



# Astronomia e celluloide

Anna Wolter



# Scienza e celluloide

Anna Wolter

# Le origini

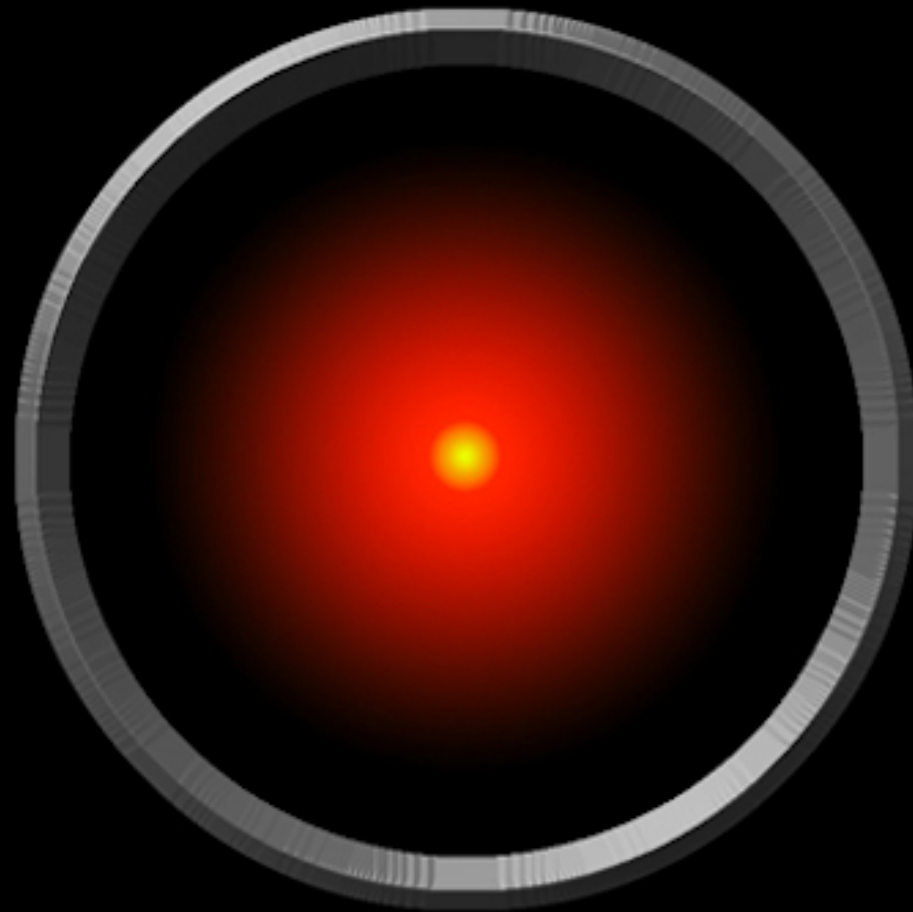
- **Le Voyage dans la Lune (1902) Georges Méliès** – Hugo Cabret (2011)

- **2001: A Space Odyssey**  
*Kubrick*



- **Solaris (1972) Andrei Tarkovsky**

I'm sorry Dave,  
I'm afraid I can't do that.



# Le origini

- **Le Voyage dans la Lune (1902) Georges Méliès** – Hugo Cabret (2011)

- **2001: A Space Odyssey (1968) Stanley Kubrick**

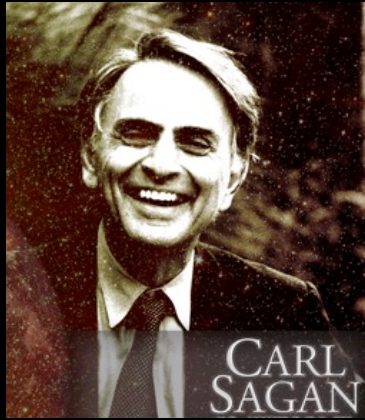


**Solaris (1972) Andrej Tarkovskij**

# Le origini



1985



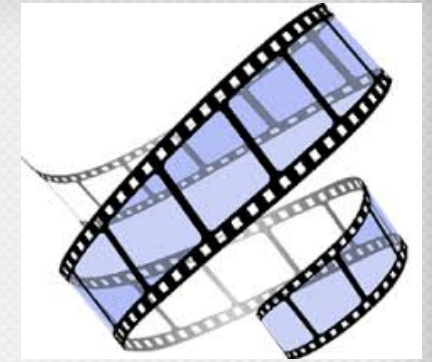
# CARL SAGAN

A NOVEL  
**CONTACT**

1997 (Robert Zemeckis)



# E poi ci sarebbe..



- Saghe: [UFO 1970-73]  
es. Star wars vs. Star trek
- Coinvolgimento istituti italiani

Ma quando arrivano le ragazze (2005)  
*Pupi Avati* [Italia] Loiano

La corrispondenza (2016) *Giuseppe Tornatore* [Italia] Asiago

Gli asteroidi (2017) *Germano Maccioni*  
[Italia] Medicina





# I catastrofici

- *Apollo 13* (1995) *Ron Howard* [USA]
- *Deep Impact* (1998) *Mimi Leder* [USA]
- *Armageddon – Giudizio finale* (1998)  
*Michael Bay* [USA]
- *Gravity* (2013) *Alfonso Cuaron* [USA, GB]
- *The Martian – Sopravvissuto* (2015)  
*Ridley Scott* [USA]
- *Arrival* (2016) *Denis Villeneuve* [USA]



**MOVIE  
DUEL**

# Gravity – effetti speciali



# Concept art



# Space X – 6 febbraio 2017



# Film recenti

- Interstellar (2014) *Christopher Nolan* [USA]
- The imitation game (2014) *Morten Tyldum* su Alan Turing e ENIGMA [GB]
- The theory of everything – [La teoria del tutto](#) (2014) *James Marsh* su Stephen Hawkings [GB]
- The man who knew infinity – [L'uomo che vide l'infinito](#) (2016) *Matt Brown* [USA]
- Hidden figures – [Il diritto di contare](#) (2016) [USA]



# Hidden figures

- *Le calcolatrici*  
di Pickering



# Langley Res. Ctr. Hampton VA

- Programma Mercury:
  - Portare un razzo con un astronauta fuori dall'attrazione gravitazionale della Terra e riportarlo salvo a terra.
- Programma Apollo
  - Raggiungere la Luna

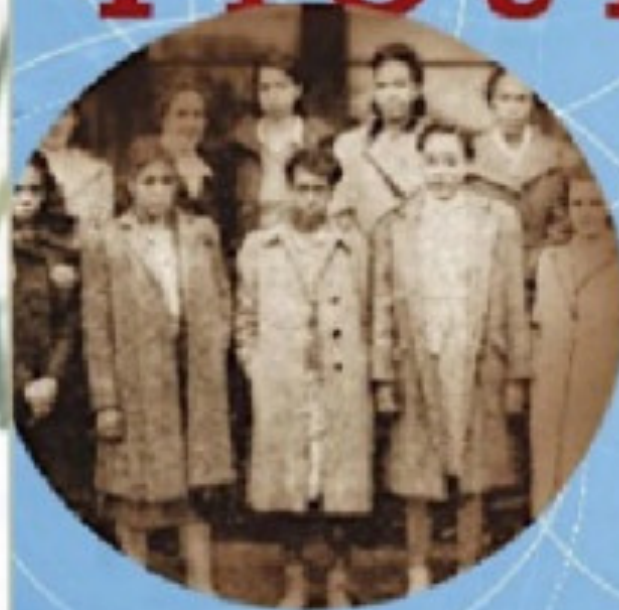
La corsa allo spazio è iniziata ....  
e i russi stanno vincendo.





During World War II, America's fledgling aerospace industry hired Black female mathematicians to fill a labor shortage. These "human computers" stayed on to work for NASA and make sure America won the Space Race. They fought for their country's future, and for their share of the American Dream. This is their untold story.

# HIDDEN FIGURES



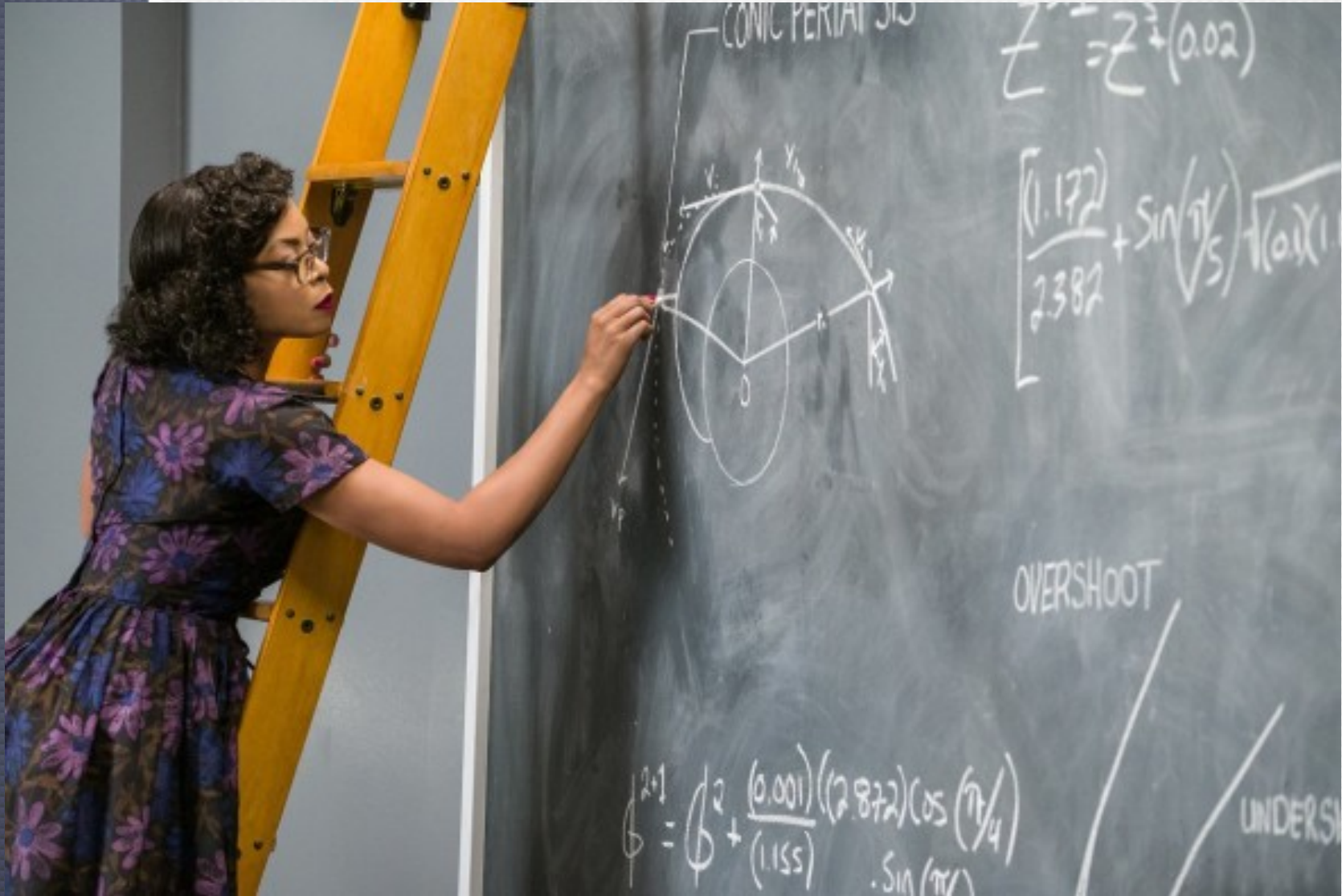
MARGOT LEE SHETTERLY

# John Glenn



# John Glenn





# Le vere protagoniste

***Katherine Johnson (1918-)***

***Dorothy Vaughan (1910-2008)***

***Mary Jackson (1921-2005)***



# Dopo la medaglia di Obama, un edificio



# Citazioni

- “Mi occorrono dei numeri che ancora non esistono. Trovatemmi un matematico prima che i russi piantino una bandiera sulla luna.”  
Al Harrison (Kevin Costner)
- “Come giustifichiamo un programma spaziale che non manda qualcosa nello spazio?” (J. Webb – Amministratore NASA)

# The men who knew infinity

- Srinivasa Ramanujan (1887-1920).





# The men who knew infinity

- Srinivasa Ramanujan (1887-1920).



Subramanian Chandrasekar



# Trinity College – Cambridge UK



# The real ones



# Sul rapporto Hardy – Ramanujan

Vissuto in estrema povertà, la sua geniale intelligenza viene poco compresa e accettata dal mondo scolastico indiano e si ritrova a elaborare in solitudine le sue scoperte quasi miracolose. Per far conoscere al mondo la sua mente geniale, è necessario l'incontro con l'eccentrico professore G.H. Hardy con cui forgerà un forte legame. La guida di Hardy, che diventa a mano a mano anche suo amico oltre che mentore, lo porta da un lato a imparare la metodologia "occidentale" delle dimostrazioni dei teoremi e dell'altro a essere accettato da un ambiente ostile.

# Chautisa Yantra (954 AD)



Every number was  
his personal friend

# Numeri - taxi



# Numeri - taxicab

- $Ta(n)$  - è il più piccolo numero rappresentabile in  $n$  modi come somma di due cubi positivi.
- $Ta(2) = 1^3 + 12^3$   
 $= 9^3 + 10^3$

Se ne conoscono 6 ; il più grande è  
 $Ta(6) = 24153319581254312065344$   
(2.4 e22)



# Superfici K3

- In [mathematics](#), a **K3 surface** is a complex or algebraic smooth minimal complete surface that is [regular](#) and has trivial [canonical bundle](#).
- In the [Enriques–Kodaira classification](#) of surfaces they form one of the 4 classes of surfaces of [Kodaira dimension](#) 0.
- Together with two-dimensional [complex tori](#), they are the [Calabi–Yau manifolds](#) of dimension two. Most complex K3 surfaces are not algebraic. This means that they cannot be embedded in any projective space as a surface defined by polynomial equations.

not write on this margin.

W

add MS. 9.94.

(1)

add MS. a. 94.

15(1)

(15)

(16)

(17)

N.B This transformation might interest you

In § 10. (4) writing  $dy$  for  $a$  we have  $du (dy)^{-1} = q^{\frac{1}{2}(n-1)} a^{-1} y^{-1}$

$$(1-dy) + dy(1-dy)(1-dy^2) + q^{\frac{1}{2}} a^2 y^2 (1-dy)(1-dy^2)(1-dy^4) \\ = 1 - q^{\frac{1}{2}} a^2 y^2 - q^{\frac{3}{2}} a^2 y^4 + q^{\frac{5}{2}} a^2 y^6 + q^{\frac{7}{2}} a^2 y^8 - \quad (1)$$

$$\text{Now } (1-dy)(-a) = (-a) - \frac{d(-a)}{1+a} = (-ay) = y(-a)$$

$$(1-dy^2)(-ay) = (-ay^3) = y^3(-a)$$

Hence operating on  $(-a)$  in (1), it is equivalent to

$$(y + ay^3 + q^{\frac{1}{2}} a^2 y^5 + q^{\frac{3}{2}} a^2 y^7 + \dots) (-a) \\ = (1 - q^{\frac{1}{2}} a^2 y^2 - \dots) (-a)$$

$$\therefore \frac{1}{1+a} + \frac{a}{(1+a)(1+a^2)} + \frac{q^{\frac{1}{2}} a^2}{\dots} + \dots \\ = 1 - \frac{q^{\frac{1}{2}} a^2}{(1+a)(1+a^2)}$$

or writing  $p_1$  for  $(1+a)(1+a^2)$  &  $r$  for

$$\frac{1}{p_1} + \frac{a}{p_2} + \frac{q^{\frac{1}{2}} a^2}{p_3} + \frac{q^{\frac{3}{2}} a^2}{p_4} + \dots = 1 - \frac{q^{\frac{1}{2}} a^2}{p_1} - \frac{q^{\frac{3}{2}} a^2}{p_2} + \frac{q^{\frac{5}{2}} a^2}{p_3} + \dots$$

$$\text{Let } a = -y : \quad \frac{1}{p_1} - \frac{y}{p_2} + \frac{y^3}{p_3} - \frac{y^5}{p_4} + \dots = 1 - \frac{y^2}{p_1} + \frac{y^4}{p_2} - \frac{y^6}{p_3} + \frac{y^8}{p_4} - \dots$$

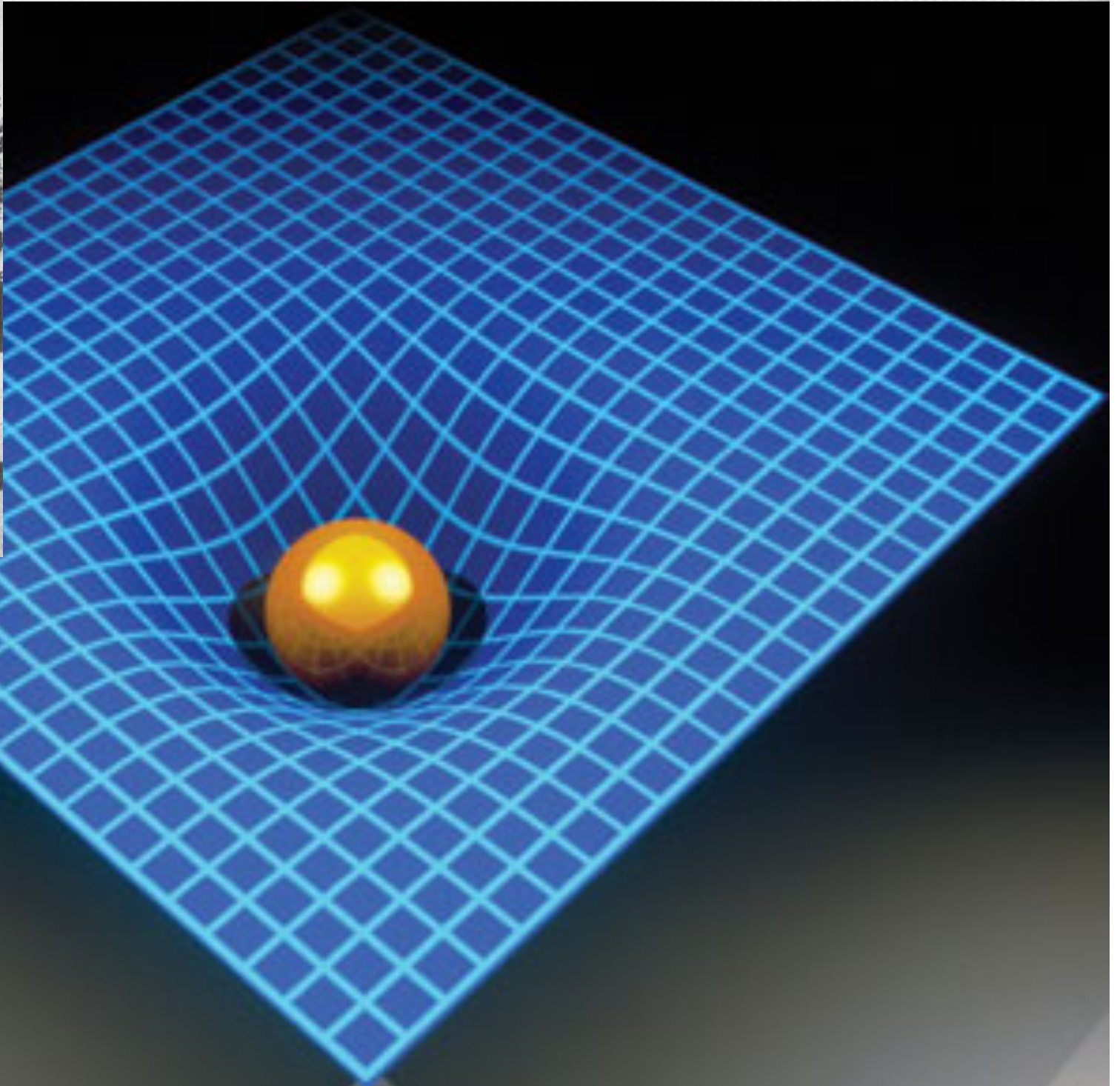
$$a = -y^{\frac{1}{2}} + ay \quad \frac{1}{p_1} - \frac{y}{p_2} + \frac{y^2}{p_3} - \dots = 1 - \frac{y^{\frac{1}{2}}}{p_1} + \frac{y^{\frac{3}{2}}}{p_2} - \dots$$

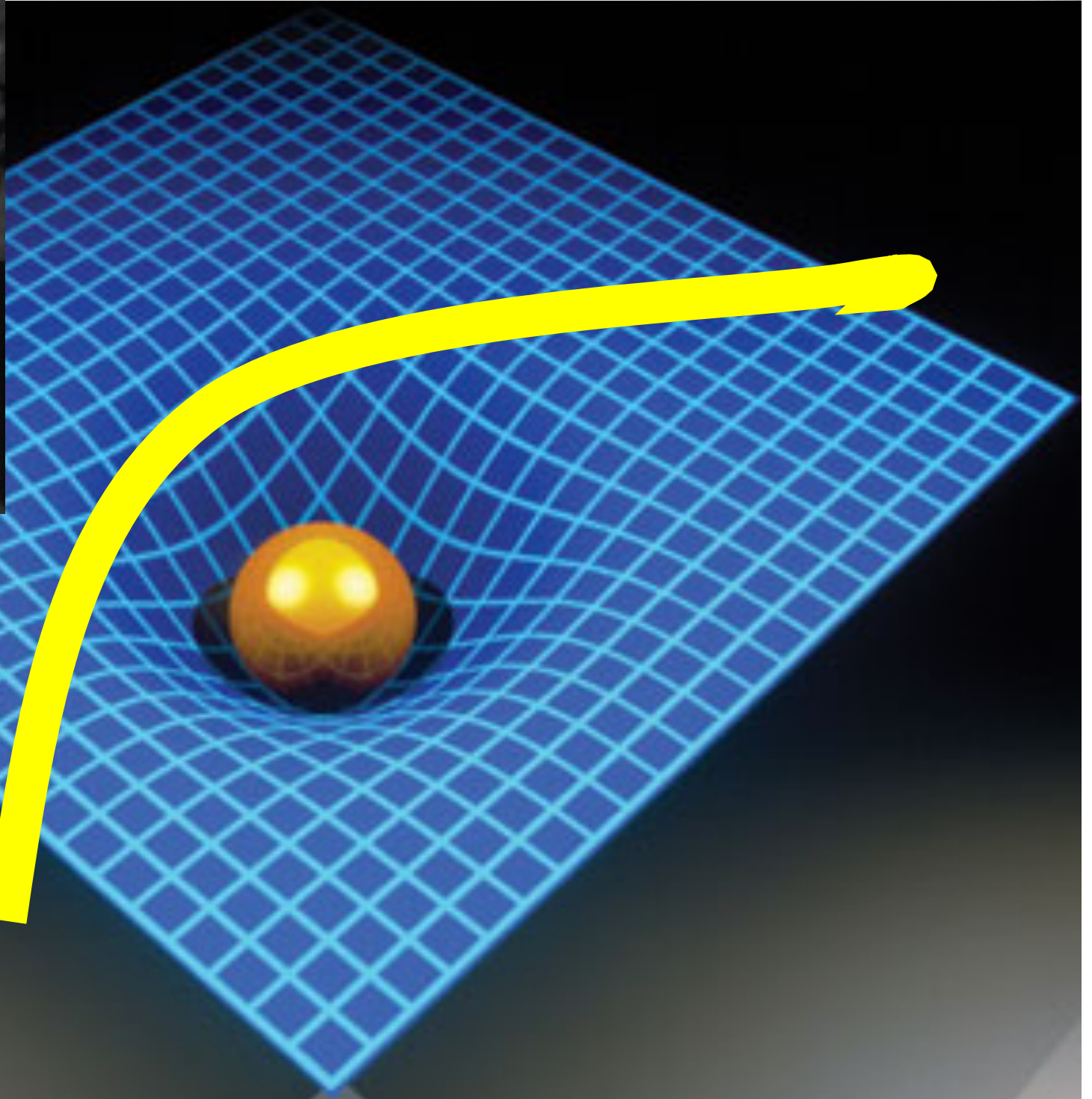
# Citazioni

- Ramanujan: "Un'equazione per me non ha senso, se non rappresenta un pensiero di Dio."
- G.H. Hardy: "Ci servono le dimostrazioni, noi siamo semplici esploratori dell'infinito alla ricerca della perfezione assoluta"

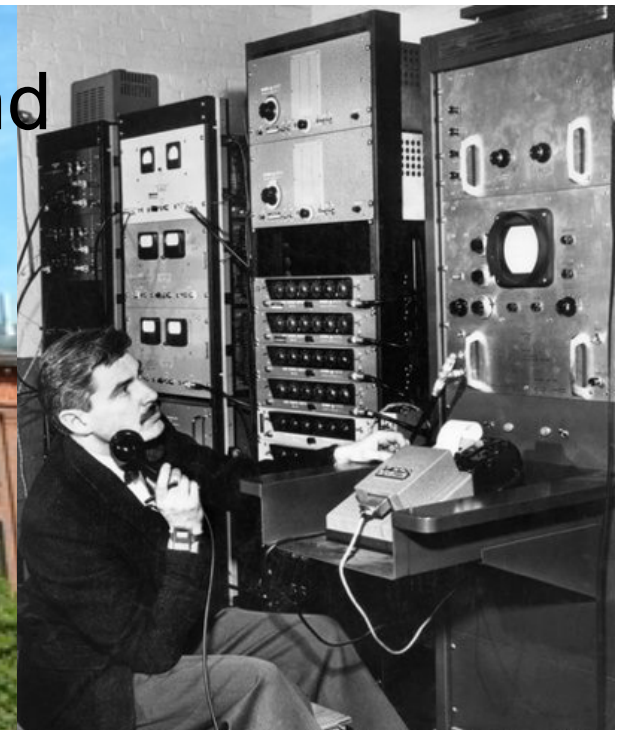
# Interstellar





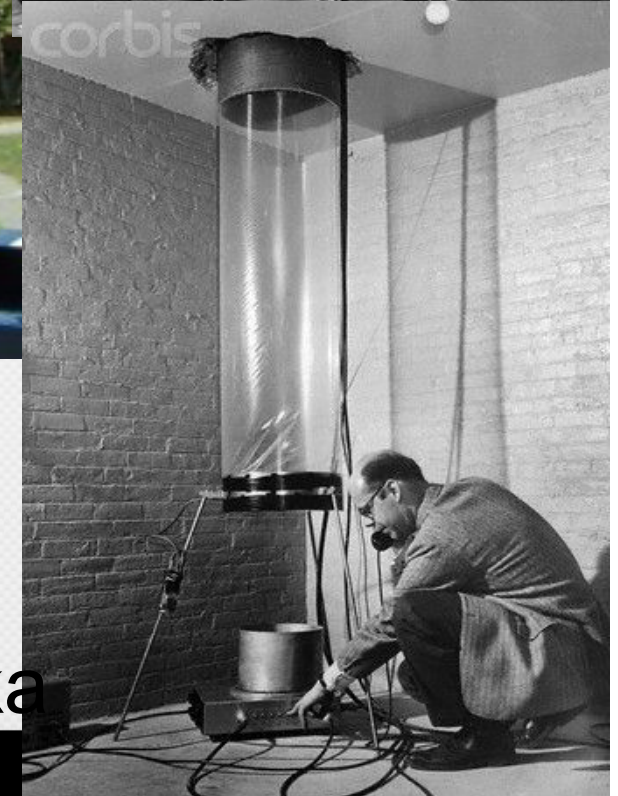


Robert Pound



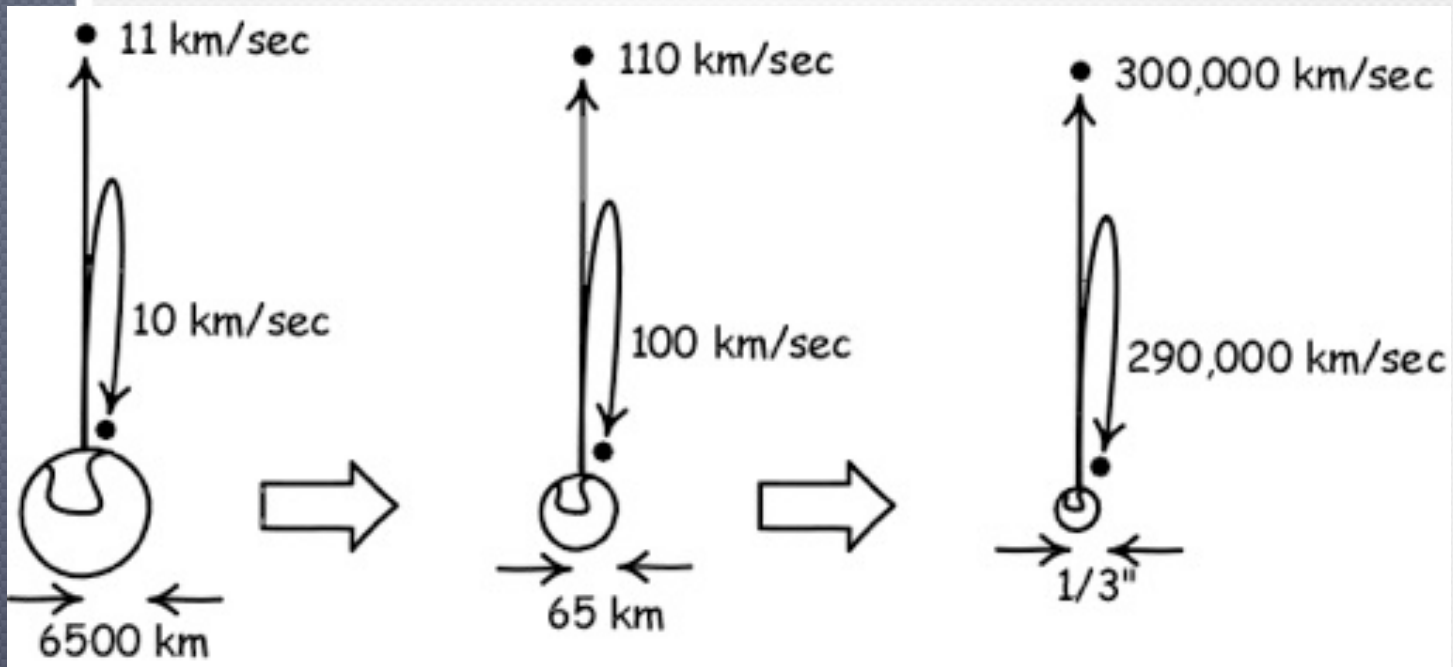
Nel 1959 a 22,6 metri di  
distanza misurano una  
differenza nello scorrere del  
tempo di  $210 \cdot 10^{-13}$  sec

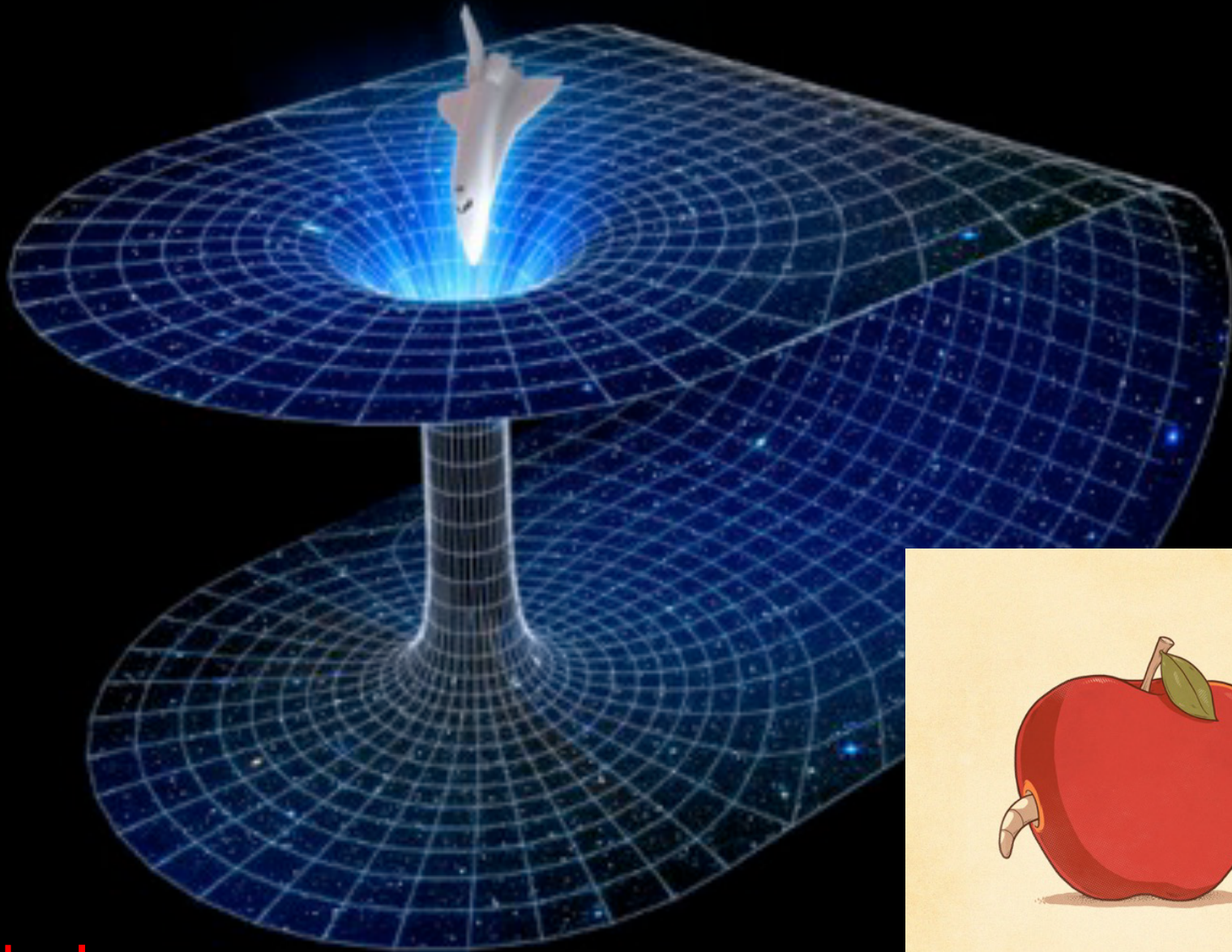
Glen Rebka



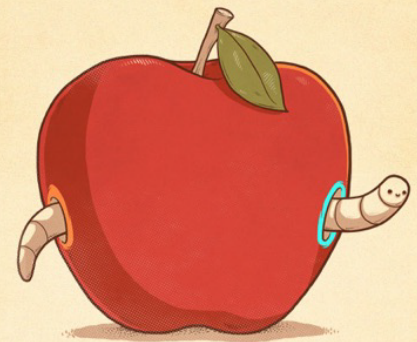




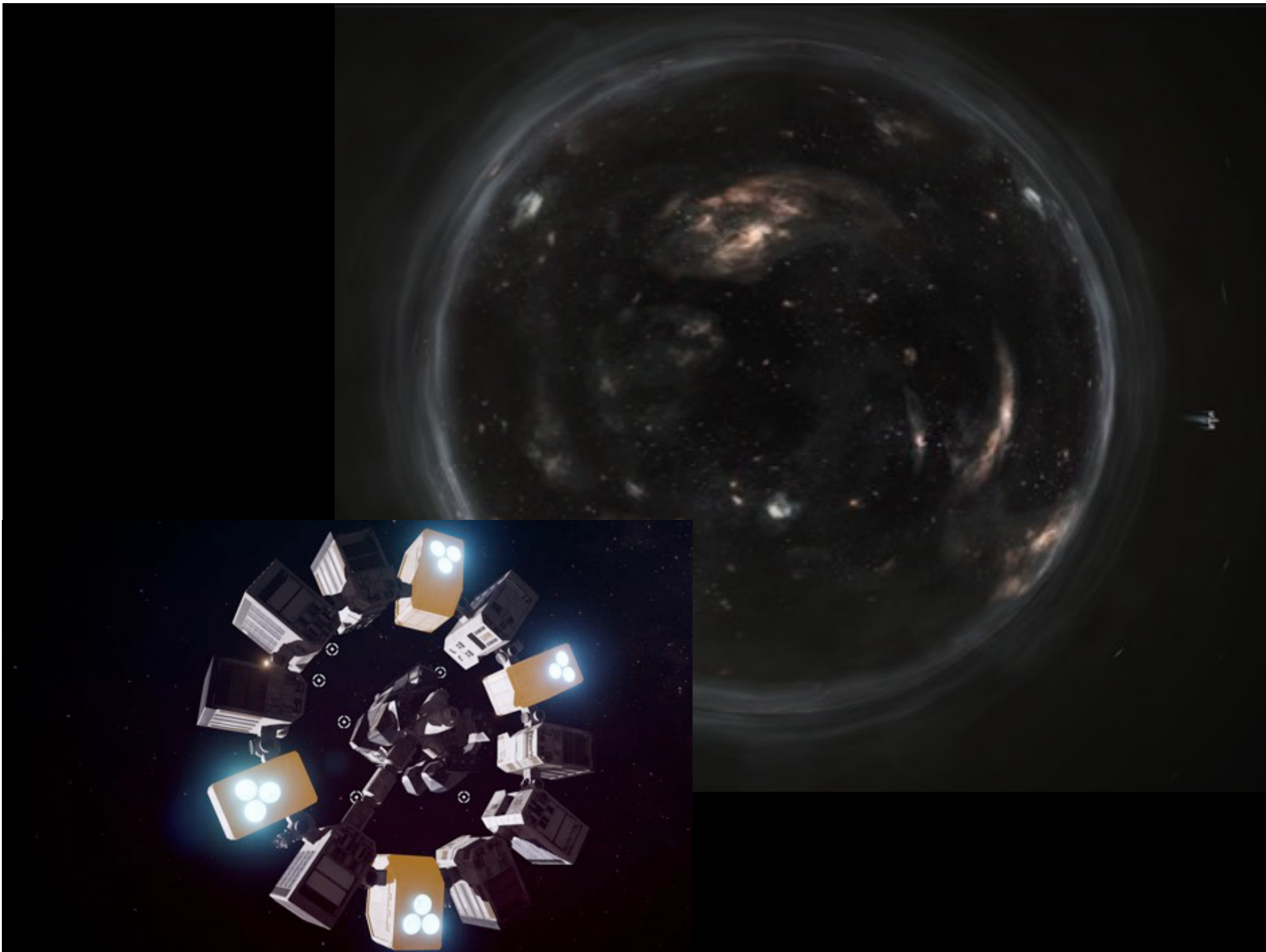




Wormhole



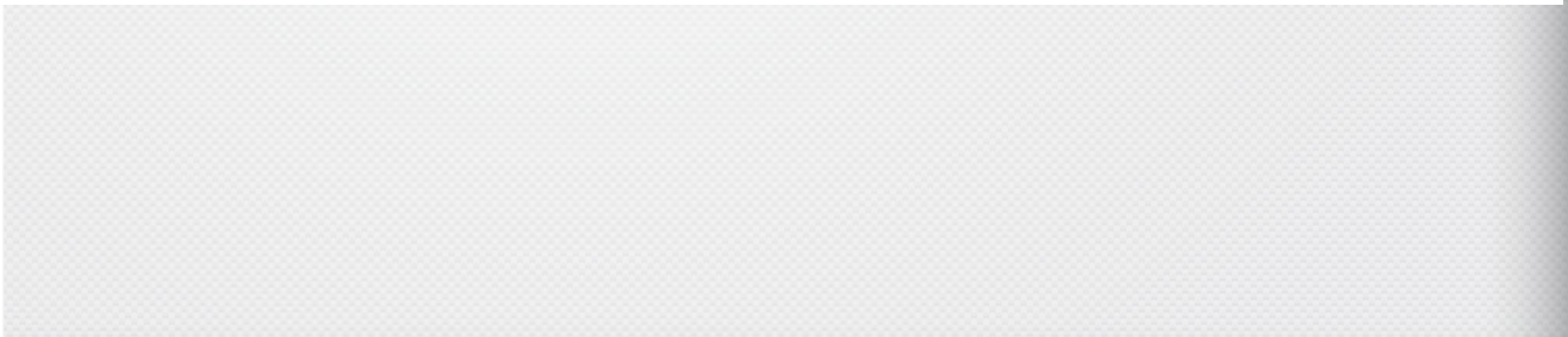
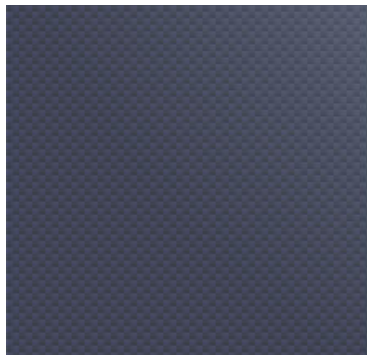
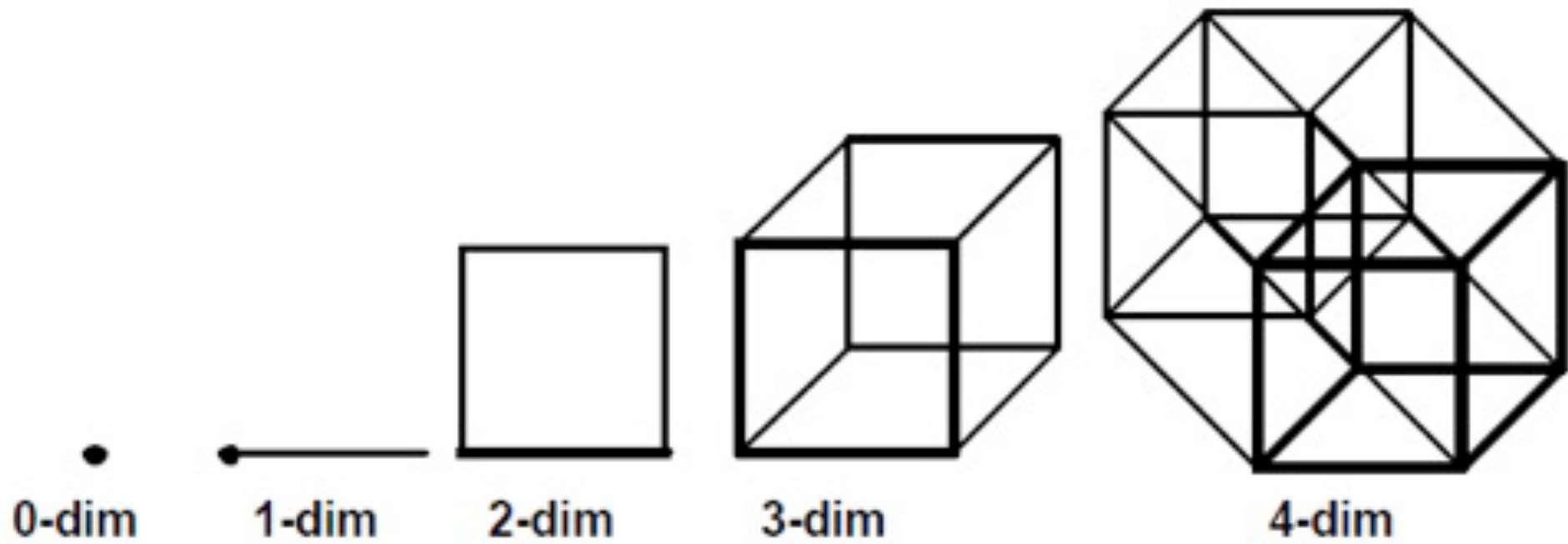
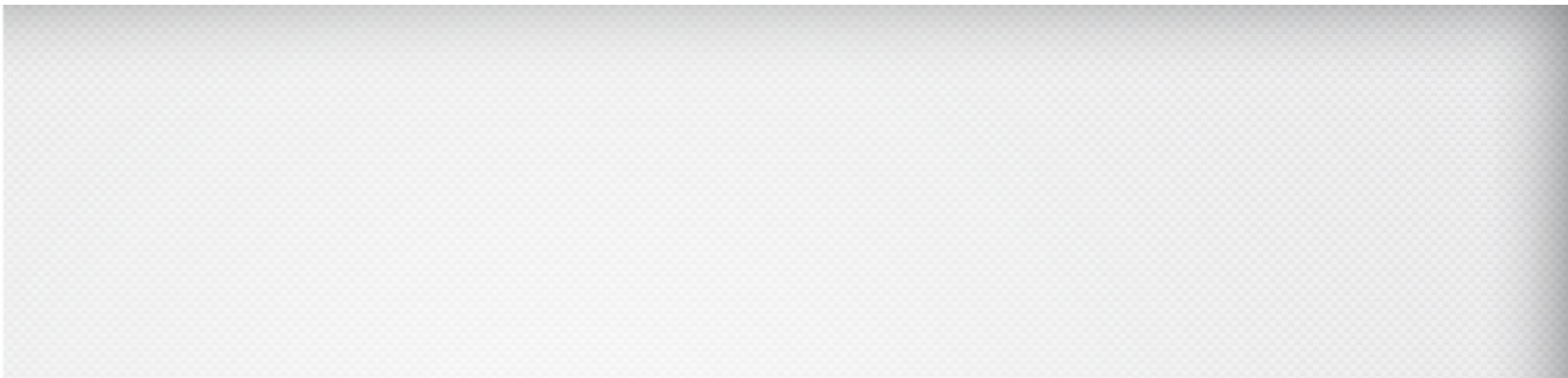
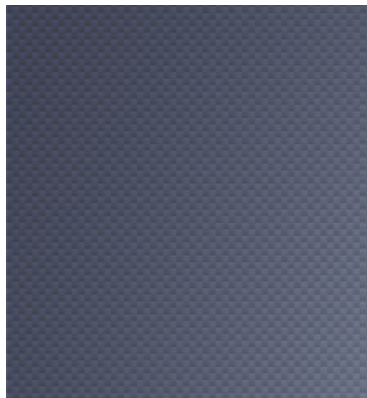




# Pianeta di Miller

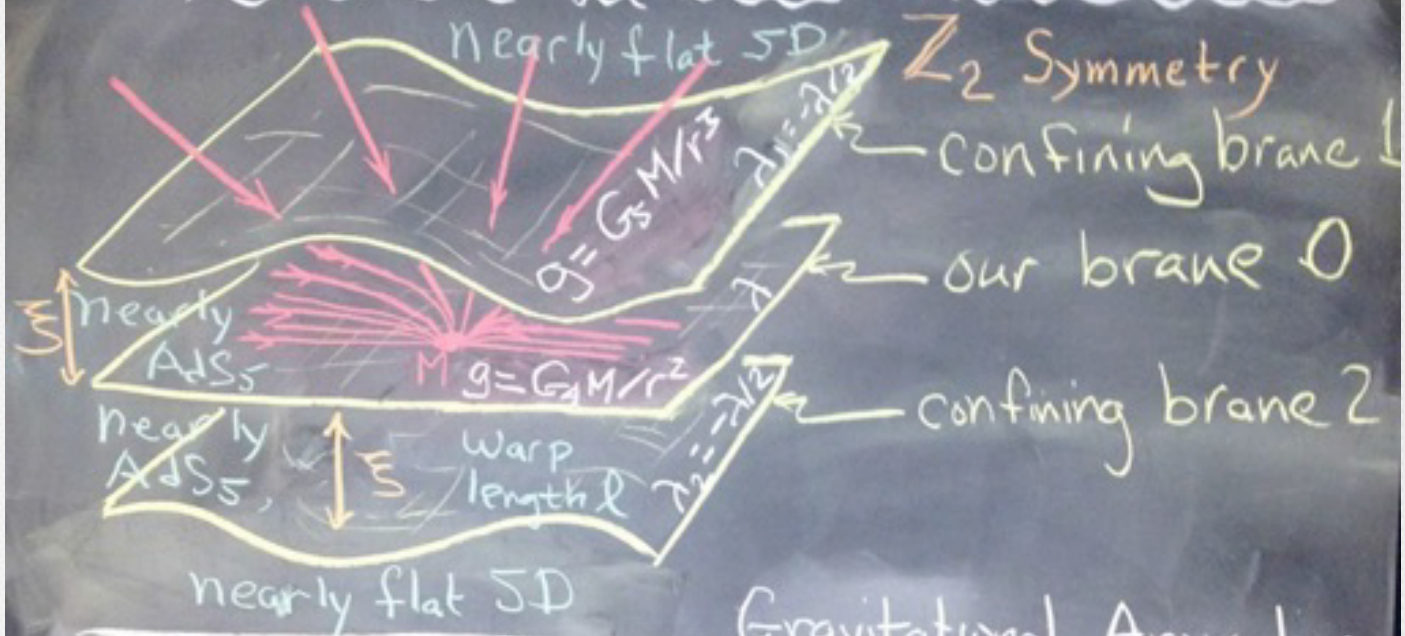
così vicino che 1 ora = 7 anni sulla Terra







# GRAVITY IN 4&5 DIMENSIONS



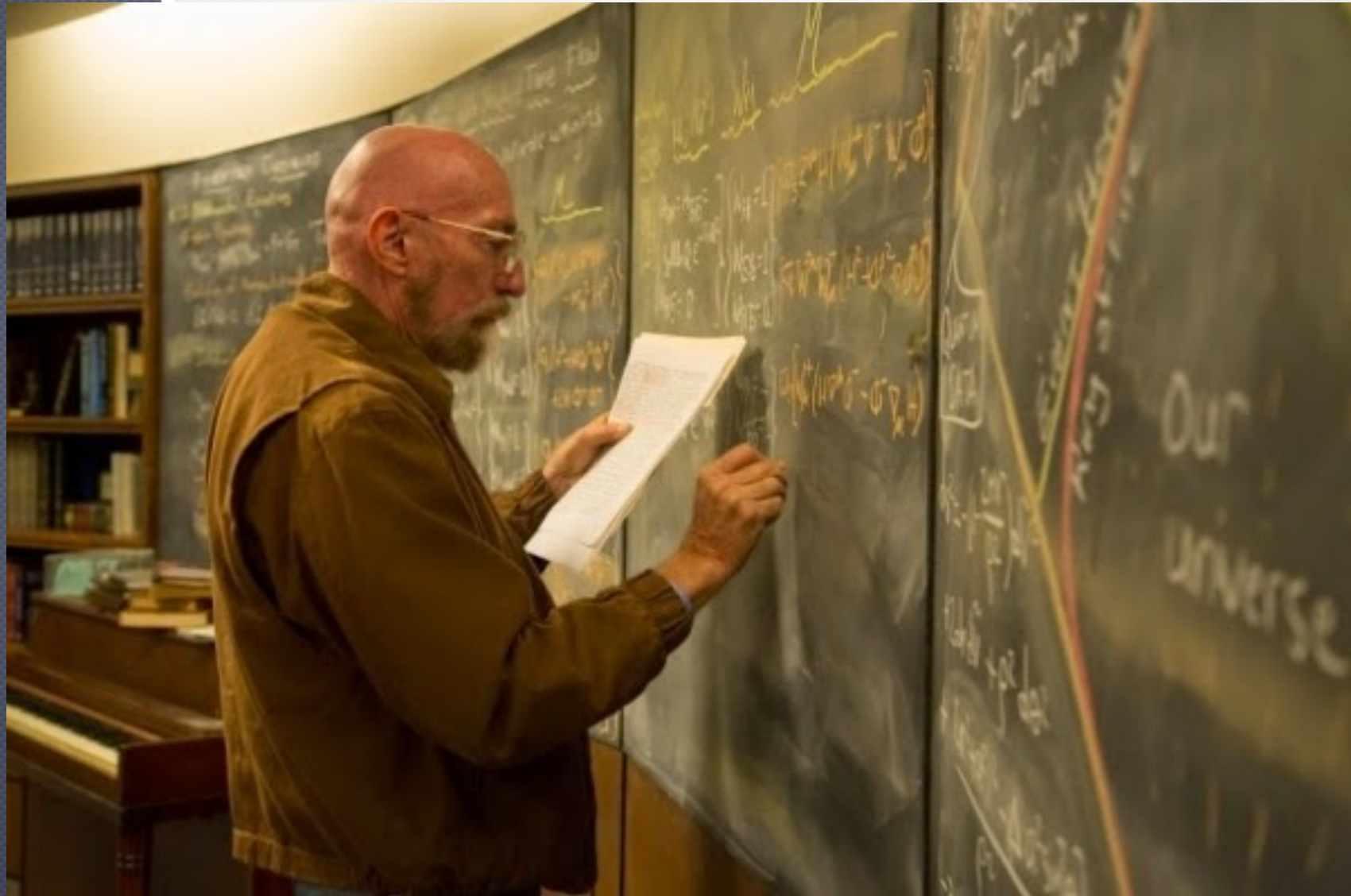
$$G_4 = \frac{4\pi}{3} \lambda G_5^2 \approx \frac{G_5}{6l}$$

Gravitational Anomalies caused by fluctuations of our brane's tension  $\lambda$

- $\lambda(x,t)$  - Our brane's tension
  - $\xi(x,t)$  - Radion field (distance between branes)
  - $Q(x^A)$  - Stabilizing 5D Bulk field
- } coupled by my Effective Action  $S$



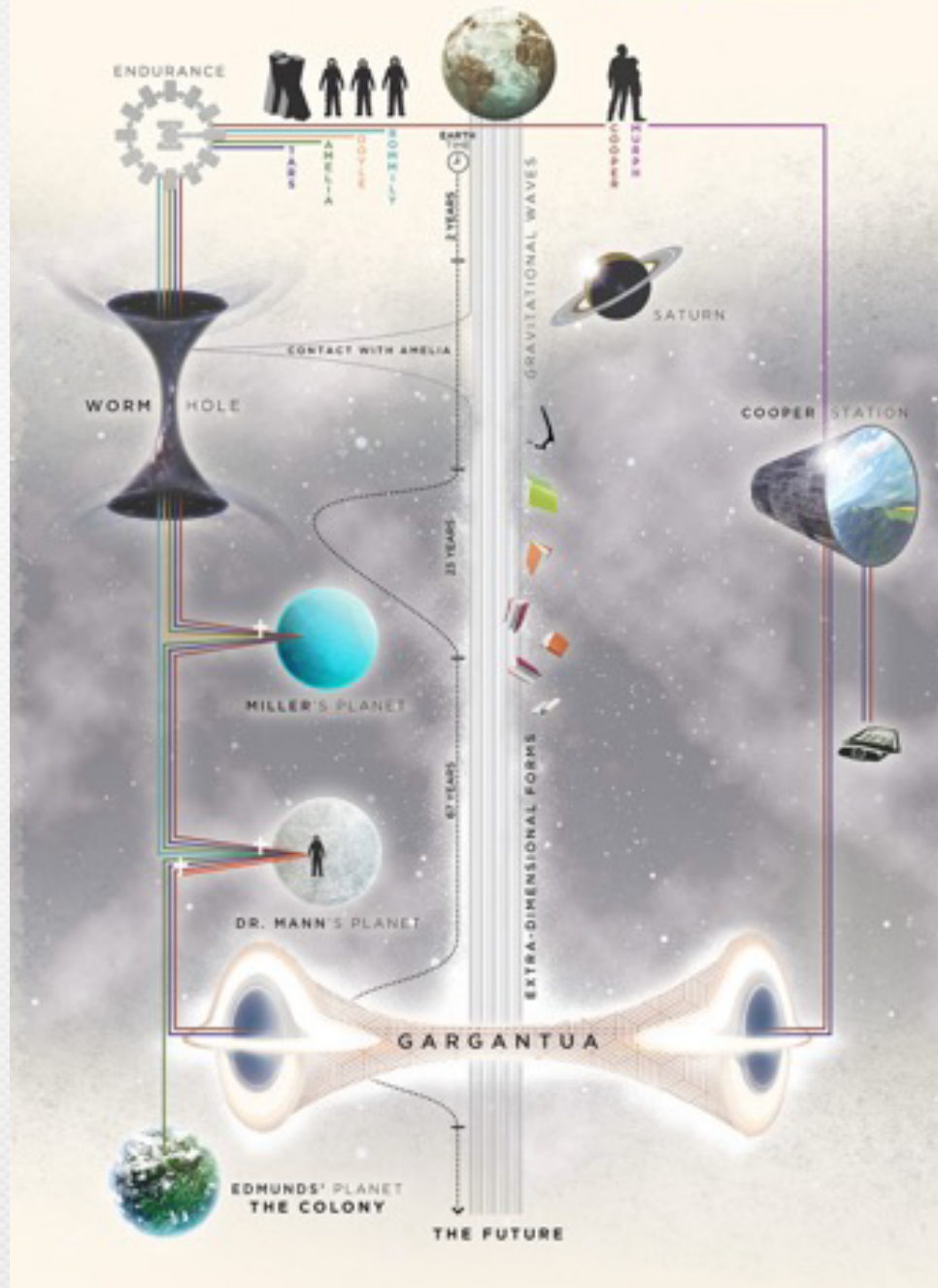






# INTERSTELLAR TIMELINE

BY DOGAN CAN GUNDOGDU



FROM CHRISTOPHER NOLAN

# INTERSTELLAR TIMELINE

PLAN A

Use data gathered from the gravitational anomalies to solve the quantum gravity equations. Use the solution to develop gravity-manipulating technology and construct ships to evacuate those on Earth.

PLAN B

Start a human colony offworld using a small group of settlers and a massive zygote bank to ensure genetic diversity. Those left on Earth will perish as a result of the blight.

### Character Key

Cooper Murph Amelia Romilly Doyle  
TARS Prof. Brand Mann Miller Edmund

### THE TESSERACT

Time Dilation Factor: N/A

A hyperdimensional realm beyond spacetime as we know it, where time in the Universe is a tangible spatial dimension. Created by the descendants of humanity in the far future as part of a stable temporal loop.



### EARTH

Time Dilation Factor: 0

The home of humanity, ravaged by a blight that is slowly terraforming the atmosphere.



The Lazarus Missions: 12 of the bravest humans are sent to 12 different potentially habitable worlds on the other side of the wormhole. Each is equipped with a robot, a stasis pod, and 2 years of life support. Communication with Earth will be limited; they'll be able to send back a "thumbs up" or "thumbs down" indicating whether or not their world is viable for long-term habitation. They are aware it is most likely a suicide mission.

### THE WORMHOLE

Time Dilation Factor: Negligible

A region of intensely curved spacetime connecting the Solar System with Gargantua's system. Created by the descendants of humanity in the far future as part of a stable temporal loop.



### MANN'S WORLD

Time Dilation Factor: Negligible

An icy planet covered in a sponge-like array of frozen clouds and glaciers that reach for the sky.



### EDMUND'S WORLD

Time Dilation Factor: Negligible

A rocky wasteland with a breathable atmosphere and comfortable gravity.



### MILLER'S WORLD

Time Dilation Factor: ~61,000

A high-gravity ocean world continuously swept by skyscraper-size waves.



Cooper begins sending messages to Murph via gravitational anomalies—first frantically, then in a more deliberate manner.

Coordinates to the NASA facility

Its purpose fulfilled, the Tesseract is closed.

TARS's readings from within Gargantua

### COOPER STATION

Time Dilation Factor: Negligible

A 22<sup>nd</sup> century cylindrical space station in orbit around Saturn, carrying refugees from the dying Earth.



Rangers retrieve Cooper and TARS from space.

Cooper & Murph reunite as Murph lies on her deathbed.

Murph dies of old age.

### ENDURANCE

Time Dilation Factor: Varies

The mothership of the Lazarus Missions, carrying an array of shuttles & supplies to carry out Plan B.



Cooper holds Amelia's hand via gravity anomaly.

Mann realizes his world is uninhabitable. Not wanting to die alone, he continuously broadcasts a "thumbs up" in hopes of eventual rescue and enters stasis.

Edmund is killed in a landslide.

Romilly refuses to go into stasis the whole 23 years, and ages several years.

In a desperate bid for survival, Mann attempts to kill the Endurance crew and seize the ship for himself, intending to complete Plan B on his own. He fails, not only killing himself and Romilly but also severely damaging Endurance.

Doyle is killed by a wave.

Romilly is killed by KIPP exploding. Mann is killed trying to dock the Ranger.

Humanity's far-flung descendants continue her work and eventually learn how to directly manipulate spacetime and other higher dimensions. They build the wormhole and the Tesseract, sending them back to the proper points in history to create a stable temporal loop.

Amelia sets up camp on Edmund's world, expecting to carry out Plan B on her own.

### THE ACCRETION DISK

Time Dilation Factor: ~2,400,000

A massive disk of material swirling around Gargantua at incredible speeds, visibly glowing as friction heats it up.



### WITHIN GARGANTUA

Time Dilation Factor: ∞

The void between the singularity and the event horizon. Here, Gargantua's escape velocity exceeds light speed.



TARS is ejected to probe Gargantua.

Cooper detaches to allow Amelia to escape Gargantua.

Cooper & TARS are pulled in to the Tesseract.

Timeline Version 1 by stoic42 from NolanFans (sto-ific42 on Reddit).

All images are from the film, except for Cooper Station (painting of an O'Neill cylinder) and Edmund's world (picture of Meteor Crater taken by stoic42).

Film credits: PARAMOUNT PICTURES AND WARNER BROS. PICTURES PRESENT IN ASSOCIATION WITH LEGENDARY PICTURES A SYNCOPE/LYNDIA ORST PRODUCTIONS PRODUCTION A FILM BY CHRISTOPHER NOLAN "INTERSTELLAR" MATHIEW MCCONAUGHEY ANNE HATHAWAY JESSICA CHASTAIN BILL IRWIN ELLEN BURSTYN AND MICHAEL CAINE WITH MARY ZOPHRES AND HANS ZIMMER MUSIC BY LEE SMITLACE COSTUME DESIGNER NATHAN CROWLEY EXECUTIVE PRODUCERS HOYTEVAN HOYTEVAN ISHAK NAGI PRODUCED BY JORDAN GOLDBERG JAKE MYERS KIP THORNE THOMAS TULL WRITTEN BY JONATHAN NOLAN AND CHRISTOPHER NOLAN DIRECTED BY CHRISTOPHER NOLAN

PS: da vedere

**From the Earth to the Moon (1998)**

*Registi vari*

12 episodi