Lo que no podes no saber luego de un curso de cuerdas

Balance y lecturas de verano

Disclaimer: las opiniones expuestas a continuación no pretenden representar a las de la comunidad de altas energías

Hay que diferenciar dos cosas al valorar la teoría de cuerdas

I) Cuerdas como ejemplo de un modelo de gravedad cuántica

II) Cuerdas como un modelo realista de la naturaleza

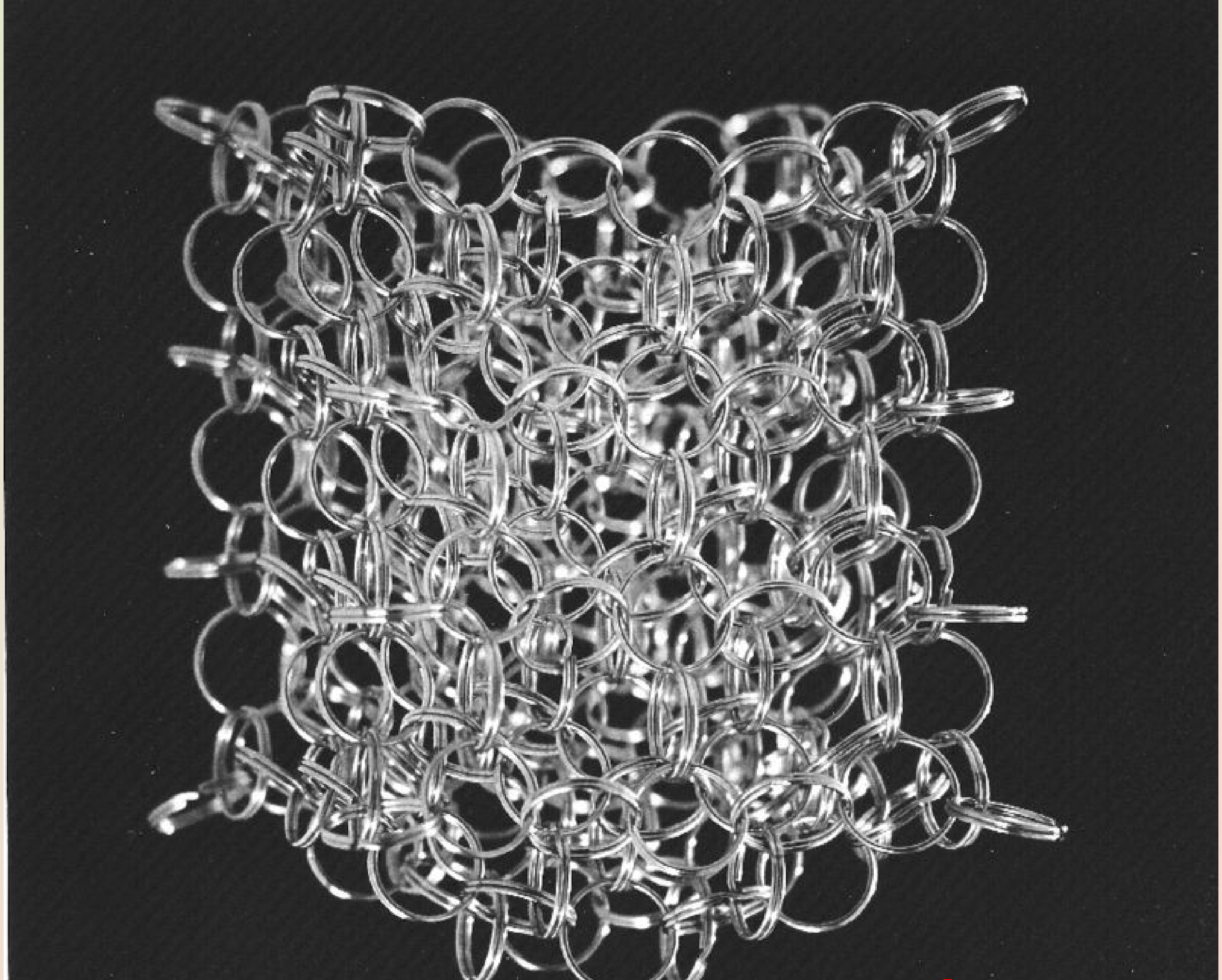
¿En que momento cuantizamos la gravedad?

$$G_{\mu\nu} \to \hat{G}_{\mu\nu}$$

?

No parece ser lo que hicimos, que fue cuantizar una cuerda moviendose en el espacio de Minkowski!.

Si uno se quiere sacar las ganas y ver ponerle un sombrero a la métrica el lugar indicado es otro.



Loop quantum gravity

Loop quantum gravity nace a mediados de los 80

Es un heredero directo del intento por hacer la cuantización canonica de gravedad, que se empezó a explorar desde principios de los 60, sin mucho exito

La clave de este enfoque fue la de encontrar las variables adecuadas a quantizar: integrales a lo largo de lazos cerrados. De ahi el nombre.

Nombres de la comunidad: Ashtekar, Smolin, Rovelli, Pullin, Baez, Thiemann

Wheeler-DeWitt equation

$$\left[-G_{ijkl}\frac{\delta^2}{\delta\gamma_{ij}\delta\gamma_{kl}} -^3 R(\gamma)\gamma^{1/2} + 2\Lambda\gamma^{1/2}\right]\Psi[\gamma_{ij}] = 0$$

$$G_{ijkl} = \frac{1}{2}\gamma^{-1/2}\left(\gamma_{ik}\gamma_{jl} + \gamma_{il}\gamma_{jk} - \gamma_{ij}\gamma_{kl}\right)$$

La teoría de cuerdas tiene un origen menos elevado pero hace mas contacto con los metodos de la fisica fierrera que fueron exitosos para describir la fisica de particulas

La teoría de cuerdas provee una cuantización consistente de un campo de spin 2, que reproduce resultados de la teoría perturbativa de un gravitón en Minkowski y otras métricas de fondo (backgrounds)

Ya eso es algo a destacar. Recordemos que la teoría de gravedad en torno a Minkowski no es renormalizable

Dos preguntas diferentes

1) ¿Tiene la teoría de cuerdas independencia de Background?

sss si

2)¿Existe una formulación manifiestamente independiente del background?

No se

On Background Independence in String Theory

Olaf Hohm

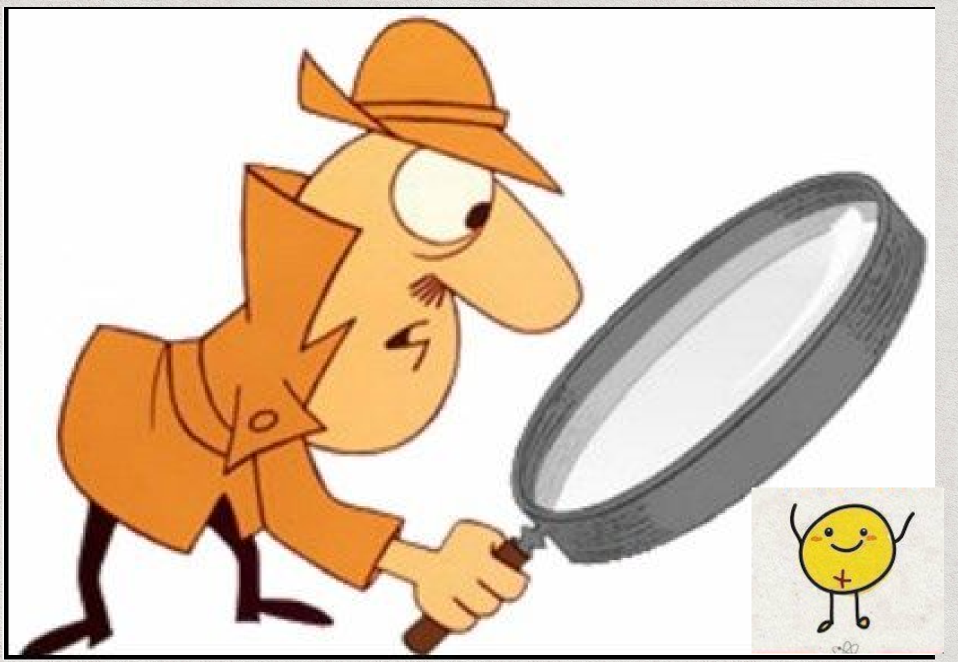
Versión linearizada, recontra dependiente del background

$$\mathcal{L}[h] = \frac{1}{2}\partial^\mu h^{\nu\rho}\partial_\mu h_{\nu\rho} - \partial_\mu h^{\mu\nu}\partial^\rho h_{\rho\nu} + \partial_\mu h^{\mu\nu}\partial_\nu h - \frac{1}{2}\partial^\mu h\,\partial_\mu h\,,$$

Versión no perturbativa idependiente del background

$$S = \frac{1}{2\kappa^2}\int \mathrm{d}^4x\,\sqrt{-g}\,R\,,$$

II) Cuerdas como modelo realista de la naturaleza



¿Que pasa si resulta que los objetos fundamentales no son cuerdas?

Maldacena salvó a las cuerdas

Aun si resulta que la teoría de cuerdas pierde todo interés como descripción de la naturaleza, subsistirá el principio holgráfico que encuentró materializado en la teoría de cuerdas.

Este principio da una nueva perspectiva para encarar el dificil problema del regimén no perturbativo de las teoriás cuánticas de campos

Conjetura en su versión original

The Large N Limit of Superconformal field theories and supergravity

Juan Maldacena[1]

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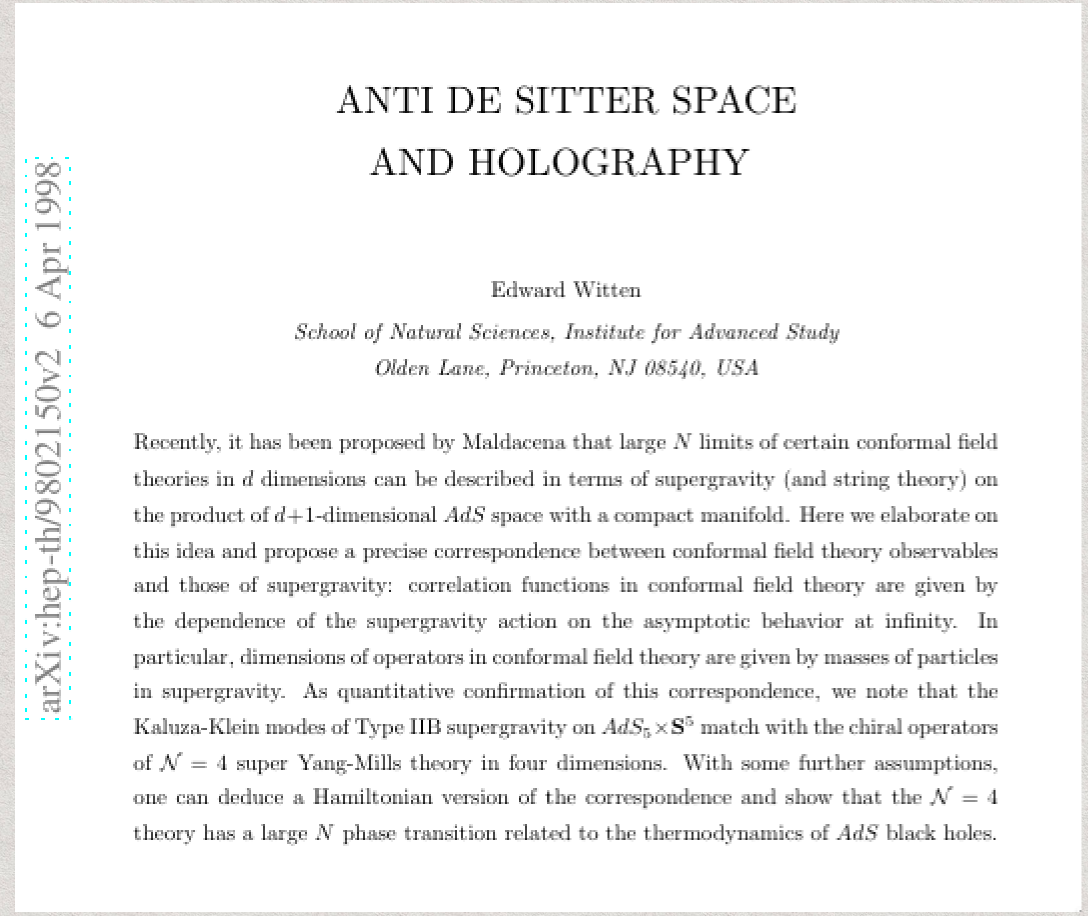
Abstract

We show that the large N limit of certain conformal field theories in various dimensions include in their Hilbert space a sector describing supergravity on the product of Anti-deSitter spacetimes, spheres and other compact manifolds. This is shown by taking some branes in the full M/string theory and then taking a low energy limit where the field theory on the brane decouples from the bulk. We observe that, in this limit, we can still trust the near horizon geometry for large N. The enhanced supersymmetries of the near horizon geometry correspond to the extra supersymmetry generators present in the superconformal group (as opposed to just the super-Poincare group). The 't Hooft limit of 3+1 $\mathcal{N} = 4$ super-Yang-Mills at the conformal point is shown to contain strings: they are IIB strings. We conjecture that compactifications of M/string theory on various Anti-deSitter spacetimes is dual to various conformal field theories. This leads to a new proposal for a definition of M-theory which could be extended to include five non-compact dimensions.

No es tan glamorosa
como sus
versiones posteriores

“Eduard” Witten nos hizo entender a Maldacena



arXiv:hep-th/9802150v2 6 Apr 1998

ANTI DE SITTER SPACE
AND HOLOGRAPHY

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Recently, it has been proposed by Maldacena that large N limits of certain conformal field theories in d dimensions can be described in terms of supergravity (and string theory) on the product of $d+1$-dimensional AdS space with a compact manifold. Here we elaborate on this idea and propose a precise correspondence between conformal field theory observables and those of supergravity: correlation functions in conformal field theory are given by the dependence of the supergravity action on the asymptotic behavior at infinity. In particular, dimensions of operators in conformal field theory are given by masses of particles in supergravity. As quantitative confirmation of this correspondence, we note that the Kaluza-Klein modes of Type IIB supergravity on $AdS_5 \times \mathbf{S}^5$ match with the chiral operators of $\mathcal{N} = 4$ super Yang-Mills theory in four dimensions. With some further assumptions, one can deduce a Hamiltonian version of the correspondence and show that the $\mathcal{N} = 4$ theory has a large N phase transition related to the thermodynamics of AdS black holes.

AdS/CFT correspondence

$\mathcal{N}=4$ supersymmetric $SU(N_c)$ YM theory in 4 dim $\Longleftrightarrow$ type IIB superstring theory on $AdS_5 \times S^5$backgrond

conjectured
exact equivalence

$$Z_{\mathrm{SYM}}[J] = \langle e^{-\int J\,\mathcal{O}\,d^4x} \rangle_{\mathrm{SYM}} = Z_{\mathrm{string}}[J]$$

Generating functional for correlation functions of gauge-invariant operators $\langle \mathcal{O}\ \mathcal{O}\ \cdots \mathcal{O} \rangle$ $\Longleftrightarrow$ String partition function

In particular

$$Z_{\mathrm{SYM}}[J] = Z_{\mathrm{string}}[J] \simeq e^{-S_{\mathrm{grav}}[J]}$$

$\lambda \equiv g_{YM}^2\,N_c \gg 1$

$N_c \gg 1$

Classical gravity action serves as a generating functional for the gauge theory correlators

According to [13], an $\mathcal{N} = 4$ theory formulated on M_4 is equivalent to Type IIB string theory on $AdS_5 \times \mathbf{S}^5$. We can certainly identify the M_4 in question with the boundary of AdS_5; indeed this is the only possible $SO(2,4)$-invariant relation between these two spaces. The correspondence between $\mathcal{N} = 4$ on M_4 and Type IIB on $AdS_5 \times \mathbf{S}^5$ therefore expresses a string theory on $AdS_5 \times \mathbf{S}^5$ in terms of a theory on the boundary. This correspondence is thus "holographic," in the sense of [32,33]. This realization of holography is somewhat

DIMENSIONAL REDUCTION in QUANTUM GRAVITY †

G. 't Hooft

Abstract

The requirement that physical phenomena associated with gravitational collapse should be duly reconciled with the postulates of quantum mechanics implies that at a Planckian scale our world is not 3+1 dimensional. Rather, the observable degrees of freedom can best be described as if they were Boolean variables defined on a two-dimensional lattice, evolving with time. This observation, deduced from not much more than unitarity, entropy and counting arguments, implies severe restrictions on possible models of quantum gravity. Using cellular automata as an example it is argued that this dimensional reduction implies more constraints than the freedom we have in constructing models. This is the main reason why so-far no completely consistent mathematical models of quantum black holes have been found.

Una nueva inyección de pochoclerismo en la física de altas energías

The World as a Hologram

Leonard Susskind

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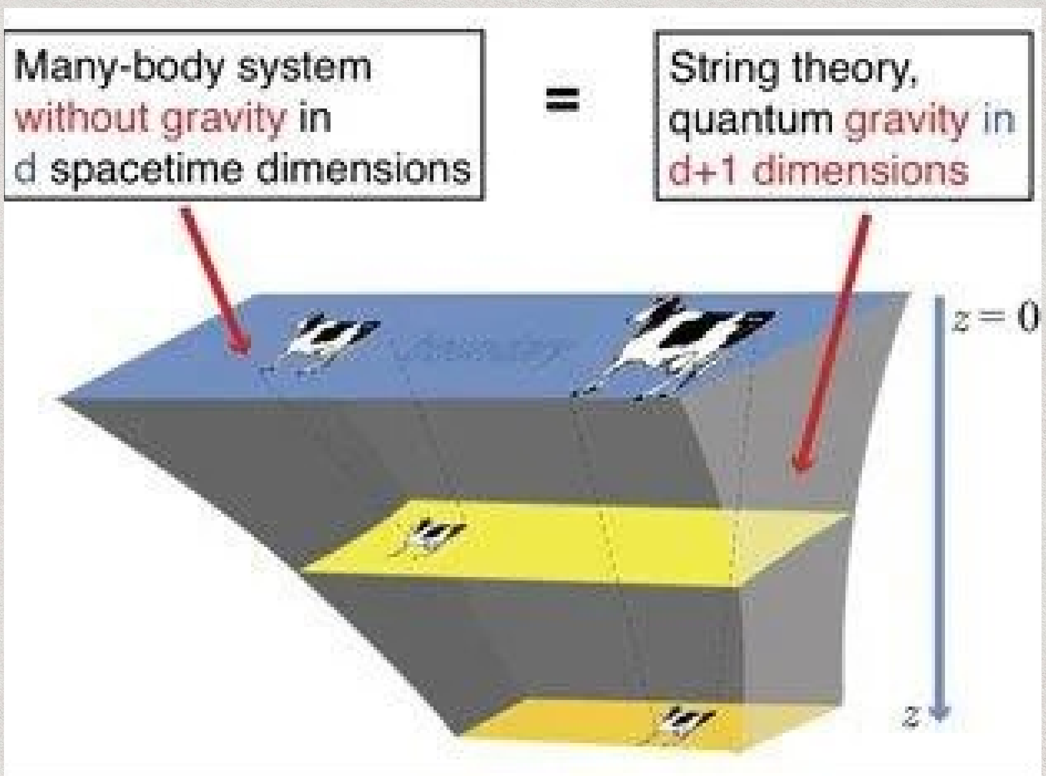
ABSTRACT

According to 't Hooft the combination of quantum mechanics and gravity requires the three dimensional world to be an image of data that can be stored on a two dimensional projection much like a holographic image.

CFT en Minkowski d / Quantum Gravity en torno a AdS en d+1



El paradigma holográfico

No podes no saber que

existieron y existen criticas a la teoría de cuerdas,
desde muchos flancos

Conocer estas es parte de la cultura general y hay material pochoclero.

Weinberg sobre teoria de cuerdas

NOVA: String theory makes some pretty bizarre predictions. How is it regarded by the general physics community?

Weinberg: I don't think anyone ever thought of string theory as a crackpot theory. The people who were working on it were working in the recognized traditions of elementary particle physics or fundamental theoretical physics. Even the ideas that seemed strangest, like the idea that there were extra dimensions, had a long history in physics. Einstein had flirted with the idea of a fifth dimension as a way of unifying electromagnetism with gravity.

But there has been a division among physicists, not so much as to whether or not string theory will ultimately be proved to be right or not, but as to whether it's worth working on something that's so far removed from experimental reality. I would say I'm awfully glad that not every theoretical physicist is working on string theory, and I'm awfully glad that some of them are.

NOVA: If string theory doesn't have testable predictions, is it science or is it philosophy?

Weinberg: Sometimes people say that string theory, because it's unrelated to any experiment, is no longer science, it's just a kind of a mysticism. I don't think that's right at all. I think that the string theorists are trying to accomplish something that will be recognized if it succeeds in unifying all the forces, but it will be experimentally verified as well. It won't be experimentally verified by finding the strings themselves—by seeing the one-dimensional little rips in space that we call strings—but it will be experimentally verified if it explains the things that are still mysterious about the physics we know about. It is just a part of ordinary science. Unfortunately, it's further removed from observation than most parts of science but not hopelessly removed from it.

Desperately Seeking Superstrings?

by Paul Ginsparg and Sheldon Glashow

Physics Today, May 1986

Why is the smart money all tied up in strings? Why is so much theoretical capital expended upon the properties of supersymmetric systems of quantum strings propagating in ten-dimensional space-time? The good news is that superstring theory may have the right stuff to explain the "low-energy phenomena" of high-energy physics and gravity as well. In the context of possible quantum theories of gravity, each of the few currently known superstring theories may even be unique, finite and self-consistent. In principle a superstring theory ordains what particles exist and what properties they have, using no arbitrary or adjustable parameters. The bad news is that years of intense effort by dozens of the best and the brightest have yielded not one verifiable prediction, nor should any soon be expected. Called "the new physics" by its promoters, it is not even known to encompass the old and established standard model.

Glashow sobre teoría de cuerdas

NOVA: Is there any danger in this for physics in general?

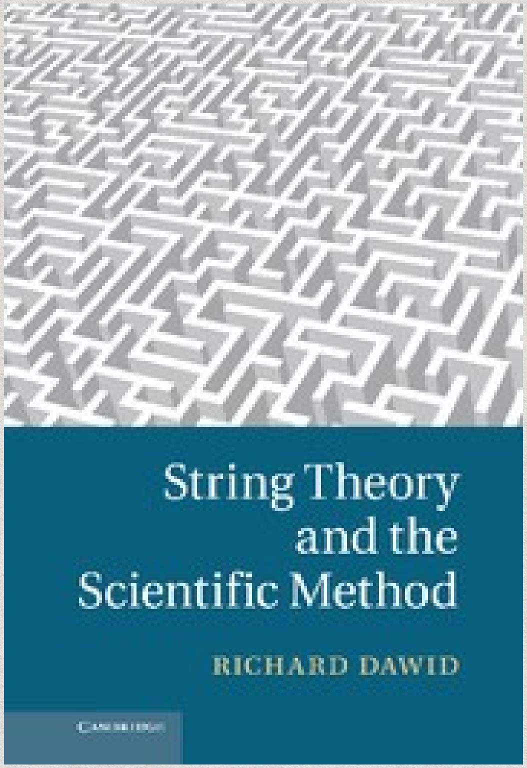
Glashow: There is today a disconnect in the world of physics. Let me put it bluntly. There are physicists, and there are string theorists. Of course the string theorists are physicists, but the string theorists in general will not attend lectures on experimental physics. They will not be terribly concerned about the results of experiments. They will talk to one another.

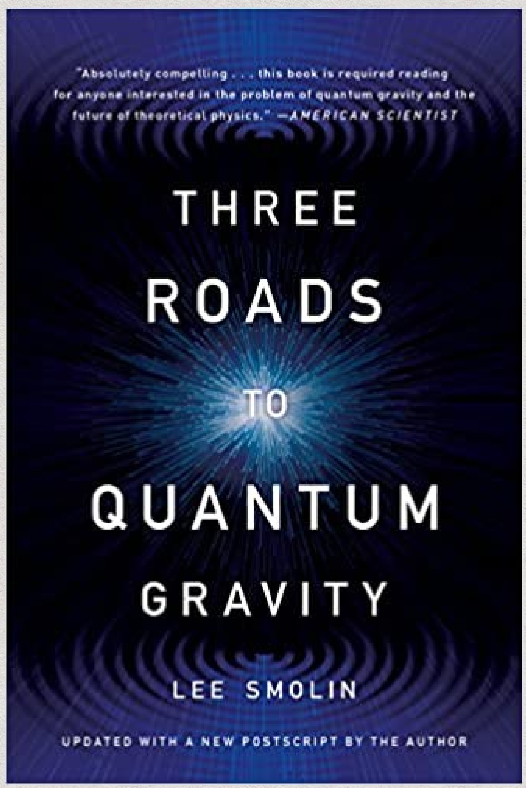
"We don't listen to them, and they don't listen to us."

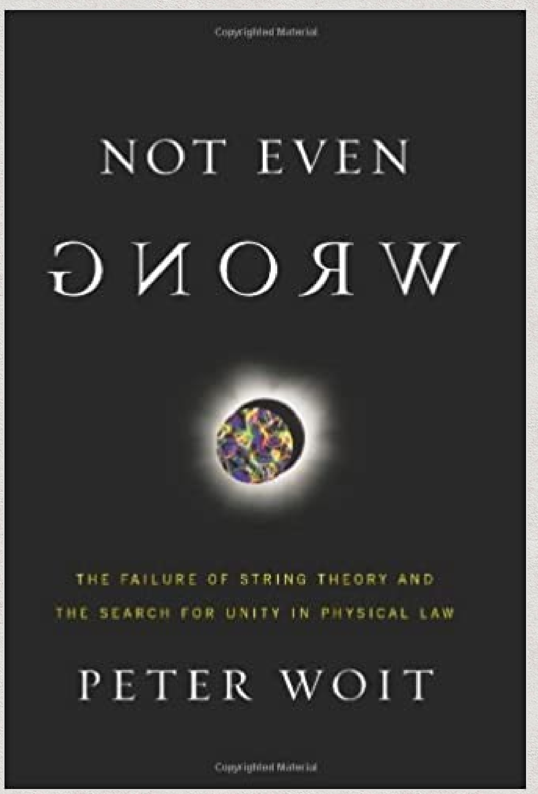
At Harvard today there's a very strong group of string theorists upstairs on the fourth floor of the Jefferson Laboratory. Each week there are visitors from around the world giving lectures. I've occasionally attempted to attend these lectures. I can't understand the titles, and I can't understand the lectures, and it's not just me. I think most theoretical physicists who are not themselves string theorists could not possibly follow these lectures. In other words, we don't listen to them, and they don't listen to us. We can't understand them, and what we do is not of any direct interest to them.

https://www.pbs.org/wgbh/nova/elegant/viewpoints.html#view_top

Lecturas de verano







No viene mal una visión global de teoría de cuerdas desde el lado de la divulgación

José Edelstein y Gastón Giribet