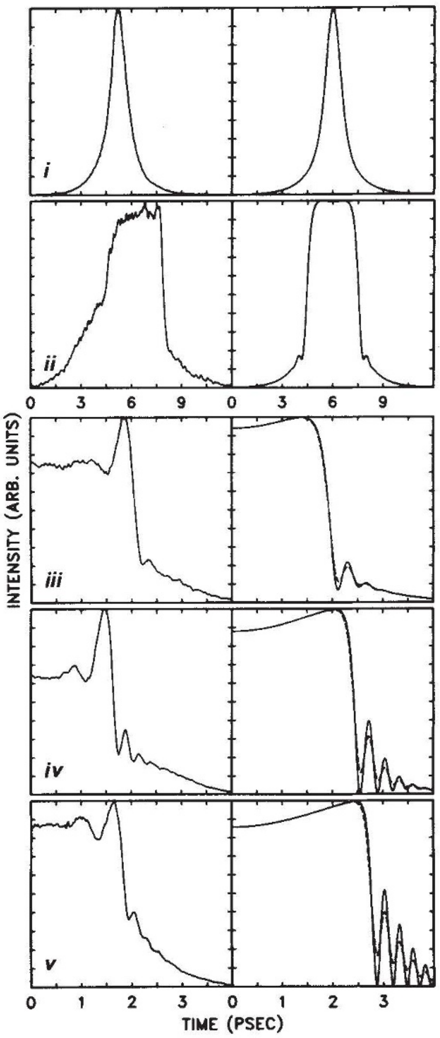

FIG. 2 Optical shock front formation and wave breaking as observed (first column) and predicted (second) by Rothenberg and Grischkowsky[3]. *i*, Input pulse; *ii–v*, output pulses for peak input pulse powers of 125, 250, 500 and 750 W. With increasing power (which accelerates the process), the formation of the shock (*ii*, *iii*) and wave breaking indicated by the appearance of 330-fs oscillations (*iv*, *v*) are clearly visible.

Raman amplification to overcome absorption and scattering losses.

For positive dispersion ($\lambda < 1.3$ μm), in the visible region, bright pulses cannot propagate as solitons, and the interaction of the nonlinear index with the group velocity dispersion leads to spectral and temporal broadening of the propagating pulses. For both signs of dispersion, the experimental results are in quantitative agreement with the predictions of the nonlinear Schrödinger equation, of fundamental importance because this equation represents the general situation of dispersive wave propagation with weak nonlinearity.

However, for positive dispersion the nonlinear Schrödinger equation admits a 'dark-soliton' solution[7], which is a localized intensity dip in a constant intensity background. Mathematically this is an antisymmetric function of time with an abrupt phase shift of π and zero intensity at its centre. Other dark solitons with a reduced contrast and a lesser, more gradual phase modulation also exist. Recently, Weiner *et al.*[2] generated 100–200-fs dark antisymmetric pulses on background pulses of red light, 1–4 ps in duration. These were passed through a single-mode optical fibre 1.4 m long, five times the characteristic length for soliton propagation of these pulses (Fig. 1*a*). The pulses have to be tailored to the right form before they can propagate as solitons: in this case, the fundamental wave form was obtained with spatial masking in a temporally non-dispersive lens and grating apparatus. Both the broadening of the dark pulse at lower powers and the narrowing of high powers (Fig. 1*b*) are predicted in the numerical simulations.

Also predicted in the nonlinear Schrödinger equation are so-called 'wave breaking' effects of solitons[7–9]. High-resolution experiments by Rothenberg and Grischkowsky[3] confirm this. In water waves, wave breaking occurs because the group velocity of the wave is greater at the peak than at the edges: the wave overtakes itself. Similarly, in nonlinear optical fibres, the effects of self phase modulation and positive group-velocity dispersion combine to make the pulse more rectangular (reshaping) and to impose a range of frequencies through the pulse (chirping). The edges of the rectangular pulse overtake the low-intensity wings: because of the differing frequencies in the pulse and in the carrier wave, interference causes intensity oscillations to appear at the leading edge — optical wave breaking (Fig. 2). Rothenberg and Grischkowsky observe this optical intensity-shock formation and subsequent wave breaking at various stages by varying the intensity of the input pulse and probing the output pulse with a resolution of 120 fs.

These elegant experiments do not merely verify numerical predictions of purely theoretical interest. Optical communications systems are currently based on linear techniques. It is an intriguing possibility that stable optical pulses could be used to increase the density of information in data transfer. This possibility has been substantiated by the 4,000 km transmission demonstrated in the laboratory by Mollenauer and Smith[6]. □

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DAEDALUS

Paradise delayed

OVER the past century or so, the age of adolescence in Western society has dropped by three to five years. Daedalus points out that this trend is quite wrong. In primitive society, a child entered adolescence with all the knowledge needed to become an economically useful adult and an effective parent. By contrast, children in our increasingly complex society need an ever-longer childhood to acquire the knowledge necessary for citizenship. But ever earlier in this process, puberty intrudes. Teachable children suddenly become rebellious and intractable adolescents, rightly resentful of the many further years of education they must face before becoming functionally adult citizens. Between the natural child and adult stages we have created an artificial teenage one.

So Daedalus is looking for ways to retard adolescence. It seems to take off when the child reaches a crucial weight; thus it is later in poorly fed societies where it takes longer to reach this threshold. It is also later at high altitudes — Daedalus reckons that the lower *g* at those heights reduces the body's perception of its threshold weight. On this argument, space-borne children should never reach adolescence at all. But this is hardly a practical solution to the problem.

The most appealing approach would be to 'reset' upwards the crucial weight at which adolescence is triggered. This can happen quite naturally: apparently normal children sometimes reach puberty extremely late. Nobody quite understands the hormonal mechanism; DREADCO's endocrinologists are comparing such children with their fellows, looking for some hormone or metabolite in the bloodstream whose concentration rises with age and weight, but is lower for the delayed adolescents. Once this crucial puberty-trigger has been identified, it should be possible to counter it. A suitable silicone implant could leak a chemical antagonist, DREADCO's Delay® into the bloodstream, holding off puberty to a more socially convenient age.

Upwardly-mobile, aspiring parents should queue to have their children Delayed. Their eager, untroubled offspring will sail through the whole educational system without being sidetracked by the angst and friction of adolescence. Maturing controllably late, they will enter physical and mental adulthood together, dodging the feckless, useless teenage period with its introverted sub-culture. By the time they crave children of their own, they will be economically fit to have them. Their late development could be wonderfully creative. Many scientists and mathematicians do their best work very early, before the clear and penetrating gaze of youth is distracted by the escalating problems of maturity.

David Jones