

Edited by Alison Wright

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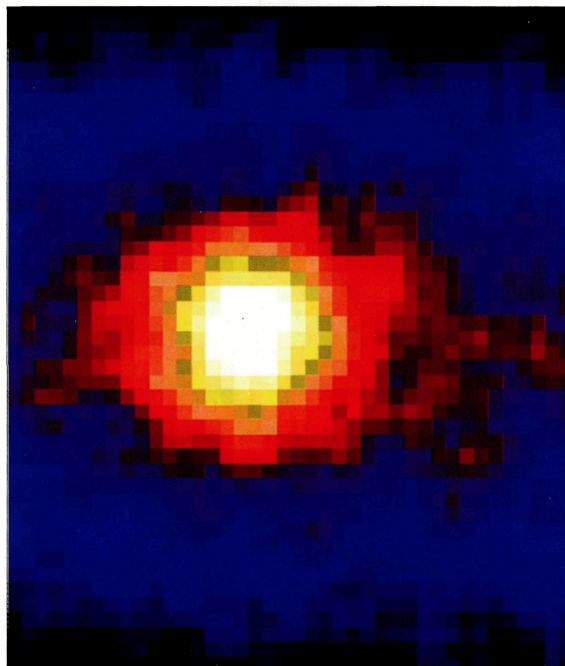
Space weather forecast is fine

Weather forecasting in space is a serious business: bad space weather, associated with solar flares or coronal mass ejections, can cause surges in terrestrial power grids, disrupt telecommunications and put the safety of both astronauts and spacecraft at risk.

Now US scientists have demonstrated an effective forecasting technique using helioseismic holography. They can predict Sun-related disruption more than a week in advance by spotting active regions on the far side of the Sun.

As sunspots absorb and scatter acoustic waves, while the solar interior is transparent to seismic waves, surface acoustic wave disturbances can be mapped back into the interior of the Sun to produce holographic images.

The researchers analysed



Another view of the Sun – the Super-Kamiokande 50 000 ton water Cerenkov detector, 1 km underground in Japan, took this “photograph” of the sun in “neutrino light”. The exposure time was 503.8 days and each pixel represents about 1 degree of the sky. (R Svoboda, Louisiana State.)

“Dopplergrams” (or sound travel time maps) made over two consecutive 24 h periods by the Solar Oscillations Investigation–Michelson Doppler Imager (SOI-MDI) flying onboard the Solar Heliospheric Observatory (SOHO). The maps revealed an active region on the far side of the Sun that was confirmed 10 days later by a surge in magnetic activity in that region, as the sunspot swung into view with the rotation of the Sun.

AIP

Hydrocarbons ease fibre-optic links

Electro-optic (EO) modulators that convert electric pulses into optical signals are important components of fibre-optic communication links.

Both high speed and wide bandwidth are already possible, but the “holy grail” of these modulators is a device that would operate at drive voltages of less than 1 V, rather than the current operating voltages of around 5 V. However, because gain is inversely proportional and noise is directly proportional to the drive voltage, subvolt devices could significantly increase the efficiency of fibre-optic communication systems.

US researchers have experimented by adding bulky hydrocarbon chains to the organic molecules (“chromophores”) of the modulating material so as to minimize electrostatic interactions between the molecules. The electro-optic properties of the device were then enhanced such that a drive voltage of only 0.8 V was needed.

How can you make a million?

Many young physicists have moved into high finance to help with sophisticated market simulations. In an unusual example of experimental physics input into high finance, Japanese scientists have unveiled a \$5 electrical circuit that can mimic fluctuations in the yen-dollar exchange rate.

Electrical noise in the circuit is the seed

that generates voltage variations similar to yen-dollar fluctuations. The researchers hope to develop a cheap calculator for currency options (the right to buy currency in the future at a predetermined price, rather than at the existing exchange rate) to outperform the current system, which combines mathematical simulation and pricey computer power. AIP

Double-quantum vortex seen in helium-3

A group of physicists from Finland, France, the Netherlands and Russia have seen a double-quantum vortex in superfluid helium-3. The vortex is typical of the linear defects in quantum systems and analogous to quantized flux lines in superconductors and cosmic strings in relativistic quantum field theories.

For superfluids, Landau, Onsager and Feynman developed the picture of a quantized vortex line with a central core around which the phase of the order parameter winds by $2\pi n$. Usually vortices are singly quantized ($n = 1$),

but in superfluid helium-3, double-quantum vortex lines with $n = 2$ should appear.

The team set a tiny helium-3-filled cylinder spinning about its axis and used NMR in a 9 mT field to spot the lines. In fact, these can be made to appear one by one by increasing the rotation rate in constant steps, where this increment depends on the winding number n .

Their measured value for the incremental rotation rate increase of $6.2 \times 10^{-3} \text{ rads s}^{-1}$ implies $n = 2$ for the most commonly formed vortex line in superfluid helium-3.

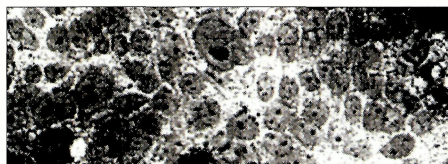
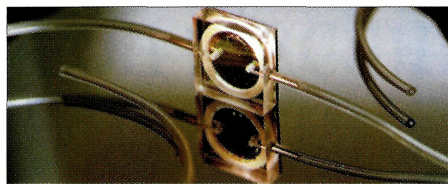
Smart scalpel cuts tissue damage

A "smart scalpel" that will allow surgeons to cut away malignant growth while minimizing damage to healthy tissue may soon be available. Developed by US scientists, the crucial component is a small microcavity laser.

"We can quickly identify a cell population that has abnormal protein content, as do tumour cells, by passing only a few hundred cells – a billionth of a litre – through our device", says Paul Gourley, leader of the research team at the Department of Energy's Sandia lab.

The biocavity laser is a sandwich of gallium aluminium arsenide between layers of gallium arsenide. Energizing the middle layer makes it emit photons, while the others act as mirrors reflecting photons back and forth and amplifying the output in the classical process of a laser – all on the scale of a few nanometres.

A micropump pushes blood cells from the



surgeon's incision through tiny channels on the cavity's surface and the cells are incorporated into the lasing process. Cancer cells contain more protein than normal cells, so their higher refractive index causes a change in the laser light's output frequency. The signal is relayed to

Top: blood cells pumped through this 18 mm diameter biological microcavity laser can be checked for cancer in real time, helping surgeons to cut away malignancies while minimizing the removal of healthy tissue.

Centre: light scattering in the epithelium, the layer of tissue lining organs like the colon or bladder where an estimated 85% of cancers begin, offers a more quantitative, less invasive method for detecting cancer early, say MIT scientists. Measuring the refractive index and spectral content of reflected white light via a fibre-optic probe indicates symptoms such as abnormal crowding of cells or enlargement of cell nuclei. Bottom: map of epithelial tissue from the colon, which shows normal (blue), precancerous (yellow) and cancerous tissue (red).

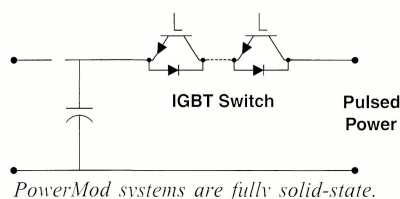
a nearby laptop, where it is translated into an easy-to-read graph for the surgeon to monitor.

In lab tests the device has distinguished normal human brain cells from malignant ones and can detect other blood abnormalities, such as sickle cell anaemia. AIP

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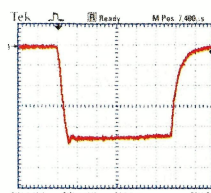
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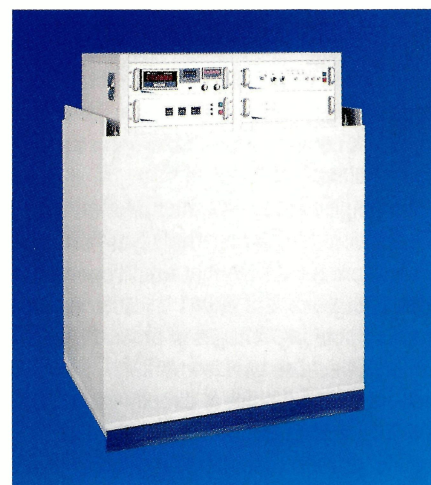


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