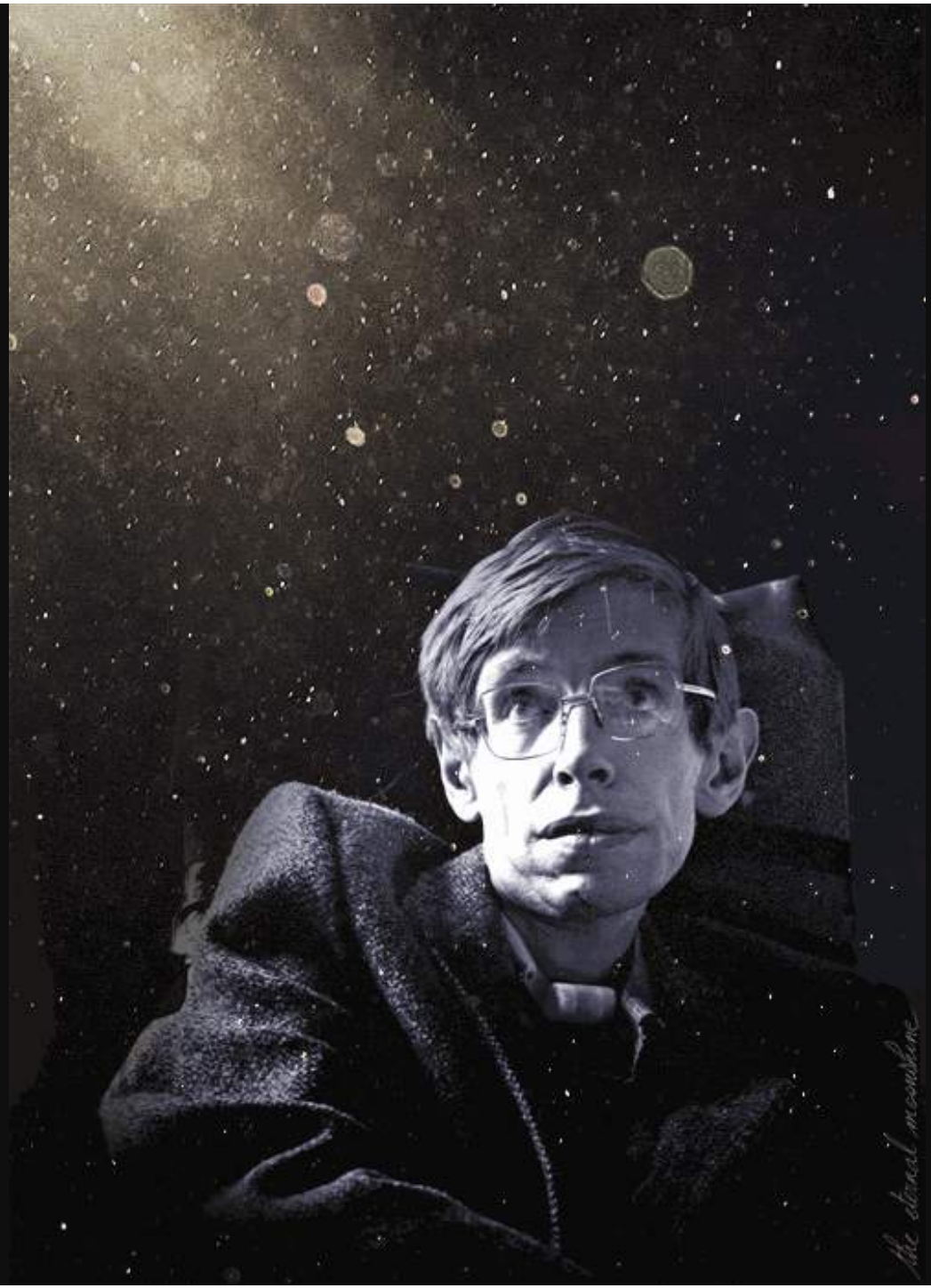
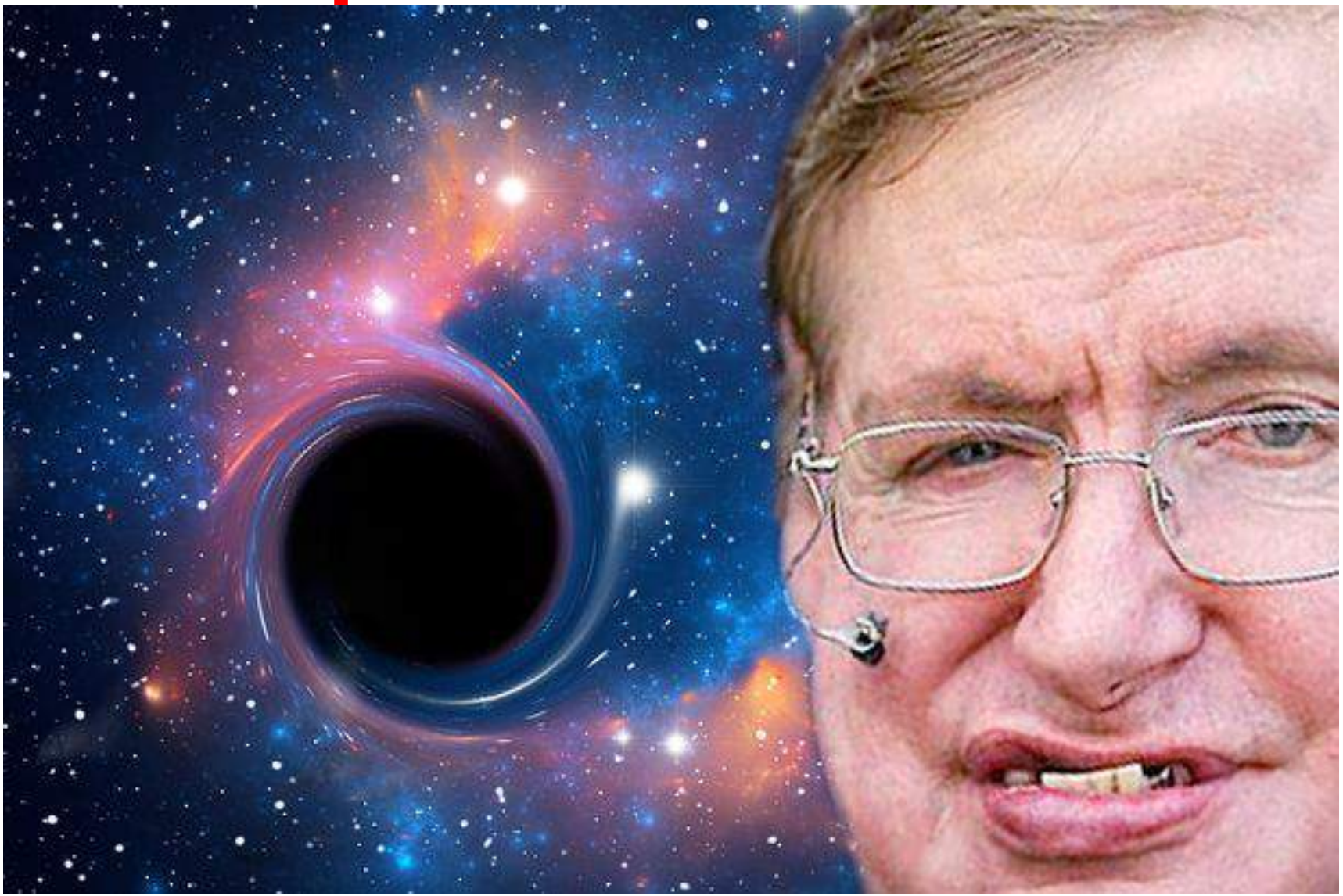


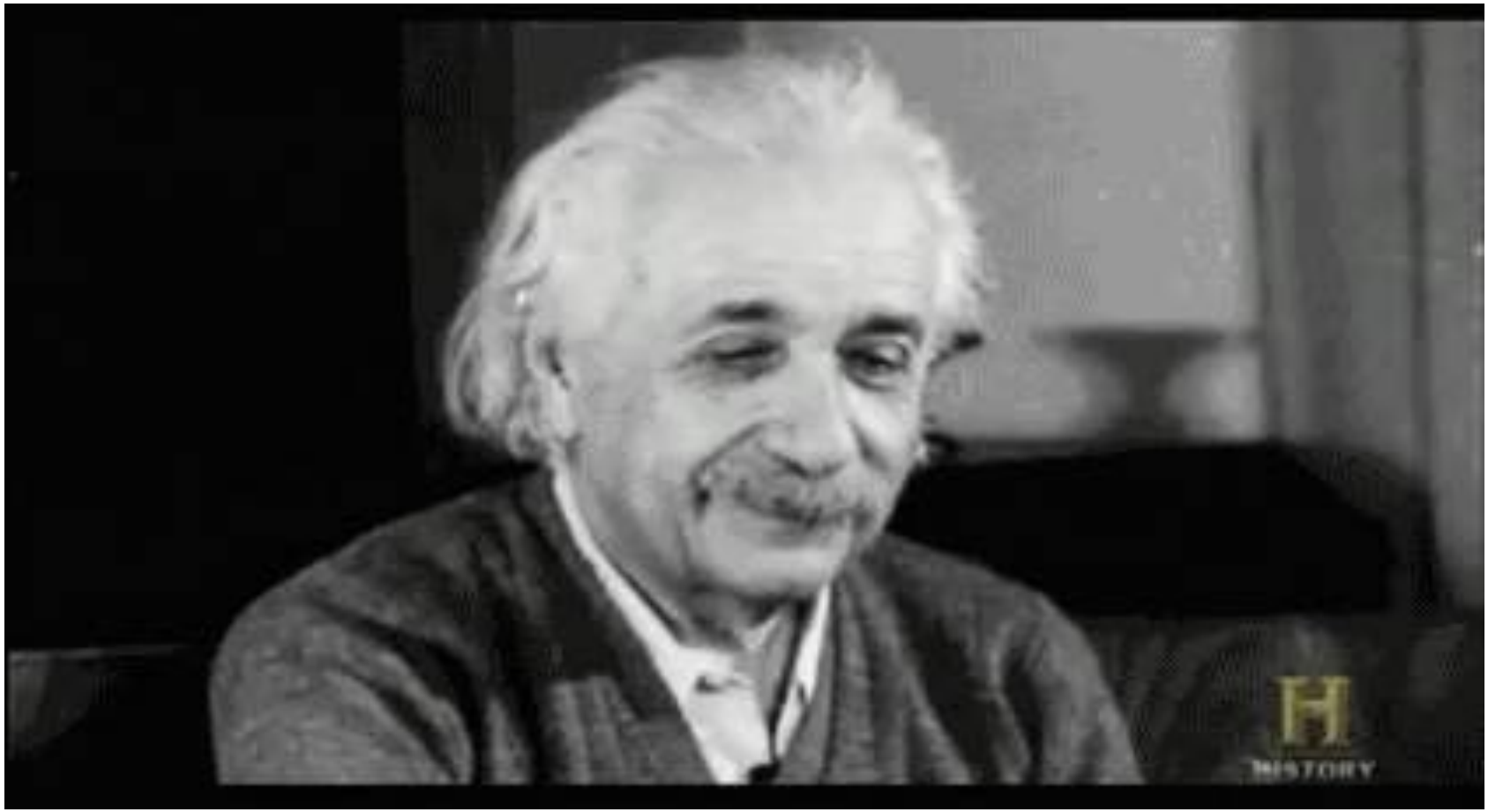

L'estrema intuizione di Hawking:
è possibile fuggire dai buchi neri!
Catalina Curceanu, LNF-INFN
Open Labs – LNF-INFN, 26 maggio 2018

Se finite in un buco nero, non datevi per vinti. Un'uscita c'è

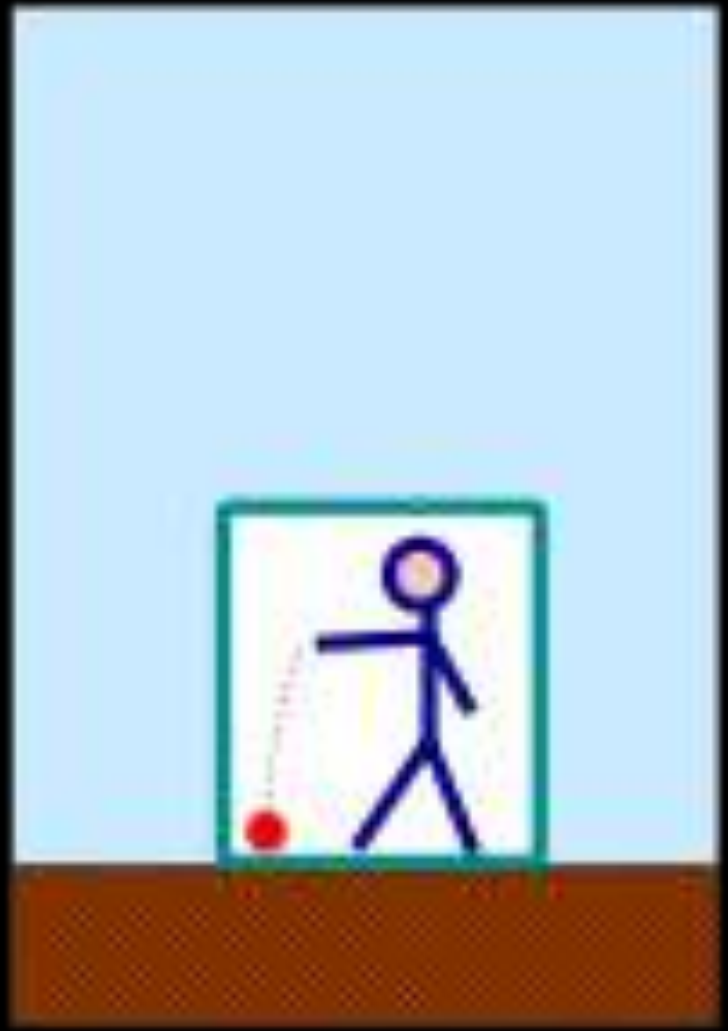


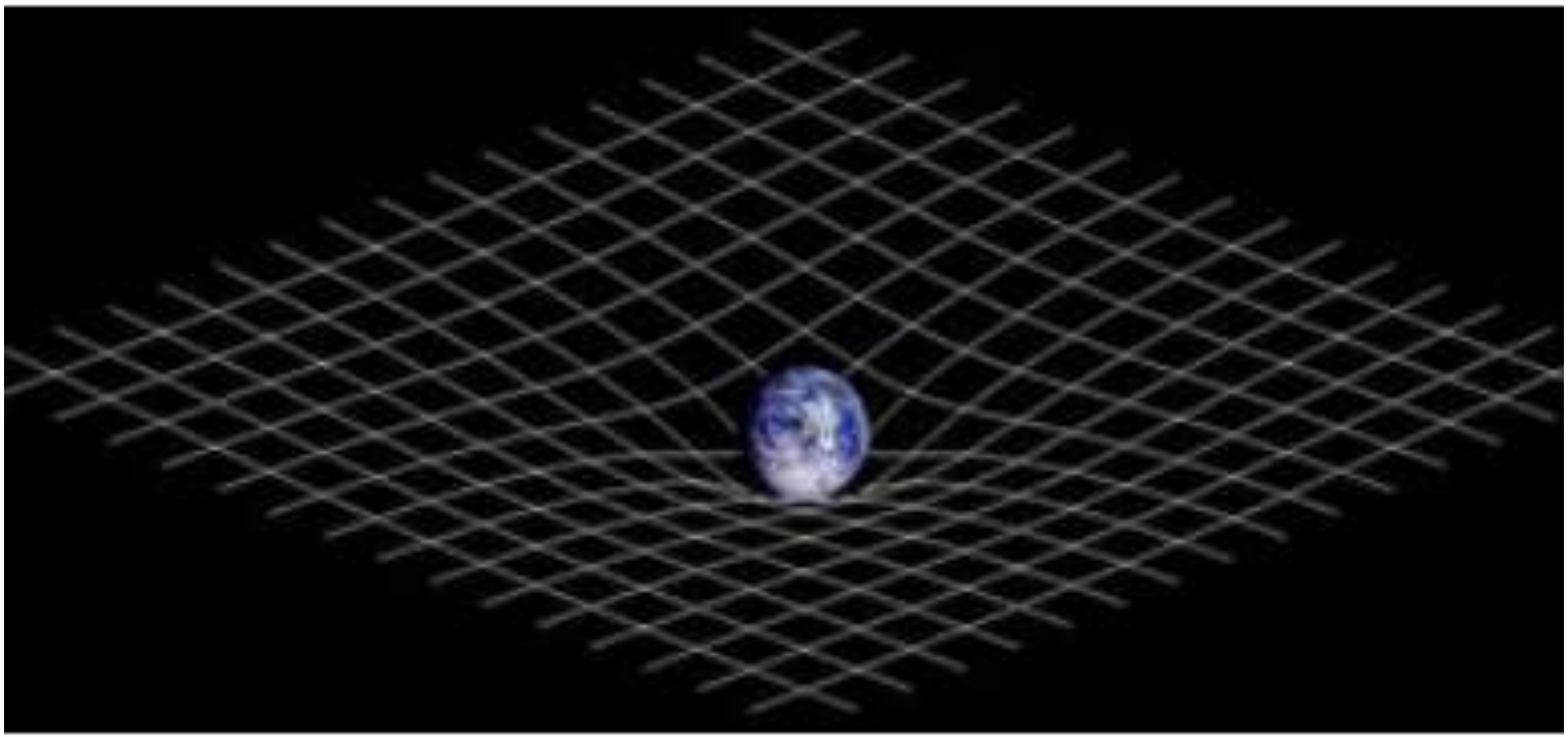

- THE WORLD'S SMARTEST MAN!
- WHAT ARE YOU DOING HERE?

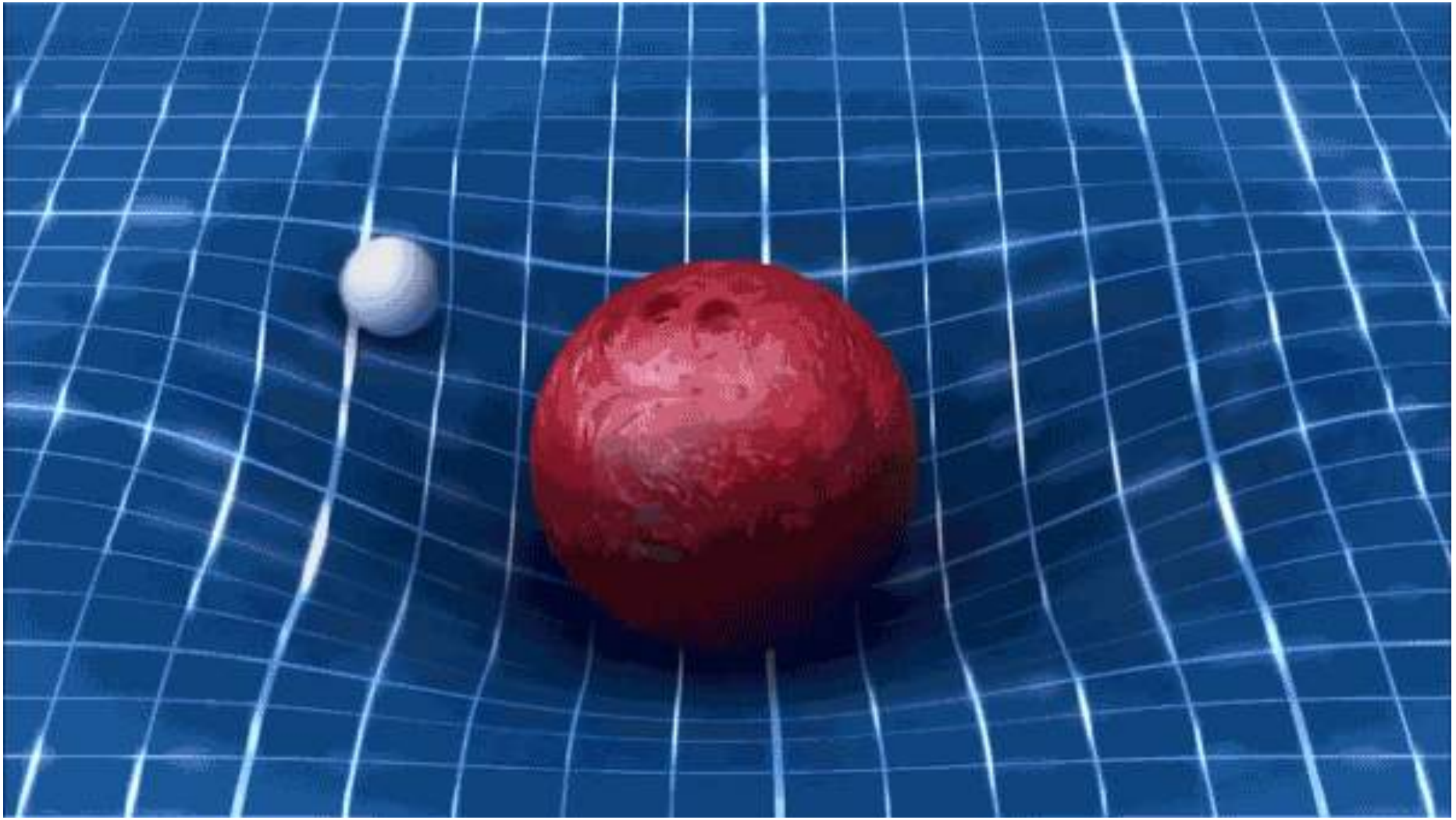
La Relativita' generale

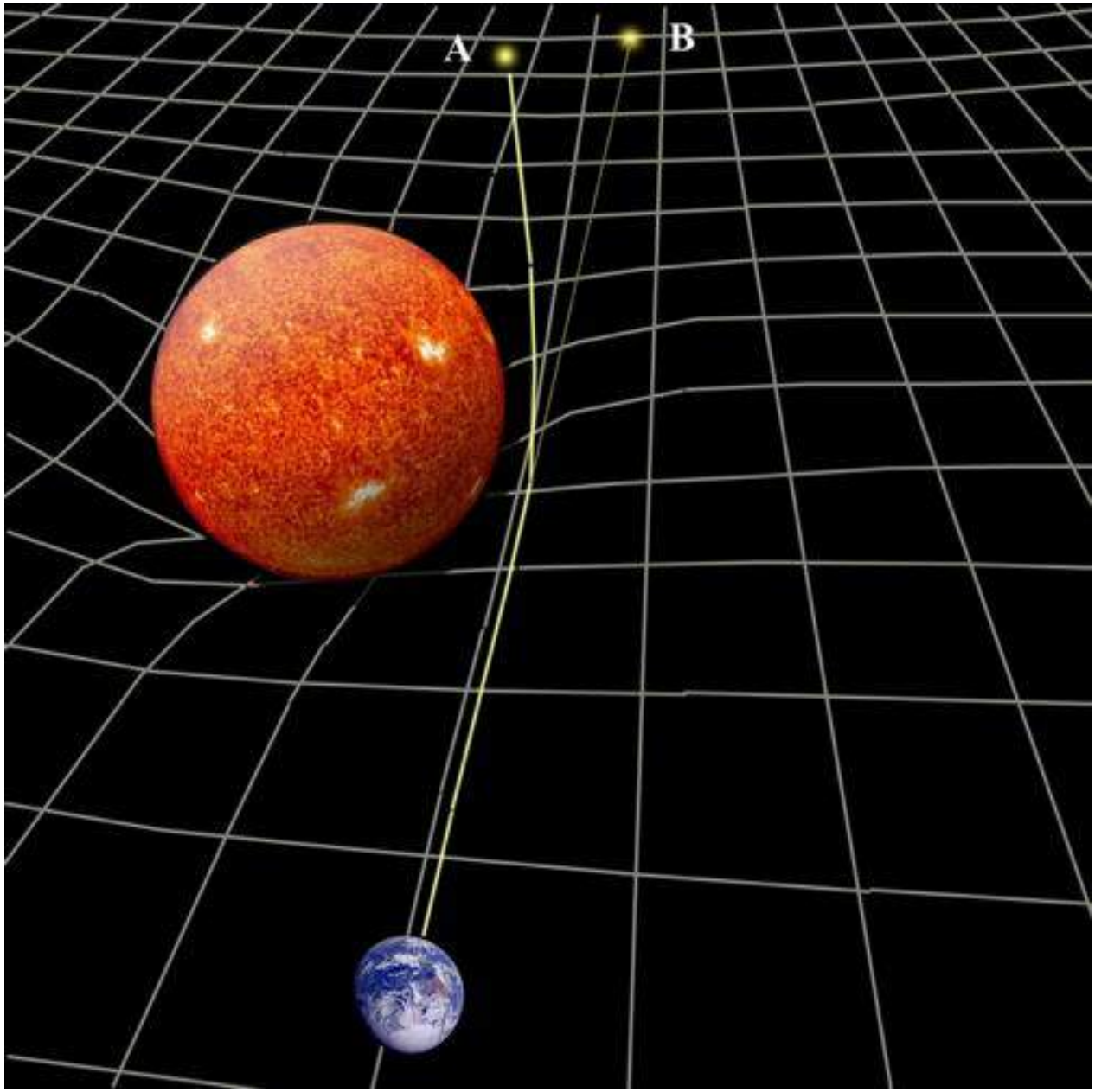

H
HISTORY

Relativita' generale – principio di equivalenza








A
B

Le Equazioni di Einstein

Sono equazioni di campo che pongono in relazione il grado e la natura della distorsione dello spazio-tempo con la materia gravitante che la produce

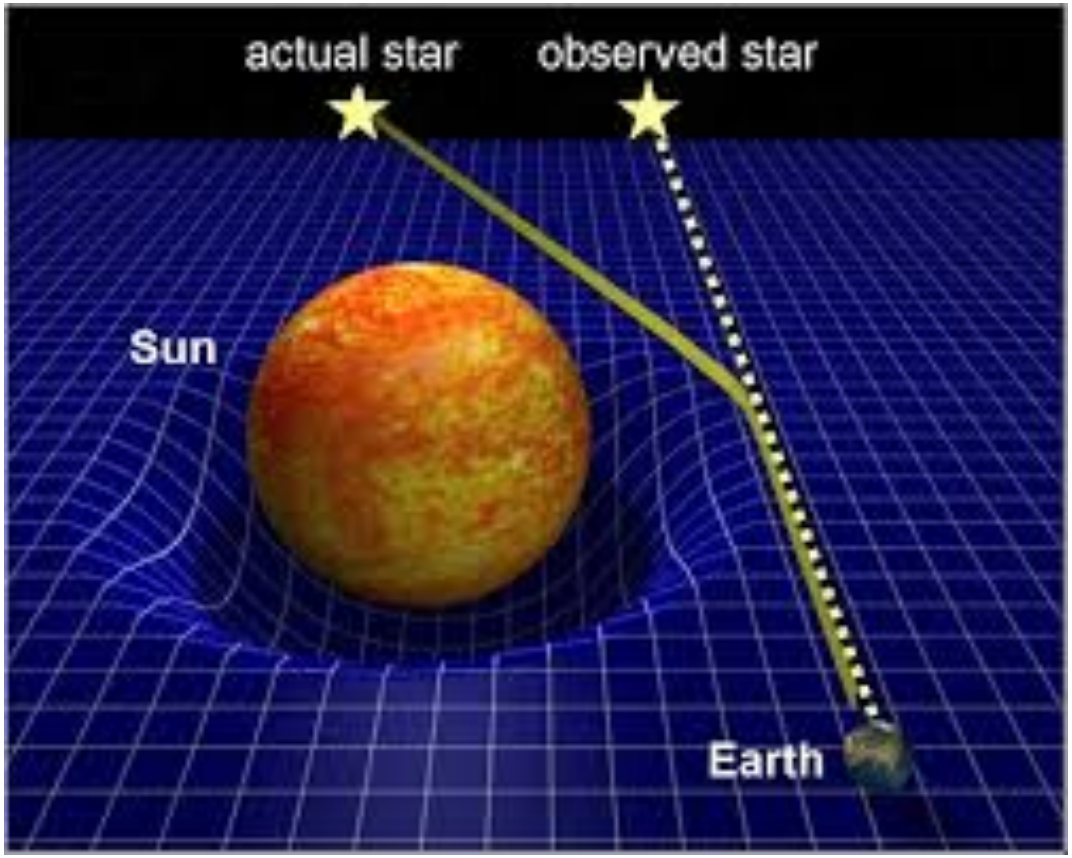
$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = \frac{8\pi G}{c^4} T_{\mu\nu}$$

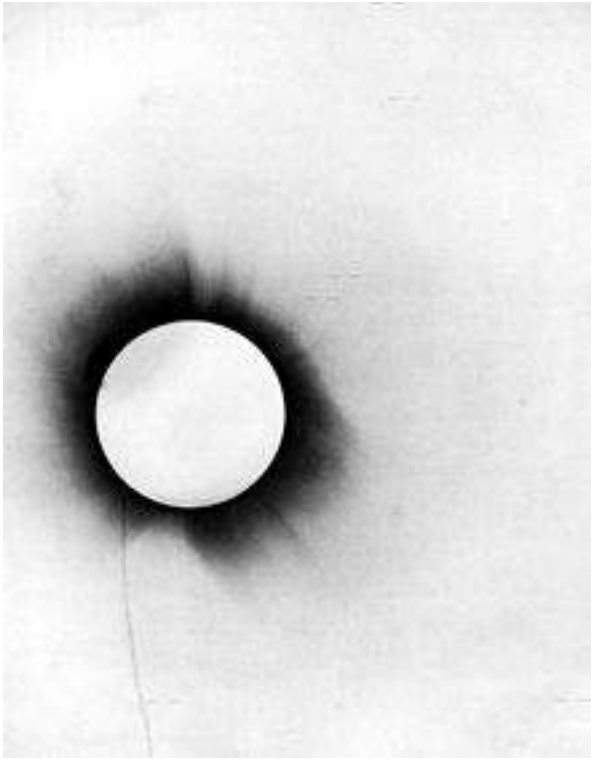
geometria spazio-tempo = **distribuzione massa-energia della sorgente**

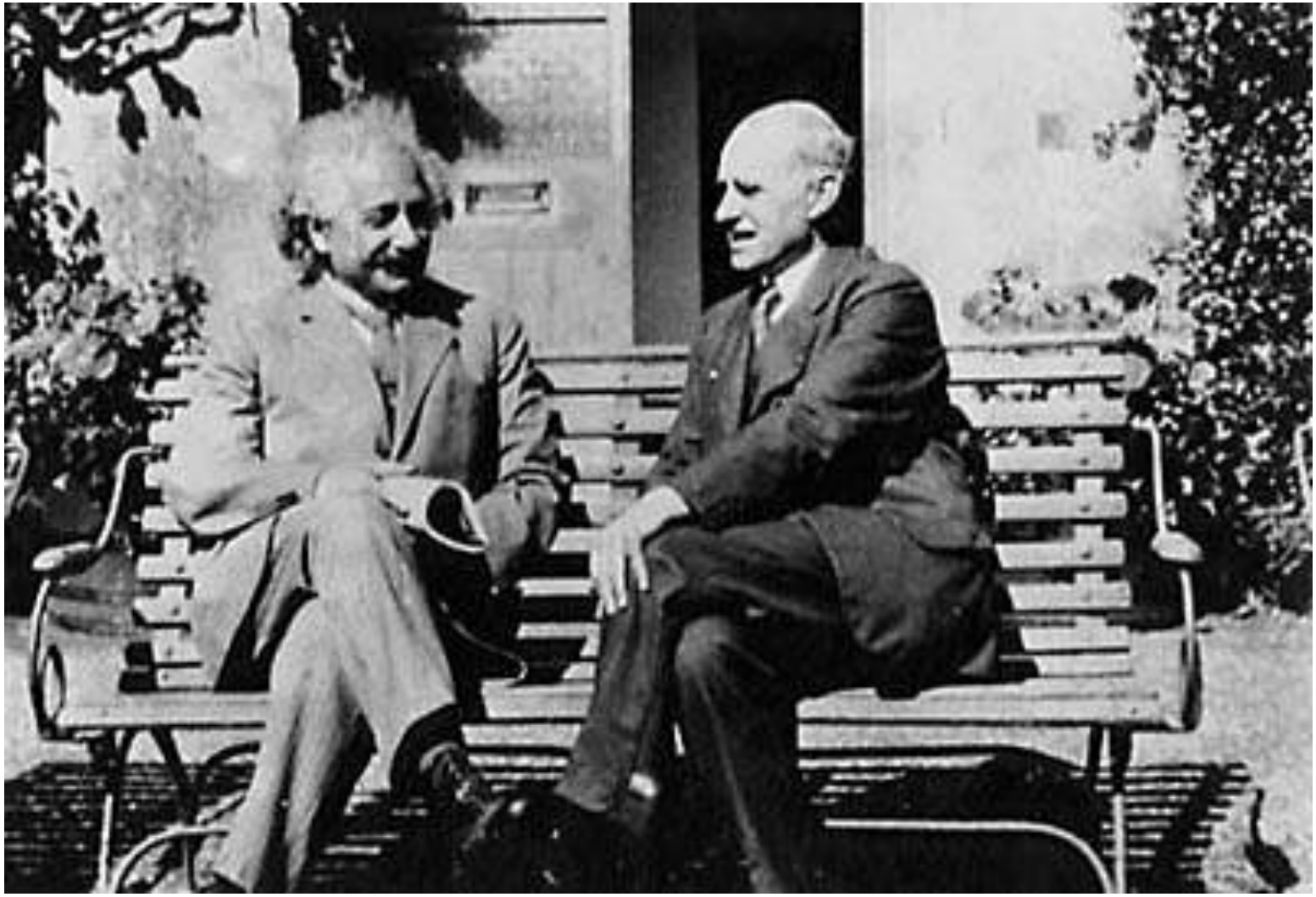
Lo spazio-tempo dice alla materia come muoversi;

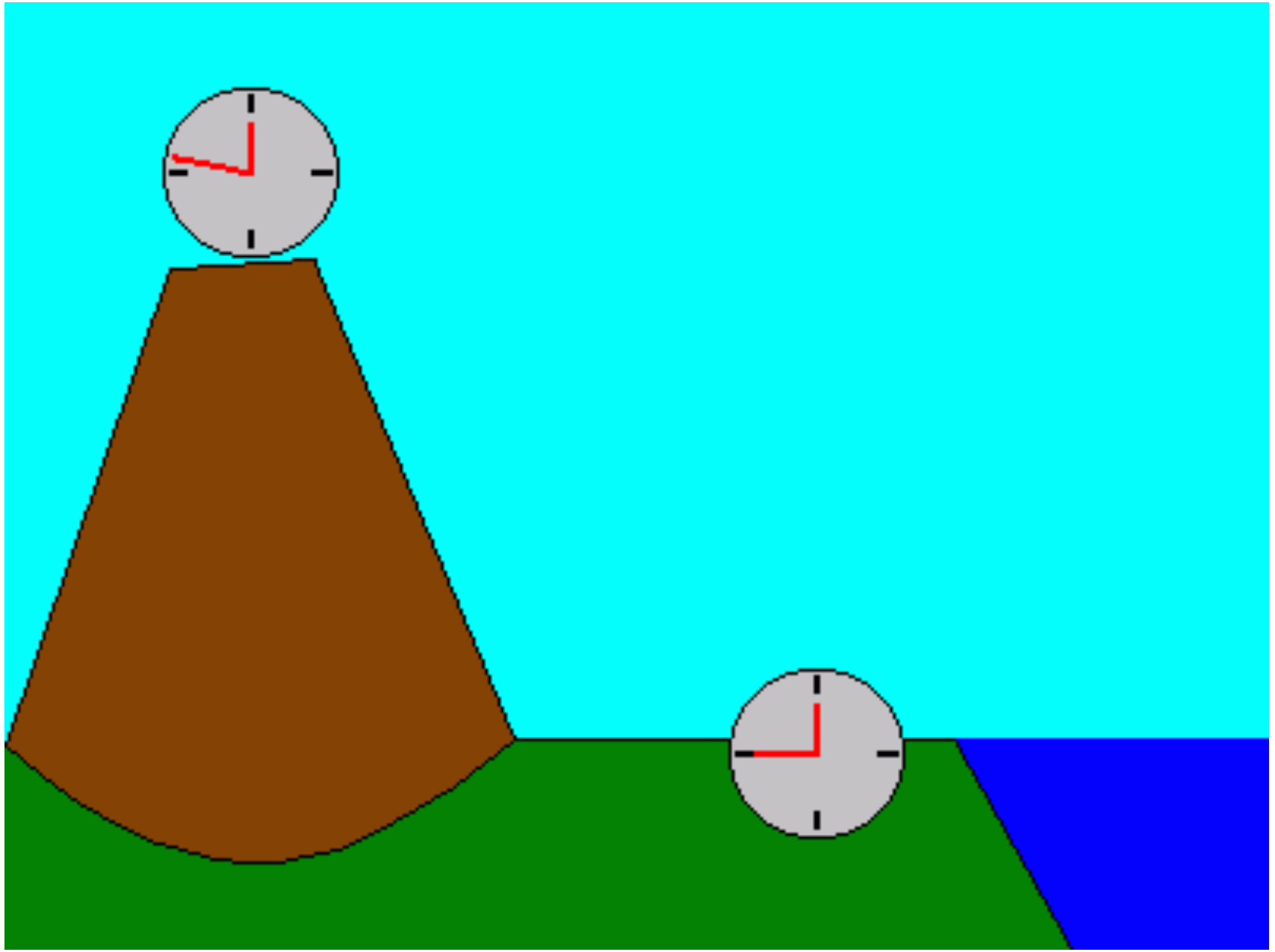
La materia dice allo spazio-tempo come distorcersi

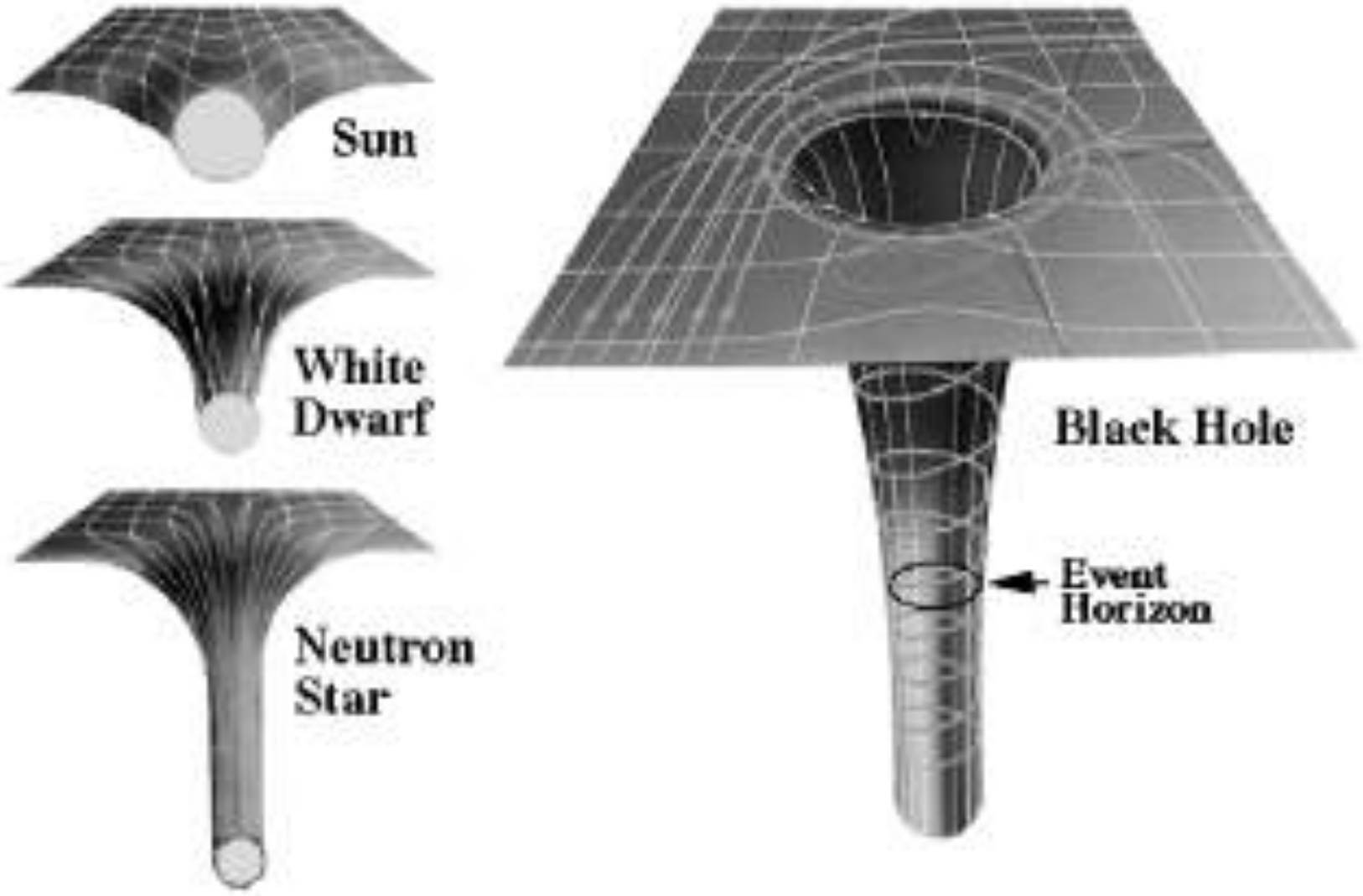
$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} + \overset{?}{\Lambda}\, g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$


actual star
observed star
Sun
Earth

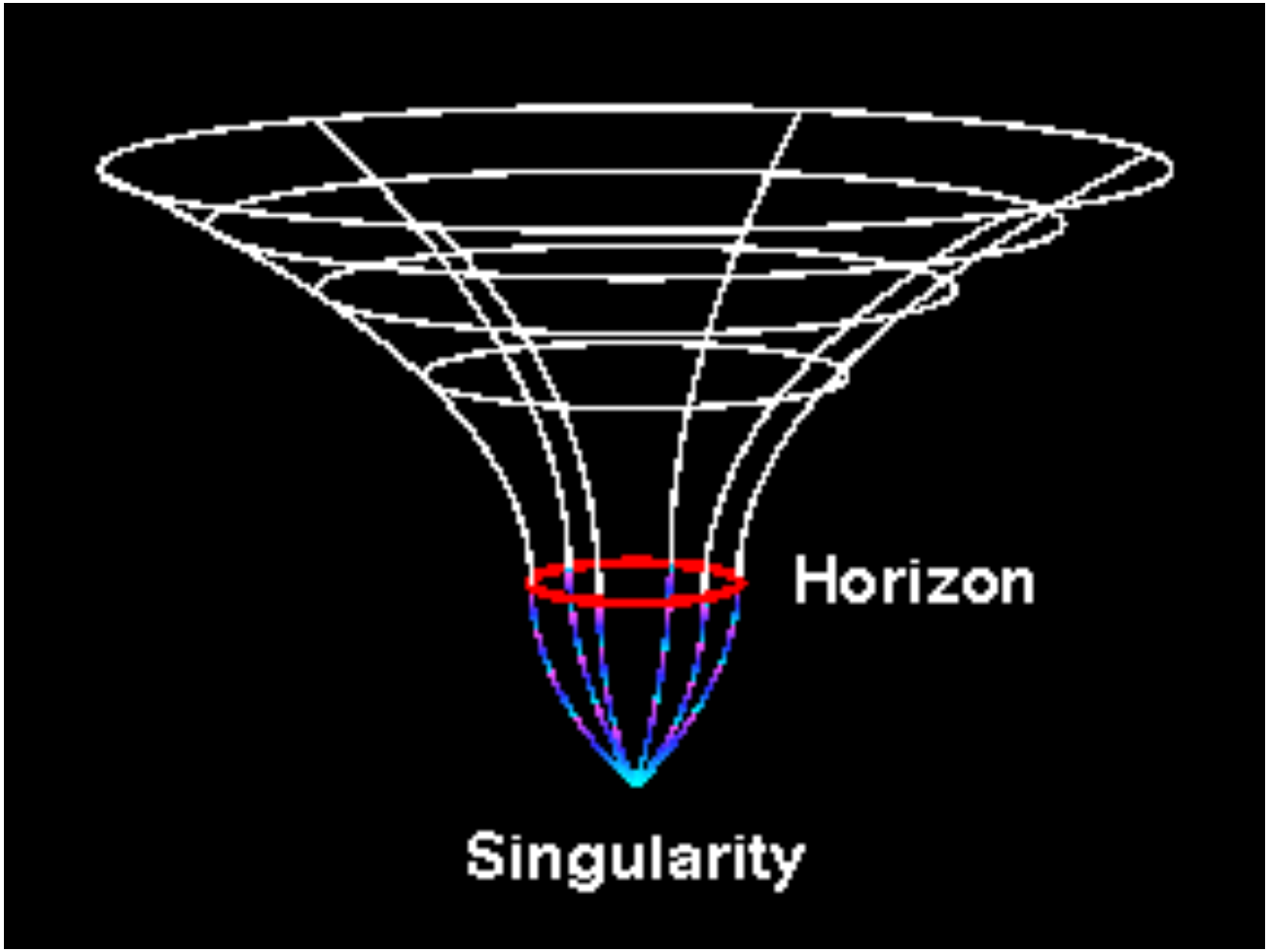


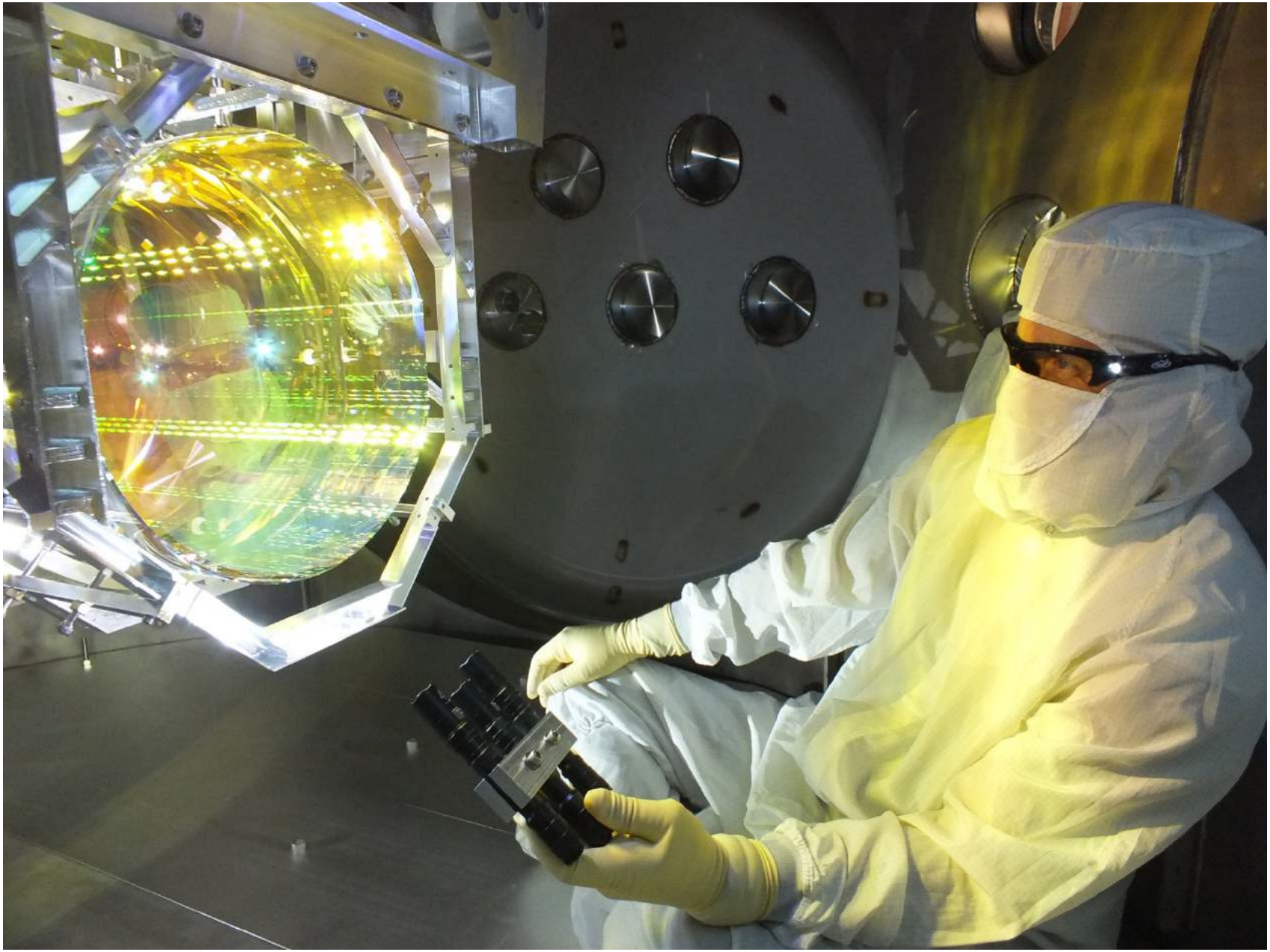


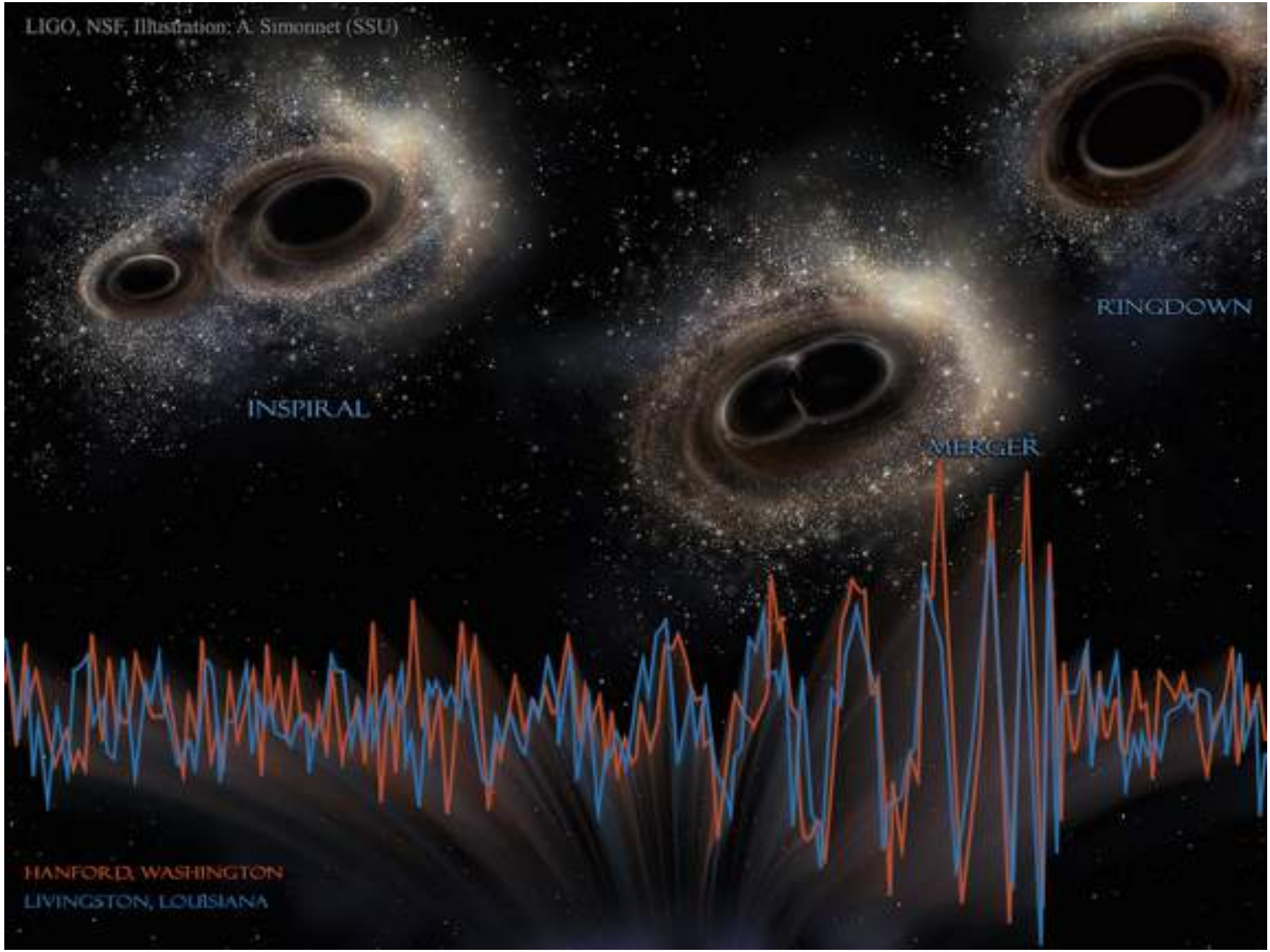


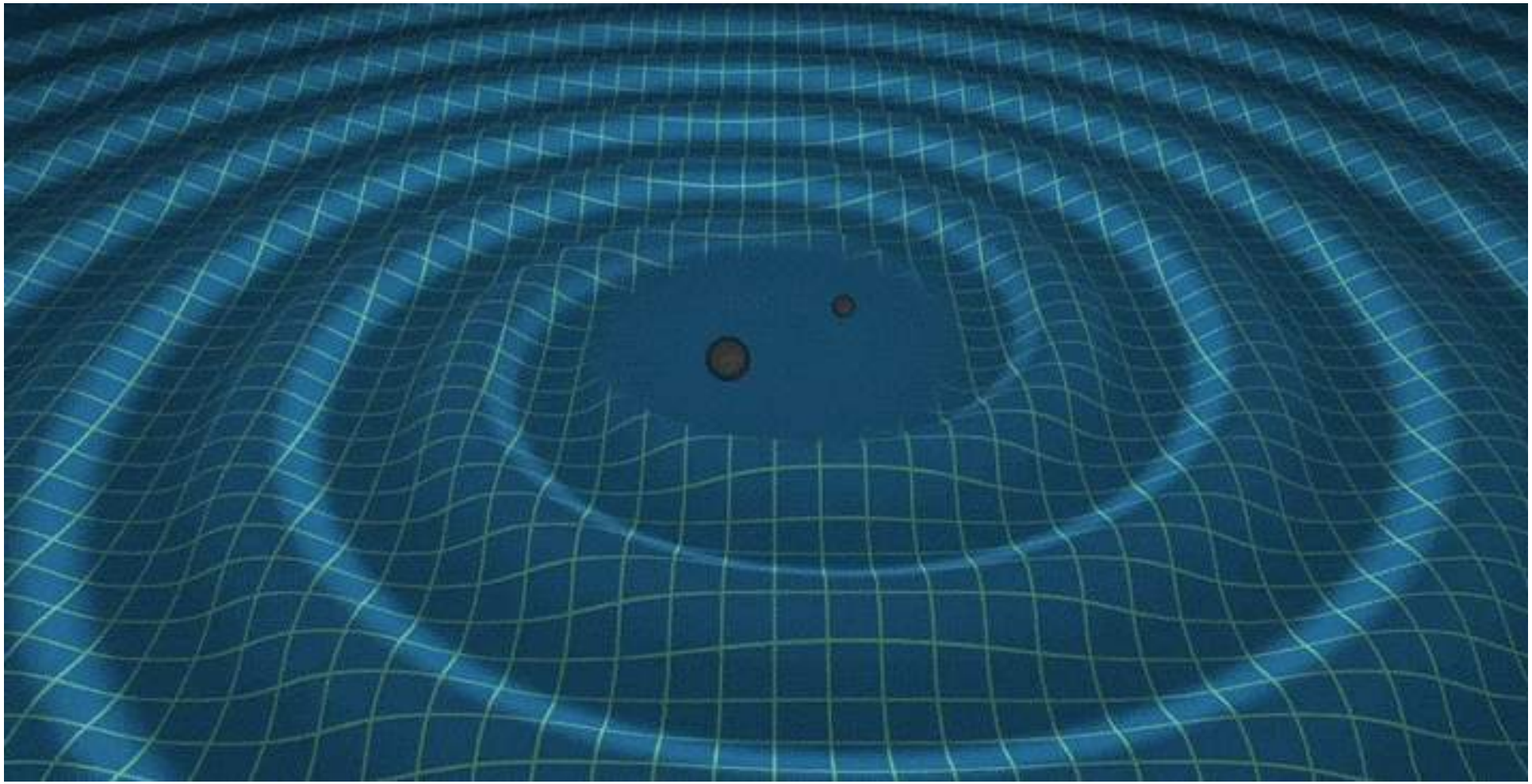


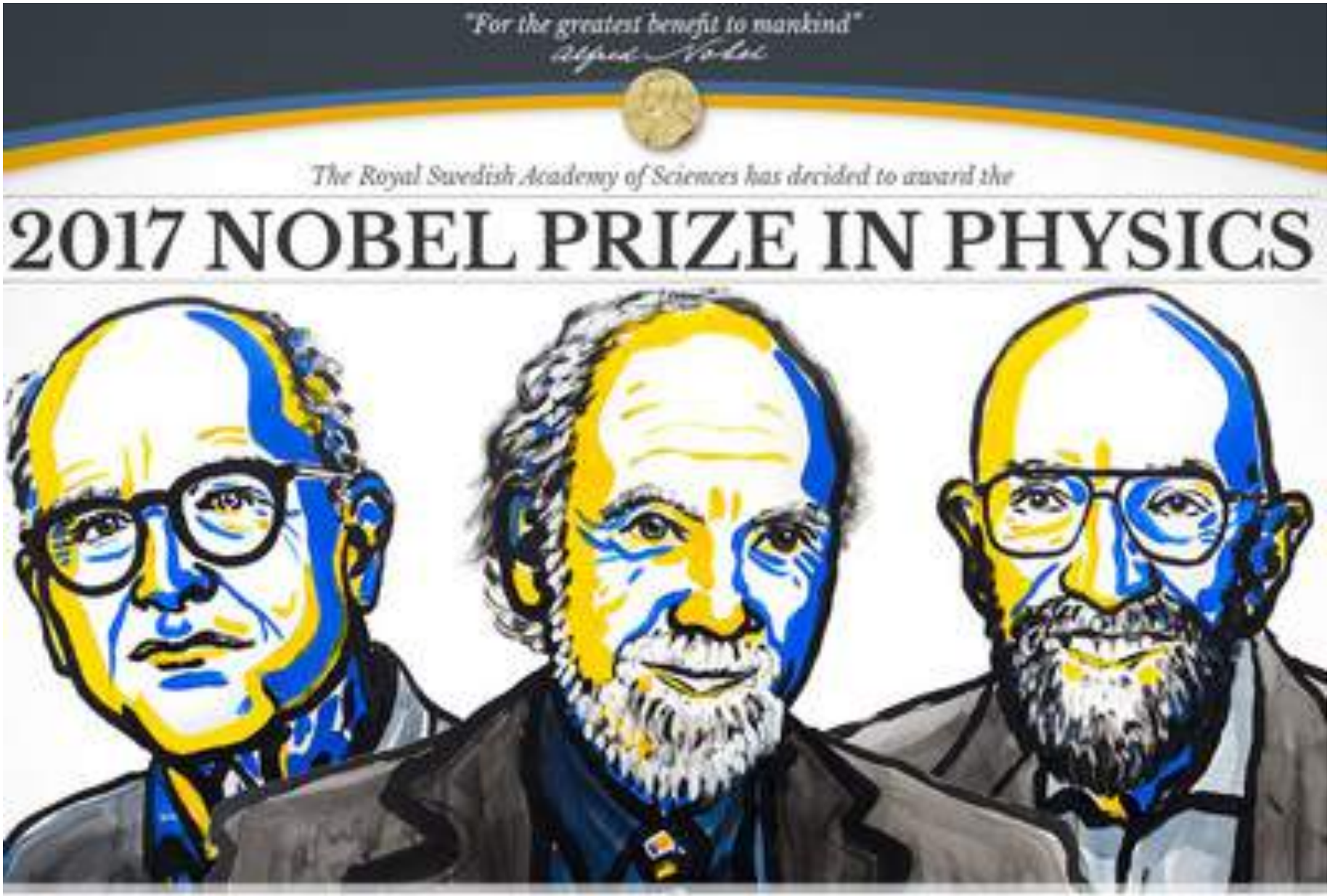
Credit: Adam Apollo


Horizon
Singularity

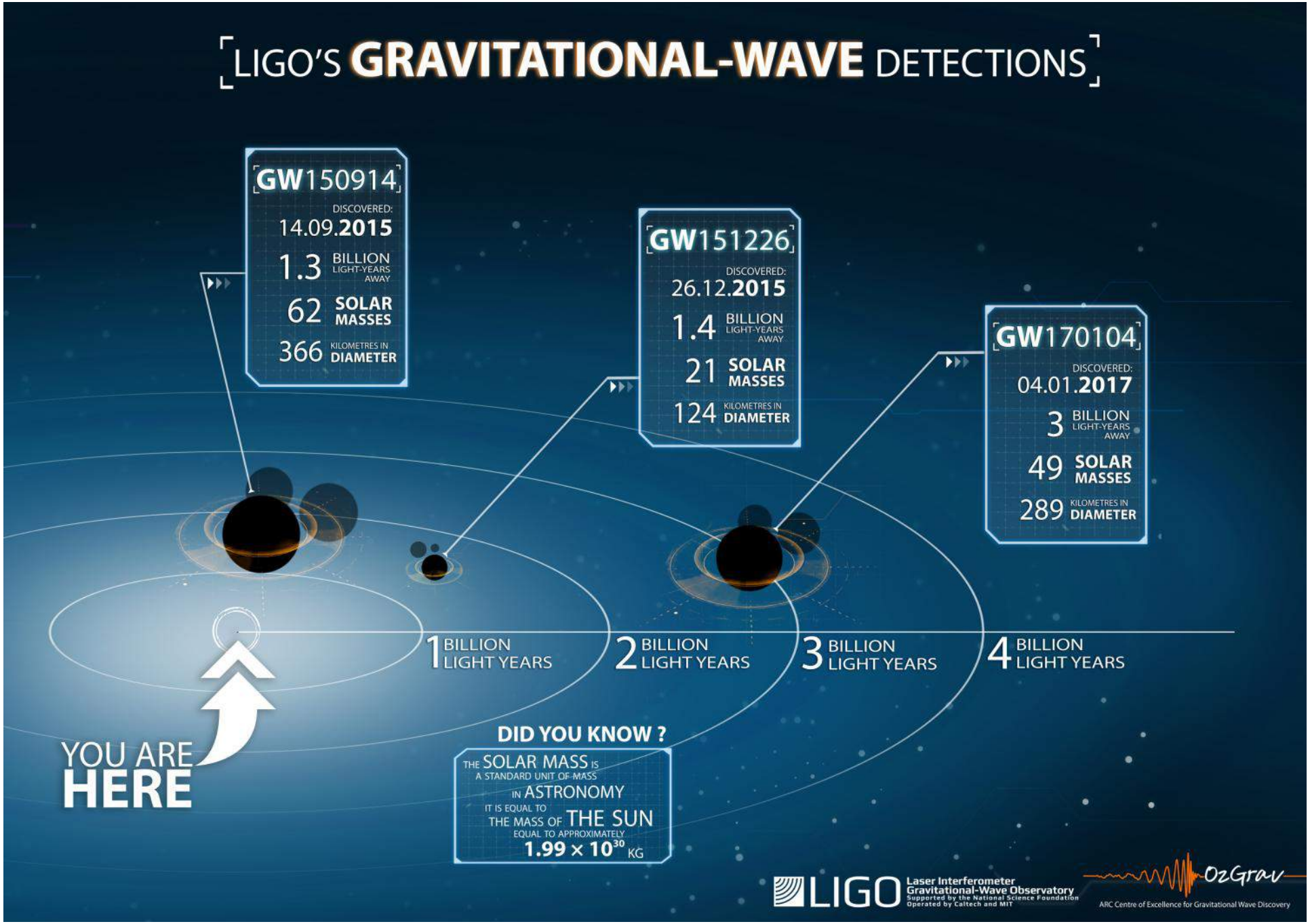


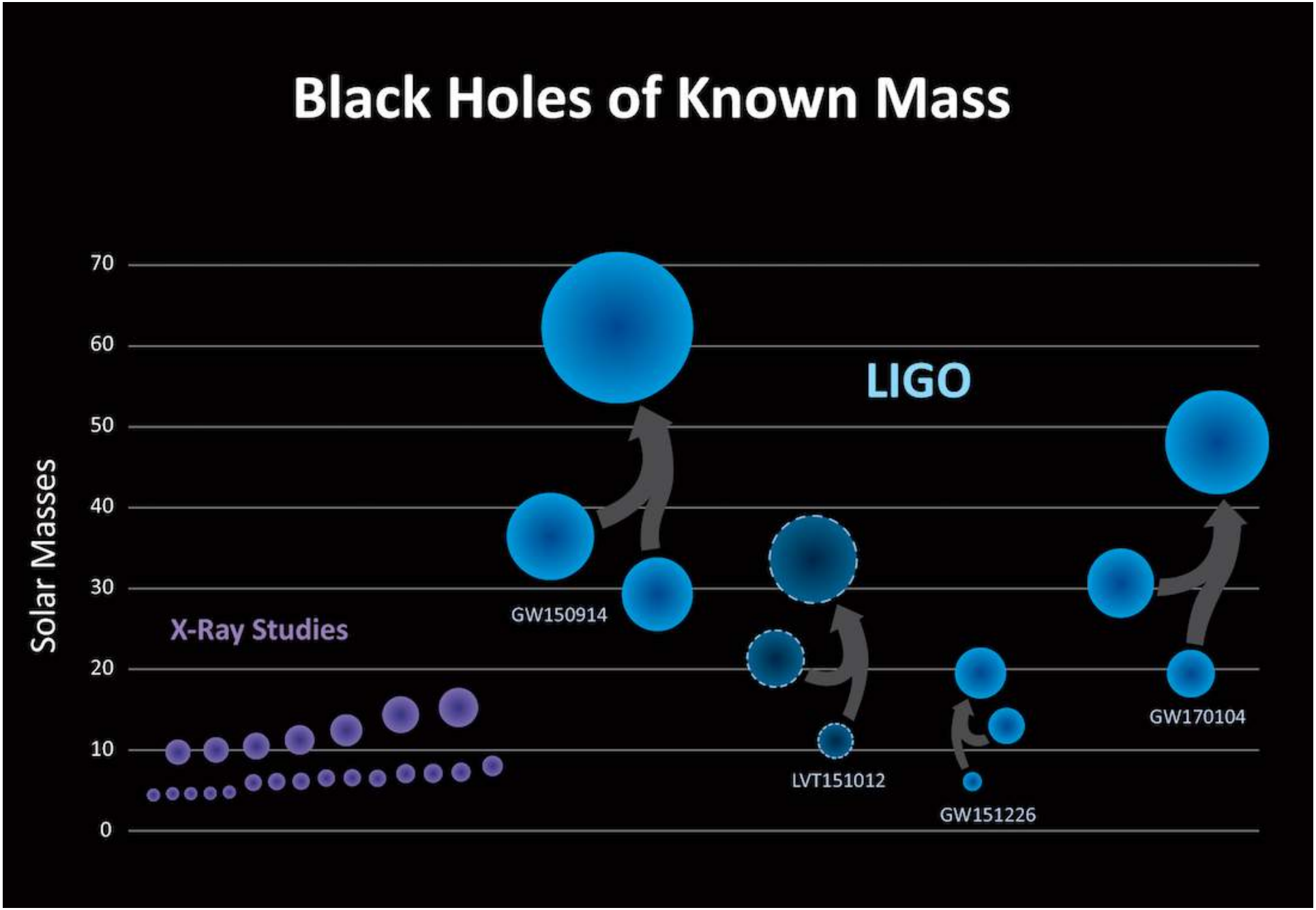

LIGO, NSF, Illustration: A. Simonnet (SSU)
INSPIRAL
MERGER
RINGDOWN
HANFORD, WASHINGTON
LIVINGSTON, LOUISIANA





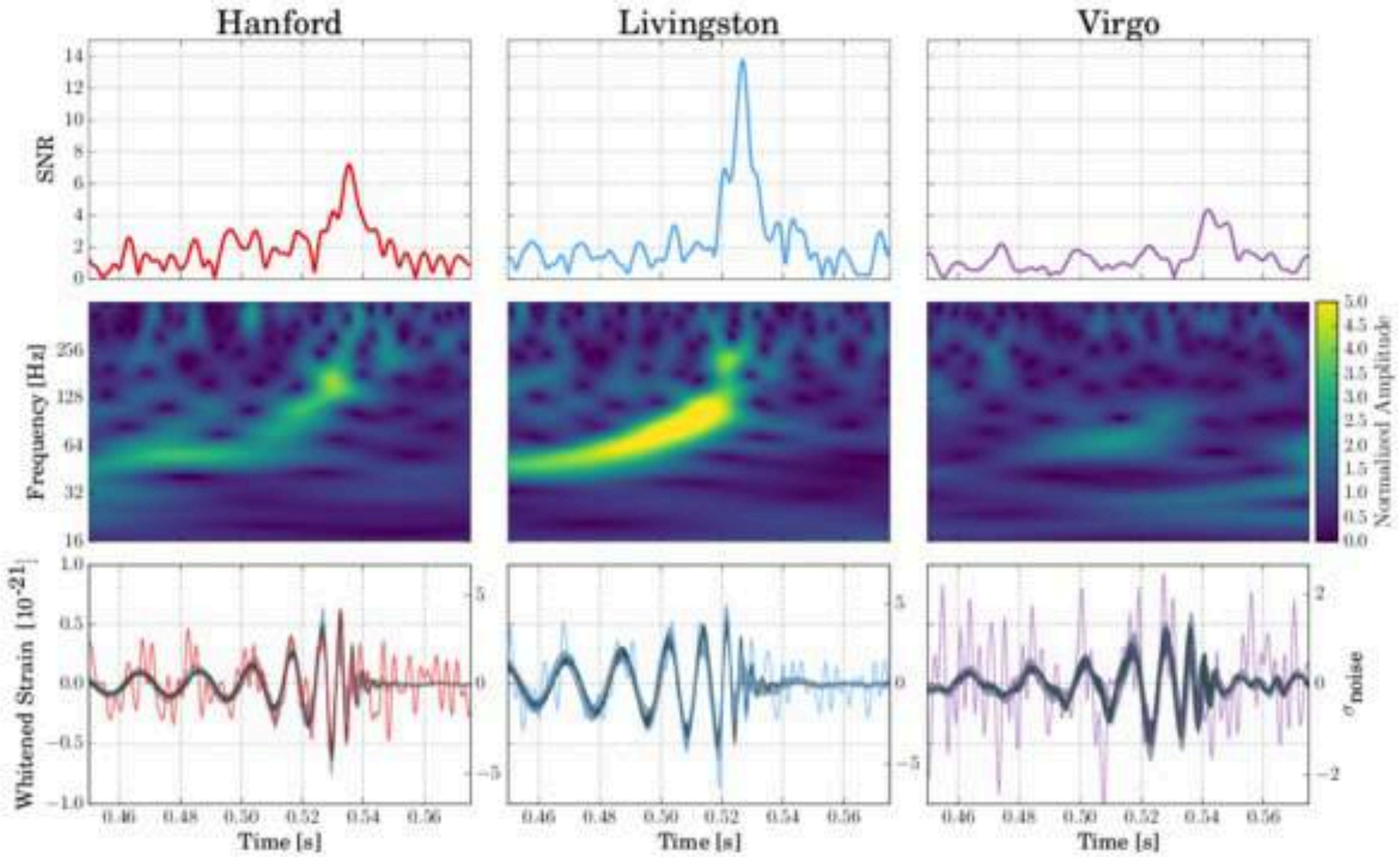
Half: Rainer Weiss and the **other half jointly** to **Barry C. Barish** and **Kip S. Thorne** - LIGO/VIRGO Collb.


LIGO'S GRAVITATIONAL-WAVE DETECTIONS
GW150914
DISCOVERED:
14.09.2015
1.3 BILLION LIGHT-YEARS AWAY
62 SOLAR MASSES
366 KILOMETRES IN DIAMETER
GW151226
DISCOVERED:
26.12.2015
1.4 BILLION LIGHT-YEARS AWAY
21 SOLAR MASSES
124 KILOMETRES IN DIAMETER
GW170104
DISCOVERED:
04.01.2017
3 BILLION LIGHT-YEARS AWAY
49 SOLAR MASSES
289 KILOMETRES IN DIAMETER
1 BILLION LIGHT YEARS
2 BILLION LIGHT YEARS
3 BILLION LIGHT YEARS
4 BILLION LIGHT YEARS
YOU ARE HERE
DID YOU KNOW ?
THE SOLAR MASS IS A STANDARD UNIT OF MASS IN ASTRONOMY
IT IS EQUAL TO THE MASS OF THE SUN
EQUAL TO APPROXIMATELY
1.99 × 10^30 KG
LIGO Laser Interferometer Gravitational-Wave Observatory
Supported by the National Science Foundation
Operated by Caltech and MIT
OzGrav
ARC Centre of Excellence for Gravitational Wave Discovery

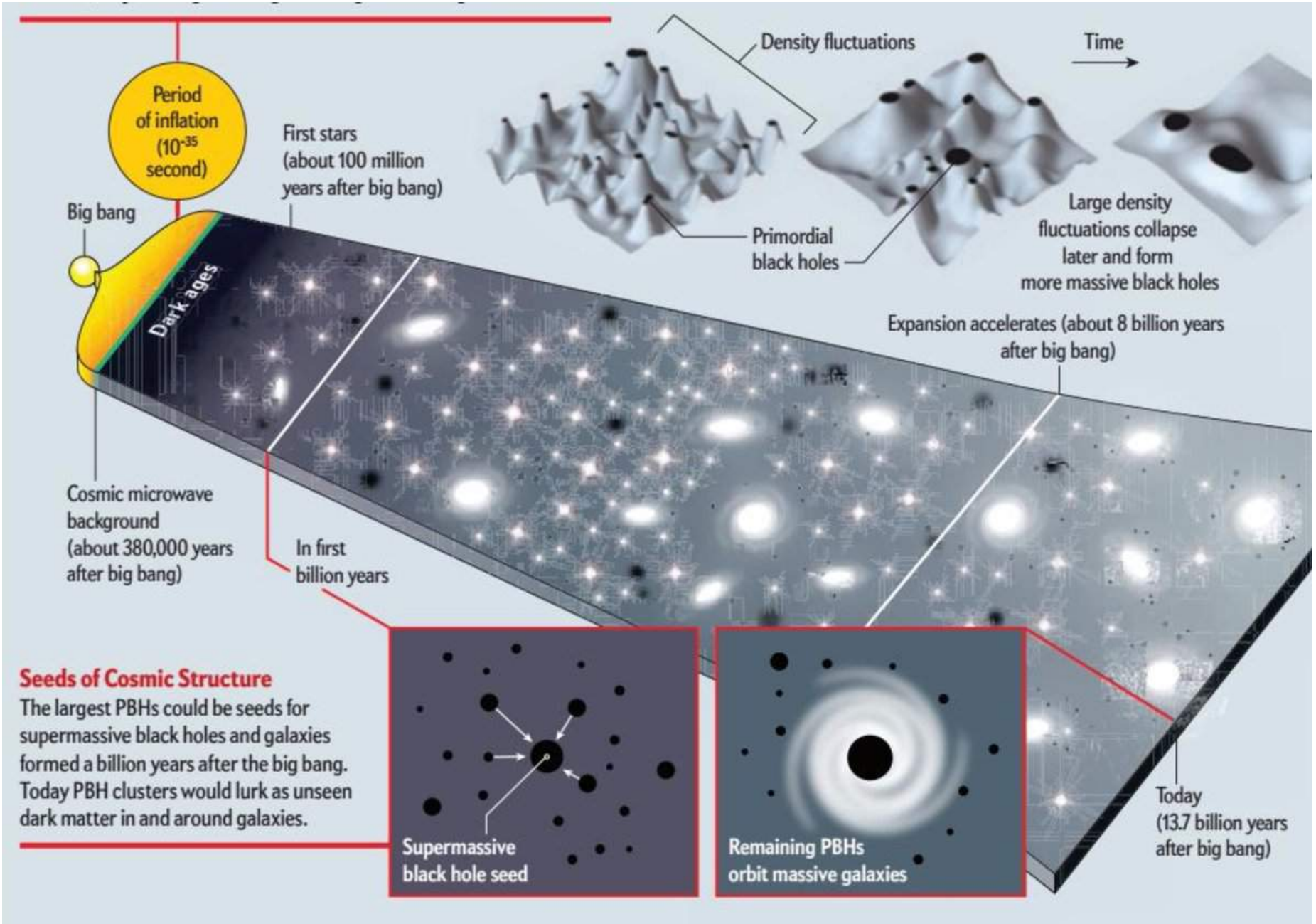

Black Holes of Known Mass
Solar Masses
70
60
50
40
30
20
10
0
LIGO
X-Ray Studies
GW150914
LVT151012
GW151226
GW170104

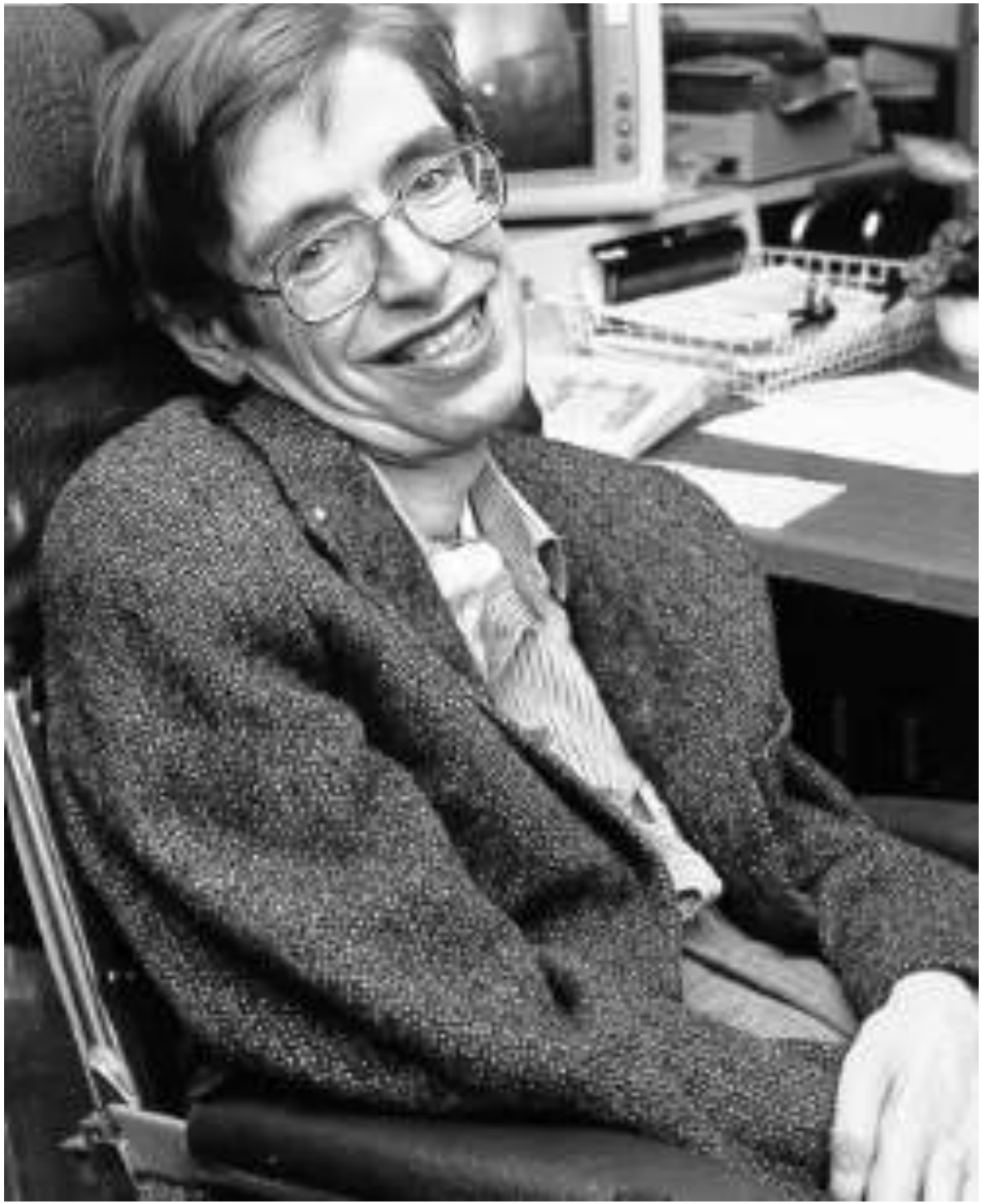
VIRGO

14 Agosto 2017: LIGO e VIRGO - GW170814 –
2 buchi neri distanti 1.8 miliardi anni luce
(31, 25 Masse Solari -> 53 masse solari)



Buchi neri primordiali? (articolo Le Scienze Settembre 2017)

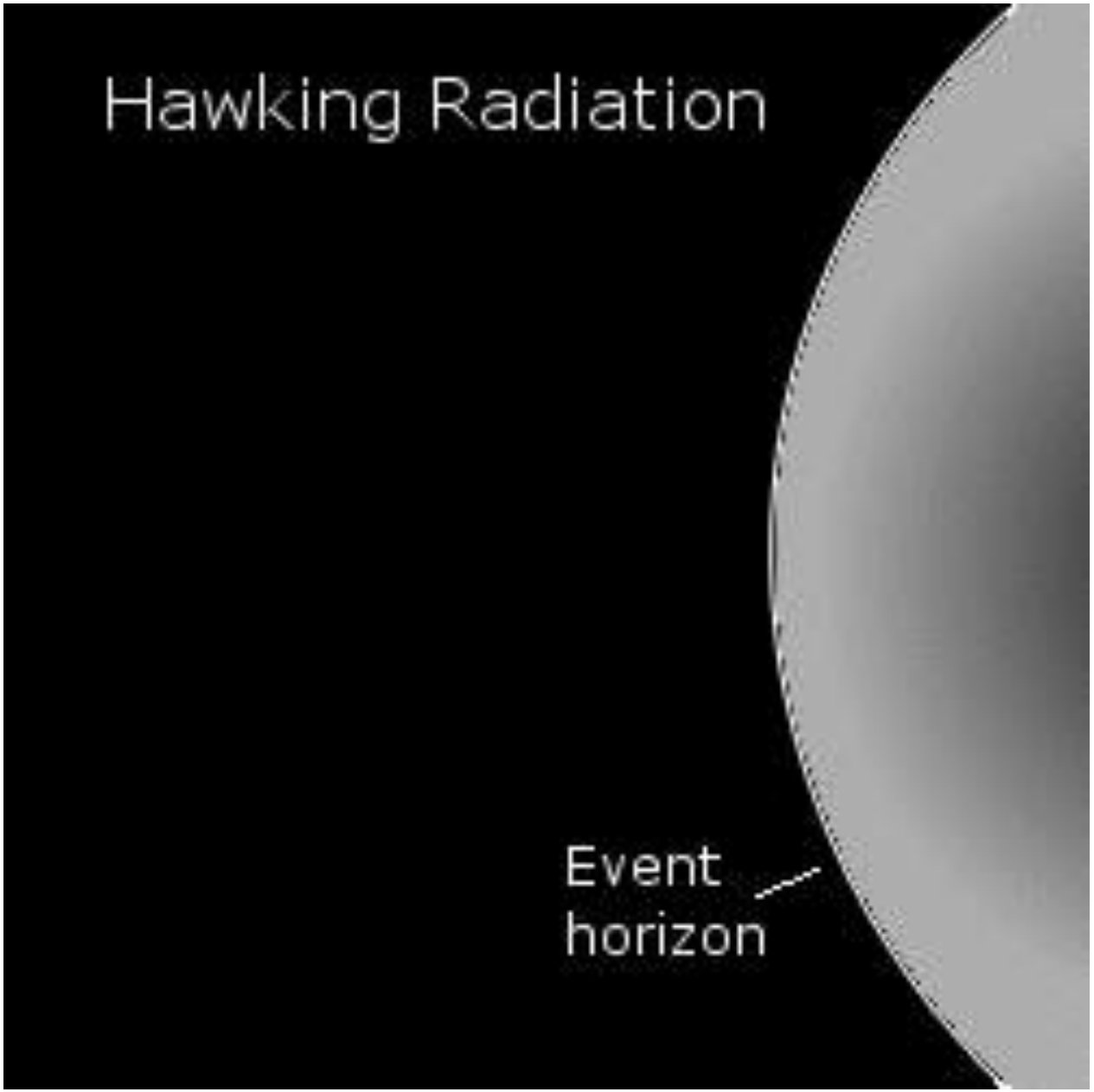




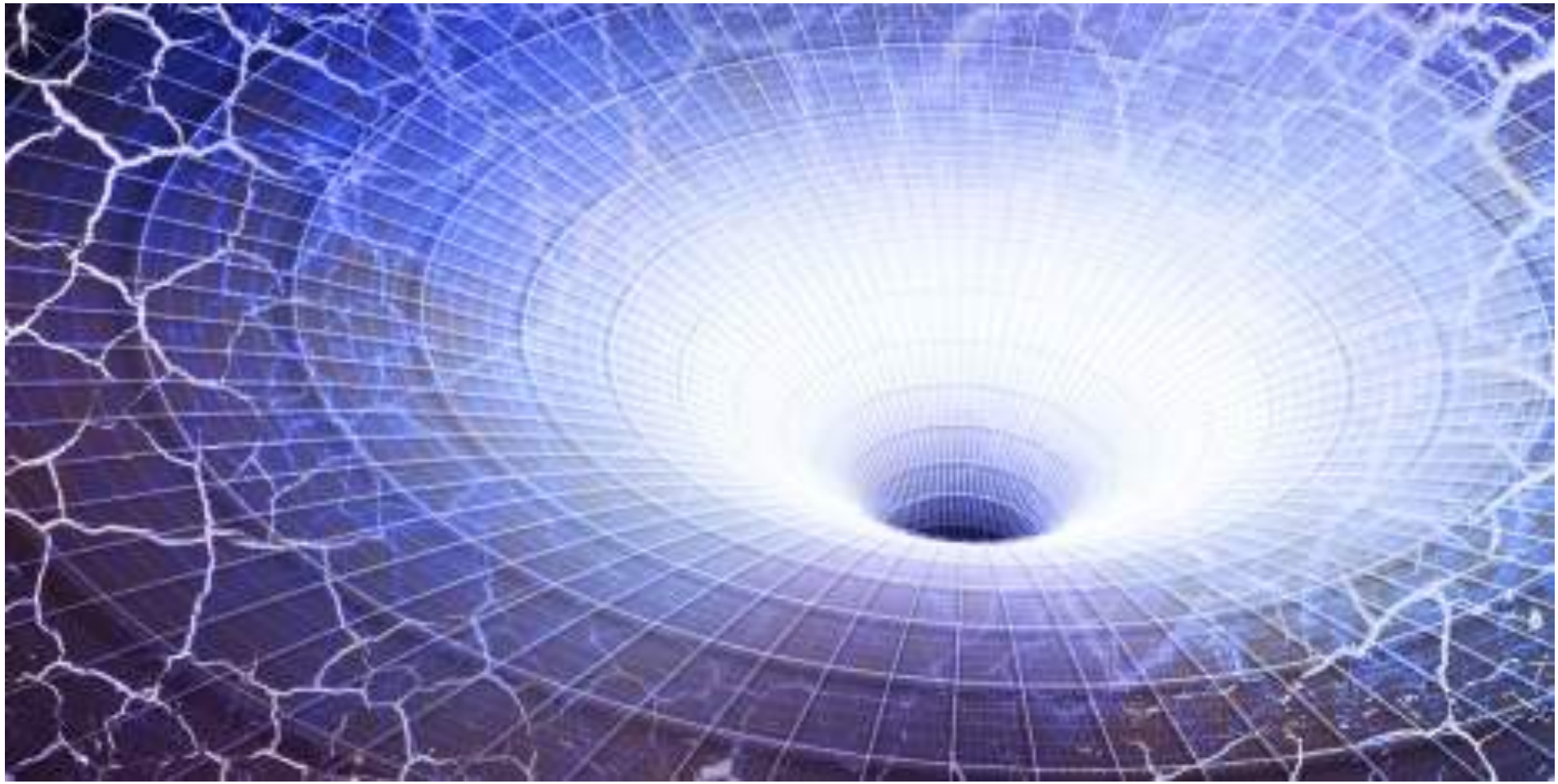

Aforismario
La considerazione dei buchi neri
suggerisce non solo che Dio gioca a dadi,
ma che a volte ci confonde
gettandoli dove non li si può vedere.
Stephen Hawking

I buchi neri non sono cosi'….neri
radiazione di Hawking
(effetti quantistici)


Creazione di una coppia di particelle virtuali nello spazio ordinario: di norma si annichilano subito.
Orizzonte degli eventi
Creazione di una coppia di particelle virtuali nei pressi dell'orizzonte degli eventi di un buco nero: una particella sfugge nello spazio e l'antiparticella precipita all'interno del buco nero.
Buco nero


Hawking Radiation
Event
horizon

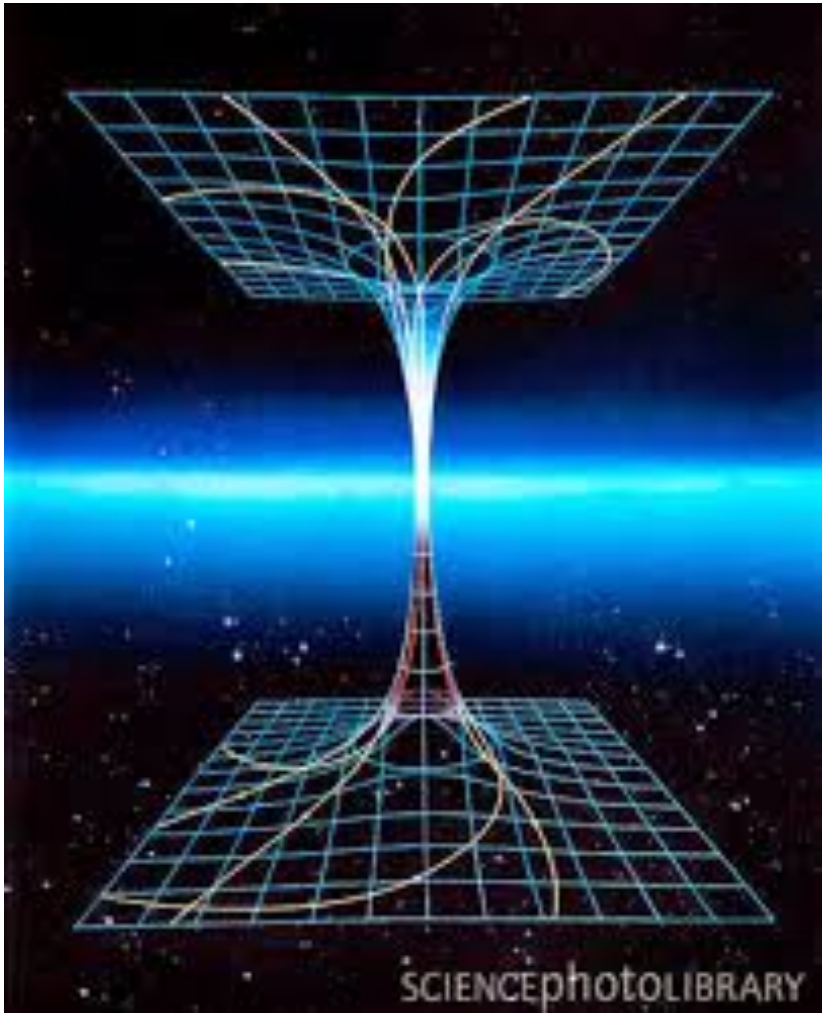
Per capire i buchi neri: gravita' quantistica?



La “guerra” dei buchi neri cosa accade all’informazione?

Hawking e Preskill (la scommessa)

La “guerra” dei buchi neri
cosa accade all’informazione?
Hawking e Preskill (la scommessa)

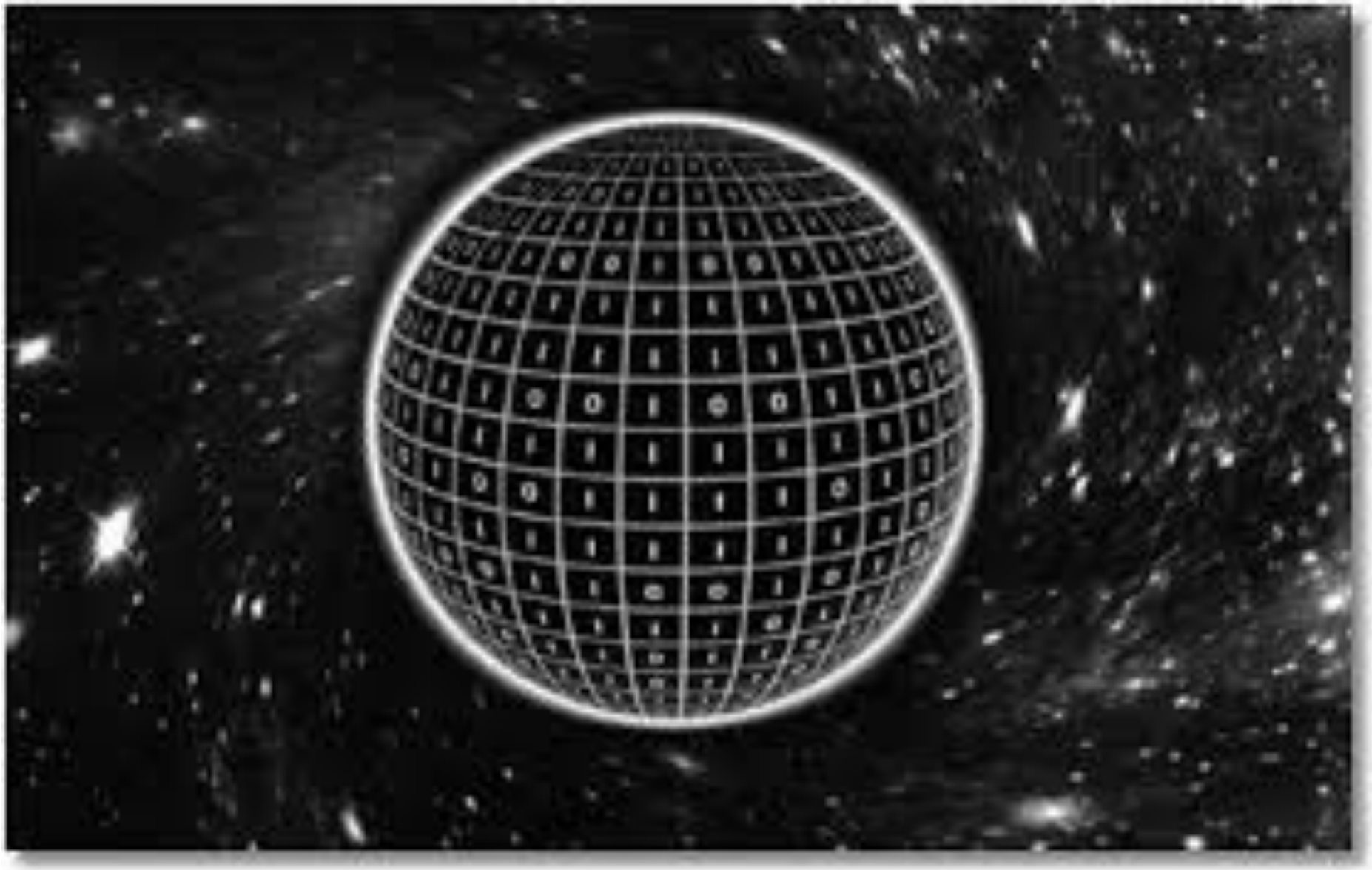


La “guerra” dei buchi neri l’informazione – entropia di un buco nero

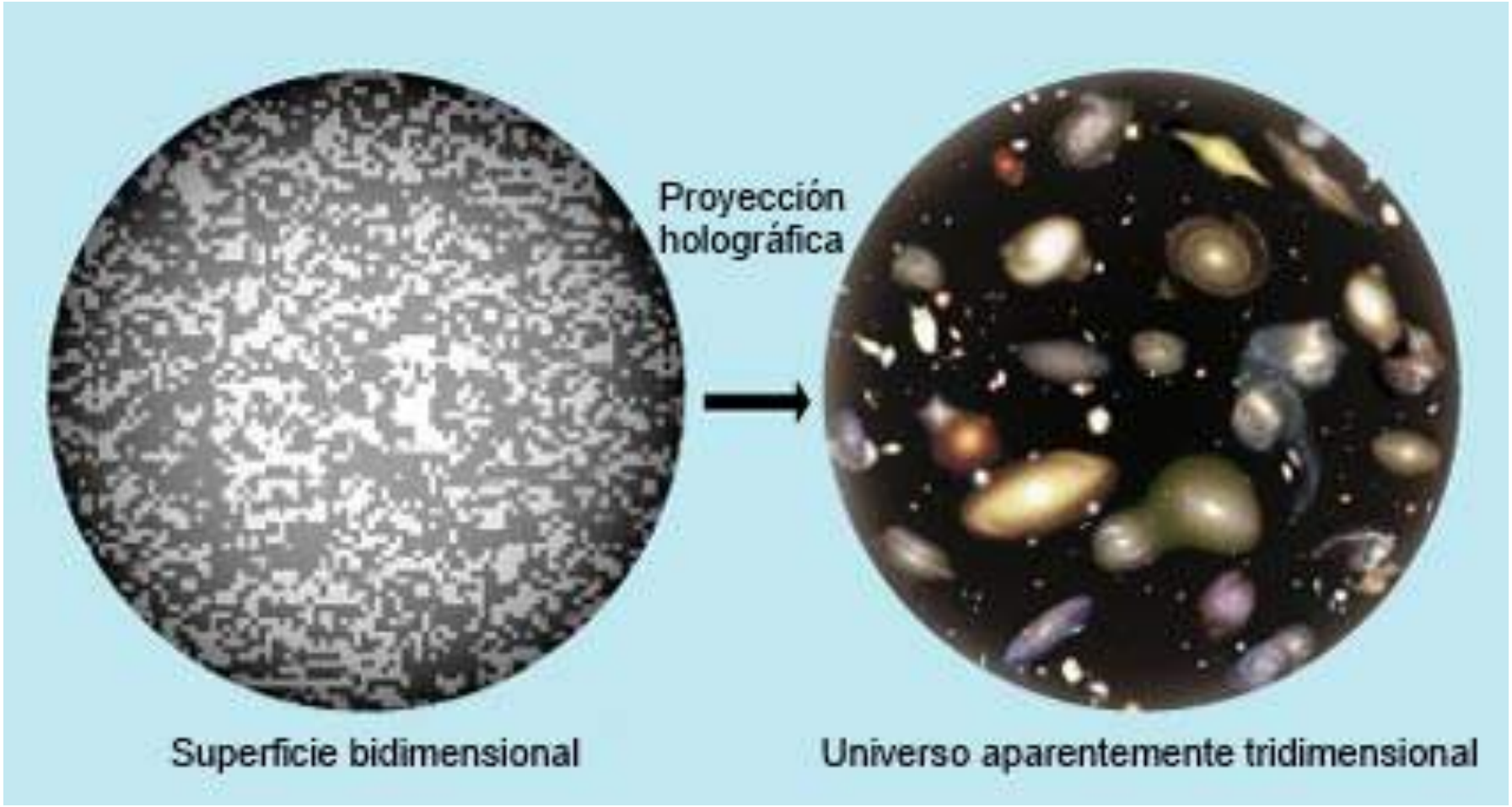
Bekenstein - Hawking:

$$S = \frac{\pi A k c^3}{2hG}$$

Informazione di un buco nero: Principio olografico

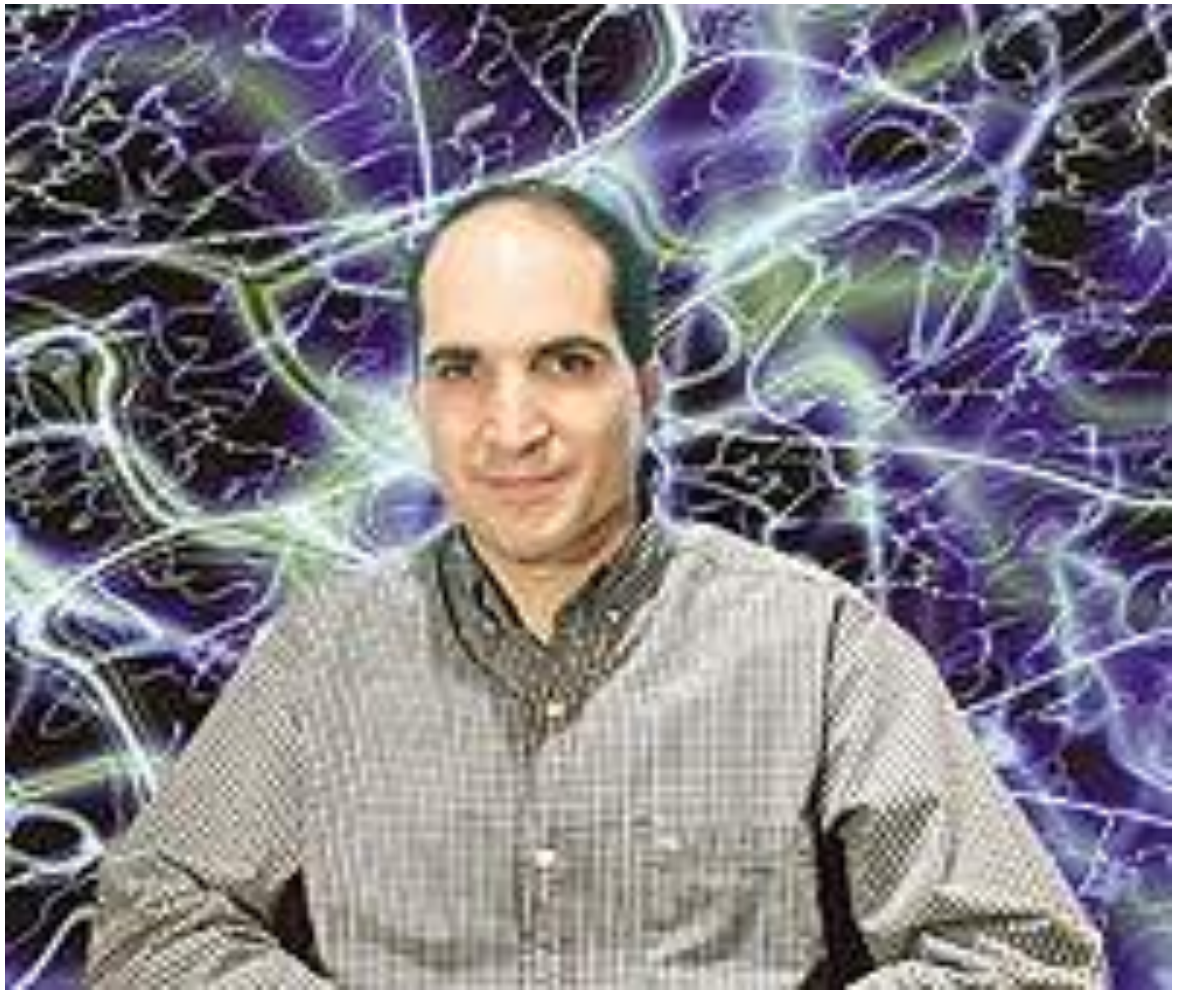


Informazione di un buco nero: Principio olografico

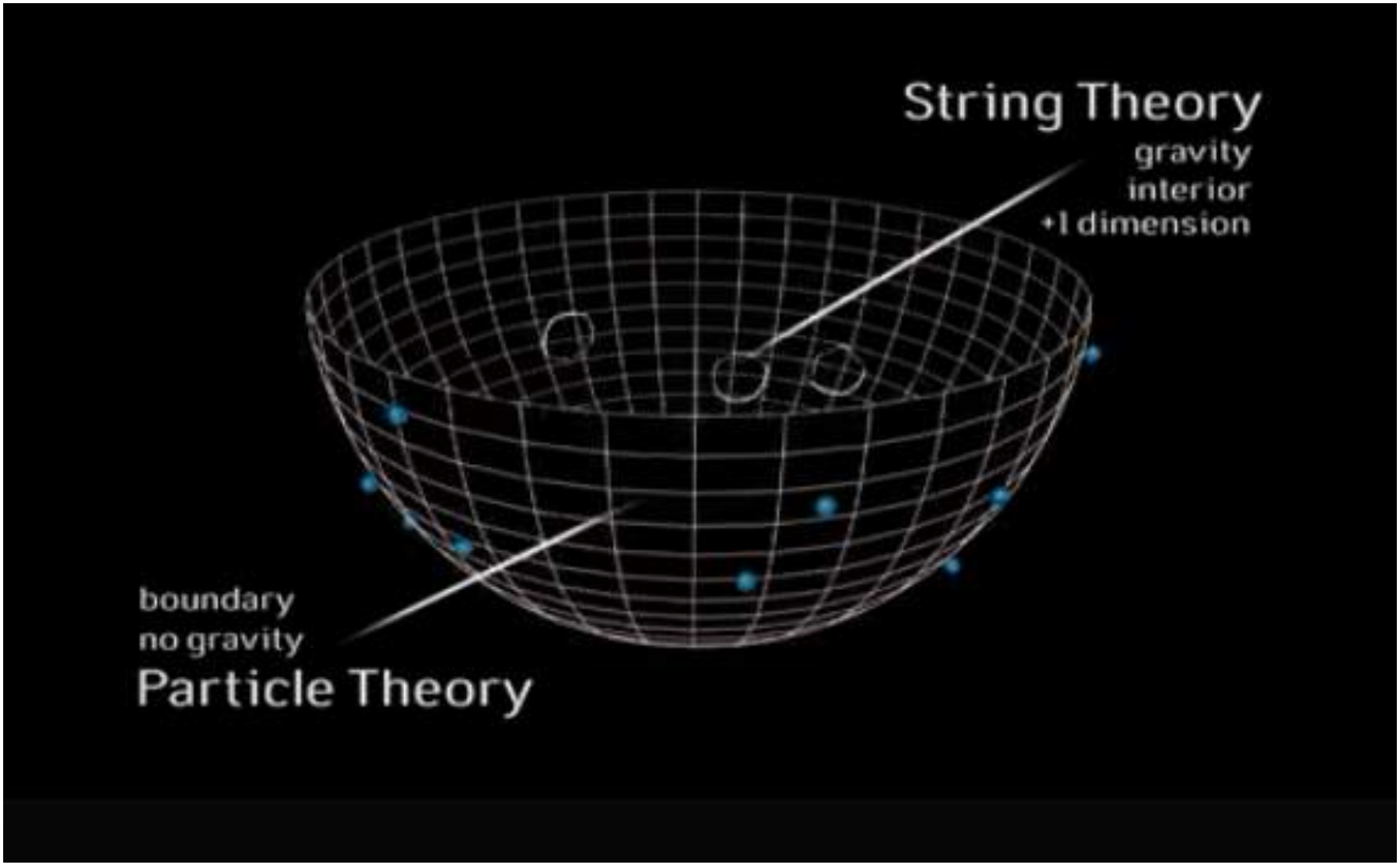


La “guerra” dei buchi neri cosa accade all’informazione?

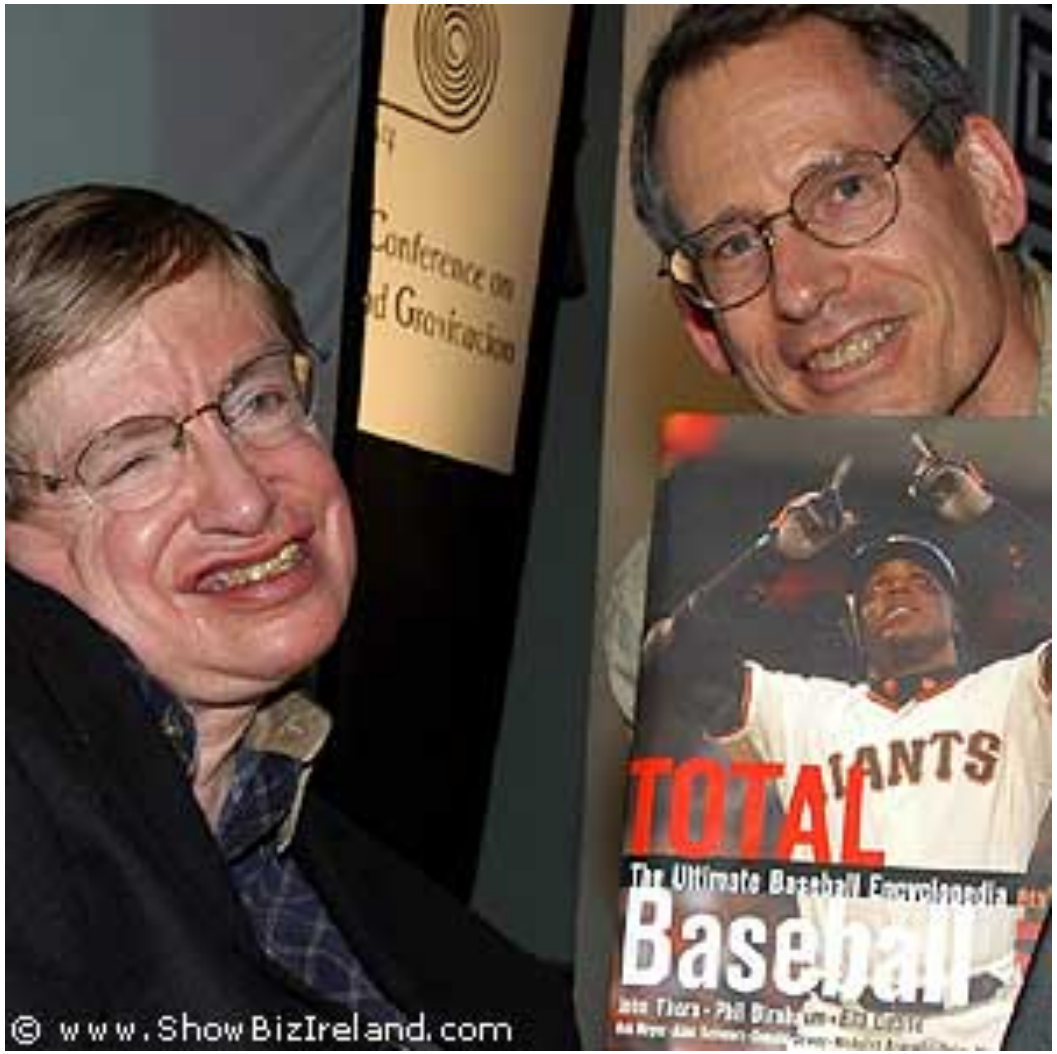
Maldacena



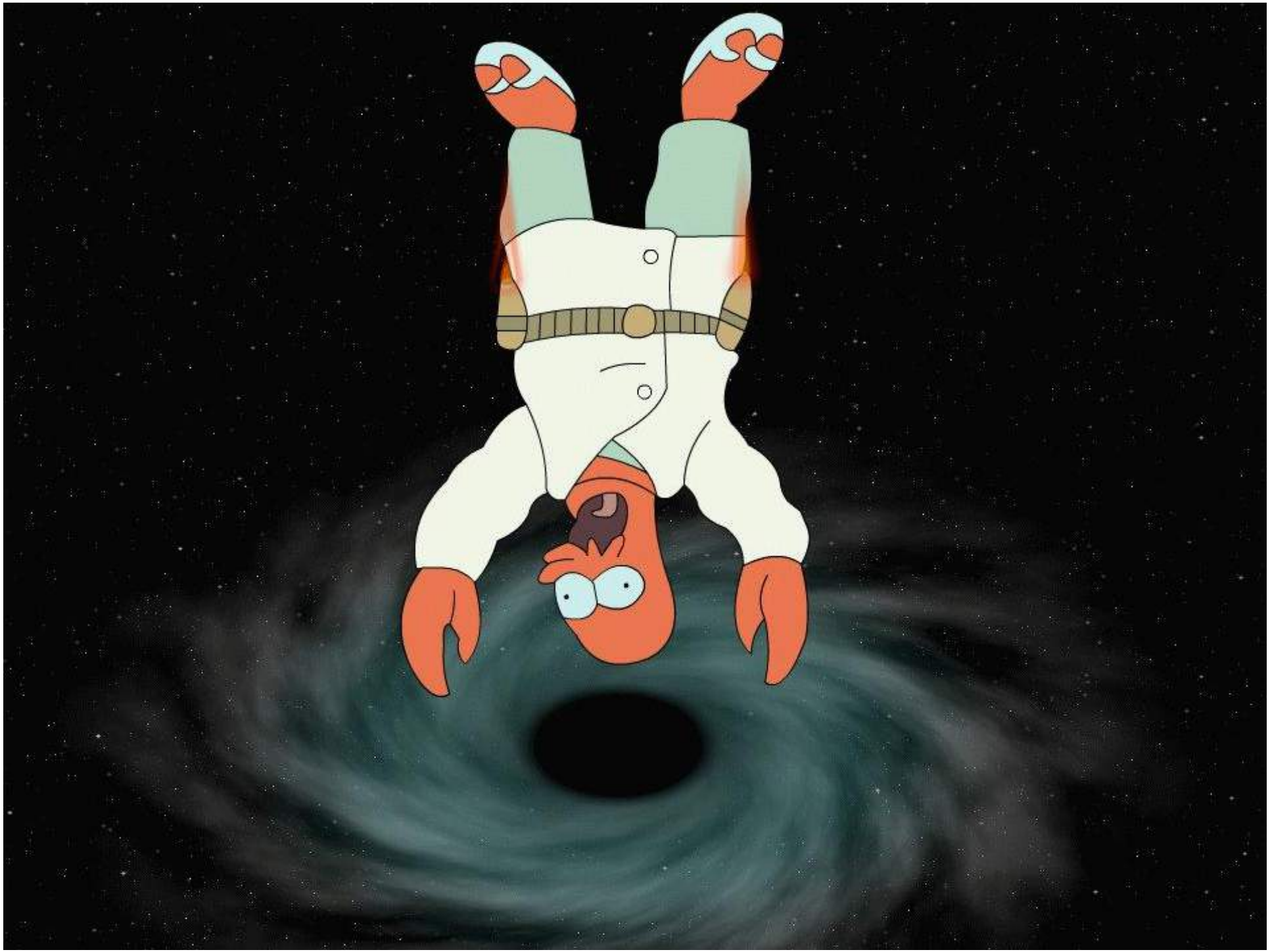
Le teorie duali
Maldacena



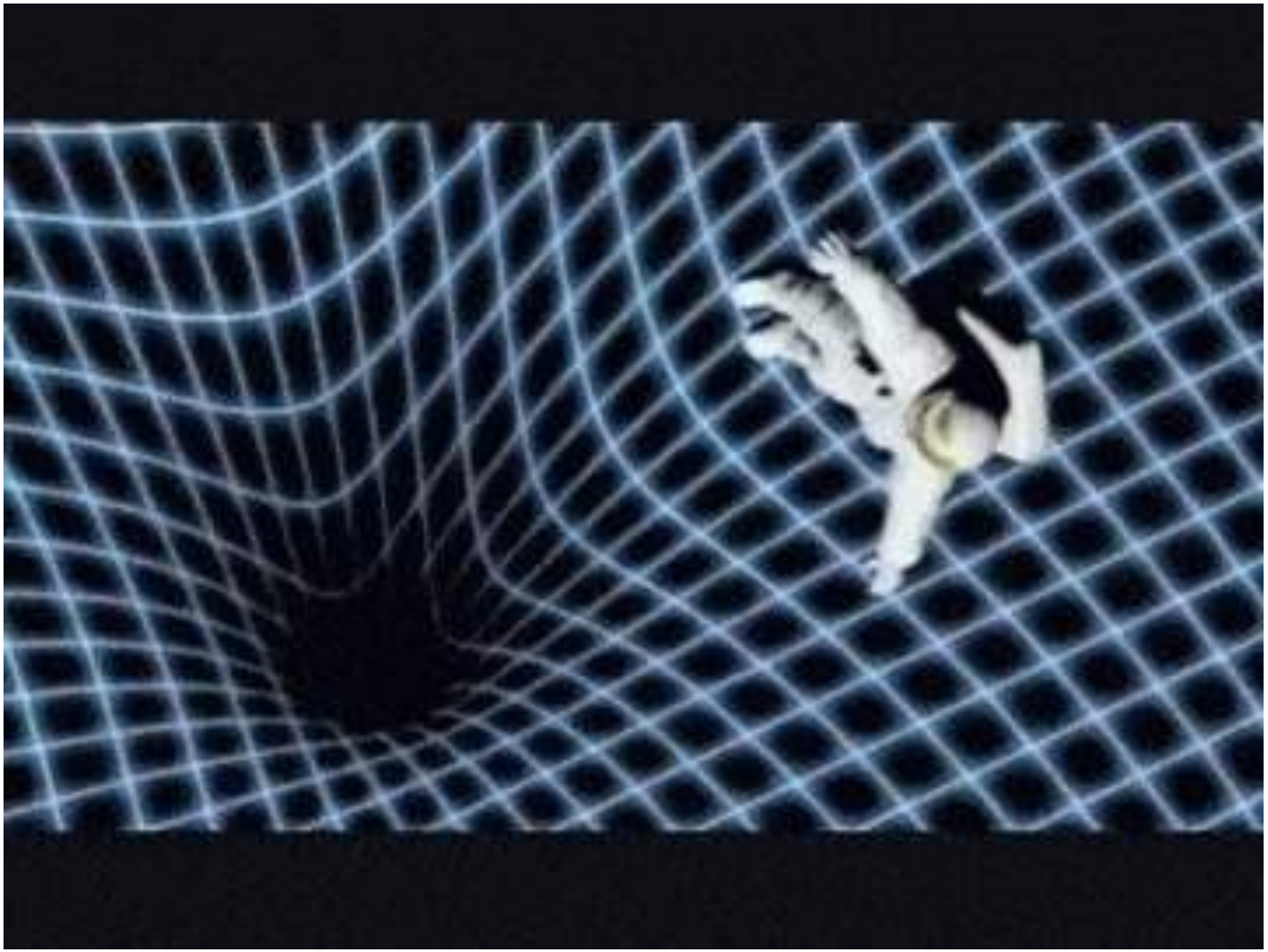
La “guerra” dei buchi neri cosa accade all’informazione? Hawking e Preskill (la scomessa)



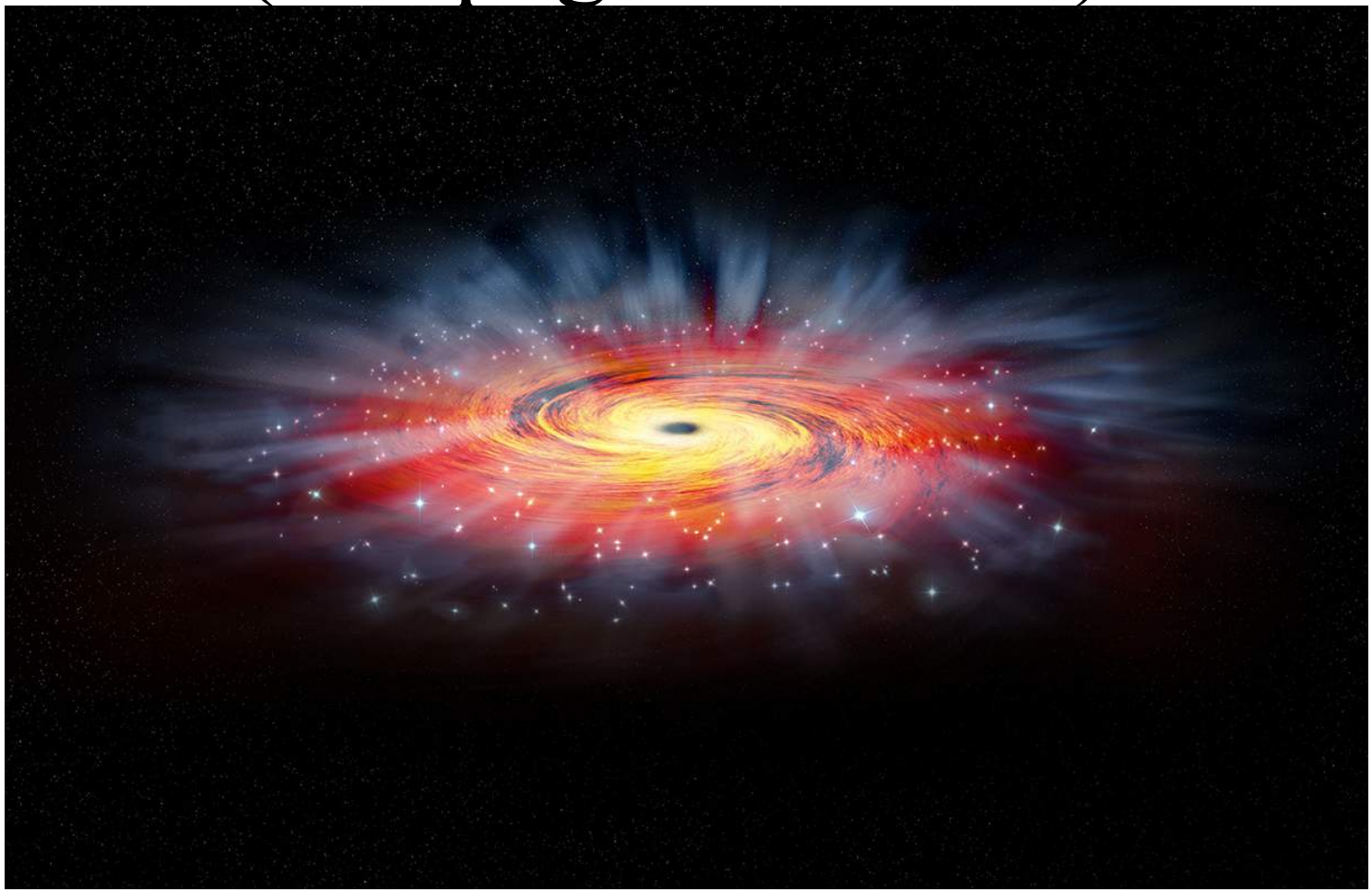
Allora, cosa accade se mi lancio in un buco nero?



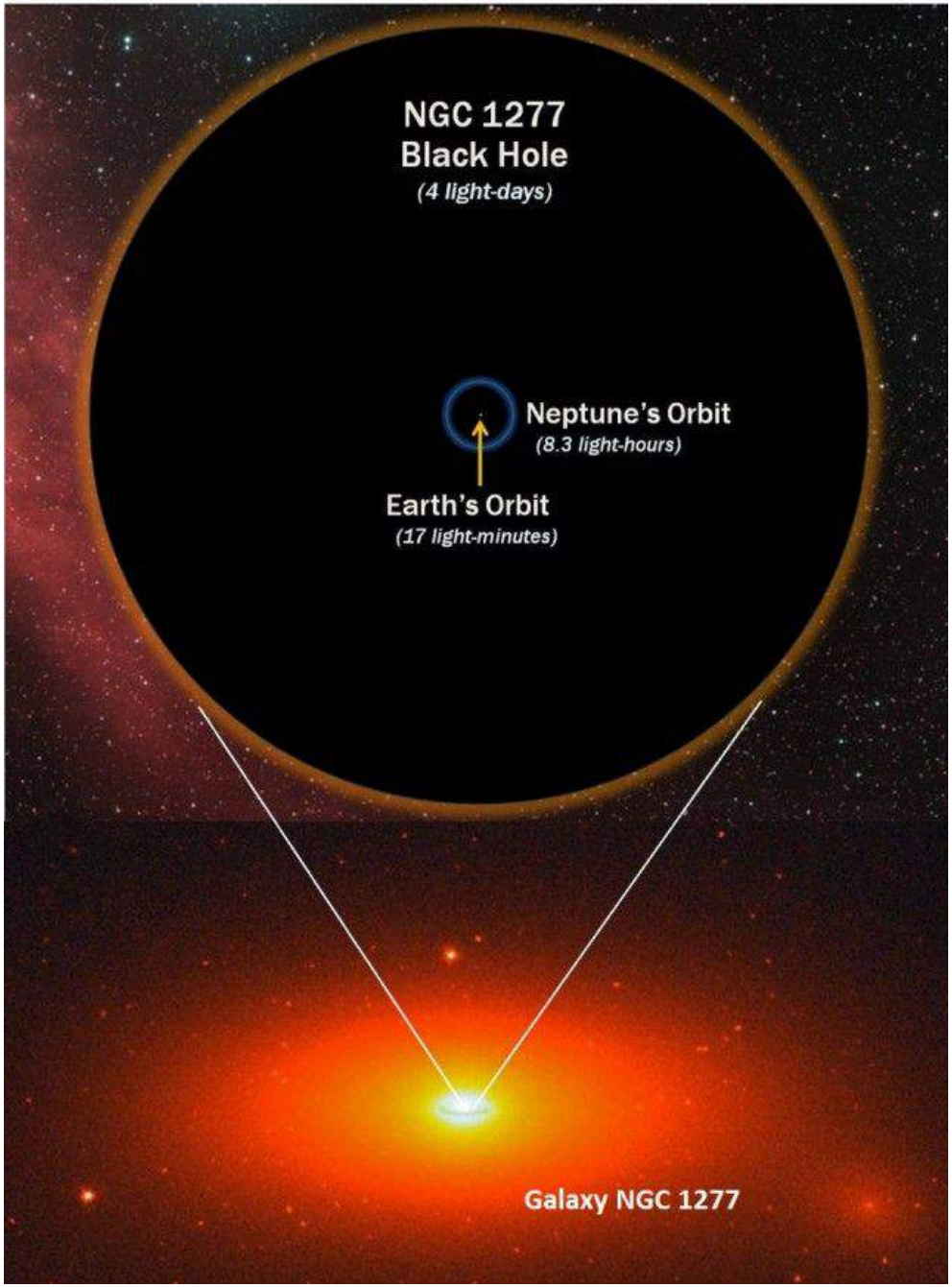

Spaghettification!
To Black Hole



Buchi neri supermassicci densita' bassa (no spaghetificaton)

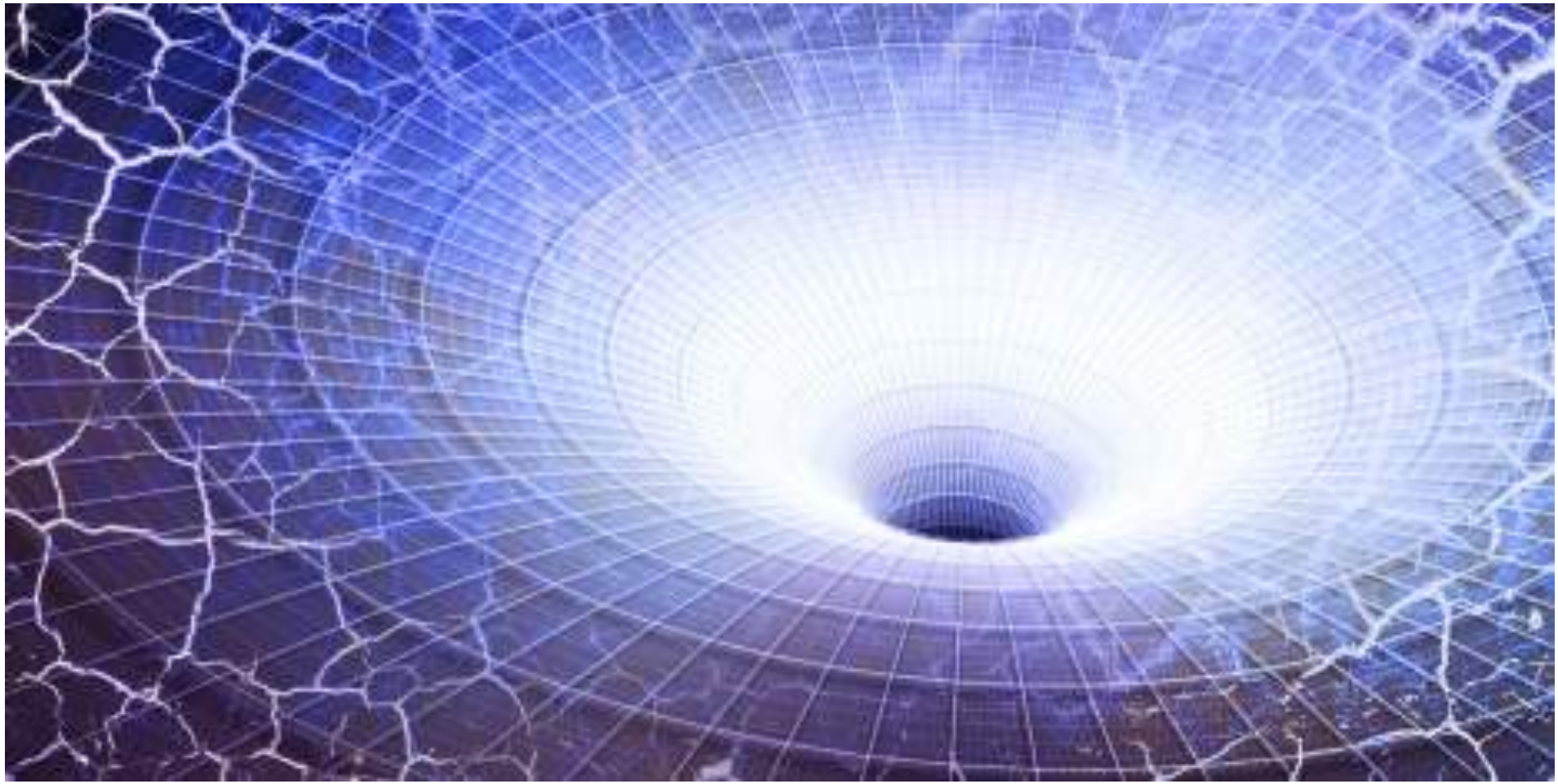


Black Hole – mass about 17 miliarde di volte massa Sole

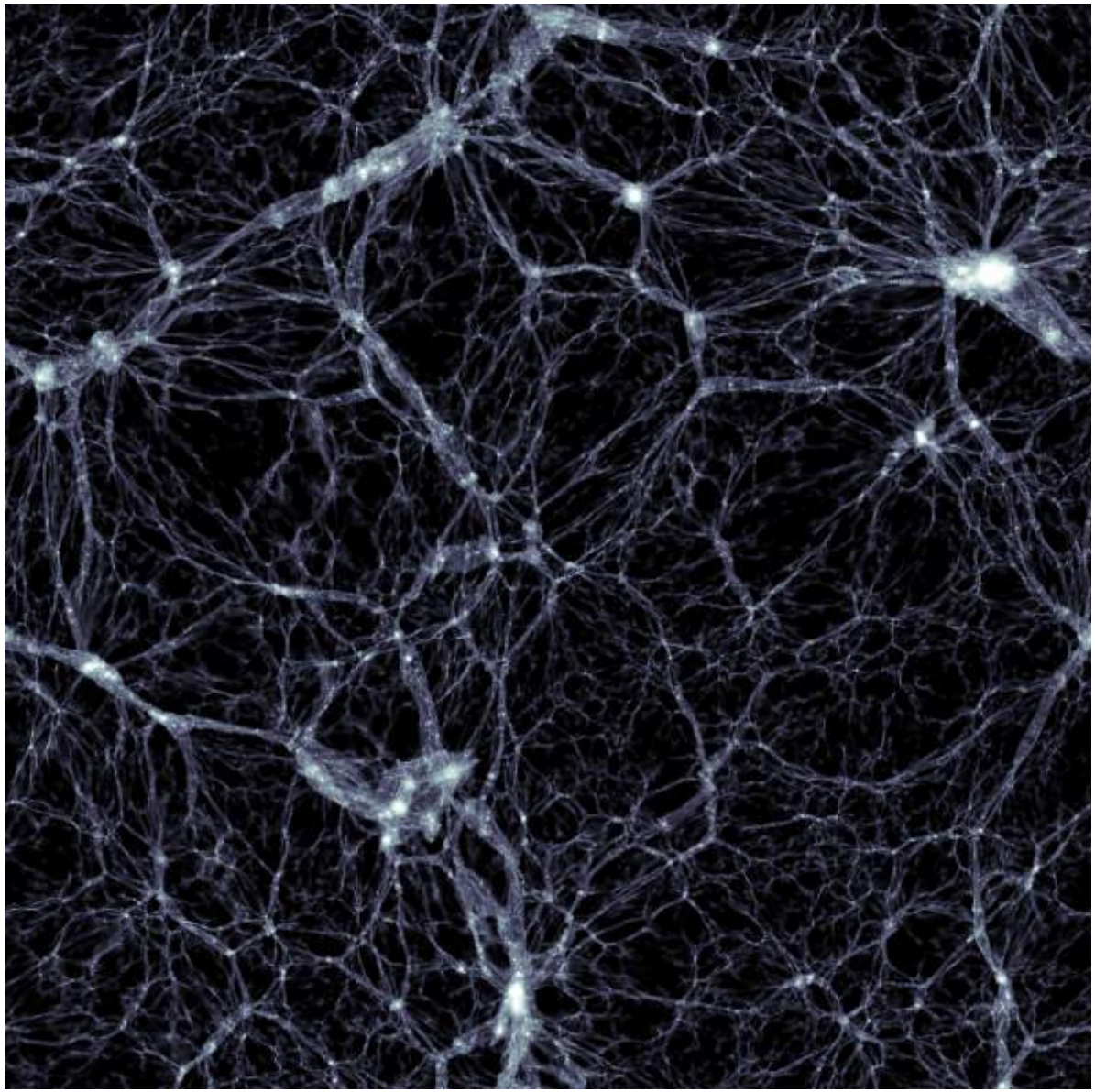


Viaggi interstellari?

Per capire i buchi neri:
capire meglio spazio-tempo-materia

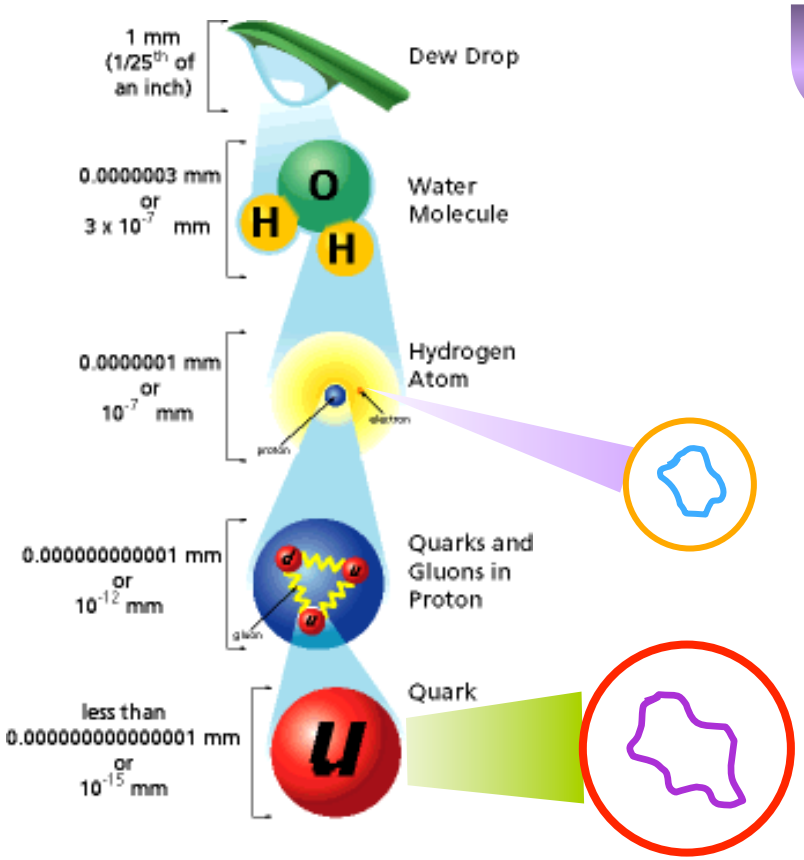


Gravita' quantistica?



Teoria delle stringhe

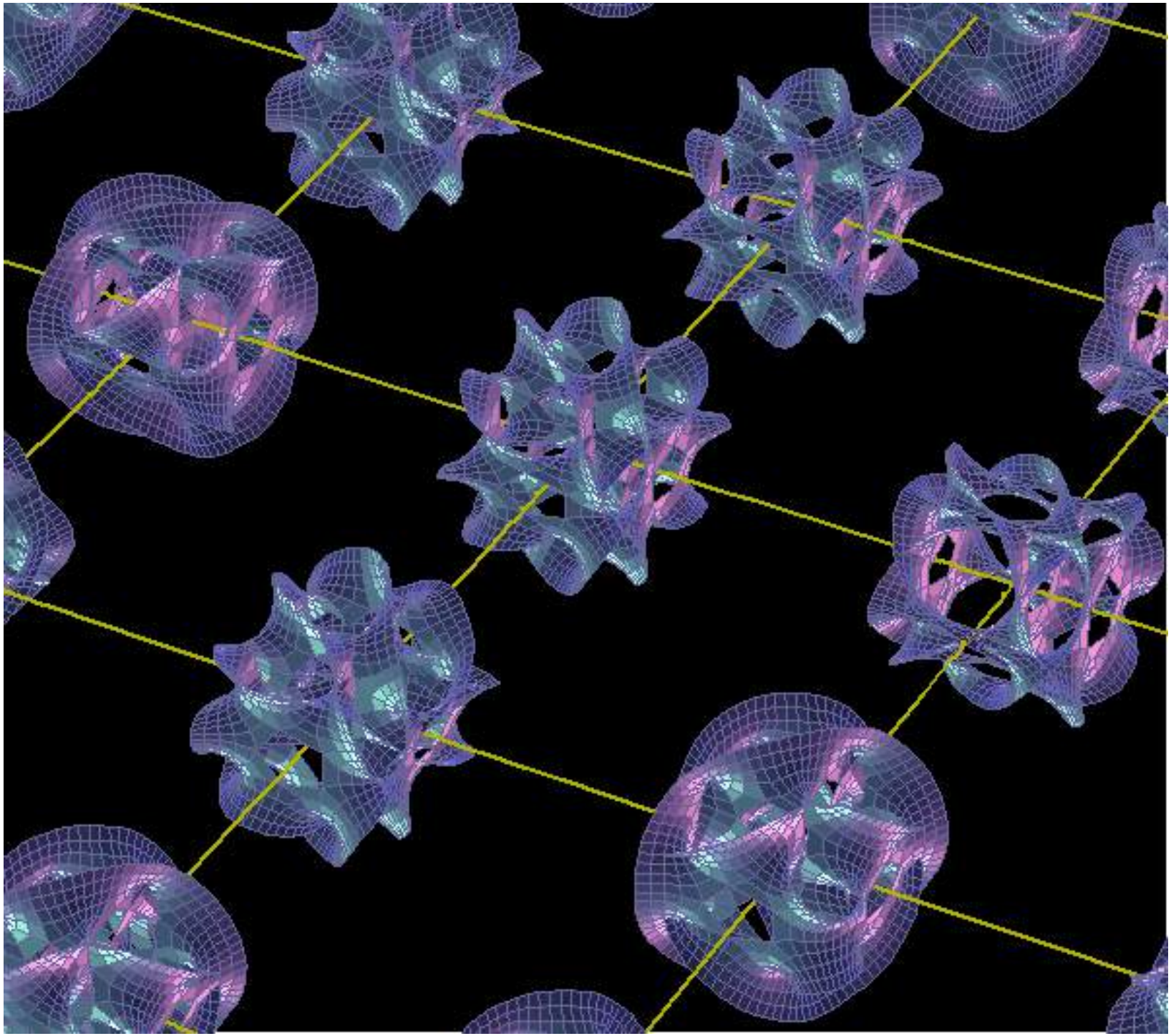
- Le particelle sono veramente puntiformi ?



Teoria delle Stringhe

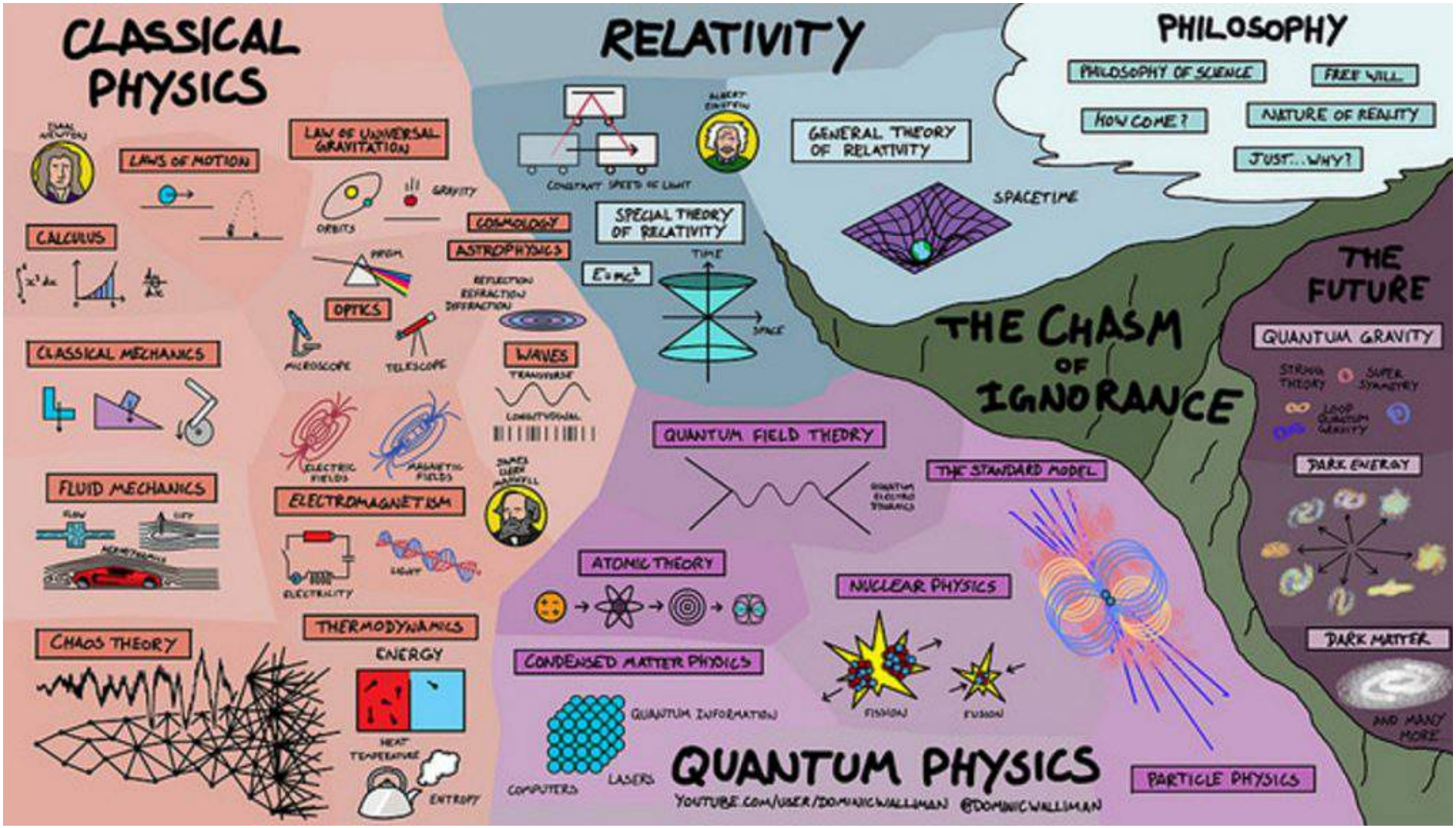
ulteriore livello microscopico: particelle non sono puntiformi, ma piccoli (10^{-33} cm) anelli oscillanti

diversi stati di oscillazione della stringa → particelle diverse



10^{500} Universi paralleli!!!

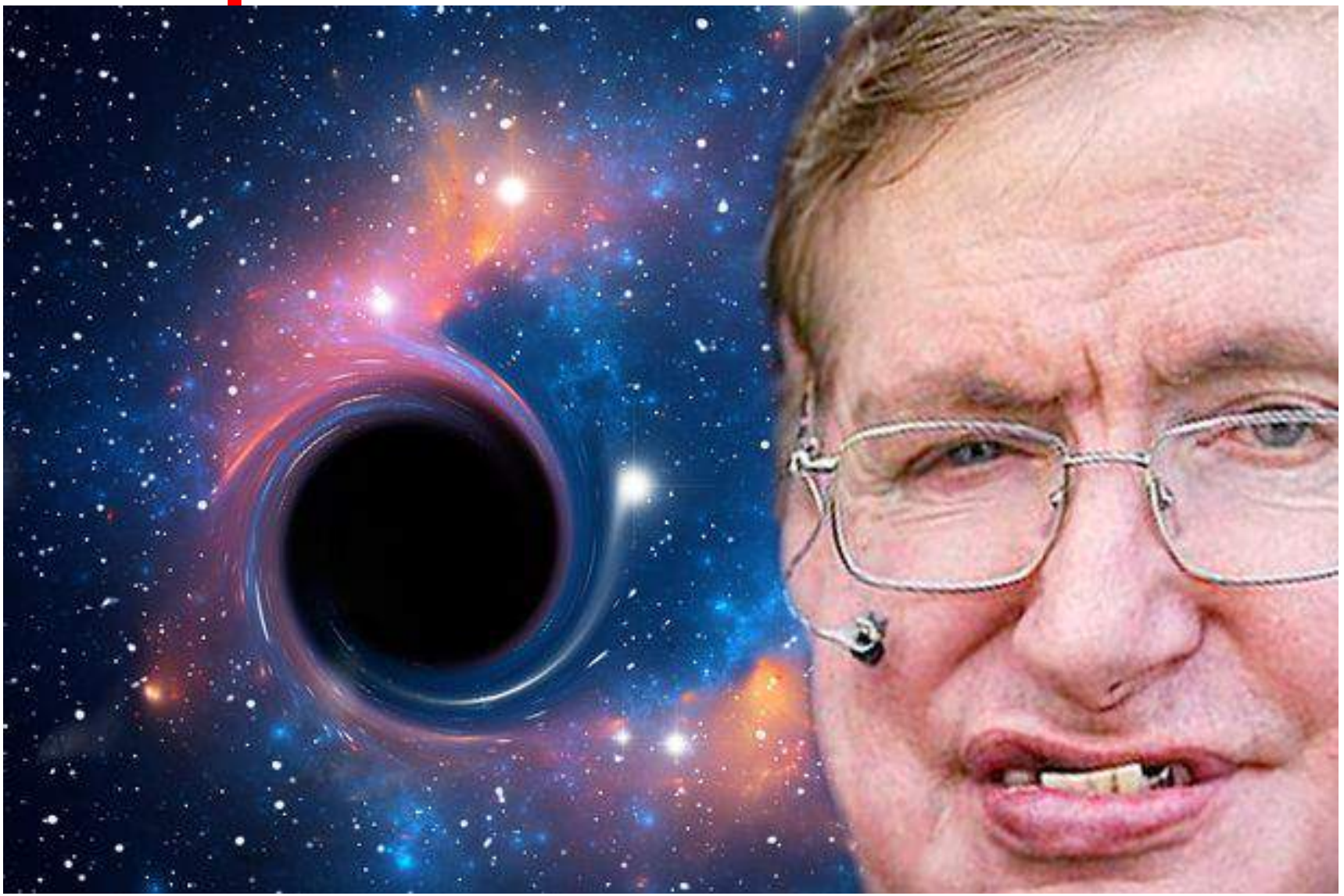
La Terra Incognita della Fisica moderna




Black Holes Are Passage To Another Universe


You've stated that you believe

Se finite in un buco nero, non datevi per vinti. Un'uscita c'è



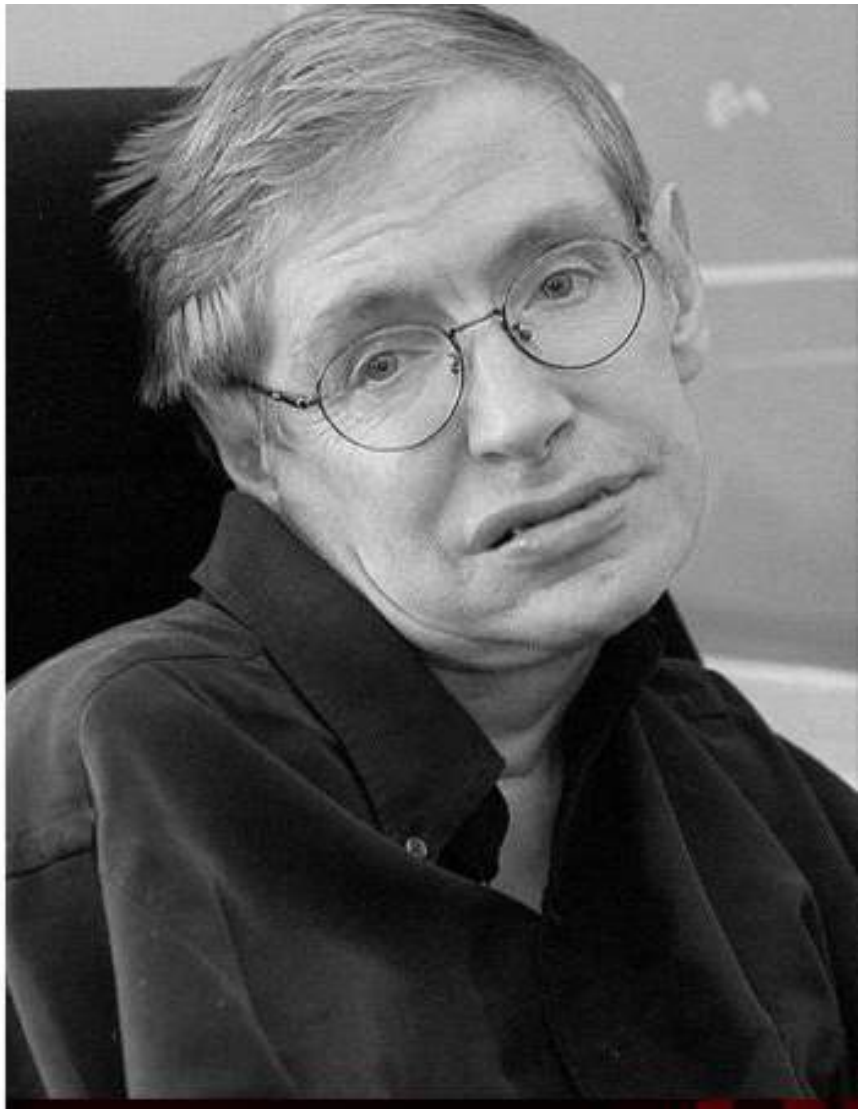
E' quando le aspettative

sono ridotte a zero

che si apprezza veramente

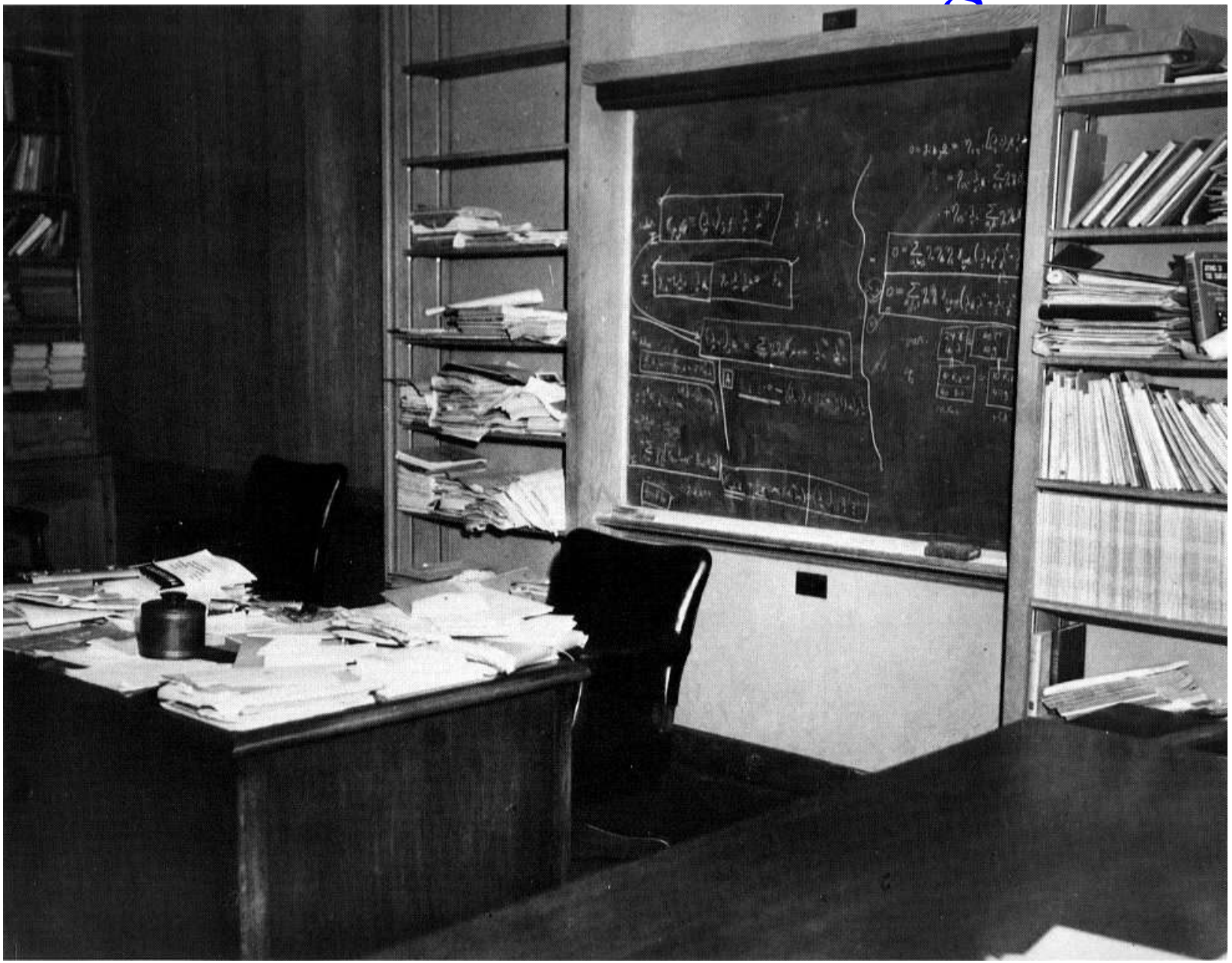
ciò che si ha.

Stephen Hawking



Lanciarsi in un buco nero?

Einstein – l'ultima lavagna



Catalina Oana Curceanu

Dai buchi neri all'adroterapia

Un viaggio nella fisica moderna

http://www.springer.com/physics/applied+%26+technical+physics/book/978-88-470-5240-6

CURCEANU • DAI BUCHI NERI ALL'ADROTERAPIA