Our results show, moreover, that, in the absorption measurements of the radiation which produces nuclear disintegrations[4], a large percentage of the events observed (stars and bursts) are produced by the secondaries generated in the absorbers.

Scattering. We have searched for other interactions of the penetrating particles of the bursts, that is, for scattering. To do this we measured the scattering angles through the three plates of thirty-eight penetrating particles associated in bursts produced in S in a manner similar to that used by Rochester[7]. These tracks were found on photographs selected *a priori* owing to their being technically good. The scattering observed is never larger than 6°, except in one case (9°), and can be explained by Coulomb scattering alone, without any anomalous scattering. One scattering of $\sim 25°$, on the contrary, has been observed in penetrating particles not clearly associated in bursts.

A typical photograph of a burst produced by a penetrating particle of a penetrating shower is reproduced in Fig. 2.

A detailed report will be submitted to the *Nuovo Cimento*. We are greatly indebted to Prof. B. Ferretti for helpful discussions.

[1] Rossi, B., *Rev. Mod. Phys.*, **20**, 537 (1948), and references cited there.

[2] Brown, R., Camerini, U., Fowler, P. H., Muirhead, H., Powell, C. F., and Ritson, D. M., *Nature*, **163**, 47 (1949).

[3] The existence of successive multiple nuclear disintegrations is referred to in Bridge, H. S., Hazen, W. E., Rossi, B., and Williams, R. W., *Phys. Rev.*, **74**, 1083 (1948).

[4] Bridge, H. S., and co-workers, *loc. cit.*

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DISSOCIATION EXTRACTION

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A PROCESS has been devised for separating organic acids (or bases) of different dissociation constants from each other by solvent extraction. It is based on the fact that, in general, weak organic acids are soluble in solvents only in the form of the free undissociated acid. In essence, the system consists of a continuous counter-current extraction column in which the solvent flows in one direction (say, upwards) and water flows in the opposite direction. The mixture to be separated is fed to an intermediate point in the column. The acids partition themselves between the solvent and the water in a way which depends on the dissociation constant (K) and the pH. The concentration of an acid in the solvent (C_S) is related to its concentration in the water (C_W) by the equation

$$\frac{C_S}{C_W} = S.\frac{[\mathrm{H}^+]}{[\mathrm{H}^+] + K}, \qquad . \quad . \quad (1)$$

where S is the partition ratio of the acid between the solvent and water. The weaker acid is preferentially present in the solvent; for example, if the partition ratios of the two acids are equal and the first acid is taken as the weaker ($K_1 < K_2$), then

$$\frac{C_{1S}}{C_{2S}} \Big/ \frac{C_{1W}}{C_{2W}} = \frac{[\mathrm{H}^+] + K_2}{[\mathrm{H}^+] + K_1}. \qquad . \quad . \quad (2)$$

This equation shows that the degree of separation can be improved up to a maximum value by reducing the hydrogen ion concentration. There is, however, a practical limit to this as it entails a reduction in the concentration of acid in the solvent (equation 1); on the other hand, this can be to some extent counterbalanced by suitable choice of solvent, which should be one with a high partition ratio.

The solvent as it flows upwards is, by repeated contact, progressively enriched in the weaker acid, and correspondingly the aqueous phase is enriched in the stronger acid. The column is operated so that the total concentration of acid in each phase is constant; thus, since the weaker acid is segregated to the top of the column, the pH is higher there than at the bottom, and there is a continuous pH gradient along the length of the column. Reflux is applied at both ends of the column. At the top it is effected by adding alkali with the ingoing water, thus removing part of the acid from the outgoing solvent. At the bottom, strong mineral acid is added with the solvent in order to displace some of the organic acid from the aqueous phase to the solvent. The condition of constancy of total acid concentration in each phase follows from the fact that additions of mineral acid and alkali are made only at the ends of the column and with the feed.

This column bears a considerable resemblance to a continuous distillation column. The material to be separated consists here of two acids of different dissociation constants, in place of two liquids of different volatilities. Both processes involve the transfer of material from one phase to another, followed by separation of the phases. The solvent phase is analogous to the vapour phase in distillation, and the weaker acid which is preferentially present in the solvent phase is analogous to the more volatile component. The process of transfer from aqueous phase to solvent is paralleled by the process of vaporization. The greater the hydrogen ion concentration in the aqueous phase, the greater will become the acid concentration in the solvent phase; in the case of distillation, the higher the temperature of the liquid, the greater becomes the pressure (or concentration) in the vapour phase. Thus temperature in distillation corresponds to hydrogen ion concentration. The weaker the acid, the more readily it passes into the solvent phase at a given pH; that is, a weak acid with a low value for the dissociation constant corresponds to a volatile liquid of low boiling point. The ratio on the left-hand side of equation 2 has the same meaning as the volatility ratio. Application of reflux by addition of alkali with the water corresponds to the use of a dephlegmator in distillation.

The operating conditions of the column can be calculated along similar lines to those used in distillation. An equilibrium curve can be calculated, knowing the partition ratios and the dissociation constants, or it may be determined experimentally. From this, by using a construction similar to the McCabe–Thiele construction for distillation, the number of theoretical stages required to effect a given separation can be deduced.

The analogy developed here is with continuous distillation; a similar analogy may be drawn between batch distillation and the Craig[1] separation process, which likewise depends on differences in partition ratio and dissociation constant.

It is proposed to term this process 'dissociation extraction'. A full account of this work will be

published elsewhere. The process appears in essence to have been independently discovered elsewhere; it is described in a patent[2] which does not deal with the theory of the process, and which was published after the present work had been completed.

I am indebted to the directors of the Distillers Company, Ltd., for permission to publish this work.

Craig, L. C., *J. Biol. Chem.*, **155**, 519 (1944).
[2] B.P. 599,854.

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RESEARCH GRANTS IN BELGIUM

THE annual report of the Institute for the Encouragement of Scientific Research in Industry and Agriculture, Belgium, for 1948, in addition to the budget and accounts and a list of members of Council, details the grants made during the year, with some notes on the researches in progress. Of thirty-two new grants, only one was to an individual investigator. The National Centre for Metallurgical Research at Hainault received 9,466,000 francs for metallurgical research, which during the last two years has been concerned with the determination of gases in metals, the spectrographical determination of carbon and phosphorus in steel, the study of the influence of the grain of steel on its weldability, the heterogeneity of ingots, the conditioning and control of the charge in blast furnaces, the influence of the chemical composition of the melt on the behaviour of the ingots, the micro-analysis of steels and X-ray diffraction studies. The Committee for the Establishment of a Pedological Map of Belgium received 8,085,000 francs for the systematic investigation of the pedological characteristics of Belgian soils; and the Electrical Construction Works of Charleroi received 6,550,000 francs for investigations on applications of ultra-short waves, ultrasonics, the recording of over-voltage, Geiger–Müller tubes and counters, electronic medical appliances and sources of ions, all directed to the development in Belgium of a new branch of the electrical industry.

The National Centre for Research on Pastures and Fodder was granted 3,561,000 francs for its work on the phytosociological analysis of pastures in different agricultural regions, the regeneration of pasture by deep aeration following partial seeding, the control or elimination of weeds, including the use of calcium cyanamide, and on the rational and intensive exploitation of pastures and fodder at the four experimental stations of Berlaer, Herve, Leval and Eccloo. The Centre for the Study of High Polymers received 2,892,800 francs for research on the kinetics of polymerization and polycondensation, the characterization of different fractions of a high polymer, on the statistical form of the molecules, the behaviour of the molecule in solution, and cellulose ethers and esters. The Foundation for Potato Research received 2,545,000 francs for work on genetical selection and the breeding of selected varieties. To the Committee for the Scientific and Technical Study of Milk and its Products 2,490,000 francs was given for work on the improvement of the quality of milk and butter, and to the Belgian Institute for the Improvement of the Beetroot 2,352,500 francs for agronomical, chemical and biological research on the cultivation of the sugar-beet and for the study of its mechanization. The National Institute for the Improvement of the Conservation of Vegetables received 1,615,000 francs for research on the cultivation of such crops, the selection of varieties, and the biological, chemical and physical conditions of preservation.

The Belgian Institute for High Pressures received 1,346,000 francs for both static and dynamic work at high pressures, work on explosives, spectroscopical work, and biological work at high pressures. The Belgian Committee for Electrochemistry and Thermoelectricity received 1,121,800 francs for research on induction furnaces and their use in metallurgy; and to the Committee for the Study of Creep of Metals at Ordinary Temperatures 1,037,000 francs was granted for research on the creep of high-resistance steels. Smaller grants were made to the National Centre for Animal Research, the Photo-Products Gevaert (for the study of emulsions), the Centre for Child Care and Pediatry, the Union for Electrical Development in Belgium (for research on high-pressure steam pipes), the Belgian Association for the Study, Testing and Use of Materials for investigations on the protection of steel by paint, the Bureau of Physico-Chemical Standards for metrological research on standards, the Belgian Institute of Welding, the National Committee for the Investigation of Penicillin and the Committee for Physico-chemical Research at Low Temperatures.

10/-

AMERICAN PHYSICAL SOCIETY

ANNUAL MEETING

THE 1948 annual meeting of the American Physical Society, the largest meeting in its history, was held at Columbia University, New York City, during January 26–29. The retiring presidential address was delivered by Prof. J. R. Oppenheimer, who took as his subject "Fields and Quanta"; and the after-dinner speeches, "Sentimental Democracy and the Forgotten Physicist" and "Freedom versus Security in the Modern World", were made by Profs. P. W. Bridgman and R. E. Cushman, respectively. The text of Prof. Cushman's speech is reprinted in the March issue of *Physics Today*.

At the business meeting on January 28 the following officers were elected: *President*, F. W. Loomis; *Vice-President*, I. I. Rabi; *Secretary*, K. K. Darrow; *Treasurer*, G. B. Pegram; *Members of Council* (four-year terms), L. W. Alvarez and V. F. Weiskopf; *Members of the Board of Editors* (three-year terms), J. Bardeen, R. G. Herb and W. E. Lamb, jun.

The total number of papers contributed to the meeting was three hundred and eight. Most of these were ten-minute papers; but there were a few invited papers. These included: in the general programme, papers by L. Brillouin on the interaction between waves and electrons travelling together, and by H. Yukawa on models and methods in meson theory; in the division of electron physics, W. Shockley on the electronic theory of the transistor; and in the division of fluid dynamics, T. von Kármán and C. C. Lin on the statistical theory of isotropic turbulence, and M. Schwarzschild on turbulence in the atmosphere of stars. A complete list of the papers, together with abstracts, is given in the minutes of the meeting, which are printed in the April 15 issue of the *Physical Review* (**75**, 1279–1338; 1949).

At the Council meeting it was reported that the financial position of the Society was unsatisfactory. It was certain that nearly half the accumulated