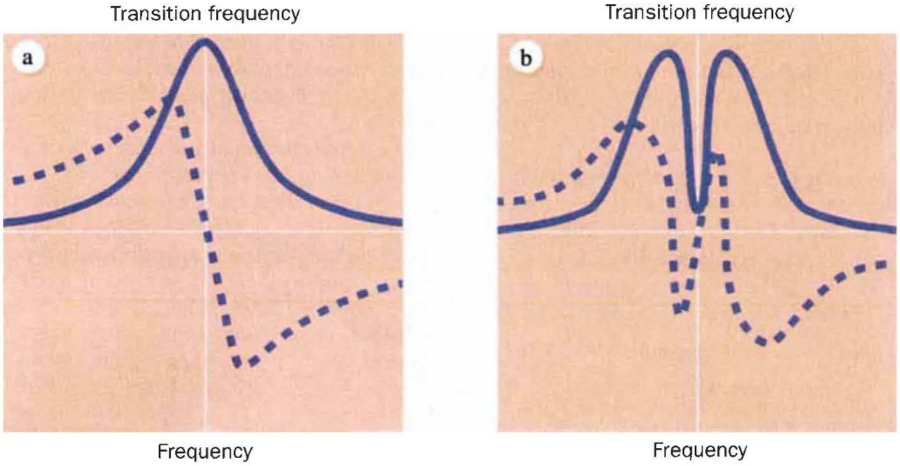

FIG. 2 *a*, Schematic diagram of the normal absorption (solid line) and refraction (broken line) near a resonance (like that at 780 nm in rubidium). Here the absorption shows a single, Doppler-broadened peak with high absorption loss near the line centre. The refraction shows a characteristic dispersion profile with a rapid variation (from positive to negative values) around the central frequency of the transition but this is exactly where absorption losses are high. *b*, The contrasting situation for the case with a strong coupling field at 776 nm. The absorption peak is now split with a region of vanishing absorption at the central frequency. The dispersion profile shows additional structure here, in particular a rapid variation in exactly the region of low absorption. This is the origin of both the increased refractivity and the induced lensing described in refs 1 and 2.

normally too small to achieve this, even if the laser beams are focused. This is where careful choice of the gaseous medium by the experimenter comes in. In the rubidium scheme, the near equality of the two laser wavelengths involved (780 and 776 nm) permits an experiment that is almost free from Doppler effects. The laser beams can be counter-propagated in the rubidium vapour so that the Doppler shift 'seen' by a particular atom is nearly equal and opposite for the two beams and thus effectively cancelled.

In the experiment of Xiao *et al.*[1], appropriately tuned laser diodes were used. They measured the refractive index changes near to resonance for the weak probe beam at 780 nm by means of a Mach–Zehnder interferometer. Their results confirm the predictions of theory, and further show that considerable changes to refractive index can be achieved using even relatively low-power diode lasers.

The work of Moseley *et al.*[2] goes somewhat further. They studied the spatial quality of the probe laser beam transmitted through the rubidium vapour, and observed convincing evidence of focusing and defocusing of the probe laser beam as its detuning was varied close to the resonance. Their observations were consistent with the lensing that would be expected given the spatial distribution of the coupling laser intensity and hence the spatial variation in the induced refractive index. The sign of the induced lens depends on the detuning of the probe laser, as this determines the sign of the induced refractive index gradient between the centre and the edge of the laser beam. The strength of the lens depends only on the strong laser field intensity. Moseley and collaborators also observed laser-induced deflection of the probe beam, indicating the possibility of steering as well as focusing of one laser beam by the field of another.

Applications that await these enhanced refractivity systems might include ultrasensitive magnetometers[6], high-sensitivity microscopy using a medium with laser-enhanced refractive index (rather than, for example, oil immersion) and compact particle accelerators[7]. But first there remain a number of practical problems to solve, not least the general problem of Doppler broadening.

Another important question, currently being addressed theoretically, is whether the optical properties of solid-state materials (for instance semiconductor quantum-well structures) can be similarly altered[8]. The proof-of-principle experiments suggest an exciting future for the laser control of the optical properties of a medium via coherent excitation. □

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1. Xiao, M., Li, Y., Jin, S. & Gea-Banacloche, J. *Phys. Rev. Lett.* **74**, 666–669 (1995).
2. Moseley, R. R., Shepherd, S., Fulton, D. J., Sinclair, B. D. & Dunn, M. H. *Phys. Rev. Lett.* **74**, 670–673 (1995).
3. Field, J. E., Hahn, K. H. & Harris, S. E. *Phys. Rev. Lett.* **67**, 3062–3065 (1991).
4. Kocharovskaya, O. *Phys. Rep.* **219**, 175–190 (1992).
5. Scully, M. O. *Phys. Rev. Lett.* **67**, 1855–1858 (1991).
6. Fleischhauer, M. & Scully, M. O. *Phys. Rev.* A**49**, 1973–1986 (1994).
7. Scully, M. O. *Phys. Rep.* **219**, 191–201 (1992).
8. Lee, D. S. & Malloy, K. J. *IEEE. J. Quantum Electr.* **30**, 85–92 (1994).

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DAEDALUS

# Gore no more

**EVEN a minor cut or abrasion leaks blood. Major surgical operations can lose so much blood that transfusions are often needed to replace it. Sometimes the patient's own blood is used — either withdrawn beforehand and stored, or recycled during the operation. Daedalus now plans to prevent the blood escaping in the first place.**

**Blood leaks out of a wound under its own blood pressure. To stop it, says Daedalus, simply pressurize the air over the wound to a slightly higher value. You might think that this would drive air into the tissues, with disastrous results. But Daedalus is unworried. Most blood leakage, he points out, comes from the capillaries. Their blood pressure is only about 0.05 atmospheres, but they are so narrow that capillary action would exclude air up to a pressure of 0.15 atmospheres. The bigger blood vessels lack this protection, but their internal pressure is about 0.15 atmospheres anyway, and surgeons routinely clamp the bigger blood vessels. So, says Daedalus, surgery conducted under a mere 0.1 atmospheres of overpressure should be effectively bloodless.**

**At first he envisaged a sort of pressurized tent sealed round the incision, with inset rubber gloves for the surgeon's hands. But this would need a tricky air-lock to enable clamps and scalpels to be passed in, and excised tissue out. It would be better to put the whole patient in a sort of 'iron lung' container, seal the region of the incision to a hole in its wall, and pump the container down to 0.9 atmospheres. The surgeon and his team could then work in the open, while the anaesthetist handled the circulation of air and anaesthetic gas to the patient in the container. All the problems of blood loss and top-up transfusion would vanish, and the surgeon would have dry, readily visible tissue to work on.**

**This scheme is so appealing that Daedalus wants to extend it to the more casual cuts and abrasions that never get inside a hospital. For these everyday nuisances, he is inventing a pressurized sticking-plaster. His first prototype had to be kept pumped up by a little lever, but he is now designing a much neater, self-pressurized plaster. It contains a volatile antiseptic such as ether, whose vapour pressure keeps the blood from leaking out until the scab over the wound has hardened sufficiently. Careless shavers, clumsy handymen and incautious glaziers will rush to order the new product. The small wounds of everyday life will soon be as bloodless and quickly healed as the more drastic incisions of surgery.**

David Jones