

Something about Information

Georgina. Parry 2013

A quick look at some ideas pertaining to information such as, its definition, noise, forms and 'superposition' at the macroscopic scale, as a prelude to answering- 'It from Bit 'or 'Bit' from It'?

I for information

In "Information the new language of science" by Hans Christian von Baeyer ¹ it is explained that 'information' as used in science, and in particular information science, is different from the everyday use of the word. It is not referring to facts and figures but has something to do with communication, activity and meaning, and is an attribute that is carried. At the foundational level it is about communication of binary choices. The outcome of each simple binary choice is a 'bit' of information - The smallest amount of information that can be sent or received according to Anton Zeillinger, who said, "an elementary system carries one bit of information". A 'bit' is not a particle but an associated attribute, eg. spin or polarization. Nonetheless, there is a connection with the material world as information is carried by material structures and arrangements (forms), such as chemical structures and wave patterns.

Putting the upstart bits back in their place, Julian Barbour wrote, "A 'bit' is merely part of the huge interconnected phenomenological world that we call the universe and interpret by science; it has no meaning separated from that complex". ²

Christian von Baeyer tentatively gives the following definition: "Information is the transfer of form from one medium to another". ³

This captures the ideas of communication, activity and being carried, but not the idea of meaning or of function.

I would like to add to that definition the following; *Information is also the carried potential to direct change (function) in Object reality and carried potential meaning that may lead to manifest meaning in subjective Image reality.*

This expanded definition is not just about form and communication but also about function and meaning.

The directed change is in Object reality, because given conducive environmental conditions it happens whether observed or not. An example is the transcription of mRNA at a ribosome. Meaning is within *subjective* Image reality. Subjective, as whether something is meaningful or not depends upon the knowledge of the observer and its application in deciphering the information. A coded message may be just nonsense to one person but valuable information to another. In "Handbook of binding and memory" it says "It is assumed that in perception different features, such as colour, shape, location etc. are processed in parallel, in distributed networks. The relations between these features have to be processed by means of synchronized activity within a cell assembly, giving rise to a coherent percept." ⁶ The meaning output is formed by association of existing knowledge via working memory with object tokens. These are files of characteristics formed from sensory input. That association allows identification, familiarity or full contextual recall.

Meaningfulness can even depend upon the levels of neurotransmitters within the observer. Too much dopamine and associations are made where there should be none, giving delusional beliefs. Too little can lead to confusion derived from difficulty processing information into meaningful output. When information is processed by a machine, meaning is fabricated by the process. The input alone does not have meaning, nor the machine alone,

but meaning is 'uncovered' when the machine acts upon the direction of the input. These examples give another glimpse of the participatory nature of Image reality.

N for Numbers and Noise

Not all information is stored or communicated as simple binary choices. Data can be compressed so that it has the same potential meaning but uses fewer characters. Compare written English to Morse code or compression of mathematical statements.

10x10x10x10	2x2x2x2	2 ⁴
Binary	Base ten	Power

Information theory has been developed from Claude Shannon's pioneering work. His paper "A mathematical theory of communication" was published in 1948.⁸ He gave a model of communication as a statistical process. There was no differentiation of meaning from the total information transmitted. This is not as strange as it might at first seem. Noise too can be considered information. Whether the information is noise or message depends upon what the observer wishes to receive, a state of mind or pre-selection of what is worthy of attention from the total. Consider many simultaneous conversations in a busy restaurant or interference picked up by a radio receiver. For example, even white noise (no clear signal at all) could be information if it is known that a message will only be sent under particular circumstances. A single click of a detector or spot on a screen might make a physicist very happy indeed. Not because of what the click or dot is but because of the mental connection that attaches significance to it. Unable to attach significance to the stimulus, a layman would have no emotional response, it occurred and nothing more.

It is possible to calculate what proportion of some information is meaningful according to the researcher's pre-selection of what will be considered meaningful, such as the percentage of DNA that is code for protein synthesis. However that does not mean that the rest is meaningless. Meaning may not yet have been fully elucidated. There is increasing evidence that shows RNA is a key regulator of metabolic processes as well as a message transmitter. Quote- "It is discovered by next generation sequencing techniques that most genomic DNA are generally transcribed to non coding RNA ...[which]... have critical roles in many cellular processes".⁴

F for Forms

In Julian Barbour's words, "The status of Wheeler's 'it' is not controversial and requires less discussion. It is the underlying invisible world, the world of quantum fields and particles, whose existence we deduce from the correlations within the interconnected phenomenological world."²

Atoms are not imaginary things. They can now even be seen using a scanning tunneling microscope and also moved, as demonstrated by the movie "A Boy and his atom" created by IBM nano-technologists.

At the atomic scale there is a binary choice, which is whether a position in a structure is occupied or vacant. Due to the Pauli exclusion principle two atomic nuclei may not occupy the same position. This kind of information is transmitted by a mould such as a cake tin or sandcastle bucket. Where there is and isn't cake tin directs where the cake mixture can and cannot go. Another example is a librarian's rubber stamp. The form of a river bank informs the flow of the water, and therefore the sites for further deposition, creating a new form and so on. This simple choice present/absent is seen in Stephen Wolfram's cellular automata where the

choice is black or white. It is seen that mere reiteration of simple rules upon the current structure can lead to the generation of complex arrangements. The information directs the building of the form, but the information is nothing without the thing that carries it. Though they can be separated in the mind they are inseparable in nature. There can be no code without something to embody the code.

In nature there is more than a binary choice of atom or no atom . There are 98 naturally occurring elements with different abundances and properties. Which element is present is not random but is directed, not just by environmental abundance but by the information carried by the current arrangement. Charges attract or repel ions, and the shape of a molecule may exclude or allow another molecule to fit into place. An example of this is the complex shape of biological enzymes that each work with a particular substrate. The forces that bring about change co-exist with structure or arrangement, new forms supplying new forces for further change. Charges can also bind parts of structures together, as can be observed in the 3D folding of protein molecules. A dramatic example is embryo-genesis where growth of the larger form is directed by the information at the molecular and atomic scale, physics and chemistry in action.

It can be seen that information is not just the disembodied stuff of probabilities and theoretical wave functions. It is carried by actual parts of the Object reality, and form and function go 'hand in hand'.

O for Observation

Photons interact with the surface of object-forms. They are absorbed and may or may not be re-emitted depending upon the chemical structure. The frequency and intensity of emitted light is controlled by the material object-form. Frequency and intensity (number of photons) provides data that can be received and processed into output by an observer (organism, device or sensitive material).

Encoded within the form of an object is the information necessary to give all of the possible image manifestations of it. One manifestation is the output from processing one selection of data out of all possible selections that might have been made.

It might seem that because a manifestation is made from bits of information, it must be from bit. However the manifestation is not an object with atomic structure in its own right, it is a representation, such as a mental image seen together with the information that it exists externally. This is brain activity in which cognitive items within distributed systems are linked.

“In thinking, remembering , and knowledge representations, features are processed within distributed systems as sets of separate units in a highly parallel way.”⁵

When remembering an item it is usually not stored as a lone object token but will be stored with a larger collection of cognitive units, such as a scene, event or other stimuli encountered at the same time. This requires binding together of relevant attributes and contextual information and also separation of the different objects that were seen at the same time, as separate things not the same one.⁵ The perceived manifestations and recalled manifestations are *very different* from the object-forms in external object reality. To avoid temporal paradoxes they **must not** be confused.

The observed reality is emergent in part from the combination of observer function and behavior. I.e. where, when and how to observe (including the type and state of the observer). The other part being the independent existence and function of the object-forms and potential sensory data within the material Object reality.

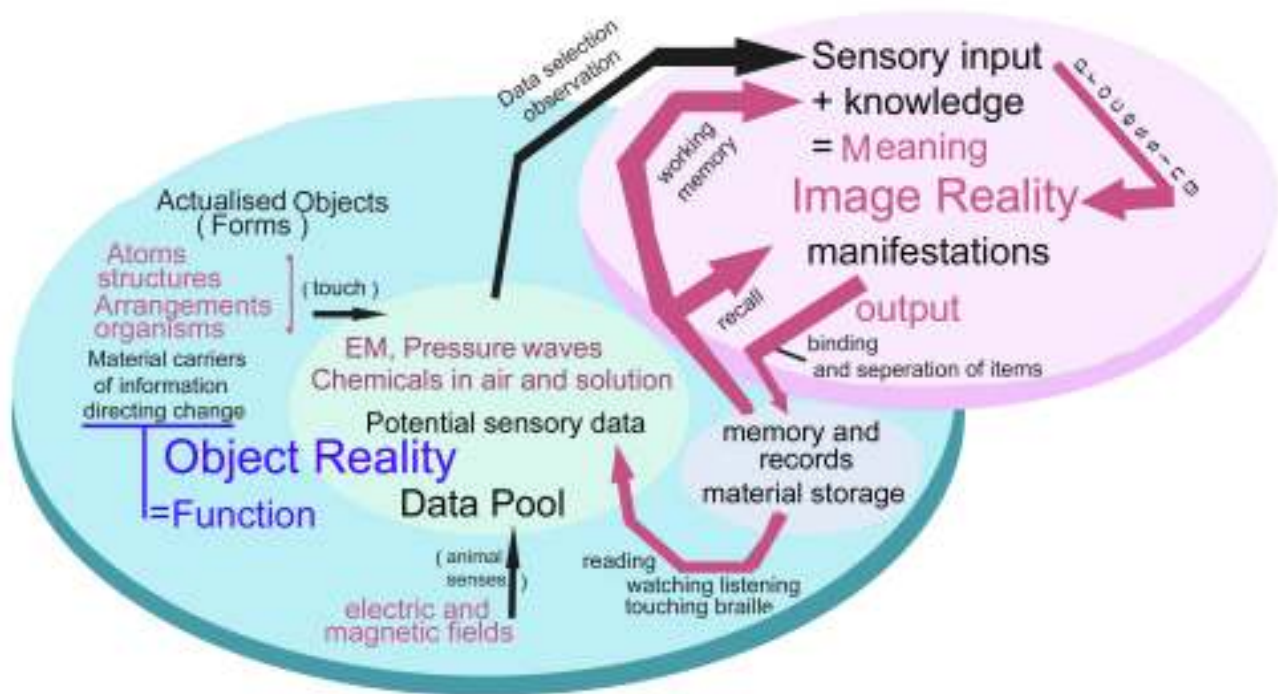


Diagram A. G Parry 2013 Filling the gaps between quarks, lawnmowers and the "human soul", (Ref. to Edward O. Wilson)

A long standing question has been 'why don't we see superposition in everyday reality?'. After all, it has been found an inextricable feature of quantum mechanics.

Firstly the world of quantum mechanics is not the external reality that exists but it is a theoretical 'world' built up from the measurement and counting of many binary choices, which gives probabilities of events.

According to Niels Bohr, "there is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of the physicist is to find out how nature is. Physics concerns what we can say about nature"⁶. He did not deny the external material reality but thought it less important to physicists.

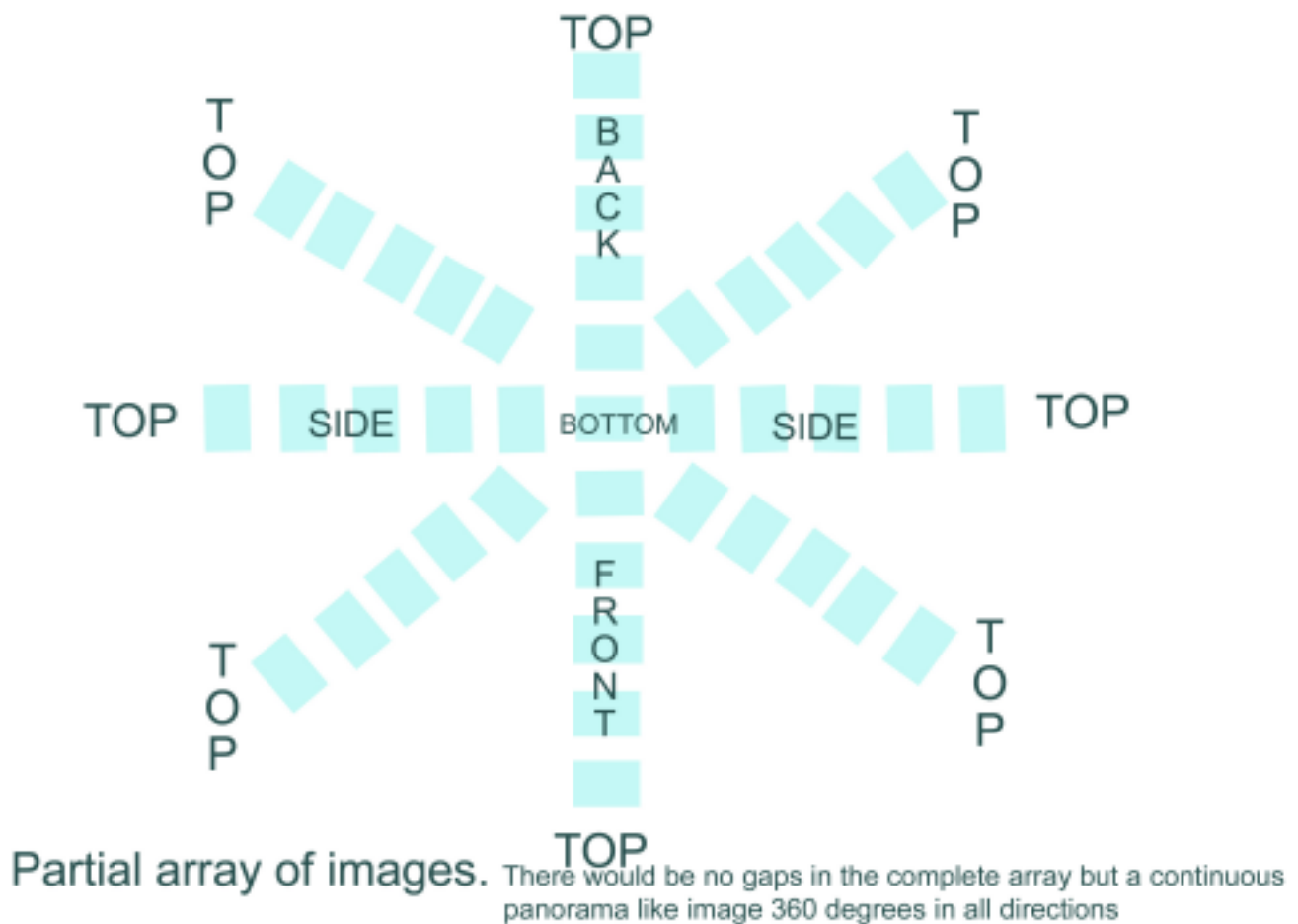
Julian Barbour wrote, "Probabilities are for outcomes: what you find when you open the box. Thus, even if quantum probabilities are an integral and essential part of the world, they are meaningless in themselves. They are at best secondary essentials, not primary essentials. They must always be probabilities for something"². Whether enamored by probabilities or not, together they make clear that the theoretical quantum world is not the external reality or the reality that is experienced in everyday life but has a different make up and place of its own. So a direct correlation between macroscopic observed reality and theoretical quantum realm should not be expected.

That said, all material object-forms do exist as 'superpositions' of a kind. They are templates for *all* possible manifestations of them. The observed reality is *one* out of a vast array of

possible alternative viewpoints that might be observed. It is fabricated from a tiny fraction of all of the information available in the environment. See diagram B. Relative to an observer, an object-form's top, bottom, front, back, left and right side (and every other position in between) exist as the material form with atomic structure, and that is reflected in the information surrounding it in the environment. For example a suspended die possesses all numbers 1 to 6 and there is information in the environment which would allow manifestation of any of those numbers. When and where and how observation is made is selection of the available data. So rather than having many alternatives co-existing as the object-form and as data in the environment, the information to build one manifestation is processed into output, which is the Image reality.

There is a transition from having the possibility of many different alternative viewpoints in external reality to what is known from observation or measurement, a singular outcome. If the pre-selection state of the object-form is described by a wave function, then selection of the information is a transition from the hypothetical quantum world to the Object reality world of Object-forms in which the measurement is made. The selected information forms the only manifestation or detection in Image reality. This is like wave function collapse, though it is only changing attention, switching explanatory model, when a selection is made. i.e. Disregarding the former superposition quantum state (and the 'macroscopic superposition' of the object-form and new co-existing potential data in the Object reality environment) and concentrating on the singular Image reality output.

Diagram B



It from bit or bit from it?

Julian Barbour's award winning essay in the 'Is reality Digital or Analogue?' FQXI essay competition 2011 makes a very good case for 'Bit from It'. He argues that 'bits' are nothing without 'its'. So its are more fundamental.² It can be seen that information has to be carried and does not exist on its own. There can't be spin or polarization without something to have those attributes.

However it is also possible to see that the development of structures and configurations of matter is directed by information and would not exist in that form without it. The macroscopic world of objects, containing billions of atoms, is far more organized and predictable than the behaviour of individual particles. As Hans Christian von Baeyer writes, in a chapter about probabilities, "More is different" and "There must therefore be many layers of emergence of novel properties of these complex, macroscopic things that are not explained by the standard model of particles."⁷ Even neural pathways are plastic and can change according to use. Strengthened by frequent use and diminishing, even being lost, through disuse.

The underlying invisible world, Object reality, is shaped by information *and* the emergent. *'Higher level' Image reality, the world that we experience, is fabricated from information. It could not exist without information from which to fabricate it **and** material structures which enables processing of information into the observed output.* In Object reality, along with the constituents of matter, is energy. The material world is not static but in constant activity. Forming a cycle. Information can direct the formation of structures and configurations of matter and the *structure and configuration of matter provides both forces and information for further change. The forces drive change, (they make change happen), and the information directs what change can occur, producing a new output structure or configuration.*

Having taken my particular journey I would not like to choose between 'It from Bit' or 'Bit from It' but would take them both and tuck them together in the real, foundational (Object reality) world. 'It from Bit' *and* 'Bit from It', together.

Soft center or liqueur hangs as latent information.....

In Object reality the indistinguishable sweets are in 'macroscopic superposition' ... Each *all* that it solely is and source for all possible manifestations of it. The truth, the whole truth and nothing but chocolates.

While in the quantum realm, the realm of probabilities, the sweets are 'quantum chimeras', waiting as neither one thing or the other but both - until the choice is made.

In Image reality, the observer fabricated world and world of experience, information is a delicious outcome, -but only with *the material confection **and** the choice.*

References

1. "Information the new language of science" by Hans Christian von Baeyer published by Phoenix (imprint of Orion books Ltd), London 2004 Ch-pt 1 pg.1
2. "Bit from it", FQXi essay competition entry, Julian Barbour, 2011
3. "Information the new language of science" by Hans Christian von Baeyer Ch-pt.3 pg.25
4. Genomic wide expression of non coding RNA and global chromatin modification, by Rukai Zhang, Lan Zhang, Wenqiang Yu, Journal of molecular cell biology, Nov 2011
5. Handbook of binding and memory, Edited by Hubert D. Zimmer, Axel Mecklinger, Ulman Lindenberger, Oxford University Press, 2006 Ch-pt.1 pg.8-9
6. "Information the new language of science" by Hans Christian von Baeyer, Ch-pt.8 pg.65 and Ch-pt. 7. pg.55
7. "Information the new language of science" by Hans Christian von Baeyer, Ch-pt.7 pg. 58
8. "A mathematical theory of communication" Claude Shannon, Bell System Technical Journal, vol. 27, pp. 379–423 and 623–656, July and October, 1948