THE AUSTRALIAN NATIONAL UNIVERSITY

Cutting Corners in Fibre Optics

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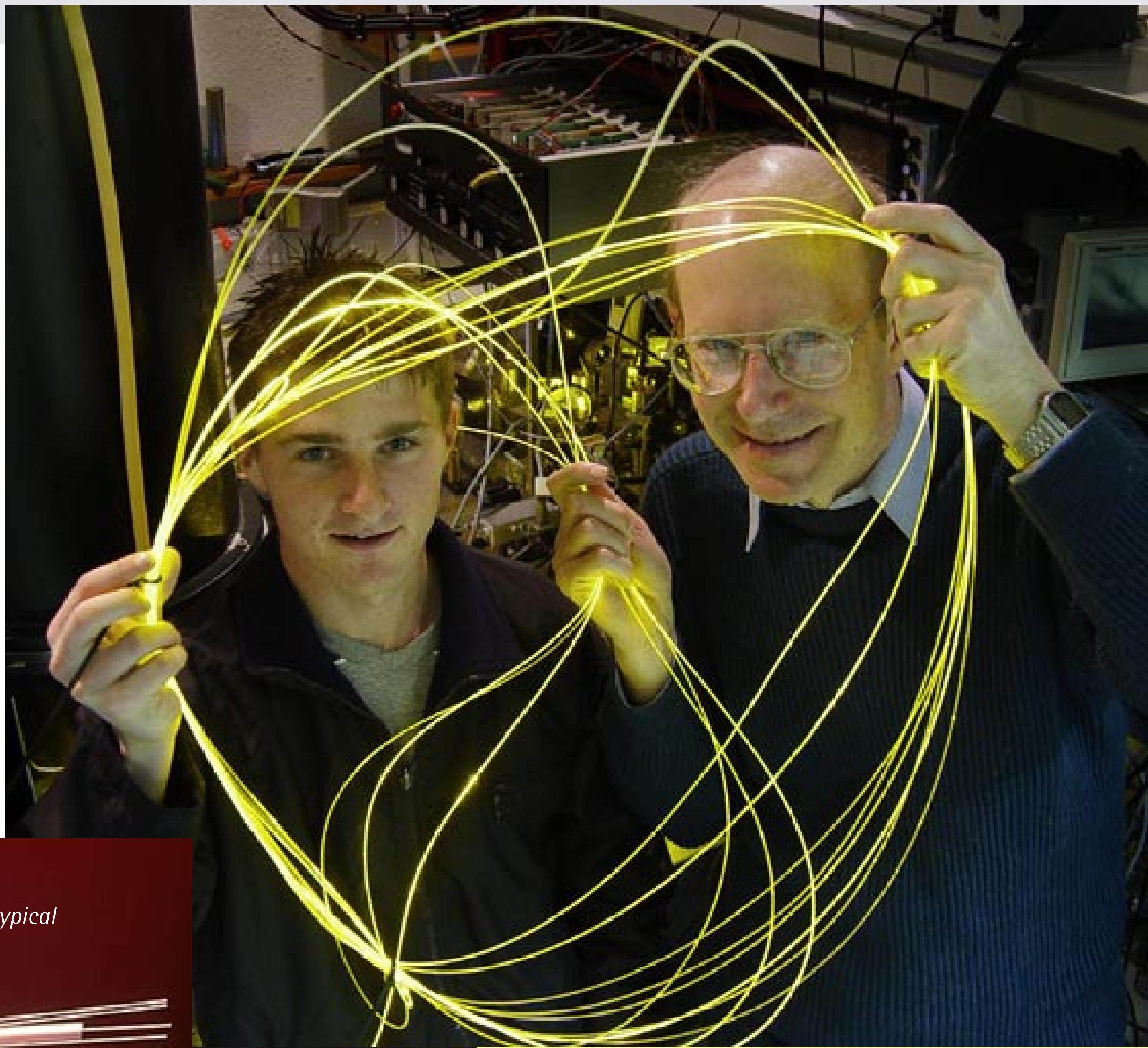
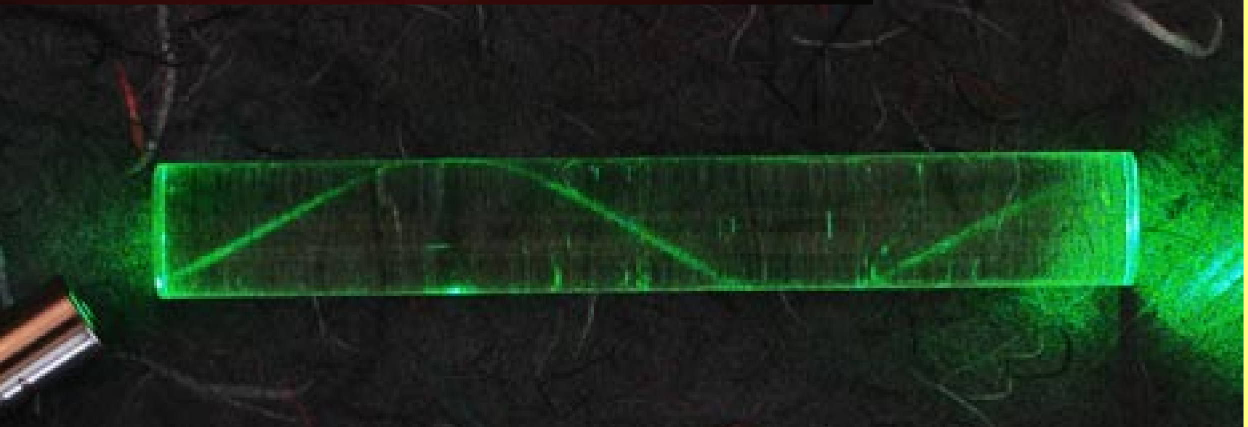
During the last two decades of the twentieth century, single-mode optical fibres rapidly became the back-bone of the world's vast telecommunications network both on land and under the oceans because of their ability to propagate large volumes of digitised data over vast distances with minimal light loss and signal distortion. These fibres are normally encased in optical cables to protect them from environmental hazards, but these cables, such as the one shown in the picture, are flexible enough to be bent into small radii of some tens of centimetres that are encountered when they are laid in ducting under city streets and elsewhere. The light propagating in these fibres readily follows these bends with essentially no propagation loss.



Fibre core and protective layers of a typical telecommunications optical fibre



Light traveling down an optical fibre is confined by total internal reflection. Each time the beam hits the wall the difference in refractive index at the boundary acts like a mirror bouncing the light back. However, because the reflectivity depends on the angle of incidence, sharp bends in the fibre tend to create poor mirrors leading to high light loss.

However, as optical fibre and especially optical waveguide, technology finds its way into ever more diverse areas such as medicine, remote sensing and aerospace, small radius bends become an inevitibility. These tight bends are especially desirable in integrated optics planar waveguides, because they reduce the overall device size. The problem is that such bends make it difficult to confine the the light within the waveguide. Conventional theoretical understanding of this phenomena has been unable to offer any practical solutions.

However, ANU researchers have recently developed a radically new model of bend loss which more strongly relates to the actual physics of the waveguide. This new approach examines the physical evolution of the waveguide mode into, along and out of the bend, and takes into account the finite structure of the cross-section of a practical single-mode waveguide.

Using this model, scientists believe it may be possible to engineer waveguide refractive index profiles to greatly improve light transmission in tight bends.

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