Is fine structure constant related to Shannon information entropy?

By Victor Christianto[1]

Abstract

Here is an attempt to derive fine structure constant based on Shannon information entropy. This derivation is inspired by a lecture by Prof. Anosov back in December 2008. He presented his ideas in a seminar held in Moscow State University, Moscow, but my note on his lecture is lost. So this is my simple derivation.

Introduction

While there are many proposals discussing how to derive fine structure constant from theories, there are only few of them which are interesting enough, see for instance Gilson [3] and Stephen Adler. Other interesting explanations are given by Oldershaw [2] and Castro [4]. Most of other proposals are rather speculative or numerological.

Here is an attempt to derive fine structure constant based on Shannon information entropy. This derivation is inspired by a lecture by Prof. Anosov back in December 2008. He presented his ideas in a seminar held in Moscow State University, Moscow, but my note on his lecture is lost. So this is my simple derivation.

Outline

a. The formula

   First we start with coin tossing problem, which has probability of p=0.5.

   Then Shannon information entropy can be written as follows:

[1] Email: victorchristianto@gmail.com, URL: http://www.sciprint.org, and http://independent.academia.edu/VChristianto

$$S = k.\ln 2 = k.0.693147\ldots \tag{1}$$

Or if we choose k=100, then we have:

$$S = 100.\ln 2 = 69.314718\ldots \tag{2}$$

Then as a simple guess we can write an equation for α as follows:

$$\alpha = \frac{p}{S} = \frac{0.5}{100.(\ln 2)} = 0{,}007213 \approx 7.297x10^{-3} \text{ (98.85\%)} \tag{3}$$

Therefore we can conclude that a simple formula based on coin tossing problem divided by Shannon entropy gives a number which is very near to fine structure constant (98.85%). Of course, if a reader wishes to make the above formula equals to the experimental value of fine structure constant, he can adjust k variable in formula (1).

b. The motivation

Since my note on Anosov's lecture is lost since few years ago, I cannot recall what exactly the theoretical motivation is. I can only guess that it may be because he believes that the fine structure constant is fundamentally related to coin tossing problem and Shannon information entropy. In this regards, perhaps it is worth mentioning here a paper by A. Granik [1], where he describes Schrodinger equation as a result of information spread, and then it is related to Shannon entropy.

Furthermore, there are also methods to describe information entropy of harmonic oscillator [6], and of hydrogen atom [7]. The information entropy for these physical systems is given by:

$$S = -\int \rho(r) \log \rho(r) dr \tag{4}$$

Of course, a reader may be more interested to use Fisher entropy or Rènyi entropy instead of Shannon entropy to derive fine structure constant. It is known that Rènyi entropy is widely used generalization of Shannon entropy [7].

This coincidence (3) seems interesting enough to investigate further, especially if we consider its simplicity of expression compared to other numerological formulas.

Concluding remarks

The outline of fine structure constant formula given here is not intended as an exact proof, but instead it is intended to motivate further investigation on possibility to find possible theoretical link between fine structure constant and Shannon information entropy.

This author will appreciate if somebody can inform him paper or books discussing similar ideas of relating fine structure constant with Shannon entropy.

January 7th, 2014

VC, email: victorchristianto@gmail.com

References:

[1] Granik, A. (2005), Transition from Quantum to Classical Mechanics as information localization, arXiv:quant-ph/0503162

[2] Oldershaw, R.L. (2007), The meaning of the fine structure constant, arXiv:physics/0708.3501

[3] Gilson, J.G., http://www.btinternet.com/~ugah174/

[4] Castro, C. (2001) A note on Transfinite M Theory and the Fine Structure Constant, arXiv:physics/0104016

[5] CODATA, http://physics.nist.gov/constants/

[6] Dehesa, J.S, Van Assche, W., and Yanez, R.J. (1997) Information entropy of classical orthogonal polynomials and their application to the harmonic oscillator and Coulomb potentials, Methods and Applications of Analysis 4 (1) 1997, pp. 91-110

[7] Sen, K.D., & Katrie, J. (2009) Relativistic effects on information measures for hydrogen-like atoms, arXiv: 0902.3970 [physics.atom-ph]