https://youtu.be/zH1orKdvTkQ

[00:00,0]

To fos trechei, me 1 disekatommyrio chiliometra tin ora.
Light travels at 1 billion kilometers per hour.

Mechri na teleioso autin tin protasi...
mia aktina fotos, echei paei mechri ti selini kai echei epistrepsei.
Until I'm done saying this, a light ray has flown to the moon and back.

2 fores!
Twice…

3!
Three times…

4!
Fo..

Auto poy prospatho na po einai oti
to fos kineitai para poly grigora.
What I am trying to say is that light moves very fast.

[00:19,6]

Toso grigora, malista, poy gia to megalytero kommati tis istorias mas
Actually, so fast, that for the biggest part of our history

pisteyame oti to fos, apla, metadidetai pantoy, stigmiaia.
we thought that light just appears everywhere instantaneously.

Kai, entaxei, gia na poyme kai toy stravoy to dikio...
Ok, in a point of view..

i kathimerini mas ebeiria, auto mas leei.
..this is what seems to happen according to our everyday experience.

'Otan anoigo tis koyrtines, to proi, gia na bei fos
When I open the curtains in the morning, light enters the room instantaneously.

to fos bainei mes to domatio, akariaia.
'H as poyme edo. Na!
Or here, look..

[00:35,3]

i skia moy kai to cheri moy, einai panta...
My hand and its shadow are always perfectly synchronized,

teleia sugchronismena.
'Oso kai na prospatho...
and no matter how hard I try,

De boro na kano to cheri moy, na trexei pio grigora apo ti skia.
I cannot make my hand move faster than the shadow.

(Ektos an eisai o Loyki Loyk)
"Unless you are Lucky Luke!"
In a few words, our everyday experience shows

Me liga logia, i kathimerini ebeiria mas, leei oti
that light travels from its source to our eye instantly.

[00:48,7]

to fos, taxideyei, ap' tin pigi toy, sto mati mas, akariaia.

Kai opos toses alles fores, stin istoria tis epistimis
And as usual in the history of science,

etsi kai tora
our everyday experience is what we call..

i kathimerini mas ebeiria, einai auto poy leme...
..wrong!

Lathos!
i proti episimi apopeira na metrisoyme tin tachytita toy fotos
egine to 1638, apo to Galilaio
The first serious attempt to calculate the speed of light was made by Galileo in 1638,

o opoios, eiche tin exis idea.
who had this idea:

Tha anevo ego se ena lofo, kratontas ena fanari...
"I will climb up on a hill holding a beacon

[01:07,9]

tha aneveis kai esy, ston apenanti lofo, me to diko soy fanari...
and you will climb on the opposite hill holding your beacon.

me to poy anapso to fanari moy, kai to deis...
Once you see my beacon shinning, you light up yours.

anaveis kai to diko soy.
Opote...metrame autin edo ti chronokathusterisi...
So, counting this time difference,

metrame kai tin apostasi ton 2 lofon...
the distance between the two hills

ta diairoyme...
and dividing the two, there, we have the speed of light!

Tachytita toy fotos. Sosta;
Right?"..

[01:22,4]

Fusika kai ochi!
Of course not!

'Opos polloi upopsiazeste idi
As many of you already suspect,

i moni tachytita poy boreis na metriseis me auto to peirama
einai i tachytita, ton anthropinon antanaklastikon.
the only speed that we end up calculating in this way is the speed of human reflexes,

Diladi, poso grigora antedrase o filos toy Galilaioy
meaning how quickly Galileo's friend responded to the light.

me to poy eide auti ti lampsi.
To fos DE MPORE'IS na to metriseis etsi
giati to fos, einai upervolika grigoro.
Light cannot be measured since it is super fast.

Paidia, sugnomi, epanalamvanomai, alla, PRAGMATIKA
Guys, I am sorry I repeat myself but honestly,

[01:39,1]

niotho oti, akoma, den sas echo dosei na katalavete
P'OSO grigoro, einai to fos.
I still feel that I have not made clear how fast the light is.

Ok, teleutaia prospatheia...
Ok, last chance, if you don’t feel it now you will never do:

An den to nioseis kai tora, de tha to nioseis pote.
Auto to vinteo, poy guristike sto panepistimio toy MIT
This video was recorded in MIT and shows a photon passing through a bottle in slow motion.

mas deichnei ena fotonio, se argi kinisi, na pernaei mesa apo ena boykali.
Sto idio plano, mia sfaira, tha chreiazotan...
In the same take, a bullet would require...

1 ChR'ONO!
A WHOLE YEAR to pass through the same picture.

gia na diaschisei, tin idia eikona.
Auto to peirama, DE tha doylepsei.
Therefore, this experiment will not work,

[02:00,9]

Ektos kai an vreis tropo, na valeis ta 2 fanaria
se terastia, terastia, terastia... terastia, apostasi metaxy toys.
unless you find a way to put both beacons in a huge huge huge huge distance apart.

Opote, 35 chronia meta
So, 35 years later, in 1672,

to 1672...
o Danos astronomos, 'Ole Roymer
Danish astronomer Ole Rømer arrives in Paris to get a job at the city’s observatory,

katafthanei sto Parisi, gia na doylepsei, sto asteroskopeio tis polis
sugkekrimena, gia na meletisei, toys doruforoys, toy Dia.
specifically to observe Jupiter’s satellites.

To afentiko toy kai dieuthuntis toy asteroskopeioy, Tziovani Kasini
His boss, the observatory’s director Giovanni Cassini

ascholeitai me to thema, edo kai mia dekaetia
has studied this matter for over a decade and has recorded their orbits in great precision.

[02:21,7]

kai echei katagrapsei, tis trochies ton doruforon, me terastia akriveia.
Oplismenos, me tis simeioseis toy Kasini, loipon
o Roymer, xekinaei kai meletaei, ton esoteriko doruforo toy Dia
Armed with Cassini’s notes, Rømer starts to study Jupiter’s inner satellite, Io.

tin Io.
This is Rømer’s model:

Kai auto, einai to montelo toy Roymer
echoyme, sto kentro, ton 'Hlio
echoyme ti Gi
i opoia periferetai, sti diki tis trochia.
'Echoyme to Dia
the sun is at the center, the Earth moves around the sun on its orbit, Jupiter also moves around the sun in a much wider orbit

o opoios, periferetai, se poly megalyteri trochia
kai echoyme kai ti Io, ton esoteriko doruforo toy Dia
o opoios, kanei mia peristrofi, gyro apo ton Dia

and Io satellite (Jupiter's inner satellite) makes a full rotation around Jupiter in around 42,5 hours.

kathe, peripoy, 42.5 ores.
Emeis, apo ti Gi
auto poy paratiroyme, einai
o doruforos, na exafanizetai, piso apo to Dia
kai na emfanizetai, apo tin alli meria.
From a terrestrial perspective, Io is vanished behind Jupiter and appears on the opposite side, what is called an eclipse.

Auto poy leme, mia ekleipsi.
Tora, o Kasini, echei paratirisei oti
o chronismos, ton ekleipseon, paroysiazei kapoies diakumanseis, mes ti chronia
Cassini has observed that the timing of the eclipses presents some variation throughout the year.

[03:02,9]

Kai o Roymer, me ti seira toy, paratirei
Furthermore, Rømer observes that these fluctuations are not random,

oti, autes oi diakumanseis, den einai tuchaies.
ALL'A...'Otan i Gi...
einai pio makria ap' ton Dia...
oi ekleipseis, erchontai, 11 lepta argotera
on the contrary, when the Earth is away from Jupiter eclipses occur 11 minutes later,

kai otan i Gi, einai pio konta ston Dia...
oi ekleipseis, erchontai 11 lepta noritera.
and when the Earth is close to Jupiter eclipses occur 11 minutes earlier.

O Roymer, suberainei, sosta...
Rømer then correctly assumes that the fluctuations

oti oi diakumanseis, ofeilontai sto gegonos oti
to fos, den erchetai akariaia...
apo ti Io, sti Gi
are due to the fact that light does not reach the Earth instantly from Io satellite

alla, chreiazetai, ligo chrono, na taxidepsei.
but it needs some time to travel to the Earth.

[03:26,2]

Kai, i chroniki diafora stis ekleipseis,
einai,poly apla, ta extra, 11...
The time difference between the eclipses is the extra 11 plus 11,

sun 11..22 lepta
poy chreiazetai, to fos, na diaschisei...
tin trochia tis Gis.
22 minutes that light needs to cross the Earth's orbit.

Tora, to peirama toy Galilaioy
Here, Galileo's experiment found the huge distance needed between the beacons to function

echei, tin terastia apostasi, poy chreiazotan, gia na leitoyrgisei
and in order to find light speed,

To mono poy prepei na kanoyme, einai
na diairesoyme, ti diametro ti trochias tis Gis
poy echei upologisei, apo prin, o Kasini
dia 22 lepta.

we need to divide the Earth's orbit dimeter, pre-measured by Cassini, by 22 minutes.
And there it is, the speed of light.

[03:48,6]

Kai echeis, tachytita toy fotos.
Paradoxos, o Roymer, den ekane pote tin krisimi diairesi.
Oddly, Rømer never did the crucial division,

Auti i timi, anikei, ston Ollando astronomo
Kristian Cha..
Choigkin...
Choichens..;
Chaigkens...;
this honor belongs to the Dutch astronomer Christiaan Huygens ….

(Kristian Chogens, foni tis google)
Nai, den paizei.
(..no way..)

To teliko apotelesma, vgike, peripoy
250.000 chiliometra, to deuterolepto.
The final result occurred around 250.000 km/sec,

Entuposiaka konta, sti monterna timi
poy einai 300.000.
impressively close to the currently accepted value of 300.000 km/sec,

Kai katholoy aschima, gia 1672, etsi;!
especially considering that it occurred in 1672.

[04:10,9]

O upologismos, tis tachytitas toy fotos, apo to Roymer kai tin parea toy
The calculation of the speed of light from Rømer et al.

apotelei, gia mena, to thriamvo tis epagogikis skepsis
for me is the triumph of inductive reasoning,

Toy na chrisimopoieis, oli tin proyparchoysa gnosi
kai na kaneis to epomeno vima.
meaning to use all the existing state of the art and take it one step further.

Borei, fainomenika, i idea toy Roymer, na itan apli
Rømer's idea might seem simple,

alla, an guriseis to chrono piso
however, if we turned back time, we would realize

uparchei mia adiakopi alusida anakalypseon
that there is an uninterrupted chain of discoveries

[04:26,7]

poy lutharaki, lutharaki, odigoyn, stin tachytita toy fotos.
which lead step-by-step to the speed of light.
Rømer made calculations based on Cassini's notes,

O Roymer, ekane upologismoys, me vasi, tis simeioseis toy Kasini
o opoios Kasini, chrisimopoiise, to tileskopio, poy teleiopoiise o Galilaios.
who used the telescope finalized by Galileo,

O opoios, Galilaios, me ti seira toy
eiche tin idea, na parei to ollandiko, nautiko kiali
who had the idea of getting the Dutch old navy binoculars

kai, gia proti fora, na to strepsei ston oyrano

and look up the sky for the first time,

anakalyptontas etsi, toys doruforoys toy Dia.
thus discovering Jupiter’s satellites.

[04:43,1]

To ollandiko kiali, kataskeuastike ton 16o aiona
Dutch navy binoculars were built in the 16th century

kai vasizetai, stin archi oti
to fos, allazei poreia, otan pernaei mesa apo ena fako.
and were based on the principle that light changes direction passing through a lens.

O fakos, me ti seira toy, san efeyresi
upirche, TOULAChISTON, ap' to 800 m.ch.
The lens in turns, had been an invention of at least 800 AD

kai oi idiotites toy, na kabtei to fos
itan gnostes, apo toys Araves epistimones, toy mesaiona.
and its property of flexing the light was known from the Arabs scientists of Middle Ages.

Kai kataligoyme, ston Eukleidi...
o opoios, meletise, tin euthugrammisi kontinon kai makrinon antikeimenon
Euclid studied the alignment of close and far away objects

gia na mas deixei, oti , to fos...
taxideyei, se eutheia grammi.
in order to prove that light travels in line.

[05:05,5]

Epagogiki skepsi...se olo tis to megaleio!
Inductive reasoning at its best!

Ki opos panta, o Neytonas, to exefrase, kalytera ap' oloys mas.
As always, Newton said it optimally:

" O monos logos poy katafera na do toso makria..."
“If I’ve seen any further, it is by standing on the shoulders of Giants”.

"...einai epeidi stekomoyn, pano se omoys giganton."