galleries of the clay like montmorrillonite to a greater extent than usual surfactants.

Without doubt, this book is a fruition of outstanding effort of collation of precious articles of interest to polymer chemists. However, mistakes are found in terms of misprinting as well as deficiencies in sentence construction, missing words besides nonuniformity in typographical format. For example, the sentence 'Plasticized PMMA samples were polymerized in the presence of plasticizer' (p. 108) is technically incorrect as PMMA is already a polymerized form of methylmethacrylate (MMA).

The acronyms used in the book leaves much to be desired. For instance, there is discussion on LiTFSI (p. 89) but its chemical name is missing in the book. This should necessarily have been mentioned earlier as lithium salt of trifluorosulphonimide. Similarly, AGM (p. 79) may not be understandable by many readers as nowhere in the book its full form is mentioned. One presumes AGM is meant to be alternate gradient magnetometer if it is not a misprint for AFM. Details of the experiments on thermal analyses in chapters 7 and 10 should have been brief yet explicit as one would expect from such a specialized book.

In all fairness to the authors, the reviewer concludes by saying that this book sparkles with substance of worthy information. In all probability its slimness implicates the significance of quality over quantity.

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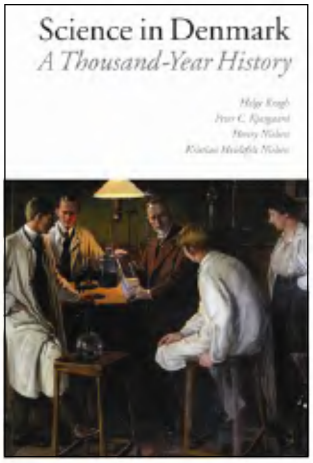

Science in Denmark – A Thousand-Year History. Helge Kragh, Peter C. Kjaergaard, Henry Nielsen, Kristian Hvidtfelt Nielsen (eds). Aarhus University Press, Langelandsgade 177, DK-8200, Aarhus. 2008, pp. 607. Price: EUR 66.95.

Science in Denmark reminds the Indian readers about *A Concise History of Science in India* edited by D. M. Bose, S. N. Sen and B. V. Subbyrayappa. The preface of *Science in Denmark* says that it is a short version of the *Dansk Naturvidenskabs Historie*. The major objective is to present the history of Danish science in the cultural, social and political context. 'The word "Danish", mainly refers to the scientific activities that took place within the varying boundaries of the Danish (or Danish–Norwegian) Kingdom, such as they were at any given time' (p. 13). Whereas science is taken in a much broader context, which includes alchemy, phrenology, etc. (p. 14). The book has been divided into four parts; each of which contains six chapters. In the end, an epilogue and an intensive list of references are given.

Part I covers the time period from 1000 to 1730 and is titled 'From medieval scholarship to new science'. While there cannot be Danish history without vikings, not surprisingly, the book starts with the chapter 'From viking age to absolute monarchy'. There is no romantic view of a prototype viking and his journeys as presented in films and literature. One of the authors Helge Kragh briefly mentions the discovered golden horns of viking, which supposedly give evidences of astronomical and astrological knowledge of the time. The chapter covers diverse topics such as the influence of the Lutheran religion on science, the financial support of science by Noblemen and Kings, the foundation of the University of Copenhagen, introduction of printed books and some of the Danish scholars.

In chapter 2 on page 26 we learn that 'throughout the 1200s Denmark gradually evolved from a peripheral and rather barbaric country into an integrated part of European culture, based on Christianity and the Latin literature'. In the late 1200s Denmark had a few hundred 'learned' people, who had command over Latin – the language of scholars. The tradition of printing of books came quite late. Until 1550 or so the annual book production was limited to three to four titles (p. 29). Due to lack of universities at home, many Danes went to France, Germany and England for higher education. Nordic regions had to wait for such a structure until 1400s. Chapter 3, 'Institutions travel and literature' describes the establishment of the Soroe Academy and University, Tycho Brahe's Observatory, Round Tower Observatory and Museum Wormianum. In the second half of 1600s about 1400 titles were published, roughly half in Latin (p. 53). The famous astronomer Tycho Brahe was the first to build a paper mill in Scandinavia. As far as scientific journals were concerned, *Acta medica* (1673–1680) was the first title. The chapter 'The religious dimension' focuses on interrelations among church, state and educational institutions. The influence of these authorities has been stated as follows: 'Whatever went on at the university had to be consistent with the teaching of the church as well as the attitudes prevalent among the social elite and the political establishment, not least the king and his advisers'. The publications were censored. However, in the Lutheran dominant Denmark there was no index of forbidden books as was the case of the Catholic Church. Subjects like physiology, mathematics and astronomy were seen as assistants of faith. The fifth chapter 'Of Tycho and his time' discusses Tycho Brahe's achievements as an astronomer and a chemist. His model of the universe was with the earth at the centre. Here we see that 'Following the persecution of Galileo in 1633 and the Catholic Church's condemnation of the Copernican system, Tycho's alternative gained a large following among Catholic astronomers' (p. 85). His student Christian Soeresen perpetuated the model. Due to his work Brahe's ideas

were transported to China, where Brahe's instruments were replicated. Here we also find a mention of Ole Roemer who is known for measuring the velocity of light. It is also mentioned that Ole Borch was the first Nordic chemist to produce phosphorus. The last chapter of Part I, 'The age of the Bartholins', informs the readers that in 1600s medical science was the supreme subject. During the reign of Christian IV, the study of medicine was standardized. 'The institution in Copenhagen was inaugurated on 1 March 1645, and many prominent citizens stopped by to follow the grisly and gradual dissection of a recently beheaded woman' (p. 111). It was not only for education purpose but 'also meant to show God's supreme creative power by demonstrating the marvellous manner in which he had arranged man and beast' (p. 112).

Part II on 'Naturalism, knowledge and the public good' covers the period from 1730 to 1850. During this period Denmark had double monarchy before it became a democratic country in 1849. In the European history of science, this epoch corresponds to the era of enlightenment and romanticism. In 'An era of progress and upheaval', Kragh has shown that between 1732 and 1788, theology was a major subject at the University of Copenhagen. Even in the 1850s some of the Danish scientists tried to justify the law of conservation of energy using spiritual and religious context. Though the influence of church started diminishing, the religious ideas of Christian Wolff. a German philosopher, influenced Danish thoughts. He claimed that the Christian teachings of the revelation were consistent with the rational or scientific recognition of God. Wolff's natural theology fitted with the Lutheran Evangelical doctrines of the Danish state church. Due to nationalistic reasons Danish as a language replaced Latin. As a consequence, much of the contributions of Danes remained unknown outside the country. At the same time, due to internal and external factors, such as fire in Copenhagen and war with England, science almost became non-existent until the *Danish Royal Academy of Sciences and Letters* was founded in 1742. This was also the period when new universities were founded. In chapter 8 on 'Institutions, patronage and funding' it is mentioned that around 1740, the need for science was felt as its connection was seen with the progress of technology and economy. Since there was lack of experts in the country in various fields, experts from the neighbouring countries were asked to occupy positions in Denmark's institutions. In 1760 the Trondheim Learned Society was founded (later to be re-named as Royal Norwegian Society of Science and Letters). In 1747 the Academy at Soroe was re-opened. The Round Tower Observatory became one of the most eminent landmarks in Europe. With an ordinance issue in 1739, physics and chemistry were made as a part of school curriculum. However, until 1850 the University of Copenhagen did not have faculty of science. The technical scientific education was imparted by the Polytechnical College (known today as the Technical University of Denmark). The Danish School of Military Engineering was also established. One of its workers, Andreas Schumacher, devised a new system of optical telegraphy. He was also involved in making a rocket used for military purpose. In order to bring science to grass-roots level, popularization of science was needed. How was it achieved? The answer and this is to be found in the chapter on 'Science, culture and education'. It shows that the discoverer of electromagnetism – H. C. Oersted and his contemporaries were instrumental through their lectures. Also it was done by translating popular books and publishing journals like *Nordlyset* (*The Northern Lights*), *Tidsskrift for Naturvidenskaberne* (*Journal of the Natural Sciences*). Around 1760 a science and technology opposing movement started gaining momentum. Its aim was to fight for due space for other subjects such as arts. It was supported by the Society for the Advancement of Fine Arts and Useful Science, which was founded in 1759. In 'Oersted and the age of romanticism' we learn the influence of German 'Naturphilosophie' (philosophy of nature) on Denmark's intellectuals. However, 'Denmark was primarily introduced to the romantic view of nature, humankind, and literature by the Norwegian geologist Henrik Steffens, whose adherence to the ideas of natural philosophy was more unconditional than Oersted's' (p. 187), writes Kragh. Independent of Robert Meyer (German), James Prescott Joule (British), another Dane named Ludvig August Colding discovered the principle of energy conservation: 'When a force disappears, it is merely subjected to an alternation of form and then becomes active in other forms' (pp. 201–202). 'Forces of nature expressed the very essence of God and must therefore be everlasting' (p. 210). His ideas were not recognized in Denmark 'where not even Oersted understood them, let alone attributed them any value. And because they were written in Danish, they at first remained unknown abroad, . . .' (p. 203). The next chapter on 'Contributions to chemistry and natural history' deals with the changing attitude of scientists towards scientific application and the interpretation of their scientific results. Here science was seen not only as knowledge to produce products for consumption, but also as an intellectual activity. Like his contemporary, the zoologist Christian Fabricus was a religious person, 'yet his ideas certainly disagreed with a literal reading of the Bible, and he was, perhaps the first Danish scientist to clearly and radically distance himself from the accepted biblical chronology' (p. 210). The work of chemists Nicolai Tychsen and Adam Wilhelm Hauch largely liberated chemistry from the hypothetical phlogiston theory.

In the last chapter of part II: 'Travel and exploration' (1730–1850), Kragh shows that among the Danish scientific community there was 'little inclination towards cosmopolitan or international thinking' (p. 223). Most of the authors published in local journals and thus were not under pressure to maintain international standards. The author refers to different foreigners who visited Denmark and gave negative testimony on science in Denmark-Norway. However, one way to expand their horizon was expeditions. Two such expeditions, the Arabia and Galathea expedition in 1760s and 1840s respectively, are then explored in detail. The expedition to Ethiopia, Yemen, northeastern Siberia and Alaska made a modest contribution to science. The first Galathea expedition was aimed not only to explore science but had political mission, namely to investigate the Nicobar Islands and other places for long-term colonization.

Part III of the book on 'Light over the land' (1850–1920) is dealt with Peter C. Kjaergaard. Stating with chapter 13 on 'Science and democracy', he shows that 'Science' became a magic word to solve the day-to-day problems. Science was seen as an activity, which could serve not only mankind and promote health, but

also serve other purposes such as 'bringing glory to the nation while generating a substantial financial profit for its supporters' (p. 246). Gradually, society started changing from traditional agricultural to industrial and the introduction of railway, telegraphy, etc. took place. In the next chapter 'The rise of a new profession' the reader observes that specialization in different branches started. A clear-cut distinction between scientific publications and works of popular science began. To compete with other nations, there was a long felt need to bring industry and scientists together. Various science departments were established as independent units at universities. Due to demand of scientists in trade and industry, the term 'career' got a new meaning. From 5 June 1915 women got equal rights as men (p. 275). This section 'The long and winding road to equality in science' is of interest for feminist scholars, as it gives information about women rights in Denmark. The chapter 'A small country in an international world of science' is interesting for historians working of the 'national styles in sciences' and 'social study of sciences'. The author shows that in some cases it is possible to talk about 'national peculiarities of science' such as 'polar research', which was regarded as Scandinavian science. The reality of the scientific life is reported as follows: Due to financial and scientific interests the 'period was marked by bitter disputes, academic nepotism, and jockeying for positions and influence'. However, 'it was also highly productive period that drew Danish naturalists at the turn of the century into an international world of science' (p. 299). Mathematical physics started expanding after Christian Christiansen appeared on the scene in 1886. His findings on dispersion and black body radiation were published in British and German journals. As far as modern research such as X-rays, radioactivity and theory of relativity were concerned, Danes showed little interest. It was soon going to change with Bohr's work on the atomic model. The chapter 'Science and the city' tells us about the forging of an alliance between scientists and industrialists. Denmark's first industrial research laboratory Carlsberg was founded. 'During the years from 1850 to 1920, Danish industry developed a dependency upon scientific knowledge and skills that became an elemental part of people's daily lives, permeating everything from the food they ate to the beer they drank and the soap they used for washing' (p. 324). The exhibitions, exposition and science fairs gave science a face that citizens could easily recognize, thereby greatly facilitating the integration of science into the daily life. Clearly it brought the scientists closer to the society. But what image had the general public of a scientist and his working place? This has been discussed in the chapter 'White coats and Wellingtons'. The media started reporting not only about scientists but also about laboratories. The image of a scientist sometime was over simplified and at other occasions were presented as saints. 'As the period wore on, a number of scientific archetypes crystallized: the tireless servant of humanity, the absent-minded professor, the white-coated lab researcher, and the inventive genius with the quirky ideas'. All of these types were images reflecting the public perception of the scientific practitioner' (p. 339). The section 'The women of science' tells us that as late as 1925 women were seen unfit for original research, but due to patience, diligence and an aptitude for repetitive work they were recognized as better laboratory assistants. Here we find examples of successful women such as, Sofie Rostrup (the first woman to get degree in science from the University of Copenhagen), Hanna Adler and Kirstine Meyer (the first graduates in physics), Caroline Rosenburg (one of the most remarkable amateur botanists). However, 'Generally speaking, equality between men and women was still not a reality in Denmark. And as for equality in the world of science, by 1920 although the situation had improved immensely, there was still a long way to go' (p. 336). The chapter 'Popular science and public culture' informs the readers that a small country Denmark had about 1450 newspapers, journals and magazines in 1913. To popularize science, books were published which contained experiments that could be performed with little effort and equipment. However, within the society, there were critics, who warned about the limits and limitations of science.

Henry Nielsen and Kristian Hvidtfelt Nielsen explore in Part IV, 'Boundless knowledge' between 1920 and 1970. In 'Profiling the period' the division of times follows as, the goldern age or inter-war period (1920–40), Denmark during the World War II and a member of the NATO (1940–55) and Denmark as the welfare state (1955–70). The points of focus are research at the universities and private laboratories and their financial support as well as the reception of the scientific work by the society. The authors show that before the World War I it was believed that the science had no national boundaries and that it promotes peace and harmony between nations. However, the World War I changed this perception. British and French scientists excluded German scientists from international conferences. During the inter-war period and thereafter the media showed Danish scientists as 'dynamic champions of peace and reconciliation between German, French and British physicists during the 1920s, or as idealistic protectors of German scientists fleeing the Nazis in the 1930s' (p. 394). This picture remained unaltered after the World War II. Though the financial position was hard, the Danish state spent money on scientific expeditions and big science. Denmark then joined CERN, European Space Research Organization and the European Southern Observatory projects. Apart from universities, other institutions involved in research were: Risoe Nuclear Research Centre (Risoe National Laboratory), the Nordic Insulin Laboratory and the Carlsberg Laboratory. By the end of sixties and the beginning of seventies, a group of concerned citizens began questioning the increasing pollution and nuclear energy. 'In the eyes of the Danish people, nuclear power was so intimately linked with physics and chemistry that the representatives of these sciences suddenly founded themselves in the harsh and hostile spotlight' (p. 395). In 'From private philanthropy to public funding' one learns that during the inter-war period a number of well-equipped laboratories were built because to 'the Danish scientific community's ability to attract capital from domestic and foreign foundations . . ' (p. 399). After the war various organizations like the Danish State Research Foundation, the Danish Technical Research Council and the Atomic Energy Commission were established. The chapter also underlines the changes in the research system and its management. For instance, 'Previously, the initiatives had issued from the scientists themselves, but now more than ever before, politicians and civil servants were beginning to set the agenda' (p. 421). The chapter 'Peaks in Danish university

research' shows that during the inter-war period theoretical physics, physical chemistry and experimental physiology were cultivated. Between 1920 and 1943 four Danes won the Nobel prizes. Which factors were responsible for the golden age? They are discussed under: 'Factors contributing to Denmark's scientific golden age during the inter-war years' (pp. 440–447). Further, we see that after the World War II, theoretical physics and physiology maintained their high status, but not so physical chemistry. It was mainly because the influential chemists of the inter-war years never succeeded in establishing a research school for the new generation. However, Denmark started dominating in a new field as shown in the section on 'Ice-core research – a new Danish peak'. Willi Dansgaard invented a method to show that ice core gives evidence of climate change. He proved that the 'violent climate change can take place – even without the influence of humankind' (p. 456). The chapter 'Scientific exploration and big science' is on the expeditions in the 20th century. Danish Galathea Deep-Sea Expedition was meant to conduct scientific research and to 'increase the world's awareness of what Denmark had to offer, culturally and commercially' (p. 466). It was also meant to bring scientists closer to the 'man on the street' – whom Hakon Mielche (a journalist and one of the organizers of the expedition) said had no interest in science, 'finding Tarzan more amusing than Einstein, and seeing Superman as far more advanced than Niels Bohr' (p. 468). Under the subtitle 'A little country in a world of big science' Denmark's participation in CERN is explored. It is observed that at the initial stage Niels Bohr and others were sceptical about the project, but later seeing no other alternative, they joined the party.

In chapter 'Pure and applied science outside the universities' the authors discuss the situation of basic and applied research in Denmark. For the purpose they focus on two private and one public undertakings. They conclude that 'utility oriented basic research' was central to research Denmark. A compact history of the Danish Nuclear programme is also presented wherein the reader learns that Reactor Department was not successful, but Electronics, Metallurgy and Accelerator Departments survived as the policy of their heads was 'basic research will always make you smarter, applied research done with no specific application in mind often turns out to be a waste of time and energy' (p. 515). In 'Science for the people' interactions between scientists and society are in the political and cultural contexts. As in the other parts of the world, after the World War I, social-democratic ideas were predominant. The Worker's Education Association brought out various volumes of the *Culture and Science* (1923–69) which was essentially for people who wished to study independently at home or in groups. In the 1950s and 1960s popular books on physics with a series of 12 'quantum books' were translated. While discussing on the interaction between the media and scientific community, it is mentioned that until the 1960s journalists were not critical. The chapter on 'The trenches in this war were dug deep when the 1970s came around' (p. 543) showed how the situation changed with issues like the student rebellion with its focus on 'critical science', environmental debate, and nuclear energy and the general pubic started imposing highly critical questions to the scientists and their role.

In the 'epilogue' conclusions and outlooks are given. Here one finds: 'The following is therefore nothing more than the personal observations of the authors when contemplating what most notably distinguishes science prior to 1970 in Denmark . . . from science in the decades approaching and entering the new millennium' (p. 545). It shows the modesty of the authors. A careful reading of the book leaves no doubt that they are able to maintain objectivity. The authors have shown that the research work of the 'individual outsiders' like Willi Dansgaard and Jens Christian Skou (inventor of sodium–potassium pump, which maintains the salt balance in the cells of living organism), were more effective than the established nuclear physics. They conclude, 'History has since shown that the linear innovation model, as this assumption is often called, did not adequately reflect the complexity of the real world. Excellent Danish basic research in the field of nuclear physics, for example, failed to engender the successful development of Danish nuclear reactors, even though the reactor physicists and engineers at the Risoe Nuclear Research Centre energetically worked towards the specific goal in the 1960s'.

In conclusion, it can be said that the present book written by renowned Danish historians offers a 1000-year history of Danish science in a compact form in its social, cultural and political context. This book is all the more interesting in that it not only explores the complicated interaction among science, scientists, media and politics, but also is an in depth study of national, international and colonial relations.

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