The atomic orbitals quantum charts into chevron form

New quantum orbitals graphical representation

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Abstract. It is proposed here to represent the quantum distribution of atomic orbitals in an unprecedented table where the quantum shells and subshells are drawn in the form of chevrons whose vertices are occupied by orbitals with the magnetic quantum number m = 0. This new representation visually shows, much better than a classic linear chart, the relationship between the number of quantum shells and the number of orbitals . Also, this new visual model can be easily used in the individual quantum depiction of the atoms represented alone or into molecules and can find its place in illustration of some two-dimensional space-time quantum theories.

1. Introduction

In the scientific quantum literature, many tables already exist describing the quantum structure of matter. Very often, these tables are represented in the same general linear form to describe the distribution of orbitals and electrons on the different quantum shells of chemical elements.

The quantum study of the genetic code [1] has was an opportunity to propose a new type of table describing the quantum organization of atoms. We will demonstrate here, after having compared it to a classical illustration, that this new concept of chart, using an innovative representation of quantum shells arranged into the form of chevrons, is more explicit in the study of chemical elements and molecular chemical structures.

2. Linear chart versus chevron form quantum chart

2.1 Classical linear quantum chart

In Figure 1 is illustrated a classical quantum table of linear form of the first three shells and the first six quantum subshells. This type of table is conventionally used in quantum scientific literature.

shells and subshells		orbitals and electrons by shells		orbitals and electrons by subshells						
1(K) n=1	*1s l=0*	1	2	1	2	•• *m=0*				
2(L) n=2	*2s l=0*	4	8	1	2	•• *m=0*				
	2p l=1			3	6	•• *m=-1*	•• *m=0*	•• *m=+1*		
3(M) n=3	*3s l=0*	9	18	1	2	•• *m=0*				
	3p l=1			3	6	•• *m=-1*	•• *m=0*	•• *m=+1*		
	3d l=2			5	10	•• *m=-2*	•• *m=-1*	•• *m=0*	•• *m=+1*	•• *m=+2*

Fig.1 Classical linear quantum chart of the first three shells and the first six subshells. See Fig.2 to comparison.

In this linear form chart, the relationship between the shell number and the orbital amount is not clear. Visually, by shell, we need to add each orbital line to understand that their sum is equal to the square power of the shell number.

- 1^{st} shell → 1 orbital = 1^2 = 1 orbital,
- 2^{nd} shell → 1 + 3 orbitals = 2^2 = 4 orbitals,
- 3^{rd} shell → 1 + 3 + 5 orbitals = 3^2 = 9 orbitals.

Note: Here it is the quantum number $m\ell$ which is subject of study. For graphic simplification, this value is simply noted *m* in demonstrations.

2.2 New chevron form quantum charts

In figure 2 is illustrated the new concept of quantum chart into chevron form. Inside this table, the different quantum shells and subshells are so presented in the form of chevrons.

At the top end of each rafter are indicated the names of the different shells and subsells; at the left end of these chevrons, the numbers of orbitals and electrons of these different shells and quantum subshells are indicated. At each chevron vertex is the orbital where the quantum number m = 0. The orbitals with positive quantum number m are progressively positioned towards the top of these chevron vertices and the orbitals with negative quantum number m are progressively positioned towards the outside left of these chevron vertices.

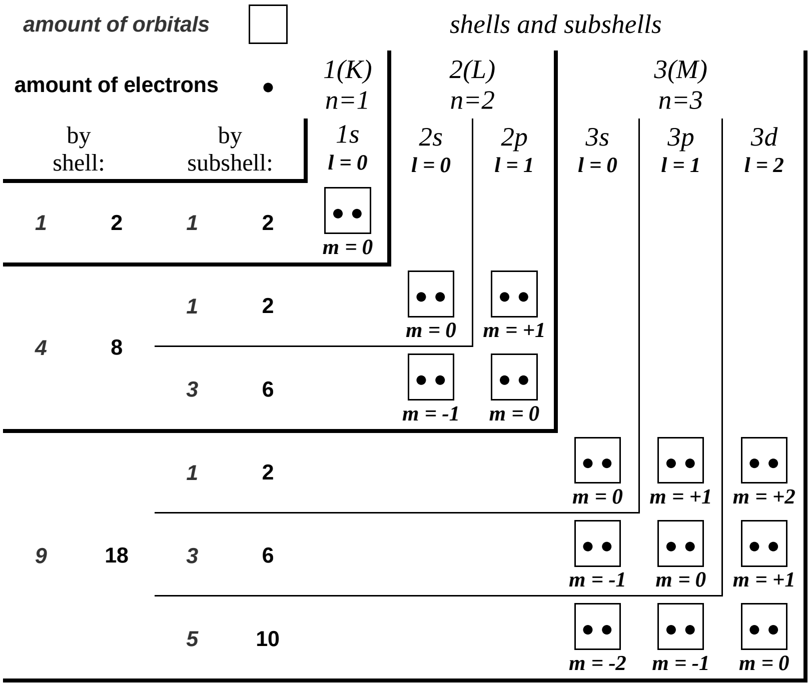

Fig. 2 New chevron form quantum chart: quantum distribution of orbitals and electrons in the first three shells and the first six subshells. See Fig.1 to comparison.

This new graphic design is more explicit in describing the quantum structure of chemical elements than any other usual linear chart. Very visually, as illustrated Figure 3, this chevron configuration clearly highlights the arithmetic progression of the orbital numbers of the different quantum shells in square powers of the level of these electronic shells.

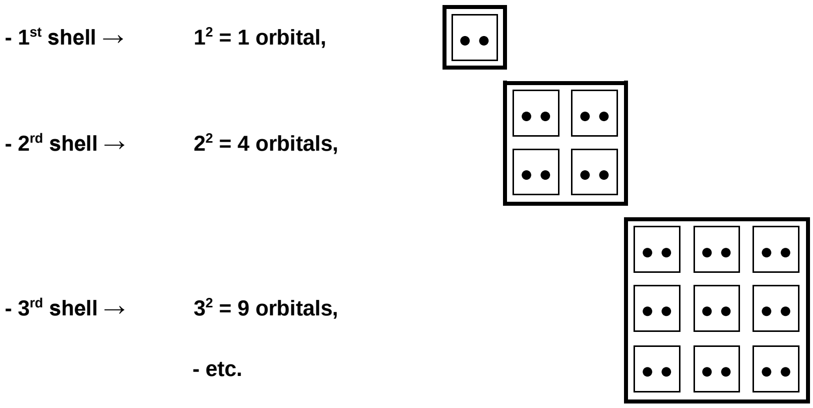

Fig. 3 Square geometric correspondences between shell quantum number and number of orbitals.

2.3 Classical versus chevron form quantum chart

Figure 4 can would be without from comment. Compared to the classic version, the chevron form version of the quantum chart brings a vision as in relief of quantum shells (See Chapter 3.1). In this new version, for each quantum shell, the orbitals appear as a compact square block whose dimension is directly proportional to the shell number (square power). Also, orbitals with the same magnetic quantum number (m) are arranged on the same diagonals. All of this is instantly visible in this chevron-shaped version, unlike the linear classic version.

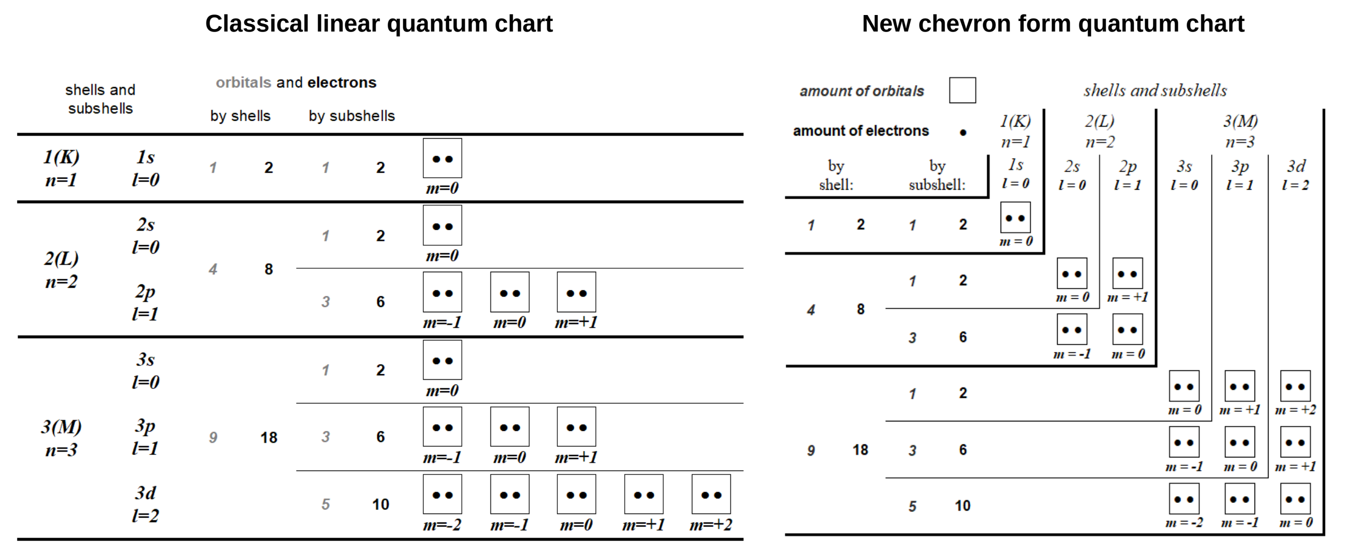

Fig. 4 Classical chart versus chevron form quantum chart.

3 General chevron form quantum chart

Figure 5 shows the chevron form quantum table of the first 15 electronic shells. This graphic concept is extensive development of that introduced in Chapter 2.1 and illustrated in Figure 2. We suggest that this new graphic type be favoured for the description of the quantum organization of the different chemical elements.

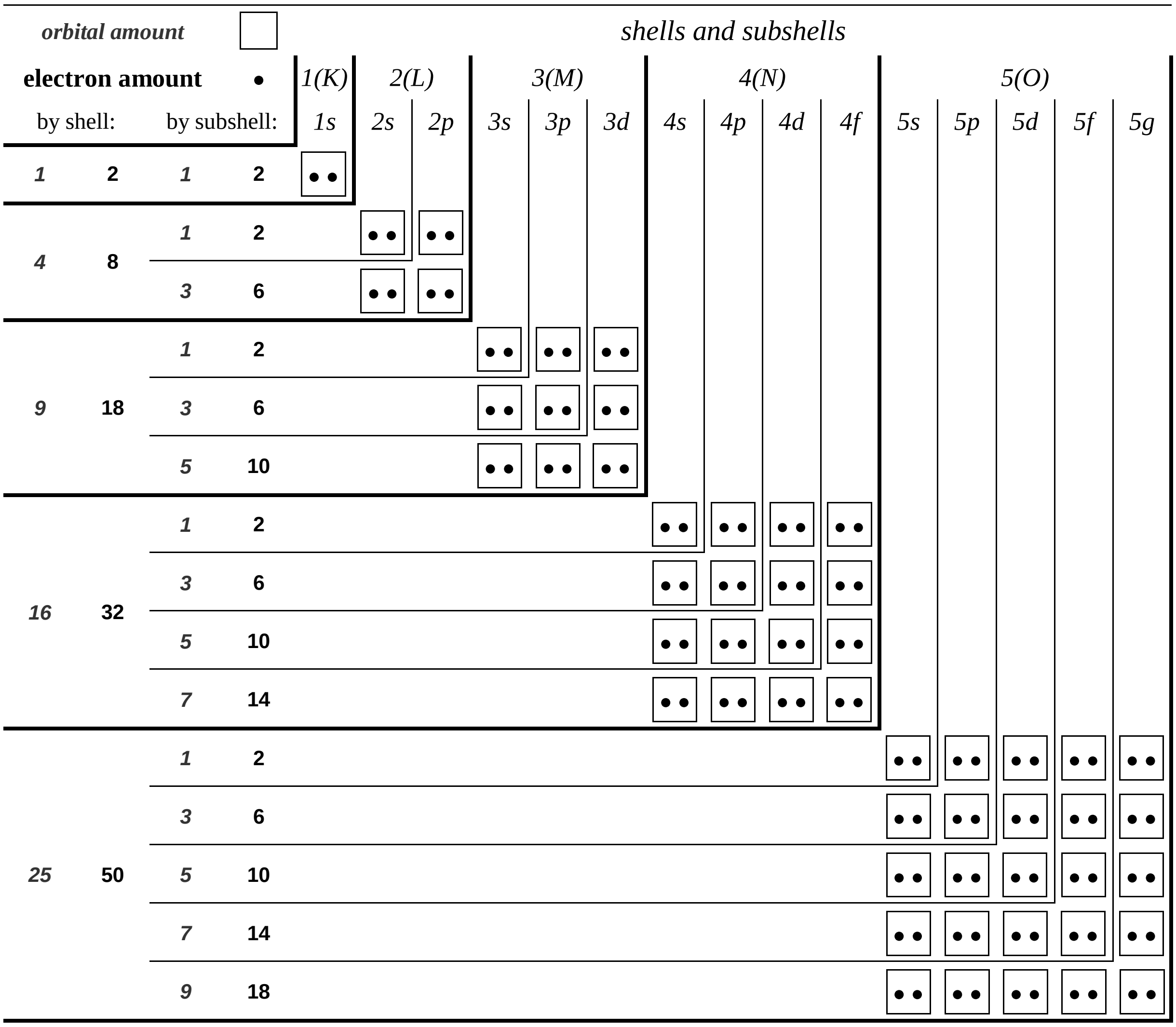

Fig. 5 General chevron form quantum chart representing the first 5 shells and first 15 quantum subshells of the chemical elements. Distribution of orbitals and electrons in these shells and subshells.

3.1 Chevron form quantum chart appellation

Although it is two-dimensional, this new type of graphics gives a three-dimensional aspect of the quantum structure of the elements. It is for this reason that the term "form" is preferred to that of "shape" in the name of this new chart concept. Nevertheless, this chevron form chart representation can find its place in illustration of some two-dimensional space-time quantum theories.

3.2 Chevron form quantum chart why electron spin

In this introduction to the new graph concept, the spin of the electron has not been detailed in order to lighten the presentation. But of course, this new chevron form quantum chart can also be represented by indicating the values of the spins as illustrated Figure 6.

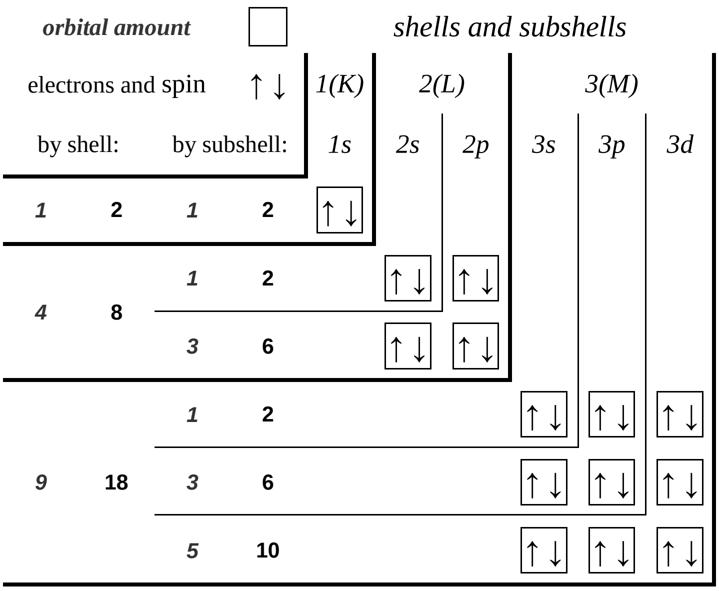

Fig. 6 New chevron form quantum chart why detail of electron spin.

The non-value presentation of spins is privileged in the following demonstrations, allowing the distinction of the own electrons from those guest in the quantum description of atoms and molecules.

4. Atoms quantum charts

In this new quantum chart concept, and more generally in the *quantum study of the chemical elements* [1], the electronic spin is so not detailed (by ascending or descending arrows). In return, it is the migratory or non-migratory nature of the electrons which is highlighted. Thus, for example, representation of the nitrogen atom and sulphur atom such as that illustrated below (Figure 7) is favoured.

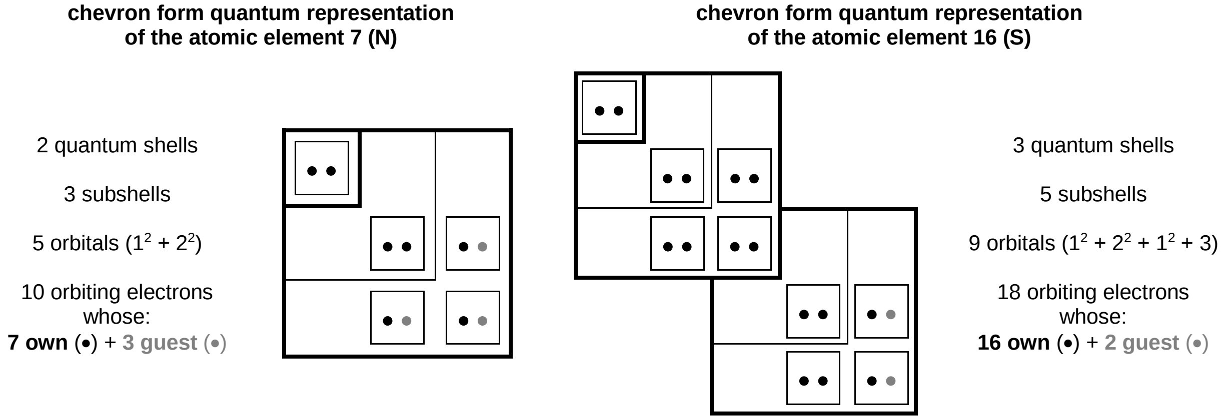

Fig. 7 Graphical quantum representation of Nitrogen and Sulphur in chevron form design (in their saturated state). See also Fig. 2 and Fig. 5.

With this new quantum chart design, the relative dimension of quantum shells and subshells is also more explicitly perceptible than in a line graph (such as the one presented in Figure 1).

4.1 The ten first chemical elements quantum chart

In Figure 8 is illustrated, in the new chevron form chart concept, the quantum structure of the first ten chemical elements. This type of table gives simultaneously, visually, a lot of quantum but also physical information, in particular a good idea of the electronic wingspan of the different chemical elements witch are represented.

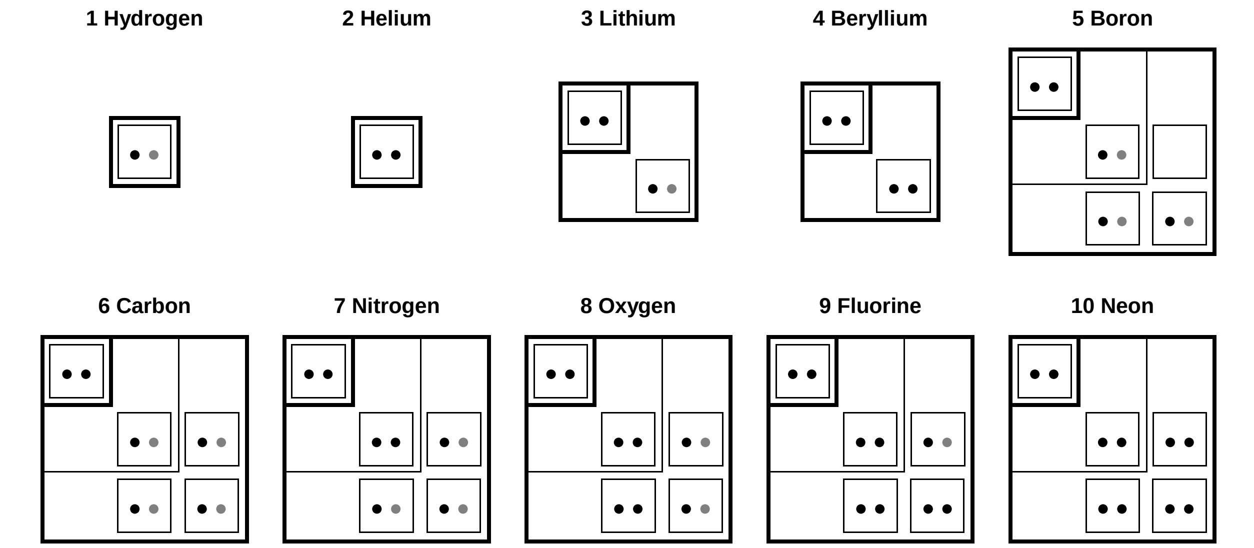

Fig. 8 Graphical quantum representation of the first ten atomic elements in chevron form design (in their saturated state). See also Fig. 2 and Fig. 5.

In this table, with this kind of graphic representation, we can clearly see the differences in electronic organization of the three groups of chemical elements isolated according to their number of quantum subshells (here 1, 2 or 3 subshells).

4.2 Atoms quantum scripting

From the concept of representation of atoms in chevron form quantum chart, we now propose a quantum writing of the chemical elements.

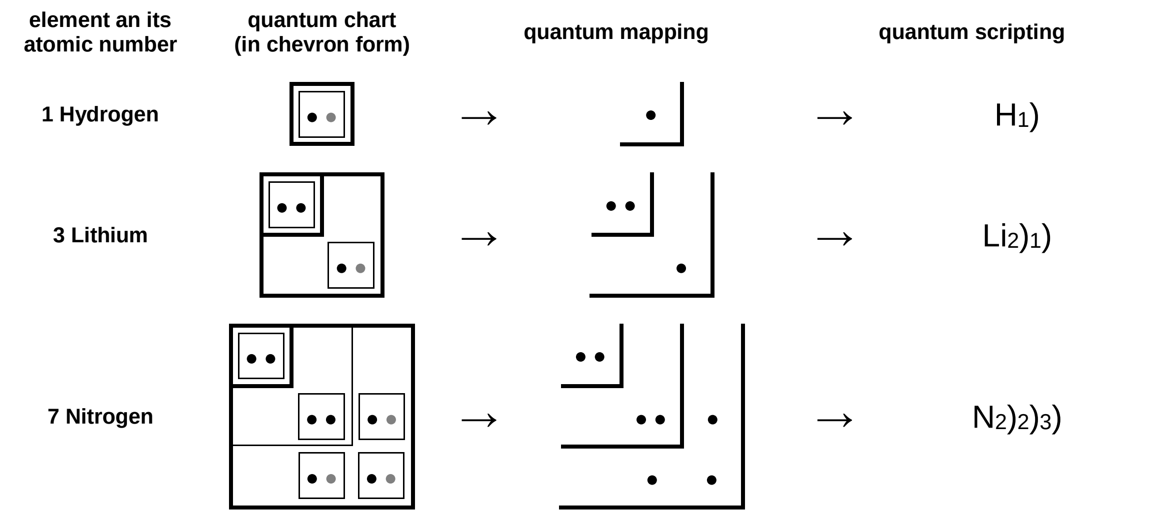

Fig. 9 Graphical scripting of chemical elements from chevron form quantum charts.

Thus, as illustrated in Figure 9, we propose for example a quantum scripting of the element nitrogen under the form:

N$_{2}$**)**$_{2}$**)**$_{3}$**)**

This type of quantum writing quickly but clearly describes the electronic structure of the element considered with the graphics parentheses separating the different subshells. This quantum scripting is more easily readable that, for example for Nitrogen, this fastidious classical script:

$$1s^2\ 2s^2\ 2p^3$$

Also, a variant of this quantum writing can be envisaged with two different sizes of parentheses distinguishing the boundaries of shells and of subshells:

$$\mathbf{N_2\big)_2)_3\big)}$$

In addition, it is possible to consider a simplified variant of this quantum writing of the elements by distinguishing only the shells alone (without showing the subshells):

$$\mathbf{N_2\big)_5\big)}$$

However, in order to clearly introduce this new concept of quantum scripting, we favour the use of the first formula with, for example, scripting $N_2)_2)_3)$ to chemical element Nitrogen.

5. Molecules quantum charts

From the atoms quantum charts in chevron form (see Figures 7 and 8), then we propose a representation of molecules under the aspect of that presented in Figure 10.

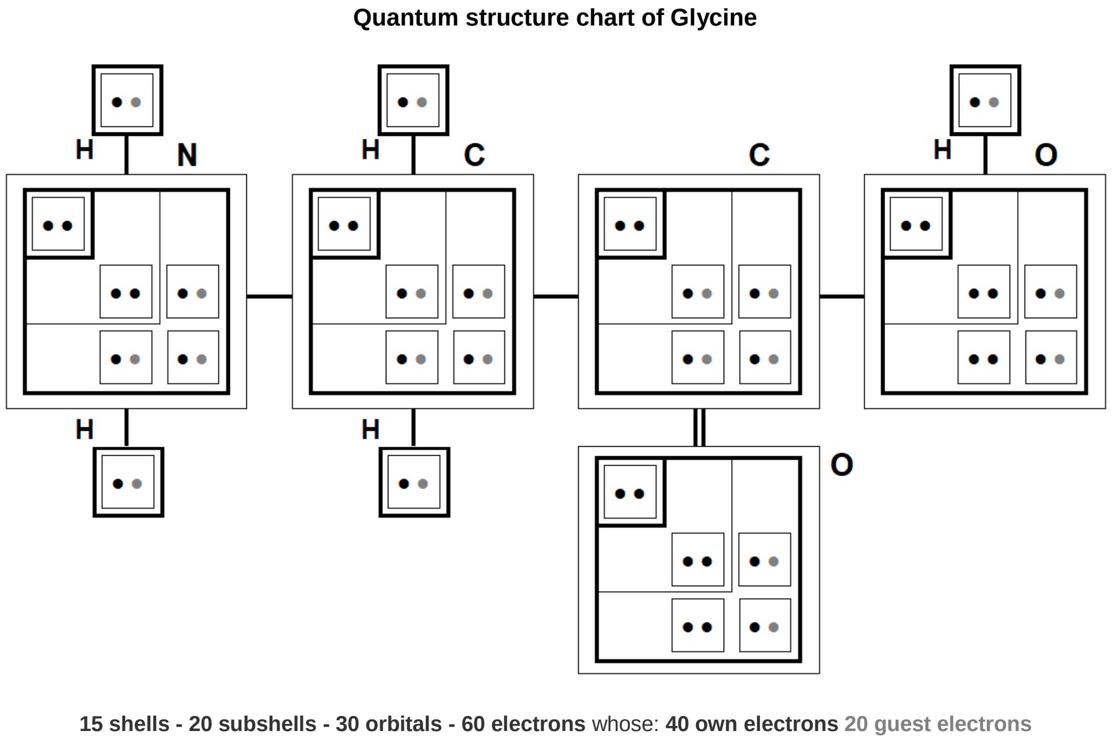

Fig. 10 Quantum structure of Glycine in a chevron form quantum chart. Own electrons (•) and guest electrons (•). See Fig. 8.

This does not represent molecular orbitals but describes the source orbitals of each atom. Again, the chevron-shaped representation of quantum shells, subshells, orbitals and electrons distributed over them appears clearer than a linear or circular representation of atoms.

6. Figurative chevron form quantum chart

In a graphic optimization of the new concept of a quantum chart into chevron form, we finally propose a figurative representation of the physico-quantum organization of the electronic shells of the different chemical elements.

This intuitive figuration illustrated in Figure 11, which is quite simply a simplified representation of the table introduced in Figure 5 Chapter 3, is therefore imposed quite naturally by the clear synthesis which emanates from its geo-arithmetic construction.

Thus, in this geometric form, the distribution of atomic orbitals appears arithmetically harmonized. Also, this image, which is very easy to memorize, can be very useful in popular articles and other quantum physics courses.

Figurative chevron form quantum chart

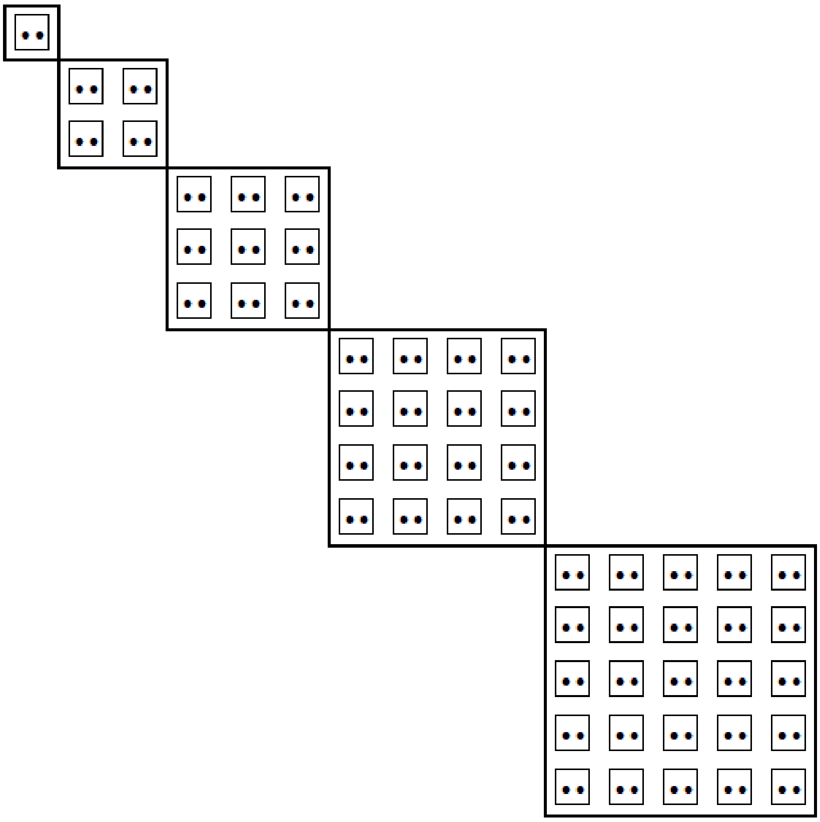

Fig. 11 In a figurative shape, general chevron form quantum chart representing the first 5 shells and first 15 quantum subshells of the chemical elements. This, as an abstract of chart in Fig.5.

7. Synthesis of proposals for graphic and quantum writing

Before the conclusion of this article, a synthesis of the proposals made as much on their graphic representation as on their mapping and quantum scripting is essential.

Figure 12 summarizes the proposals made in this paper about the graphical and quantum representations of electronic shells of chemical elements. Here are illustrated the first three shells, but of course the same representation remains valid beyond.

Thus, in summary, the quantum orbitals should no longer be represented linearly as in the left part of Figure 12 but in the form of chevrons as described in the central part.

Also, a very intuitive figurative representation (in the right part) can be deduced straight away from this new quantum chart concept into chevron form.

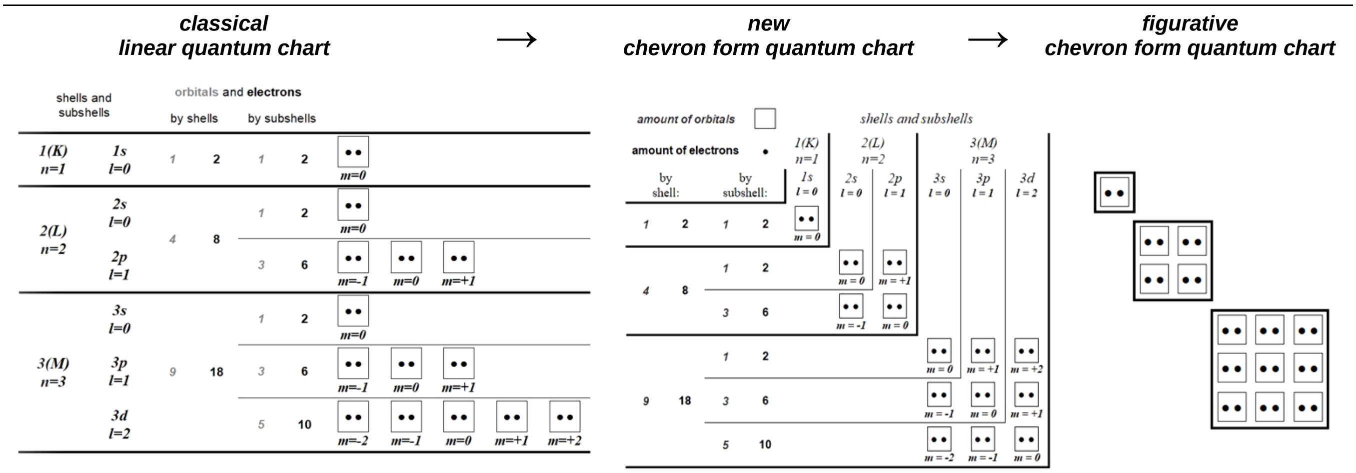

Fig. 12 Electronic quantum chart depiction of chemical elements from classical linear quantum chart to detailed chevron form quantum chart then figurative chevron form quantum chart. See Fig. 1, 2 and 11.

Finally, from the concept of representation of atoms in chevron form quantum chart, it is possible to imagine a quantum writing of the chemical elements. So a new mapping which is more explicit and faster than those of type $1s^2\ 2s^2\ 2p^3$ actually used. Figure 13 describes the realistic process of this new form of quantum writing of chemical elements with the nitrogen atom as an example.

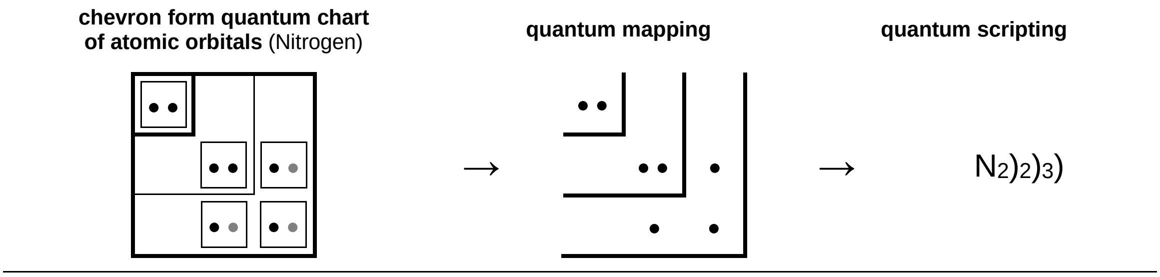

Fig. 13 Graphical scripting of chemical elements from chevron form quantum charts. See Fig. 8 and 9.

Conclusion

To illustrate the quantum composition of the various chemical elements, it is possible to represent, in a non-linear form, the distribution of the various electronic shells and subshells as well as the distribution of the orbitals which they contain.

It turns out that a graphic illustration of quantum shells representing them in the form of chevrons allows an instant viewing of the arithmetic connection operating between the number of these shells and the number of orbitals they can host.

In such representation, the groups of orbitals indeed appear in the form of a square structure whose size of the sides is directly proportional to the number of the shells, i.e. to the principal quantum number *n*.

Also, this new chart design is more explicit in describing the quantum structure of chemical elements and molecules they can form than any other usual linear depiction.

For these reasons, we suggest that this graphics be privileged in the study and quantum descriptions of chemical elements (atoms) and molecules. Also, we propose the name of ***"chevron form quantum charts"*** to name this new physical graphic concept.

Intuitively, we think that this type of representation can reflect a true two-dimensional and quantum organization of the electronic clouds orbiting around atomic nuclei.

The fact that this new representation reflects a real arithmetic organization od matter in the form of square powers reinforces our beliefs that the graphical quantum description of this matter that is proposed in this article approaches, from a certain point of view, physical reality.

References

1. Jean-Yves Boulay. Genetic code, quantum physics and the 3/2 ratio. 2020. ⟨hal-02902700⟩

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