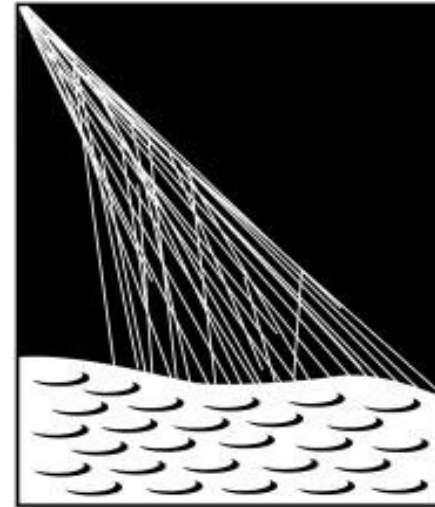


# O mensageiros de mais altas energias do Universo

Vitor de Souza  
vitor@ifsc.usp.br



PIERRE  
AUGER  
OBSERVATORY

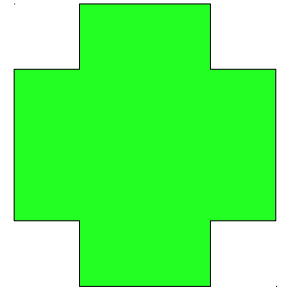
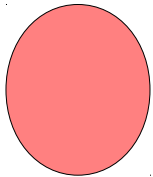
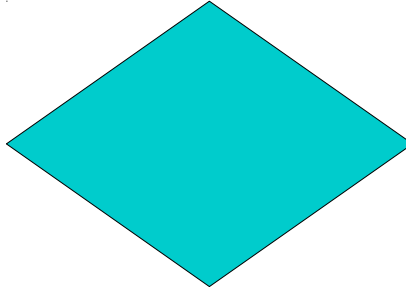
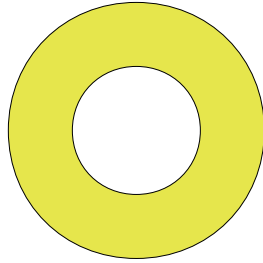


**Instituto de Física de São Carlos**

**Universidade de São Paulo**



Se algo me atinge ...



Se algo me atinge ... Eu quero saber o que é !



Se algo me atinge ... Eu quero saber o que é !



Se algo me atinge ... Eu quero saber o que é !



Se algo me atinge ... Eu quero saber o que é !



Se algo me atinge ... Eu quero saber o que é !



Se algo me atinge ...

Eu quero saber:

O QUE ?



Se algo me atinge ... Eu quero saber quem jogou !



753040 www.fotosearch.com



sps0433 www.fotosearch.com

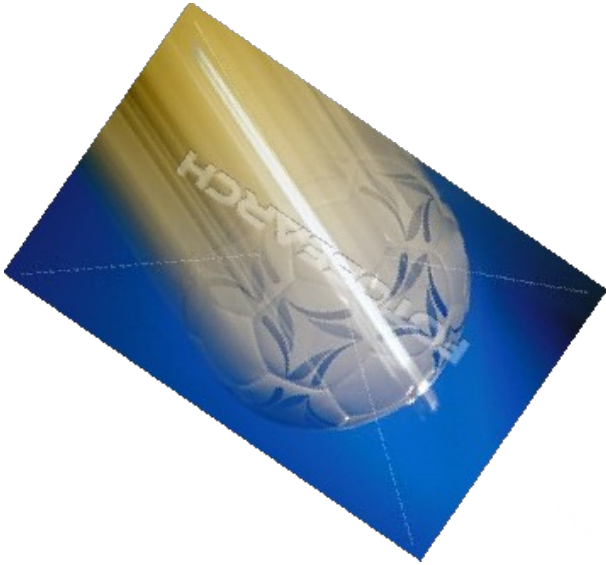
Se algo me atinge ...

Eu quero saber:

O QUE ?

QUEM ?

Se algo me atinge ... Eu quero saber a **velocidade** !



Se algo me atinge ...

Eu quero saber:

O QUE ?

QUEM ?

VELOCIDADE ?

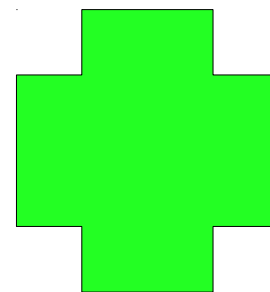
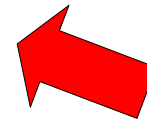
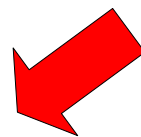
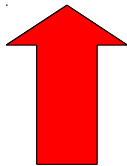
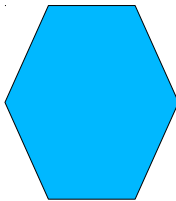
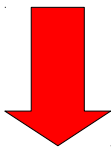
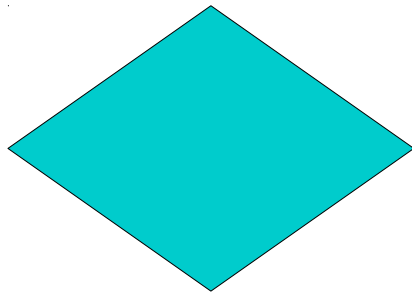
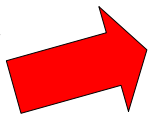
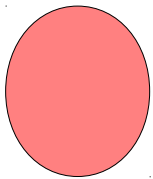
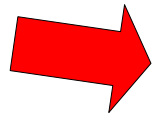
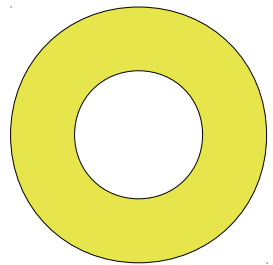
Se algo me atinge ...

Eu quero saber:

O QUE ?

QUEM ?

ENERGIA ?



Se algo me atinge ...

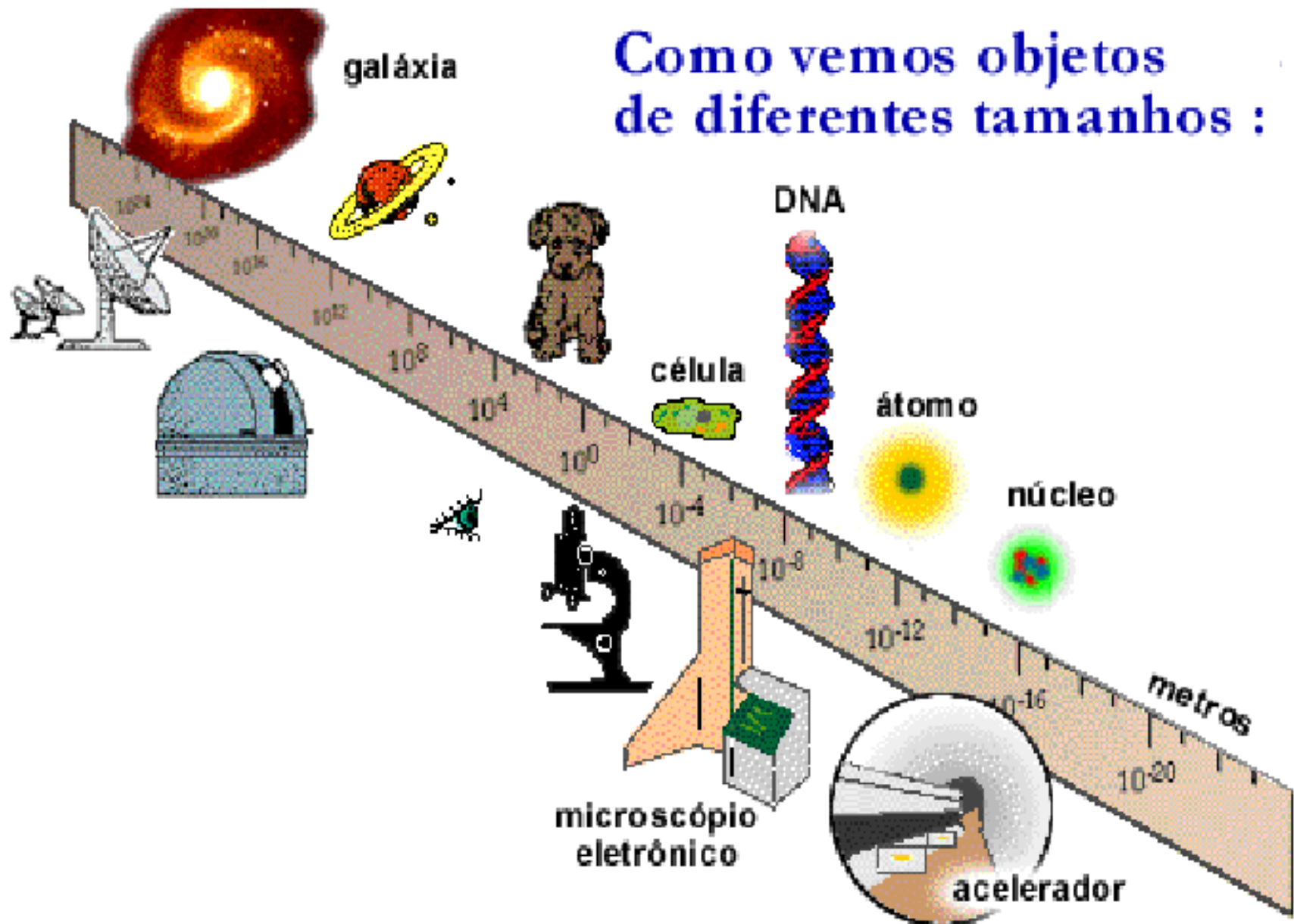
Eu quero saber:

O QUE ?

QUEM ?

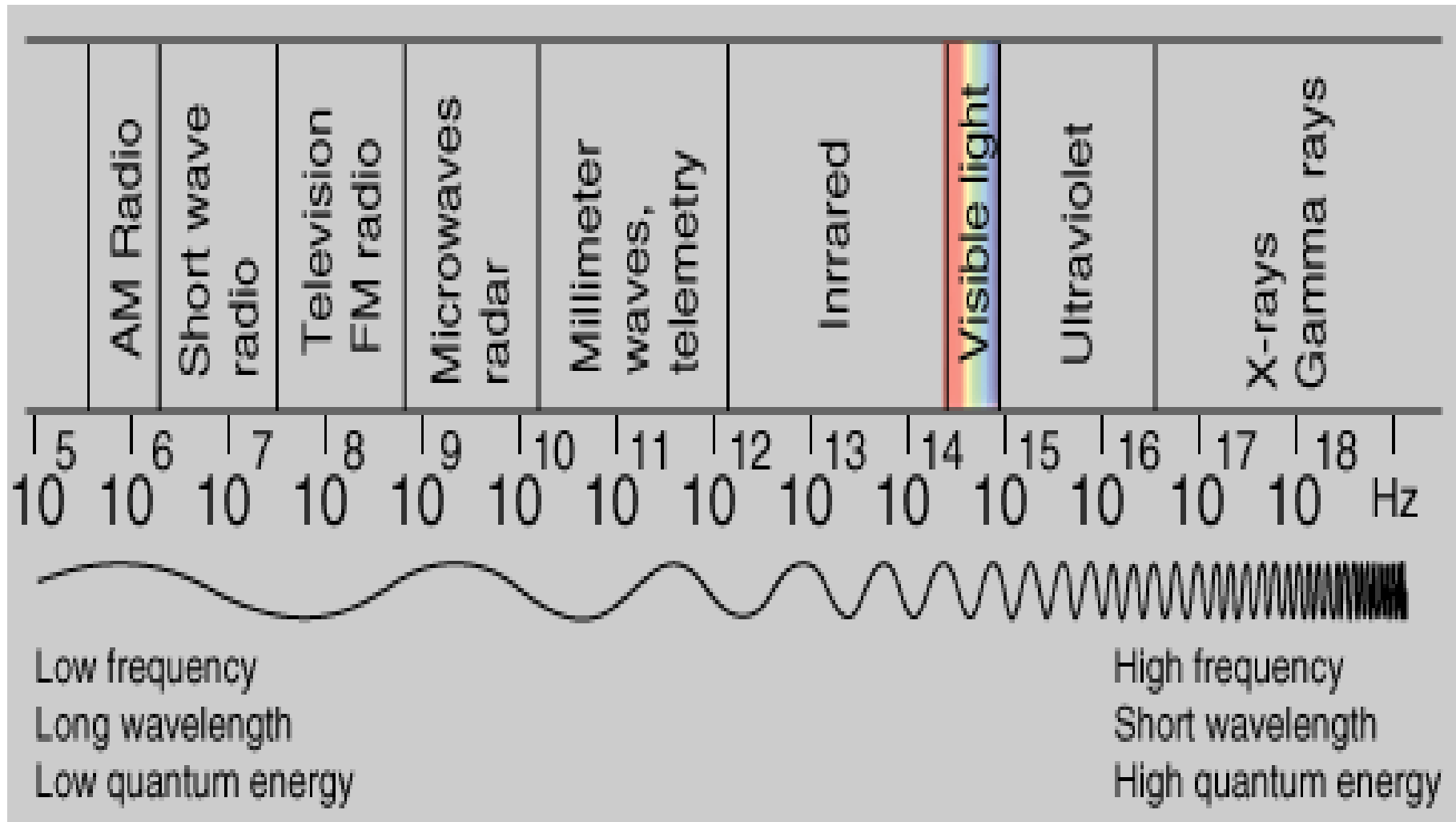
ENERGIA ?

# Como vemos objetos de diferentes tamanhos :

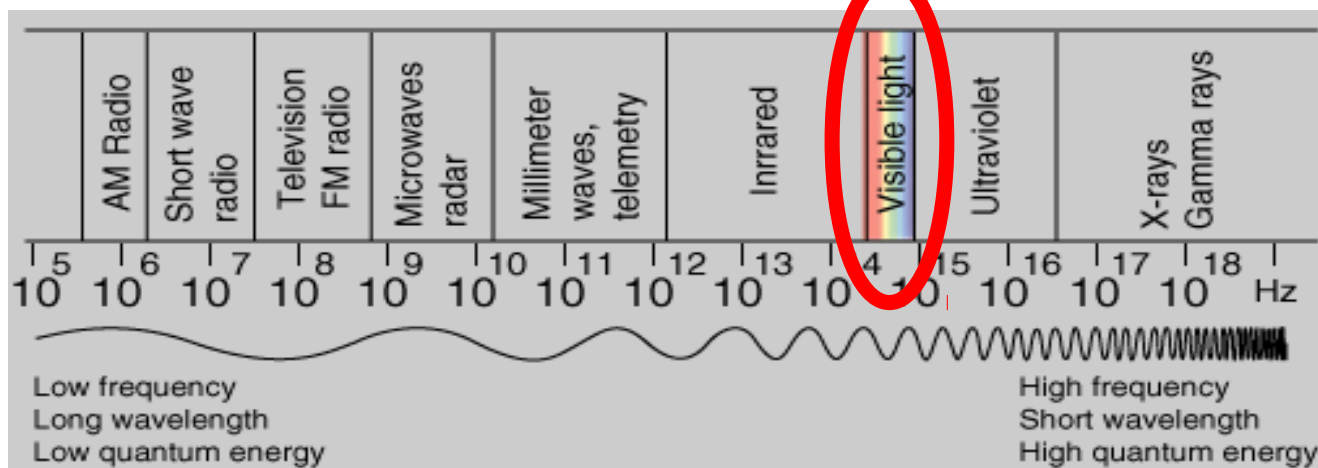




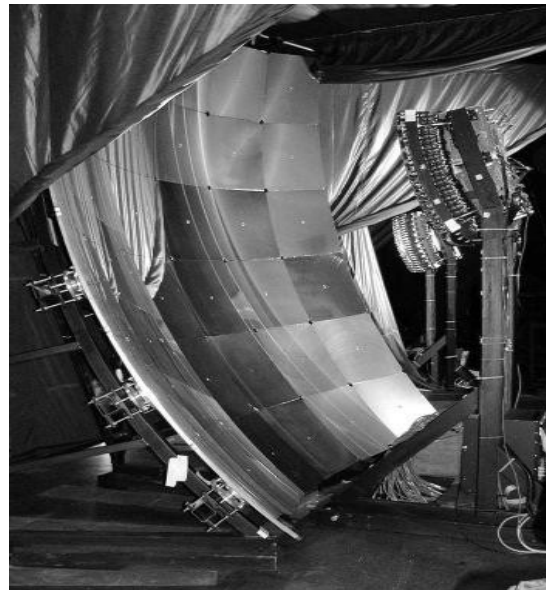
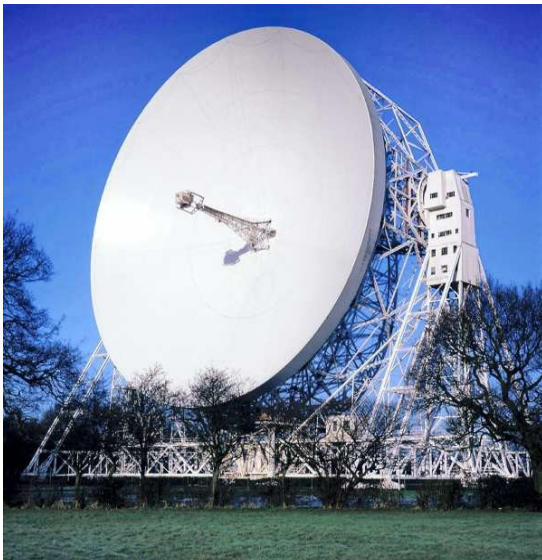
# “Tamanho” equivalente pra luz



# Olhando pro céu com o nosso olho:



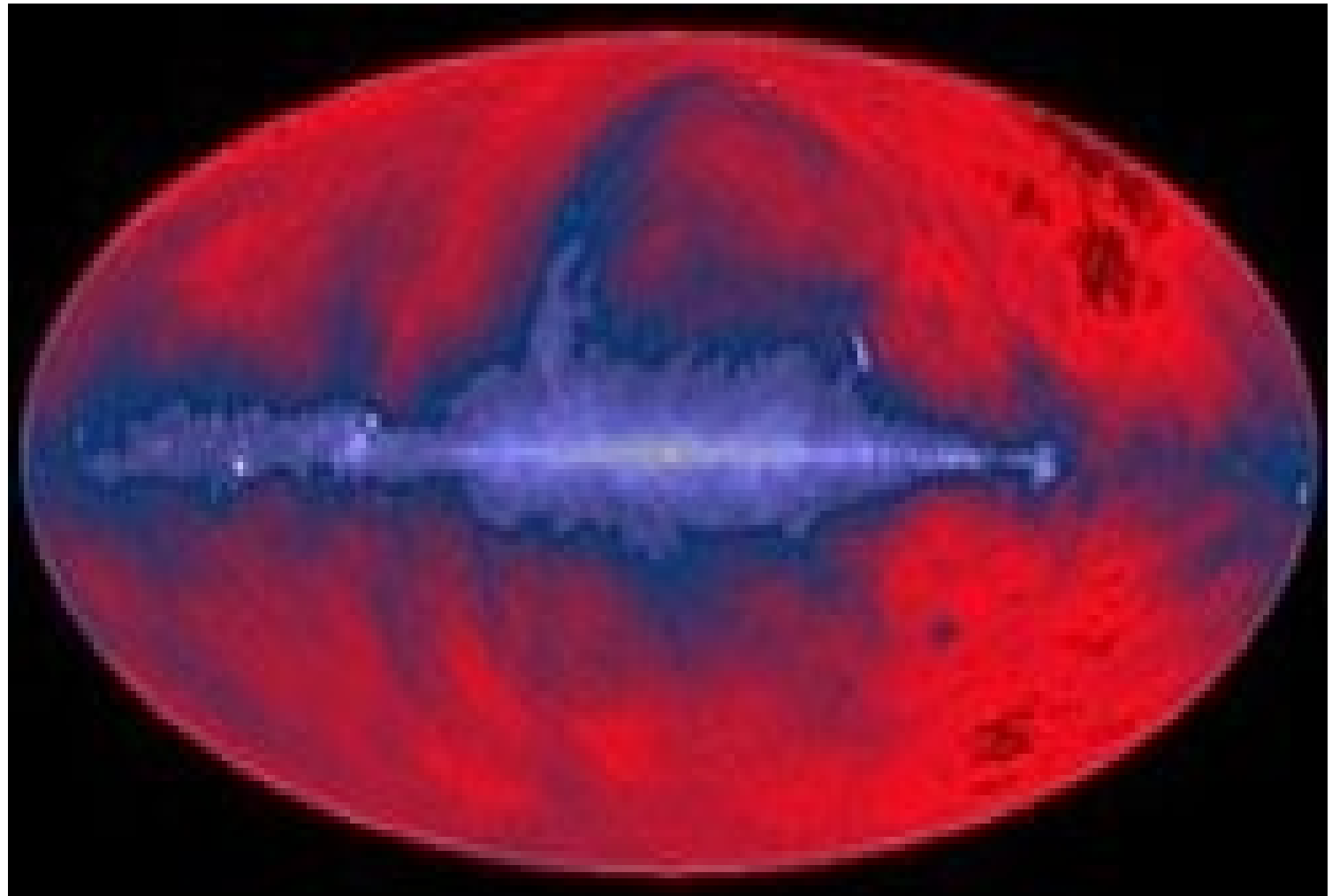
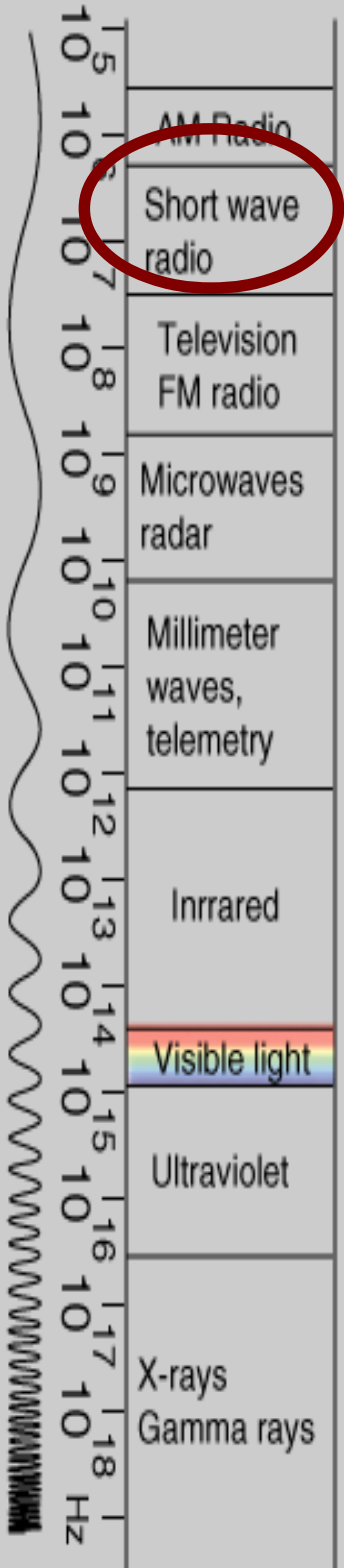
# Olhando para o céu com instrumentos:



# Via Láctea: Rádio (408 MHz)

C. Haslam et al., MPIfR, SkyView)

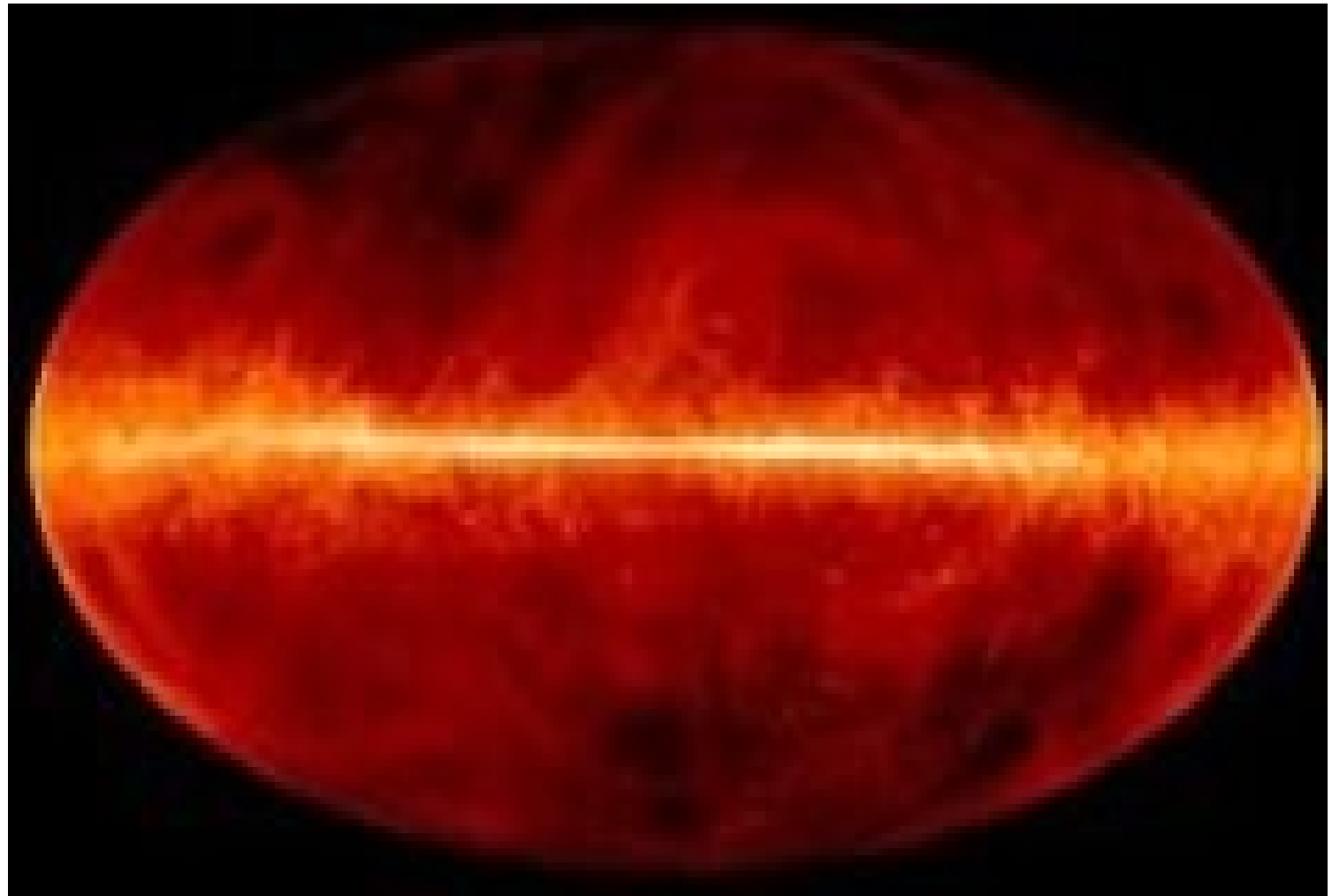
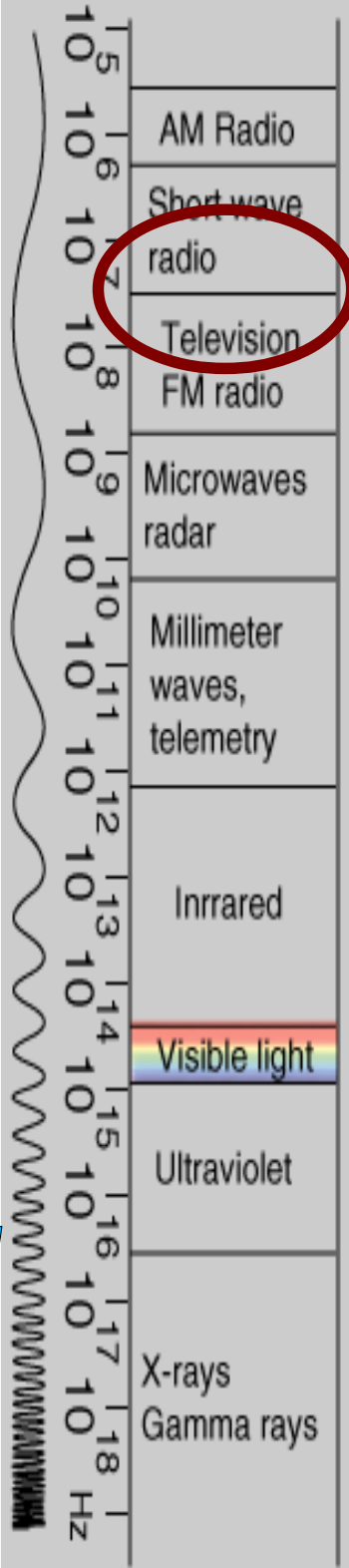
ENERGIA



# Via Láctea: Rádio (1420 MHz)

J. Dickey et.al. UMn. NRAO SkyView

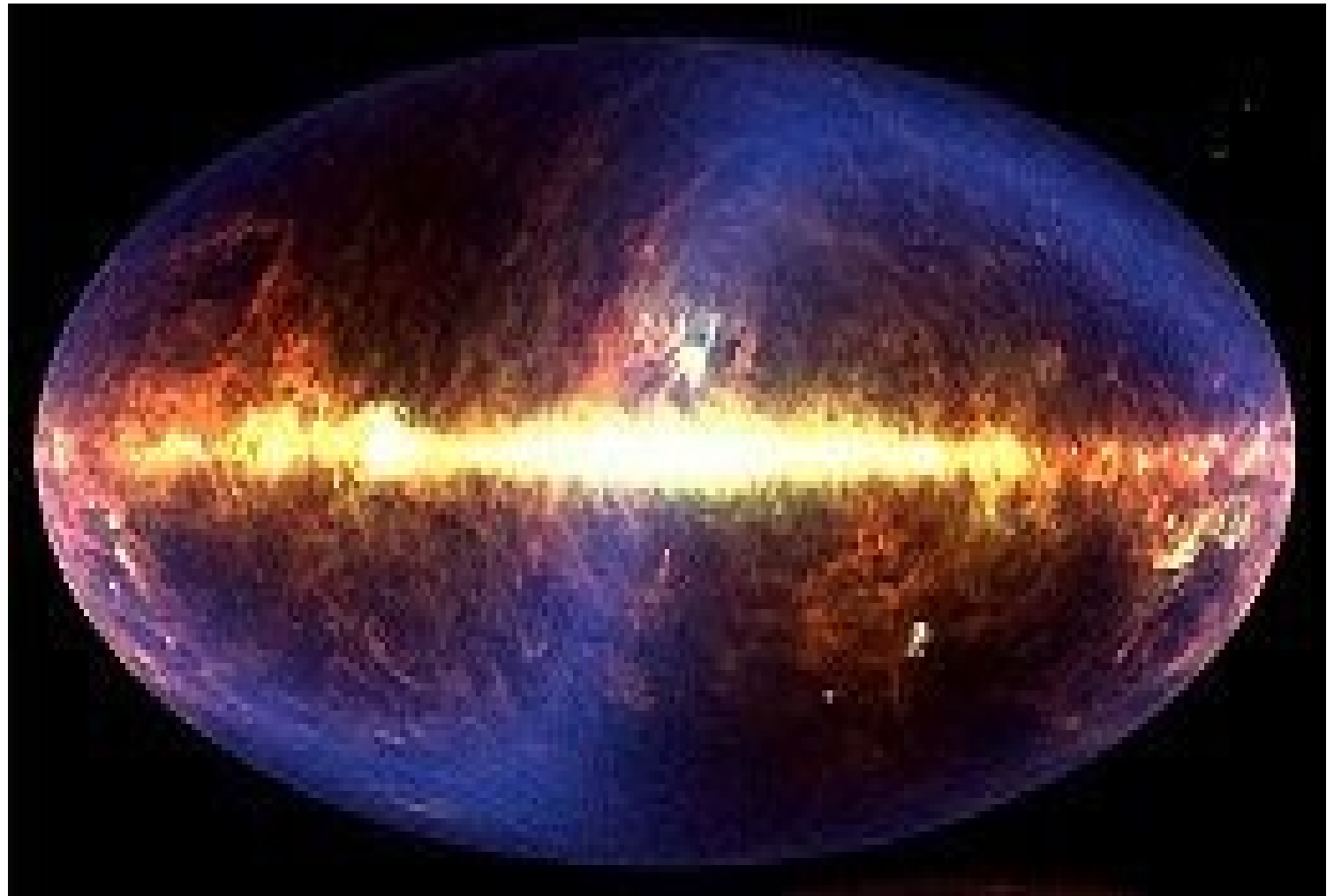
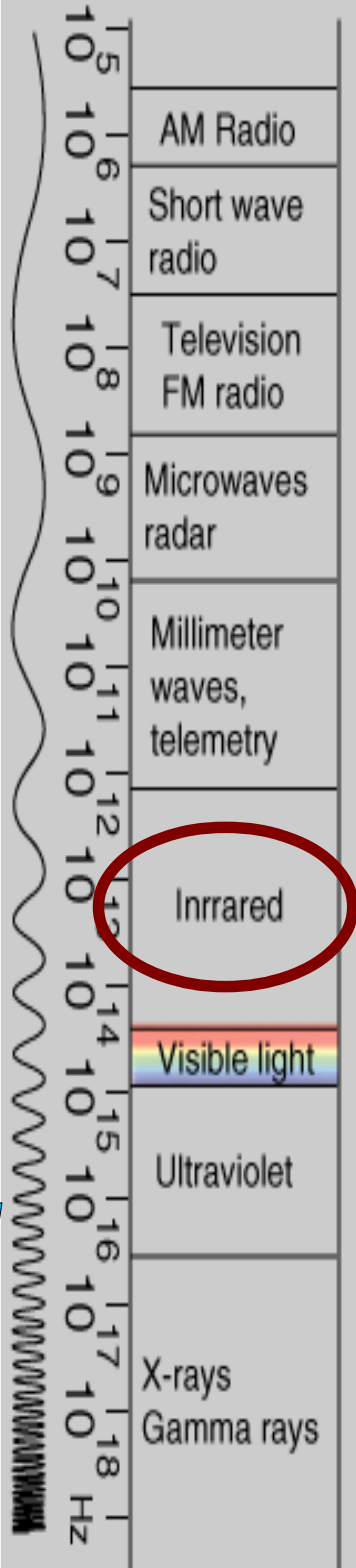
ENERGIA



# Via Láctea: Infravermelho

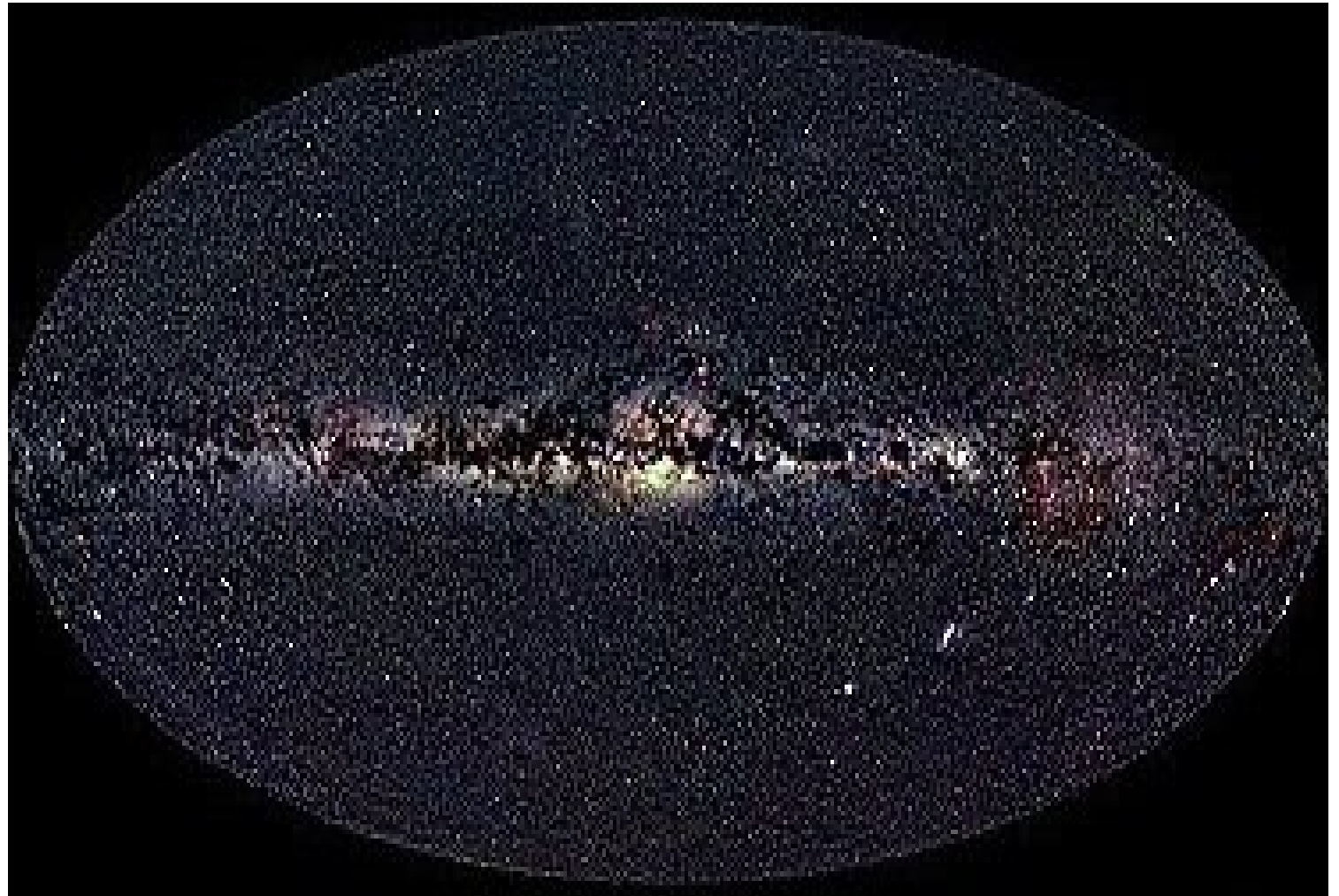
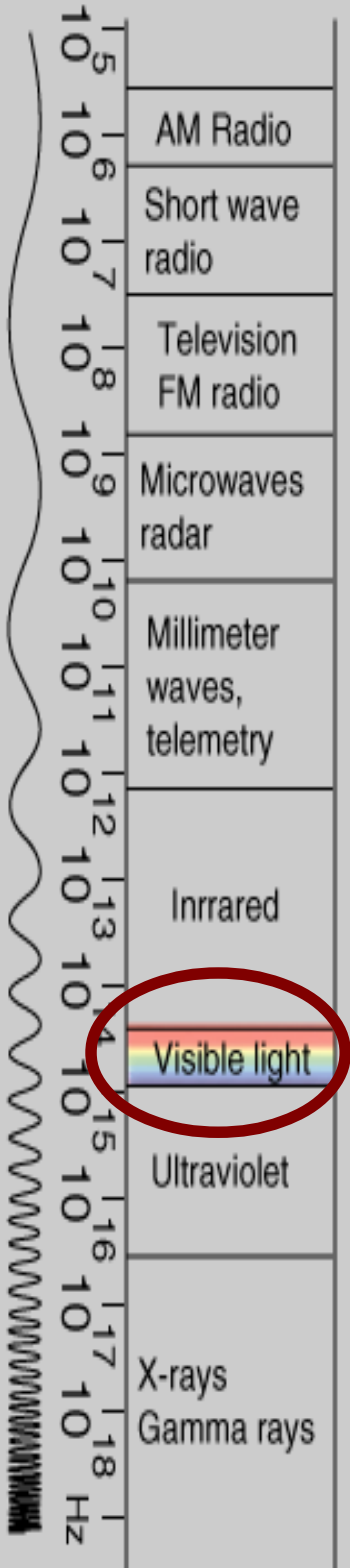
Dirbe Team, COBE, NASA

ENERGIA



# Via Láctea: Vísivel por Axel Melinger

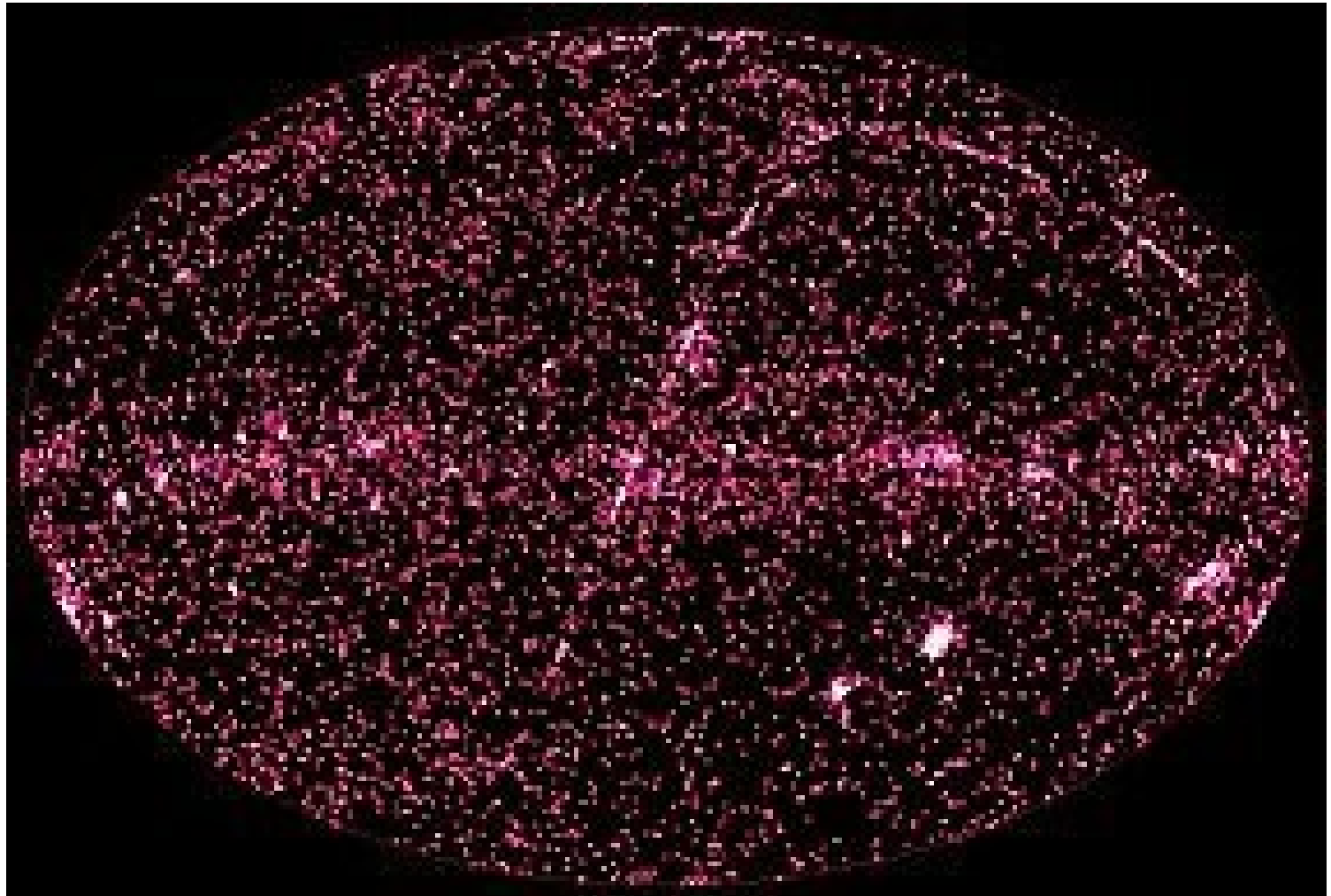
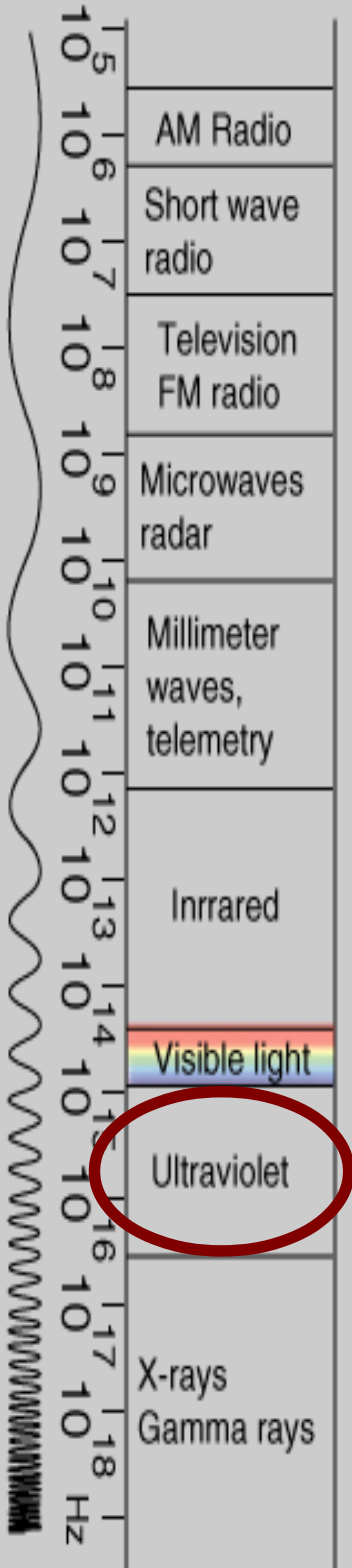
E  
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# Via Láctea: Ultravioleta

J. Bonnell et.al.(GSFC, NASA)

E  
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G  
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A

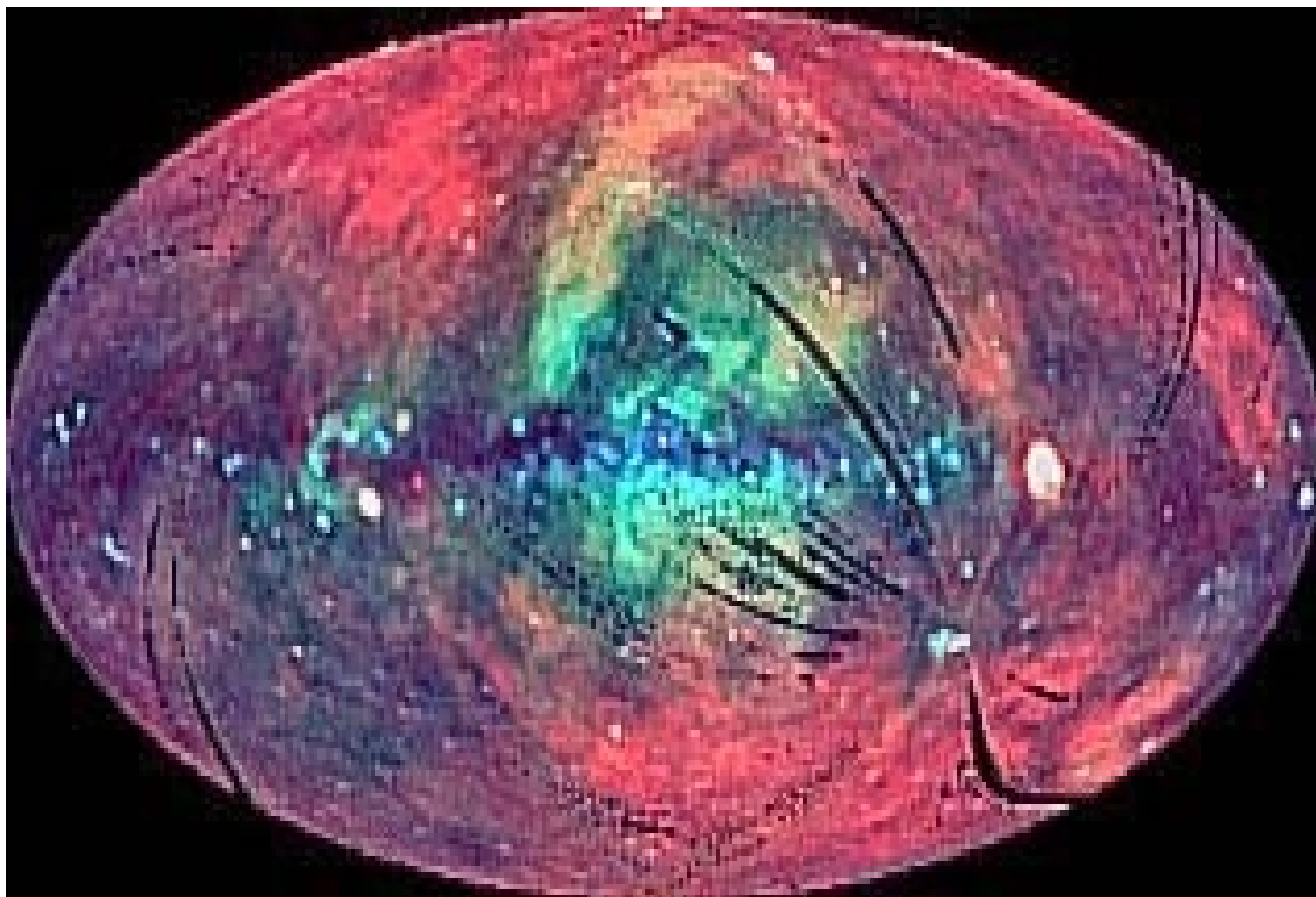
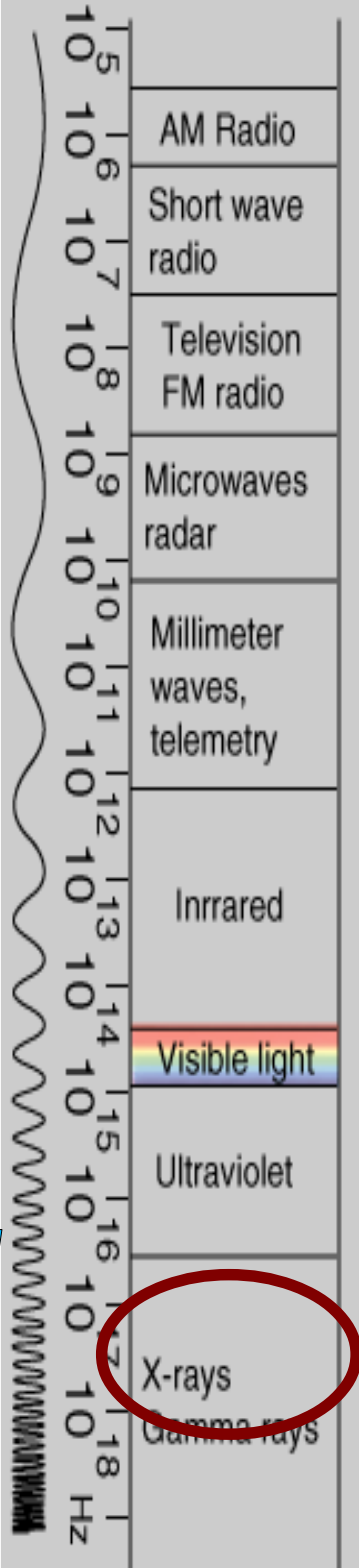




# Via Láctea: Raios X

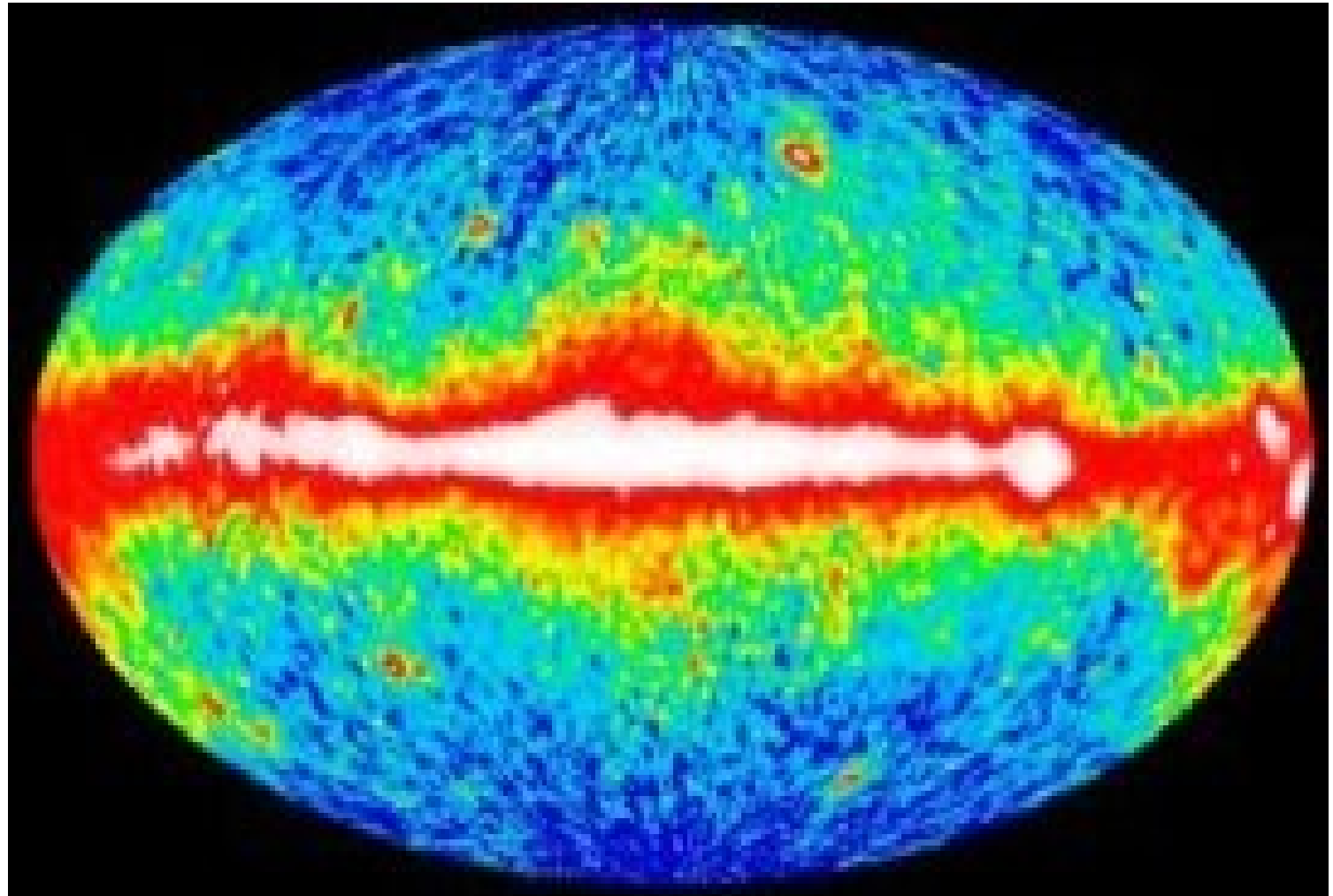
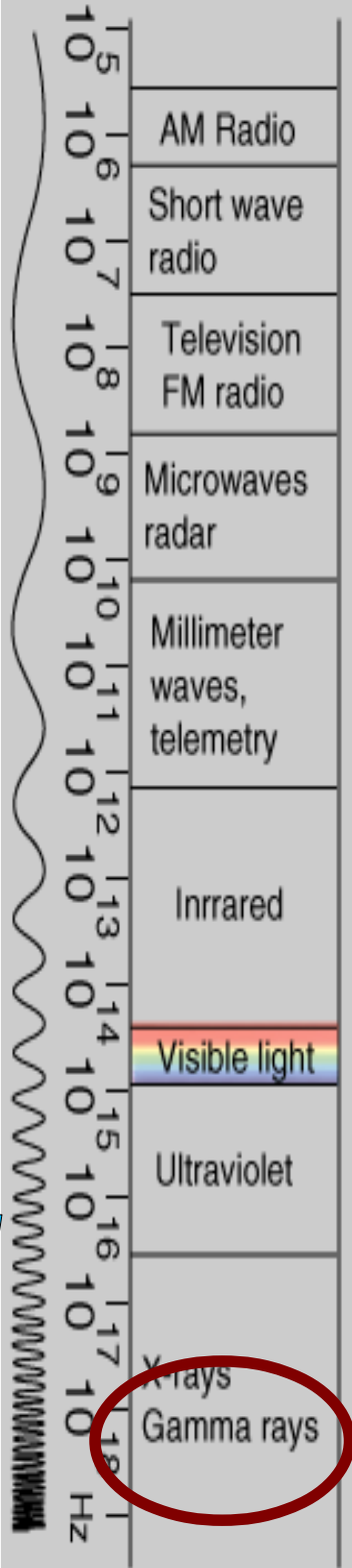
.25, 0.75, 1.5 keV (S. Digel et. al. GSFC, ROSAT, NASA)

ENERGIA



# Via Láctea: Raios Gama > 100 MeV (CGRO, NASA)

ENERGIA

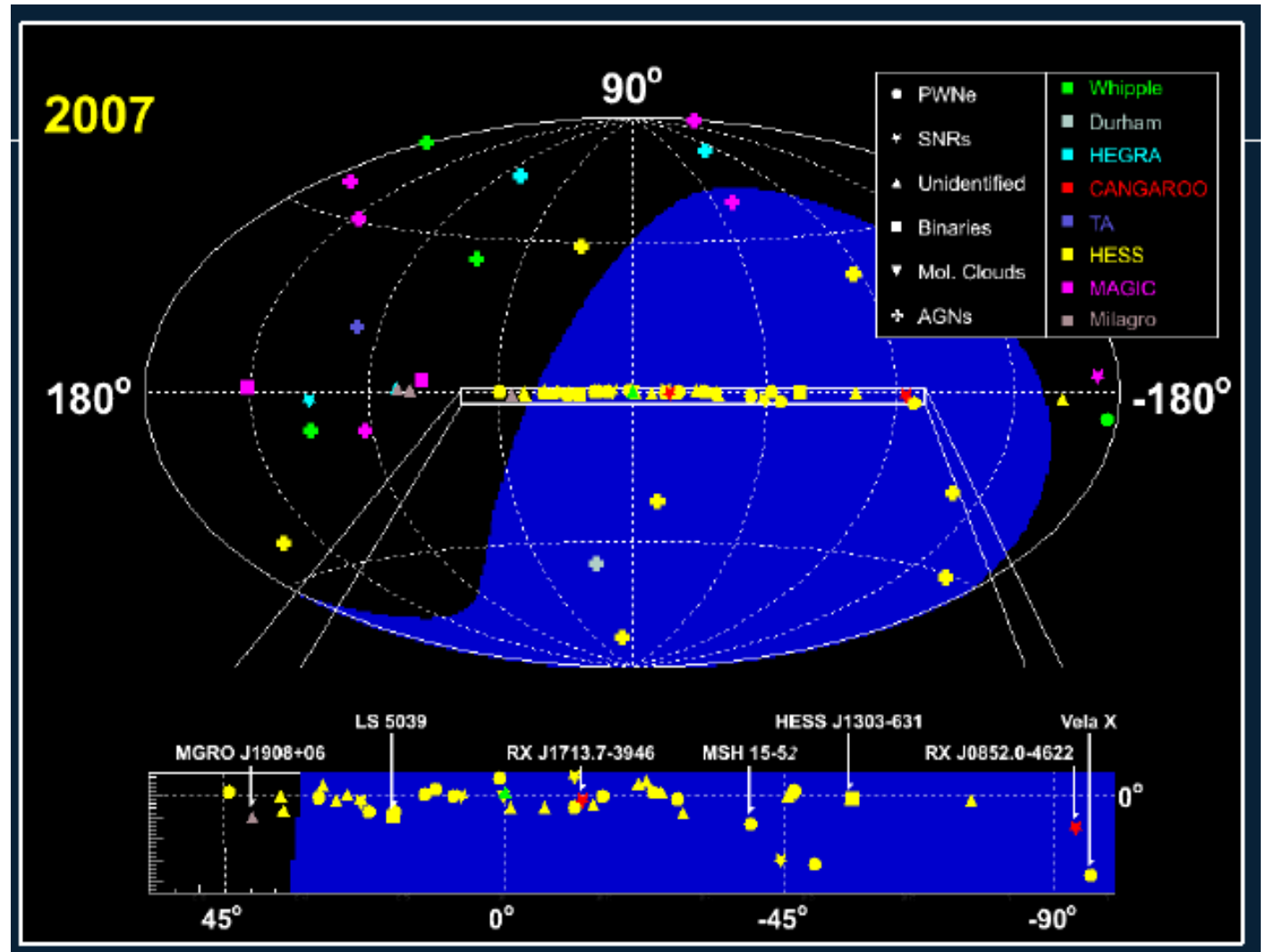
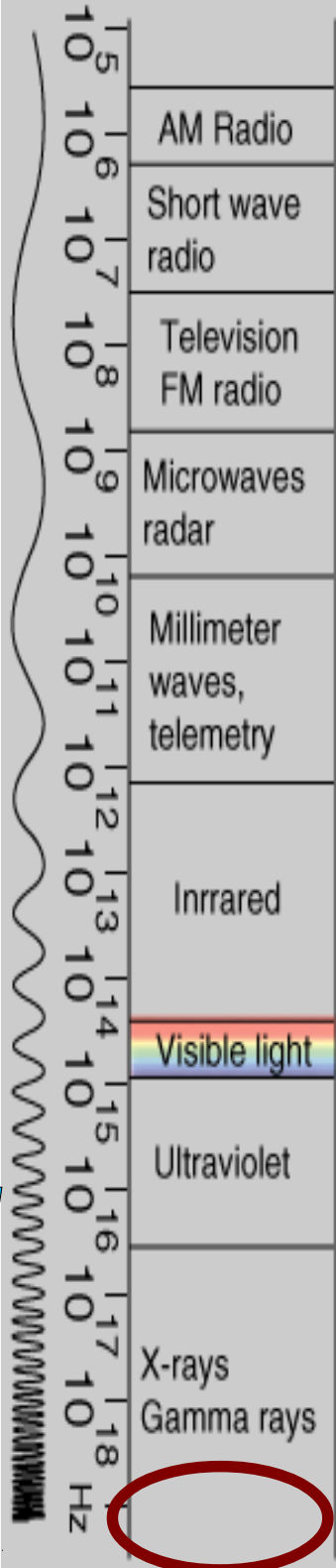


# Fontes Pontuais

## Raios Gama $> 10^{12}$ eV

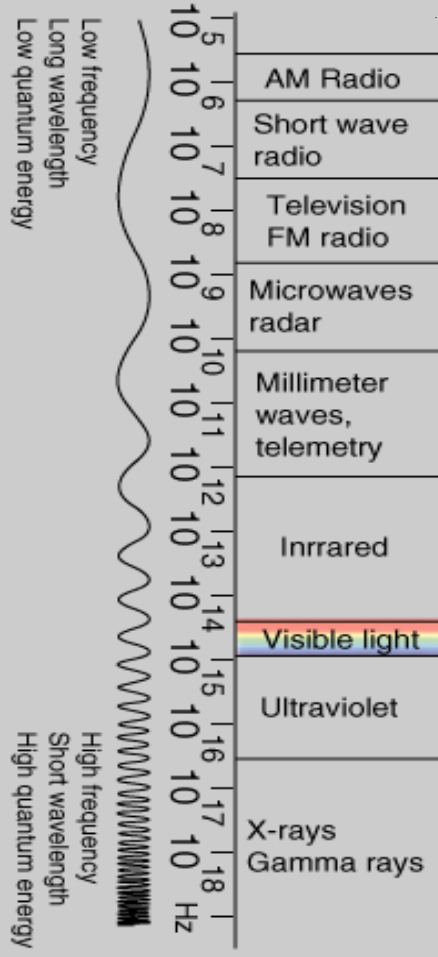
### Telescópios Cerenkov, por Jim Hinton

ENERGIA

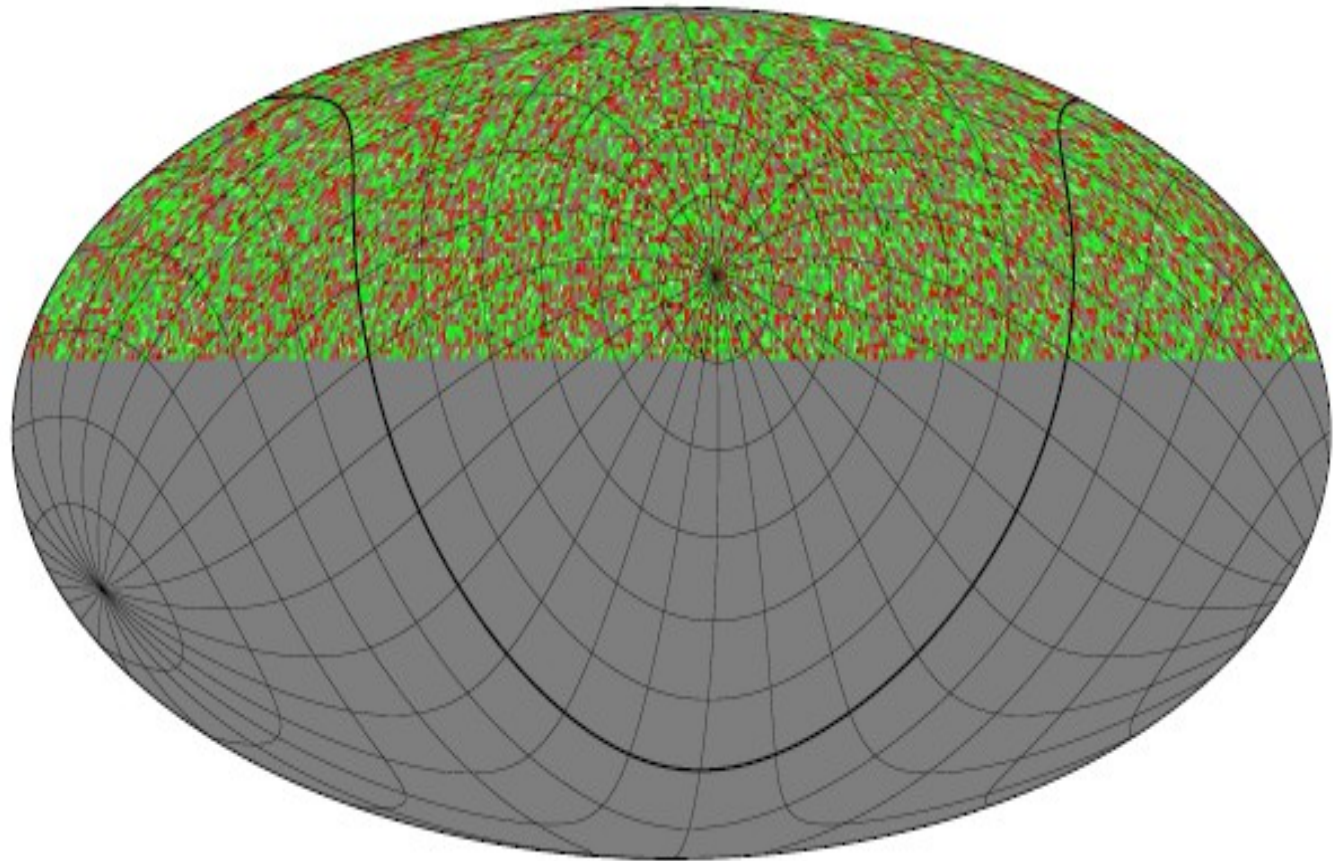


# KASCADE

$E \sim 10^{16}$  eV



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TeV = 10<sup>12</sup> eV

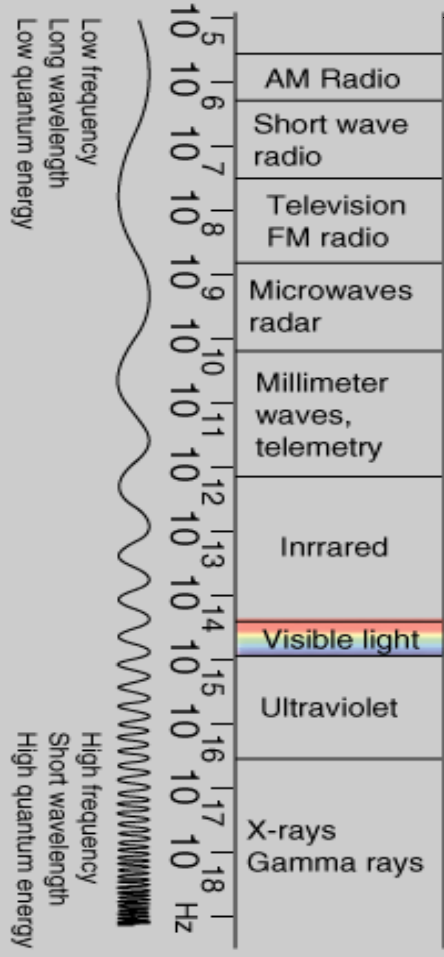
PeV = 10<sup>15</sup> eV

EeV = 10<sup>18</sup> eV

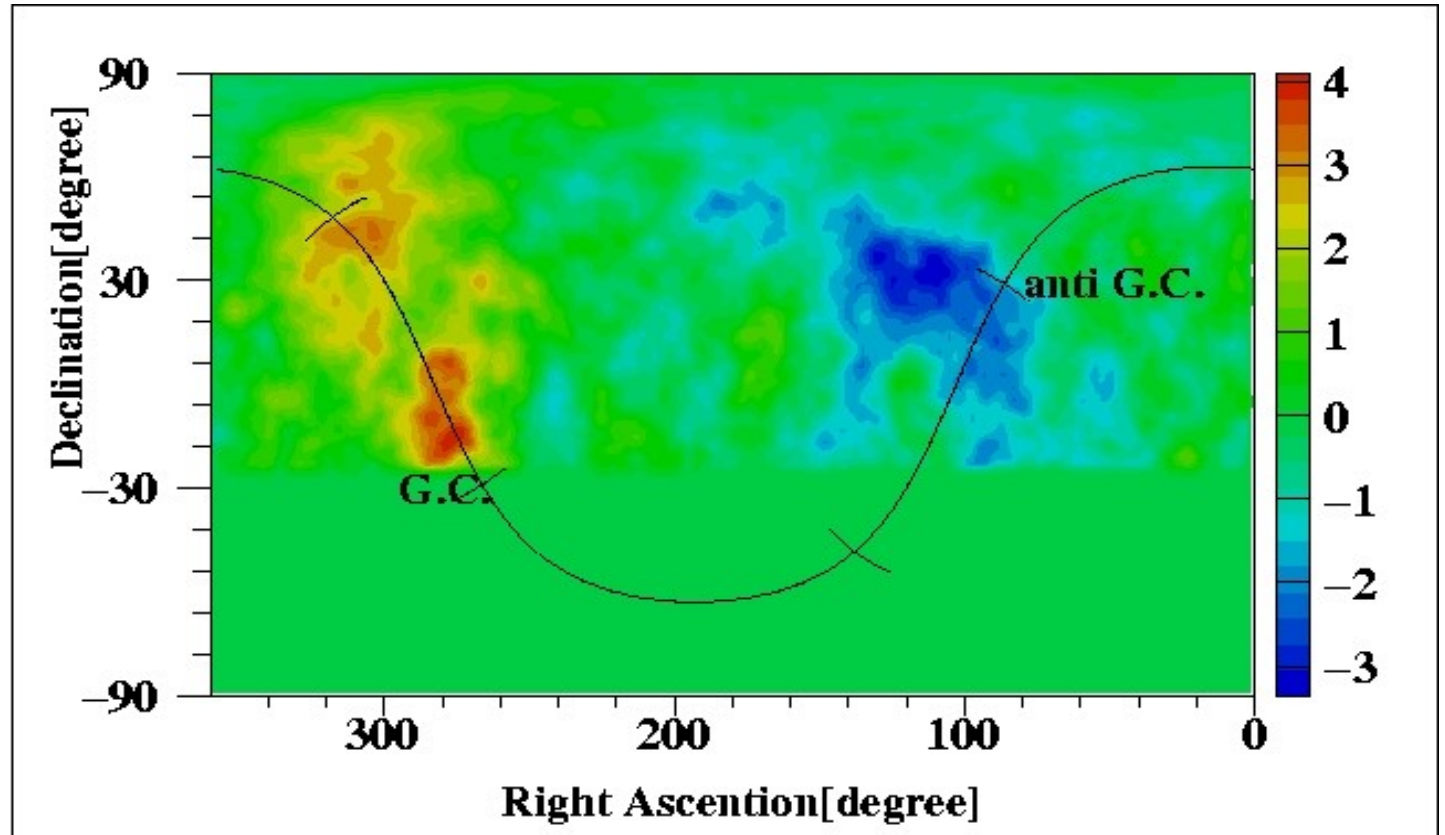
ZeV = 10<sup>21</sup> eV

# AGASA

$E > 10^{18}$  eV



ENERGIA

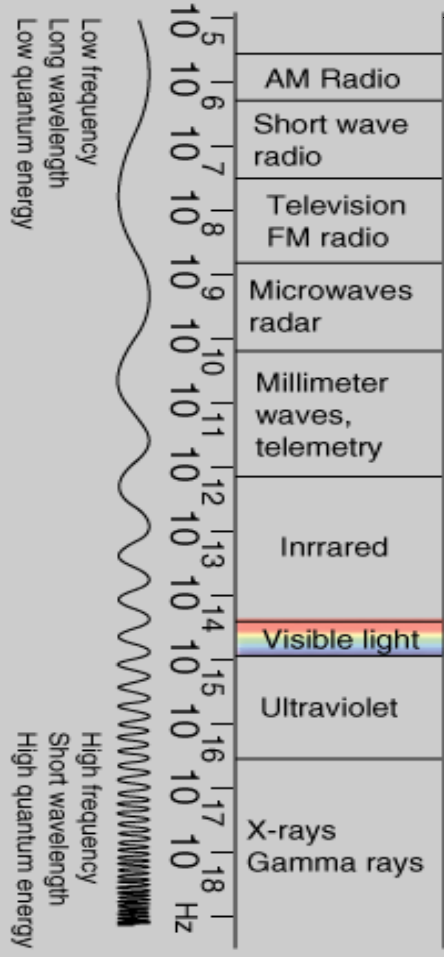


TeV

PeV

EeV

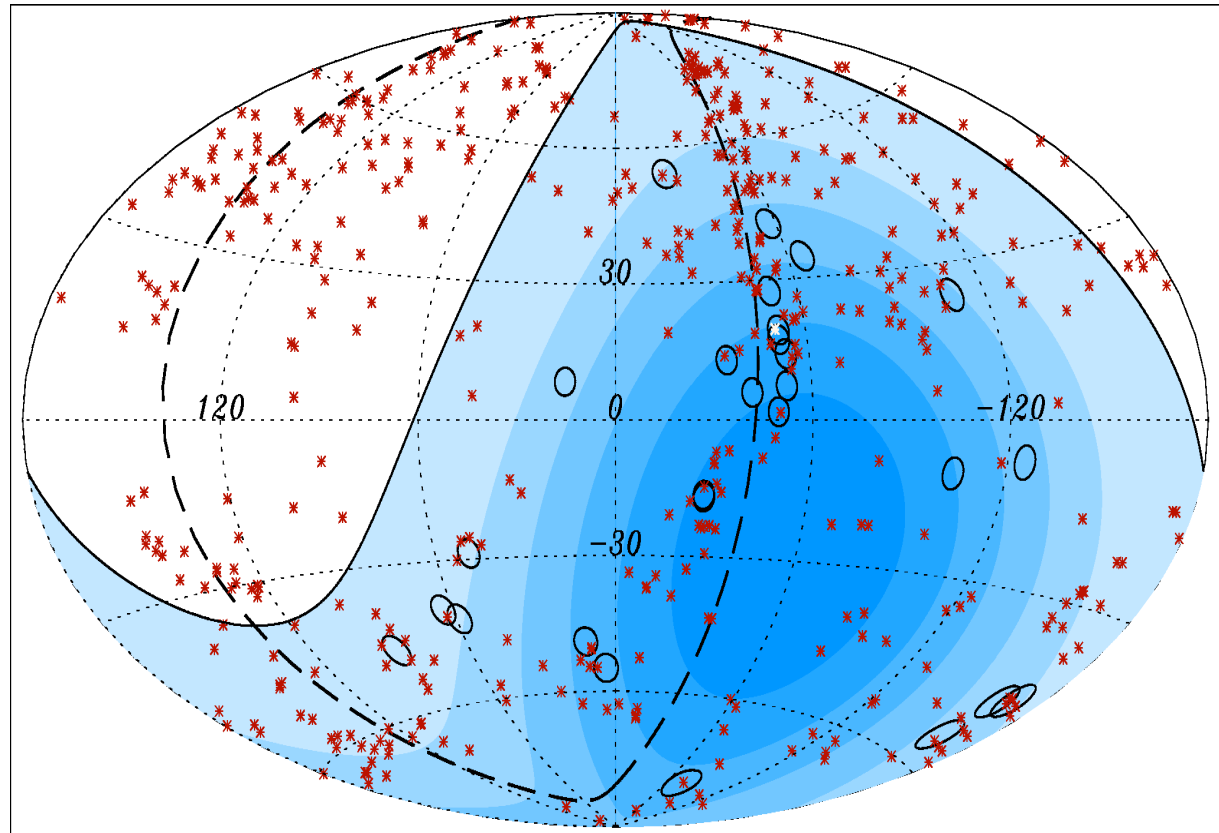
ZeV



ENERGIA

# Auger

$E > 5.7 \times 10^{19} \text{ eV}$



TeV =  $10^{12} \text{ eV}$

PeV =  $10^{15} \text{ eV}$

EcV =  $10^{18} \text{ eV}$

ZecV =  $10^{21} \text{ eV}$

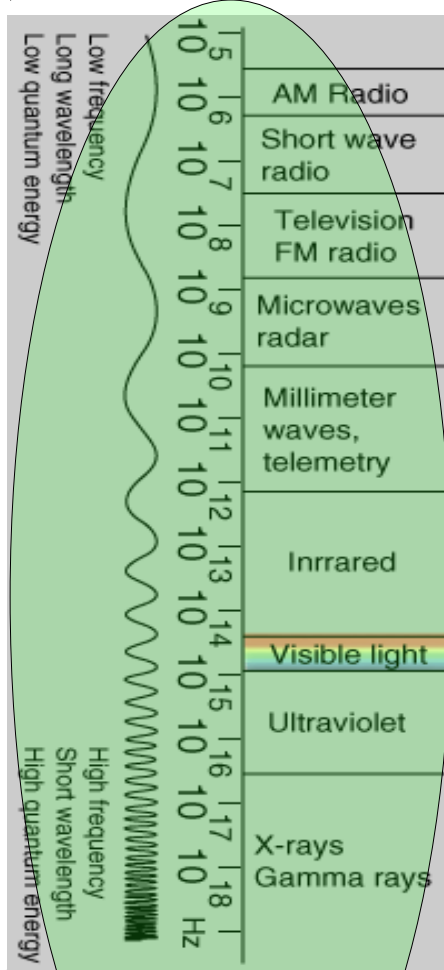
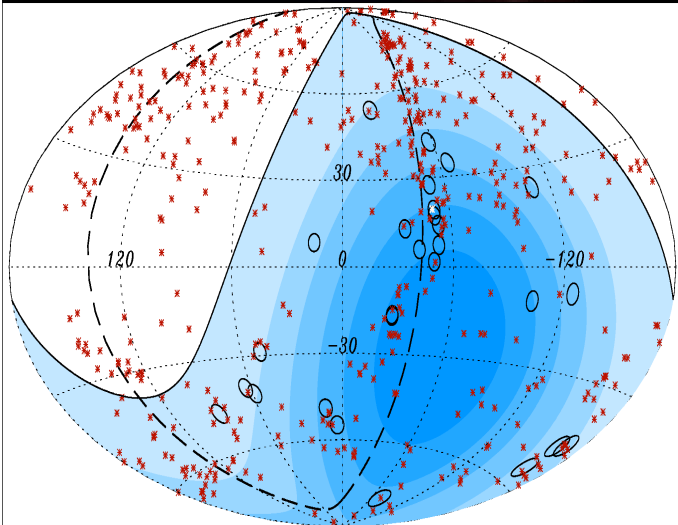
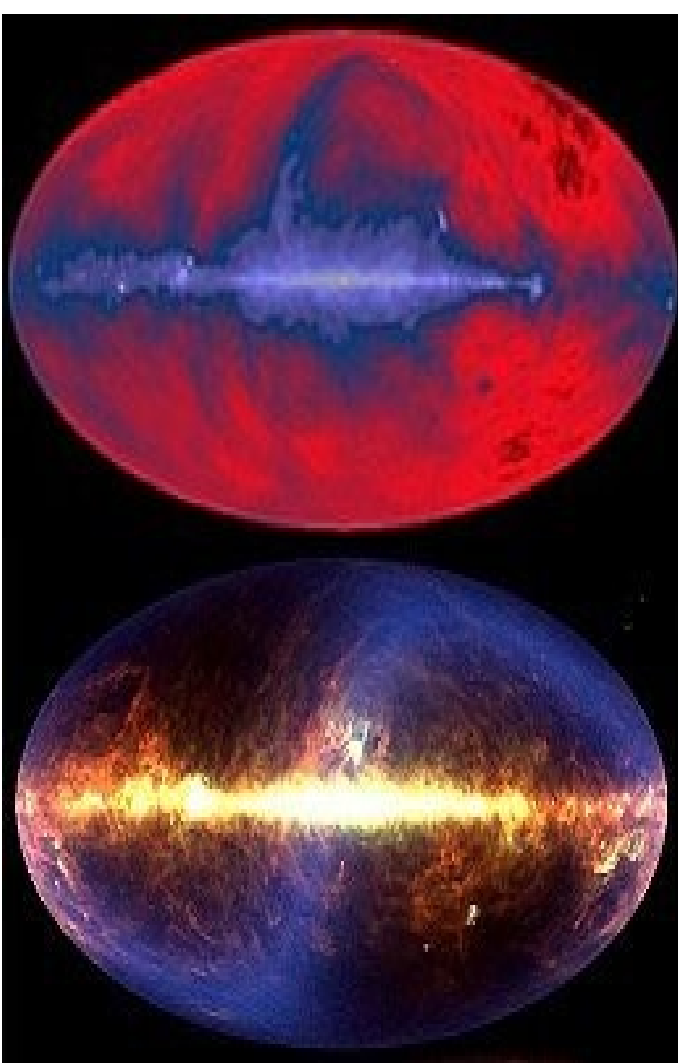
Se algo me atinge ...

Eu quero saber:

O QUE ?

QUEM ?

ENERGIA ?

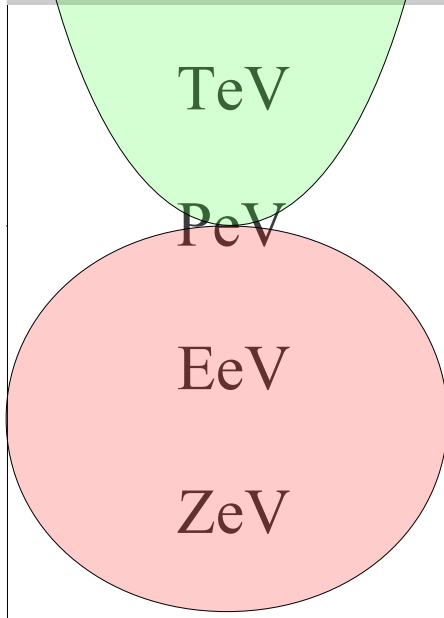


ENERGIA

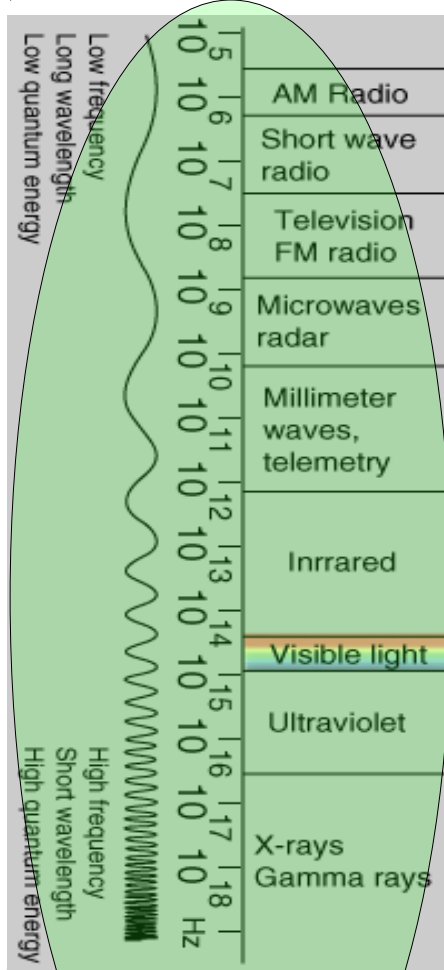
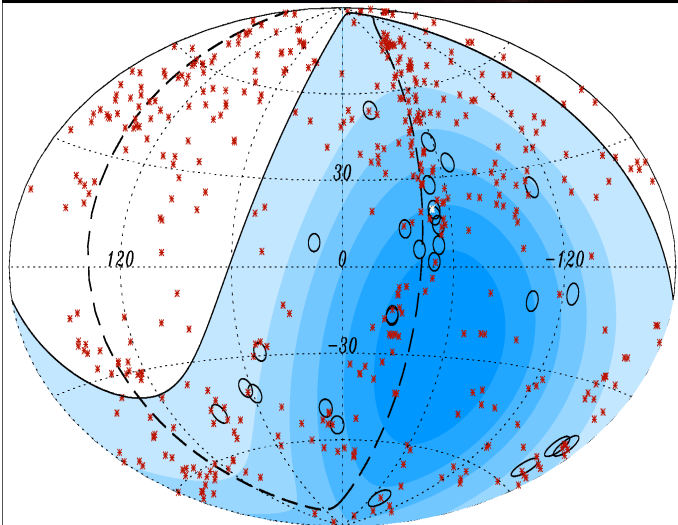
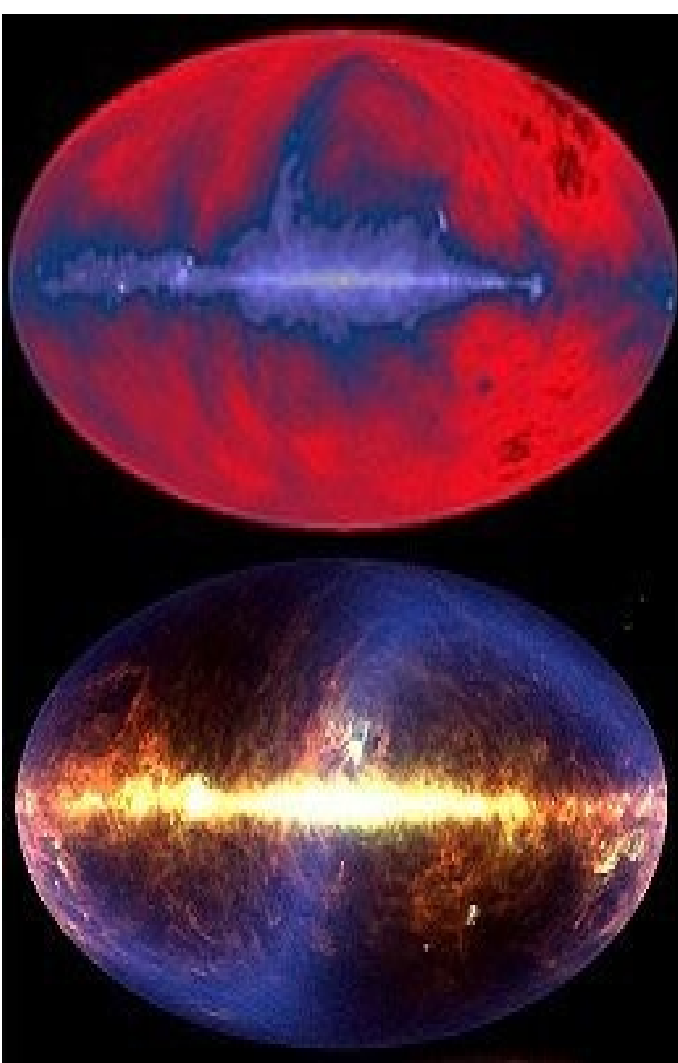
O QUE ?

QUEM ?

ENERGIA ?



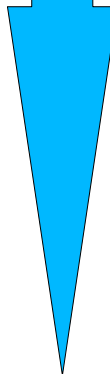




TeV

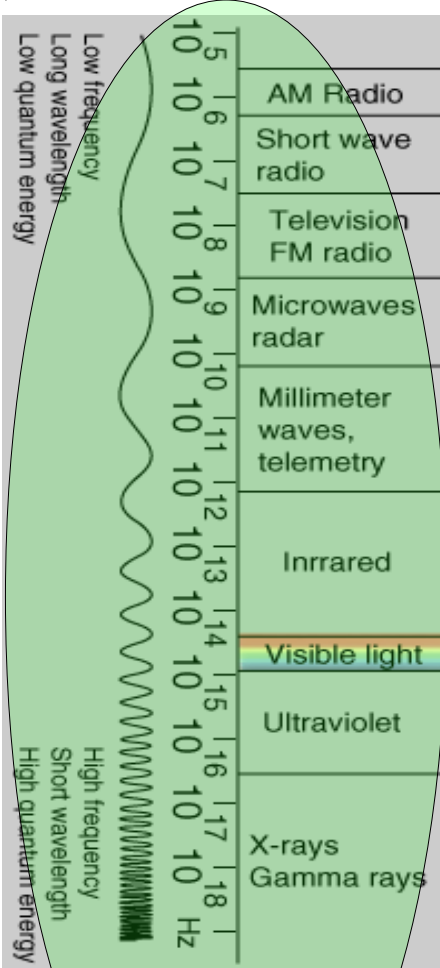
PeV

ENERGIA



O QUE ?

A maior parte  
é luz



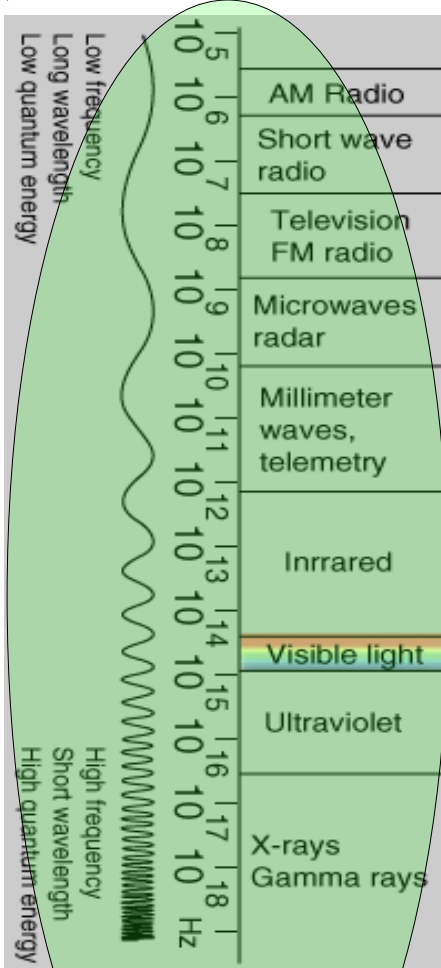
TeV

PeV



QUEM ?

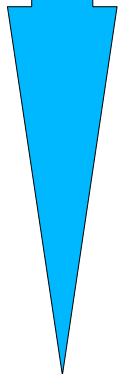
Sol e Estrelas



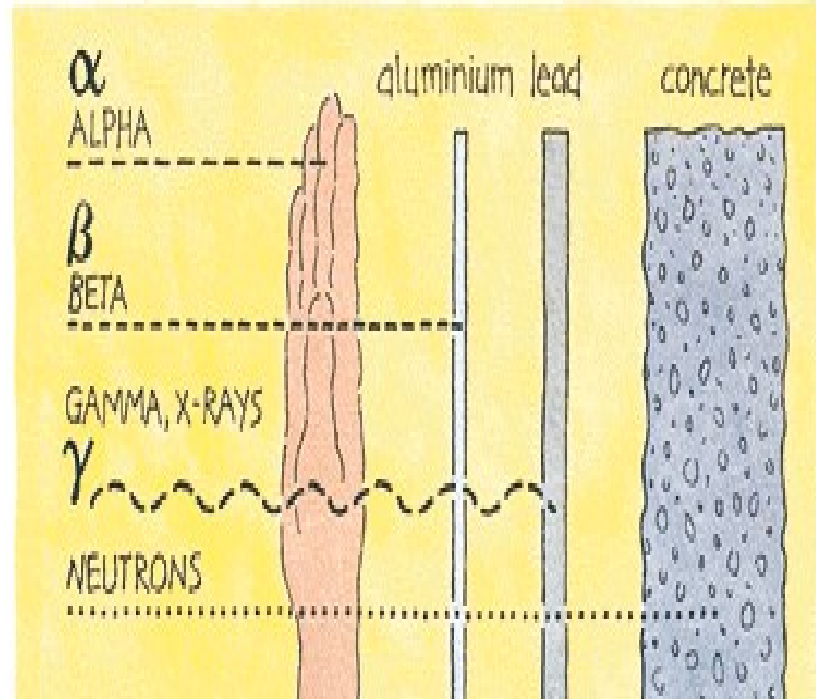
TeV

PeV

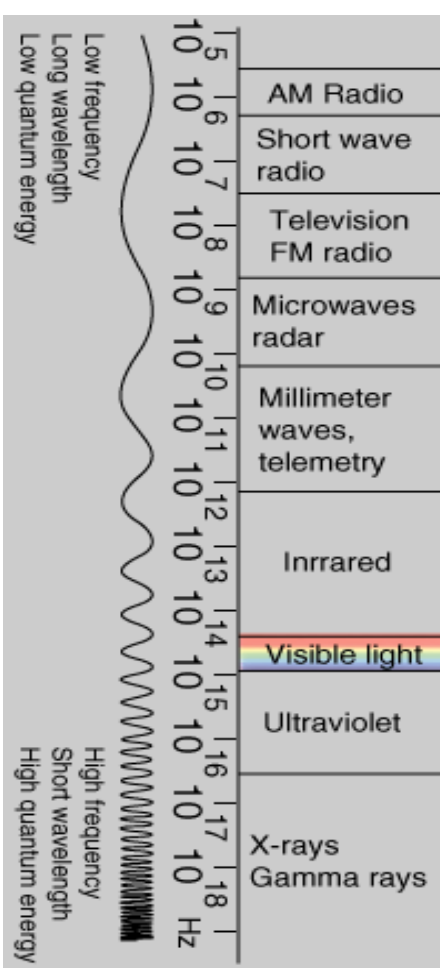
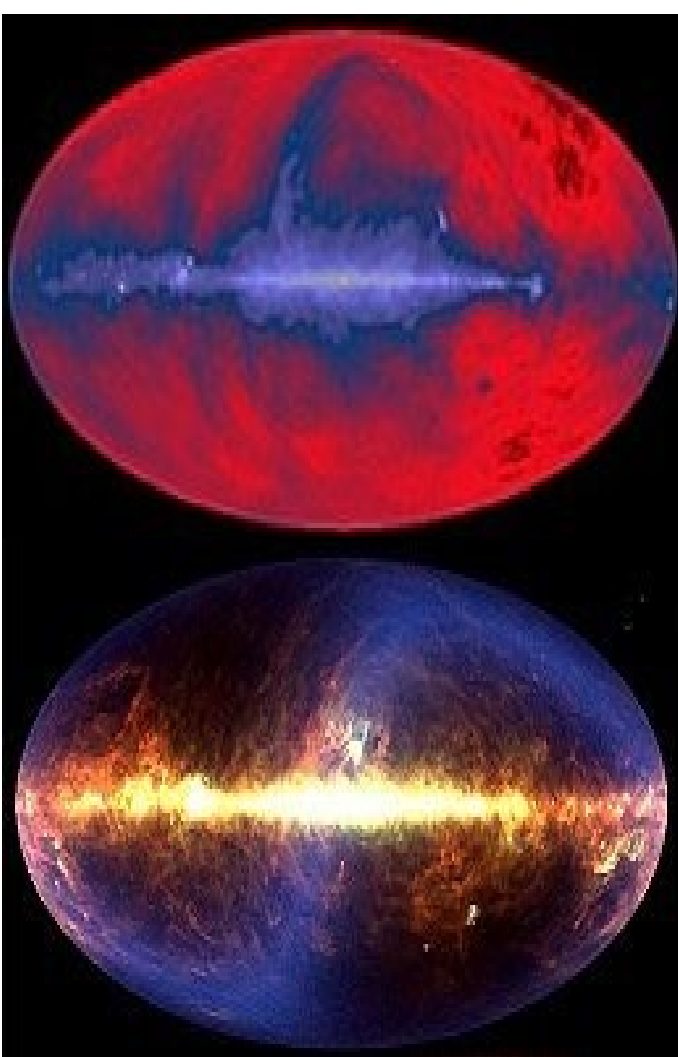
ENERGIA



# ENERGIA ?



Em um segundo bilhões de neutrinos vindos do Sol atravessam a sua mão.

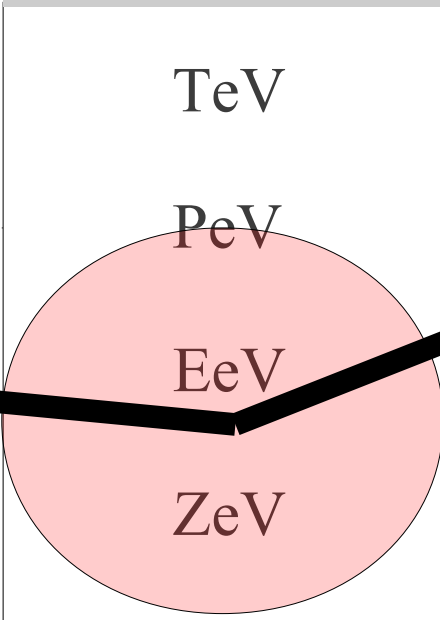
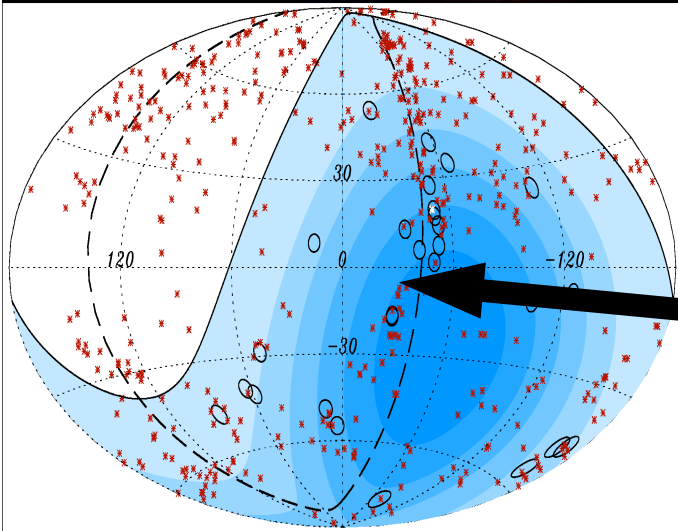


E N E R G I A

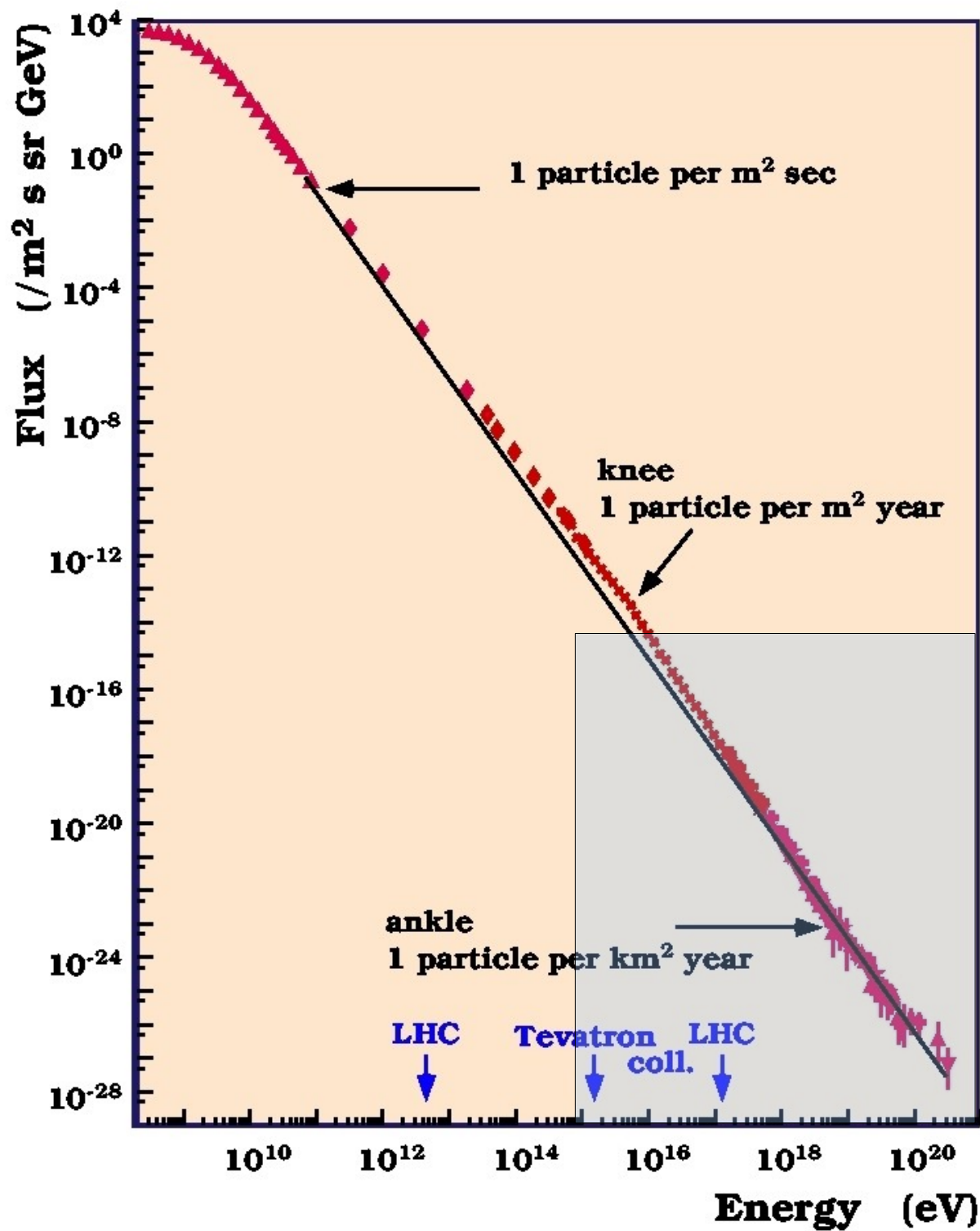
O QUE ?

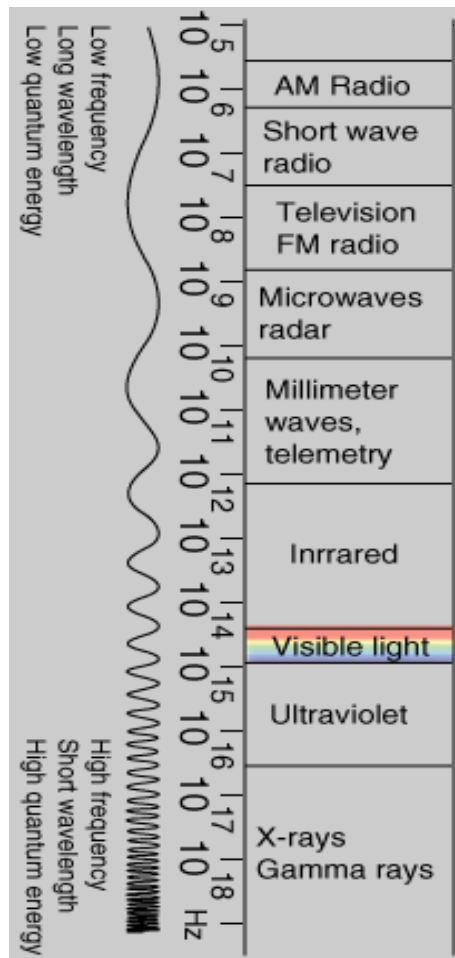
QUEM ?

ENERGIA ?



Não sabemos quase nada !





E  
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NÃO SABEMOS:

O QUE ?

QUEM ?

SABEMOS:

ENERGIA

Não sabemos quase nada !

MAS NÃO SABEMOS:

COMO PRODUZIR ESSA ENERGIA

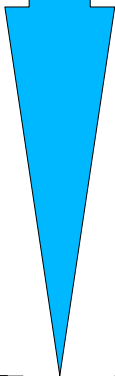
NÃO CONHECEMOS NENHUM

PROCESSO FÍSICO CAPAZ

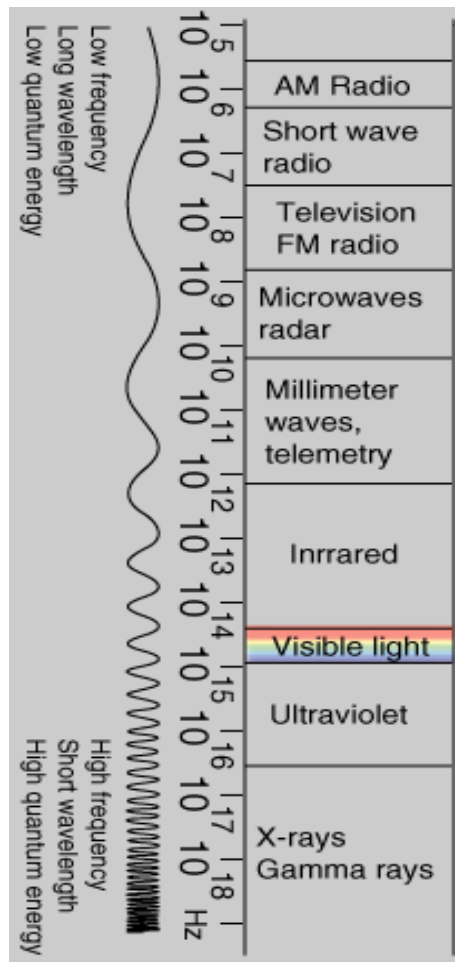
DE GERAR ESSA

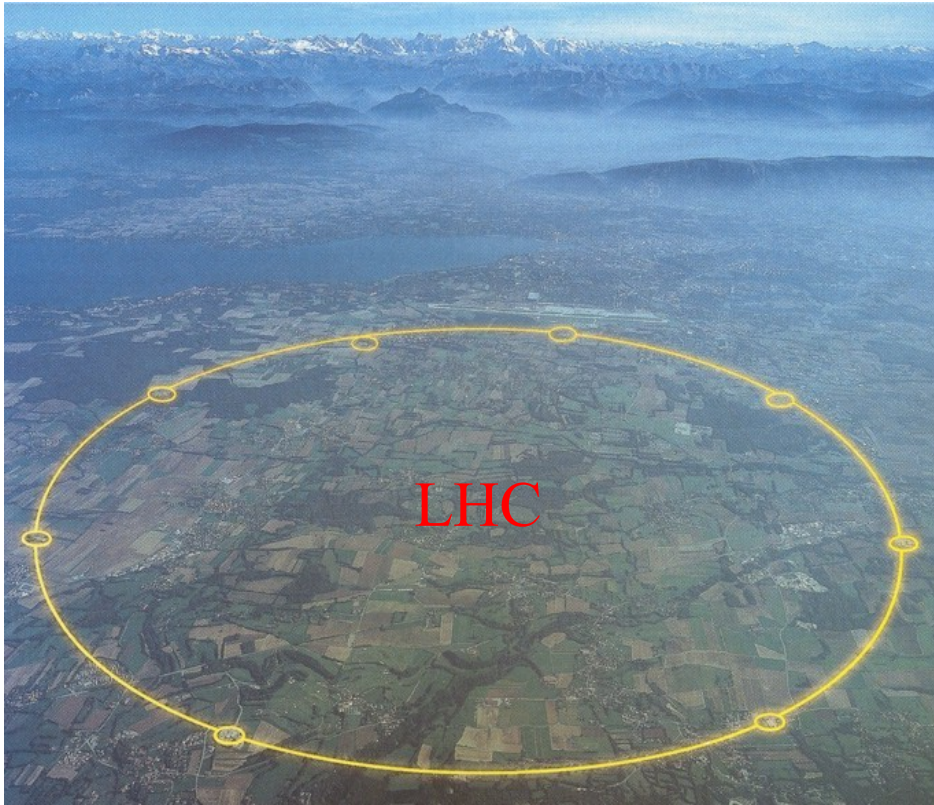
ENERGIA

E  
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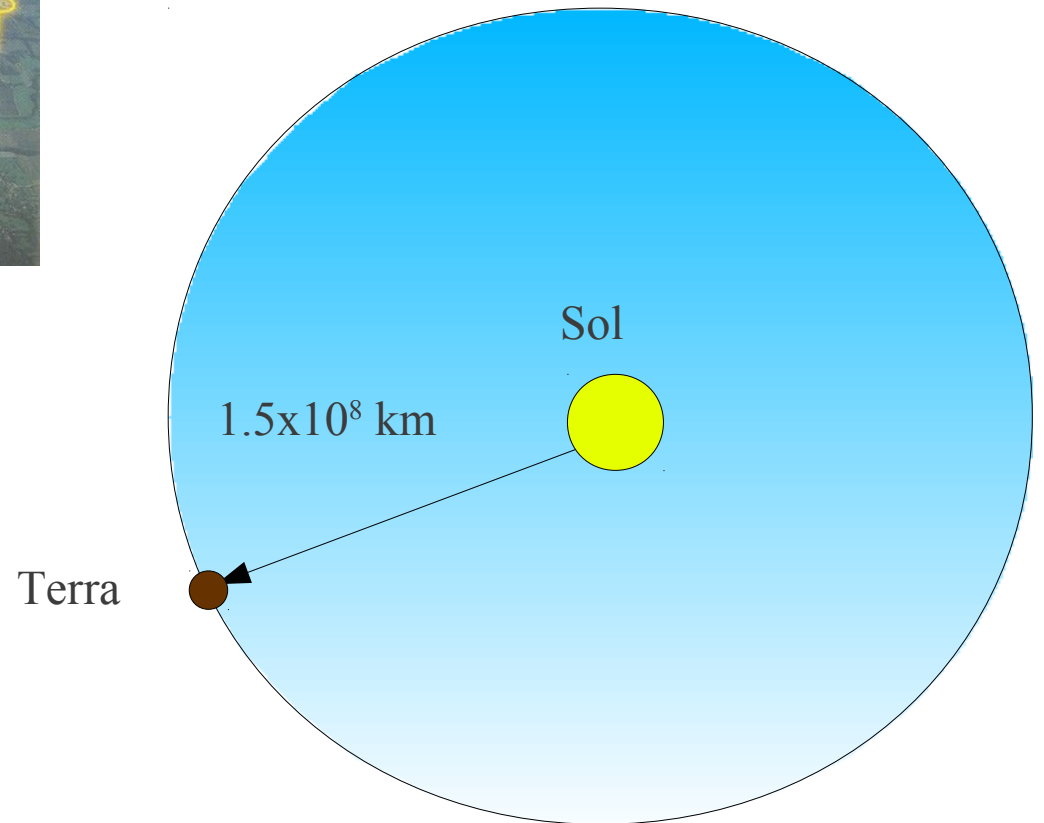
Não sabemos  
quase nada !





Vamos construir um LHC para acelerar prótons a  $10^{20}$  eV ?

Seria necessário um anel com a distância da Terra ao Sol

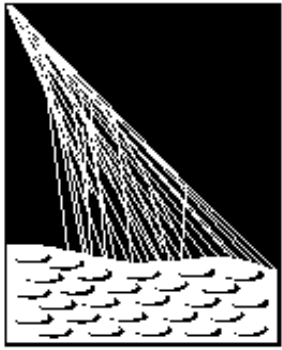




TUDO QUE SEI  
É QUE NADA SEI !

Sócrates



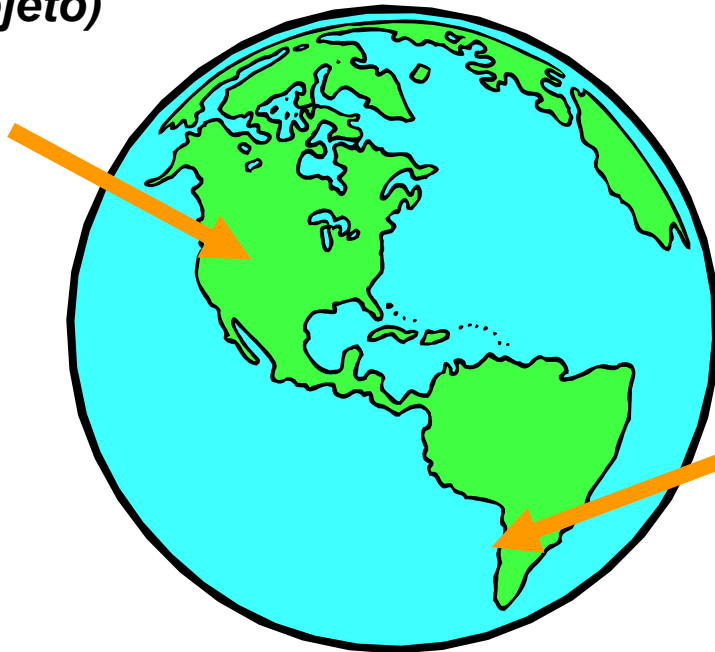


**PIERRE  
AUGER**  
OBSERVATORY

# Observatório Pierre Auger

O maior experimento de raios cósmicos já construído para medir com grande estatística a região de energia acima de  $10^{18}$  eV

**Colorado, EUA**  
*(em projeto)*



**Mendoza, Argentina**  
*(em funcionamento)*



## Colaboração Auger: 16 Países

Argentina

Australia

Bolívia\*

Brasil

República Tcheca

França

Alemanha

Itália

México

Holanda

Polônia

Eslovênia

Espanha

Reino Unido

EUA

Vietnam\*

*\*Associados*

> 60 Instituições, > 400 Colaboradores

<http://www.auger.org/>

# Colaboração Auger





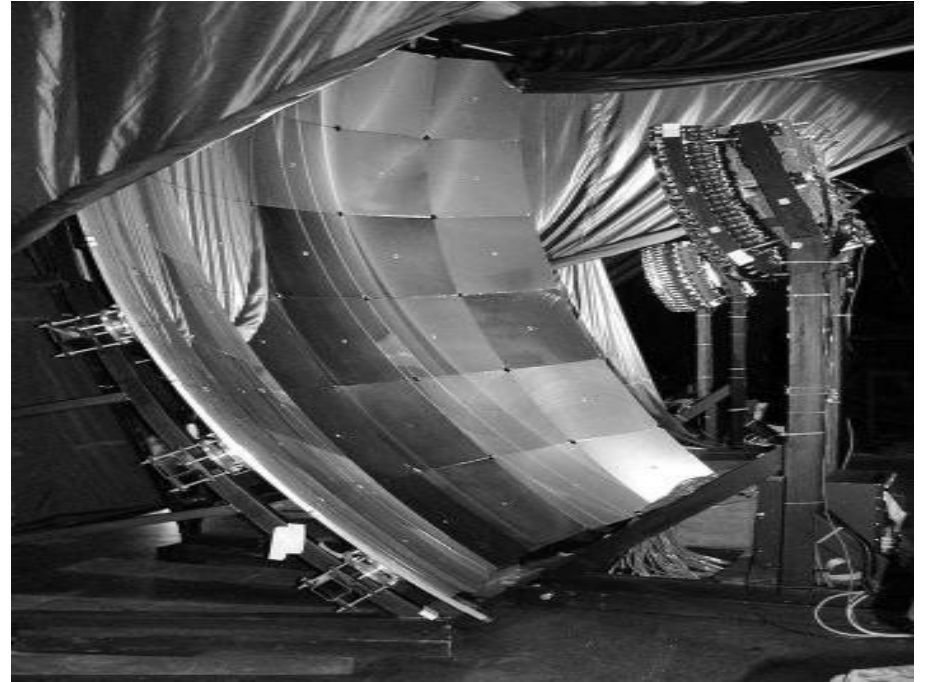
# Observatório Auger



50 km

60 km

# Observatório Auger



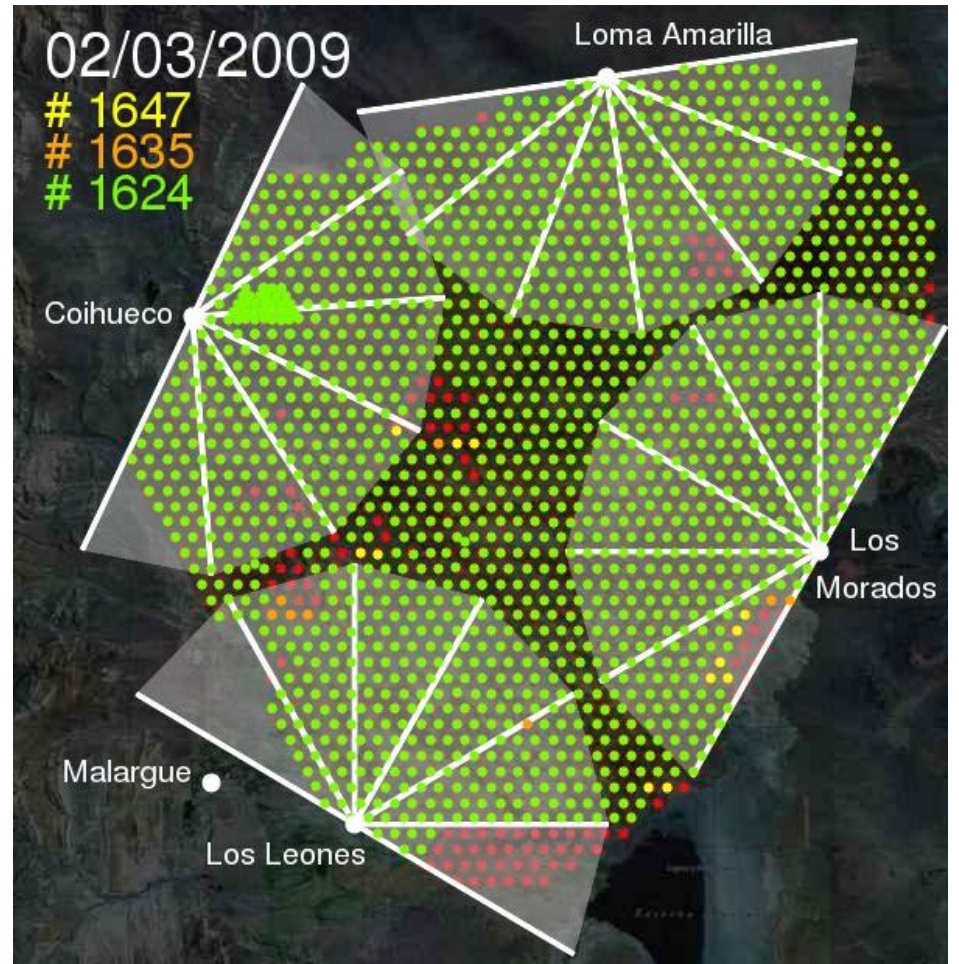
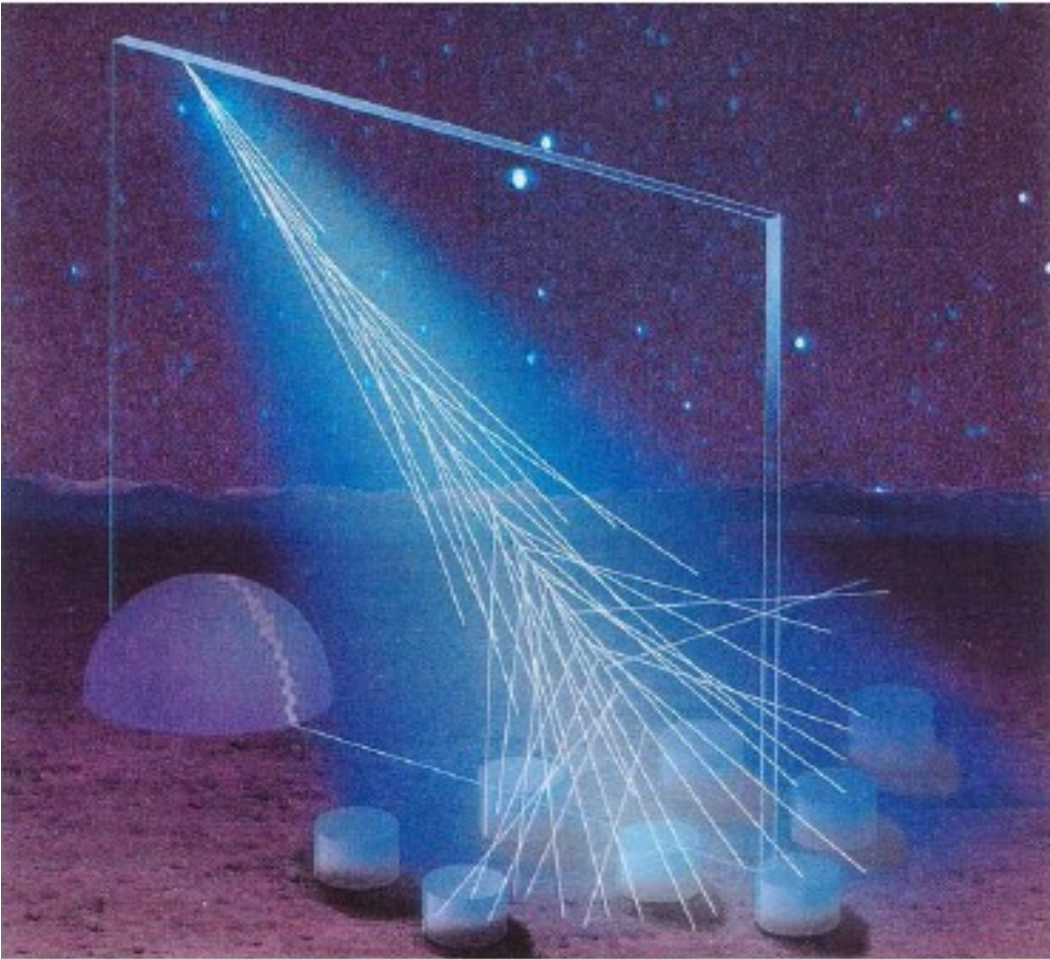
**Em funcionamento:**

**- 1600 tanques**

**- 27 telescópios**



# Observatório Auger



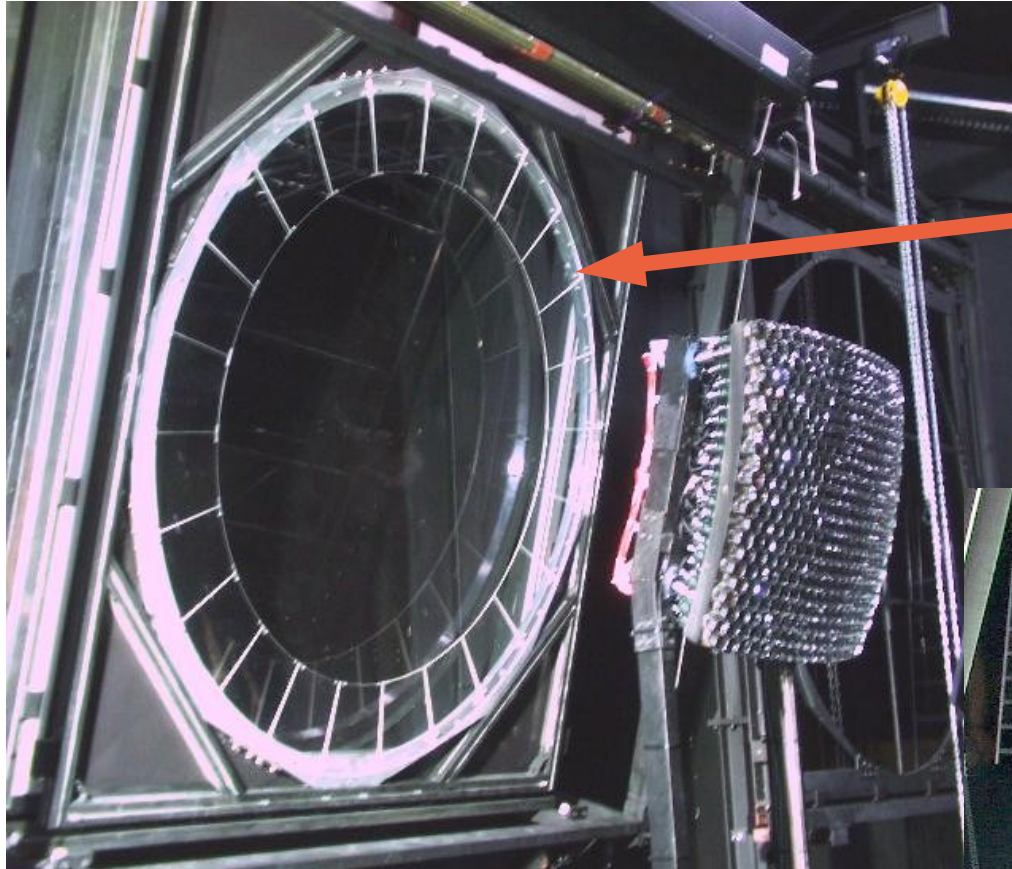


# Observatório Auger: Telescópios

*Los Leones*



# Observatório Auger: Telescópios

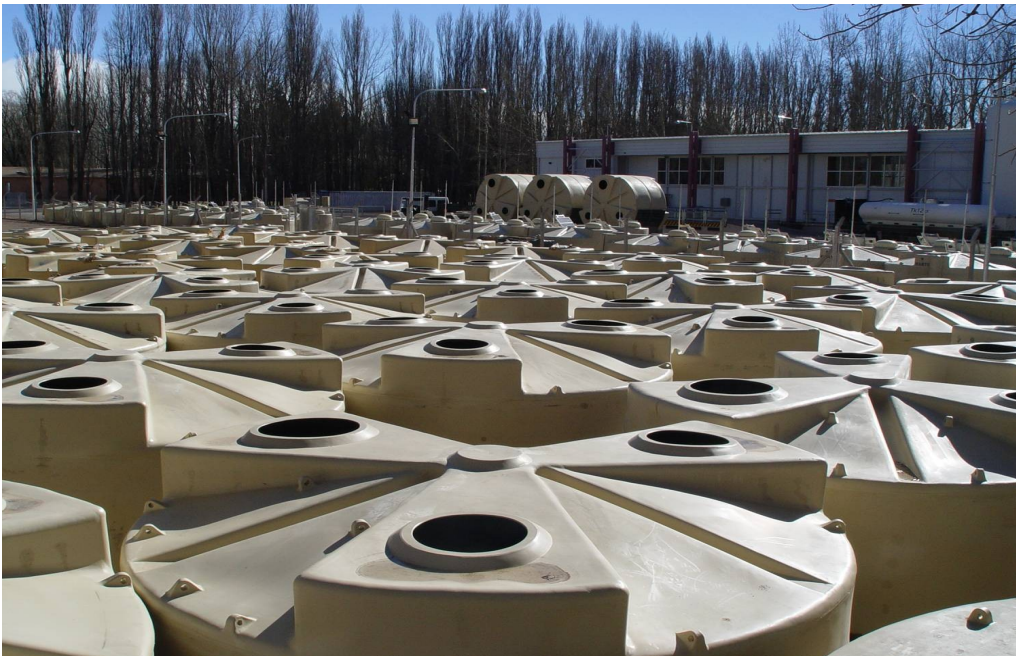


Lente Corretora:  
Fabricada em Indaiatuba  
Caixa de Abertura:  
Projeto Brasileiro

24 Telescópios  
em operação



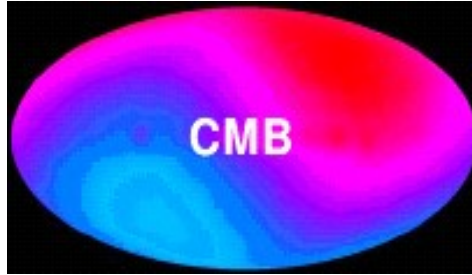
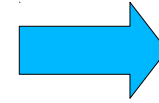
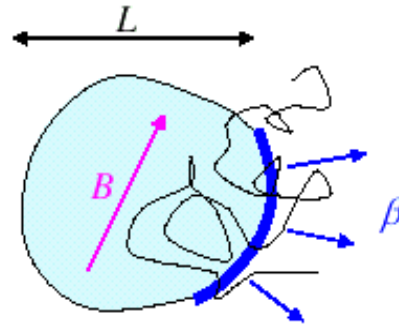
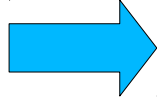
# Observatório Auger: Tanques



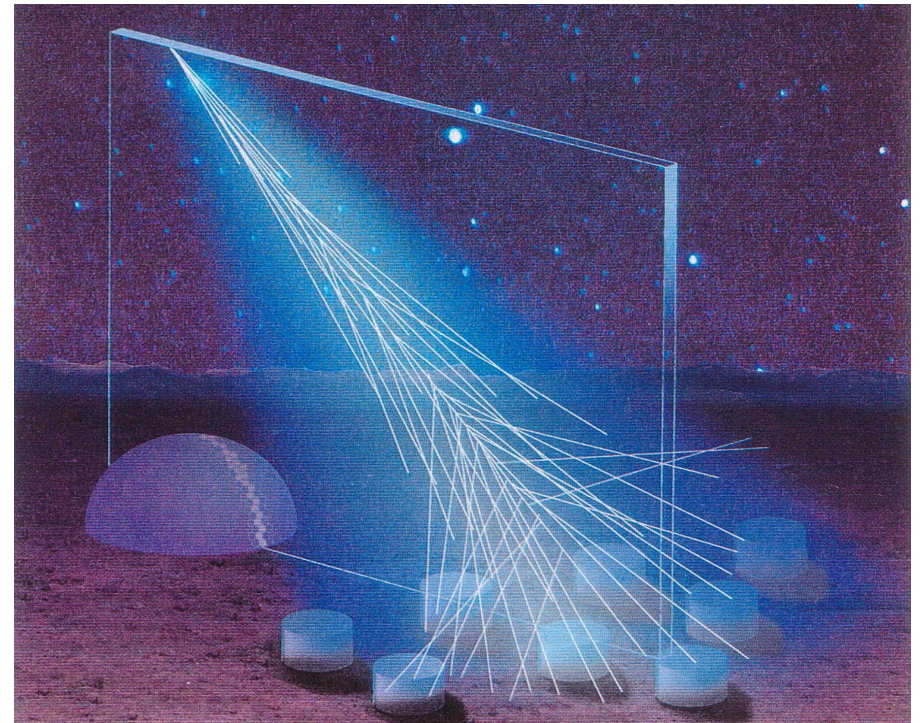
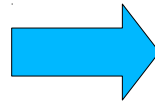
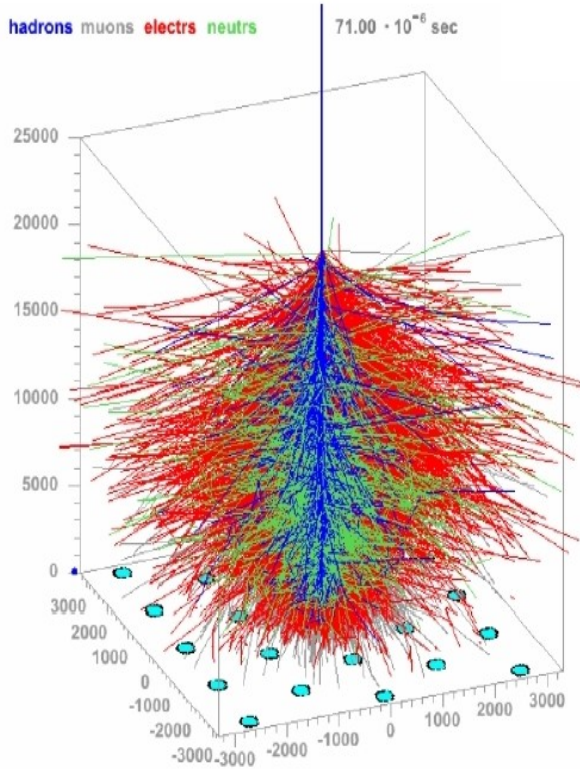
# Observatório Auger: Tanques



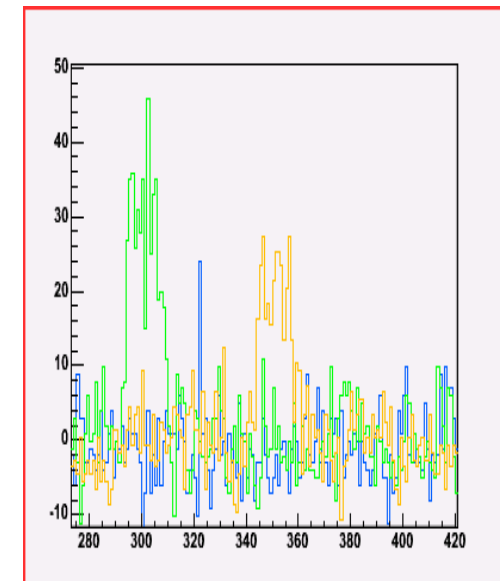
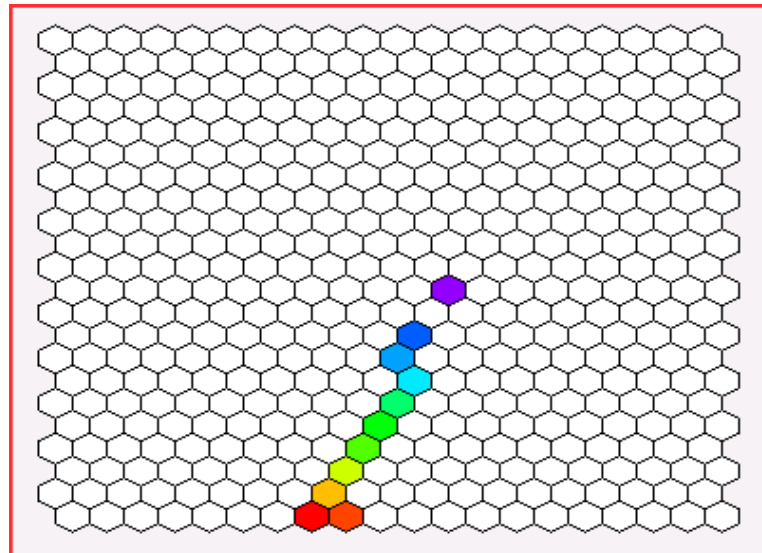
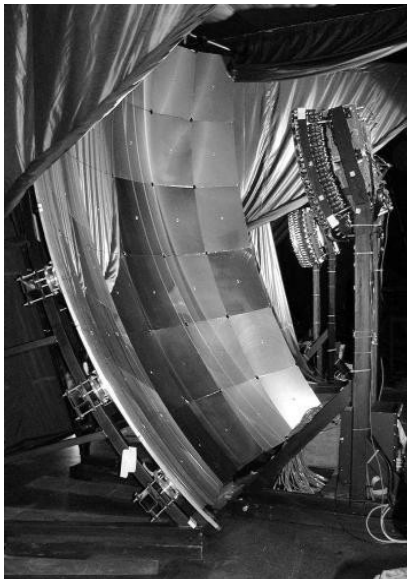
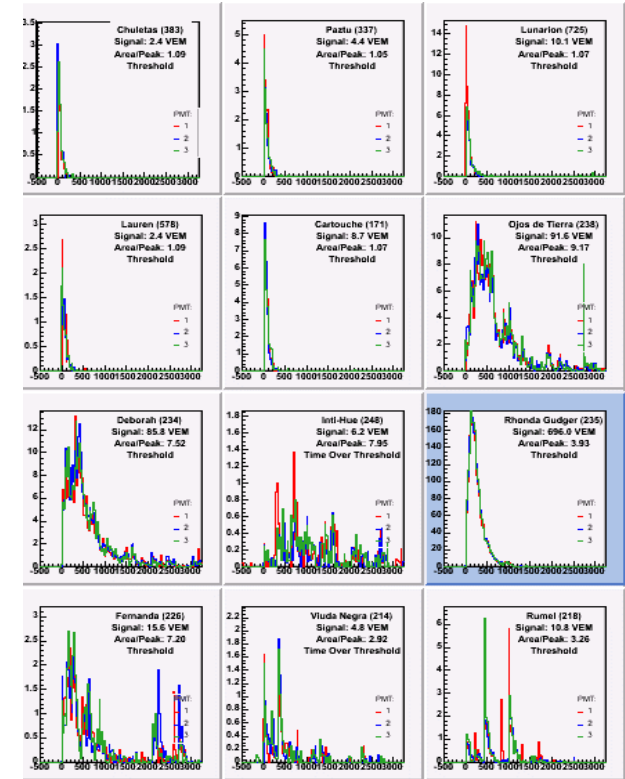
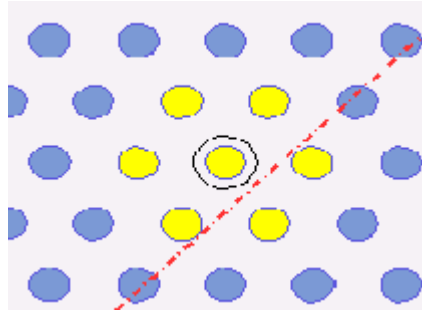


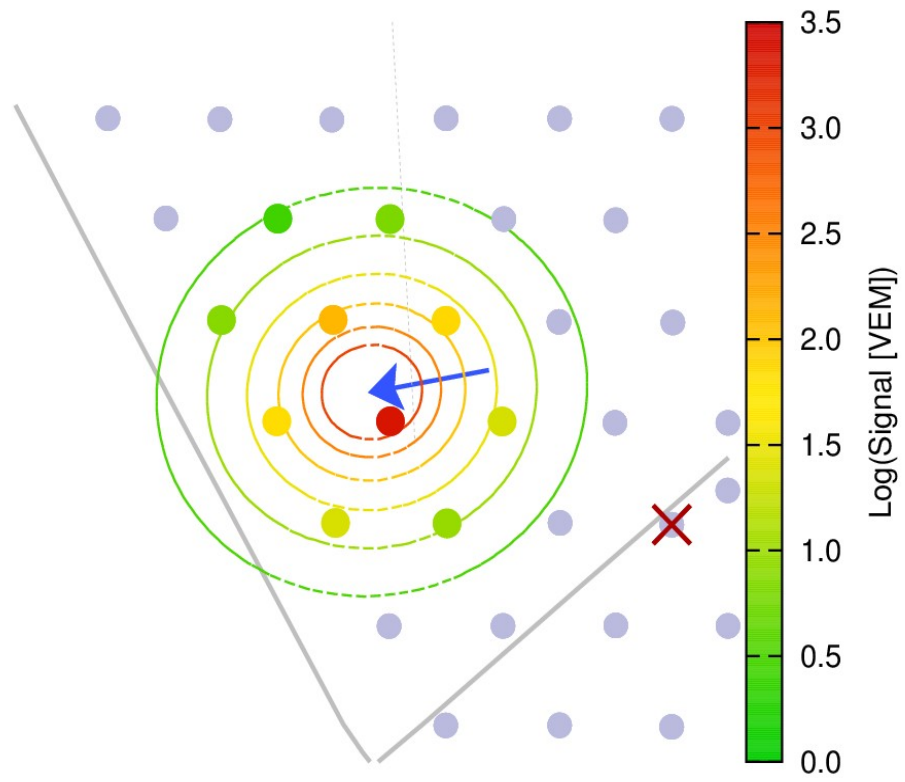


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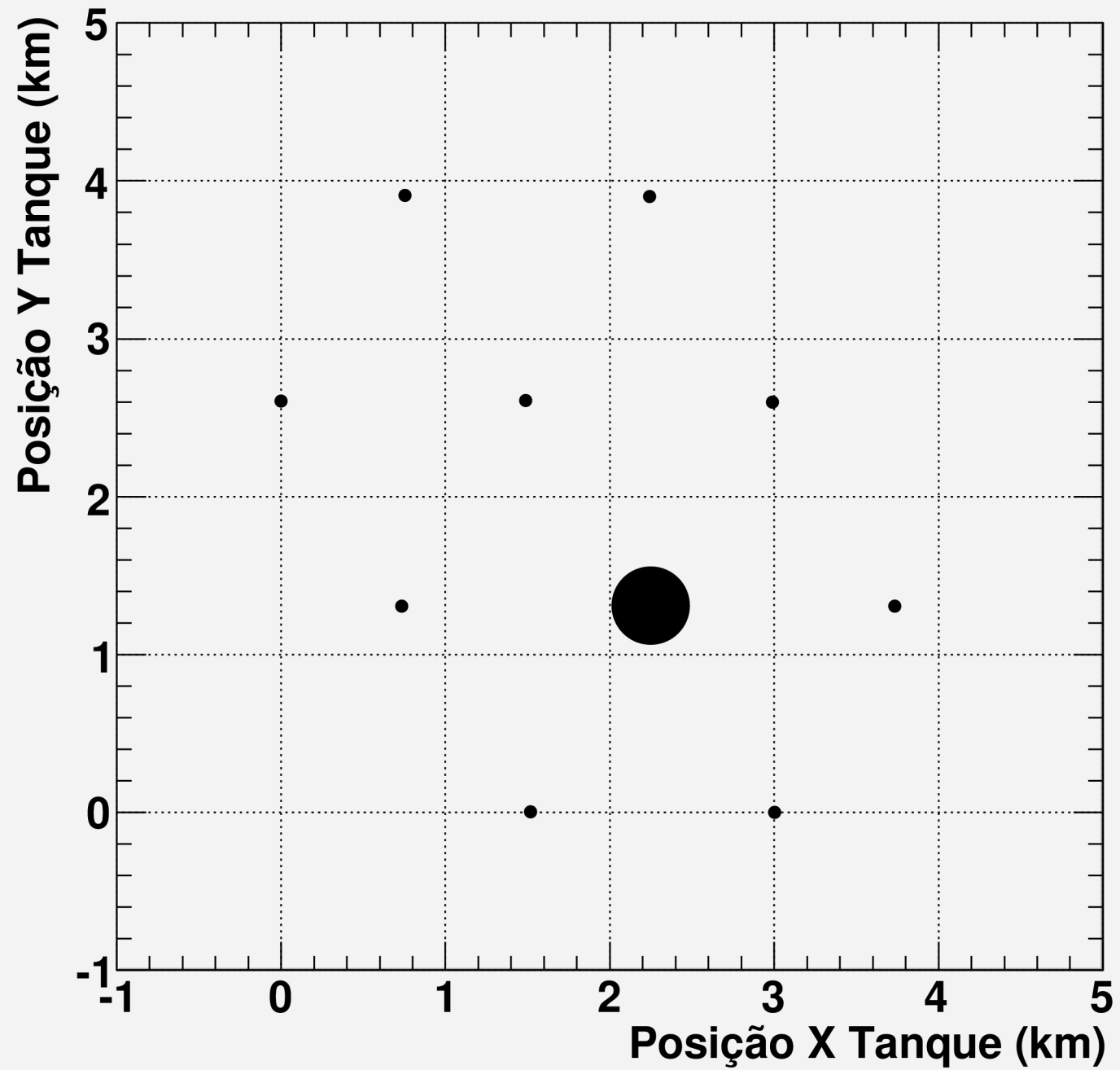


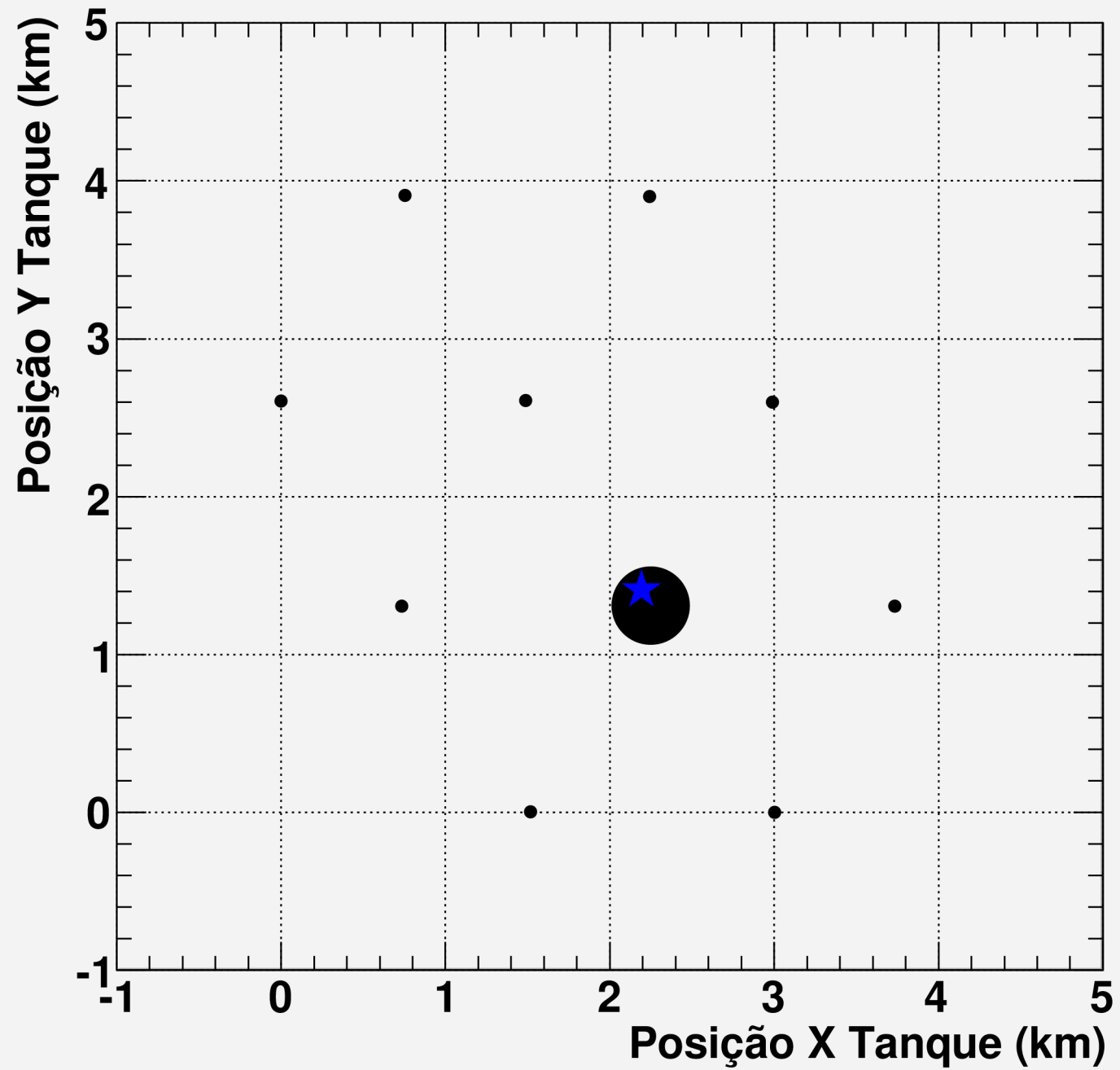
# Dados do Observatório Pierre Auger

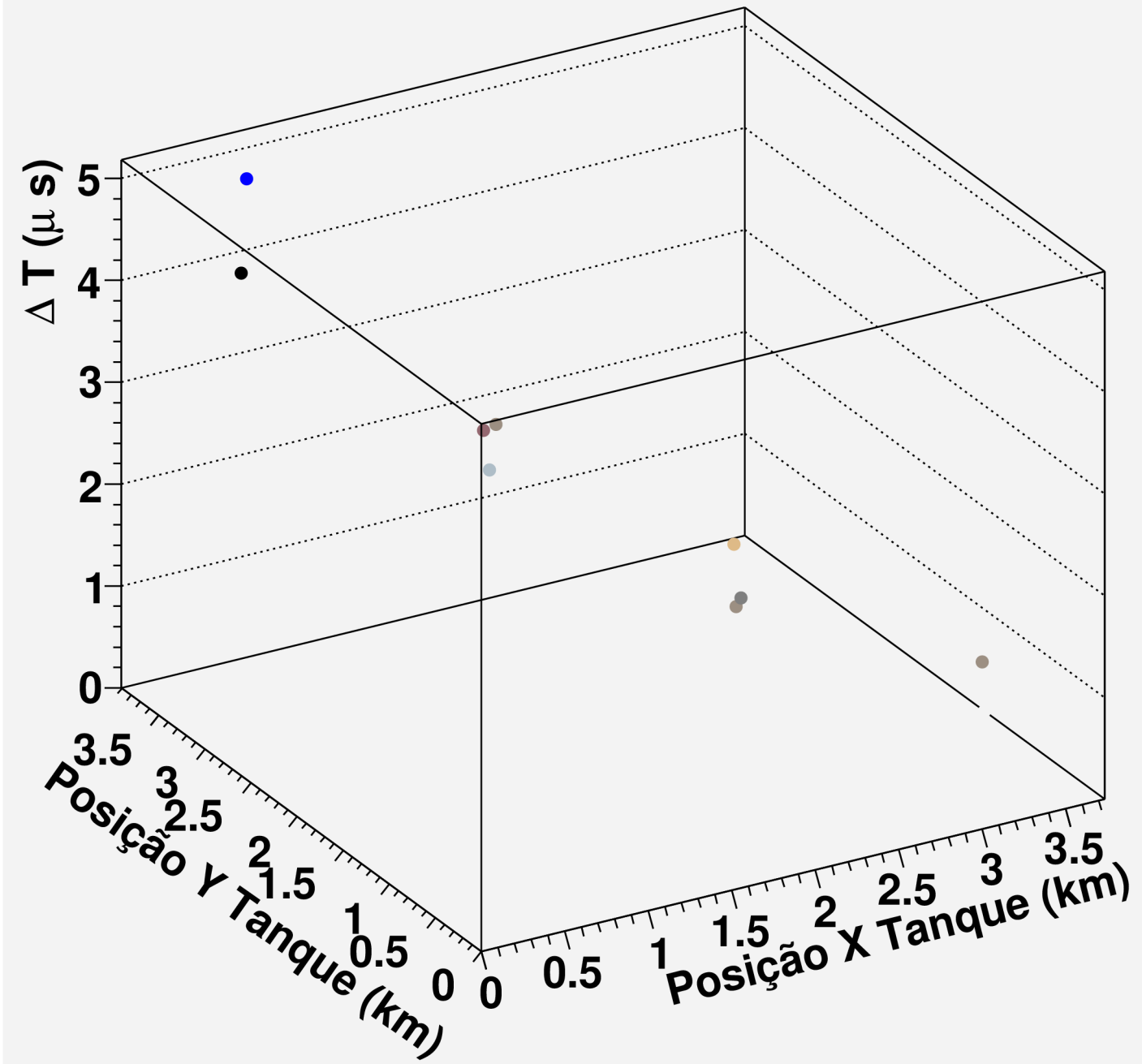


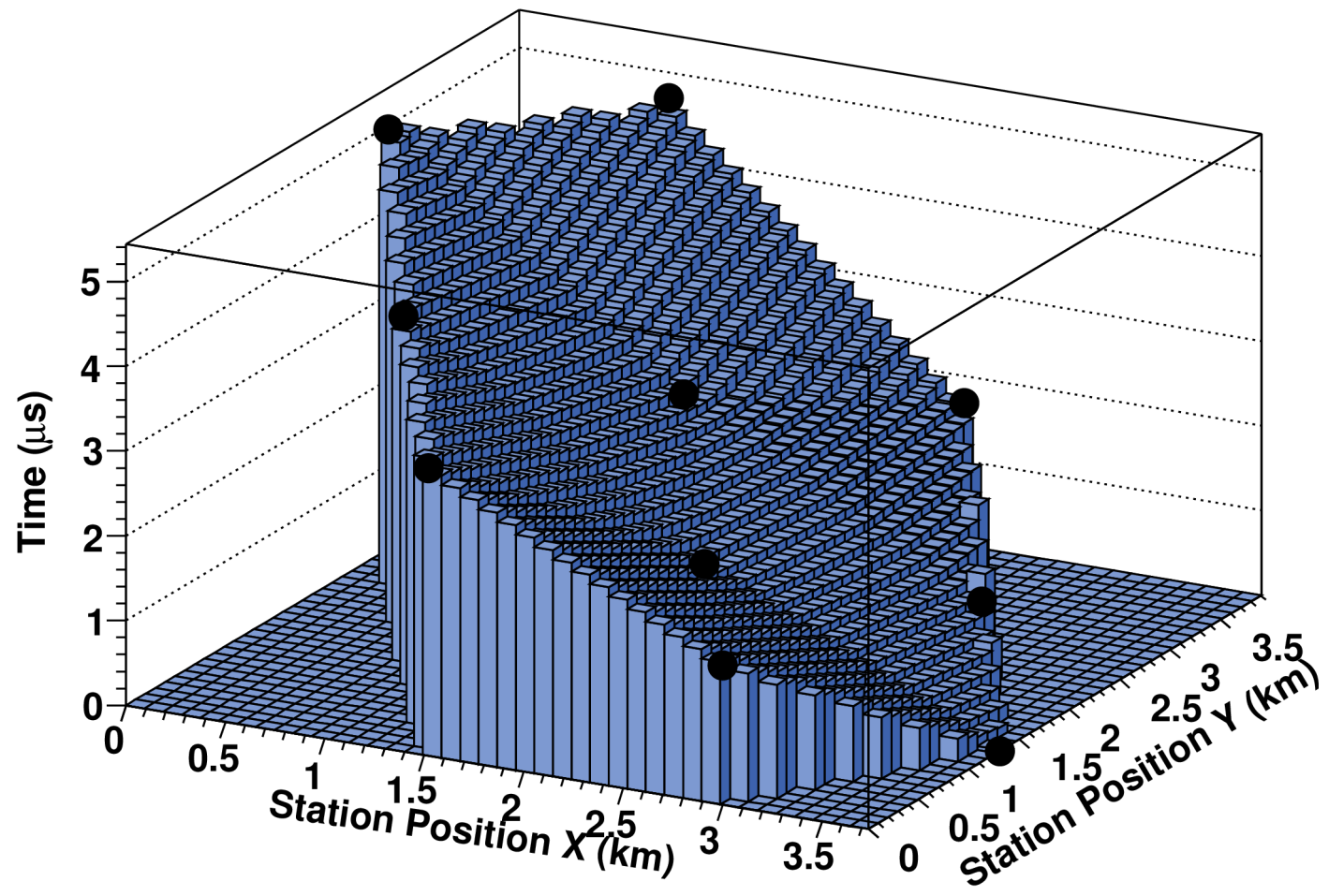


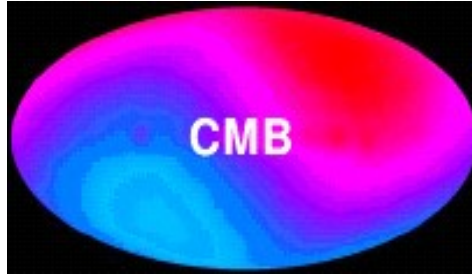
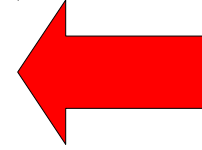
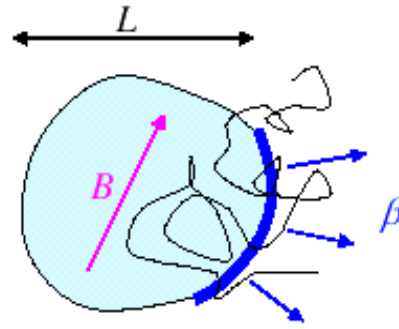
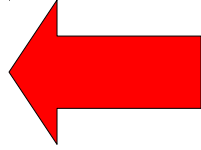




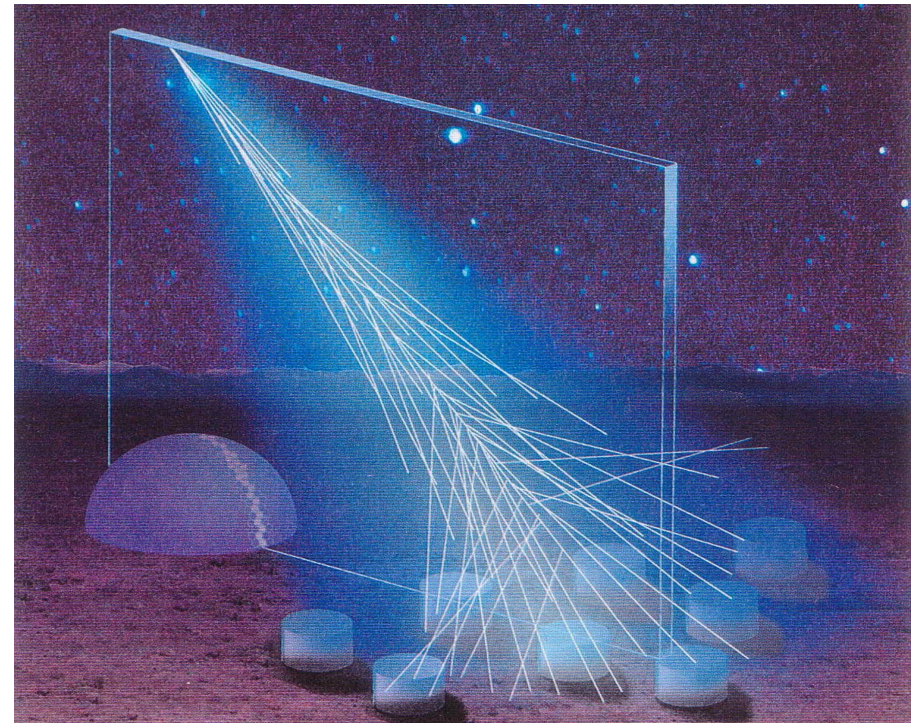
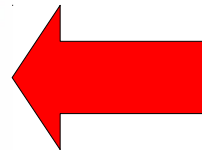
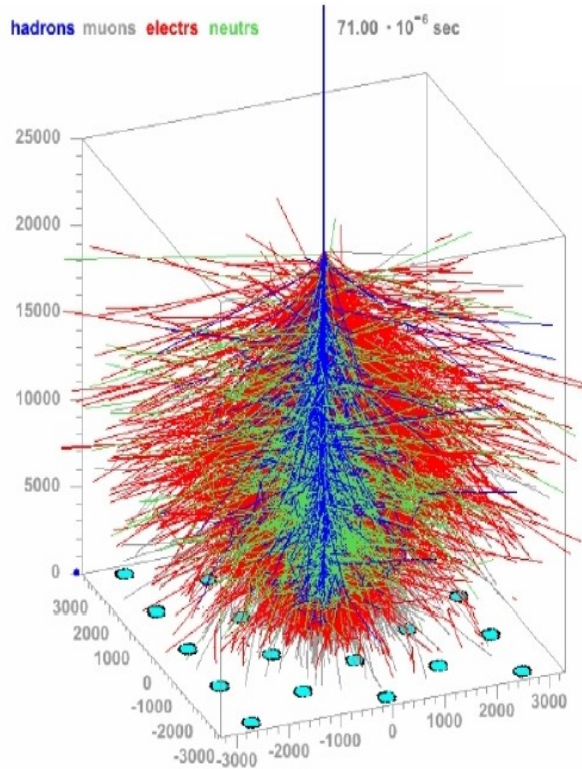








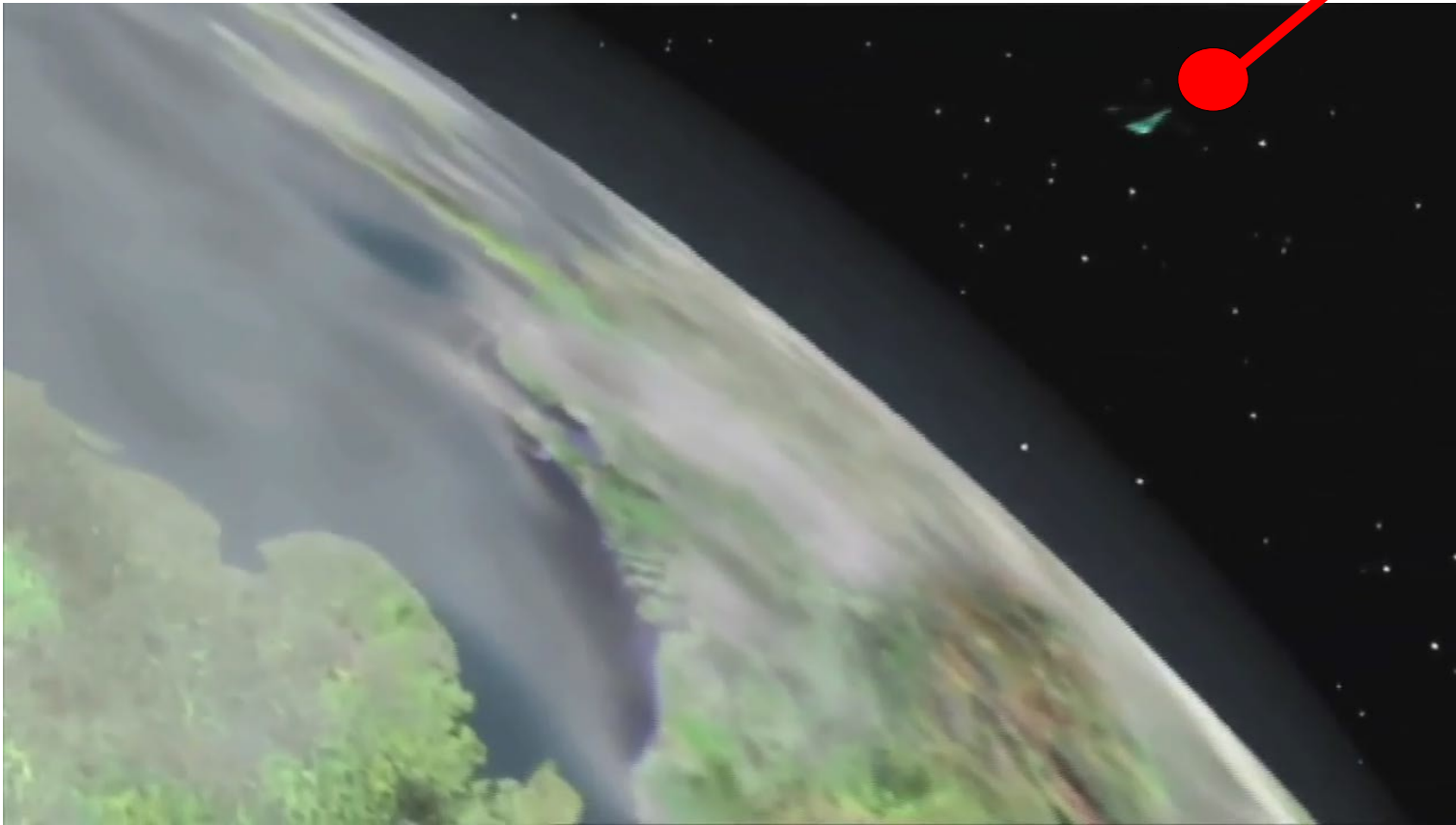
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Energia  
Direção  
Tipo





# O que já aprendemos ?



O Observatório foi inaugurado em Novembro de 2008.

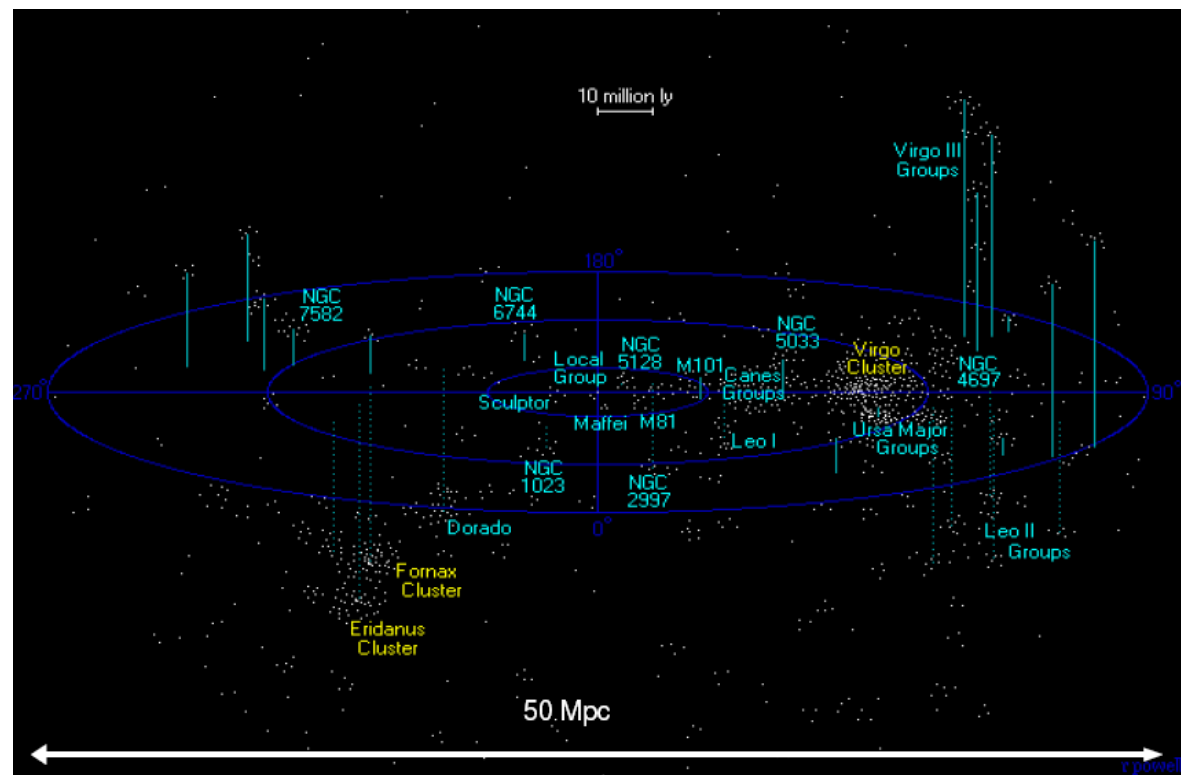
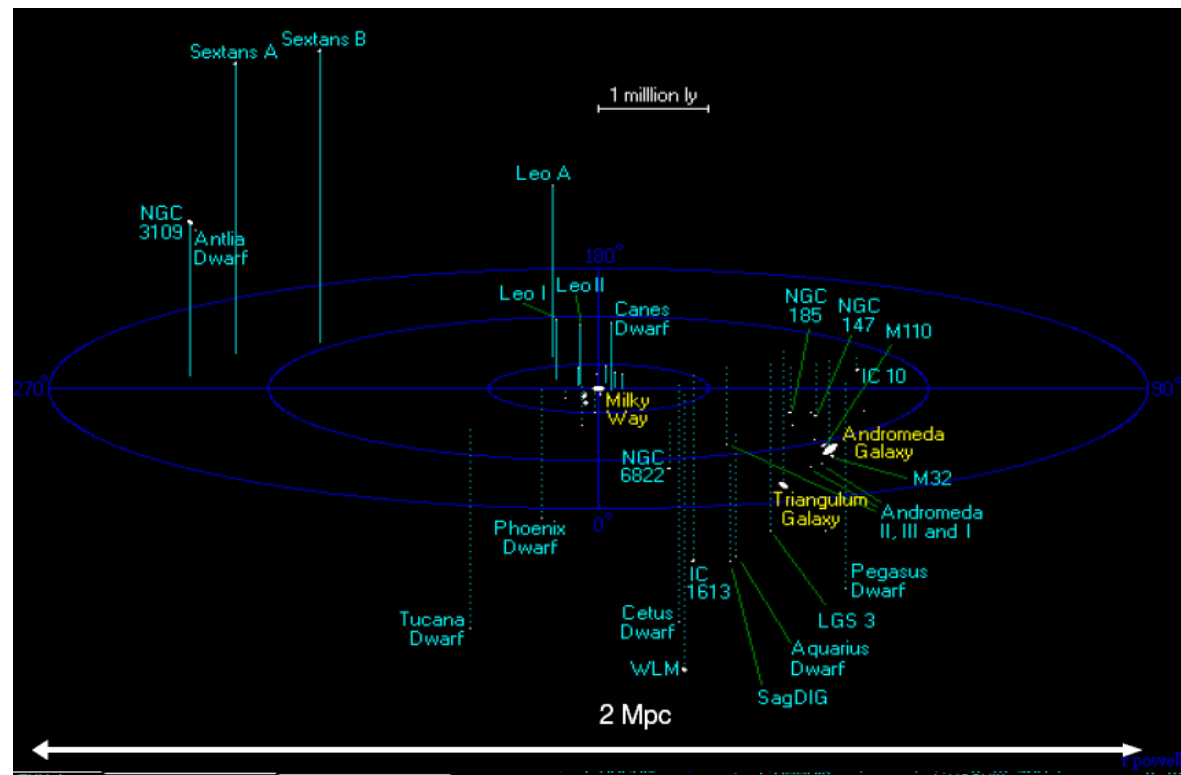
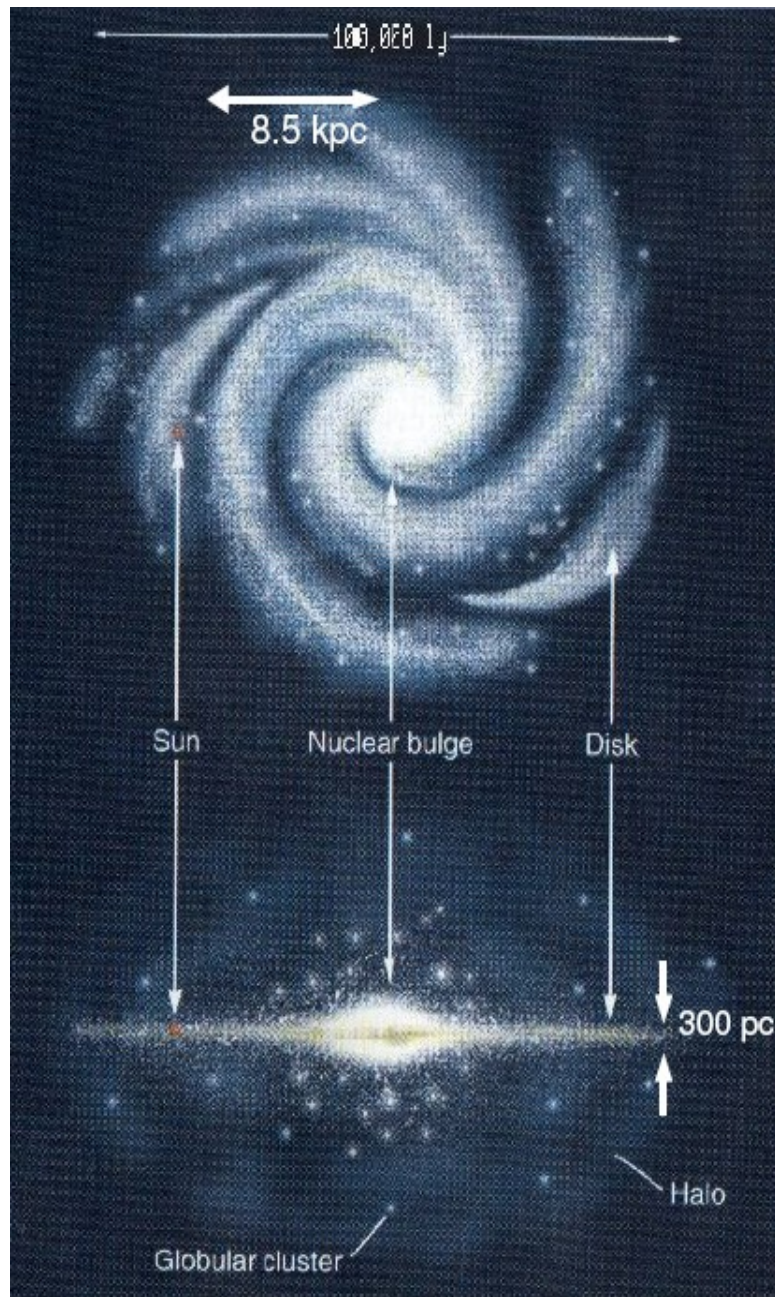
Se algo me atinge ...

Eu quero saber:

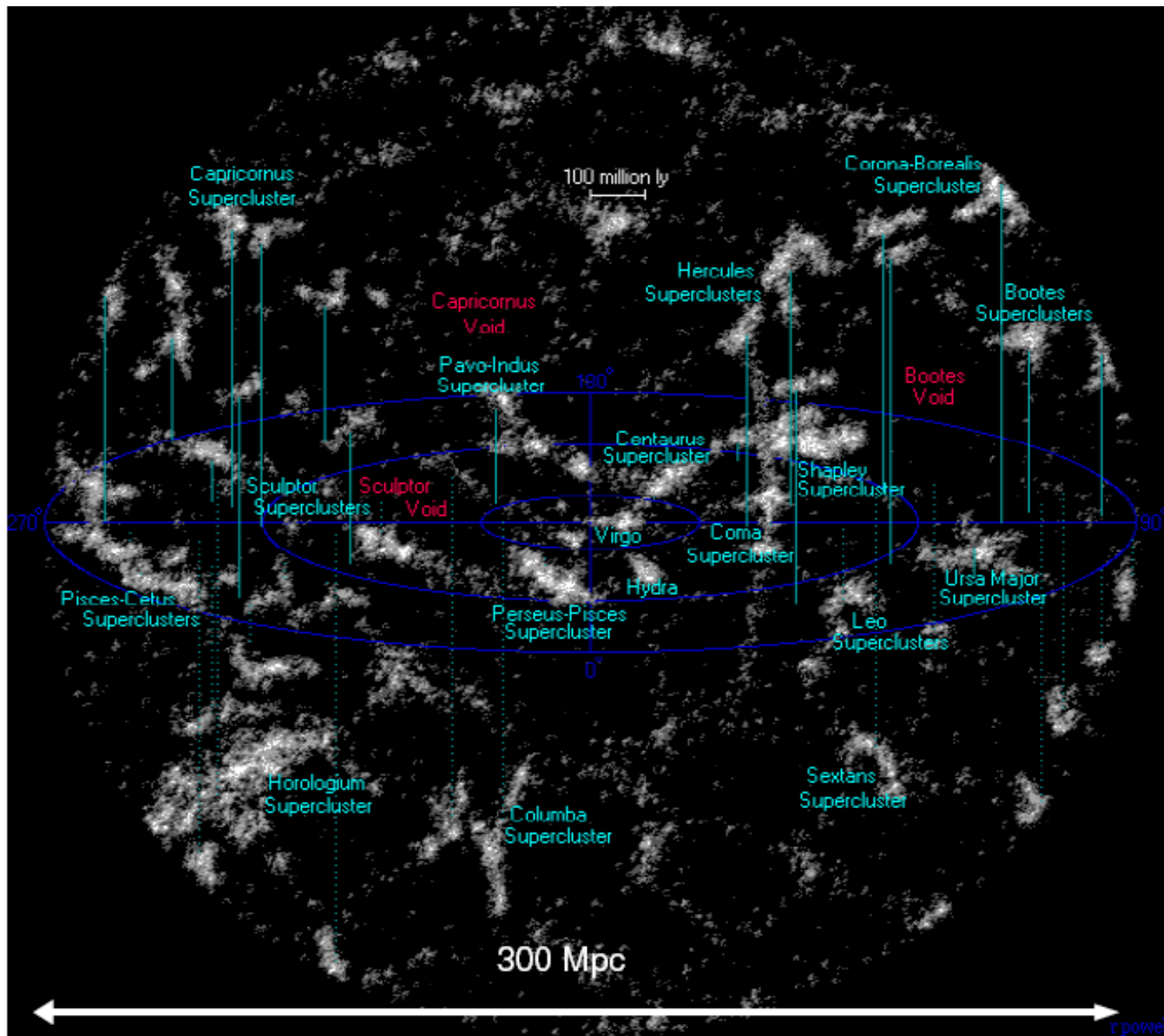
O QUE ?

QUEM ?

COMO PRODUZIR ESSA ENERGIA ?

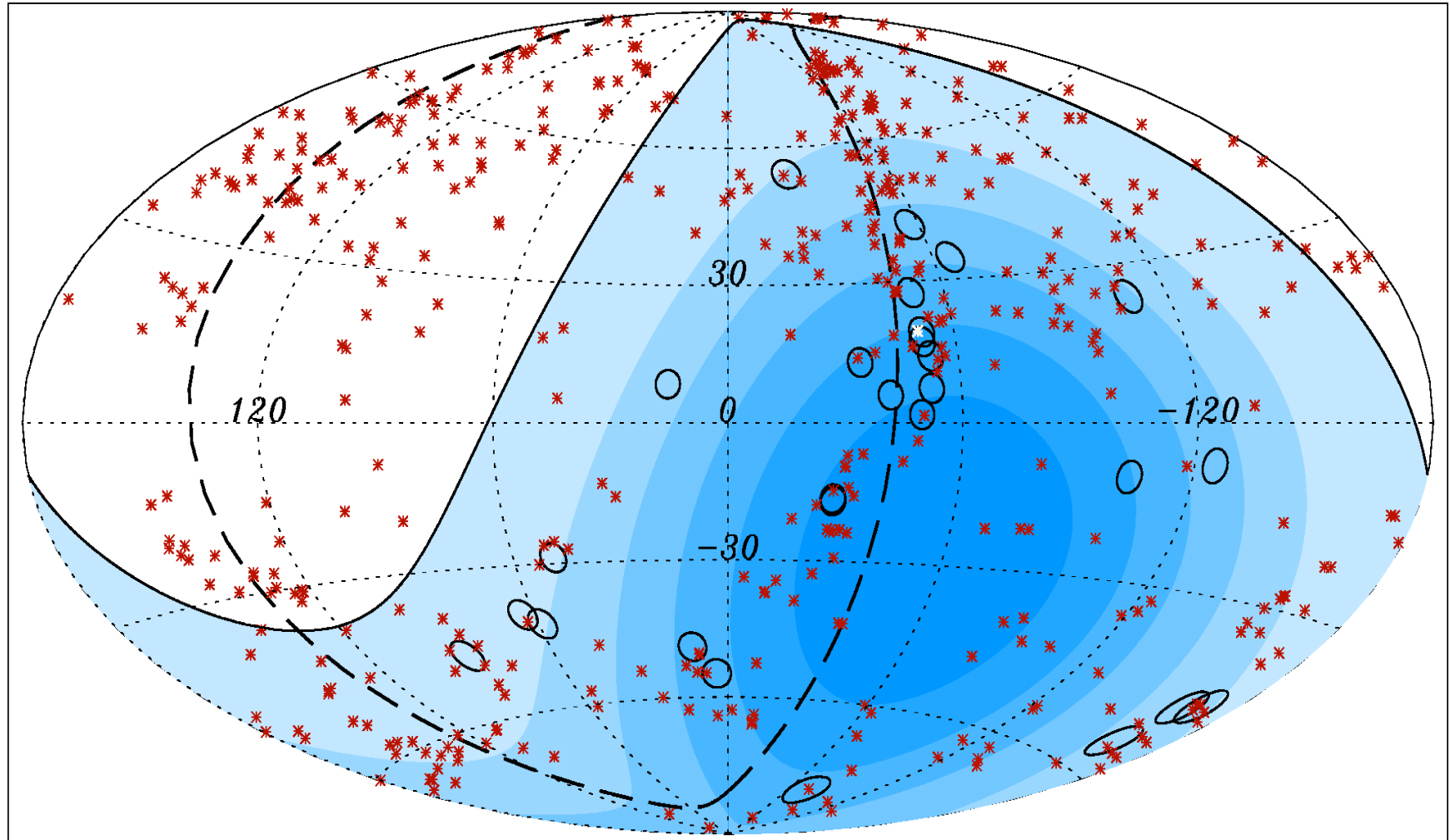


1 pc =  $3 \times 10^{16}$  metros



1 pc =  $3 \times 10^{16}$  metros

# Pierre Auger Collaboration, Science (2007)



Eventos com energia acima de  $5.7 \times 10^{19}$  eV



Núcleos Ativos de Galáxias (AGN)



Exposição do Observatório

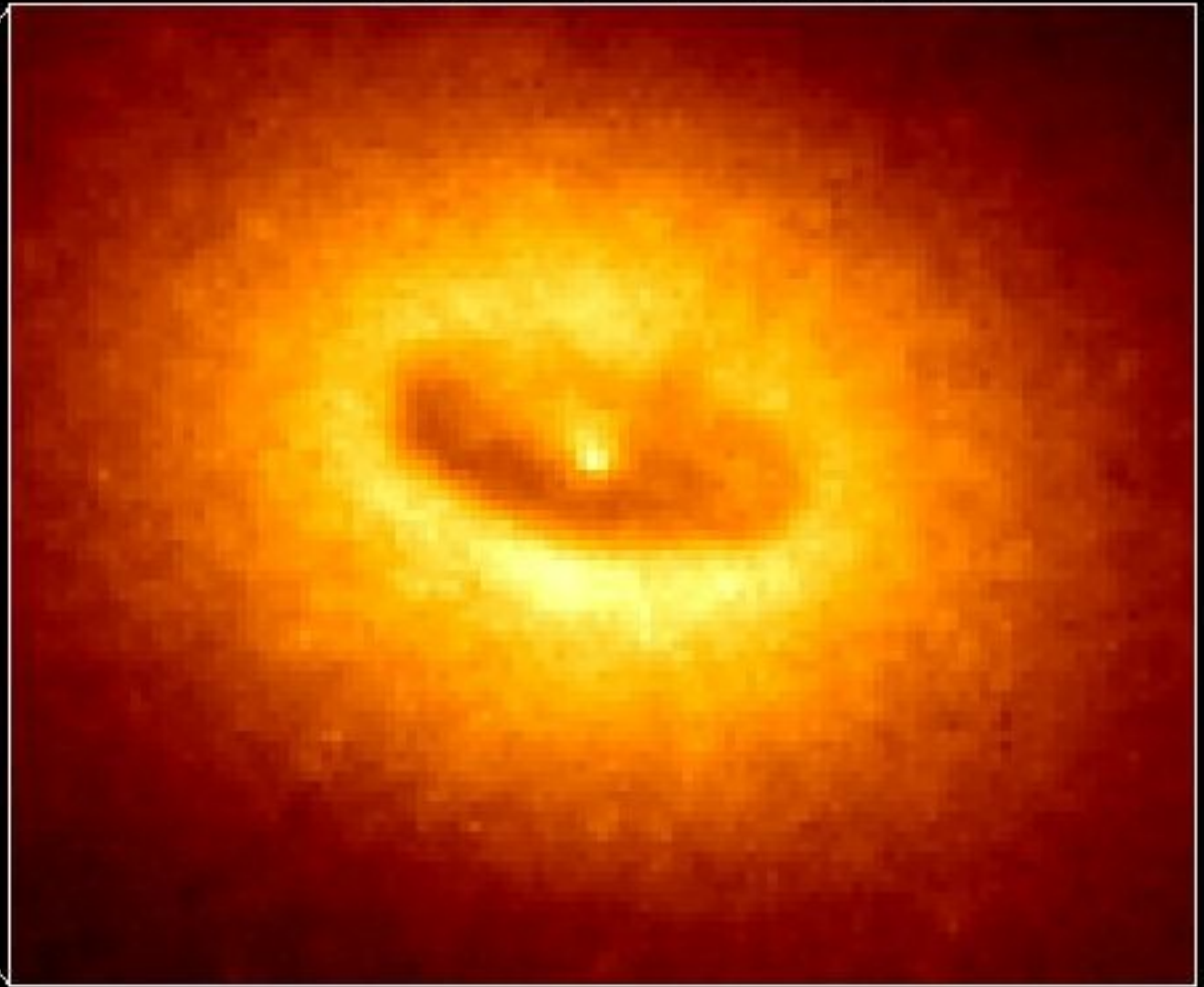
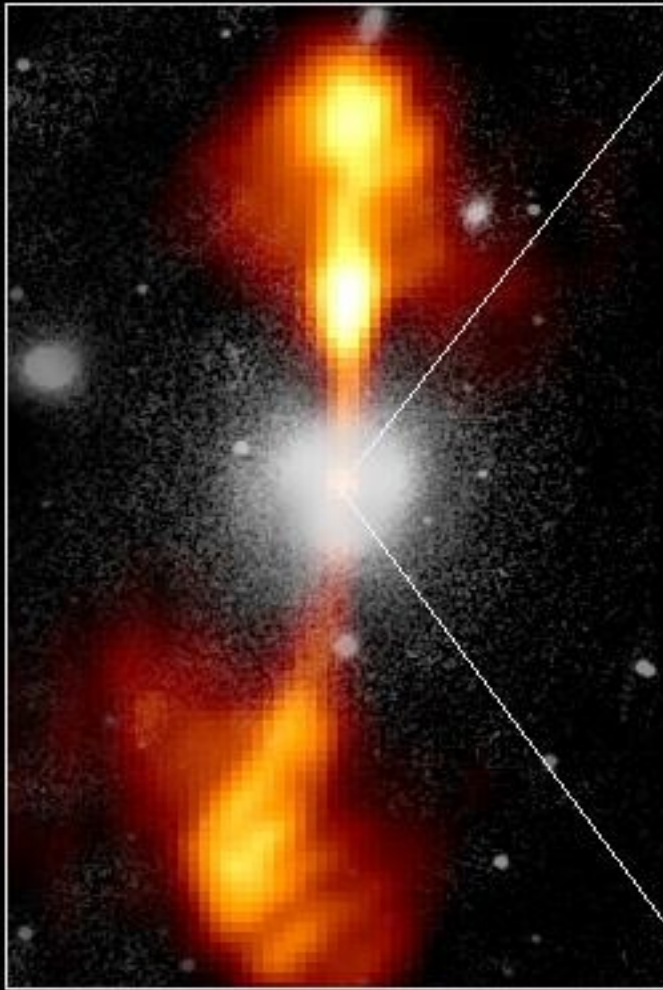
# Core of Galaxy NGC 4261

Hubble Space Telescope

Wide Field / Planetary Camera

Ground-Based Optical/Radio Image

HST Image of a Gas and Dust Disk



380 Arc Seconds  
88,000 LIGHTYEARS

17 Arc Seconds  
400 LIGHTYEARS

Quem é ?

AGNs são candidatos fortes mas não são a única possibilidade

Gáxias radio ativas é outro tipo de fonte possível

Se algo me atinge ...

Eu quero saber:

O QUE ?

QUEM ?

COMO PRODUZIR ESSA ENERGIA ?

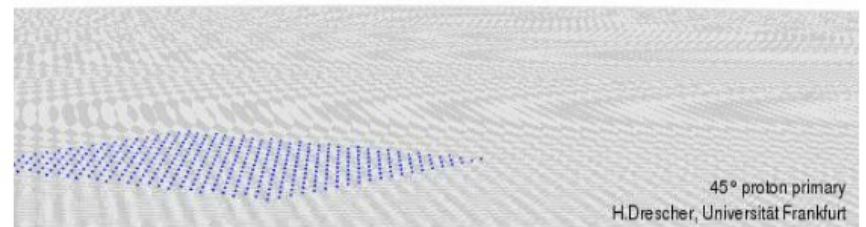
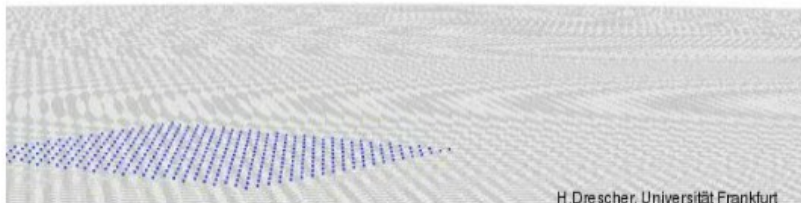


# Ferro



# Próton

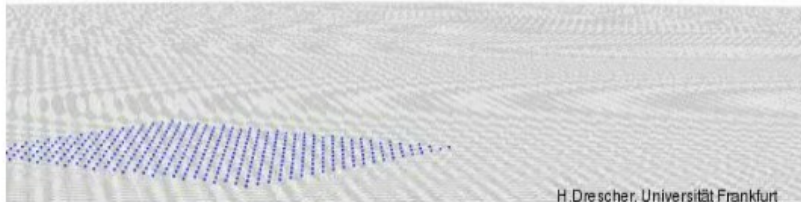
time=160 $\mu$ s



# Ferro

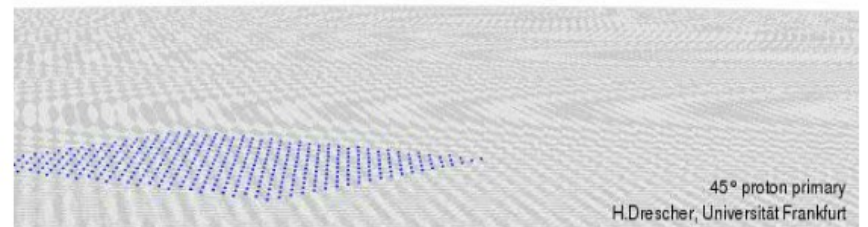


time=-106 $\mu$ s



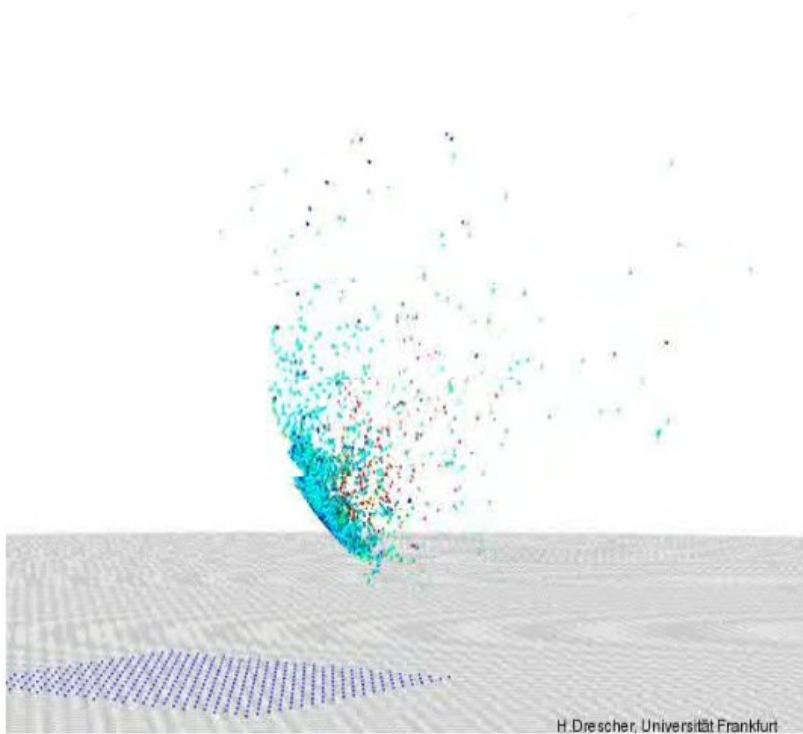
H.Drescher, Universität Frankfurt

# Próton



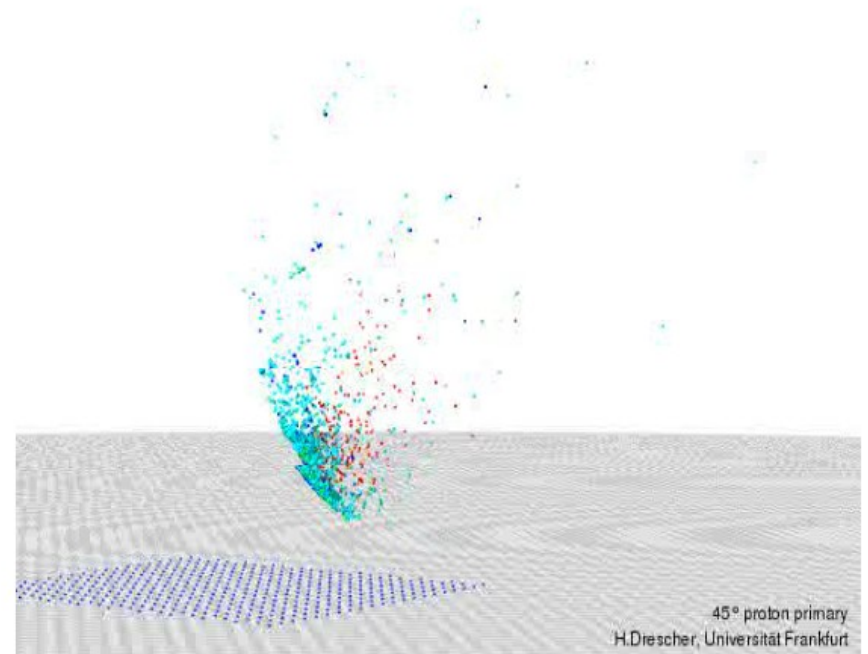
45° proton primary  
H.Drescher, Universität Frankfurt

# Ferro

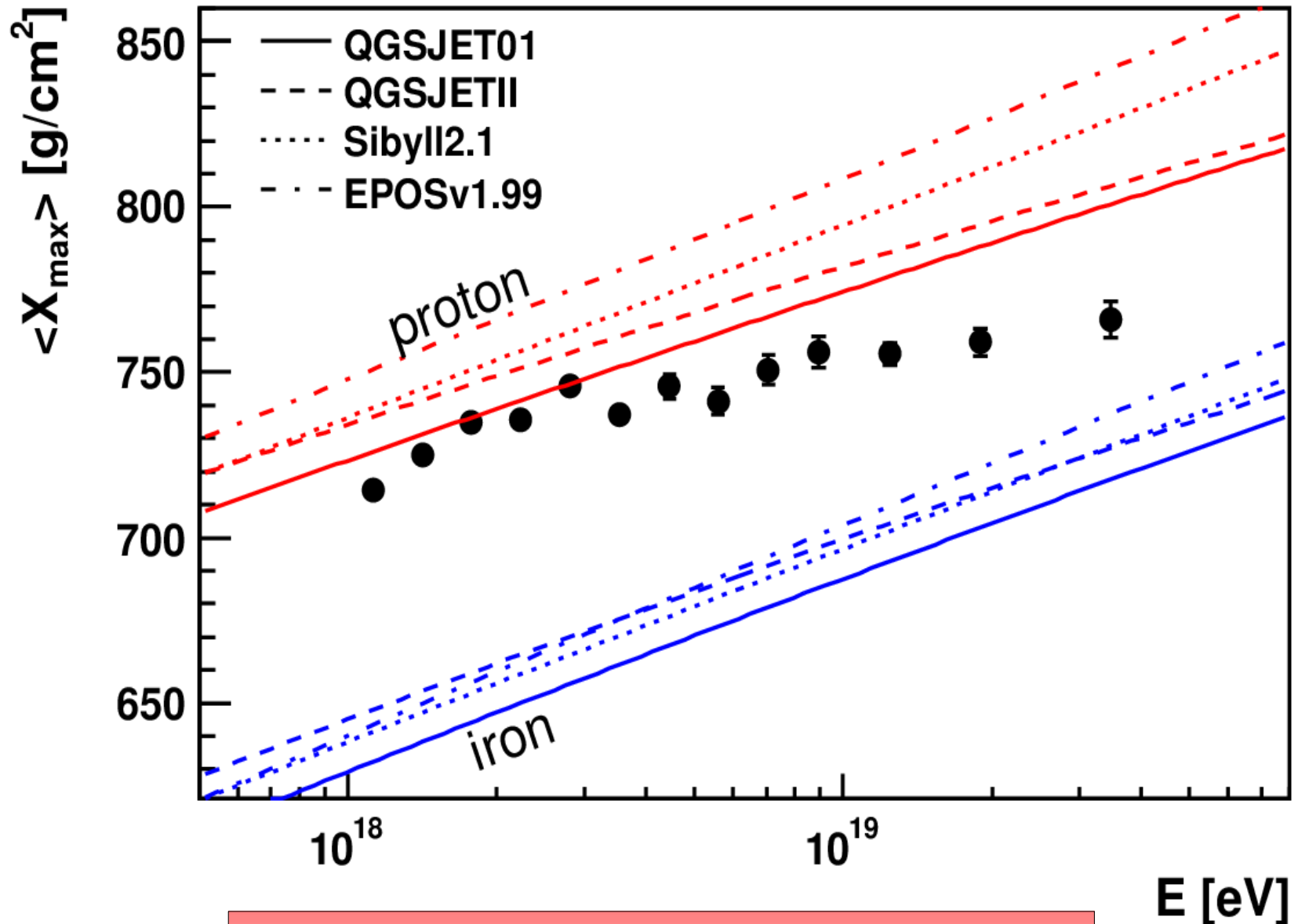


# Próton

time=-43 $\mu$ s



# O que é ?



Massa intermediária !!

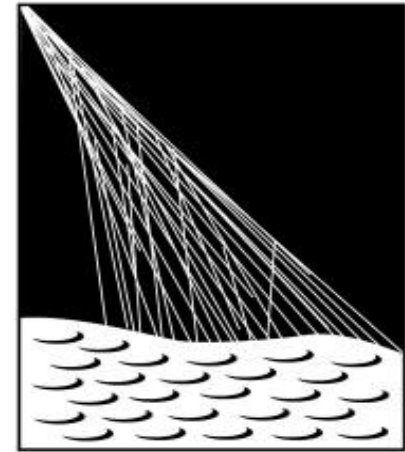
Se algo me atinge ...

Eu quero saber:

O QUE ?

QUEM ?

COMO PRODUZIR ESSA ENERGIA ?



PIERRE  
AUGER  
OBSERVATORY


Pierre Auger Observatory - Mozilla Firefox

Pierre Auger Observatory

www.auger.org

Sun Jul 15 10:23 vitor de souza

iDic. Aulete



## Pierre Auger Observatory


studying the universe's highest energy particles

**The Pierre Auger Cosmic Ray Observatory** is studying ultra-high energy cosmic rays, the most energetic and rarest of particles in the universe. When these particles strike the earth's atmosphere, they produce extensive air showers made of billions of secondary particles. While much progress has been made in nearly a century of research in understanding cosmic rays with low to moderate energies, those with extremely high energies remain mysterious.


The Pierre Auger Observatory is working on solving these mysteries.

Watch the video: [Voces del Universo / Voices of the Universe](#)

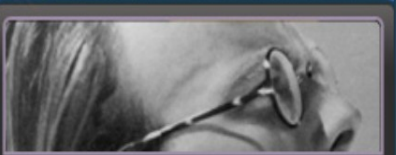
- Home
- Cosmic Rays
- Auger Observatory
- News
- Event Display
- International Collaboration
- Scientific and Technical Information
- Special Features
- Education
- Contact Us
- Auger at Work (Admin)



Southern Site Video Clip



The James Cronin School



Who was Pierre Auger?

# www.astro.ifsc.usp.br

Astroparticle Physics - IFSC/USP - Mozilla Firefox  
Astroparticle Physics - IFSC/USP  
www.astro.ifsc.usp.br  
Sun Jul 15 10:25 vitor de souza  
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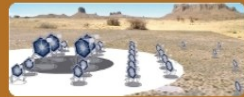
HOME PESQUISA MEMBROS



**Workshop de Física de Astropartícula**  
Neste contexto vamos realizar um workshop em física de astropartícula no qual os temas irão ser discutidos por renomados especialistas.  
[Leia +](#)



**The Cherenkov Telescope Array**  
O CTA (Cherenkov Telescope Array) é uma iniciativa para construir a próxima geração de telescópios de raios gammas. Servirá como um observatório aberto para comunidade astrofísica e proverá um profundo conhecimento do universo não térmico em altas energias.  
[Leia +](#)



**KASCADE**  
O KASCADE (KARlsruhe Shower Core and Array DEtector) é um experimento de chuveiro atmosférico extenso para estudar composição e interações hadrônicas de raios cósmicos.  
[Leia +](#)



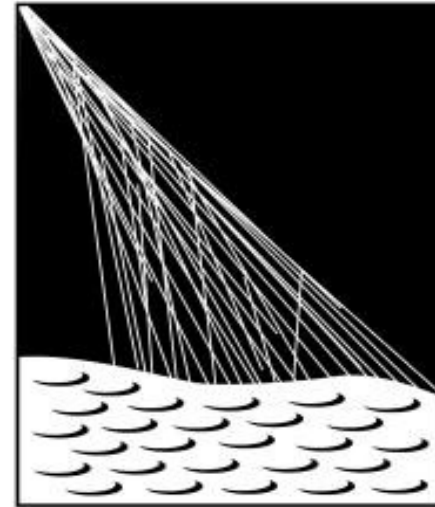
**Link's**  
**OBSERVATÓRIO PIERRE AUGER**  
Está estudando raios cósmicos de alta energia, as mais energéticas e raras partículas do universo.  
**RAIOS CÓSMICOS (WIKIPEDIA)**  
Raios cósmicos são partículas extremamente energéticas que se deslocam a velocidades próxima da luz.



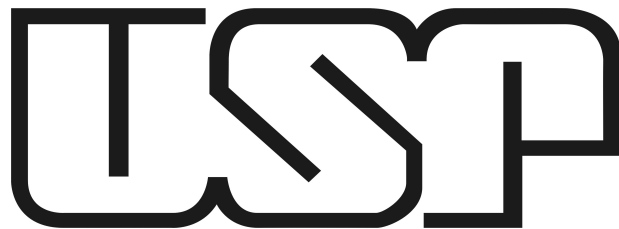
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zotero

# Obrigado !!

Vitor de Souza  
vitor@ifsc.usp.br



PIERRE  
AUGER  
OBSERVATORY



**Instituto de Física de São Carlos**

**Universidade de São Paulo**

