Forum: The Philosophy of Classification

The Stowe Table as the Definitive Periodic System*†

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* I thank Professor Hjørland for inviting me to participate in this discussion. In connection with an online scientific visualization-knowledge organization effort, Project Cosmology (www.project cosmology.net), I prepared a paper (still unpublished) that he reviewed. He was particularly interested in a brief discussion of the Stowe Periodic Table, and he suggested to the editor of this journal that I elaborate. Dr. Smiraglia has kindly agreed.

† Figures 2-4 in this article employ color gradations for visualization; although the print version shows these in grayscale, the online version if *Knowledge Organization* includes the figures in full color.—Ed.

In the debate between Professors Hjørland and Scerri (Hjørland 2008 and 2011; Scerri 2011), a question is raised as to which of the many periodic tables is best. Perhaps the confusion results in part from an excessively narrow focus on atoms. To answer this question, then, it might help to broaden one's view of classification tables. With this in mind, we should first note that there are some ten major categories of particle phenomena (Table 1), and there are now classification tables for most of these, notably elementary particles, hadrons (e.g., spin 3/2 baryons, Figure 1), hadron systems (table of nuclides), galaxies (e.g., the de Vaucouleurs system, Figure 2, see Buta and Combes 1996), and, interestingly, universes (e.g., the Friedman models).

All tables, graphs, schematics and other concept presentations are purpose-related constructions

Metacluster
Galaxy systems
Galaxies
Ellipsoid Systems
Ellipsoids
Molecules
Atoms
Hadron Systems
Hadrons
Elementary Particles

Table 1. Major categories of particle phenomena. "Hadron Systems" include atomic nuclei. "Ellipsoids" is a term introduced here as a reference to stars, planets and planetary satellites. These are grouped together, since they are essentially similar phenomena; a star seems so different only because it is, so to speak, a planet so massive that gravitational pressure ignites thermonuclear reactions. Also, the typical planet is, like a star, a "gas giant" with a radiative core. These are not essentially different categories of phenomena. Notice also that other categories of phenomena have similarly striking differences. Some atoms, for

example, are highly stable, while others emit radiation. Mass differences are likewise large. "Ellipsoid systems" is a term introduced here as a reference to planetary systems, stellar clusters and binary stellar systems. The same physics equations describe all such systems. "Galaxy Systems" is primarily a reference to galaxy clusters. "Metacluster" is a descriptive reference to the expanding aggregate of galaxy clusters (observable universe). This is a more accurate term, since we do not really know that the expanding aggregate of galaxy clusters is the universe (everything physical); this common identification is, in fact, unsubstantiated speculation. It is also speculation that is coming increasingly into question. See any of the many discussions of the "multiverse" (e.g., Tegmark 2003).

Classification tables might also be useful for organic and civil phenomena (e.g., ecosystems and languages), although none seem to have been developed so far. Interactive versions of these and other tables can be seen at www.projectcosmology.net. The Periodic Table is simply the most famous of these classification tables; atoms are no more important than any other type of phenomenon. Since this forum is concerned specifically with classification, participants might find it helpful to familiarize themselves with these other tables. If we had some general knowledge of such tables, related philosophizing would be more focused.

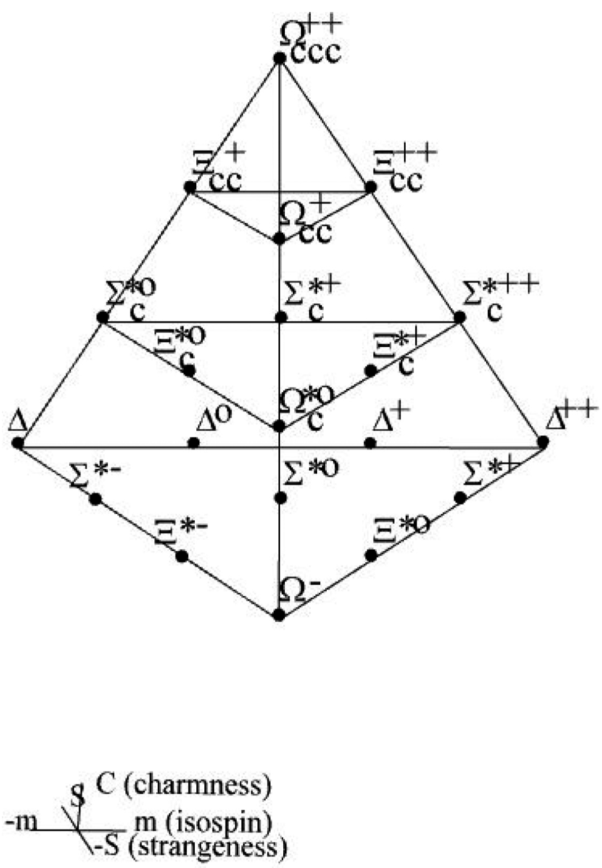

Figure 1. Spin 3/2 baryons. This is a 3D graph with charmness, strangeness and isospin as the parameters. Note the partial similarity to the Stowe table (Figure 3). A more robust table for hadrons would include spin ½ baryons as well as spin 0 and spin 1 mesons. The resemblance to the Stowe table might then be greater. See also, in this connection, Figure 2.

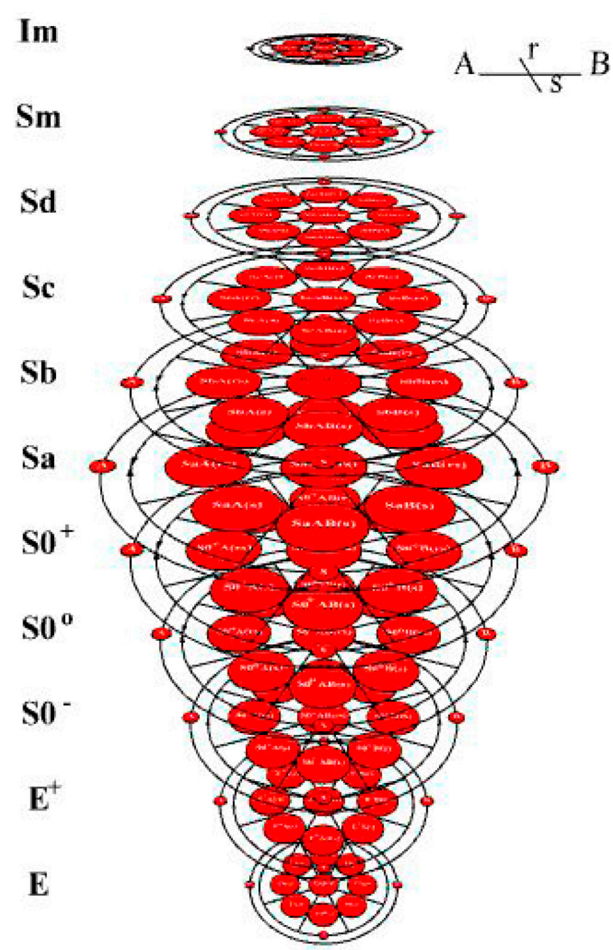

Figure 1. The de Vaucouleurs system. This table is an attempt to produce a more versatile form of simpler classification tables for galaxies (specifically the Hubble "Tuning Fork" diagram), but it is not a true 3D graph. The galaxy types (Im through E) do not represent, at present, known quantifiable parameters. Neither do the other two indexes (family and variety). This system is, nevertheless, an illustration of the greater versatility of 3D classification tables. (This table is a simulation; apparently no fully developed table actually exists.) Note the similarity to the Stowe table.

As a start, an important thing to notice about such tables is that each would be, ideally, a type of graph. Thus the Table of Nuclides has number of protons on one axis and number of neutrons on the other. Tables for hadrons, as another example, have strangeness, charmness and isospin as parameters. It is also noteworthy that, these tables would be, again ideally, interactive and three dimensional. Such tables are more versatile than their static, two-dimensional alternatives, and the computer now makes such graphs routinely feasible. The Table of Nuclides typically has half-life as a third parameter. Color is used to present this, but that does not provide a good, quantifiable representation. Two-dimensional tables have historically had precedence over three-dimensional tables, but this is simply because of limitations to the printed page. The construction of classification tables might well be an essential feature of the development of related theory for a phenomenon (as was the case for the atom), and the presence of a good table is perhaps a measure for the state of development for such theory.

At the risk of belaboring the obvious, we might further note that all tables, graphs, schematics and other concept presentations are purpose-related constructions (information presentation, the facilitation of analysis, etc.). Purposes are legitimately varied, and thus different tables would be best for different purposes. Perhaps the question itself should be recast in terms of which purpose is most fundamental, rather than which table is simply "best." This might give us the best general-purpose table. Now, if the purpose concerns something such as the printed-page display of orbital filling, then the left step table is perhaps the best, as argued by Scerri (2007). Likewise, if we wish to concern ourselves with electron configuration, then the ADOMAH or Tetrahedral Table might be best (Tsimmerman 2008). There are some one hundred different properties for atoms, and one or more tables of elements could be based (perhaps) on each of these. But this describes rather arbitrary purposes. In contrast, there would be one purpose not subject to this criticism: the intention to produce a table that reflects fundamental parameters for the elements. As Scerri, himself, states (2007, 285): "an optimal classification can be obtained by identifying the deepest and most general principles that govern the atoms." But if we want to develop the table that serves the most fundamental purpose, then this would be one that reflects basic theory relating to atoms. The parameters for our graph must then be the quantum numbers, since quantum mechanics clearly specifies these as the fundamental parameters. (Physics is the most relevant discipline to this discussion, not chemistry.) Further, we must work in 3D, since there are three primary parameters. (Color can be used for additional parameters.) If we set up the coordinate system for a 3D graph, assign the three primary quantum numbers to the axes, and plot the atoms, the result is the "Physicist's Periodic Table," as apparently developed by one Dr. Timmothy Stowe, Figure 3. And when we do this, something very interesting happens.

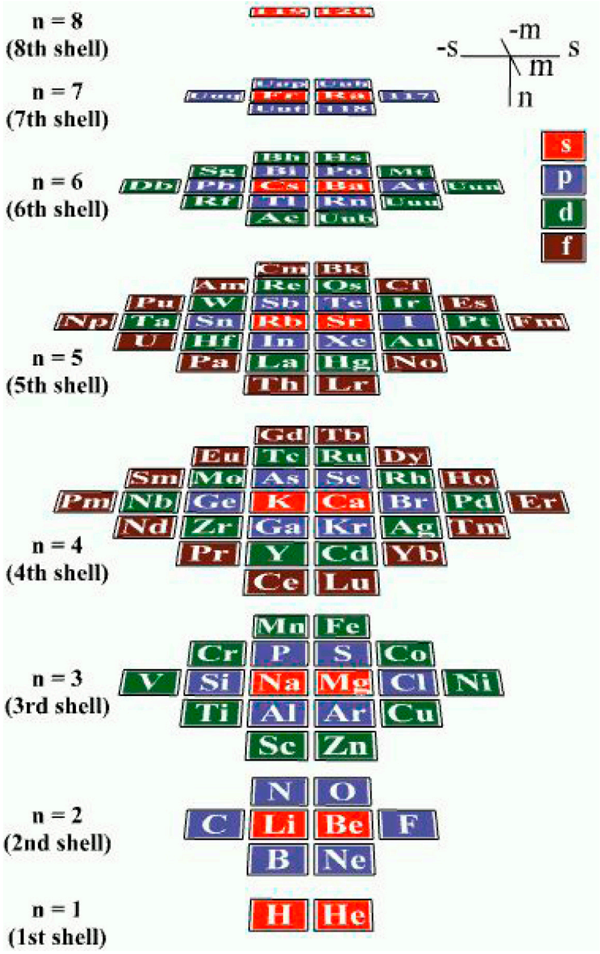

Figure 2. The Stowe Periodic Table. The parameters are the three quantum numbers, n (shell), s (spin) and m (orientation), the fundamental determinants of atomic structure and properties. Notice the perfect symmetry. All classes, groups and "blocks" fall into perfect rings, columns or levels. The 3D, interactive version (www.projectcosmology.net) provides simple, on-screen controls for manipulation and isolation of rings, columns and levels. Each individual symbol is a link to some 100 categories of data. In time, each symbol will also provide access to energy level diagrams, 3D, interactive orbital schematics, and lists of formulary for quantum mechanics. (Due to budgetary constraints, only hydrogen is fully developed at this time.)

Period \ Group #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
* Lanthanoids			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
** Actinoids			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Figure 4. The Modern Periodic Table. Source: Wikipedia (4-24-2011).

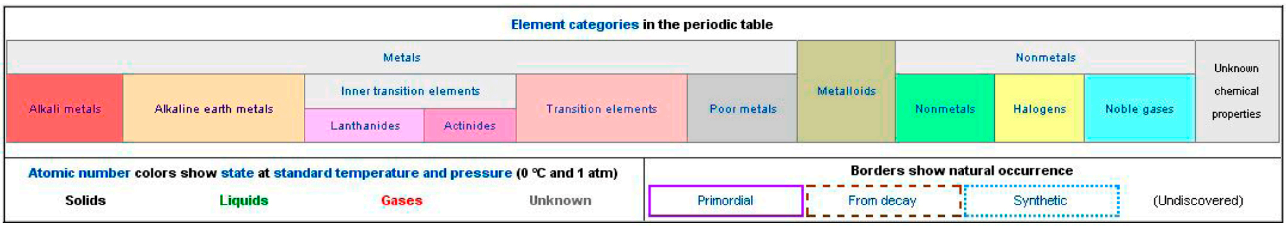

Figure 4. Guide to The Modern Periodic Table. Source: Wikipedia (4-24-2011).

Consider the Modern Periodic Table, Figure 4.

This Table is graph-like with "group" (atoms of similar properties) on the horizontal axis and "period" (same number of electron shells) on the vertical. Notice that the various standard groups of atoms (e.g., metalloids) correspond to irregular or surgically separated sections (Figure 5).

In the Stowe table, this completely disappears. Instead, the classes and shells fall into highly ordered levels, rings and columns. Notice, in particular, that the lanthanides and actinides are not cut out of their appropriate positions and inserted arbitrarily at the bottom of the table. These classes correspond to the outer-most rings of the fourth and fifth energy levels. In the Stowe table, Helium appears with the Alkaline Earth Metals, rather than the Noble gases. Thus this would appear, at first, to be a problem. But this is only from the perspective of chemistry. Physics uses the "filled shell" concept for one group, and Helium fits this perfectly. Scerri also makes this point (2007, 281). Keep in mind that physics provides the relevant theory, quantum mechanics. Notice further that in the Stowe table, hydrogen and helium effectively "float" above the rest of the Table in the manner suggested by Atkins and Kaesz (2003). (Actually, in Figure 3, hydrogen and helium "float" below the rest of the table.)

Consider, further, the representation of "blocks." In the modern table, each is a nice neat rectangle. But each rectangle has different dimensions. Nor is there any uniformity in position for the various blocks. However, in the Stowe table, the "blocks" correspond to perfectly uniform and symmetric rings. (See the color guide for the table at the web site.) The concept of period is redefined in the Stowe table, seemingly in a manner that reflects trends in a more uniform manner. Notice further that the Stowe table provides at least a crude representation of the historic development of atomic nuclei from the big bang, through stellar nucleosynthesis and on to explosive nucleosynthesis (reading upward in the table). Indeed, all of the real advantages of the modern table are duplicated or improved upon in the Stowe table. The modern table and the left step table seem to have no significant advantages, except for special purposes. These come at the expense of defeating more important purposes in a general purpose table.

The Stowe table, then, is very likely the definitive, general purpose Periodic Table. When developed in interactive 3D, symbols to the rear of the table can be brought forward by rotating the table through by 180° (using a simple, on-screen control). Atoms for particular energy levels (shell) and groups can be isolated by use of on-screen controls. Similar controls are quite feasible for blocks. The "modern" table scrambles the fundamental criteria (quantum numbers) and, as mentioned, presents shells, blocks and classes as irregular or surgically separated sections. It is little different from the one developed by Mendeleev in 1869, i.e., prior to the advent of modern atomic theory, and would be more appropriately referred to as the classical Periodic Table. It worked well for the printed page, but it is otherwise greatly inferior to the Stowe table. Note also that the modern table is not a true graph; "group" is not a quantifiable parameter. The assigned numbers are just nomenclature. Incidentally, various researchers have made sometimes repeated efforts to locate Dr. Timmothy Stowe. We find some literature mentioning Stowe's table (e.g., Ruecker and Liepert 2006; Sholten 2005), but nothing by Stowe himself. Some of us are genuinely intrigued by this little mystery. If this is indeed the definitive Periodic Table, Dr. Stowe has made an important contribution to modern science … but is seemingly nowhere to be found!

Ideal classification tables are (interactive) 3D graphs based on fundamental parameters

The Stowe table has not displaced its classical equivalent, but this is simply because it does not work well on the printed page, nor even in terms of static 3D graphics. It is a good illustration of the need for scientific visualization and knowledge organization to make the transition from the printed page to the computer. Two-dimensional, printed graphics are to their interactive, three-dimensional equivalents what the slide rule is to a calculator. The shadow of the Nook is upon us; the printed technical treatise, along with its 2D graphics, will soon be a thing of the past. All the confusion as to which is the best table arguably results from an unnoticed assumption: the expectation that the table would be on a printed page. (Another element of confusion concerns the assumption that we are talking chemistry; in fact, the relevant science is most importantly basic physics. Just as biology begins with chemistry, so chemistry begins with physics. But biology is paradigmatically concerned with organisms and chemistry is paradigmatically concerned with molecules, not atoms.)

Hjørland will have something to say relating to the Stowe table and its implications for issues concerning natural kinds, etc. This essay mostly avoids those issues, since the author has little background in the related literature. (I hope I have provided some helpful logistical support.) I will only venture to suggest that the pragmatic and traditional viewpoints are not necessarily inconsistent as concerns the atoms; if the (pragmatic) purpose for a table is nonarbitrary, i.e., to represent fundamental relations, then we might expect to find a system that carves nature "at the joints." The Stowe table seems to accomplish this. Indeed, it appears to satisfy all of the methods outlined by Hjørland (2011, 13), empiricist, rationalist, historicist and pragmatist. I would further suggest that we consider the following as a possible principle for the construction of classification tables in general:

> *Ideal classification tables are (interactive) 3D graphs based on fundamental parameters.*

I would only add one additional comment in this connection. Hjørland (2008) has argued that atomic number is not necessarily the proper criterion of natural kind for atoms. In this, I would agree; the quantum numbers provide the proper criteria.

Moving on, the Stowe table may have a certain advantage that goes well beyond those mentioned above. Let us imagine that we resolve this debate to general satisfaction and in favor of the Stowe table (and, admittedly, we have at least a little further to go). In this case, consider the symmetry of the table. Notice that this would be broken (to use physics parlance) if a ninth shell were included (elements with atomic number greater than 120). This table implies, then, on the basis of an aesthetic criterion, that there are no naturally occurring, stable elements of atomic number 121 or higher. At present, only elements up to atomic number 118 have been confirmed. The claim for the discovery of an element of atomic number 122 was made by Marinov et al. (2008), but, interestingly, that has now been discredited (Barber and De Laeter 2009; Lachner et al. 2008).

In other words, an aesthetic criterion has provided the basis for a scientific projection, in this case a negation. This may sound strange to some of us, but we should bear in mind that the theoretical use of such criteria is nothing new. Considerations of symmetry have been increasingly important in science, especially physics. Here almost all laws reflect symmetries of one kind or another. Indeed, the Nobel prize-winning physicist, Philip Warren Anderson has famously said (1972, 394) that "it is only slightly overstating the case to say that physics is the study of symmetry." Theoretical suggestions in physics are routinely assessed in terms of considerations relating to symmetry. Such considerations are also important in biology (e.g., the radial and bilateral symmetries of organisms), chemistry (molecular symmetry) and elsewhere.

Looking farther afield, Occam's razor has likewise been widely used in assessing theories, and simplicity is another aesthetic criterion. Mathematical elegance is yet another example of this. Scerri, himself, mentions the "principles of beauty and elegance" in connection with selecting among alternatives to the Periodic Table (2007, 286). What these considerations suggest is the possibility of an aesthetic calculus, a supplement to the experimental method. In the present case, this method is graphics-based. Scientific visualization, and the preparation of graphs in general, is not simply a matter of representation; it can be an analytic exercise. If we take into consideration that the development of the experimental method was the primary impetus to the explosive growth of science, the possibility of a supplemental method promises yet another such dramatic acceleration, perhaps something akin to the second industrial revolution. The philosophic community would be well advised to vigorously explore this. Consider further that philosophy is held in low esteem by many scientists; they feel that it is largely irrelevant. Here is an opportunity to change that perception. Perhaps the practitioners of knowledge organization might take the lead.

Experiments in science have been used for millennia (e.g., Eratosthenes' measurement of the Earth's circumference in 240 BC). However, it has been the more recent, conscious, professional reliance on experiments, along with various other developments, that ushered in the current, exponential growth in knowledge. Likewise, aesthetic criteria have been used for some time, but we do not yet have a clear articulation of proper procedures and, even less, a fully conscious reliance on them.

Karl Popper has famously provided us with the criterion of falsifiability. He intended this to be a replacement for the observational method, and in this he has not succeeded, but falsifiability is now all but universally accepted as an important supplement to the scientific method. However, this is serving only as a criterion of evaluation; it is not itself an analytic method. It seems that aesthetic criteria, so far, have been used exclusively for purposes of negation, and may represent the corresponding method. On the other hand, an aesthetic method may go beyond simple negation. It may allow for prediction itself. It is perhaps too early to tell (or we may be encountering a limitation to the writer's knowledge). Note also that the apparent fact of two complementary methods would suggest the possibility of even more. We need to look for these.

Nor is this something of only academic interest. As science develops, it allows us to solve practical problems. So far, this has been most notably in terms of technological solutions, largely coming out of the physical and engineering sciences. But many problems will not have purely technological solutions. The development of an enhanced scientific method will allow the civil sciences in particular (e.g., linguistics, sociology) to develop more quickly. The insights from these disciples are increasingly used in the formulation of public policy, and it is realistic to expect that an enhancement to the methods for these disciplines will improve our ability to deal with problems that have no technological solutions. Keep in mind that the criterion of falsifiability was of philosophic origin. In the consideration of an aesthetic method, philosophy has an opportunity to provide something other than intellectual stimulation.

References

Anderson, Philip. 1972. More is different. *Science* 177: 393-96.

Atkins, Peter and Kaesz, Herbert. 2003. The placement of hydrogen in the periodic system. *Chemistry international* 25(6):14. Retrieved April 24,2011 from: http://www.iupac.org/publications/ci/2003/2506/ud.html

Barber, R. C. and De Laeter, J. R. 2009. Comment on "Existence of long-lived isomeric states in naturally-occurring neutron-deficient Th isotopes". *Physical Review C* 79: 049801.

Buta, R. and Combes, F. 1996. Galactic rings. *Fundamental cosmic physics* 17: 95-281.

Hjørland, Birger. 2008. Review of *The periodic table: its story and its significance*, by Eric Scerri. *Knowledge organization* 35: 251-55.

Hjørland, Birger. 2011. The periodic table and the philosophy of classification. *Knowledge organization* 38: 9-21.

Lachner, J., Dillmann, I., Faestermann, T., Korschinek, G., Poutivtsev, M. and Rugel, G. 2008. Search for long-lived isomeric states in neutron-deficient thorium isotopes. *Physical Review C* 78: 064313.

Marinov, A.; Rodushkin, I.; Kolb, D.; Pape, A.; Kashiv, Y.; Brandt, R.; Gentry, R. V.; Miller, H. W. 2008. Evidence for a long-lived superheavy nucleus with atomic mass number A=292 and atomic number Z=~122 in natural Th. Available: http://arxiv.org/0804.3869.

Ruecker, Stan and Liepert, Susan. 2006. Taking Mendeleyev's correspondence course: interface design lessons from the periodic table of the elements. *Information design journal* 14(3). Retrieved 2011-03-17 from http://www.ualberta.ca/~sruecker/links/07_Ruecker_Mendeleyev.pdf.

Scerri, Eric. 2007. *The periodic table, its story and its significance*. Oxford: Oxford University Press.

Scerri, Eric. 2011. What is the nature of the periodic table as a classification system? *Knowledge organization* 38: 9-10, 21-23.

Sholten, Jan. 2005. *Secret lanthanides: road to independence*. Utrecht, The Netherlands: Stichting Alonnissos.

Tegmark, Max. 2003. Parallel universes. *Scientific American* 288no.5: 41-51.

Tsimmerman, Valery. 2008. Periodic law can be understood in terms of the tetrahedral sphere packing! Retrieved April 24., 2011 from: http://www.perfect periodictable.com/default.html.