Earth/matriX
SCIENCE TODAY

The Exact Fundamental Physical and Chemical Constants

A Commentary of the CODATA Recommendations

By
Charles William Johnson

Of the CODATA recommended values for the numerous fundamental physical constants of 2006, there are eleven constants which are said to be *exact* regarding their respective *relative standard of uncertainty [RSU]*. The remaining fundamental physical constants have different values listed for their relative standard uncertainty. In this essay, only those fundamental physical constants listed as *exact* in their RSU shall be examined. *[Cfr., "CODATA Recommended Values of the Fundameental Physical Constants: 2006", by Peter J. Mohr, Barry N. Taylor, and David B. Newell, published in the* ***CRC Handbook of Chemistry and Physics, 2009-2010 Edition****, Boca Raton, Florida, 2009.]*

It may be understood that the values listed as having a relative standard of uncertainty are to be considered as "recommendations". Whereas, when the RSU is deemed to be *exact*, then that could be understood to be a precise measurement and not one that is merely recommended.

Consider the eleven fundamental physical constants given as exact in their RSU in the previously cited works.

The CODATA recommended values of the fundamental constants of physics and chemistry based on the 2006 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative Standard Uncertainty [RSU]
Constant No.1.- **speed of light in vacuum**	c, c_0	**299 792 458**	m s^{-1}	(exact)
Constant No.2.- **magnetic constant**	μ_0	$4\pi \times 10^{-7}$ = **12.566370614**... x 10^{-12}	N A^{-2} N A^{-2}	(exact)
Constant No.3.- **electric constant** $1/\mu_0 c^2$	ϵ_0	**8.854187817**... x 10^{-12}	F m^{-1}	(exact)
Constant No.4.- **characteristic impedance of vacuum** $\sqrt{\mu_0/\epsilon_0} = \mu_0 c$	Z_0	**376.730313461**...	Ω	(exact)
Constant No.5.- **relative atomic mass of ^{12}C**	$A_r(^{12}C)$	**12**	-	(exact)
Constant No.6.- **molar mass constant**	M^u	**1** x 10^{-3}	kg mol^{-1}	(exact)
Constant No.7.- molar mass of ^{12}C	$M(^{12}C)$	**12** x 10^{-3}	kg mol^{-1}	(exact)
Constant No.8.- **conventional value of**				

Josephson constant	K_J-90	**483 597.9**	GHz V^{-1}	(exact)
Constant No.9.- **conventional value of von Klitzing constant**	R_K-90	**25812.807**	Ω	(exact)
Constant No.10.- **standard atmosphere**	-	**101 325**	Pa	(exact)
Constant No.11.- **atomic unit of permittivity** ($10^7 / c^2$)	$e^2/ \alpha_0 E_h$	**1.112650056**...x 10^{-10}	F m^{-1}	(exact)

The first point to mention in reviewing the CODATA constants is the fact that so many physical and chemical constants are presented with a relative standard or uncertainty. Whereas only eleven constants, as listed here, are given as *exact* in their units of measurement. I mention this because the natural or exact sciences strive to present their subject-matter as being precise and exact. The reasons why the great majority of the perceived fundamental physical constants are considered to be *inexact*, i.e., with a relative standard of uncertainty, vary. The exactness in measurement depends upon the technological capacity of human beings to measure the spacetime events being studied or treated. Therefore, over the centuries, the numerical values for the constants have themselves varied due to the increasing technological advances with which the constants may be measured.

Then, there is the theoretical question as to what represents a constant relationship within spacetime/movement, inasmuch as matter-energy exists in constant flux. A relationship or ratio of two spacetime events is itself subject to the motion inherent to those very same events being measured as they exist. Even with regard to the speed of light, scientific experiments are purportedly breaking the thresholds above and below the speed of light, drawing into question whether in fact the speed of light in a vacuum represents a limit to motion of matter-energy.

So, the concept of a physical or chemical constant depends necessarily upon the spacetime event itself as it exists in the form of matter-energy *and* the changes that it experiences throughout its existence. Furthermore, the concept depends upon the capacity for human beings to measure the event exactly and precisely. In this regard, the constant depends upon our theoretical and practical capacity to apprehend and transform spacetime events.

Without attempting to discuss fully much less resolve the previous questions, the eleven physical constants offered as being supposedly *exact* in their measurement are here examined and questioned theoretically. Within the chemical and physical sciences, historically, the cited eleven constants have been referenced so often, that from a theoretical perspective one may consider these constants to be unquestionable. However, I beg to differ. In my view, the exact sciences have become dependent upon a mathematics that employs an algebraic notation that confounds at times the very nature of the subject-matter being analyzed. The eleven exact fundamental physical constants are a case in point.

As one may view from the previous list of constants, the symbolic notation of the constants is at times quite complex. When one examines the ultimate nature of each one of the eleven fundamental constants cited, however, their nature is not as complex as they symbolic notation may suggest. Consider the numerical values of the eleven cited constants with regard to each other *and* with regard to other constants listed by the CODATA but that do not appear on the previous table.

A Commentary About

The CODATA recommended values of the fundamental constants of physics and chemistry based on the 2006 adjustment.

Quantity

Constant No.1.- speed of light in vacuum	**refers to c**	**299 792 458**
Constant No.2.- magnetic constant	**refers to 4π**	**12.566370614**....[unending value due to pi]
Constant No.3.- electric constant	**refers to 1 / 4π times c^2**	**8.854187817**... [unending value due to pi]
Constant No.4.- characteristic impedance of vacuum	**refers to 4π times c**	**376.730313461**...[unending value due to pi]

Constant No.5.- relative atomic mass of ^{12}C	**refers to 6-Carbon-12**	**12** [elemental property]
Constant No.6.- molar mass constant	**refers to unit 1.0**	**1** [fractal expression; elemental property]
Constant No.7.- molar mass of ^{12}C	**refers to 6-Carbon-12**	**12** [fractal expression, elemental property]
Constant No.8.- conventional value of Josephson constant	**refers to reciprocal of magnetic flux qunatum constant**	483 597.9 [1 / **2.067833667**]
Constant No.9.- conventional value of von Klitzing constant	**refers to <u>2 times 4π</u>**	**25812.807** [unending fractal expression due to pi]
Constant No.10.- standard atmosphere	**refers to an arbitrarily selected geographical location on Earth**	**1,013,250 dynes / m^2** [a variable value]
Constant No.11.- atomic unit of permittivity	**refers to fractal <u>$1 / c^2$</u> reciprocal of square of speed of light in a vacuum**	1.112650056... [1 / **8.987551787**]

Basically, then, constants numbers 1, 2, 3, 4, 8, 9 and 11 involve either π and/or c, in variations of multiples and reciprocals. Constants numbers 5, 6, and 7 refer to the element 6-Carbon expressed as isotope ^{12}C and a unit 1.0 derived value thereof.

The variable nature of the fundamental physical constant number 10, referring to *standard atmosphere* may even be questionable as to why this particular constant is given to be *exact.* The definition of the standard atmosphere is 1,013,250 dynes per square centimeter (101 325 Pa), at a particular location on Earth. This represents a mean atmospheric pressure at mean sea level at the latitude of Paris, France [which is obviously a city spread out over the Earth]. Hence, this particular constant falls outside of the discussion in this essay, but I have included it since this constant is given as one of the eleven *exact* fundamental constants.

In summary, constant number 3 is a variation of constants 1 and 2. Constant number 4 is a variation of constant 1 and 3, and subsequently of constants 1 and 2. Constant number 5 is fractally the same as constant number 7. Constant number 6 is fractal 1.0 unit. *[For the sake of economy, I refer only to the hereby assigned numbers of the constants and not to their names of* quantity.*]*

Constant number 8 is a reciprocal of the ***magnetic flux qua*ntum** constant, whose fractal value is 2.067833667, and which is given as inexact in the CODATA with a RSU of 2.5 x 10^{-8} . One must necessarily ask then, how could it be that constant number 8 on the list is deemed as exact when its reciprocal fractal expression in the magnetic flux quantum constant is not considered as being exact. Actually, one may note that the reciprocal of 483597.9 is fractal 2.0678336*28*, a slight difference that may explain the variation. But, I am inclined to think otherwise.

Constant number 9 is simply doubling the fractal expression of constant number 2. And, the constant number 11 is the reciprocal fractal expression of the square of the speed of light in a vacuum, i.e., constant number one.

Constant No.1.-	speed of light in vacuum	**c**	[measured value]
Constant No.2.-	magnetic constant	**4π**	[unending value]
Constant No.3.-	electric constant	**1 / 4π times c^2**	[unending value]
Constant No.4.-	characteristic impedance of vacuum	**4π times c**	[unending value]

Constant No.5.-	relative atomic mass of ^{12}C	**6-Carbon-12**	[mean value by isotopes]
Constant No.6.-	molar mass constant	**unit 1.0**	[arbitrarily assigned value]
Constant No.7.-	molar mass of ^{12}C	**6-Carbon-12**	[mean value by isotopes]
Constant No.8.-	conventional value of Josephson constant	**reciprocal of magnetic flux qunatum constant**	[unending value]
Constant No.9.-	conventional value of von Klitzing constant	**2 times 4π**	[unending value]
Constant No.10.-	standard atmosphere	**arbitrarily selected geographical location on Earth**	[variable value by latitude]
Constant No.11.-	atomic unit of permittivity	**fractal $1 / c^2$ reciprocal of square of speed of light in a vacuum**	[unending value]

Inasmuch as the value for pi [π], 3.141592654... represents an unending numerical expression, then, all of the numerical values of the constants [numbers 1, 2, 3, 4, 8, 9 and 11], that involve the term of pi, are themselves an unending expression. Solely upon this basis, one would have to question the theoretical concept of a constant whose numerical expression represents an *unknown* value, meaning whose *last-digit value* remains unknown. If one examines constant 11 from the term of the Bohr radius implied therein, then the exactness of its numerical expression may be questioned. But, if one views constant 11 as simply the reciprocal of the square of the speed of light, then its exactness may be accepted inasmuch as the exactness of the speed of light is itself so accepted. The question regarding the square of the speed of light and the significance of that particular value has been discussed in previous Earth/matriX essays *[www.earthmatrix.com]*.

The only two constants that are independent and not derived from any of the other constants on the list of exact constants are constants number 1 (c) and 2 (π). However, since pi is an unending number, the very nature of its exactness falls into question within a theoretical discussion of exactly what constitutes the concept of a constant within spacetime/motion and the different forms of matter-energy. The remaining constants, as we have seen, are derived constants as of derivaties of c and π. **Again, t**he exceptions to this statement are the constants 5, 6, and 7 which pertain to elemental properties.

Other sets of fundamental physical constants require further examination at some point: some concern reciprocal expressions, others concern the doubling/halving feature, and there are those that contain powers and root values. The Planck Units or Natural Units that contain powers/root values have already been discussed briefly in other Earth/matriX essays *[www.earthmatrix.com]*. For now, the CODATA constants that are given as being *exact* in their numerical values have been discussed in an attempt to understand the concept of *a constant* in the physical and chemical fields of science.

Earth/matriX Editions

P.O. Box 231126
New Orleans, Louisiana
70183 USA
Earth/matriX
Science Today
www.theschemata.com

Science in Ancient Artwork
www.earthmatrix.com

johnson@earthmatrix.com