100-200 kW of power at the first harmonic of the electron cyclotron resonance (~85 GHz) to raise the electron temperature in the Soviet tokamak T-10. In this frequency range the generation of high powers is the major difficulty; coupling to the plasma is through relatively simple wave-guide launchers. A general feeling at Oxford was that plasma heating in tokamaks by the injection of electromagnetic waves is at last becoming competitive with neutral injection. With the rich possibilities arising from a variety of frequencies it is hoped that an efficient method can eventually be found to deposit megawatts of power into the plasma core.

A second potential disadvantage of the tokamak arises from the same strong toroidal field that gives it its stability and general robustness. The ratio of plasma pressure to magnetic field pressure (β) tends to be very low, typically less than 1%. To be near economic a reactor needs β averaged over the volume ($\bar{\beta}$) to be in excess of 5%. New results included β values of the order 2-3%, seen in the ISXB (Oak Ridge), T-11 (Moscow) and TOSCA (Culham) devices. These values are obtained in circular cross-section devices and there are theoretical grounds for hoping that the higher values needed will be obtainable in non-circular cross-section systems such as JET. It should be emphasised that all three of these high $\bar{\beta}$ experiments are in effect limited by the available input power. Thus we only know that the values of β at which instability leads to a decrease in confinement are greater than those seen so far. Apart from these advances in tokamak heating and $\bar{\beta}$ there were many other results reported — notably the operation of the large Soviet tokamak T-10 at low values of q(~1.6) without a decrease in the confinement properties.

First results were reported from the new ETA-BETA II reversed field pinch experiment at Padua. This is approximately a one-third scale version of ZETA with some additional control of the toroidal magnetic field. To the surprise of some, the main features of the so-called quiescent period in ZETA have now been reproduced in this smaller device. Fluctuations in $\mathrm{d}I/\mathrm{d}t$ are markedly reduced following field reversal and the electron temperature rises during quiescence from ~40 eV to ~100 eV. It will now be possible to study this quiescence phase in detail with modern diagnostics and hence to assess the potential of the reversed field system.

Research on the mirror system of magnetic confinement is now concentrated on two versions. The first is one in which the initial field of the mirror is reversed by plasma currents to give a final configuration which is similar to a compact tokamak without toroidal field and which has closed field lines and is therefore not a mirror at all. This is being studied at the Lawrence Livermore Laboratory and so far all attempts to achieve field reversal by pumping up the plasma pressure have marginally failed. New experiments are planned in which a low temperature plasma with field reversal is first created by a plasma gun and then heated by intense neutral beams. The second version is the so-called tandem mirror in which a long straight solenoid has intensely heated minimum $|B|$ mirrors at each end. This line is also being studied at Livermore as well as in Japan and Novosibirsk. The aim of the tandem mirror is to create an electrostatic potential at the ends of the solenoid in such a way as to confine the ions. A major difficulty with all these open-ended systems is the heat conduction along the field lines by the highly mobile electrons. First results from the Livermore tandem mirror TMX were presented at Oxford. These show encouraging evidence of electrostatic plugging and of effective electron heat confinement. Thus the electron temperature in an end mirror is ~160 eV while in the solenoid the ion temperature is low (<100 eV), the density ~10^{13} cm^{-3} and the end loss small.

In the field of inertial confinement attention is now focused on ablative compression of complex pellets using as driver systems either lasers, electron, light ion or heavy ion beams. In the USA 10 kJ, 20 TW lasers at 1 and 10 μm wavelengths are now operating at Livermore and Los Alamos respectively. With the big Livermore laser (SHIVA) the D-T fuel has been compressed to ~160 times liquid density. These ablatively compressed cores are relatively cold and the next step will be to increase the implosion velocities through the use of higher power lasers on to larger targets. An interesting technique reported at the meeting was the use of radiochemical methods to deduce the density of the compressing shell. Transmutations are produced by the neutrons from the core and the subsequent radioactive decay is measured.

The choice of the best system is still open with lasers clearly ahead for research purposes but with embarrassingly low efficiencies for an ultimate reactor. All the particle drivers are more efficient but there are greater difficulties in transporting and focusing them to a target. If the energy gain from a single implosion can be made large enough then the efficiency of a CO_2 laser (1-5%) may be tolerable. Such high gains (~100) are theoretically possible from complex targets, but there is then the problem of making them cheaply.

For the first time in this series of conferences there was a report on the fusion programme in the People's Republic of China. Many were surprised by the size, breadth and sophistication of this work which includes mirror machines, laser compression and several tokamaks. The programme is gathering momentum after the setbacks of the Cultural Revolution. The presentation at Oxford was limited to a catalogue of devices but we can expect a serious contribution to fusion physics from China in the near future. ☐

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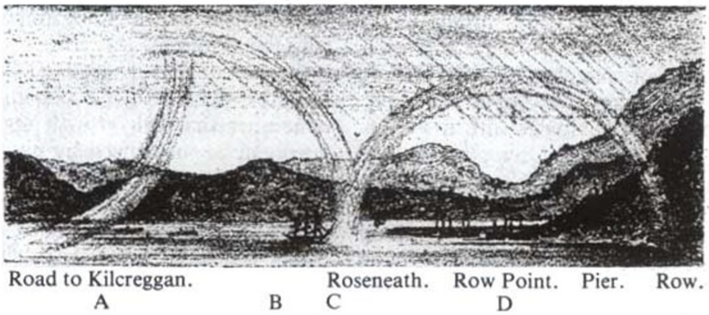
Erratum

During printing a line was inadvertently ommitted from the article 'Road to unification' (*News & Views* **282**, 131; 1979). The first sentence in column 3, page 132 should read "Experimentally, weak neutral currents were discovered *at CERN in 1973*[19] *and parity-violation in neutral currents of precisely the right size was discovered* in the remarkable experiment[20] at SLAC last year." Our apologies to CERN.

100 years ago



A curious rainbow

I send you a rough sketch of a curious rainbow group seen in Gareloch about 8.25 a.m. on October 20. I would have written sooner but I delayed till I had obtained sketches from several different sources. I only saw the junction of the two bows at C, that being the only part of Row Bay visible from my standpoint, but several observers saw the whole group as I have drawn it. The sea was quite glassy, so that the inverted rainbow A must have been formed by the sun's rays reflected from the water. The wind was just beginning to rise and some scudding showers were passing up from the Firth of Clyde from the south-west, but the bay was quite calm. The bow D was perfectly full and bright, while B died away at its highest point. I can only imagine that B was formed by light reflected by some bright cloud, but I did not observe any bright enough. The view is nearly north-west.

From *Nature* **21**, 20 Nov., 56; 1879.