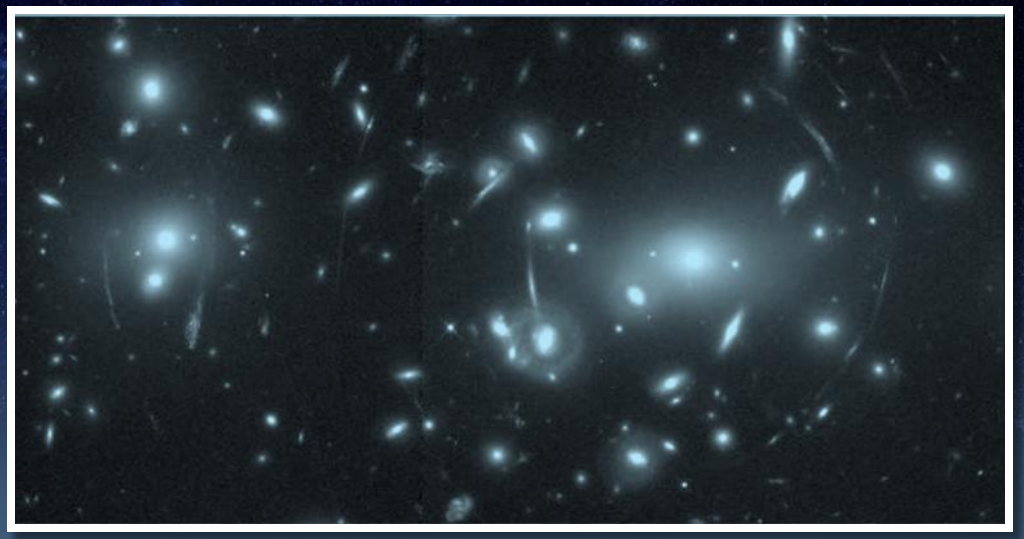


LENTES GRAVITATORIAS ENTRE EL ARTE Y LA CIENCIA

José A. de Diego

jdo@astroscu.unam.mx

Instituto de Astronomía – UNAM

ININ – 2009

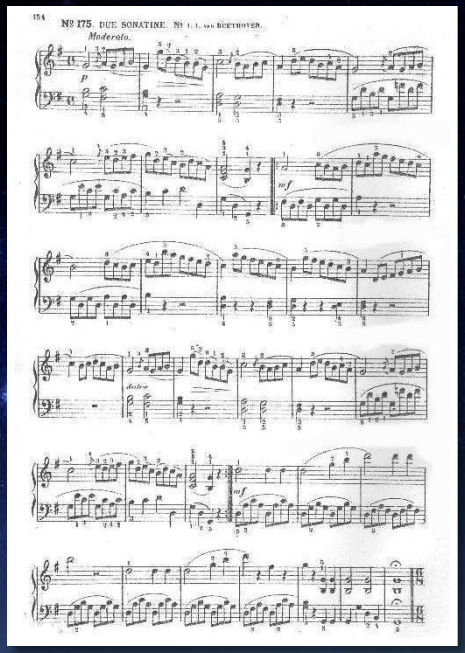
1. EL ARTE Y LA ASTRONOMÍA

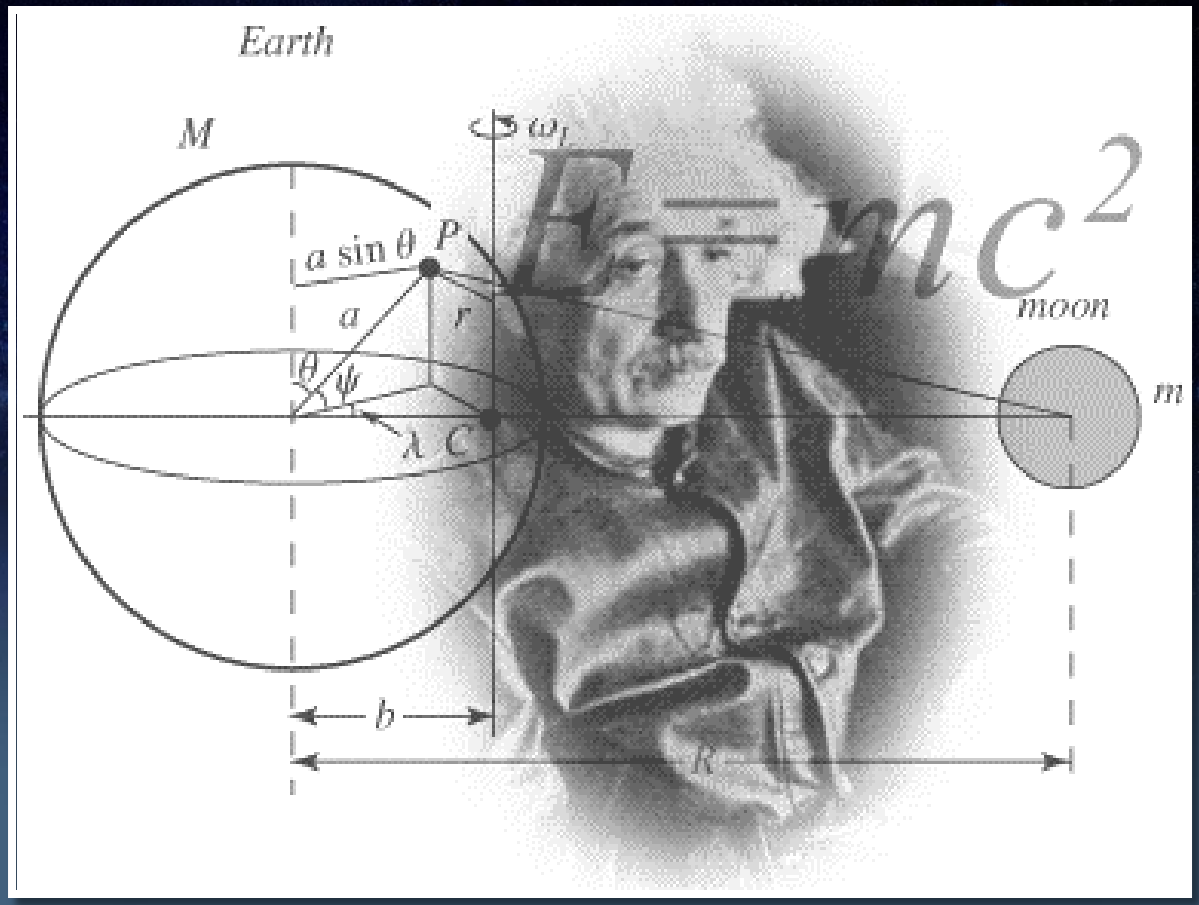
¿Por qué la Astronomía nos resulta tan atractiva?

Todas las actividades humanas hacen uso de los sentidos.

- La ciencia es subjetiva
- El arte es objetivo

Los instrumentos científicos son ayudas mecánicas para nuestros sentidos.



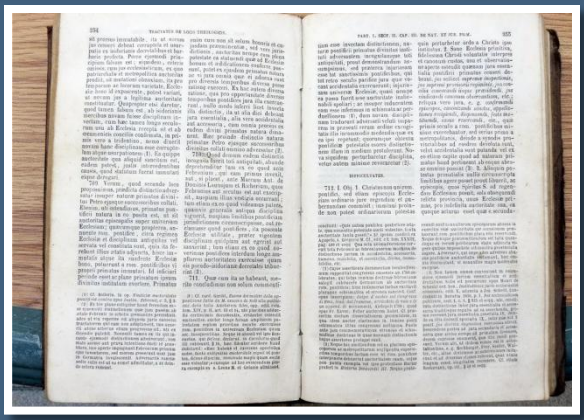


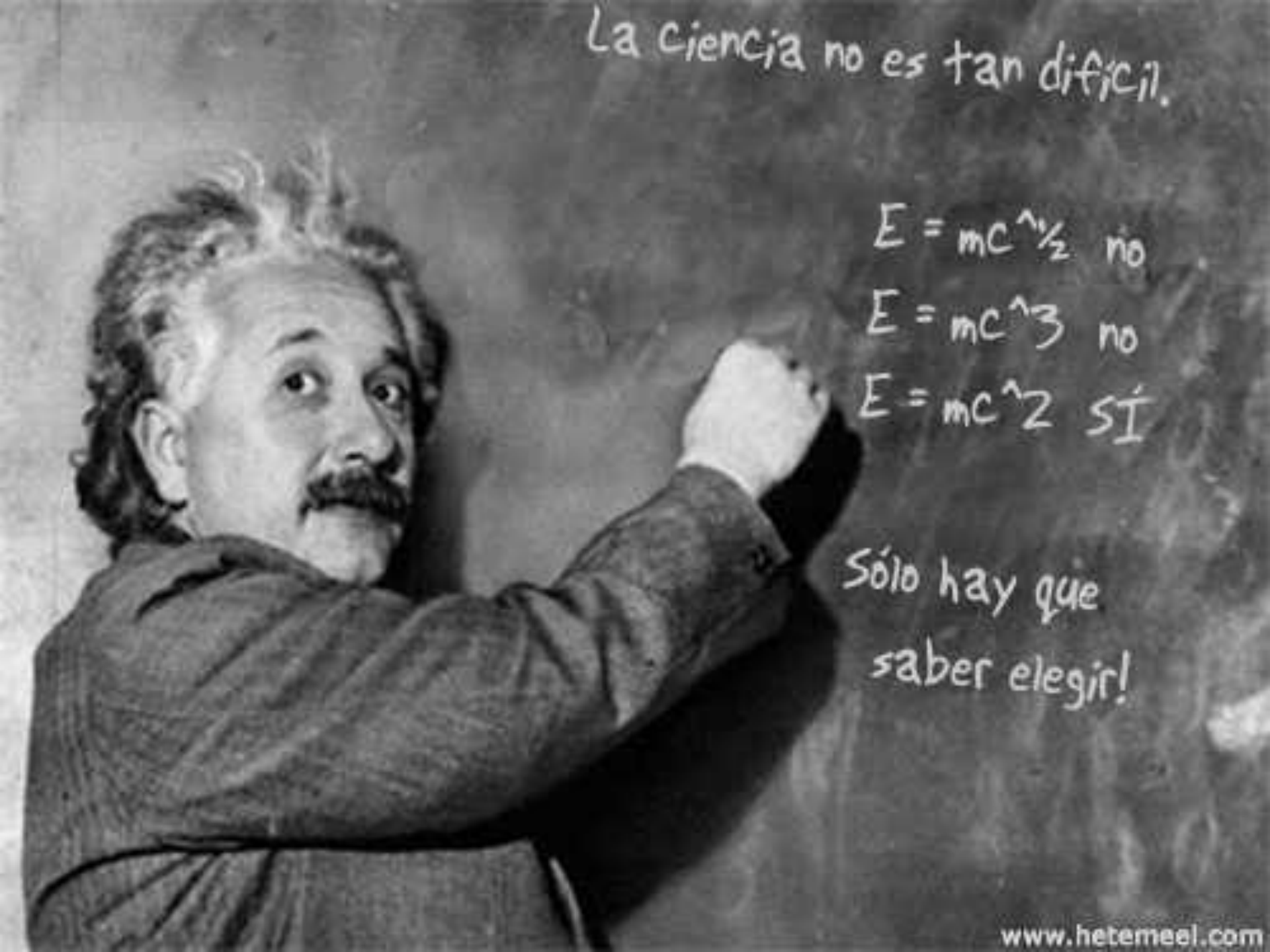
一座宏伟的宫殿，名叫《西班牙语词典》，身躯庞
学家说，如果摆在普通人家常见的那种一物多用
分之一的空间。在一个年代久远的写字台里曾经发
上面说，一家主人打算把它搁在书架上，结果是滑
下住，眼看就要塌陷，危及书架上所有的东西。宫殿
似的两个硬壳，外面包裹着绘有碧绿条纹的牛
皮做的，一行烫金的标题赫然向今人和后世宣告这
和功用。
里面，就身陷一座令人茫然失措的迷宫，与克里特这
面纸墙充当隔断，都标着称作页码的符号。每个隔
的走廊或过道，其中密密麻麻布满了数不清的小
生灵在这座广厦里安家落户。这些生灵就是人们所

* * *

清晨，突然响起一片聒噪，又是顿足跺脚，又是刀
玉，大呼小叫，驴吼马嘶，好像大队士兵正在匆忙
一场恶战。看来还真是要打仗了。不一会儿，差不多
典里跑了出来，手持明光铮亮的利器，很快摆成一
国立图书馆也容纳不下。那情景真是壮观得惊人！
老掉牙的《圣典选萃》后来告诉我的；它当时在附
近的隐蔽处看到了一切，结果成了唯一的目击者

¿Es tan difícil la ciencia?



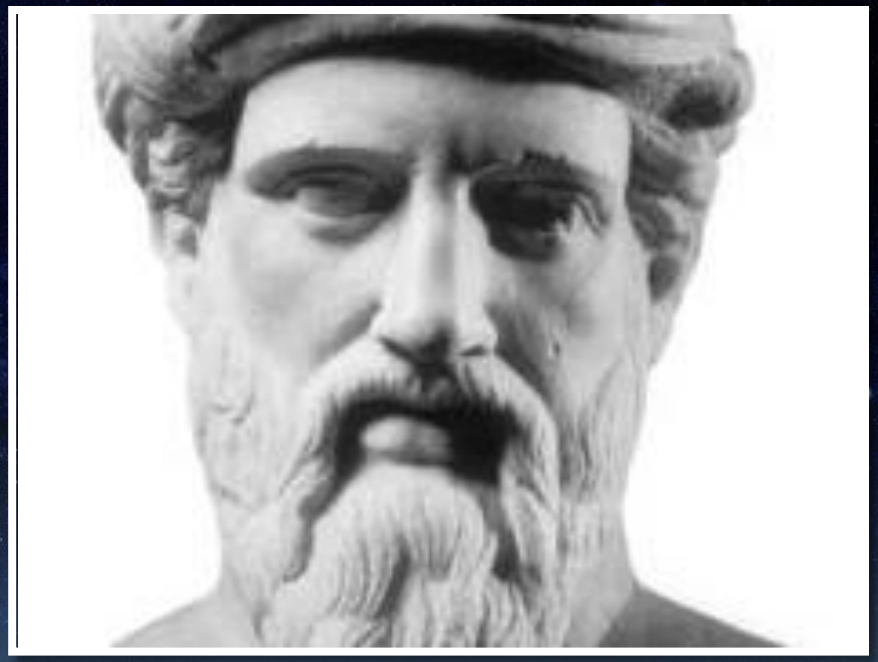

La ciencia no es tan difícil.
E = mc^½ no
E = mc^3 no
E = mc^2 SÍ
Sólo hay que saber elegir!
www.hetemeel.com

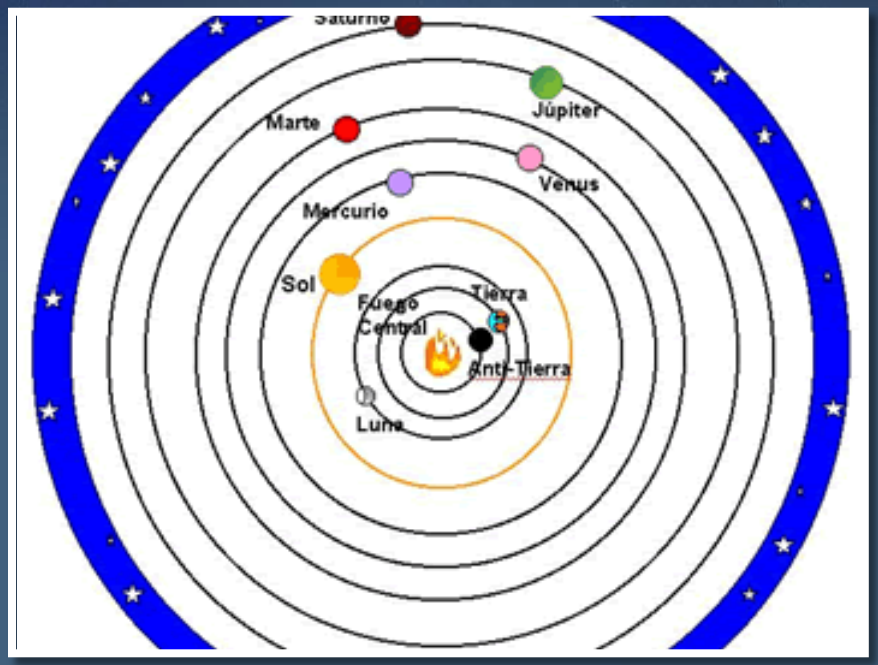
Aurora boreal en Islandia

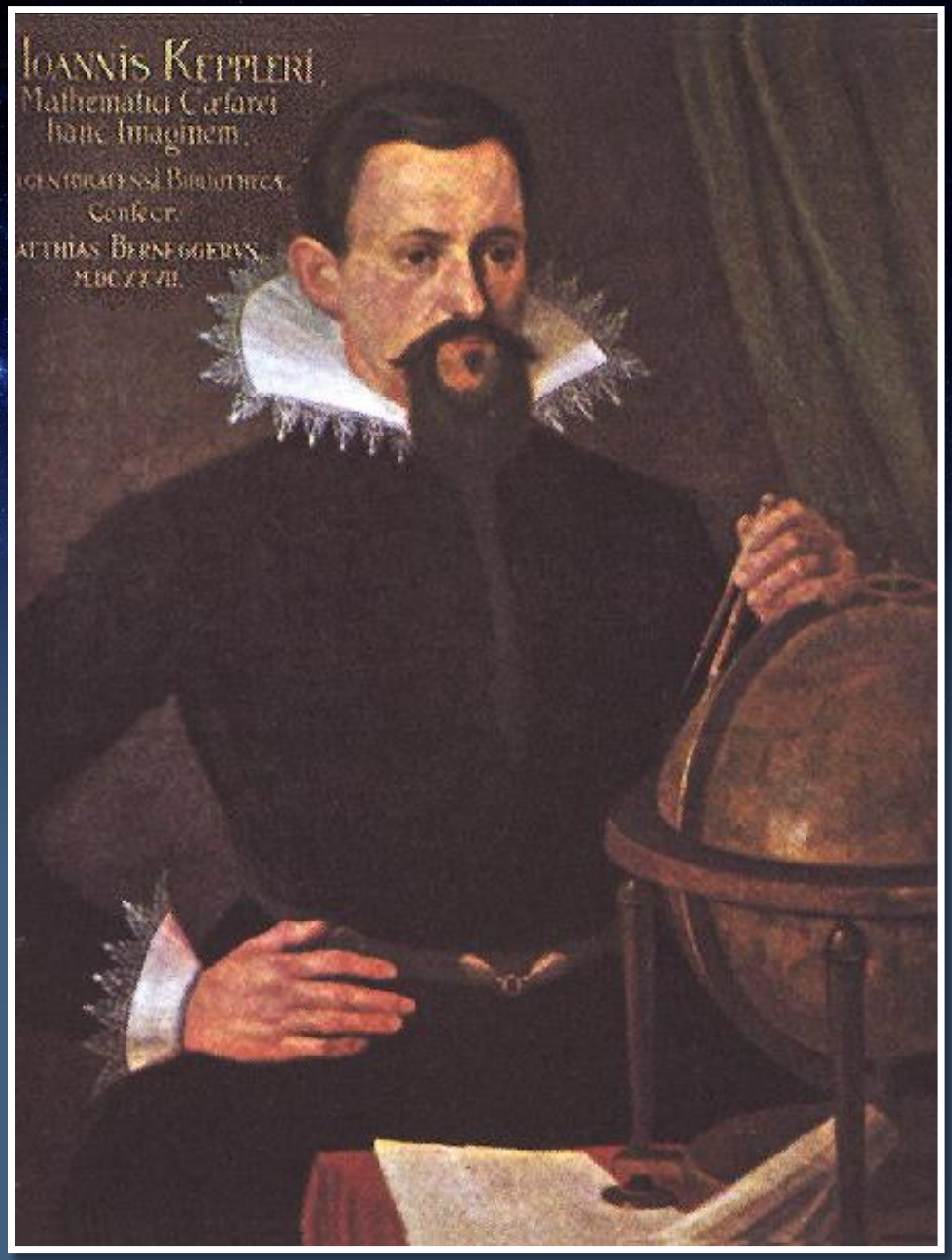
Pitágoras

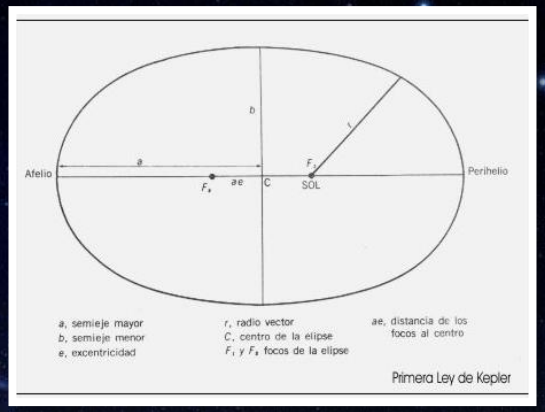
(S. VI AC, Samos 582 AC)

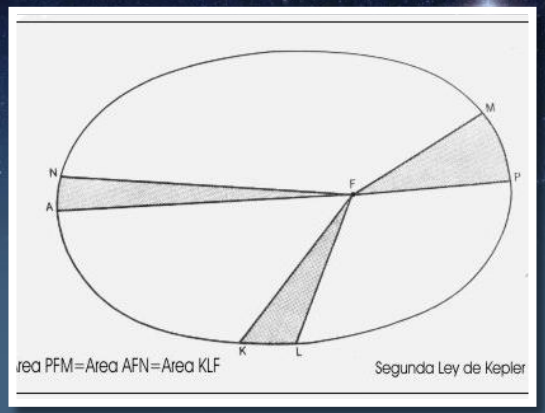
- Armonía de las esferas
  - Matemáticas
  - Astronomía
  - Música
- Cada esfera emite un tono musical











$$\frac{P_1^2}{P_2^2} = \frac{a_1^3}{a_2^3}$$

Ioannis Keppleri

HARMONICES MVNDI

LIBRI V. QVORVM

Primus GEOMETRICVS, De Figurarum Regularium, quæ Proportiones Harmonicas conſtituunt, ortu & demonſtrationibus.

Secundus ARCHITECTONICVS, ſeu ex GEOMETRIA FIGVRATA, De Figurarum Regularium Congruentia in plano vel ſolido:

Tertius propriè HARMONICVS, De Proportionum Harmonicarum ortu ex Figuris; deque Naturâ & Differentiis rerum ad cantum pertinentium, contra Veteres:

Quartus METAPHYSICVS, PSYCHOLOGICVS & ASTROLOGICVS, De Harmoniarum mentali Eſſentiâ earumque generibus in Mundo; præſertim de Harmonia radiorum, ex corporibus cœleſtibus in Terram deſcendentibus, eiuſque effectu in Natura ſeu Anima ſublunari & Humana:

Quintus ASTRONOMICVS & METAPHYSICVS, De Harmoniis abſolutiſſimis motuum cœleſtium, ortuque Eccentricitatum ex proportionibus Harmonicis.

Appendix habet comparationem huius Operis cum Harmonices Cl. Ptolemæi libro III. cumque Roberti de Fluctibus, dicti Flud Medici Oxonienſis ſpeculationibus Harmonicis, operi de Macrocoſmo & Microcoſmo inſertis.

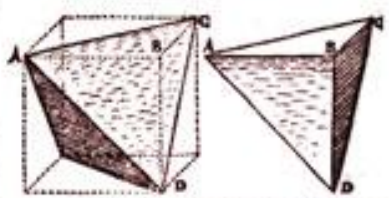
Cum S. C. M^tis. Priuilegio ad annos XV.

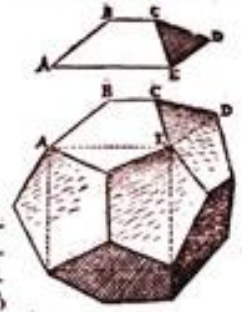
Lincii Auſtriæ,

Sumptibus GODOFREDI TAMPACHII Bibl. Francof.
Excudebat IOANNES PLANCVS.

ANNO M. DC. XIX.

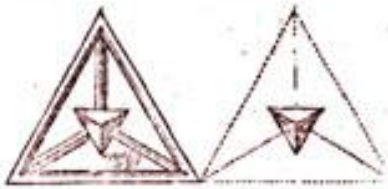
ędris irregularibus, quibus tegitur Cubus intus. Huic ſuccedit Icoſaē



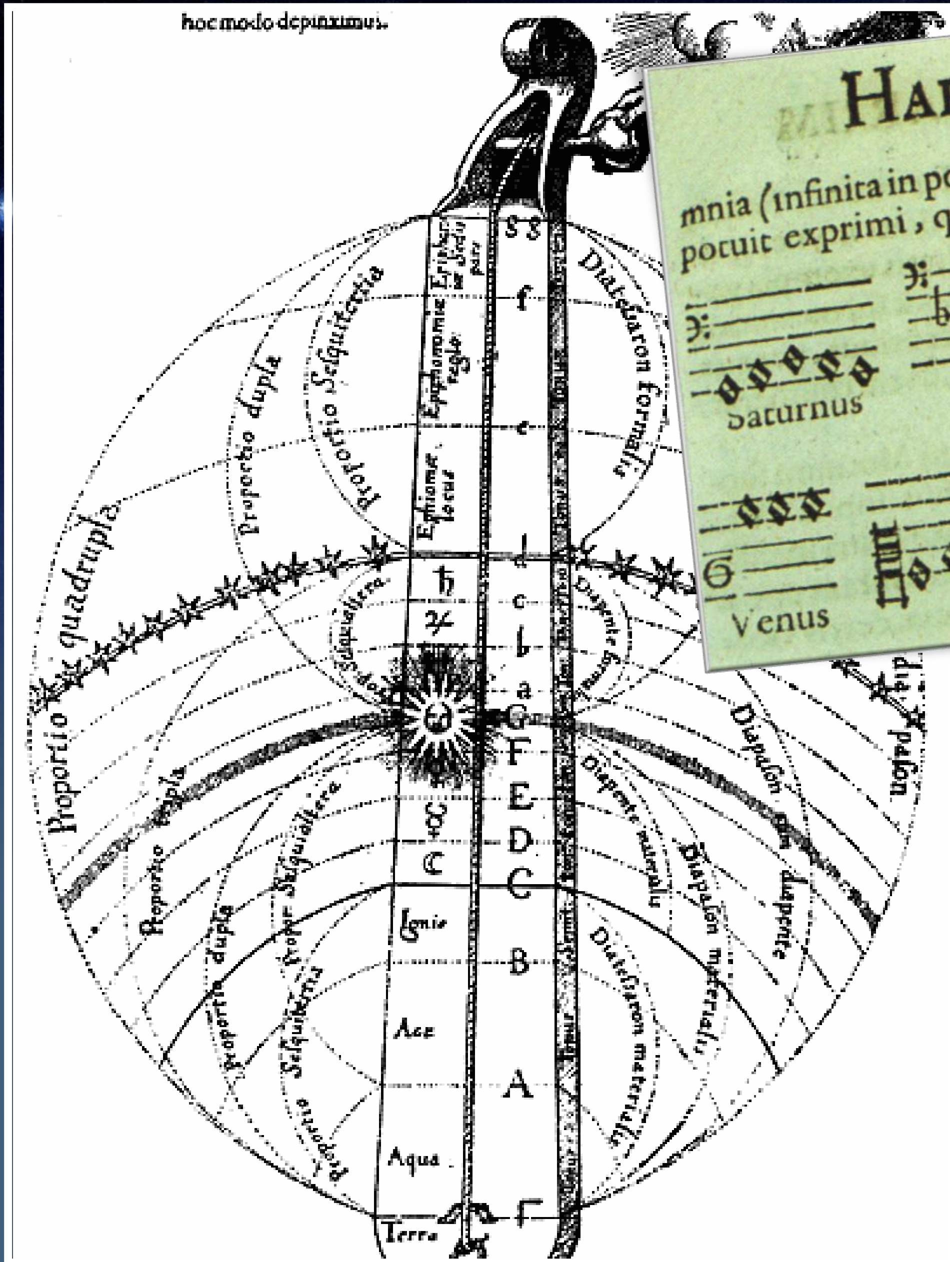


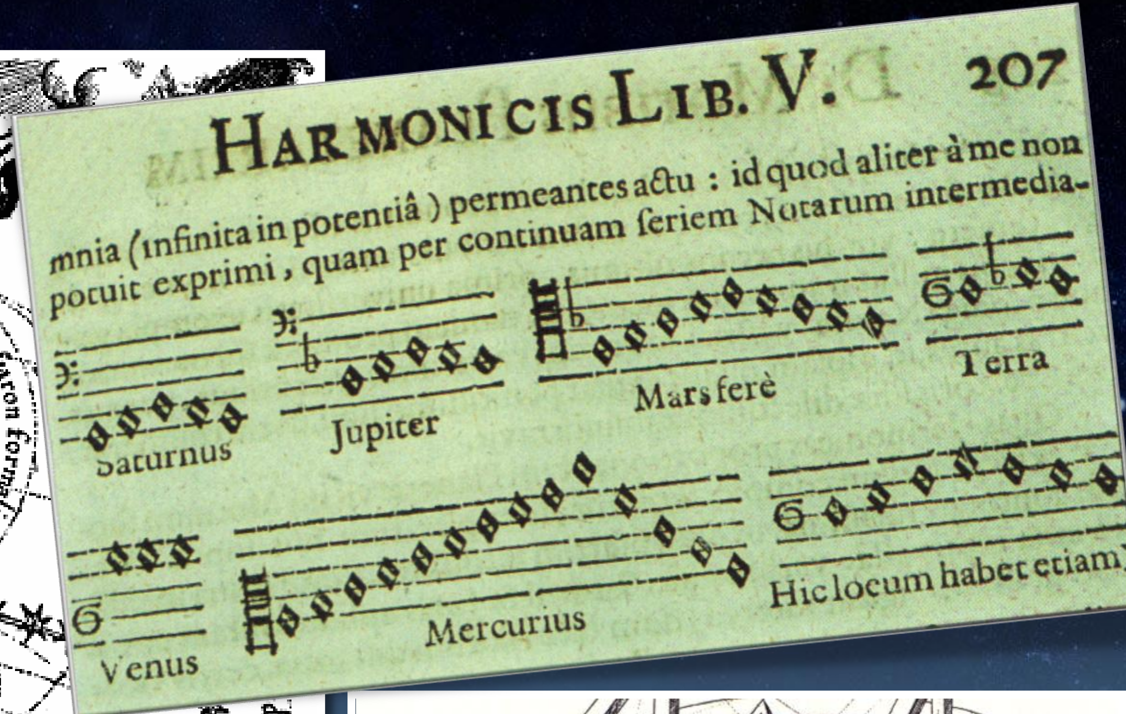
dron 4. ob ſimilitudinem, ultima ſecundariarum, angulo ſolido plurilineari utentium. Intimum eſt Octoēdron 5. Cubi ſimile, & prima figura ſecundariarum, cui ideò primus locus interiorum debetur, quippe inſcriptili; uti cubo circumſcriptili primus exteriorum.

Sunt autem notabilia duo veluti conjugia harum figurarum, ex



diverſis combinata claſſibus Ma
res, Cubus & Dodecaēdron ex
primarijs; fœminæ, Octoēdron
& Icoſiēdron ex ſecundarijs; qui.

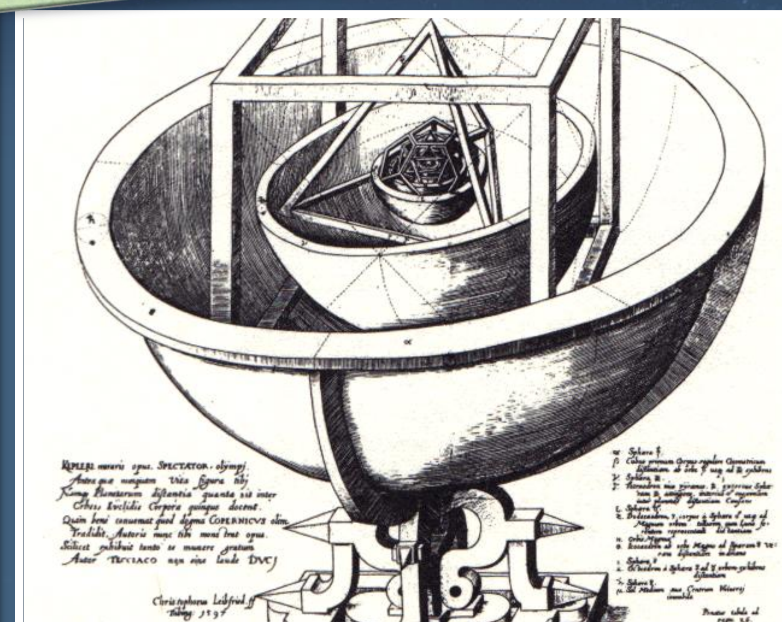


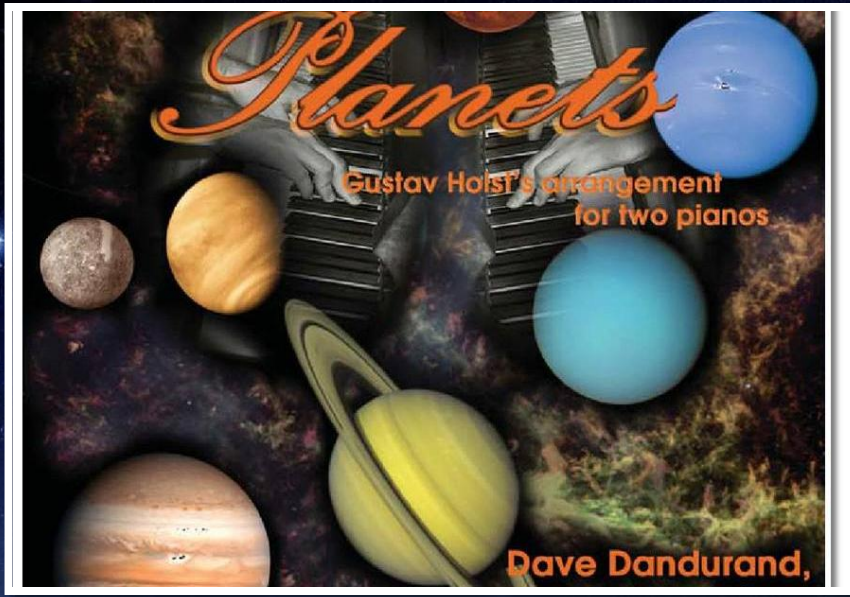

HARMONICIS LIB. V. 207

mnia (infinita in potentiâ) permeantes actu: id quod aliter à me non potuit exprimi, quam per continuam seriem Notarum intermedia-

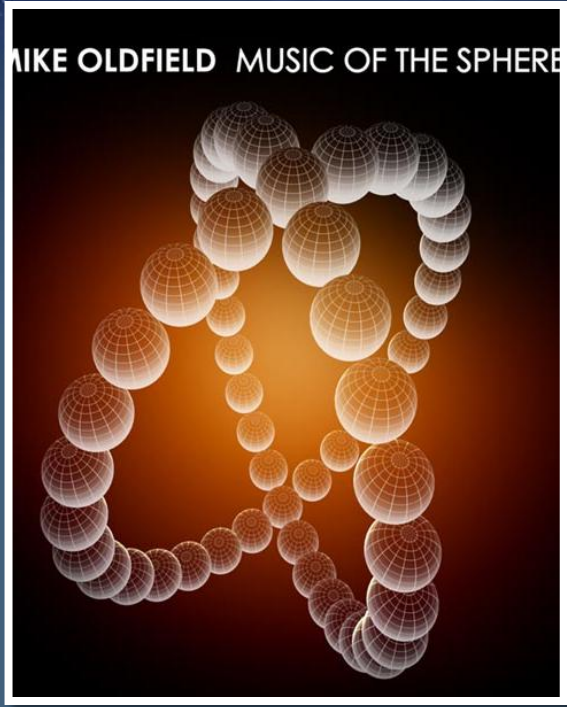
Saturnus | Jupiter | Mars ferè | Terra

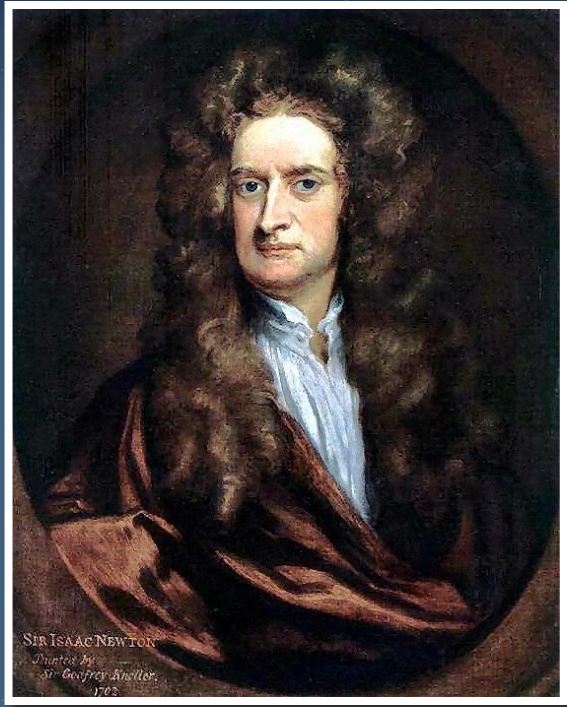
Venus | Mercurius | Hic locum habet etiam



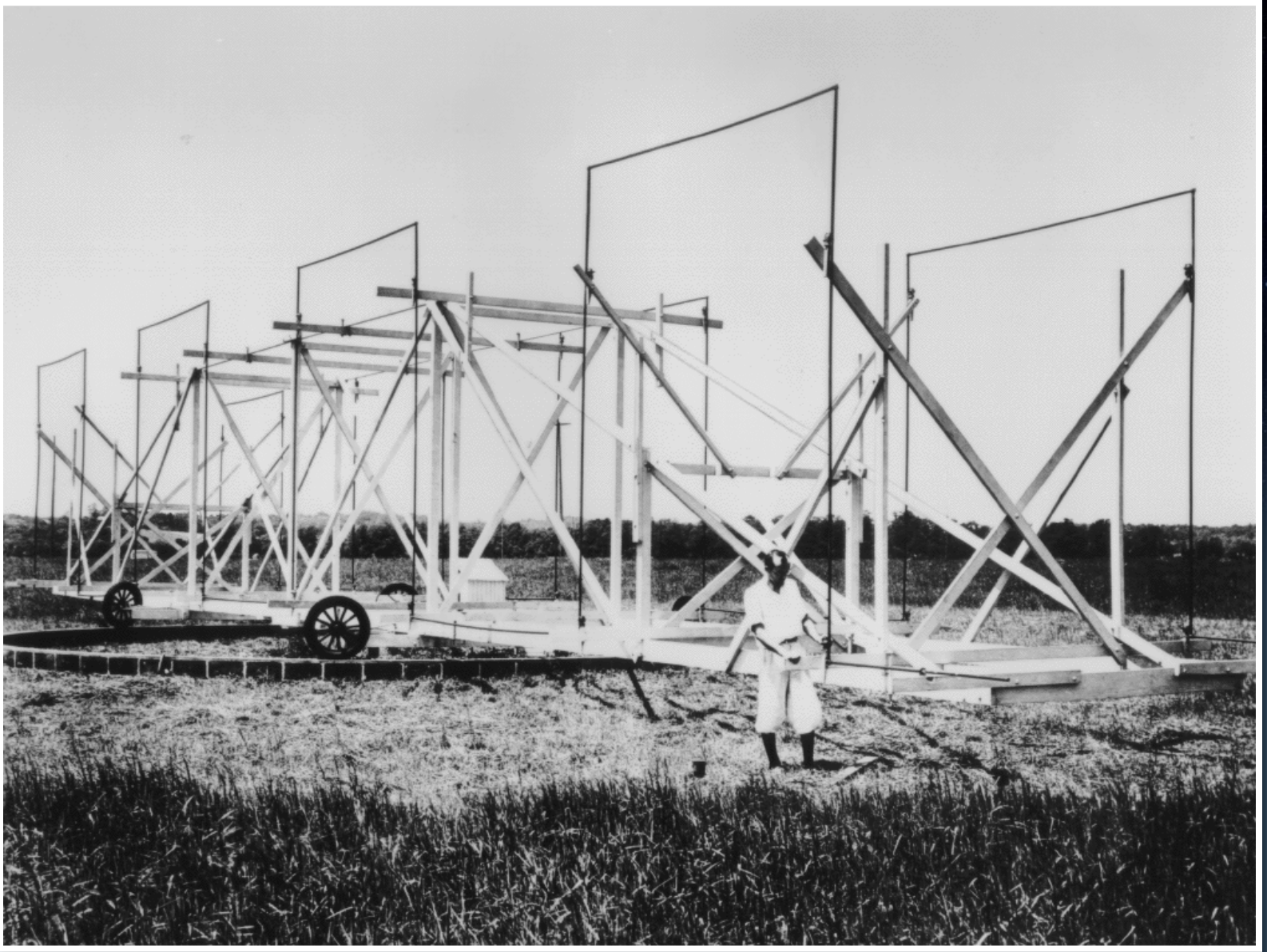

Planets
Gustav Holst's arrangement
for two pianos
Dave Dandurand,


2CD
Vangelis
COSMOS


IKE OLDFIELD MUSIC OF THE SPHERE

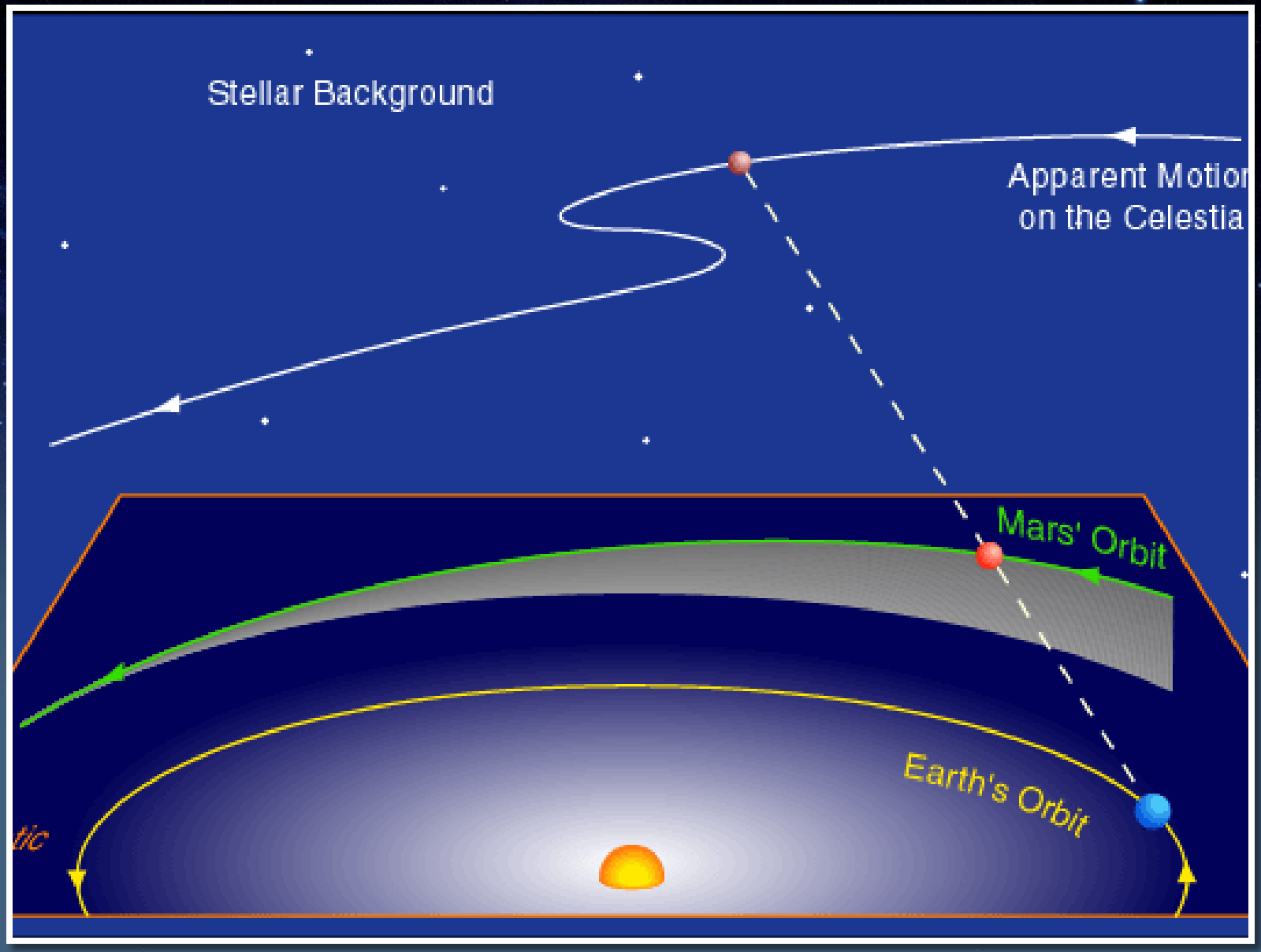

Sir Isaac Newton
Painted by
Sir Geoffrey Kneller.
1702


PianoM

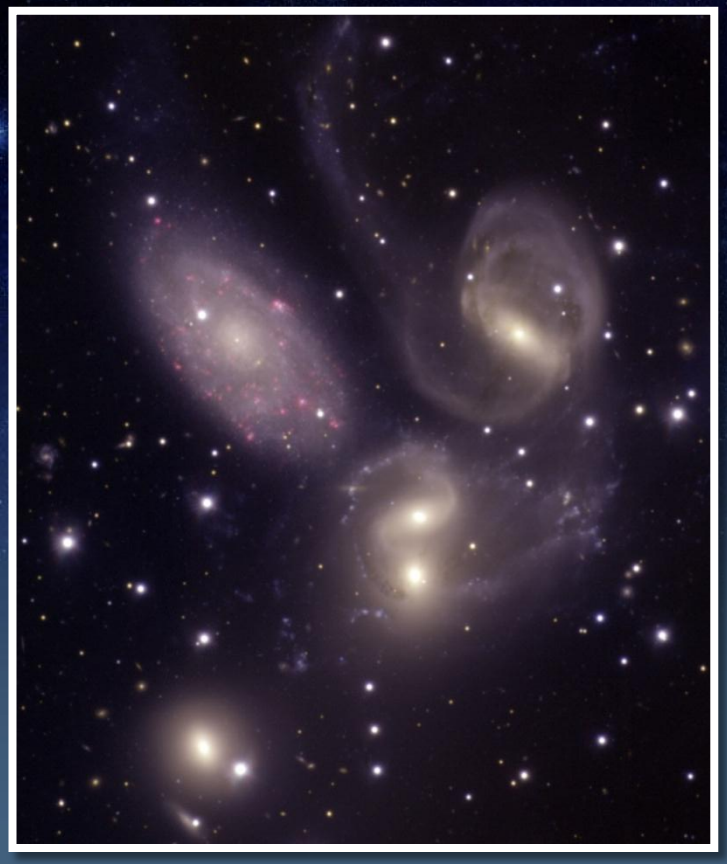


Karl Jansky, Laboratorios Bell (1932)

Primero en oír la Música de las Esferas



La danza de los planetas

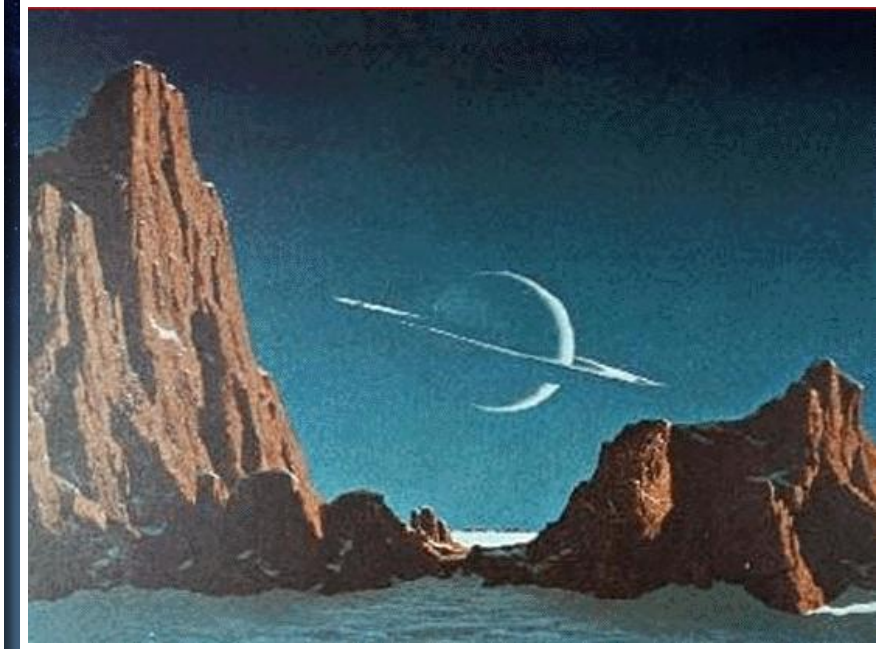


Quinteto de Stephan

Edgar Degas

Bailarinas azules (1890)

Rockaway Beach, California



Chesley Bonestell 1944

Saturn as seen from Titan

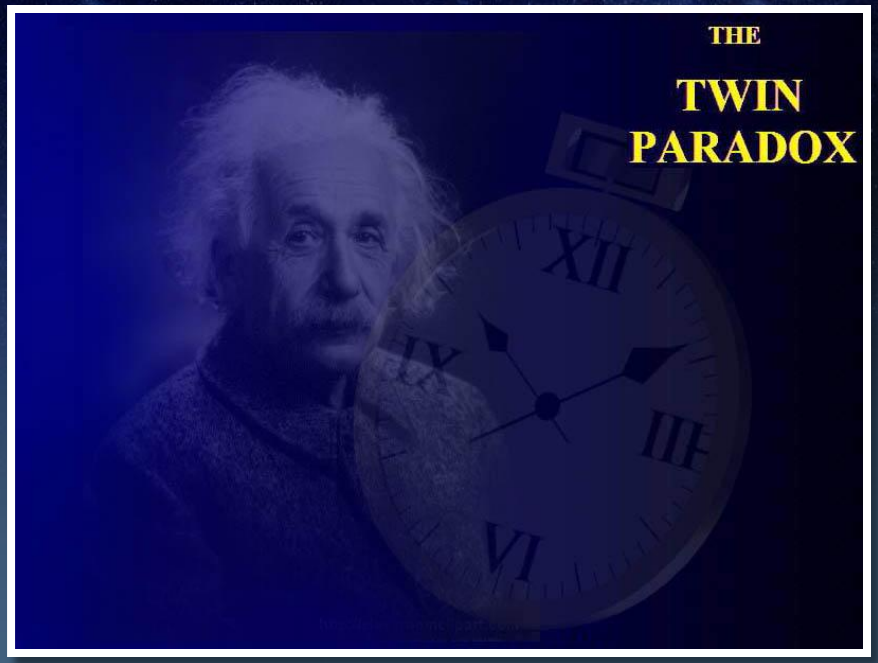
Nova Monocerotis 2002
V838 Monocerotis

Vincent van Gogh
De sterrennacht (1889)
Museum of Modern Art, New York

Gran Mancha Roja en Júpiter

Sheila Szabototh

Jupiter's Red Spot Jr. (2007)



Einstein

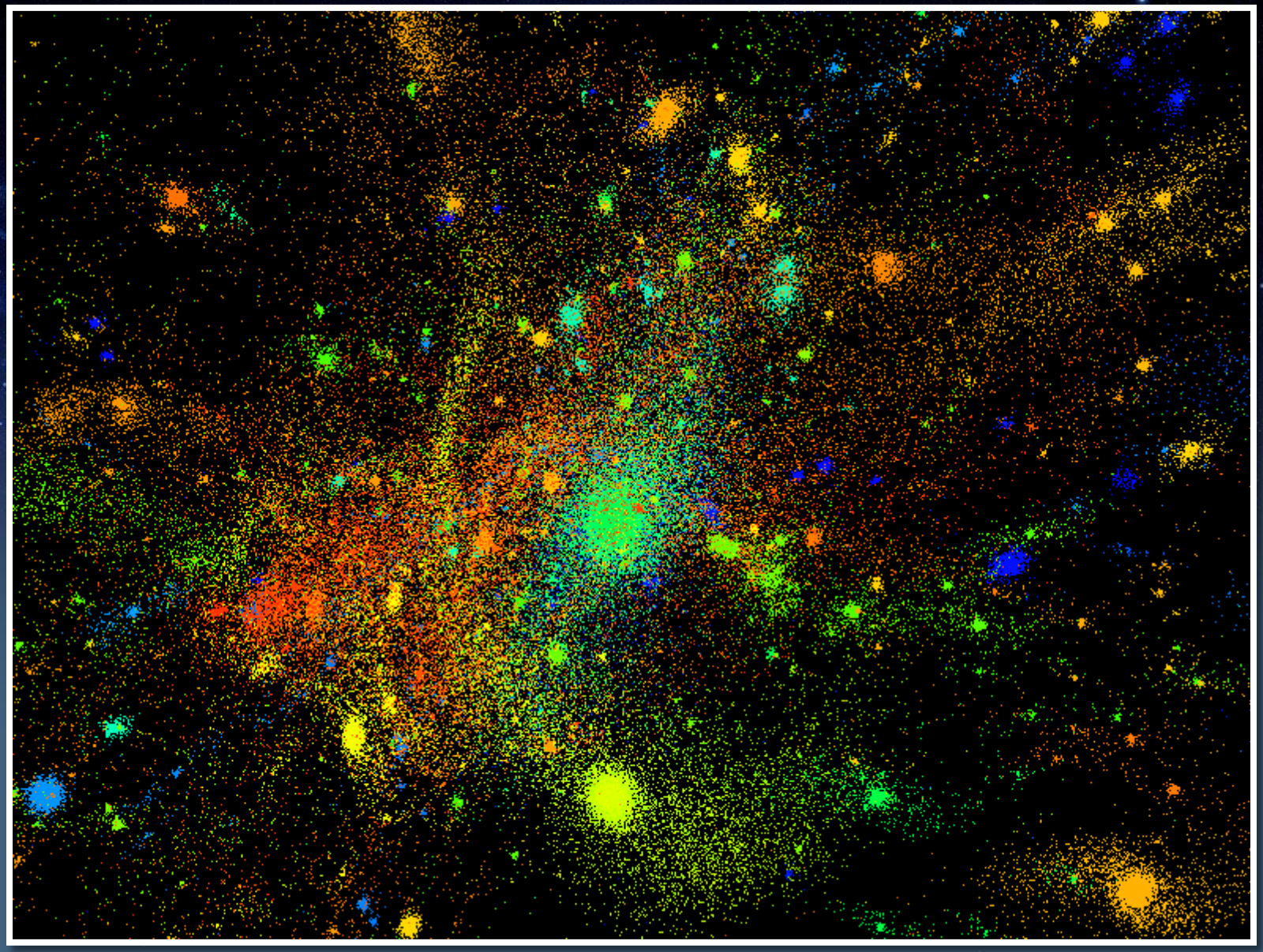
Teoría de la Relatividad (1905-1916)

- La relatividad del tiempo
- La paradoja de los gemelos

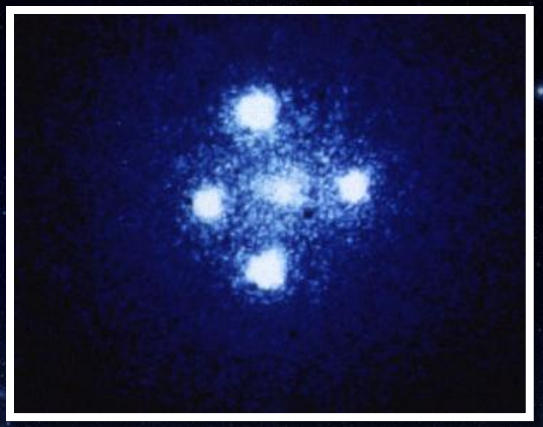
Salvador Dalí

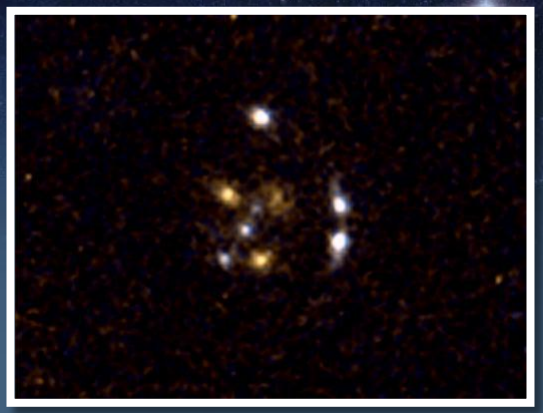
La persistencia de la memoria (1931)

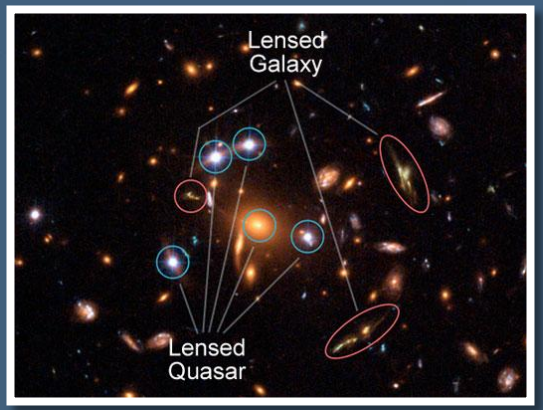
Wassily Kandinsky – Composition 10



Octavio Valenzuela – Halo de una galaxia

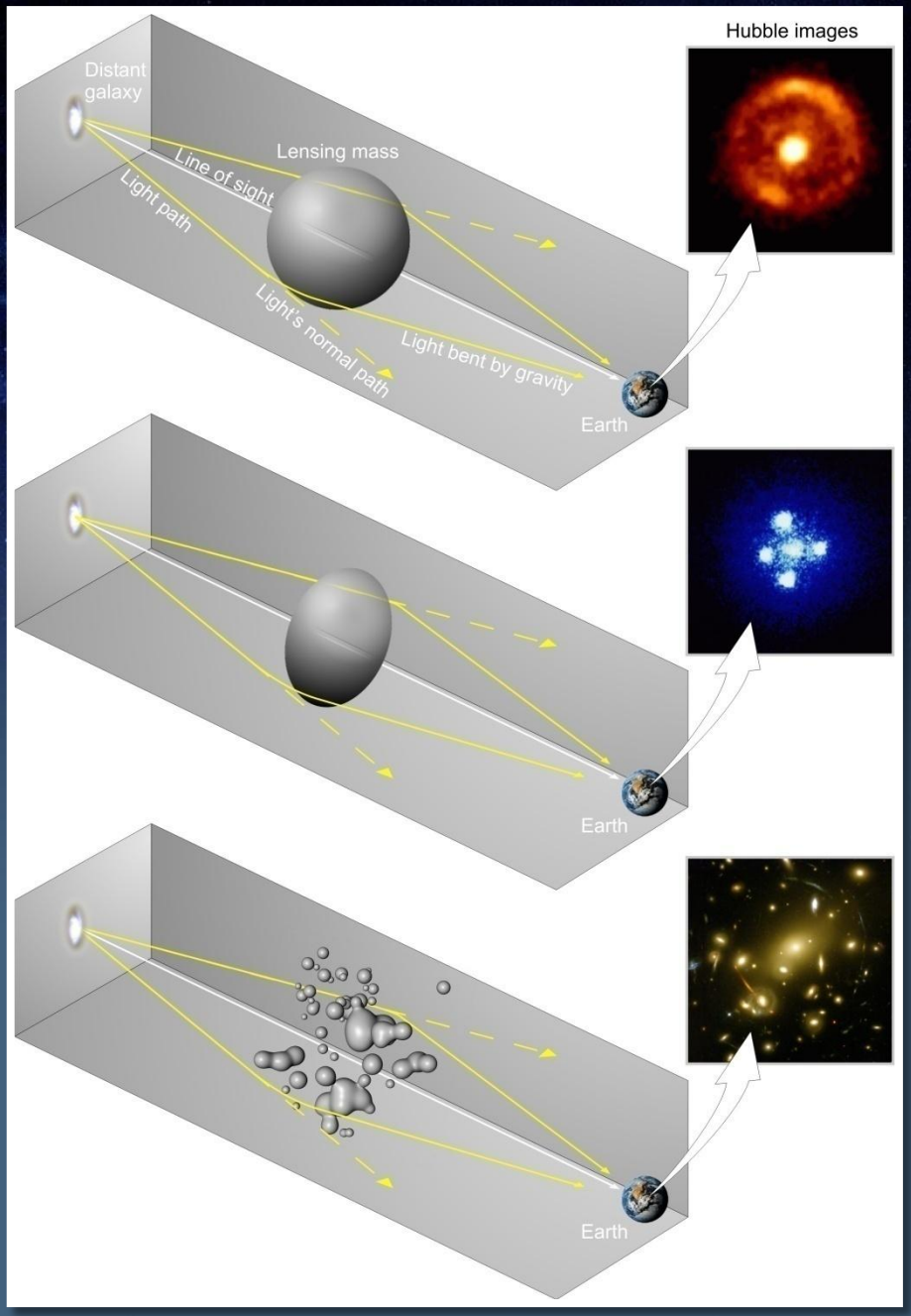




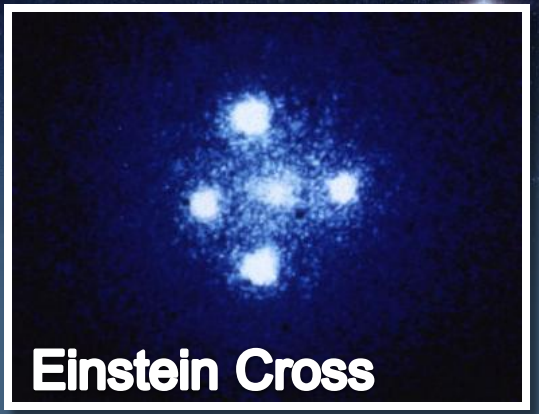

Lensed
Galaxy
Lensed
Quasar

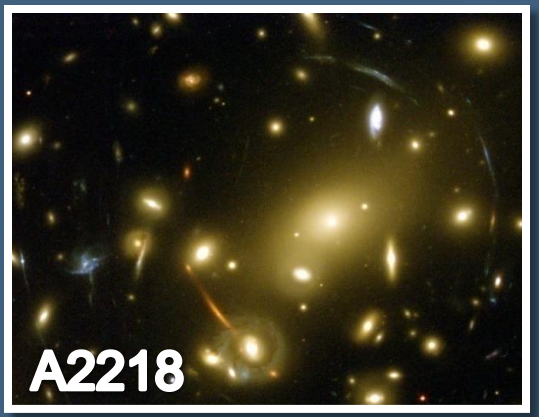
2. LOS LENTES GRAVITATORIOS

¿Qué son y cuál es su importancia?


Hubble images
Distant galaxy
Lensing mass
Line of sight
Light path
Light's normal path
Light bent by gravity
Earth
Earth
Earth


Q1938+666


Einstein Cross


A2218

SIMULACIÓN DE LENTE GRAVITATORIA

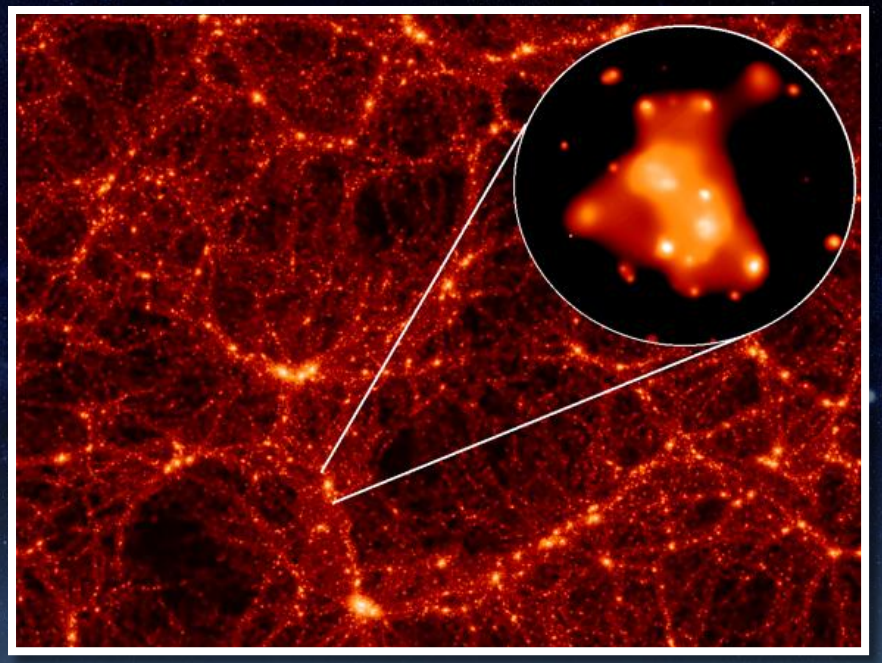
Lars Lindberg Christensen - ESA

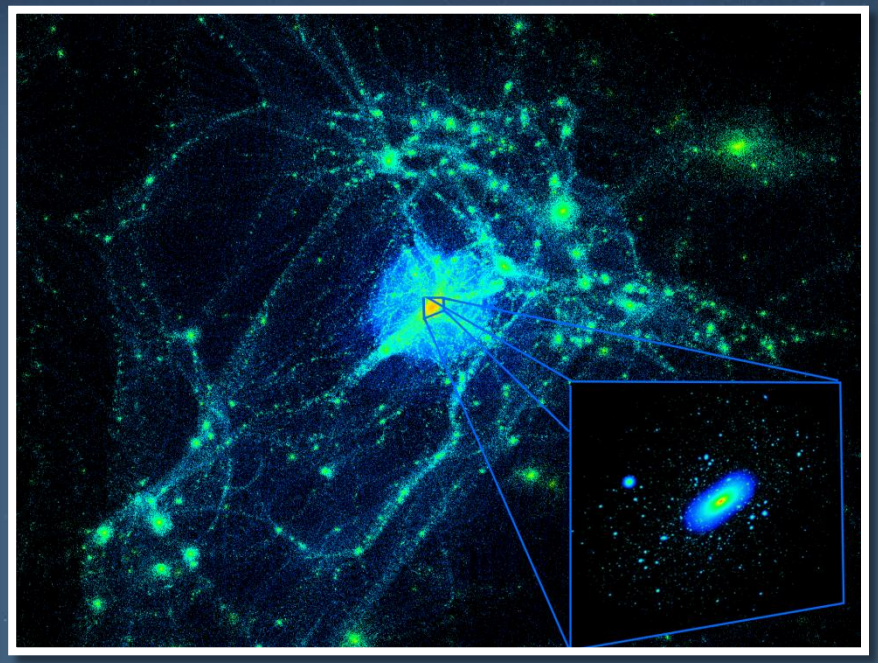
Cúmulo de galaxias Abell 2218

HST • WFPC2

NASA, A. Fruchter and the ERO Team (STScI, ST-ECF) • STScI-PRC00-08

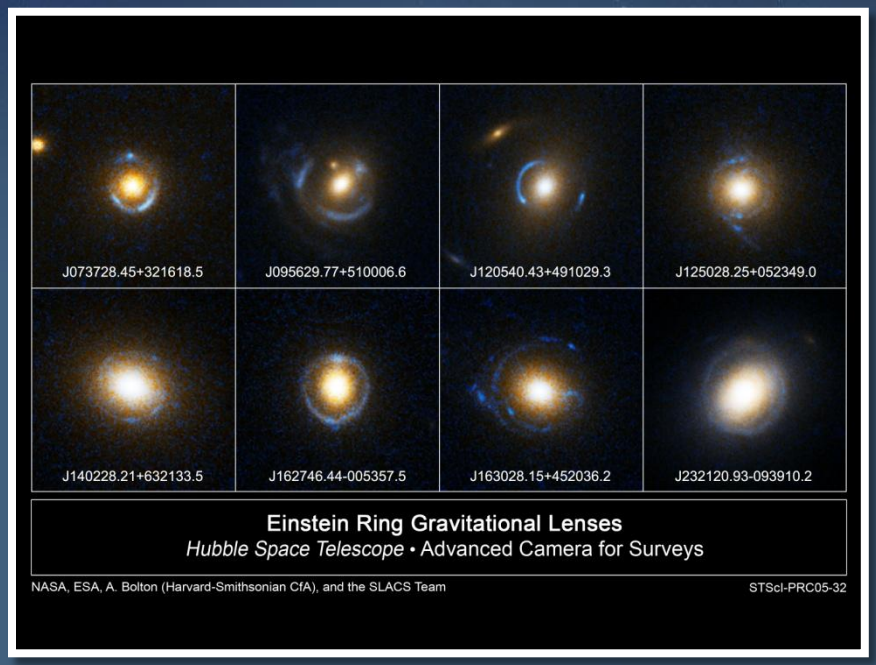
- U&R: XMM-Newton X-ray imagen de un cúmulo de galaxias real.
  - Virgo consortium; Jenkins et al.1998
- D&L: Distribución de materia oscura en un cúmulo de galaxias.
  - *Imagen de Andrey Kravtsov*
- D&R: Galaxia aislada

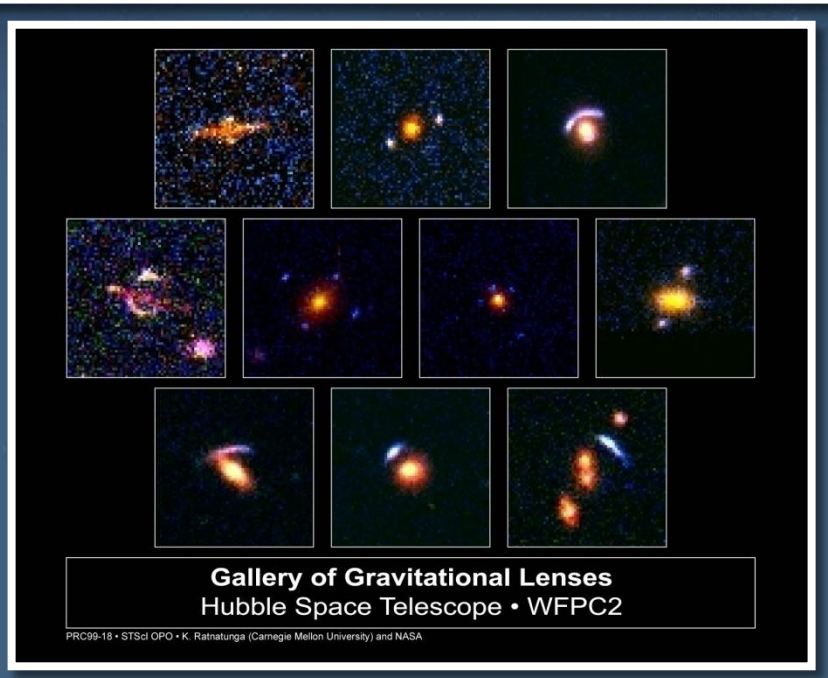




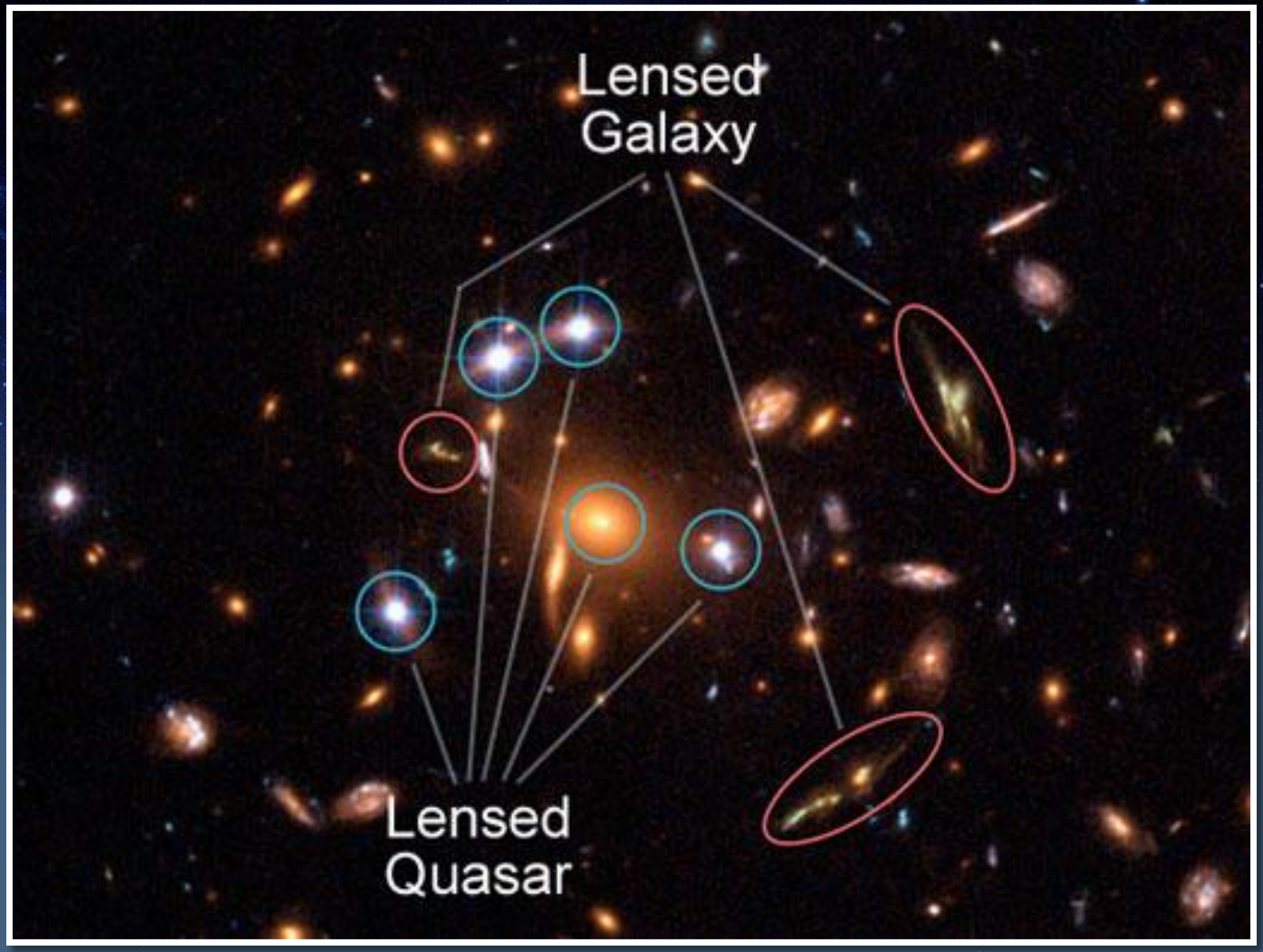
Cuásares lenteados

- U&R: Cruz de Einstein
- D&L: Anillos deEinstein
- D&R: Galería LG

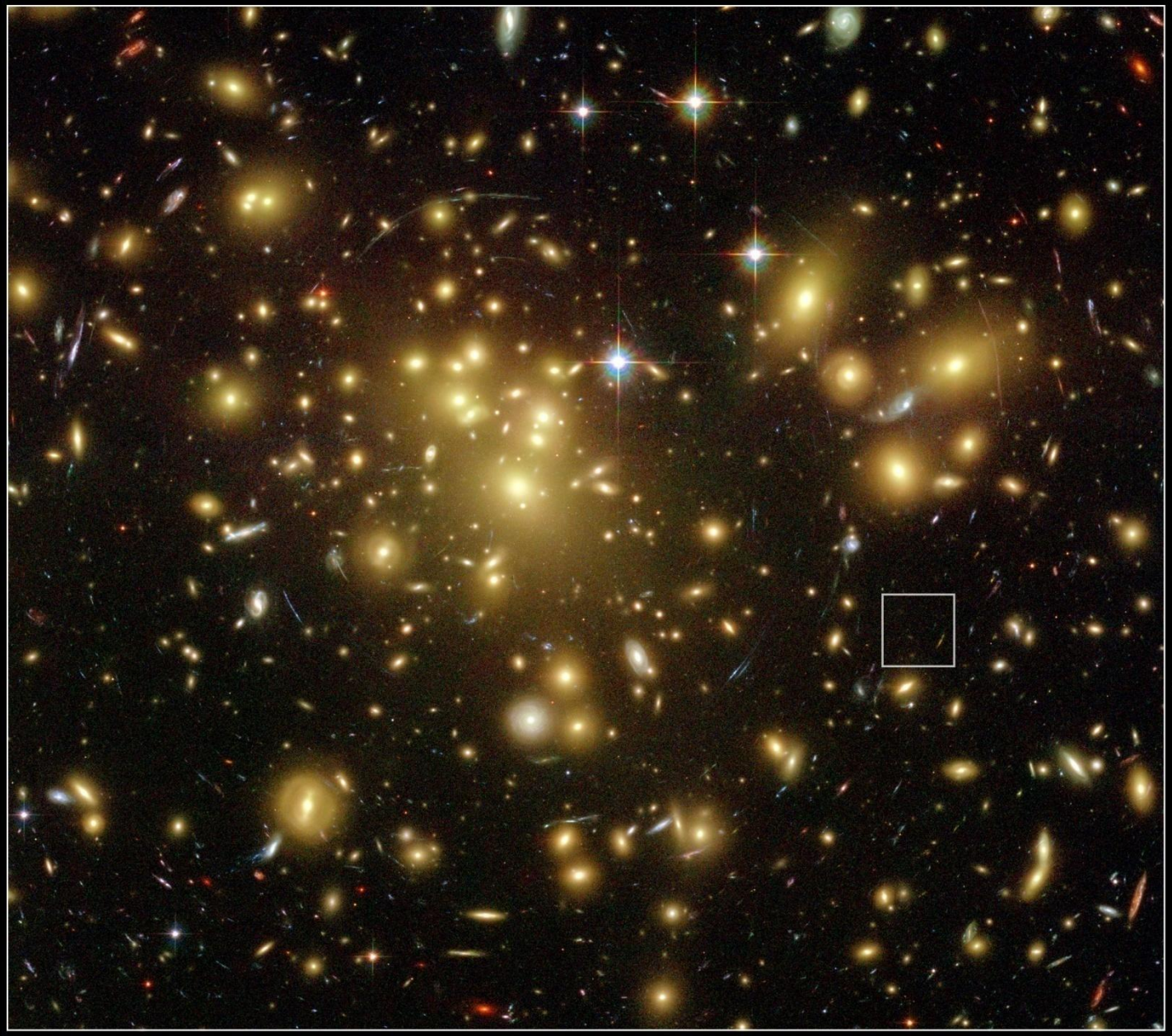


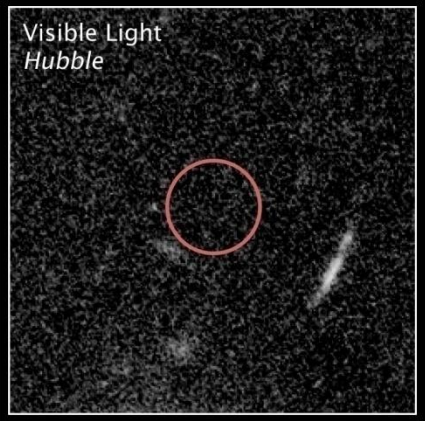


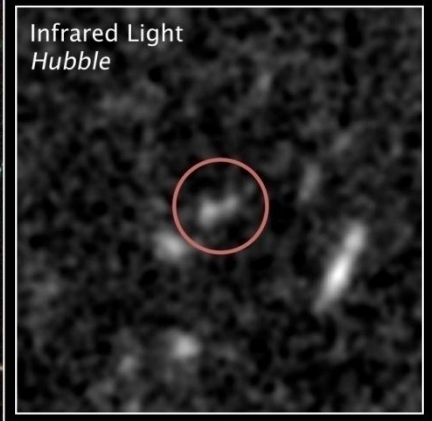
- Imágenes de un cuásar y su galaxia huésped

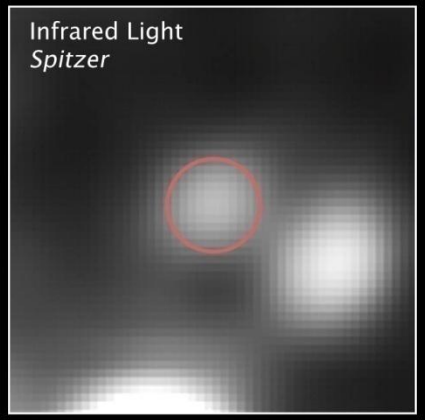


- Cuásar y galaxia huésped (detalle)

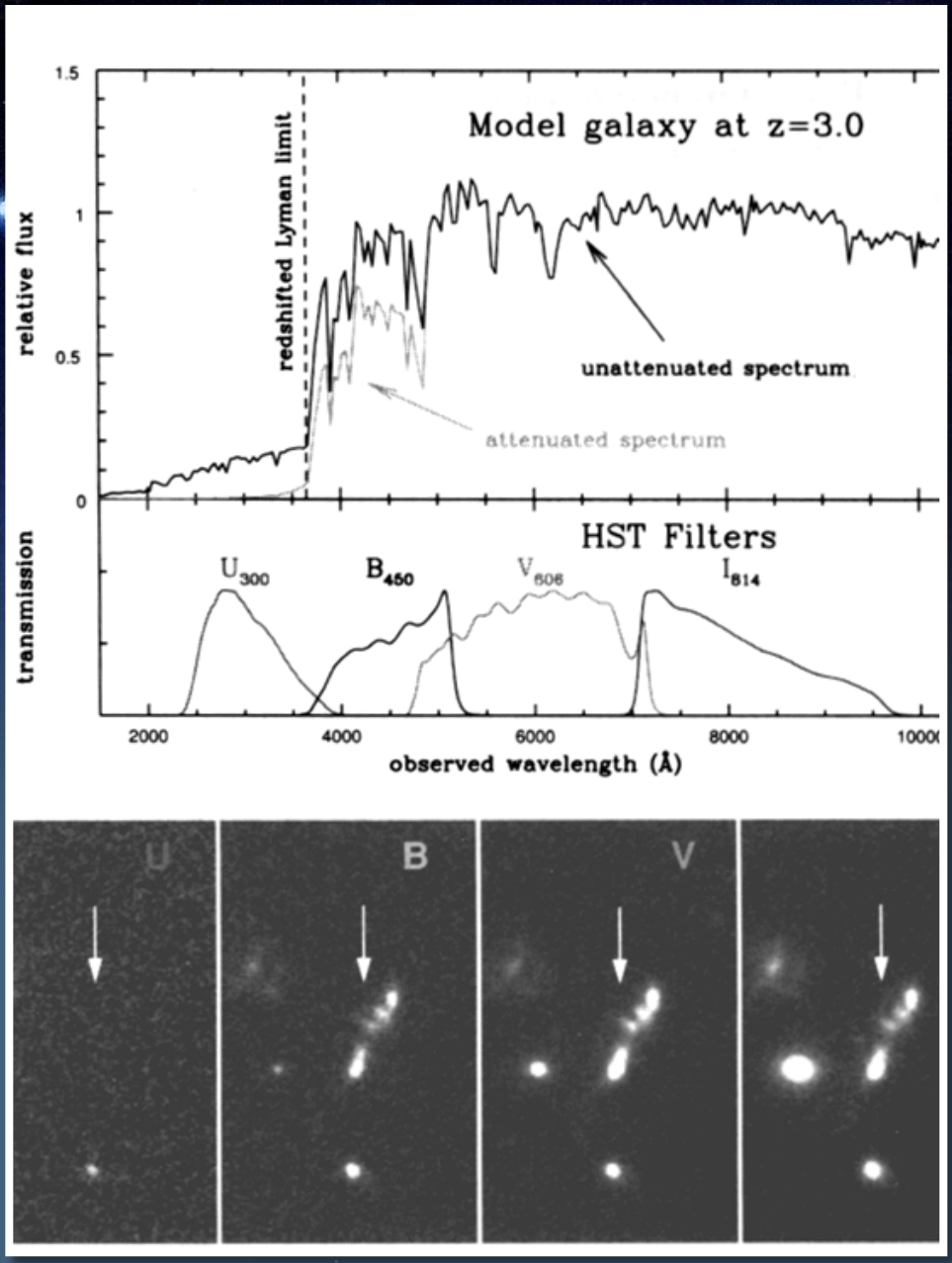


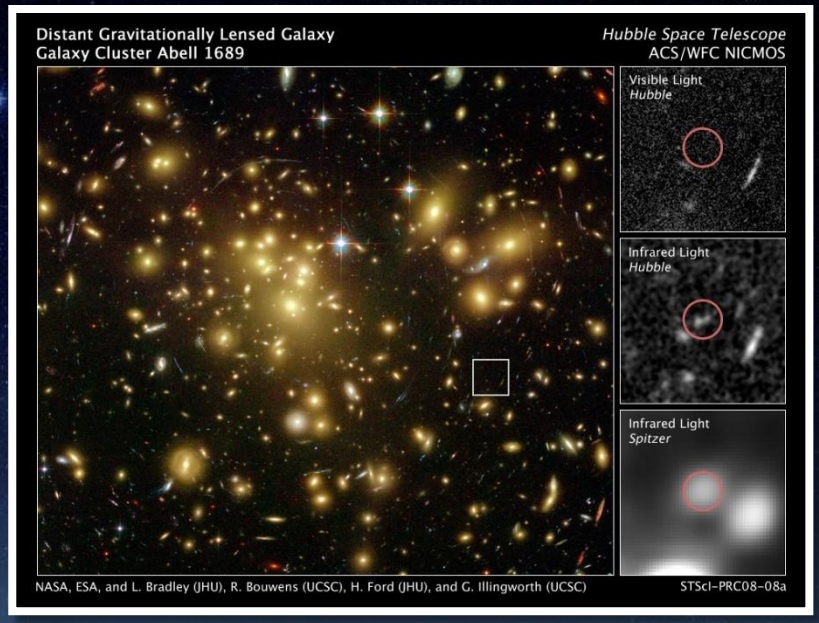




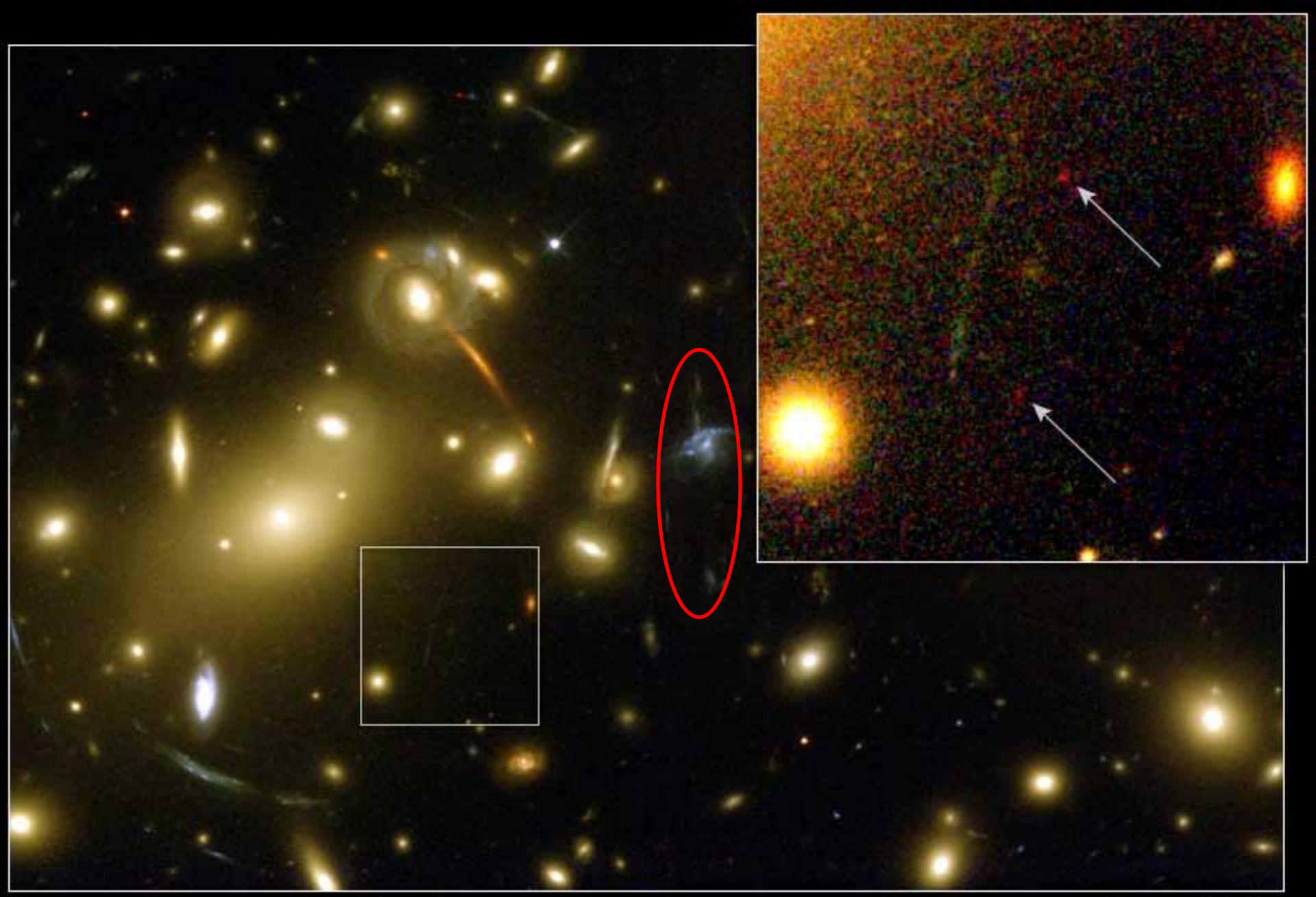


Distant Gravitationally Lensed Galaxy ▪ Galaxy Cluster Abell 1689
Hubble Space Telescope ▪ ACS/WFC NICMOS



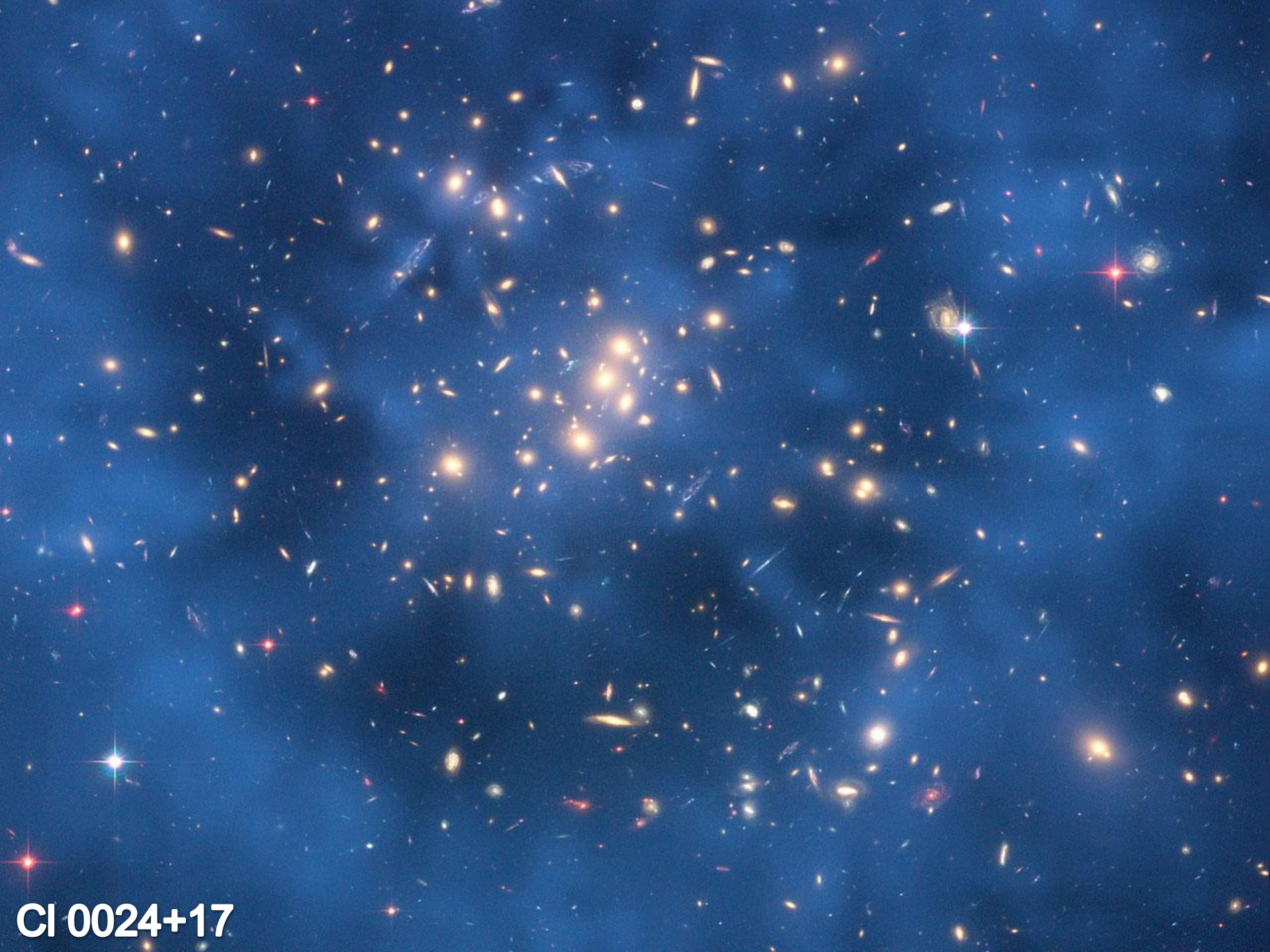


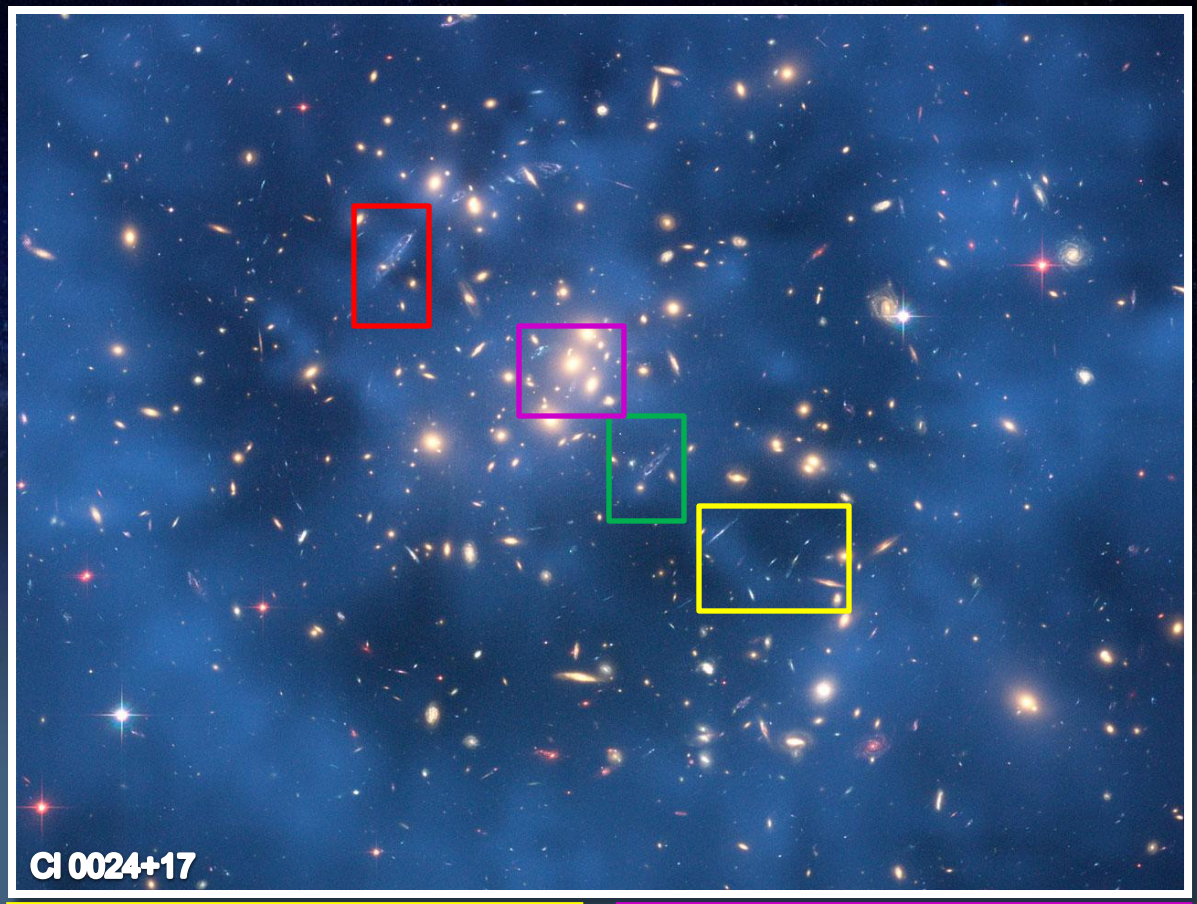
- Distancia al cúmulo
  - 2.2 mil millones a-l
  - 675 megaparsecs.
- Distancia a la galaxia
  - 12.8 mil millones a-l.

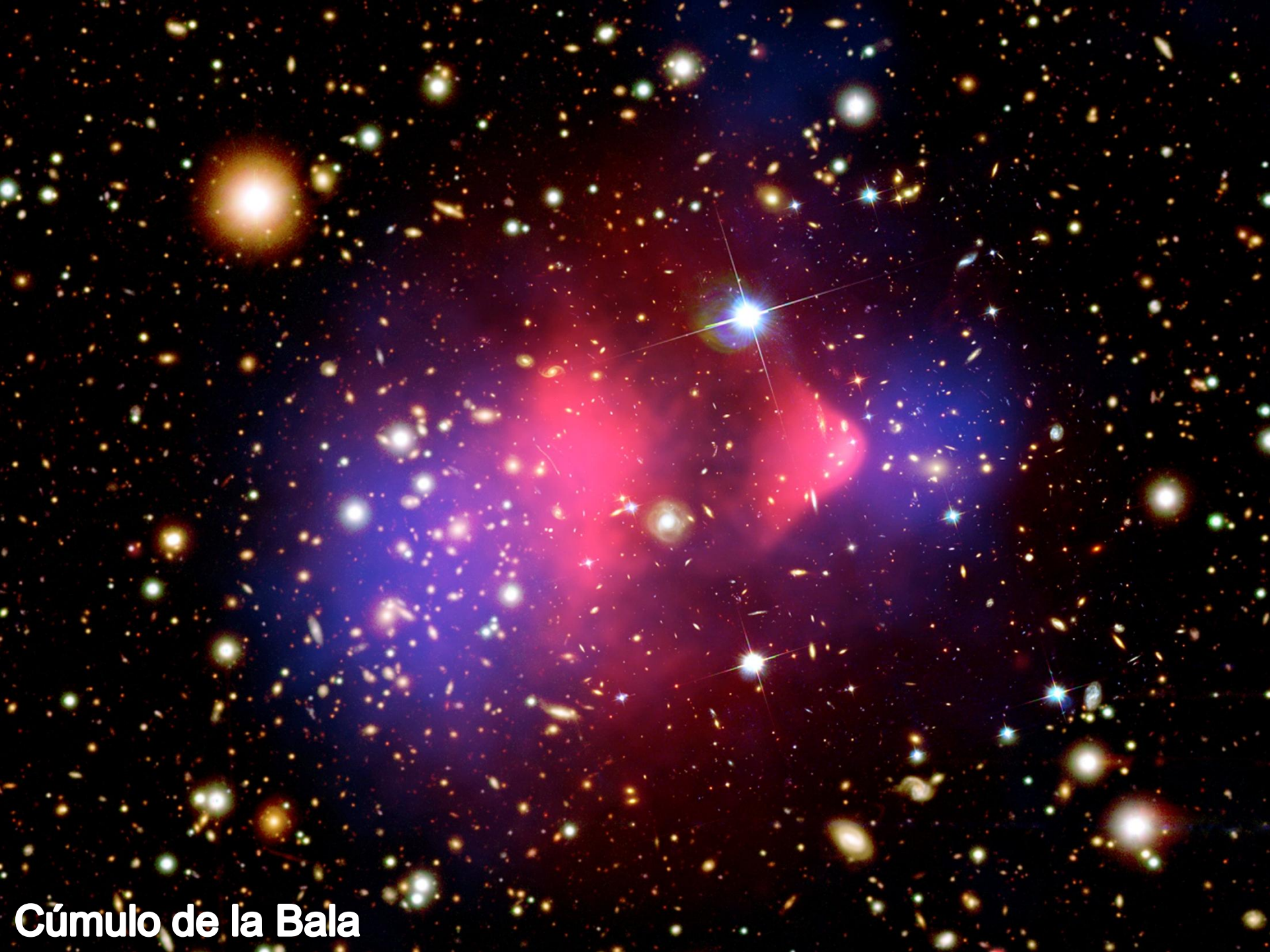


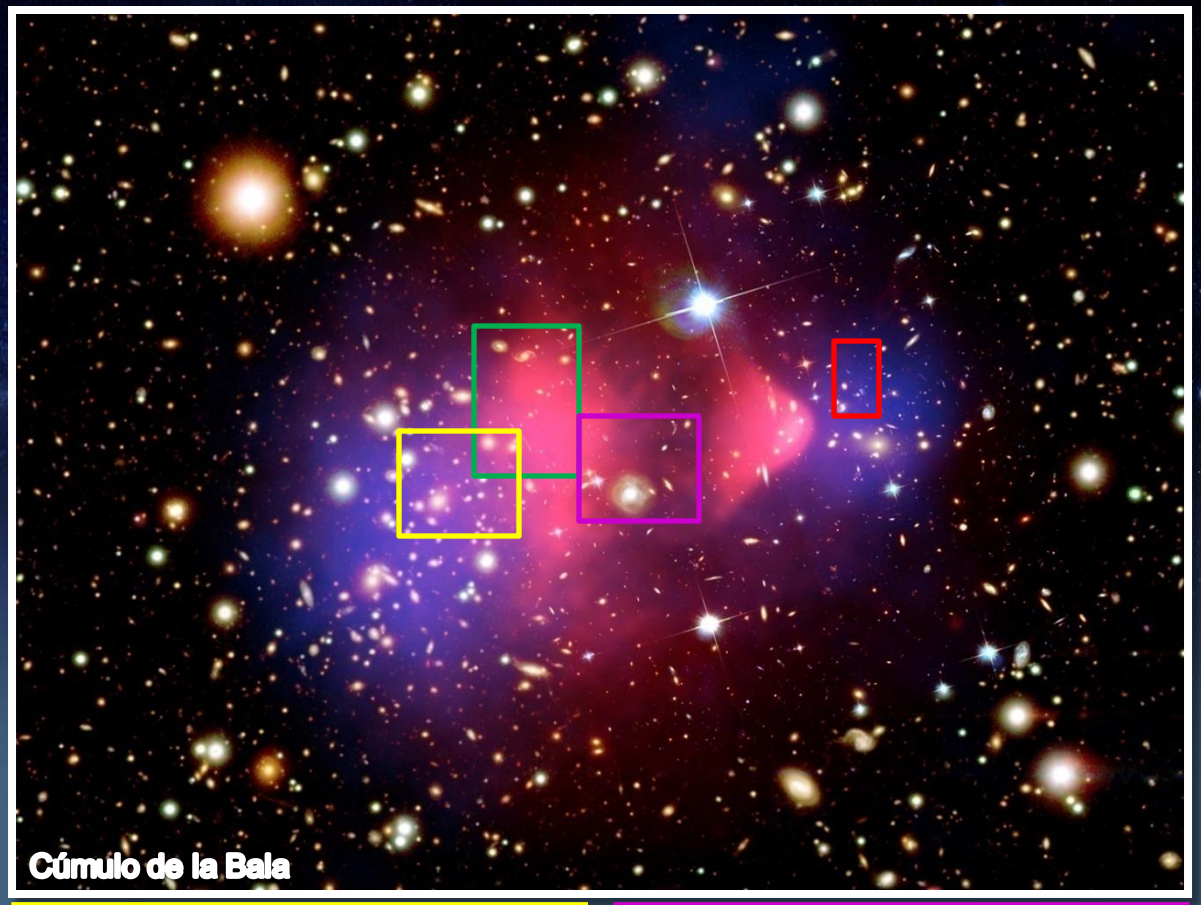
Distant Object Gravitationally Lensed by Galaxy Cluster Abell 2218 **HST** • WFPC2

NASA, ESA, R. Ellis (Caltech) and J.-P. Kneib (Observatoire Midi-Pyrenees) • STScI-PRC01-32

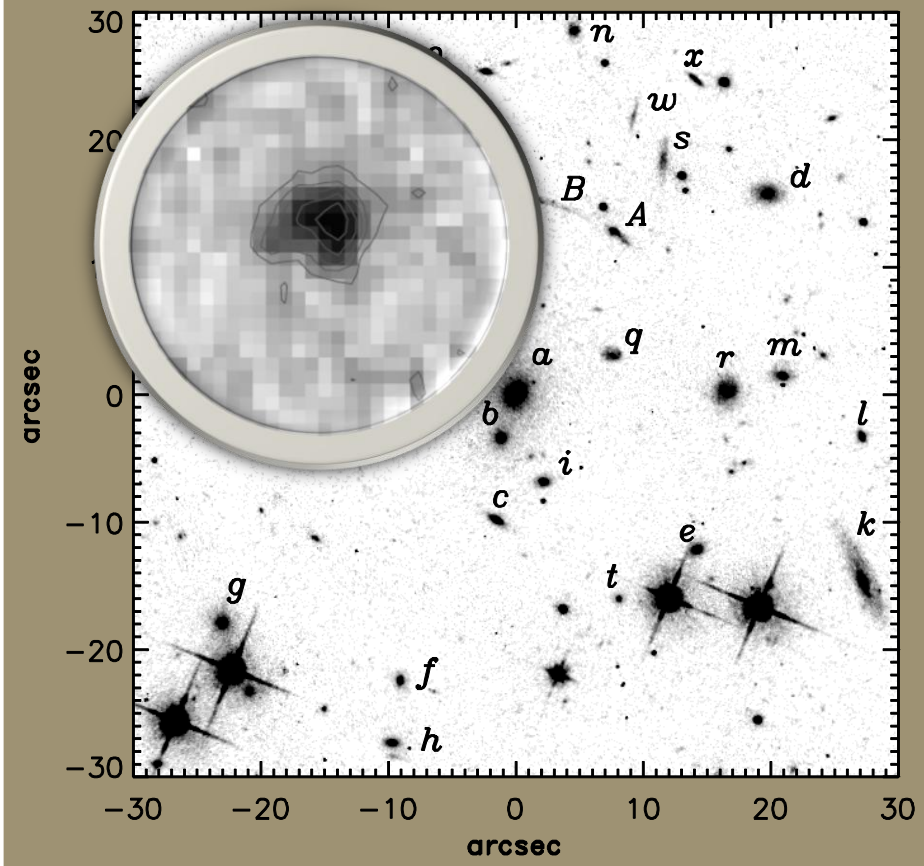

Cl 0024+17


Cl 0024+17

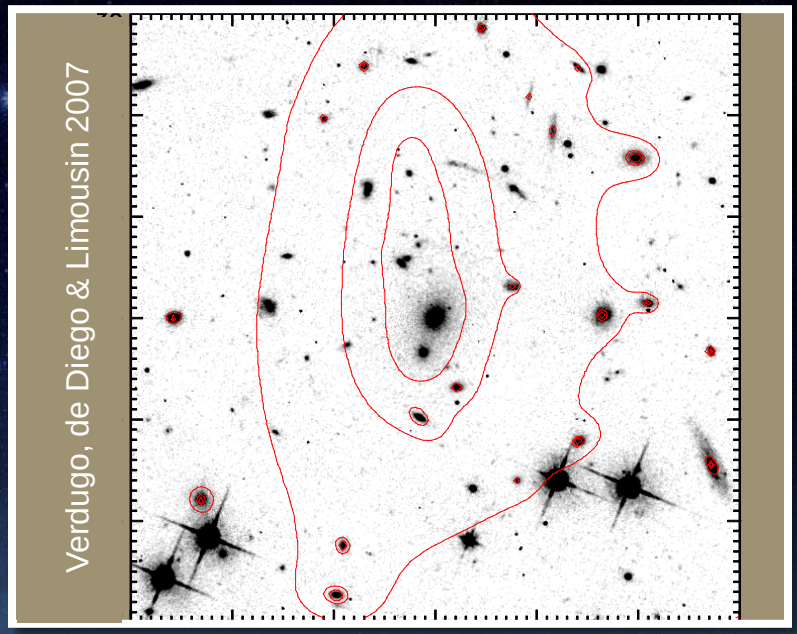

Cúmulo de la Bala


Cúmulo de la Bala

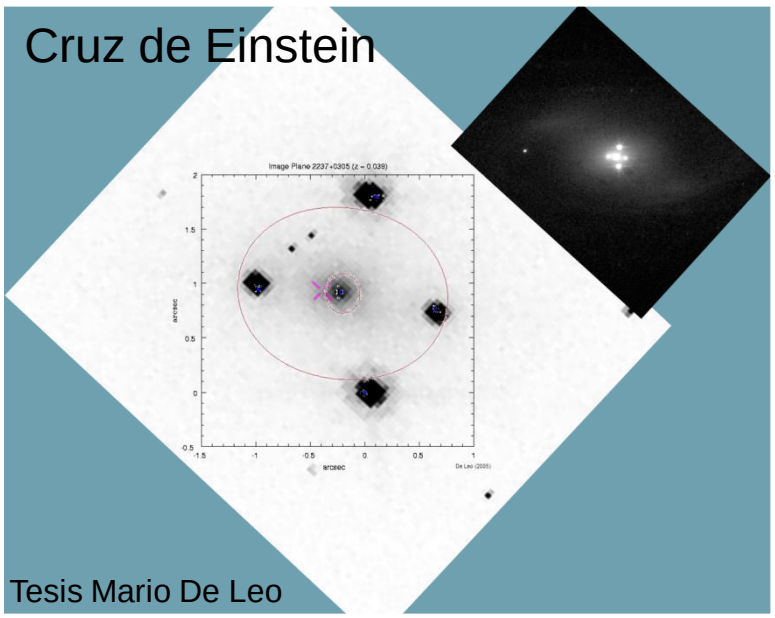
MS2053.7-0449



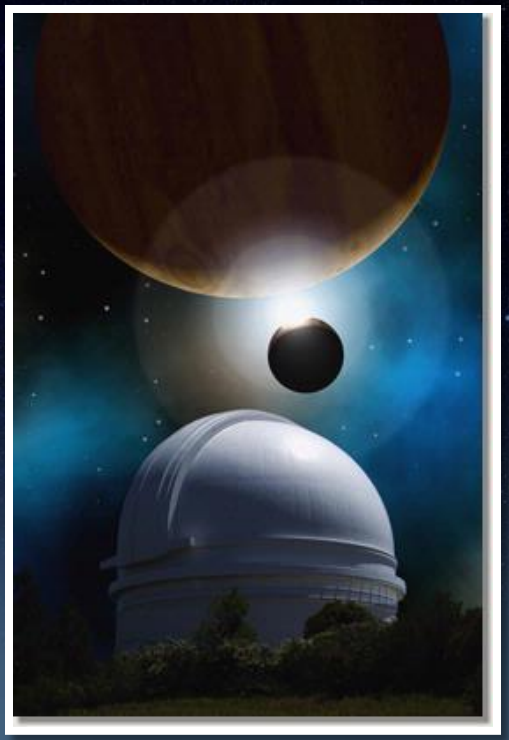
Verdugo, de Diego & Limousin 2007



Cruz de Einstein



Tesis Mario De Leo



3. ASTRONOMÍA EN MÉXICO

Instalaciones actuales y futuras

Instituto de Astronomía UNAM-CU

Instituto de Astronomía UNAM-ENS

Centro de Radioastronomía – UNAM

INAOE – Puebla

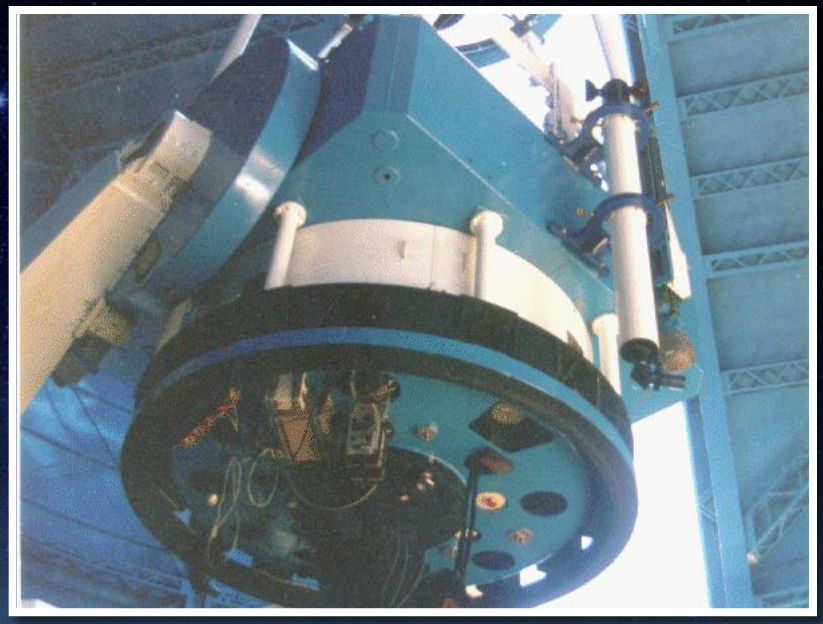
Área de Astronomía – Dep. Inv. Fís.
Universidad de Sonora

Departamento de Astronomía
Universidad de Guanajuato

Inst. de Astronomía y Meteorología
Universidad de Guadalajara

Observatorio de Tonantzintla (UNAM)

- Astrógrafo Carta del Cielo
- Telescopio 1 m
- Cámara Schmidt 64 cm

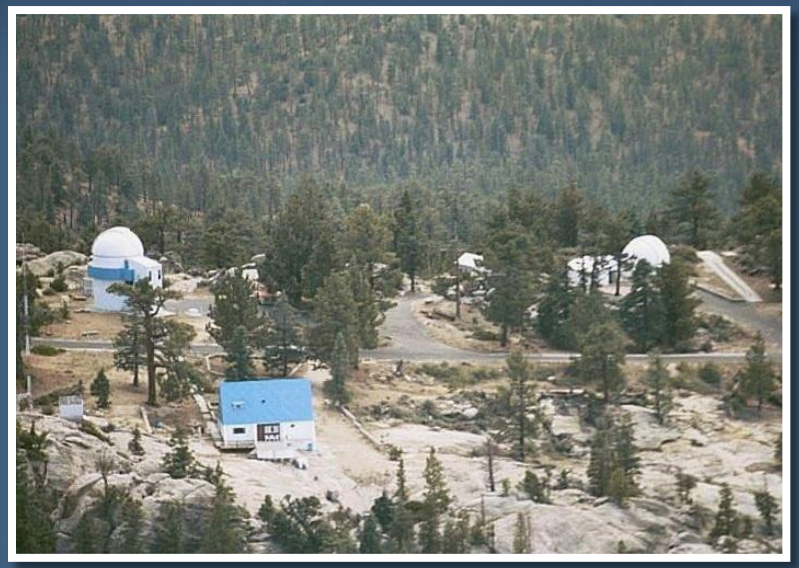


Observatorio Astrofísico Guillermo Haro (INAOE)

- Sonora
- Telescopio 2.12 m

OBSERVATORIO DE SAN PEDRO MÁRTIR (UNAM)

Baja California Norte



OBSERVATORIO EN SIERRA NEGRA – GTM y Pico de Orizaba

HAWC - Rayos Gamma

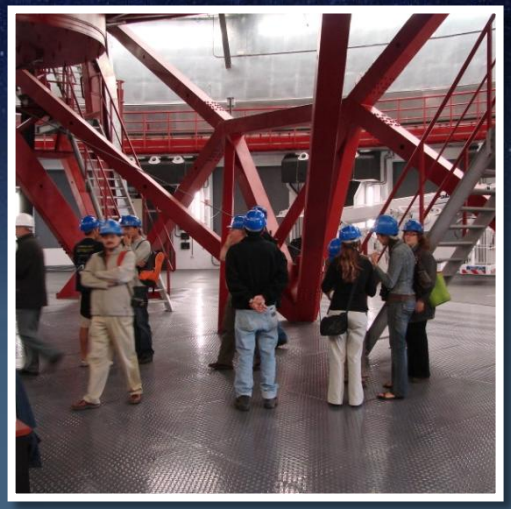
OBSERVATORIO DEL ROQUE DE LOS MUCHACHOS

Isla de La Palma

España

La Palma es una de las siete islas Canarias.

El archipiélago está situado en el Atlántico frente a la costa de Marruecos.

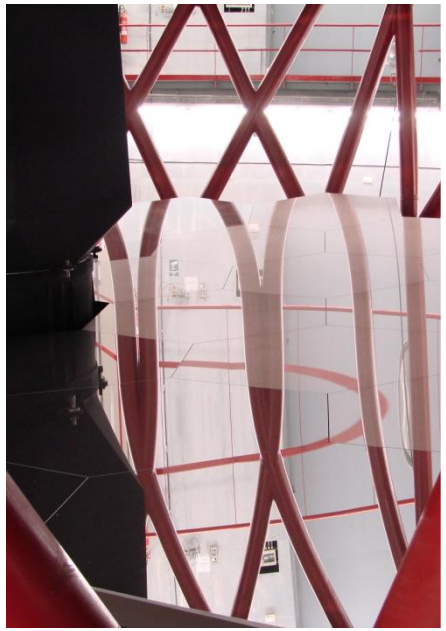


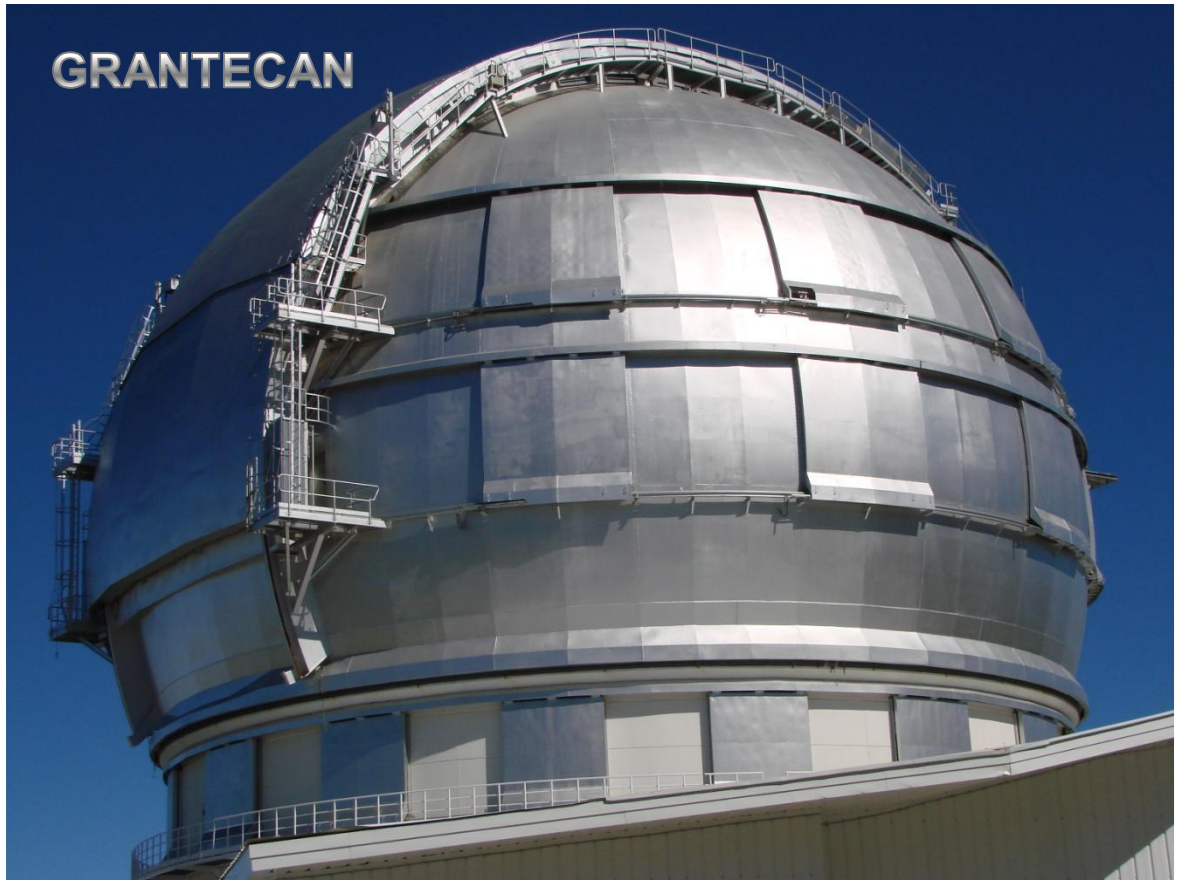
GRANTECAN

Noviembre del 2007

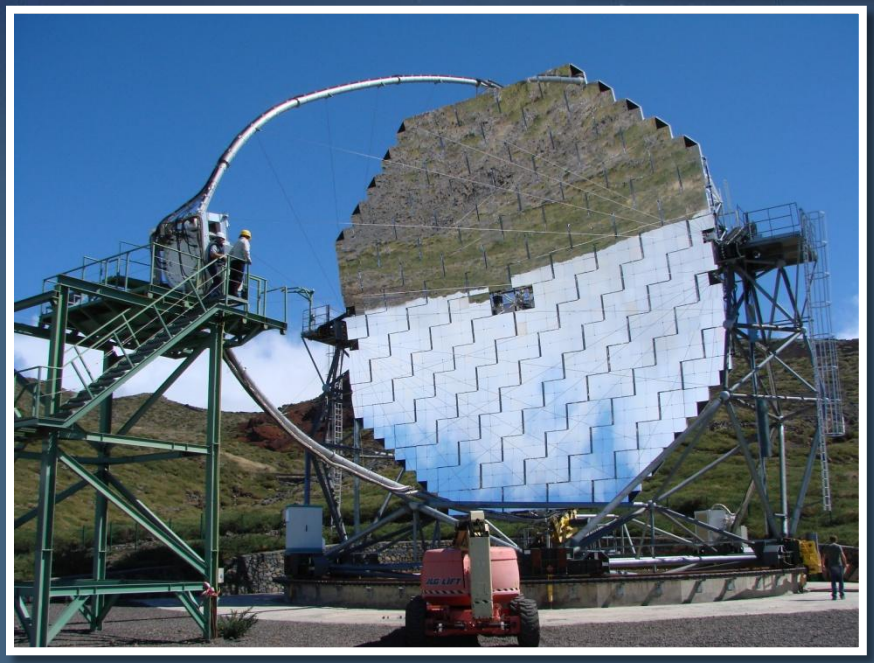
Observaciones empezaron en Marzo 2009

Tiempo concedido para la observación de lentes gravitatorias




GRANTECAN

Telescopio MAGIC



William Herschel Telescope

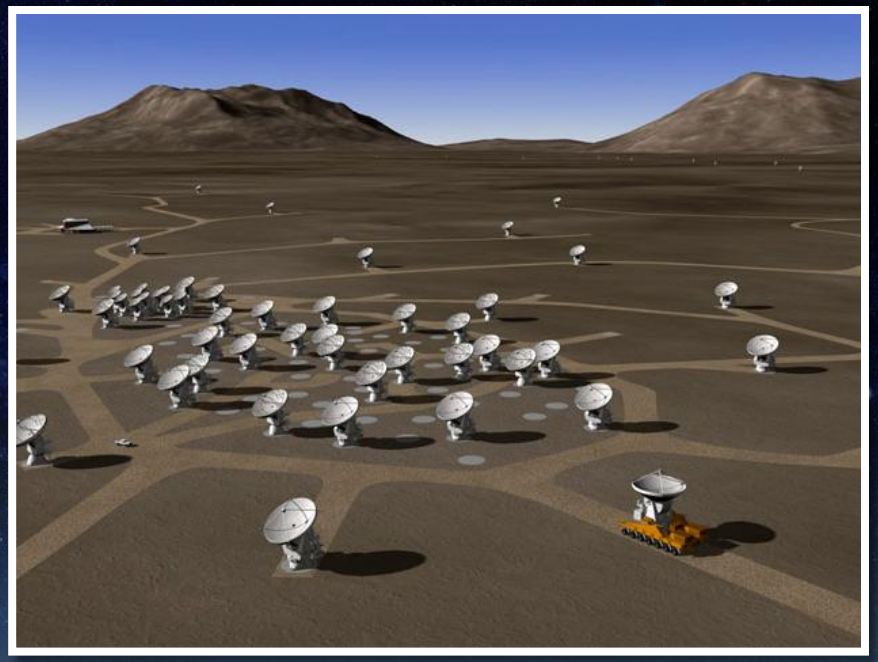
Isaac Newton Telescope

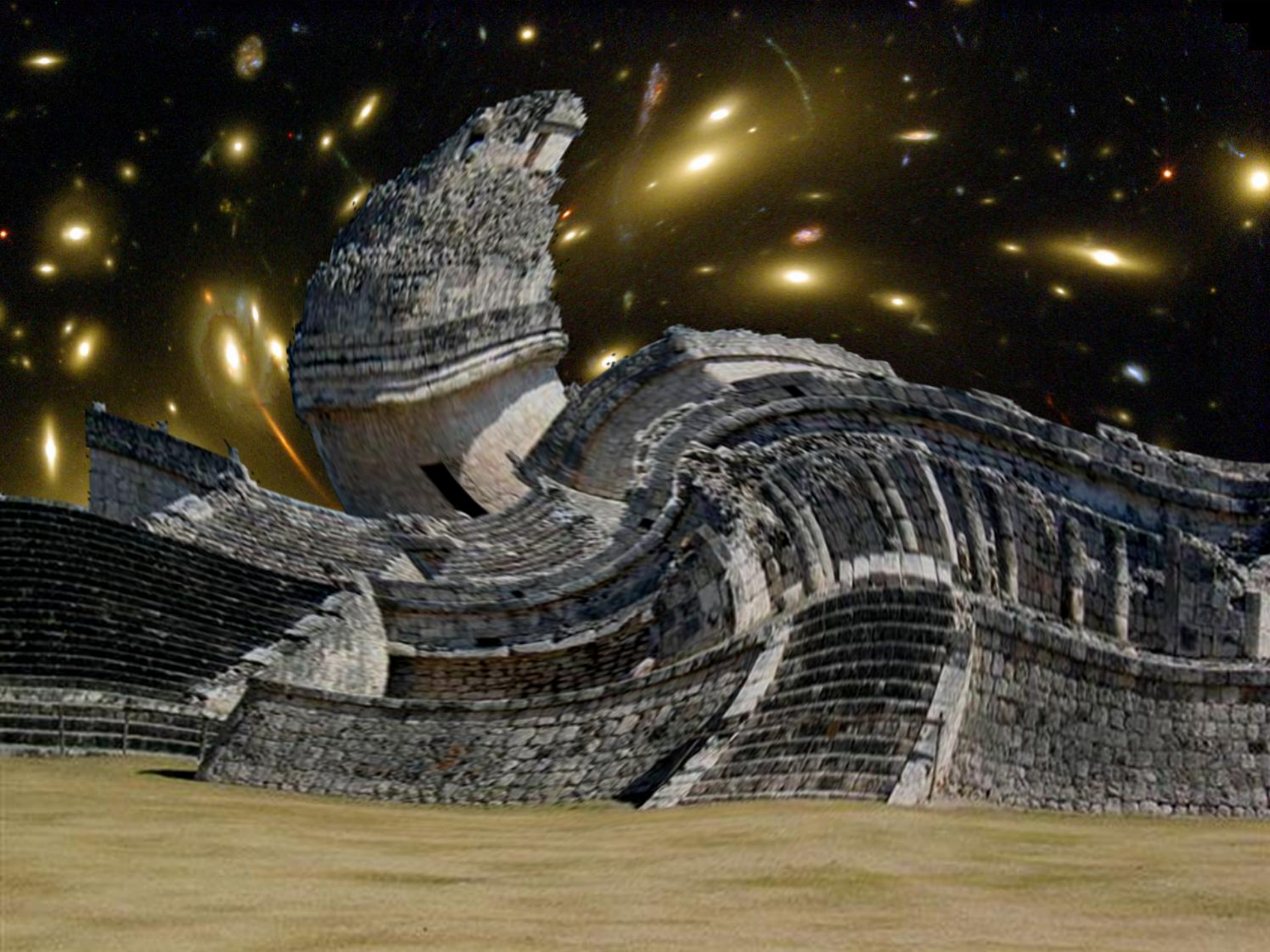
Telescopio Nazionale GALILEO

Nordic Optical Telescope

Atacama Large Millimeter Array

- ALMA
- Chile
- 64 antenas x 12 m
- Año 2012






Muchas gracias
José A. de Diego
jdo@astroscu.unam.mx
http://www.astroscu.unam.mx/~jdo