SOME OF US FEEL INSECURE ABOUT WIGNER UNREASONABLE EFFECTIVENESS: TO ENJOY OR TO DISTRUST?

THE UNREASONABLE EFFECTIVENSS OF MATHEMATICS IN THE NATURAL SCIENCES [1960]

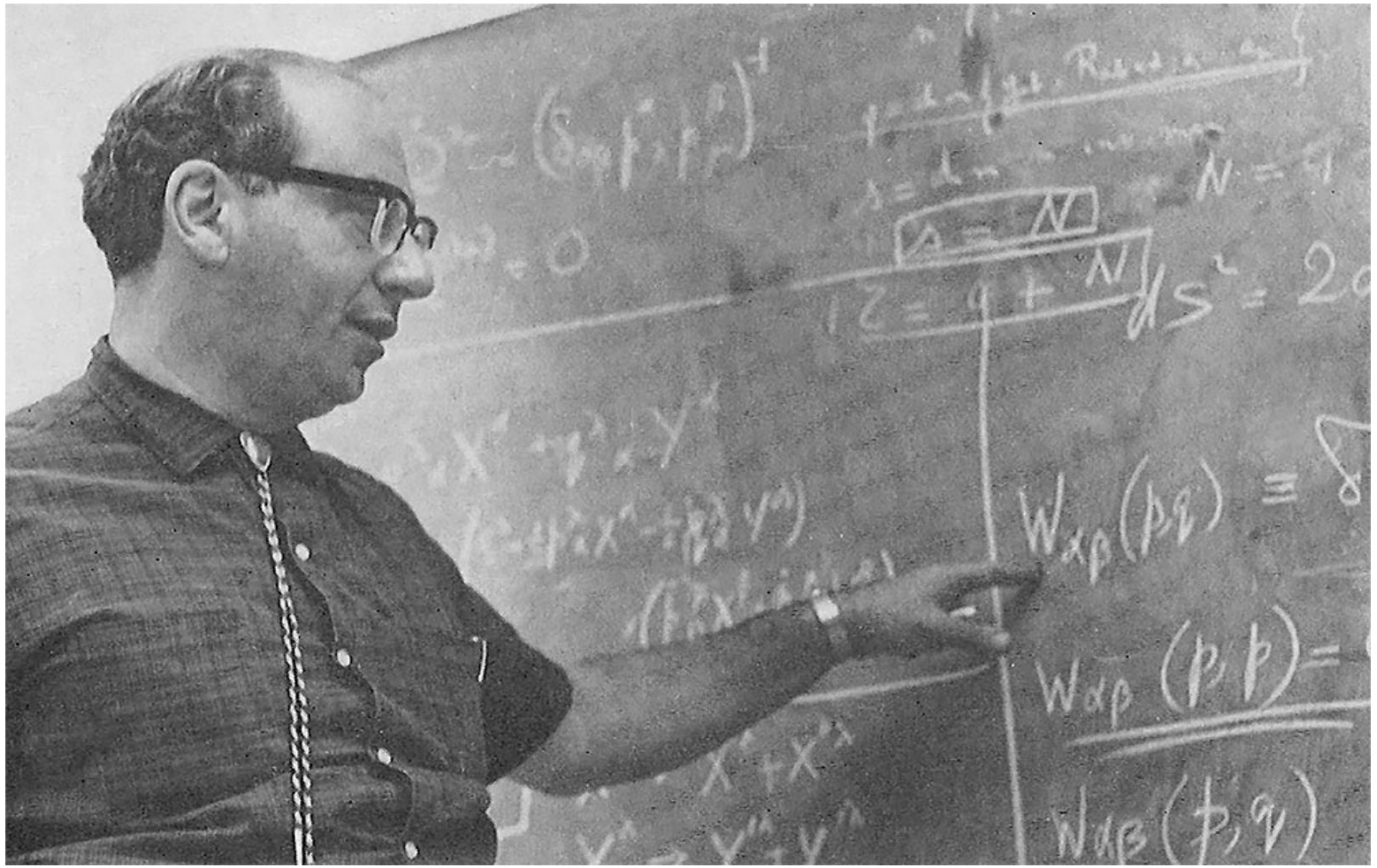
Eugene Wigner [1]

Mathematics, rightly viewed, possesses not only truth, but supreme beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than Man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry.

- BERTRAND RUSSELL, Study of Mathematics

Some doubts appeared in a humorous statement of Ivor Robinson

Ivor Robinson in 60-ties



In 1962 during the first General Relativity Conference in the soviet block held in Poland, Ivor was eating in the Palace of Culture, the tallest building in Warsaw.

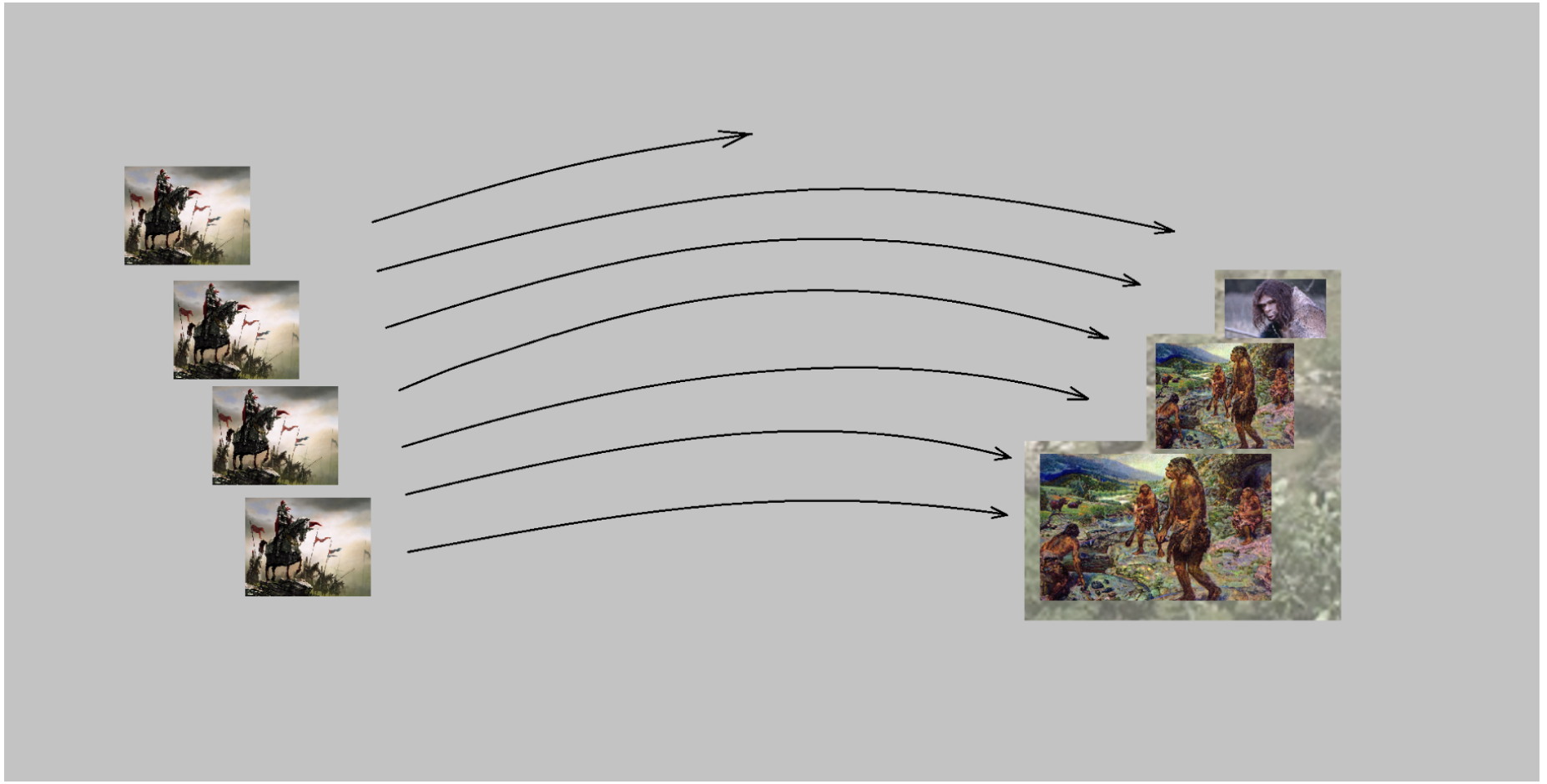
When biting a cake, he almost broke his tooth, since there was something dure inside. He exclaimed: What a strange country, where the palaces are made by cakemasters, but cakes are constructed by arquitects! Some good jokes may have an additional life.

In fact, what about our physical, social and political doctrines: are they not like the cakemaster palaces with something ugly inside?

Trying to understand this (generalized Robinson´s) phenomenon one sees that it is not new at all. To find its origin I was trapped into some more and more distant past, until arriving unexpectedly to an almost forgotten prehistorical problem.
Why did the Neandertals die?

Robin Mckie [2] science editor: No climate changes, no epidemic diseases, but...

The apearence of *homo sapiens,* with new comunication techniques, which permitted to organize hundred or thousand followers, under the direction of charismathic liders...



Once eliminated competition, the homo sapiens remained at mercy of their own talents...
They developed agriculture, great human aglomerations, cities, religions and powerful empires.

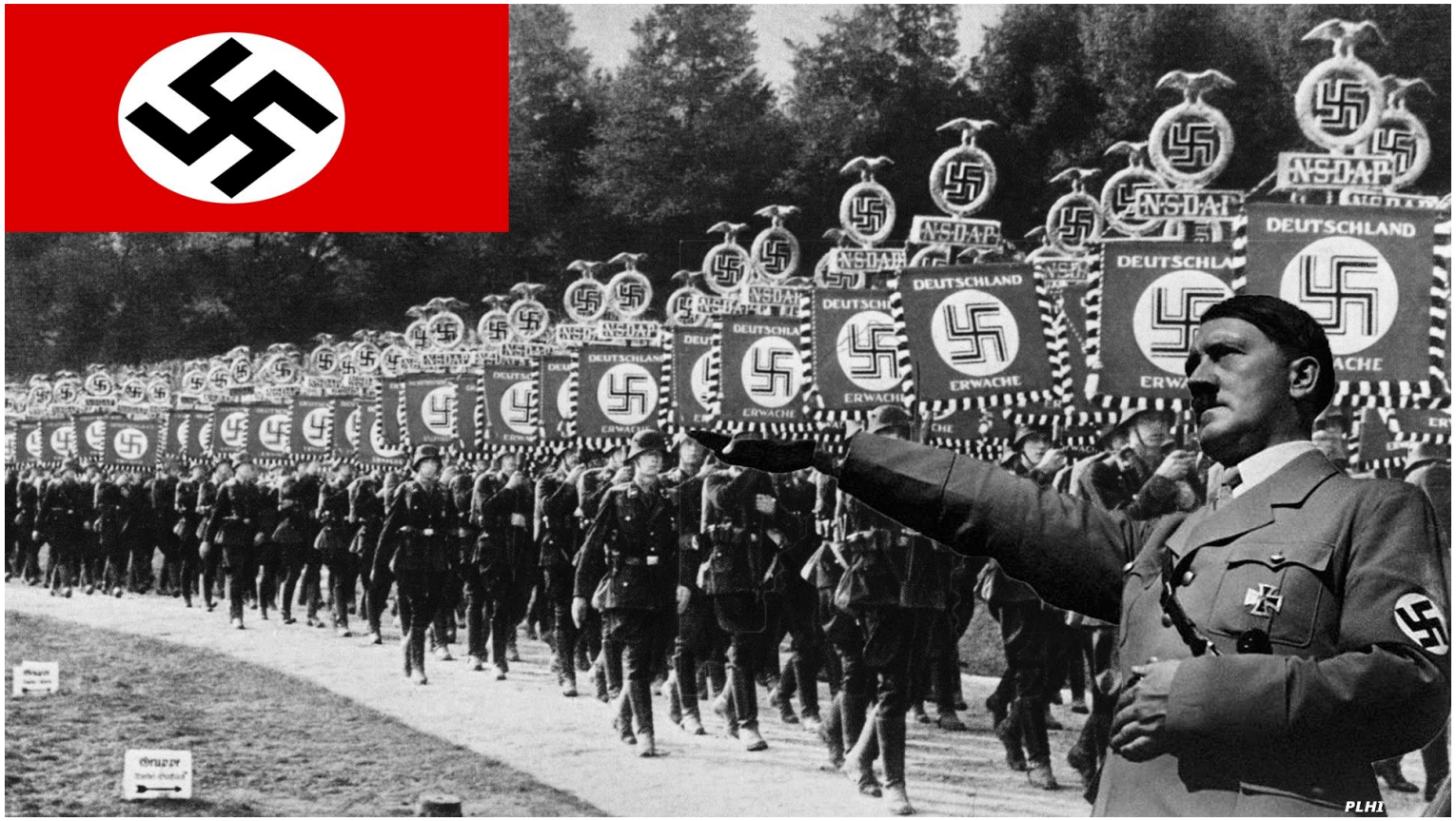
The Niniveh Palace in the capital of the Assirian empire. But also ...

They submerged into political competition, revolutions and cruel battles. I ask you to forgive me to show only few episodes.

The battle in Grünwald between the Teutonic order and Polish-Lithuanian forces (*shown in the painting of Jan Matejko*), changed the European history.

Vladimir Ilich Lenin, the leader of the soviet revolution.

Adolf Hitler... What organizational talents!



But what about science? Trends

Publish or perish?
the avantages of rapidly
published work. But will it be interesting for the arqueologist of XXII century?

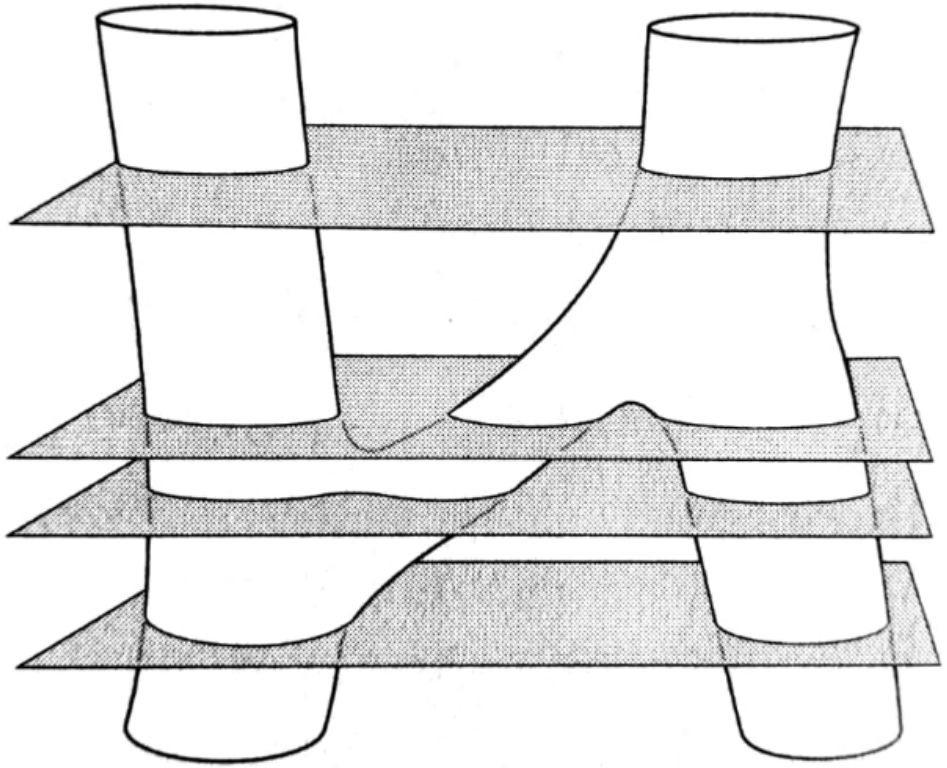
Jean de la Fontaine:

All minds of the world are helpless against any stupidity which became fashionable..

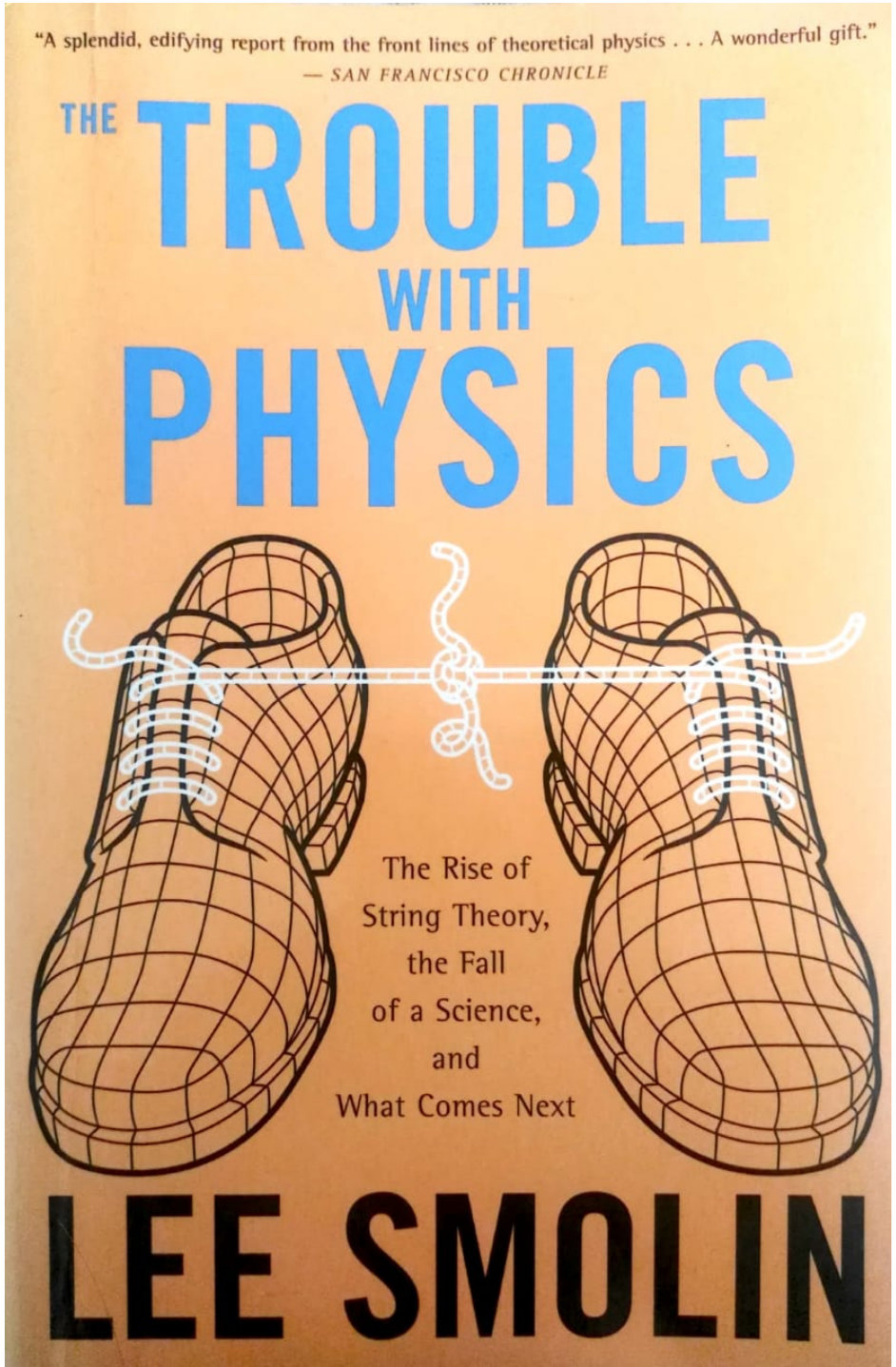
However even the wrong doctrines can accidentally lead to interesting discoveries. There exist quite old examples. One of them was the strong belief of Cristopher Columbus that the best way to India is by navigating to the west. The astronomers in Salamanca knew already, (from Eratosthenes), that the Earth radius was too big for Columbus and his team to arrive to India. In fact, Columbus did not fulfill his dream. But fortunately he just discovered an obstacle, later called the "West India".

STRINGS

If the graphs of quantum field theories are surrounded by some higher dimensional tubes, a lot of divergencies vanish!



It looks as one of advantages of “Unreasonable effectiveness” of Wigner or “mathematical poetry” of Russel. However...



The Trouble with Physics

The Rise of String Theory, the fall of a Science, and What Comes Next

Yet, some science centers adopt the dogma:

Strings: the only game in town!

But is it indeed so? Are they close to discover their west India? The problem is desperately open!...

The RADIATION EFFECTS seen by NON-INERTIAL OBSERVES.

In the simplest case of a static, rotation invariant Hamiltonian, the evolution operator seen by an observer rotating with frequency ω is:

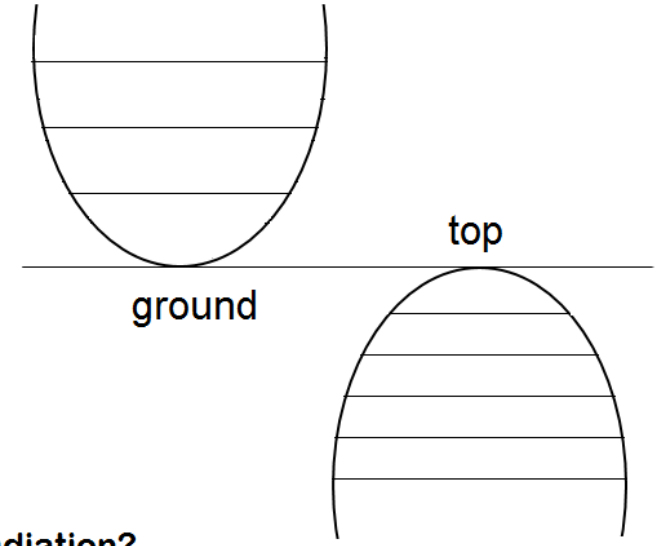
$$U(t) = e^{-i\omega Mt} e^{-iGt}$$

Where G is a time independent operator
("Hamiltonian" in the rotating frame?)

CAN IT DEFINE RADIATION?

FOR THE SIMPLE 2-D OSCILATOR

If ω is too big, then G has a misterious structure:



Can it describe radiation?

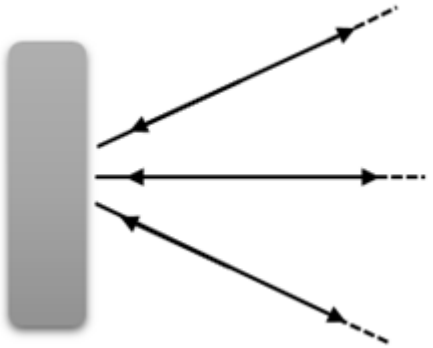
By adopting G as a criterion for the radiation (see [3]) one might be tempted to infer that the *ground–top* state is unstable and must fall down spontaneously to the subsequent negative levels, producing an avalanche of radiation. It looks as a treasure of Mathematical Effectiveness of Wigner. But...

Can it be true?

UNRUH RADIATION

In the uniformly acelerated frames. Unruh 1976 [4]:

> "What the detector regards as the detection (and thus absorption) of a Φ-quantum, the Minkowski observer sees as the emission by detector of such a quantum. The energy of this emission (…) comes from the external field accelerating the detector".



The surprising Unruh statement on the equivalence of the emission and absorption acts. Is it again the of Mathematical Efectiveness of Wigner or a "philosophical poetry" of Russel? Not exactly…

Unruh Exaggerates?

It seems that Unruh reduced too much the concept of measurement. First of all: the measuring device should be macroscopic. Next: the particle detection does not necessarily mean the particle absorption.
Next: in quantum particles their wave aspects coexist with corpuscular aspects. Now, if the experiments are performed in an accelerated laboratory where some particle detectors are submerged in a photografic emulsion (accelerated as well) then each particle emmited from one detector, and perhaps arriving to another will mark a semi-classical trajectory, whose beginning and the end cannot be oppositely interpreted by the internal and the inertial observers. This is true even for zero-mass particles as photons. Worse, for the massive particles if they exist in the particle bath (see our next image!)

ROASTING THE STEAK

According to Unruh, the quanta emitted by the detector create the temperature:

$$T = \frac{a\hbar}{2\pi ck}$$ = Temperature of the particle rain.

Can the Unruh radiation affect the macroscopic objects? The answer was offered by Unruh himself: "it is real enough to roast a steak"

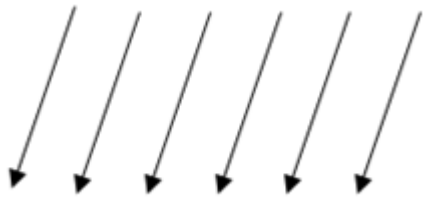
This, however, depends on the coupling constant ϵ relating the acelerated detector with its radiation field. As stated by Unruh ([4] p.885 col.2), if $\epsilon = 0$, the caloric effect will not materialize. Yet, he does not explain why the final termal effect T does not depend on ϵ.

HAVE THE BATH PARTICLES O-REST MASS?

Almost all publications on Unruh effect refer to the massless particles “seen” in the accelerated frame. However, on p. 886, Top of col. 2, in his paper [4] Unruh writes: “… one could also say that the accelerated proton has detected one of many high energy neutrinos which are present in the Minkowski vacuum in the proton’s accelerated frame of reference”. Yet, if neutrinos, then why not other massive particles, like nucleons, atomic nuclei, or tennis balls (or even worse, like the gun bullets)? AGAIN WIGNER EFECTIVENESS?

THE RAIN OF ZERO-ENERGY QUANTA?

In their review article [5] Luis Crispino et al report the rain of the zero- energy photons in **Unruh** radiation!



Then they "regularize" by introducing the charge current oscillating with frequency *E*,

$$j^{\tau} = \sqrt{2}q \cos E\tau\delta(\xi)\,\delta(x)\,\delta(y), \quad j^{\xi} = j^{x} = j^{y} = 0,$$

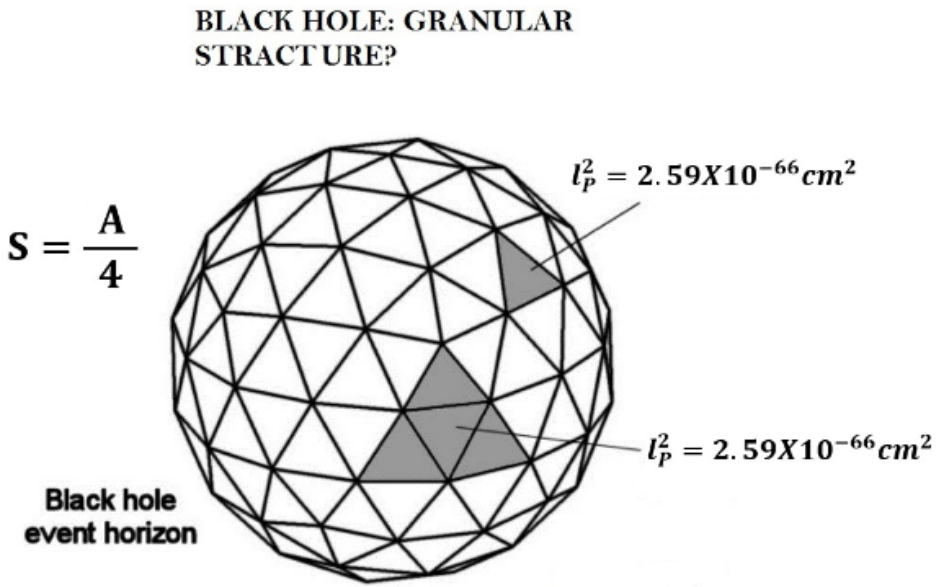
taking the limit $E \rightarrow 0$

The QFT is full of verbal manipulations, "regularizations" etc., but this one resembles the humorous observation of Earman [6] about the detector which can predict the results of its measurements in the future.

All these trends show some aspects of geniality thout not so much in constructing the new theories but rather in exhibiting the limitations of the known ones. Another use of Wigner effectiveness?

BLACK HOLE ENTROPY?

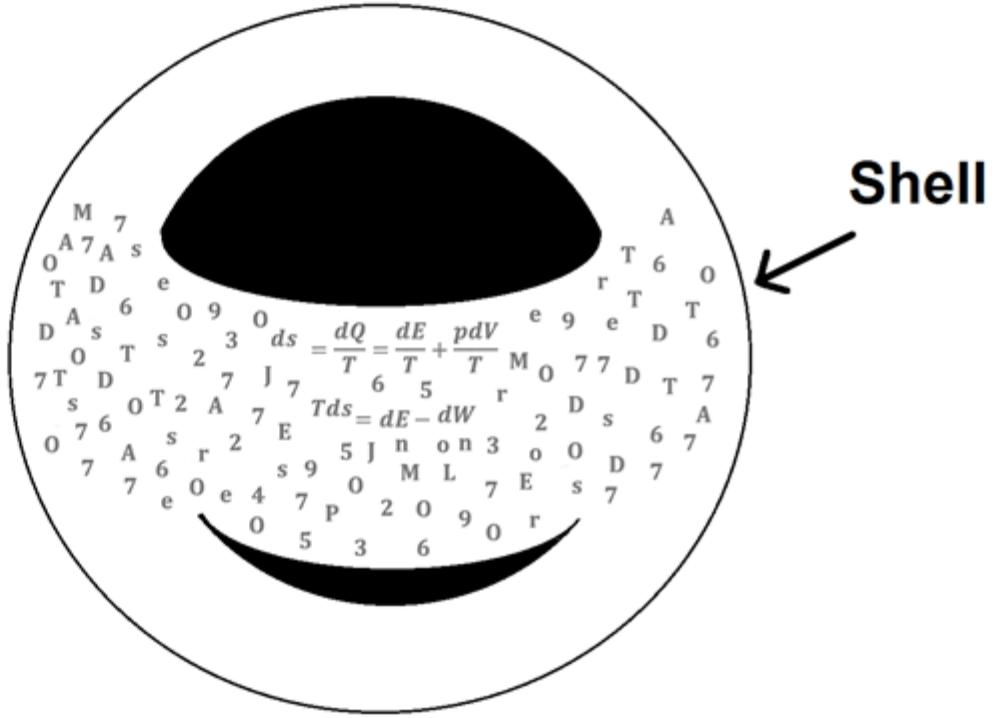
One of the well known hypotesis concerns the entropy of the black holes. The original argument: since the back hole never returns anything which it absorbed, its mass (and surface) must constantly grow. The other quantity which always grows is the entropy. Hence (Bekenstein 1973) the blach hole Surface (horizon) defines an entropy [7]. However to assure that black hole horizon has finite entropy, it cannot be a continuous classical surface.



The quantum (granular) structure of the black hole (e.g. of Schwarschild solution) is assumed by postulating the quantum surface elements equal to the squares of the Planck distance l_p^2. Under this assumption, the black hole of Schwarschild can hold an entropy $S = \frac{A}{4}$ where A is the horizon Surface in units defined by l_p^2.

THE IDEALLY SPHERICAL SHELL FALLING ON THE SCHWARSCHILD HORIZON:

The information - desinformation written on the shell will be soon swallowed by the black hole



Can it change the horizon entropy?

Bekenstein-Hawking: Yes, it will change the black hole entropy and temperature!
But it seems that they disregarded something essential…

INFORMATIONAL ENTROPY

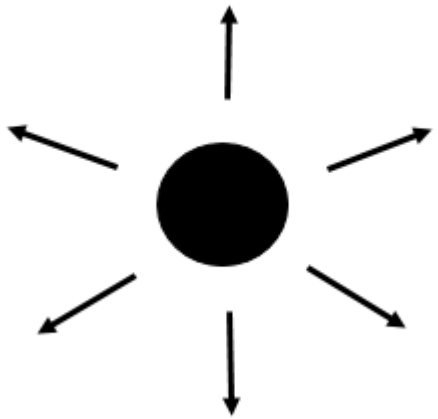
$$S = -\sum_j p_j \ln p_j$$

Is not termal, $\delta Q = 0$, so basically it should not modify the black hole entropy. Discussion between Shannon and V. Neumann [10]:

> Shannon:
> My greatest concern was what to call it. I thought of calling it `information´, but the word was overly used, so I decided to call it `uncertainity´.
> When I discussed it with John von Neumann, he had a better idea. Von Neumann told to me: “You should call it entropy, for two reasons. In first place, your uncertainty function has been used in statistical mechanics under that name. In the second place, and more important, nobody knows what the entropy really is, so in a debate you will always have the advantage.”

HAWKING RADIATION

What worried Hawking was that if the black hole has some temperature, then it should radiate. However, during some time, thare was no sign of this effect.



Finaly, in 1985 [8] Hawking could describe an interaction between the strong gravitational field of the black hole horizon and the polarized vacuum which created the black hole radiation. The argument was repeated in his “Theory of Everything [9]” .

Not without open problems!

INFORMATION LOST?

The fear of Hawking was that the information
transfered into the interior of the hole migth be lost in the radiation.
But he believed that the information is never lost: it can basically
be reconstructed from the rays send by the black hole.

BLACK HOLES EVAPORATE?

Another aspect, which could awake doubts was the supposed radiation
effect on the hole itself. Due to the emited radiation, the black holes,
if not absorbing matter, don´t grow but reduce their size, until vanishing.
Hawking calculation suggested that their vanishing is much faster when they
are already very small. He writes [9]:

> "What happens when the mass of the black hole eventually becomes
> extremely small is not quite clear. The most reasonable guess is that
> it would disappear completely in a tremendous final burst of emission,
> equivalent to the explosion of millions of H-bombs".

Is it another step of the poetry? But can this be true? (Better not?)

THE SURFACE ENTROPY ON EVENT HORIZONS BECOMES CRUCIAL?

The humorous article

T. Padmanabhan, “Secret life of the Spacetime” Int. J. Mod. Phys. D 21 1241005 (2012)

Warm Up: Secret Life of Matter...

The V-th prize of 2012 Essay competition of the Gravity Research Foundation.

Lessons from Classical Gravity about the Quantum Structure of Spacetime*

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There is large literature on this subject a small sample of which will be: Cai R G *et al* 2008 *Phys. Rev.* D **78** 124012; Kothawala D, Sarkar S and Padmanabhan T 2007, *Phys. Lett.* B **652** 338 [gr-qc/0701002]; Paranjape A, Sarkar S and Padmanabhan T 2006 *Phys. Rev.* D **74** 104015 [hep-th/0607240]; Akbar M 2007 *Chin. Phys. Lett.* **24** 1158 [hep-th/0702029]; Cai R G and Kim S P 2005 *JHEP* **0502** 050 [hep-th/0501055]; Sheykhi A, Wang B and Cai R G 2007 *Nucl. Phys.* B **779** 1 [hep-th/0701198]; Sheykhi Wang A B and Cai R G 2007 *Phys. Rev.* D **76** 023515 [hep-th/0701261]; A. E.Shalyt-Margolin, [arXiv:1006.4979]; Cai R G 2008 *Prog. Theor. Phys. Suppl.* **172** 100 [arXiv:0712.2142]; Ge X H 2007 *Phys. Lett.* B **651** 49 [hep-th/0703253]; Gong Y and Wang A 2007 *Phys. Rev. Lett.* **99** 211301 [arXiv:0704.0793]. Wu S F, Wang B and Yang G H 2008 *Nucl. Phys.* B **799** 330 [arXiv:0711.1209]; Wu S F *et al* 2008 *Class. Quant. Grav.* **25** 235018 [arXiv:0801.2688]; Cai R G and Ohta N 2009 [arXiv:0910.2307].

ENTROPOMANIA

A hypothesis appears about the “holographic principle” which permits to reconstruct all information hidden in a closed volumen from the data visible on the volume surface. (This includes the statistics, entropy, etc.) The entropies exist not only on the surfaces of the black holes but also on other space-time event horizons [11].

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The quantum space-time aspects are parts of modern visions of the evolution of the Universe, dark matter and energy, inflationary cosmologies etc.

Are all these theories the blessed results of the “Unreasonable effectiveness” of Wigner, or rather the “Cakemaster palaces” of Ivor Robinson? The problem is entirely open.

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