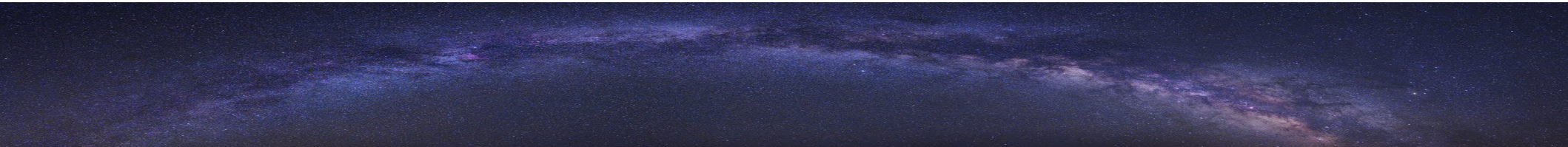




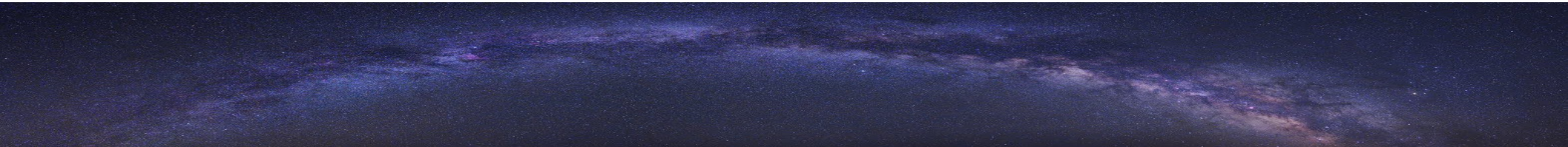
## Clase 6: Instrumentación II

Christian Sarmiento

Escuela de Física  
Grupo Halley de Astronomía y Ciencias Aeroespaciales  
Universidad Industrial de Santander  
I semestre de 2014



En nuestro capítulo anterior...



# El mensajero cósmico

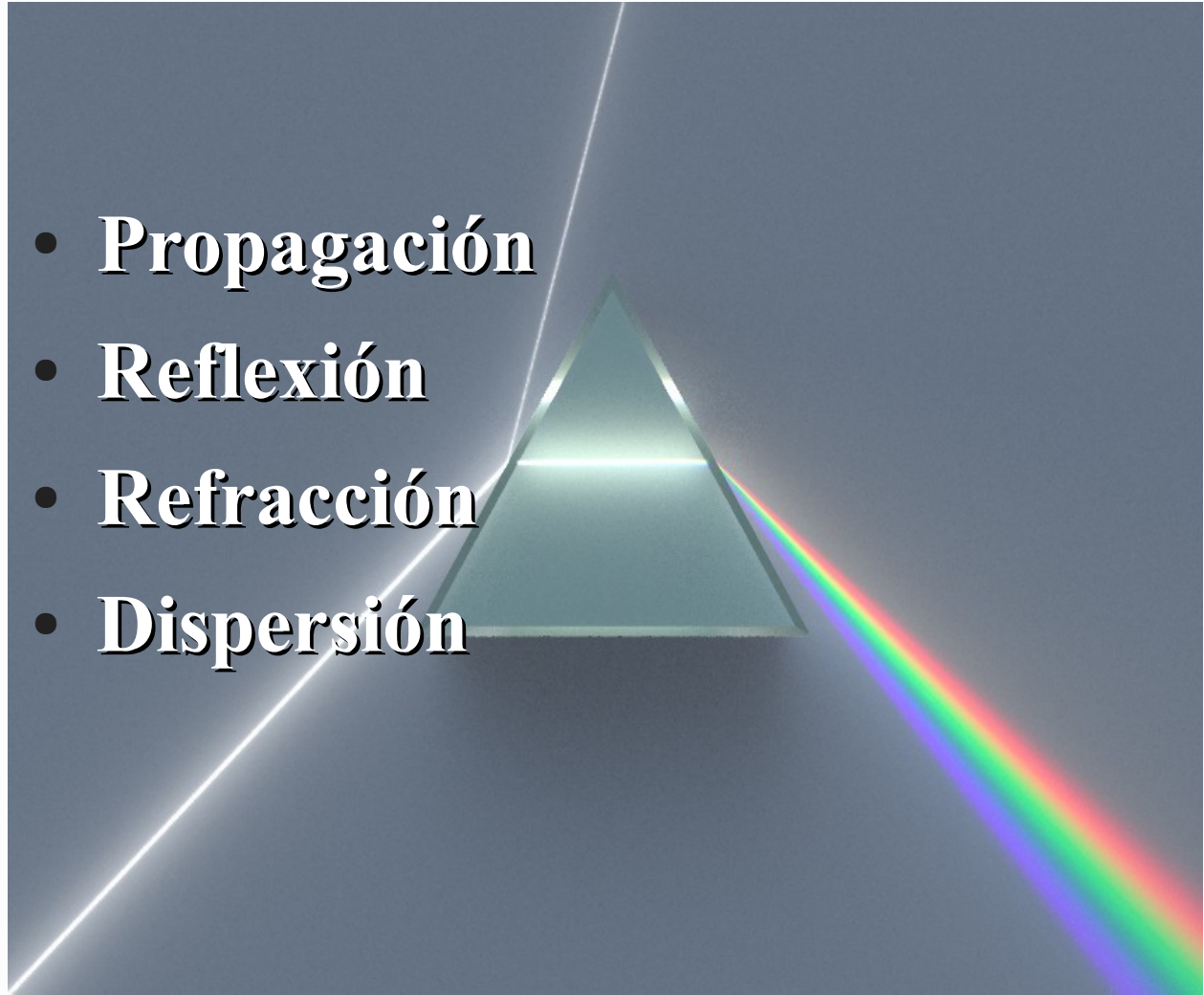
- ¿Cómo sabemos lo que sabemos del universo?



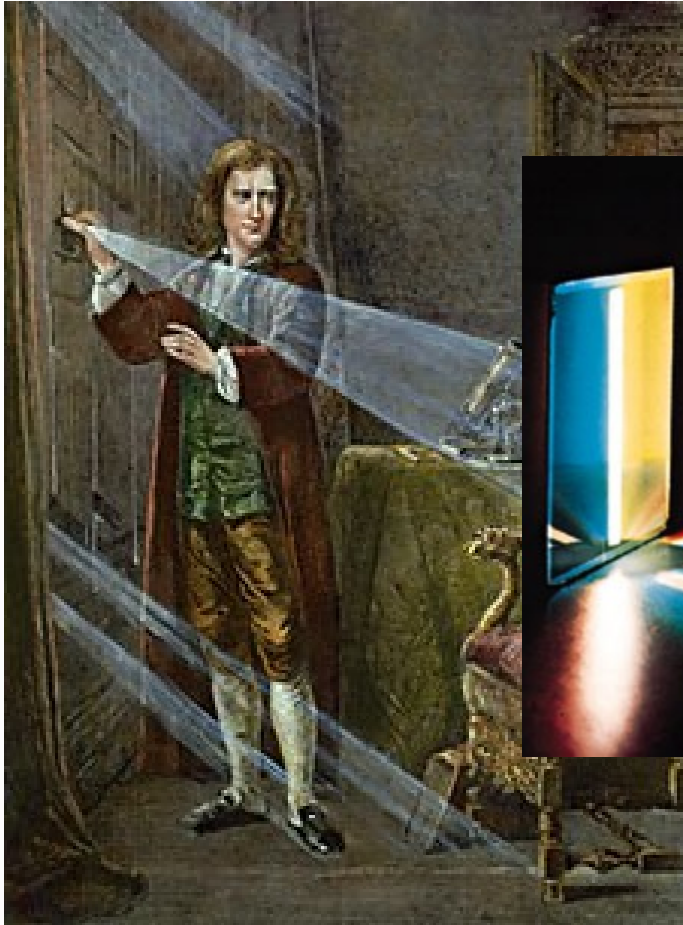
# Teoría corpuscular de la luz ~1675



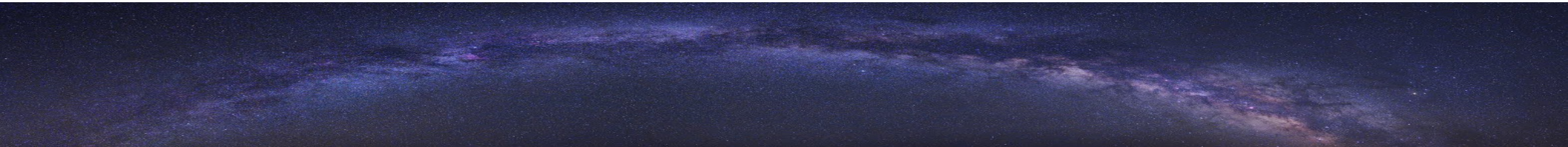
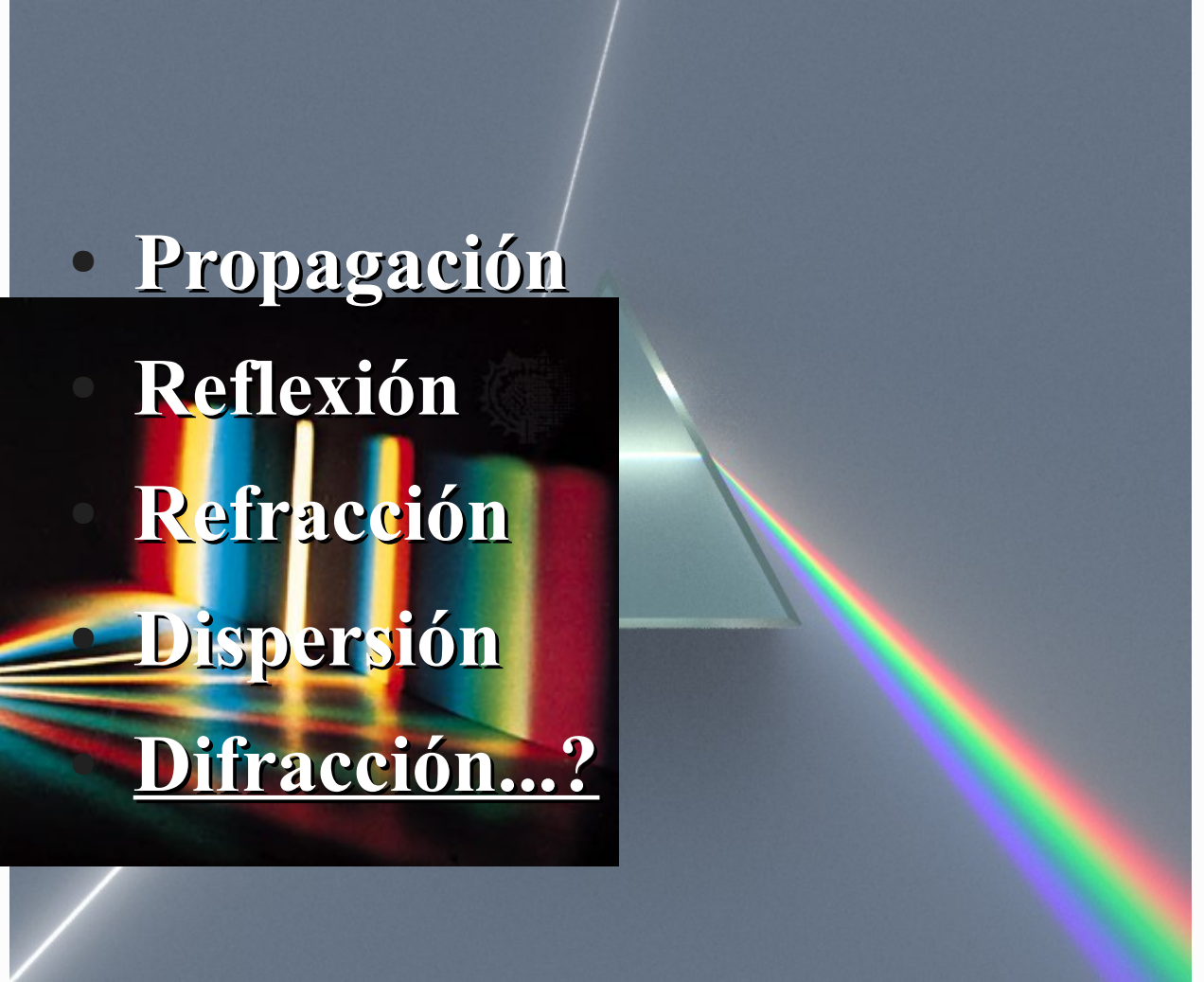
- **Propagación**
- **Reflexión**
- **Refracción**
- **Dispersión**



# Teoría corpuscular de la luz ~1675

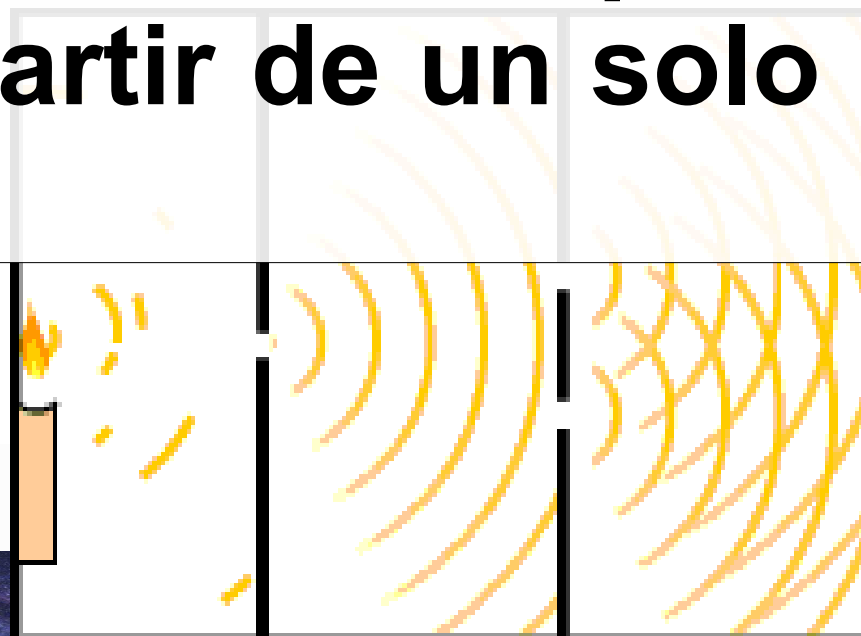
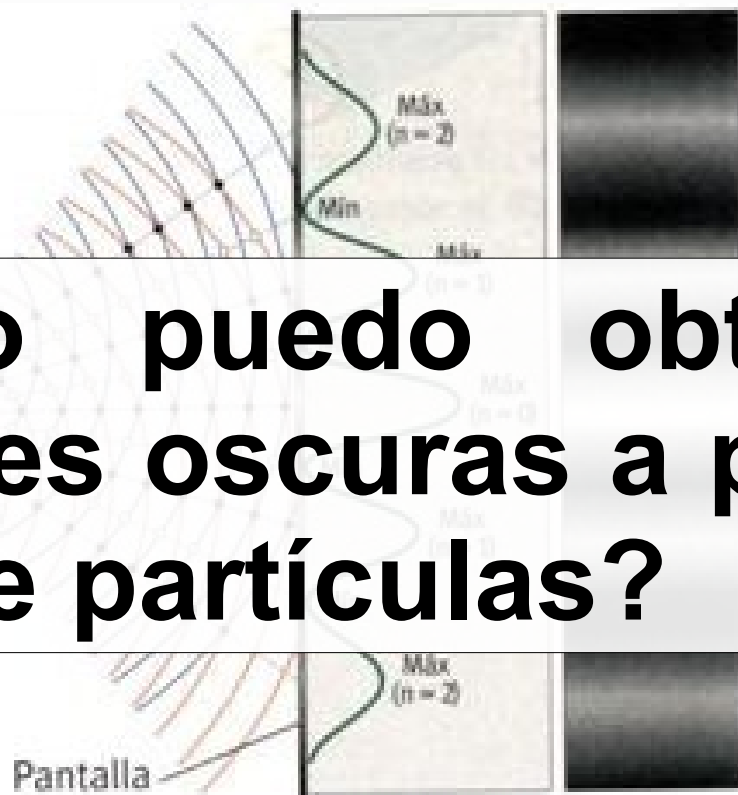


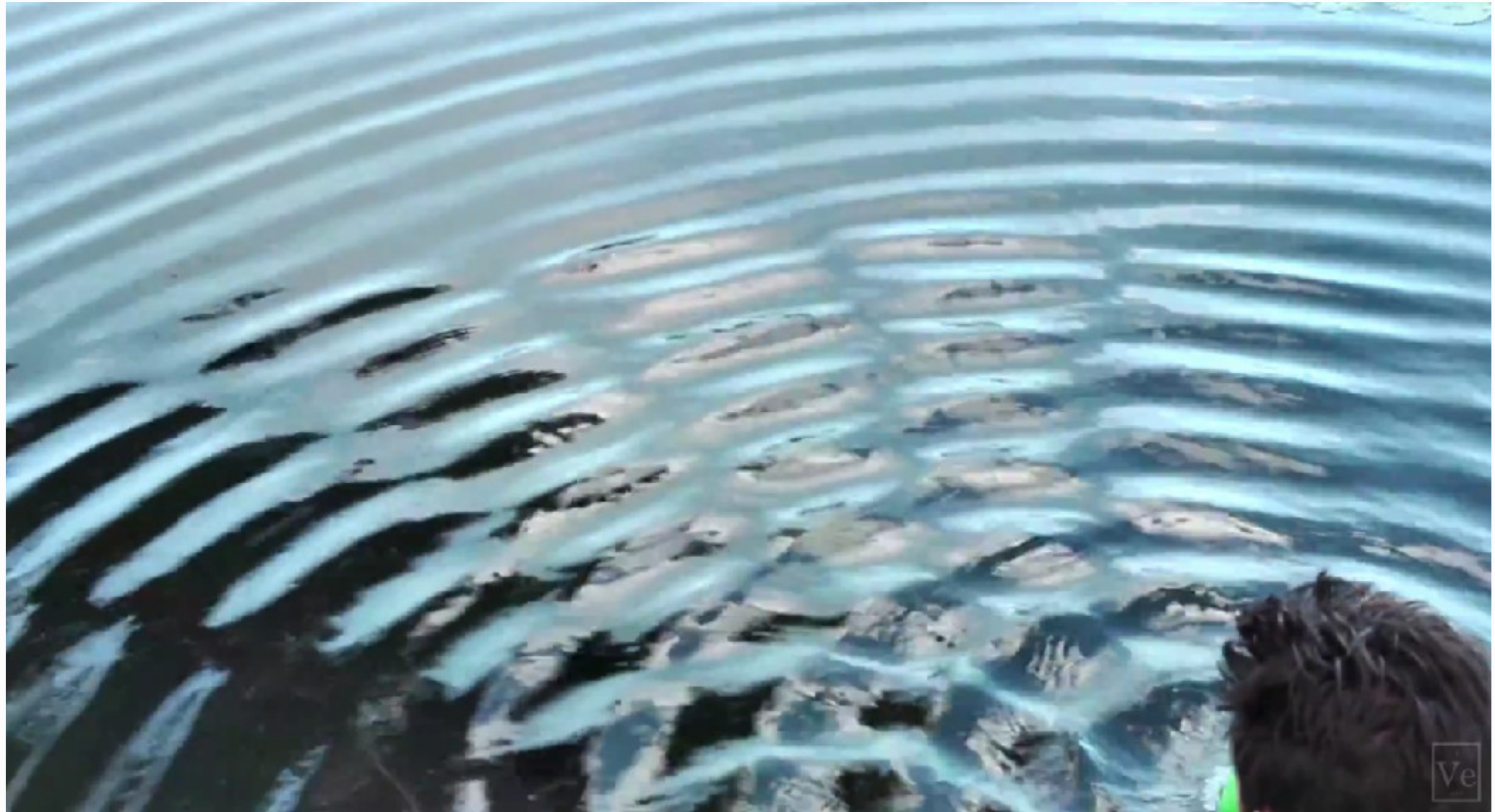
- **Propagación**
- **Reflexión**
- **Refracción**
- **Dispersión**
- **Difracción...?**



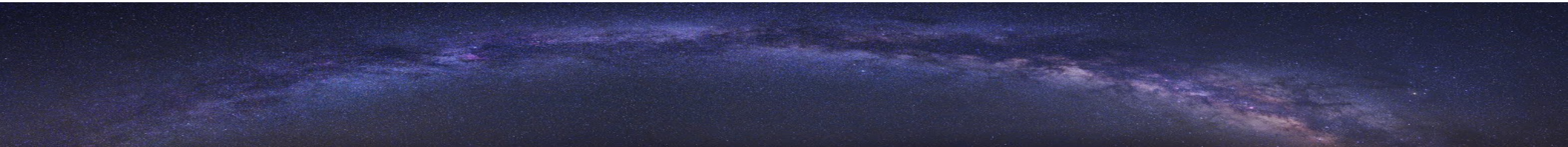
# Experimento Young $\sim 1801$

**¿Cómo puedo obtener múltiples regiones oscuras a partir de un solo flujo de partículas?**

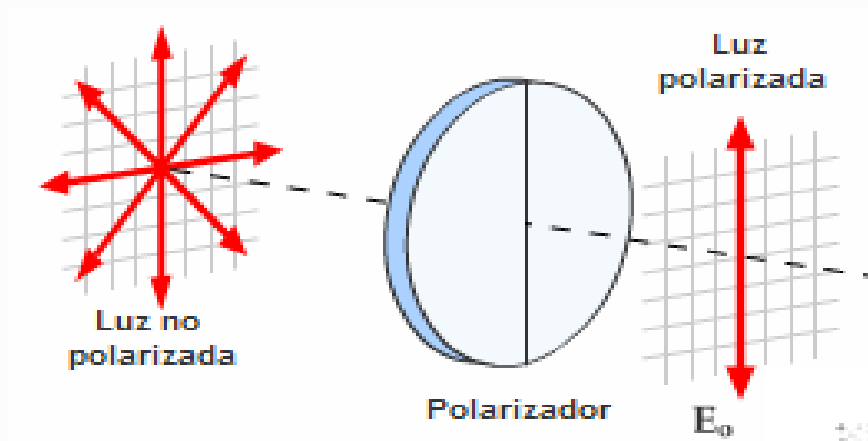




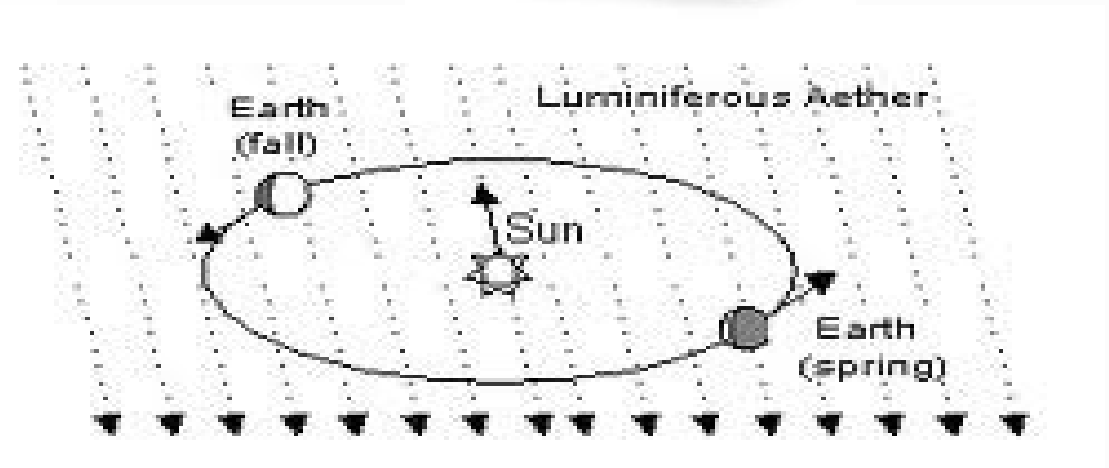
Vídeo



# Pero si la luz es una onda, entonces...

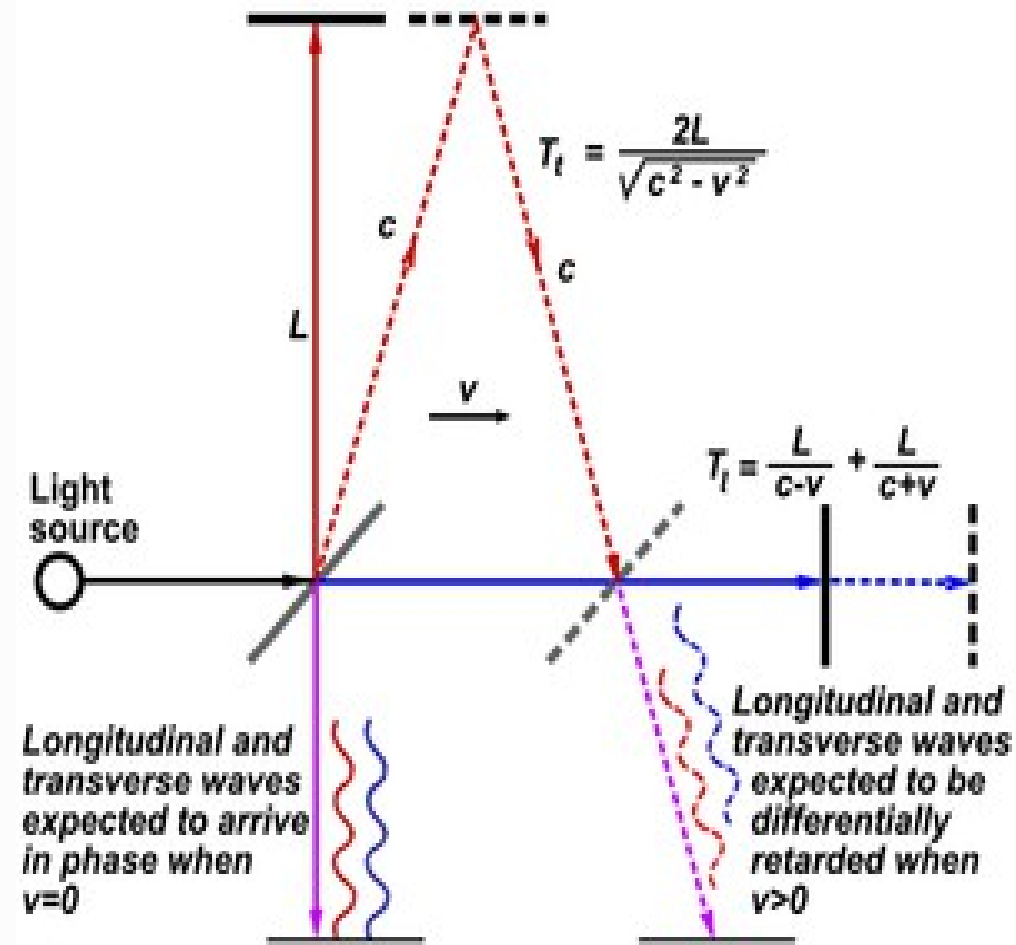


<http://www.youtube.com/watch?v=8LHRAi>



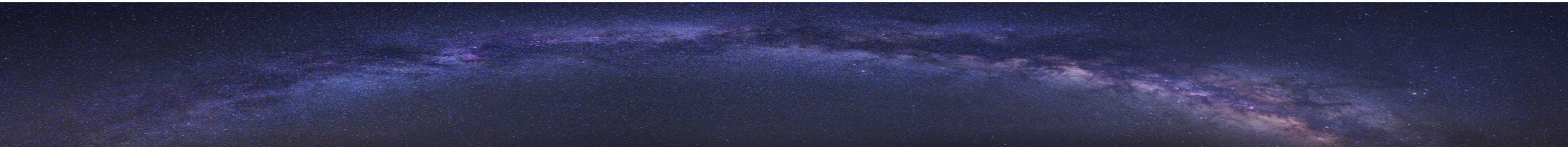


# Michelson y Morley

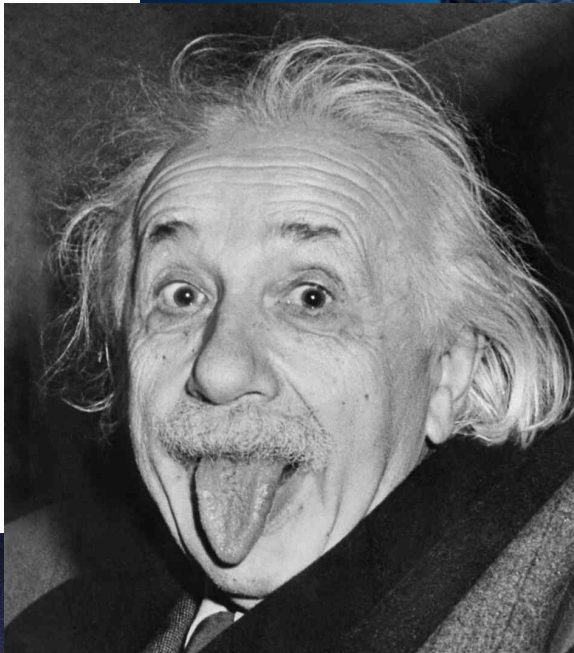


# Entonces, lo que tenemos hasta el momento...

- La luz es una onda (Difracción)
- Viaja en el vacío, luego es una onda electromagnética (Michelson-Morley)
- Viaja a velocidad constante (Ec. de Maxwell)
- Es polarizada (diversos experimentos)

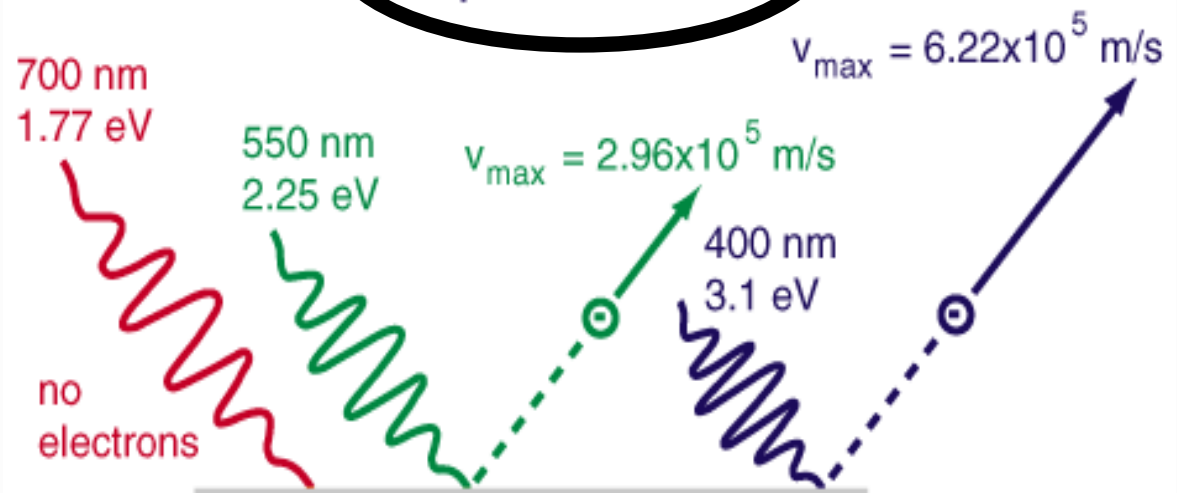


# El tío Albert 1905



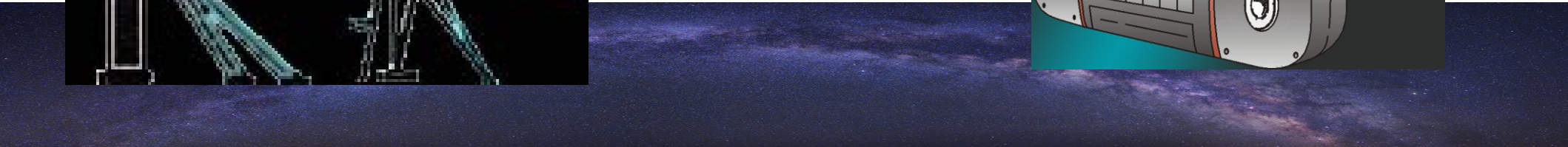
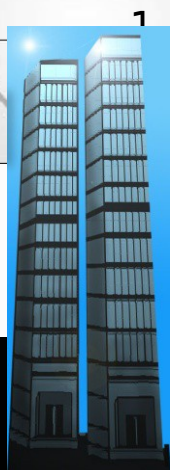
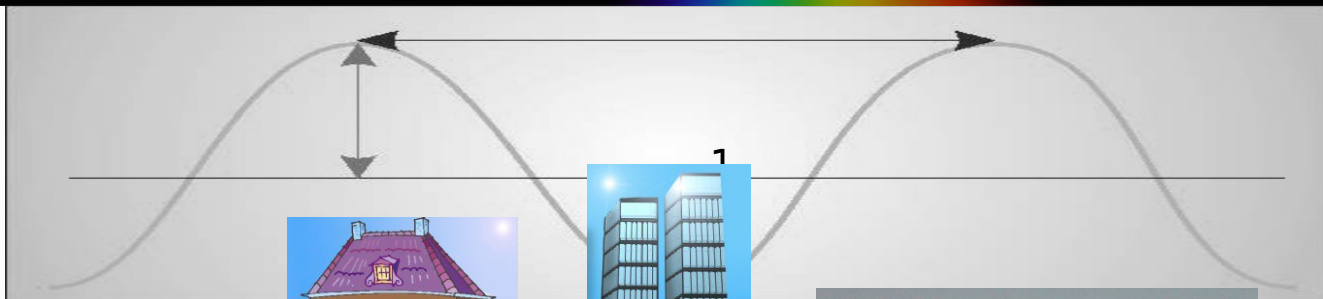
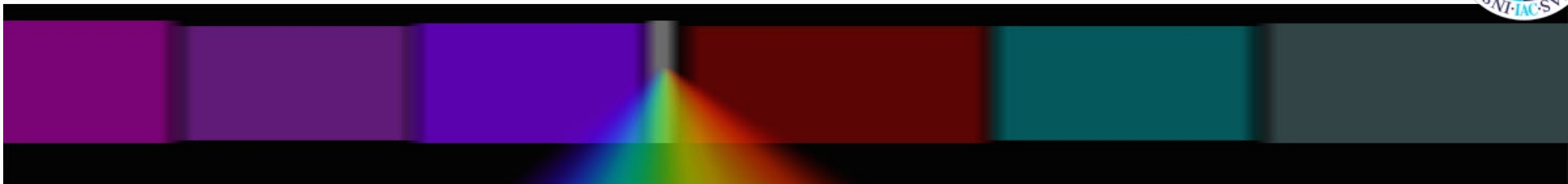
Max planck, radiación de cuerpo negro

$$E_{\text{photon}} = h\nu$$

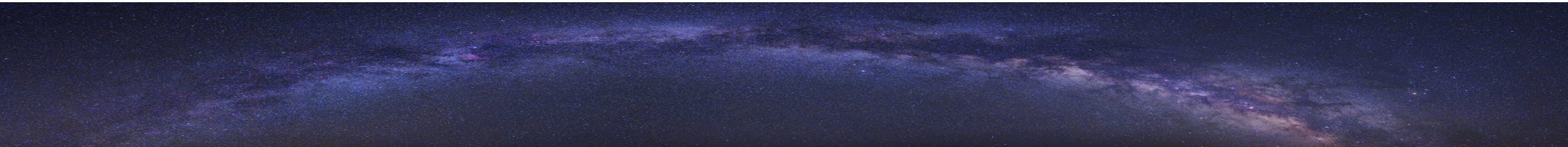


Potassium - 2.0 eV needed to eject electron

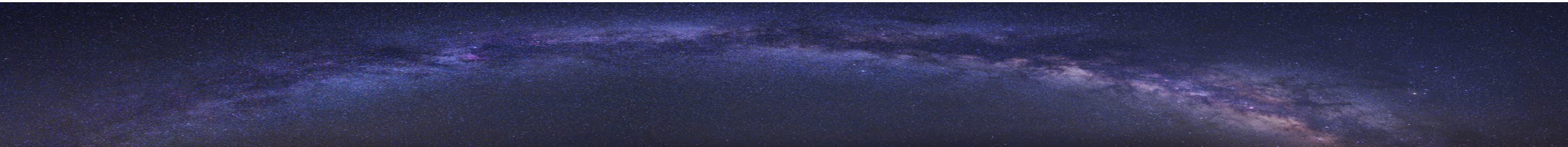
## Photoelectric effect



# Instrumentación



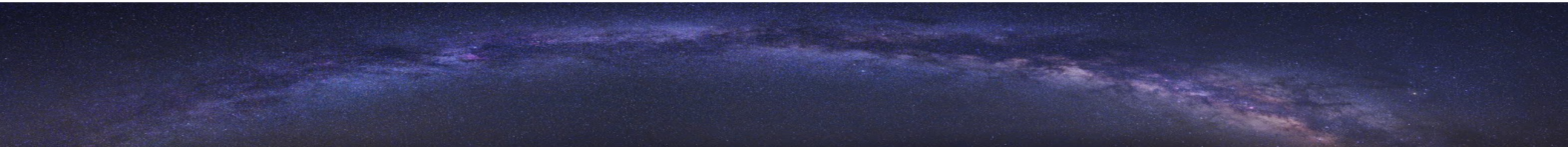
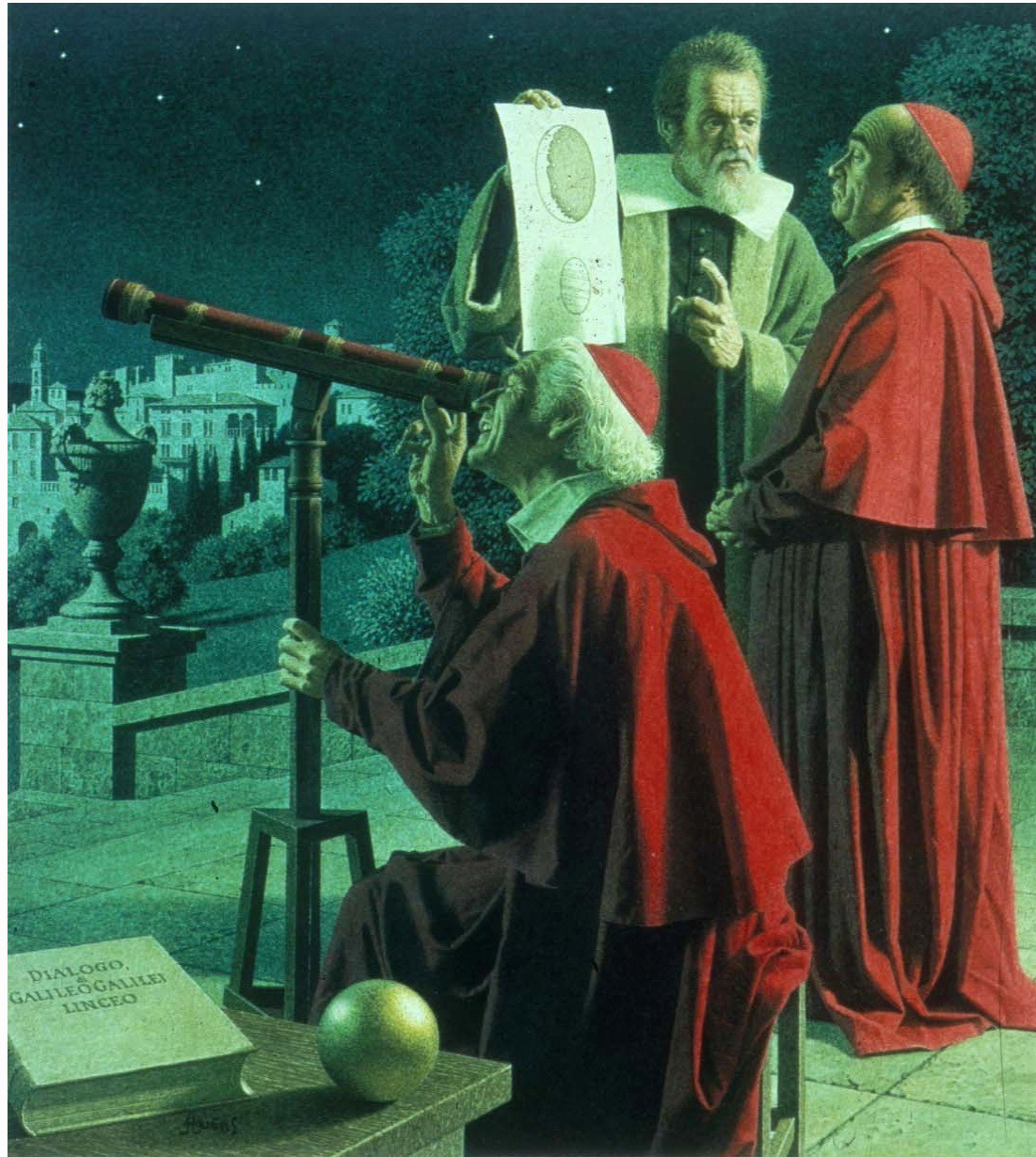
# El telescopio



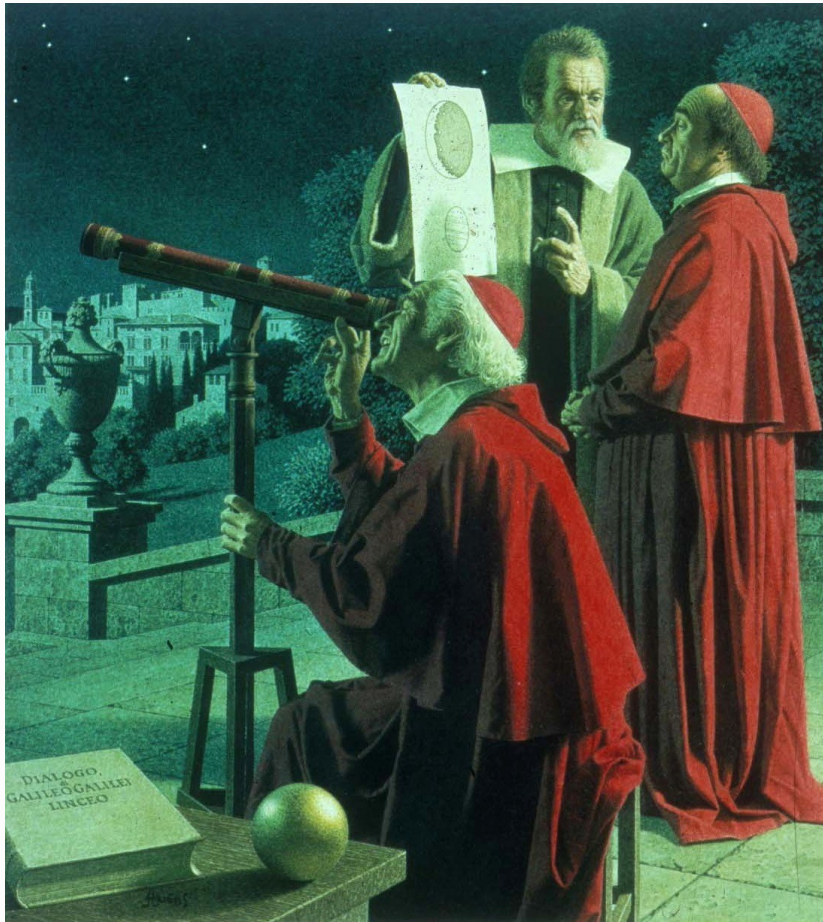
# El telescopio



Inventado a principios del S. XVII.  
Mejorado por Galileo en 1609 para observar el cielo.





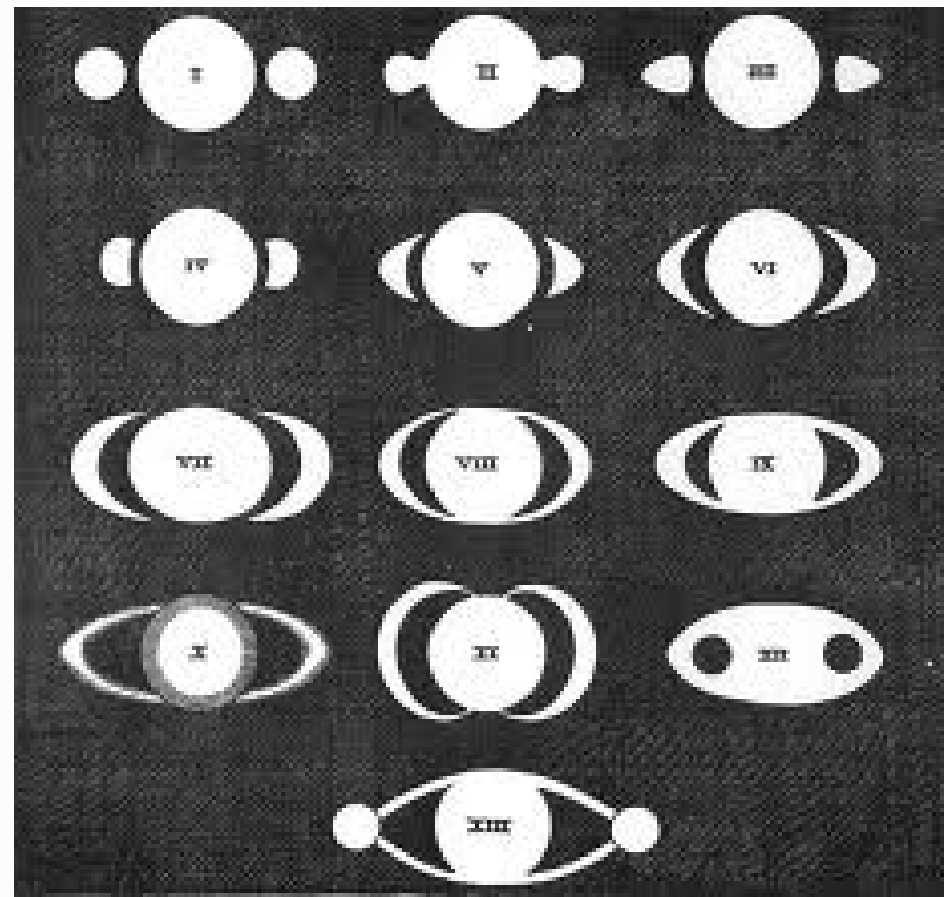


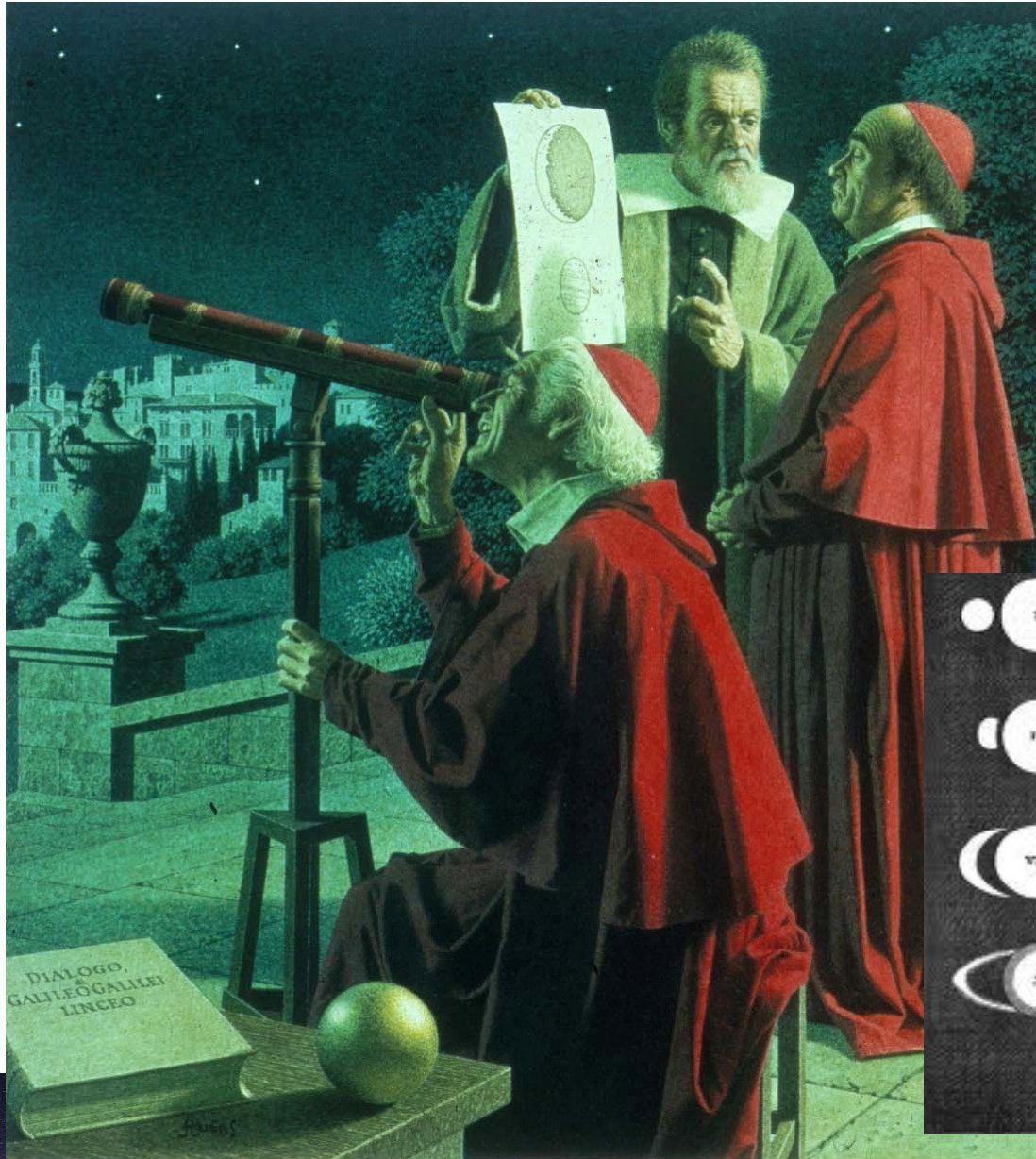
*Observations Jovianae*  
1610

20. Febr. marc' H. 12	○ * *
30. marc'	* * ○ *
2. Apr.	○ * * *
3. marc'	○ * *
3. Ho. 5.	* ○ *
7. marc'	* ○ * *
6. marc'	* * ○ *
8. marc' H. 13.	* * * ○
10. marc'	* * * ○ *
11.	* * ○ *
12. H. 4. 2. 1/2.	* ○ *
13. marc'	* * ○ *
14. marc'	* * * ○ *

Образования Перилы  
1500

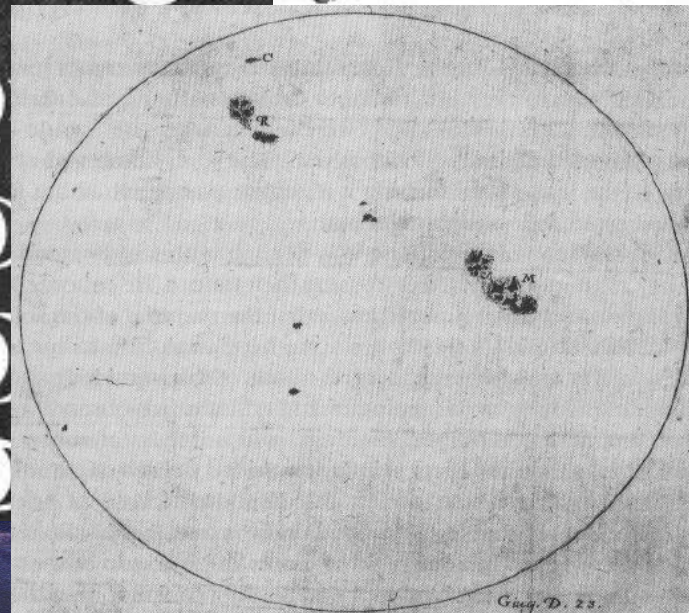
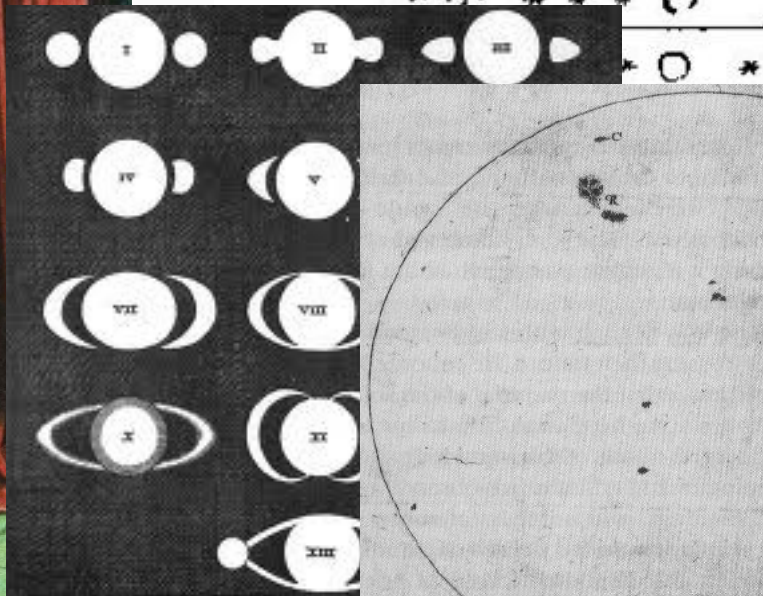
20. 7. 1815	○ * *
30. 11. 1815	** ○ *
2. 1. 1816	○ ** *
3. 1. 1816	○ * *
3. 11. 1816	* ○ *
7. 1. 1817	* ○ **
6. 1. 1817	** ○ *
8. 1. 1817	* * * ○
10. 1. 1817	* * * ○ *
11.	* * ○ *
12. 11. 1817	* ○ *
13. 1. 1818	* ** ○ *
14. 1. 1818	* * * ○ *





*Observationes Jovialis*  
1610

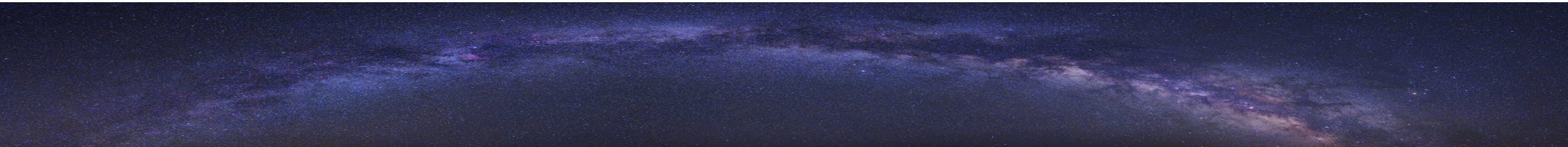
20. Jan.	mar H. 12	○ * *
30. mar		* * ○ *
2. feb.		○ * * *
3. mar		○ * *
3. Ho. 5.		* ○ *
4. mar		* ○ * *
6. mar		* * ○ *
8. mar H. 17.		* * * ○



# Partes del telescopio

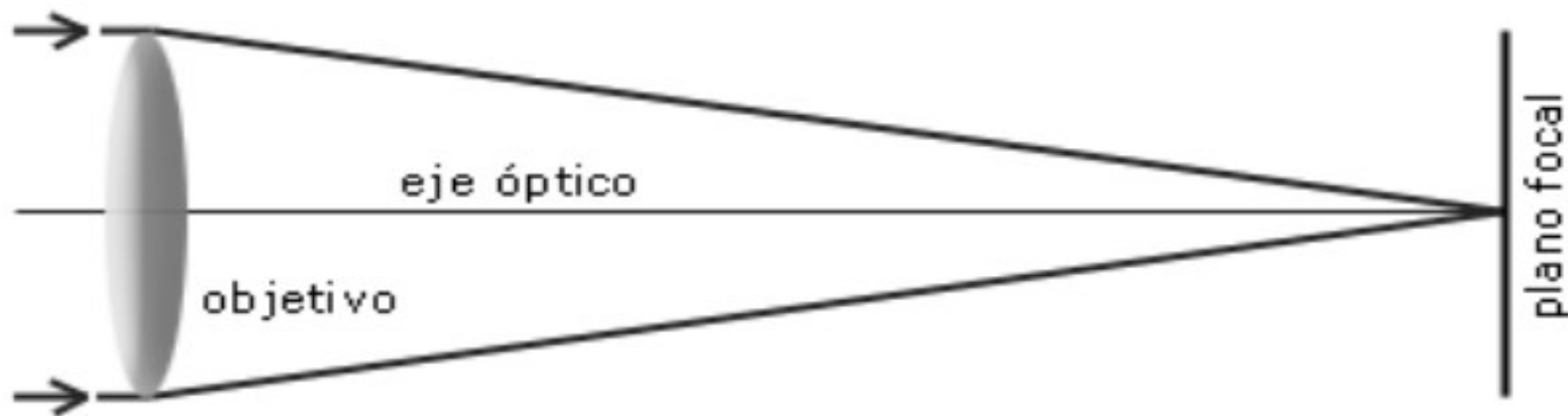


# ¿Cómo funciona un telescopio?



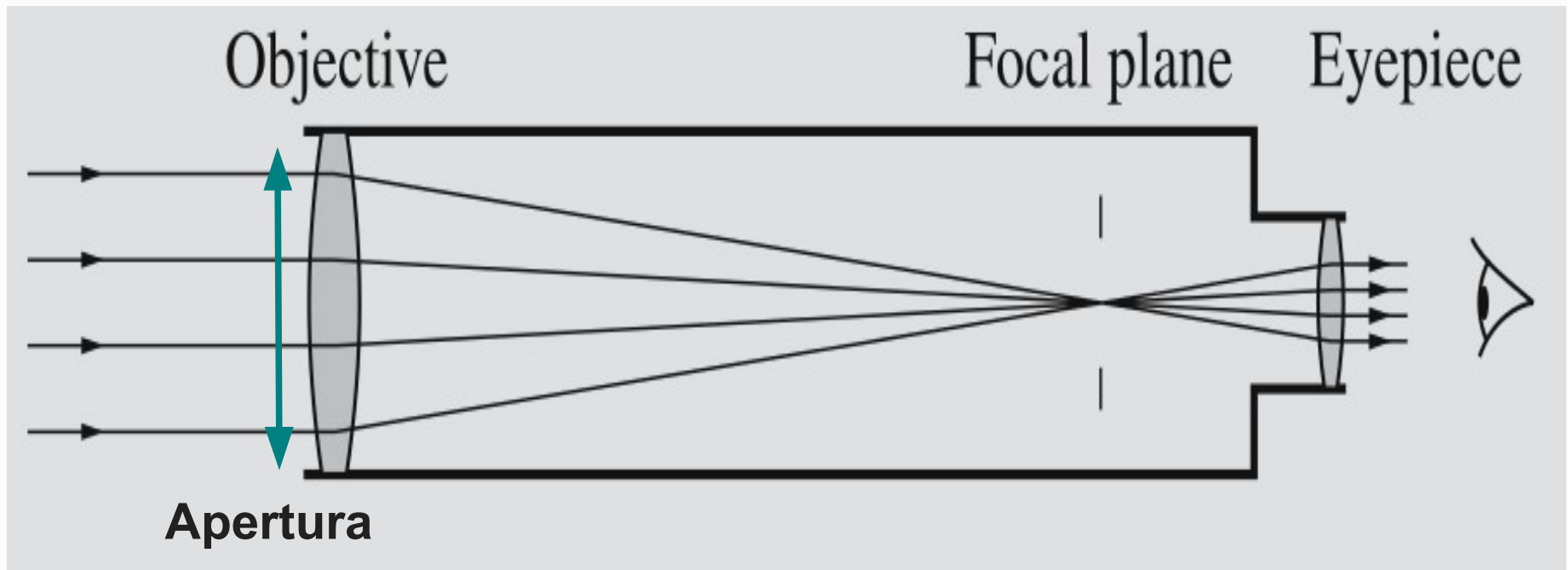
# ¿cómo funciona un telescopio?

- Recolecta luz y la enfoca, o concentra, en un punto.



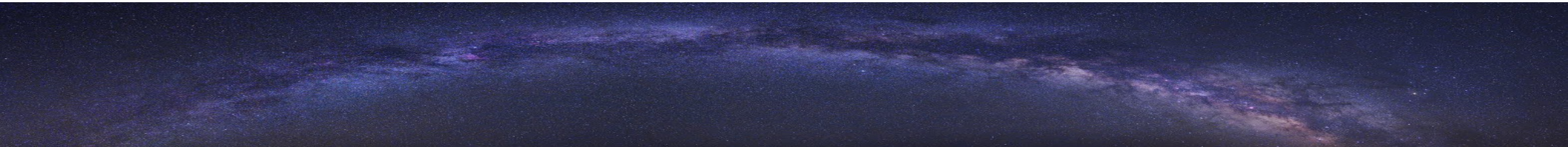
# ¿cómo funciona un telescopio?

- Recolecta luz y la enfoca, o concentra, en un punto.



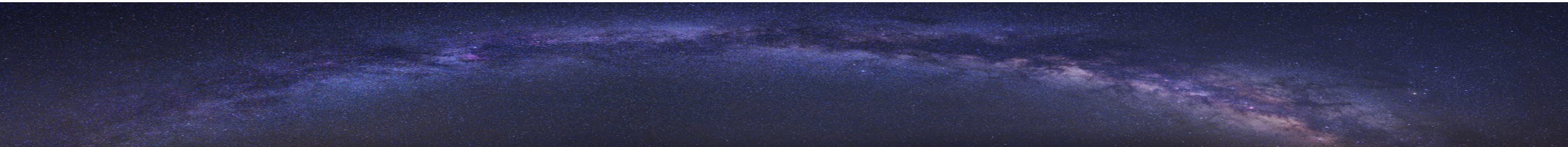
# Tipos de telescopios

- Kepleriano o **refractor**
- Newtoniano o **reflector**
- **Cassegrain**
- **Catadioptricos**

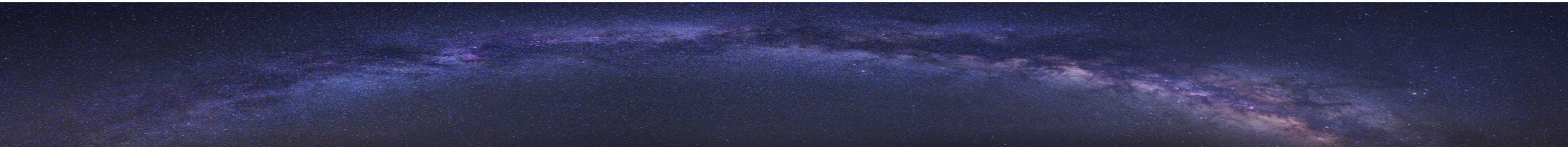
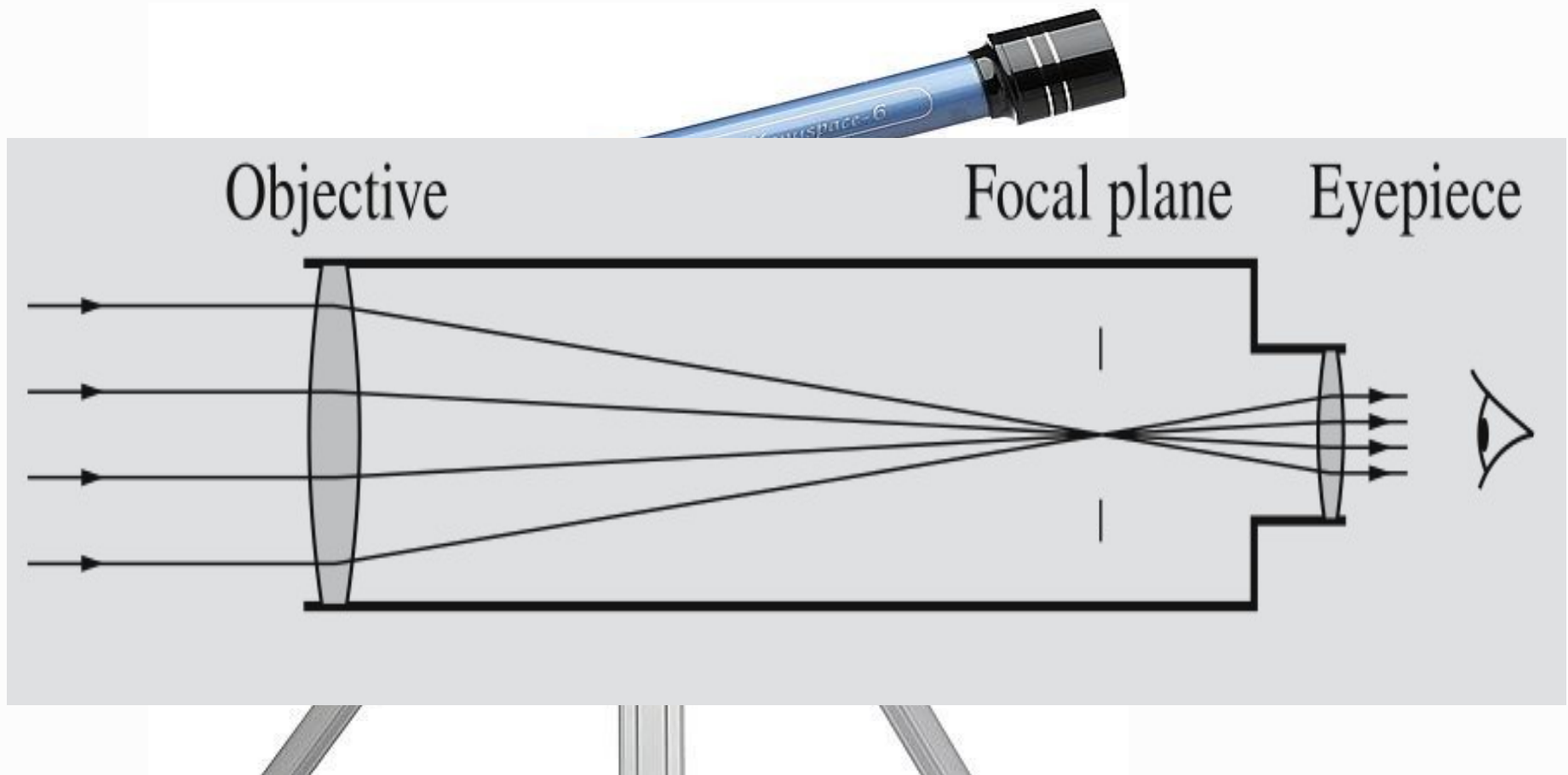




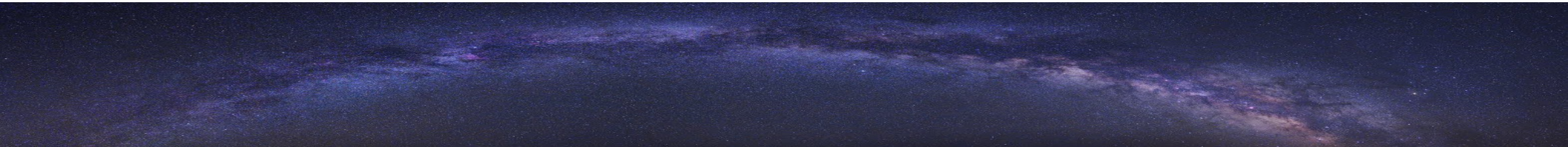
- Kepleriano o **refractor**



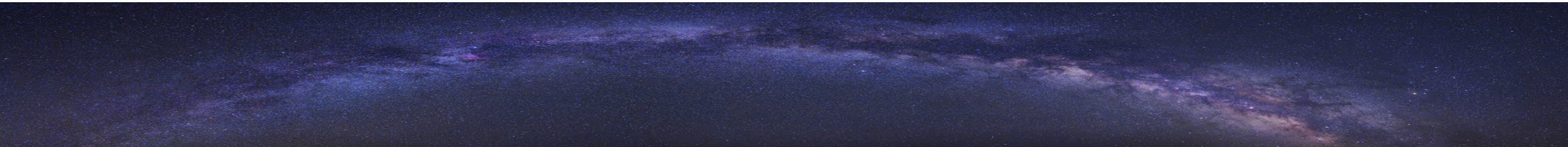
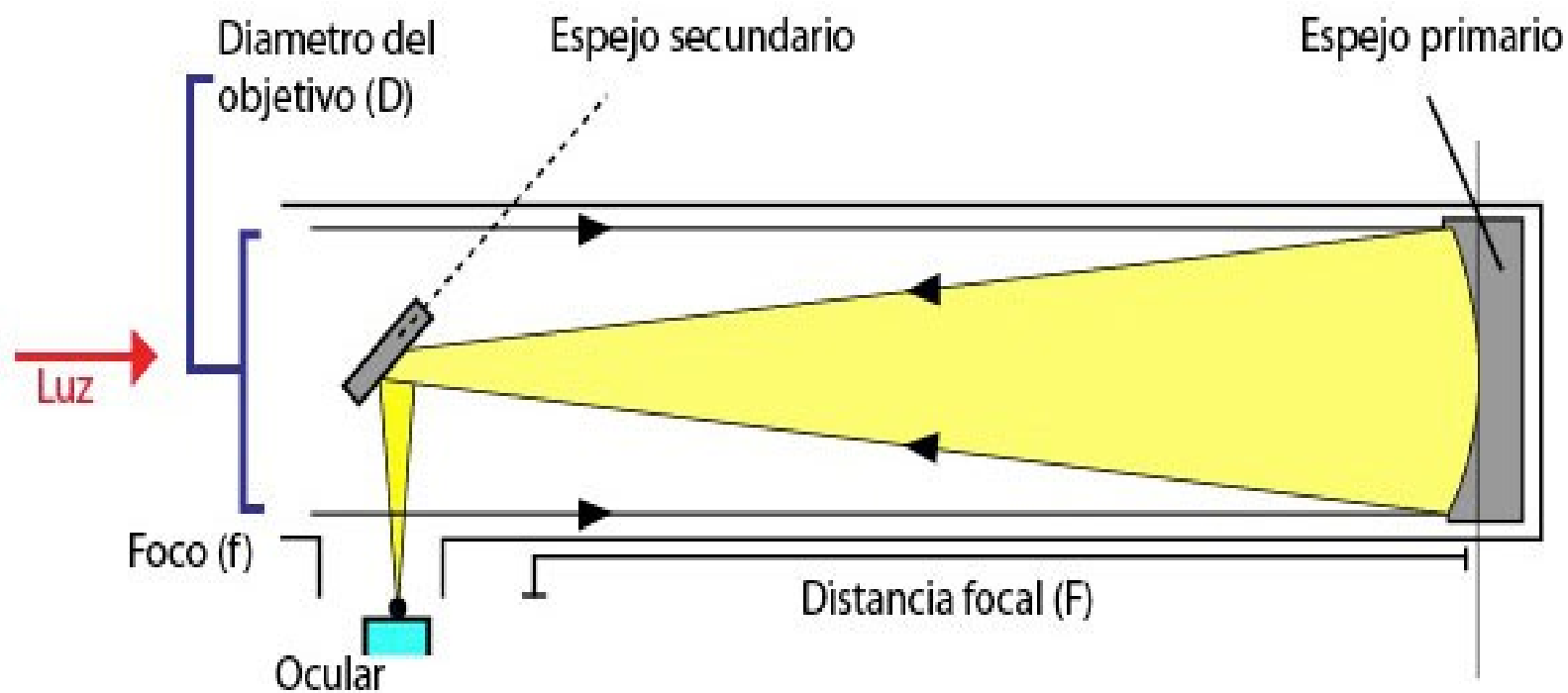
- Kepleriano o **refractor**



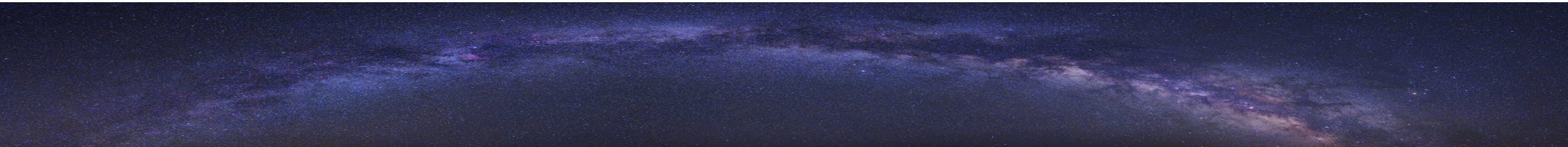
- Newtoniano o **reflector**



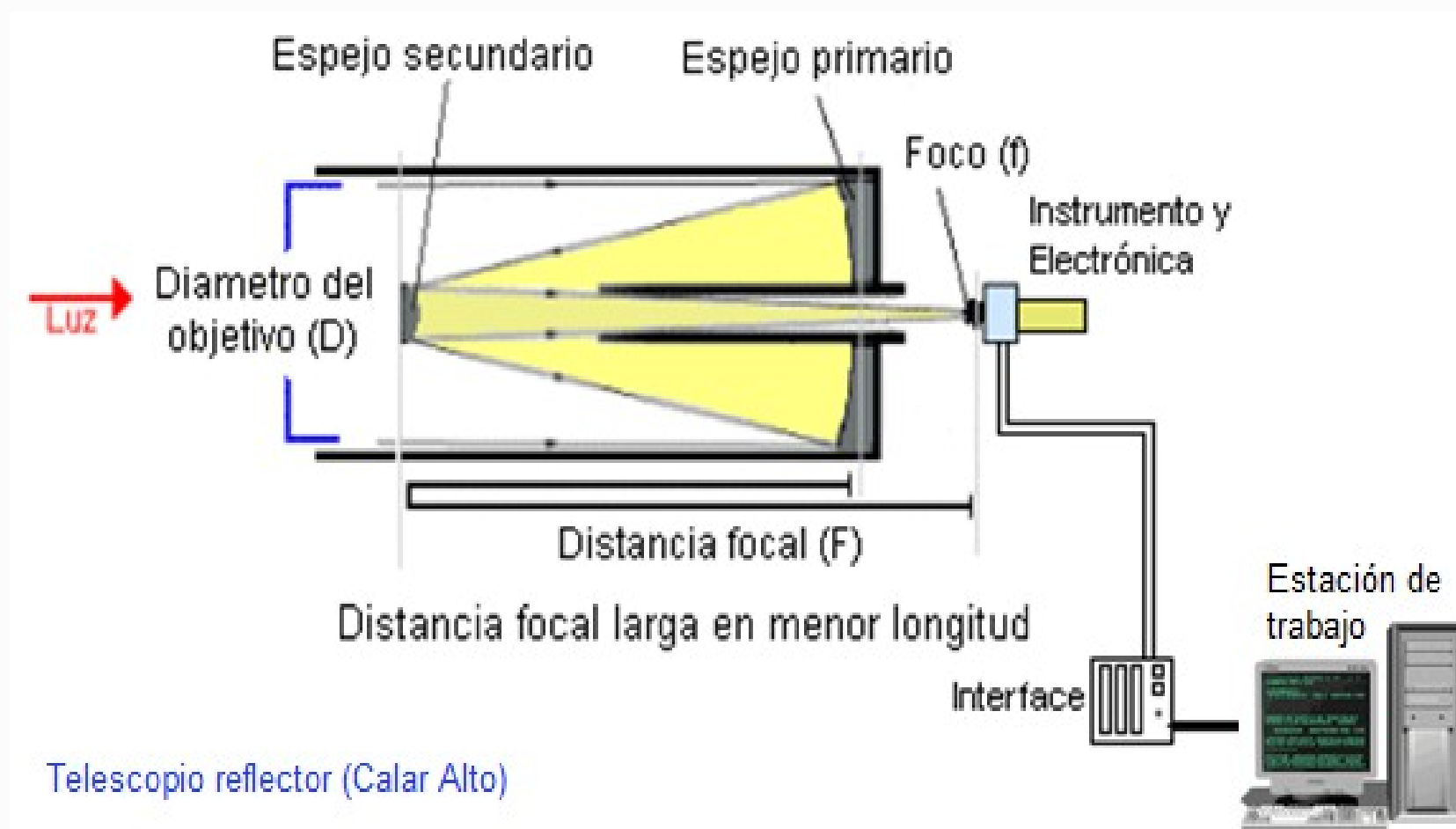
- Newtoniano o **reflector**

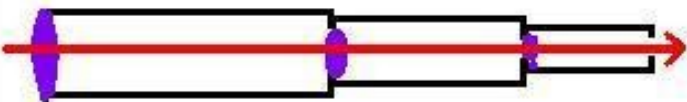



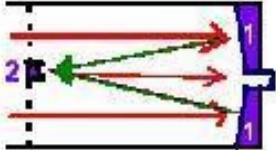
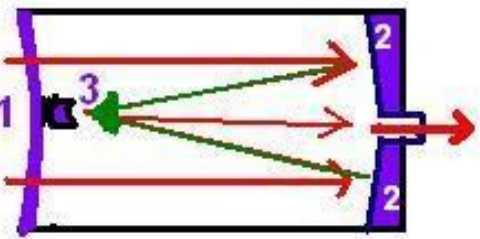

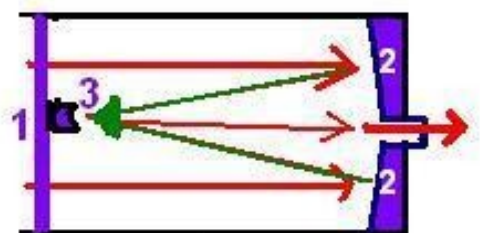



- **Schmid-Cassegrain**

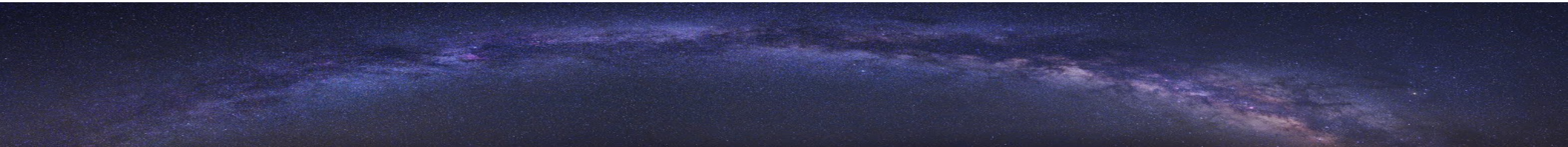


# • Schmid-Cassegrain

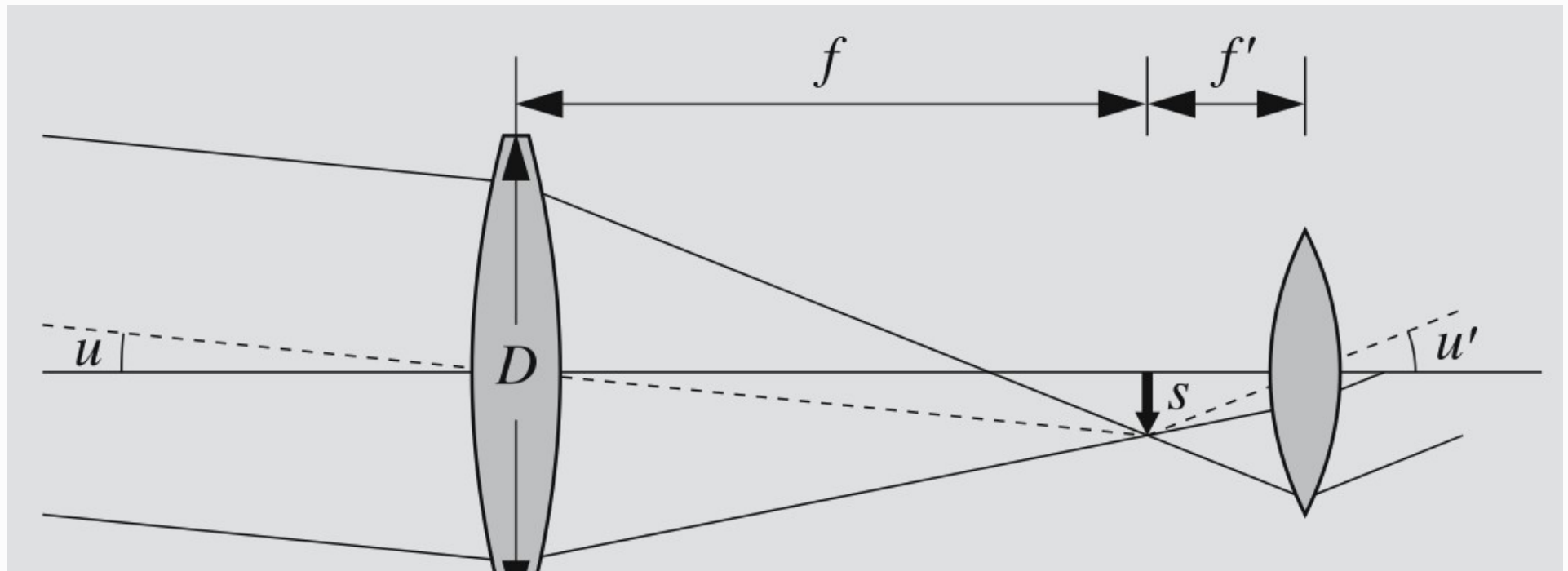


Tipo	Esquema de lentes y espejos		Imagen
Refractores			
Reflectores	Newton		
	Cassegrain		<p>Su imagen es similar a los Schmidt-Cassegrain</p>
Catadióptricos (Mixtos)	Maksutov-Cassegrain		
	Schmidt-Cassegrain		

Markcopolo 2004©



# Y, ¿cómo funciona un telescopio?



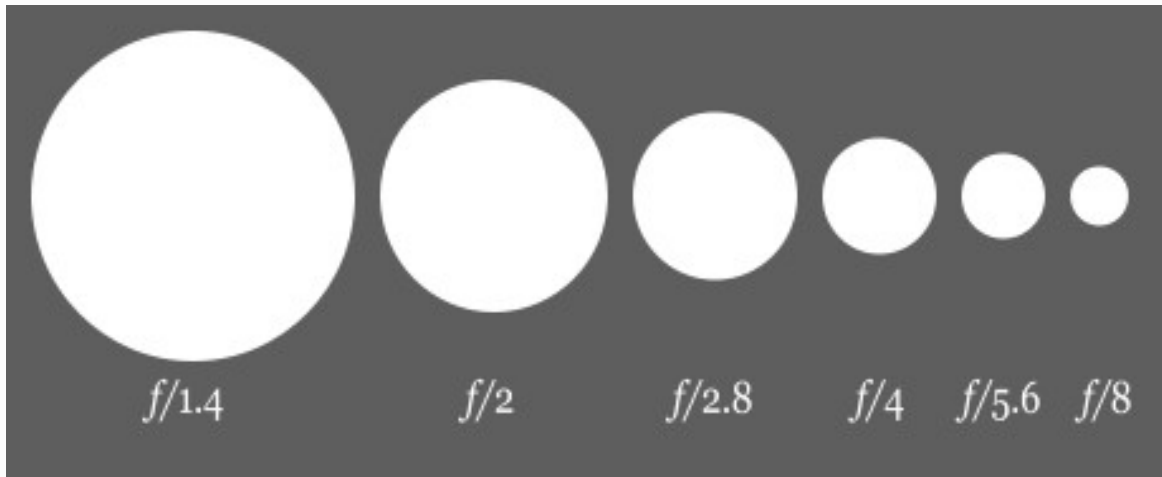
Razón de apertura  
 $F = D/f$



Número  $f$  (razón focal)  
 $f/n$



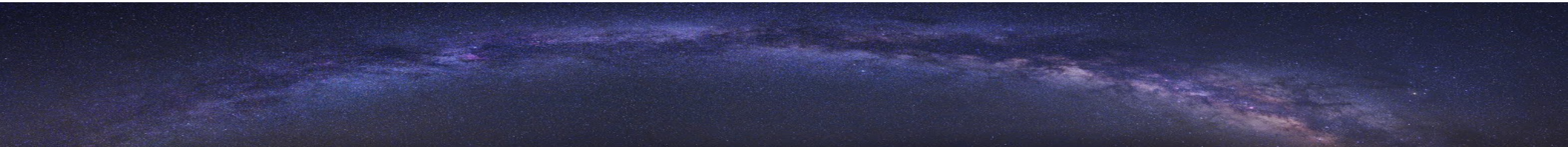
Razón focal: es una medida del poder concentrador de un telescopio. O de cuanta luz es capaz de recoger.

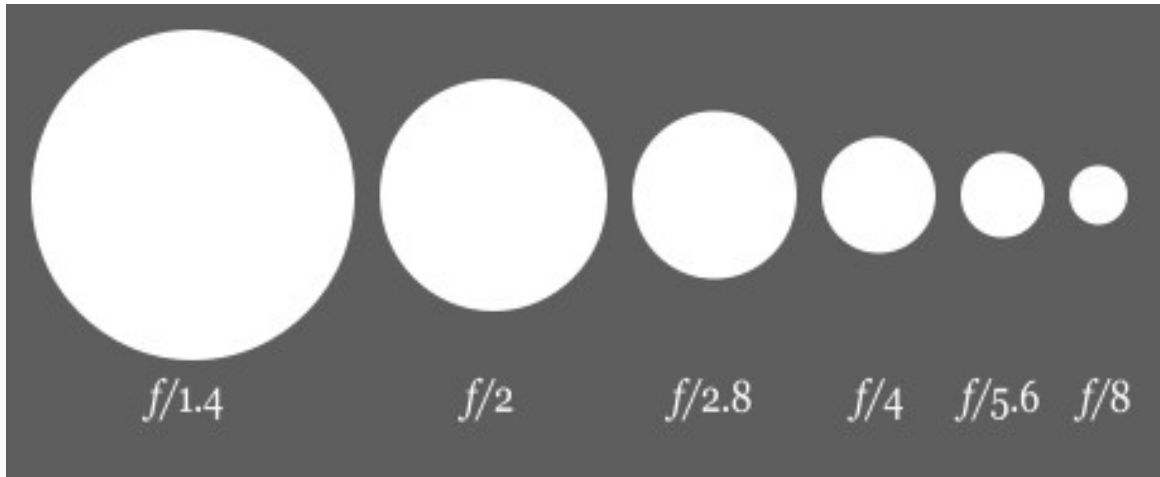


Razón de apertura  
 $F = D/f$



Número f (razón focal)  
 $D = f/n$





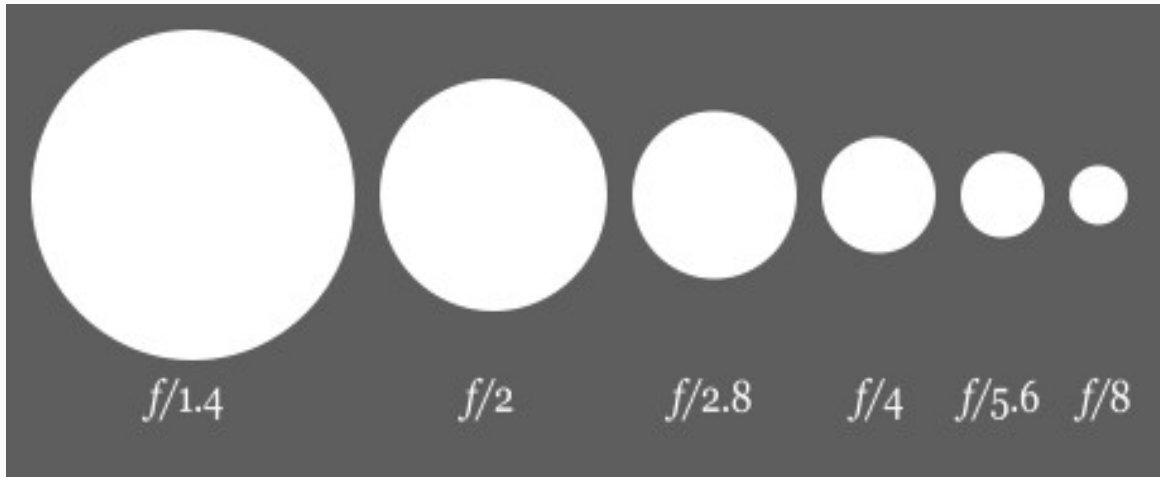
Para  $f/4$ ; Si  $D=50\text{mm} \Rightarrow f=????$

Para  $f/0.95$ ; Si  $D=50\text{mm} \Rightarrow f=????$

Razón de apertura  
 $F=D/f$



Número  $f$  (razón focal)  
 $D=f/n$



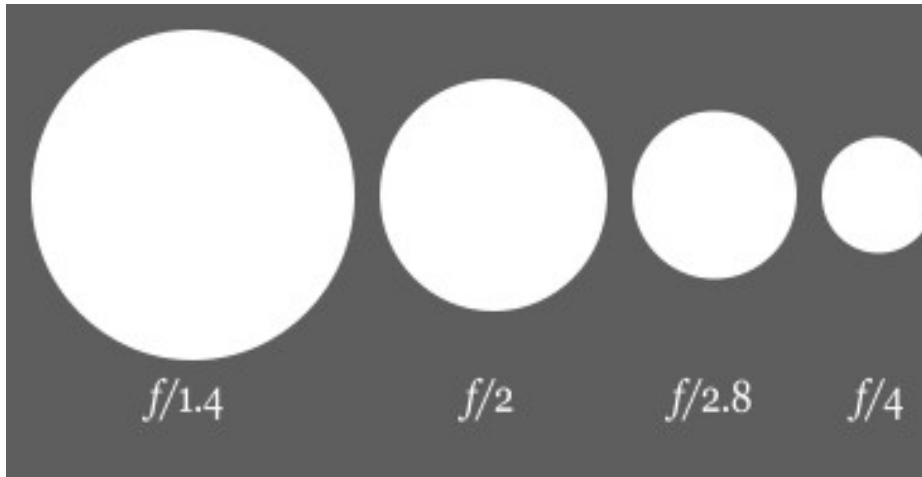
Para  $f/4$ ; Si  $D=50\text{mm} \Rightarrow f=200\text{mm}$

Para  $f/0.95$ ; Si  $D=50\text{mm} \Rightarrow f=47,5\text{mm}$

Razón de apertura  
 $F=D/f$



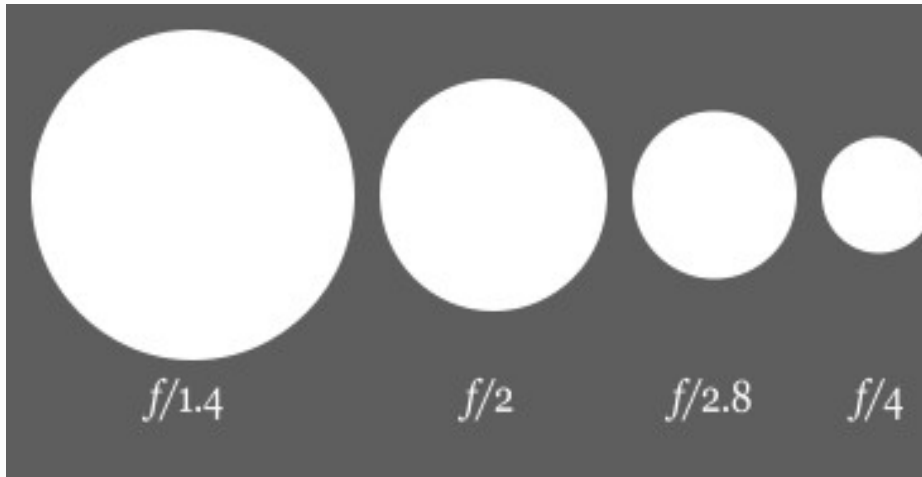
Número  $f$  (razón focal)  
 $D=f/n$



Para  $f/4$ ; Si  $D=$   
**Para  $f/0.95$**  Si  $D=$

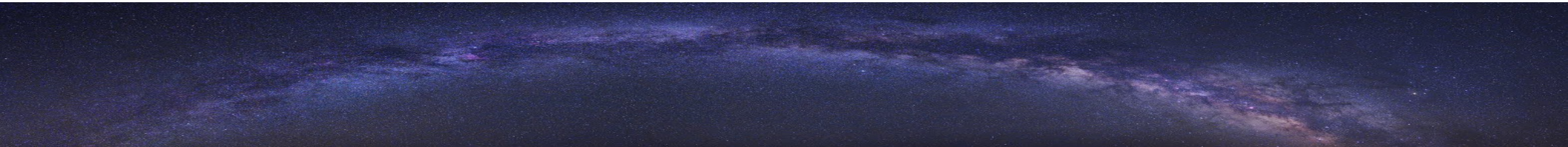
Razón de apertura  
 $F=D/f$



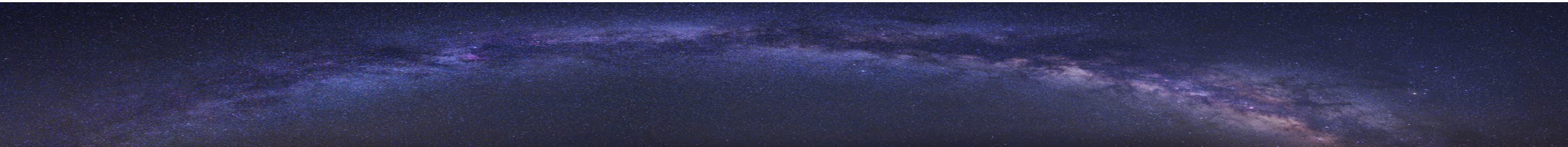


Para  $f/4$ ; Si  $D=$   
**Para  $f/0.95$**  Si  $D=$

Razón de apertura  
 $F=D/f$



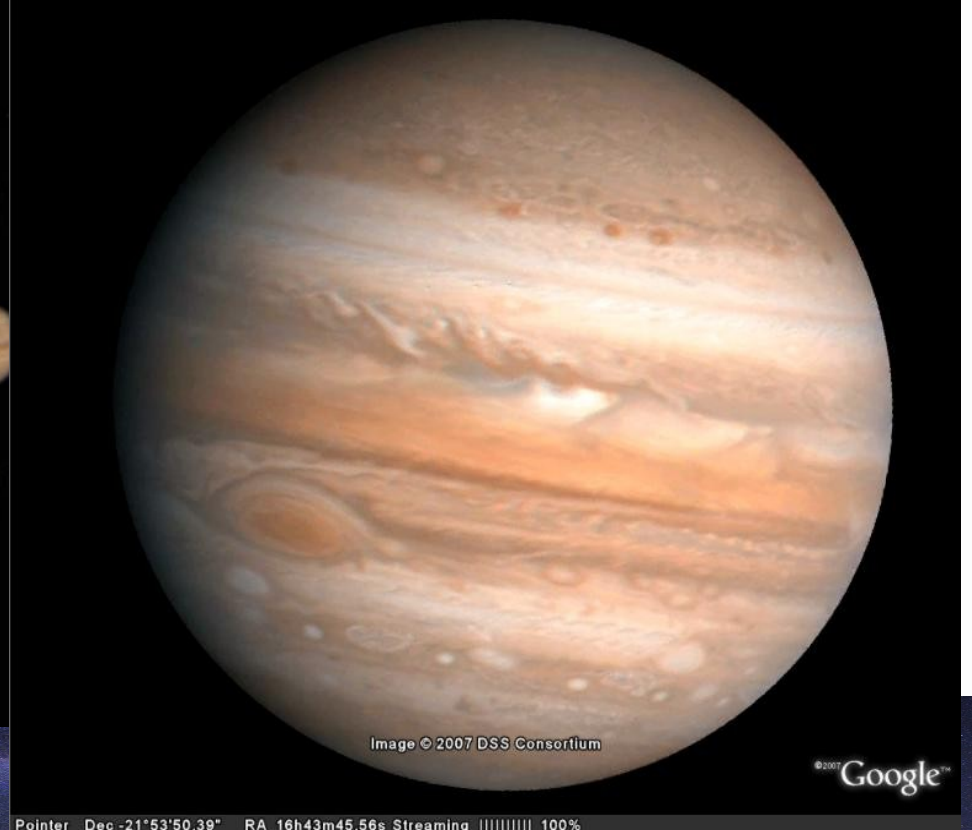
# Y la magnificación (Zoom)



# Y la magnificación (Zoom)



# Y la magnificación (Zoom)





# Y la magnificación (Zoom)



$$w = f/f'$$

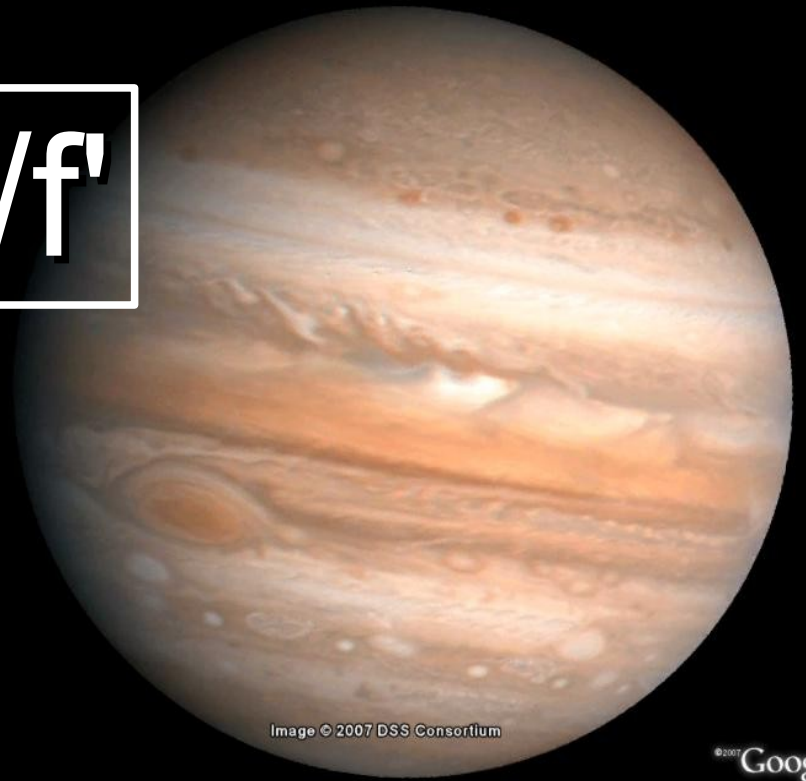


Image © 2007 DSS Consortium

©2007 Google™

# Pero magnificación no es resolución..



$$w = f/f'$$

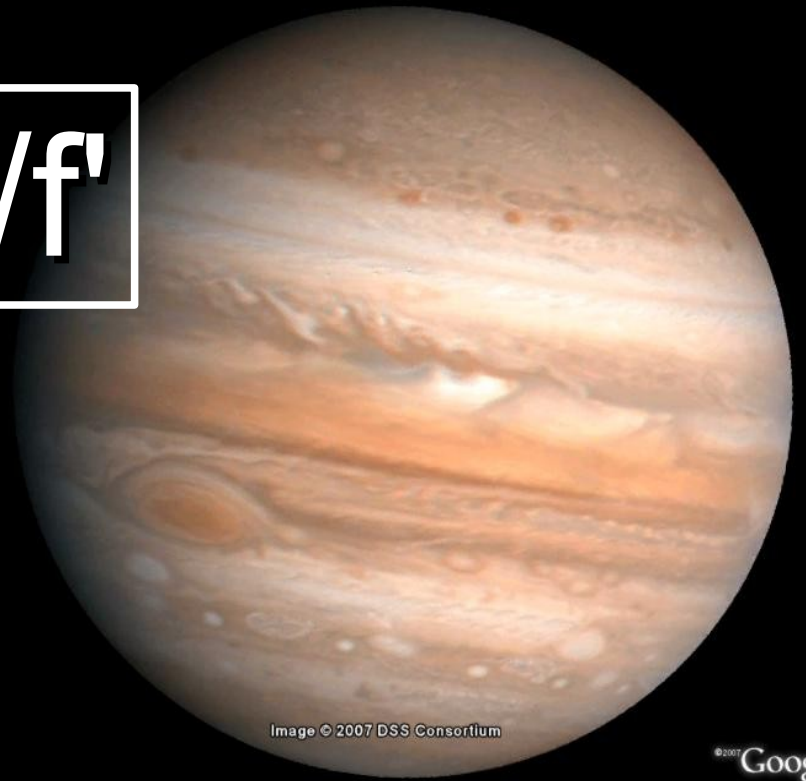
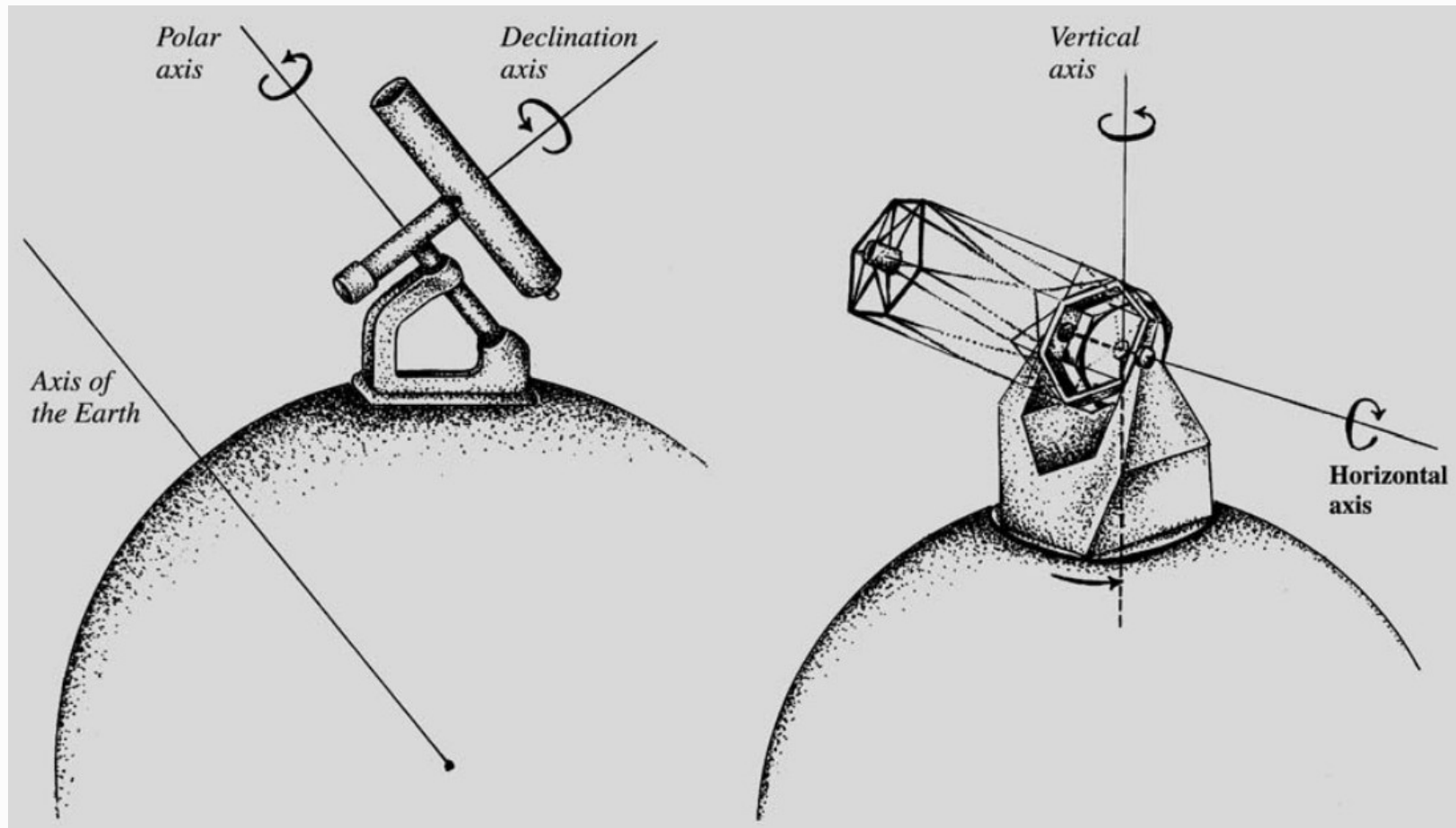


Image © 2007 DSS Consortium

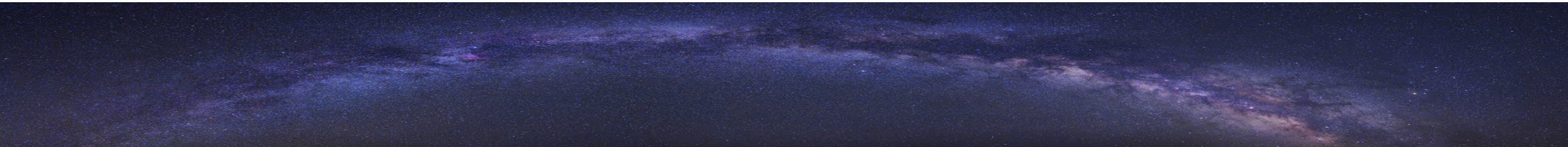
©2007 Google™

# Monturas



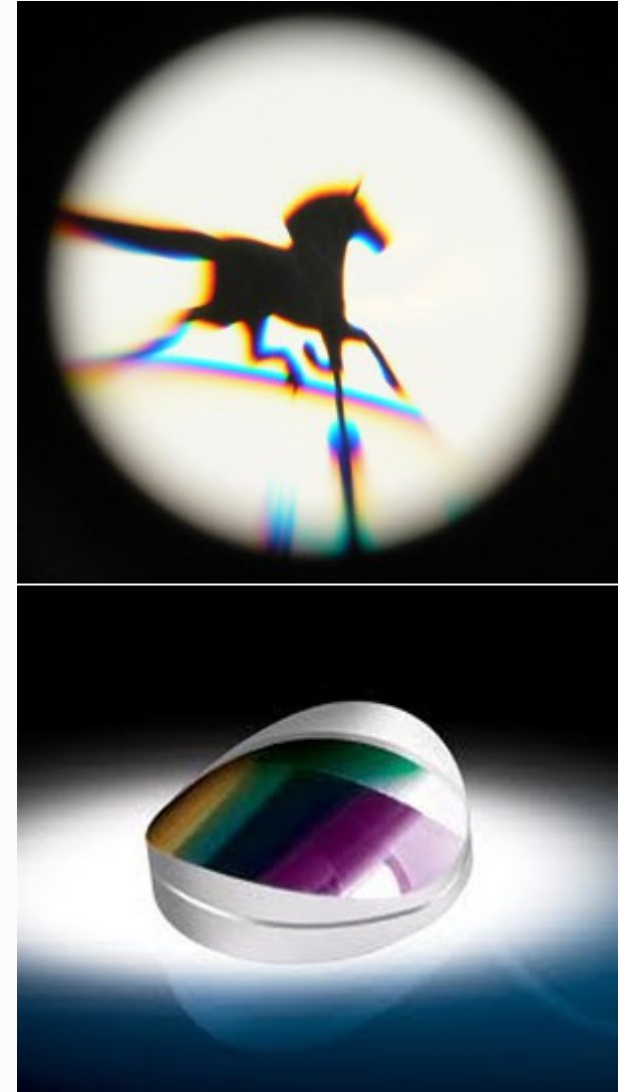
# Aberraciones

- Cromática:



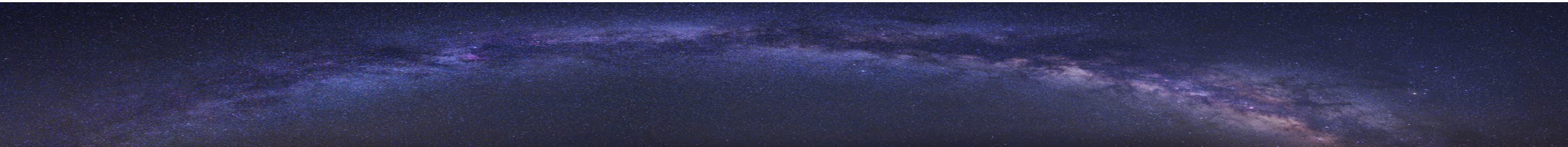
# Aberraciones

- Cromática:
  - Índice de refracción



# Aberraciones

- Cromática:
  - Índice de refracción
- Esférica:

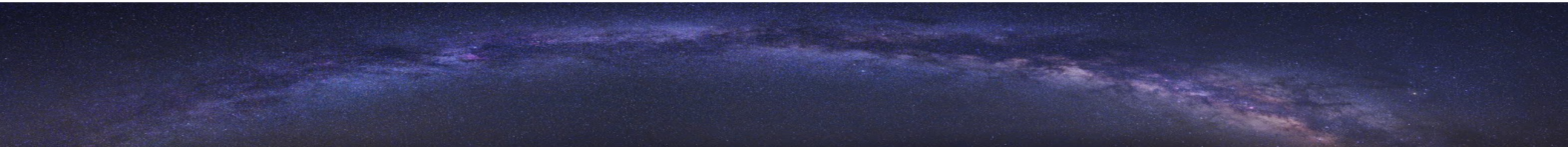


# Aberraciones

- Cromática:
  - Índice de refracción
- Esférica:
  - Rayos paralelos no llegan al mismo foco



- Cromática:
  - Índice de refracción
- Esférica:
  - Rayos paralelos no llegan al mismo foco
- Coma:





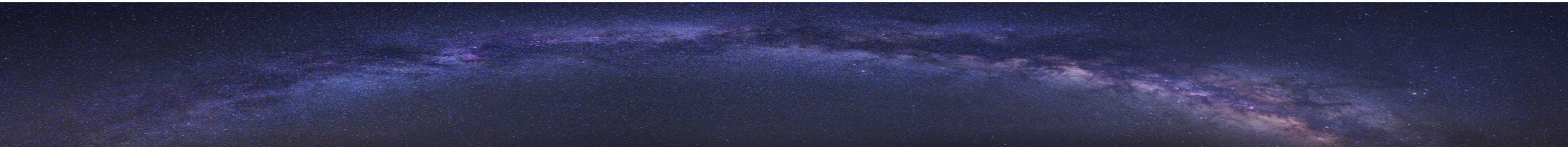
# Aberraciones

- Cromática:
  - Índice de refracción
- Esférica:
  - Rayos paralelos no llegan al mismo foco
- Coma:
  - Imperfecciones de la lente



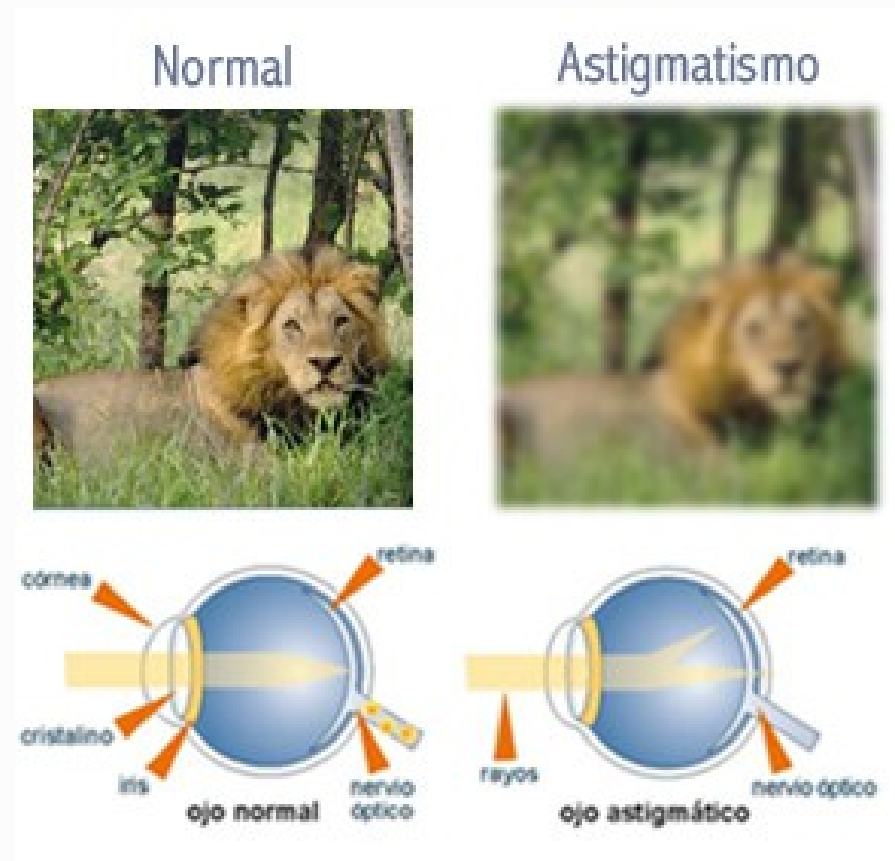
# Aberraciones

- Cromática:
  - Índice de refracción
- Esférica:
  - Rayos paralelos no llegan al mismo foco
- Coma:
  - Imperfecciones de la lente
- Astigmatismo:

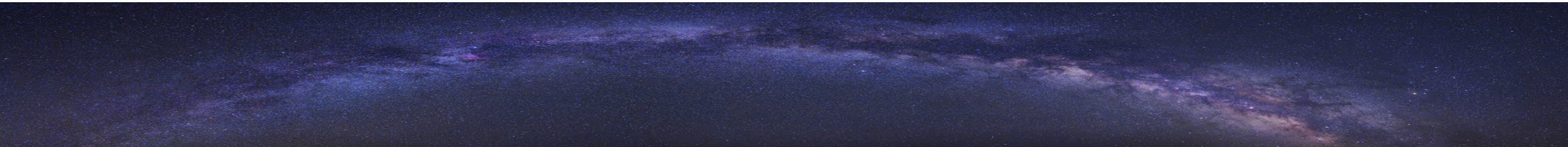


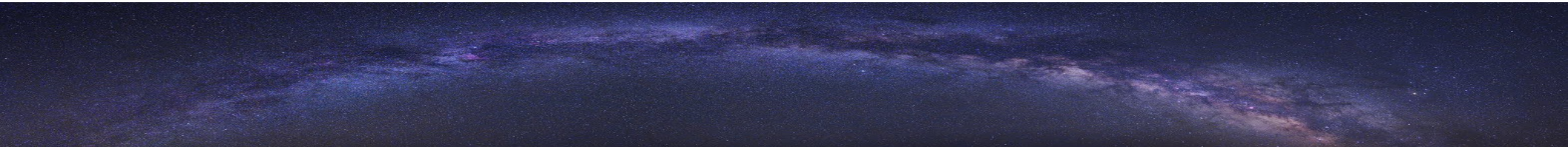
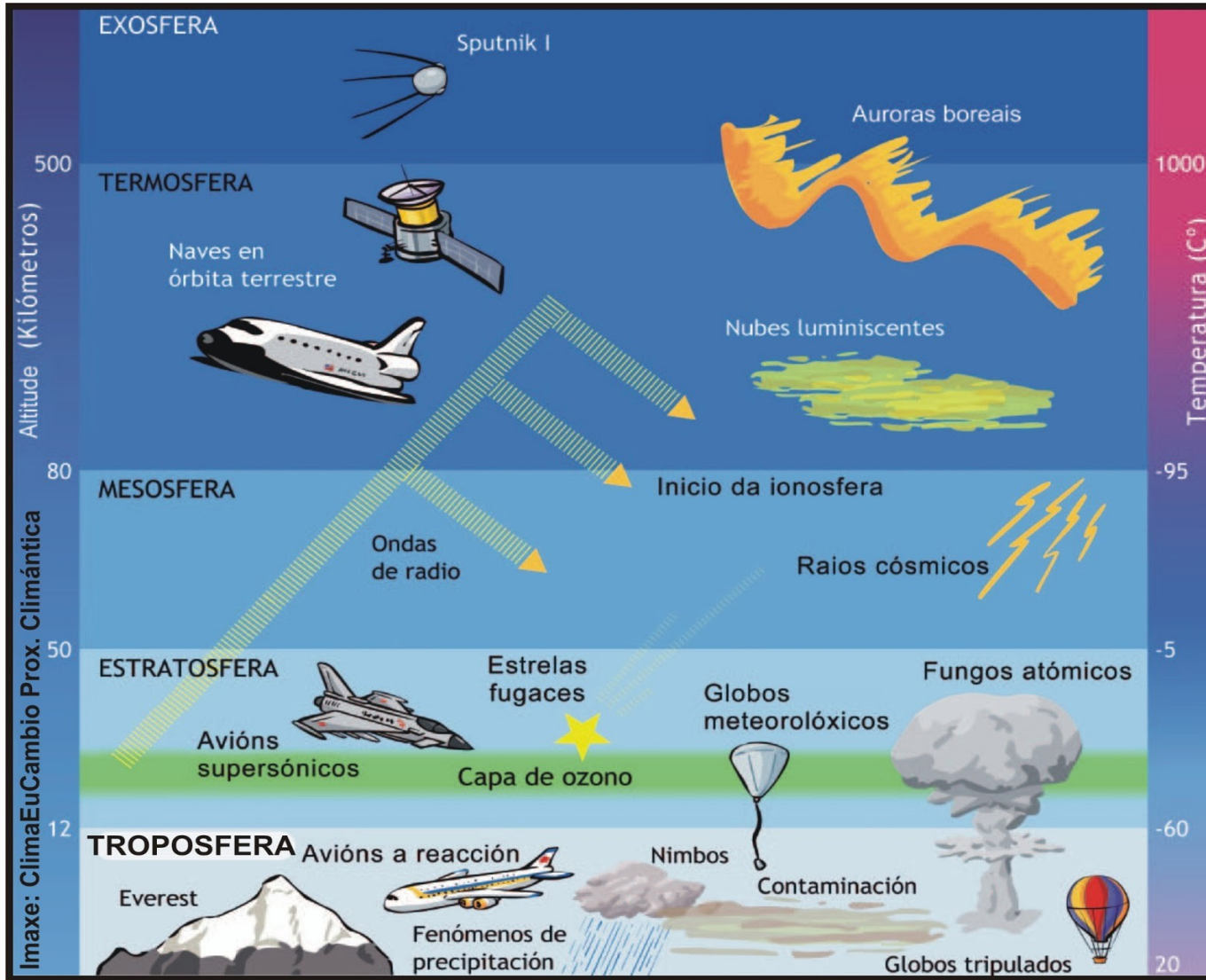
# Aberraciones

- Cromática:
  - Índice de refracción
- Esférica:
  - Rayos paralelos no llegan al mismo foco
- Coma:
  - Inperfecciones de la lente
- Astigmatismo:
  - Incapacidad de enfocar en un mismo punto

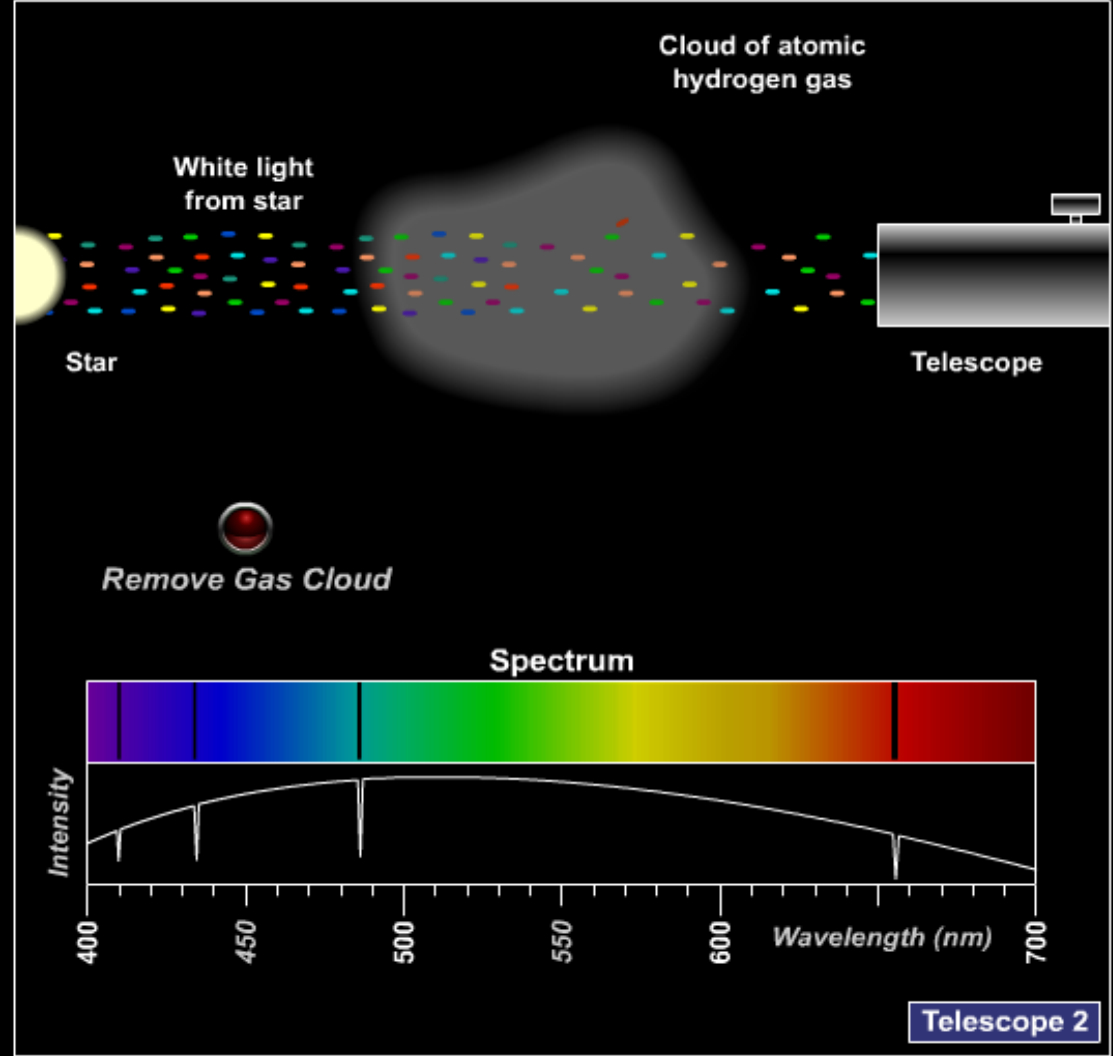


**Y, ¿qué pasa con la atmósfera?**





### Production of Absorption Lines

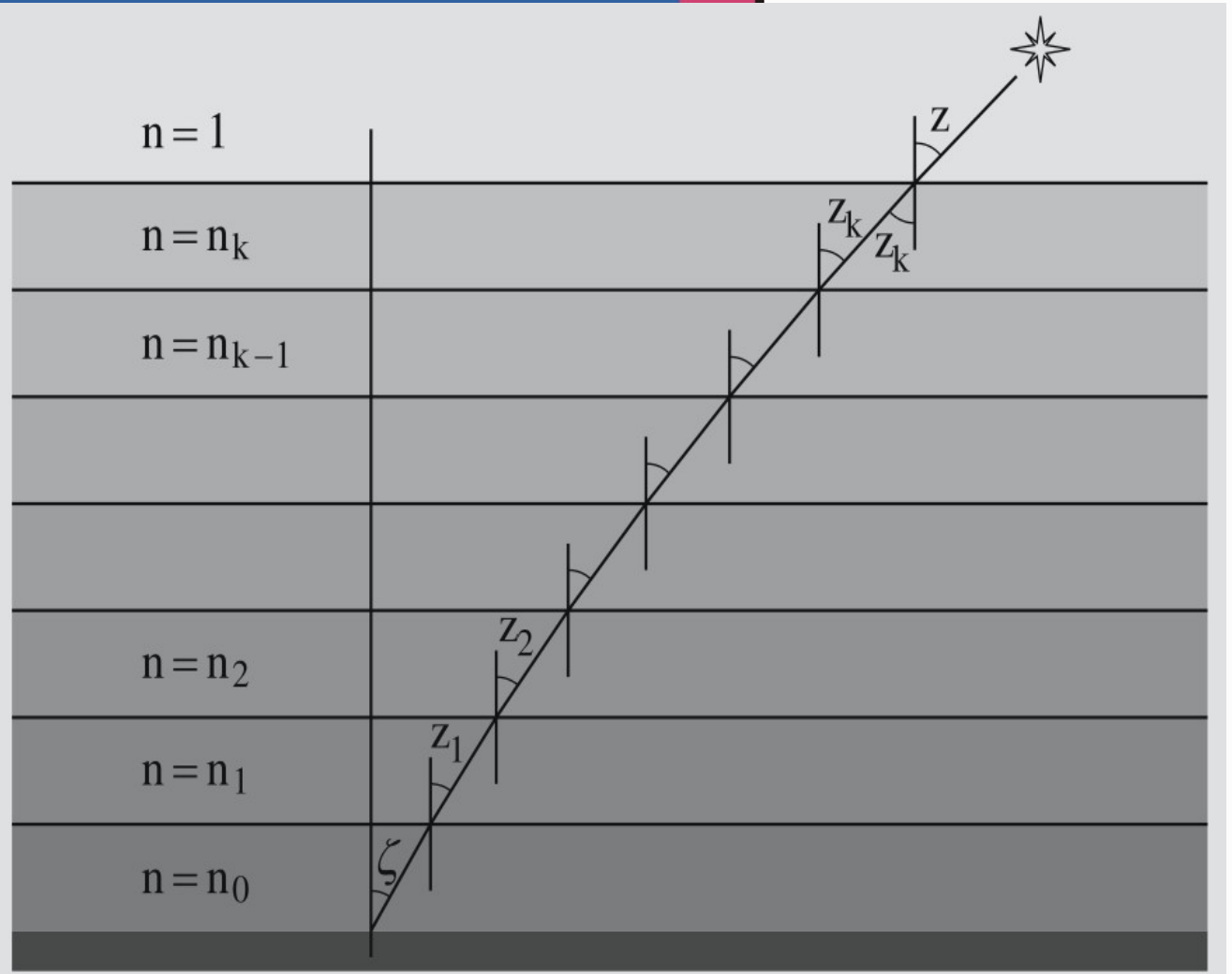
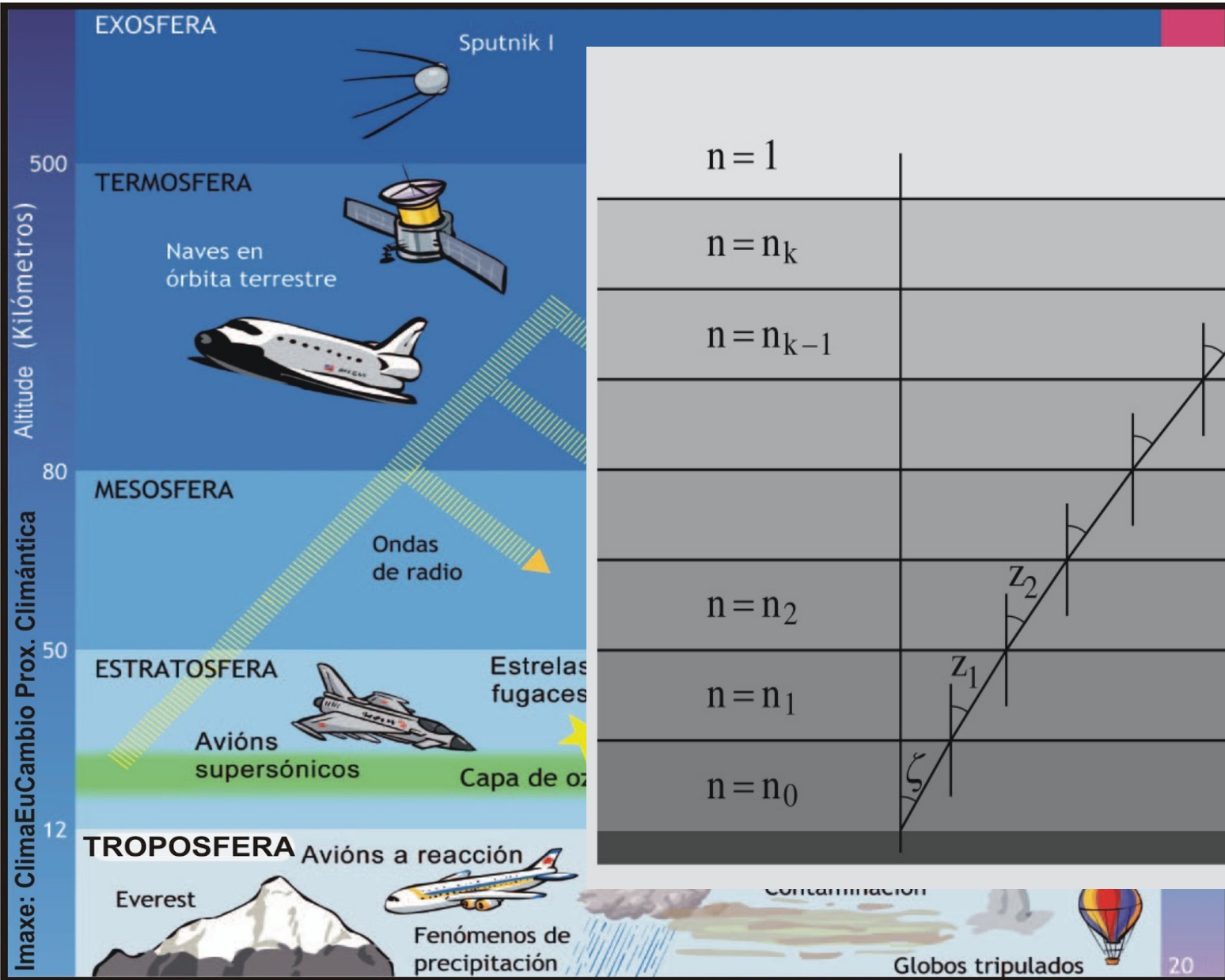


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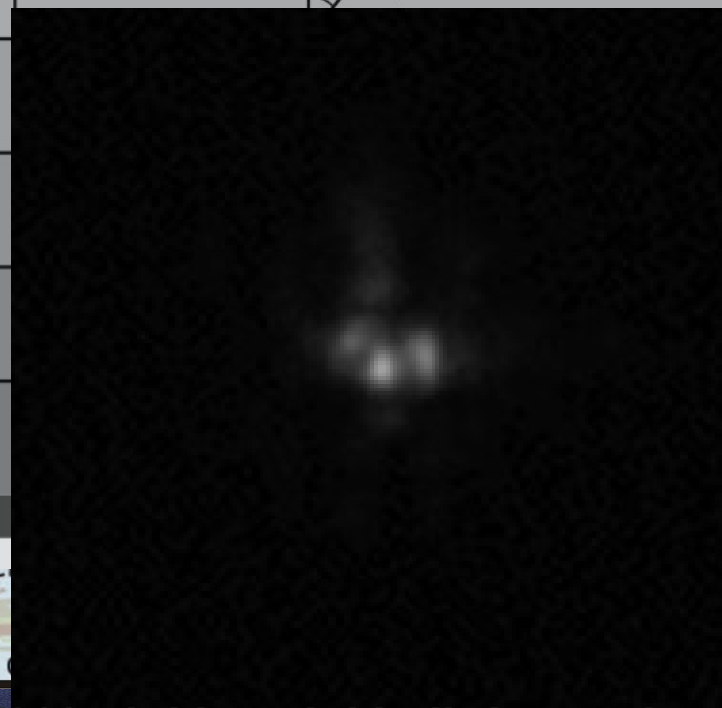
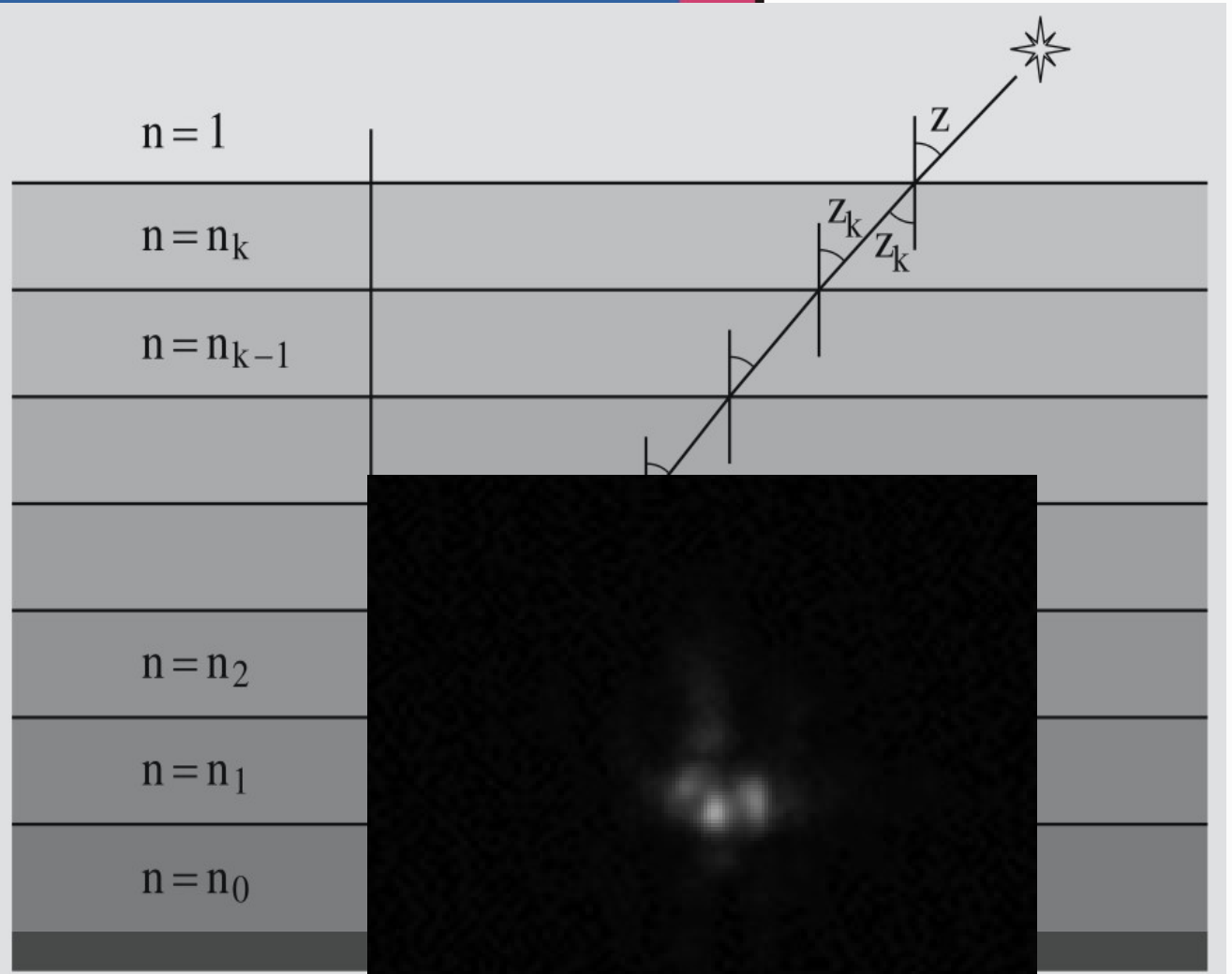
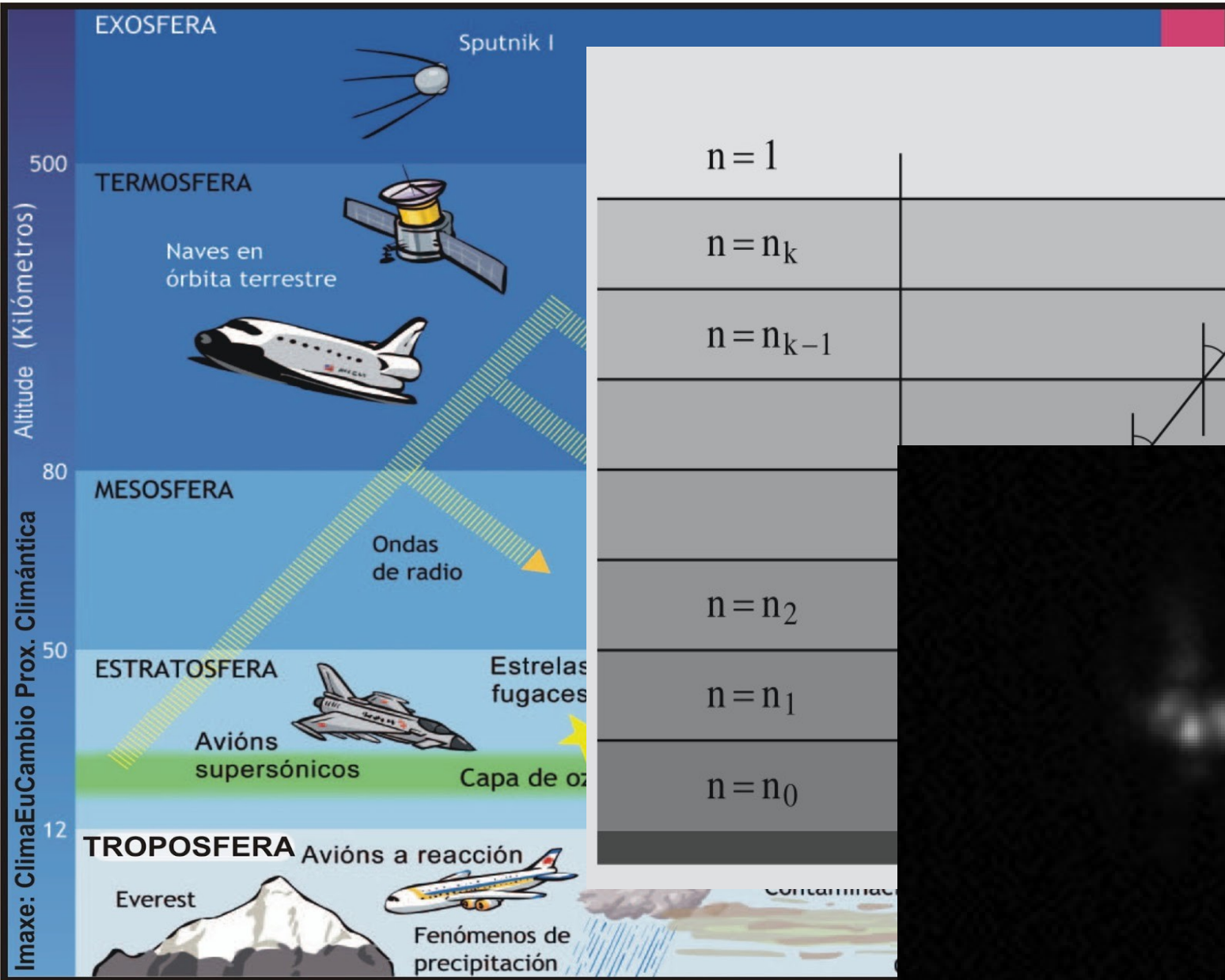
How To Use

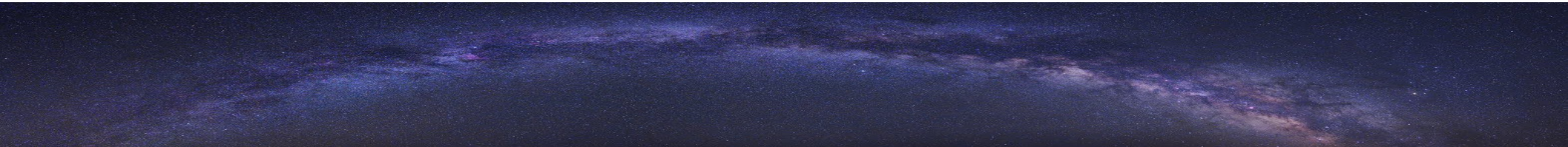
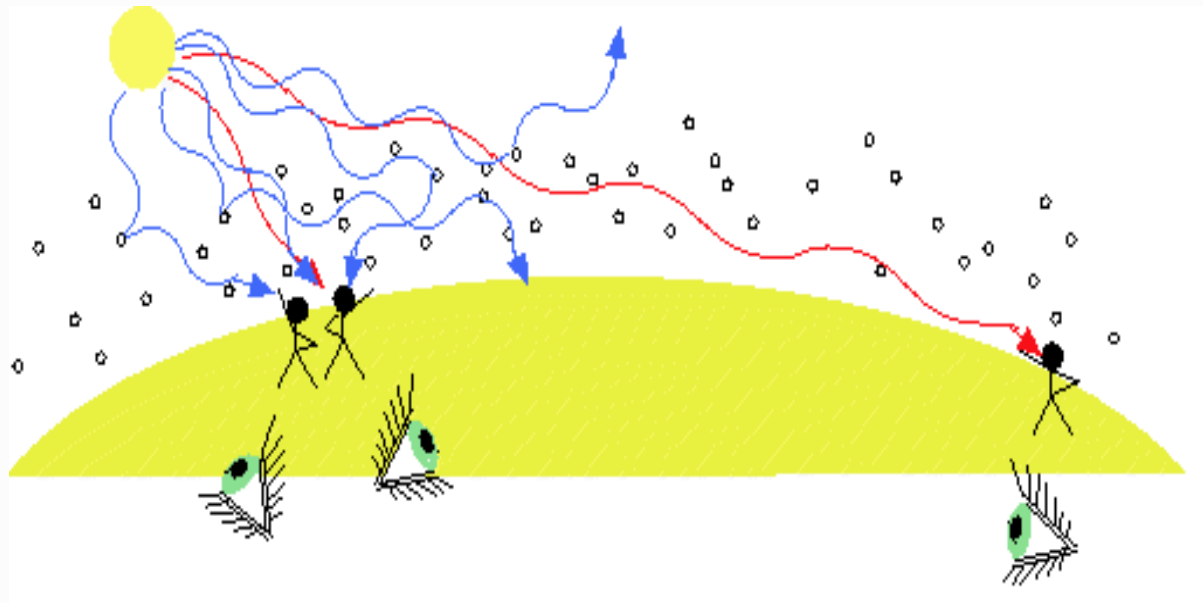
Credits

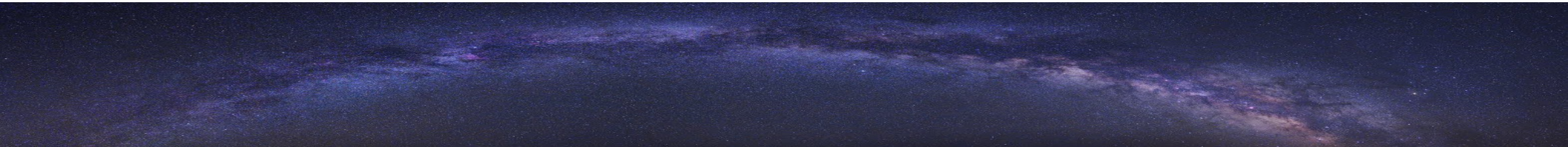
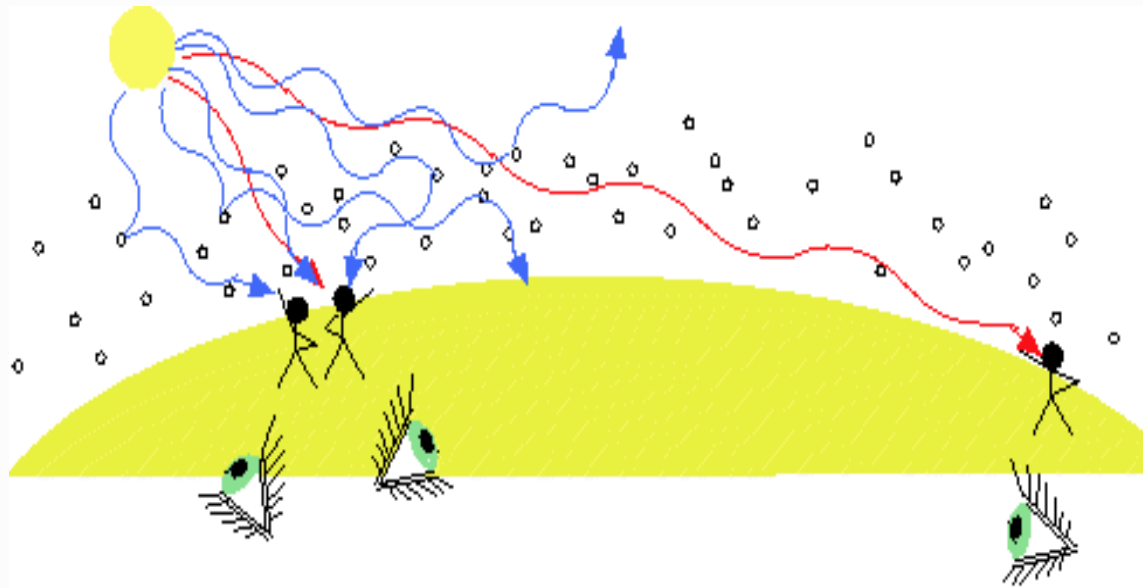


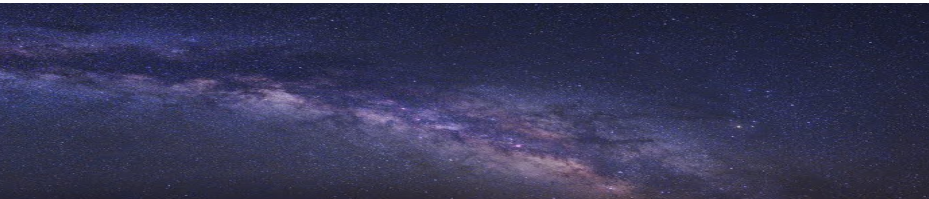
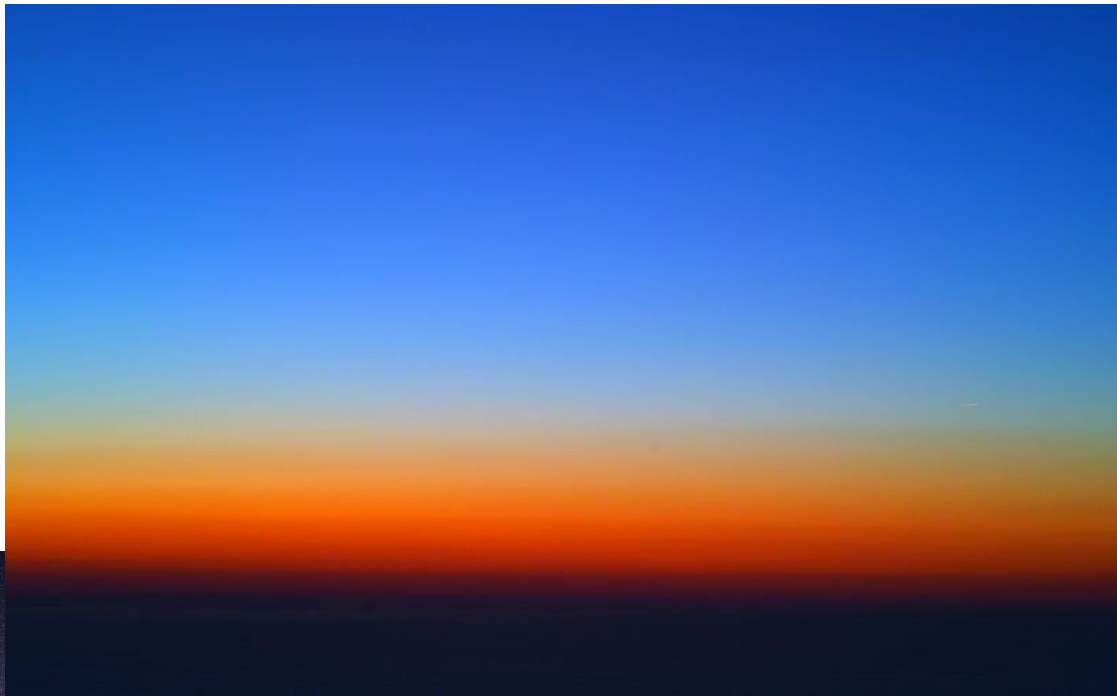
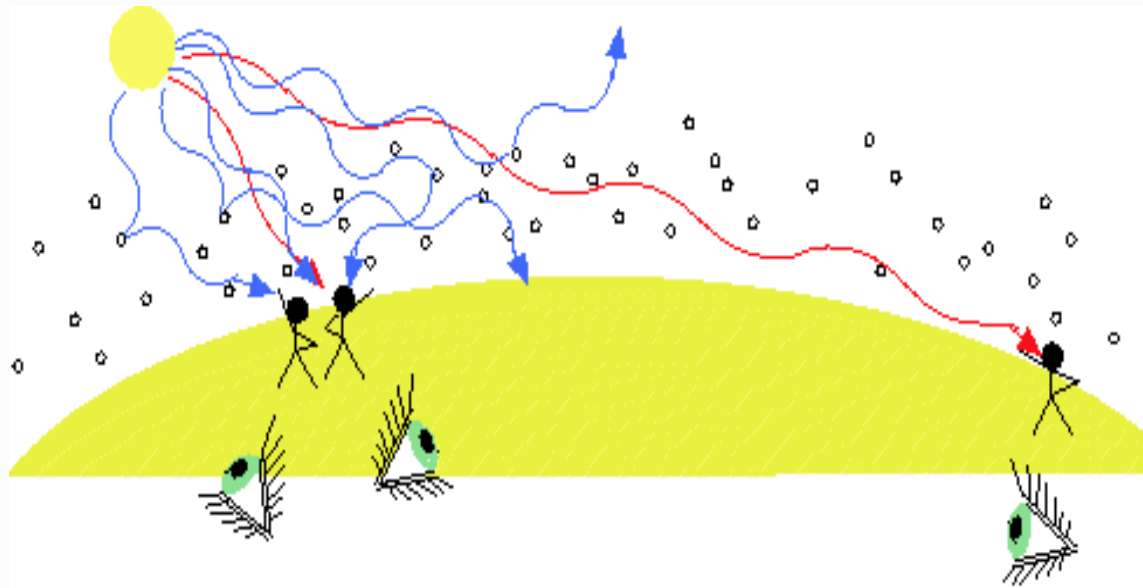


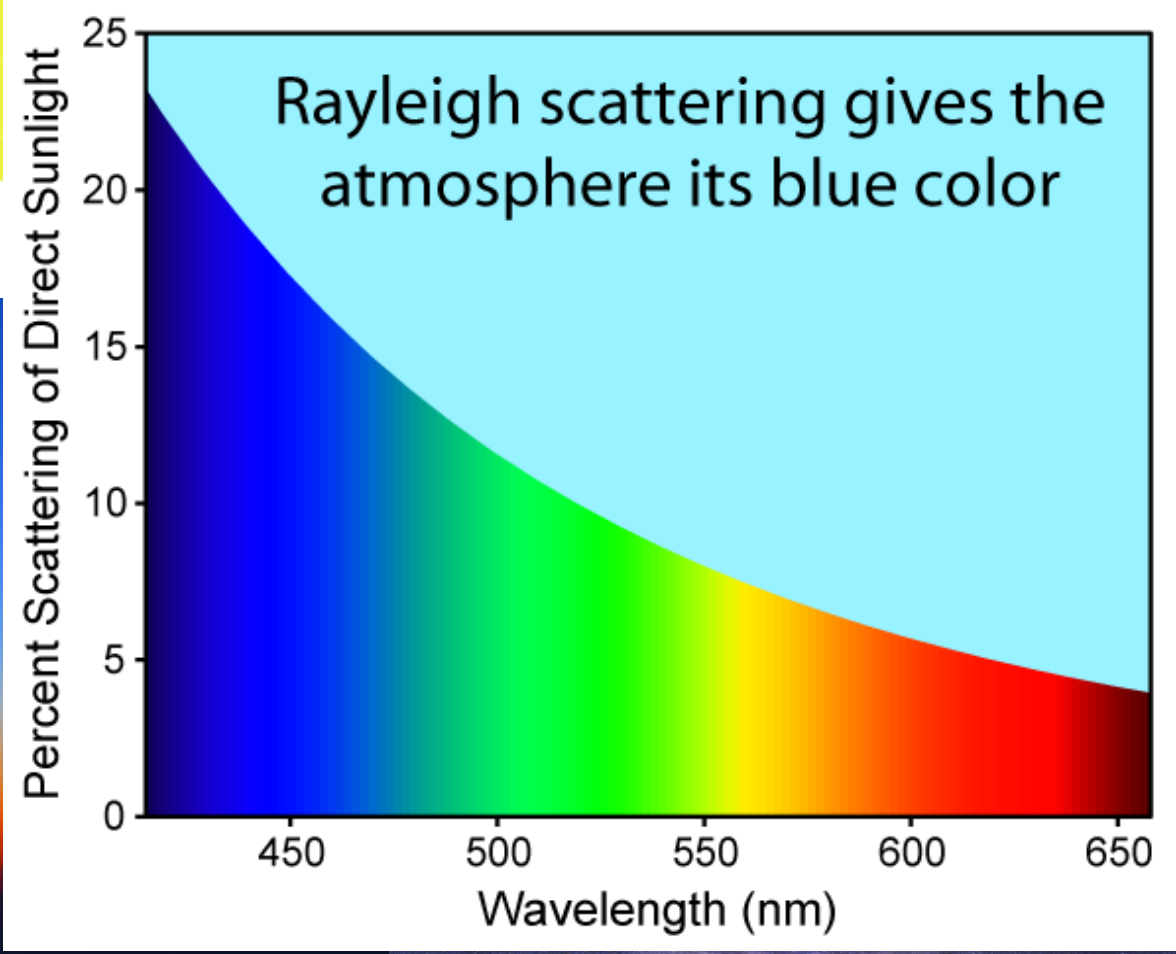
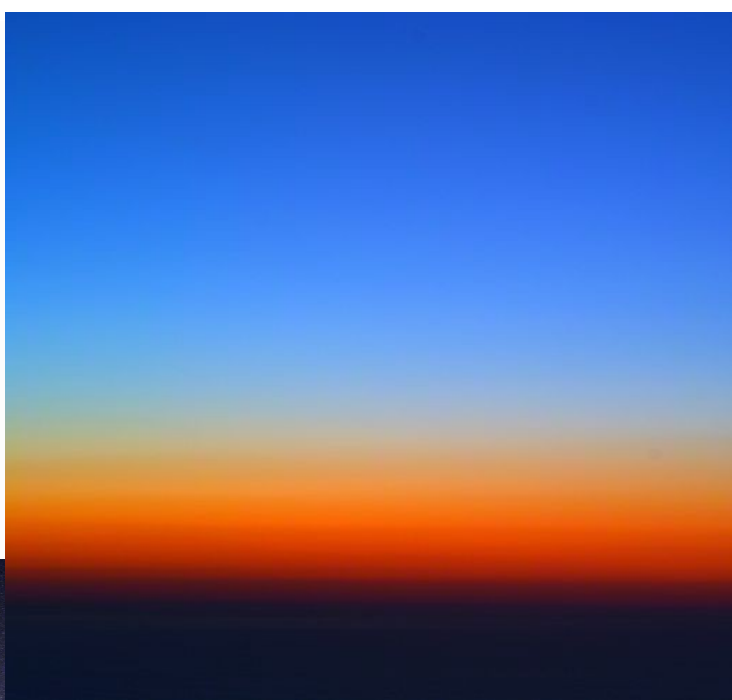
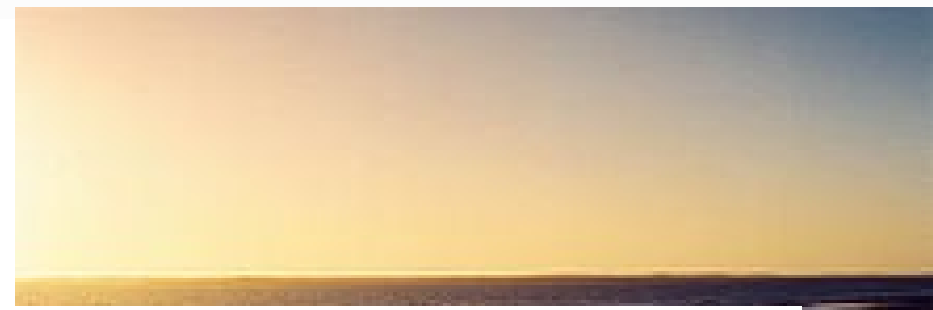
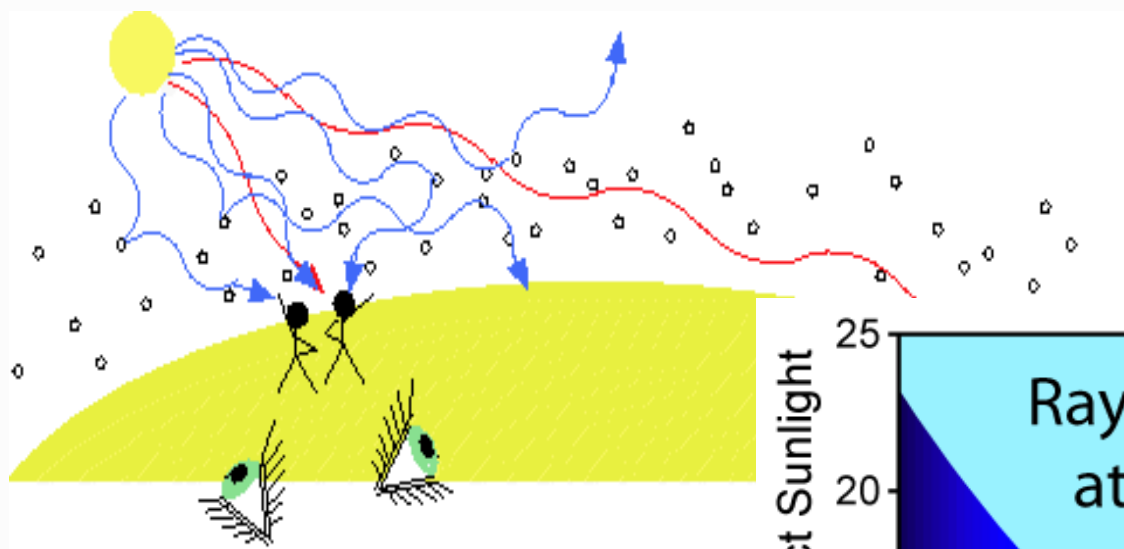




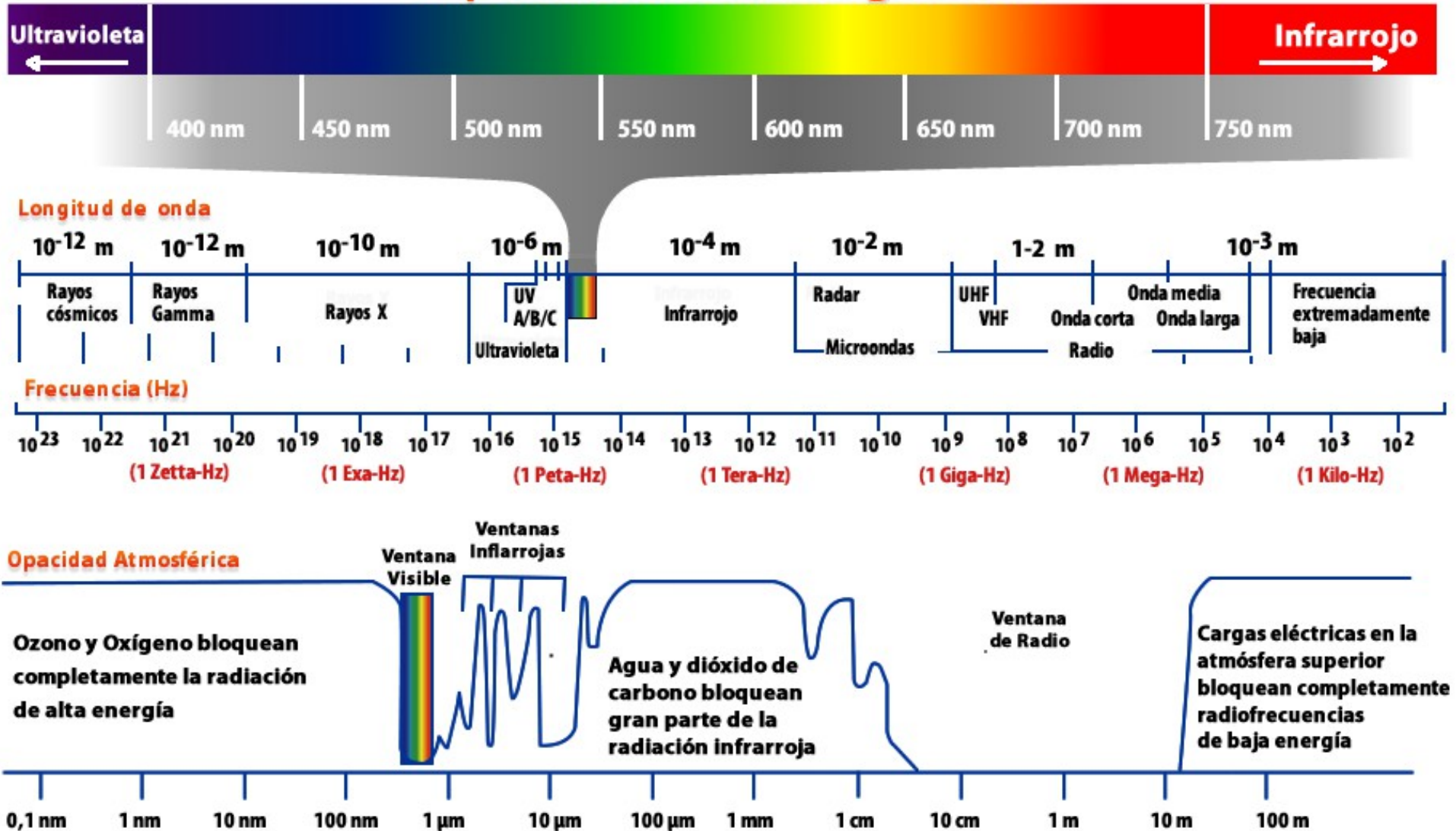




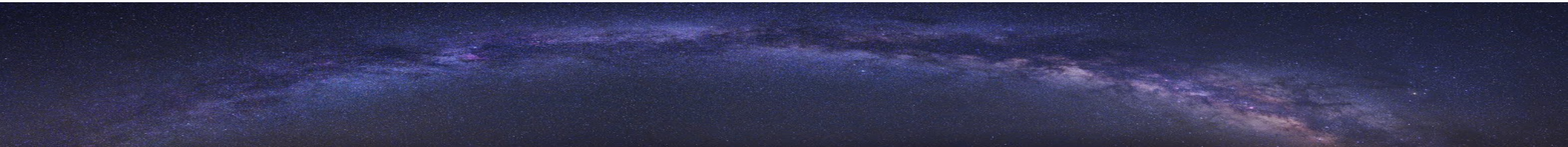




# Espectro Electromagnético

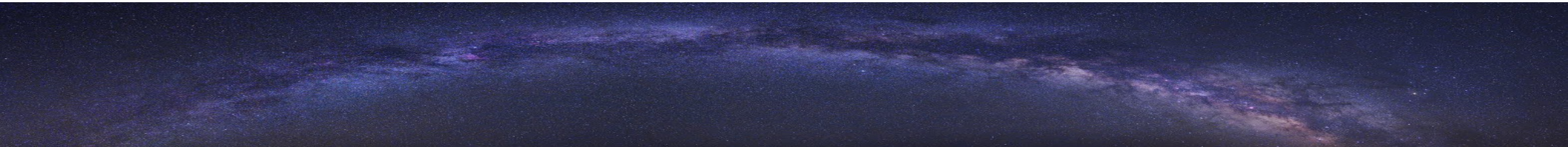


# Telescopios modernos



# Telescopios modernos

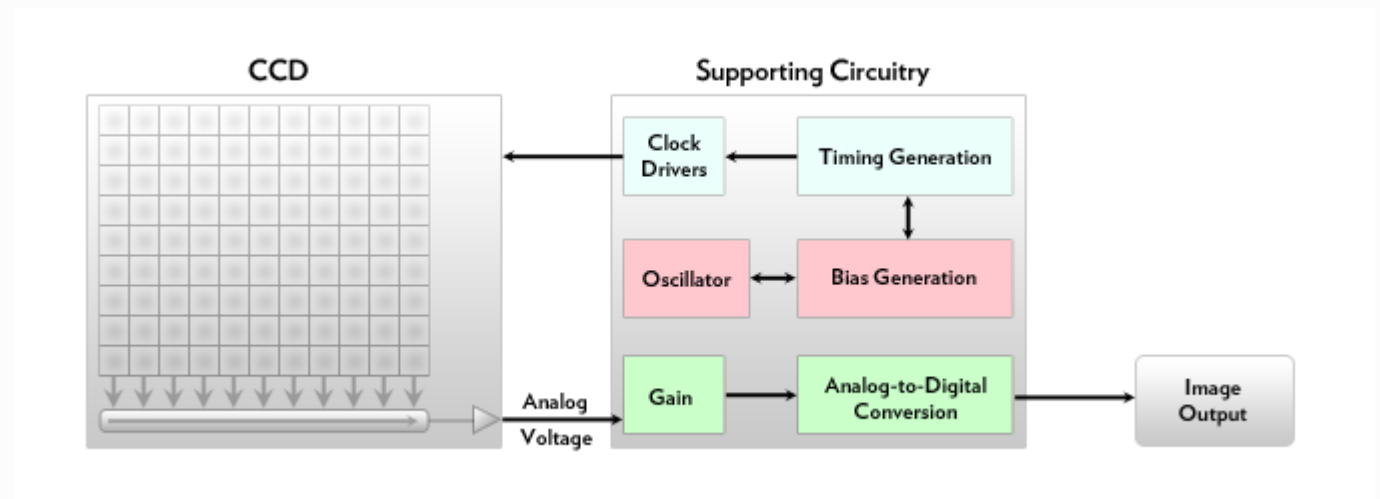
Dispositivo de Carga Acoplada, CCD  
(Charge-coupled device)





# Telescopios modernos

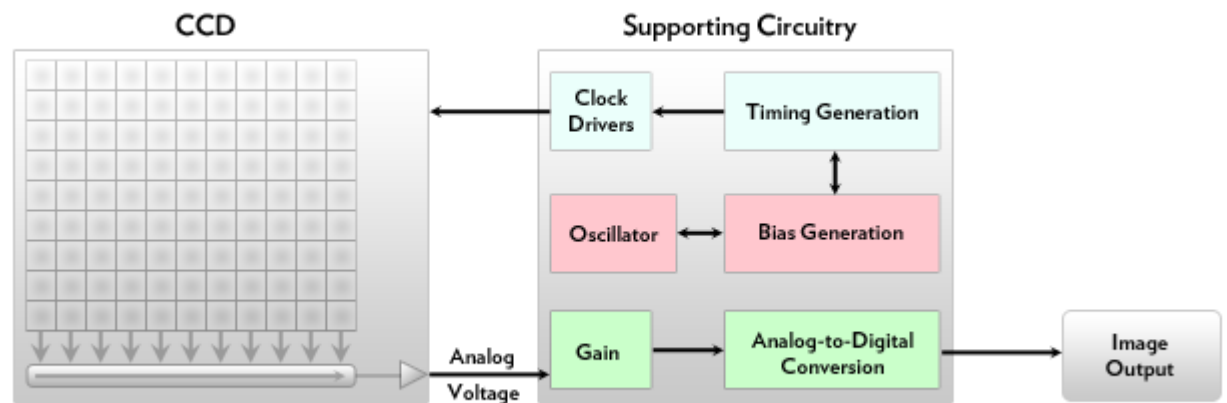
Dispositivo de Carga Acoplada, CCD  
(Charge-coupled device)



# Telescopios modernos

Dispositivo de Carga Acoplada, CCD  
(Charge-coupled device)

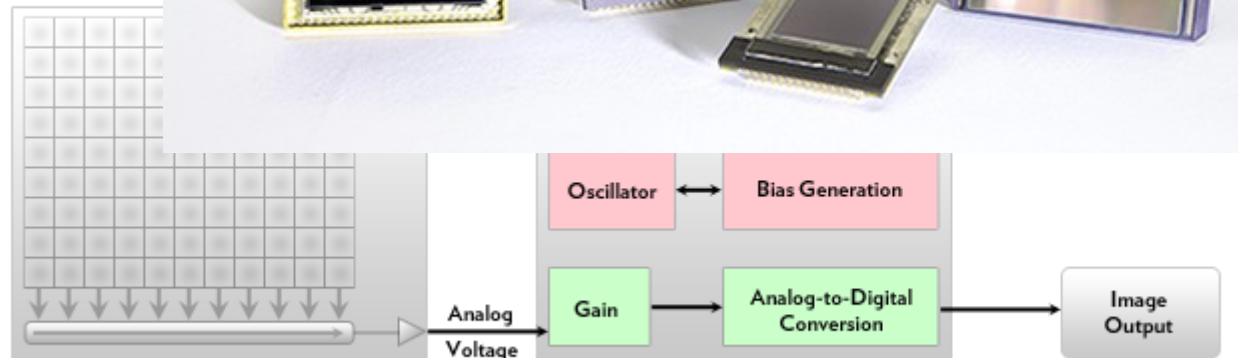
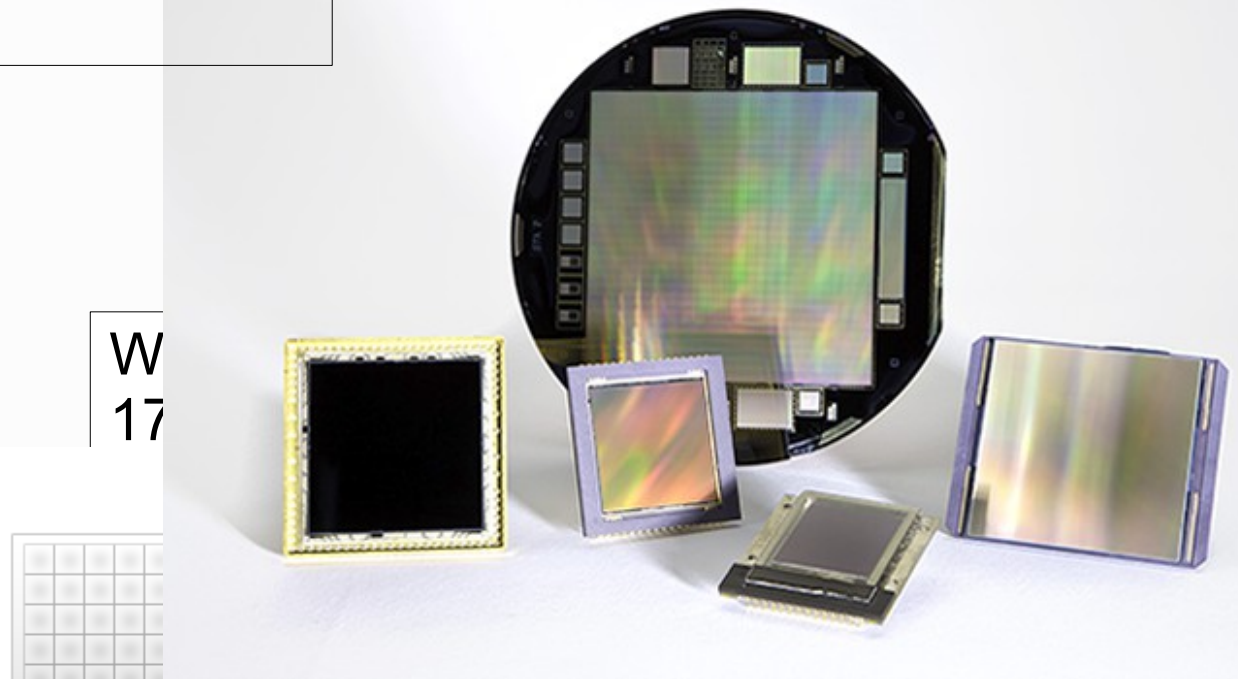
Willard Boyle y George Smith  
17 de octubre de 1969. Laboratorios Bell.  
Premio Nobel de Física en 2009



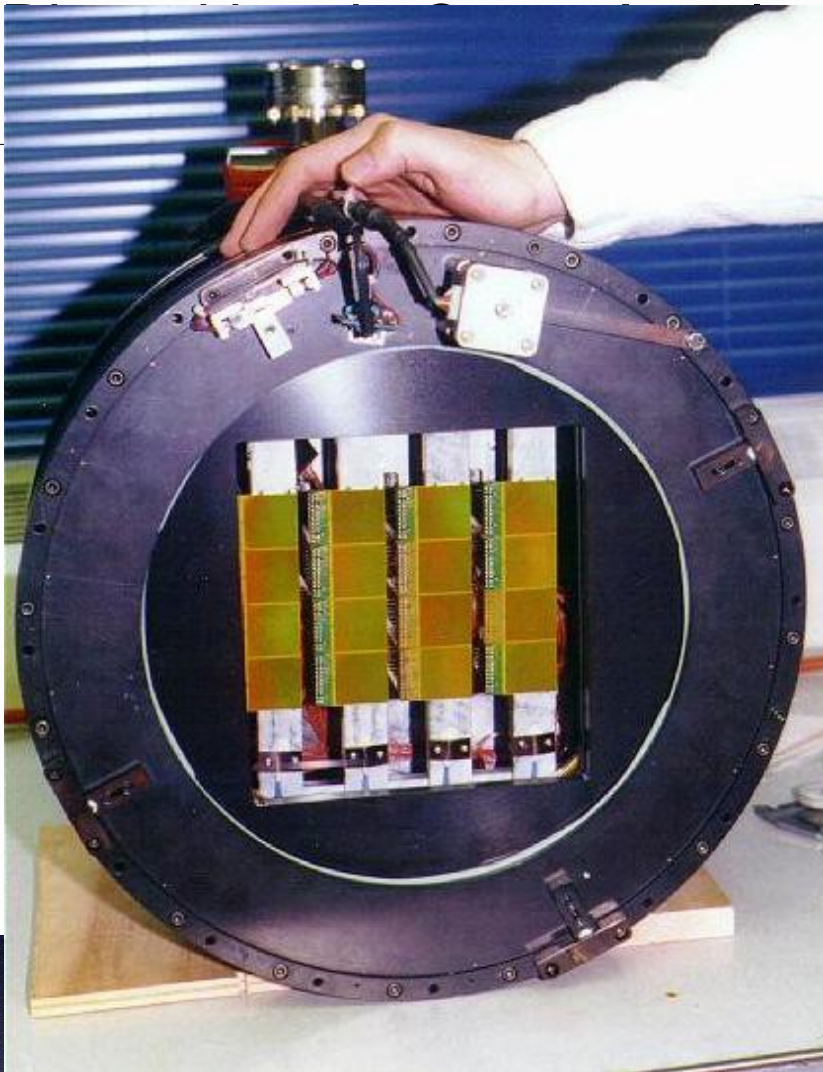
# Telescopios modernos

Dispositivo de Carga Acoplada, CCD  
(Charge-coupled device)

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17



# Telescopios modernos



la, CCD

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