Observando o Universo

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Universidade Federal do Espírito Santo

- Primeira Escola de Ciências Físicas Brasil-Cabo Verde
- 2017 - Cidade de Praia, Cabo Verde

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

Ministério da Ciência, Tecnologia e Inovação

Chamada MCTI/CNPq Nº 46/2014 - Programa de Cooperação em Ciência, Tecnologia e Inovação com Países da África - PROÁFRICA

UNIVERSIDADE FEDERAL DO ESPÍRITO SANTO
DOCETE OMNES GENTES
UFES

UNIVERSIDADE CABO VERDE
uniCV

CBPF
Centro Brasileiro de Pesquisas Físicas

VIRTUTE SPIRITUS
UFBA

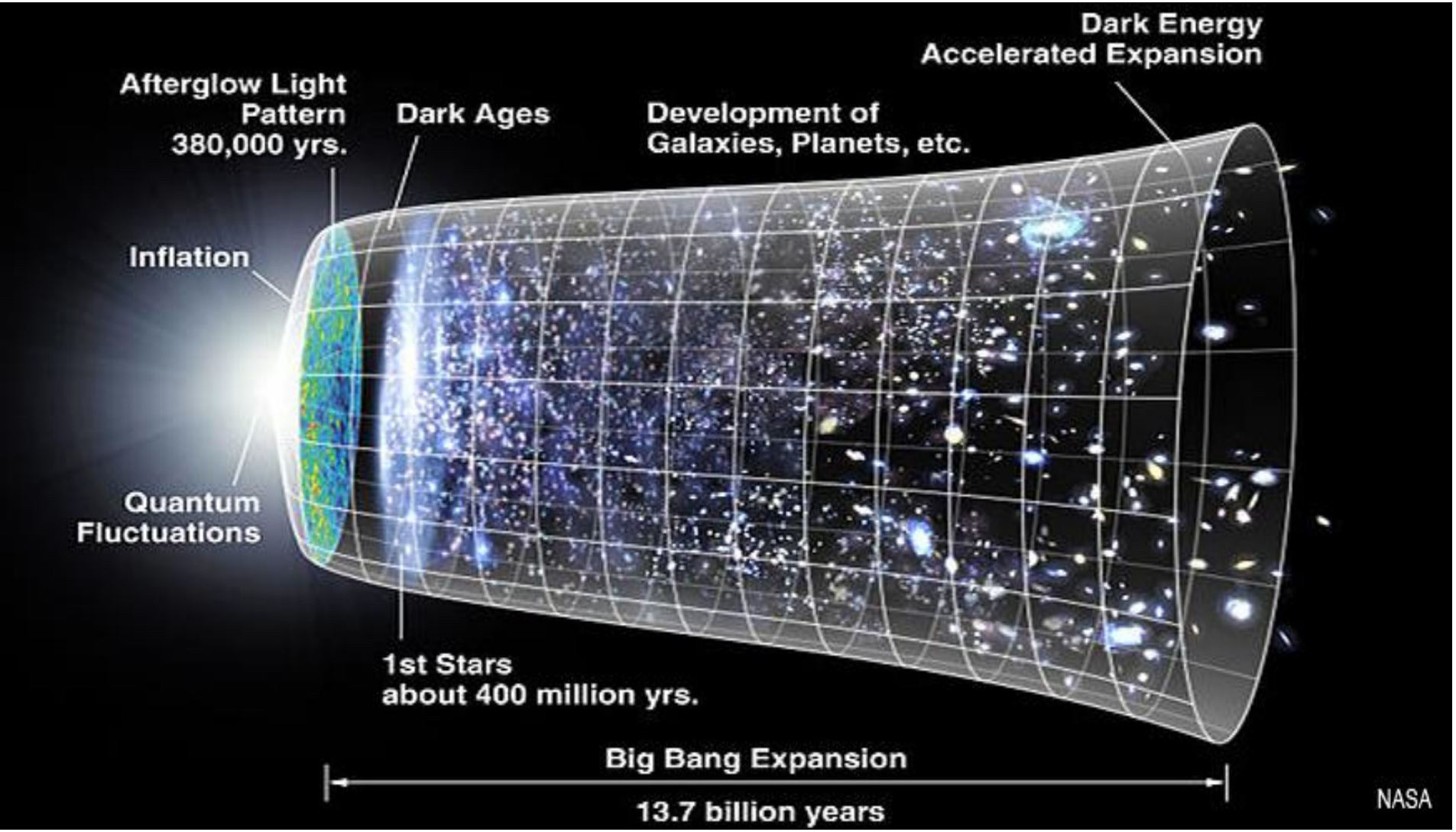
UFPR
UNIVERSIDADE FEDERAL DO PARANÁ

Dmsp
Depuis 1988

UNIVERSITÉ D'ABOMEY-CALAVI

UNIVERSITY OF BUEA
UNIVERSITE DE BUEA
KNOWLEDGE WITH WISDOM

O que seria o Universo?
Que objeto estamos estudando?

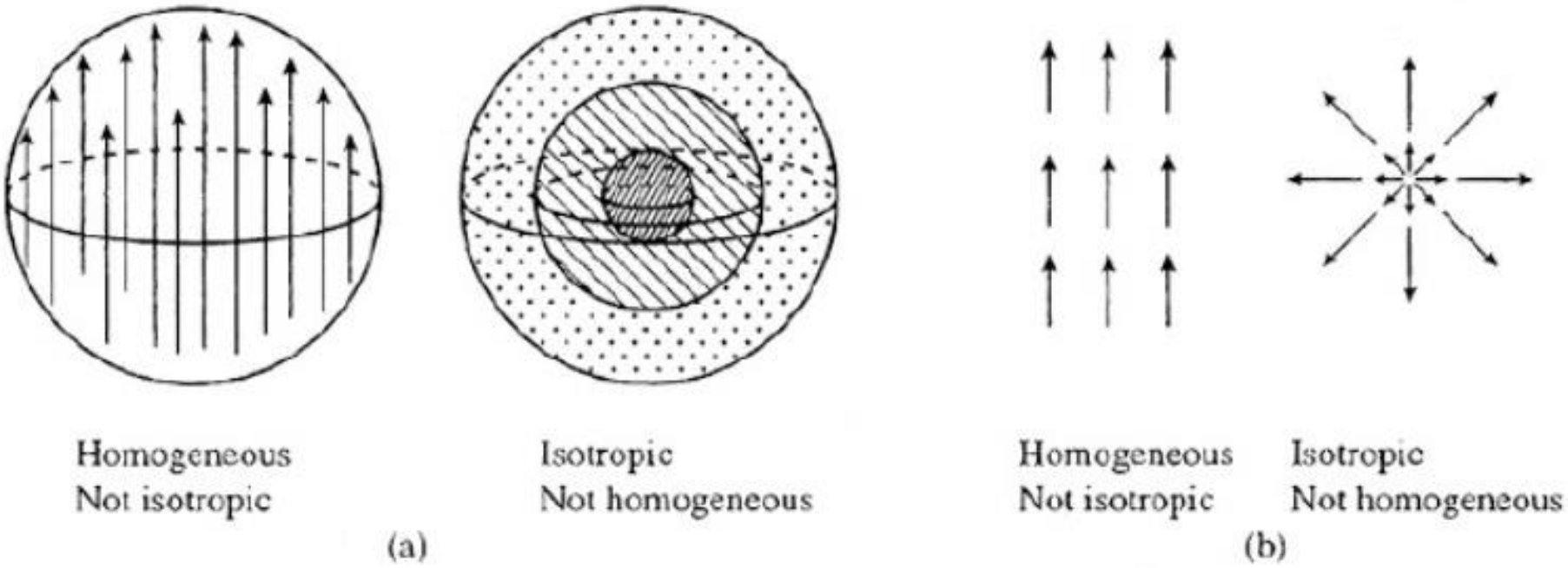


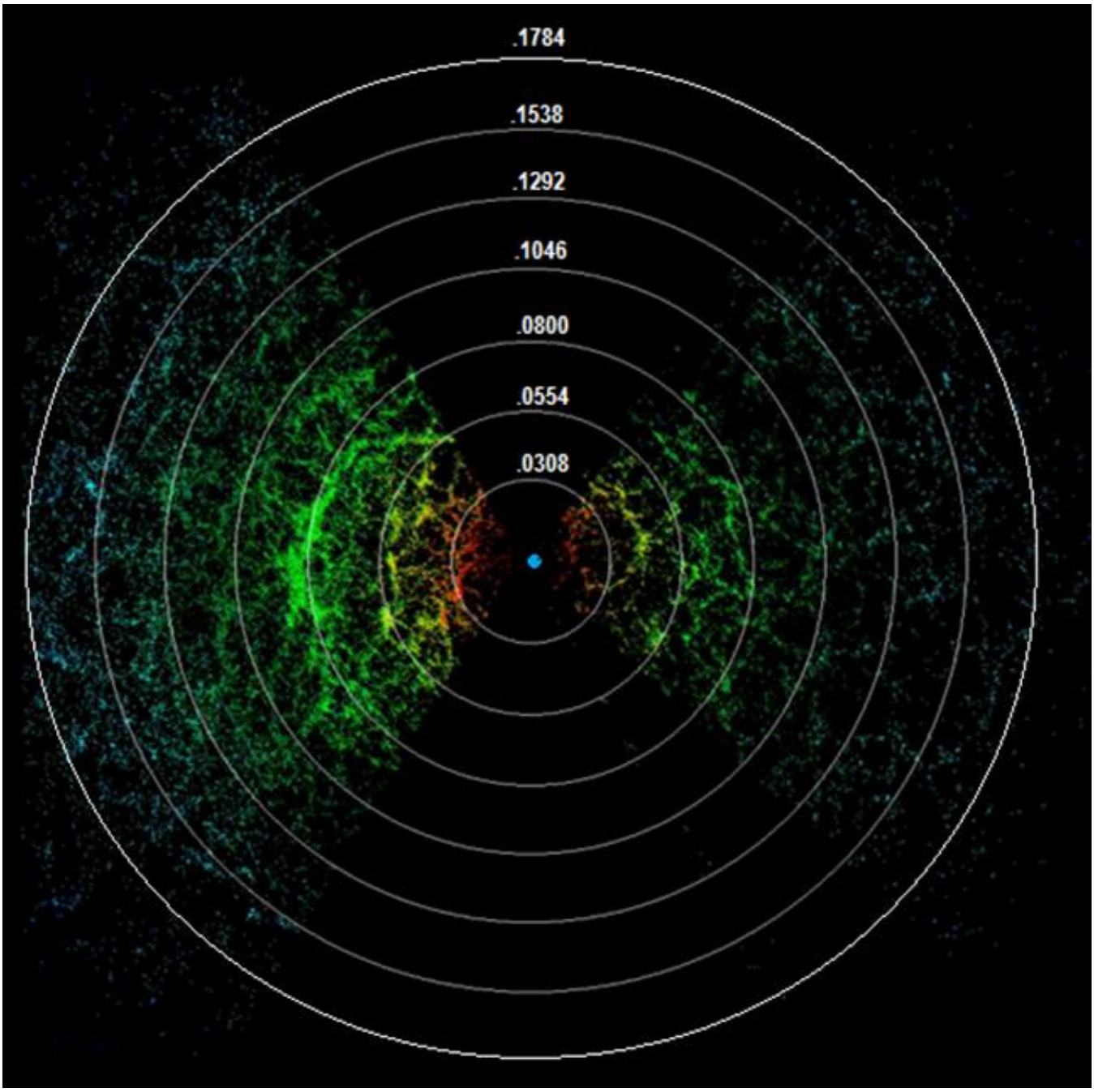
Unidades astronômicas de distância

Unit	Abbreviation	Conversion
Astronomical Unit	AU	1 AU = 1.5×10^{11} m
Light Year	lyr	1 ly = 9.46×10^{15} m
Parsec	pc	1pc = 3.08×10^{16} m
		1 pc = 3.26 ly or 1 pc = 206265 AU

Princípio Cosmológico: o Universo é homogêneo e isotrópico em grandes escalas.

Mas que escala é essa?



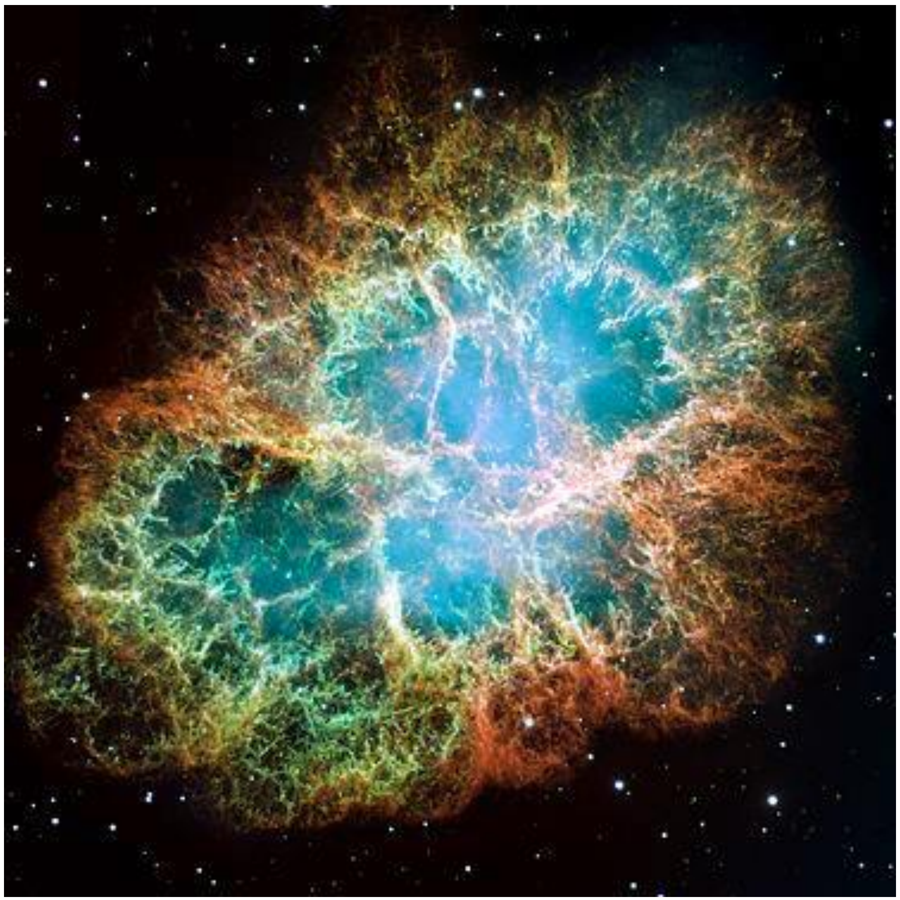

.1784
.1538
.1292
.1046
.0800
.0554
.0308

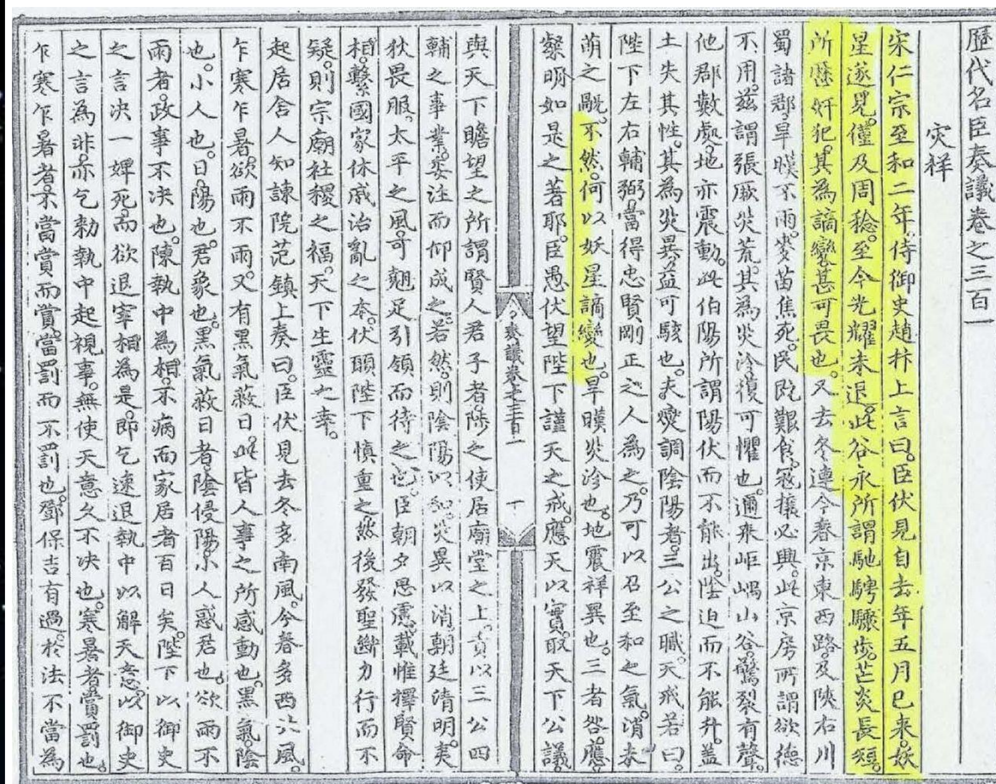
Primórdios da astronomia:

Sumérios ~3.500 AC.

Astronomia oriental:

Chineses observaram uma supernova em 1054





歷代名臣奏議卷之三百一

災祥

宋仁宗至和二年侍御史趙抃上言曰臣伏見自去年五月已來妖
星遂見僅及周歲至今光耀未退此谷永所謂馳騁驟步芒炎長爲
所歷奸犯其爲譴變甚可畏也又去冬達今春京東西路及陝右川
蜀諸郡旱暵不雨麥苗焦死民既艱食寇攘必興此京房所謂欲德
不用茲謂張厥災荒其爲災沴復可懼也通來岷峨山谷驚裂有聲
他郡數處地亦震動此伯陽所謂陽伏而不能出陰迫而不能升蓋
土失其性其爲災異益可駭也夫燮調陰陽者三公之職天戒若曰
陛下左右輔弼當得忠賢剛正之人爲之乃可以召至和之氣消未
萌之戾不然何以妖星譴變也旱暵災沴也地震祥異也三者咎應
粲明如是之著耶臣愚伏望陛下謹天之戒應天以實取天下公議

奏議卷三百一 十

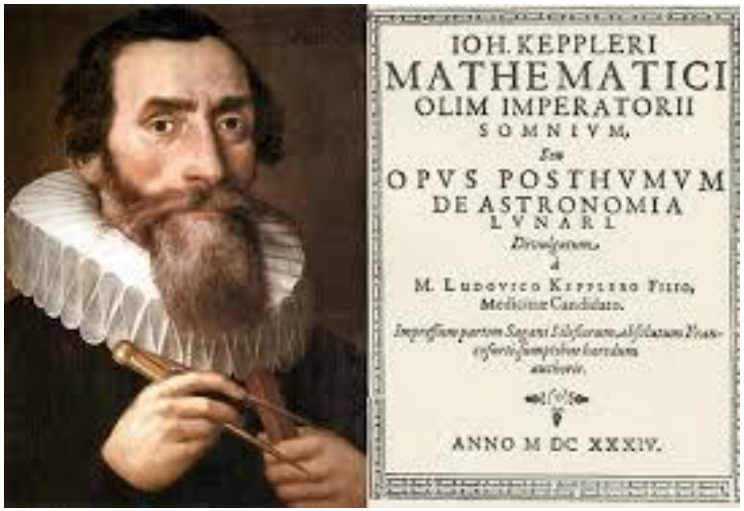
與天下瞻望之所謂賢人君子者陟之使居廟堂之上責以三公四
輔之事業委注而仰成之若然則陰陽以和災異以消朝廷清明夷
狄畏服太平之風可翹足引領而待之也臣朝夕思慮載惟擇賢命
相繫國家休戚治亂之本伏願陛下慎重之然後發聖斷力行而不
疑則宗廟社稷之福天下生靈之幸
起居舍人知諫院范鎮上奏曰臣伏見去冬多南風今春多西北風
乍寒乍暑欲雨不雨又有黑氣蔽日此皆人事之所感動也黑氣陰
也小人也日陽也君象也黑氣蔽日者陰侵陽小人惑君也欲雨不
雨者政事不決也陳執中爲相不病而家居者百日矣陛下以御史
之言決一婢死而欲退宰相爲是即乞速退執中以解天意以御史
之言爲非亦乞勅執中起視事無使天意久不決也寒暑者賞罰也
乍寒乍暑者不當賞而賞當罰而不罰也鄧保吉有過於法不當爲

Renascença da astronomia:

Nicolau Copérnico (1473-1543)

Tycho Brahe (1546-1601)

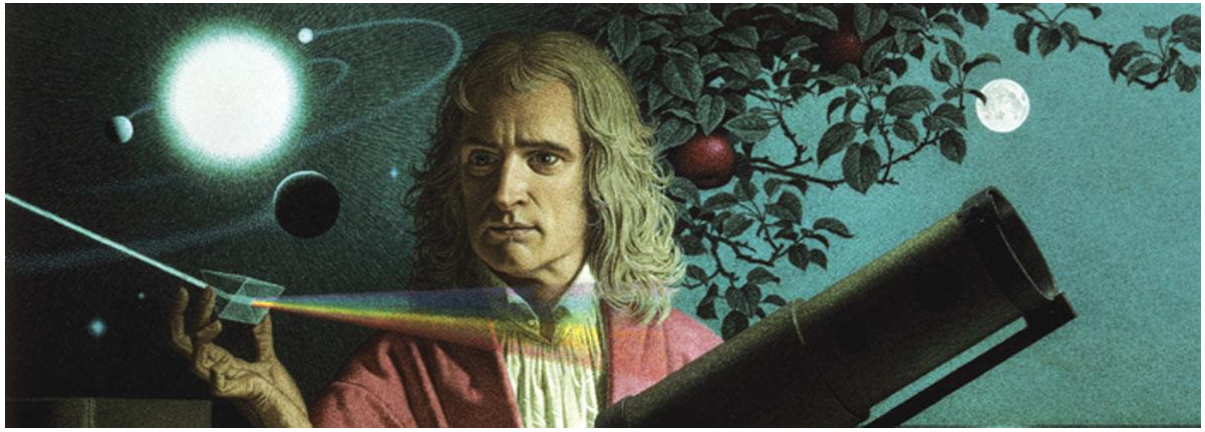
Galileu Galilei (1564-1642)



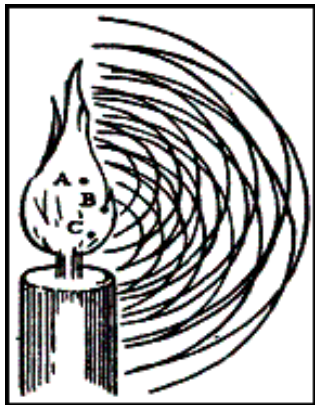
Johannes Kepler (1571-1630)

Primórdios da teoria óptica: Corpuscular x ondulatória

Isaac Newton (1642-1727)



Christiaan Huygens (1629-1695)



Eletromagnetismo moderno:

James Clerk Maxwell (1831-1879)

Eletromagnetismo (equações de Maxwell)

Equações de Maxwell

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$$ *(**Lei de Gauss** para o campo elétrico)*

$$\nabla \cdot \vec{B} = 0$$ *(**Lei de Gauss** para o campo magnético)*

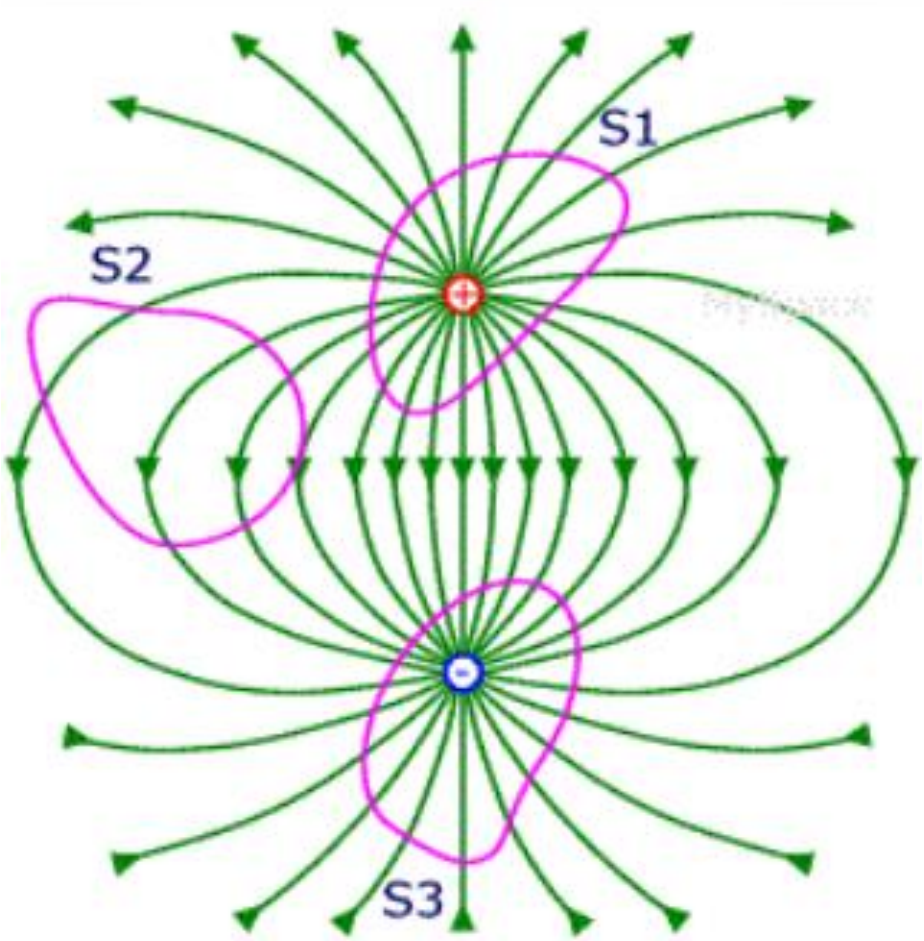
$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$ *(**Lei de Faraday** para a indução)*

$$\nabla \times \vec{B} = \mu_0 \vec{j} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$$ ***(Lei de Ampere)***

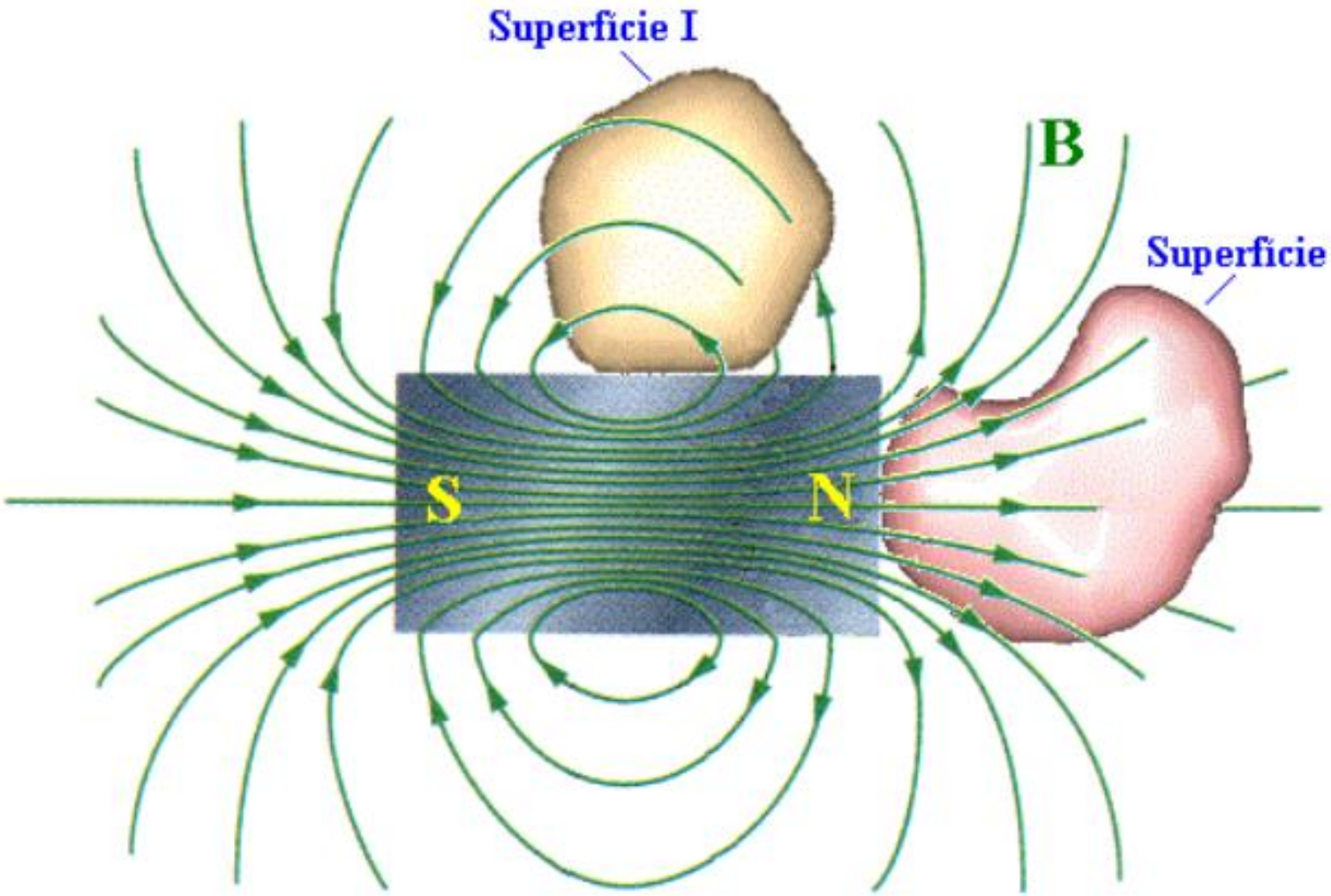
Lei de Gauss:

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$$

*(**Lei de Gauss** para o campo elétrico)*



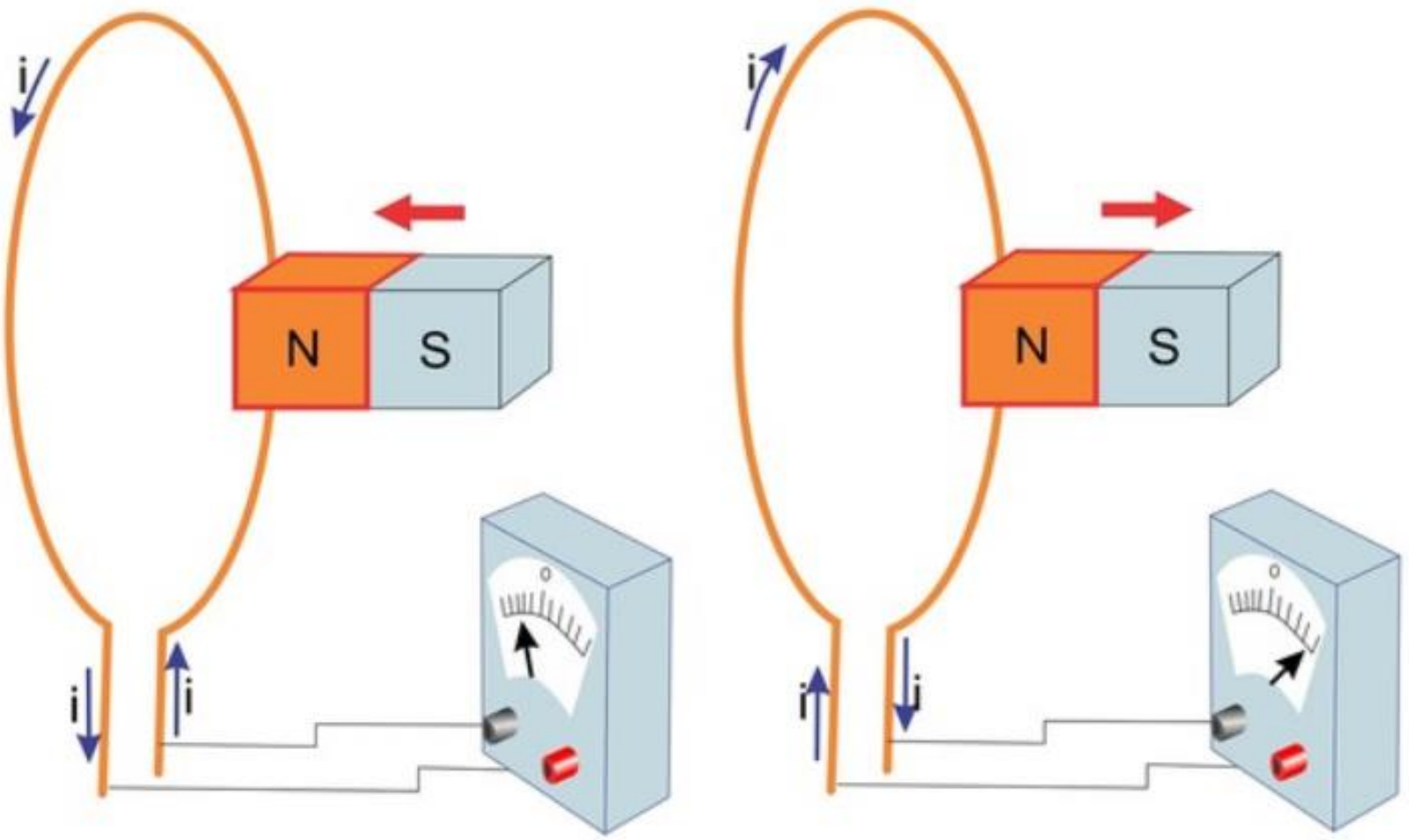
Lei de Gauss (B): $\nabla \cdot \vec{B} = 0$ (*Lei de Gauss para o campo magnético*)



Lei de Faraday:

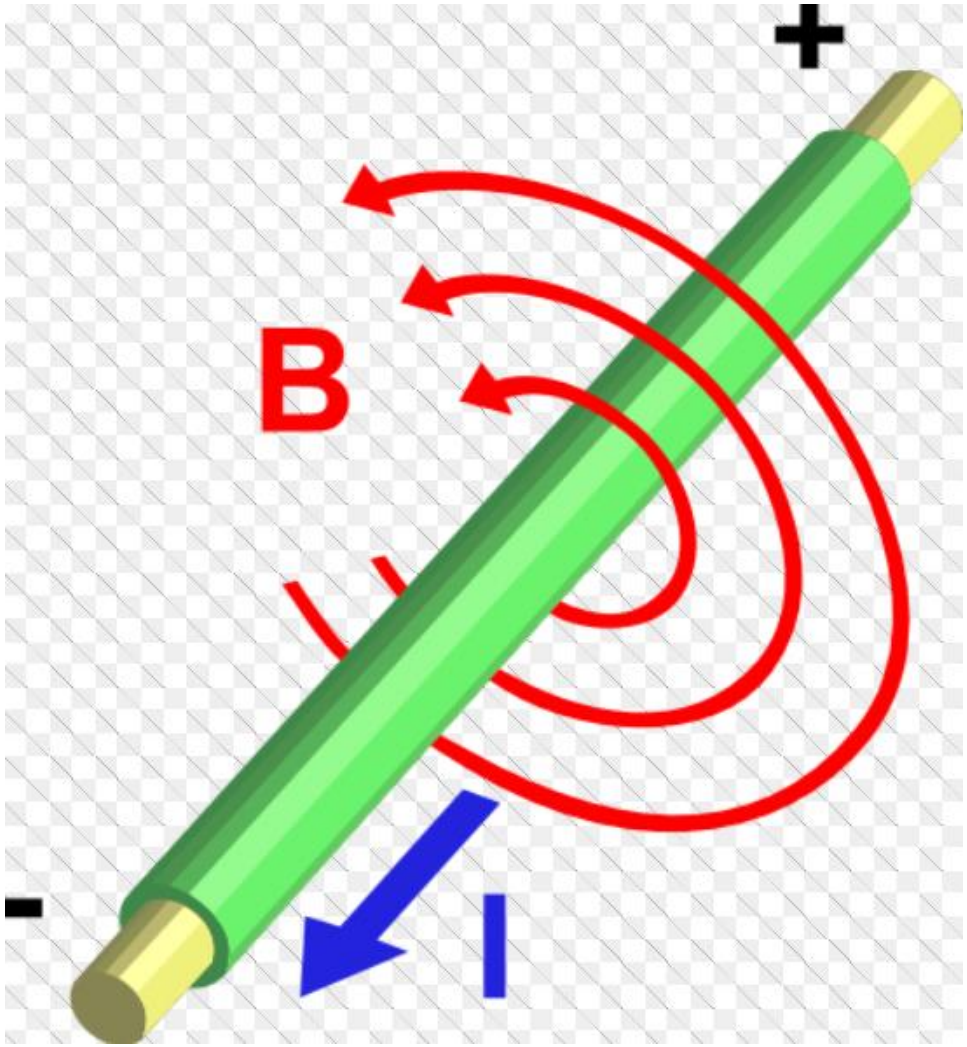
$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

*(**Lei de Faraday** para a indução)*



Lei de Ampere:

$$\nabla \times \vec{B} = \mu_0 \vec{j} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$$ *(Lei de Ampere)*



O eletromagnetismo prevê uma equação de uma onda para o campo Elétrico e Magnético

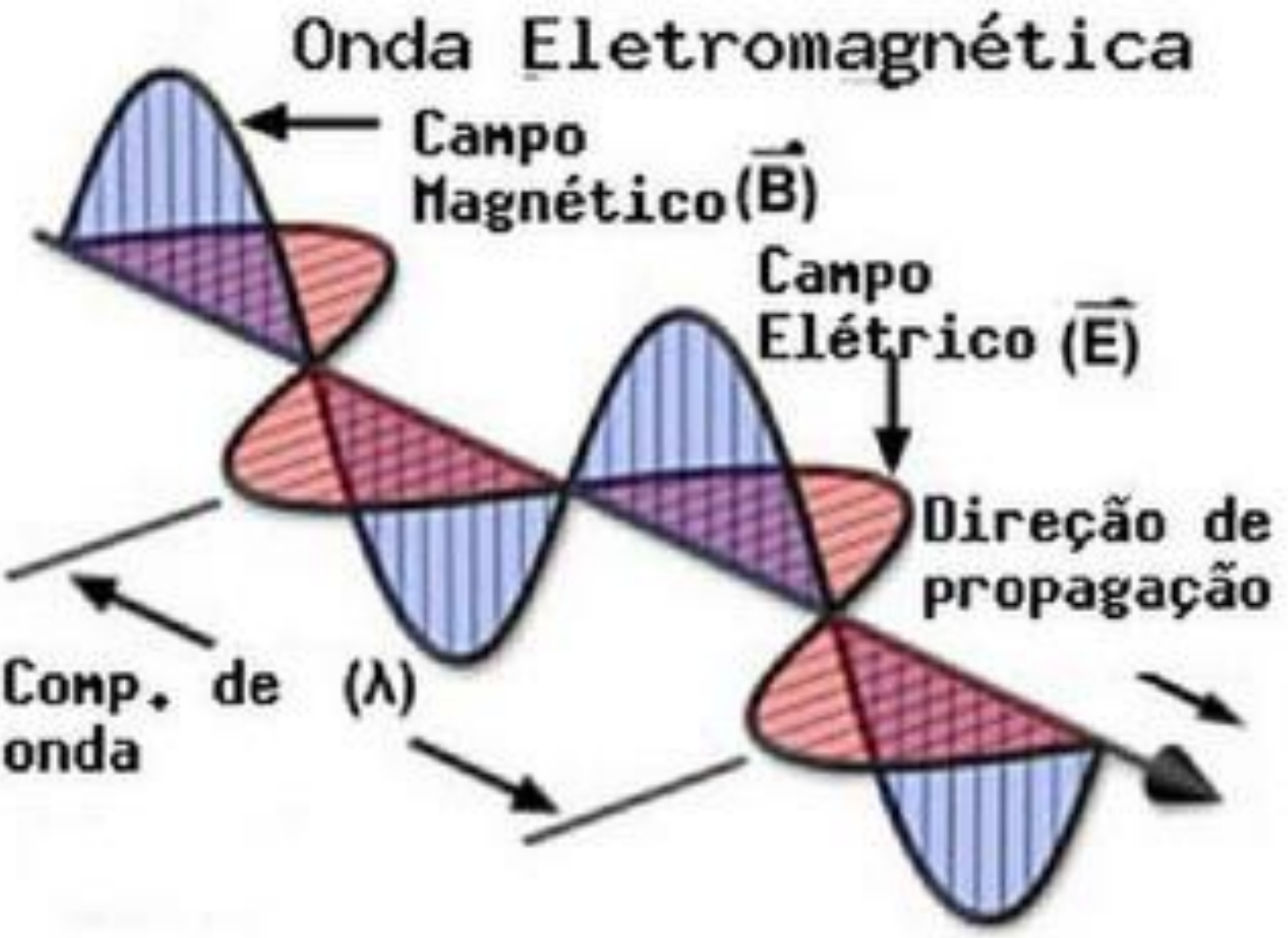
Possível solução das Equações de Maxwell (no vácuo)

$$\nabla^2 \cdot \vec{E} = \mu_0 \varepsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2}$$

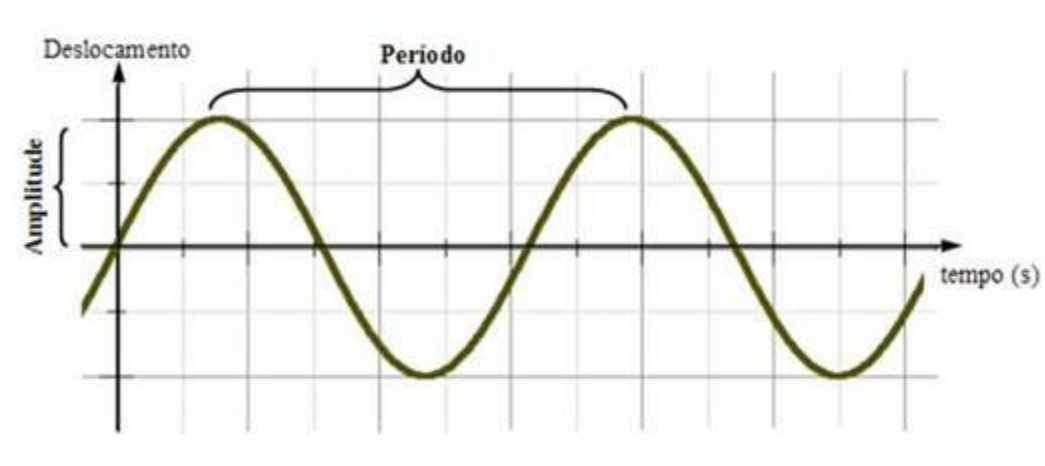
(para o campo elétrico)

$$\nabla^2 \cdot \vec{B} = \mu_0 \varepsilon_0 \frac{\partial^2 \vec{B}}{\partial t^2}$$

(para o campo magnético)


Onda Eletromagnética
Campo Magnético ($\vec{B}$)
Campo Elétrico ($\vec{E}$)
Direção de propagação
Comp. de onda
(λ)

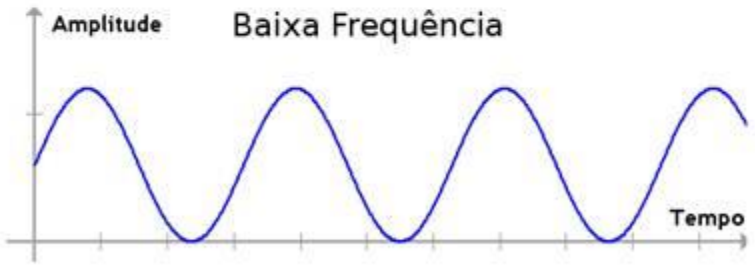
Frequência e Período

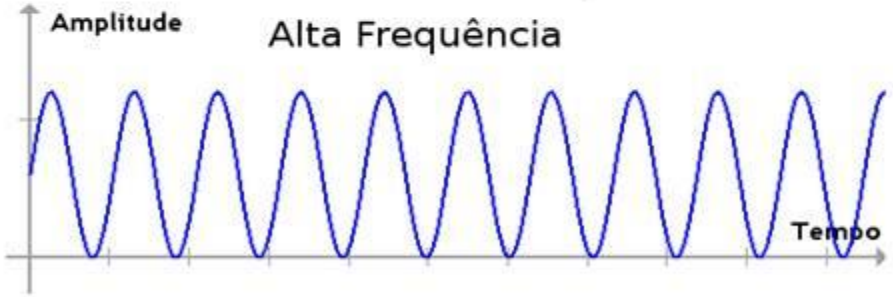


$$f = 1 / T \text{ (Hz)}$$

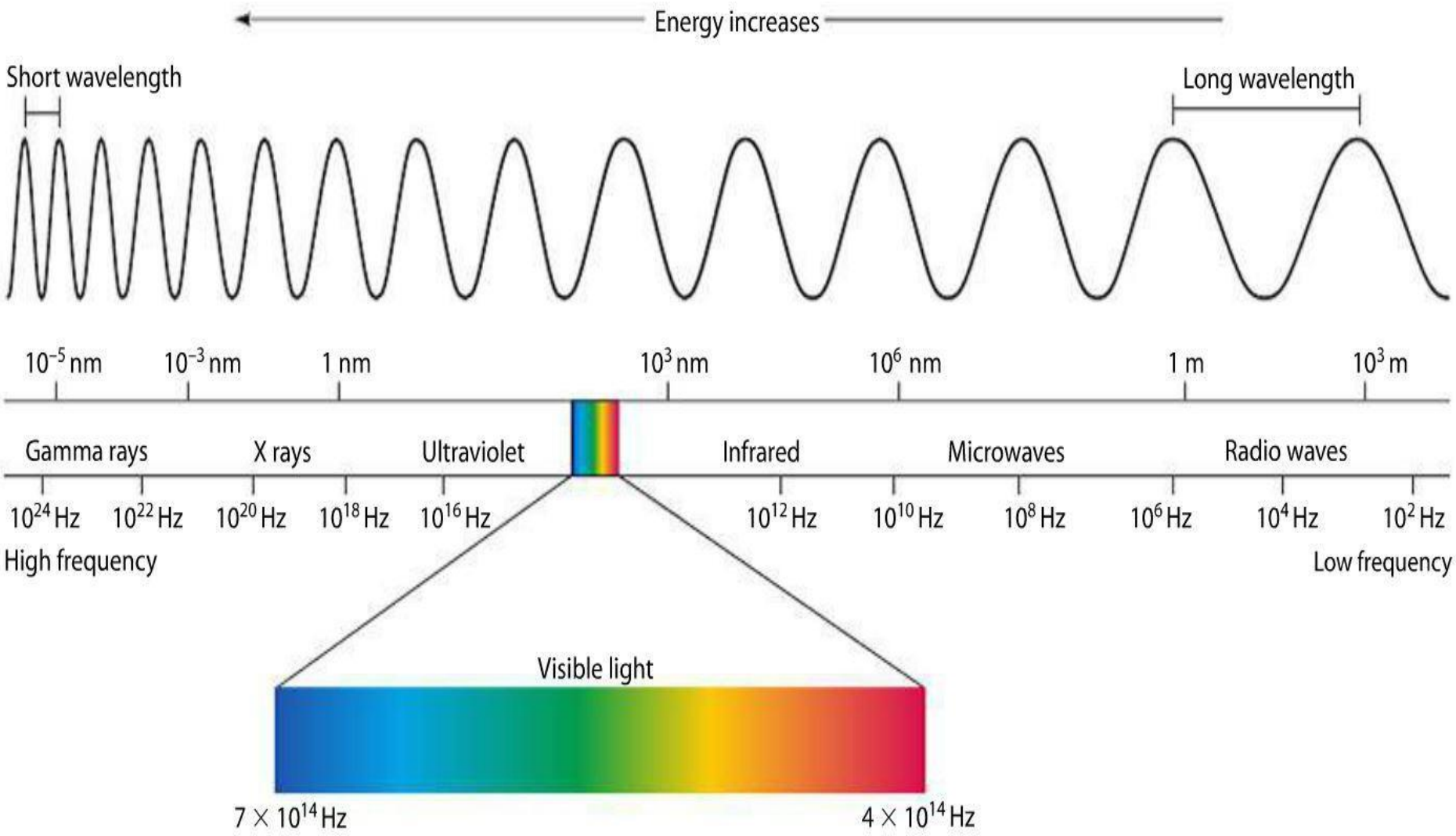
ou

$$T = 1/f \text{ (s)}$$

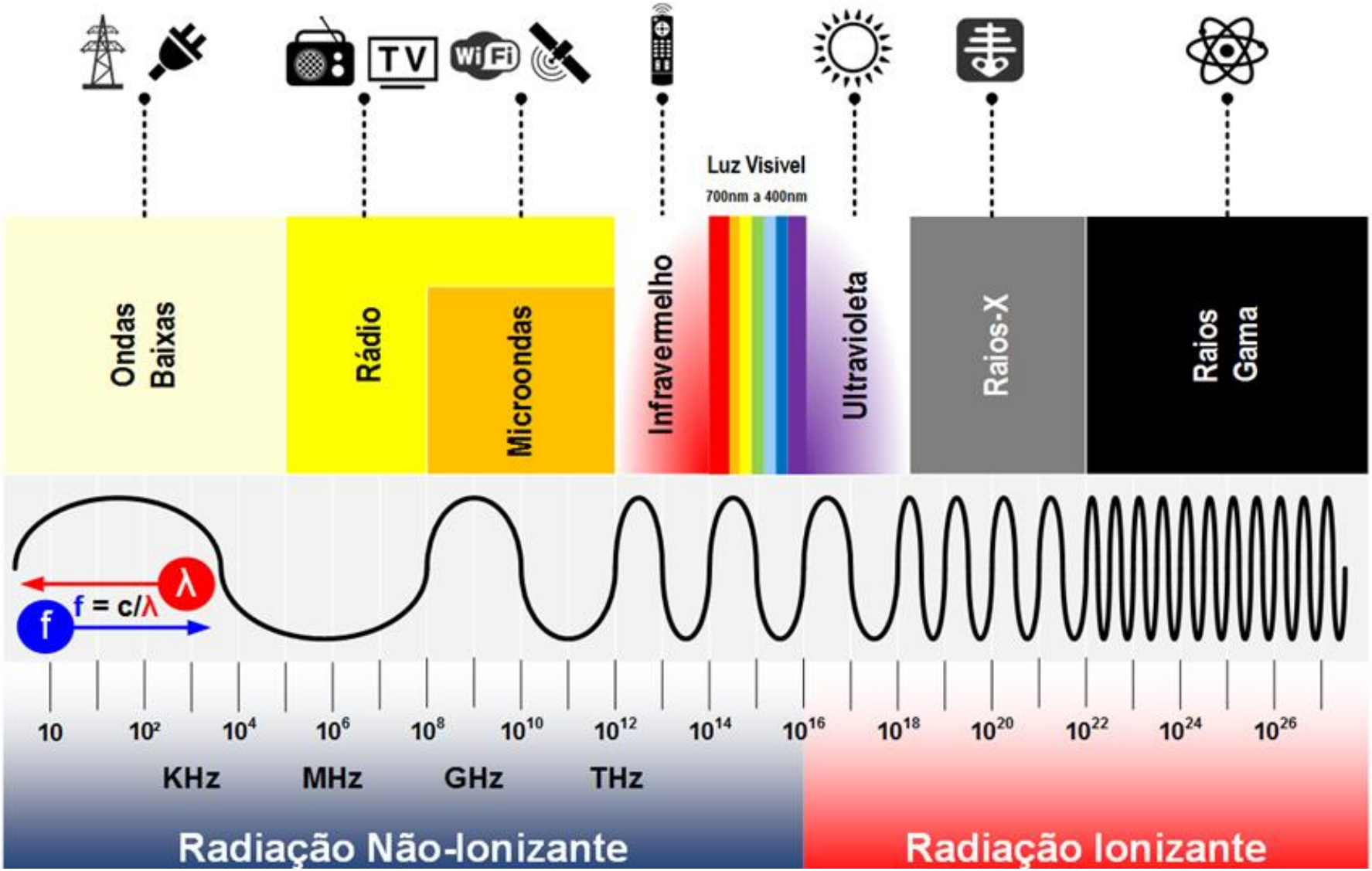




O espectro eletromagnético



O espectro eletromagnético



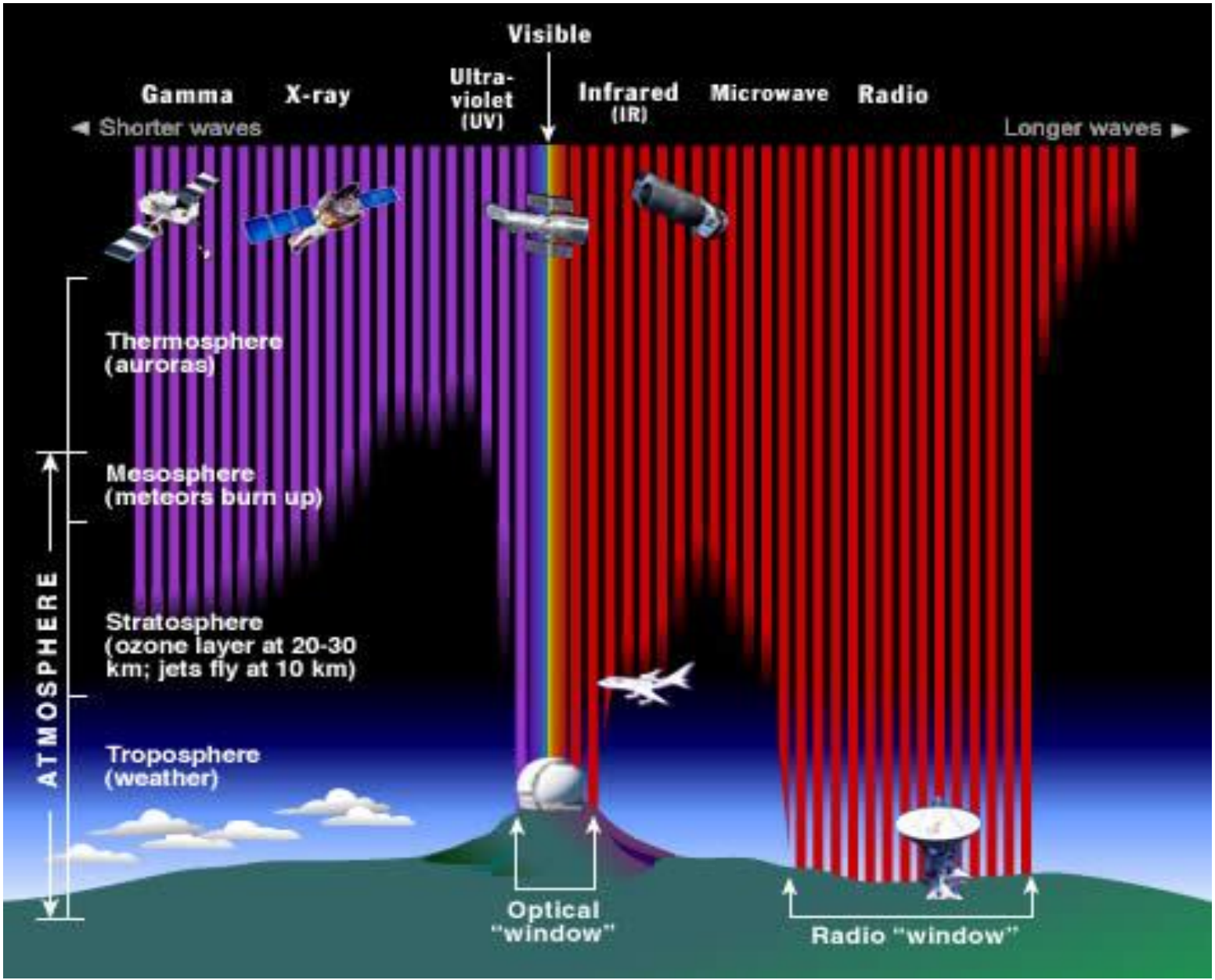
Ondas de rádio e raios gama são objetos físicos diferentes?

- Resposta: Elas são produzidas de maneiras (processos físicos) diferentes, são detectadas através de diferentes técnicas, mas são essencialmente o mesmo objeto: uma onda! Uma radiação eletromagnética.

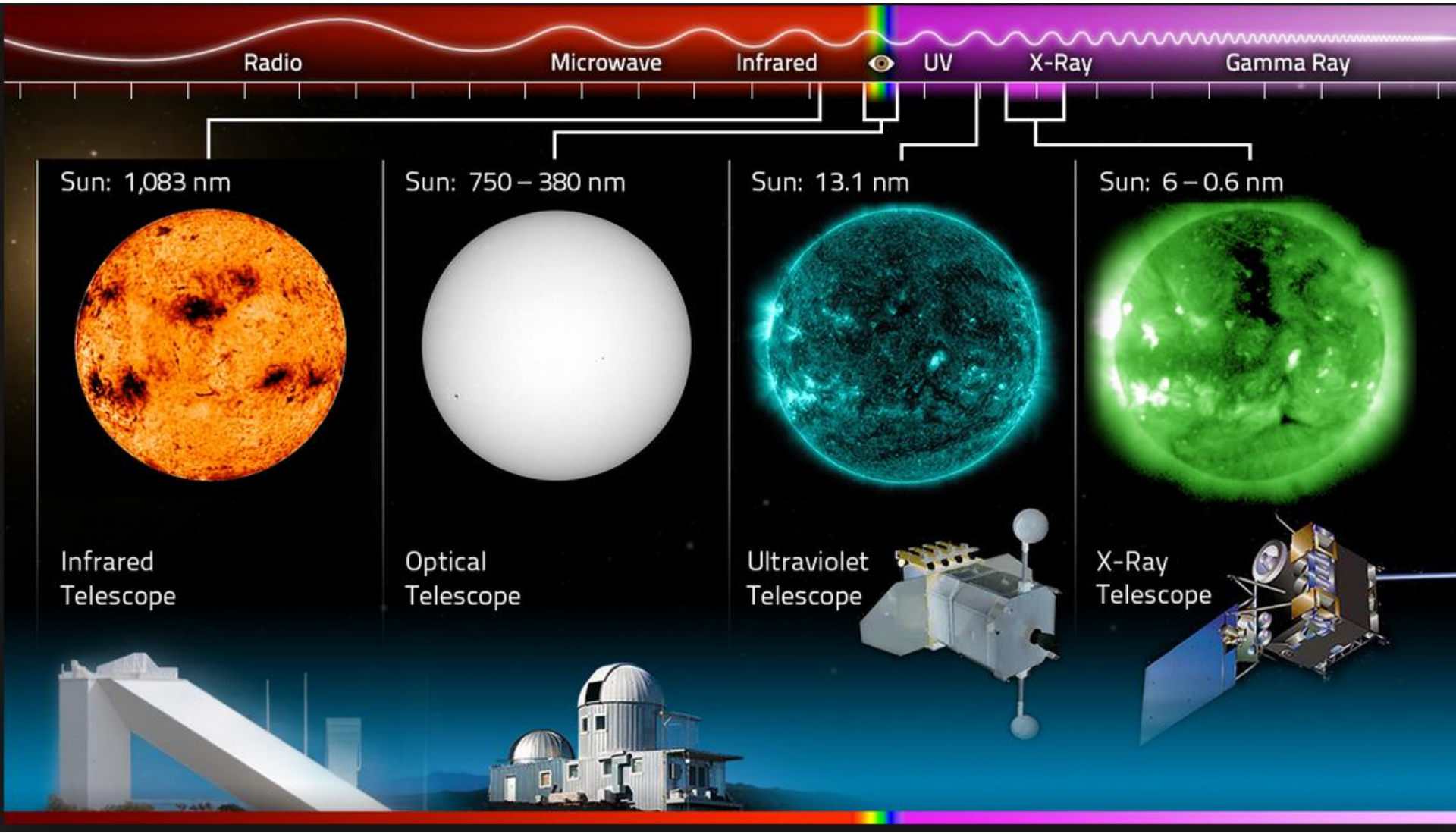
Como descrever esse objeto?

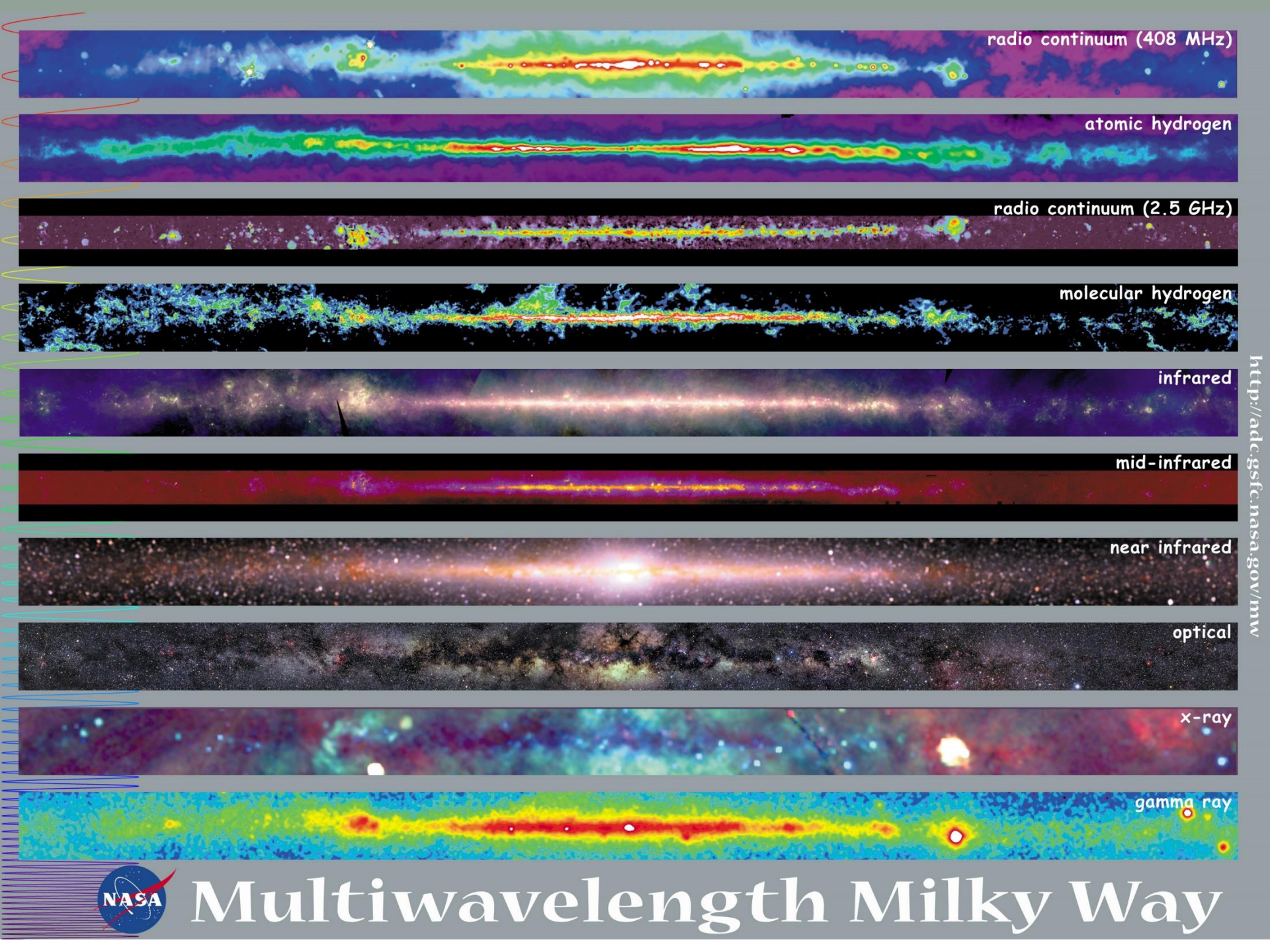
- Resposta: Imaginamos a existência de uma partícula chamada FÓTON. Fótons possuem características ondulatórias e viajam a velocidade da luz no meio. Cada fóton possui uma frequência, logo, cada fóton possui uma certa quantidade de energia.

Como diferentes partes do espectro atravessam a atmosfera



O sol visto em diferentes frequências




radio continuum (408 MHz)
atomic hydrogen
radio continuum (2.5 GHz)
molecular hydrogen
infrared
mid-infrared
near infrared
optical
x-ray
gamma ray
http://adc.gsfc.nasa.gov/mw
NASA
Multiwavelength Milky Way

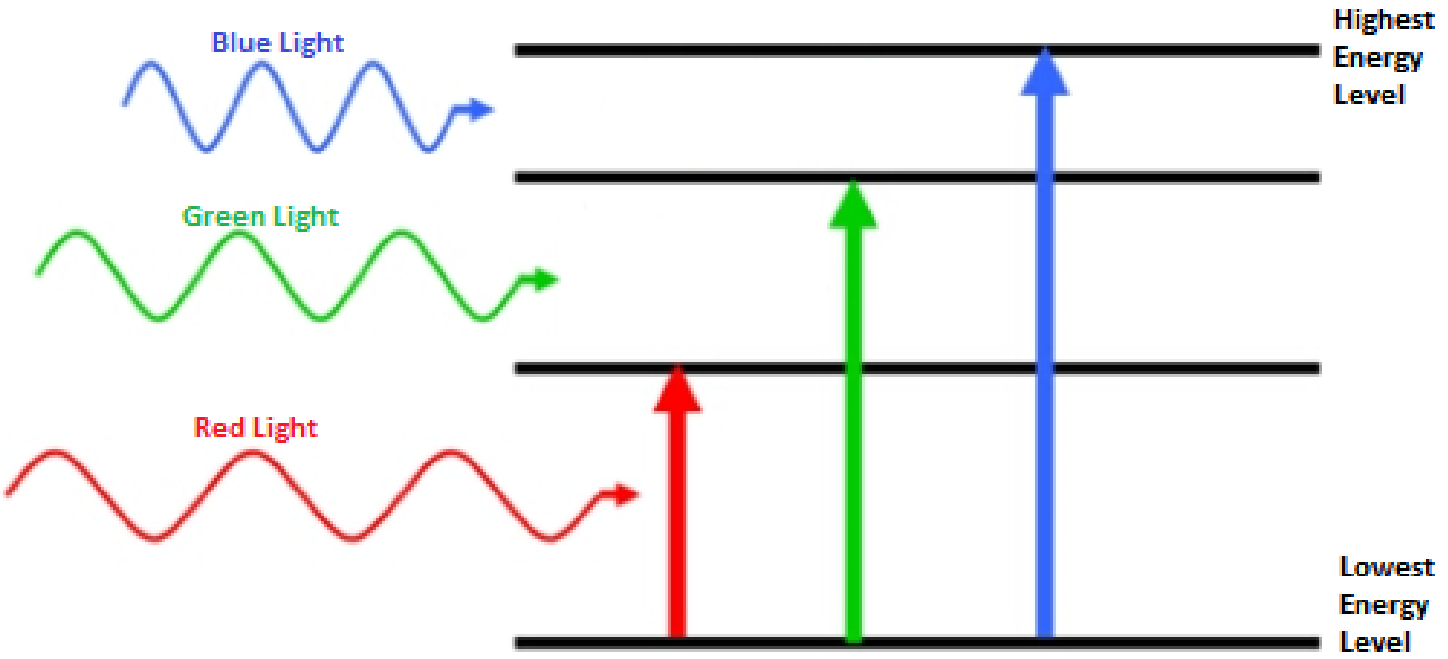

Como os Átomos Emitem Luz
©2001 HowStuffWorks
Partículas
1
Núcleo
2
3
1. Uma colisão com uma partícula em movimento excita o átomo.
2. Isso faz com que o elétron passe para um nível mais alto de energia.
3. O elétron retorna ao seu nível de energia inicial, liberando a energia excedente na forma de um fóton de luz.
Fóton de Luz

$$E = h\nu$$

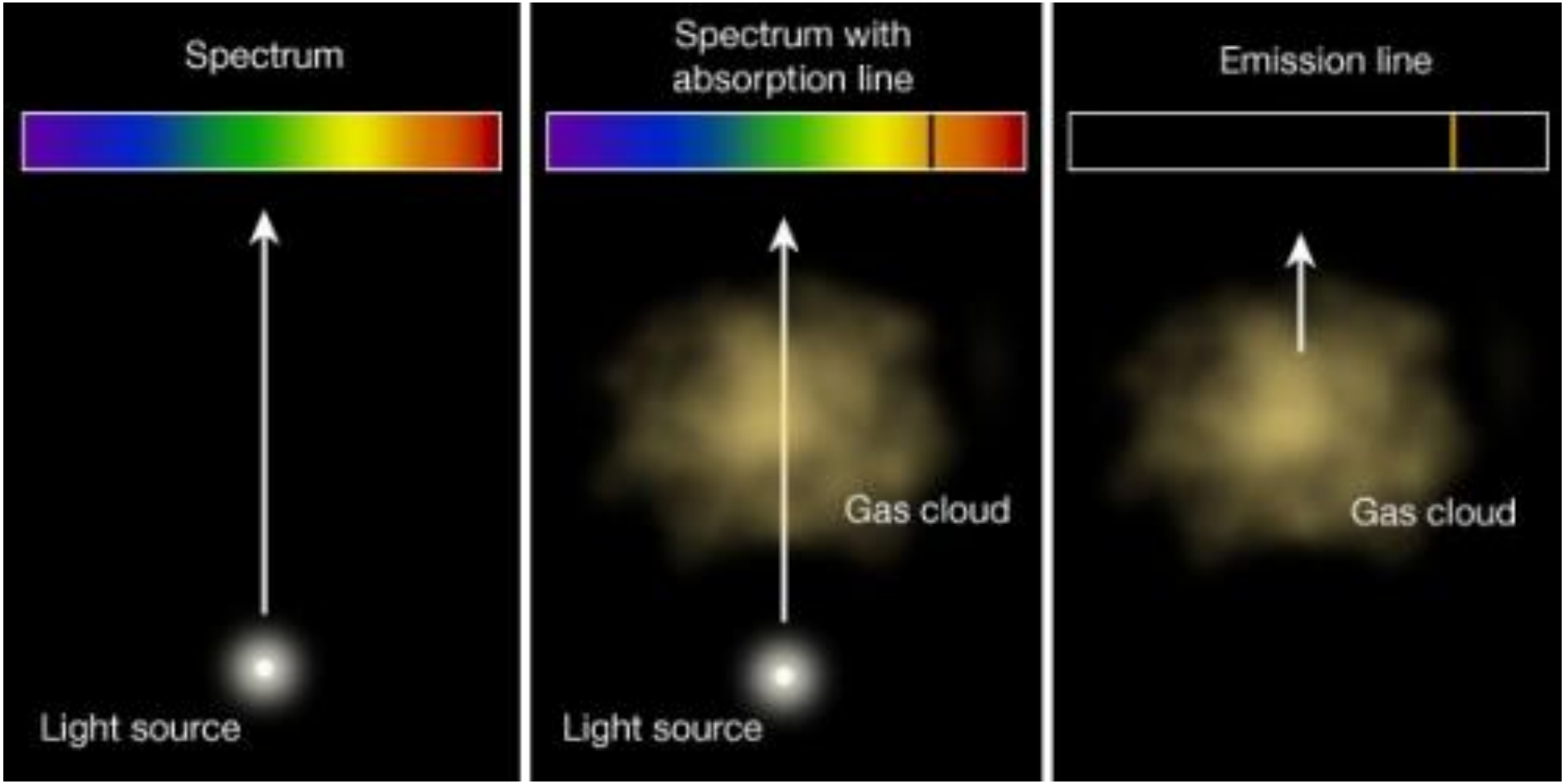
frequency of radiation, sometimes written as f
giving expression E = hf.

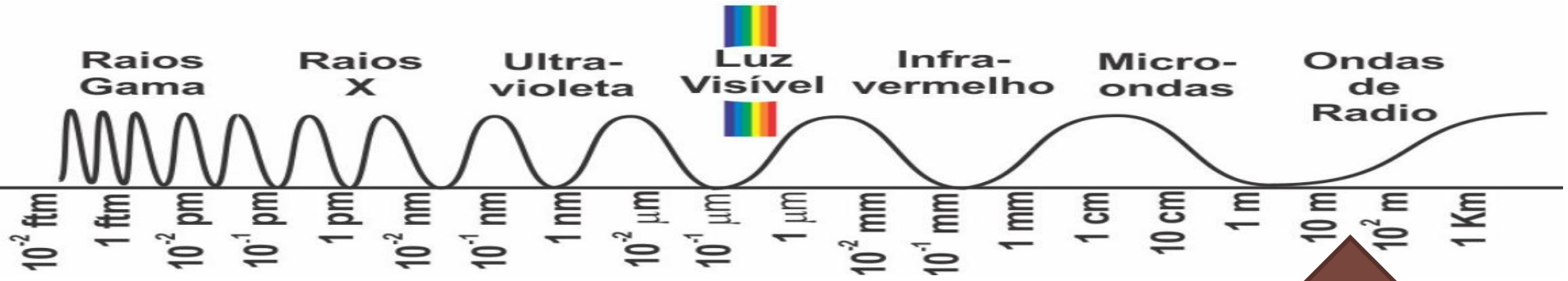
Quantum energy of a photon.

h = Planck's constant = 6.626×10^{-34} Joule·sec = 4.136×10^{-15} eV· s



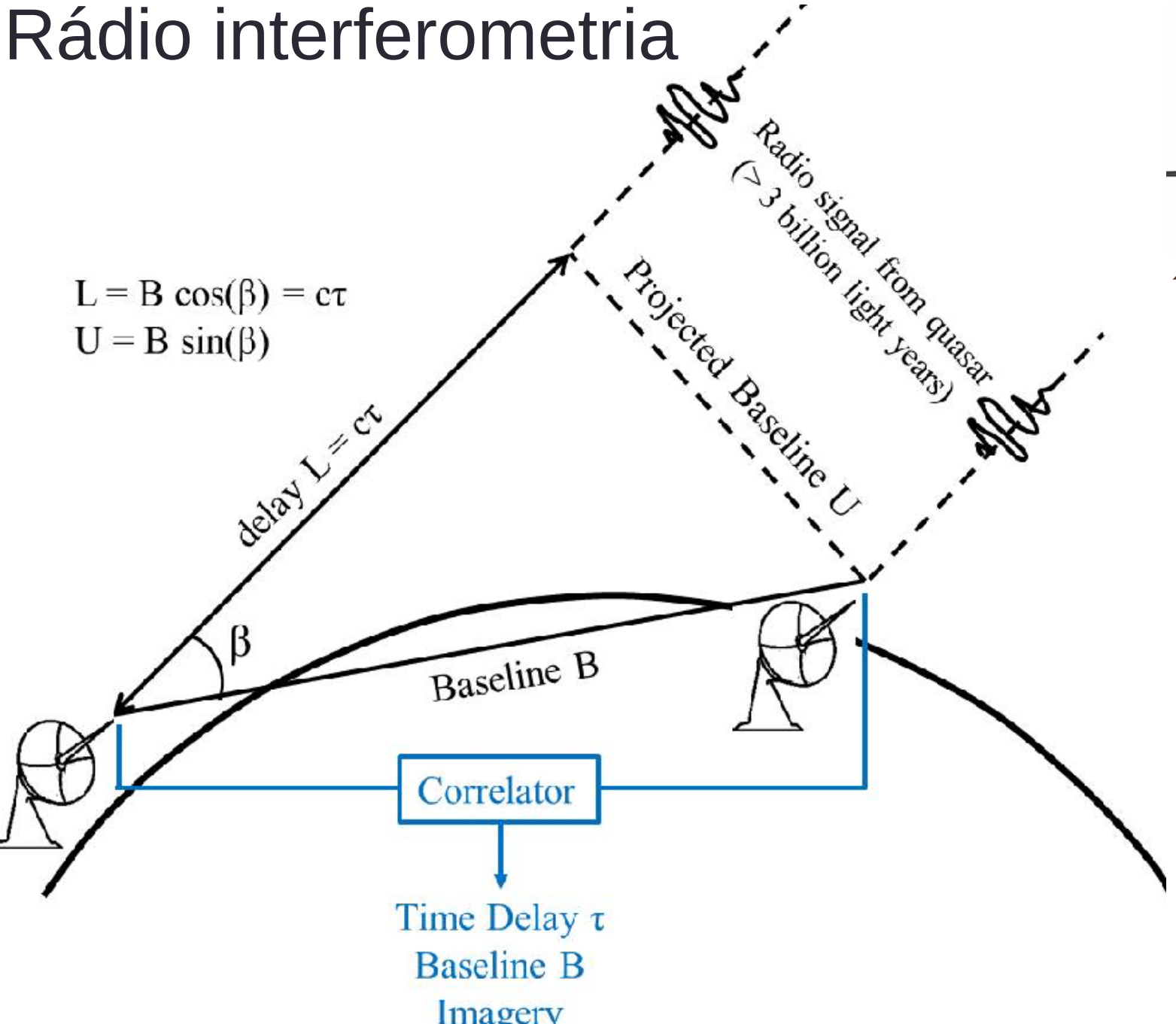
Espectroscopia astronômica

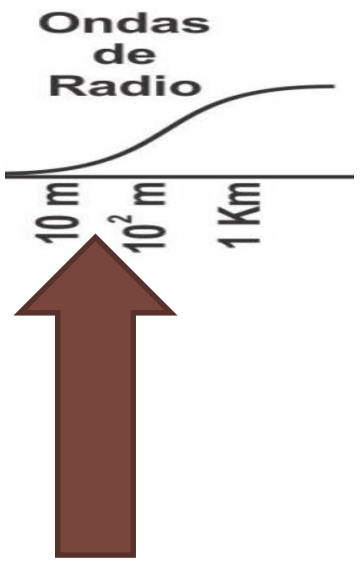




Radio Telescópios: 10MHz – 100MHz

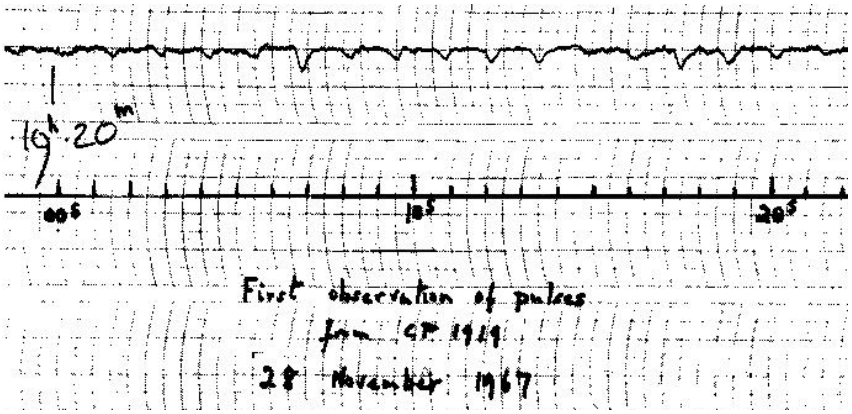
Rádio interferometria





Pulsating + Star = Pulsar

- O primeiro pulsar foi observado em 28 de Novembro de 1967, por Jocelyn Bell Burnell e Antony Hewish

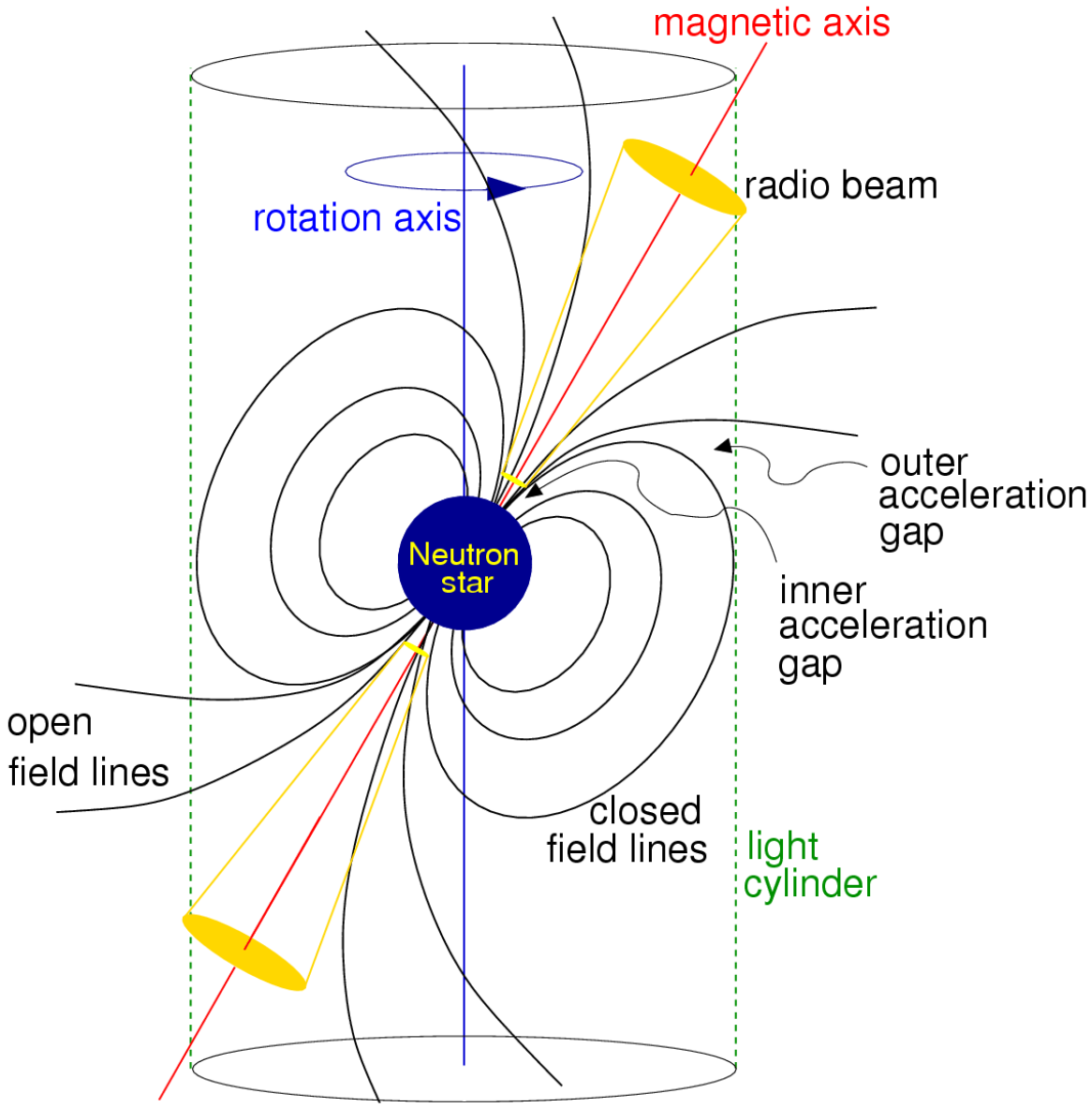


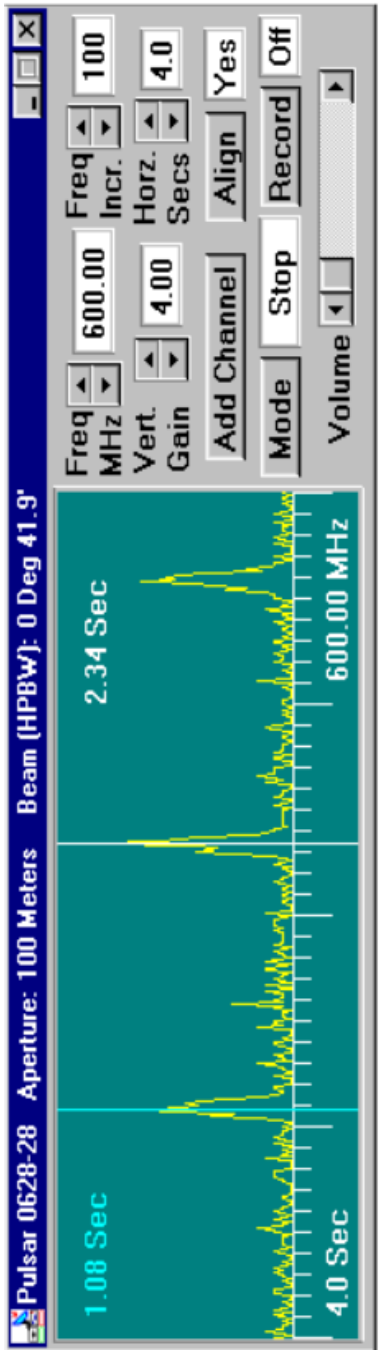
KUNGL. VETENSKAPSAKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

Press Release

15 October 1974

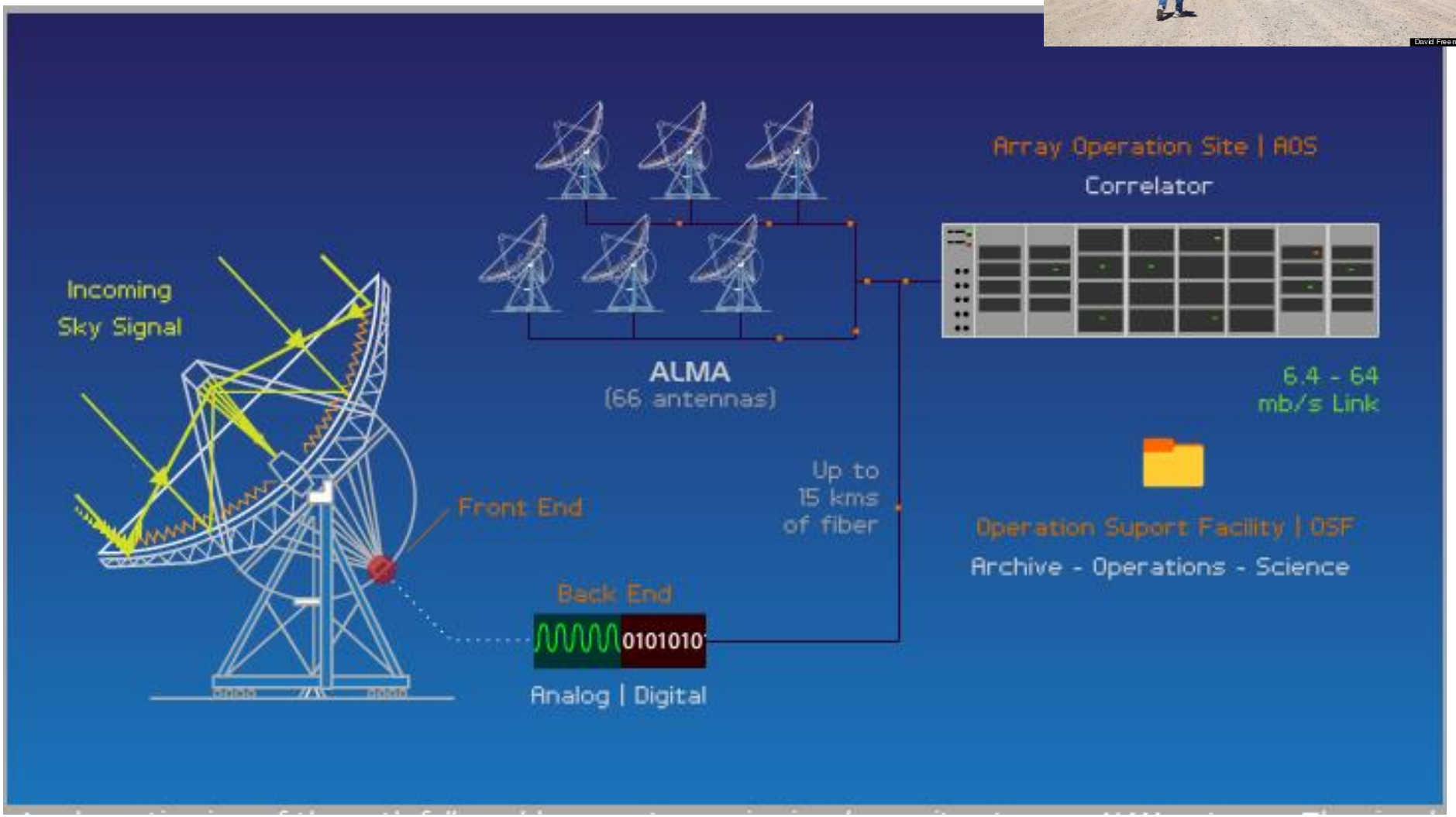
The Royal Swedish Academy of Sciences has awarded Professor **Martin Ryle** and Professor **Antony Hewish** the 1974 Nobel Prize in Physics. Professors **Ryle** and **Hewish** have been awarded the Prize **for their pioneering research in radioastrophysics: Ryle for his observations and inventions, in particular of the aperture-synthesis technique**, and **Hewish for his decisive role in the discovery of pulsars.**


magnetic axis
rotation axis
radio beam
outer
acceleration
gap
inner
acceleration
gap
Neutron
star
open
field lines
closed
field lines
light
cylinder

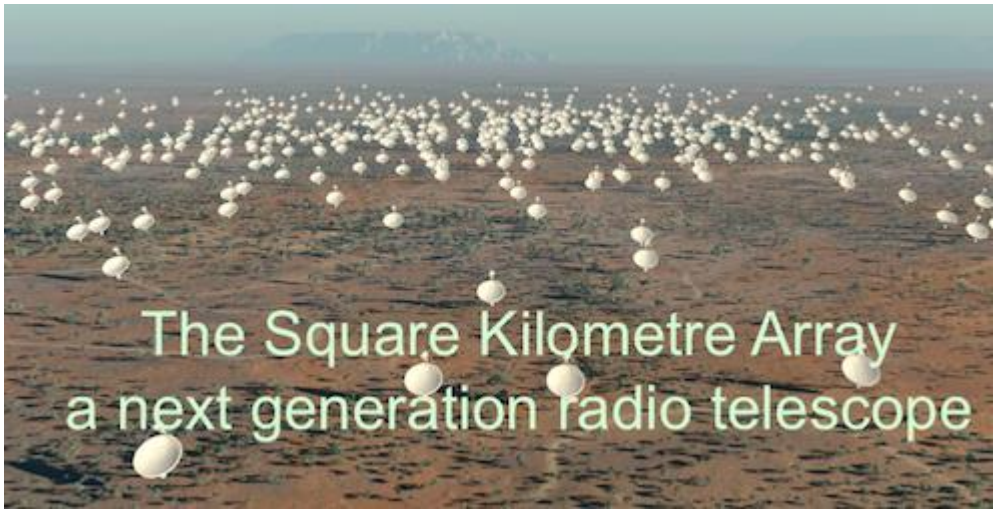

Pulsar 0628-28 Aperture: 100 Meters Beam (HPBW): 0 Deg 41.9'
Freq MHz
600.00
Vert. Gain
4.00
Add Channel
Mode
Stop
Freq Incr.
100
Horz. Secs
4.0
Align
Yes
Record
Off
Volume
2.34 Sec
600.00 MHz
1.08 Sec
4.0 Sec

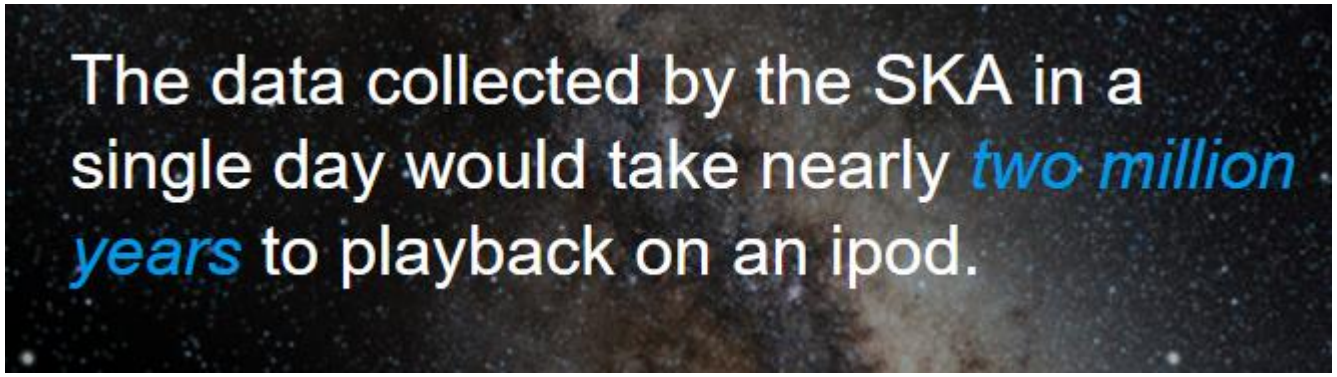
Atacama Large Millimeter/submillimeter Array

In search of our Cosmic Origins




SKA
SQUARE KILOMETRE ARRAY
SKA TELESCOPE
SQUARE KILOMETRE ARRAY
Exploring the Universe with the world's largest radio telescope
Choose your local minisite


The Square Kilometre Array
a next generation radio telescope

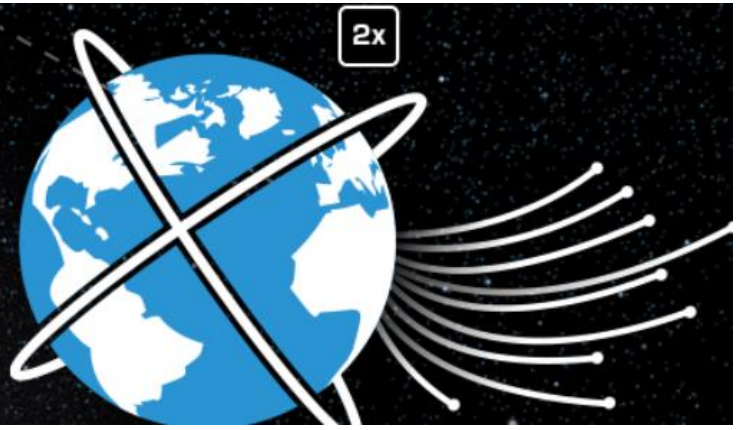

The data collected by the SKA in a single day would take nearly two million years to playback on an ipod.

The SKA will be so sensitive that it will be able to detect an airport radar on a planet *tens of light years away*.

The SKA central computer will have the processing power of about *one hundred million PCs*.

The dishes of the SKA will produce *10 times* the global internet traffic.

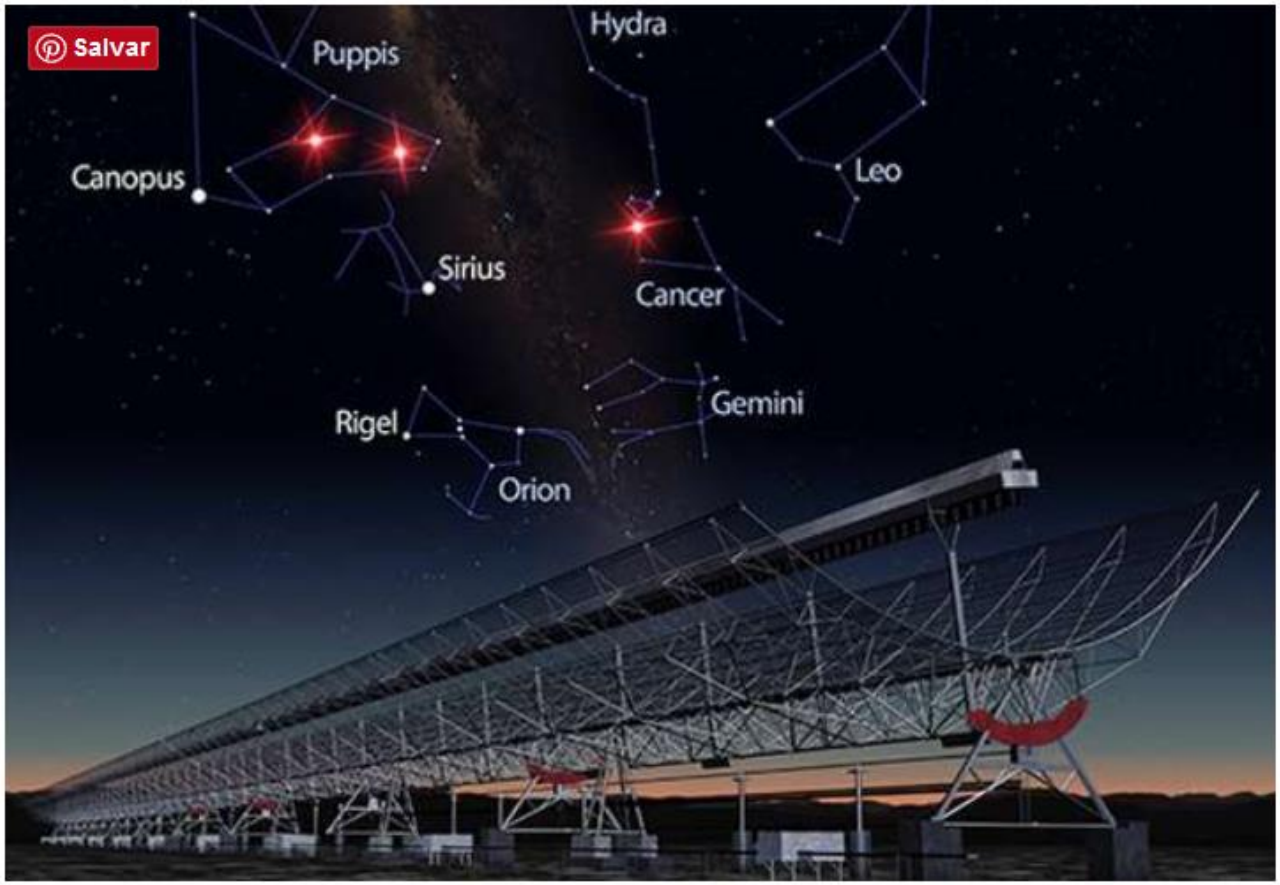
The SKA will use enough optical fibre to wrap *twice around the Earth*!



Mistério recentes

Mysterious bursts of energy do come from outer space

April 3, 2017 by Lea Kivivali

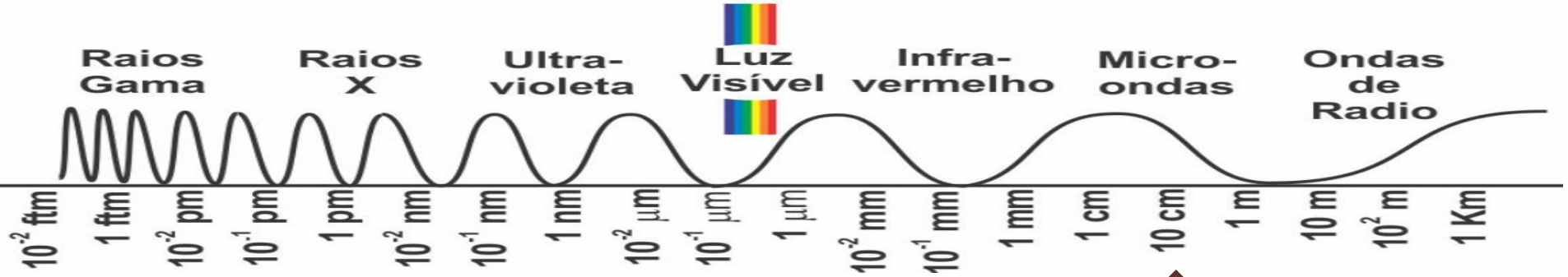


Artist's impression shows three bright red flashes depicting fast radio bursts far beyond the Milky Way, appearing in the constellations Puppis and Hydra. Credit: James Josephides/Mike Dalley.

Fast Radio Bursts (FRBs)

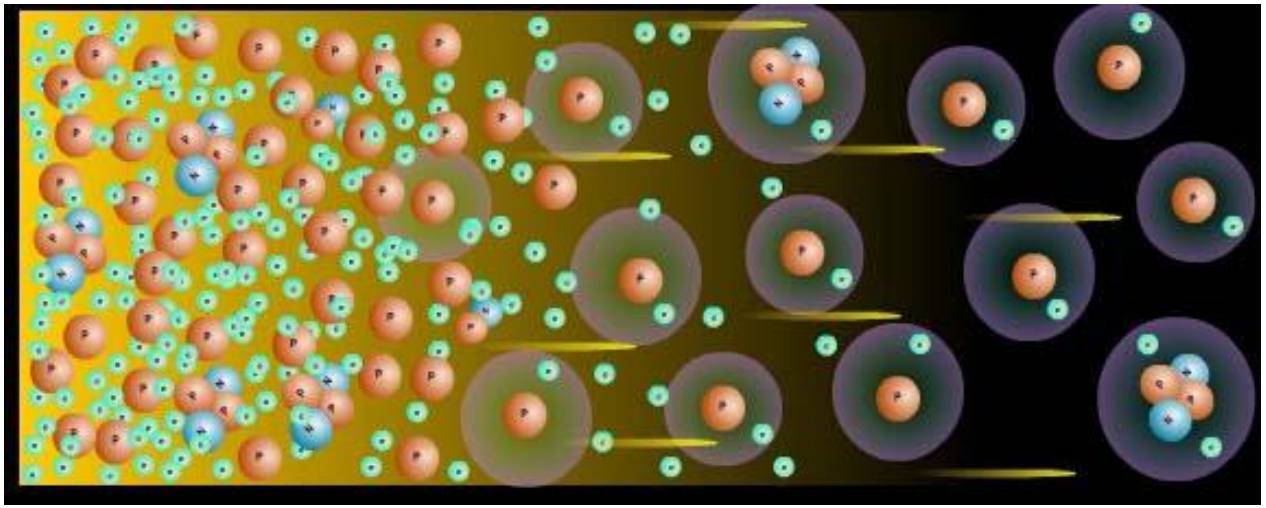
Sinais de curta duração (~mili segundo) provenientes de outra galáxia.

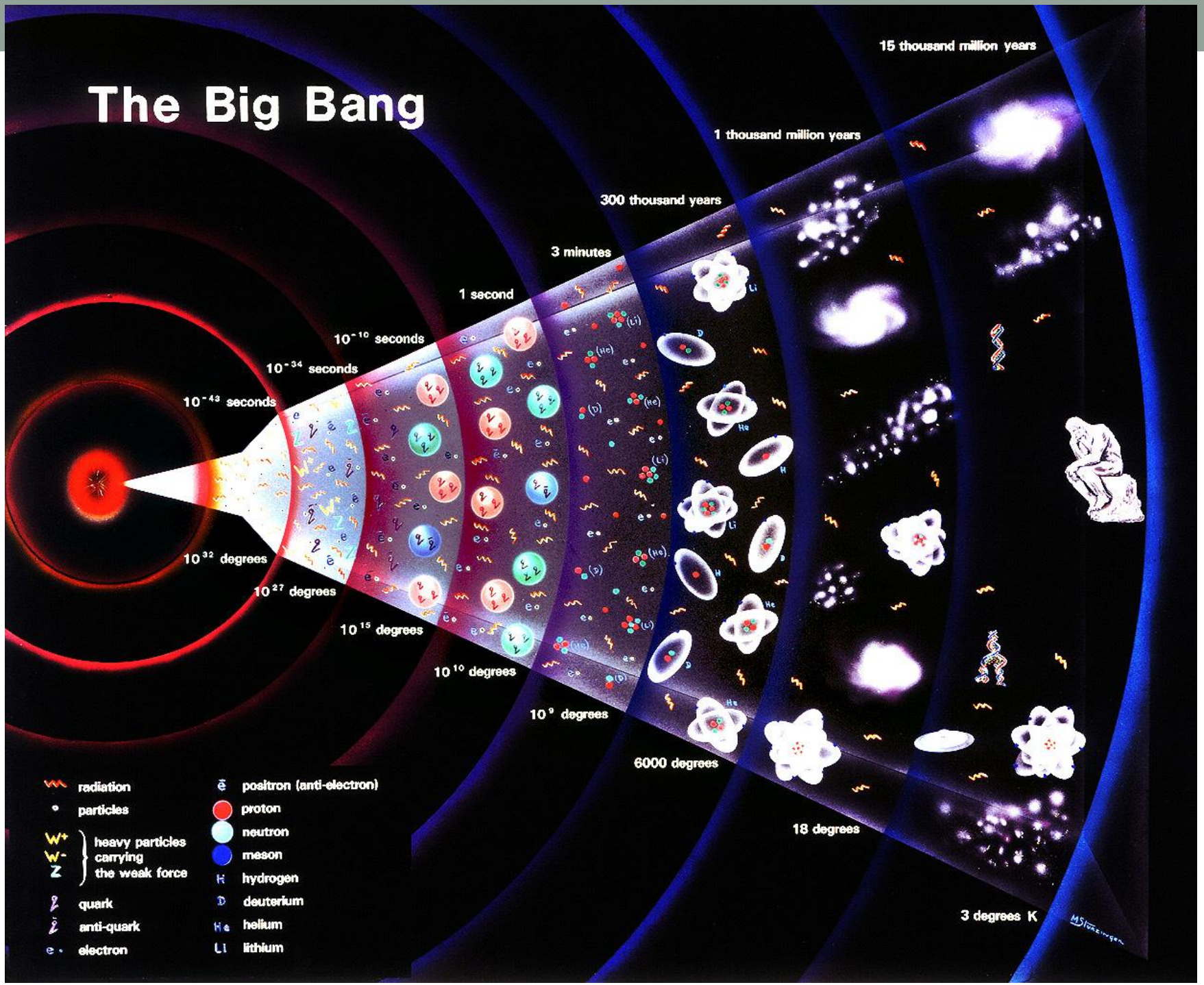
Intensidade 1 bilhão de vezes os sinais de rádio provenientes da nossa galáxias.

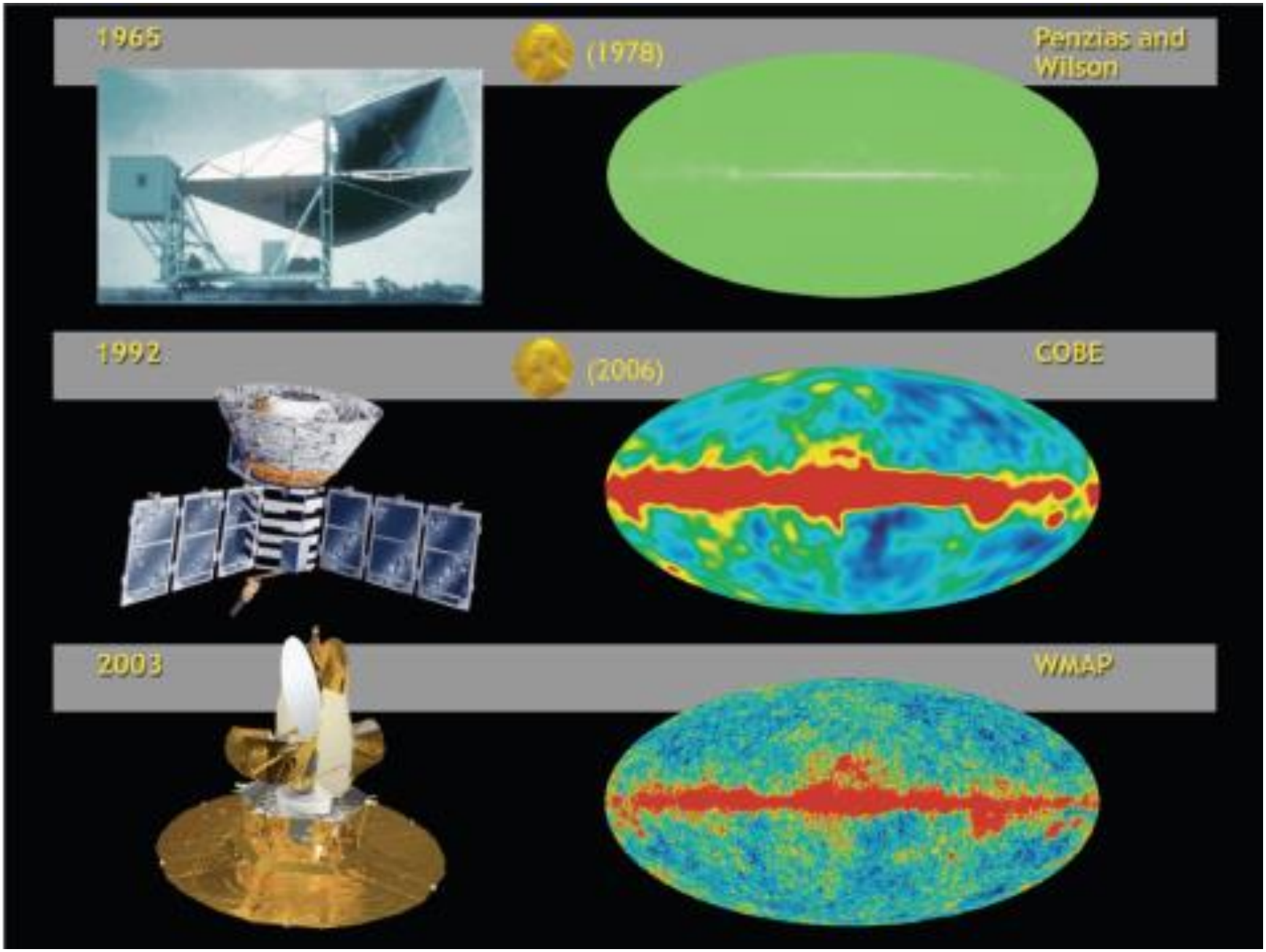


Micro-ondas:

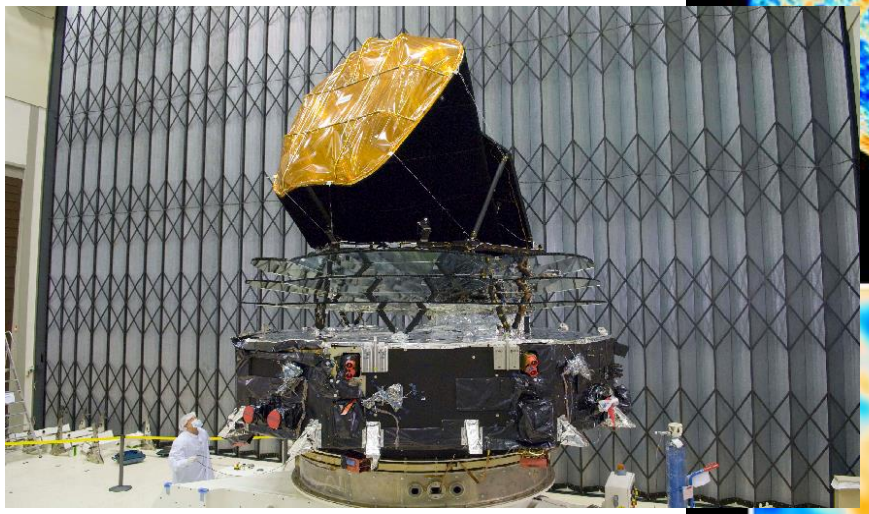
A Radiação emitida pelo universo quando ele tinha apenas 300.000 anos chega até nós hoje na faixa de micro-ondas



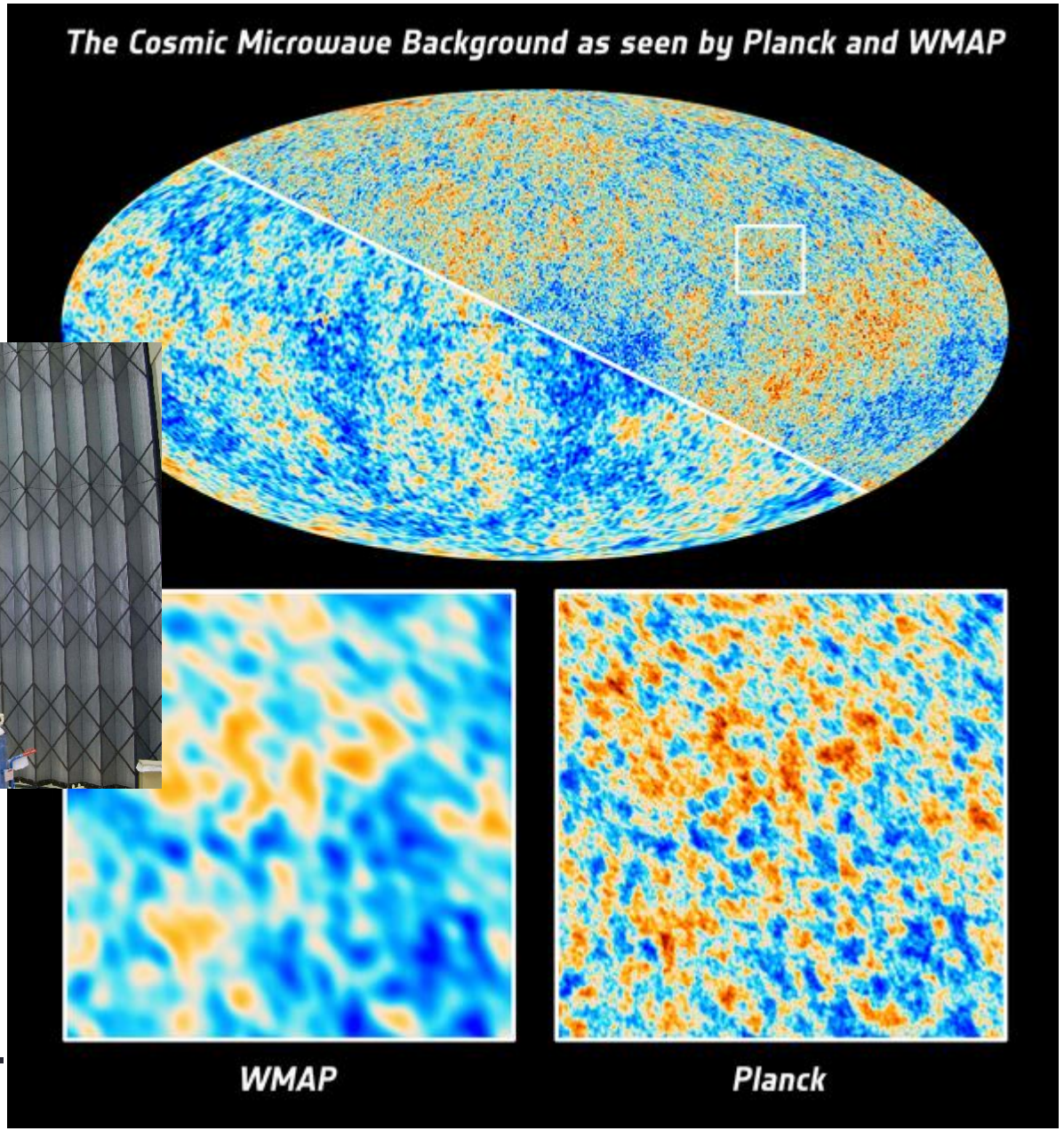

The Big Bang
15 thousand million years
1 thousand million years
300 thousand years
3 minutes
1 second
10⁻¹⁰ seconds
10⁻³⁴ seconds
10⁻⁴³ seconds
10³² degrees
10²⁷ degrees
10¹⁵ degrees
10¹⁰ degrees
10⁹ degrees
6000 degrees
18 degrees
3 degrees K
radiation
particles
W+ W- Z heavy particles carrying the weak force
quark
anti-quark
electron
positron (anti-electron)
proton
neutron
meson
H hydrogen
D deuterium
He helium
Li lithium


1965
(1978)
Penzias and Wilson
1992
(2006)
COBE
2003
WMAP

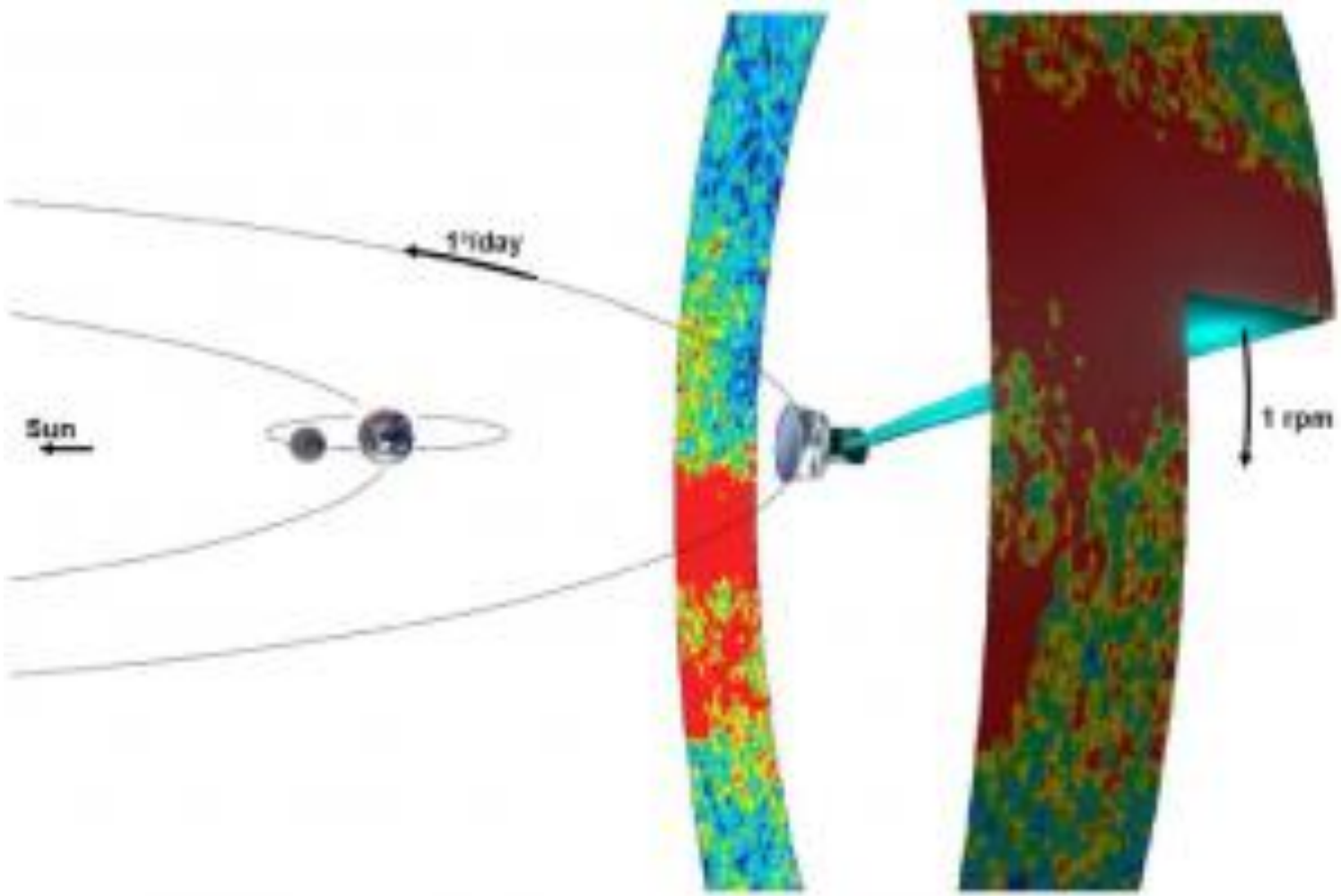
Satélite PLANCK

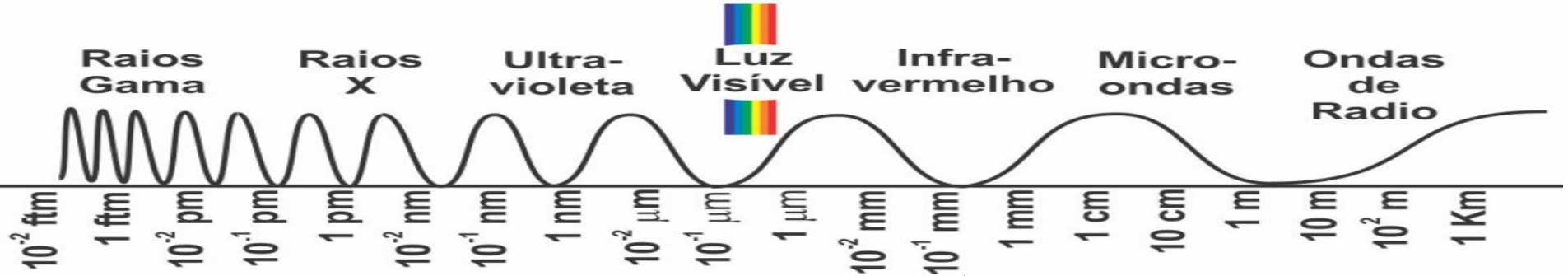


Lançado em 2009.
Coletou dados até 2013.



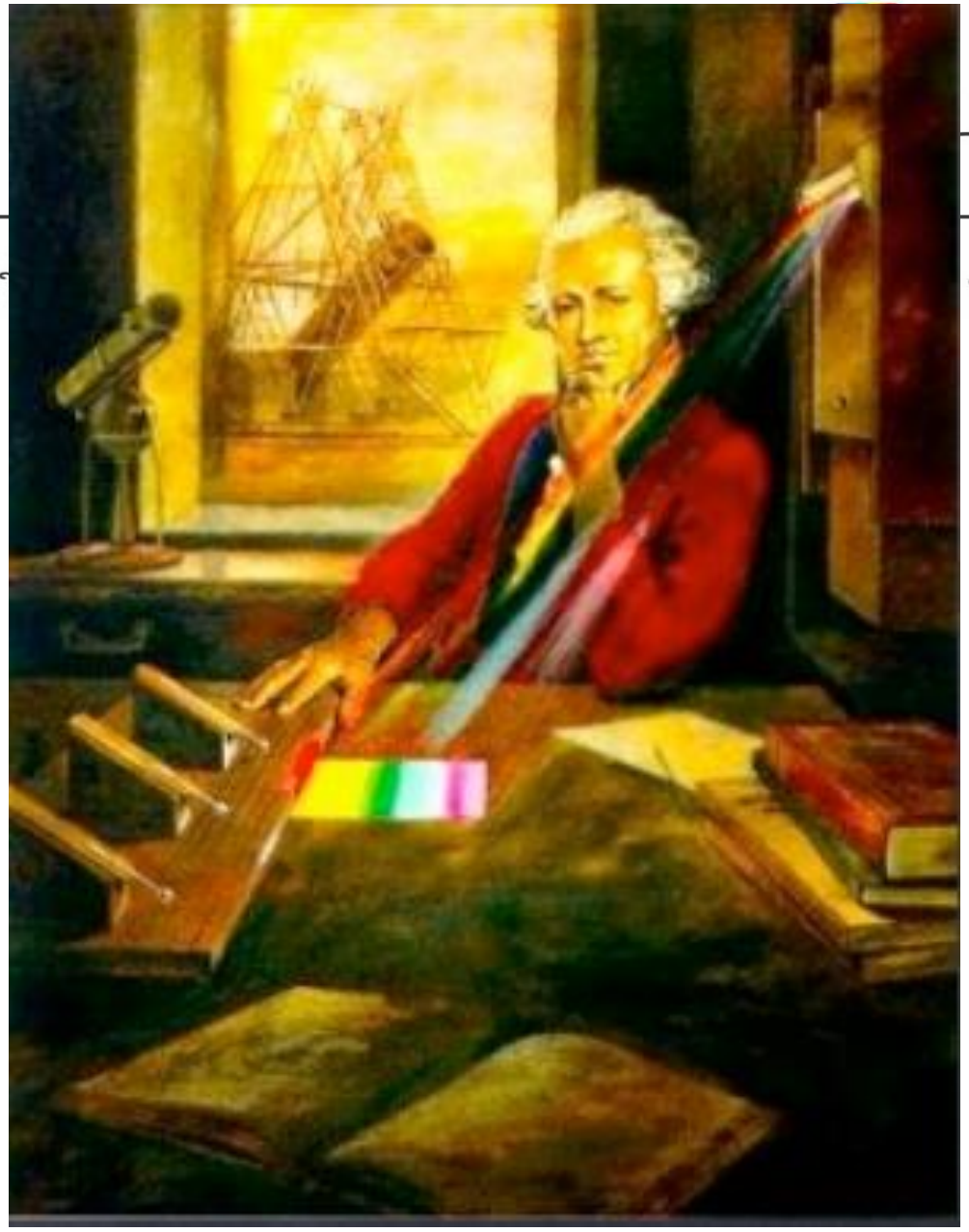
Estratégia de observação: Satélite PLANCK - ESA

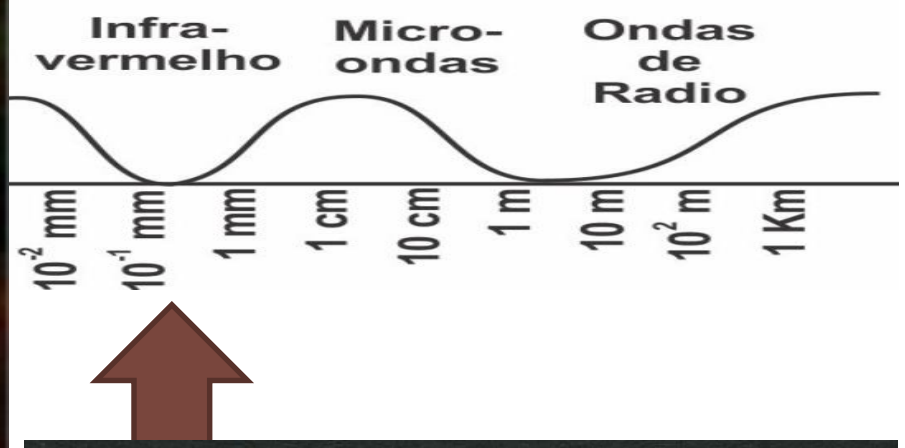




Infra-vermelho:

1) Atravessa a poeira interestelar, que geralmente bloqueia a luz visível.
2) Nos permite observar as galáxias mais distantes que conhecemos no universo



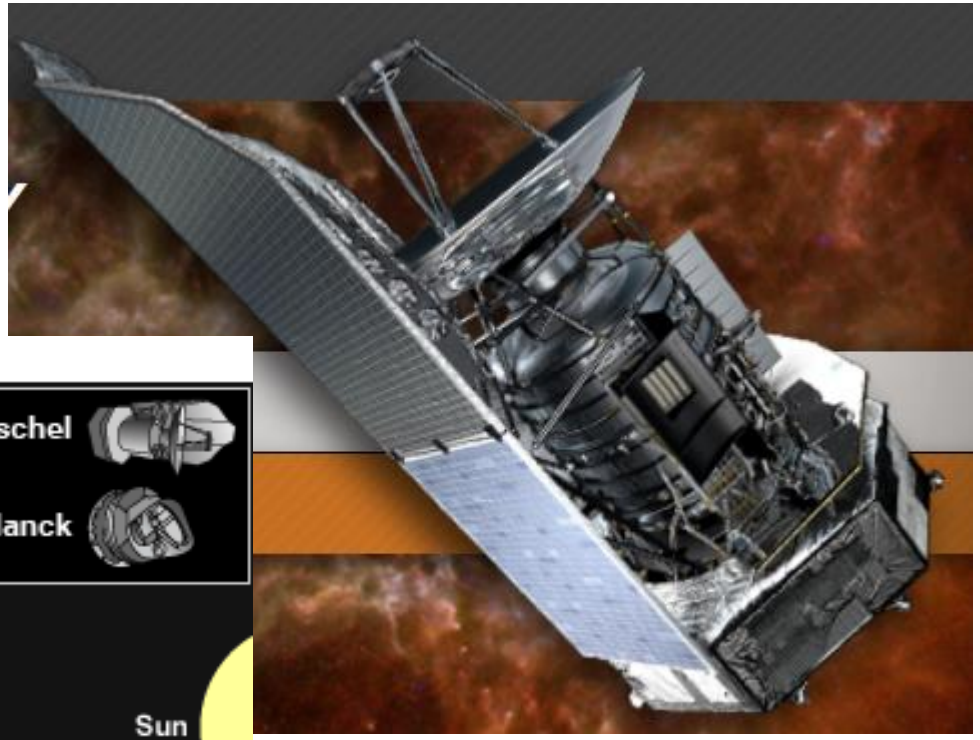


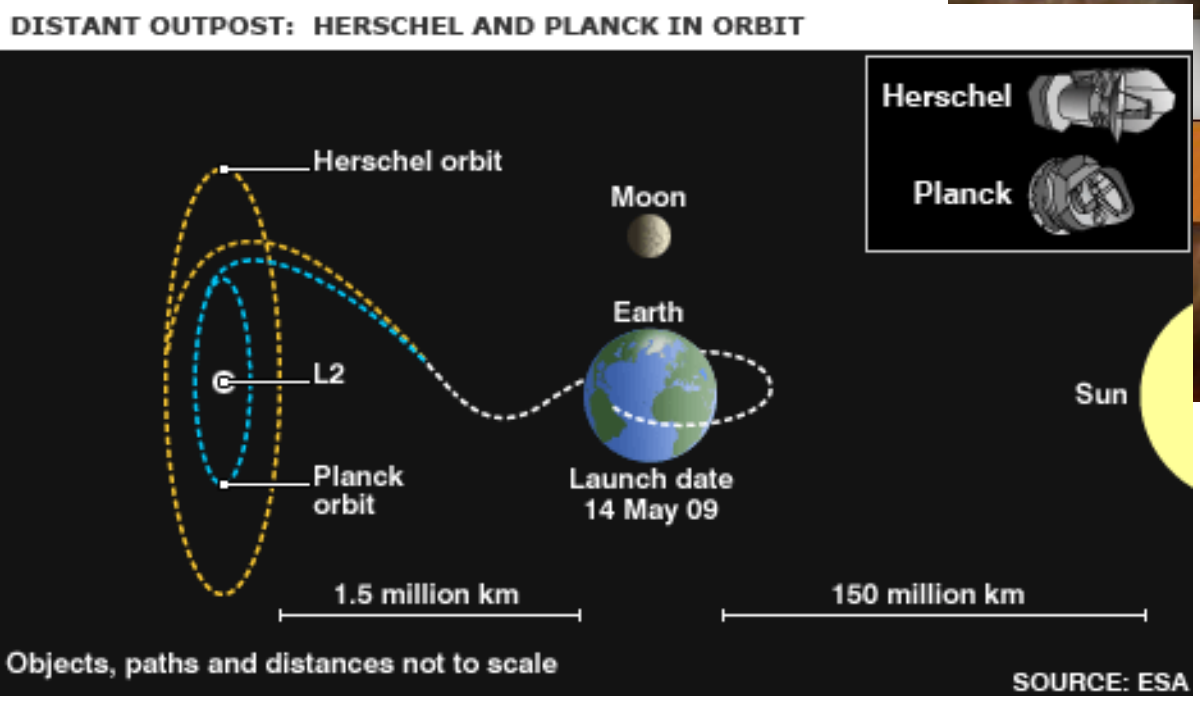
William Herschel 1800


Infrared
Visible

HERSCHEL SPACE OBSERVATORY
AN ESA MISSION WITH PARTICIPATION FROM NASA

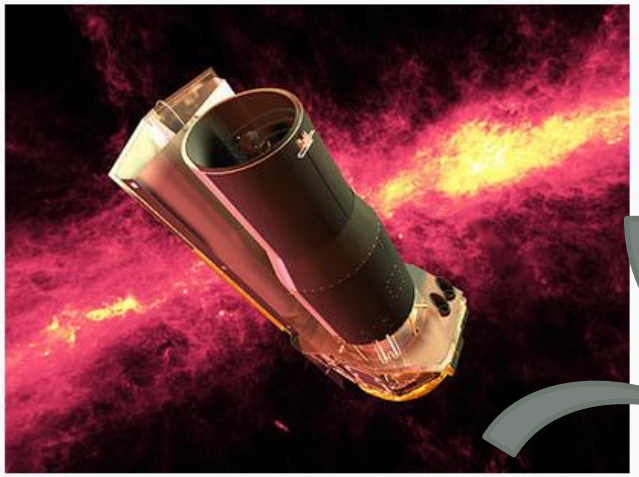
Detectou vapor de água no asteroide CERES





Confirmou a existência de Oxigênio molecular no espaço

SPITZER SPACE TELESCOPE



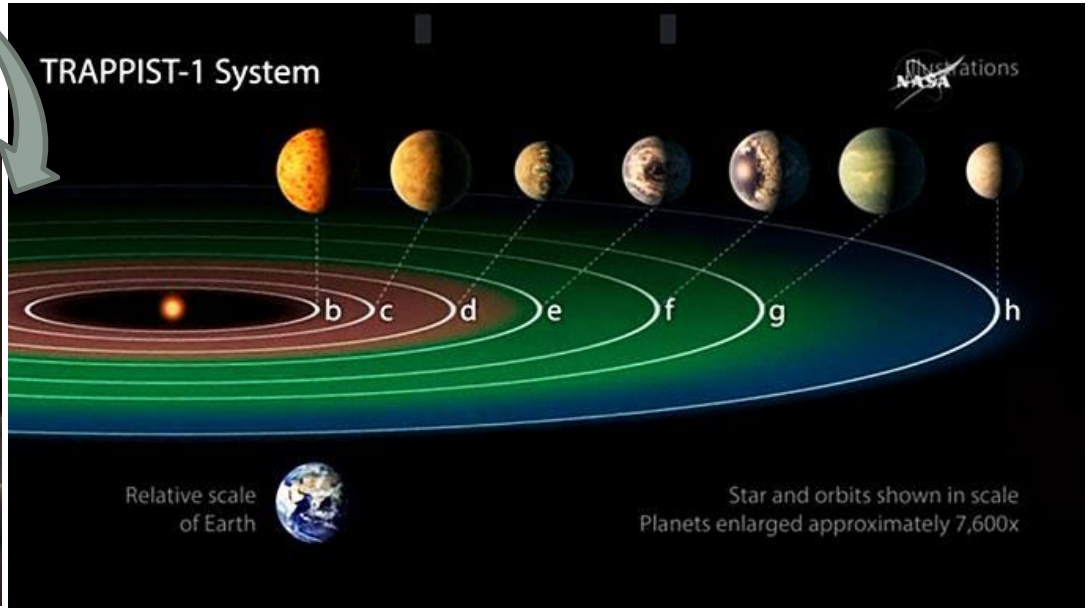
Artist rendering of the Spitzer Space Telescope

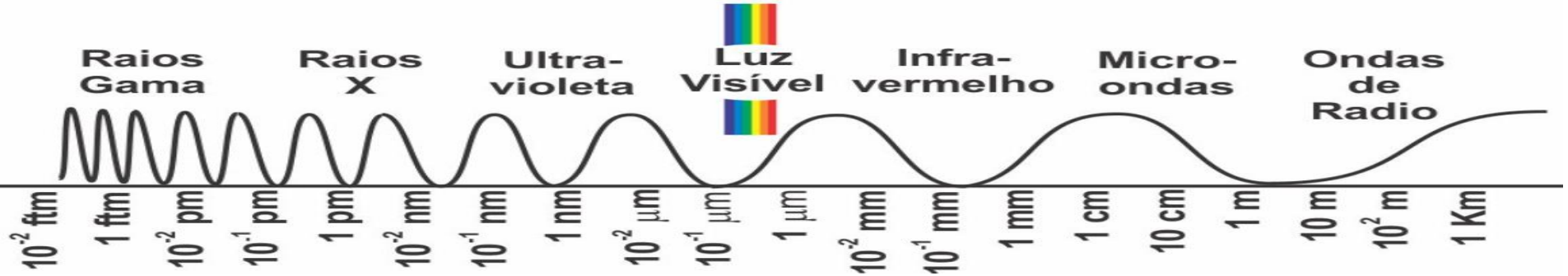
nature International weekly journal of science

Nature **440**, 308-310 (16 March 2006) | doi:10.1038/nature04554; Receiv
December 2005

A magnetic torsional wave near the Galactic Centre traced by a 'double helix' nebula

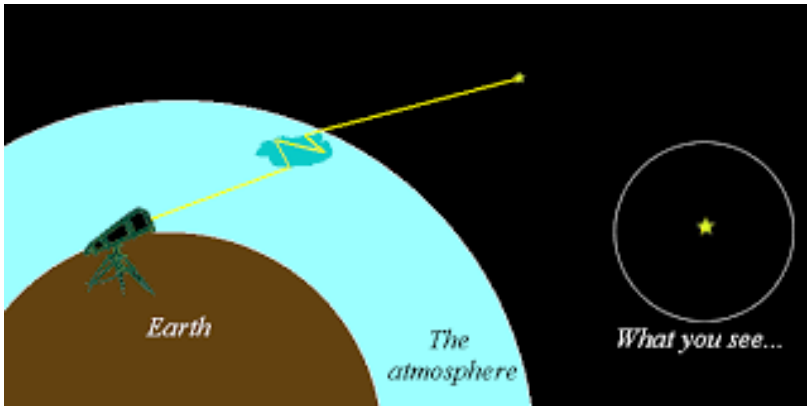
Mark Morris[1], Keven Uchida[2] & Tuan Do[1]

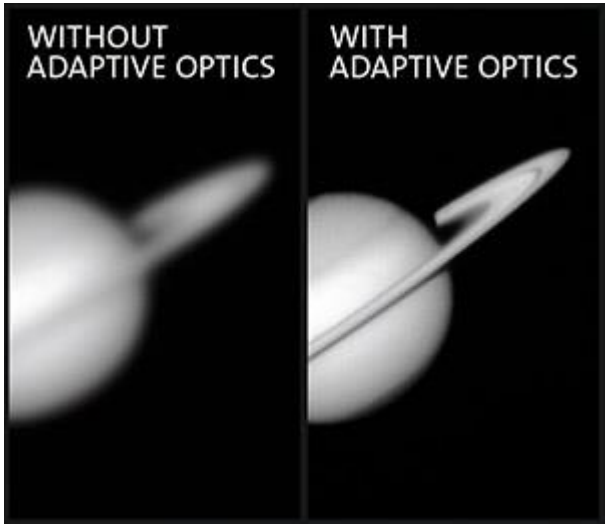




Visível:

Astronomia Ótica






Hubble Space Telescope

HUBBLE'S TOP BREAKTHROUGHS

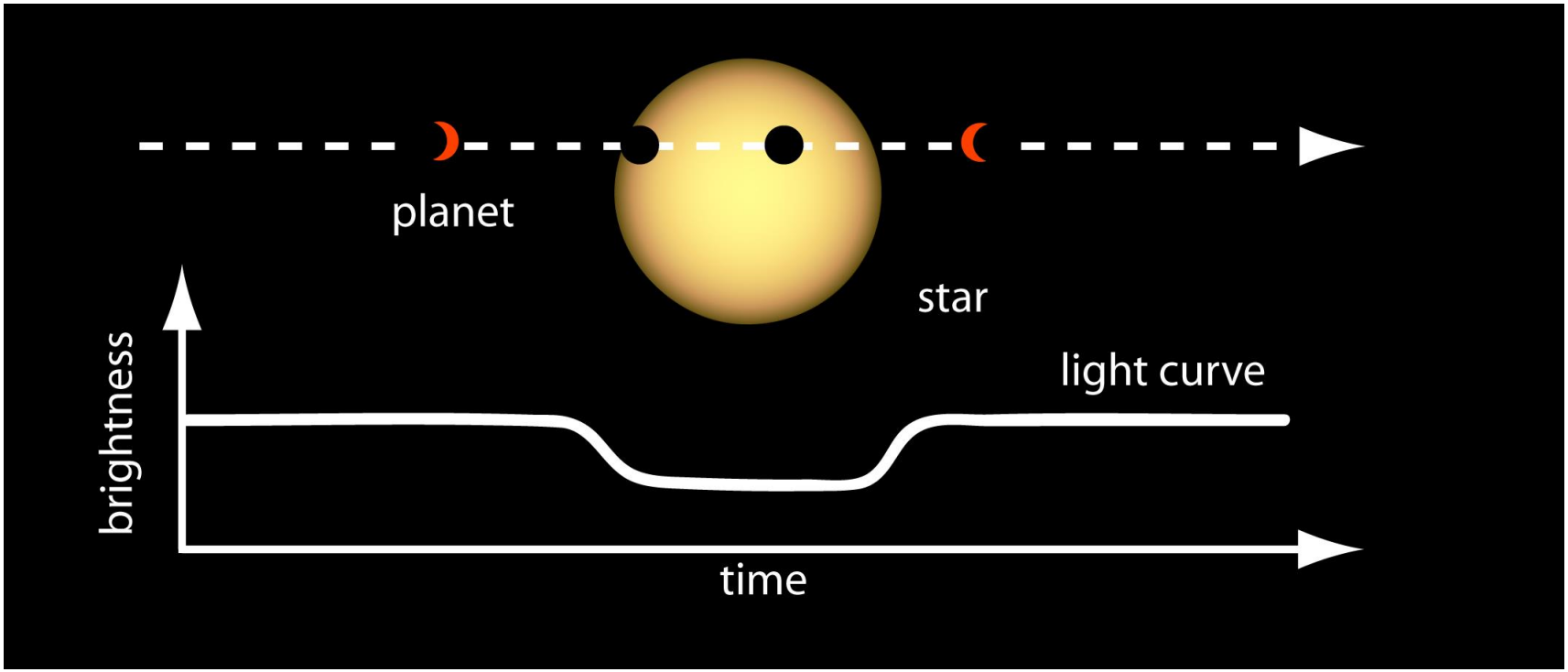
Orbiting the Earth for over two decades, Hubble has helped to answer some of the most compelling astronomical questions of our time – and uncovered mysteries we never knew existed. Investigating everything from black holes to planets around other stars, Hubble has changed the face of astronomy, ushering in a new chapter of humanity's exploration of the universe.

Choose a Topic ...

Ames Research Center

Kepler

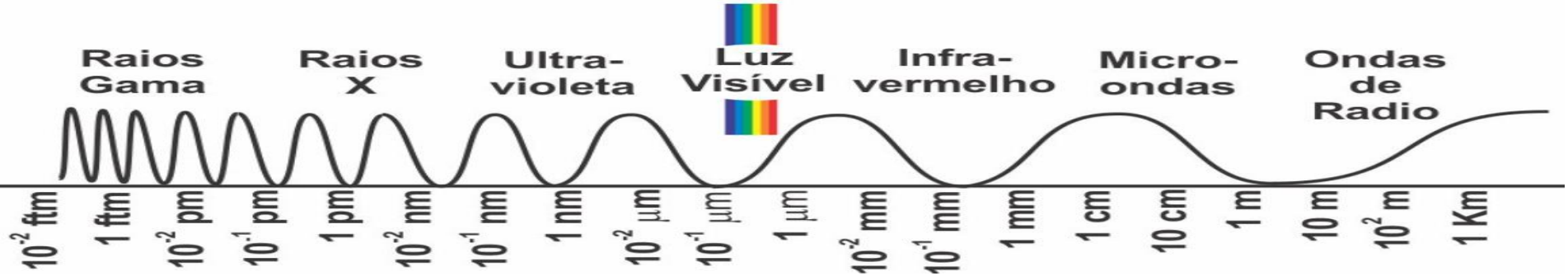
A Search for Habitable Planets



3,472 Confirmed Planets 03/30/2017 →

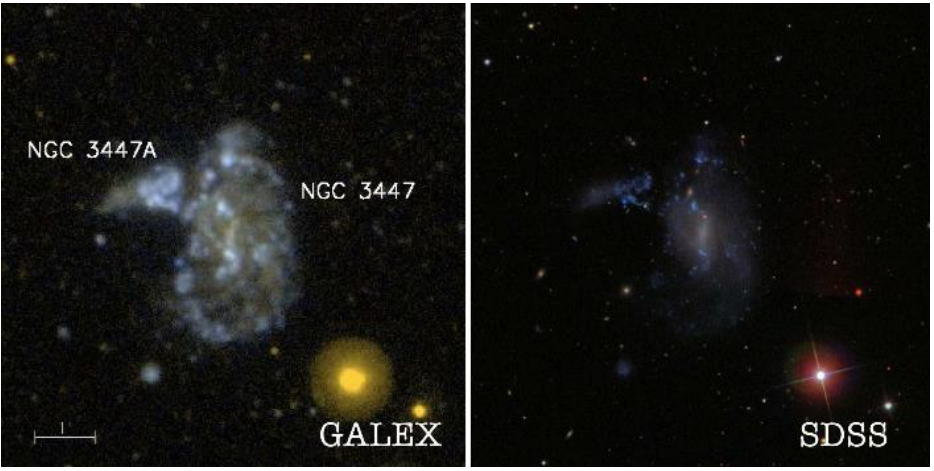
581 Multi-Planet Systems 03/30/2017 →

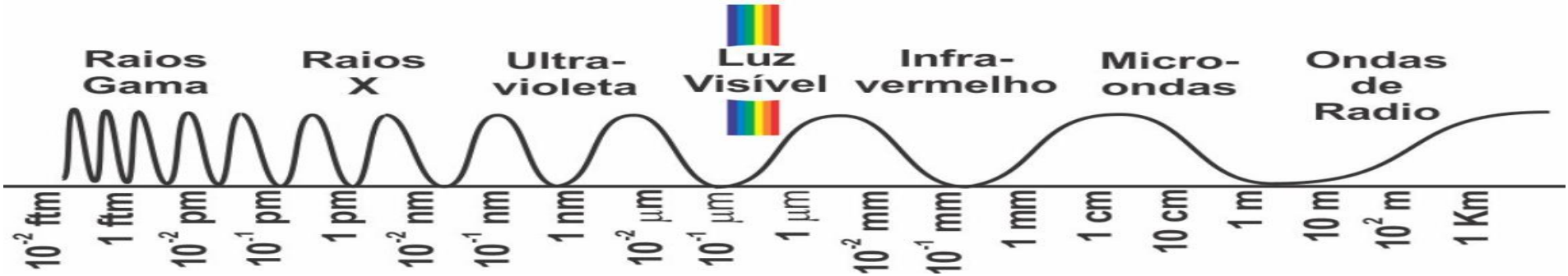
4,496 Kepler Candidates 03/23/2017 →



Ultra-violeta:

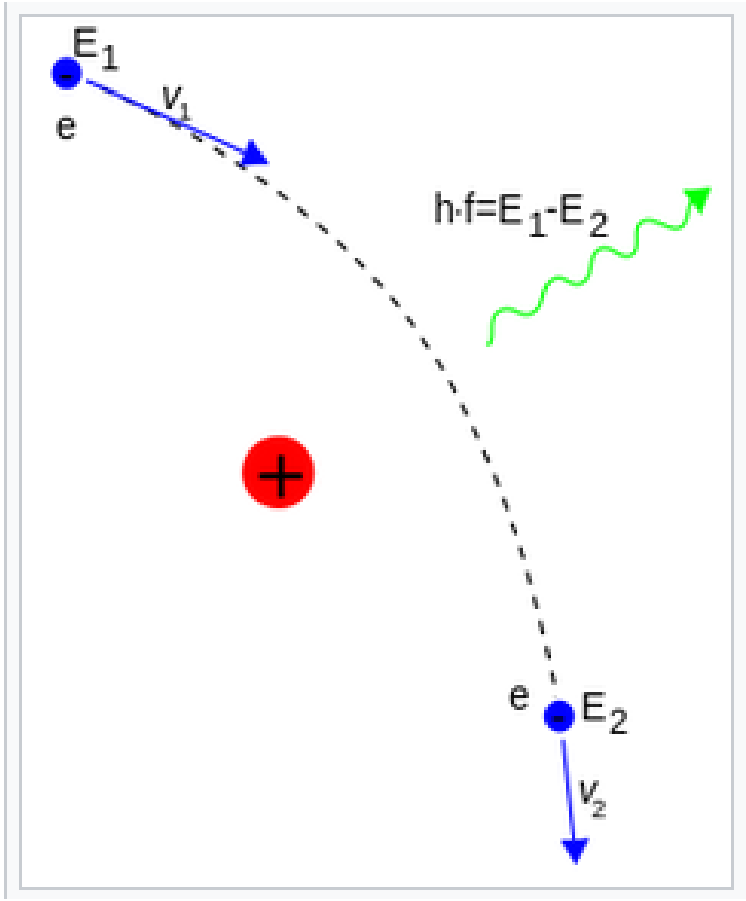
Mapeamento da história da formação estelar

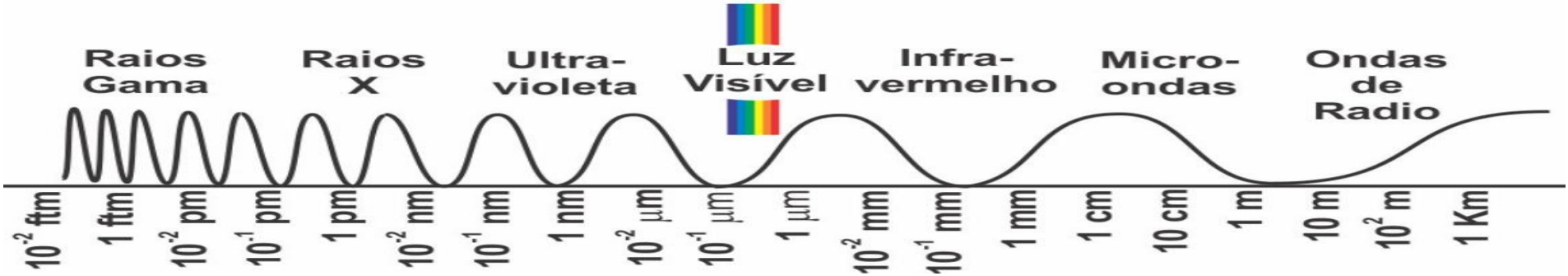




Raios-X:

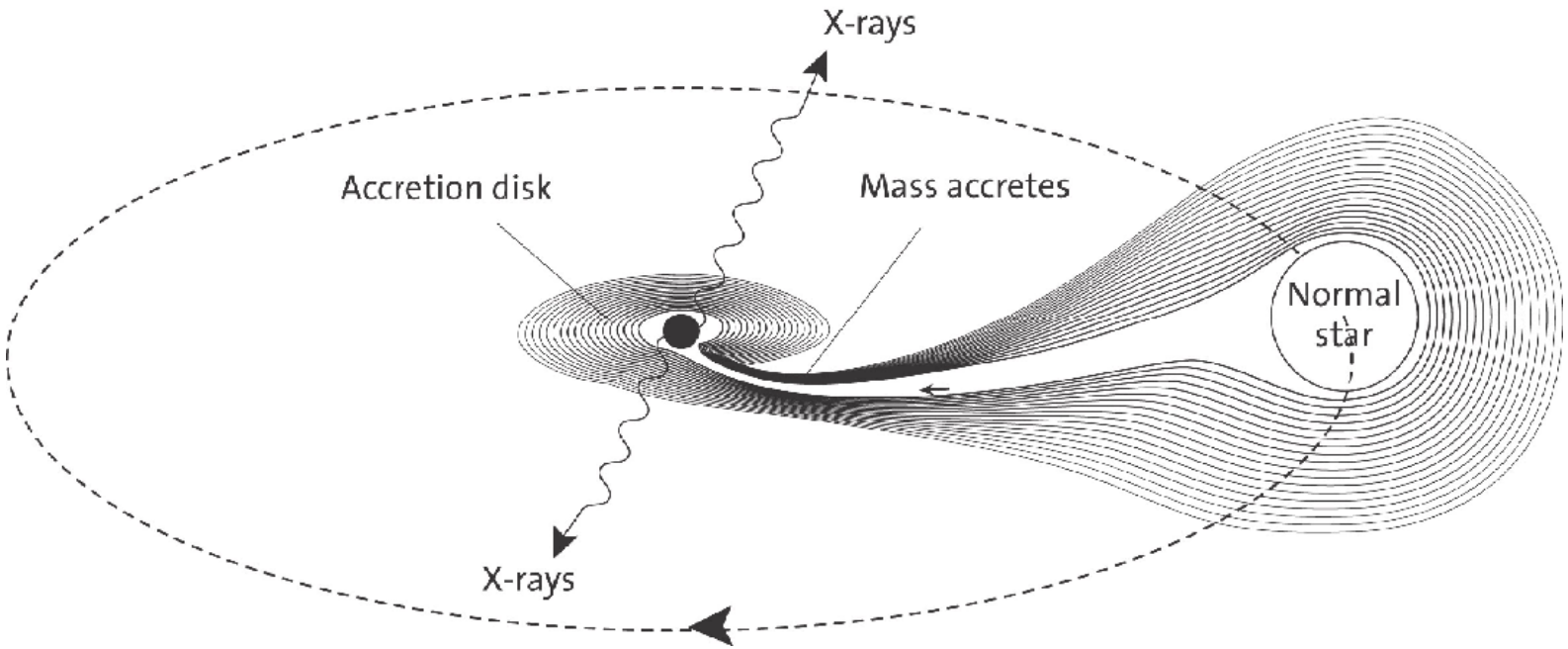
Processo de desaceleração de um elétron (Bremsstrahlung) leva a emissão de um fóton de radiação.

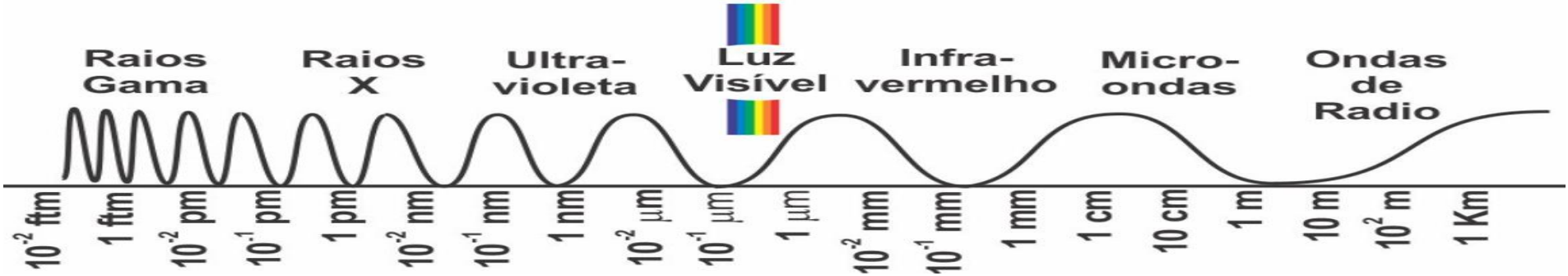




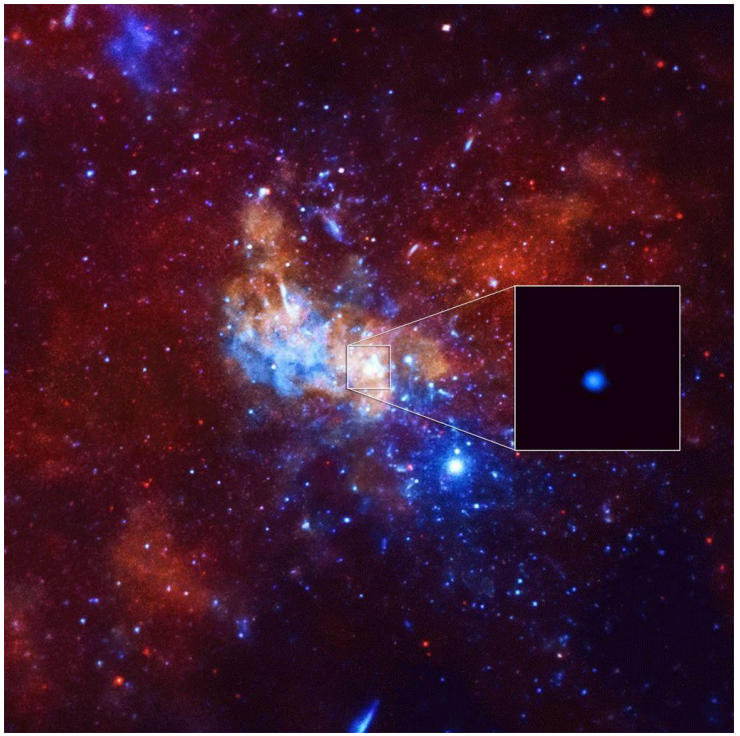
Raios-X:

Scorpius X-1: (1962) Primeira fonte de raios-X fora do sistema solar. Emissão em raio-X é 10.000 vezes maior forte que a emissão visível

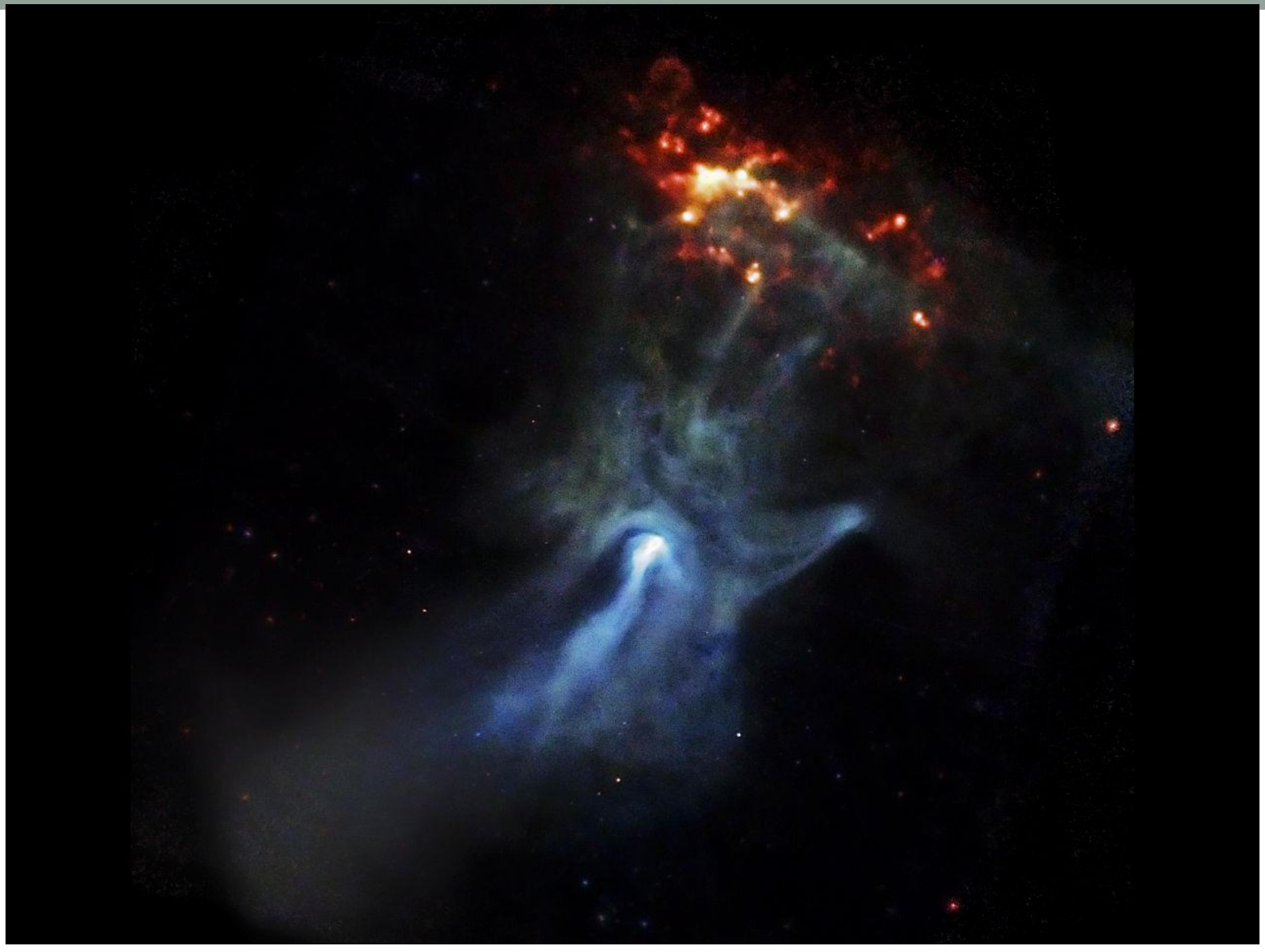


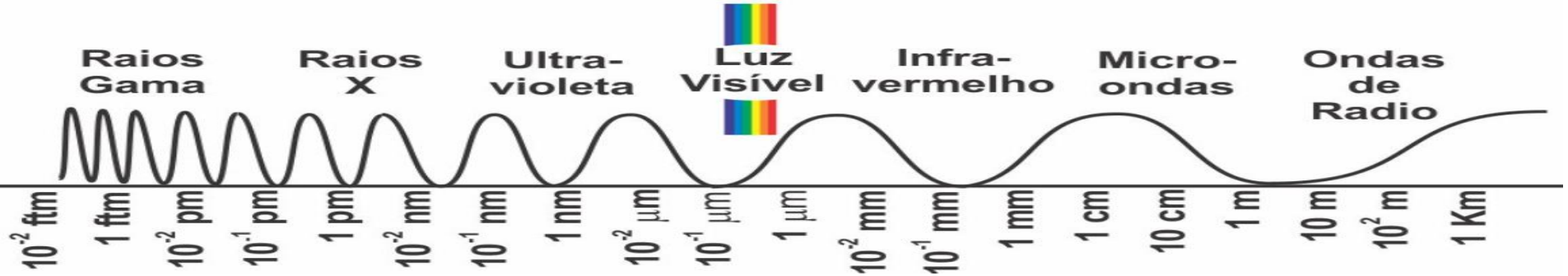


Raios-X:



Primeira fonte raio-X de Sagittarius A

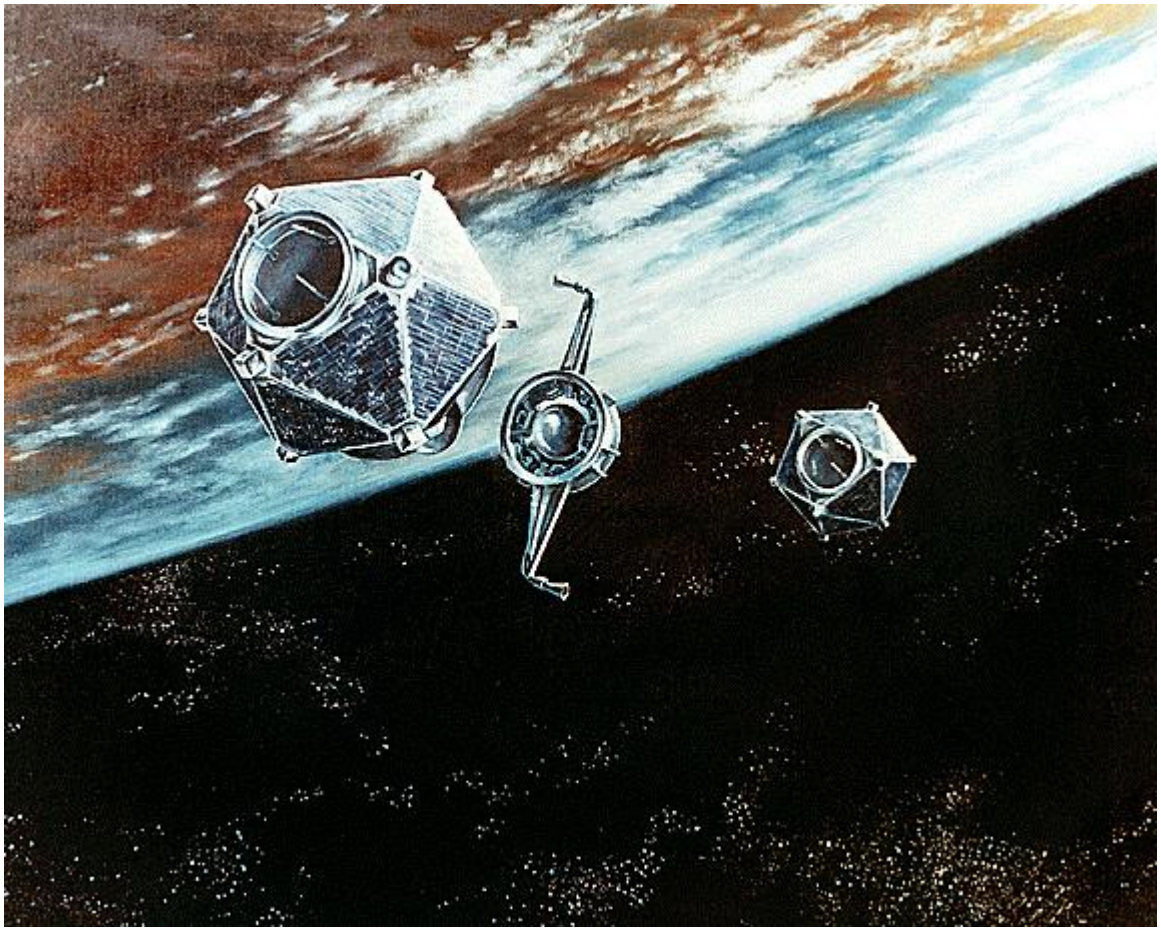




Raios Gama:

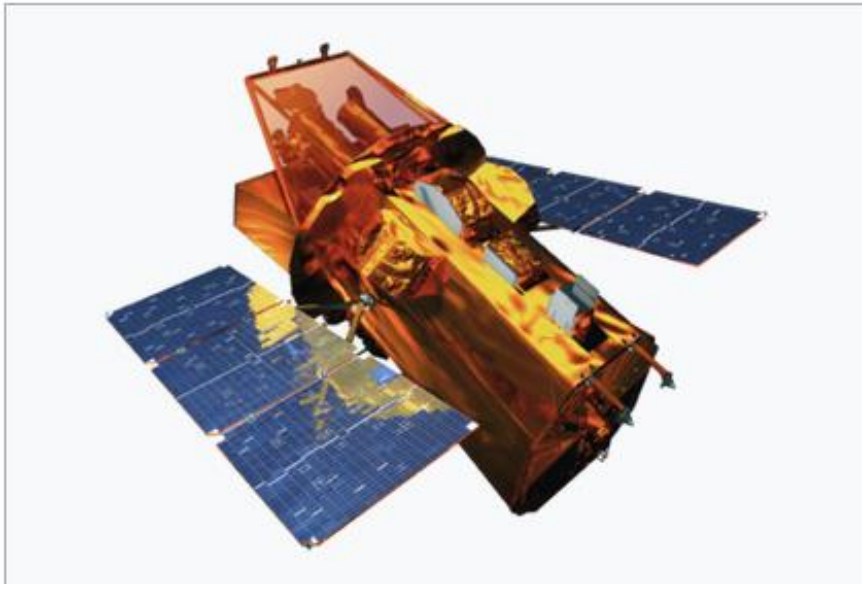
Explosões de Raios Gama - Gamma ray bursts (GRBs)

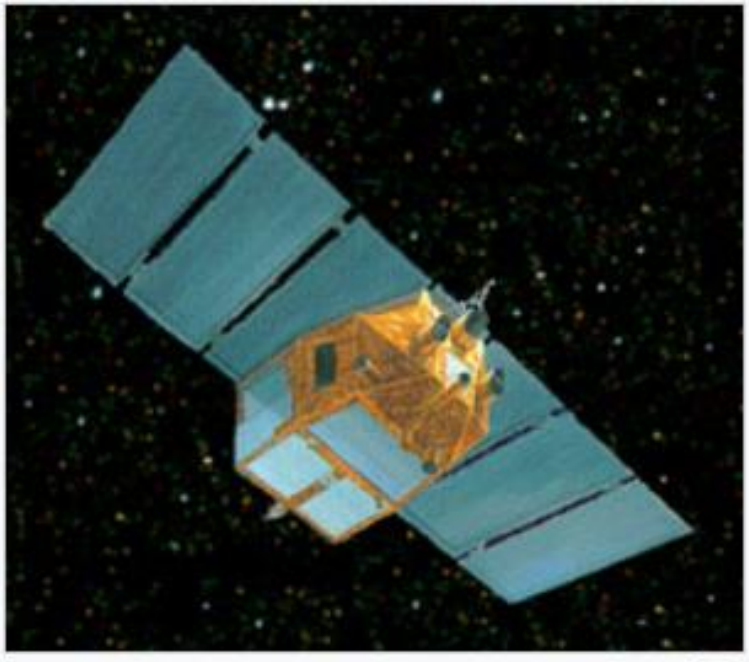
Satélite Vela (1967): apesar de desenvolvido para detectar atividade nuclear soviética, encontrou os primeiros sinais da existência de Surtos de raios gama



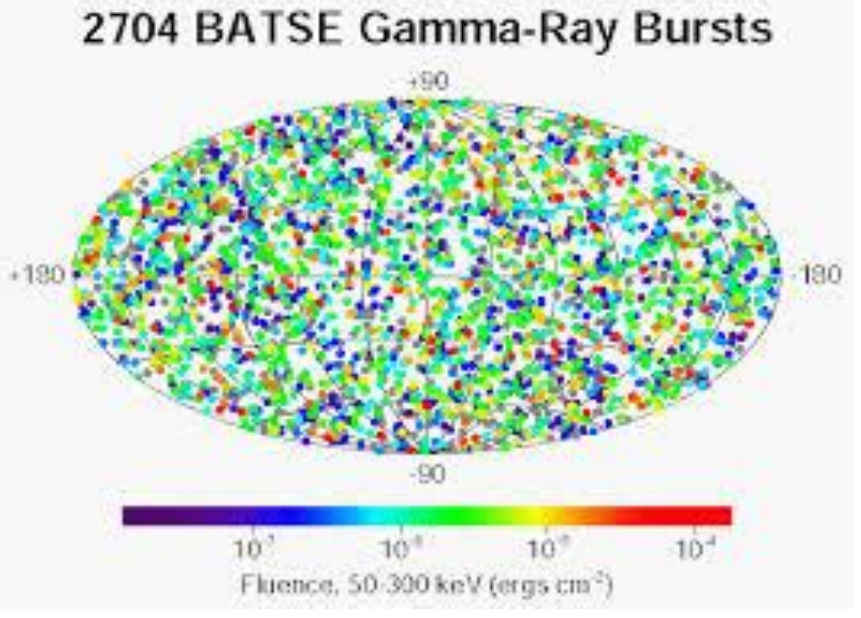
Fermi Gamma-ray Space Telescope

Swift Gamma-Ray Burst Mission





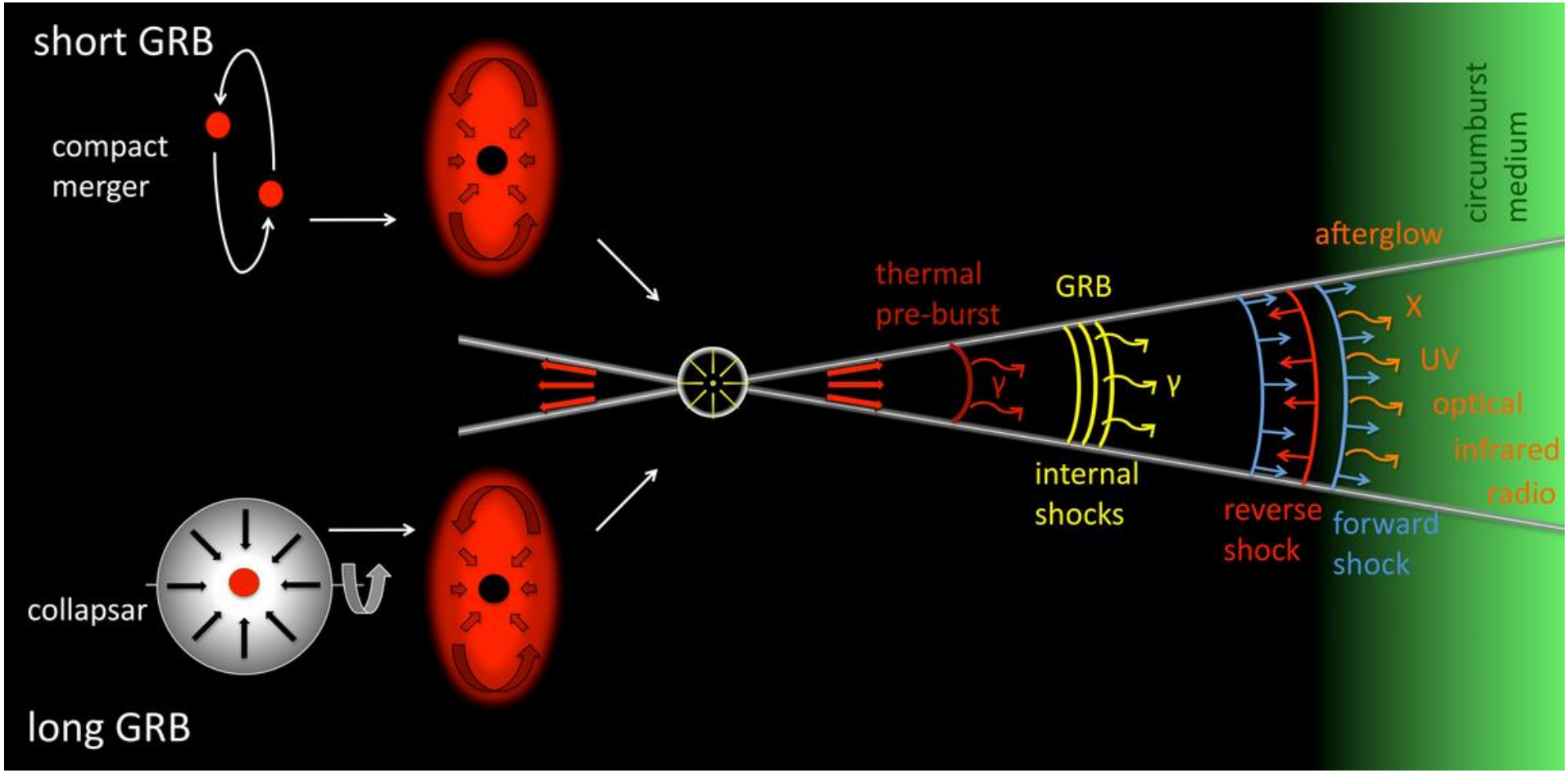
The Italian–Dutch satellite BeppoSAX, launched in April 1996,



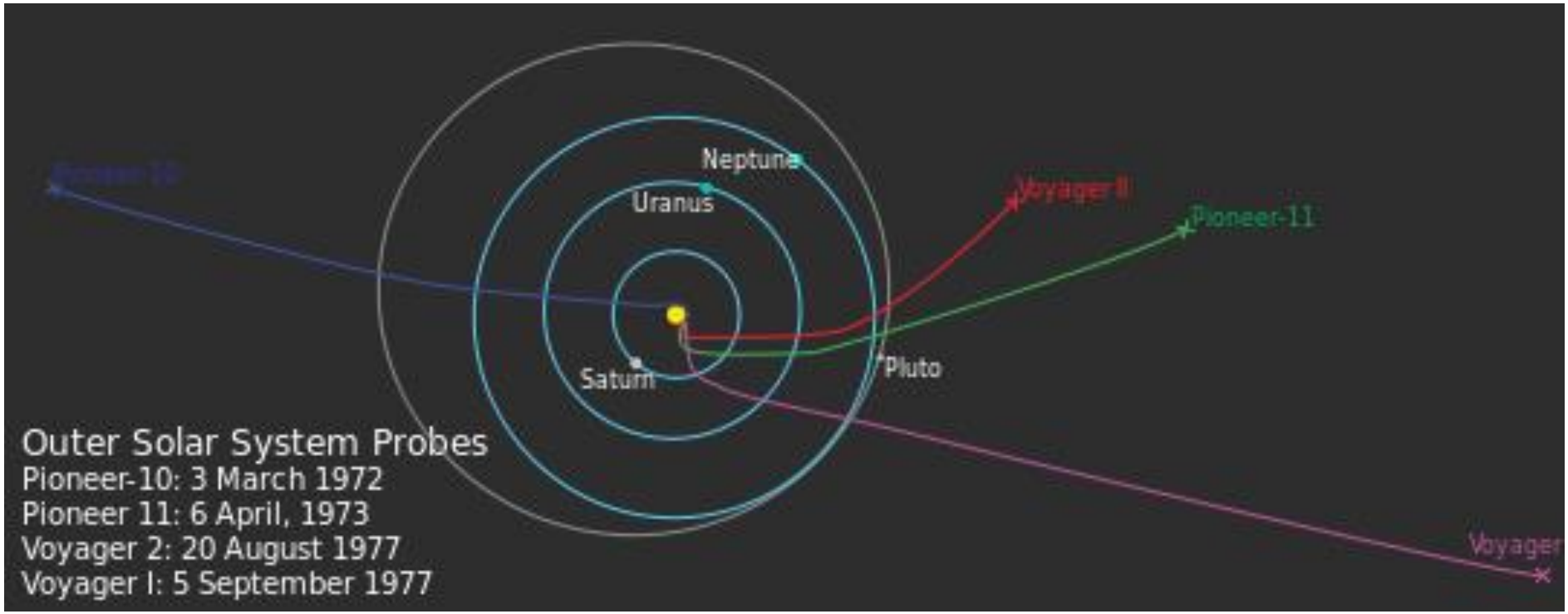
GRB:

i) curtos (<2segundos)

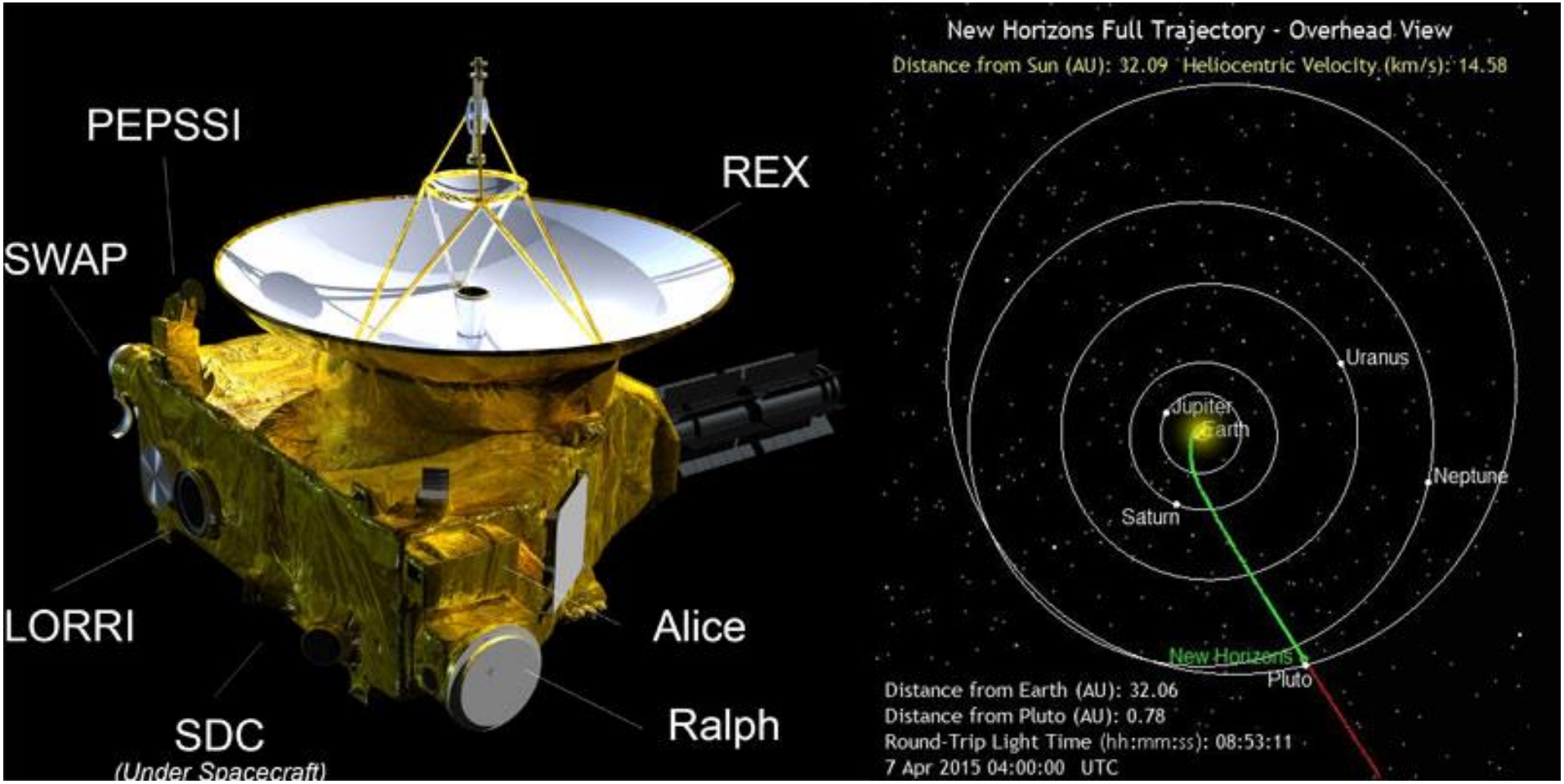
ii) longos (>2 segundos)



Astronomia nos confins do sistema solar:
Voyager and Pionner



Astronomia nos confins do sistema solar:
New Horizons



OBRIGADO!

Hermano Velten

Universidade Federal do Espírito Santo

- Primeira Escola de Ciências Físicas Brasil-Cabo Verde
- 2017 - Cidade de Praia, Cabo Verde