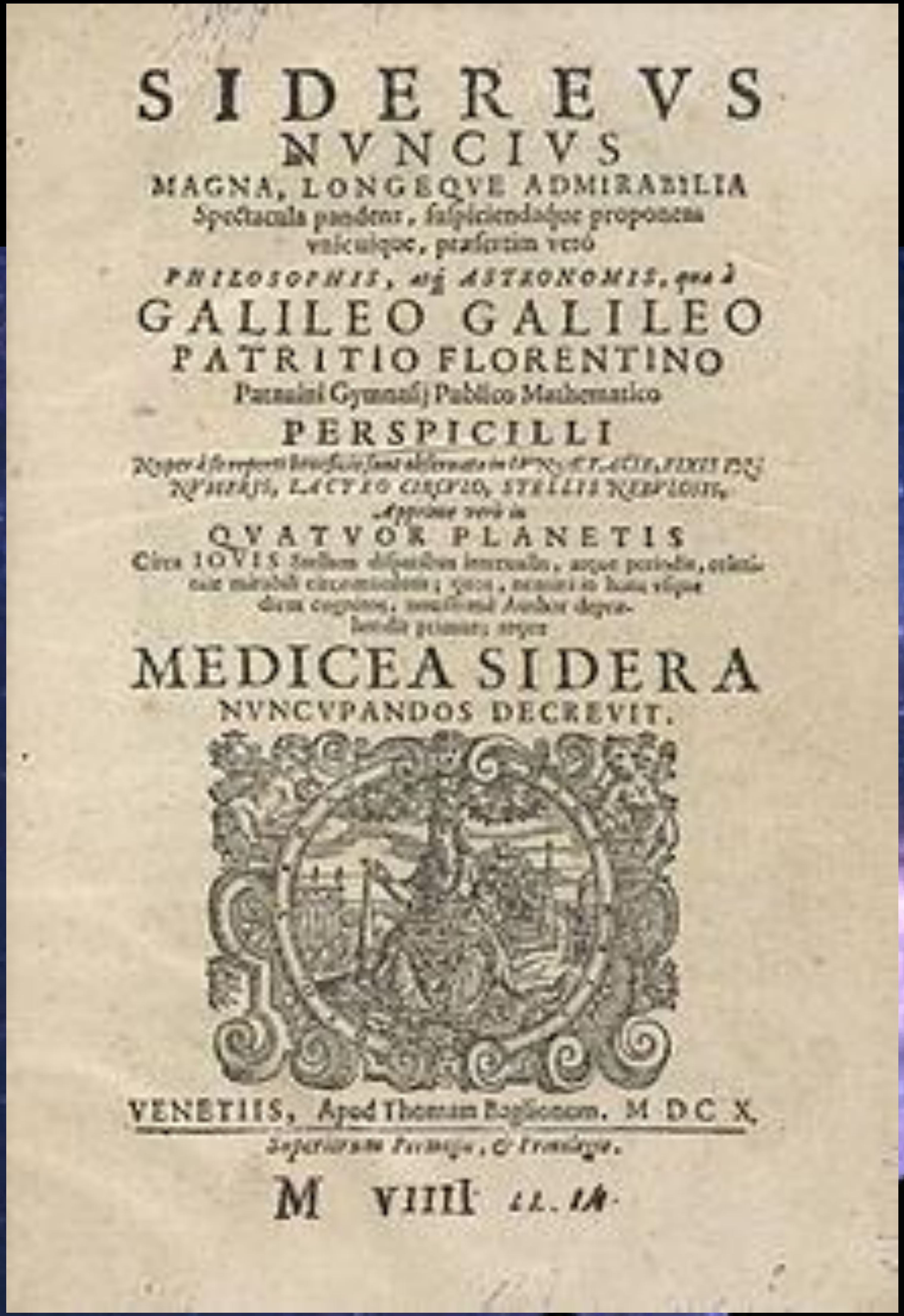
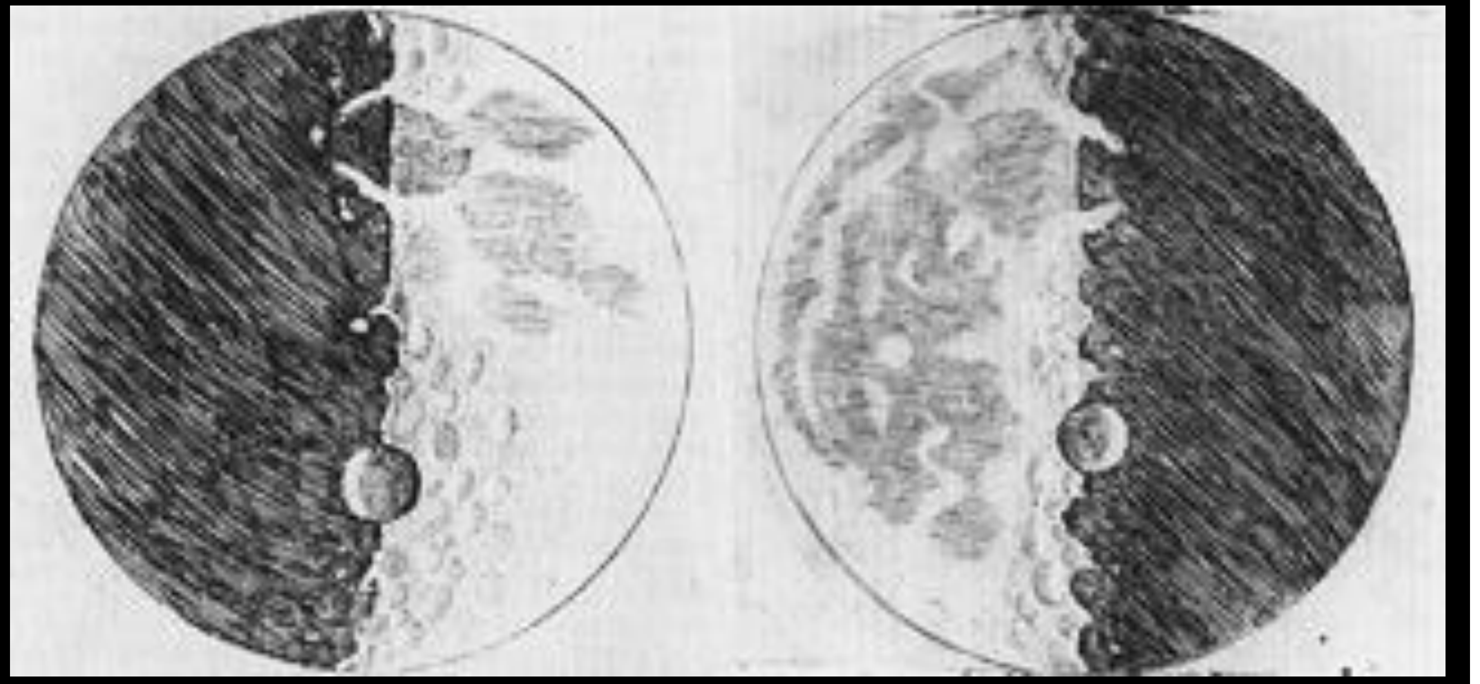
# Svemirski čauši/glasnici (Sidereus Nuncius)


SIDEREVS
NVNCIVS
MAGNA, LONGEQVE ADMIRABILIA
Spectacula pandens, suspiciendaque proponens
vnicuique, praesertim verò
PHILOSOPHIS, atq; ASTRONOMIS, quae à
GALILEO GALILEO
PATRITIO FLORENTINO
Patauini Gymnasij Publico Mathematico
PERSPICILLI
Nuper à se reperti beneficio sunt obseruata in LVNAE FACIE, FIXIS INNVMERIS, LACTEO CIRCVLO, STELLIS NEBVLOSIS,
Apprimè verò in
QVATVOR PLANETIS
Circa IOVIS Stellam disparibus interuallis, atque periodis, celeritate mirabili circumuolutis; quos, nemini in hanc vsque diem cognitos, nouissimè Author depraehendit primus; atque
MEDICEA SIDERA
NVNCVPANDOS DECREVIT.
VENETIIS, Apud Thomam Baglionum. M DC X.
Superiorum Permissu, & Priuilegio.
M VIIII

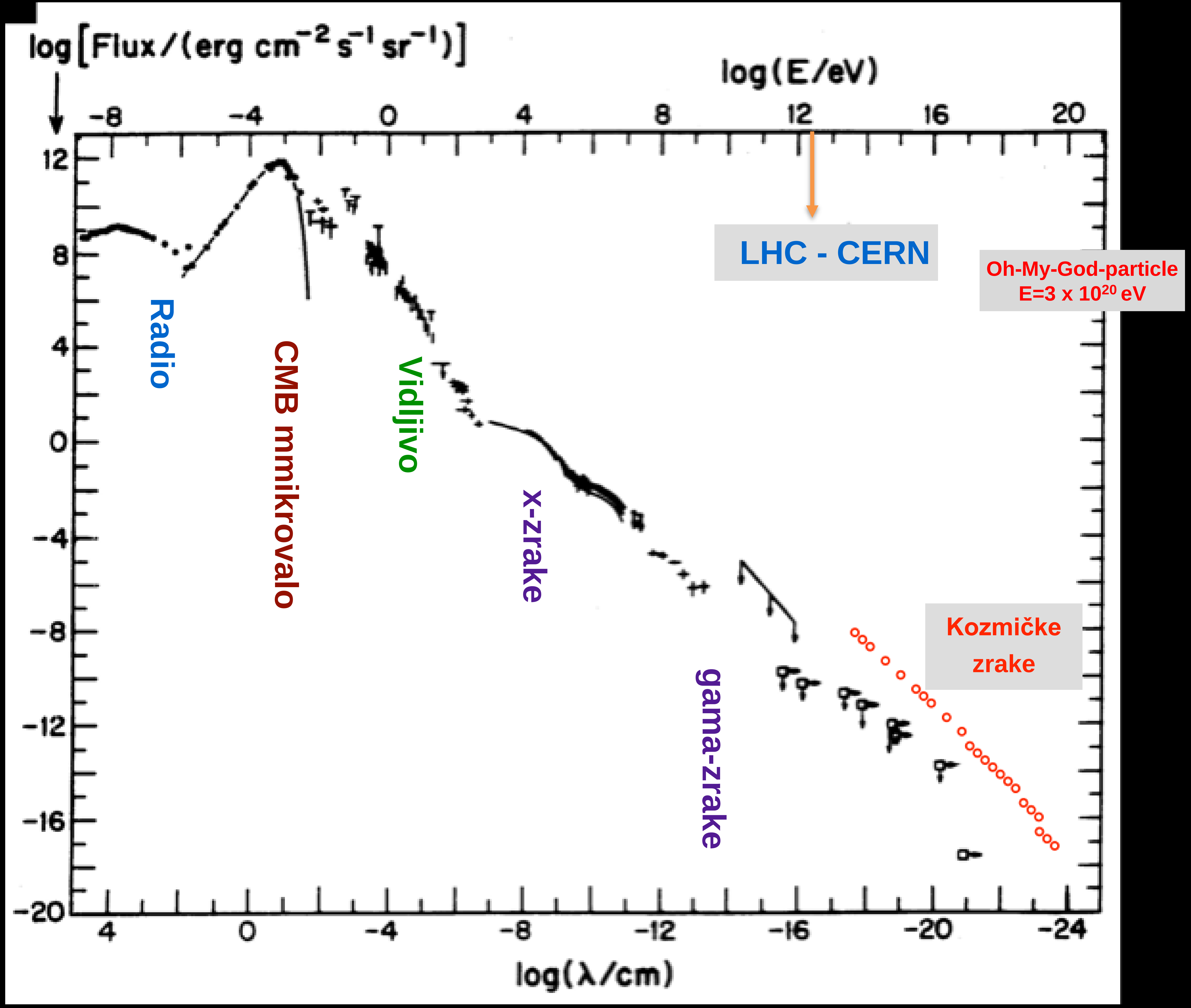
Sveučilište u Split, FESB
Nikola Godinović

# Difuzni spektar kozmičkog elektromagnetskog zračenja


1610



400 godina



# Spektar elektromagnetskih valova

# Blue pale dot – naš dom

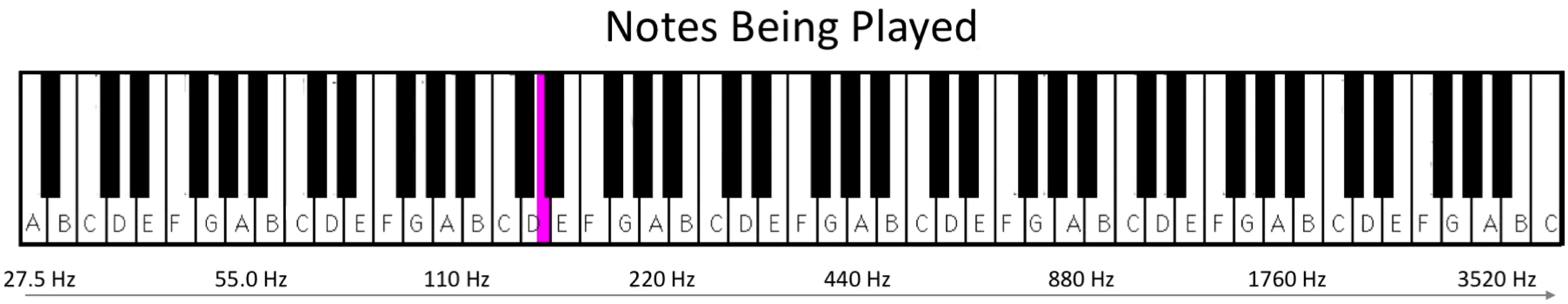
Voyager 1: Slika Zemlje s udaljenosti 6,4 milijarde kilometara

# Elektromagnetski prozori za promatranje svemira

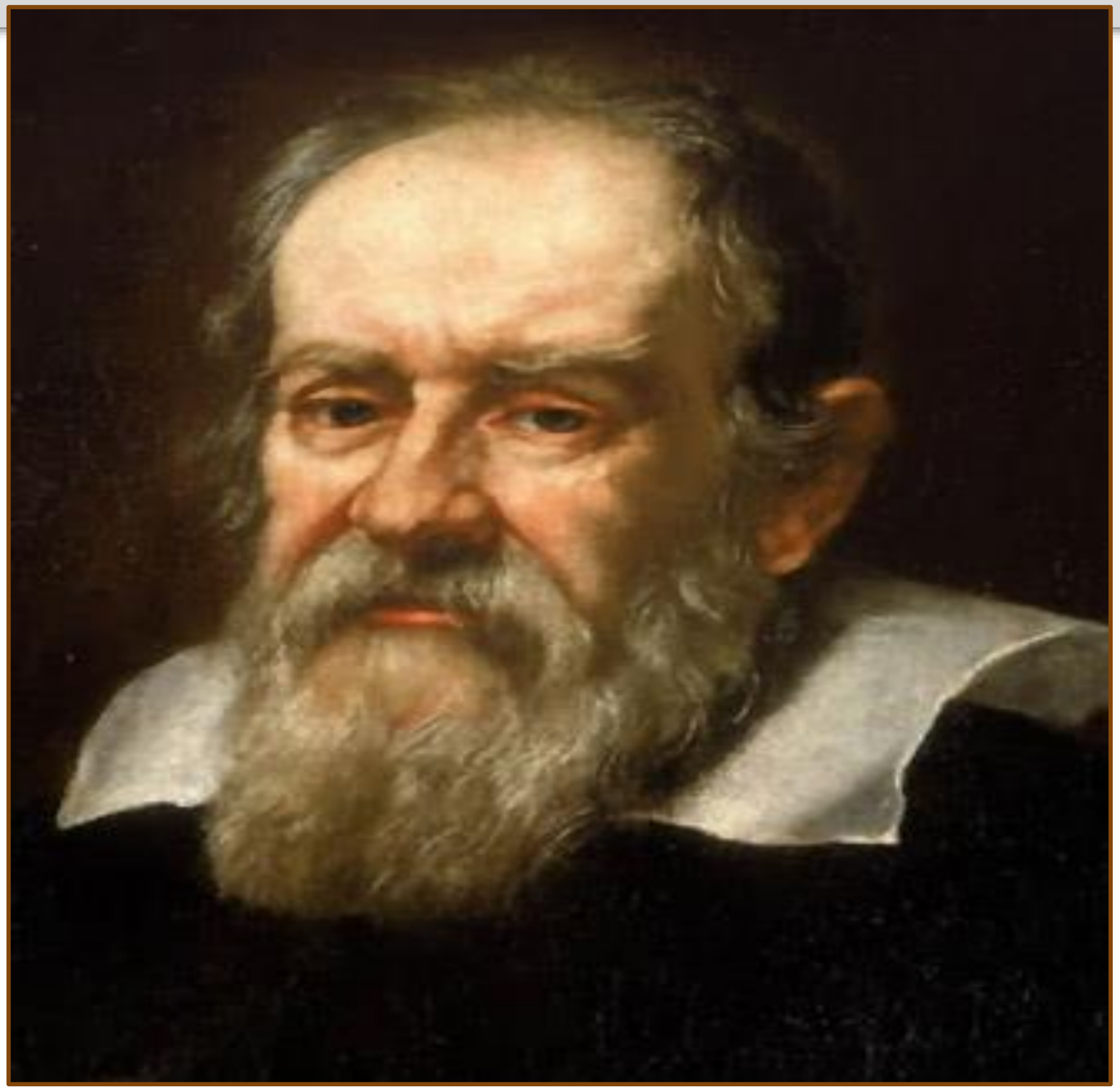
# Zašto je potrebno otvoriti sve prozore

**Svaki dio spektra (prozor) nosi informaciju o određenim fizikalnim procesima**

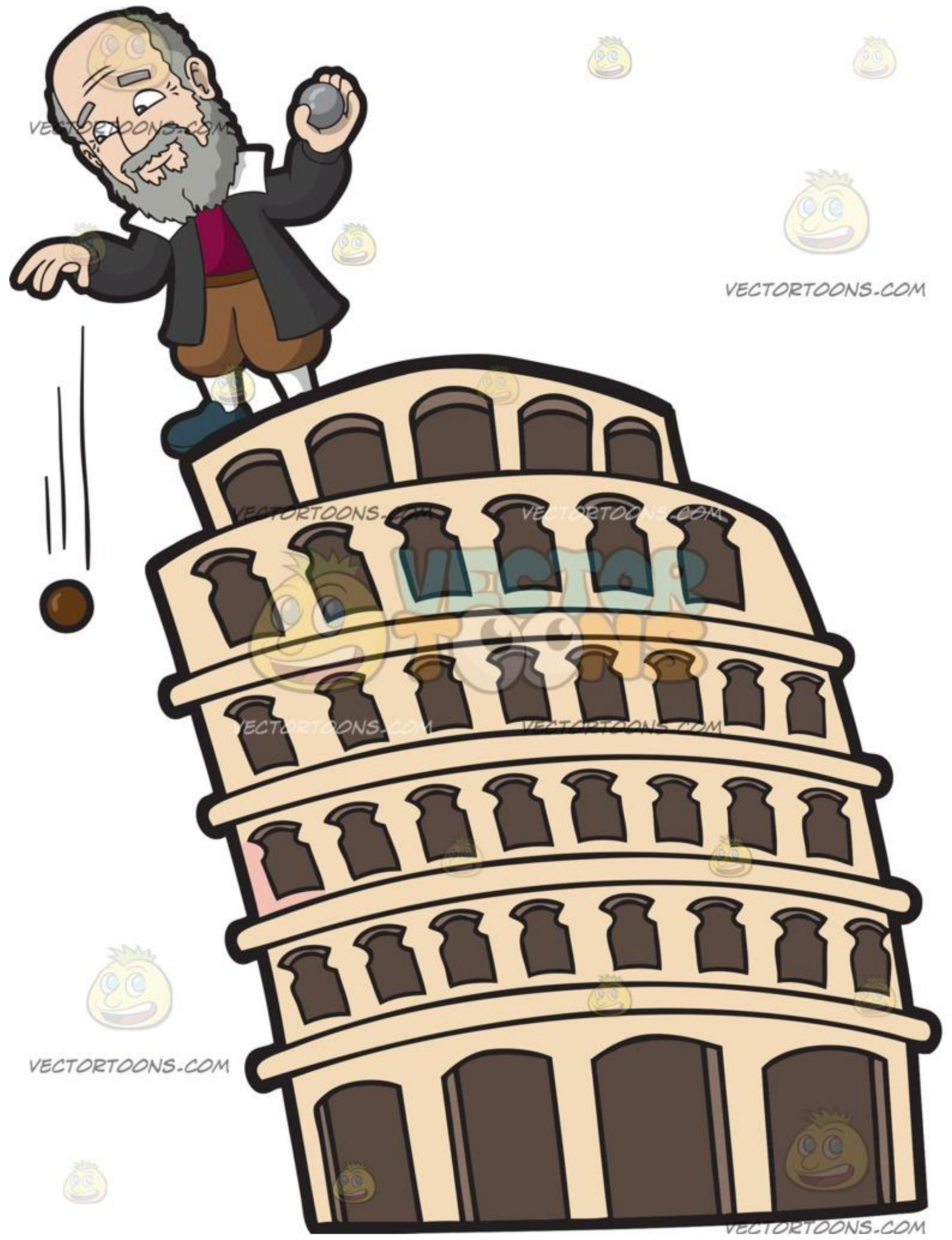
# Sve svemirske note treba čuti

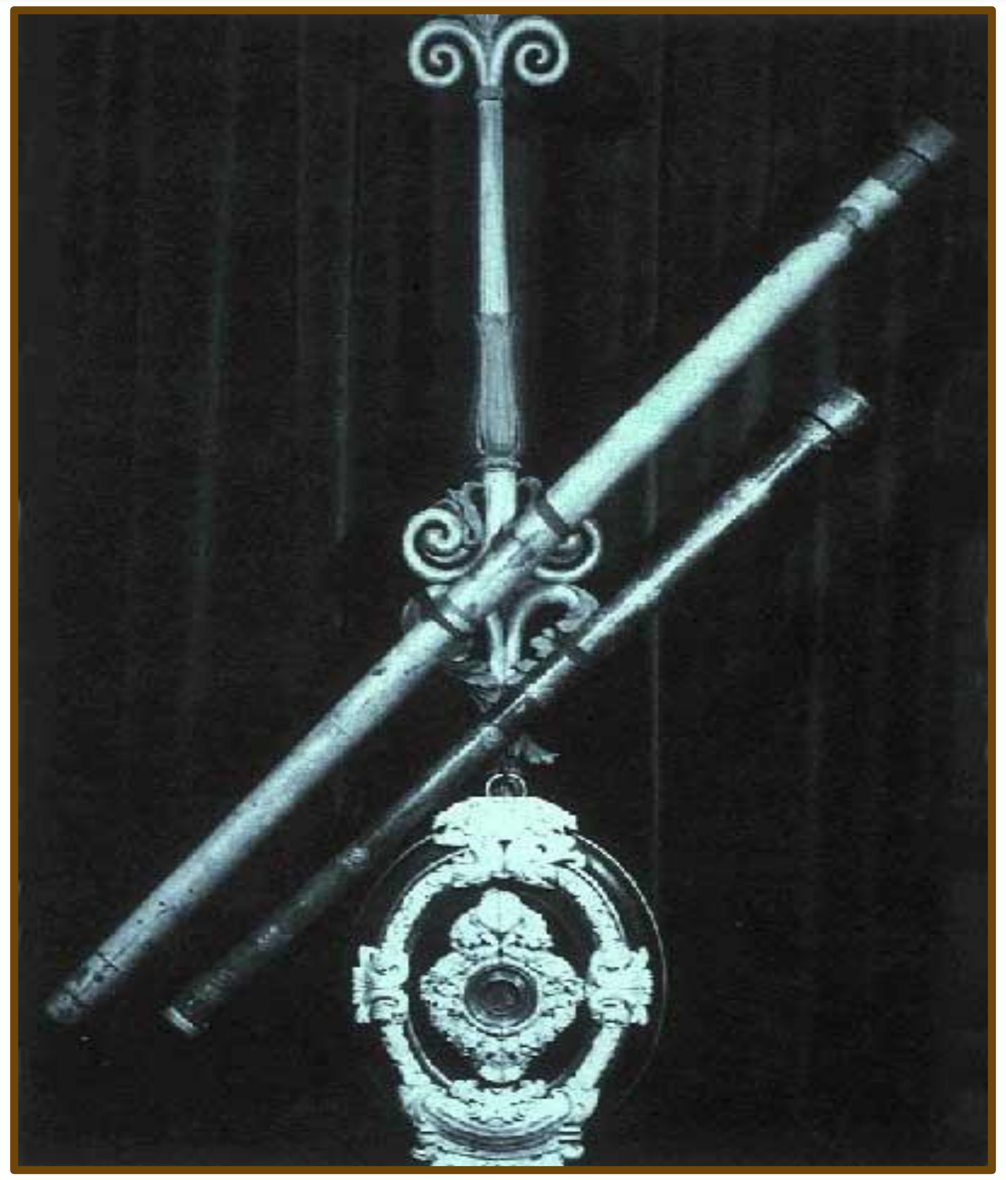


# Kad je sve počelo



**Galileo Galilei (1564 – 1642)**



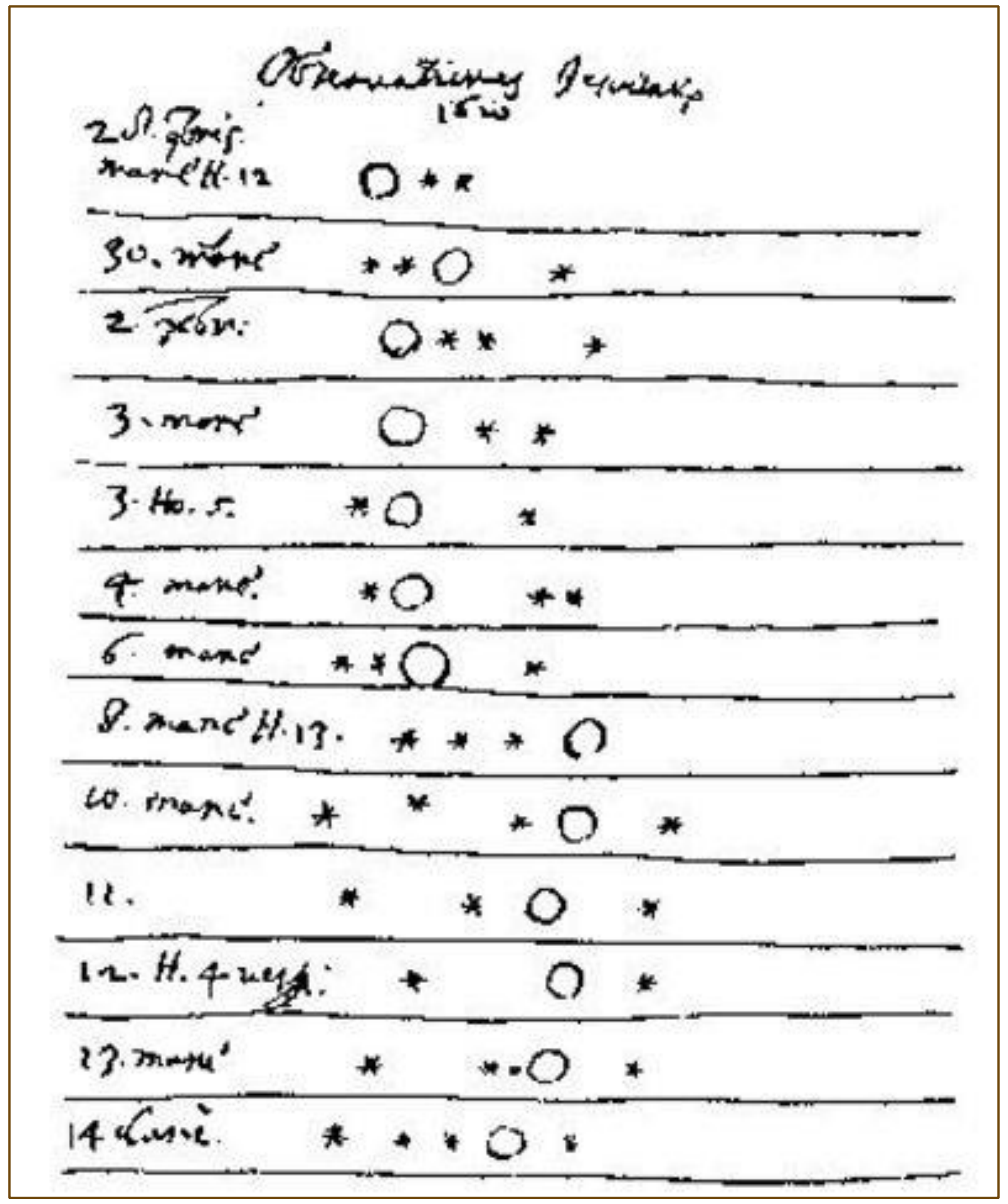


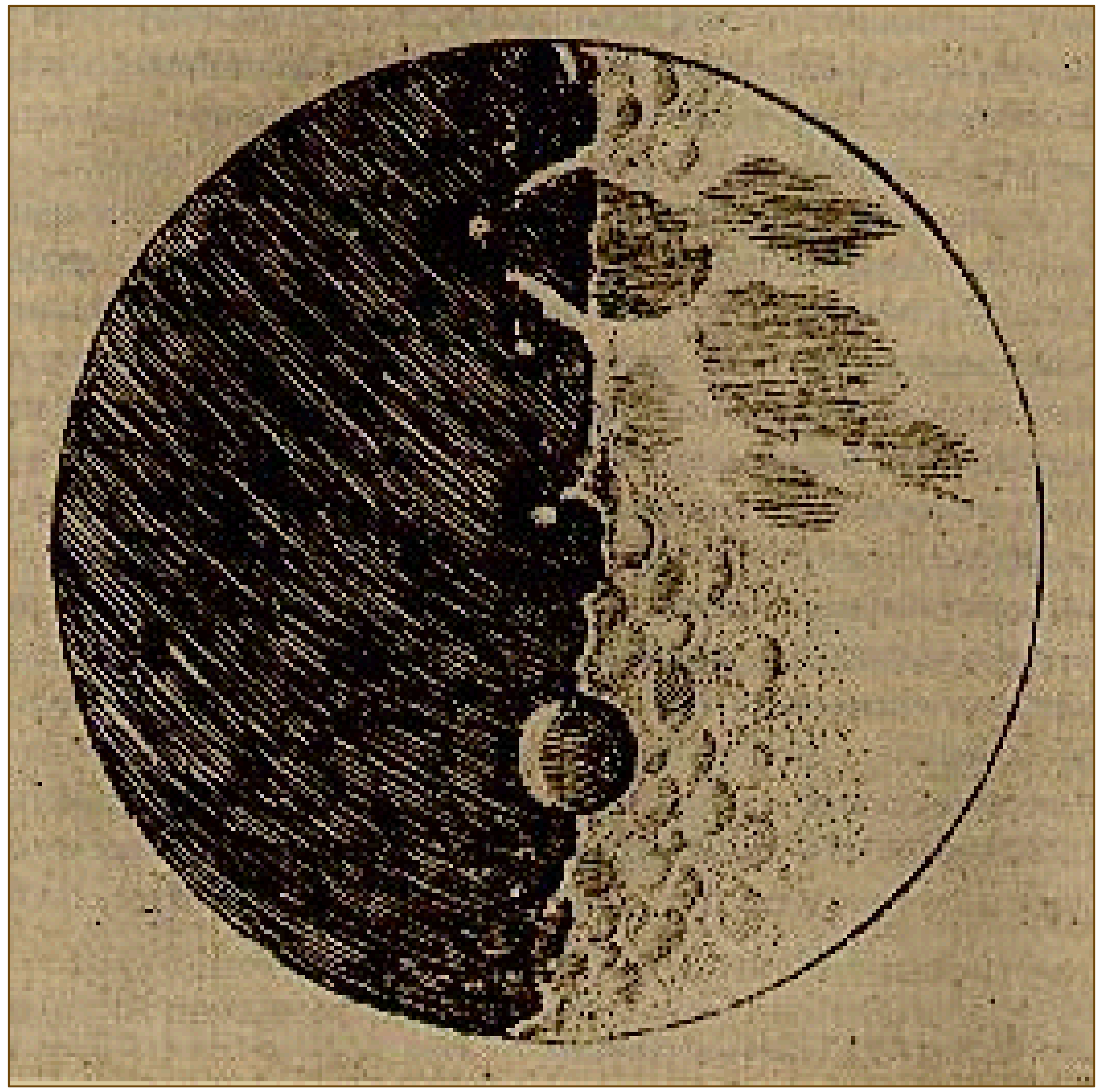
Galilean teleskop

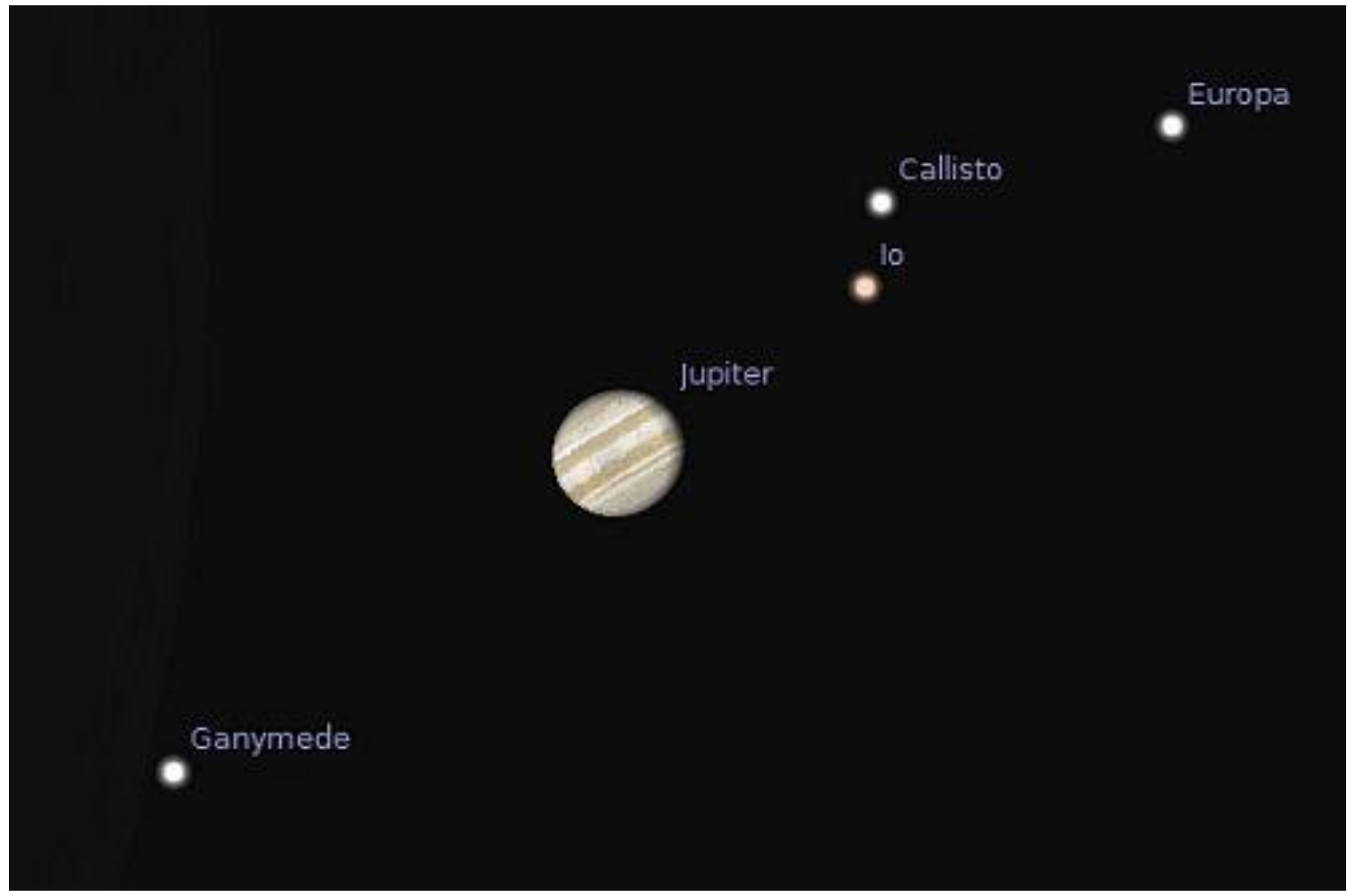
- **Ne zna se točno tko je prvi napravio teleskop, Lipperhey ili Janssen oko 1600.**
- **Zna se da je Galilei prvi usmjerio teleskop u nebo i otkrio: Mjesec nije ravan, tamne pjege na Suncu, 4 Jupiterova mjeseca, faze Venere.**
- **25. kolovoza 1610 demonstrira svoj teleskop u Veneciji**

# Od srebra do silicija (1)

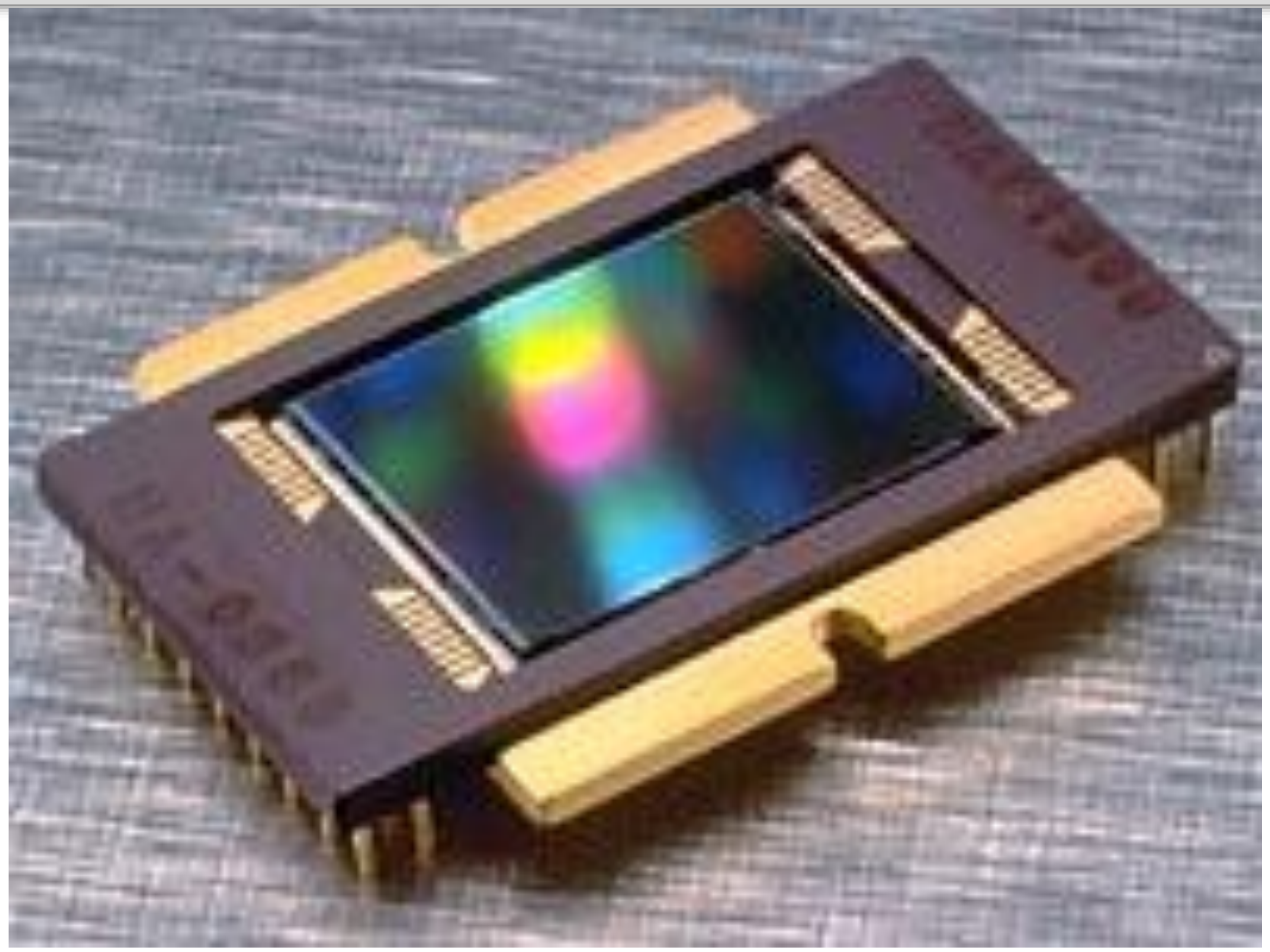
- Prvi astronomi poput Galiela su morali biti i vješti crtači kako bi zabilježili svoja promatranja.
- Prvu fotografiju mjeseca J. W. Draper napravio 1840. Mala zrnca kristala srebrenog halida u emulziju izložena svjetlu postaju crna.
- Primjenom fotografije astronomija postaje objektivna, reproducibilna znanstvena metoda i znatno osjetljivija, duža ekspozicija znači više sakupljenog svjetla. Prvi put su uočeni objekti koje nije moguće vidjeti golim okom.



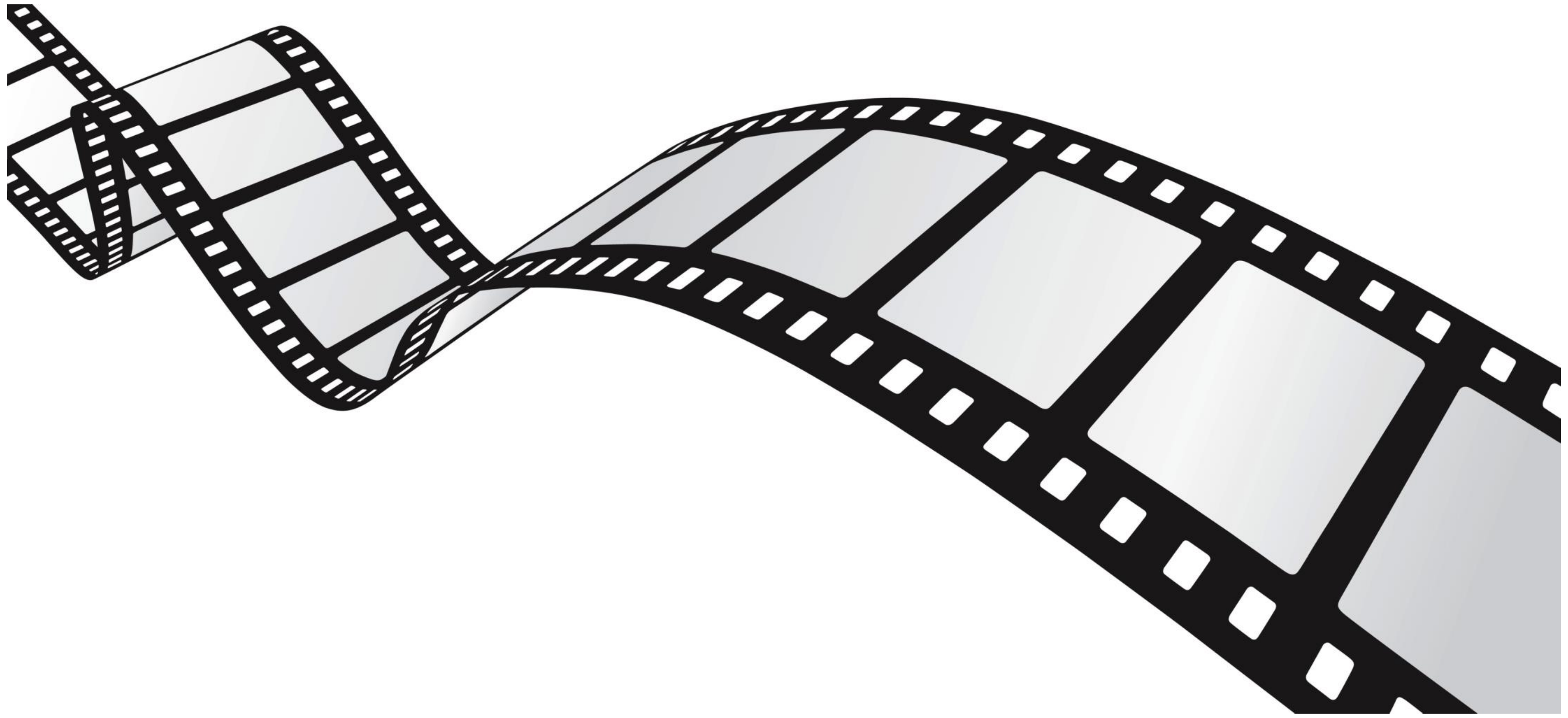





# Od srebra do silicija (2)



- Za gotovo 100 puta povećala se sposobnost sakupljanja svjetla. (Osjetljivost na jedan jedini foton)
- Moguće snimiti vrlo slabe izvore u kratkom vremenu.
- Danas  15 cm teleskop (amaterski) opremljenim CCD kamerom sakupi jednaku količinu svijetla kao i 1 m teleskop iz 60-tih godina.



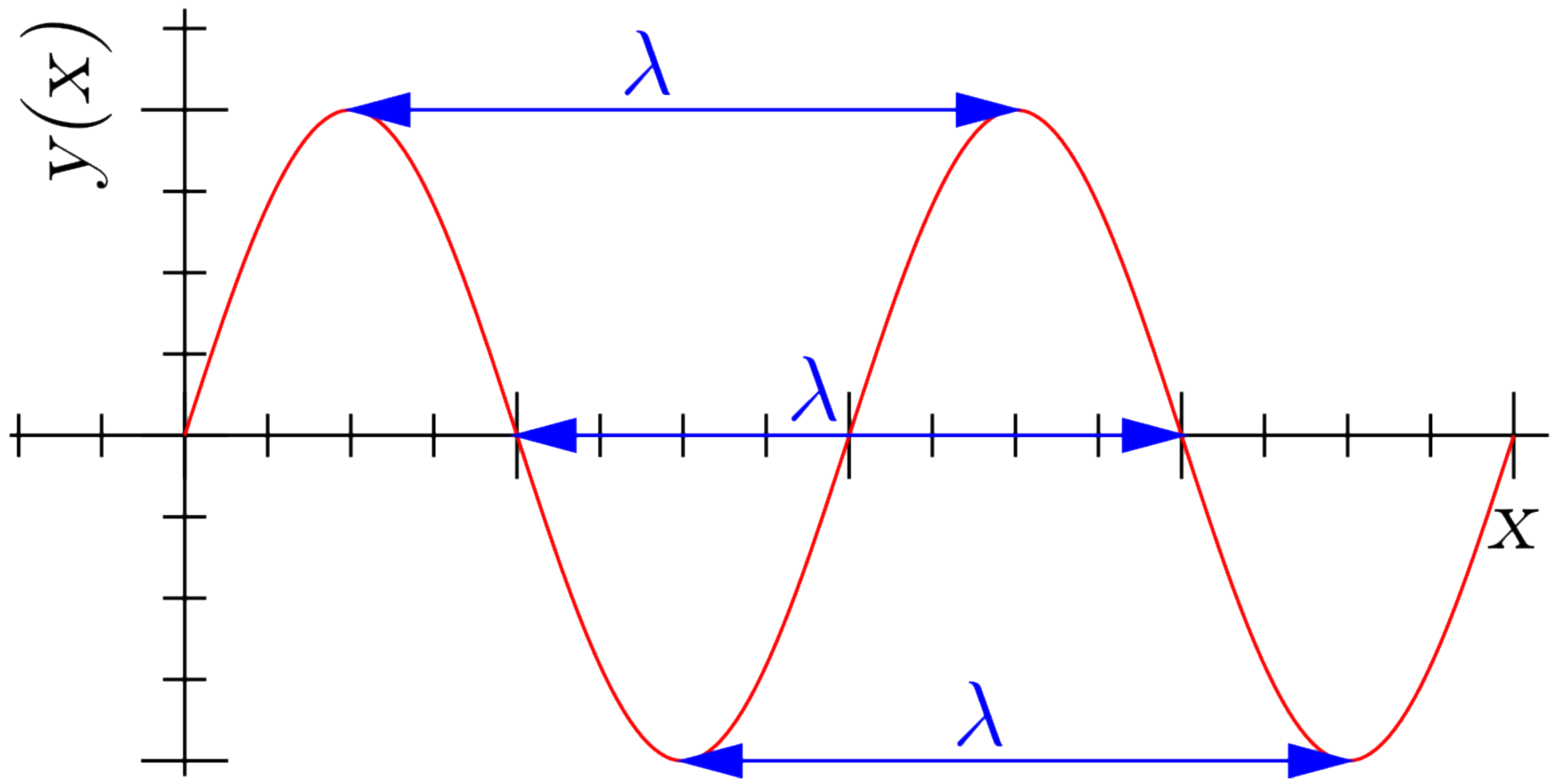
# Kutno razlučivanje

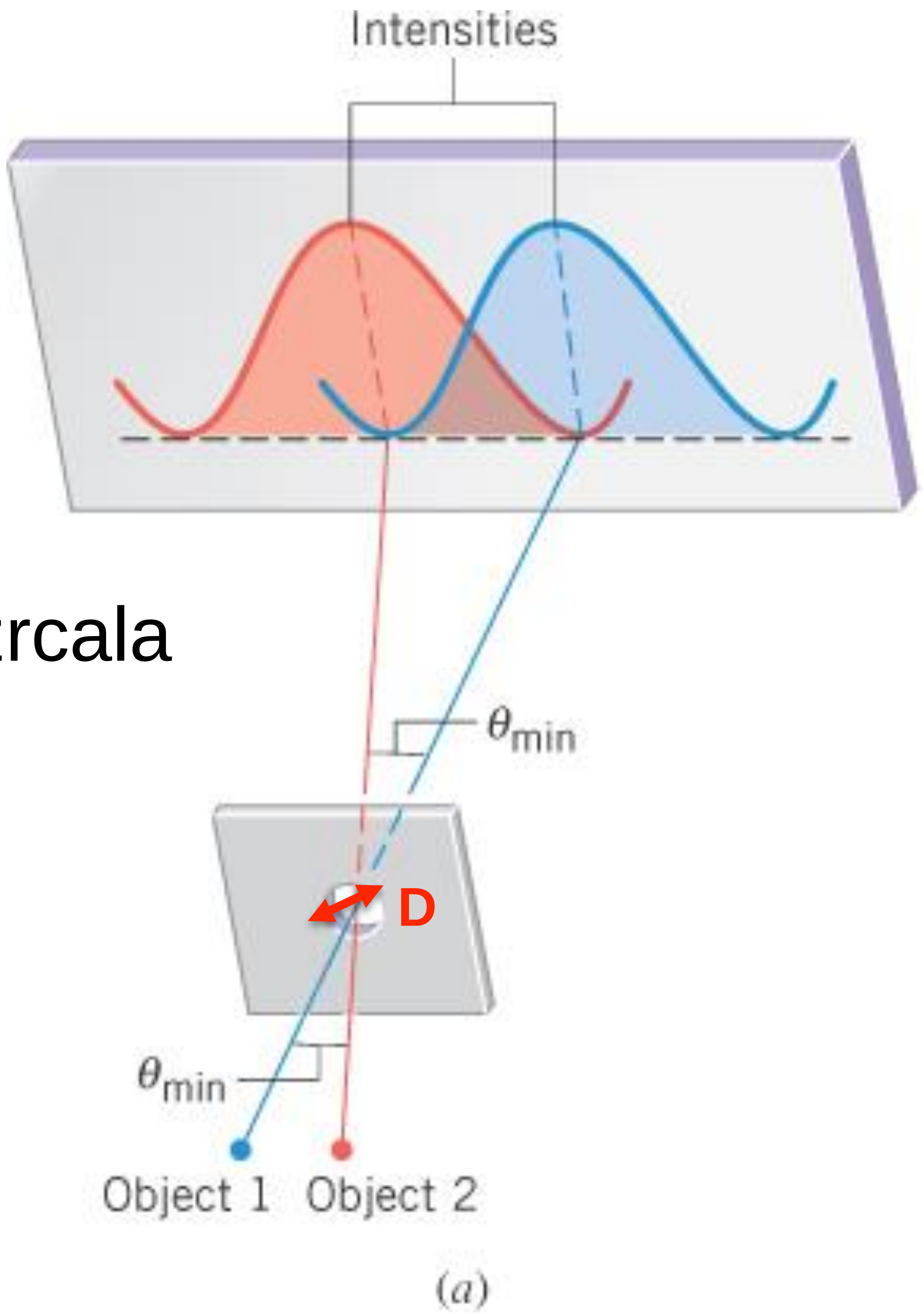
**Relacija koja definira minimalni kut između dva izvora koja se još mogu razlučiti**

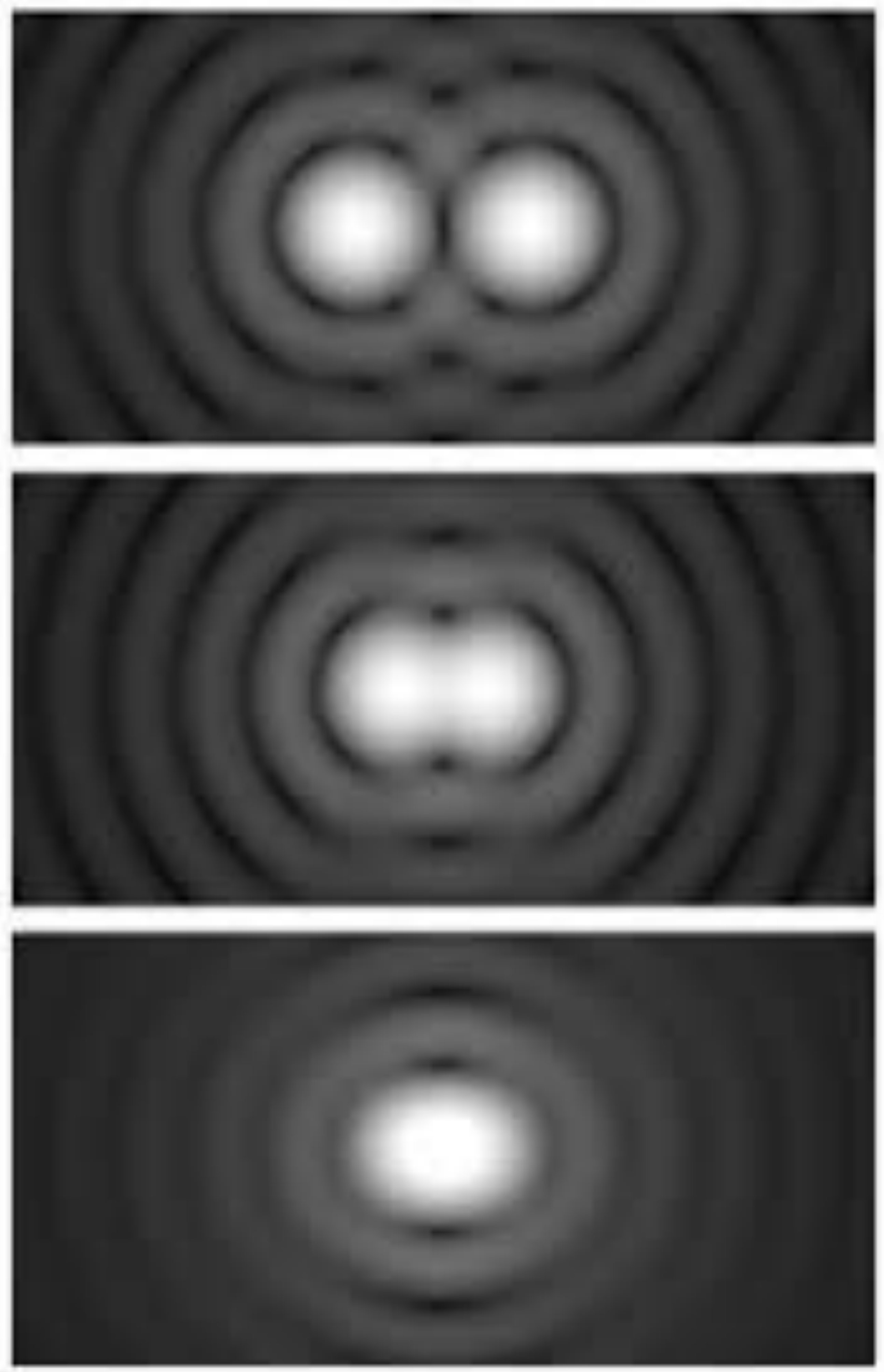
$$\theta_{min} \approx 1.22\frac{\lambda}{D}$$

$\lambda$- valna duljina (100 km do $10^{-18}$ m)

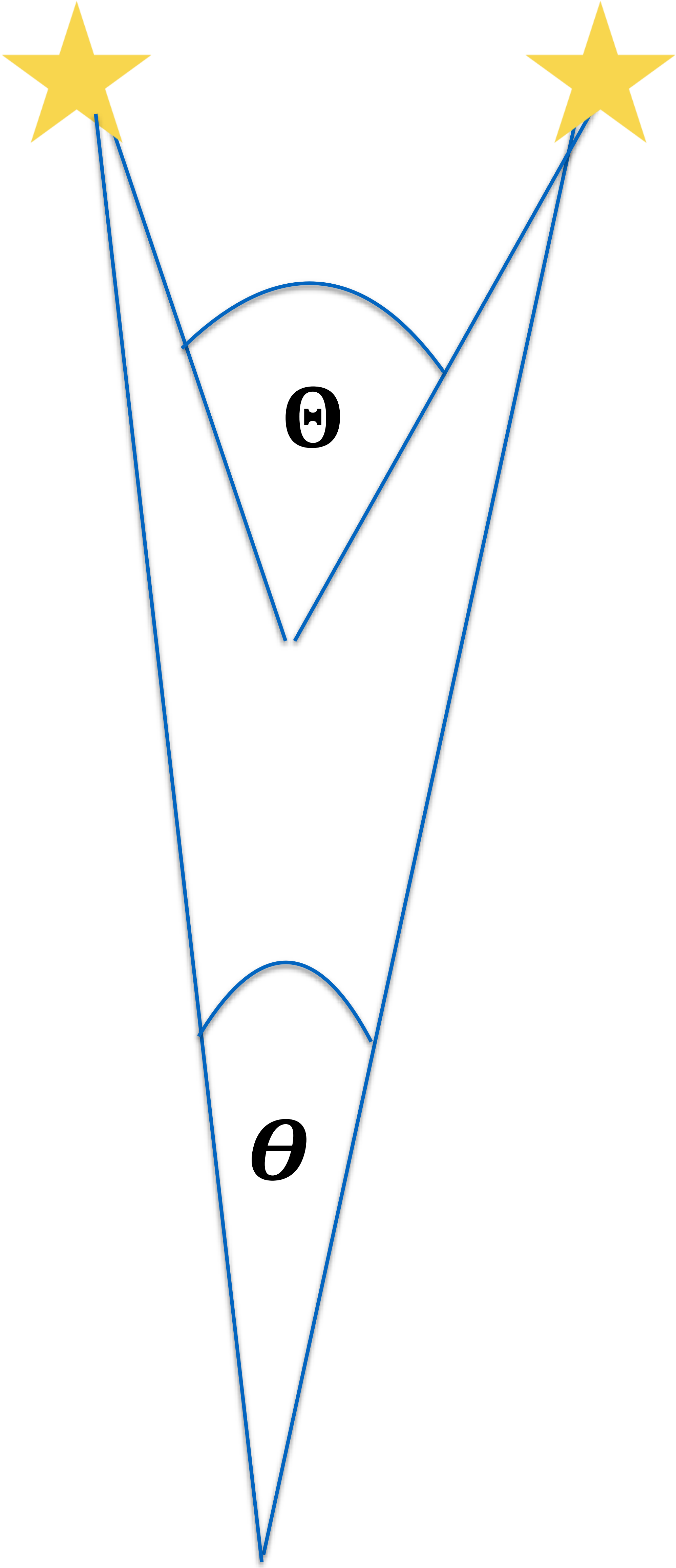
**D** - promjer kružnog otvora ili promjer zrcala



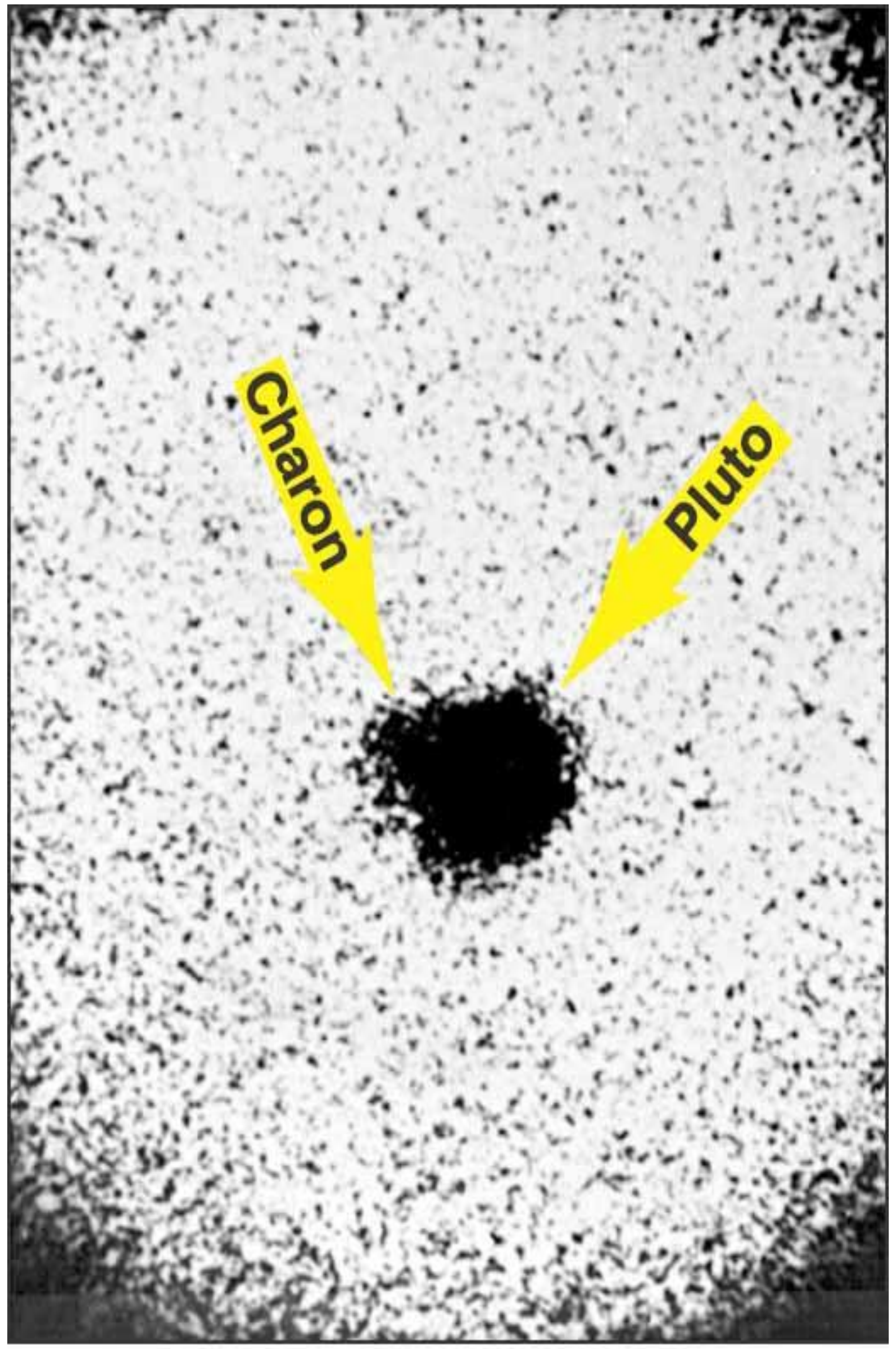



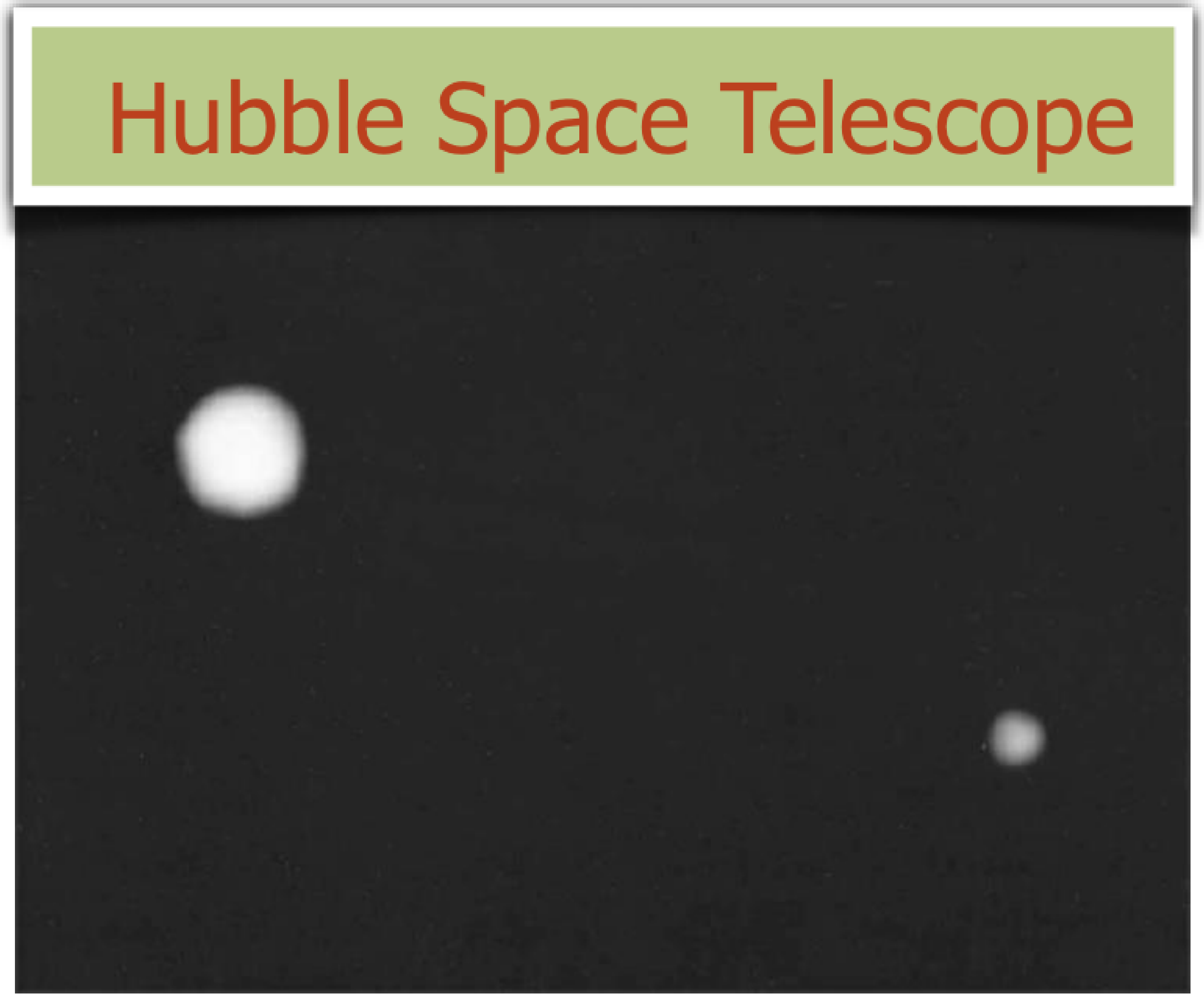
# Koliko malo možemo vidjeti




# Primjer razlučivanja

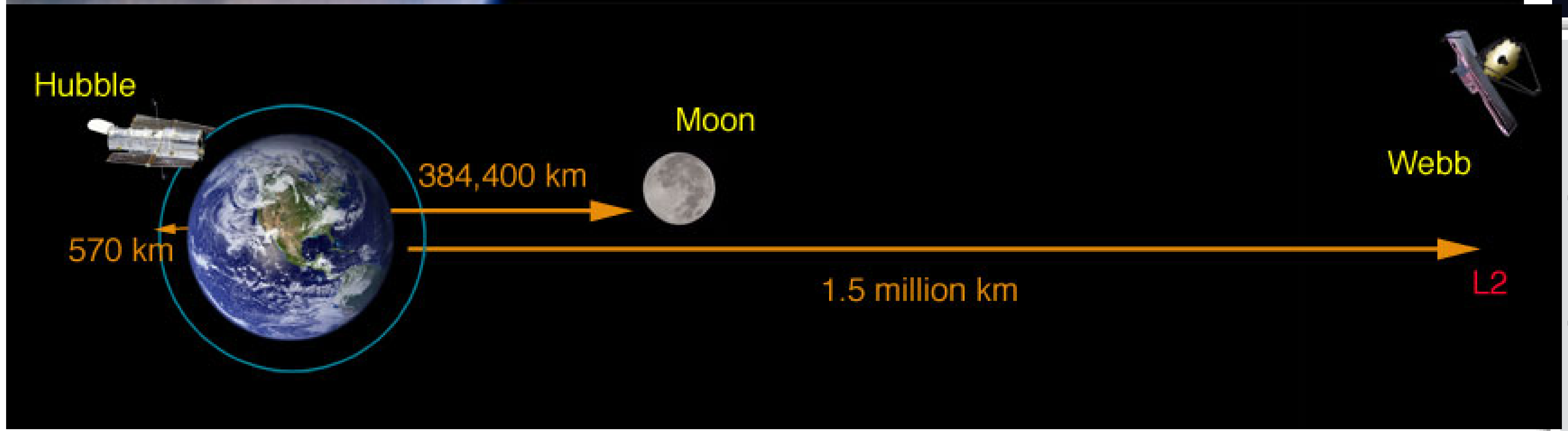
- Planet Pluton i njegov mjesec Charon
- Krajnje lijevo: Teleskop na Zemlji vidi razmazanu sliku planeta Plutona i njegovog mjeseca,
- Krajnje desno: “Hubble Space Telescope” jasno razlučuje i planet Pluton i njegov mjesec Charon.
- **Hubble Space Telescope može razlučiti dvije bliske zvijezde čija je kutna udaljenost oko $\theta_{min} = 10^{-7}$ rad, (0,05°) što je ekvivalentno mogućnosti razlučivanja dva objekta udaljena 1 cm na udaljenosti od 100 km.**



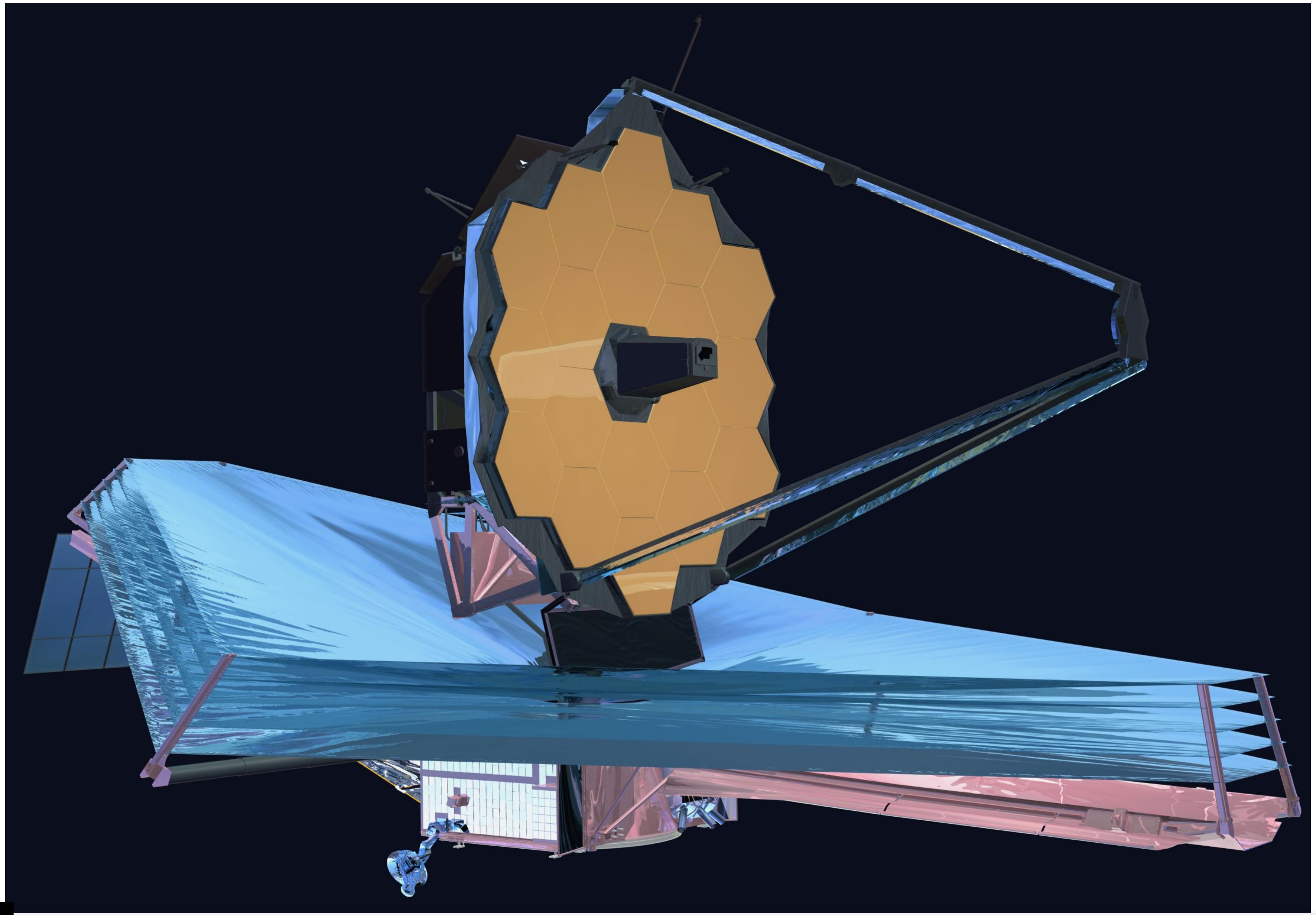



# Teleskopi na satelitima

Hubble Space Telscope (HST) (1990, opitčko + UV)

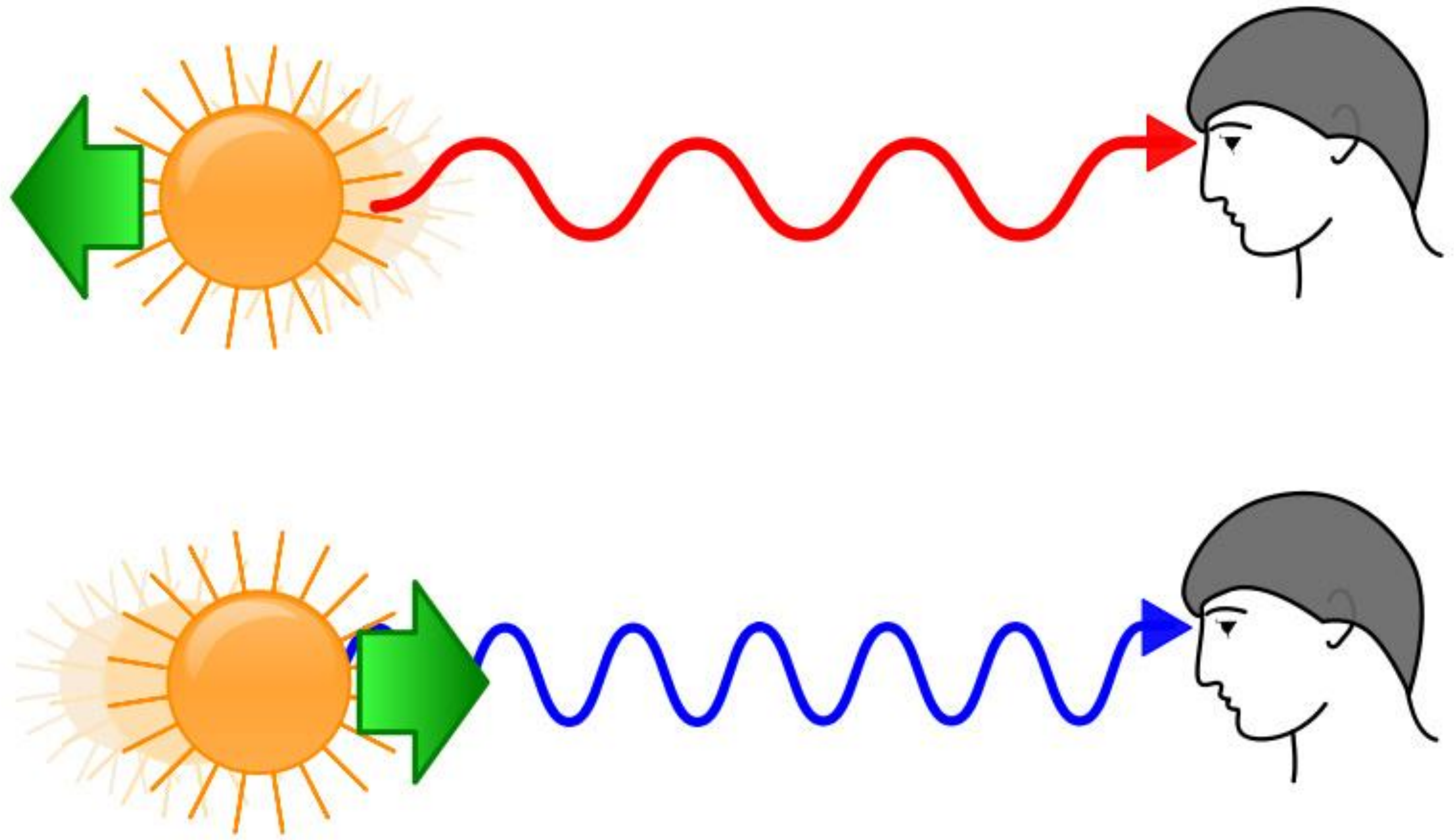



James Webb Space Telscope (JWST)



**JWST započeo (2022) opažati svemir u infracrvenom području Zaviriti će u epohu kad su nastale prve zvijezde, tragati za molekulama u ekstrasolarnim planetima. Istraživati dosada nevidljive faze i aspekte evolucije svemira. Radna temperatura mu je 7 K. Promjer zrcala 6,5 m. Udaljenost od Zemlje 1,5 milijun km, L2.**

# Pomak ka crvenom - vidiš dalje u prošlost svemira

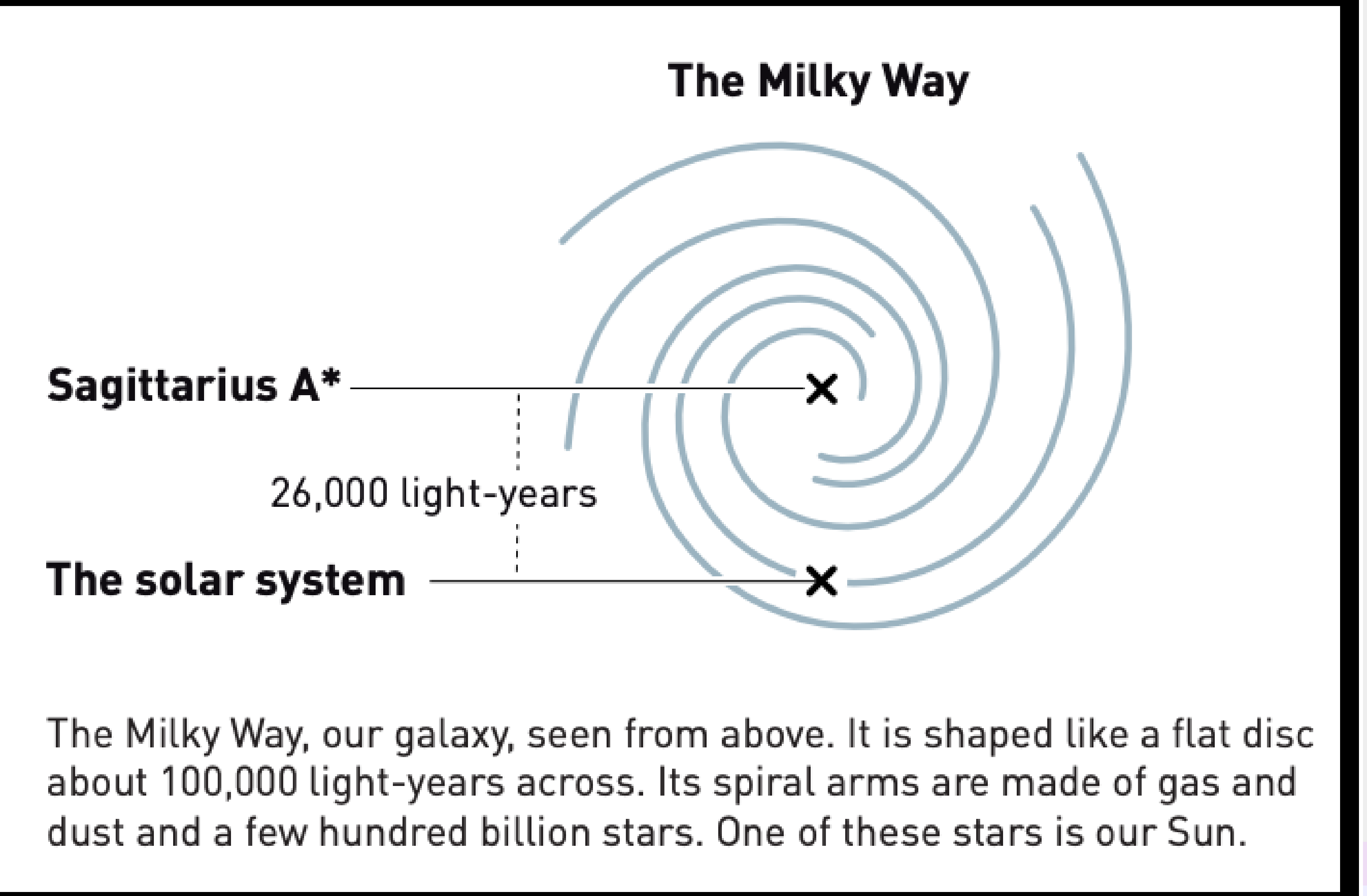


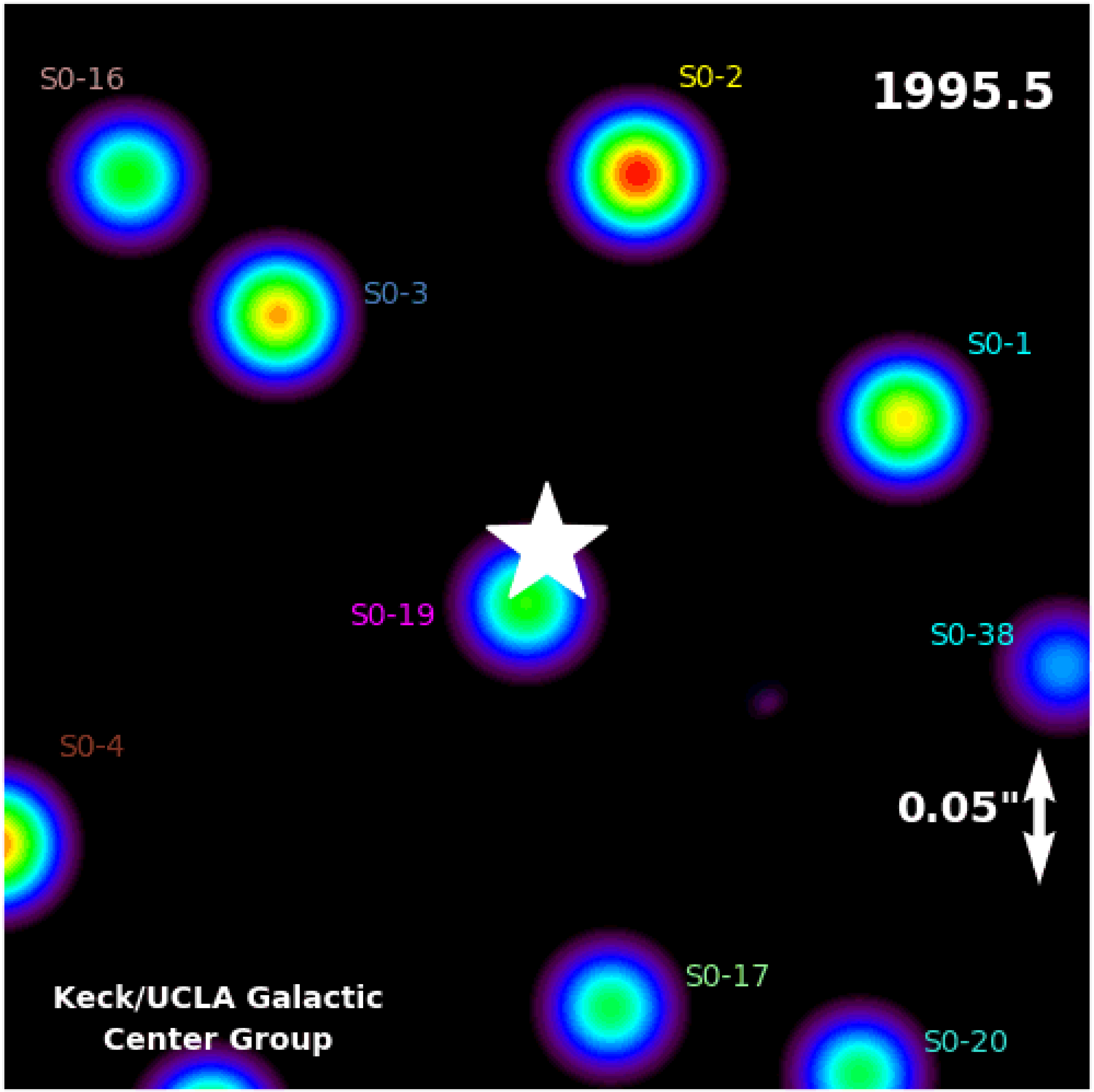

*Webb će moći vidjeti unatrag od oko 100 milijuna do 250 milijuna godina nakon Big Banga. Ali zašto trebamo opažati infracrveno svjetlo da bismo razumjeli rani svemir? Zato što je svjetlost tih objekata pomaknuta u crveno jer se udaljavaju od nas.*

JWST - osjetljiv u infracrvenom (hladi se na 7 K, omogućit će da vidimo prve zvijede u svemiru, nastale nekolilo stotina milijuna godina nakon Big Banga

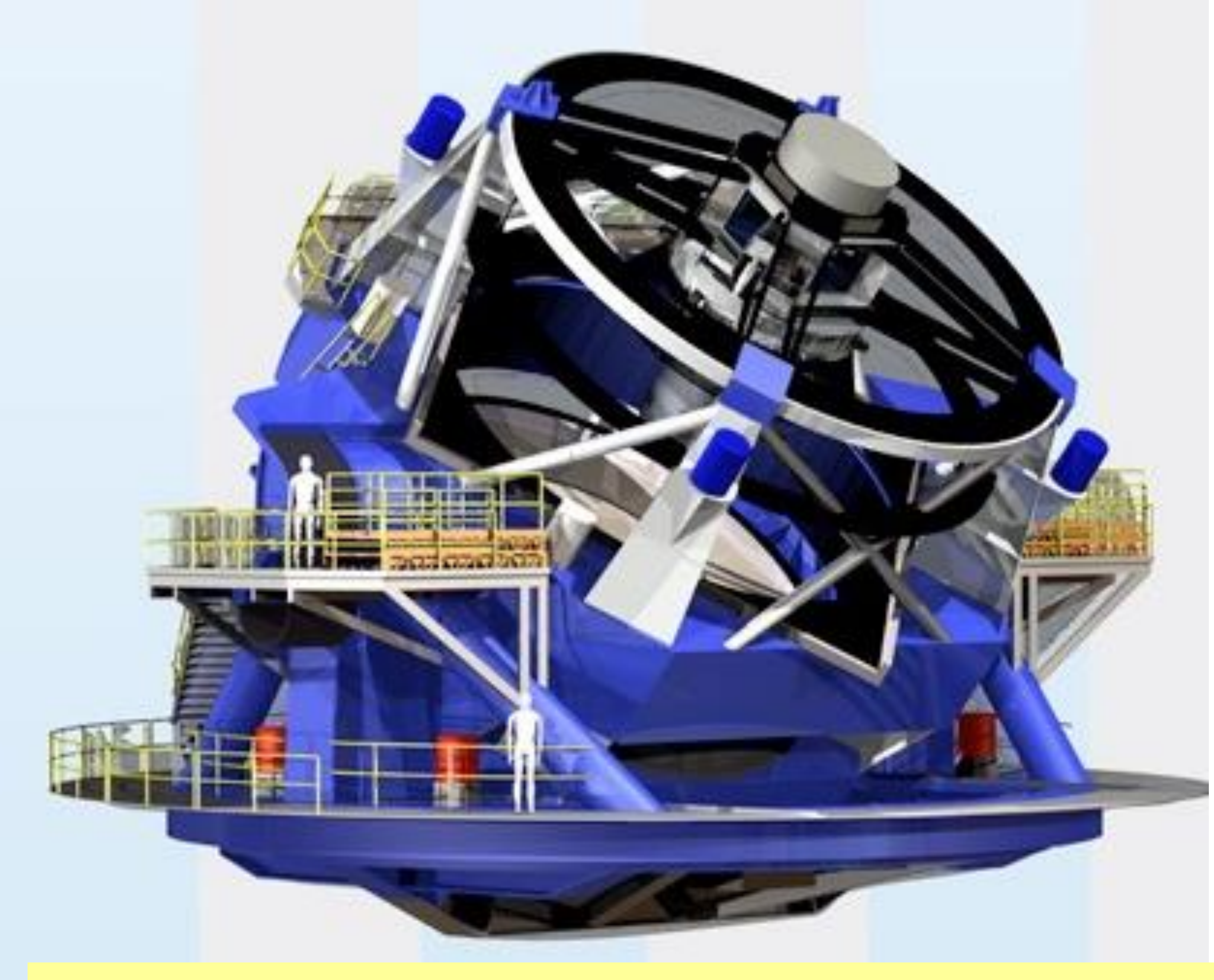

Visible
Infrared

# Crna rupa u našoj galaksiji - IR



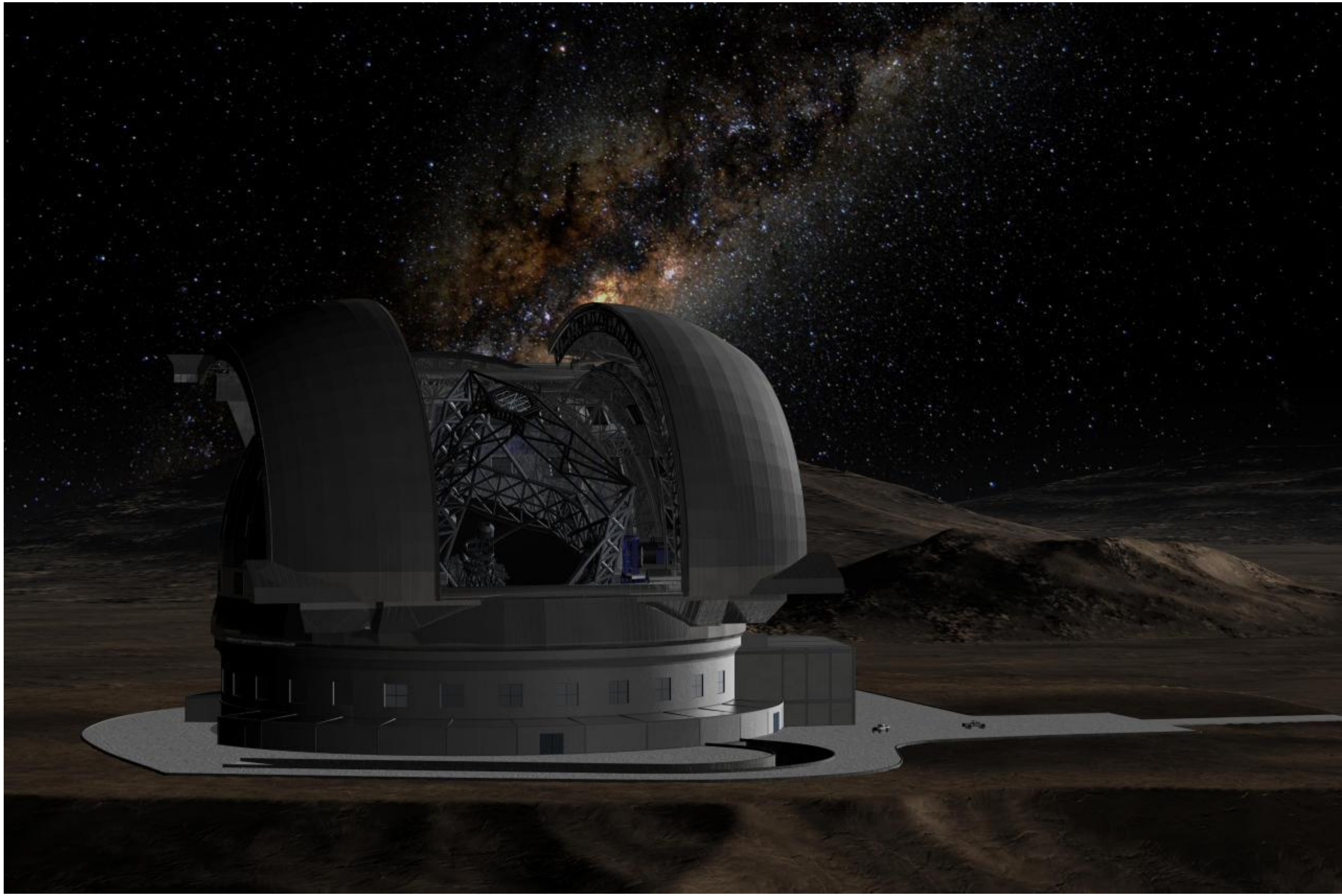
# Vera C. Rubin Observatory-LSST - svemirsko kino



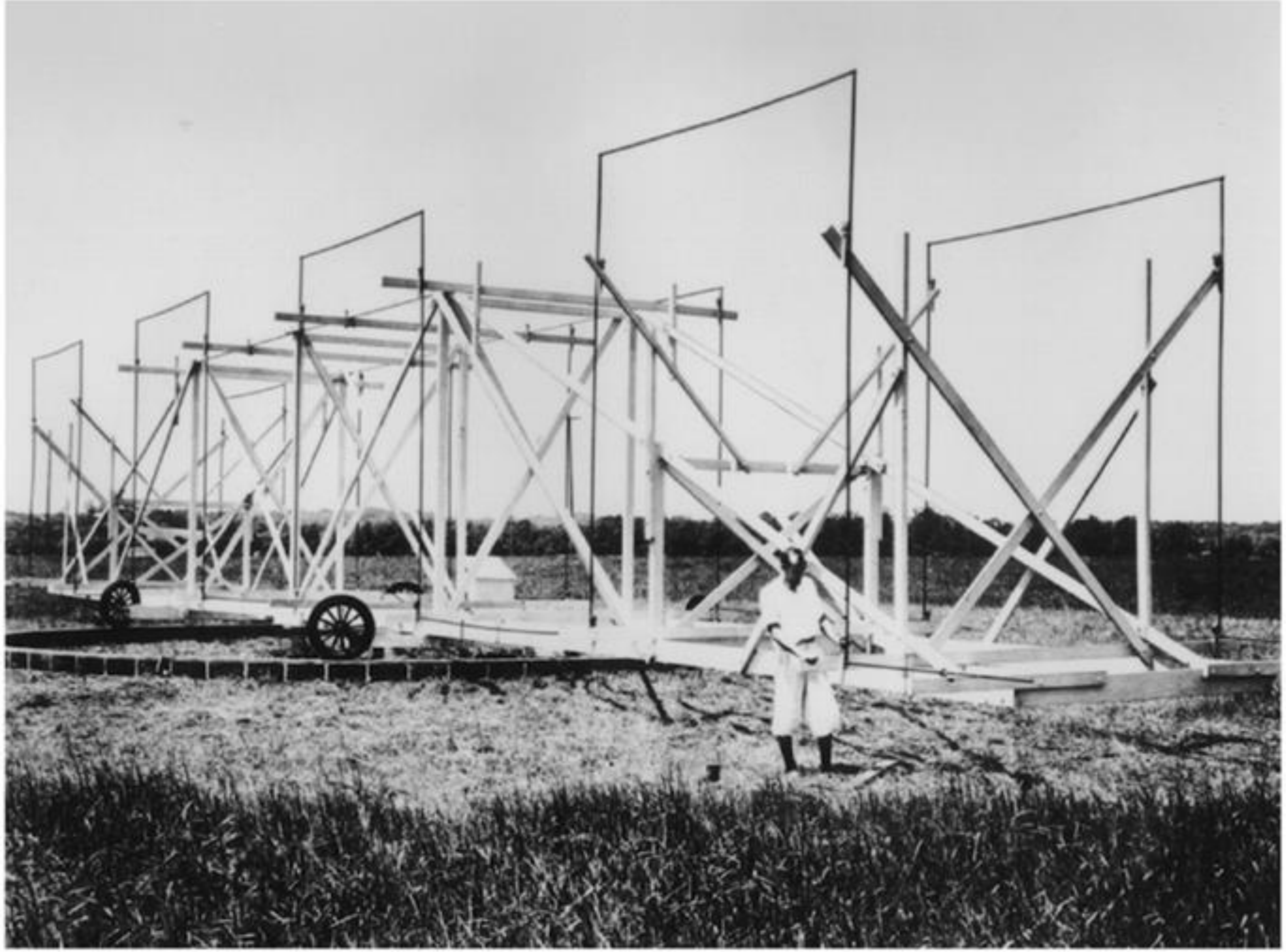
**Investicija: 457 milijuna $. FoV: 40 punih mjeseca (10 kvadratnih stupnjeva). Kamera 3.2 milijarde piksela Svake 3 noći nova slika neba - svemirska kinematografija. Početak rada uskoro. Snimiti 20 milijardi galaksija i zvijezda. Big Data izazov (6 milijuna Gb/godina) (Željko Ivezić – direktor Vera Rubin opservatorija)**

# The World's Biggest Eye on the Sky, E-ELT

- European Extra Large Telescope (E-ELT) 1300 MEura, **optičko & IR**)
- **Prvo svjetlo 2025.**
- Zrcalo promjera 39 m !
- Lokacija: Argentina ?
- **Rezolucija 18 puta bolja HST!**
- **Potraga za ekstrasolarnim planetima.**
- E-ELT predstavlja kvantni skok poput Galieleva teleskopa prema golom oku.
- Razlučit će zvijezde u dalekim galaksijama
- Mjeriti koliko se brzo Svemir širi.
- Raspodjelu tamne materije
- Supermasivne crne rupe
- Tko zna što će novo vidjeti E-ELT …?

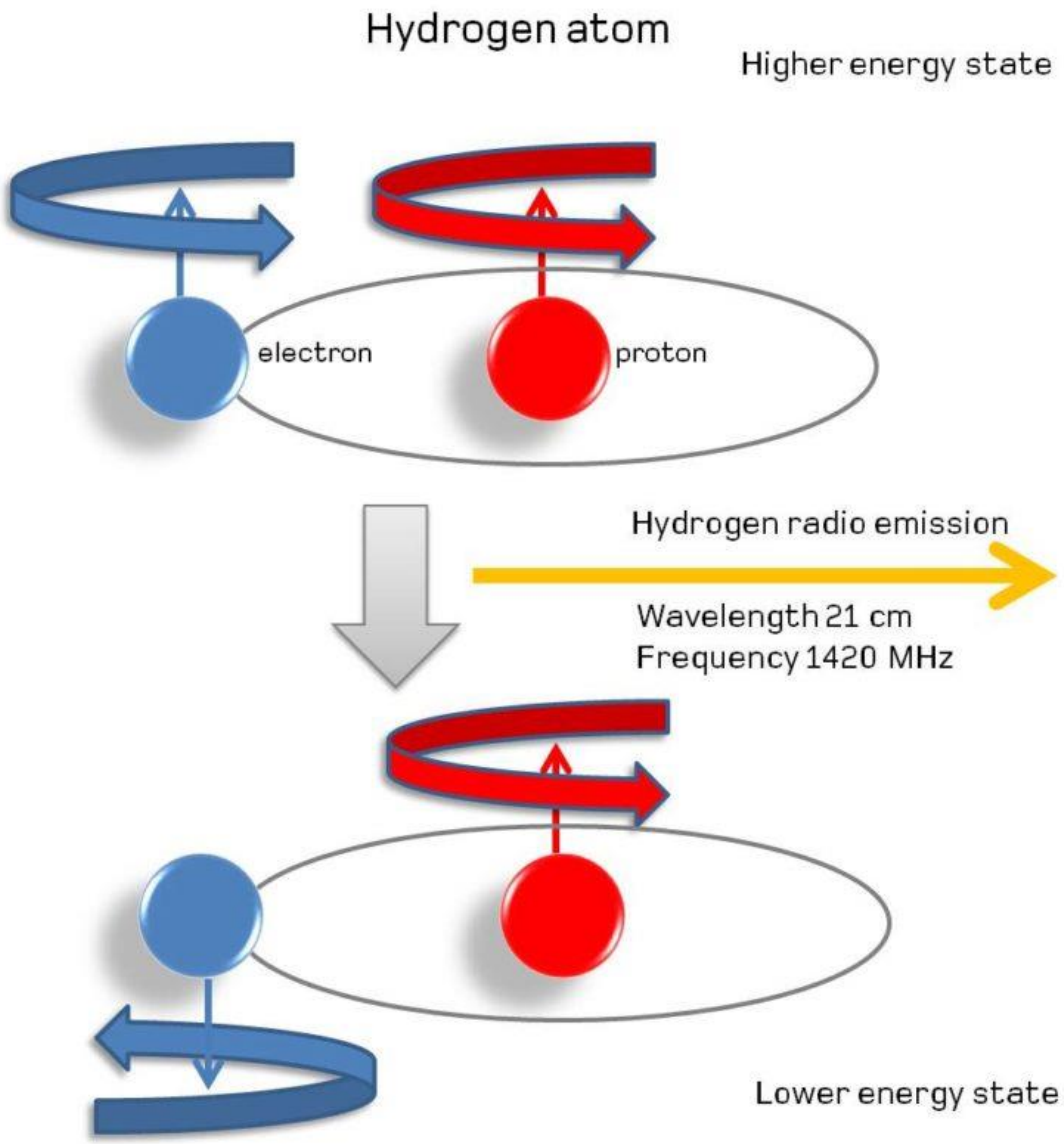


# Radio astronomija (1933 Karl Jansky



# Radio astronomija (λ ~ mm - km)

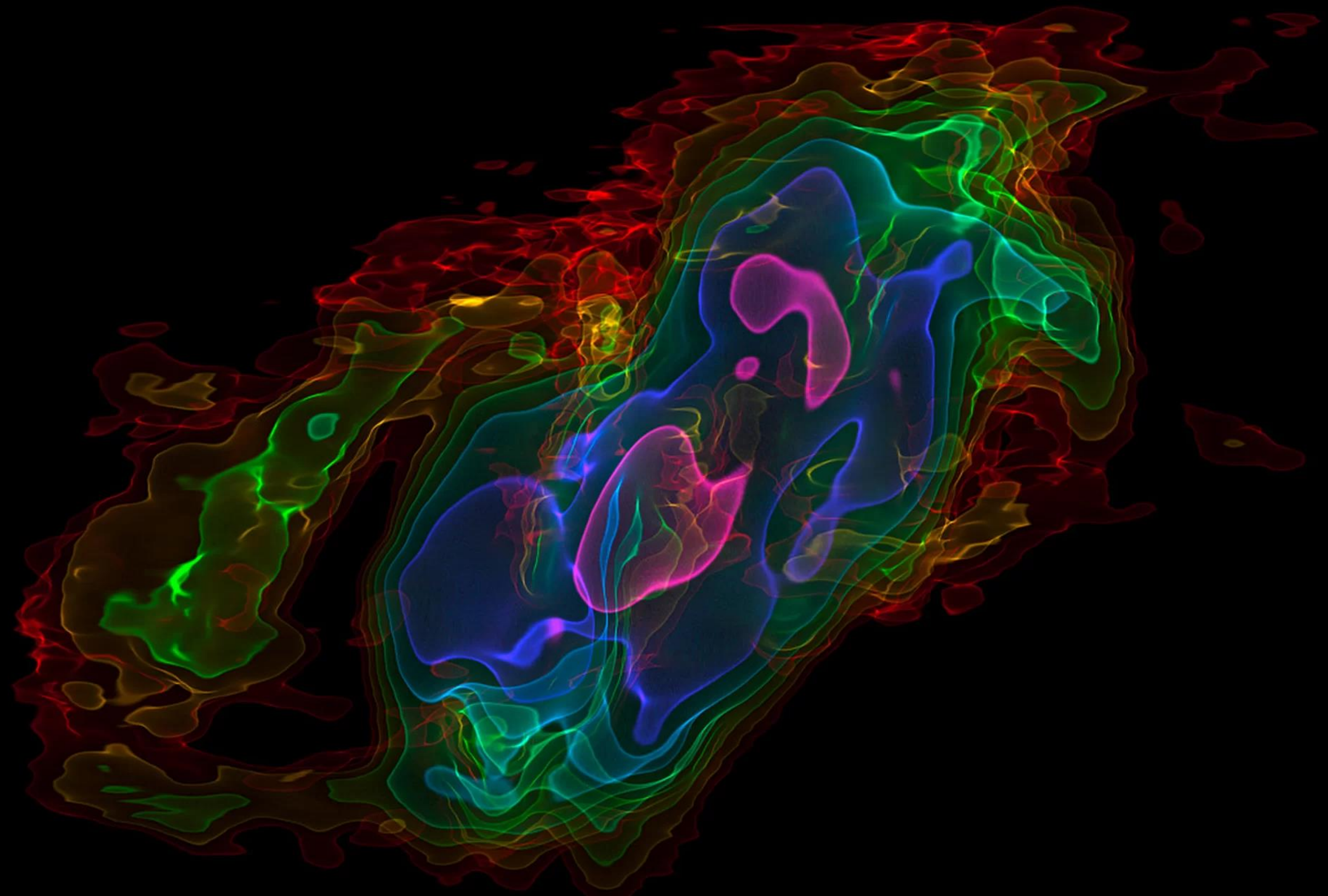
- Radiovalovi imaju veliku valnu duljinu u području od mm do km, zato imaju parabolična zrcala promjera i do 305 m Arcebio u Puerto Rico.



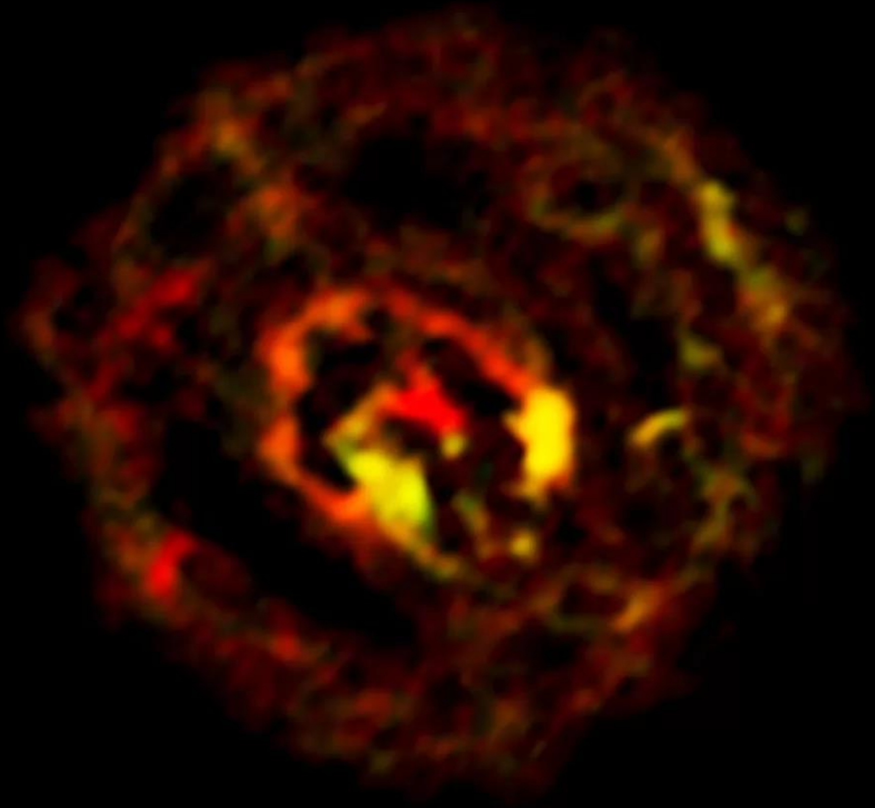
# Very Large Array - New Mexico (USA)

- 27 radio teleskopa
- Promjer reflektora 25 m
- Podaci iz svih 27 teleskopa se elektronički kombiniraju i daju rezoluciju kao da je jedan reflektor promjera 130 m

# ALMA (λ ~ 0.32 mm - 3.6 mm)



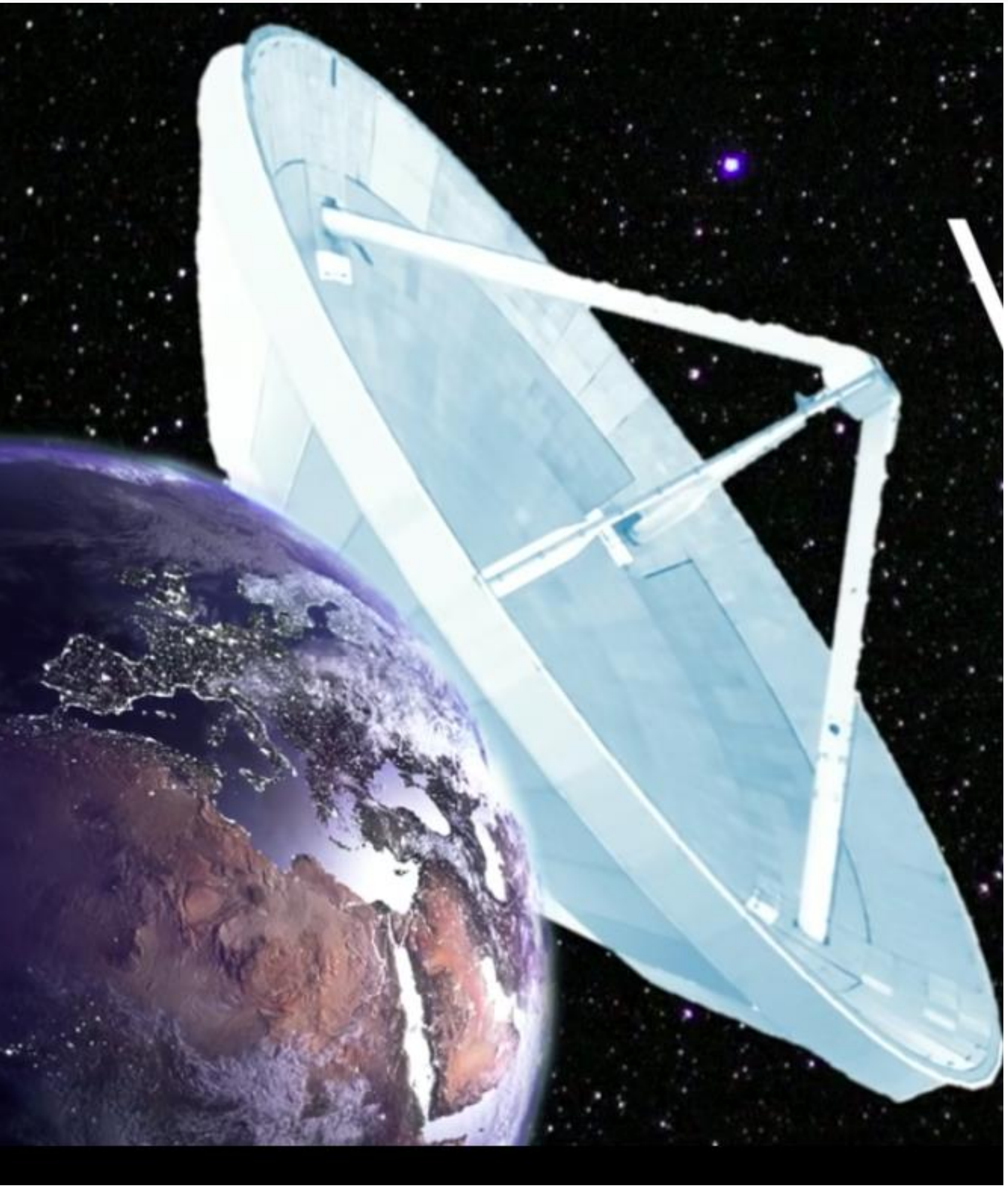
Plin u starburst galaksiji



Raspodijela molekularnog plina

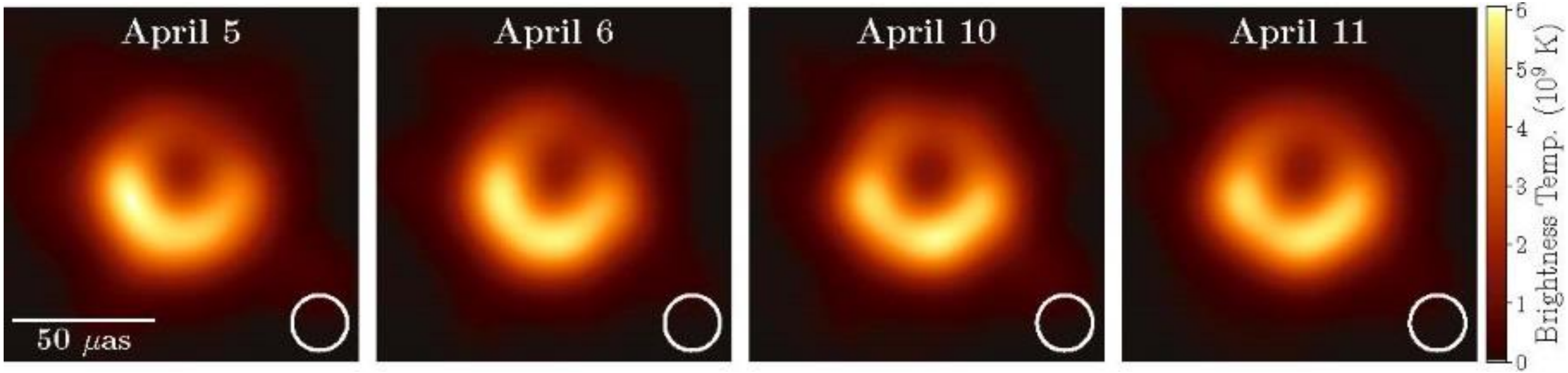
# Event Horizon Telescope - Kolika rezolucija?

# Virtualni radio teleskop veličine Zemlje - Event Horizon Telescope

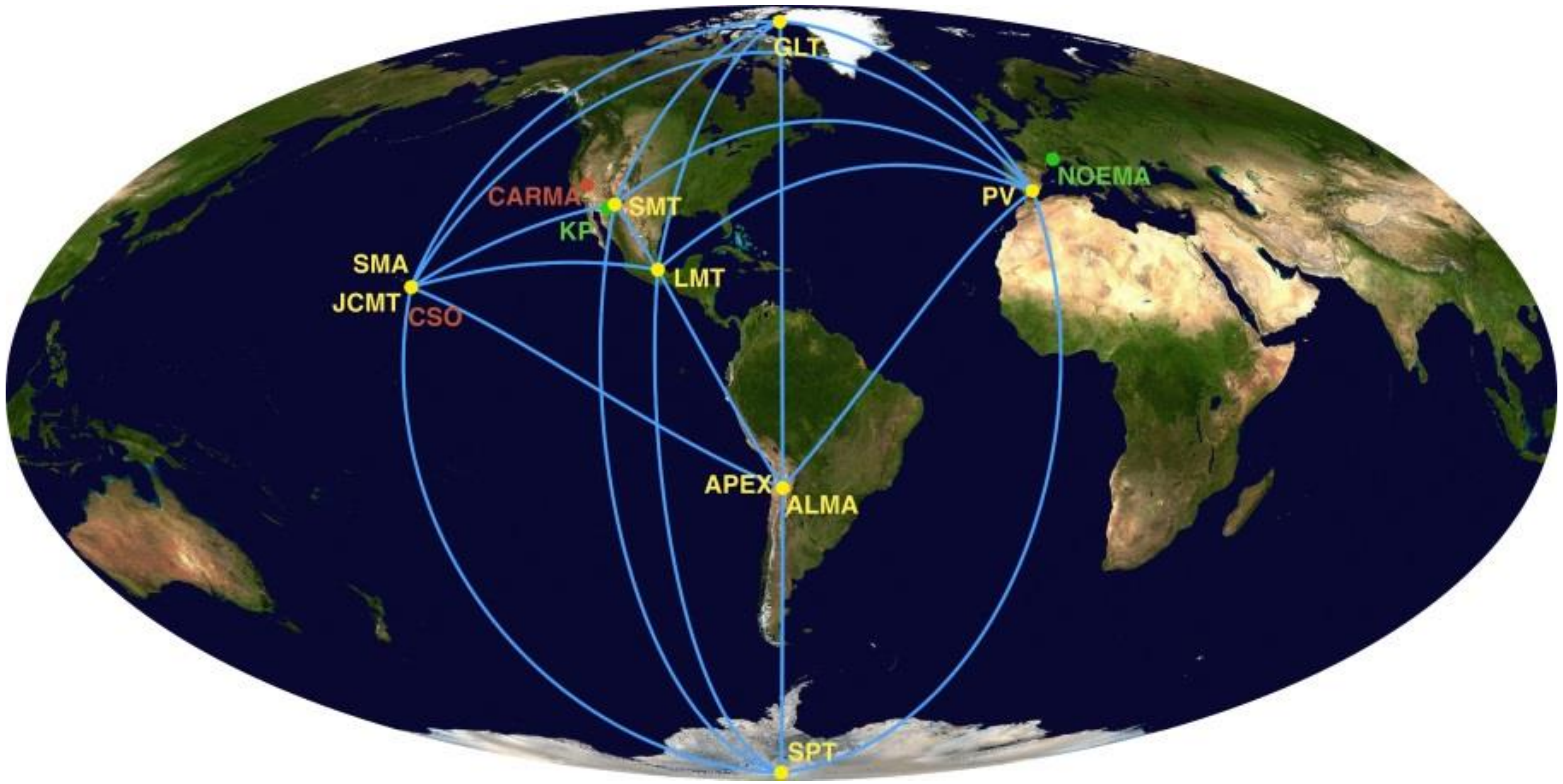


=

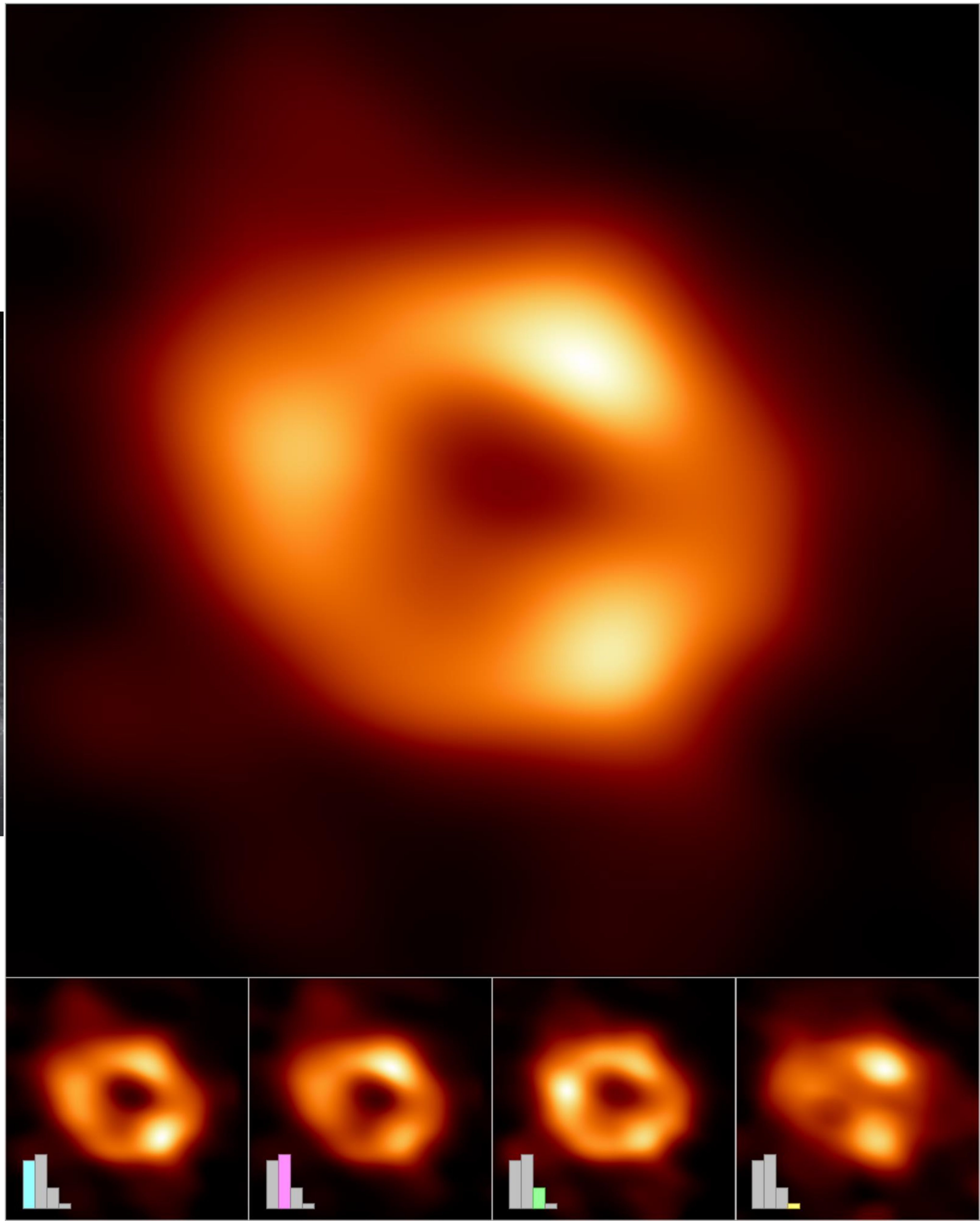
# Prva slika sjene crne rupe - M87

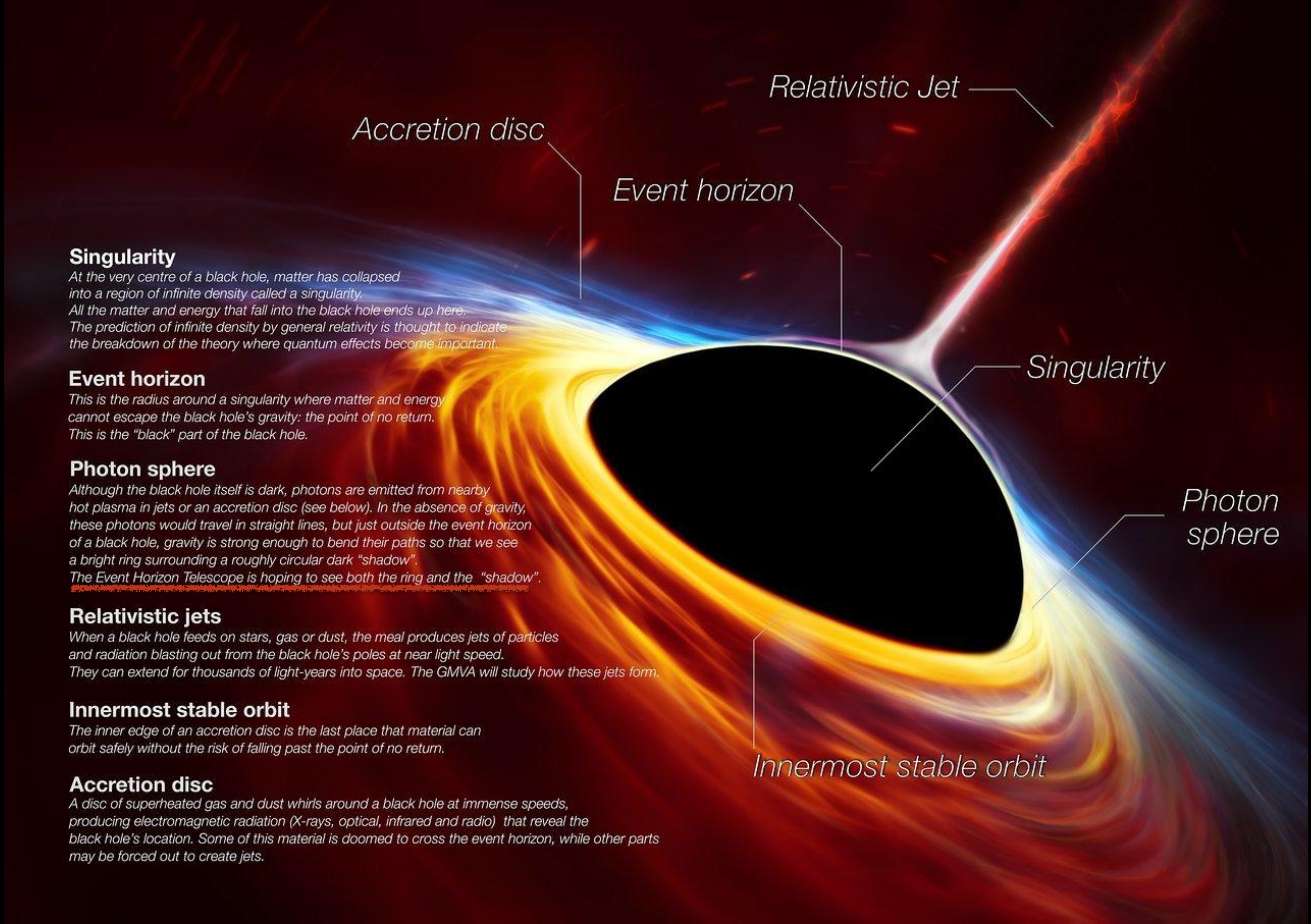



Masa crne rupe:
Milijardu masa sunca
Udaljena: 54 milijuna  l.y.



# EHT - prva slika crne rupe u našoj galaksiji (2022)




Relativistic Jet
Accretion disc
Event horizon
Singularity
Photon sphere
Innermost stable orbit
Singularity
At the very centre of a black hole, matter has collapsed into a region of infinite density called a singularity. All the matter and energy that fall into the black hole ends up here. The prediction of infinite density by general relativity is thought to indicate the breakdown of the theory where quantum effects become important.
Event horizon
This is the radius around a singularity where matter and energy cannot escape the black hole's gravity: the point of no return. This is the "black" part of the black hole.
Photon sphere
Although the black hole itself is dark, photons are emitted from nearby hot plasma in jets or an accretion disc (see below). In the absence of gravity, these photons would travel in straight lines, but just outside the event horizon of a black hole, gravity is strong enough to bend their paths so that we see a bright ring surrounding a roughly circular dark "shadow". The Event Horizon Telescope is hoping to see both the ring and the "shadow".
Relativistic jets
When a black hole feeds on stars, gas or dust, the meal produces jets of particles and radiation blasting out from the black hole's poles at near light speed. They can extend for thousands of light-years into space. The GMVA will study how these jets form.
Innermost stable orbit
The inner edge of an accretion disc is the last place that material can orbit safely without the risk of falling past the point of no return.
Accretion disc
A disc of superheated gas and dust whirls around a black hole at immense speeds, producing electromagnetic radiation (X-rays, optical, infrared and radio) that reveal the black hole's location. Some of this material is doomed to cross the event horizon, while other parts may be forced out to create jets.

# Astročestična fizika

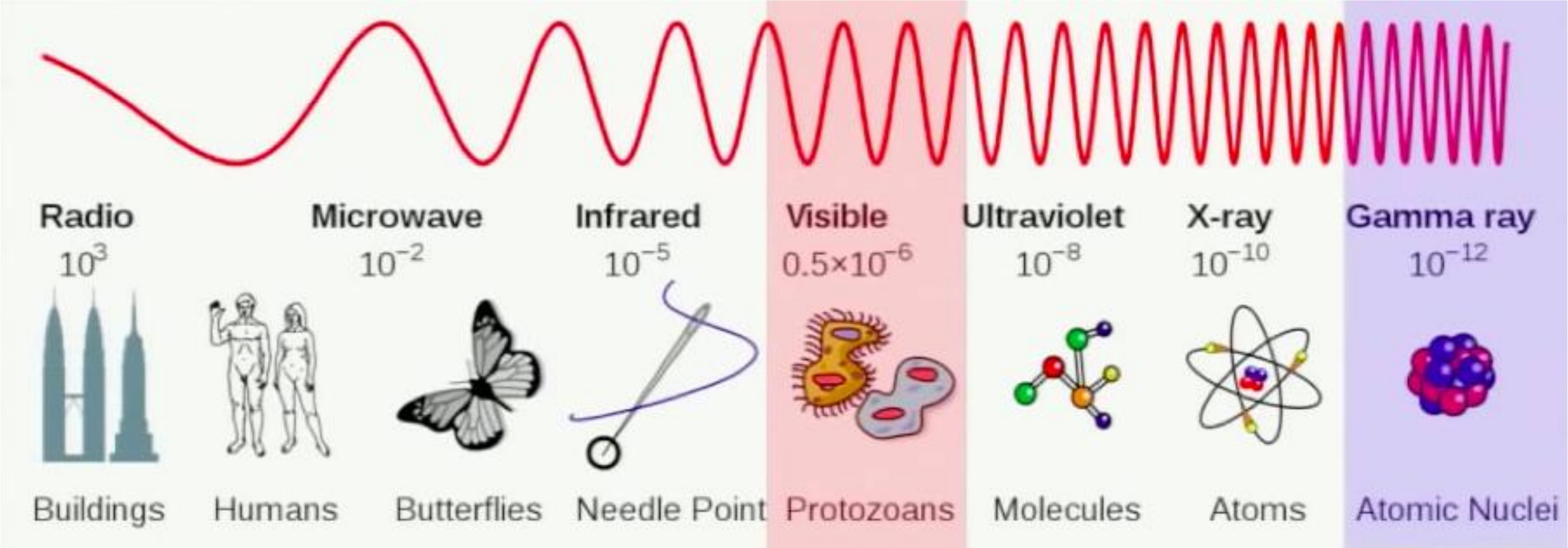
Gama zrake

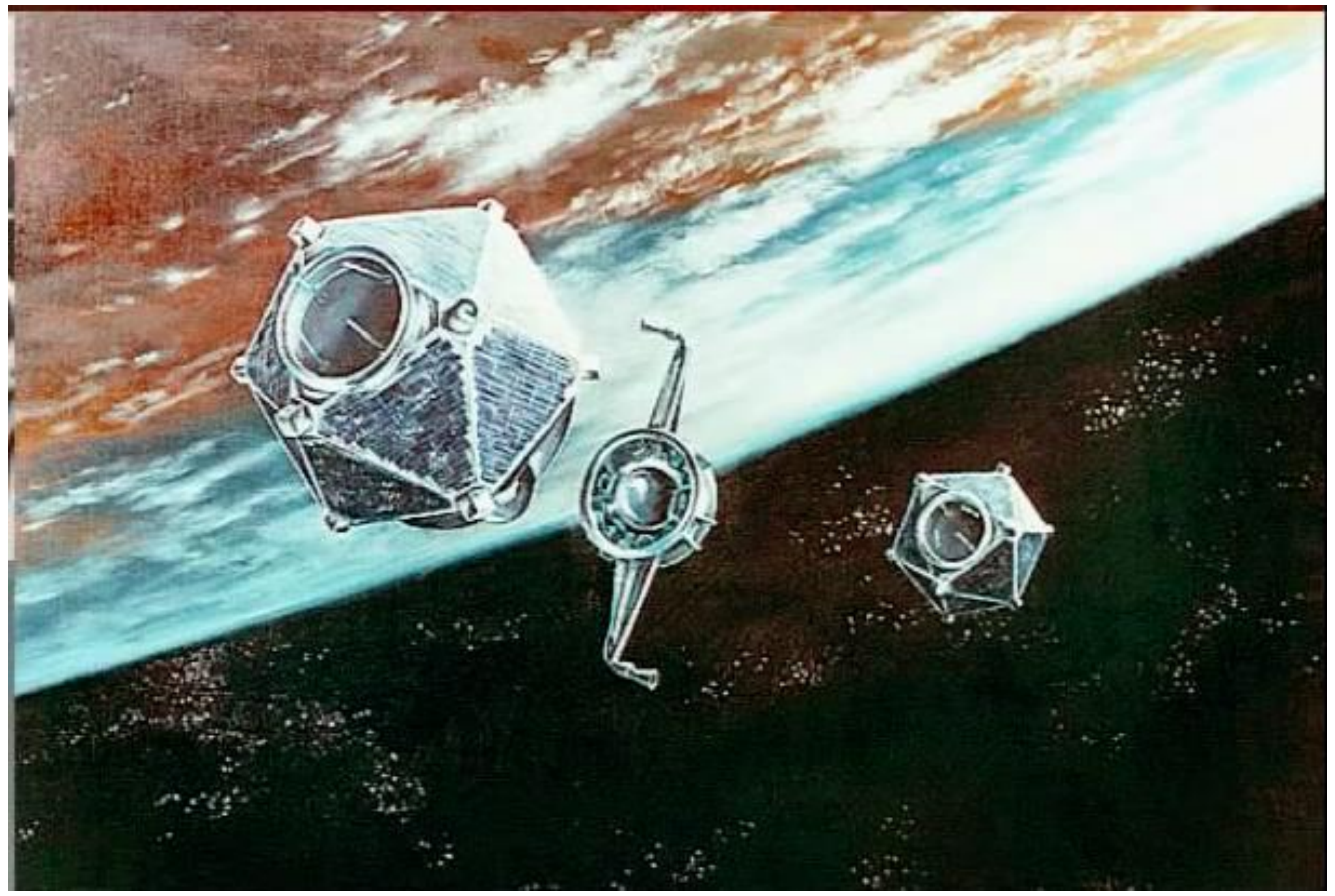
Neutrini

Kozmičke zrake – nabijene čestice

Gravitacijski valovi

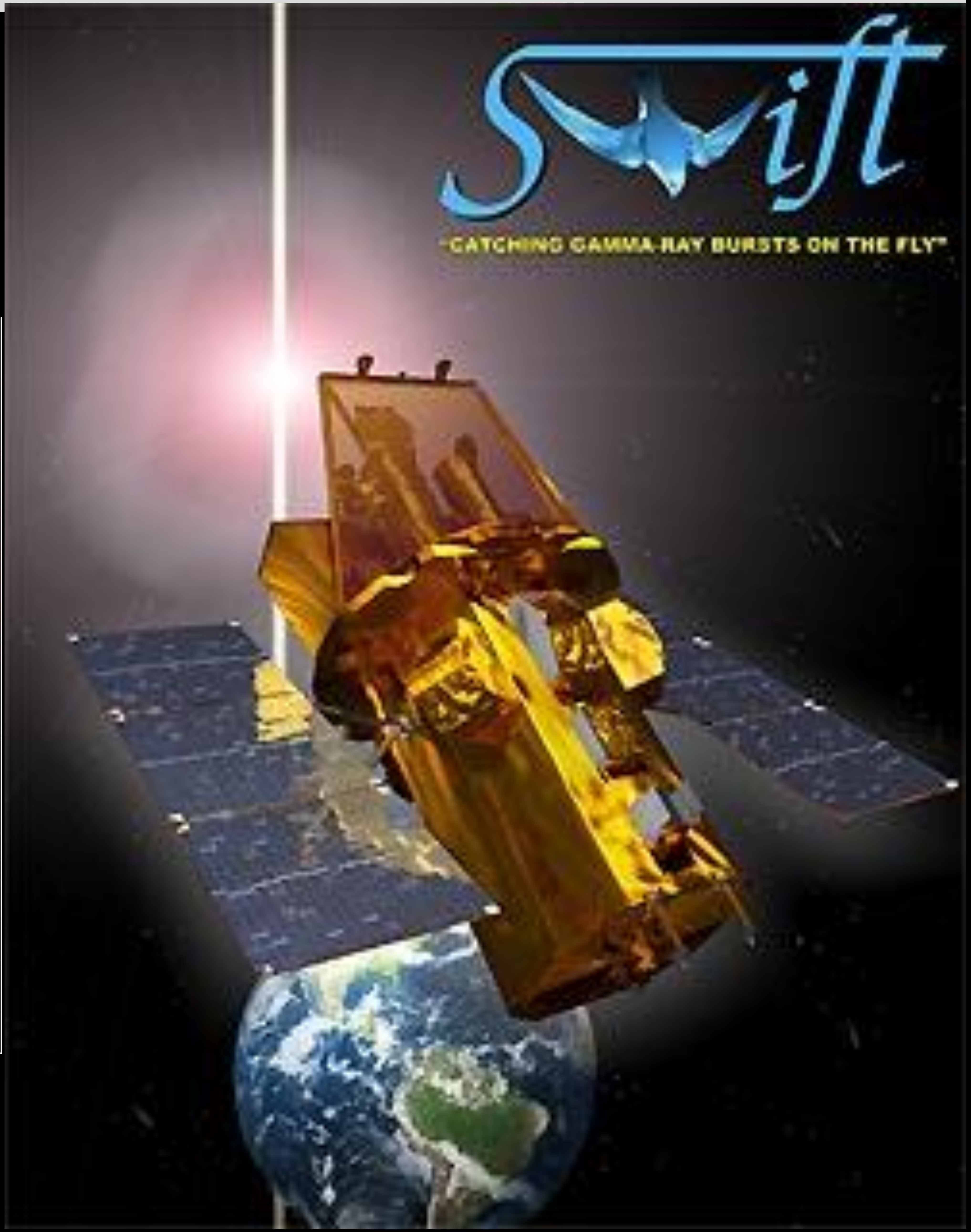
# Gamma zrake  - najsilovitije svjetlo



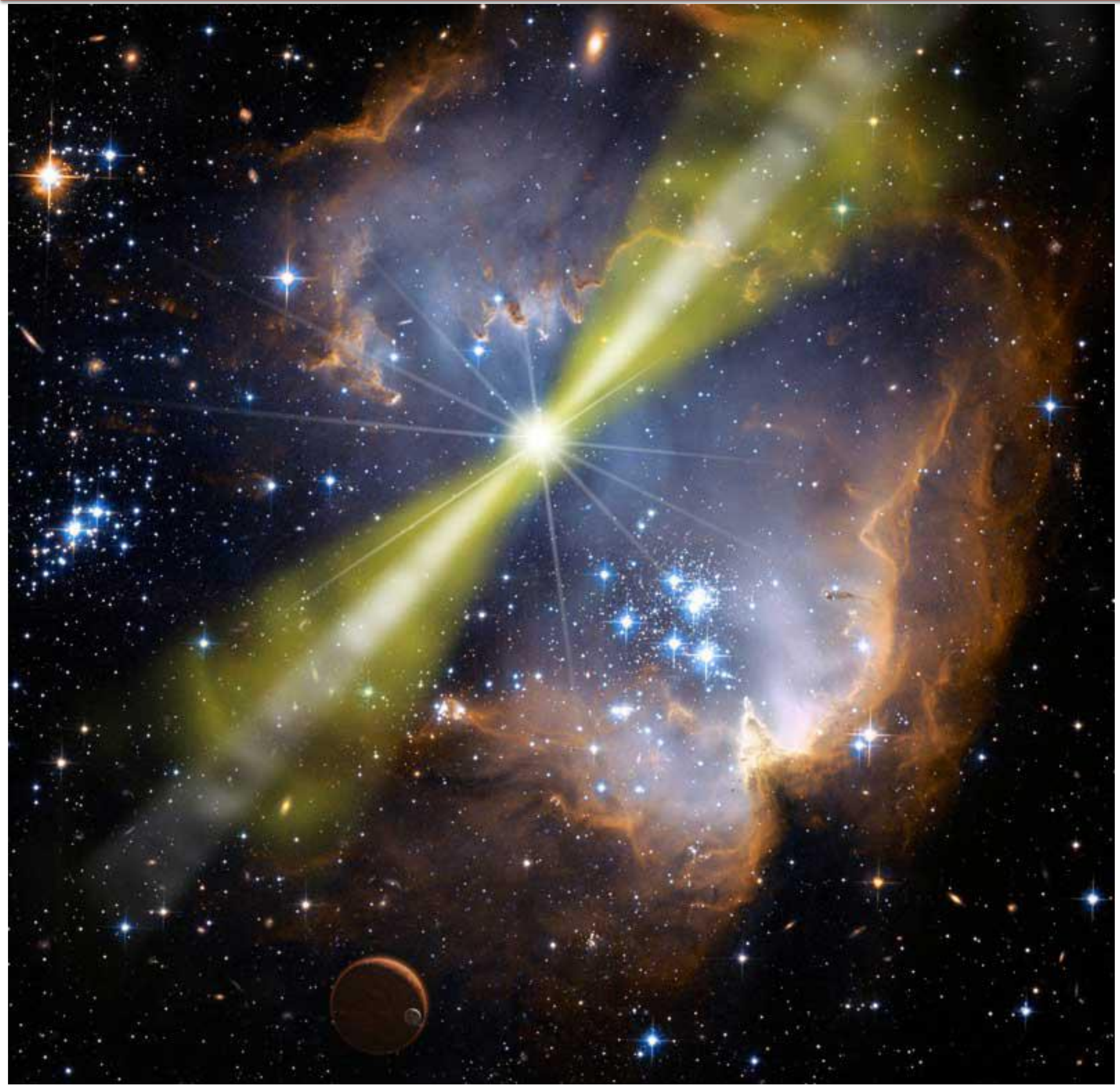



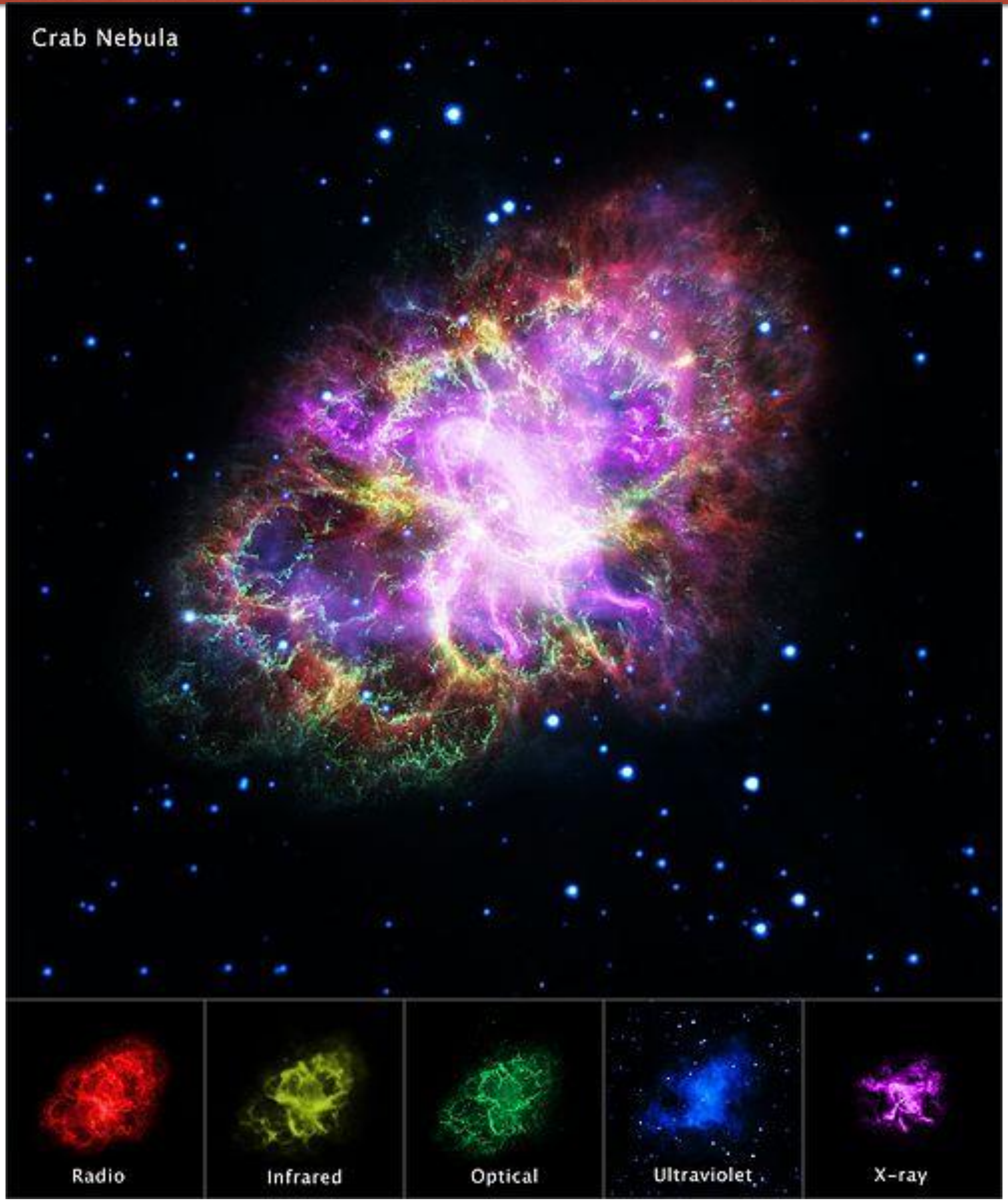
- Gama zrake - najenergetskiji oblik svjetla
- Srećom ne prolaze kroz atmosferu
- 1967 Američki špijunski satelit Vela otkrio bljeskove gama zraka  svemirskog porijkela
- 1973 obaviještna javnost - više nije državna tajna !

# Gama detektori na satelitima

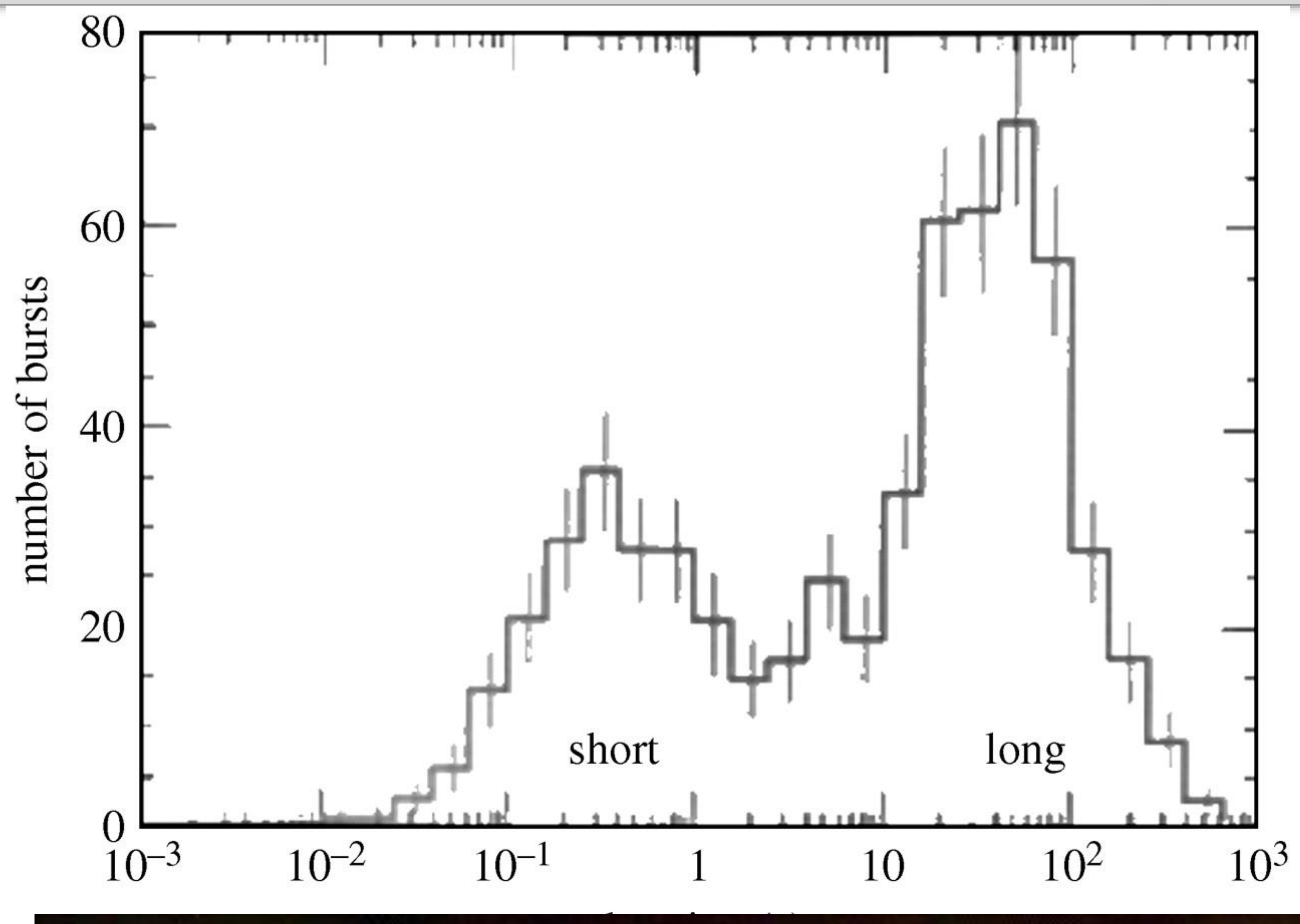


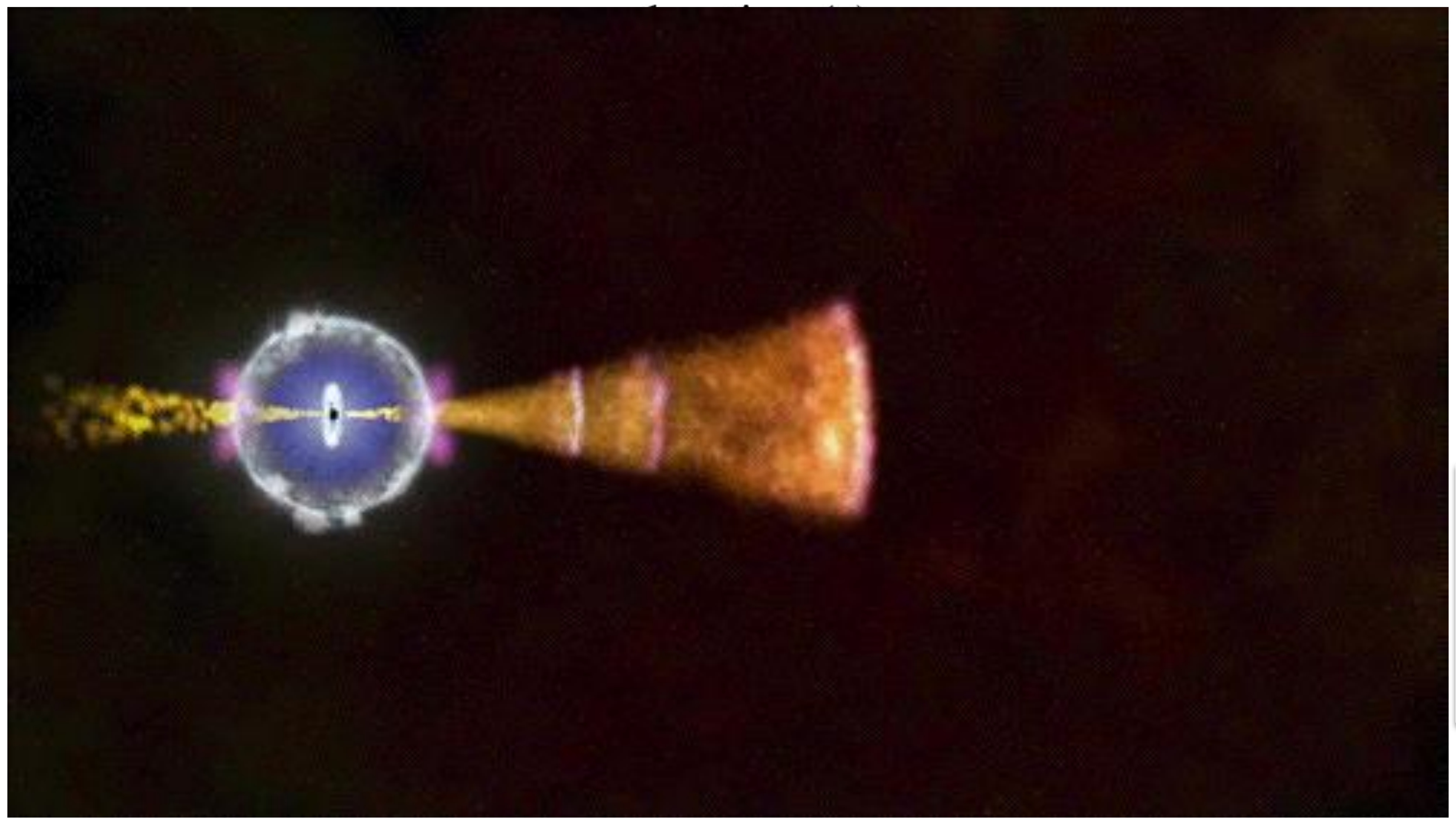
# Gama zrake - najsilovitije svjetlo

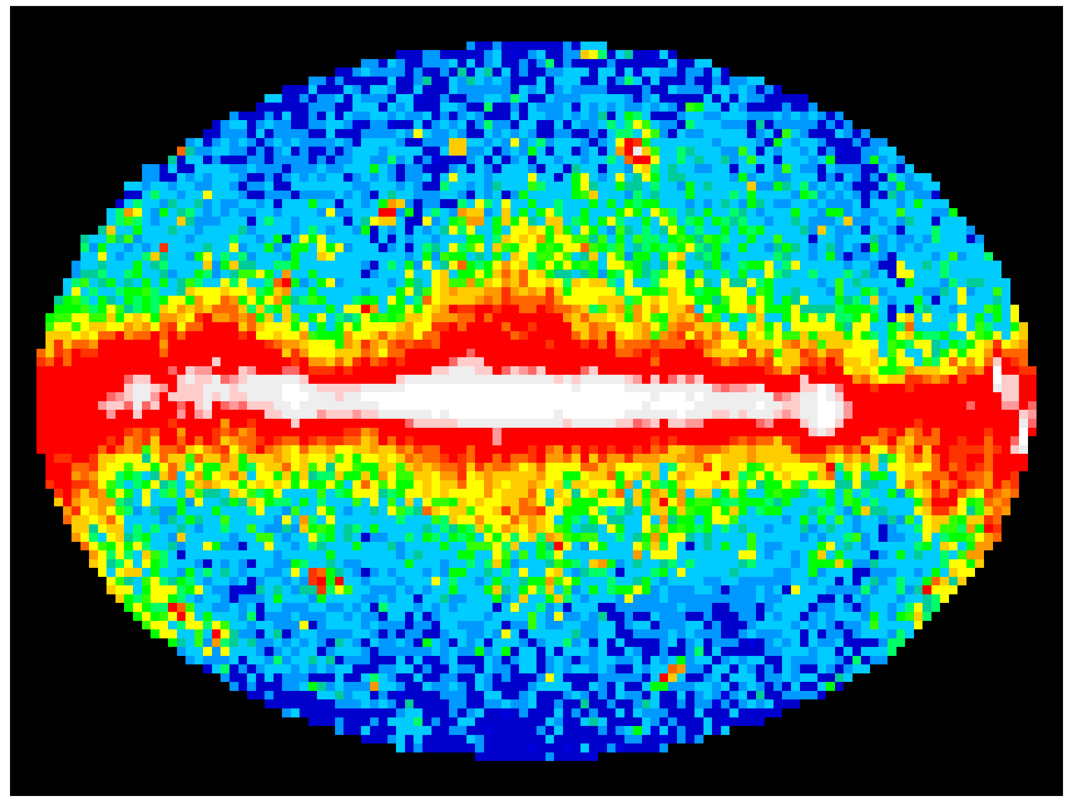


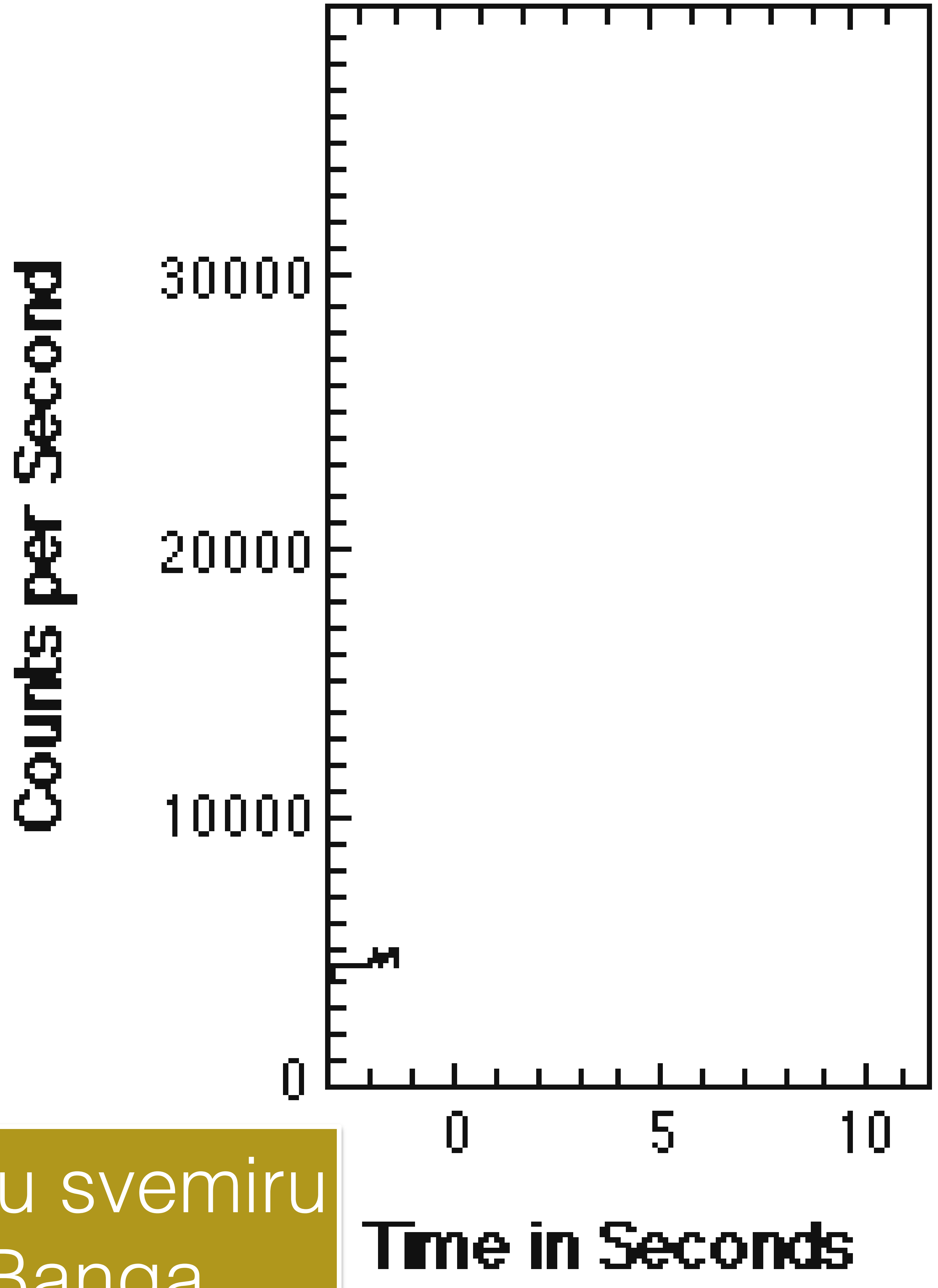


# GRB (Provale gama zraka)








Najsilovitije eksplozije u svemiru nakon velikog Big Banga


GRB

Afterglow

# Current status

# LST


cta cherenkov telescope array
El primer LARGE SIZE TELESCOPE de la red de telescopios Cherenkov financiado por:
The first LARGE SIZE TELESCOPE of the Cherenkov Telescope Array funded by:
Japan Society for the Promotion of Science
日本学術振興会
Max-Planck-Institut für Physik
ICRR
IFAE
LAPP
Ciemat
EXCELENCIA MARÍA DE MAEZTU
cnrs
文部科学省
EXCELENCIA SEVERO OCHOA
東京大学 THE UNIVERSITY OF TOKYO
CBPF
UNIVERSITÀ DI SIENA
CPPM
甲南大学 KONAN UNIVERSITY
Dipartimento di Fisica e Astronomia Galileo Galilei
京都大学 KYOTO UNIVERSITY
UNIVERSITAT DE BARCELONA
山形大学
INFN
FEDER
UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO
徳島大学 TOKUSHIMA UNIVERSITY
NAGOYA UNIVERSITY
Aix-Marseille université
茨城大学 Ibaraki University
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
FAPERJ
Ministarstvo znanosti i obrazovanja
Universität Hamburg
UJa. Universidad de Jaén
KINDAI UNIVERSITY
FACULTY OF PHYSICS AND APPLIED INFORMATICS University of Lodz
Politecnico di Bari
Saitama University
UNIVERSITÉ SAVOIE MONT BLANC
CAN
JUNTA DE ANDALUCIA
UNIVERSITÀ DEGLI STUDI DI UDINE
ICE
INSTITUT DE CIÈNCIES DE L'ESPAI
CSIC
IEEC
UNIVERSITÀ DEGLI STUDI DI TORINO
tifr
TOKAI
FESB

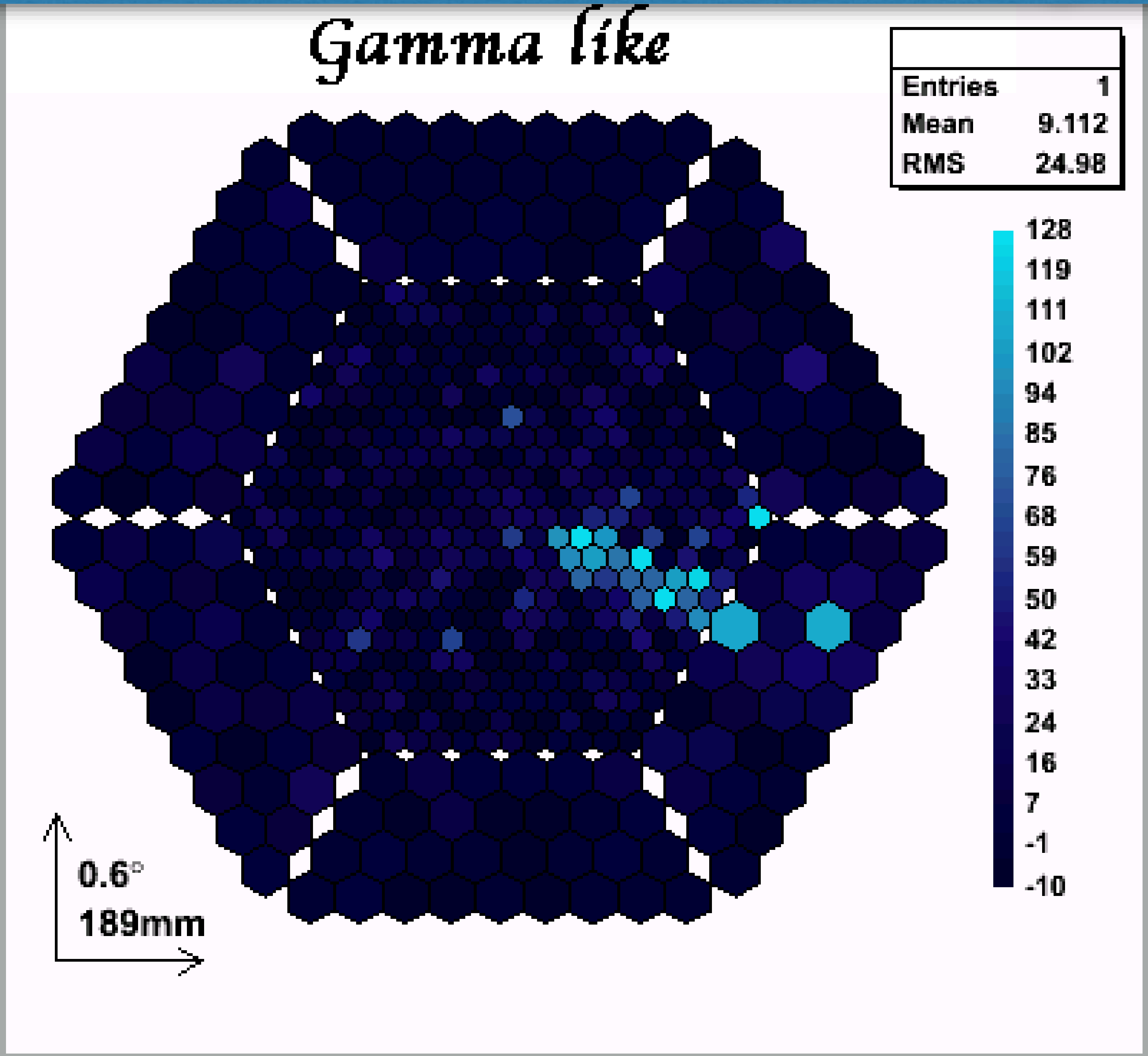
# Upravo je izgrađen novi još veći teleskopa gama zraka

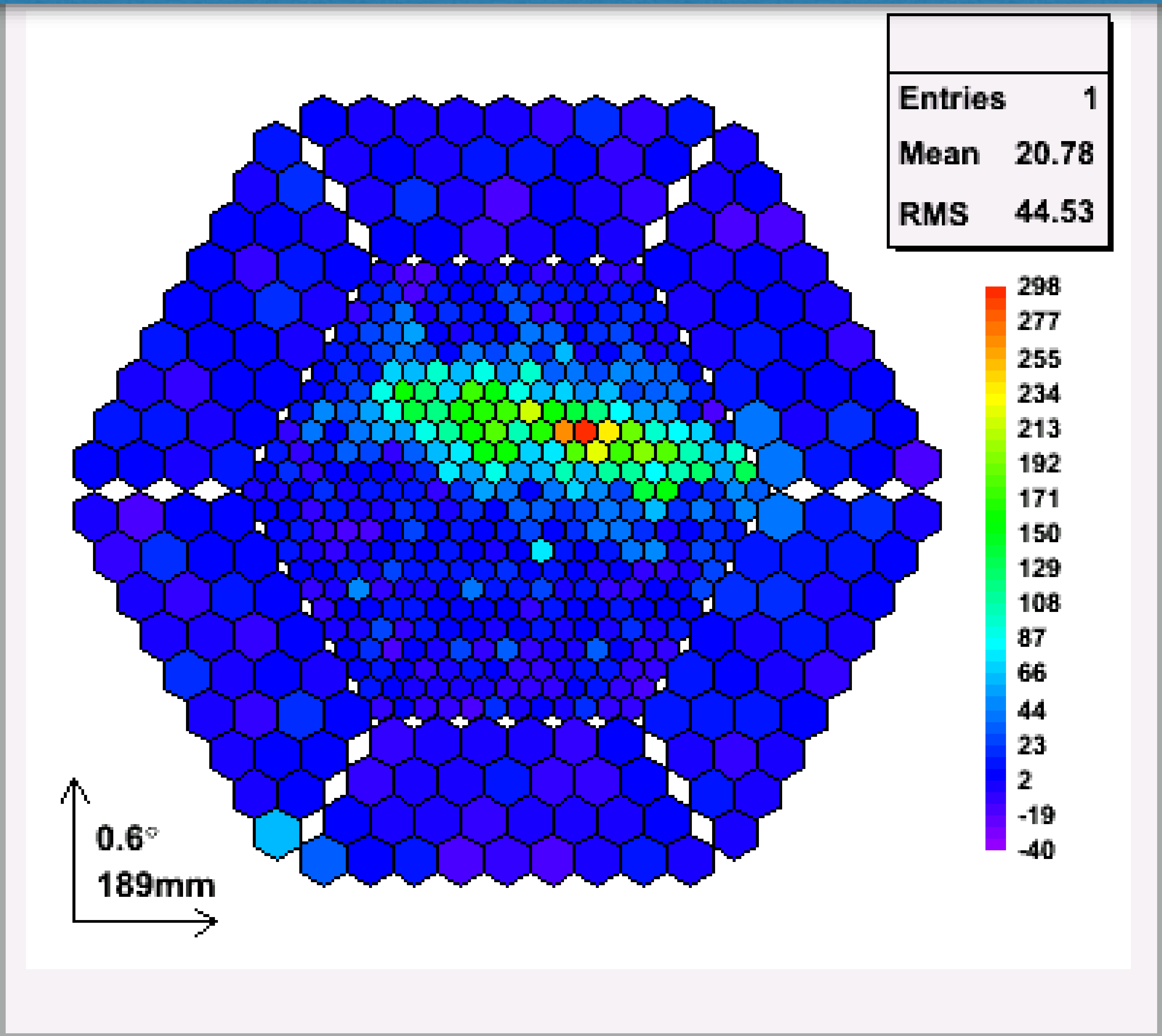
# Zemaljski teleskopi gama zraka na Zemlji

# Kako detektiramo gama zrake zemaljskim teleskopima

# Kako MAGIC vidi gama zrake

**Brza i osjetljiva kamera MAGIC teleskopa od oko 1000 piksela snimi u sekundi oko 200 kratkotrajnih plavičastih bljeksova svjetlosti, nevidljivih ljudskim okom**



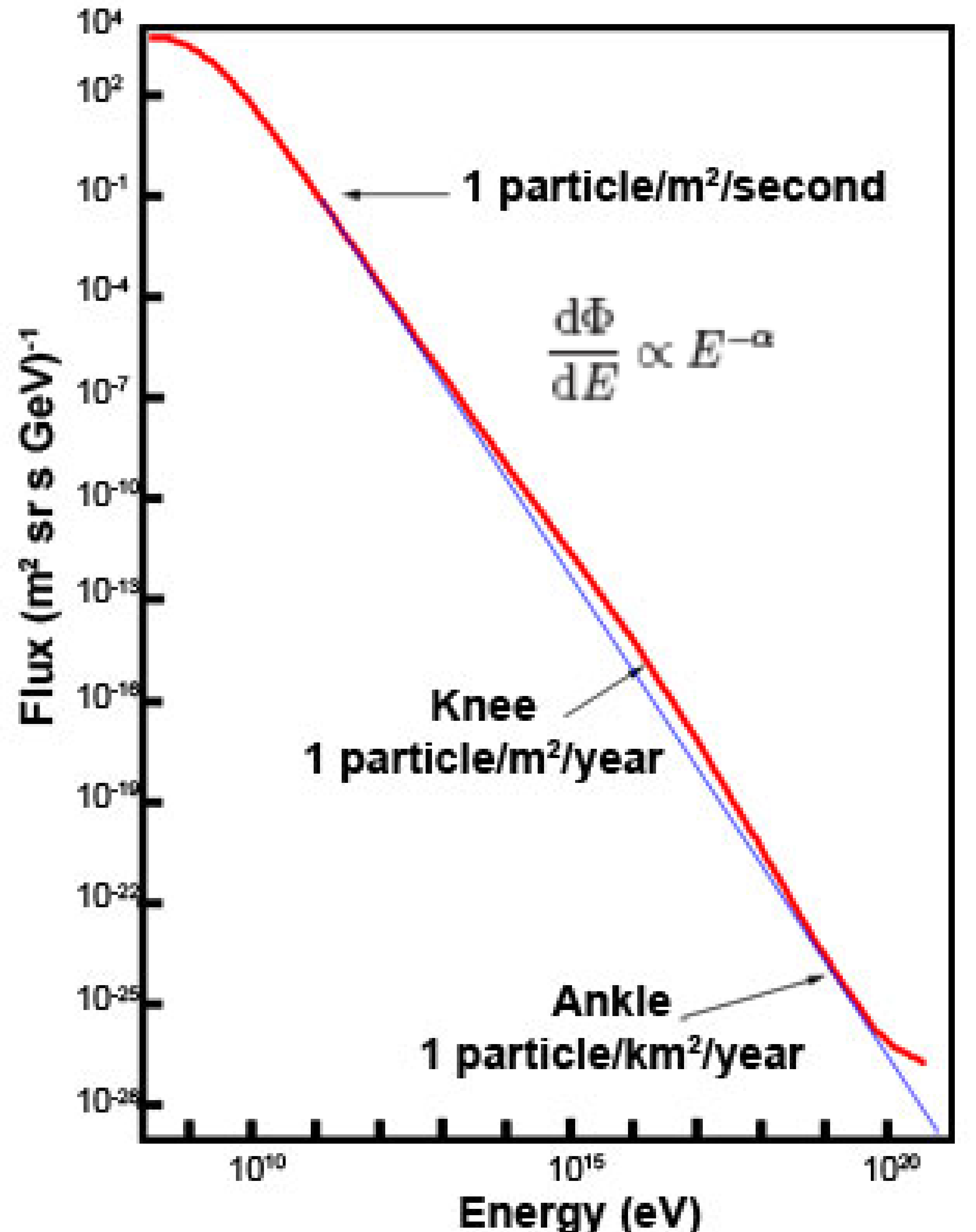
# Cherenkov Telescope Array (CTA) - North

# Cherenkov Telescope Array (CTA) - South

# Kozmičk zrake

# Kozmičke zrake

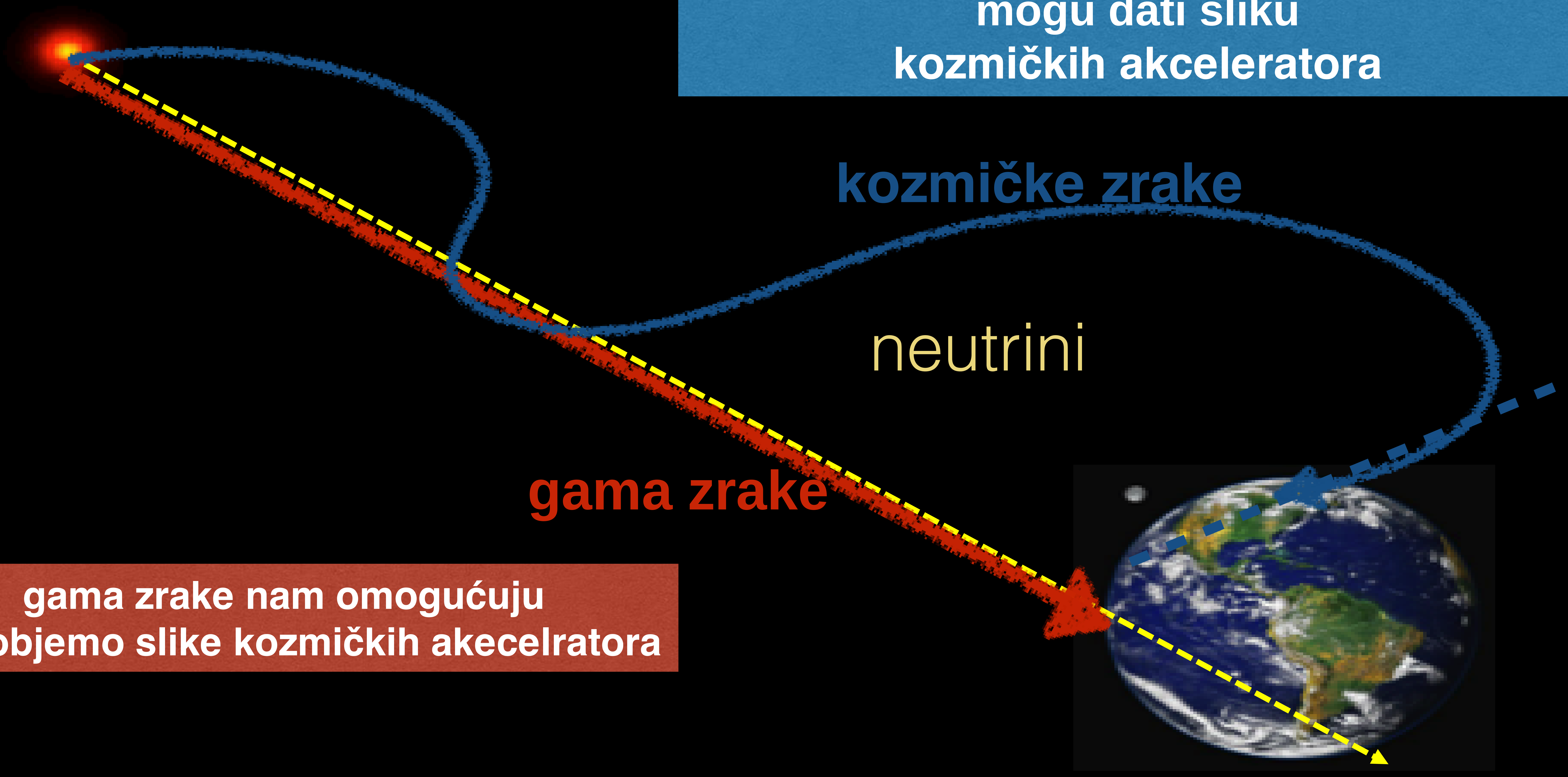
- Što su kozmičke zrake
  - 89% protoni
  - 10 % jezgre Helija
  - 1 % ostale teže jezgre
- Izvori kozmičkih zraka i gama zrake su **svemirski akceleratori**
- **Mjerenjem kozmičkih zraka i gama zraka i neutrina opažamo kozmičke akceleratore**



# Kako opaziti kozmičke akceleratore

## Kozmički akcelerator

**kozmičke zrake imaju električni naboja, magnetska polja ih zarkreću tako da ne mogu dati sliku kozmičkih akceleratora**

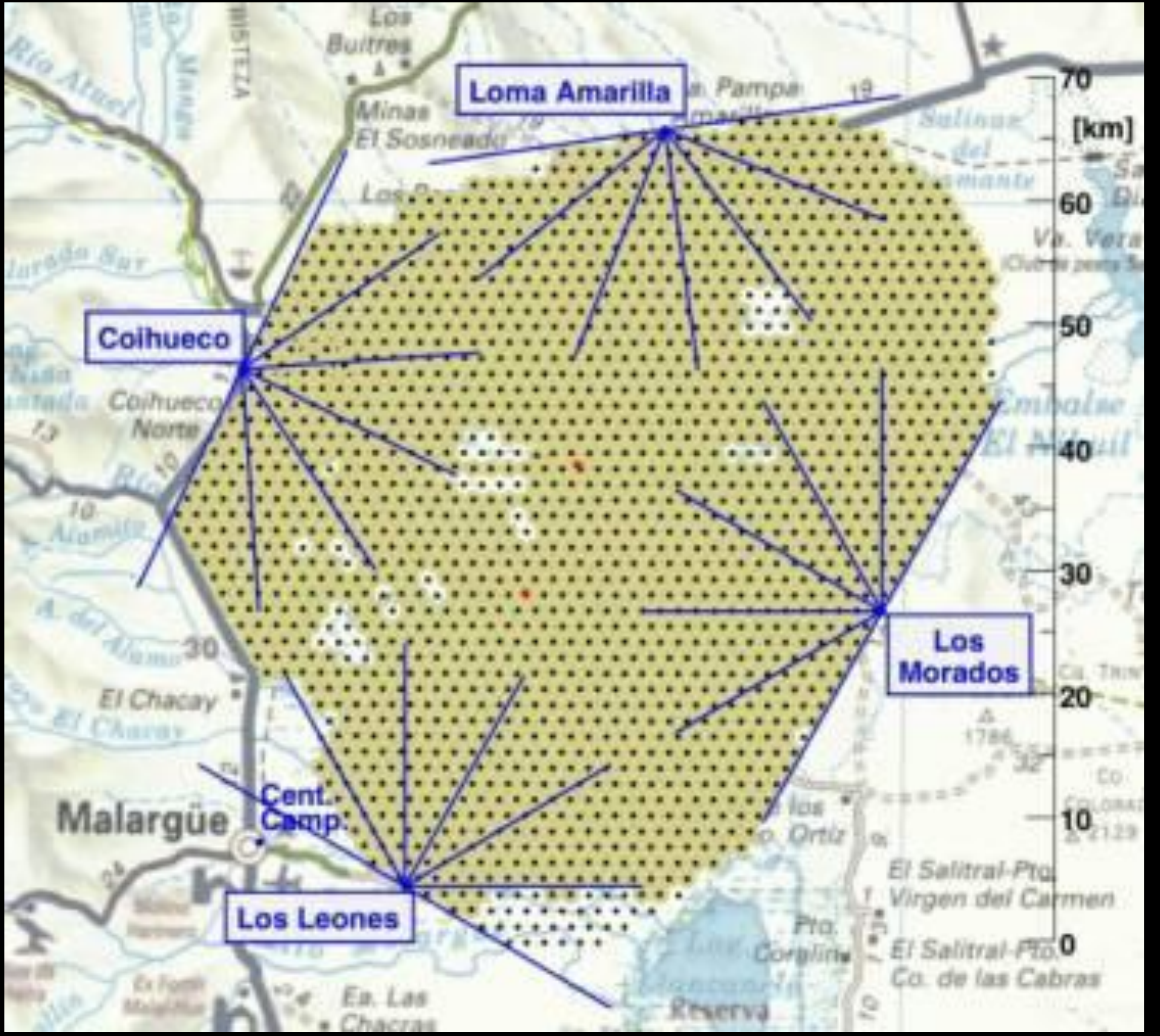



**gama zrake nam omogućuju da dobjemo slike kozmičkih akecelratora**

# Pierr Auger Observatory

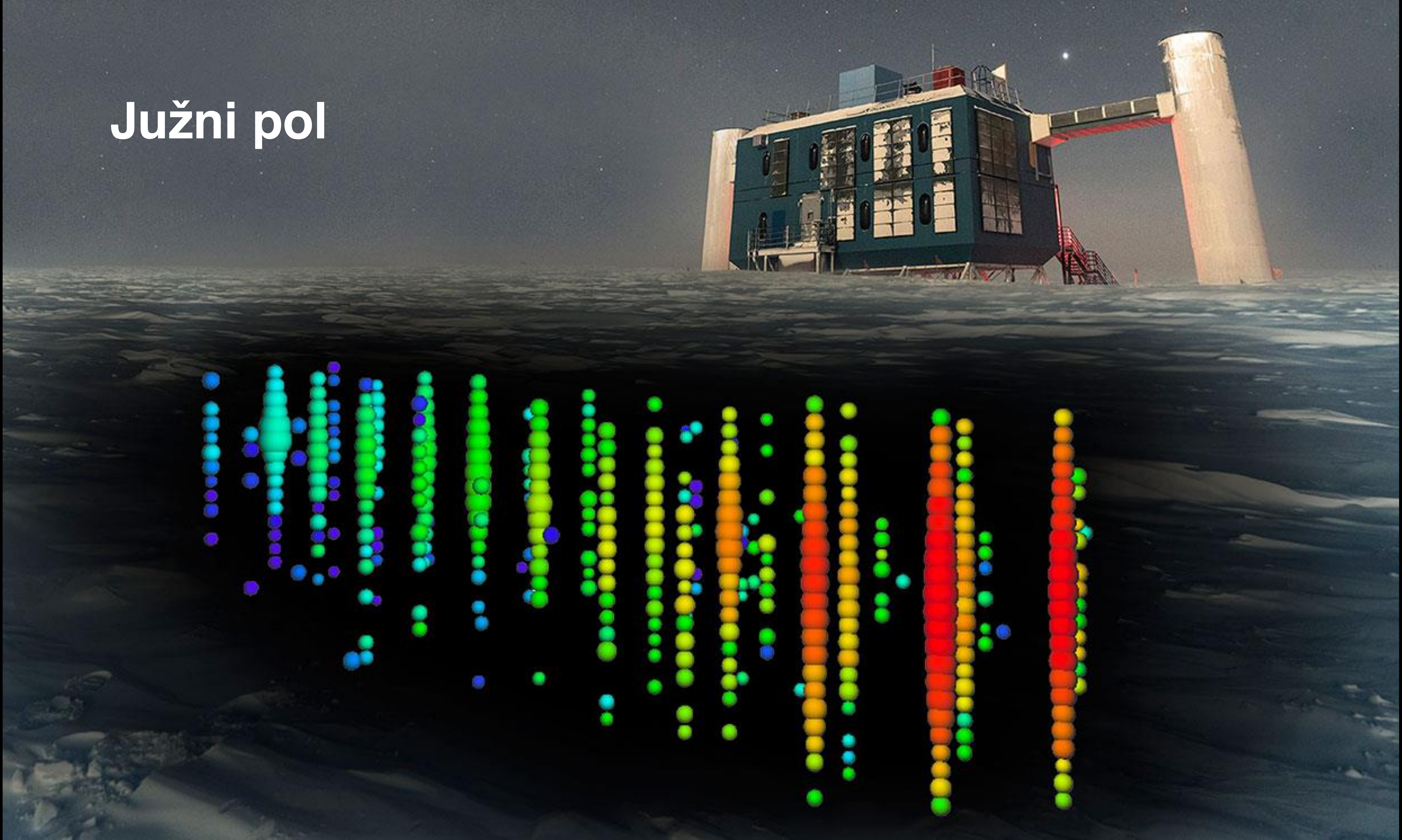
# Pierr Auger Obesrvatory

Mreža od 1600 detektora razmaknutih 1,5 km prekriva površinu od 3000 km$^2$

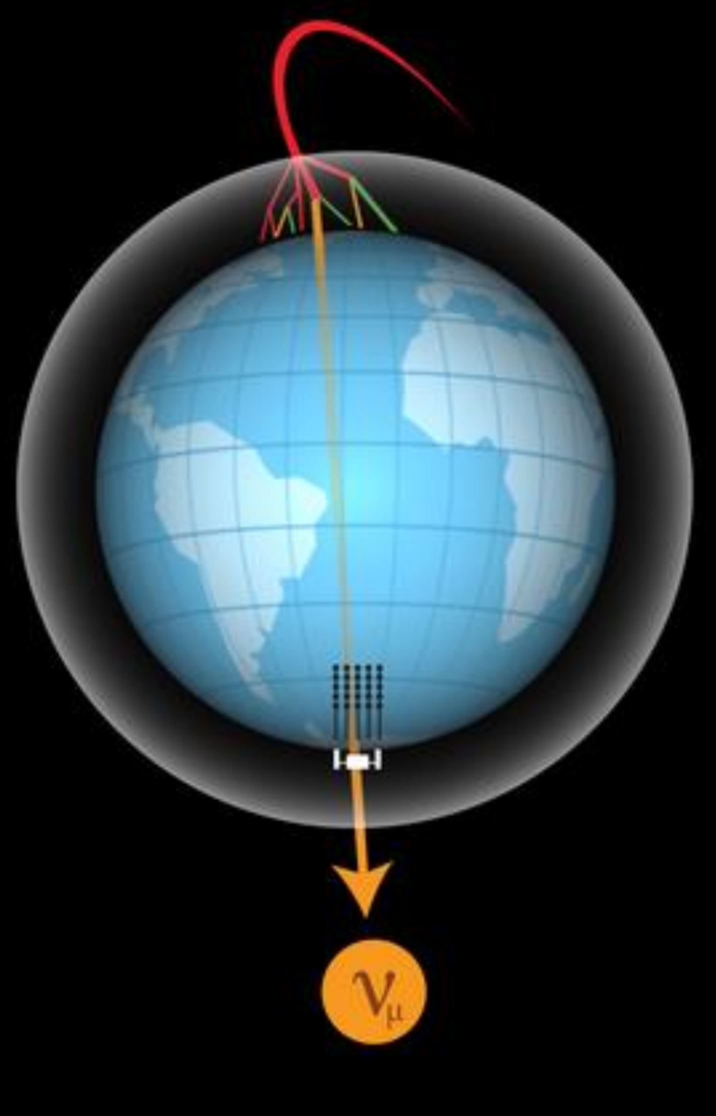


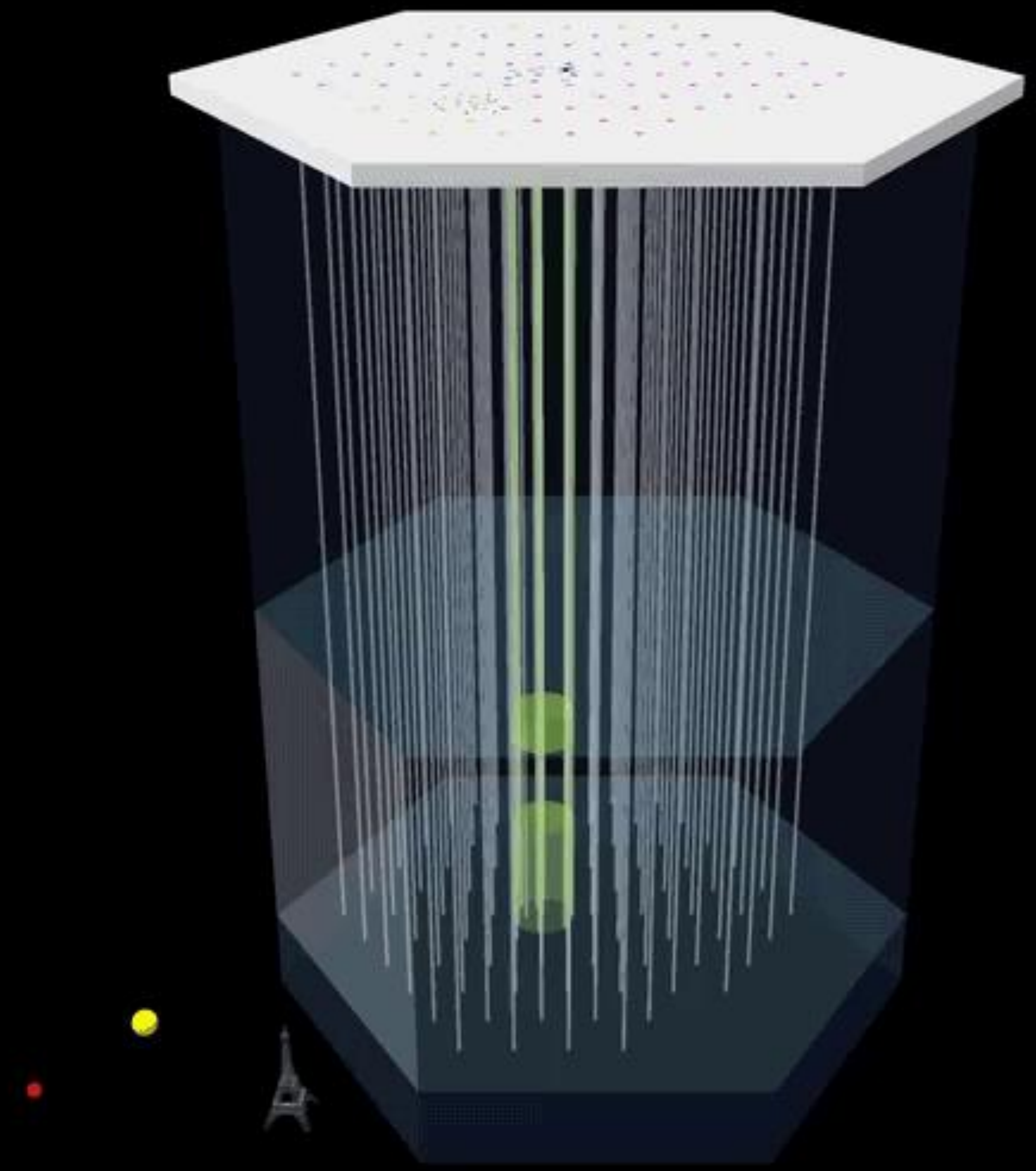
# Kozmičk neutrini

# Južni pol



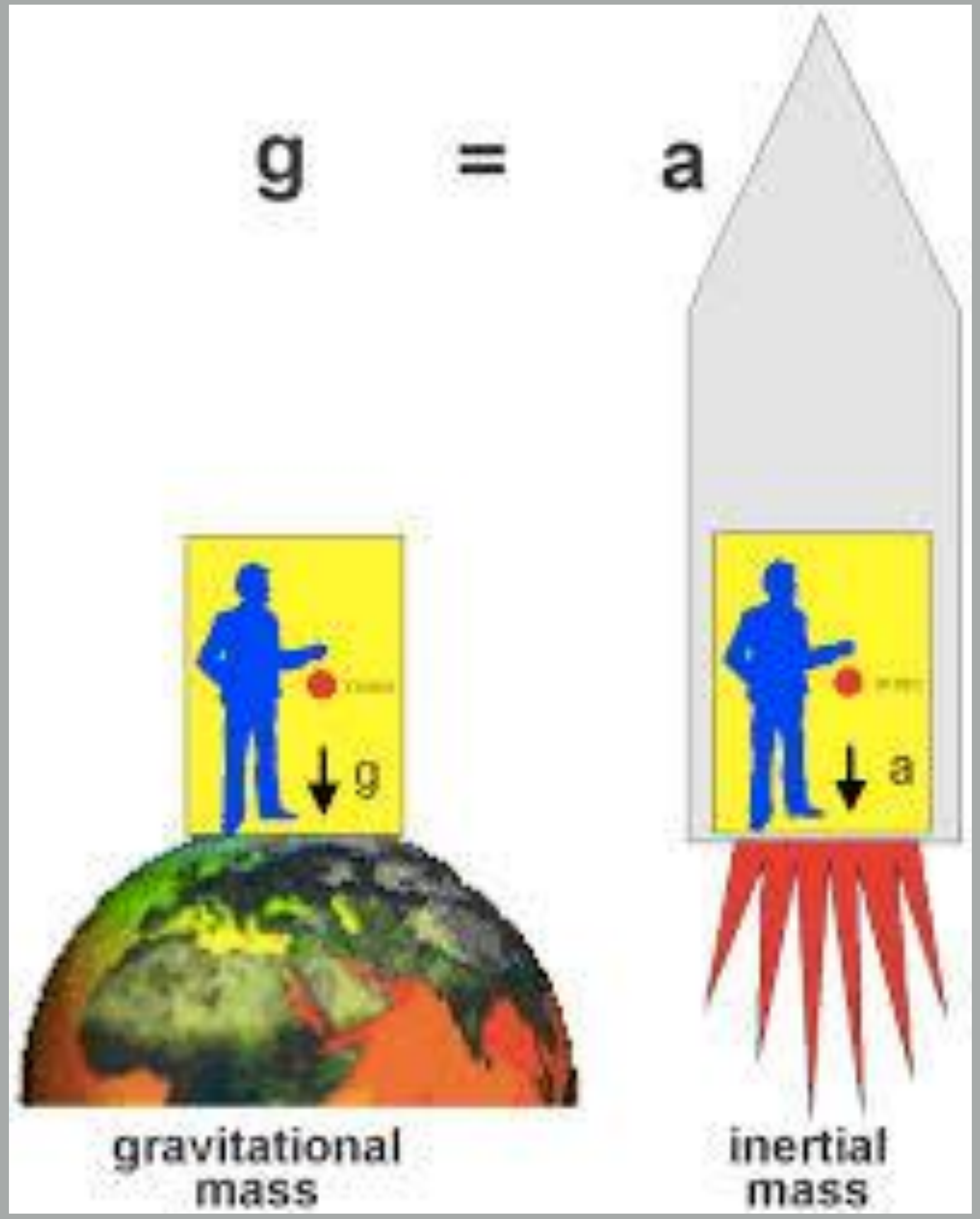
# Detekcija neutrina u IceCube



# Gravitacijski valovi

# Einstein: “Najsretnija misao mog života”

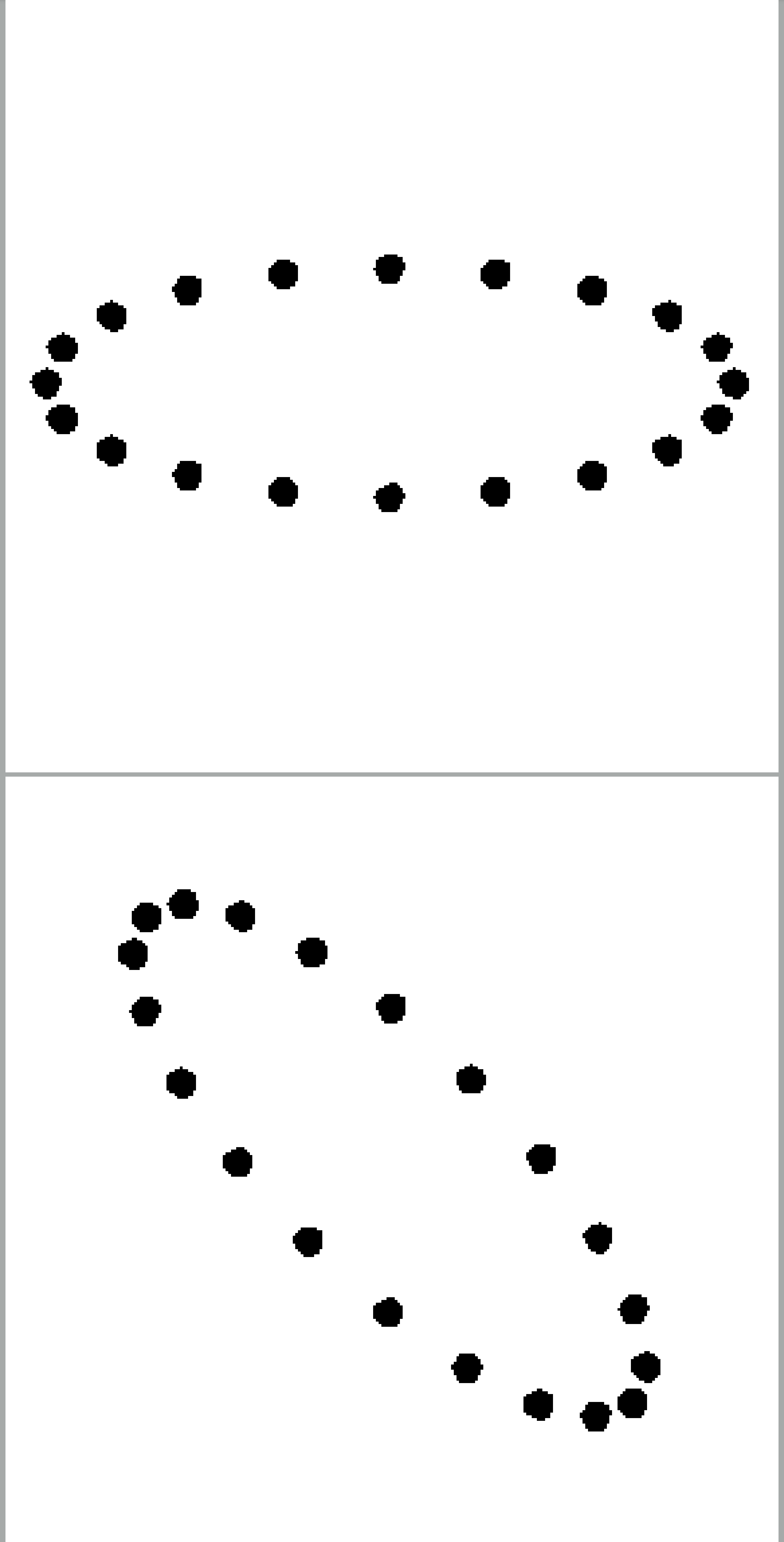

Gravitacija je isto što i akceleracija

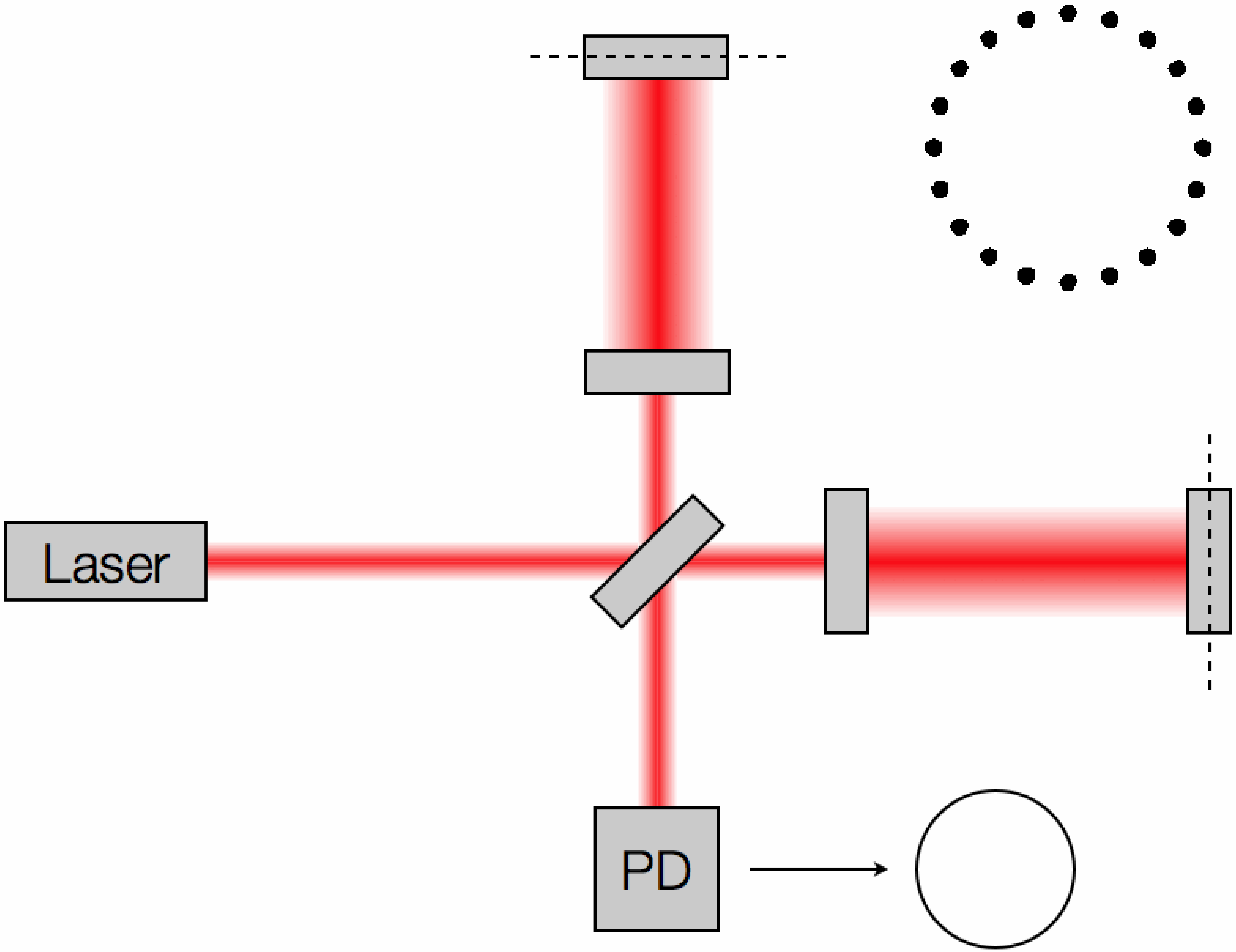
**Gravitacija nije privlačenje, gravitacija nije sila (!!!) već posljedica geometrije prostor-vremena**

**Dosada može biti jako kreativna**

# Kako detektirati gravitacijske valove

- Gravitacijski val rasteže prostor u jednom smjeru a drugom/okomitom smjeru ga sažima.
- Potrebno je vrloooo preciznoooo mjeriti dužinu krakova objekta oblika “L”
- Koliko preciznoooo? Jakooo preciznoooo …
- Detektirati promjene u duljini reda veličine $10^{-18}$ m (milijarditniki dio milijarditinke metra)
- Kako?
- Pomoću lasera.



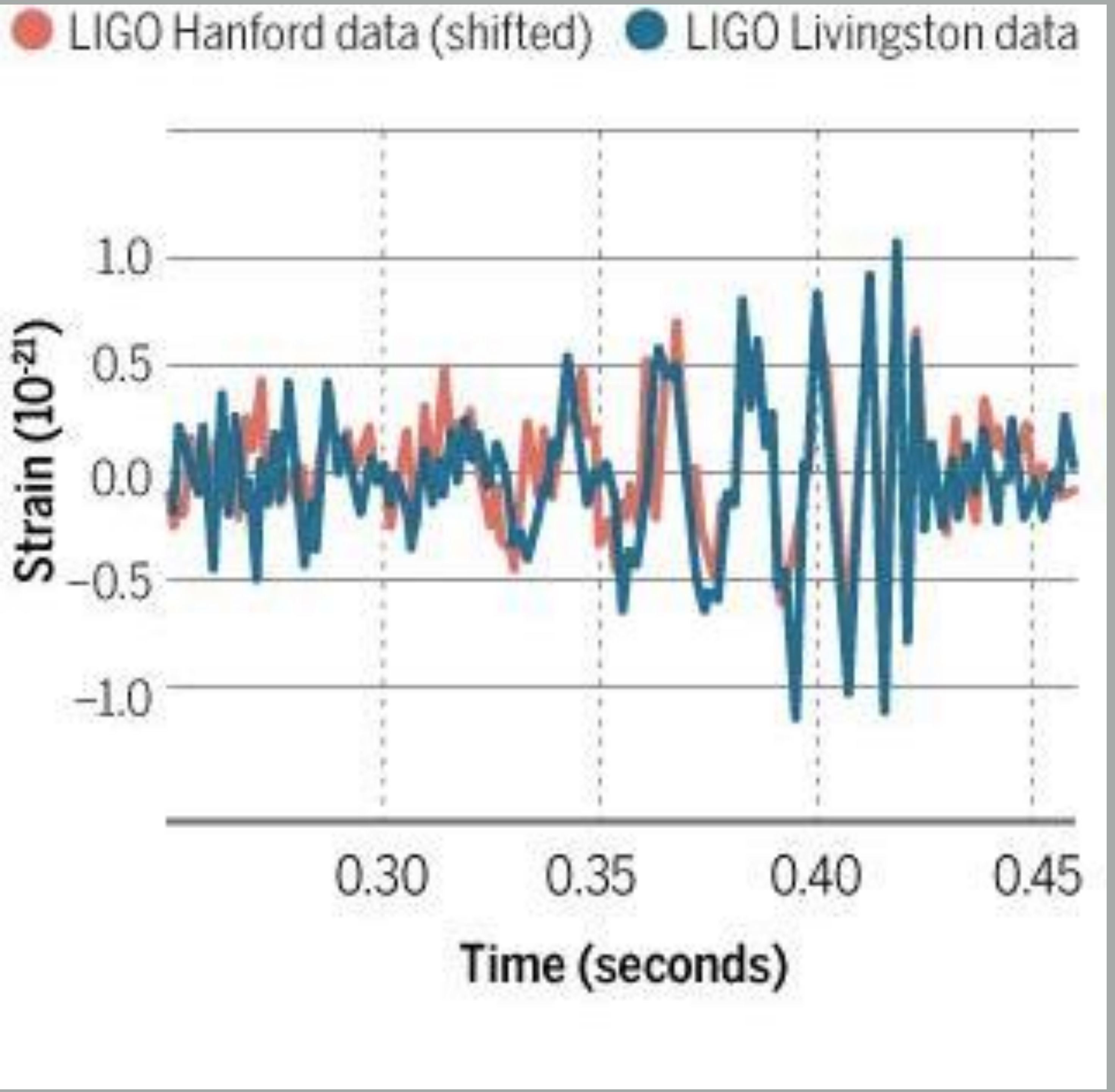

Laser
PD

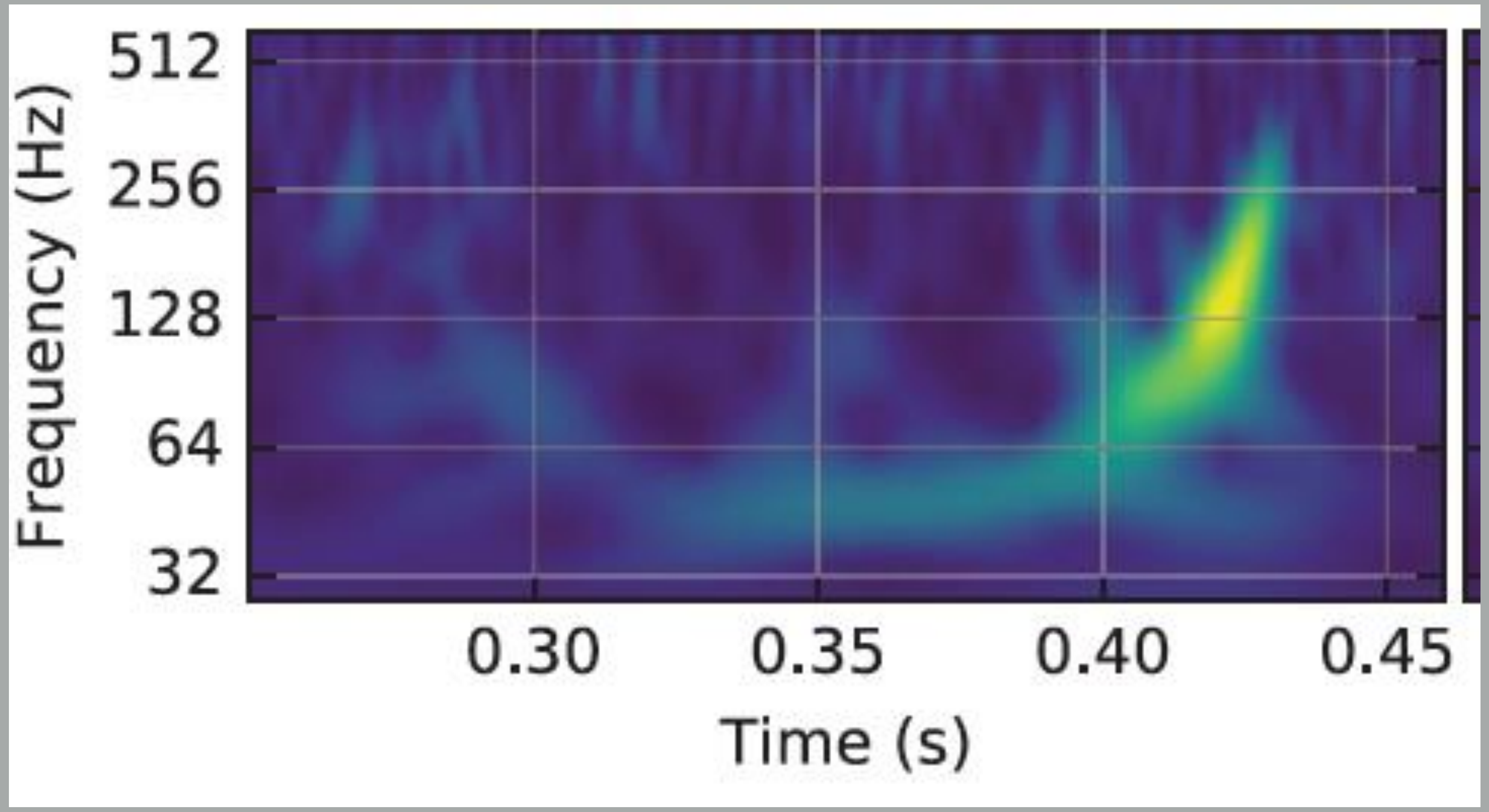
# LIGO opservatorij čine dva detektora - stereo

# Što je LIGO vidio

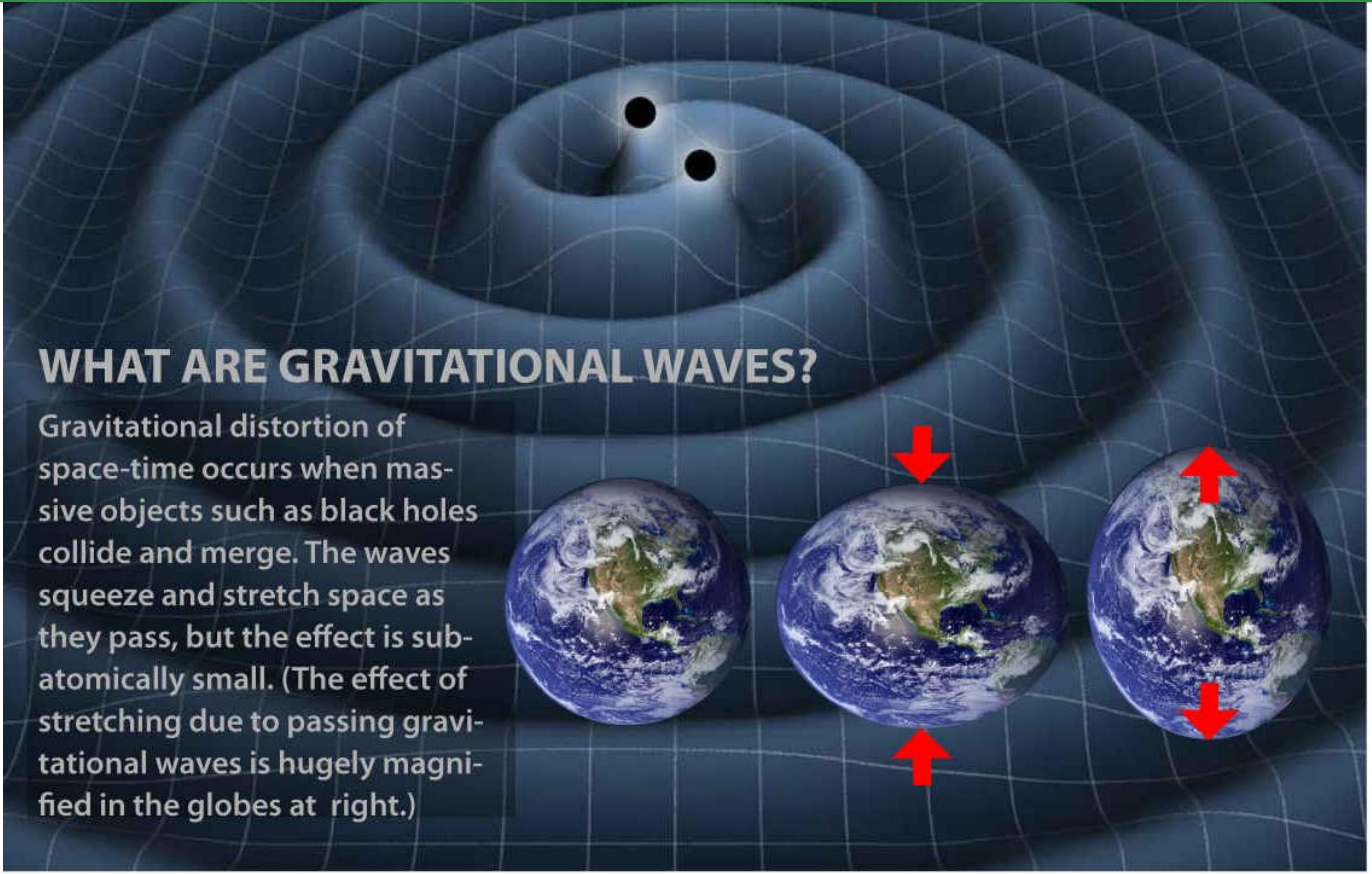
- 14 rujna, 2015. u 09:50: 45 (UTC) odnosno u 04:50 po lokalnom vremenu u Louisina i 02:50 i Washington  detektirana je relativna promijena duljine dva kraka detektora u tajanju 0,25 sekundi. Signal je prvo detektirao H1 0,007 seknudi L1 detektor

- Promijene duljine na početku su oscilirale frekvencijom 35 Hz a zatim su rasle do 250 Hz da bi izčezle nakon 0,25 sekundi.



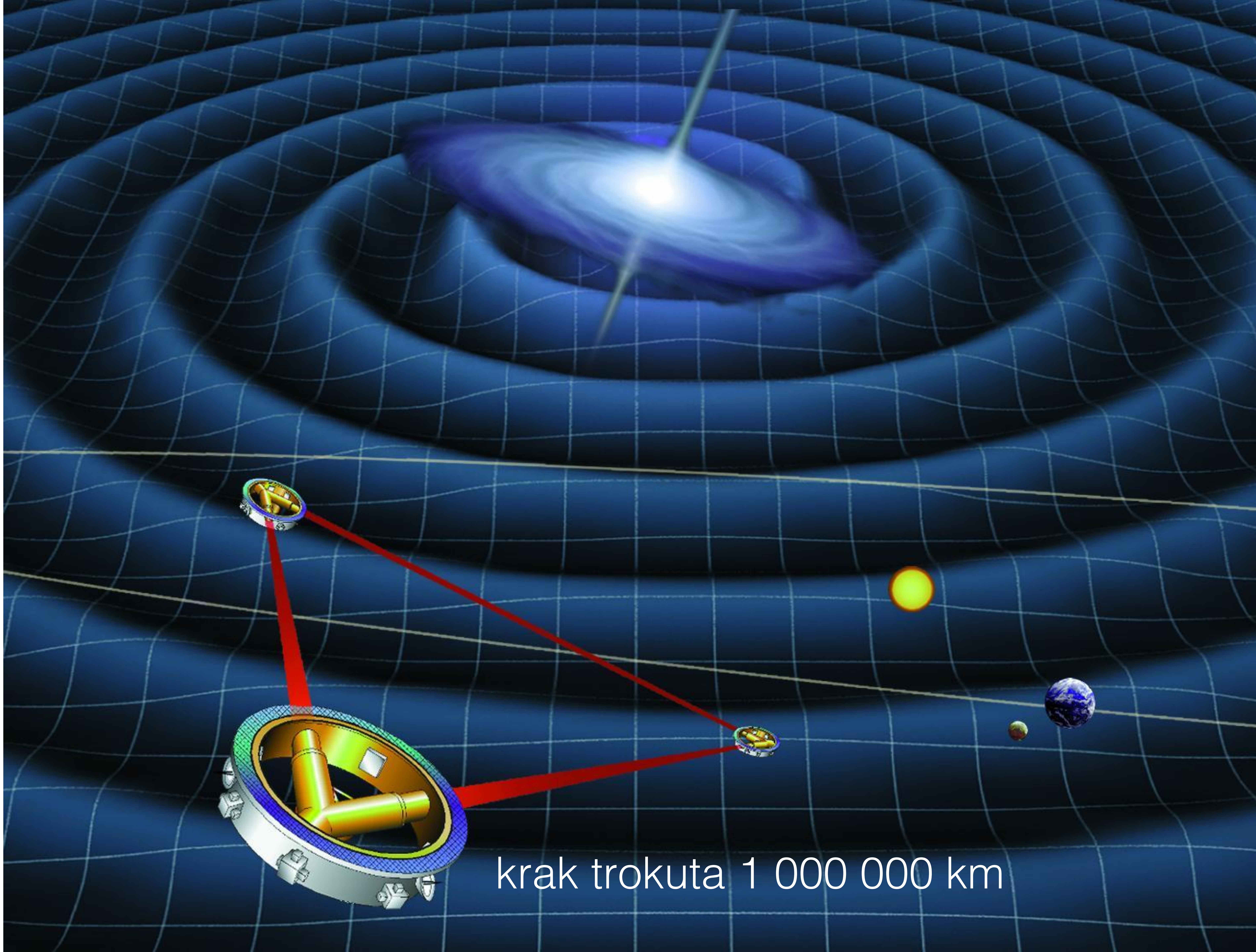



# I vi ste se i svi malo stegli i restegli 14. 09. 2015



Kako pametno potrošiti dvije milijarde EURA ?

Napraviti LISA 💻



# Budućnost obrazovanja – apstraktno razmišljanje

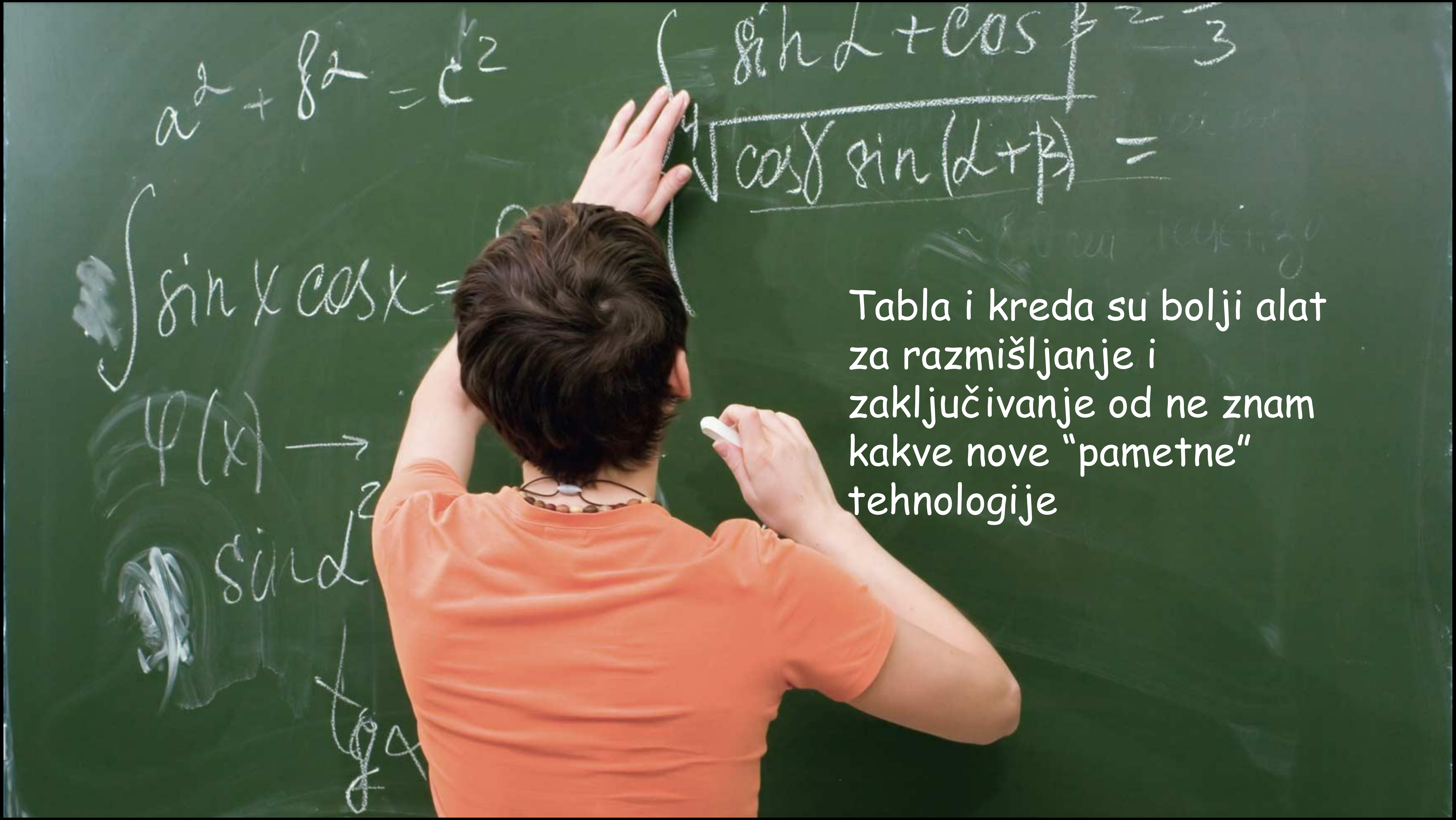


Tabla i kreda su bolji alat za razmišljanje i zaključivanje od ne znam kakve nove “pametne” tehnologije https://www.popsci.com/story/science/survival-of-the-friendliest/

SCIENCE

# Humans owe our evolutionary success to friendship

Cooperation is the key to long-term survival.

*Brian Hare and Vanessa Woods*
July 21, 2020

Our ability to show each other compassion could be the quality that has kept humans alive for so long. *Photo by Helena Lopes on Unsplash*

Vjerojatno nijedna narodna mudrost o ljudskoj prirodi nije nanijela više štete - ili je više pogrešna - od "opstanka najjačih". Ideja da će jaki i nemilosrdni preživjeti dok slabi nestaju postala je zacementirana u kolektivnoj svijesti nakin objavljivanja petog izdanja knjige Podrijetlo vrsta Charlesa Darwina 1869 U kojoj je napisao da je, kao zamjena za pojam prirodne selekcije, "Preživljavanje najjačih je točnije, a ponekad je i jednako zgodno."

Tijekom proteklog stoljeća i pol, ova pogrešna verzija "prilagođenosti" bila je temelj društvenih pokreta, restrukturiranja korporacija i ekstremnih pogleda na slobodno tržište. Korištena je za argumentiranje ukidanja vlade, za prosuđivanje skupina ljudi kao inferiornih i za opravdavanje okrutnosti. Ali za Darwina i suvremene biologe, "preživljavanje najjačih" odnosi se na nešto vrlo specifično - sposobnost preživljavanja i ostavljanja za sobom sposobnih potomaka - "Survival of the fittest " je ništa više I ništa manje od ovoga.

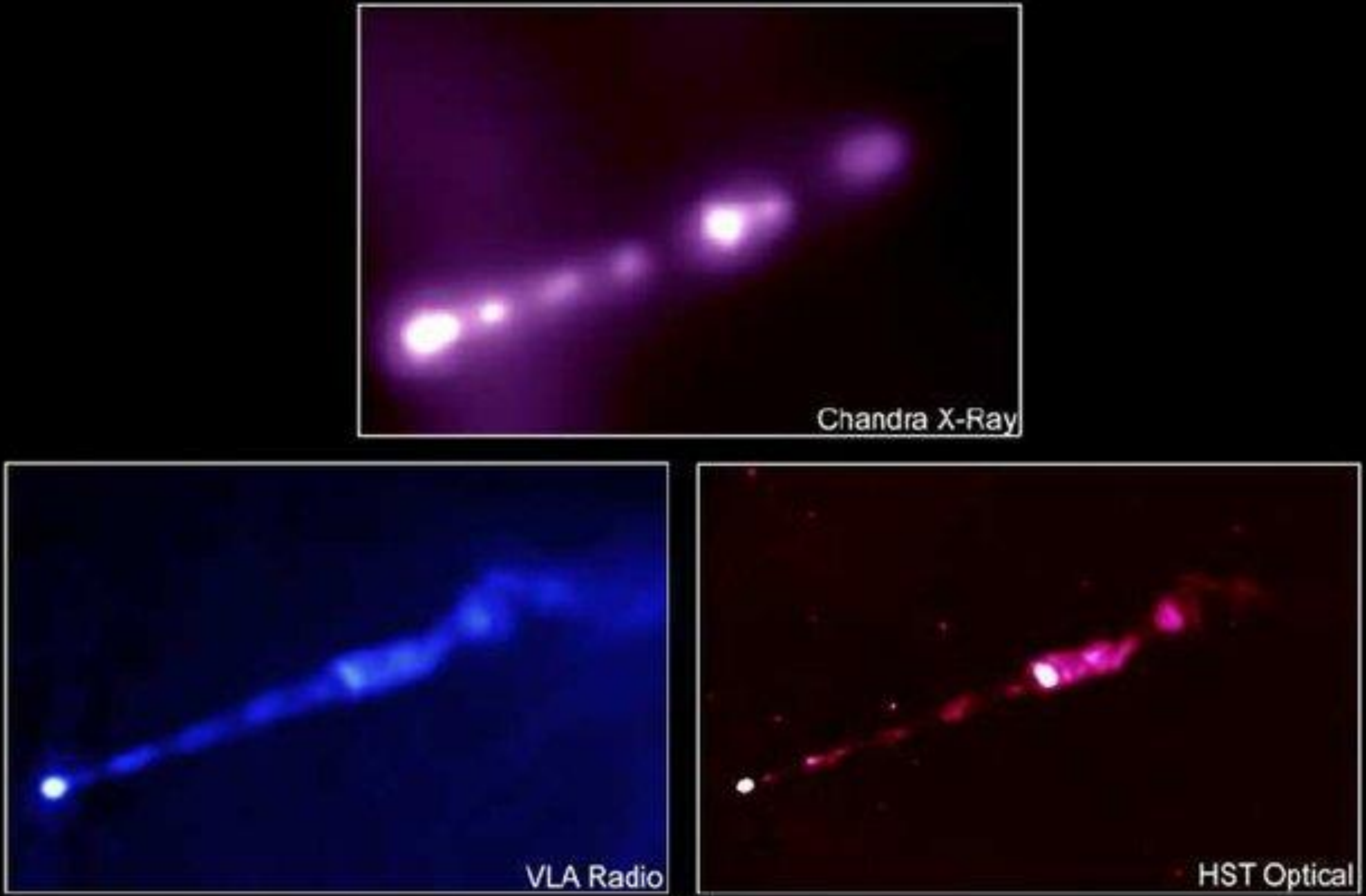
Ono što nam je omogućilo da preživimo I napredujemo dok su druge vrste izumirali bila je vrsta kognitivne supermoći: posebna vrsta prijateljstva koja se naziva kooperativna komunikacija. Mi smo stručnjaci za suradnju s drugim ljudima, čak i strancima. Možemo komunicirati s nekim koga nikada nismo upoznali o zajedničkom cilju i zajedno raditi na njegovom ostvarenju

Ovo je kao ”influencer”

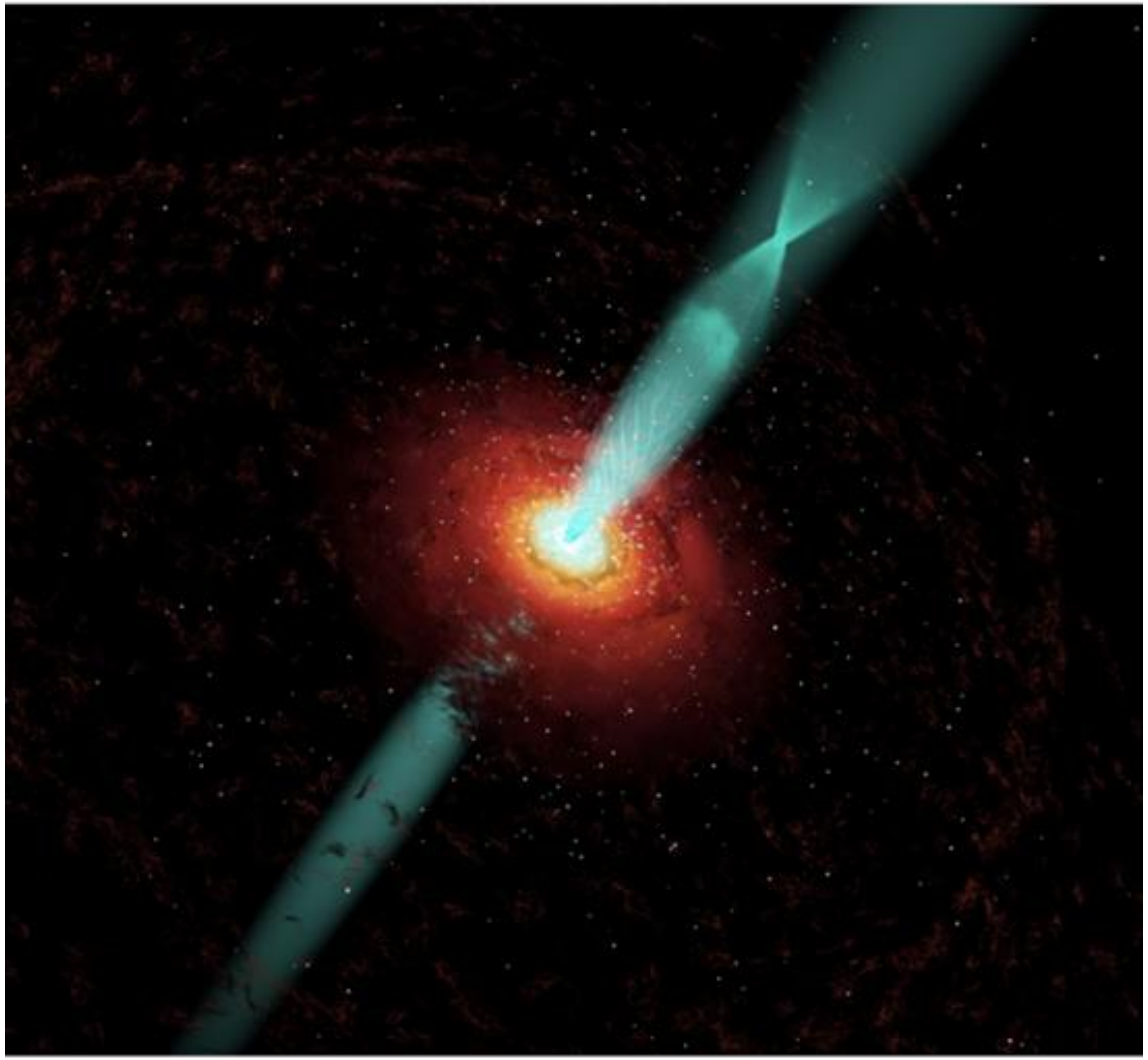
Ovo su kao ”folouеleri”

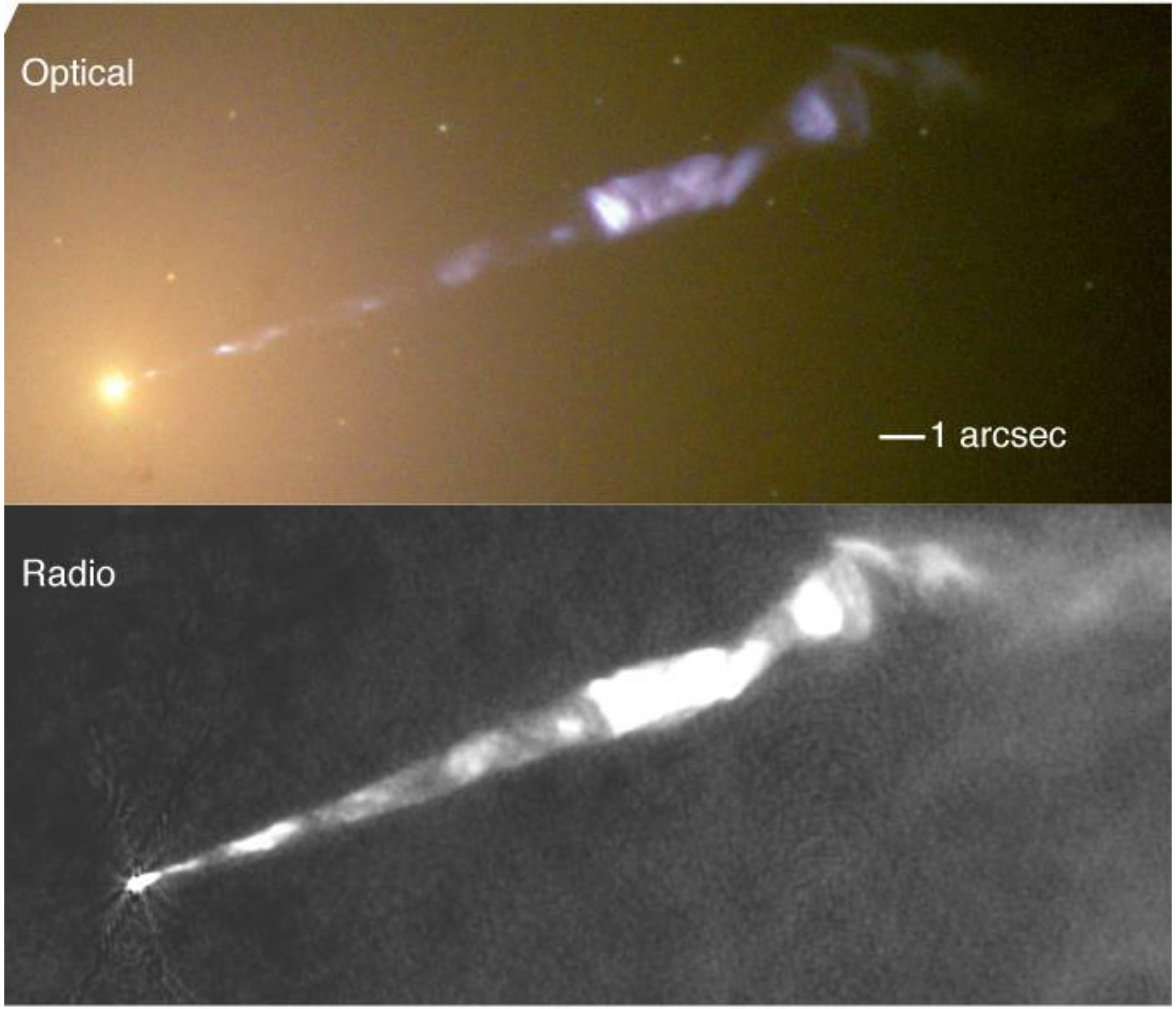
# Hvala

# M87 – mlaz relativističkih čestica

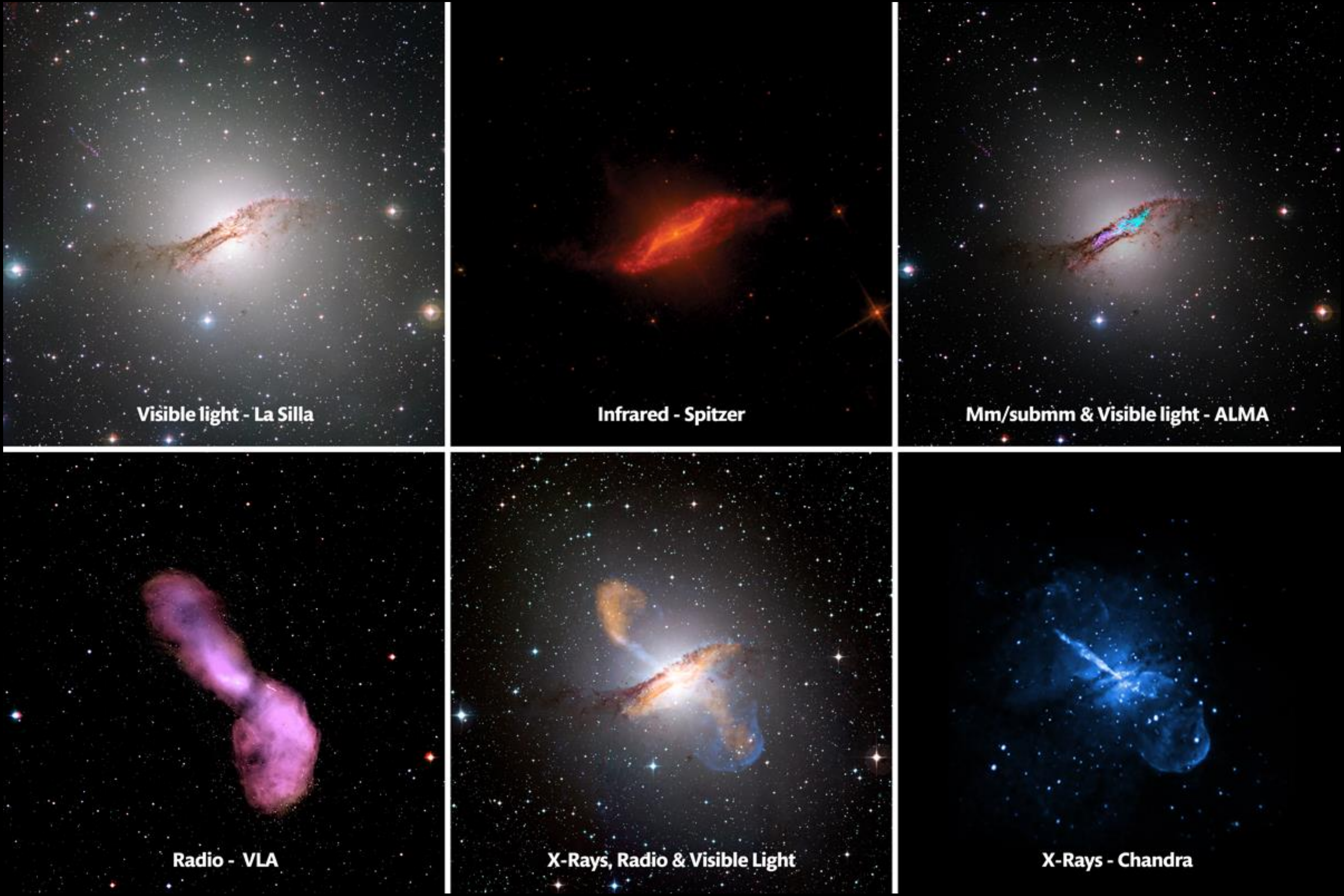


# Aktivne galaktičke jezgre - mlaz emitira od radiovalova pa do gama zraka

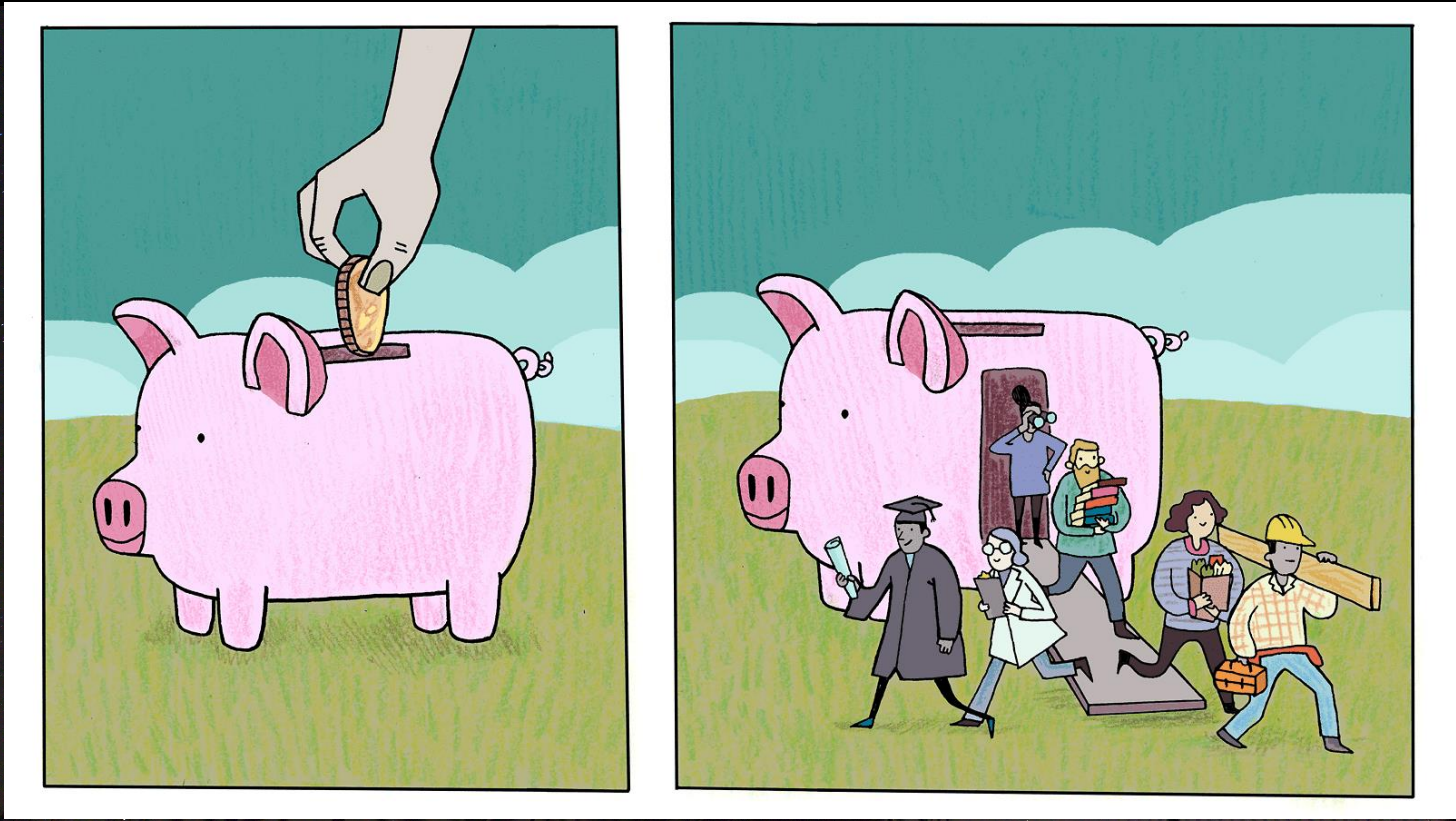




Centaurus A


Visible light - La Silla
Infrared - Spitzer
Mm/submm & Visible light - ALMA
Radio - VLA
X-Rays, Radio & Visible Light
X-Rays - Chandra

# Jasnije se vidi očima uma



**Ulaganje u obrazovanje/znanost je najisplatvije**

# Još o obrazovanju

- **Obrazovanje znači naučiti razmišljati i zaključivati na apstraktan način na temelju činjenica.**
- Bolje je proći kvalitetno i duboko promišljeno neke osnovne koncepte kako bi se formirao mentalni sklop koji se temelji na razmišljanju i zaključivanju, nego veći dio gradiva a bez pravog istinskog razumijevanja.
- **Naučiti što to znači razumjeti!**
- **Imaginaciju treba vježbati!**
- **Misao se gradi korak po korak!**
- Moraju li predavanja biti zabavna ?
  - Ne, nema veće zabave od usvajanja novih znanja i nema recepta za to, to je kreativni i individualni proces.
  - **Zabavi se razmišljanjem**
- Razmišlja se u formi sms poruke, a tako se ne može procesuirati složeni tekst niti izraziti duboka i složena misao. Tako da se formira stanje svijesti gdje se preko tri klika hoće doći do znanja.

- Arguably, no folk theory of human nature has done more harm—or is more mistaken—than the "survival of the fittest." The idea that the strong and ruthless will survive while the weak perish became cemented in the collective consciousness around the publication of the fifth edition of Charles Darwin's Origin of Species in 1869, in which he wrote that, as a proxy for the term natural selection, "Survival of the Fittest is more accurate, and is sometimes equally convenient."

- Over the past century and a half, this mistaken version of "fitness" has been the basis for social movements corporate restructuring, and extreme views of the free market. It has been used to argue for the abolition of government, to judge groups of people as inferior, and to justify the cruelty that results. But to Darwin and modern biologists, "survival of the fittest" refers to something very specific—the ability to survive and leave behind viable offspring. It is not meant to go beyond that.

- What allowed us to thrive while other humans went extinct was a kind of cognitive superpower: a particular type of friendliness called cooperative communication. We are experts at working together with other people, even strangers. We can communicate with someone we've never met about a shared goal and work together to accomplish it