phenomenon had recently been observed experimentally. The radiation laboratory has compressed a ring of 3·3 MeV electrons to a diameter of 3·5 cm and a final energy of 19·0 MeV, but these have not been accelerated laterally. Two papers from the same laboratory at Berkeley proposed schemes for compression of rings by static fields which would avoid the need for large pulsed power supplies. One of these, by Christofilos, was for an accelerator of 1,000 GeV.

Superconductivity is now at the point at which it can be exploited, as demonstrated by O. W. Chamberlain of the Lawrence Radiation Laboratory, who described five months of operating experience with a superconducting solenoid. From Stanford came a report on the development of a 500 foot superconducting linear accelerator and a feasibility study of a two-mile machine of 100 GeV. Another paper described the performance of a prototype injector section to be used with the 500 foot machine. M. A. Green, also of Berkeley, reviewed prospects for superconducting synchrotons and found them both feasible and economic. Such machines would depend critically on the performance of pulsed superconductors, a topic which was also reported by workers from Brookhaven National Laboratory and the Rutherford Laboratory.

Another area in which hardware has replaced paperwork is computer control. At least eight major accelerator installations have control schemes under way. One of the most advanced is at the Argonne National Laboratory, where beam optical computations are performed on a computer in the main control room in response to requests from experimenters. These operations are assisted by a large oscilloscope display of the profile of the extracted proton beam from the 12 GeV proton synchrotron.

COMPLEXING AGENTS

Analysis with Complexes

THE influence of complexometry on analytical chemistry was the subject of a symposium last Friday at the Chelsea College of Science and Technology. Dr Rudolf Pribil of the Czechoslovak Academy, the guest speaker, began his lecture with a review of some of the newer complexometric methods—indicators, masking agents and complexing agents. Dr Pribil's special interest is the separation of the rare earths using complexes—he uses not only EDTA but also HEDTA, MEDTA, TTHA and DTPA in conjunction with PO_4^{3-} and $P_2O_7^{4-}$ for displacing the equilibrium. He also uses spot reagents for distinguishing between various pairs of elements such as In and Ga; Zr and Hf; Th, Tl and Bi; Fe and Zr; and Th and Zr. His lecture showed what can be achieved with simple apparatus, ingenuity and a few rather special compounds.

Dr J. A. W. Dalziel of Chelsea College of Science and Technology described the use of organo-sulphur compounds as complexing reagents. Thio-oxine is used for the determination of Pd^{II} and QDT (quinoxaline-2,3-dithiol) for Co^{III} and Ni^{II}, but Dr Dalziel spoke particularly of 2-mercapto pyridine-1-oxide (thione) which is useful for determining Fe^{II}, Cu^{II} and Hg^{II} by absorptiometric methods. Thione is a stable reagent and seems to have two or three useful applications including the determination of copper in steel.

Professor H. M. N. H. Irving of the University of Leeds spoke on the use of solvent extraction. He described how solvent extraction has been, and might be, applied to complexometry, not only for separation, but also to find the concentration of a compound. But the most important use is the extraction of EDTA complexes to facilitate the separation of elements—for example, Al and In.

Dr R. A. Chalmers of the University of Aberdeen described the use of complexometry in a different inorganic problem. His object was to estimate the hetero-atom in heteropolyacids of the general formula $H_{(8-n)}\ X_{(n)}Mo_{12}O_{40}$, where X = Si, P, Ge or As. He described the "molybdenum blue" method, which involves the reduction of Mo^{VI} to Mo^{V} but which is complicated by two forms of the heteropolyacid, α and β. This difficulty can be overcome by using either selective extraction or masking reagents such as tartaric, citric or oxalic acids or mannitol. Nobody knows what the difference is between the α and β forms, but Dr Chalmers thinks there may be a difference in the symmetry of the molecule involving rotation through 60° by one of the groups.

CRYOGENICS

Mechanical Cold

DOUBTS about the feasibility of adiabatic compression as a method of reaching very low temperatures have proved to be unfounded. A mixture of solid and liquid helium-3 has been cooled by adiabatic compression to between 0·002° and 0·003° K, the lowest temperature ever obtained by purely mechanical means. The experiment is reported in *Phys. Rev. Letters* (**22**, 449; 1969) by R. T. Johnson, R. Rosenbaum, O. G. Symko and J. C. Wheatley. Although slightly lower temperatures have been reached by the standard technique of adiabatic demagnetization, in which a specimen is magnetized and then demagnetized at constant entropy, and still lower temperatures have been recorded for the special case of nuclear demagnetization, the success of the compressional methods is none the less significant. Considerable dexterity is required to retain the necessary control of the pressure, taken up to about 30 atmospheres, at such low temperatures. Moreover, frictional heating caused by the rubbing together of pieces of solid helium, presents a limit to the attainment of still lower temperatures and probably accounts for the limit in the experiment which has now been reported.

The theory of the cooling process is similar to that for adiabatic demagnetization. The lattice entropy of helium-3 is virtually nothing, but each atom has a spin of $\frac{1}{2}$ and the spin entropy of the solid is large. At high temperatures, the spins are aligned at random, but as the temperature falls they align themselves antiparallel, as in an antiferromagnet, and the spin entropy falls to zero. The entropy of helium-3 in the liquid state is lower than that of the solid for temperatures below 0·3° K, so that when the liquid is compressed adiabatically—or, more accurately, isentropically—to form a solid, the entropy stays the same so that the temperature falls. In adiabatic demagnetization, the same process is effected by switching off a magnetic field. The size of the temperature fall is regulated by the strength of the spin interactions between atoms, and the weak coupling in helium-3 means that the fall is large.

In the experiment carried out at the University of