

NOTE ON T. JACOBSON'S "THERMODYNAMICS OF SPACETIME:
THE EINSTEIN EQUATION OF STATE"

1. The *Einstein equation* may be understood as a *state equation*. For this to be possible, *entropy* must be regarded as being proportional to the area of the *causal horizon*. However, for this *equivalence* to make sense, we must seek to define what is meant by *temperature* and *flow of energy* in the new context.

2. *Heat* – energy flowing between the various degrees of freedom which are not macroscopically observable – is understood, according to the new interpretation, as a flow which crosses a causal horizon. Temperature, which in thermodynamics is indissociable from the huge set of fluctuations, vibrations and movements associated with the various degrees of freedom of the objects that make up the system, is now understood as a function of the acceleration of the observer located on the horizon (Unruh temperature). The diathermic wall, which in thermodynamics separates the object from the outside world, is replaced by a causal barrier.

3. For the above-mentioned equivalence to be declined, *equilibrium* (which in thermodynamics is the condition that allows for the *definition* of the concepts used here) should be taken into account in the way in which the causal horizon of the Einstein equation is now to be thought of. In order that the question may be solved in general terms, an equivalence devoid of any *ambiguity* should be established between the terms considered here. The relationship which is sought between *thermal* and *gravitational* conceptual systems should make clear the *equality* that is hidden in this equivalence.

4. Thus, I hold that *curvature* is another name for *temperature* – which are two ways of saying the same thing. The latter should be able to be thought about on the basis of the former (and vice versa) without recourse to the interpretation it has been traditionally assigned. Thus, the so-called *vacuum fluctuations* which have hitherto been assigned a thermal character when observed from the perspective of a uniformly accelerated observer, can and indeed should be unnecessary according to the new doctrine. Rather, they may now be understood as a kind of "ether" that physics has not yet managed to do without.

5. Just as the constant of velocity c enabled Einstein to solve the problem which scientists were wrestling with at that time, and $G/c^2 = d/m$ allowed him to think of *force* as a curvature of space-time, so the constant $K = Td^3$ – as it contains a new definition of temperature that is not bound up with the ideas of statistical mechanics – manifests the *equality* which is referred to above in the simplest way: the *content* of the world cannot be separated from its *form*. *Radiation* and *mass* are another way of saying *temperature* and *volume*. The relationship between the last two expresses the relationship between the first two: both express the *quality* of the energy involved in each natural process. The equivalence that derives from this must be able to be shown as an *equality*.

6. The equality mentioned above should be sufficient for thinking about Physics, making so-called "dark" mass and energy superfluous. To conclude, then: just as the *Einstein equation* may be understood as a *state equation*, so the *state equation* of thermodynamics may be understood as an *Einstein equation*. Perhaps this approach will lead to a solution to the problem of *equilibrium* which assigns to *space* the importance that Einstein, for the first time, provided due recognition. Far from being a *scenario* in which the *Process* that Physics seeks to describe occurs, space is its most important manifestation. In it, the *present* may be seen as a *presence*.