

# **The introduction of the Einstein Model of a Solid to Analytical Psychology.**

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## **Abstract.**

If we intend to bridge physics and psychology one of the shortest paths is through Thermodynamics and Analytical Psychology (AP). That is because in AP both the First and the Second Law of Thermodynamics, are well defined (Principle of Equivalence, Principle of Entropy). There are not too many thermodynamic models. As a result our choices are limited. The Einstein model of a Solid (ES) is a thermodynamic model with applications in thermodynamics, quantum statistics and solid state physics. I intend to show that the ES is a suitable model to bridge thermodynamics and theoretical AP.

The approach I follow is an attempt to match the abstract entities of AP to those of the ES. I also attempt to prove that the conditions on which the ES is based, agree with AP. Finally I attempt to solve a crucial paradox met in theoretical AP, but not explained yet.

The results of this paper could be summarized as follows: I prove that a match between the abstract entities of AP and those of the ES can be achieved. I prove that two of the conditions, on which the ES is based, are clearly met in AP. I meet no conflict between the rest of the conditions of the ES and the theory of AP. Finally I explain and solve the paradox.

The Conclusions/Significance of this research is that I introduce algebraic expressions in AP. Additionally, I help both the practitioner and theorist of AP as any improved theory would.

**Keywords:** Einstein solid, Analytical psychology, Entropy.

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## **Presentation of the ES and the physical conditions it is based on.**

The ES is a thermodynamic model that refers to a system of harmonic oscillators. It is useful because with a few and fundamental assumptions, algebraic expressions are produced that agree with the relevant experiments. The title of the book that is useful for the understanding of the physics part of this paper can be found here<sup>[1]</sup>. The parts of this book that are the most useful to us are in Chapter 2, pages 53 - 66. In pages 54, 55 one examines the way of arranging  $q$ , the number, integer positive, indistinguishable units of energy (values<sup>[2]</sup>, pg. 60, according to Jung) in  $N$ , the number, energy tanks. We suppose that these tanks obey the following conditions: (a) they are separate/distinguishable among them, (b) non interacting, (c) all the energy levels of all tanks are equiprobable, (d) each tank can contain from one to  $q$ , units of energy, (e) the energy levels of all tanks are equally spaced. The algebraic expressions [Equation 2](#), [Equation 3](#) that I am going to produce, occur after some algebra from our conditions. The conditions (a) to (e) are set from the definition of the ES. Let us state here that  $N$  should be large "enough".

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## **A successful match between the abstract entities of AP and the physical entities and conditions the ES is based on.**

There is an intuitive match between the abstract entities of AP and those of the ES:

- Energy units/quanta  $q$  can be matched to Values<sup>[2]</sup>, pg. 60, according to Jung: "One of Jung's most important dynamic concepts is that of value. A value is a measure of the amount of energy that is committed to a particular psychic element."<sup>[2]</sup> page 60. This also implies that psychic structures/elements can be matched to energy tanks.
- The principle of conservation of energy in our model matches the one in analytical psychology. That is because the psyche is considered a closed system, just like the ES: "The question of whether or not the energetic point of view is even applicable to psychic phenomena at all is raised along with the question of whether the psyche can be looked upon as a relatively closed system. Although these questions are controversial, they are answered in the affirmative. In order to apply the energetic standpoint to psychology it is assumed that a quantitative estimate of psychic energy is possible."<sup>[4]</sup> As a result,  $q$  will be considered as a constant in our physical model (ES).
- "Such is not the case, however; there are many interactions among them. Jung discusses three kinds of interactions. One structure may

compensate for the weakness of another structure, one component may oppose another component, and two or more structures may unite to form a synthesis.”<sup>[2]</sup> page 53. On a first look we could say that the ES is not compatible with AP because in the ES the energy tanks are non interacting with one another<sup>[1]</sup>, page 54. This could end our discussion here and straight away. However, in our model we accept the fact that N can decrease (or increase) while q still remains constant. This means that when a structure abandons our model, it “leaves” the whole amount of its energy “behind”, which is redistributed among the rest of the tanks. This implies that although the tanks can be separate and distinguishable and not interacting directly, with one another (in the ES), there is an independent “process” (the “canalization of libido”<sup>[6]</sup>, in AP) that arranges/distributes the energy among them, as soon as N increases or decreases. As a result we may consider the conditions (a) and (b) of the ES as valid.

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### **A crucial controversial issue/paradox met in AP.**

“There is another obstacle to the operation of the entropy principle in the personality dynamics. When a structure becomes highly developed and consequently assumes a position of great power in the psyche, it tends to become independent of and cut off from the rest of the psyche. Like an autocratic ruler, it seizes more and more power (energy) from other structures, besides monopolizing new energy that enters the psyche. The flow of energy from a strong structure to a weak one is not only blocked; it is reversed. Thus, the psyche becomes greatly unbalanced; there is one dominant structure which becomes stronger and a lot of weak ones which become weaker. A strong complex, for example, will attract a great many of the new experiences to it, just as a rich and powerful nation tends to become richer and more powerful by appropriating or discovering new sources of wealth. This sort of autocracy in the personality may be a stabilizing influence, for a time, but there is always the danger that the ruling complex will be overthrown by the operation of the entropy principle. The sudden flow of energy out of a powerful system can have the same disastrous consequences that result from the breaking of a dam.”<sup>[2]</sup> , page 72.

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## Resolution of this paradox by introducing the ES in AP.

We may consider the case of a patient whose psyche deviates from equilibrium as described in the paradox: “Thus, the psyche becomes greatly unbalanced”<sup>[2]</sup>, page 72. During this procedure in the psyche of the patient, the total energy is conserved while the number  $N$  of the discrete psychic structures decreases: “there is one dominant structure which becomes stronger and a lot of weak ones which become weaker”<sup>[2]</sup>, page 72.

As dictated by the application of the ES:

- i. We observe that when  $N$  decreases, the entropy also decreases ([Equations 1 and 2](#), [Figure 1](#)), in contrast to the Second Law of Thermodynamics (the psyche is a closed system, so the entropy cannot decrease). That makes the specific person to be considered as a patient.
- ii. We introduce the probability  $p$  of the “dominant structure”, “the favorite structure, of the patient”, to gain the total amount of energy in the psyche. According to the conditions of the ES,  $p$  increases by the decrease of  $N$  ([Equation 3](#), [Figure 2](#)). This increase of the particular probability is what motivates the patient to continue this monotonous “game” (keep decreasing the  $N$ , in his/her mind). No matter how exciting the prospects of the increase of  $p$  seem, the more chaotic the state of the mind of the patient becomes. This more chaotic state of mind of the patient is imposed axiomatically, due to the decrease of entropy by a decreasing  $N$  ([Equations 1 and 2](#), [Figure 1](#)).  
As concluded from the above, entropy increases/decreases if and only if  $p$  decreases/increases accordingly and in this order.

This is how the ES solves the paradox<sup>[2]</sup>, page 72. It means that the particular patient cannot have it all, both “peace of mind” and “total victory”.

This also means that the ES explains the phenomenon a case/state that seems as improbable to the external observer (for him/her  $N$  is a large number and the possibility  $p$  defined in [Equation 3](#) is negligible) to be considered a definite fact by the patient ( $N$  is small and  $p$  close to one/maximum).

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## Technical part.

$S = k \log \Omega$  (Equation 1), the definition of entropy in thermodynamics.  $k =$  Boltzmann constant.

$\Omega = \frac{(q+N-1)!}{q!(N-1)!}$  (Equation 2), the multiplicity of an ES (Schroeder<sup>[1]</sup> pg. 55, Equation (2.9) with its proof).

The probability ( $p$ ) for the total amount of energy ( $q$ ) to be concentrated in one specific energy tank is after some elemental combinatorics:

$p = \left(\frac{1}{N}\right)^q$  (Equation 3). As we can see it increases by the decrease of  $N$ .

*Comment:* If one assumes that all the microstates are equiprobable, then Equation 3 becomes,  $p = \frac{1}{\Omega}$ . I will not adopt this assumption in this paper, though.

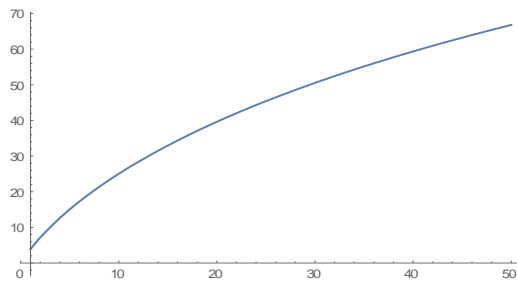


Figure 1.

$\frac{S}{k} = \log \Omega$ . The number of tanks  $N$  in the horizontal and  $\frac{S}{k}$  in the vertical axis.

$k =$  Boltzmann constant. I have set  $q = 50$  arbitrarily.

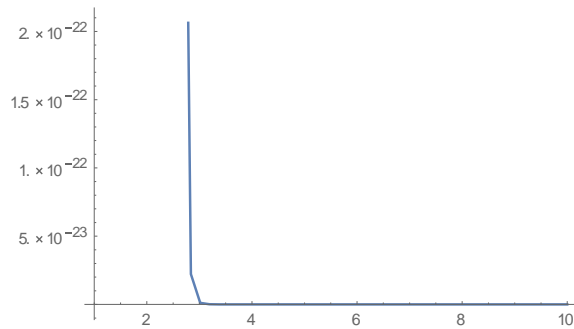


Figure 2.

$p = \left(\frac{1}{N}\right)^q$  (Equation 3). The number N of tanks is in the horizontal and p in the vertical axis. I have set  $q = 3$  arbitrarily.

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## Literature.

Here I introduce acknowledged and classic literature on Thermal Physics and AP.

1. Daniel V. Schroeder, An Introduction to Thermal Physics, Addison-Wesley Publishing Company, San Francisco, CA, 1999. The parts of this book that are the most useful to us are in Chapter 2, pages 53 - 66. In pages 54, 55 one examines the way of arranging  $q$ , the number, integer positive, indistinguishable units of energy (values [\[2\]](#), pg. 60, according to Jung) in  $N$ , the number, distinguishable energy tanks. In page. 55, Equation (2.9): The multiplicity of an ES with its proof.
2. A Primer on Jungian psychology, Calvin S. Hall, Vernon J. Nordby, January 1, 1999, Penguin Group.
3. Collected Works of Jung, Vol. 8, paragraph [7]. The principle of conservation of energy in our model matches the one in analytical psychology. That is because the psyche is considered a closed system, just like our ES model: "The question of whether or not the energetic point of view is even applicable to psychic phenomena at all is raised along with the question of whether the psyche can be looked upon as a relatively closed system. Although these questions are controversial, they are answered in the affirmative. In order to apply the energetic standpoint to psychology it is assumed that a quantitative estimate of psychic energy is possible."
4. Jung, C., Collected Works of C. G. Jung, Vol. 8. 2nd ed., Princeton University Press, 1972. 588 p. (p. 6-14). Energy units  $q$  can be

matched to Values<sup>[2]</sup>, pg. 60, according to Jung: “Complexes are defined as constellations of psychic elements grouped around feeling toned contents, or complexes. These are said to consist of a nuclear element and a large number of secondarily constellated associations. The objective estimate of psychological value intensities is based on the assumption that the constellating power of the nuclear element corresponds to its value intensity, i.e., to its energy.”

5. Jung, C., *Collected Works of C. G. Jung*, Vol. 8. 2nd ed., Princeton University Press, 1972. 588 p. (p. 25-28). In analytical psychology: “Entropy, as important as equivalence in the practical application of the theory of energy to psychology, is explored. It is defined as a principle of partial processes that make up a relatively closed system. Since the psyche can also be regarded as a relatively closed system in which transformations of energy lead to an equalization of differences, the principle of entropy is applicable to psychic energy.”
  6. Jung, C., *Collected Works of C. G. Jung*, Vol. 8. 2nd ed., Princeton University Press, 1972. 588 p. (p. 41-45). “The canalization of libido is defined as a transfer of psychic intensities or values from one content to another, a process corresponding to the physical transformation of energy. Examples chosen from primitive customs and ceremonies illustrate this process. Human culture is seen as the machine that provides for the canalization of libido as well as of mankind's physical and chemical energy. It is described as the means by which instincts are made productive. The transformation of instinctual energy is achieved by its canalization into an analogue of the object of instinct. An analogy is drawn to the manner in which a power station imitates a waterfall to gain possession of its energy, in order to explain how the psychic mechanism imitates the instinct and is thereby enabled to apply its energy for special purposes. Primitive man used complicated ceremonies to accomplish the canalization of libido; modern man does this by an act of will. Besides succeeding in taming external nature, man has succeeded in taming his internal nature to some extent. It is observed, that only slight threats to present conditions are needed to revive the magical ceremonies of our ancestors.”
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