History and Philosophy of Science
История и философия на науката

CARL FRIEDRIECH RAMMELSBERG AND THE EARLY DIFFUSION OF THE PERIODIC TABLE OF DMITRI MENDELEEV

Pierre-Léonard Zaffalon

Abstract When Dmitri Mendeleev (1834 – 1907) proposed his periodic law in 1869 on a pedagogical purpose, few teachers were enthusiastic. However, as early as 1873, a manual of chemistry already reproduced his periodic table. A renowned German chemist wrote it: Carl Friedrich Rammelsberg (1813 – 1899). With the exception of the chemists involved in the classification of the elements, he was, as far as we know, the first to present the periodic table of Mendeleev in a textbook.

Keywords: Mendeleev, Rammelsberg, textbook, periodic table

The origins of the periodic table of Dmitri Mendeleev (1834 – 1907) were pedagogical: as a professor at the St-Petersburg University, he proposed the periodic law while writing a textbook on the arrangement of elements (Kaji, 2003; Scerri, 2007).

In 2015, a review of the influence of the periodic table on chemical textbooks was published in *Early Responses to the Periodic System*. Gisela Boeck studied the impact of the ideas of Dmitri Mendeleev in Germany and according to her, the first person (excluding the discoverers of the periodic system like Mendeleev or Lothar Meyer (1830 – 1895)) to have included the ideas of the periodic system in a German manual of chemistry was Professor Victor von Richter (1841 – 1891) in 1875 (Boeck, 2015). Santiago Alvarez *et al.* had previously cited the *Lehrbuch der anorganischen Chemie* of Eugen von Gorup-Besanez (1817 – 1878) as the first textbook referencing the periodic law (Von Gorup-Besanez, 1873; Alvarez et al., 2008). However, von Gorup-Besanez wrote only about periodic series and he didn't cite Mendeleev neither he reproduced his periodic table (Brush, 1996). In an earlier review of Western manuals, Stephen G. Brush had reported the 1874 *Grundriss der Chemie gemäss den neueren Ansichten* of Carl Friedrich Rammelsberg as an example of a very early citation (Brush, 1996; Rammelsberg, 1874).

In fact, the 1873 version of the book of Rammelsberg already mentioned Mendeleev and even reproduced the periodic table (Rammelsberg, 1873) (Fig. 1). It was no coincidence that Rammelsberg had presented Mendeleev. His interest for his periodic system dated back to 1872.

ihren Atg. stehen, und dass diese Beziehungen die Form einer periodischen Funktion haben (das periodische Gesetz). Er ordnet die Elemente demgemäss in 12 Reihen und 8 Gruppen, und giebt die beifolgende Tabelle*), in welcher ? vor dem Symbol andeutet, dass die Stellung, nach der Zahl, dass das Atg. unsicher sei.

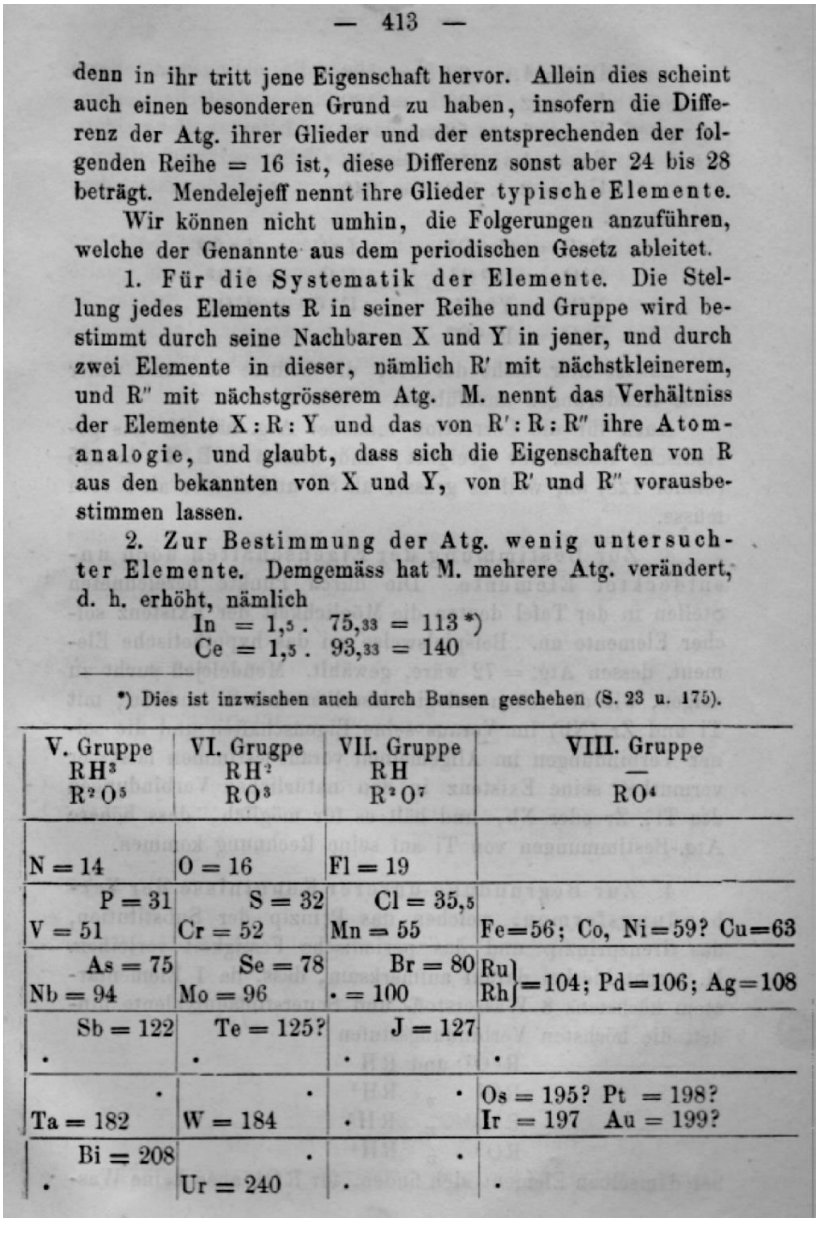
Wir gehen nicht in Einzelnheiten ein, um jene Beziehungen klar zu machen, und beschränken uns darauf, die zweite und dritte Reihe hervorzuheben, in welchen sich, bei arithmetischer Progression der Atg., der Charakter der Elemente mit der Zunahme jener in beiden Reihen gleichartig ändert, so dass analog sind: Li = Na, Be = Mg, B = Al, C = Si, N = P, O = S, Fl = Cl.

Die Glieder der paaren Reihen, und ebenso die der unpaaren Reihen, haben unter sich mehr Analogie, als die der paaren und der unpaaren.

Die Glieder der paaren Reihen liefern keine flüchtigen Verbindungen mit Wasserstoff und mit organischen Radikalen. Die zweite Reihe jedoch hat einen besonderen Charakter,

*) Ein Theil dieser Beziehungen ist schon aus der Tabelle S. 22 u. 23 ersichtlich.

Reihe	I. Gruppe $\frac{}{R^2O}$	II. Gruppe $\frac{}{RO}$	III. Gruppe $\frac{}{R^2O^3}$	IV. Gruppe $\frac{RH^4}{RO^2}$
1	H = 1			
2	Li = 7	Be = 9,4	B = 11	C = 12
3	Na = 23	Mg = 24	Al = 27,3	Si = 28
4	K = 39	Ca = 40	· = 44	Ti = 48?
5	(Cu = 63)	Zn = 65	· = 68	· = 72
6	Rb = 85	Sr = 87	?Y = 88?	Zr = 90
7	(Ag = 108)	Cd = 112	In = 113	Sn = 118
8	Cs = 133	Ba = 137	?Di = 138?	?Ce = 140?
9	(·)	·	·	·
10	·	·	?Er = 178?	?La = 180?
11	) Au = 199)	Hg = 200	Tl = 204	Pb = 207
12	·	·	·	Th = 231



— 413 —

denn in ihr tritt jene Eigenschaft hervor. Allein dies scheint auch einen besonderen Grund zu haben, insofern die Differenz der Atg. ihrer Glieder und der entsprechenden der folgenden Reihe = 16 ist, diese Differenz sonst aber 24 bis 28 beträgt. Mendelejeff nennt ihre Glieder typische Elemente.

Wir können nicht umhin, die Folgerungen anzuführen, welche der Genannte aus dem periodischen Gesetz ableitet.

1. Für die Systematik der Elemente. Die Stellung jedes Elements R in seiner Reihe und Gruppe wird bestimmt durch seine Nachbaren X und Y in jener, und durch zwei Elemente in dieser, nämlich R′ mit nächstkleinerem, und R″ mit nächstgrösserem Atg. M. nennt das Verhältniss der Elemente X : R : Y und das von R′ : R : R″ ihre Atomanalogie, und glaubt, dass sich die Eigenschaften von R aus den bekannten von X und Y, von R′ und R″ vorausbestimmen lassen.

2. Zur Bestimmung der Atg. wenig untersuchter Elemente. Demgemäss hat M. mehrere Atg. verändert, d. h. erhöht, nämlich

In = 1,5 . 75,33 = 113 *)
Ce = 1,5 . 93,33 = 140

*) Dies ist inzwischen auch durch Bunsen geschehen (S. 23 u. 175).

V. Gruppe RH^3 R^2O^5	VI. Grugpe RH^2 RO^3	VII. Gruppe RH R^2O^7	VIII. Gruppe — RO^4
N = 14	O = 16	Fl = 19	
P = 31	S = 32	Cl = 35,5	
V = 51	Cr = 52	Mn = 55	Fe=56; Co, Ni=59? Cu=63
As = 75	Se = 78	Br = 80	Ru, Rh = 104; Pd=106; Ag=108
Nb = 94	Mo = 96	· = 100	
Sb = 122	Te = 125?	J = 127	·
·	·	·	
·	·	·	Os = 195? Pt = 198?
Ta = 182	W = 184	·	Ir = 197 Au = 199?
Bi = 208	·	·	
·	Ur = 240	·	·

Fig. 1. Reproduction of the periodic table presented in the textbook of Rammelsberg (1873): it was similar to the version published by Mendeleev (1872)

Carl Friedrich Rammelsberg (Fig. 2) was born on April 1st, 1813 in Berlin and died in the same city on December 28th, 1899. Of humble origins (his father was a small businessman), Rammelsberg was first trained as an apothecary. Encouraged by the analytical chemist Heinrich Rose (1795 – 1864), he studied chemistry, mineralogy and crystallography, even becoming an ordinary professor of mineralogy and chemistry at the University of Berlin in 1874. Among his numerous works, one can cite his studies of ammoniac compounds of bromides and iodides and his preparation of iodates and periodates. As a mineralogist and crystallographer, he established the formula of mineral silicates such as augites, feldspars or hornblendes (Miers, 1901; Bartel & Remane, 2013). His skills in inorganic chemistry made the English mineralogist Henry Alexander Miers (1858 – 1942) said in 1901 that "*there were few men in Europe between 1840 and 1870 whose practical knowledge of chemistry and crystallography was sufficient to achieve what was accomplished by Rammelsberg*" (Miers, 1901). Along 300 publications, he also wrote several treatises on mineral chemistry, like his famous *Handwörterbuch der chemischen Theils der Mineralogie* published in 1841 (Bartel & Remane, 2013; Anonymous, 1900). In 1845, a nickel arsenide ($NiAs_2$) mineral was named Rammelsbergite in his honor by the mineralogist Wilhelm von Haidinger (1795 – 1871) (Bartel & Remane, 2013).

Fig. 2. Carl Friedrich Rammelsberg[1)]

In the 1840s, Rammelsberg investigated the atomic weight of uranium (Rammelsberg, 1843; 1845). On the 9th of December 1872, the mineralogist presented at the meeting of the Berlin Chemical Society (whose he was the president in 1870 and 1874 (Miers, 1901)) the ideas of Mendeleev on the atomic weight of uranium published earlier in the Liebigs Annalen (Mendeleev, 1872; Rammelsberg, 1872). According to the new periodic law of Mendeleev, the mass of uranium was 240 instead of 120 (Laing & Laing, 2006; Scerri, 2007). Rammelsberg concluded "*mit Aufnahme der Zahl 240 ist das Uranatom das schwerste von allen Elementaratomen"* (with an atomic weight of 240, uranium is the heaviest element) (Rammelsberg, 1872). Although the mass was corrected to 238 in 1902 (Richards & Marigold, 1902), this sentence lasted until 1940-1941 when the team of Glenn Theodore Seaborg (1912 – 1999) synthesized plutonium ^{239}Pu (Seaborg & Wahl, 1948).

A last interesting detail: in the 1873 version (3rd edition) of his manual, Rammelsberg exposed the characteristics of uranium but kept the former atomic weight of 120 while he correctly wrote 240 in the table of Mendeleev (Rammelsberg, 1873). The preface of the 3rd edition was dated back to September 1872 for a book published in 1873. It is maybe possible that Rammelsberg hastily incorporated the table of Mendeleev without having the possibility to correct his own text. This discrepancy was corrected one year later in the 4th edition where the value of 240 was assigned to both masses (Rammelsberg, 1874).

NOTES

1.Wikipedia

REFERENCES

Alvarez, S. Sales, J. & Seco, M. (2008). On books and chemical elements. *Found. Chem.*, *10*, 79 – 100.

Anonymous (1900). Carl Friedrich Rammelsberg. *Zeit. Ang. Chem.*, *13*(2), 31 – 32.

Bartel, H.-G. & Remane, H. (2013). Mehr als unzählige Kristalle. *Nachr. Chem.*, *61*, 417 – 420.

Boeck, G. (2015). The periodic system and its influence on research and education in Germany between 1870 and 1910 (pp. 47 – 71). In: Kaji, M., Kragh, H. & Pálló, G. (Eds). *Early responses to the periodic system.* New York: Oxford University Press.

Brush, S.G. (1996). The reception of Mendeleev's periodic law in America and Britain. *Isis*, *87*, 595 – 628.

Kaji, M. (2003). Mendeleev's discovery of the periodic law: the origin and the reception. *Found. Chem.*, *5*, 189 – 214.
Laing, M. & Laing, M. (2006). Dulong and Petit's law: we should not ignore its importance. *J. Chem. Educ.*, *83*, 1499 – 1504.
Mendeleev, D. (1872). Die periodische Gesetzmässigkeit der chemischen Elemente. *Ann. Chem., Justus Liebigs*, *Suppl. 8*, 133 – 229.
Miers, H.A. (1901). Rammelsberg memorial lecture. *J. Chem. Soc. Trans.*, *79*, 1 – 43.
Rammelsberg, C. (1843). Ueber das Atomgewicht des Urans, seine Oxydationsstufen und die Salze des Uranoxyduls, *J. Prakt. Chem.*, *29*, 234 – 238.
Rammelsberg, C. (1845). Versuche, das Atomgewicht des Urans zu bestimmen. *Ann. Phys.*, *142*(9), 91 – 95.
Rammelsberg, C. (1872). Über das Atomgewicht des Urans. *Ber. Deutsch. Chem. Ges.*, *5*, 1003 – 1006.
Rammelsberg, C.F. (1873). *Grundriss der Chemie gemäss den neueren Ansichten.* Berlin: Habel.
Rammelsberg, C.F. (1874). *Grundriss der Chemie gemäss den neueren Ansichten.* Berlin: Habel.
Richards, T.W. & Merigold, B.S. (1902), A new investigation concerning the atomic weight of uranium. *Proc. Amer. Acad. Arts*, *37*(14), 365 – 395.
Scerri, E. (2007). *The periodic table. Its history and its significance*. New York: Oxford University Press.
Seaborg, G.T. & Wahl, A.C. (1948). The chemical properties of elements 94 and 93. *J. Am. Chem. Soc.*, *70*, 1128 – 1134.
Von Gorup-Besanez, E.F. (1873). *Lehrbuch der anorganischen Chemie.* Braunsweig: Vieweg.

✉ **Dr. Pierre-Léonard Zaffalon**
100, Case postale
1258 Perly
Switzerland
E-mail: pierre.zaffalon@chymia.ch

.