Motion of an Object due to the Adjusted Rate of Modifications Performed on its Environment

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Abstract. A special statistical model illustrates how an object moving in one dimension, embedded in a tubular structure, can progress anisotropically towards a single direction and produce work. The anisotropic motion of the object is fueled by the thermal fluctuations originating from an ordinary thermal bath, whose coupling with the object depends in a carefully adjusted way on the position of the object itself. A limiting case of this scenario can be solved exactly in a very simple way. From a global physical point of view, it is justified to say that the object and its environment become ever more correlated as time increases ; surprisingly, however, the infinite topology of the system makes it theoretically possible for the object to continue its anisotropic progression at an unabated speed during an infinite time.

1. Introduction

As Bernard Derrida has recently pointed out [1], physicists have recently become actively preoccupied with the study of several features of Szilard's engine [2–5], which Leó Szilárd first conceived as a theoretical concept in 1929, but which has now become a concrete reality [6–12]. In 2014, I focused nearly exclusively on the quantum mechanical behavior of a certain modification of Szilard's model [13], showing how such a modification could circumvent the need for any costly "memory erasure". The resulting picture was arguably rather deprived of intuitive features. In the present article, I undertake to discuss a closely related model by starting from a purely classical level (§2). The role of its most fundamental physical ingredients can be understood in a transparent way (§3). The link of the present model with two earlier schemes I considered respectively in 2005 and 2014 is briefly discussed in a last section.

2. A simple model

Let us consider in the present section a simple discrete statistical model, constituted by a grid of tubular shape ; the grid is considered to be ideally infinite along the *xx'* axis. All the knots of the grid are located at the orthogonal intersection of a straight line oriented along the *xx'* axis and a circular loop parallel to the *yz* plane. The grid's knots can be occupied by a unique object named *A* or by one among a countable number of objects B_1, B_2,…B_i. Each grid's knot is either empty or occupied by at most one object. We further suppose that each loop contains at least one knot left unoccupied by all B_i objects. Let us also suppose that *A* can move along the *xx'* direction only, from one grid-intersection to the next, whereas all B_i objects can move within a single loop only, from one grid-intersection to the next. The only authorized motion of *A* and B_i consists in jumping from their temporary position on the grid to a nearest *empty* location at discrete times t_{4n+1} , t_{4n+2} , t_{4n+3} , t_{4n+4} with $n \geq 0$. This condition of emptiness implies that the motions of *A* and B_i are correlated.
Let us now describe in more detail the rules according to which our system, whose initial state is randomly chosen (cf. Fig. 1), must evolve.

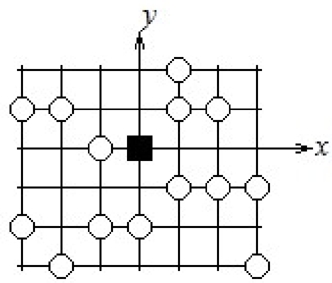

Figure 1. Initial configuration of the system at time $t_0=0$. The configuration of B_i objects has been randomly chosen. Object *A* has been represented by a square (■). Objects B_i correspond to empty circles (O). For the sake of graphical convenience, the three dimensional tubular structure of the grid has been projected on a 2-dimensional plane ; it must therefore be understood that each pair of "vertically" aligned (along *y*) *upper* and *lower* knots are directly connected ; as a consequence, the *upper B* object whose position in Fig. 1 can be indexed by ($x = 1$; $y = 2$) is represented in Fig. 2 at position ($x = 1$; $y = -3$).

– At time t_{4n+1}, all objects B_i, except those belonging to the same column as *A*, are simultaneously translated in the same direction within their loop by one grid unit-length. In the representation used in Fig. 2, this corresponds to a one-step move towards *y*. All objects belonging to the same loop as *A* remain immobile (cf. Fig. 2) :

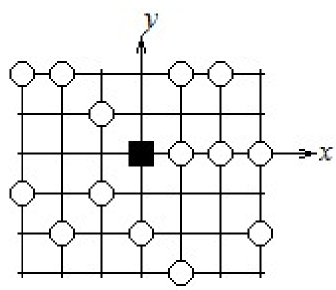

Figure 2. Configuration of the system at time $t=t_1$. All B_i objects have been shifted by one grid unit, except for the only one located along the same vertical as *A*.

– At time t_{4n+2}, object *A* is allowed to move by one unit length, either towards the left or the right, provided that the corresponding location(s) is(are) empty. Supposing for instance that only the *left* (resp. *right*) location is available for *A*'s move, we expect that the two possible final locations of *A* will be occupied with pre-defined probabilities p_{left} and p_{middle} (respectively : p_{middle} and p_{right}), with $p_{left}+p_{middle}=1$ (respectively : $p_{middle}+p_{right}=1$). One possible resulting configuration is represented in Fig. 3 :

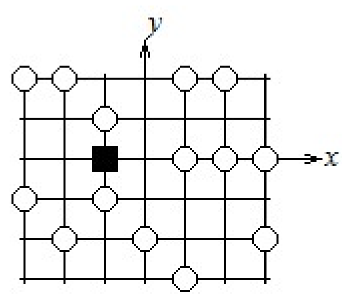

Figure 3. Configuration of the system at time $t=t_2$. Object *A* has been shifted towards the left by one lattice unit. According to our rules, *A* could have either stayed in place with probability p_{middle}, or shifted towards the left with probability p_{left}. Only the second alternative has been represented here.

– At time t_{4n+3}, all objects B_i located *at A's left side* are uniformly translated by one unit of length inside their own loop, the direction of the shift being the same as at time t_{4n+1} (which corresponds to a move towards y in Fig. 4), whereas all other B_i (located either within A's loop or at A's right side) remain immobile :

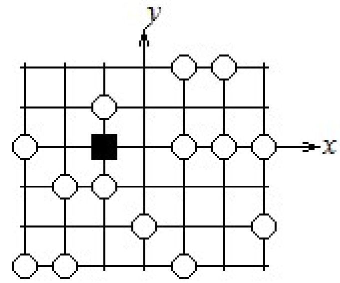

Figure 4. Configuration of the system at time t=t₃. All objects B_i located at A's left side have been shifted upwards by one lattice unit.

– At time t_{4n+4}, A is allowed to move according to exactly the same rules as at time t_{4n+2} (cf. Fig. 5) :

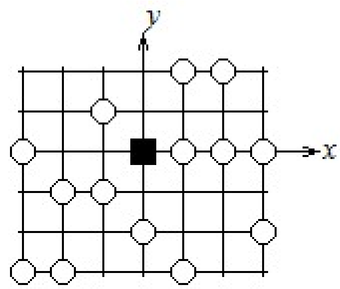

Figure 5. Configuration of the system at time $t=t_4$. Object A has been shifted towards x by one lattice unit. According to our rules, A could either have moved towards the left, remained at the same place or moved towards the right by one lattice unit. Only the third possibility has been represented here.

In order to allow A to jump from one site to another, the Hamiltonian of our model needs to contain appropriate nearest-neighbor transfer terms, whose magnitude "t" can be supposed to be uniform over the whole grid. We shall suppose that the magnitude of "t" is negligible in comparison with the quantity k_BT determined by the uniform temperature of our entire system, which explains why, for the sake of simplification, "t" will be neglected within all the forthcoming equations of this article.

In most cases, the resulting long-term motion of A can be expected to exhibit some rather complex behavior, with chaotic characteristics. However, at least one limiting case can be analyzed easily without any computer simulation : it corresponds to the situation wherein the average density $\rho_{(B)}$ of B_i objects is identical for each loop, and where it becomes so close to 1 that nearly all grid locations are occupied by one B_i (even as we continue to require that each loop contains at least one knot unoccupied by any B_i item).
During the interval $t_{4n+1} \leq t \leq t_{4n+4}$, two rotations of B_i rings have occurred on A's left side (respectively at $t= t_{4n+1}$ and $t= t_{4n+3}$). Therefore, the probability that A may have moved towards the left during this interval corresponds, in first order of $(1-\rho_{(B)})$ (*i.e.*, neglecting the probability that A may have drifted twice during this time interval), to :

$$P_{A\text{'s drift towards the left}} \approx 2(1-\rho_{(B)})\,p_{left} \qquad (1)$$

During the same time interval $t_{4n+1} \leq t \leq t_{4n+4}$, a single rotation of B_i rings has occurred on A's right side (at t=

t_{4n+1}). Therefore, the probability that A may have moved towards the right during the same interval corresponds, in first order of $(1-\rho_{(B)})$, to :

$$P_{A\text{'s drift towards the right}} \approx (1-\rho_{(B)})\,p_{right} \tag{2}$$

Eqs. (1) and (2) immediately lead to the conclusion that A's anisotropic average displacement towards the left during the interval $t_{4n+1} \leq t \leq t_{4n+4}$ is, in first order, equal to :

$$Drift_{(A)} \approx (1-\rho_{(B)})(2p_{left} - p_{right}) \tag{3}$$

Under the most common physical circumstances, supposing that A's motion can be described for instance in terms of Brownian motion, we can expect that $p_{left}=p_{right}={}^{1}/_{2}$.
A more useful scenario corresponds to the case when A's displacement towards the left costs a non-zero amount of work δW per grid unit-length. For the sake of simplicity, let us continue to suppose that $\rho_{(B)}$ is so close to 1 that A is practically never surrounded by two empty locations at the same time, and that A's drift is influenced by Brownian collisions with a large thermalizer whose uniform and constant temperature is T. We obtain :

$$p_{left} \approx e^{-\delta W/k_B T} \Big/ \left(1 + e^{-\delta W/k_B T}\right) \tag{4a}$$

$$p_{right} \approx e^{+\delta W/k_B T} \Big/ \left(1 + e^{+\delta W/k_B T}\right) \tag{4b}$$

Eq. (3) thus becomes :

$$Drift_{(A)} \approx (1-\rho_{(B)})\left[\; 2e^{-\delta W/k_B T} \Big/ \left(1 + e^{-\delta W/k_B T}\right) - e^{+\delta W/k_B T} \Big/ \left(1 + e^{+\delta W/k_B T}\right) \;\right] \tag{5}$$

Provided that δW remains small enough, A continues to drift, on average, towards the left. The amount of thermal energy (random collisions) converted to "useful" energy (derived from A's anisotropic motion) can increase linearly with time. If the grid possesses infinite dimensions, energy conversion can thus reach arbitrarily high levels.

3. Salient features of the model

Imposing that A and B_i should move in discrete steps upon a grid, jumping from one intersection to a neighboring one, provides us with an idealized representation which, admittedly, does not look very physical. A fully realistic picture can be easily constructed, however, without altering its statistical properties, for instance by supposing that the tubular shape within which the grid is enclosed possesses a non-zero thickness, so that our tube can be divided into boxes of identical dimensions (Fig. 6) among which A may evolve in the same way as a single molecule would do. The rules enunciated above (§2) for the motion of A and B_i can be replaced respectively by rules for A's motion and by rules for the motion of the boxes themselves in the following way : at times t_{4n+1} and t_{4n+3}, suitable rings of boxes are shifted by one unit-length (towards y in the planar representation of Figs. 1–6) ; at times t_{4n+2} and t_{4n+4}, the separations between the box containing *A* and its two nearest neighbor boxes (left and right) are slightly opened ; shortly before t_{4n+3} and t_{4n+5}, these separations are fully reinstated.

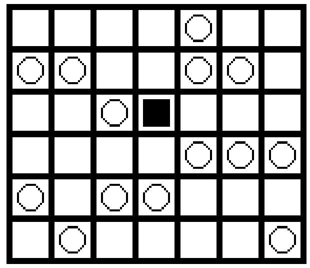

Figure 6. Insertion of our system within an array of boxes, whose separating walls can supposedly be controlled at will by an operator (or by object *A* itself, depending on what kind of specific model one wishes to consider). The configuration of *A* and B_i objects is identical to the initial configuration represented in Fig. 1.

Within a classical picture, shifting entire rings of boxes at t_{4n+1} and t_{4n+3} does not cost any energy ; opening or closing dividing walls at t_{4n+2} and t_{4n+4} does not cost any energy either. Within a quantum picture, the situation becomes slightly different : since boxes simply move from one position to a neighboring position of identical potential energy, shifting boxes at t_{4n+1} and t_{4n+3} can remain energetically costless provided that a clock may guarantee us that the duration needed for shifting boxes remains under control. We shall discuss in more detail the issue raised by the need of a clock in paragraph (iii) below. Within a quantum picture, opening or closing dividing walls at t_{4n+2} and t_{4n+4}, as well as shortly before t_{4n+3} and t_{4n+5}, is more delicate, since such an opening/closing operation can be expected to involve some energy expenditure. However, this expenditure becomes negligible if we ensure that the opening made within the walls is sufficiently small. In that case, the energy cost of opening or closing dividing walls can become marginally small in comparison with k_BT.
Yet another complication arises, at least in principle, within a quantum picture : object *A* may partially occupy different boxes *simultaneously*, with a different occupation probability for each box. Fortunately, this kind of delocalization effect cannot affect *A*'s energy in any significant way if the opening made within the walls is sufficiently small ; what is more, sooner or later, some decoherence process can be expected to localize *A* somewhere in the lattice, which will lead us to recover a classical picture, even if we do not really need to care about such a simplification.

Under more general terms, let me further emphasize that no part of the present article implies the use of any unconventional physical concept ; even less the use of any mathematically sophisticated tool. Standard thermodynamic notions, which can be found in any textbook, fully suffice to describe what happens in my model. In order to keep my article as short as possible, and to avoid the fastidious discussion of concrete details that would not raise any fundamental issue, I shall merely focus on four key features of the above model :

(i) My model supposes that a suitable machine can be used to displace all the boxes containing B_i objects (or, alternatively, to displace B_i objects themselves, if one comes back to the first modality considered above) according to some predetermined fashion, without necessarily increasing its own entropy. This feature constitutes an intrinsic part of Szilard's own original idea [2] concerning what has later become commonly designed as "Szilard's engine". One should clearly recognize the fact that the very existence of such a mobile engine implies that our global system cannot be considered as perfectly thermal, in other words, that it has not reached a state of optimal relaxation. However, this does not forbid us to consider that the temperature of our large thermalizer is well defined, and that equations [4] and [5] are correct. Moreover, the fact that our machine remains, *stricto sensu*, out of perfect thermal equilibrium bears no influence on the functioning described in §2, since nothing forbids us to consider a machine whose internal relaxation towards greater thermodynamic equilibrium can require a time duration as large as we wish, *i.e.* much larger than the time during which one intends to make use of this machine. The time needed for the machine to become out of order can be expected to depend on the stability of the internal connections of its constituents as well as on the intensity of its thermal coupling with its environment. As far as the stability of its internal connections is concerned, nothing prevents us from considering *a priori* that it can be practically infinite. For instance, one may suppose that some parts of the machine consist of solid glass, which constitutes a good example of an out-of-equilibrium, yet very stable material. As far as the coupling of our machine with any kind of destructive environment is concerned, one should note that the operations of the machine described above do not require the existence of any environment of this kind. Neither B_i objects nor the boxes surrounding them enjoy any degree of freedom, except in connection with the machine that displaces them from one position to another. In our scheme, only A directly enters in contact with a thermalizer (at times t_{4n+2} and t_{4n+4}). Since no material object can be expected to be fully stable in this world, one can admittedly assume that our machine will finally become out of order one day in the future. However, if such a machine is both sufficiently stable and sufficiently isolated from any kind of destructive environment – which raises no conceptual difficulty – it can *a priori* enable us to store more energy during its lifetime than the quantity needed to build another identical machine.

(ii) It appears obvious that the most original step of the procedure described in §2 above occurs at $t=t_{4n+3}$: only the B_i objects located *on the left side* of A are supposed to be manipulated at $t=t_{4n+3}$. Such a procedure immediately raises the following question : doesn't one need to be informed of A's location in order to displace those B_i which are located on the left side of *A only* ? If this knowledge were really necessary, handling the corresponding information erasure would become thermodynamically so costly that the efficiency of our energy-conversion scheme would be entirely ruined (even if the information needed at $t=t_{4n+3}$ consisted of a few bits only). It is therefore absolutely crucial for us to show that any "knowledge" of A's location by an external machine is not necessary, independently of A's precise characteristics. Indeed :
– If A's size is macroscopic enough, A can contain an internal machine whose task consists in displacing surrounding boxes. Such a machine will not need to update any knowledge about its location in order to distinguish between its left and its right[1]. Therefore, no information-erasure difficulty can exist in this case.
– If A is too small to contain an internal machine (for instance, if A consists of a single molecule or a single atom, as in Szilard's 1929 article), shifting B_i objects or their surrounding boxes must be performed by an external procedure ; this can be accomplished at $t=t_{4n+3}$ with a Hamiltonian of the following form :

$$H = \mathrm{W}.\sum_{\mathrm{i,j}} \left|\text{i ring, located at the left of j, shifted by one box unit length}\right\rangle . \left\langle \text{i ring located at the left of j}\right| \otimes \left|A_j\right\rangle . \left\langle A_j\right| + c.c. \qquad (6)$$

In the above Hamiltonian, rings of boxes are indexed by i , and A's locations are indexed by j ; one naturally supposes that all the i rings are systematically shifted in the same fashion (either always clockwise, or always anticlockwise). W simply serves as a numerical factor. This Hamiltonian is strongly reminiscent of another Hamiltonian proposed in 2014 [13], enabling an operator to monitor a modified version of Szilard's engine in a perfectly mechanical way, without needing to erase any information in a costly way at all.

(iii) Another feature of the model presented in §2 should at least be mentioned : the need for a clock to

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[1] This situation is strongly reminiscent of the one I described in 2005 [14,15], where a compass (playing a role analogous to a macroscopic version of the object named A in the present article) was supposed to be equipped with all the machinery required to modify its own moment of inertia, thereby enabling it to explore different rotation states.

monitor the series of successive instants t_{4n+1}, t_{4n+2}, t_{4n+3}, t_{4n+4} *etc*, as well as to ensure that the machine serving to displace B_i objects (or their boxes) displaces them efficiently during a well calculated amount of time. Information about current-time, like any other kind of information, should *a priori* be considered thermodynamically costly to erase. As it happens, however, in the present case, we do not even need to examine whether a clever procedure may help us to avoid the cost of erasing information about time. Let us rather simply suppose that we find ourselves experimentally in the worst situation ; in other words, let us suppose that the implementation of our model requires us to handle information concerning time at a cost reaching as much as several k_BT for each time interval. Instead of studying a single object A, we might then choose to deal simultaneously with several A_i objects located within different similar experimental set-ups. Only one clock would be necessary for dealing simultaneously with all those set-ups. The work produced by the drift of all A_i should increase in a roughly linear fashion with the number of A_i objects. A sufficiently high number of A_i objects would therefore enable us to store more energy that needed for monitoring a single clock.

(iv) A last feature of the model presented above may deserve a short clarification : one may legitimately ask whether the condition imposed on the density of B_i objects (which has been assumed to be quite close to 1) is a crucial feature of our model. The answer to this question is negative. The only advantage of our assumption concerning the density of B_i objects is that it leads to an equation for A's drift which can be calculated exactly (Eq. 5) in a straightforward manner. From an experimentalist point of view, however, the requirement that the density of B_i objects should be close to 1 can be expected to appear quite inconvenient. A much more easily implementable model could be developed with small "rings" (still perpendicular to the xx' axis), each of them containing only two knots. For the sake of brevity, we shall not describe such an option any further.

4. Comparison with two other previously proposed models

The model presented above (§2) presents some very strong links with a modified version of Szilard's single-particle engine which I formulated in 2014 [13]. Fundamentally speaking, it appears even justified to consider it as kind of two-dimensional (more precisely, "tubular") "illustration" of my 2014 model. The present version nevertheless presents several original features :

(i) Although, from the point of view of quantum physics, the simplicity of my 2014 model could hardly be surpassed, my new model provides the distinctive advantage to appear simpler and self-contained from the point of view of *classical physics* (even simply "statistics"), which may possibly prove helpful one day for the development of concrete experimental set-ups. What is more, the validity of my new model is quite independent from any broader perspective and can be evaluated, primarily, for its own sake.

(ii) The first thermodynamically puzzling model I published dates from 2005 [14] ; a later brief discussion of this model briefly can be found in [15][2]. In 2014, I conjectured that "it is rather likely that a hidden

[2] I wish to mention that my 2010 article contains a technical error – fortunately deprived of any significant thermodynamical consequence – in its part A.4, where I have stated that "the condition that initial eigenstate populations should decrease as a function of energy eigenvalues is never exactly fulfilled at the macroscopic level, even when macroscopic equilibrium is attained. This is due to the fact that whenever the spatial length required to distinguish between two different eigenstates exceeds the thermal coherence length of the system, thermalization of such different eigenstates cannot impose their respective occupations to be energetically ordered". I wish to apologize for this erroneous statement, which I wrote awkwardly in an attempt to discuss the consequences of A.E. Allahverdyan and Th. M. Nieuwenhuizen's 2002 challenging study [18], which proves the validity of the second law of thermodynamics under several conditions. Their demonstration demands as a prerequisite, in particular, that the initial eigenstate populations of a canonical ensemble should decrease monotonously as a function of energy eigenvalues. Whenever decoherence effects occur in a system, eigenstate components are likely to be "measured" (quantum mechanically speaking) by the system's environment at any time, which shows that A.E. Allahverdyan and Th. M. Nieuwenhuizen's constraint cannot be expected to be universally implementable in practice. However, the precise characteristics of the initial eigenstate populations of a given system have nothing to do with the main reason explaining why A. E. Allahverdyan and Th. M. Nieuwenhuizen's proof does not apply to any of the three models I

continuity may be found between both of my [2005 and 2014] models". My present model goes a long way into showing how this conjecture must indeed have been correct. The crucial step t_{4n+3}, described in §2 above, serves to increase the degrees of freedom available on *A*'s *left* side *only* ; it can be paralleled with the procedure serving to temporally decrease the moment of inertia of the "compass" of my 2005 model, thereby increasing the number of its thermally accessible rotational degrees of freedom ; it can also be closely paralleled with the functioning of the Hamiltonian $\mathcal{H}$ described in my 2014 model. Eventually, although the technical details of energy storage shared by both my 2014 and my present model do not seem to reproduce closely those of my 2005 model, all of these three models possess a most essential ingredient : an isothermal procedure analogous to the one followed at step t_{4n+3} above (§2), according to which some fluctuating process may be adjusted as a function of the variable location of a given object (described respectively by the "compass" of my 2005 model, the "single molecule" of my 2014 model, and "object *A*" in my present model).

(iii) Already in 2005, I wondered why I needed to mimic a quasi-cyclic evolution of events in order to produce work in a sustainable way, even as my model did not require the use of two different sources of heat characterized by different temperatures, as standard Carnot cycles do. The quasi-cyclic features of my 2014 model are also quite prominent. Why couldn't my earlier models operate in a more "continuous", less "cyclic" fashion ? In fact, it now appears that the quasi-cyclic functioning of my former models was essentially fortuitous. My present model provides a rather convenient way to illustrate the fact that the removal of the quasi-cyclic features of my previous models is indeed possible.

5. Conclusion

The idea according to which a finite being endowed with extremely sharp faculties might serve to illustrate the statistical nature of the second principle of thermodynamics was originally enunciated by Maxwell in his 1871 treatise entitled *Theory of Heat*[3]. Three years later, such a hypothetical being was nicknamed by William Thomson an "intelligent demon". A humoristic mythology has continued to develop about this term (even in cartoons [17]) ever since. Perhaps such folklore would not have enjoyed the same degree of popularity if Thomson had used the more antiquated spelling *dæmon*, which would have suggested more clearly that

have proposed in 2005, 2014 and at present. A. E. Allahverdyan and Th. M. Nieuwenhuizen's proof is based on the calculation of the energy variation of a system $\delta W = \mathrm{tr}\{H_0[\rho(t)-\rho(0)]\}$, which, as they demonstrate, verifies $\delta W \geq 0$. In all my models, adopting the most direct way to define a quantity similar to Allahverdyan and Nieuwenhuizen's δW leads to the perfectly satisfying equality $\delta W=0$! In other words, Allahverdyan and Nieuwenhuizen's mathematical theorem is not violated in the least by any of my models. But this does not imply that these models are unable to transform heat into work : in order to provide a universal demonstration of the second law, it does not suffice to compute the energy variation of what Allahverdyan and Nieuwenhuizen define as their "system". For instance, my 2005 model consists of one "compass" *C* with two different isothermal baths (which I may note here Th_1 and Th_2). As it happens, Th_1 thermalizes the ensemble $\{C + Th_2\}$, whereas Th_2 thermalizes the ensemble $\{C + Th_1\}$. As I have shown in 2005, the entire process results in some energy loss in Th_2 (whereas the average energy variation of *C* remains zero in the end, as Allahverdyan and Nieuwenhuizen's demonstration require). In my 2014 and my present model, the average energy of what Allahverdyan and Nieuwenhuizen's article would induce us to define as a "system" also remains constant. Energy conversion is therefore not to be searched for within such a "system", but within its thermalizer(s), whose history does not develop in a cyclic way at all. The non-cyclical evolution of the thermalizer forbids one to apply Allahverdyan and Nieuwenhuizen's theorem to it in a meaningful way.

3 Maxwell later stated more clearly that the 2nd Law of Thermodynamics is based on a kind of "statistical certainty" in an undated letter to Tait (Cf. Ref. [16]). In this letter, Maxwell wrote :
Concerning Demons.
1. Who gave them this name ? Thomson.
2. What were they by nature ? Very small BUT lively beings incapable of doing work but able to open and shut valves which move without friction or inertia.
3. What was their chief end? To show that the 2nd Law of Thermodynamics has only a statistical certainty.
4. Is the production of an inequality of temperature their only occupation? No, for less intelligent demons can produce a difference in pressure as well as temperature by merely allowing all particles going in one direction while stopping all those going the other way. This reduces the demon to a valve. As such value him. Call him no more a demon but a valve like that of the hydraulic ram, suppose.

nothing malignant was implied about such a hypothetical being. In any case, Thomson's reaction to Maxwell's treatise can be *a posteriori* credited with the merit of having encouraged more physicists to ponder on the potentially interesting connections existing between entropy and information (even "intelligence"). The title of Szilard's 1929 article *On the decrease of entropy in a system by the intervention of intelligent beings* appears quite emblematic in this respect. Along the years, scientists like Claude Shannon, Rolf Landauer, Charles H. Bennett and many others have helped to clarify a large number of related issues. Ultimately, their answer to the question of whether any concrete "intelligent being" could decrease the entropy of a system in any useful way has been clearly negative. My own answer to the same question is just as negative as theirs. However, as it happens, what an "intelligent being" cannot do, a "perfectly ignorant being" can achieve. Such a mindless being can perpetuate its own oriented course of motion without ever needing to bother about erasing the information which it has never even started to record in the first place.

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