Making Sense of Measurement

B. F. Riley

An account is provided of how the observer is given the values of measurements in intuition, by means of sensibility in unity with understanding. Chains of discovery show that the conceptual preferences of the observer are imprinted on the phenomenal world of the observer.

1 Introduction

In 2020 I discovered that measurement gives meaning to the world of the observer when I found that the current distances of the stars from earth take values within a discrete framework of my design despite the inconstancy of the distances [1]. I went on to find that the numerical value of any measurement in any units may be mapped by any function of the observer's choice to a rational number that lies within any infinitely-divisible discrete numerical framework designed by the observer [2, 3]; the output of the function explains the value of the input (measurement value) in the context of the wider, probabilistic, model. To explain the findings I have drawn on Kantian philosophy [3]; in this paper I elaborate on that theme, showing how the a priori concept of causation enables the observer to experience a logical world. A selection of past results, presented as chains of discovery, shows how the observer's intuitions build one on another as the observer's comprehension broadens and new concepts are conceived. Some reflections follow.

2 In the phenomenal world of the observer

2.1 A Kantian view

According to Kant [4], *phenomena* are the 'appearances' that constitute the observer's experience, while *noumena* are the 'things in themselves' that constitute reality in itself, which is unknown to the observer. Space and time are the a priori intuitions that frame the observer's experience; they are not things in themselves that are independent of the observer. The phenomenal world is constructed in the mind of the observer by the synthesis of data received through the senses from the noumenal world (reality in itself) in accordance with the a priori concepts of quantity, quality, relation (including causation) and modality (possibility, existence, necessity). Kant said, 'Objects are…given to us by means of sensibility, and it alone affords us intuitions; but they are thought through the understanding [intellect], and from it arise concepts.' Also, "The understanding is not capable of intuiting anything, and the senses are not capable of thinking anything. Only from their unification can cognition arise."

2.2 This observer's thesis

The value of a measurement is given to the observer in intuition, by means of sensibility in unity with understanding, in accordance with the a priori concept of causation.

2.3 The model

Central to the model discussed here is a concept, interpreted as a function that takes as input the numerical value of the measurement and outputs a rational number that lies within any infinitely-divisible numerical framework of the observer's design – how the output of the function can be a rational number is made clear below. The value of the output of the function explains the value of the measurement in the context of the model. For a significant (to the observer) measurement, the understanding attempts to accommodate the output of the function within the framework in a conspicuous way, to the extent that the measurement value is consistent with the phenomenal world of the observer. Integer values of the output are often found for the first measurements in a set and for the most significant measurements, which are usually the first measurements.

In 2013, building on my work on particle mass [5], I found the Bohr radius to be equal in value to $(\pi/2)^{125}\ l_{\mathrm{Planck}}$, to high precision [6]. It was the first length scale I had considered in this project. As I had initially done for particle mass scales [7], I had conceived a model in which all length scales derive directly from Planck scale through multiplication by powers of π/2. Since 2005 the base of the power had been understood to be the length relative to Planck scale of an orbifold and the exponent of the power had been understood to be a brane winding number [8]. A function *f* maps the length scale l to the exponent n of the base $\pi/2$, i.e. $f\colon l \rightarrow ln(l)/ln(\pi/2)$; $n = ln(l)/ln(\pi/2)$. The exponent n takes a value within my framework of integers, half-integers, quarter-integers etc. The exponent 125 explains the value of the Bohr radius in the context of the model, i.e. the Bohr radius is the length scale on a brane distant $125 \times \pi/2$ Planck lengths from the Planck brane. This understanding need not make sense to another observer. Powers of $\pi/2$ are very significant to this observer; they had featured in my work on particle masses since 2003 [5]. Exponents that are multiples and powers of 5 are also significant to this observer [9]; I often use these values for markers when graphing the outputs of the functions used in my models. I had judged the Bohr radius to be of special significance as a length scale; its value reflects the degree of significance.

The value of the Bohr radius had been given in intuition, by means of sensibility in unity with understanding, in accordance with the a priori concept of causation by which every effect has a preceding cause – Kant's principle of causation. The Bohr radius is in this way understood to have always had the value $(\pi/2)^{125}\ l_{\mathrm{Planck}}$ in the phenomenal world of the observer.

Many different functions and frameworks have now been utilised, e.g. see [2]. Measurements of elapsed time may be treated like any other measurements; some examples are presented in [10].

2.4 Chains of discovery

Many 'chains of discovery' may be identified within the papers I have written. As concept is built upon concept, and model upon model, more and more intuitions are reached. Two chains of discovery resulting from an uninhibited approach to conceptualisation are presented here. Planck units are used (c = G = ħ = 1). My preferred exponents (multiples and powers of 5) feature widely.

Chain 1: The small and the large

In the equations below, all exponents are highly precise. All the equations balance numerically.

2013 [7]	The Bohr radius	$a_0 = (\pi/2)^{125}$	(1)
2013 [11]	The dark energy density in terms of the Bohr radius	$\rho_\Lambda = \frac{1}{2} {a_0}^{-5}$	(2)
2015 [12]	A relationship between the radius of the observable universe and the Bohr radius	${r_{\mathrm{OU}}}^2 = 2{a_0}^5$	(3)
2017 [13]	A relationship between the radius of a nearby star and the mass of a stable nuclide	${r_*}^2 = 2{m_{\mathrm{nuc}}}^{-5}$	(4)
2018 [14]	A relationship between the radius of a nearby GK-type star and the mass of a period 4 transition metal nuclide	${r_{\mathrm{GK}}}^2 = 2{m_{\mathrm{P4}}}^{-5}$	(5)
2018 [14]	A relationship between the mass of a nearby GK-type star, the Bohr radius and the atomic radius of a period 4 transition metal nuclide	$(a_0 m_{\mathrm{GK}})^2 = 2{r_{\mathrm{P4}}}^5$	(6)
2019 [15]	The total mass/energy of the observable universe	$E_{\mathrm{OU}} = \pi^{125}$	(7)
2019 [15]	The mass of the Higgs boson in terms of the Bohr radius	$m_{\mathrm{H}} = \frac{2^{25}}{a_0}$	(8)
2020 [1]	The mass, 2.16 MeV [16], of the up quark in terms of the Bohr radius and earth's semi-major axis	$m_{\mathrm{u}} = \frac{a_0}{2A_\oplus}$	(9)

Equations (5) and (6) refer to the same pairings of star and nuclide.

Chain 2: The solar system

In the equations below, all exponents are shown to the nearest unit. All relationships between parameters are highly precise.

2018 [17]	Moment of inertia of the sun	$I_\odot = \pi^{250}$	(10)
	The Carrington sidereal rotation period of the sun (25.38 days)	$P_\odot = \pi^{100}$	(11)
	Spin angular momentum of the sun	$S_\odot = 2^{250}$	(12)
	The geometric mean orbital angular momentum of the eight planets of the solar system	$L_{\mathrm{p,mean}} = 2^{250}$	(13)
2018 [18]	Radius of the sun	$R_\odot = \mathrm{e}^{100}$	(14)
	The rotation period of the sun in terms of its radius and mass	$P_\odot = \frac{2{R_\odot}^2}{M_\odot}$	(15)
	Surface gravity of the sun – follows from (15)	$g_\odot = \frac{2}{P_\odot}$	(16)
	Central temperature of the sun	$T_{\odot,\mathrm{c}} = \pi^{-50}$	(17)
	Luminosity of the sun in terms of its radius and surface temperature	$L_\odot = 2{R_\odot}^2{T_{\odot,\mathrm{s}}}^4$	(18)

2.5 Reflections

The observer makes sense of the phenomenal world by intuiting measurement values through the use of models. In this way every object may be related in scale to something else. There are no absolute scales [19].

The model described in this paper is probabilistic by reason of its framework. Probabilities are assigned in the understanding to different outputs of the applied function, and thereby different measurement values, according to the significance to the observer of the measurement and according to personal preference, to the extent that the intuited measurement value is consistent with the phenomenal world of the observer.

The first model used to explain a small number of measurements will probably result in outputs (of the function employed) that are integers or fractions of low denomination [2] but as more measurements are considered the outputs will more probably be fractions of higher denomination and the overall utility of the model may decrease. A different and probably more complex model could then find greater utility. But because of its facility to explain what are probably the most significant measurements, the original and probably simplest model may be retained in addition to the newer model of greater scope, exemplifying a correspondence principle.

Since the commencement of this project [5] the values of pairs of related measurements, such as the masses of the hadrons constituting an isospin doublet, have resulted in numbers (outputs of the function employed) that are symmetrically arranged about 'levels' of integer or fractional value in the model framework. In such pairings the two objects whose parameters have been measured are understood to constitute a partnership and in this respect neither object has more significance than the other to the observer. Accordingly, there is no basis for the observer to intuit that either of the outputs from the function applied should be a more significant number (such as an integer) than the other (such as a fraction). A compromise is reached in the understanding of the observer and a symmetrical arrangement is observed.

This work may have implications for prediction, where the measurement value is predicted through the understanding and on observation the same value is intuited by means of sensibility in unity with understanding. Perhaps above all other considerations, for a successful outcome the observer must have a very high degree of confidence in the prediction.

One can now understand why the universe appears fine tuned for life: the values of the critical physical quantities have been intuited in the context of the phenomenal world of the observer.

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