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DENMARK

and some Danish Scientists of Note

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PUBLISHED BY THE COMMITTEE FOR SELECTING AND PROCURING THE COLLECTIVE SCIENTIFIC EXHIBIT, DONATED BY THE DANISH GOVERNMENT TO THE MUSEUM OF SCIENCE AND INDUSTRY AT CHICAGO

COPENHAGEN · DENMARK

1933

PRINTED BY EGMONT H. PETERSEN,
BY APPOINTMENT PRINTERS TO H. M. THE KING
OF DENMARK

H. M. KING CHRISTIAN X OF DENMARK AND ICELAND

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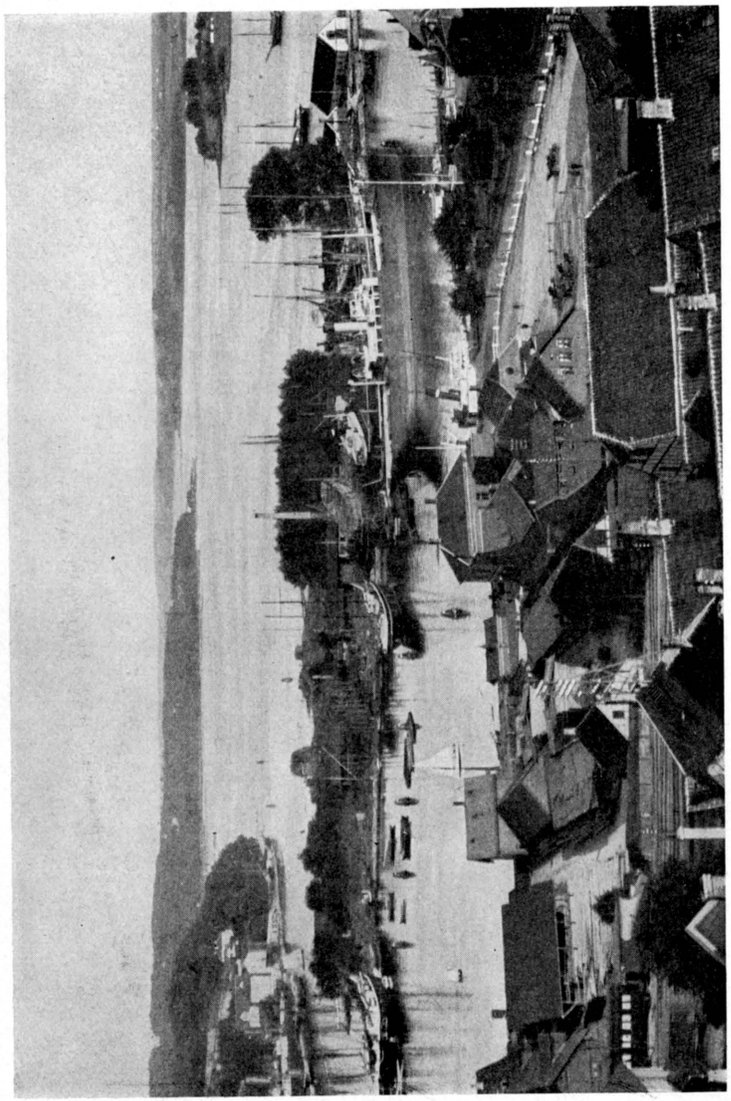
Note: Danish ø or ö pronounced oe



Svendborg, Funen, is a popular yachting center in the summer months and an ideal vacation resort.

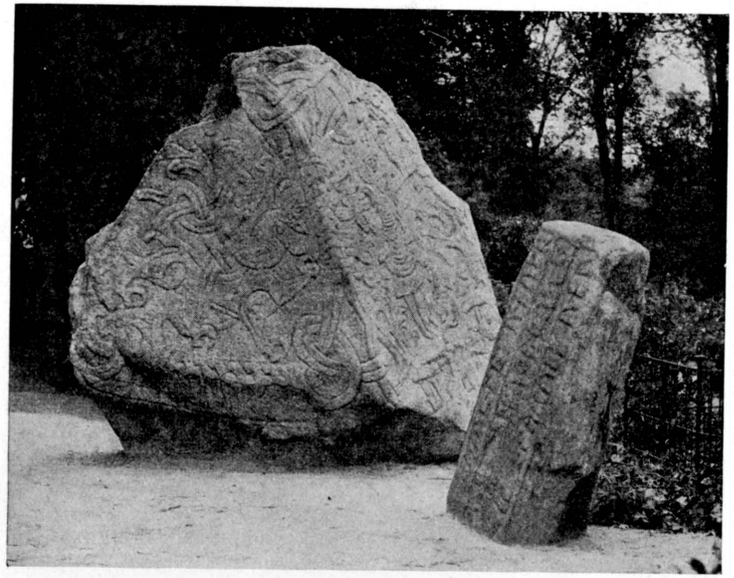
DENMARK

Moderation in all things, an ideal realized

Hendrik Willem van Loon, most modern of present day historians, states in his recently published Geography that Denmark "is worth a dozen other countries of infinitely greater size and more pretentions and militaristic ambitions which I could mention if I felt so inclined. The Danish people, entirely through their own efforts, have lowered the illiteracy percentage to zero, they have made themselves the second richest country per capita of all Europe and they have practically abolished both riches and poverty as they are known in the rest of the world, establishing instead a balance of average, moderate well-to-do-ness which is without an equal anywhere else."

Mr. van Loon is very generous in his praise, a bit too generous, according to the Danes themselves. They will point out that there is a great deal of unemployment in Denmark, that the Danish farmers at present are far from being well off and that import regulations and trade restrictions the world over have hit Denmark harder than any other country because no nation is so dependent on exporting as are the Danes. On the other hand, everybody in Denmark violently disagrees with van Loon when he says that the Danish climate is "exceedingly unpleasant". All modern geographers ought to know that a spring day in Denmark is worth a month in California!

However, there is a grain of truth in everything Mr. van Loon says. The ideal of the ancient Greeks was moderation in all things, and this has — in moderation! — been realized by the Danes. The size of their country, its natural resources and climatic conditions are all on the moderate scale, certainly not too large or very good, but neither too small nor very bad. The same is true of the population, just enough



The Runic Stones at Jellinge, Jutland, date back to year 922 A. D.

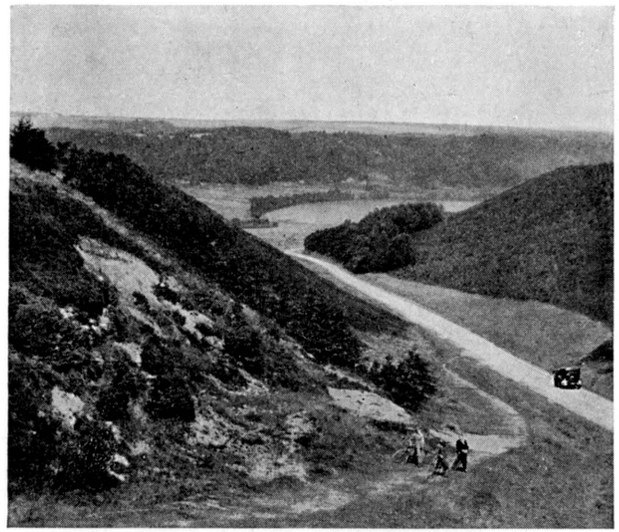
people to make an independent nation, few millionaires and no slums, everybody able to read and write and geniuses easily counted, politically advanced but abhorring extremes.

Denmark is not a large country, being about the size of Massachusetts and New Jersey combined, 16,570 square miles altogether. Only eigth American states are smaller. On the other hand, only ten Amerikan states have a larger population than Denmark where 3,600,000 people now make their living.

In 1920 the area of Denmark was increased by 1540 square miles and the population gained some 165,000 when the people of North Slesvig in a plebiscite voted overwhelmingly for returning from German rule to adherence to Denmark.

We have, so far, dealt only with Denmark proper, the peninsula of Jutland and the islands between the Baltic sea and the Kattegat. But also the Faroe Islands in the North Atlantic are a part of Denmark, a Danish county, 540 square miles with a population of about 25,000.

And if we in Denmark include also the colony of Greenland, more than 825,000 square miles must be added to Danish



Denmark is a hilly country

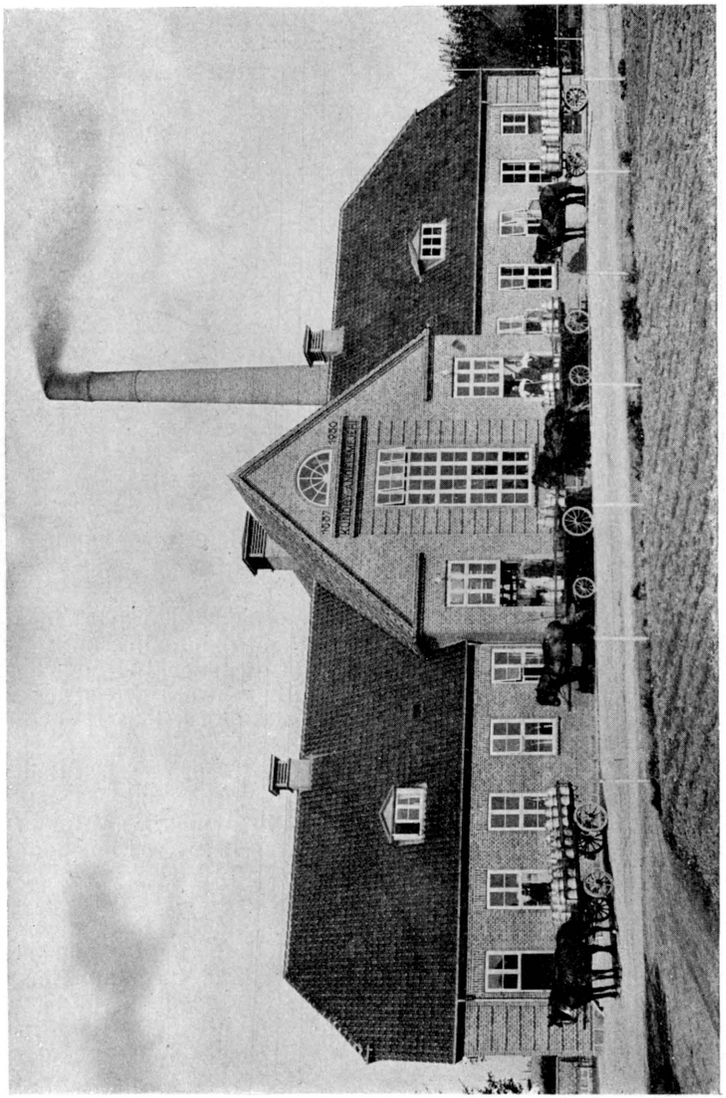
territory, though the population of Greenland only numbers about 17,000.

A rolling country of small farms, producing butter, bacon and eggs

To return to Denmark proper, it is a country without mountains, not flat all over as for instance the Netherlands, but rolling. There are a good many hills reaching a height of three or four hundred feet above sea level, the highest rising to 565 feet, less than half the height of the Empire State Building in New York. The only rocks in Denmark are found on the granite island of Bornholm in the Baltic sea but none of them rise above a few hundred feet.

As there are no mountains in Denmark there are no mines. Of natural resources the country has only its soil, its commercially valuable situation at the entrance to the Baltic, the surrounding seas and the ability and energy of its population.

The soil af Denmark is not rich, fairly good on the east coast of Jutland and in the islands, but distinctly poor in some places, especially along the west coast of Jutland. Much



One of the 1400 co-operative dairies in which the famous Danish butter is made according to the latest scientific methods

the greater part of the land area has however been made productive, almost 80 per cent being farmed, while 10 per cent is timbered. The mild and moist Danish climate, with an average temperature the year round of 45 Fahrenheit, is good for the fields and the soil is so intensely cultivated that the crops have increased by 150 per cent during the past fifty years.

Grain growing is of secondary importance in Danish agriculture. The main thing is to produce as much cattle feed as possible. The dairy industry occupies first place and needs plenty of feedstuffs, green fodder, supplemented by oil cake and similar imports. There is a milch cow for every other person in Denmark, the cattle totalling 3,240,000.

Of the world trade in butter Denmark provides 30 per cent. While the butter exported from other countries varies in quality and quantity according to the seasons, Danish butter is of the same high quality all the year round and the output constant. This fact is so much more remarkable because the soil of Denmark is not owned by a few rich landlords on whose vast holdings a uniform commodity could be easily produced. On the contrary, no other country is so cut up in small holdings as is Denmark today. There are about 206,000 farms and less than 5400 are larger than 150 acres. 135,000 farmers operate farms, ranging from one and a third acre to 37 acres, but the largest cultivated area, around 57 per cent of the total, is occupied by 66,000 farms of from 37 to 150 acres.

Now, it may seem strange that Denmark is able to produce butter of uniform high quality although the milk has to be collected from so many, different sized farms. But this is due to the great number of modern dairies established all over the country. There are some 300 privately owned dairies in Denmark but 90 per cent of the milk is handled by the co-operative dairies, owned by the farmers themselves. The co-operative dairies, now numbering about 1400, manufacture butter, cheese and other dairy products according to the latest scientific methods. The greater part of the farmers are educated not only in elementary schools but as grown-ups in Folk Schools and Agricultural Schools, and their dairies are organized in local dairy societies whose experts provide the members with advice as to the handling of milk, the best way of feeding the cattle and so forth. The Danish government guarantees that alle butter exported from Denmark is made from pasteurized cream, contains not more than 16 per

cent water, at least 80 per cent butter fat and no preservatives except common salt.

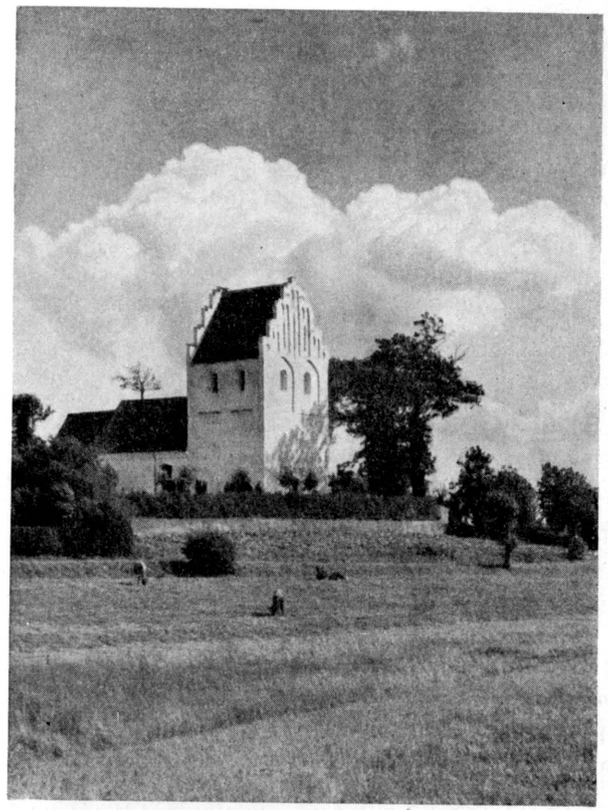
The production of bacon in Denmark is intimately connected with the dairy industry. The skimmed milk and the butter milk go from the dairies back to the farmers for feeding the pigs. Of these there are some four and a half million in Denmark but the number is now being reduced to prevent overproduction for the limited English market. By feeding the pigs milk and grain the Danish farmers produce an excellent quality of bacon, and around 60 per cent of the international trade in bacon comes from Denmark, an astounding total for so small a country. To complete the breakfast table 10 per cent of the world trade in eggs is provided by the Danes and their 22,000,000 chickens.

No raw materials, but Denmark manufactures everything

However, Denmark is not exclusively an agricultural country. As a matter of fact, less than half the population live in the country. Of gainful workers there are 1,330,000 and only 475,000 of these are occupied with farming and gardening, foresting and fishing. Fishing as sole occupation employs only 14,000 persons but many of the smaller farmers do a great deal of fishing on the side.

The trades and industries take care of 370,000 persons. Commerce, finance, transport and communication employ 225,000 persons, public and professional services some 80,000 persons, while more than 180,000 make their living as domestic and personal servants. Of the total number of gainful workers, 355,000 are employers, 225,000 managers, officials, foremen, overseers, functionaries, clerks and so forth, leaving a balance of 750,000 as the working class proper.

One third of the people of Denmark get their living from the soil or the sea but almost as many from the trades and industries. The most important raw materials such as coal, oil, iron and other minerals are totally lacking in Denmark, as are also the extensive pine and fir forests which in Norway and Sweden make lumbering such a valuable business and match and paper factories one of their greatest industries. Neither has Denmark any rivers of importance or waterfalls to turn into sources of power.



A typical Danish country church

Nevertheless, though handicapped in many ways Denmark has succeeded in establishing numerous manufacturing industries some of which are noted the world over. Ocean going motor ships are a Danish invention and most of them use the Diesel marine motor, manufactured or licensed by the largest Danish shipyard. Also cement making machinery is exported in large quantities from Denmark, and one Danish company has for years been building cement factories all over the globe.

Next to butter and bacon no other product of Danish origin is probably as well known as the Copenhagen porcelain, a

triumph of industrial culture. Also Danish silverware of great artistic merit is now finding an ever increasing market in New York, London and Paris. But many other Danish commodities are exported, from vegetable oils and dry batteries to Danish Aquavit, Cherry Cordial and the far famed Lager and Pilsner Beer.

Practically every product under the sun is being manufactured in Denmark, flour and sugar and canned goods, clothing and textiles, machinery of every description, automobiles and the almost too popular bicycles, soap and chemicals, leather goods and glassware, paper and building materials and what not.

Denmark has not gone in for mass production. Quality is the keynote. The standard of education is unusually high and results in great technical efficiency. After leaving the elementary schools to become apprentices the young men and women continue to study in special technical schools every night for several years and are not recognized as skilled workers unless they pass their examinations. Even of the industrial workers more than half are skilled, and an additional sixth are specially trained, leaving a balance of less than a third as unskilled laborers.

Charming Copenhagen, commerce and shipping, provincial cities

Commerce and shipping were of prime importance to Denmark as long as a thousand years ago. The vikings were traders in their own, somewhat rough way. Later they became more civilized and, in the Middle Ages, the Danes chose for their capital the city of Copenhagen, in Danish Koebenhavn, which means simply the Merchants' Harbor.

Almost 800,000 people now live in Copenhagen and its suburbs, making it by far the largest city of the three Scandinavian countries. Is it a charming place, gay and busy, as modern and progressive as any American city and still retaining that old world air of artistic refinement. Copenhagen is surrounded by water, the Sound, the canals, the lakes, and everywhere there are green parks and green copper spires of every description. Some prefer the old parts of the town with their quaint buildings and crooked streets, others the much trafficked business district or the theatres and the large and

Copenhagen, with City Hall in center

festive restaurants which have made Copenhagen the amusement capital of Northern Europe.

Most visitors remember Copenhagen as a delightful place in which to spend a vacation. For the Danes it is their government seat, the hub of their cultural life and the center of the country's manufacturing, shipping and commerce. Forced to import the most essential raw materials and dependent on her agricultural exports Denmark has, of necessity, a large foreign trade. Situated at the entrance to the Baltic, Copenhagen has also become a sort of clearing house for trade and traffic on other countries bordering the Baltic sea. Some of the Danish steamship companies are of considerable size, maintaining regular cargo and passenger routes to all parts of the world, particularly on America and the Far East. There is also a Danish telegraph company of world wide renown, with cable lines all through Russia and Siberia to the Chinese Sea.

The Copenhagen Free Port with its bonded warehouses for

goods to be transshipped has made the harbor of the Danish capital the busiest in all Scandinavia. Some 18,000 vessels call at Copenhagen every year, totalling not far from 6,000,000 net register tons.

The numerous provincial ports, however, total much more, some 80,000 vessels yearly with a combined tonnage of almost 10 million net register tons. Although few of the provincial towns are large there are many of them and together they number about the same population as Copenhagen, around 800,000.

Only eight Danish cities, outside of Copenhagen, number more tham twenty thousand inhabitants and seven of these are situated in Jutland. The capital of this peninsula is Aarhus with a population of some 85,000, one of the oldest cities of Denmark, although not quite as old as the small and picturesque town of Ribe, where Ansgar, the Apostle of Scandinavia, more than a thousand years ago built the first church in present-day Denmark.

Next in size comes Odense with a population of 65,000, the capital of the fertile island of Funen and birth place of Hans Christian Andersen whose fairy tales have been translated into more languages than any other book except the bible. Of the remaining six towns five are on the East coast of Jutland, Aalborg, Horsens, Randers, Vejle and Kolding. The most important is Aalborg whose population is approaching half a hundred thousand and whose harbor handles more tonnage than any other provincial port because of the large cement factories located there. Near Aalborg is the Rebild National Park where Americans of Danish descent celebrate the 4th of July every year, and the city has donated the Sohngaardsholm Manor House to the Dan-America Archives, containing thousands of original documents, books, pamphlets and pictures on Danish emigration to America.

The only accessible harbor on the West coast of Jutland is Esbjerg, population 30,000, unique among Danish cities because it is only some sixty years old, although now the main export harbor for agricultural products and the principal port for Denmark's deep-sea fishing.

Of incorporated towns, having between two and twenty thousand inhabitants, there are 65 in Denmark. Many of them are well worth visiting such as Skagen on the northernmost point of Jutland; the idyllic Svendborg; the cathedral city of Roskilde, for many years the royal residence; and Helsingør,

known to the English speaking world as Elsinore, famous for its old Kronborg Castle where the ghost of Shakespeare's Hamlet used to walk.

Government, social legislation, general education

Denmark is a constitutional monarchy. King Christian X who succeeded to the Crown in 1912 is now in his sixties and very popular. It always surprises foreigners but seems quite natural to Danes that the King goes horseback riding every day unaccompanied by even a groom.

Executive power is vested in the King through his twelve ministers. Legislative authority rests jointly with the Crown and the Rigsdag, the latter consisting of the Folketing or House of Representatives, with 149 members, and the Landsting or Senate, with 76 members. All men and women of more than 25 years of age have the franchise to the Folketing but must be at least 35 years old before they can vote in the Landsting elections. The proportional system is used for all elections.

No government is possible in Denmark if not upheld by a majority in the Folketing. The Liberal Lefts, supported by the Conservative Party, and the Socialists, supported by the Radical Lefts, have alternated in power. Since 1929 the government has been in the hands of the Social Democrats and the Radical Lefts whose coalition cabinet, headed by Prime Minister Stauning of the Socialist Party and Foreign Minister Munch of the Radical Lefts, emerged victorious in the general election last year.

It should be noted that the Radical Lefts are not, as sometimes supposed by foreign commentators, identical with the Communist Party. The Communists only recently succeeded in getting two members elected to the Folketing while the Radical Lefts are an older party, representing the smaller farmers and certain intellectual circles in the towns. The German minority in North Slesvig which, by the way, enjoys every possible liberty, including education of their children in German schools maintained by the Danish government, is represented in the Folketing by one member who received 13 per cent of the total vote in North Slesvig.

Social legislation is very advanced in Denmark. Nobody needs suffer because he is ill or unemployed or too old to

work or has lost a husband or a parent. Old age pensions have been in force for more than forty years. Unemployment insurance and unemployment relief have been developed to meet existing conditions as have sickness assurance, invalidity and accident insurance; widows and widowers and children one or both of whose parents have died are supported, if necessary, and there are all kinds of laws to take care of the needy and protect the workers, women and children. Practically all hospitals are owned by the government or the municipalities and charge only a nominal fee, a quarter a day at the present rate of exchange, or nothing for treatment or operations performed by the most skilful doctors.

There is very little illiteracy in Denmark, only the feeble minded being unable to read or write. Education is compulsory, and half a million children are taught in 3500 schools, of which 333, with 60,000 pupils, are high schools of some sort. No fees are paid except in the private schools or high schools, and in the latter only if the parents have an income above a certain figure.

Universities, science and art, Folk High Schools

Of universities there are two in Denmark, the University of Copenhagen, founded thirteen years before America was discovered, and the Aarhus University, established only five years ago. The importance of the University of Copenhagen in the cultural and scientific life of the Danish nation can hardly be exaggerated; almost every Dane of learning or literary talents down through the centuries has had some connection with the old university. Well known throughout the scientific world are several institutions more or less connected with the University of Copenhagen such as the Institute of Physiology and the Institute of Theoretical Physics, both, to a great extent, established with the assistance of the Rockefeller Foundation; the Carlsberg Laboratories; the Serum Institute; the State Hospital; the Finsen Institute; the Royal Library and the University Library; the National Museum of Archaeology, Etnography etc.

The number of students at the universities is above five thousand, one fifth of whom are women. In addition there are around 900 students at the Royal Technical College which

Main Street, Ribe, Denmark's oldest city

scientifically ranks with the universities. At the Royal Veterinary and Agricultural College there are 600 students while about 500 study at the College of Commercial Science. There is also a College of Pharmacy, a Dental College, about a score of teachers colleges spread all over the country, an Institute of Physical Culture and so forth.

Agricultural schools, technical and commercial schools are numerous in Denmark, and there is a public library in every community. Of great importance in the spiritual and national awakening of the Danish farmers as well as in their economic and social advancement have been the Folk High Schools. The first of these was etablished in 1844 and there are now sixty of them. The co-operative movement on which is founded the success of Danish agriculture would hardly have been possible but for the rural Folk Schools and it is interesting to note that the new power in Danish politics, the trade unions and the Social Democratic Party are now taking over some of the Folk High Schools to further the cultural development of the working classes.

Mention should also be made of the Technological Institute of Copenhagen which is not a scientific institution but a school giving short instruction courses in the different trades and in the use of farm machinery; between five and six thousand people attend every year.

For foreign students wishing to scrape an acquaintance with Danish institutions, language, life and manners there is the International High School at Elsinore, Niels Bukh's High School of Physical Culture at Ollerup and other institutions as well as special courses of study in Danish, held in Copenhagen for the benefit of foreigners every summer.

As for art instruction in Denmark there are the Royal Academy of Fine Arts and the Copenhagen Conservatory of Music. Modern Danish artists do not go in much for tradition and instruction, except the architects for whom there is no *vie libre* until they have mastered the technical parts of their profession.

Of the art galleries the best known is Thorvaldsen's Museum, housing most of the great sculptor's original models at well as a number of his works in marble. The State Museum of Art contains the largest collection of Danish paintings and sculpture as well as a good many pictures of foreign masters, old and modern. Very select and valuable is the antique sculpture in The New Carlsberg Glyptotek which also houses other sculptures of great artistic merit and a smaller collection of pictures. The Danish Museum of Applied Art specializes in Danish and foreign art crafts. There are many other art collections and museums in Copenhagen and the provincial cities.

Of great interest to foreign visitors are the Danish historical museums. Mention has already been made of the National Museum but it should be emphasized that it contains exceedingly rich collections from prehistoric time in Denmark and from Greenland of the Eskimos. Practically intact through more than 300 years stands the castle of Rosenborg, now the Chronological Museum of the Kings of Denmark, where the apartments of the different monarchs may be seen as they left them at their death. The Museum of National History at Frederiksborg is beautifully housed and contains a large collection of paintings and portraits concerning Denmark's history. The old Kronborg Castle should not be missed by anybody visiting Denmark.

From all of which it will be seen that Denmark is not exclusively a country of butter and bacon. There is also room for science and art. All in moderation!

DANISH SCIENTISTS REPRESENTED AT THE CENTURY OF PROGRESS EXPOSITION AT CHICAGO 1933

Unveiling of the Memorial to Emil Christian Hansen, eminent Danish scientist, at Ribe, 1925. The monument was presented by the Wahl-Henius Alumni Association of Chicago U. S. A.

Tycho Brahe (Tyge Brahe) (1546—1601)

one of the greatest figures in the history of astronomy, belonged to a noble Danish family. He was born in 1546 and died in Prague in 1601.

Tycho Brahe marks the culmination of the art of astronomical observation before the invention of the telescope. The main part of his activity is connected with his two observatories Uranienborg and Stjerneborg on the Isle of Hven in the Sound, models of which have been sent to the Chicago Museum as a gift from the Danish government and are shown at the Exhibition. The foundation-stone of Uranienborg was laid in 1576 while Stjerneborg was founded in 1584.

The main points in Tycho Brahe's astronomical work can be summarized as follows: He built the biggest observatory up to his time. He constructed a great many instruments and mainly according to novel ideas. With these instruments he and his pupils made systematic observations surpassing in accuracy and number all series of observations of his predecessors. Tycho Brahe himself from his observations derived a number of epoch-making astronomical results: an accurate star-catalogue, an improved determination of the constant of precession, he found some important laws concerning the motion of the moon and of the comets, a research on refraction and a study of the famous new star in 1572, etc. Tycho Brahe's observations of the planets in our Solar System was the material that enabled KEPLER to find his famous laws, which in their turn became the basis of NEWTON's discovery of the law of gravitation. The chief instruments on Hven were his big *mural quadrant*, the *armillae* and the *sextants*. A model of one of Tycho Brahe's sextants, constructed in the original size according to a drawing and description given in one of Tycho Brahe's principal works: Astronomiae Instauratae Mechanica, is shown at the Exhibition.

The main part of Tycho Brahe's life-work was carried out during the fruitful years spent on Hven; the work was planned however while he as a young man was travelling and

discussing scientific problems with the ablest men of that time, among whom especially the famous landgrave Wilhelm IV of Hessen was of great service to him later in his life. After the death of his patron, King Frederik II, Tycho Brahe met with great difficulties — partly through his own fault — which ultimately resulted in his giving up his work on Hven and leaving Denmark, in 1597. He entered the service of the Emperor Rudolf II and spent his last years in Prague.

Rasmus Bartholin (1625—1698)

was born in Roskilde in 1625, the son of a theological professor. After various studies in Denmark and in foreign countries he was created doctor medicinae in Padua in 1654. In 1656 he was appointed Professor of geometry, and in 1657 Professor in medicine, at the University of Copenhagen. His name became especially famous because of his discovery of the double refraction of the calcite but he also made observations of the large comet of 1664 and his scientific production includes both mathematics, physics and medicine. He died in 1698.

Nicolaus Steno (Niels Steensen) (1638—1686)

was born in Copenhagen in 1638. After various studies, mostly anatomical, in Amsterdam and Leyden he returned to Copenhagen in 1664 but as he did not obtain a professorship here, he went abroad again and soon found a temporary home in Florence. Here he wrote, besides very significant anatomical works, his most famous book: "De solido intra solidum naturaliter contento dissertationis prodromus", where he treats most of the large problems of geology in such a manner that his results are quite in accordance with modern conclusions. They were however quite unintelligible to his contemporaries, and also to the geologists of the next hundred years. He pointed out, that the sedimentary layers were formed on the bottom of the sea, and if we find them consolidated and disturbed these processes were performed afterwards, furthermore that fossils were relicts of animals which had, in former times, lived on the sea-bottom, a thought which was decidedly opposed to the peculiar theories then commonly prevalent among the geologists. In the same

work he expresses the highly fundamental laws of crystallography, that among the many different forms of crystals of the same substance, especially of the rock crystal, only the relative size of the faces is variable whereas the angles pertain the same values (the law of the constancy of the angles). In the same year (1667) he was converted to Catholicism, and some years afterwards he became bishop in various German dioces, became more and more ascetic and was eventually wholly lost for science. He died in 1686.

Ole Römer (1644—1710),

famous Danish astronomer and physicist, was born in 1644, 43 years after the death of TYCHO BRAHE, 34 years after the invention of the telescope and about the time when the first attempts to construct the pendulum clock were made. He died as a professor of astronomy at the University of Copenhagen in 1710.

TYCHO BRAHE was the greatest representative of observational astronomy before the invention of the telescope. OLE RØMER is one of the leading men in the science of observation after the invention of the telescope. Ole Römer has essentially improved the two types of instrument, that work in the co-ordinate-systems, which have the horizon and the equator respectively as the fundamental plane. He constructed the first complete transit instrument — a model of which has been sent as a gift to the Chicago Museum by the Danish government and which is shown at the Exhibition — he was the first to suggest the construction of the heliometer; he constructed the first meridian circle and the first transit instrument in the prime vertical. His name is connected with the discovery of the finite velocity of light; a model at the Exhibition, also presented to the Chicago Museum by the Danish government, serves to illustrate this discovery which is equally fundamental in astronomy and physics. Römer was the first to construct a thermometer based on the two fixed points of temperature, freezing-point and boiling-point, and with calibration of the thermometer tube, so that one degree is well defined. The Danish system of weights and measures, worked out by Römer and adopted by the government in 1683, is based on principles that became fundamental, about 100 years later, in the elaboration of the metric system.

The construction of the meridian circle and the discovery

of the finite velocity of light are the two most famous results of Römer's scientific work. The superiority of the meridian circle over earlier instruments in which a telescope was used in combination with some angle-measuring device, is due partly to the long axis, which makes the instrument a very stable one, and partly to the use of a full circle instead of the quadrants formerly used — a full circle is not exposed to the influence of changes of temperature on the angular value of the divisions, and with a full circle it is possible to eliminate certain instrumental errors that play an important role when parts of the circle only are used. Observations which Römer himself had made with his meridian circle became the basis of the first quantitative determination (by Tobias Mayer) of proper-motions of fixed stars and indirectly of the first determination (by W. Herschel) of the motion of the Solar System relative to the system of the fixed stars.

The discovery of the finite velocity of light was soon after to become the basis of Bradley's explanation of the phenomenon of aberration; and this was only a small beginning of all the conclusions it has been possible to draw from the fact that the velocity of light is finite.

Hans Christian Ørsted (1777—1851)

began his studies in science in Copenhagen in 1794, and from 1796 until 1820 he issued a great number of scientific papers, dealing with experimental subjects as well as with theoretical-philosophical subjects. In 1817 he was appointed professor of physics at the University of Copenhagen.

In 1820 he made his great discovery of electromagnetism. This discovery came as a surprise to the scientific world and apparently without any preparatory work. It was communicated in a paper (July 21, 1820) entitled: *Experimenta circa effectum conflictus electrici in acum magneticam,* which in the briefest form possible gave an account of the conditions under which the experiments were made and of their results, which have later proved to be correct. It has been said that the whole discovery was due to chance but that is far from the truth. Ørsted had for years been seeking a connection between electricity and magnetism, and the discovery was the result of his search. The experiments were extended and the results were published soon after, under the title *Neuere elektromagnetische Versuche,* in the July, 1820 number of

Schweigger's Journal für Chemie und Physik. This work was evidently finished, shortly after the first and should be regarded as connected with it, as it forms an important supplement. It contains the following results: (1) The effect of a conducting wire on the pole of a magnet depends on the quantity of electricity and not its tension — in modern words on the current and not on the electromotive force of the supply. (2) The reaction effect is found by showing that a suspended closed circuit is turned by a magnet. (3) It is established in a new way that a closed circuit has a north end and a south end just like a magnet.

Ørsted did a good deal of chemical work too. He discovered the alcaloid piperine and was the first to prepare metallic aluminium.

In 1829 he founded the Technical College in Copenhagen.

William Christopher Zeise (1789—1847),

Danish Chemist, Professor of chemistry at the University of Copenhagen.

Zeise discovered in 1822 the XANTHOGENIC COMPOUNDS, a theoretically very interesting new group of substances. They are formed by interaction between alcohols, strong bases and carbon disulfide. As specimen is shown the ETHYL XANTHOGENATE OF POTASSIUM, prepared by interaction between ordinary ethyl alcohol, carbon disulfide and potassium hydroxide. The chemical formula of this substance is $C_2H_5O.CS_2K$. Of late xanthogenic compounds have been technically very important, ordinary artificial silk, the "viscose silk", being manufactured by means of xanthogenic compounds. The so called „viscose" is a xanthogenic compound formed by interaction between cellulose, sodium hydroxide and carbon disulfide. By decomposition of the viscose in a suitable way with acids or other reagents the cellulose may be recovered as a fine filament, which is the ordinary artificial silk, the viscose silk, or as transparent sheets, the „cellophane", which also has numerous important applications in daily life.

Zeise has also discovered another important group of organic sulphur compounds, the MERCAPTANS.

Zeise's investigations were first published in Danish by the Kongelige danske Videnskabernes Selskab and later in foreign periodicals.

Julius Thomsen (1826—1909),

Danish Chemist. His international reputation is due largely to his thermochemical studies. He began to work on thermochemical problems in 1850, and in 1852 he published a paper: „Contribution to a thermochemical system", in which he outlined the scheme of his subsequent thorough investigations in this field. This paper contains the first enunciation of the principle that chemical affinity between substances can be measured by the heat evolved when they combine, a view which became the scientific creed of chemists for the next half-century. The results of Thomsen's thermochemical investigations are collected in his famous work „Thermochemische Untersuchungen", published 1882—86.

Thomsen did not confine himself, however, to the thermochemical domain. He was a man of wide-spread scientific interests, and contributed considerably to other fields of research. His investigations of atomic weights and regularities in the periodic system originated in his interest in the problem of the unity of matter. He was able to predict the existence and approximate atomic weights of the inert gases, and also contributed to the knowledge of electromotive forces of galvanic cells. He also worked to a considerable extent on industrial problems, and for instance, discovered an important method of obtaining soda from the Greenland mineral cryolite.

Thomsen, after having held positions at the Royal College, was appointed professor of chemistry in 1866 at the University of Copenhagen. He held this position up to his seventy-fifth year. He was Rector of the University in 1891—92 and Director of the Technical College from 1883 to 1902. He also devoted himself considerably to administrative work. His important achievements were fully recognized by his contemporaries both at home and abroad.

Ludvig Valentin Lorenz (1829—1891)

was a Danish Physicist of an extraordinary intelligence. He has worked in Chemistry, Mathematics and Physics. He was a professor of Physics at the Danish Military College (1866—1887). In 1887 he accepted the offer from the Carlsberg Foundation of a lifetime stipend enabling him to devote himself

solely to scientific work. After his death his various scientific papers have been issued in two volumes „Oeuvres scientifiques de L. Lorenz" edited by Dr. Valentiner.

Working on the relations between the different natural forces light, heat and electricity he was led to the question of determining the value of an electric resistance in absolute electromagnetic units. For this purpose he worked out a method of his own which was wonderfully simple in principle. In a copper disk situated in a coil and rotated by a handle is generated an E. M. F. between the centre and the circumference. The coil and the resistance to be measured are series connected in a circuit. The drop of potential in the resistance is balanced against the E. M. F. of the disk by adjusting the speed. The resistance was expressed in terms of a length divided by a time as in the formula of dimensions. Lorenz's first determination of the absolute value of the resistivity of mercury took place in 1873. The method was taken into consideration by the International Electrical Congress held in Paris 1881. Results obtained with an improved apparatus were laid before the International El. Congress at Paris 1884. — A new Lorenz' Apparatus substantially improved by Mr. F. E. Smith of the British National Physical Laboratory has enabled the determination of the absolute value of resistance with the greatest accuracy hitherto attained (Philosophical Transactions Serie A. Vol. 214 p.p: 27—108. 1914).

S. M. Jørgensen (1837—1914),

Danish Chemist, was born in a small town in Denmark. Even as a schoolboy he was keenly interested in chemistry. He entered the University of Copenhagen in 1857, became Director of the chemical laboratory of the Technical College of Denmark, 1867—1908, Professor of Chemistry at the university 1871—1908, and in 1877 he discovered that a certain coboltcompound, which had hitherto been considered as free from chlorine, contained a well defined amount of this Element but so firmly bound, that it defied the ordinary method detection. This discovery was the starting point of his scientific work covering about 25 years, on the composition and properties of so called complex compounds, especially of the metals cobolt, rhodium chromium and platinum. His work was of outstanding quality and contains a vast amount

of reliable data which were used by Alfred Werner in the foundation of his theory for the constitution of inorganic compounds.

A small book, Elements of Chemistry, which has been translated into many languages, and is a historical introduction to chemistry, and several historical-chemical papers shows, that he had a profound knowledge of the history of chemistry.

Emil Chr. Hansen (1842—1909),

Danish Biologist, Prof., Dr., Director of the Carlsberg Laboratory, Copenhagen 1878—1909.

Trough his *Investigations into the morphology and physiology of yeast* Emil Chr. Hansen established well-defined species among the saccharamycetes and elaborated: *A method for pure cultivating microorganisms* comprising the isolation in a solid nutritive medium of one single cell and the constant miscroscopical control of its growth. The original simple types of apparatus are exhibited.

Other extensive studies Hansen devoted to the variability of yeast, to the elaboration of analytical methods, to the correlations of top-fermenting and bottom-fermenting yeast and to acetic acid bacteria.

The scientific research of Hansen led to a new conception of the species within microbiology and in practice has done away with one of the main sources of uncertainty in the process of fermentation. Publications: Comptes-rendus du Laboratoire Carlsberg Vol. I—IX.

Christian Christiansen (1843—1917),

Danish Physicist. Until 1886 he held various posts as assistant at the Collection of Physical Instruments of the Royal Technical College, and as teacher at various colleges in Copenhagen. From 1886 to 1912 he was professor of physics at the University of Copenhagen.

Among Christiansen's numerous and varied works in physics, which were chiefly pioneer works, may be mentioned: Investigations on the Refraction Conditions for Red Aniline (1870—72), including the discovery that fuchsine refracts red light more strongly than blue light, a Description of a Water Jet Air Pump (1872), a Report on Crystallographic-Optic Investigations by C. and the chemist H. Topsøe (1873), Experiments on Thermal Conductivity (1881), Investigations on Radiation and Absorption (1883—84), Remarks on the Temperature of the Planets (1885), Investigations on the Effusion of Gas through narrow Fissures (1890) and a series of papers on the origin of frictional and contact electricity (1894—1917).

Johan Kjeldahl (1849—1900),

Danish Chemist, Professor, Dr. Director of the Carlsberg Laboratory, Copenhagen, 1876—1900.

Kjeldahl elaborated: *A new method for nitrogen-estimation in organic substances.* The original types of apparatus are exhibited. According to this method the substance in question is decomposed by means of boiling concentrated sulphuric acid and subsequent oxydation with potassium permanganate. By this procedure nitrogen is transformed into ammonia which is determined by distillation with sodium hydroxide into a measured amount of acid. In comparison to those previously employed, this method requires less attention and a considerably shorter time and, consequently, has been universally adopted. In enabling the analyst to carry through large series of determinations within a reasonable time it has rendered inestimable service not only to scientific research but also to all industries dealing with organic nitrogenous substances.

Besides Kjeldahl has carried out a series of important enzymatic investigations, especially of distase and invertase. He has also made elaborate studies of the conditions involved in quantitative determination of sugars.

Publication: Comptes-rendus du Laboratoire Carlsberg Vol. I—IV.

Niels Ryberg Finsen (1860—1904),

Danish Surgeon. Before Finsen the effect of light upon the organism was attributed to the heating effect only. As to the non heating ultraviolet rays in sunlight only the injurious „inflammatory" effect was known. In a series of original publications (1893—1904) Finsen demonstrated that light possesses also an intense, stimulating fundamental effect upon the living organism. He proved through physical and biological experiments, that this is due principally to the ultraviolet part of the rays. He was the first to recommend ultra

violet Light Baths (Sun light and carbon arc light) for many diseases (Tuberculosis etc.) A large part of his work was concentrated upon the application of concentrated light upon skin tuberculosis (Lupus vulgaris). He constructed in rapid sequence a series of physical apparatus for this purpose and thereby obtained definite cure of that ravaging disease in a majority of cases. For this he was awarded the Nobel Prize in 1903. He founded a large Institute for Light Theraphy in Copenhagen which bears his name.

S. P. L. Sørensen,

Danish Chemist, Professor, Dr. Born 1868. Director of the Carlsberg Laboratory, Copenhagen 1901.

In an extensive investigation: *The measurement of the concentration of hydrogen ions and the its effect upon enzymatic processes,* Sørensen has introduced the highly simplifying term of *pH = the logarithm of the reciprocal value of the hydrogen ion concentration* establishing series of pH-values by mixing standard solutions of the salts exhibited, and testing indicators as to their suitability in the different pH-regions as given in the table exhibited. This work has been of fundamental importance to scientific research and has found unusually wide practical application in agriculture and in all industries where enzymatic processes are involved.

Among the other works by Sørensen the following deserve special mention: The establishment of a titrimetric standard by means of sodium oxalate and in connection herewith the laying down of principles for determining the degree of purity of chemical substances in general. — Analytical investigations concerning the salt content of sea water including a previously missing clear definition of this term which has been generally adopted. — Synthesis of a series of amino acids among which phenylalanine, proline, ornithine and arginine and the first decisive proof of the constitution of the last mentioned. — The elaboration of a method of quantitative estimation of the degree of proteolytic decomposition which is extensively used under the name of „formol titration". — Extensive and thoroughgoing studies on proteins constituting a very important contribution to the question whether these substances may properly be considered chemical individuals. Sørensen found that certain proteins like egg albumin and hemoglobin may be regarded as chemical individuals with

negligible „dissociation tendency" whereas others like serum proteins, gliadin and casein may be regarded as „reversibly dissociable component systems" with much higher dissociation tendency.

Publications: Comptes-rendus du Laboratoire Carlsberg, in Vol. VI—XIX. Zeitschrift für anorganische Chemie, in Vol. V, VII, XI, and XL. Det Kgl. Danske Videnskabernes Selskabs Skrifter 1902.

Valdemar Poulsen,

Ph. D. h. c. & Techn. D. h. c. Born 1869 in Copenhagen. Educated in Copenhagen at the University and at the Royal Technical College 1889—1893. 1893—1899 Research Engineer of the Copenhagen Telephone Company.

Chief Inventions:

1898: *The Telegraphone,* in which sounds are magnetically recorded — for later reproduction — in a moved steel body by means of telephone currents. 1899 *Poulsen* retired from the Telephone Company and, in cooperation with Research Engineer, later Professor *P. O. Pedersen,* he worked successfully on the technical and industrial development of the Telegraphone (for use on the Dictaphone, etc.).

1902—1903: *The Arc Generator for producing undamped, continuous, electric oscillations* (described in: Transactions of the International Electrical Congress, St. Louis, Vol. II, 1905). 1905—1907 *V. Poulsen* obtained in cooperation with *P. O. Pedersen* between experimental wireless stations the expected great superiority of the continuous arc waves, (with great capacity of range, very selective wireless telegraphy and wireless telephony).

Poulsen has also made several other radio-technical investigations and during the last 15 years he has been and is still occupied with researches concerning thermodynamic and electromagnetic oscillations.

Martin Knudsen,

Danish Physicist, born 1871, studied physics at the University of Copenhagen and has been professor at the University since 1912. Has taken a special interest in Physical Oceanography and the Properties of Gases at very low pressures. On both these subjects he has written a number of papers, and his work on gasses at low pressure has been of fundamental importance for the modern high Vacuum technique.

Einar Biilmann,

Danish Chemist, born 1873, Professor of chemistry at the University of Copenhagen.

Biilmann found, in 1920, that hydrogen ion concentrations may be determined very quickly by means of a socalled QUINHYDRONE ELECTRODE. The apparatus is simply an electrode vessel and a bright platinum or gold electrode. To the fluid to be examined is added a little of the organic compound *quinhydrone,* and the mixture is poured into the electrode vessel. The potential between the quinhydrone electrode and a suitable comparison electrode is measured. This potential depends upon the hydrogen ion concentration in a similar way as that of the usual hydrogen electrode.

The method which is applicable at pH lower than about 8 is very rapid and exact. It allows pH measurements to be made in a series of instances when the hydrogen electrode method or colorimetric methods fail or are impractical, e. g. solutions containing certain easily hydrogenated substances, coloured solutions, suspensions, etc. The rapidity and reliability of the method has made possible a number of applications of high importance in science as well as in agriculture and industry, e. g. determination of acidity of soils and pH control in numerous industrial chemical processes. The broad applicability has caused a number of outfit constructions which, however, all are based on the original simple quinhydrone vessel shown here.

Biilmann's first investigations on the *quinhydrone electrode* were published in Danish in Københavns Universitets Festskrift (1920) and then in French in Annales de Chimie 1921. A review of the whole process is given by Biilmann in Bulletin de la Société chimique, Paris, 1927.

P. O. Pedersen,

Ph. D., born 1874 in Denmark, 1897 graduated in Civil Engineering from the Royal Technical College, Copenhagen, Denmark. From 1899—1914 Research Engineer associated with Dr. Valdemar Poulsen. Was in 1909 appointed Assistant Professor in Telegraphy, Telephony and Radio at the Royal Technical College in Copenhagen, becoming Professor in 1912. Since 1922 he is also Principal of the College. Is a member of both Danish and a number of foreign Societies and Academies of Sciences and has received various Medals of Honour.

Pedersen has written a great number of papers and books among which may be mentioned "On the Lichtenberg Figures", parts I, II and III; "The Propagation of Radio Waves"; "Wireless Echoes of Long Delay" and various publications in the German and the Danish languages over investigations of the electric spark.

J. N. Brönsted,

Danish Chemist, born 1879. Professor of physical chemistry at the University of Copenhagen 1908. Has made studies within the following fields:

From 1904: Thermodynamics, including Affinity, Electromotive forces, Heat of reaction and Specific heat.
From 1919: (with G. Hevesy) Separation of isotopes.
From 1920: Solubility of salts, Theory of salt solutions.
From 1922: Kinetics of electrolytes.
From 1923: Theory of acids and bases.
From 1924: Acid and basic catalysis.
From 1929: Effect of the medium in the field of electrolytic equilibria and kinetics.

Niels Bjerrum,

Danish Chemist, born in Copenhagen in 1879, appointed Professor of Chemistry at the Royal Veterinary and Agricultural College of Copenhagen 1914.

Bjerrum has mainly investigated electrolytes. 1908 he put forward the conception that all strong electrolytes are completely ionized. In 1916 this idea was further developed by the introduction of a series of ionic coefficients instead of the erratic degrees of dissociation formerly used. For weak electrolytes the calculation with both ionic coefficients and degrees of dissociation was introduced. In later papers these ideas were further elaborated.

In other investigations Bjerrum studied thoroughly the incomplete dissociation of some selected electrolytes. As far as possible all complexes present were determined together with the velocity and equilibrium constants of their formation (chromic chloride 1906, chromic compounds containing hydroxyl 1908, chromic thiocyanate 1915, thiocyanates and chlorides of gold 1918, amino acids 1923, weak acids 1923, 1924, 1929, aluminium phosphate 1931). In his theory of

alkalimetric and acidimetric titration (1914) Bjerrum has shown how to apply the knowledge of ionic equilibria to problems of analytical chemistry.

Of a purely physical nature is Bjerrum's interpretation of the infrared spectrum of different substances, either as a quantum spectrum of rotation or as a spectrum of oscillation, whose lines are split up owing to the rotation of the molecules (1912).

Niels Bohr,

born 1885, Professor of theoretical physics at the University of Copenhagen. Received the Nobel-Prize in Physics 1922. Founder of the Modern Atomic Theory.

In three epoch-making papers on the constitution of atoms and molecules, Bohr, in 1913, developed the priciples upon which our present understanding of atoms rests. By an ingenious application of Planck's discovery of the quantum of action to the atomic model of Rutherford, he was able to give a simple account of the basic laws of spectroscopy. His theory was brought to a certain completion in 1921 through his work on the periodic system of the elements. In the following years, Bohr, by a number of critical surveys of the state of the theory, prepared the way for the modern quantum mechanics which replaces the Newtonian mechanics in the domain of atomic phenomena. The guiding principle in this development was the so-called Correspondence Principle, formulated by Bohr in 1918, which makes possible a definite use of the classical mechanical and electromagnetical equations in the atomic theory, although the classical concepts are essentially at variance with the existence of the quantum of action. Indeed, the quantum mechanics, created by Heisenberg, may be considered as an exact formulation of Bohr's Principle of Correspondence. In later years, Bohr has mainly contributed to the elucidation of the essentially statistical character of the quantum theory stressed by Heisenberg in his Principle of Indeterminacy, and has in particular shown that the problem of the self-consistency of atomic mechanics finds its solution when proper regard is taken to the complementary relationships of exclusion which limit the definition of the various physical quantities, and which are closely connected with old epistemological problems concerning the relation between subject and object.