Response to Commentary

Is There a Generalized Way to Represent Entropy?

Andrew Beckwith*

Abstract

This is my Response to Glinka's Commentary. I take the view that reality is actually analog until at a critical limit as when the Octonionic gravity condition kicks in. Then for a time it appears discrete. My work introduced the discreteness of reality through a generalization of Ng infinite quantum statistics. I thank L. Glinka for presenting a highly specialized interpretation of early-universe entropy and seek to show what L. Glinka brought up is a simple version of infinite quantum statistics first proposed by Y. Jack Ng in the journal Entropy in 2008. I add in further details which the readers should be aware of, in particular, how to use the inverse of frequency, as wave lengths, to treat entropy as a counting algorithm, while also adding in the important datum of vacuum energy, as initially brought up in inflaton physics. Finally, I discuss the point raised by Paul Steinhardt of Princeton University that inflation is not necessarily correct. These are important details that I believe Glinka has missed in his criticism of the entropy formula.

Key words: entropy, gravity, analog, discreteness, early universe, inflation, entropy formula.

Introduction

I will first present infinite quantum statistics, with its treatment of wave length of a particle as inversely proportional to frequency. This crucial insight of Y.J. Ng is a most important point of entropy physics and should not be missed.

Our presentation takes note of several developments. First of all the onset of pre Octonionic gravity, with tiny masses associated with gravitons, is in line with Quantum mechanics as embedded within a larger, non linear classical theory. It is important to appreciate the role of infinite quantum statistics, as a tool for describing entropy. The author will present a simple case of infinite quantum statistics, and from there will add details missed by L. Glinka in his generalization of entropy.

Infinite quantum statistics, the preliminary formula – corrected here for the record

First of all the formula which L. Glinka did not fully present in his document, as presented in Prespacetime by Beckwith, is actually (if $V' = dV/d\phi$, where V is an inflaton potential, and dist = distance of Planck length, or more)

$$[T\Delta S / dist] = [\hbar / dist] \cdot \left[2k^2 - \frac{1}{\eta^2}\left[M_{Planck}^2 \cdot \left[\frac{6}{16\pi} - \frac{3}{4\pi}\right] \cdot \left[\frac{V'}{V}\right]^2 - \frac{3}{4\pi} \cdot M_{Planck}^2 \cdot \left[\frac{V''}{V}\right]\right]\right]^{1/2} \qquad (1)$$

* Correspondence: Andrew Beckwith, Ph.D., Department of Physics (Institute of Theoretical Physics), Chongquing University, Chongquing, China. E-mail: abeckwith@uh.edu

The above formula is using the relationship of **S ~ n**, i.e. a counting algorithm. The main point of confusion is with the counting algorithm, so we will explain it fully

Equation (1) divided by a charge, q, gives a relic electric field. Eq. (1) is actually from the so called "cosmological Schwinger principle as established by [2a]. The main misunderstanding was in the actual relationship of entropy with infinite quantum statistics, and the author will elaborate upon this topic, next.

Revisiting Ng's counting algorithm for entropy, & graviton mass

The wavelength for a graviton may be chosen to do an information exchange which could be part of using a graviton in an information counting algorithm. Namely I argue that when taking the log, that the 1/N term drops out. As used by Ng (2008)

$$Z_N \sim (1/N!) \cdot (V/\lambda^3)^N \tag{2}$$

This, according to Ng (2008) leads to entropy of the limiting value of, if $S = (\log[Z_N])$ will be modified by having the following done, namely after his use of quantum infinite statistics, as used by Beckwith (2010a, 2010b)

$$S \approx N \cdot (\log[V/\lambda^3] + 5/2) \approx N \tag{3}$$

Eventually, the author hopes to put on a sound foundation what 't Hooft (2002, 2006) is doing with respect to deterministic quantum mechanics and equivalence classes embedding quantum particle structures. Furthermore, making a count of gravitons as $S \approx N \sim 10^7$ gravitons, with Lloyd's (2002) formalism used by Beckwith (2010b) one can consider the following, namely

$$I = S_{total} / k_B \ln 2 = [\#operations]^{3/4} \sim 10^7 \tag{4}$$

as implying at least one operation per unit graviton, with gravitons being one unit of information per produced graviton. Note, Smoot (2007) as noted by Beckwith (2010b) gave initial values of the operations as

$$[\#operations]_{initially} \sim 10^{10} \tag{5}$$

What was misunderstood in the derivation?

$$\lambda \approx 1/\ frequency \tag{6}$$

Question: Is Equation (3) only for inflation? The answer: No

Eq. (3) was presented by Y. J. Ng for the purpose of DM, i.e. for very long wave length DM, which is not at all connected to initial space time physics! Saying it is connected to such physics is incorrect. Secondly, if one makes the identification of later time physics, not necessarily in the initial space time regime one no longer has a vacuum energy and/ or an inflaton contribution potential at all to contend with, namely

$$[T\Delta S / dist] \xrightarrow[Large-Time]{} [\hbar / dist] \cdot [2k^2]^{1/2} \approx n \qquad (7)$$

i.e. the potential and its derivatives become large distances from the starting point nearly zero and their derivatives vanish. And, of course, there is nothing to stop making use of Eq. (6). i.e. the point missed is that Beckwith was from the beginning making use of a partition function treatment of entropy.

Is inflation the only game in town as assumed by Glinka's early universe treatment of his dispersion relationship?

Not according to P. Steinhardt. Beckwith as far back as 2006 in documentation given to him by Steinhardt at the meeting in 2006 on DM at UCLA was warned as to not take inflation too literally. Consequently, the methodology developed by Dr. Beckwith has been more general than what Glinka has supposed, and that as a result, both Eq. (3) and Eq. (6) and Eq. (7) have been part of a more general approach. Recently, Steinhardt in FFP 11, in discussions with the author in FFP 11, as witnessed by J. Dickau, and also in a new article in Scientific American, has been making the point to the author to not take the dispersion relationship as given by inflation as the only way to consider the initial evolution of the universe.

Beckwith asserts, in any case, that the entropy formula he has developed is far broader than just applied to the initial starting point of inflation, from the beginning of his work.

Needless to say though, we do have some observations as to the limits of applicability of the entropy formula which we will share – regarding the initial phases of cosmology – while not necessarily restricting ourselves to just the inflationary stand point.

Increase in degrees of freedom in the sub Planckian regime.

Starting with

$$E_{thermal} \approx \frac{1}{2} k_B T_{temperature} \propto [\Omega_0 \breve{T}] \sim \tilde{\beta} \qquad (8)$$

The assumption is that there is an initial fixed entropy arising, with $\overline{N}$ as a nucleated structure arising in a short time interval as temperature $T_{temperature} \varepsilon (0^+, 10^{19} GeV)$ arrives. Then by

$$\frac{\Delta \tilde{\beta}}{dist} \cong (5 k_B \Delta T_{temp} / 2) \cdot \frac{\overline{N}}{dist} \sim q E_{net-electric-field} \sim [T\Delta S / dist] \qquad (9)$$

This was part of what the author brought up as a possible expansion of the initial degrees of freedom

$$x_{i+1} = \exp[-\tilde{\alpha} \cdot x_i^2] + \tilde{\beta} \qquad (10)$$

In dynamical systems, one would get a diagram with tree structure, as given by Binous [17].Now that we have a model as to a change in space time geometry, what can we mention about pre Planckian space time?

Relevance to octonionic quantum gravity constructions: Where does non commutative geometry come into play?

Crowell [24] wrote on page 309 that in his Eq. (8.141), namely

$$\left[x_j, p_i\right] \cong -\beta \cdot \left(l_{Planck}/l\right) \cdot \hbar T_{ijk} x_k \rightarrow i\hbar\delta_{i,j} \tag{11}$$

Here, β is a scaling factor, while we have, above, a Kronecker function so that at a small distance from the confines of Planck time, we recover quantum mechanical behavior. We recover the regime in which quantum mechanics holds.

$$\left[x_j, x_k\right] = \beta \cdot l_P \cdot T_{j,k,l} \cdot x_l \tag{12}$$

Does the (QCD) condensate occur post Planckian, and not work for pre Planckian regime? Yes. The problem lies with Eq. (8.140) of Crowell [23]. If one integrates across a causal barrier,

$$\oint [x_j, p_i] dx_k \approx -\oint p_i [x_j, dx_k] = -\beta \cdot l_P \cdot T_{j,k,l} \oint p_i dx_l \neq -\hbar\beta \cdot l_P \cdot T_{i,j,k} \tag{13}$$

Very likely, across a causal boundary, between $\pm l_P$ across the boundary due to the causal barrier, one gets

$$\oint p_i \, dx_k \neq \hbar\delta_{i,k}, \oint p_i \, dx_k \equiv 0 \tag{14}$$

i.e.

$$\left.\oint_{\pm l_P} p_i dx_k \right|_{i=k} \rightarrow 0 \tag{15}$$

If so, [23]

$$\left[x_j, p_i\right] \neq -\beta \cdot \left(l_{Planck}/l\right) \cdot \hbar T_{ijk} x_k \quad and \quad does \quad not \rightarrow i\hbar\delta_{i,j} \tag{16}$$

The application of Eq. (16) in pre-Octonionic space time would appear to be a serious problem for entropy. In fact, it is not, and that a proper rendition of non inflationary initial cosmology could still use Eq. (3) to telling effect. We argue that Eq. (16) in fact makes application of Eq. (3) more necessary.

Conclusion

We hope that the initial confusion subsides, and that we do not subscribe to inflation as a new religion. What has been presented, via both Eq. (3), Eq. (6) and Eq. (7) is a far more general treatment of entropy, and that the confusion L. Glinka showed in , particular as to only treating an inter relationship of entropy to inflationary dispersion especially in lieu of the Kolb and Turner model of entropy density as given by

$$s \approx g(T)T^3 \tag{17}$$

g(T) as given by Kolb and Turner has a maximal value of 120 or so, at or about the electro weak transition. It is noticeable though that Eq. (17) is highly non linear in temperature dependence. i.e. the derivation given by Glinka for entropy is for a closed system. If the system is open, and / or one is employing a partition function interpretation of entropy, then Glinka's elegant derivation of entropy as proportional to one over temperature, T, is no longer valid.

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