IJIRR

International Journal of Information Research and Review
Vol. 05, Issue, 08, pp.5667-5669, August, 2018

REVIEW ARTICLE

DEFINITION AND CALCULATION OF POSITIVE INFORMATION

[1]*Dr. Gang Sha and [2]Rulin Xiu

[1]Institute of Soul Healing and Enlightenment, 30 Wertheim Court, Unit 27D, Richmond Hill, Ontario L4B 1B9, Canada
[2]Hawaii Theoretical Physics Research Center, 16-266 E. Kipimana St, Keaau, HI 96749, USA

ARTICLE INFO

Article History:

Received 16th May, 2018
Received in revised form
22nd June, 2018
Accepted 10th July, 2018
Published online 30th August, 2018

Keywords:

Phenomena, Superconductivity, Superfluidity, Phase transitions.

ABSTRACT

In this work, we introduce the concept of positive information into physics. We define positive information as the degree of internal order within a system and the degree of connection a system has with other systems. Negative information, as the opposite positive information, is the degree of internal disorder in a system and disconnection between systems. It corresponds to entropy in current physics theory. We show how to calculate positive information with concepts fromthe quantum theory and possibly other systems. We suggest that positive information plays a significant role in studying phenomena such as superconductivity, superfluidity, phase transitions of states of matter, the study of living systems, and more. Positive information is an important physical quantity worthy of further study.

INTRODUCTION

What is information? Information is what informs. Information is an entity that provides the answer to a question that resolves uncertainty. Information is conveyed as the content of a message. Information reduces uncertainty. The uncertainty of an event is measured by its probability of occurrence and is inversely proportional to it. Thus, to measure information contained in something is to measure the uncertainty it has. The founder of information theory, Claude Shannon, discovered that the measure of information is related to entropy, which is the measure of disorder within an object or system. In our recent work (Zhi Gang Sha and Rulin Xiu, 2018), we show that information is a basic constituent of our existence just as matter and energy. Information can be stored, transported, and converted just like matter and energy. Here, by matter we mean everything we observe as physical reality. Energy is what moves and changes matter. Information is what gives form and shape to matter. Quantum physics and thermodynamics show how to calculate the matter, energy, and information of a system and their relationship. In quantum physics, everything is described by a wave function. A wave function shows mathematically the properties of matter such as wavelength, frequency, amplitude, spin, electric charge, as well as energy and information. Information relates to the possible states within a system.

Corresponding author: **Dr. Gang Sha**
Institute of Soul Healing and Enlightenment, 30 Wertheim Court, Unit 27D, Richmond Hill, Ontario L4B 1B9, Canada.

Thermodynamics studies physical quantities such as energy, entropy, volume, pressure, and free energy to describe the matter, energy, and information within an object. Entropy is related to the possible states of a system. It indicates the innate disorder, uncertainty, and possibilities of a system. Entropy is one of the basic physical quantities like energy, volume, and pressure that determine the quality and behavior of a system. In quantum statistical mechanics, John von Neumann (von Neumann, 1955] extends the classical Gibbs entropy concepts to the field of quantum mechanics and introduces von Neumann entropy as:

$$S = -\,\mathrm{tr}\,(\rho \ln \rho)$$

Here ρ is the density matrix. Von Neumann entropy corresponds to Claude Shannon's entropy in information theory (Shannon, 1948]. Von Neumann entropy is being extensively used in different forms such as conditional entropies and relative entropies in quantum information theory. To better study non-local correlations and quantum entanglement existing in quantum phenomena, the non-additive Tsallis entropy (Tsallis, 1988), a generalization of the standard Boltzmann-Gibbs entropy, was proposed. In this paper, we introduce a new physics quantity, positive information. We propose to define positive information as the order existing within a system and the degree of connection a system has with other systems. We show how to calculate positive information within a system. We suggest that positive information can be a useful concept and tool for studying phase transitions of states of matter and other phenomena such as superconductivity, superfluidity, and other systems such as water and livingsystems in a deeper and more quantitative manner.

Definition of Positive Information and Negative Information: Definition of positive information: Positive information is the order, connection, and certainty that a system has within itself and with other systems. Definition of negative information: Negative information is the disorder, the disconnection, and the uncertainty within a system. Negative information corresponds to entropy in current physics. Information, as described by Claude Shannon and other physicists, is in fact negative information. Entropy measures negative information in a system. Positive information is the opposite of entropy. It describes how much order a system has within it and its connections with other systems. With the introduction of positive information, one has a physics concept and quantity to study asystem with order and its connections with other systems. A good example of a system that has positive information is a crystal. Within a crystal, each molecule or ion is aligned in a certain predictable way. A crystal has order. It has positive information.

In mathematics, a fractal has order. Even with all its complexities, every point in the fractal can be predicted. A fractal has positive information. Quantum entanglement is a connection among certain quantum states. Positive information can account for the amount of quantum entanglement and other connectionsa system has. Living thingsare systems that have order. Positive information provides a way to describe life mathematically. Most things have both order and disorder, positive information and negative information, co-existing simultaneously. For instance, water has both order and disorder. It has both positive information and negative information. A phase transition, such as the change from ice to water, is the abrupt transformation of information within a system. Studying positive information within a system provides a way to study phase transitions.

Calculation of Positive Information: In statistical mechanics, the correlation function is a measure of the order and connection a system has. It describes how microscopic variables, such as spin and density, at different positions and times are related. The most common definition of a correlation function is the average of scalar product of two random variables s1 and s2, at different positions R and R + r and times t and t + τ:

$$C(r,\tau)=\langle s1(R,t)\cdot s2(R+r,t+\tau)\rangle - \langle s1(R,t)\rangle\langle s2(R+r,t+\tau)\rangle \quad (1)$$

$$C1,2(r, \tau) = \langle s1(R,t) \bullet s2(R+r, t + \tau)\rangle - \langle s1(R,t) \bullet s2(R, t)\rangle \quad (2)$$

To calculate the positive information a system has, one needs to study all the correlation functions existing in a system, including autocorrelation functions. An autocorrelation function is the correlation function between the same random variable such as:

$$C1,1(r, \tau) = \langle s1(R,t) \bullet s1(R+r, t + \tau)\rangle - \langle s1(R,t) \bullet s1(R, t)\rangle \quad (3)$$

In quantum physics, for a system with wave function Ψ(x,t) expressed in space coordinate x and time coordinate t, one of the autocorrelation functions is:

$$\begin{aligned} G(\Delta x,\Delta t) &= \langle\Psi^*(x,t)\, \Psi(x+\Delta x,t+\Delta t)\rangle - \langle\Psi^*(x,t)\, \Psi(x,t)\rangle \\ &= \int dx\, dt\Psi^*(x,t)\, \Psi(x+\Delta x,t+\Delta t) - 1 \\ &= \int dx\, dt\Psi^*(x,t) \exp[i(H\Delta t - P\Delta x)/h\,]\Psi(x,t) - 1 \\ &= \int dx\, dt\, |\Psi(x,t)|2\exp[i(H(x,t)\Delta t - P(x,t)\Delta x)/h\,] \\ &= \int dpdE\, |\Psi(P,E)|2 \exp[i(E\Delta t - P\Delta x)/h\,]- 1 \end{aligned} \quad (4)$$

In quantum field theory, the partition function is the generating functional of all correlation functions. It is usually expressed by the following functional integral:

$$G[J] = \int D\phi \exp\{i(S[\phi] + \int dx4J(x)\, \phi(x))\} \quad (5)$$

Here S[ϕ] is the Lagrangian of the system ϕ. Because G[J] generates all correlation functions, G[J] is related to the positive function (Matthew, 2015; Michael Edward Peskin, 1995]. To find the exact definition of positive information as the opposite of negative information, notice to calculate the entropy in statistic mechanics, which corresponds to the negative information defined here, one usually computes the partition function in statistical mechanics:

$$Z(\beta) = \sum xi \exp[-\beta H(x1, x2, \ldots)] \quad (6)$$

The function H is understood to be a real-valued function ofthe space of states {x1, x2, …}, while β is a real-valued free parameter (conventionally, the inverse temperature). The sum over the x1, x2, …is understood to be the sum over all possible values that each of the random variables xi may take. When the xi are continuous rather than discrete, the partition function is:

$$Z(\beta) = \int \exp[-\beta H(x1, x2, \ldots)]\, dx1\, dx2 \quad (7)$$

Notice the similarity between (4) and (7) or (6). The correlation function is simply the extension of the partition function to the cases where β can take on a complex number.

In statistical mechanics, from the partition function, one can calculate the expectation value of energy H, which is E:

$$E = \langle H\rangle = - \partial \log(Z(\beta))/\partial\beta \quad (8)$$

The entropy is given by:

$$S = kB\, (\beta\langle H\rangle + \log(Z(\beta))) \quad (9)$$

To extend this result to the case of positive information, we define positive information PI is related to the partition function as:

$$PI = kB\, (\sum J\langle H\rangle + \log(G[J])\,) \quad \begin{matrix}(1)\\(2)\end{matrix} \quad (10)$$

$$\text{Here,} \langle H\rangle = - \partial \log(G[J])/\partial J \quad (11)$$

Here G is the generating functional of all correlation functions, which is a partition function in quantum physics. We propose that equations (10) and (11) give the mathematical definition for positive information. This definition can be extended to all systems, including statistical systems, as long as we can calculate the generating function of all correlation functions G[J]). Notice both negative information, the entropy S, and positive information PI depend on keyparameters. Entropy depends on parameter 1/β which is related to temperature. In the case of positive information, PI depends on J. What is the physical meaning of J? As J is the inverse of the field ϕ, 1/J relates to the intensity of the field ϕ. Just as equations (8) and (9) describe the energy and entropy of a system at different temperatures, equations (10) and (11) describe the positive information and energy at different intensitiesof the field. Although the formulasforpositive information and negative information are similar, they are very different physical quantities. The partition function Z(β) measures the randomness of asystem. The generating functional of all correction functions G[J] measures the connection and order within a system.

Conclusion

In this paper, we introduce the concept of positive information and demonstrate how to mathematically define and calculatepositive information. We findthe mathematical formula for calculating positive information is quite similar to the calculation of entropy, except that the partition function for calculating positive information is the generating functional of all correlation functions while the partition function for calculating negative information, entropy, is the partition function for measuring the randomness of the system. We suggest there are three possible applications of positive information. First, positive information measures order existing within a system and the connection it has with other systems. It may be a better measure of quantum entanglement than von Neumann entropy. Second, the calculation of positive information provides a way to study phenomena such as phase state transitions, super conductivity, superfluidity, and other related phenomena. The mathematical formula of positive information provides a way to quantitatively study phase state transitionsbyderivingthe value of field strength 1/J at which a transition may happen. Third, the concept of positive information provides a quantitative way to study living phenomena because living systems build and enhance positive information. We will discuss these applications in ourfuture work.

REFERENCES

Matthew D. 2013. Schwartz, Quantum Field Theory and the Standard Model.

Michael Edward Peskin, Daniel V. 1995. Schroeder, An Introduction to Quantum Field Theory.

Shannon, C. E. 1948. A mathematical theory of communication. Bell System Technical Journal, vol. 27, pp. 379–423 and 623–656, July and October

Tsallis, C. 1988. "Possible generalization of Boltzmann-Gibbs statistics". Journal of Statistical Physics. 52: 479–487.

Von Neumann, 1955. Mathematical Foundations of Quantum Mechanics, Princeton University Press, Princeton, NJ.

Zhi Gang Sha and Rulin Xiu, 2018. “Composition of existence and the definition of spirit, heart, and mind according to quantum physics”. *International Journal of Information Research and Review* Vol 5 (1) 5072-5075, Jan

****