with the new data—assuming the radiation is black-body, which it seems not to be—depends on the pairing of the flux measurements to allow for sources of radiation in the equipment and the atmosphere. From raw data which indicate that temperatures in the three spectral responses are not higher than 7.4, 8 and 4.7 K, Muehlner and Weiss obtain 5.5, 7 and 3.6 K after corrections. Obviously there is a need for more experiments in this awkward region where the 3 K spectrum peaks—unfortunately a second MIT balloon failed. It remains to be seen whether the infrared measurements will force a revision of ideas about the background radiation or whether they will come to be regarded as a shoal of red herrings.

CRYOGENICS

The Cool Red of Ruby

by our Solid State Physics Correspondent

WHEN temperatures below about 1 K are required, one usually reaches for the cerium magnesium nitrate and sets up the demagnetization apparatus. But there are advantages to be had from using other materials, such as ruby, as J. W. Bakker, H. Van Kempen and P. Wyder have discovered (*Phys. Lett.*, **31**, 290; 1970). They used quite moderate fields of 12 kG to cool samples of commercial ruby to below 0.1 K and found that they could measure the temperature by the tunnelling characteristics of a junction between a superconductor, insulator and normal metal.

The millidegree temperatures obtained with cerium magnesium nitrate are often an unnecessary luxury, particularly for cooling superconducting materials with relatively high transition temperatures. A coolant such as ruby has some distinct advantages. It can be polished to a high finish to allow superconducting films to be deposited on it, and it is very stable. Its high thermal conductivity ensures that for superconducting tunnelling experiments there is good thermal contact between the films and the ruby.

Bakker *et al.* used the characteristics of a superconductor-insulator-normal metal junction, as described by the simple BCS theory of superconductivity, as a thermometer for temperatures between 0.1 and 1 K. The junction, consisting of an Al-Al₂O₃-Ag sandwich, was vacuum deposited on to the highly polished face of a cylindrical ruby crystal, containing 0.3 atomic per cent chromium. A germanium thermometer, calibrated against the susceptibility of cerium magnesium nitrate, was glued to the other face of the ruby. Bakker *et al.* determined the current to voltage characteristics of the junction between 0.25 and 1.2 K and deduced a set of temperatures by means of the BCS theory, which turned out to be fairly consistent with those derived from the germanium thermometer.

If it proves possible to tighten up the accuracy of the junction thermometer, as seems likely, and if a clearer picture can be obtained of the magnetic and thermal properties of ruby below 1 K, the technique of Bakker *et al.* could prove an important new method for cooling and measuring superconducting films below 1 K. In many respects, the battle is no longer to try to reach still lower temperatures, but to reach them in the right conditions. In this context, the success of Johnson *et al.* (*Phys. Rev. Lett.*, **22**, 449; 1969) in cooling helium-3 to about 3 mK by purely

mechanical means should be measured as much by the information it produces on the exchange parameter of ³He as by the refrigeration potential. With the superconducting properties of thin films very much in the spotlight at present, the special properties of ruby may well prove as useful as any extra gain in temperature drop for studying these films.

ENGINEERING

Innovation Wanted

from a Correspondent

CREATIVITY in the engineering professions was the theme of a conference at the University of Aston in Birmingham on April 2 to 3, organized by the university's design and innovation group under the auspices of the Council of Engineering Institutions' Working Party on Creativity in Engineering. The object, said the chairman, Dr H. G. Conway (Rolls-Royce Bristol Engines), was to explore the nature of creative activity, with particular reference to engineering technology, and of possible ways of improving and increasing it. This had demanded a study of the characteristics of engineering in all its aspects, by the working party whose comprehensive report was included in the proceedings.

The topic was put into its economic context by Mr S. A. Gregory (Aston University) and Mr J. D. Monk (Enfield College of Technology), who pointed out that the achievement of an up to date technology depended, in the end, on the creativity of engineers in general. Mr E. P. Hawthorne (Urwick Technology Management) also showed how technological ingenuity was closely related to economic growth and a favourable international trading position, especially with regard to the licensing and royalty balance of payments, the so-called know-how balance of payments.

Creativity in itself was of little or no value, however, argued Mr A. B. Robertson (Science Policy Research Unit, Sussex University), who offered an analysis of innovation based on research in progress at Sussex. The work so far has indicated that certain factors thought to favour innovation, such as the large size of a company or of its research and development department, are not well supported by empirical evidence.

The importance of giving the research worker more say in the planning of his research programme was stressed by Mr P. R. Whitfield (Mond Division, ICI), who felt that creativity was not encouraged when the management gave the research and development department prearranged projects to carry out. He also suggested that creativity is not helped by tight restrictions on the research budget.

Education could contribute to the stimulation of creativity through more carefully designed short courses, Mr J. Heywood (Lancaster University) said. But unless companies are responsive to new ideas, there would be no value in sending individuals on courses to sharpen their creativity. Monk pointed out that one of the barriers to successful innovation is the inability of creative engineers to think beyond the bounds of their own discipline—civil, mechanical, electrical and so on. Because most innovations require a multidisciplinary approach, he said, horizons must be broadened. Monk is trying to do this at Enfield by training his students in perceptual skills.