Why are there Laws of Nature ?

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Abstract

It is argued that solving the enigma of information theory via a self-consistency requirement straightforwardly implies that the information content of nature is logarithmically small, what means that there are laws of nature.

PACS:
Key words:

Invariances alias symmetries alias redundancies alias laws of nature are the very topic of physical science. They allow to know parts of nature there and then - in what ever space may be relevant - from what it looks here and now. For example, measuring the energy of a closed classical system at one instant makes one know this quantity forever.

There are very interesting aspects of such invariances, whith Noethers theorem as a key. However, the most pressing questions reach down even deeper, to where the only concept left is those of information itself. Why isn't nature completely random? To which extent is nature redundant?

By definition, nature shall be everything relevant for the following conclusions, be it the universe, be it more. When I shall speak about the "state" of nature, this is nothing dynamic. Rather, it shall span over all relevant dimensions including time - or even a greater number of timelike dimensions.

To proceed, it must be assumed that nature is finite. Since it was reckognized that nature is quantized, countability is widely out of question anyway (despite of the fact that there are quantum operators with continous spectrum). Finity is a quite plausible addition. If so, nature is isomorphic to some data file. There is evidence that the element of information is a 2-valued “bit”, but this basis of the exponential function is not crucial for the following conclusions. The symbols exp and log shall be read with this abstraction. Furthermore I shall use the metapher of a “screen” and call the element of information a “pixel”.

So one has a screen showing an image with symmetries, what means with less information than possible: The image can be produced by a computer code consuming less pixels than the screen has available. This leads to the basis of information theory, namely to the very meaning of this notion. Though omnipresent in modern physics (black hole entropy, information loss [1], entanglement [2] and many more), it is not yet free from a fundamental enigma. Instinctively, one would say that the information associated with a screen is what one sees there, for example a sketch of the expanding universe. However, such semantic content correctly is to be addressed as the factual state of the screen, while the information is defined to be the number of pixels - which is the logarithm of the number of possible states. Now, if both aspects of information coincide, this conflict is solved in a self-consistent manner. This means the factual state of the screen displays its number of pixels. Translated back, **the - one and only - state of nature encodes its number of degrees of freedom**.

Something of that kind can occur in practical life if a screen is used to advertise itself. In such case, it is let display a message like “5 Megapixels Screen - Promotion”. Addressed to humans, this contains some linguistical encoding and additional message. The fonts are human-sized as well and consume a lot of pixels. But puritanically, to encode a number, the number of pixels needed is only the logarithm thereof.

This yields the following characteristica of the screen:

Number of pixels	N
Number of possible states	exp N
Number of factual states	1
Semantic content of factual state	’N’
Non-redundant information	log N

while all the rest of the screen is filled with redundant content.

There are different ways of distributing the redundant pieces. The most proper separation is achieved if each line of a 2-dimensional screen identically encodes the number of lines. The extension of the matrix is quite asymetric.

If there are L lines, then there are only $[\log L]$ columns, where the bracket shall symbolize the following integer. L has to be non-redundant, that means there does not exist a computer code shorter than $[\log L]$ pixels to generate it. The digits are random like results of appropriate quantum measurements. In contrast, all the lines are the same, what is like the full determinism of conservation laws. Knowing a single line is enough to know everything, what can be addressed as a holographic structure. Well, the factual encoding of the redundancy seems to be somewhat more tricky. In particular, the screen looks higher dimensional. So a pixel can be enumerated by an n-tupel of natural numbers where $n > 2$. It may be reemphasized that timelike degrees of freedom are regarded as part of these n dimensions.

So as a clear result, **the information content of nature is logarithmically small**. Is this plausible? In [3], a drawing appears showing God pointing at a tiny portion of phase space. This exactly shall illustrate how incredibly small the entropy of nature is (well, precisely this refers to the entropy of our universe at early times - I leave away any discussion on that apart from repeating that I see information as nondynamic). There is also evidence from mathematics. It is a standard exercise for students of informatics to write a computer code producing "random" numbers. This is a remarkable self-contradiction, however it is the experience that such "random" numbers can be absolutely useful in practical terms.

References

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