

plasma physics, especially stability theory, to give predictions a secure foundation and to analyse individual experiments in detail, using available theory, to supplement and interpret the diagnostic measurements, suggest new experiments, and check the theory itself.

In written answers in the House of Commons on July 19, the Parliamentary Secretary for Science, Mr. D. Freeth, said that the volume of design work on reactor systems and other plant associated with the civil nuclear power programme carried out by industry on behalf of the Atomic Energy Authority is at the same level for 1961-62 as for 1960-61. The Authority received £2 million from the sale of fuel-elements in 1960-61, in addition to £6.5 million advance payments received in 1959-60, and expected to receive about £13 million from such sales in 1961-62. The three completed fuel canning lines at Springfields are fully employed, and all five lines are expected to be in production by May 1962, when the factory should be capable of meeting all demands now foreseen for natural uranium fuel-elements canned in magnox. It will be necessary in due course to plan new facilities for the fabrication of uranium oxide fuel elements if it is decided to include power stations using such elements in the nuclear power programme.

The Atomic Energy Authority now employs 350 professional staff on design studies and research and development for the prototype fast reactor, compared with 200 a year ago; but when full design and construction of a prototype commercial reactor can begin will depend on progress in developing a suitable fuel. Of the Authority's professional staff engaged on civil research and development, the proportions working on the main reactor systems in 1961 were: magnox

reactors, 15; advanced gas-cooled reactors, 20; fast reactors, 14; high-temperature gas-cooled reactors, 8. In 1960 the corresponding figures were 20, 20, 9 and 8, respectively.

The Authority has in hand an intensive programme on the development of plutonium fuel elements for the prototype fast reactor. The fuels include mixed plutonium and uranium dioxides in a steel matrix and mixed plutonium and uranium carbides. The programme involves the preparation, irradiation testing and examination of specimen fuel materials, investigation of methods of making complete fuel elements and their testing under irradiation, and investigation of the behaviour of the fuel elements under conditions simulating those expected to be experienced in a power reactor. The number of professional staff engaged on the development of fast reactor fuels has approximately doubled since last year. It is not at present planned to run the Dounreay fast reactor completely on plutonium fuel, but shortage of plutonium is not holding up the development of fuel elements in the fast reactor. Ten engineers from the industrial consortia are attached to experimental reactor projects compared with 26 a year ago, and the Authority maintained a close association with the industrial consortia through a Nuclear Power Collaboration Committee and its supporting technical committees, including a joint committee which advises on the design and development of the Authority's experimental reactor projects and on advanced reactor systems. All information derived by the Authority on reactors is available to the industrial consortia through the Authority's reports, and the technology and progress have been discussed jointly under arrangements made by the Nuclear Power Collaboration Committee.

THE BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

THE twenty-first meeting of the Research Panel of the British Gelatine and Glue Research Association was held on May 17, under the chairmanship of Mr. S. G. Hudson (Richard Hodgson and Sons, Ltd.). The chair was taken in the afternoon by Mr. C. F. C. Simeons (British Gelatine Works, Ltd.).

Mr. W. G. Cobbett (British Gelatine and Glue Research Association) gave the first paper entitled, "Rupture Properties of Gelatine Gels". An apparatus has been built for the extension of dumb-bell shaped strips. The gels are cast from 10 per cent gelatine solutions in 'Perspex' moulds and are matured at 10° C. Extension is then performed at chosen constant rates, the gel strips being floated on mercury at 10° C. Rupture properties are more closely related to jelly strength (rigidity) than to the 40° C. viscosity of the gelatine solution. Thus gelatines with similar viscosities break at loads which follow the order of their jelly strengths while gelatines with similar jelly strengths are not greatly influenced in their breaking loads by differences in viscosity. The extension at rupture is greater for gelatines of higher jelly strength when the viscosities are equal, but is also higher for gelatines of higher viscosity where the jelly strengths are similar. The slope of the linear (lower) portion of the load-extension graph is directly related to the jelly strength as measured on the Bloom gelometer.

Discussion on the paper was opened by Prof. A. G. Ward, who had initiated the project in 1957. He

recalled that the work was begun to provide information on the mechanical properties of gels in relation to food uses. The field was largely unexplored and it would be desirable to examine a series of fractions and a selection of total samples exhibiting extreme values in other physical properties. The lively discussion which followed showed that there was considerable interest in exploring the effects of additional variables on the extension properties of gelatine gels, for example, gel concentration and pH, chemical modification, including cross-linking, and dilution with additives such as water-soluble block polymers.

Dr. A. Courts presented his recent work on "Structural Re-orientation of Gelatine in Citrate". He has investigated the rise of viscosity with time which aqueous solutions of gelatines undergo over a period of days at moderate temperatures (< 25° C.). The effect is enhanced several-fold in the presence of certain buffers, and most work has been done with approximately 0.3 per cent solutions in 0.15 M citrate at 20° C.; the rise is rapid during the first day, is slower but linear over the next 3-4 days and thereafter falls off. The rise is maximal near pH 7 and is unrelated in magnitude to the viscosity (log. viscosity number) of the sample and hence to its weight average molecular weight. It is dependent on the rigidity modulus of the gelatine and a quantitative relationship exists between the linear portion of the rate of viscosity increase and the rigidity. The increase in viscosity

is explained in terms of partial reversion to a highly ordered state probably resembling that of the original collagen. This concept is supported by other properties of the matured solutions, for example, their ability to give fibres with precipitants and their resistance to complete digestion by trypsin. Dr. K. Little (Nuffield Orthopaedic Centre, Oxford) showed some electron micrographs which she had obtained on the precipitated materials and which exhibited undoubted fibrous forms.

The afternoon paper, "Glueing in the Furniture Industry", was contributed by Mr. M. J. Merrick (Furniture Research Association). Attention was directed to the increasing mechanization of the modern furniture industry with the concomitant

features of high production-rates and low labour content. Three main adhesives are in use, namely, animal glue, urea-formaldehyde and polyvinyl acetate. The more obvious differences between the properties of these, such as strength or resistance to water, have but a minor influence on the manufacturer's choice which is, instead, governed by the necessity for speed and reproducibility in the glueing of wood joints and veneers. Mr. Merrick then described the detailed operations involved in glueing in the furniture industry. A further point which emerged in the discussion was that synthetic glue manufacturers have built up an enviable technical service to ensure that the best use is made of the properties and behaviour of their products.

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RESEARCH BY SIXTH-FORM SCHOOLBOYS

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THE editorial in *Nature* (187, 883; 1960) directed attention to the need for educational research and mentioned some specific topics. My work was cited as one of the examples in that editorial¹, and I have been concerned with several projects of this nature. The first has been concerned with project work for sixth formers, a second continuing the study previously mentioned¹ and a third into the opinions of technical college students on liberal studies. In this article the investigations made on project work will be discussed and some results presented.

This work has already been mentioned in *Nature*² since it has been carried out through the auspices of the Radio-Electronics Section of the British Astronomical Association. Four sixth formers have undertaken the same form of project and two of them have worked as a pair. The object was to provide a system of work which would have a liberalizing influence on the students' scientific studies and at the same time provide insight into the basic techniques of research inquiry. As an enticement the scheme aimed at providing some useful data for the Radio-Electronics Section.

Two of the students already possessed an interest in astronomy before the project was envisaged and were members of the Section. The other two were in attendance at the Salesian College, Battersea, and had no previous interest in astronomy or radio. Part of their project which is of considerable interest is at the moment in the press³, and that of the third student will appear in the same publication⁴.

Each project is in three parts, the first two parallel and the third being the item of use to the Section. The students were informed that their results should be written up in a form suitable for presentation as a 'letter' to *Nature*—there was of course no guarantee of publication anywhere but the concept of a letter in *Nature* gives the student an idea of how much has to be done to produce a small item.

An important feature of this work is the system of 'least instruction'. The students are encouraged to get on with the jobs themselves: at the same time they are equally encouraged to seek advice from their tutors but it is left to them to make the appointments. O'Neil and Borlengi⁵ visited me at my home on four occasions during a three-month period and then

submitted the article noted. This article was seen once previously and modified. In the case of Murdin⁶, who already had an interest in radio astronomy and had worked with me previously, only two discussions were necessary. Murdin did, however, withdraw his article and make some additions before it was finally sent to press. These two articles summarize the scope and intentions of the first part of the project, while Sabbagh is concerned with the third part.

The fundamental units of radio astronomy provide an interesting introduction to the m.k.s. system and the relation between physical and radio units of brightness, brightness distribution and magnitude. A further comparison can be made with the unit of field strength as used in radio communications. In the first part of the project the student is given a number of references⁵ which vary in level and told to investigate the problems of radio astronomy with particular reference to its units; he is asked to note how they differ from similar units used in optics and radio communications. His reactions to the various fields of observational radio astronomy are noted, and it is expected that a written account of this work in the form of the summary will be presented when complete. It is interesting to note that all the approaches to this same task have differed widely.

Normally the second part of the test is the construction of a simple piece of radio equipment with the view of its being used for observations. A typical project might be the construction of a sudden enhancement of atmospherics (associated with solar flares) recorder similar to that described by Ellison⁶, or the construction of a simple radiometer⁷ after Sander⁸ or Osborne⁹. The third part would then consist of observing solar radiations or sudden enhancement of atmospherics (associated with solar flares) over a period of about two months. There is a number of possibilities open to simple investigation involving the analysis of such records.

At the time of writing all the students had completed the first part of the project. Sabbagh¹⁰ had, however, undertaken a statistical analysis of some records made by Hyde and Castelveccchi² as a combined part two and three.