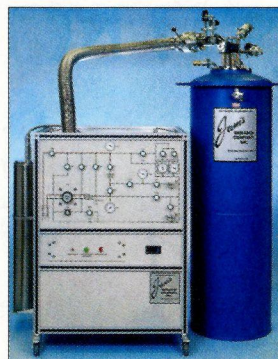
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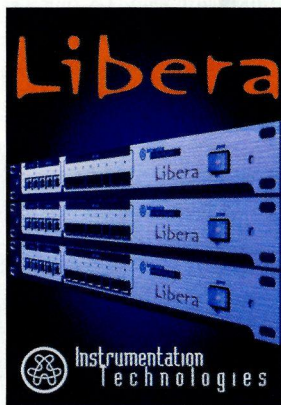
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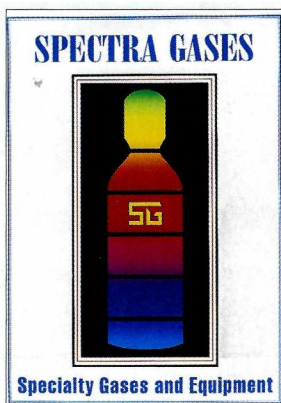
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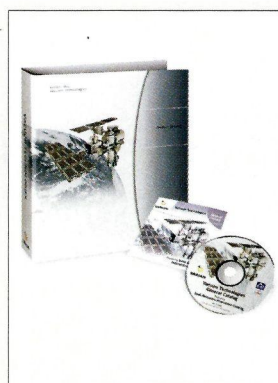


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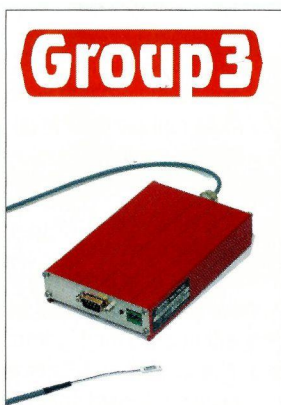
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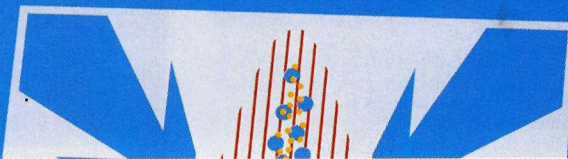
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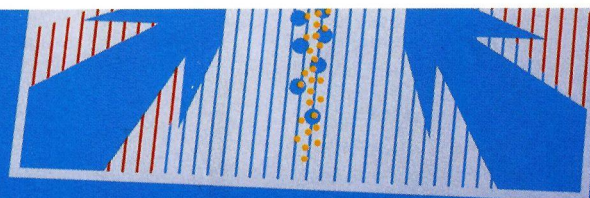
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