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EDITORIAL

Year of the periodic table: Mendeleev and the others

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Abstract
On the occasion of the Year of the Periodic Table of the Elements, the authors look back at the original discovery, its simultaneity and the difficulties of the discoverers in their own countries, the missing Nobel recognition for this discovery, and the abundance of memorials honoring Mendeleev in Russia and elsewhere.

Keywords Periodic table · Dmitry Mendeleev · John Newlands · Lothar Meyer · Stanislao Cannizzaro

Introduction

The General Assembly of the United Nations has proclaimed 2019 as the International Year of the Periodic Table of the Elements (Fig. 1). Similarly, 2011 was the Year of Chemistry and 2014 the Year of Crystallography. There is no exclusiveness, and several other designations may be proclaimed for a given year. Nonetheless, it is remarkable that, within a single decade, three times topics that belong to the scope of Structural Chemistry have been declared to be the subjects of International Years.

The year 2019 marks the 150th anniversary of the birth of Dmitry I. Mendeleev's (1834–1907) first periodic table. The date of its first compilation is considered to be February 17, 1869. However, this could not be a sudden Eureka moment and the date must refer to the compilation of an already presentable version of the table. On this day, Mendeleev sent his table to the printers and it was printed on March 1, 1869. Once Mendeleev received the printed version, he mailed copies at once to Russian and international colleagues. However, there must have been several draft versions leading to the presentable one, and such an early version is reproduced in Fig. 2 [1]. We are showing this early, hardly intelligible version to indicate how painstaking the process must have been.

Mendeleev was preparing for his general chemistry lectures and his text Foundations of Chemistry (*Osnovi Khimii*) when he made the observation of periodicity in the properties of the elements. In this he provided an example *par excellence* of how the physical chemist turned philosopher Michael Polanyi described the process of scientific discoveries. His idea was conveyed in the brief speech by Eugene P. Wigner on December 10, 1963, at the Stockholm City Hall. The occasion was Wigner's Nobel Prize in Physics. Wigner was Polanyi's doctoral student four decades before in Berlin. Wigner said, among others, "… science begins when a body of phenomena is available which shows some coherence and regularities, that science consists in assimilating these regularities and in creating concepts which permit expressing these regularities in a natural way" [2]. Mendeleev noted the regularities and the coherence even though his observations were based on the atomic masses (rather than the then yet not known quantities of the atomic numbers) and even though some of these atomic masses needed to be corrected eventually.

From the start, Mendeleev recognized the importance of making his discovery known internationally. Another crucial feature of his achievements was that he made predictions of not yet known elements on the basis of his observations of coherence and regularities. Eventually, his predictions proved to be correct. Not only did he mail his table to colleagues in Western Europe, in 1871, he visited chemistry hubs in order to inform his colleagues first hand about his periodic table. During these months and years he kept improving his table.

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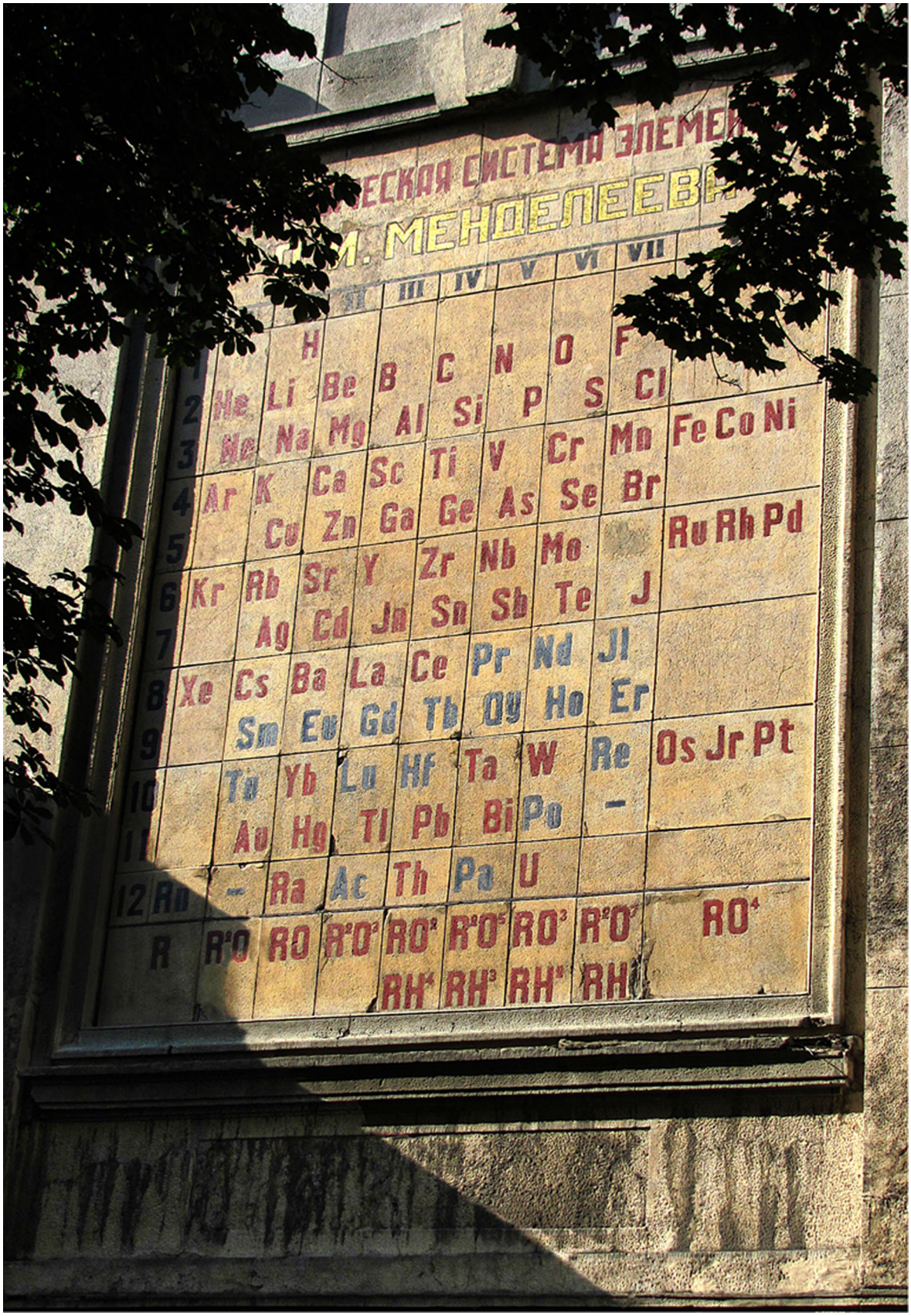

Fig. 1 Mendeleev's Periodic Table of the Elements as mural on the façade of the Mendeleev Institute of Metrology in Saint Petersburg (photograph by Magdolna Hargittai; reproduced by permission)

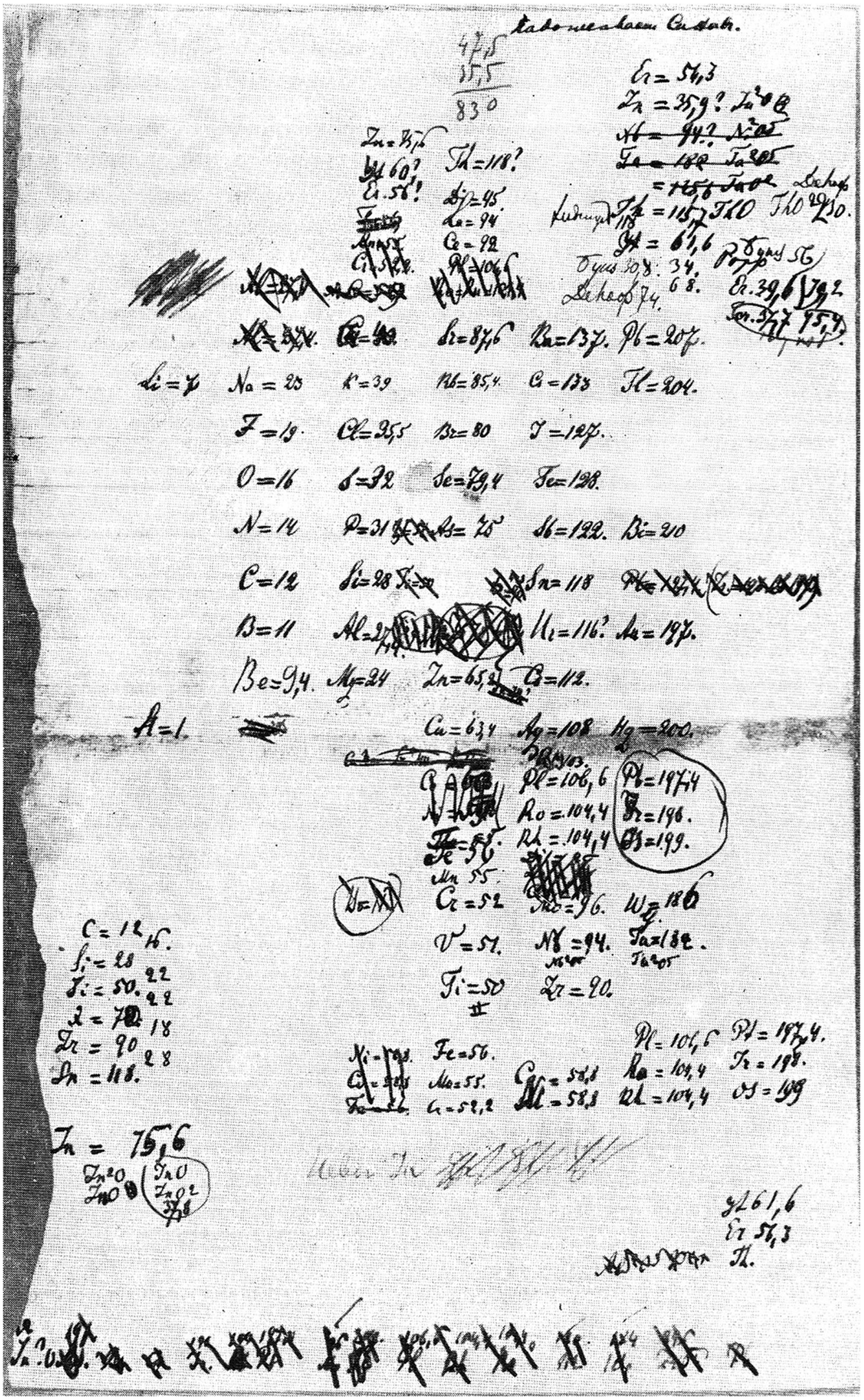

Fig. 2 Facsimile of an early version of Mendeleev's Periodic Table of the Elements [1]

Simultaneity of the discovery

As it often happens with significant discoveries for which the time had become ripe, several scientists more or less about the same time came to the conclusion of periodicity in the system of the chemical elements. The best known of them were Lothar J. Meyer (1830–1895) in Germany and John A.R. Newlands (1837–1898) in England. Newlands did not fare well in his home territory and he did not expose his discovery internationally. When he revealed his observation of periodicity in the properties of the elements, some of his colleagues ridiculed him—it was so alien to them to absorb his revolutionary idea. Someone even asked him whether he had tried to classify the elements according to the initial letters of their names. Newlands also made predictions for elements not yet known, but his ideas did not meet interest or approval. His accounts reflect his justified bitterness [3].

The professional environment of Newlands in England did not embrace his discovery whereas it welcomed that of Meyer's and Mendeleev's. They were awarded jointly the prestigious Davy Medal of the Royal Society (London) in 1882 "For their discovery of the periodic relations of the atomic weights." A few years later, in 1887, Newlands also received this distinction "For his discovery of the periodic law of the chemical elements." Then, in 1905, Mendeleev received the highest award of the Royal Society, the Copley Medal "For his contributions to chemical and physical science." Mendeleev was elected a foreign member to the Royal Society, the National Academy of Sciences of the U.S.A., and the Royal Swedish Academy of Sciences.

No *prophet* in his own country

Considering the milestone significance of the discovery of the Periodic Table of the Elements, there is scarce remembrance of Newlands and Lothar Meyer. Newlands has a blue plaque in London, on the façade of the building at 19 West Square. Its text is "J.A.R. Newlands, 1837–1898, chemist and discoverer of the Periodic Law for the chemical elements, was born and raised here." It was erected by the Royal Society of Chemistry. Meyer's birthplace, Varel, Germany, remembers him with a plaque and with a memorial consisting of three columns with the sculpted heads of Meyer, Mendeleev, and Cannizzaro. The Italian chemist Stanislao Cannizzaro (1826–1910) made seminal contribution to the discovery of the Periodic Table providing the most accurate atomic weights at the time. The Royal Society awarded him the Copley Medal in 1891 "for his contributions to chemical philosophy especially for his application of Avogadro's theory." He has a memorial plaque at the headquarters of the University of Genoa (Palazzo Balbi, 5 Via Balbi) and a bas relief at the old site of the University of Palermo (172 Via Maqueda).

Mendeleev was not spoiled by recognition in Russia during his lifetime. He became a professor at the Saint Petersburg Institute of Technology in 1864 and the Saint Petersburg State University in 1865. Subsequently, however, he lost his professorships ostensibly because of his support of the student movements aiming at improving their conditions of life and studies. For the last period of his life he continued as Controller of the Board for Weights and Measurement, which then evolved into today's Mendeleev Institute of Metrology. He was elected a corresponding member of the Russian Academy of Sciences in 1877, but in 1880, he was voted down when his full membership was being decided. This happened in spite of his international fame and his having made Saint Petersburg and international hub of chemistry. Ostensibly, the controversy of his second marriage, which took place some time before his divorce from his first wife, contributed to his negative treatment by the Academy. This was a conspicuous humiliation as the full membership is so much more important than being a corresponding member in the two-tier system of the Russian Academy of Sciences.

Missing Nobel Prize

Mendeleev was nominated for the Nobel Prize in Chemistry in 1905, 1906, and 1907. None of the nominators were from among Mendeleev's colleagues in Russia. Although the Nobel Prize is supposed to be awarded for recent discoveries, it was argued successfully that the Periodic Table of the Elements gained added significance recently. One of the most telling examples of the continuing timeliness of Mendeleev's discovery was how easily the newly discovered inert (today, noble) gases could be accommodated in the Periodic Table. In 1905, the top nominees were the German organic chemist Adolf von Baeyer and the French inorganic chemist Henri Moissan in addition to Mendeleev and the prize was awarded to von Baeyer. In 1906, the Nobel Committee of Chemistry recommended Mendeleev for the prize to the general meeting of the prize-awarding body, the Royal Swedish Academy of Sciences. The vote in the committee was by a 4:1 majority. The single dissent vote went for Moissan. The dissenting member of the committee, Peter Klason, argued forcefully for Moisson. At the same time, he did not belittle Mendeleev's achievement, but stressed that without Cannizzaro's accurate atomic weights the discovery of the Periodic Table could not have happened. He suggested Cannizzaro's recognition along with Medeleev's. This was a reasonable stipulation, but the inclusion of Cannizzaro was

not possible in 1906 because only those for whom nominations had been made by January 31 could be considered. Cannizzaro was not among the nominees in 1906. According to the decision by the Royal Swedish Academy, in 1906, the prize went to Moisson. In 1907, both Mendeleev and Cannizzaro were among the nominees, but Mendeleev died early in the year and the rules of the Nobel Prize exclude posthumous awards.

Mendeleev's missing Nobel Prize is one of the most conspicuous omissions in the roster of Nobel laureates. Given Mendeleev's milestone contribution to science, his subsequent fame, and the fact that his Periodic Table of the Elements hangs in classrooms all over the world wherever chemistry is taught, his name is above all worldly recognitions. It is the institution of the Nobel Prize that suffers from his absence from among its awardees. As the Academie Française wrote

Fig. 3 Dmitry I. Mendeleev on the façade of the former ICI headquarters, 9 Millbank, SW1, London (photographs by Magdolna Hargittai; reproduced by permission)

Fig. 4 Mendeleev's statue by Matvei G. Manizer and Elena A. Yanson-Manizer in one of the two entrance lobbies of the Ceremonial Hall of the Tower of the Lomonosov Moscow State University (photograph by Istvan Hargittai; reproduced by permission)

of Molière (attributed to Bernard-Joseph Saurin), who was never elected to its membership, "Rien ne manque à sa gloire, il manquait à la nôtre" (Nothing was missing from his glory; ours lacked only him).

Mendeleev remembered

There is a full figure Mendeleev statue in his birthplace Tobolsk. Not far from Tobolsk, there is a Mendeleyevo, one of several localities in Russia named after him. There are stamps with Mendeleev's portrait and his periodic table in Russia and internationally, as well as statues, busts, and memorial plaques (see some in [4, 5]). Here we display two memorials that are less known than some others. One is at the former headquarters of the Imperial Chemical Industries (ICI) in London. There is a giant niche at the center of the fifth level of the main facade of the building facing the western bridgehead of the Lambeth Bridge over the Themse. This niche is dedicated to Mendeleev with his portrait carved into the keystone (Fig. 3). The other sides of the building commemorate other greats of chemistry and chemical industry. The other memorial we show here is Mendeleev's full figure statue in the Tower of the Moscow State University [6]. As entrance into the Tower is by permit only, this statue is not very well known (Fig. 4).

Apart from his ubiquitus periodic tables, Mendeleev's name is immortalized by Element 101, Mendelevium, Md.

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