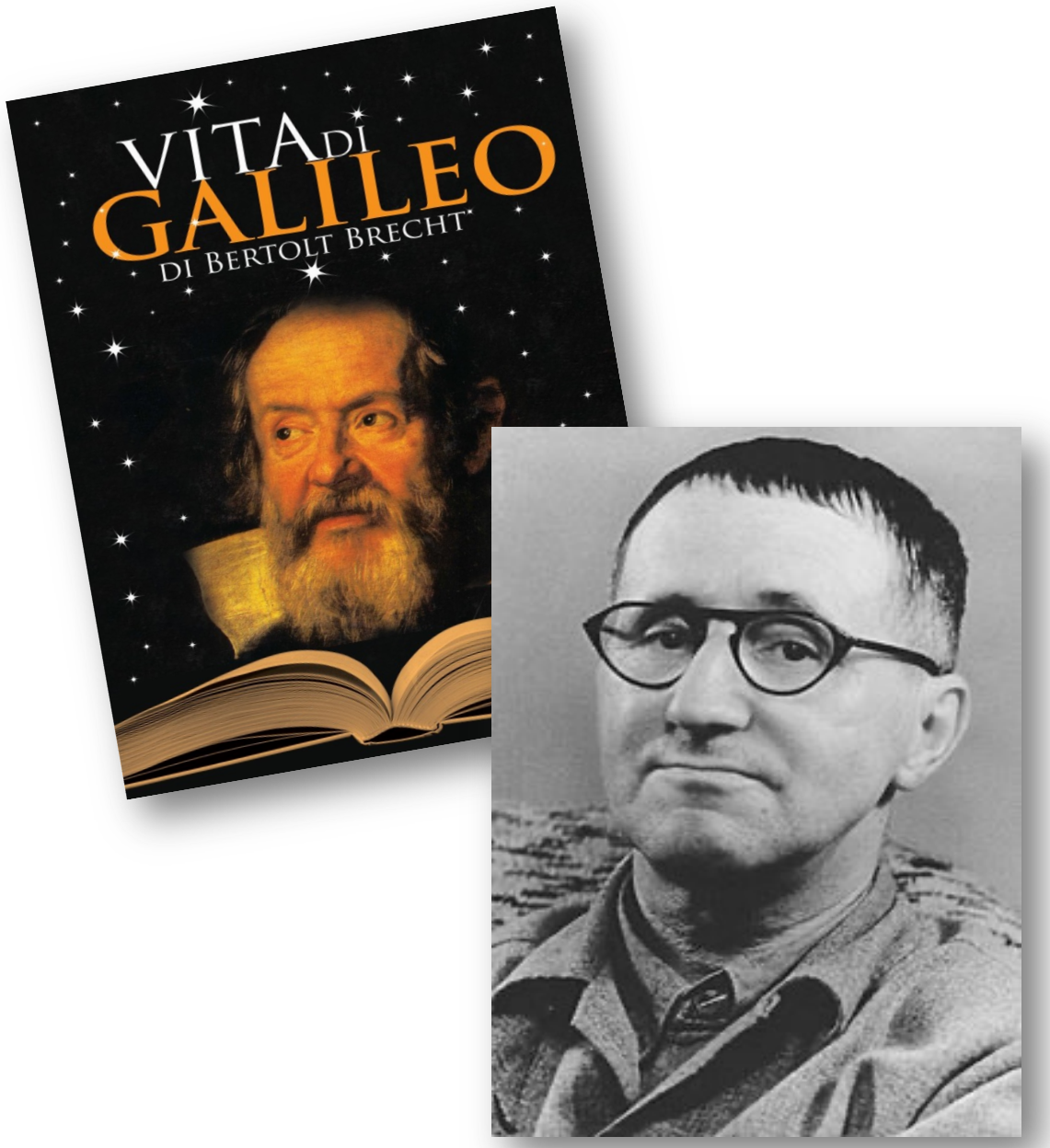
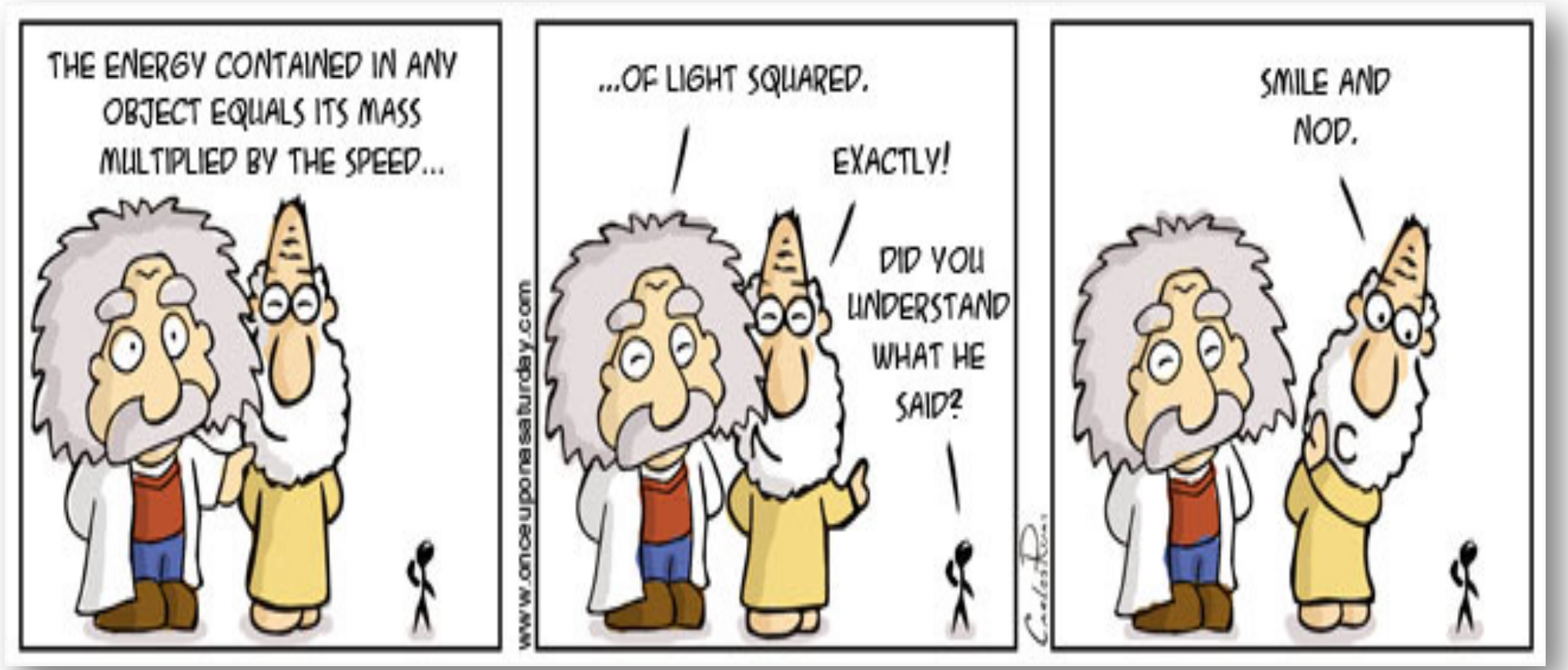

STEM
LICEO CLASSICO "GIOACCHINO DA FIORE" - RENDE (CS) - 20/21
Prof.ssa Fabiola Salerno

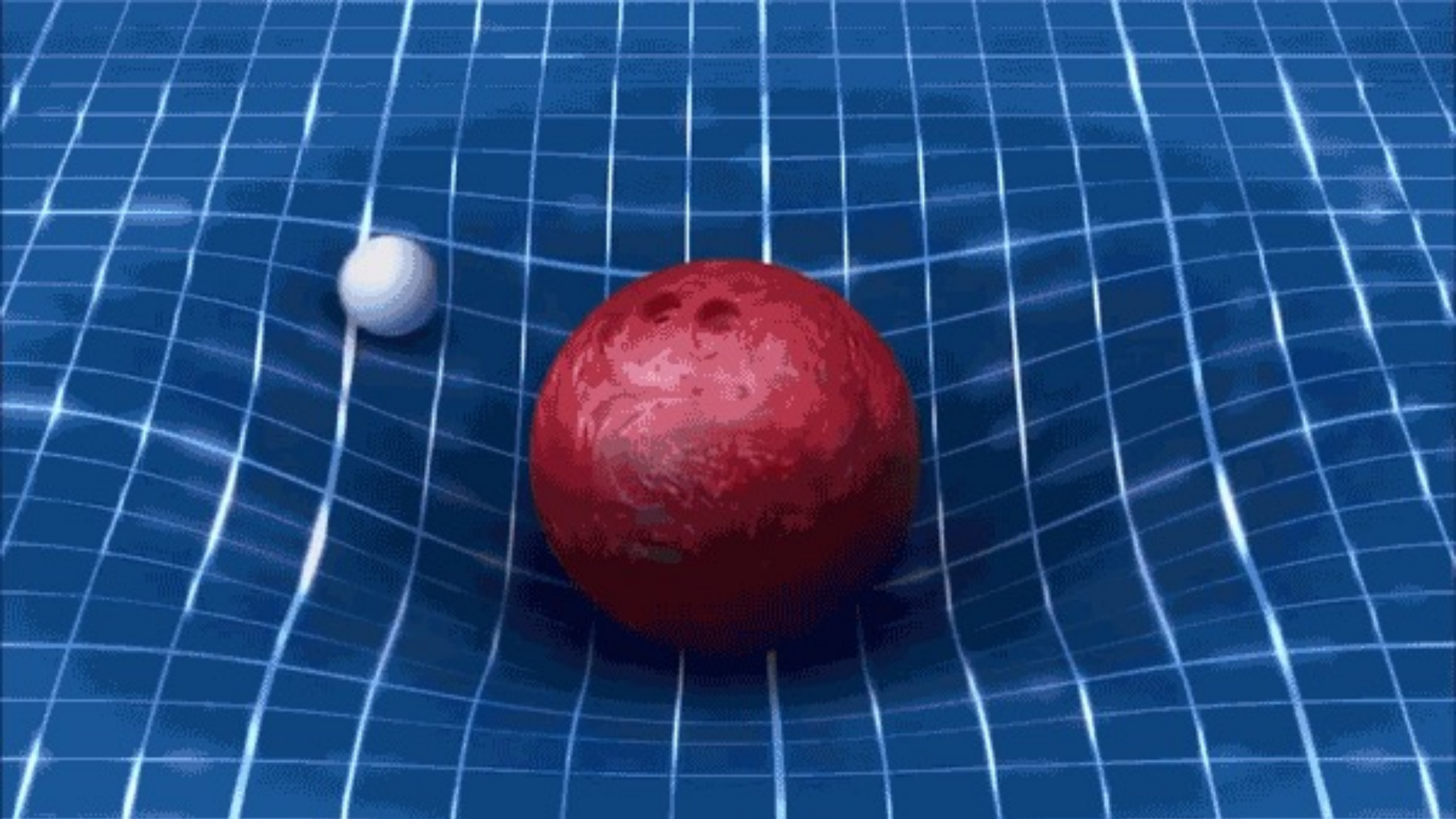
Galileo: *I moti dei corpi celesti ci sono divenuti più chiari; ma i moti dei potenti restano pur sempre imperscrutabili ai popoli. […] Se gli uomini di scienza non reagiscono all'intimidazione dei potenti egoisti e si limitano ad accumulare sapere per sapere, la scienza può rimanere fiaccata per sempre, ed ogni nuova macchina non sarà fonte che di nuovi triboli per l'uomo. E quando, coll'andar del tempo, avrete scoperto tutto lo scopribile, il vostro progresso non sarà che un progressivo allontanamento dall'umanità. Tra voi e l'umanità può scavarsi un abisso così grande, che ad ogni vostro eureka rischierebbe di rispondere un grido di dolore universale… […] Per alcuni anni ebbi la forza di una pubblica autorità; e misi la mia sapienza a disposizione dei potenti perché la usassero, o non la usassero, o ne abusassero, a seconda dei loro fini. Ho tradito la mia professione; e quando un uomo ha fatto ciò che ho fatto io, la sua presenza non può essere tollerata nei ranghi della scienza.*

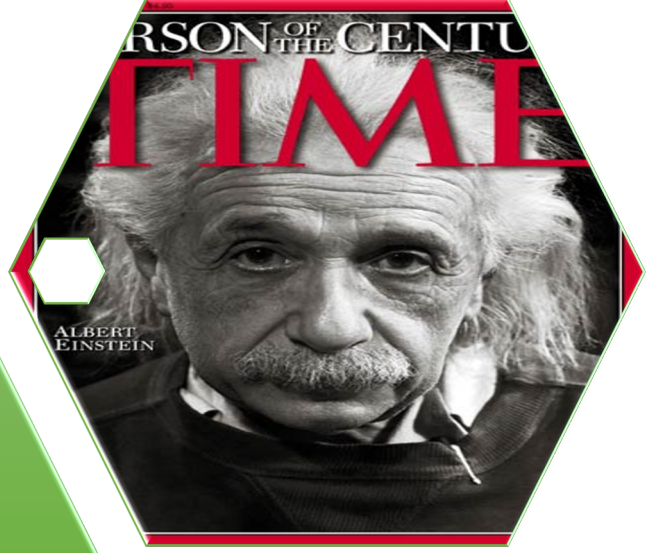


In *Leben des Galilei* (*Life of Galileo*), a play written in 1938-1939, the German author Bertolt Brecht introduces the scientists as traitors who collaborated with the power supplying armaments.

Science MUST BE FREE from
any ideological and political noose
and MUST BE
an instrument of human progress
and NOT
a source of human destruction


THE ENERGY CONTAINED IN ANY OBJECT EQUALS ITS MASS MULTIPLIED BY THE SPEED...
...OF LIGHT SQUARED.
EXACTLY!
DID YOU UNDERSTAND WHAT HE SAID?
SMILE AND NOD.
www.onceuponasaturday.com





«He was the pre-eminent scientist in a century dominated by science. The touchstones of the era – the Bomb, the Big Bang, quantum physics and electronics – all bear his imprint» Dec 31, 1999

In 1921 he got the Nobel Prize in Physics «*for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect*»

14 March 1879

Ulm (Germany)

18 April 1955

Princeton (New Jersey)

1905: MIRACLE YEAR

Einstein published FOUR papers which contributed strongly to the foundation of modern physics and changed views on space, time, and matter. They were:

ABOUT PHOTOELECTRIC EFFECT
Annalen der Physik 17, 132-148

On a Heuristic Viewpoint Concerning the Production and Transformation of Light

ABOUT BROWNIAN MOTION
Annalen der Physik 17, 549–560

On the Motion of Small Particles Suspended in a Stationary Liquid, as Required by the Molecular Kinetic Theory of Heat

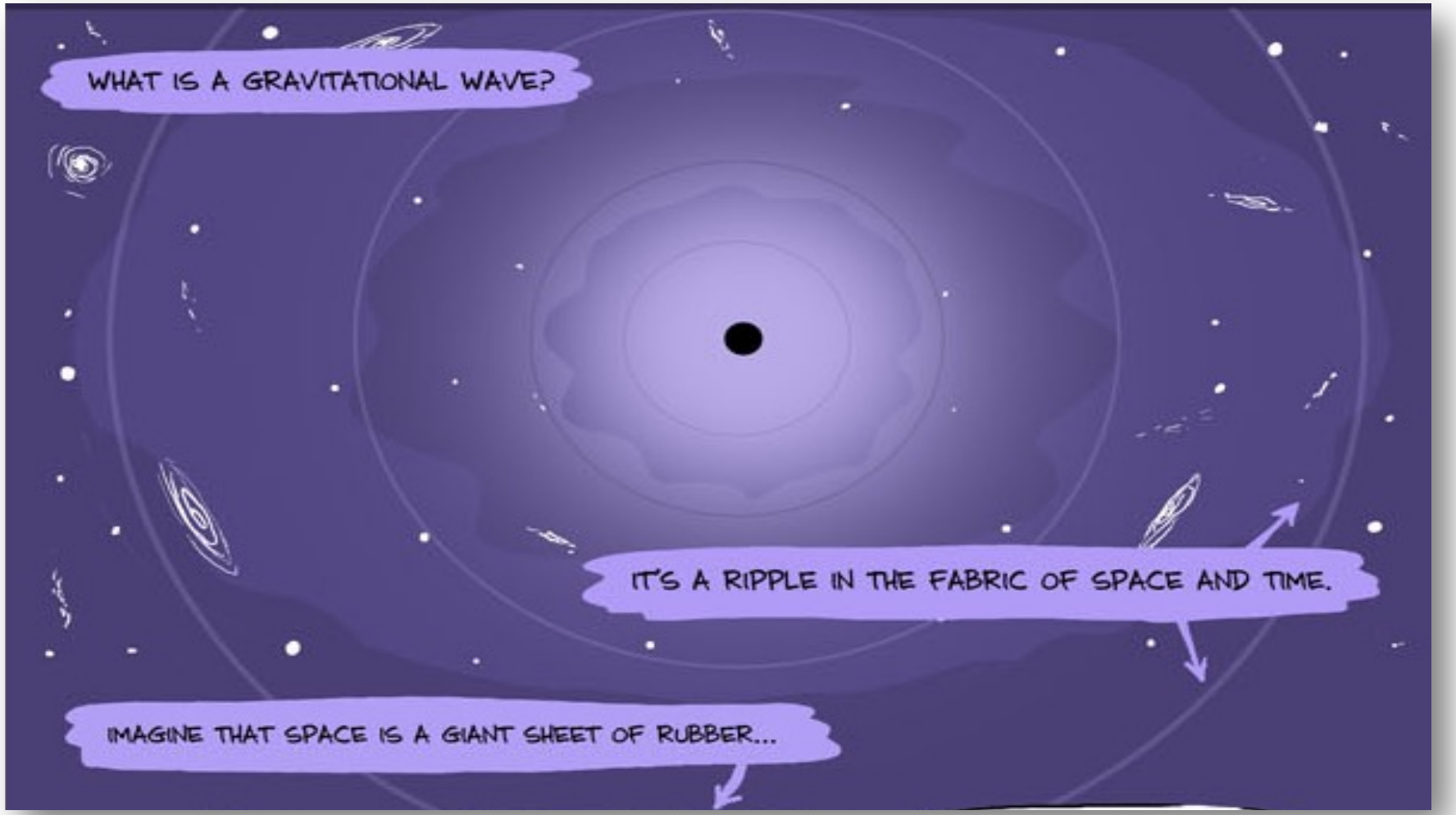
ABOUT SPECIAL RELATIVITY
Annalen der Physik 17, 891–921

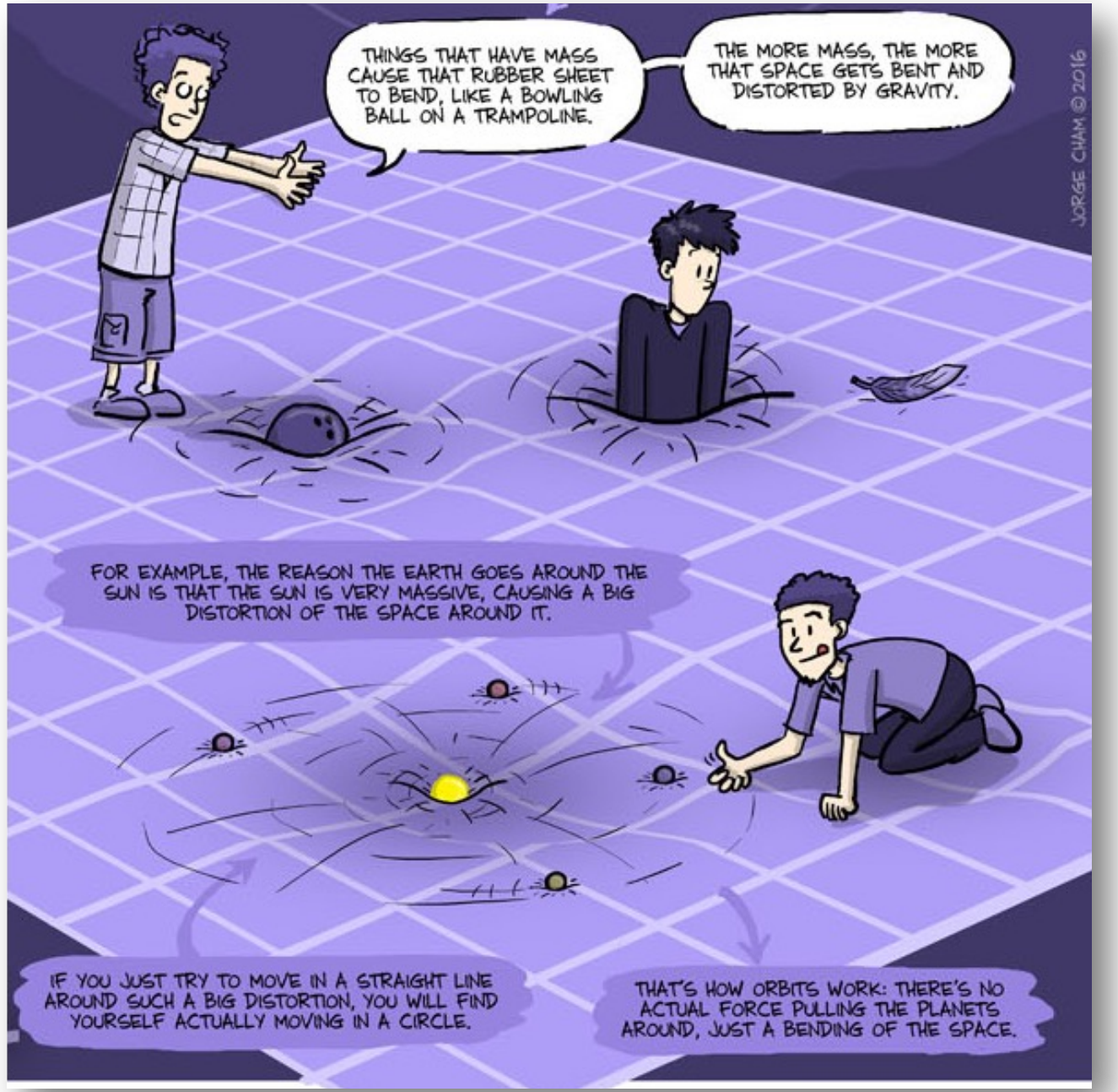
On the Electrodynamics of Moving Bodies

ABOUT MASS-ENERGY EQUIVALENCE
Annalen der Physik 18, 639–641

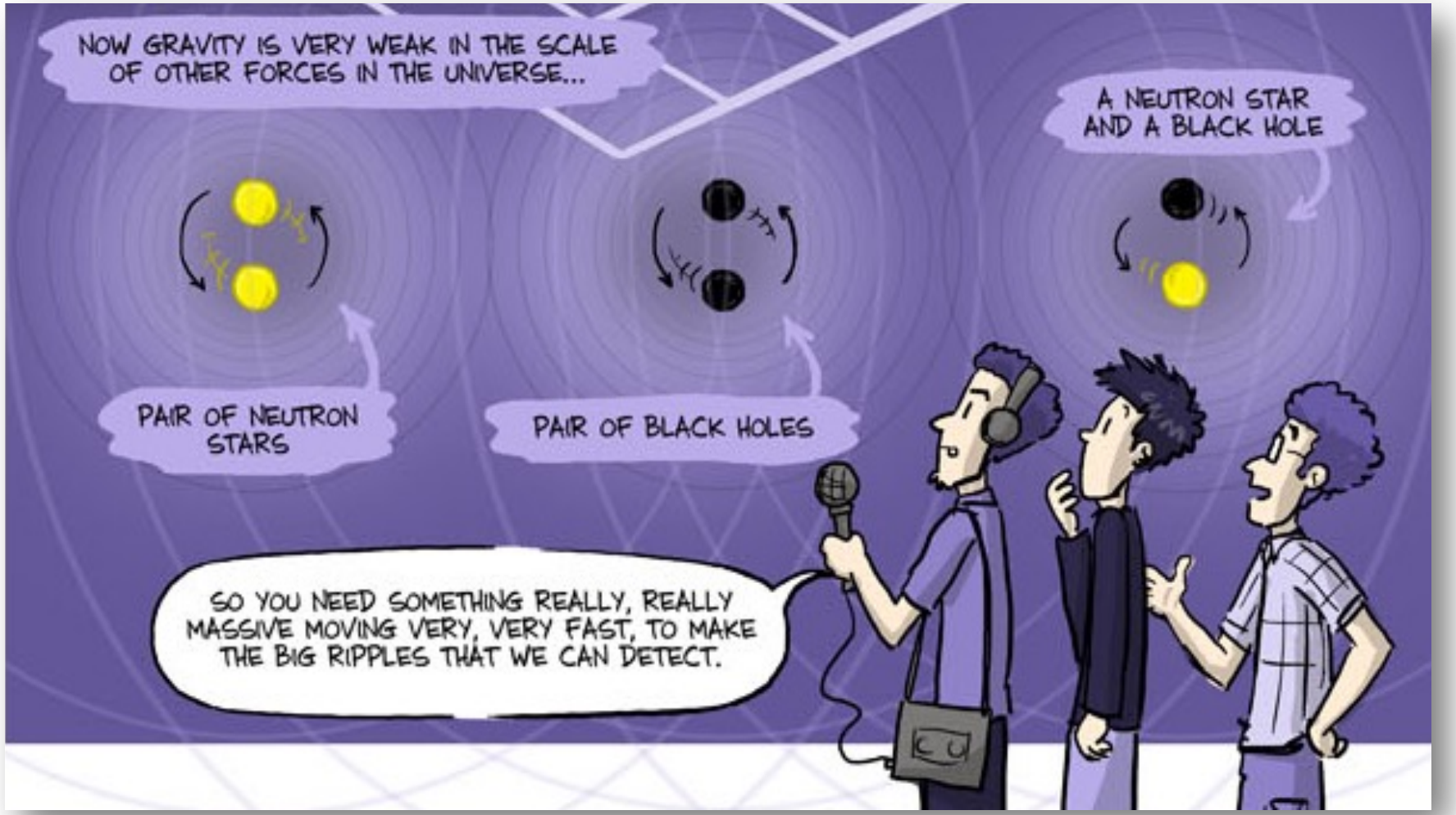
Does the Inertia of a Body Depend Upon Its Energy Content?

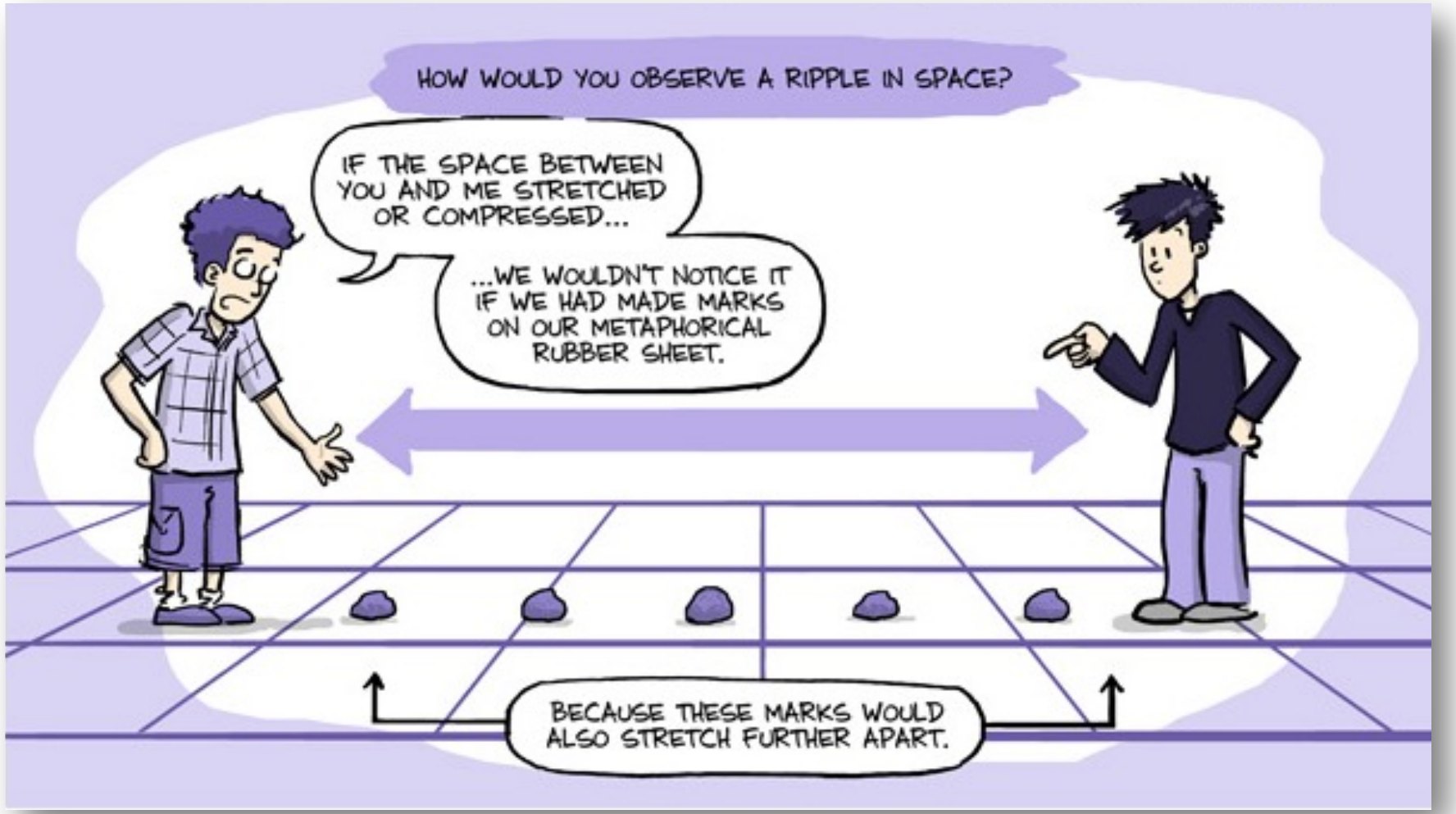
LISTENING ACTIVITY

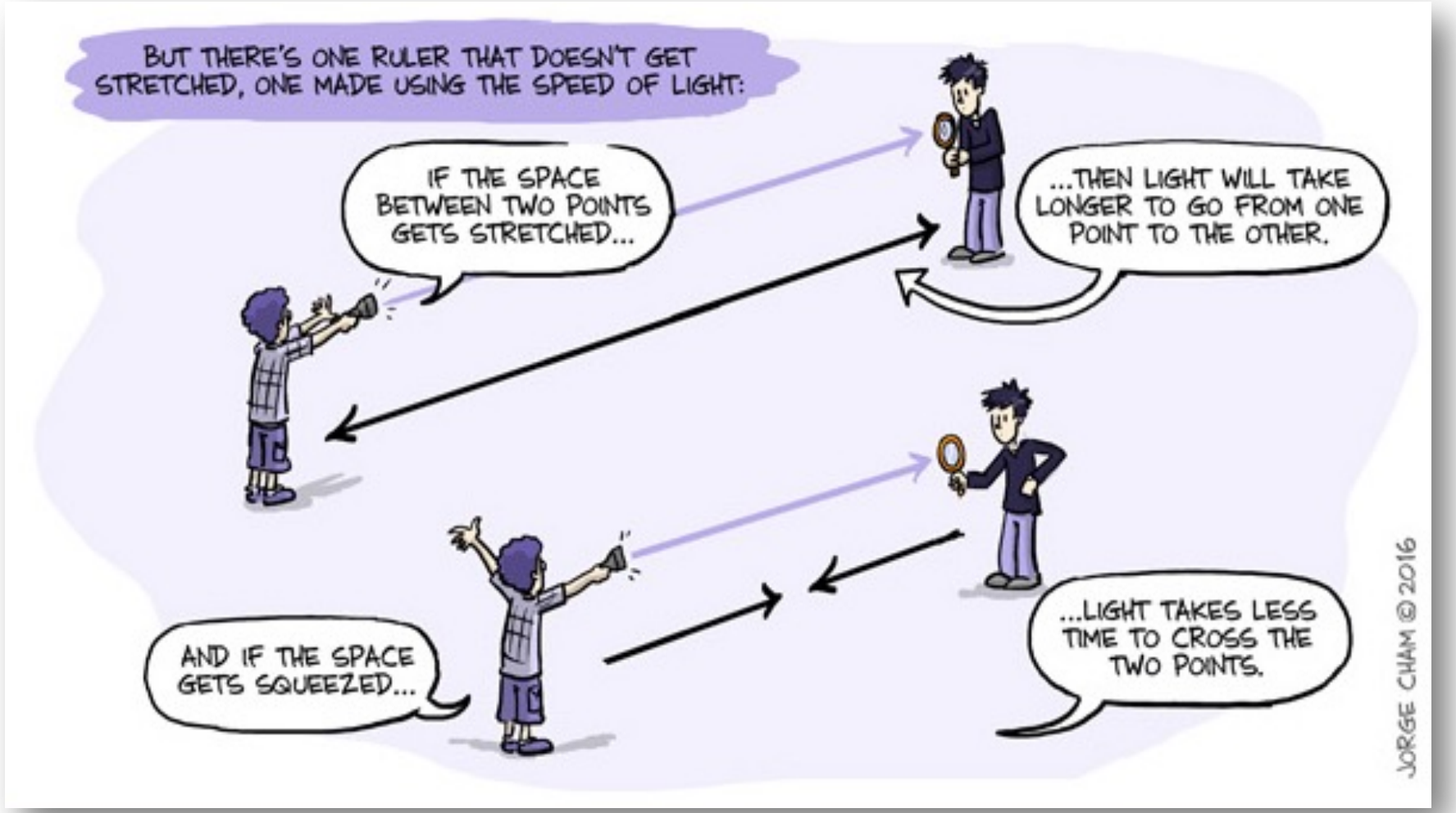

WHAT IS A GRAVITATIONAL WAVE?
IT'S A RIPPLE IN THE FABRIC OF SPACE AND TIME.
IMAGINE THAT SPACE IS A GIANT SHEET OF RUBBER...

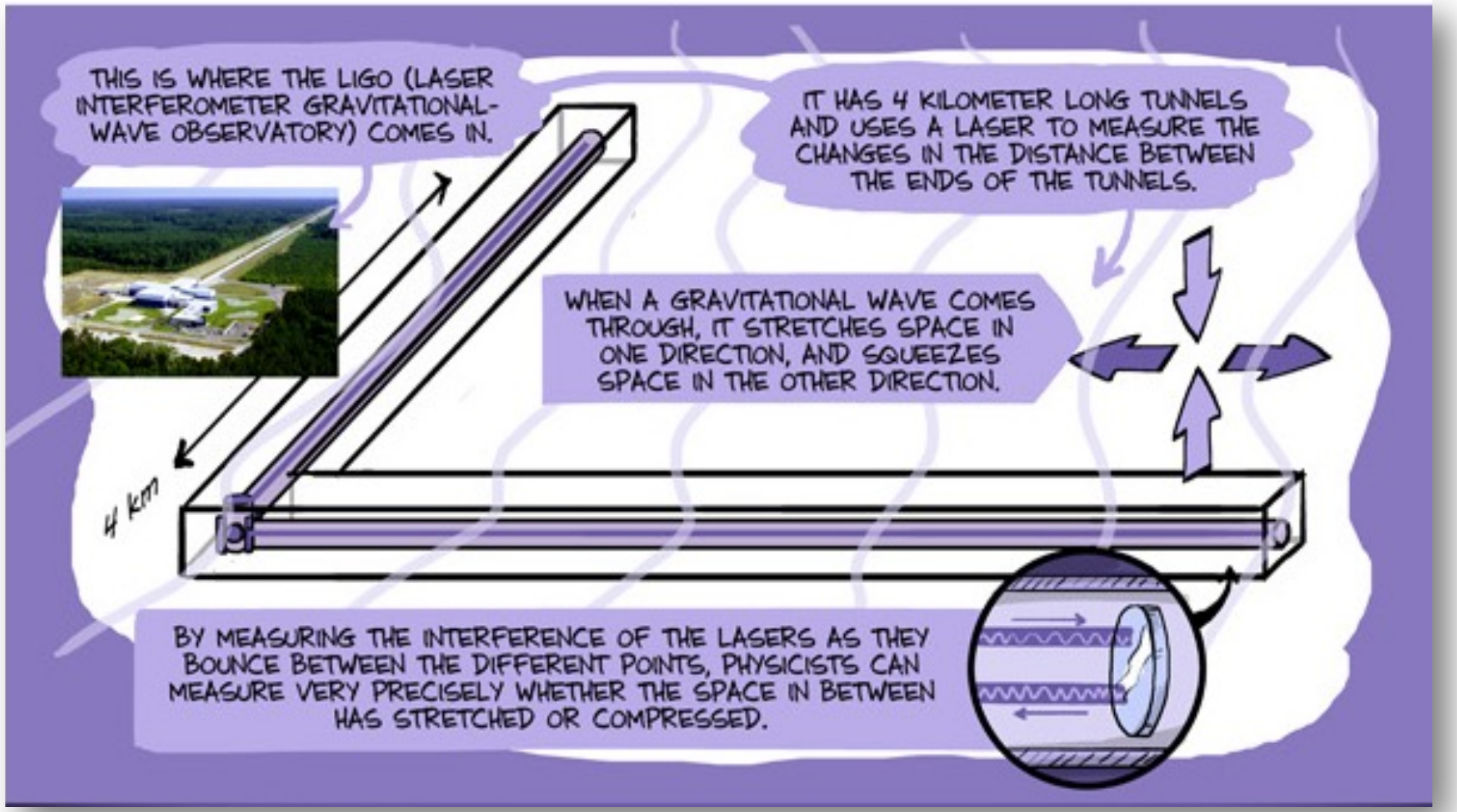

THINGS THAT HAVE MASS CAUSE THAT RUBBER SHEET TO BEND, LIKE A BOWLING BALL ON A TRAMPOLINE.
THE MORE MASS, THE MORE THAT SPACE GETS BENT AND DISTORTED BY GRAVITY.
JORGE CHAM © 2016
FOR EXAMPLE, THE REASON THE EARTH GOES AROUND THE SUN IS THAT THE SUN IS VERY MASSIVE, CAUSING A BIG DISTORTION OF THE SPACE AROUND IT.
IF YOU JUST TRY TO MOVE IN A STRAIGHT LINE AROUND SUCH A BIG DISTORTION, YOU WILL FIND YOURSELF ACTUALLY MOVING IN A CIRCLE.
THAT'S HOW ORBITS WORK: THERE'S NO ACTUAL FORCE PULLING THE PLANETS AROUND, JUST A BENDING OF THE SPACE.

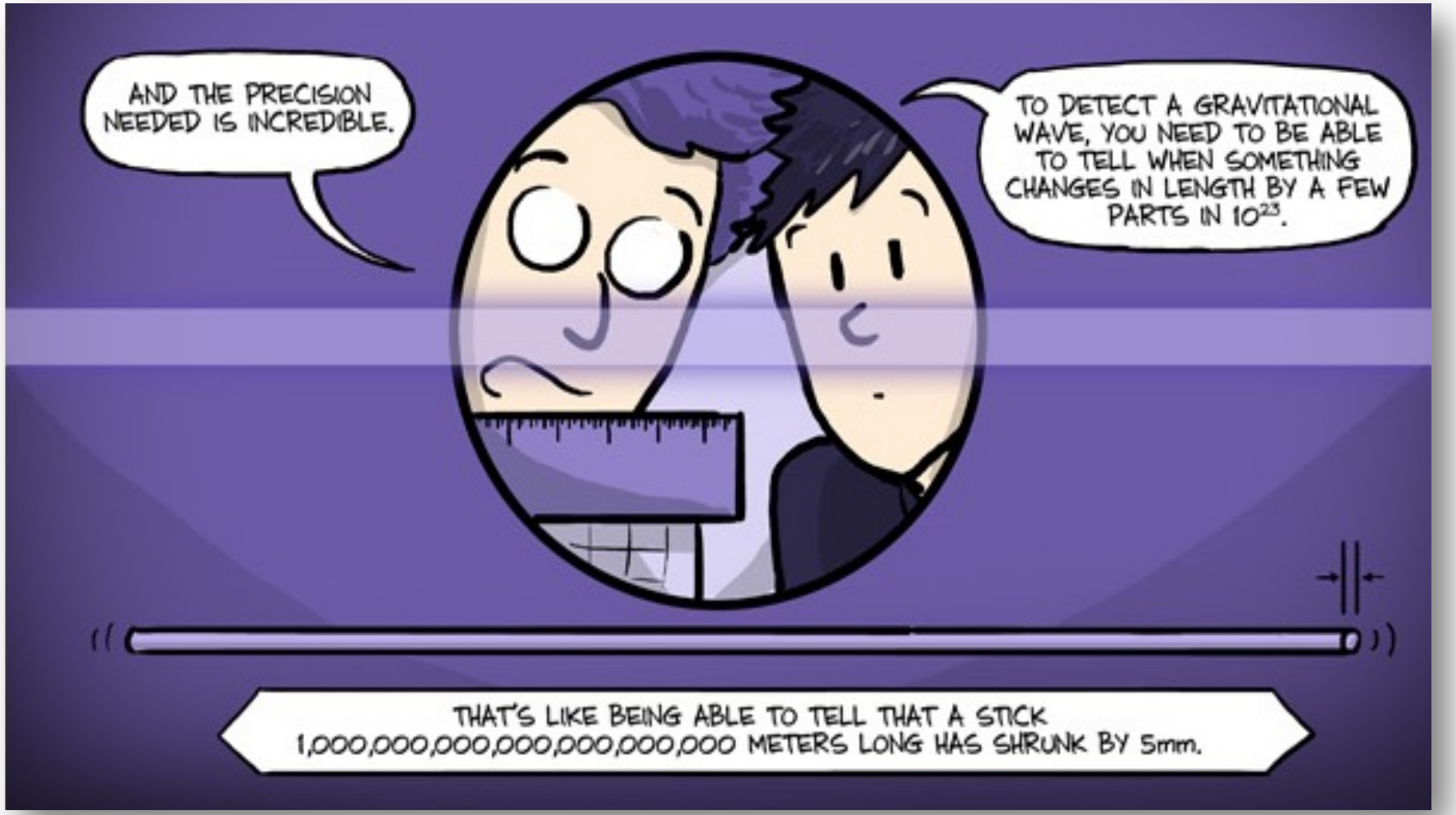

GRAVITATIONAL WAVES ARE PRODUCED WHENEVER MASSES ACCELERATE, CHANGING THE DISTORTION OF SPACE.
EVERYTHING WITH MASS AND/OR ENERGY CAN MAKE GRAVITATIONAL WAVES.
IF YOU AND I STARTED TO DANCE AROUND EACH OTHER, WE WOULD ALSO CAUSE RIPPLES IN THE FABRIC OF SPACE AND TIME.
BUT THESE WOULD BE EXTREMELY SMALL. PRACTICALLY UNDETECTABLE.

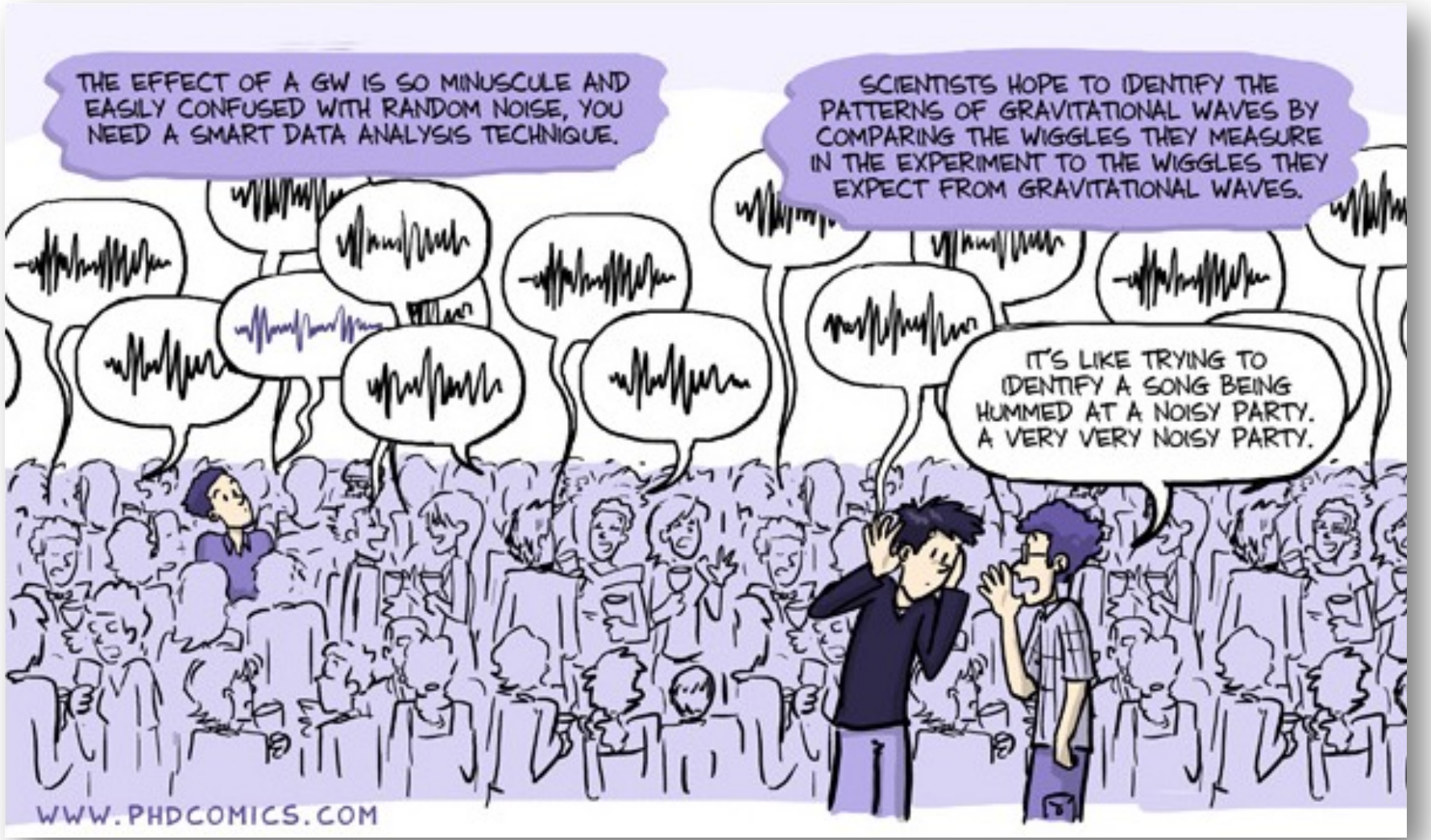

NOW GRAVITY IS VERY WEAK IN THE SCALE OF OTHER FORCES IN THE UNIVERSE...
A NEUTRON STAR AND A BLACK HOLE
PAIR OF NEUTRON STARS
PAIR OF BLACK HOLES
SO YOU NEED SOMETHING REALLY, REALLY MASSIVE MOVING VERY, VERY FAST, TO MAKE THE BIG RIPPLES THAT WE CAN DETECT.


HOW WOULD YOU OBSERVE A RIPPLE IN SPACE?
IF THE SPACE BETWEEN YOU AND ME STRETCHED OR COMPRESSED...
...WE WOULDN'T NOTICE IT IF WE HAD MADE MARKS ON OUR METAPHORICAL RUBBER SHEET.
BECAUSE THESE MARKS WOULD ALSO STRETCH FURTHER APART.


BUT THERE'S ONE RULER THAT DOESN'T GET STRETCHED, ONE MADE USING THE SPEED OF LIGHT:
IF THE SPACE BETWEEN TWO POINTS GETS STRETCHED...
...THEN LIGHT WILL TAKE LONGER TO GO FROM ONE POINT TO THE OTHER.
AND IF THE SPACE GETS SQUEEZED...
...LIGHT TAKES LESS TIME TO CROSS THE TWO POINTS.
JORGE CHAM © 2016


THIS IS WHERE THE LIGO (LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY) COMES IN.
IT HAS 4 KILOMETER LONG TUNNELS AND USES A LASER TO MEASURE THE CHANGES IN THE DISTANCE BETWEEN THE ENDS OF THE TUNNELS.
WHEN A GRAVITATIONAL WAVE COMES THROUGH, IT STRETCHES SPACE IN ONE DIRECTION, AND SQUEEZES SPACE IN THE OTHER DIRECTION.
4 km
BY MEASURING THE INTERFERENCE OF THE LASERS AS THEY BOUNCE BETWEEN THE DIFFERENT POINTS, PHYSICISTS CAN MEASURE VERY PRECISELY WHETHER THE SPACE IN BETWEEN HAS STRETCHED OR COMPRESSED.


AND THE PRECISION NEEDED IS INCREDIBLE.
TO DETECT A GRAVITATIONAL WAVE, YOU NEED TO BE ABLE TO TELL WHEN SOMETHING CHANGES IN LENGTH BY A FEW PARTS IN 10^{23}.
THAT'S LIKE BEING ABLE TO TELL THAT A STICK 1,000,000,000,000,000,000,000 METERS LONG HAS SHRUNK BY 5mm.


THE EFFECT OF A GW IS SO MINUSCULE AND EASILY CONFUSED WITH RANDOM NOISE, YOU NEED A SMART DATA ANALYSIS TECHNIQUE.
SCIENTISTS HOPE TO IDENTIFY THE PATTERNS OF GRAVITATIONAL WAVES BY COMPARING THE WIGGLES THEY MEASURE IN THE EXPERIMENT TO THE WIGGLES THEY EXPECT FROM GRAVITATIONAL WAVES.
IT'S LIKE TRYING TO IDENTIFY A SONG BEING HUMMED AT A NOISY PARTY. A VERY VERY NOISY PARTY.
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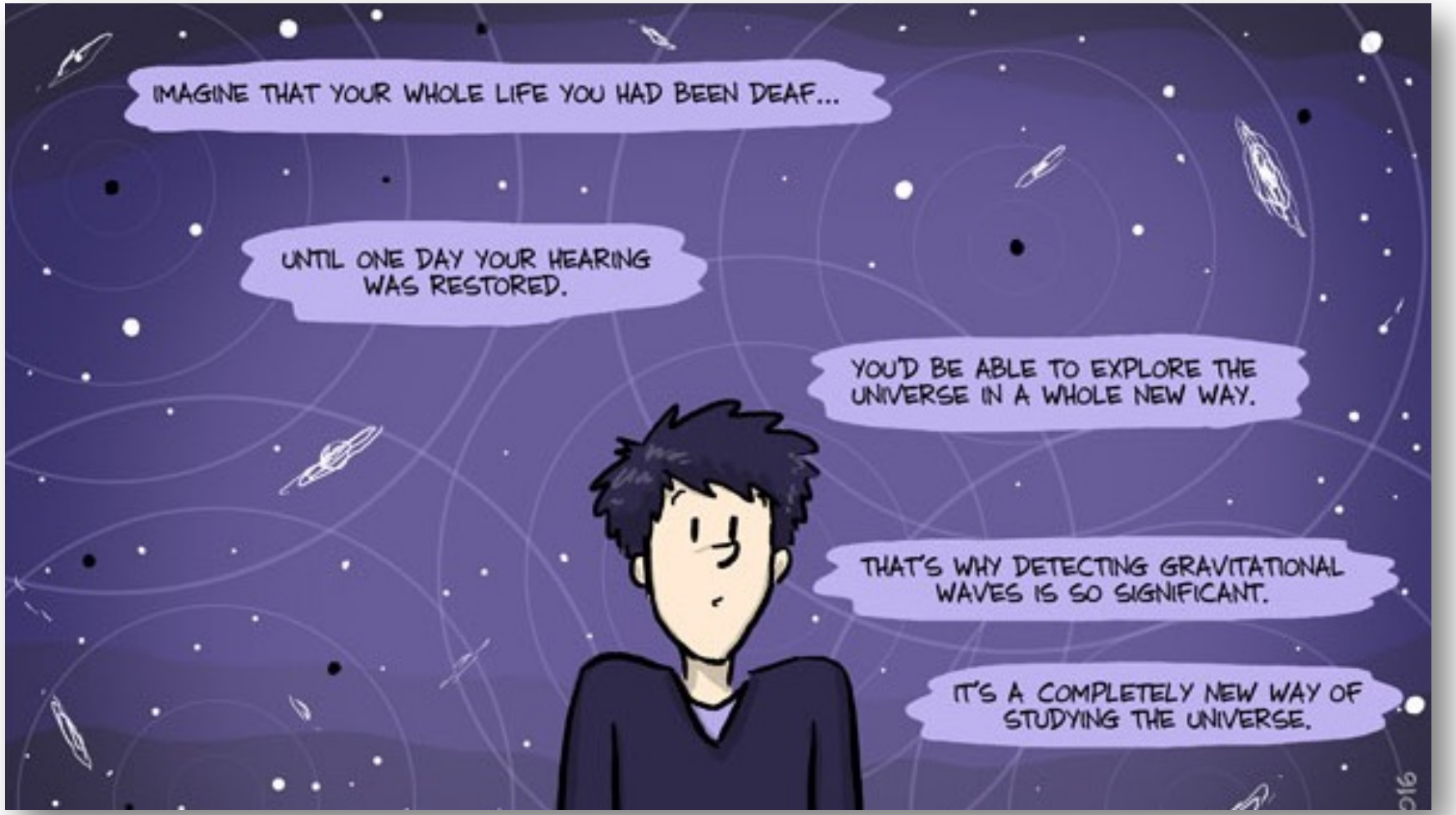
IMAGINE THAT YOUR WHOLE LIFE YOU HAD BEEN DEAF...
UNTIL ONE DAY YOUR HEARING WAS RESTORED.
YOU'D BE ABLE TO EXPLORE THE UNIVERSE IN A WHOLE NEW WAY.
THAT'S WHY DETECTING GRAVITATIONAL WAVES IS SO SIGNIFICANT.
IT'S A COMPLETELY NEW WAY OF STUDYING THE UNIVERSE.


AND ANYTIME THERE'S A NEW WAY TO INVESTIGATE THE UNIVERSE WE DISCOVER THINGS THAT WE DIDN'T EXPECT.
IT'S REALLY ABOUT LOOKING FOR NEW THINGS THAT WE DIDN'T KNOW EXISTED...
...EXAMINING THE EXTREME EDGES OF OUR KNOWLEDGE OF PHYSICS...
...AND TESTING OUR THEORIES ABOUT HOW THE UNIVERSE WORKS.
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SOURCE

Address on Peace in the Atomic Era

Speech during the aft. program
Mrs. Roosevelt Meets the Public
on NBC television network,
Feb. 12, 1950