to cover more. Why, then, proceed to build up on an equation an elaborate metaphysical structure? And, especially, why imagine that the success of the Einstein equation proves the observed velocity of light to be the same whatever the motion of the observer? If the observer thinks, and if he is aware of the FitzGerald-Lorentz contraction, he will know that such a proposition is not true; he will know that the velocity of light is not equal in all directions in a relatively drifting medium, that the wave-front is not concentric to the observer, and that the Michelson experiment gives no proof of anything of the kind.

The uniformity of the æther makes the obtaining of positive results difficult; there seem to be always compensations. Some day we may be able to evade this experimental difficulty, but meanwhile, if we choose to make the supposition that motion of the observer can never have any directly observable effect, or that one set of axes of reference is necessarily equivalent to every other and indistinguishable by any kind of superficial observation, then we seem to be in accord with present experience. From that supposition definite consequences can, with adequate skill, be deduced, and the deductions have been subjected to successful verification.

But if on the strength of that remarkable achievement some enthusiasts proceed to formulate propositions which by ignoring the motion of the observer and all its consequences complicate the rest of the universe unduly, then, however much we may admire their skill and ability, I ask whether they ought not to be regarded as Bolsheviks and pulled up.

Emil Fischer's Contributions to Organic Chemistry.[1]

By DR. M. O. FORSTER, F.R.S.

EMIL FISCHER was born on October 9, 1852, at Euskirchen, and his death on July 14, 1919, occurred at a time when every element of constructive and harmonising influence was most sorely needed. Since 1892, when he succeeded von Hofmann, he had fulfilled the duties of professor and director of the chemical institute in the University of Berlin with increasing distinction. Physically commanding, his authority rested on the solid foundation of natural dignity. The brisk, upright carriage marked the man of action; the glowing eyes revealed his attitude of constant, keen inquiry; it was impossible to escape his contagious enthusiasm.

Fischer addressed himself to organic chemical research at the opening of its brightest epoch. Having described the preparation of phenylhydrazine in 1875, he devoted many succeeding years to developing the transformations of that remarkable substance. During this period he also collaborated with his cousin, Otto Fischer, in elucidating the constitution of rosaniline bases, their first joint paper appearing in 1876. It is noteworthy that, in spite of his early interest in the chemistry of these and other colouring matters, and notwithstanding his association with von Baeyer, beginning in Strasbourg and continuing until he left Munich to occupy the chair of chemistry at Erlangen in 1882, he nevertheless resisted the temptation to succeed Caro as director of research in the Badische factory, although at this time (1883) the colour industry was in the early flush of its active growth.

When reviewed as a chapter which is closed, Fischer's work must be regarded as having established upon a firm basis the fundamental science of biochemistry. The assimilation of carbon dioxide and water by plants, the variety and complexity of saccharide molecules proceeding therefrom, the degradation of the proteins, the probable course of their synthesis from amino-acids, and the power of assemblage or of disruption exerted by enzymes on all these building materials of the animal and vegetable kingdoms are subjects which Fischer not merely illuminated, but was the first to place in coherent arrangement and intelligible sequence. Recognition of the fact that all this was accomplished, not by revolutionary processes or theories, but by skilful development of the thoughts and operations expanded by Liebig, von Hofmann, Pasteur, and von Baeyer, is perhaps the highest tribute which can be paid to his genius.

Fischer's association with the branch of chemistry which first brought him fame began in 1884, when he discovered phenylglucosazone, produced from glucose, fructose, and mannose by the action of phenylhydrazine. At that time only two aldohexoses (glucose and galactose) and two ketohexoses (fructose and sorbose) were known and recognised as straight-chain pentahydroxy-derivatives. According to the requirements of van't Hoff's theory, a pentahydroxy-aldehyde of this class, in which five carbon atoms are each associated with one hydroxyl group, should appear in sixteen stereoisomeric forms, eight of these being enantiomorphs of the remainder. The bare statement that Fischer and his collaborators elucidated the configuration of twelve such isomerides, most of which they synthesised for that purpose, although perhaps an accurate summary of his opening achievement, conveys but a nebulous impression of the character and amount of the labour involved. Moreover, his discovery of γ-methylglucoside in 1914, and the consequent recognition of cyclic relations distinct from that occurring in α- and β-glucose, have opened the way to a multitude of contingent isomerides, those of *d*-glucose alone numbering ten. Thus Fischer not only elaborated his own sugar chemistry, but also added to this the foundation of a new carbohydrate classification.

The directive influence on Fischer's work in this field was the discovery, in association with Tafel in 1887, of α- and β-acrose. The former sugar he identified with *dl*-fructose, whilst β-acrose is now recognised as *dl*-sorbose. The above-mentioned synthetical operations, and many others connected with pentoses, tetroses, and artificial sugars containing more than six atoms of carbon, were effected by means of the cyanohydrin reaction, Pasteur's method of separating optical antipodes, and the discovery that when a monobasic sugar-acid is heated with quinoline at 140° C. the configuration of the carbon atom adjacent to the carboxyl group becomes epimerised (1890).

One of the most remarkable achievements in a series unsurpassed by any organic chemist was Fischer's synthesis of the principal constituent of Chinese tannin. In 1852 Strecker had shown that gall-nut tannin is a compound of grape-sugar and gallic acid, but latterly the conclusion had become discredited, and tannin was regarded as consisting mainly of digallic acid. This was synthesised in 1908 by Fischer and found to be crystalline, although astringent, and in 1912 he showed that the principal constituent of Chinese tannin does give glucose on hydrolysis. By a series of complex synthetical opera-

[1] Synopsis of the Emil Fischer Memorial Lecture delivered before the Chemical Society on October 28.

tions in association with Bergmann he prepared in 1918 the penta-(*m*-digalloyl)-derivatives of *α*- and *β*-glucose, and found them to be indistinguishable from the principle of Chinese tannin excepting for a slight difference in optical activity.

Fischer is entitled to a high place amongst the notable figures in chemical history associated with problems arising from the structure of uric acid and its derivatives. This work, begun in 1881, when he resolved caffeine into methylcarbamide and dimethyl-alloxan, reached its climax in 1898, when he derived purine from uric acid by means of indirect de-oxidation. It has now passed into the text-books, and the classification of all such materials, many of which are important products of animal and vegetable metabolism, is based on his notation of 1897.

In view of their extent and the far-reaching bio-chemical conclusions based upon them, the labours of Fischer in the region of proteins make the same appeal to the imagination and evoke the same delight in craftsmanship as his activities amongst carbohydrates. Recognising amino-acids as the building materials of albuminoid molecules, he devised an unrivalled practical method for isolating them from the complex mixtures which follow the hydrolytic disruption of the proteins. Accumulating a large number of such units in their optically active forms, he proceeded to reassemble them as anhydrides, and thus elaborated molecules which, although much simpler than natural proteins, nevertheless approach them in physical properties. These were called polypeptides, and one of them, an octadecapeptide described in 1907, attained a molecular weight of 1213. The experimental methods developed in the course of these investigations are too complex for summary description, but they represent an extraordinary technical feat, and establish a connecting link between laboratory syntheses and the peptones arising from incomplete disruption of protein molecules. The investigation is limited only by material considerations, for a calculation made by Fischer in 1916 showed that the octadecapeptide has 816 possible isomerides, whilst a polypeptide involving thirty amino-acid molecules differing widely, but not entirely, amongst themselves may have isomerides reaching $1{\cdot}28 \times 10^{27}$ in number.

Throughout these inquiries Fischer made frequent and skilful use of enzymes, developing a technique which will offer substantial guidance to later investigators of vital changes. In 1894, having assembled a variety of artificial carbohydrates, he studied their behaviour towards different families of yeast, drawing the fundamental conclusion that the fermentative enzyme is an asymmetric agent attacking only those molecules of which the configuration does not differ too widely from that of *d*-glucose. Applying this principle to the natural and artificial *d*-glucosides, he ranged these in two groups, the *α*-*d*-glucosides being hydrolysed by maltase and indifferent towards emulsin, the *β*-*d*-glucosides exhibiting converse behaviour. The *l*-glucosides, *d*-galactosides, arabinosides, xylosides, rhamnosides, and glucoheptosides were not affected by either enzyme, and the glucosidic relation of sucrose, maltose, and lactose was determined by similar means. It was the knowledge thus gained which led Fischer to represent enzyme-action by the analogy of a lock-and-key, and to conclude that disaccharides are fermented only as a consequence of preliminary hydrolysis. Turning his attention to secretions of animal origin (1896), he studied the behaviour of carbohydrates and glucosides towards a great variety of tissue extracts and juices, but it was when these were applied by him, in association with Abderhalden (1903), to the proteins and polypeptides that the most fruitful results arose, from which it followed very clearly that the synthetic polypeptides are susceptible to zymolysis only when constructed of those amino-acids which occur in the natural proteins themselves.

Although the subjects to which Fischer mainly devoted his attention were not related directly to problems of manufacture, he quickly made contact with the chemical industry, and many of the processes in use at the Bayer, Höchst, and Böhringer factories were based upon principles developed in his laboratory; the improvement which he effected in the production of diethylbarbituric acid led to this compound becoming one of the most valuable hypnotics in pharmacy under the name "veronal." Whilst shunning publicity in its grosser forms, he played an active part in the German chemical world, and the reliance placed on his judgment by leaders of the German chemical industry ultimately grew into an attitude of trust which was quite exceptional. It was this which enabled him to become instrumental in establishing the Kaiser-Wilhelm-Institut für Chemie, a research foundation independent of teaching duties inaugurated in 1912. A pronounced individualist, he trusted personalities more than organisations and wisdom more than learning, his own kindling personality and clear wisdom being freely applied to the furtherance of scientific method, both industrial and academic.

It is not difficult to imagine the demands which were made upon him during the war period, the five years which were destined to be his last. In a directive capacity he was associated with many of the commissions charged with solving chemical problems connected with the great conflict, but it was the food shortage which engrossed his attention most urgently. There is no doubt that these labours and their fruitless issue preyed too heavily upon a constitution undermined by lifelong over-application to exhausting labour, and in view of the great age attained by his father, who passed the ninety-fourth year, his own demise was premature in every sense.

Even when due allowance has been made for the storehouse of accumulated facts upon which the chemists of his era were empowered to draw and for the variety of technique which was at their command, it can scarcely be claimed that in wealth of revelation and manipulative skill Emil Fischer is eclipsed by any of his predecessors. It is difficult to imagine that he can be surpassed by any of his successors, but whether this be so or not, his achievement will remain for all time a monument of industry, a masterpice of symmetry, and a gospel of inspiration.

The Physics and Chemistry of Colloids and their Bearing on Industrial Questions.

THE Faraday and Physical Societies held a joint discussion on "The Physics and Chemistry of Colloids and their Bearing on Industrial Questions" on October 25 in the spacious lecture theatre of the Institution of Mechanical Engineers. The societies were extremely fortunate in having the subject introduced by Prof. Theodor Svedberg, of the University of Upsala, who gave an excellent *résumé*, mainly from the physical point of view, of the present state of knowledge of the subject of colloids on the theoretical side. Prof. Svedberg's written contribution included an excellent bibliography of the subject, which will be found most helpful to physicists and others who wish to become acquainted with modern theoretical