management' (p. 106), but does not point out that a few museums cannot, for legal and other reasons, act or wish to act in this way (would it be helpful for potential donors to know that their gifts might not permanently remain in the museum in which they are being deposited?). With honesty, Alberti talks of the costly human resources needed to get rid of unwanted objects. It is not unknown for museums, a generation or so later, to regret the actions of over-keen deaccessioners of the past. Around the beginning of the twentieth century, his own museum had a massive clear-out of material acquired fifty years earlier, material which defined the original purpose of its precursor, the Industrial Museum of Scotland.

There is a significant section in the book which concerns the way in which science museums and collections are cared for, worked on and used for particular purposes. He regrets the lack of interest by historians of science in material culture (this is another contrast to academics in fields of archaeology, natural history and fine art, where museum collections are considered vital resources). To counter statistical evidence indicating that science historians do not involve collections research, it could be pointed out that in recent years some science museums have developed successful research programmes with universities. In general, the curious public is not as interested in science collections as in collections in other fields. In the case of physical science, there is not an equivalent to the profusion of amateur natural-history, archaeological or art-history societies.

A final chapter is headed 'Campaigning with collections', in which Alberti deals with how science collections might be used politically through the medium of exhibitions. In particular he writes about climate emergency, misinformation and human rights, and clearly he wants museums to feel as sufficiently concerned as he does to support such current movements, and hence to point out past wrongs. It is fairly clear that in the examples he gives, museum objects will not play a large role amongst the photographs and printed statements that establish the arguments. In an illustration of a Deutsches Museum exhibition, Willkommen im Anthropozän (Welcome to the Anthropocene), just one object, an early tractor, is displayed amongst the heavy design work.

Alberti's written style is refreshing: examples in the 'Engaging objects' chapter are: 'A good label is poetry' (p. 167), 'They [a school party] may or may not have been listening, but they did seem to be enjoying themselves' (p. 174), 'Many even find a museum visit enjoyable' (p. 191). His book is an important stimulus for those working in science museums or considering them from the outside, and should be read by science historians who have any interest at all in material culture.

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Benjamin Johnson, *Making Ammonia: Fritz Haber, Walther Nernst, and the Nature of Scientific Discovery*

Cham: Springer Nature, 2022. Pp. xvi + 278. ISBN 978-3-030-85531-4. £44.99 (hardcover).

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Fritz Haber's legacy in the history of science is a tapestry of brilliance and controversy. His role in chemical warfare during the First World War, his staunch views on the responsibilities of

scientists in times of conflict, and his tumultuous relationship with his wife, Clara Immerwahr, have been the subject of extensive debate and analysis. Despite the contention surrounding his character and choices, Haber's scientific acumen is undeniable. In *Making Ammonia*, Benjamin Johnson delves into the complexities of Haber's major discovery, the synthesis of ammonia and its industrialization through the Haber–Bosch process – a breakthrough that had profound implications for agriculture and the world economy.

Johnson's exploration is not confined to the technicalities of physics or a linear biography of Haber's life. Instead, he presents a layered study that intertwines the narrative of scientific discovery with broader themes of how science interacts with industrial forces and societal structures. The book is organized in three distinct parts, with the initial eight chapters painting a vivid backdrop of the multifaceted environment in which the discovery of the ammonia synthesis was realized. Johnson develops a confluence-of-factors argument according to which several different elements concur to build what he calls the 'arena of discovery'. Such an argumentative strategy is not new: Robin Gandy, for example, famously pictured Turing's epoch-making analysis of computation as a confluence of factors. In that case, however, the factors were mainly, if not exclusively, ideas. Instead, Johnson effectively shows that the discovery of ammonia synthesis was possible because of the alignment of industrial, scientific and technological developments.

The groundbreaking achievement happened between 1903 and 1908 and did not occur in isolation; on the contrary, it was the culmination of a series of developments across various fields of science. Benjamin Johnson's detailed analysis identifies three pivotal elements that set the stage for this scientific milestone. The initial element was the application of chemistry to meet the burgeoning needs of agriculture, which had become a focal point of scientific inquiry due to economic expansion and the Industrial Revolution. This period witnessed the 'scientification' of agriculture, when organic chemistry became the primary instrument of research. In the third chapter of his work, Johnson provides an insightful and concise exploration of the early theories surrounding the oxygen cycle, illustrating the intricate interplay between scientific discovery and industrial application.

The second element was the birth of physical chemistry as a distinct discipline. Midway through the nineteenth century, developments in theoretical thermodynamics propelled the emergence of this new field from the fusion of physics and chemistry. A generation of open-minded scientists, unafraid to employ complex mathematical methods to solve chemical problems, drove this fusion. Luminaries such as Van 't Hoff, Ostwald, Gibbs, Helmholtz and, notably, Walther Nernst, who is often regarded as the first true physical chemist, were instrumental in this development.

The third and final element was the unique combination of Fritz Haber's scientific acumen and his organizational prowess. Haber's genius lay not only in his ability to navigate the scientific challenges inherent in the process but also in his capacity to coordinate its industrial scaling up. His role transcended the confines of the laboratory; he was a maestro, orchestrating the various components of innovation to create a symphony of industrial and agricultural revolution. Johnson's narrative underscores the fact that Haber's success was not merely a product of individual brilliance but also of his ability to harness and direct the collective intellectual and industrial forces of his time.

In the second part of his comprehensive volume, spanning Chapters 9 to 14, Benjamin Johnson meticulously dissects the scientific journey that led to the synthesis of ammonia. Chapter 10 stands out as it weaves together the personal and professional strands of Fritz Haber's life. Johnson delves into Haber's interactions with his wife, Clara Immerwahr; his professional engagements with Wilhelm Ostwald; and his connections within the industrial sector. This chapter paints Haber as a scientist of great ambition, one who possessed an exceptional grasp of the scientific literature and the acumen to steer his research towards one of the era's most challenging and intellectually stimulating questions. Haber's fascination with the

ammonia problem was not incidental; it was rooted in his prior interest in the free energies of chemical reactions and a keen awareness of the problem's underlying importance.

Chapter 11 is particularly noteworthy for its in-depth analysis of the seminal article addressing the ammonia problem. Johnson painstakingly deconstructs the scientific arguments and calculations presented by Nernst, Haber, Jost, and Le Rossignol. Through this rigorous examination, he provides an indispensable resource for future historians of physical chemistry. Johnson's narrative not only highlights the intellectual rigour of these scientists but also underscores the intricate process of scientific discovery, where individual insight and collective endeavour converged to solve one of chemistry's great puzzles.

The third part of the volume is perhaps the most intriguing one for scholars working outside the field of the history of science. In Chapters 15 to 22, Johnson develops his theoretical framework, allusively dubbed 'the Haze'. The author makes original use of concepts from social network theory to elaborate his view of scientific discovery as a multi-actor process. Particularly interesting is the notion of brokerage, which models the transfer of ideas and their combination to produce new conceptions.

In conclusion, *Making Ammonia* is a well-written and engaging book that makes a significant contribution to our understanding of the history of the ammonia synthesis. Johnson's book is particularly strong in its exploration of the social and political context in which Fritz Haber worked and provides us with a vivid account of how cultural, technical, and social factors concur in producing a scientific discovery.

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Senthil Babu D., *Mathematics and Society: Numbers and Measures in Early Modern South India*

Oxford: Oxford University Press, 2022. Pp. 384. ISBN 978-8-19-483160-0. ₹1895.00 (hardcover).

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Senthil Babu D.'s *Mathematics and Society* studies a corpus of Tamil texts from south India, featuring among them the *Kaṇakkatikāram* tradition, to push the boundaries of what scholars have hitherto considered to be appropriate engagement with mathematics. He questions the primacy of the canonical 'Bhata-Bhaskara' tradition of Sanskrit works across the entirety of the subcontinent and instead explores a history of mathematics in early modern south India that pays attention to the practitioners who applied mathematical solutions to everyday problems. His main historiographical intervention – formulated in the introduction – is directed against the overemphasis on the Sanskrit canon and in favour of a more regionalized approach to the study of mathematical traditions. In his own words, he is interested in 'a regional epistemology of numerical practice' (p. 24), which he pursues by looking at different traditions of texts that discuss mathematical problems. A wide variety of sources support this approach, which aims to understand mathematical practices in their social contexts and cultural transmissions, among them Tamil books of arithmetical tables such as the *Eṇcuvaṭi* and account books written on palm leaves.