Da Poldhu a Voyager e Hubble: la fisica spaziale nel centesimo anniversario del Premio Nobel a Guglielmo Marconi.

Francesco Paresce

IASF-Bologna, INAF

2009

1. Quarto centenario delle prime osservazioni del cielo di Galileo con il primo telescopio
2. Primo centenario del premio Nobel in Fisica a Guglielmo Marconi
3. L’anno dell’Astronomia dell’UNESCO
4. L’anno del lancio della navetta spaziale Atlantis per rinnovare Hubble: il più importante telescopio del mondo

Galileo, circa 1609

Ottavio Leoni (1578-1630)
Paris, Musee du Louvre.

Marconi, circa 1909

“…l’intenzione dello Spirito Santo essere d’insegnarci come si vadia al cielo, e non come vadia il cielo”.
Lettera *A Madama Cristina di Lorena Granduchessa di Toscana* (1615)

"La filosofia è scritta in questo grandissimo libro che continuamente ci sta aperto innanzi a gli occhi (io dico l'universo), ma non si può intendere se prima non s'impara a intender la lingua e conoscer i caratteri, ne' quali è scritto.”
Il Saggiatore (1623)

“L’aspetto più entusiasmante della scienza è che essa incoraggia l’uomo a insistere nei suoi sogni. La scienza esige una mente duttile. Non serve interrogare l’universo con una formula. Bisogna osservarlo, prender ciò che esso può dire e poi riflettere con l’aiuto della scienza e della ragione.
Essa mantiene giovani. Non capisco il sapiente che ingiallisce e si incurva nel suo laboratorio, A me piace stare all’aperto e guardare l’universo, fargli delle domande, e lasciare che il suo mistero penetri nella mia mente, ammirandone la bellezza, per poi cercare la mia strada verso la verità delle cose.”

Luna
G.Galilei, Siderius Nuncius

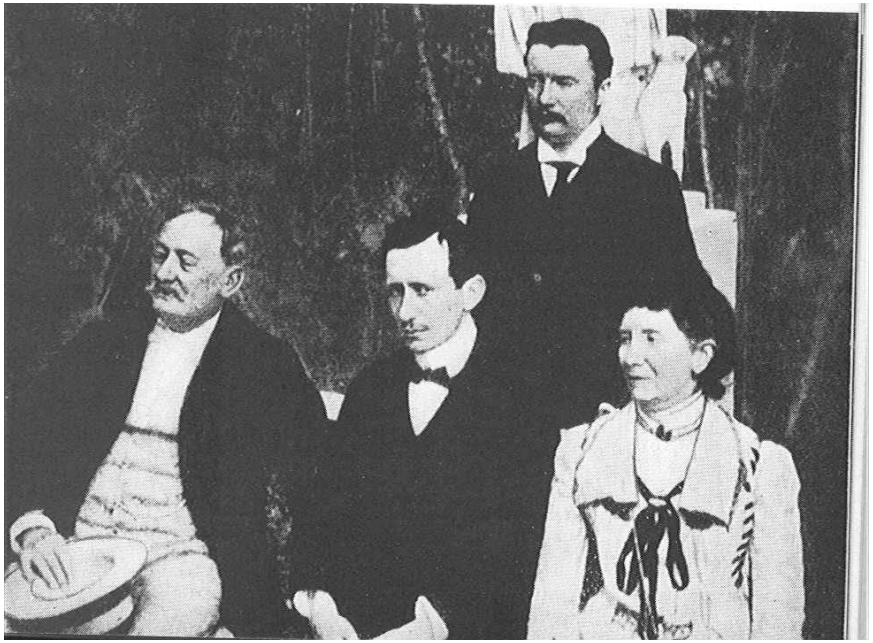
Earthrise
NASA, Apollo 8

Sviluppo della telegrafia senza fili: Guglielmo Marconi (1874-1937)

- Nato a Bologna, Aprile 25, 1874
- Genitori: Annie Jameson (Scot-Irish), Giuseppe Marconi
- Nessuna istruzione formale, auto didatta da letture attente di libri di scienza, madre, tutori occasionali
- Vita di campagna, lontananza da buone scuole, madre “will not let her son be educated by the Priests”
- Filosofia base di educazione materna: studia solo quei soggetti che trovi interessanti!

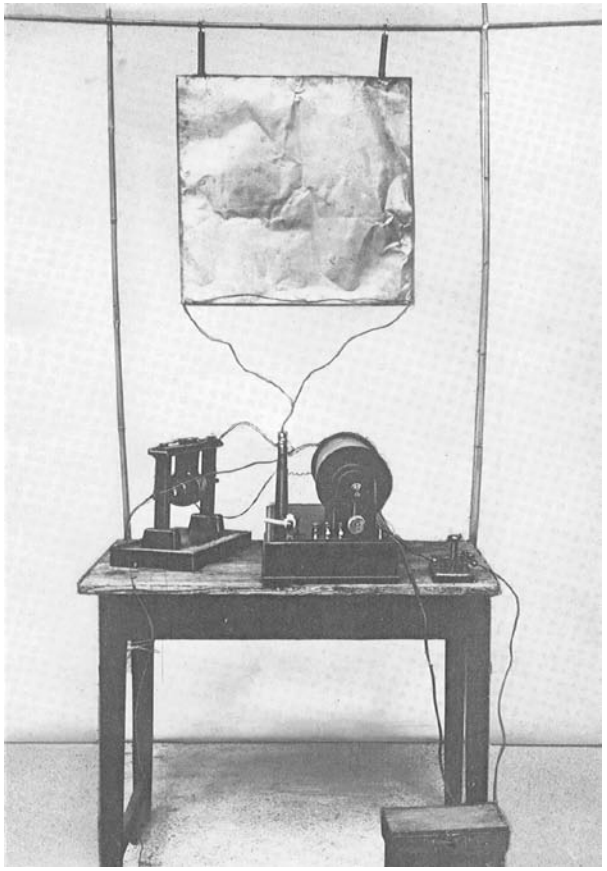
Giovinezza in Italia, 1874-1895: Sviluppo dell’idea fondamentale

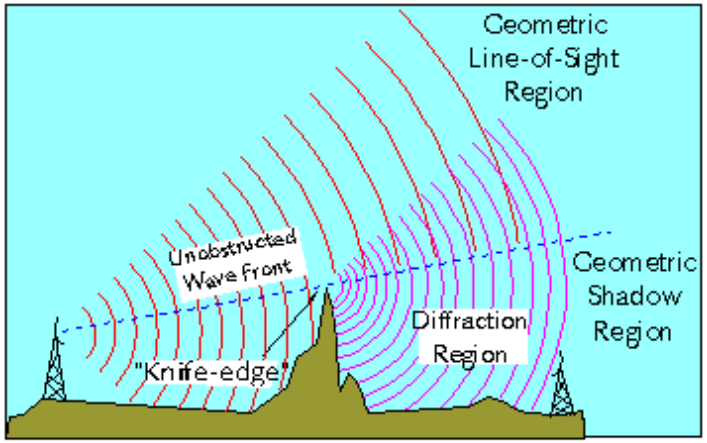
- Apprendistati con professore di fisica del liceo Vincenzo Rosa a Livorno e con Augusto Righi a Bologna gli diede le conoscenze basi delle tecniche sperimentali
- Lavora da solo nell’attico usando idee e consigli pratici da L’Elettricita’. Comincia cercando di costruire una batteria efficiente ma lascia e si dedica a “imbrigliare queste oscillazioni”.
- L’idea probabilmente gli venne da un articolo in L’Elettricita’ (44, 1893): “le lente vibrazioni dell’etere realizzerebbero il magnifico concetto della telegrafia senza fili senza cavi sottomarini, senza tutti quei costosi impianti del nostro tempo”



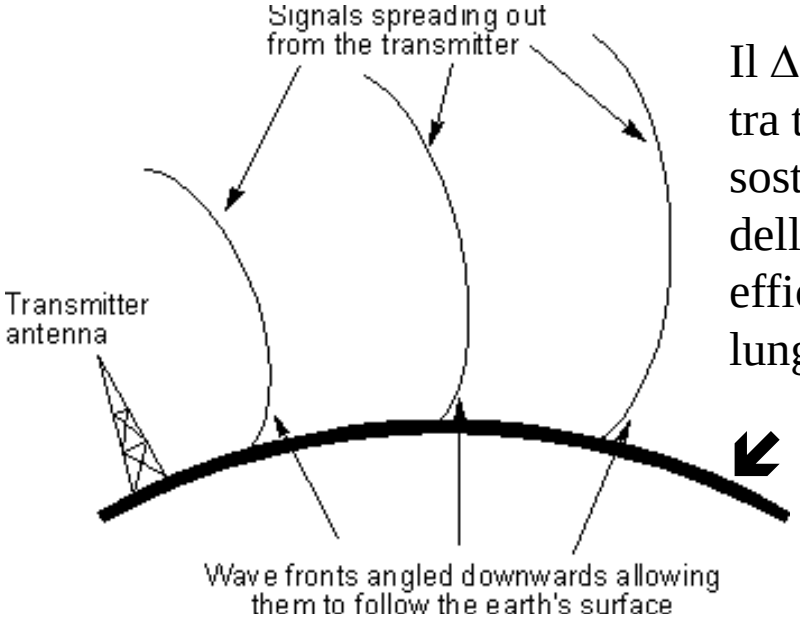
L'idea fondamentale

- Scoperte fatte provando e riprovando:
  - Alzare le antenne trasmittenti e riceventi ben al di sopra del suolo ad un'altezza ~λ
  - Mettere a terra correttamente le antenne usando lastre di metallo sotterrate profondamente nel suolo
  - Usare un rivelatore coherer preso dal concetto di Branly/Lodge/Bose (destra) e uno spark gap a codice Morse come trasmettitore (sinistra)
- Così poteva trasmettere segnali senza fili per vari km anche con una collina di mezzo!



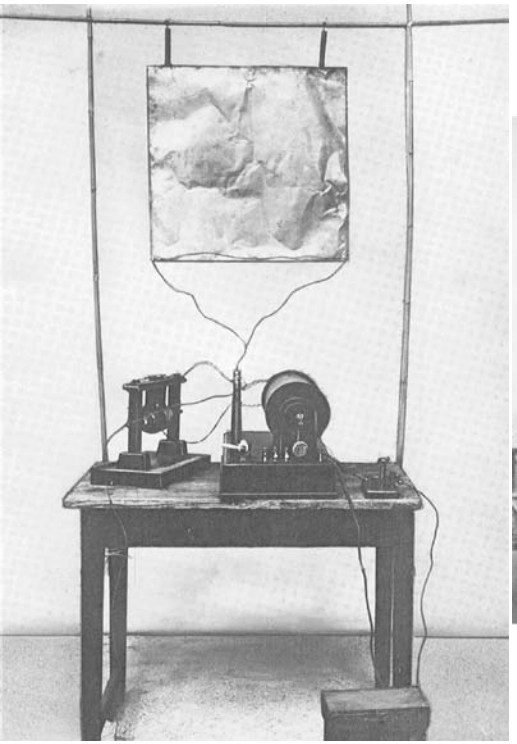


knife-edge effect



Il Δn degli indici di rifrazione tra terra (o mare) e l'atmosfera sostiene la propagazione dell'onda di terra più efficacemente per le onde lunghe (LF, MF)

1895

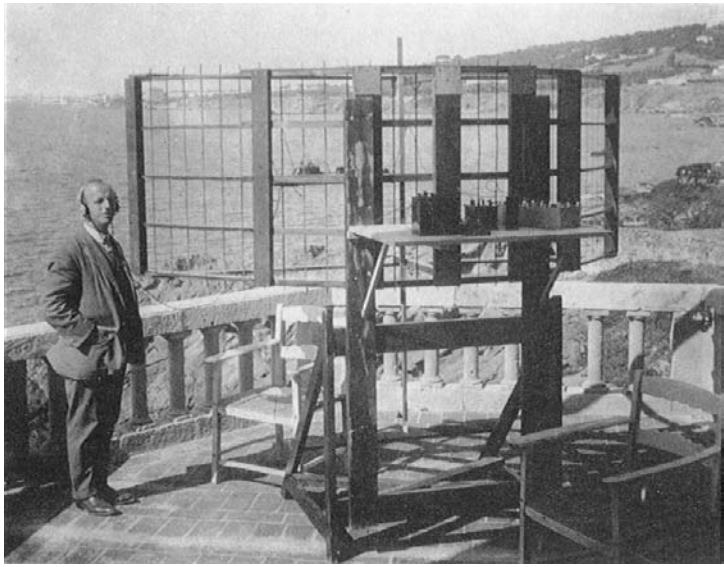


Pontecchio
$\lambda \sim 1000$m

1901

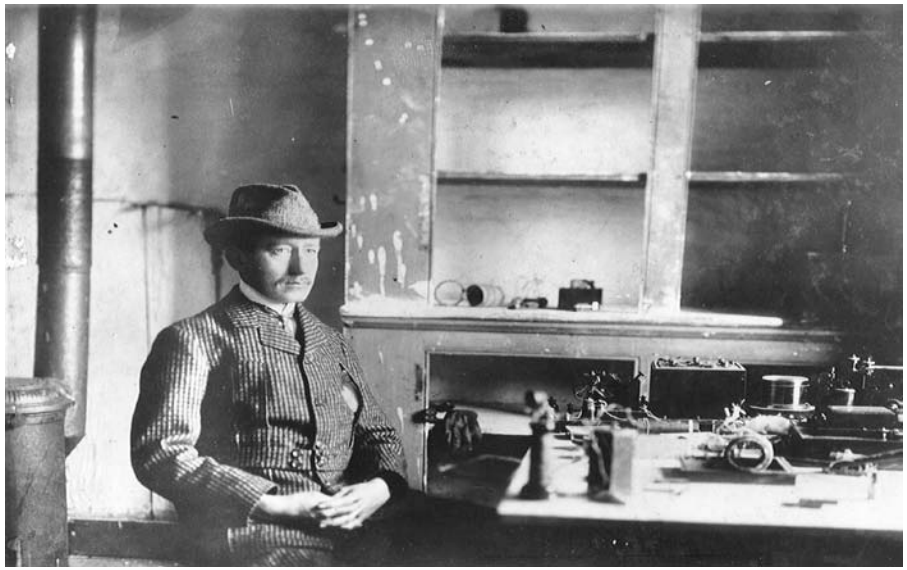
Poldhu
$\lambda \sim 1800$m
E ~ 15 kW

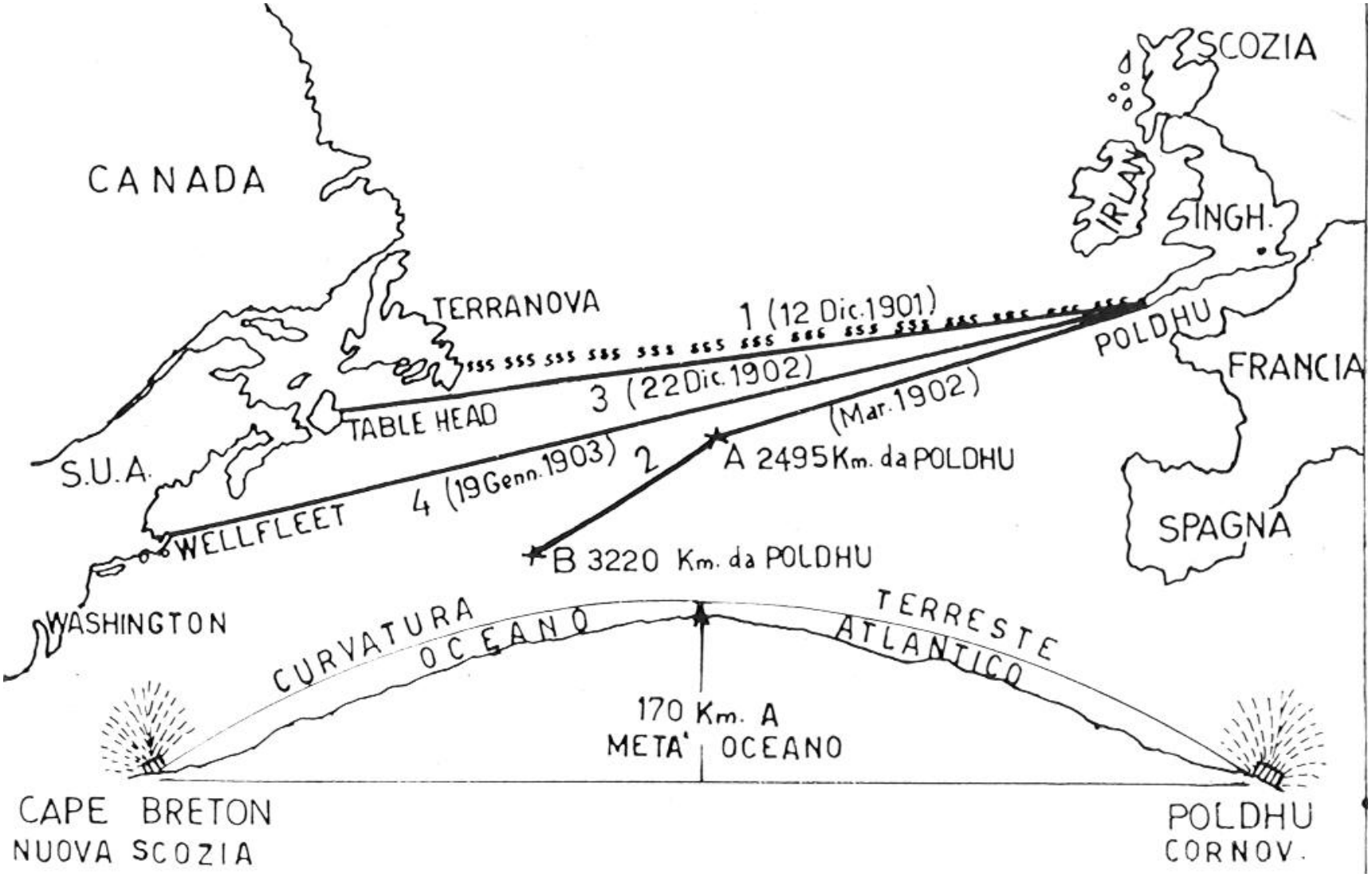
1936



S. Margh. Ligure
$\lambda \sim 50 – 100$m
E ~ 5 – 10 W

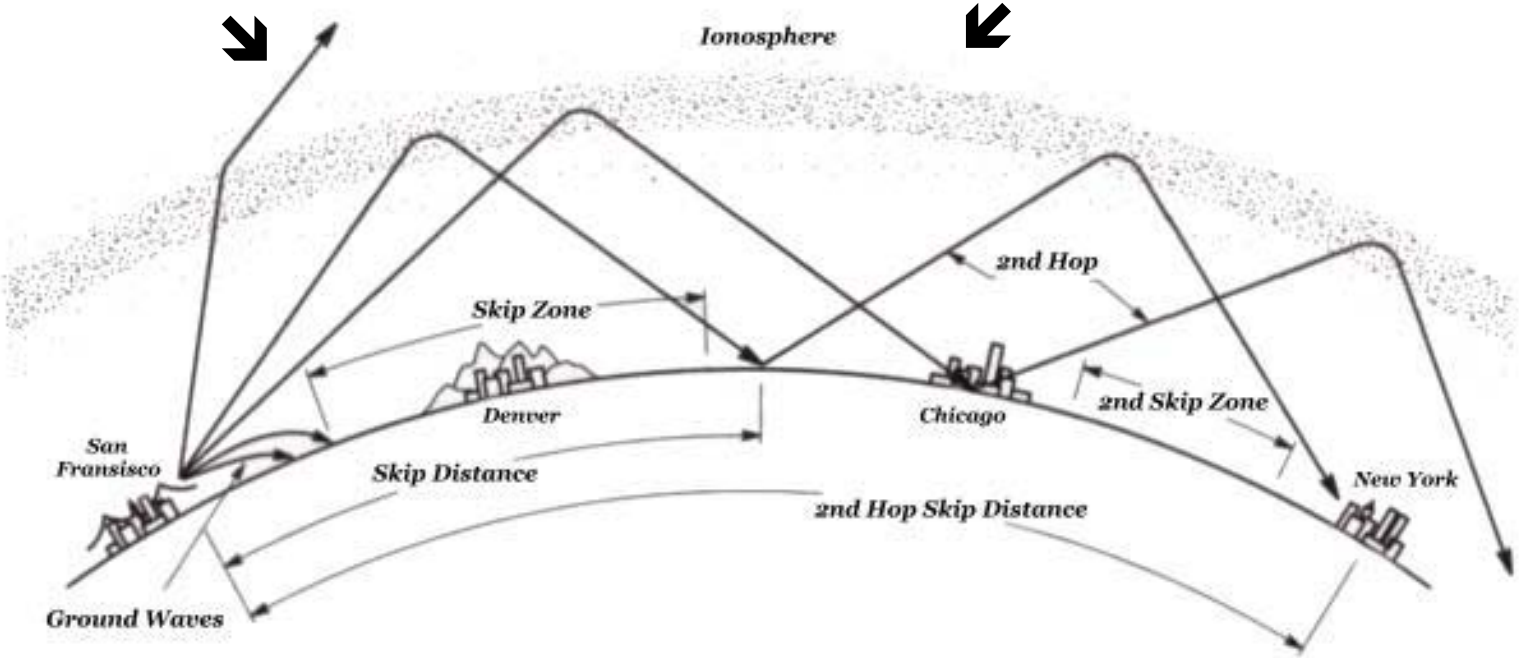
“Prova e riprova”

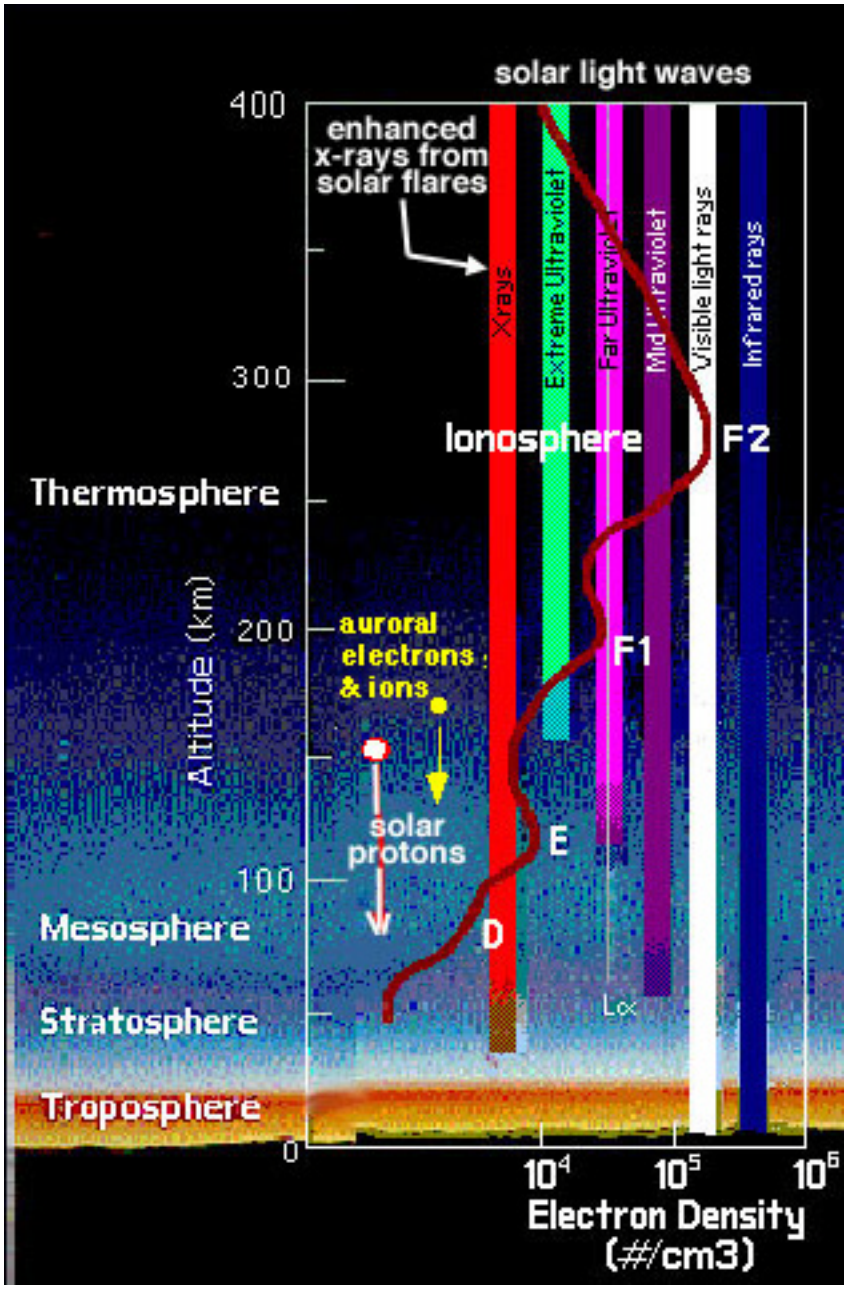


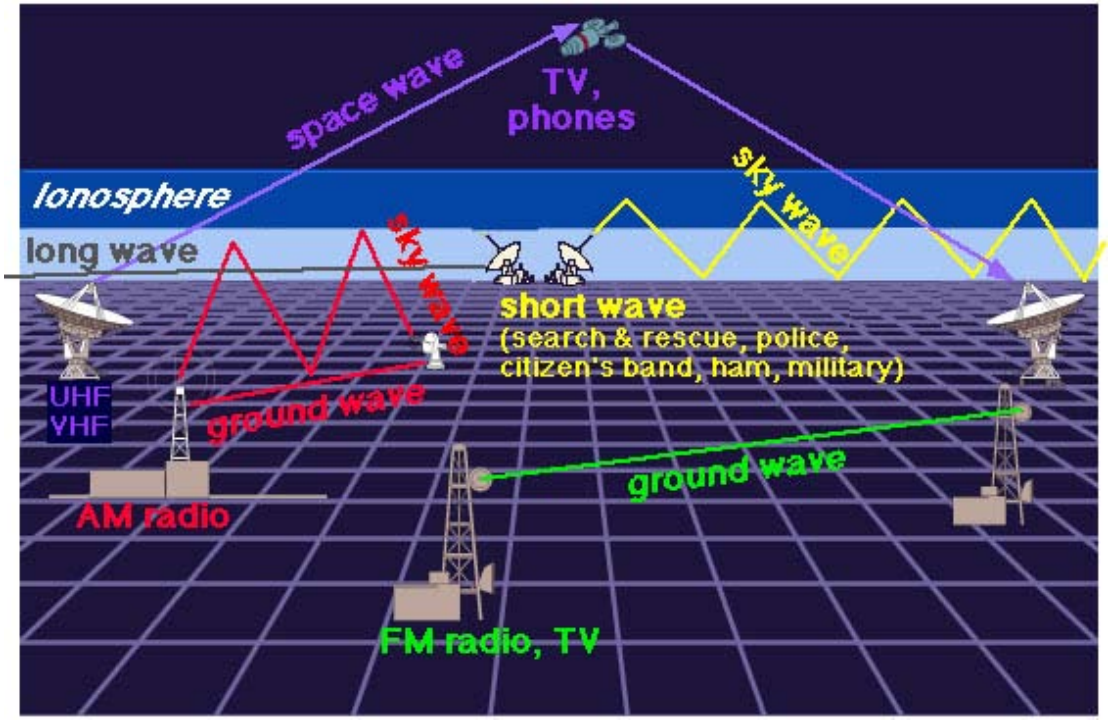

SCOZIA
CANADA
IRLAN
INGH.
TERRANOVA
1 (12 Dic.1901)
POLDHU
FRANCIA
3 (22 Dic.1902)
TABLE HEAD
(Mar.1902)
S.U.A.
2
A 2495 Km. da POLDHU
4 (19 Genn.1903)
WELLFLEET
SPAGNA
B 3220 Km. da POLDHU
WASHINGTON
CURVATURA OCEANO
TERRESTE ATLANTICO
170 Km. A
META' OCEANO
CAPE BRETON
NUOVA SCOZIA
POLDHU
CORNOV.

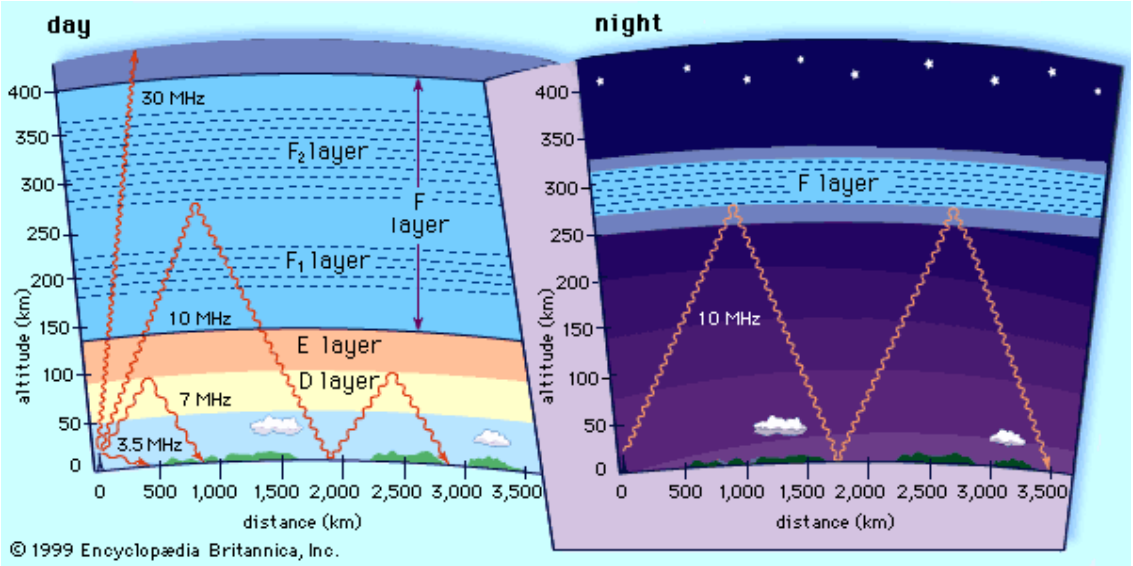
Ionosphere acts as a refracting prism for ν= 3-30 MHz long distance HF radio communication

ν > 30MHz




solar light waves
enhanced x-rays from solar flares
Xrays
Extreme Ultraviolet
Far Ultraviolet
Mid Ultraviolet
Visible light rays
Infrared rays
Ionosphere
F2
F1
E
D
Lα
Thermosphere
Mesosphere
Stratosphere
Troposphere
Altitude (km)
400
300
200
100
0
auroral electrons & ions
solar protons
10^4
10^5
10^6
Electron Density (#/cm3)


space wave
TV,
phones
sky wave
Ionosphere
long wave
sky wave
short wave
(search & rescue, police,
citizen's band, ham, military)
UHF
VHF
ground wave
ground wave
AM radio
FM radio, TV


day
night
30 MHz
F2 layer
F
layer
F1 layer
10 MHz
E layer
D layer
7 MHz
3.5 MHz
F layer
10 MHz
altitude (km)
distance (km)
0
50
100
150
200
250
300
350
400
500
1,000
1,500
2,000
2,500
3,000
3,500
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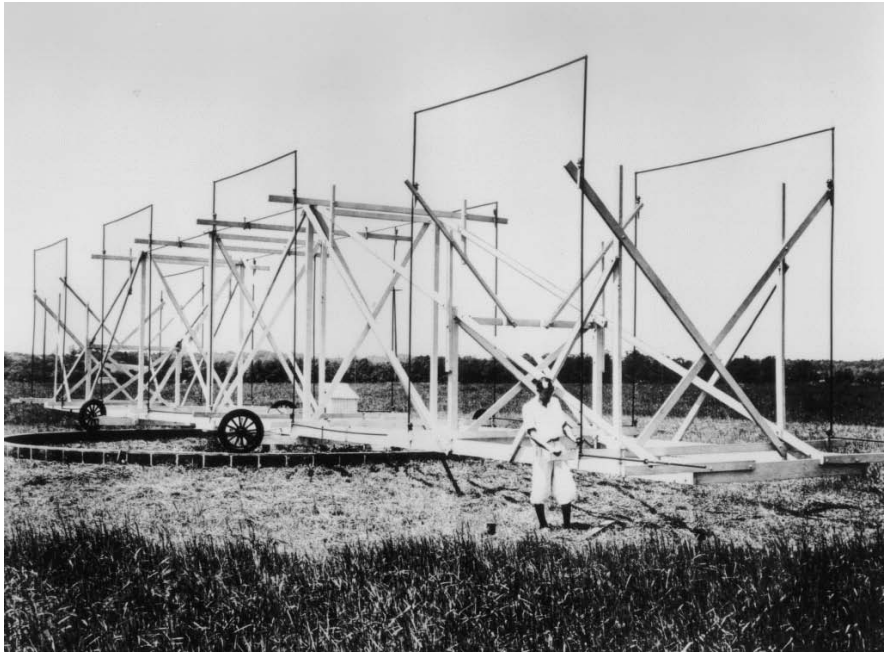
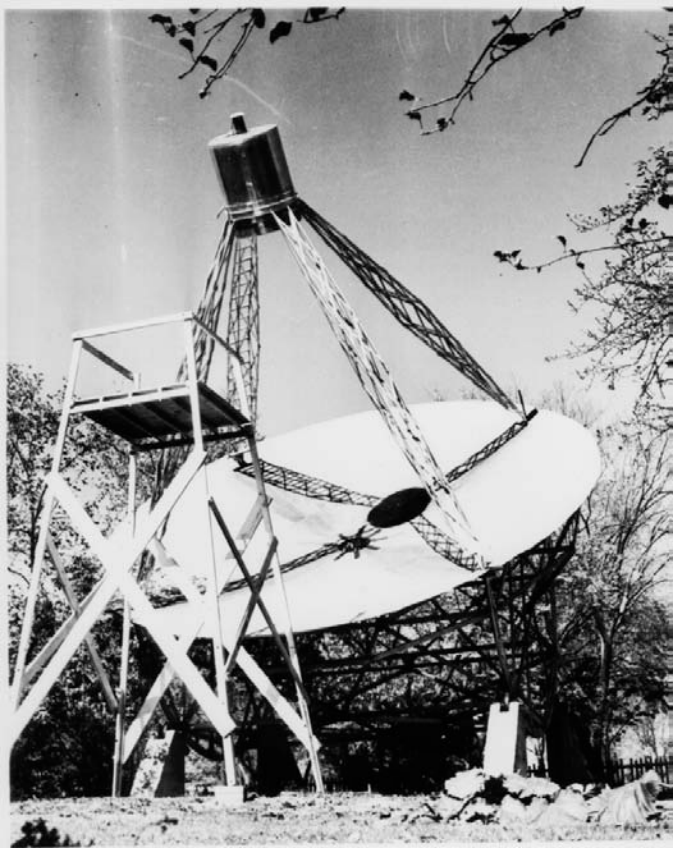
Radio frequencies and their primary mode of propagation

Band	Frequency	Wavelength	Propagation via
VLF Very Low Frequency	3–30 kHz	100–10 km	Guided between the earth and the ionosphere.
LF Low Frequency	30–300 kHz	10–1 km	Guided between the earth and the D layer of the ionosphere. Surface waves. **First transatlantic signals**
MF Medium Frequency	300–3000 kHz	1000–100 m	Surface waves. E, F layer ionospheric refraction at night, when D layer absorption weakens.
HF High Frequency (Short Wave)	3–30 MHz	100–10 m	E layer ionospheric refraction. Jansky first cosmic signal F1, F2 layer ionospheric refraction.
VHF Very High Frequency	30–300 MHz	10–1 m	Infrequent E ionospheric refraction. Extremely rare F1,F2 layer ionospheric refraction during high sunspot activity up to 80 MHz. Generally direct wave. Sometimes tropospheric ducting.
UHF Ultra High Frequency	300–3000 MHz	100–10 cm	Direct wave. Sometimes tropospheric ducting.
SHF Super High Frequency	3–30 GHz	10–1 cm	Direct wave.
EHF Extremely High Frequency	30–300 GHz	10–1 mm	Direct wave limited by absorption, CMB here

Pionieri





Karl Jansky: scoperta dell'emissione radio del centro galattico, 1932
frequenza: 20.5 MHz, 14.5m

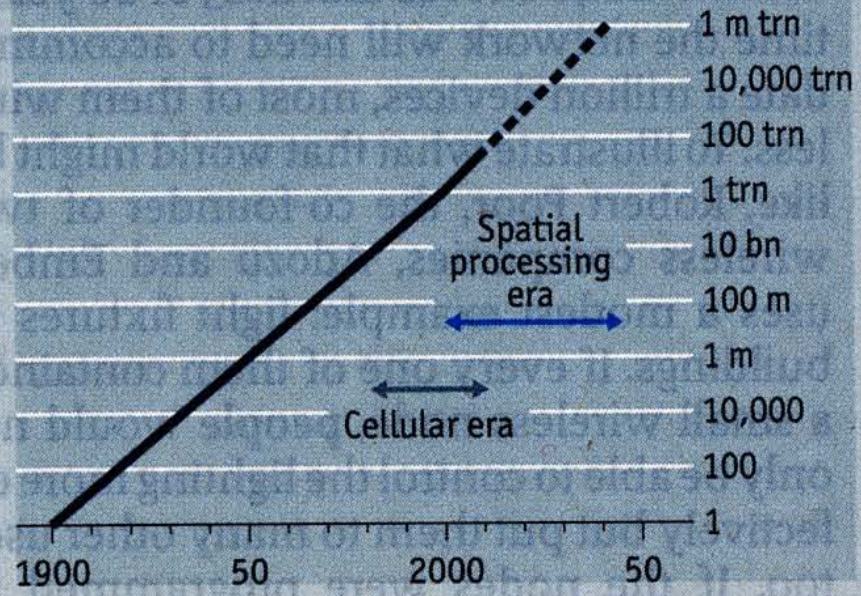
Grote Reber: primo survey del cielo, 1941
frequenza: 160MHz

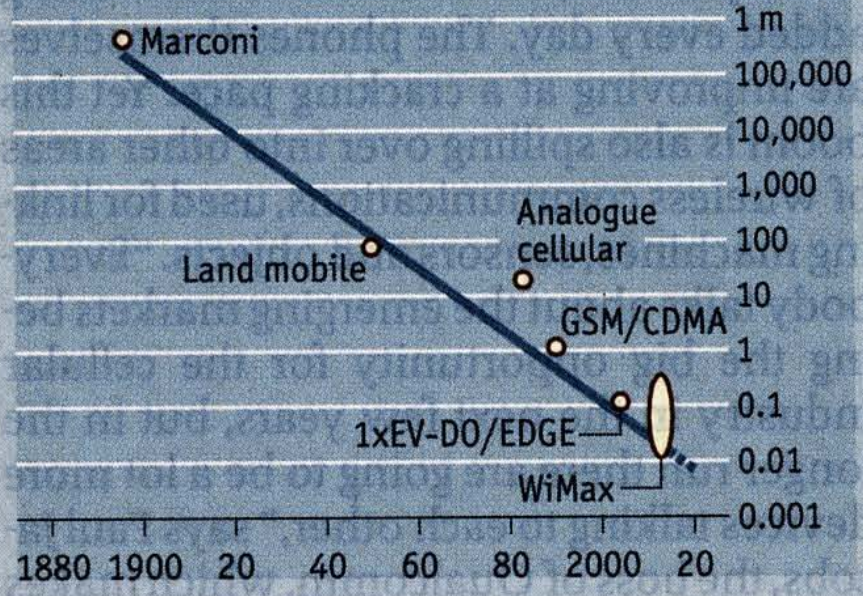
the mobile phone (see chart 1).

The invention of the transistor in 1947 and the microprocessor (which integrated transistors and other things onto a single chip) in 1958 changed the way radios func-

of Intel, the world's biggest chip company. As the billions of transistors on the chips get smaller, there is more room to add extra functions. Such chips do not just go faster, they also do more, and the cost of integrat-

More for less (log scales)





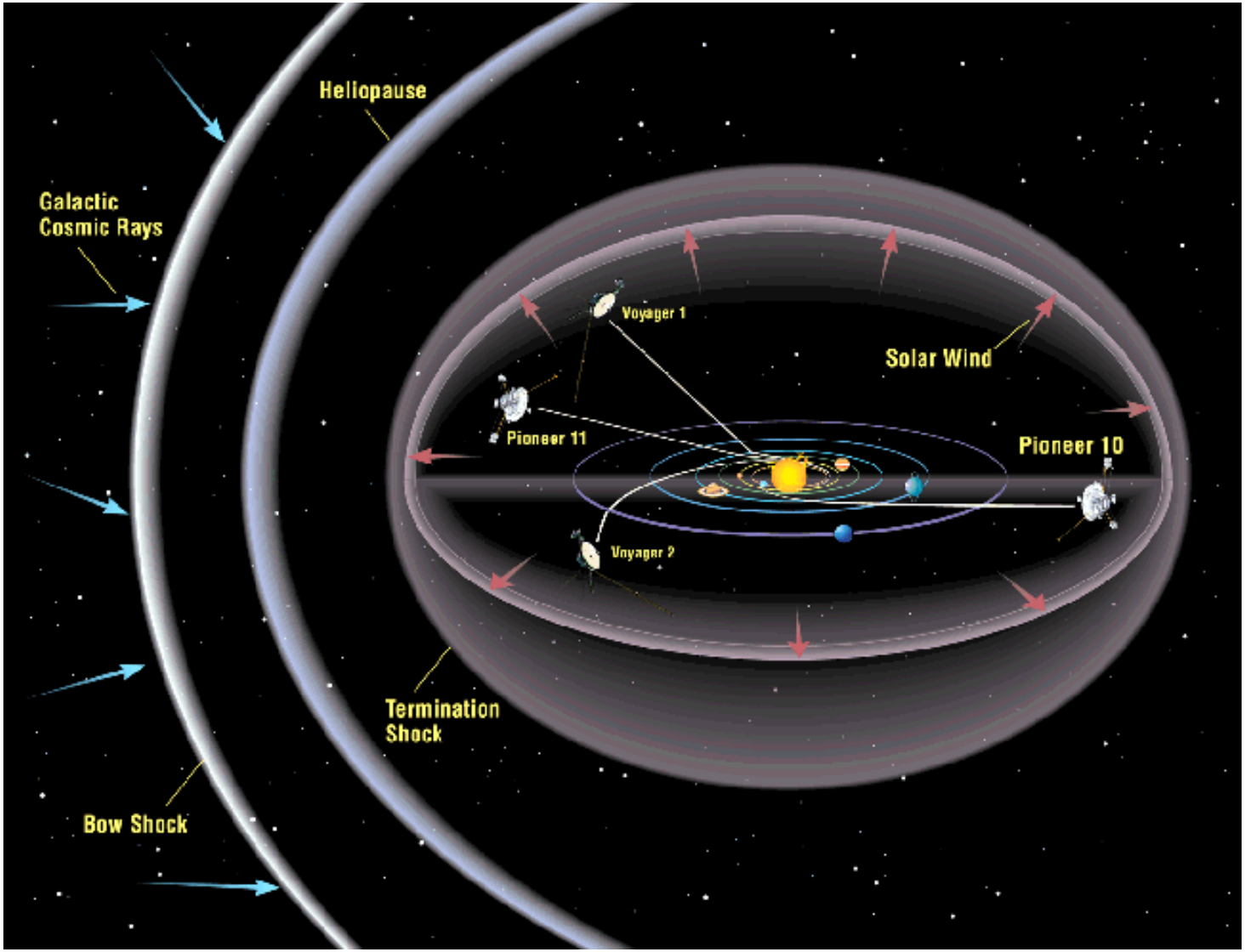
Sources: Martin Cooper (ArrayComm); Intel

The Economist, Aprile 2007

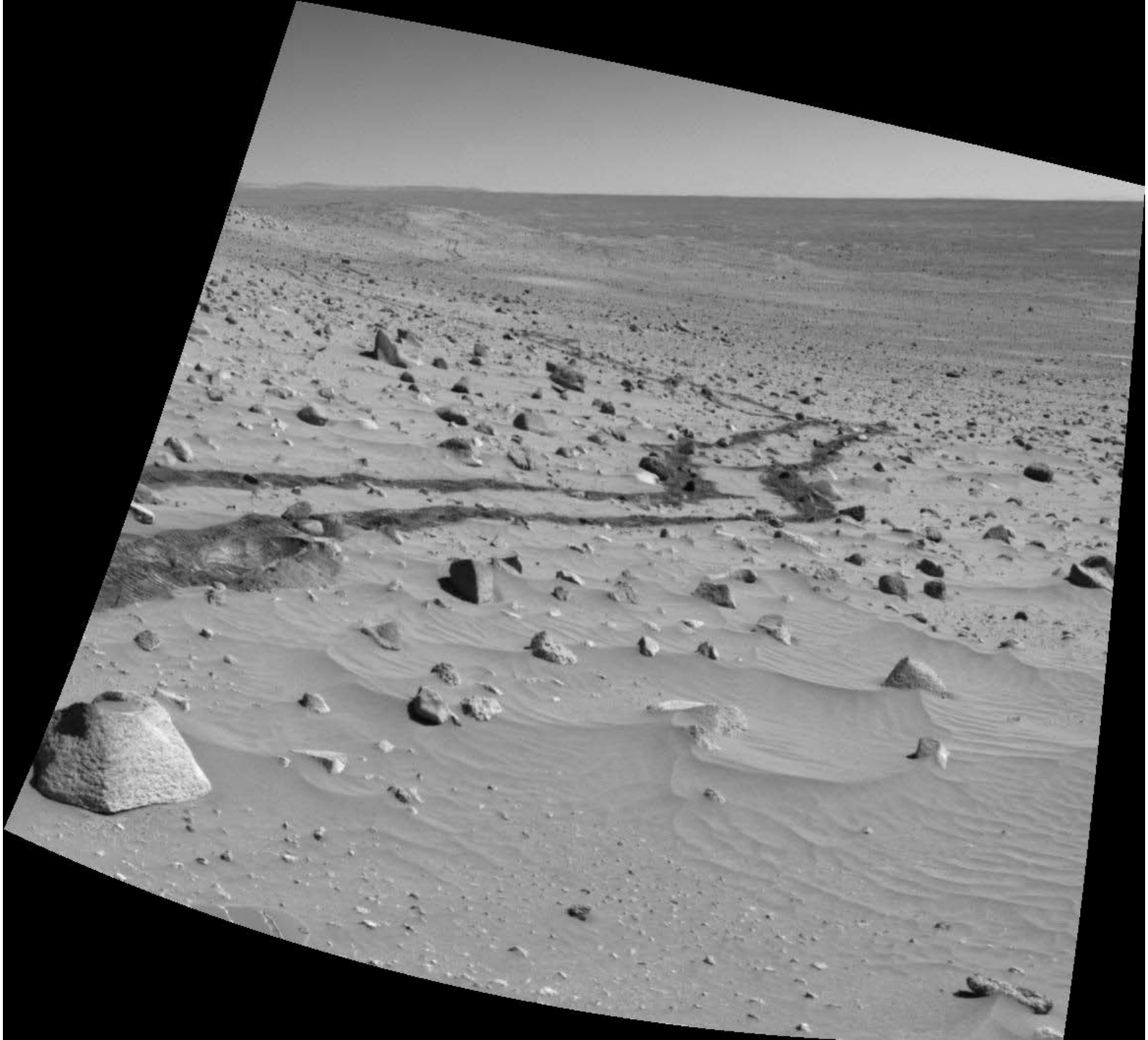
2009

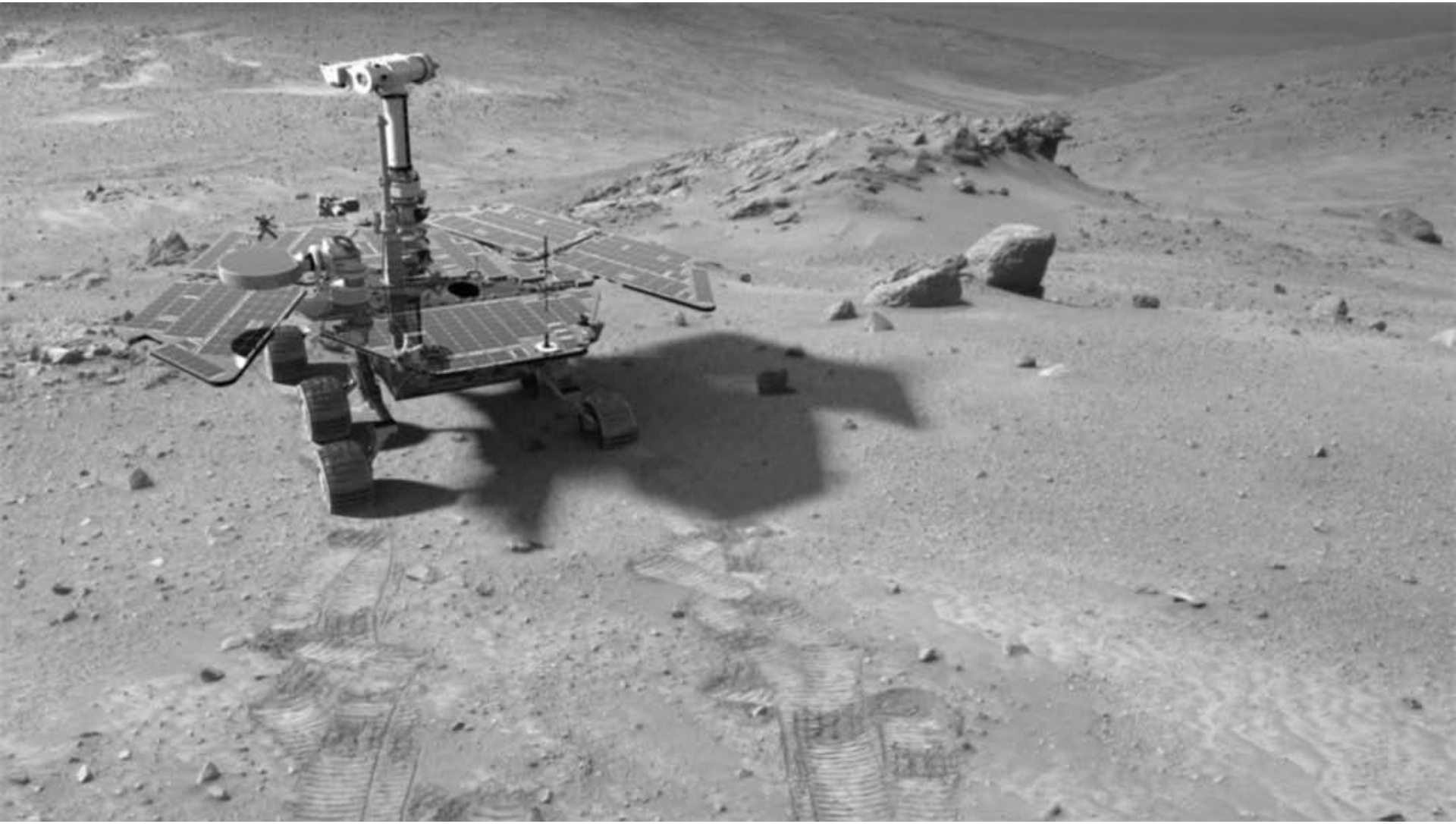
Goldstone, Calif.

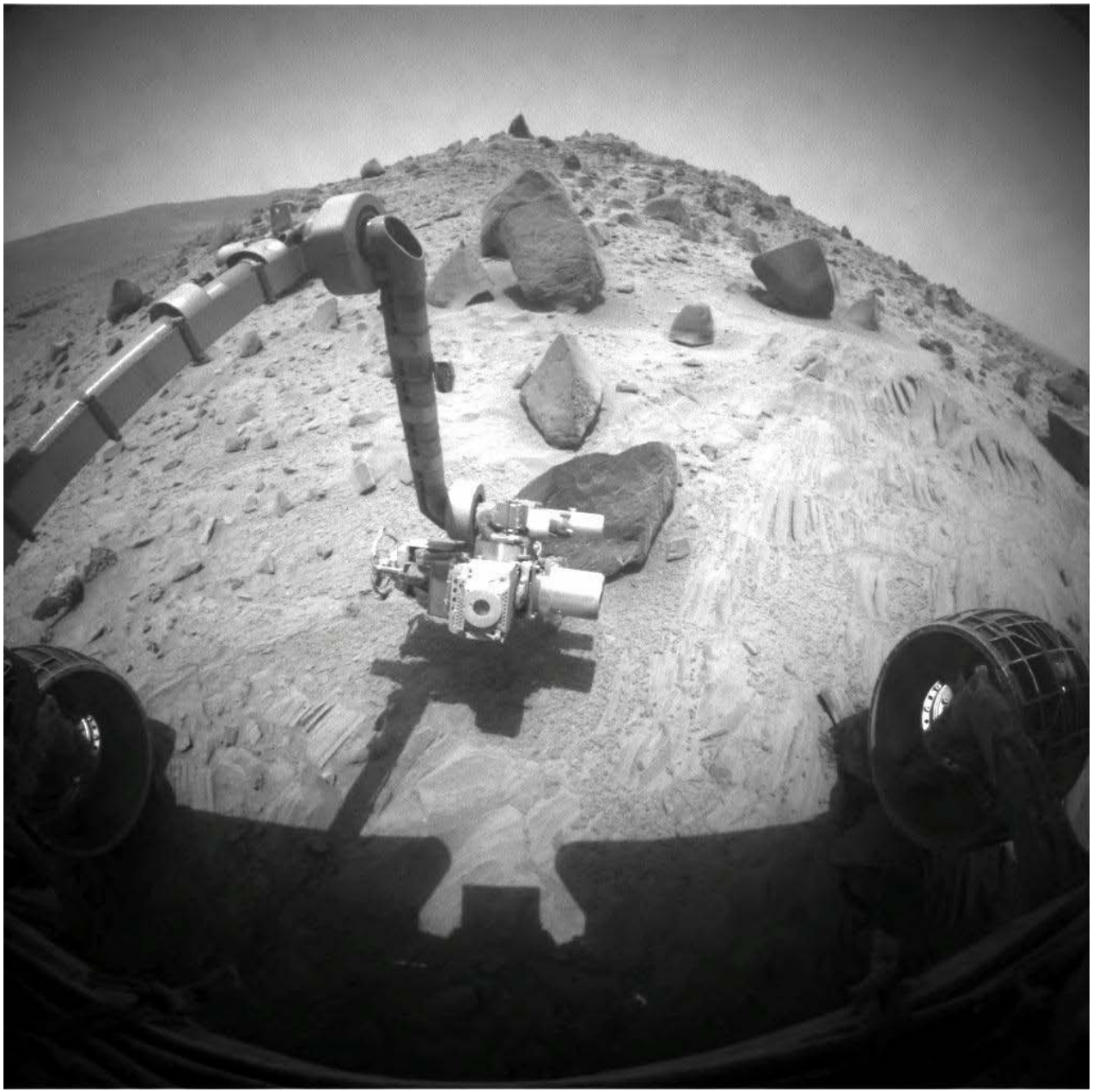
Arecibo, PR



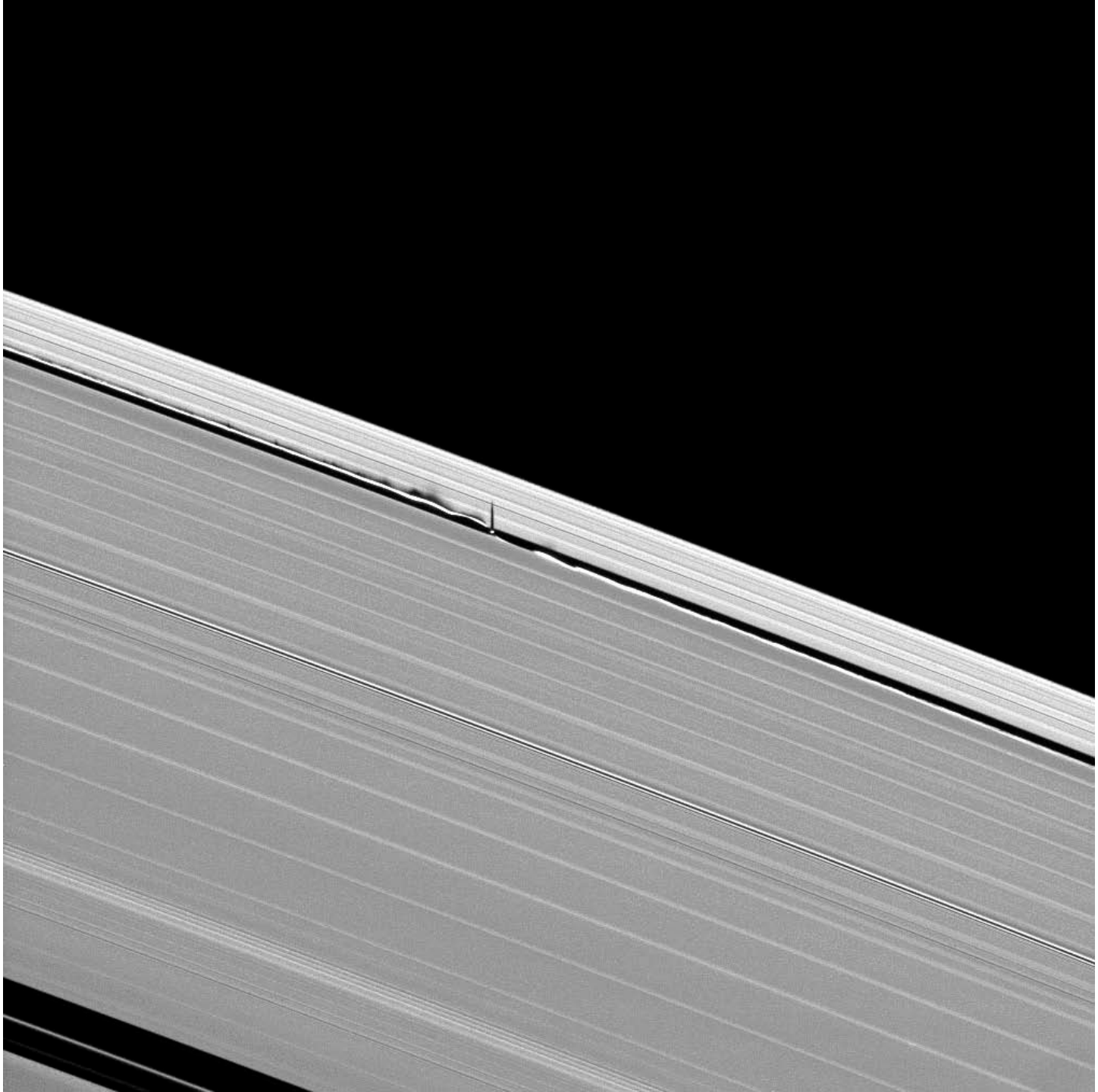
15×10^9 km

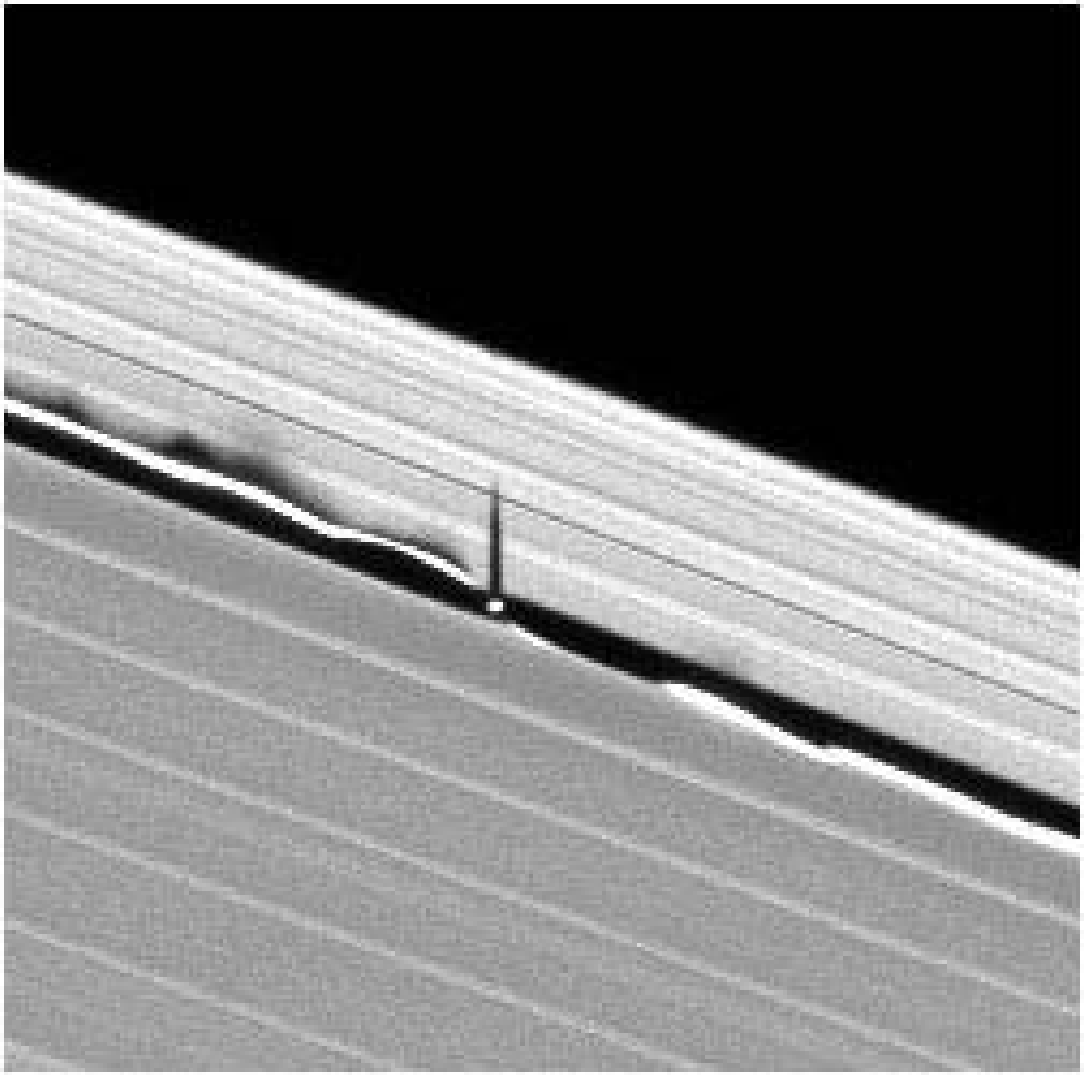


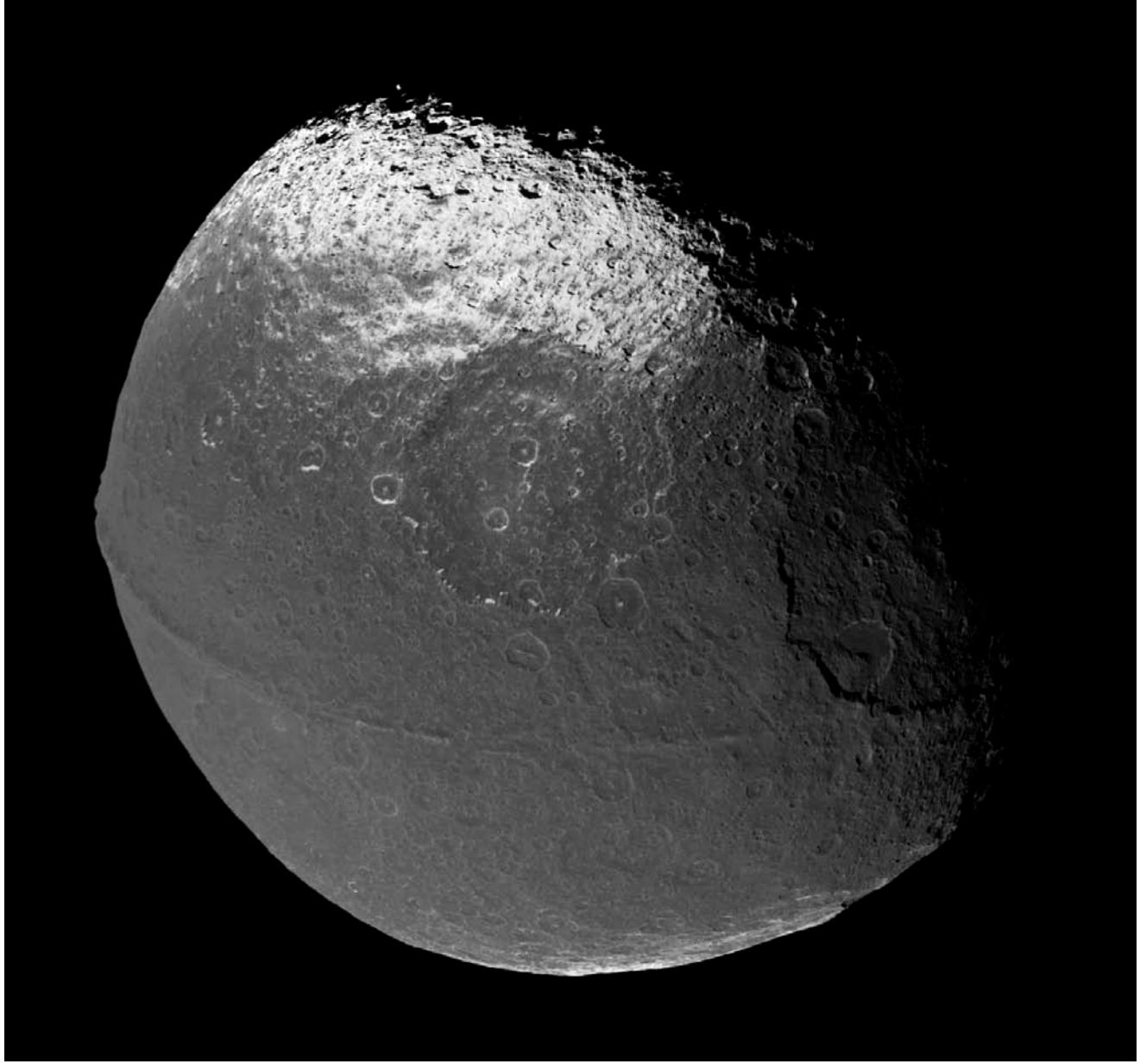




Spirit Mars Rover

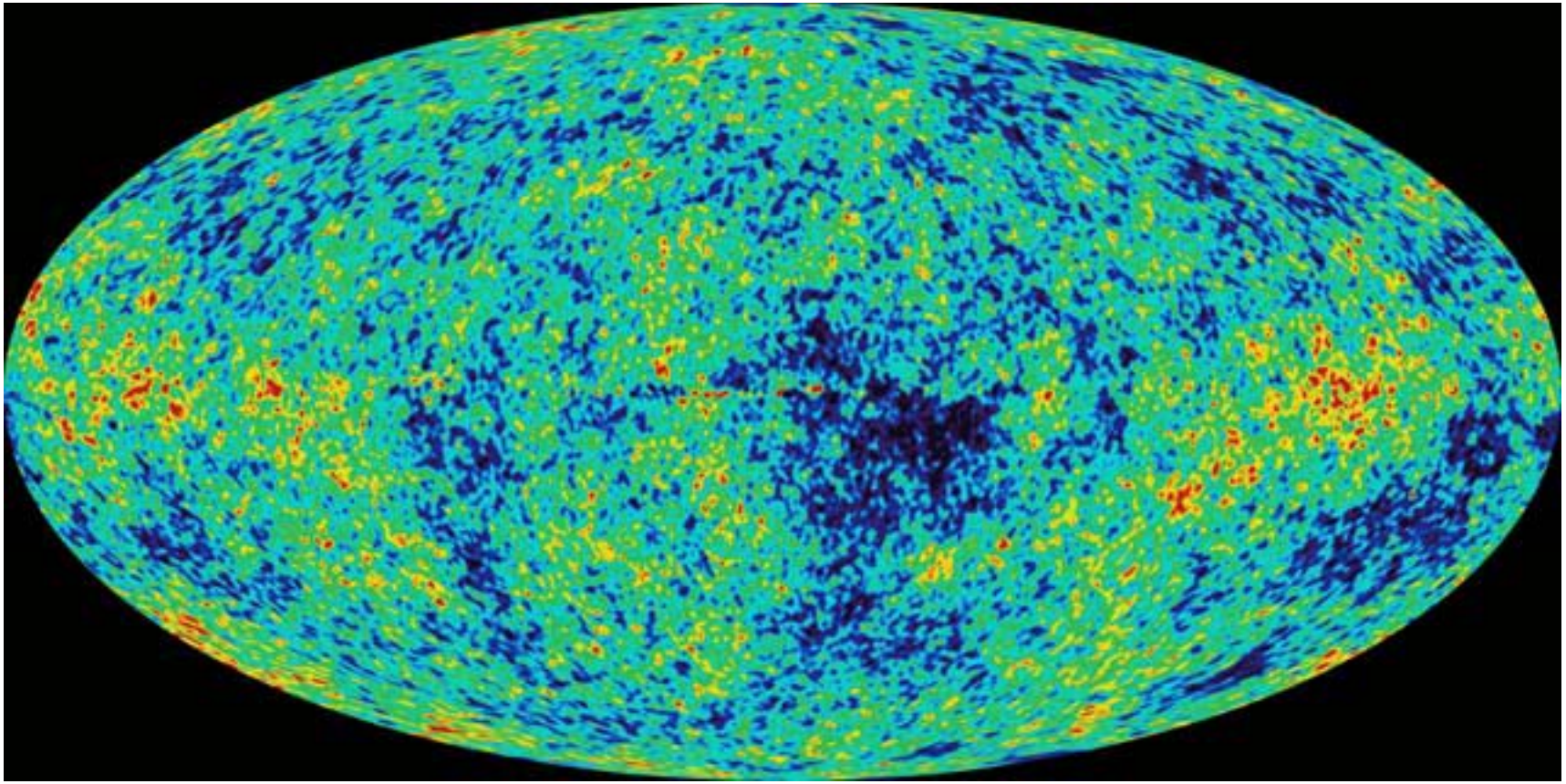






Iapetus da Cassini

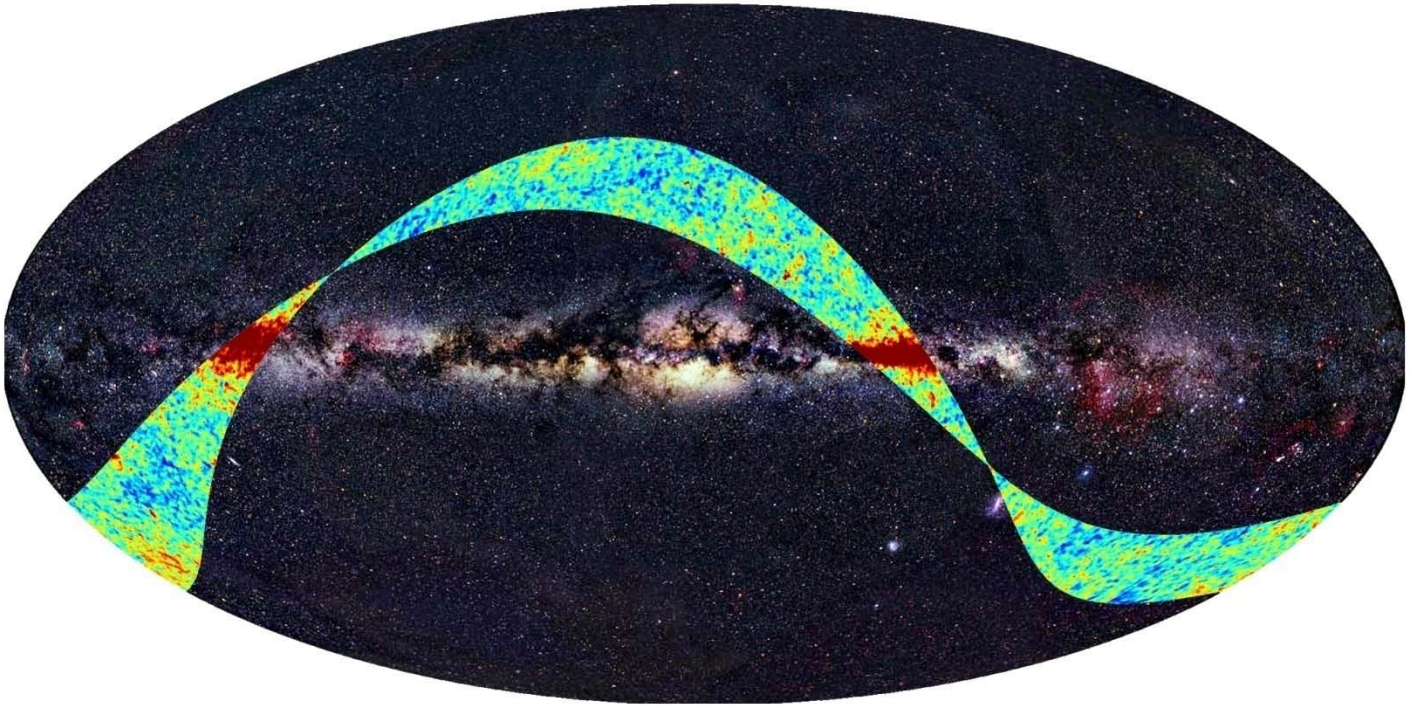
Cosmic Microwave Background



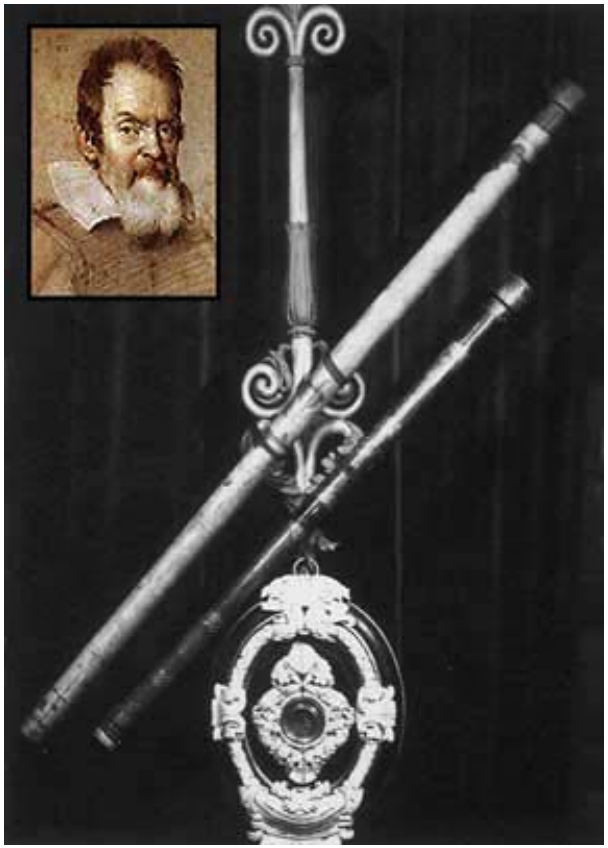
From WMAP, 160.2 GHz, 1.9mm, 2.725K

↓

t = 13.73 Byrs, baryons = 4.6%, DM = 23.3%
DE = 72.1%, curvature = flat (within 1%)



Satellite Planck: prima luce sulla prima luce, Settembre 2009



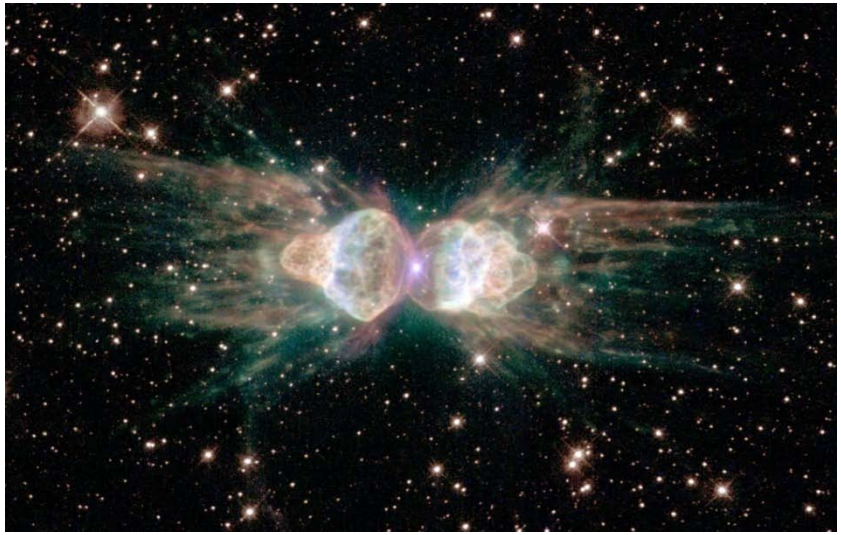
1609, D=1-2cm
Venezia

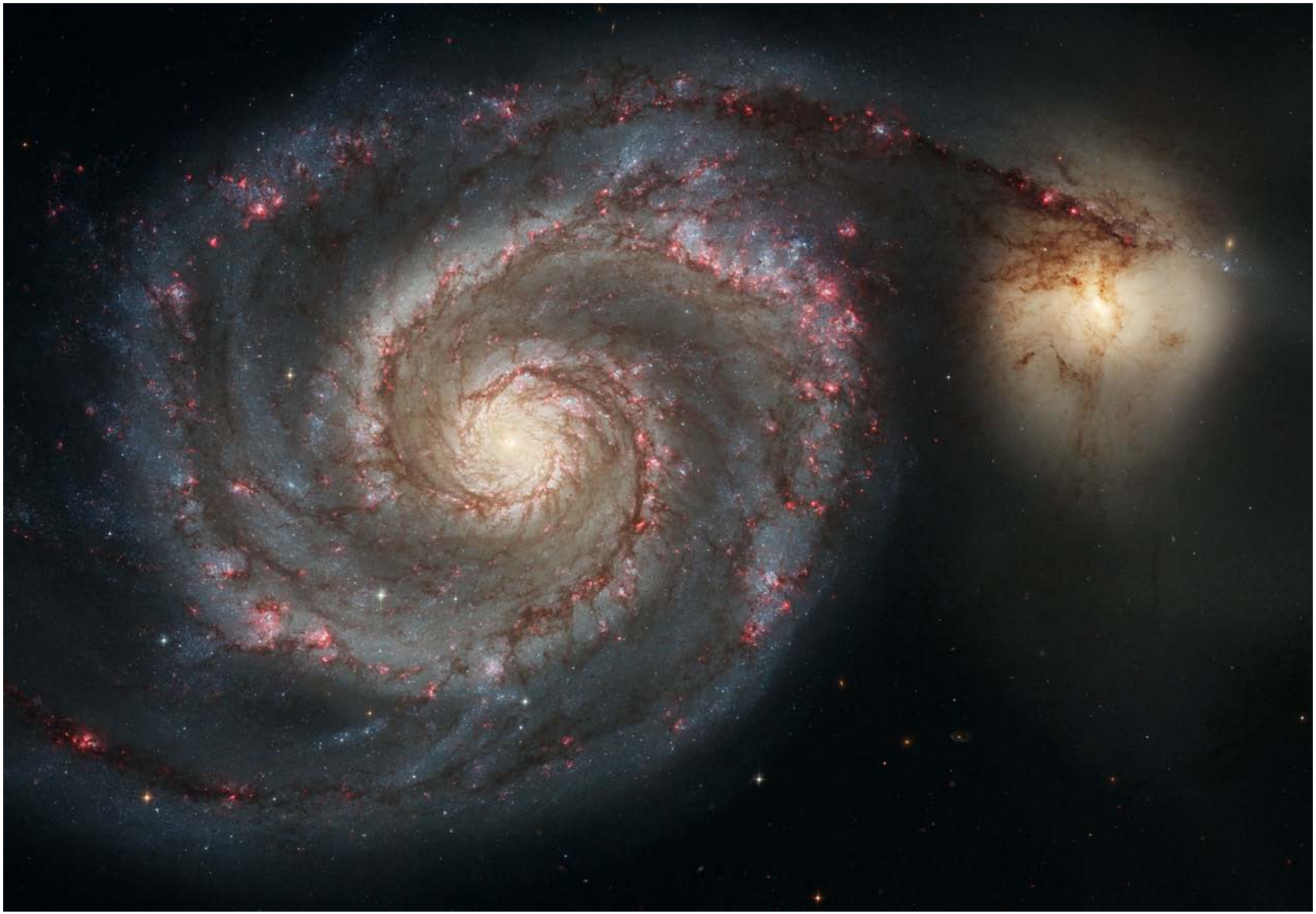
2009, D=2400cm
500 km above earth

Carina Nebula

Starforming Region in the Carina Nebula

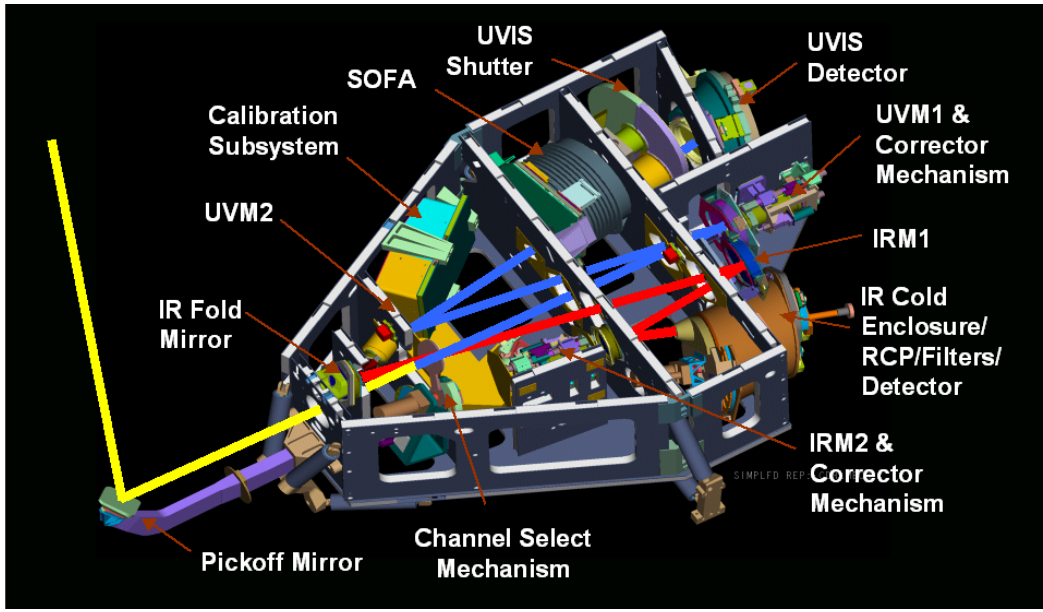
HST•ACS/WFC



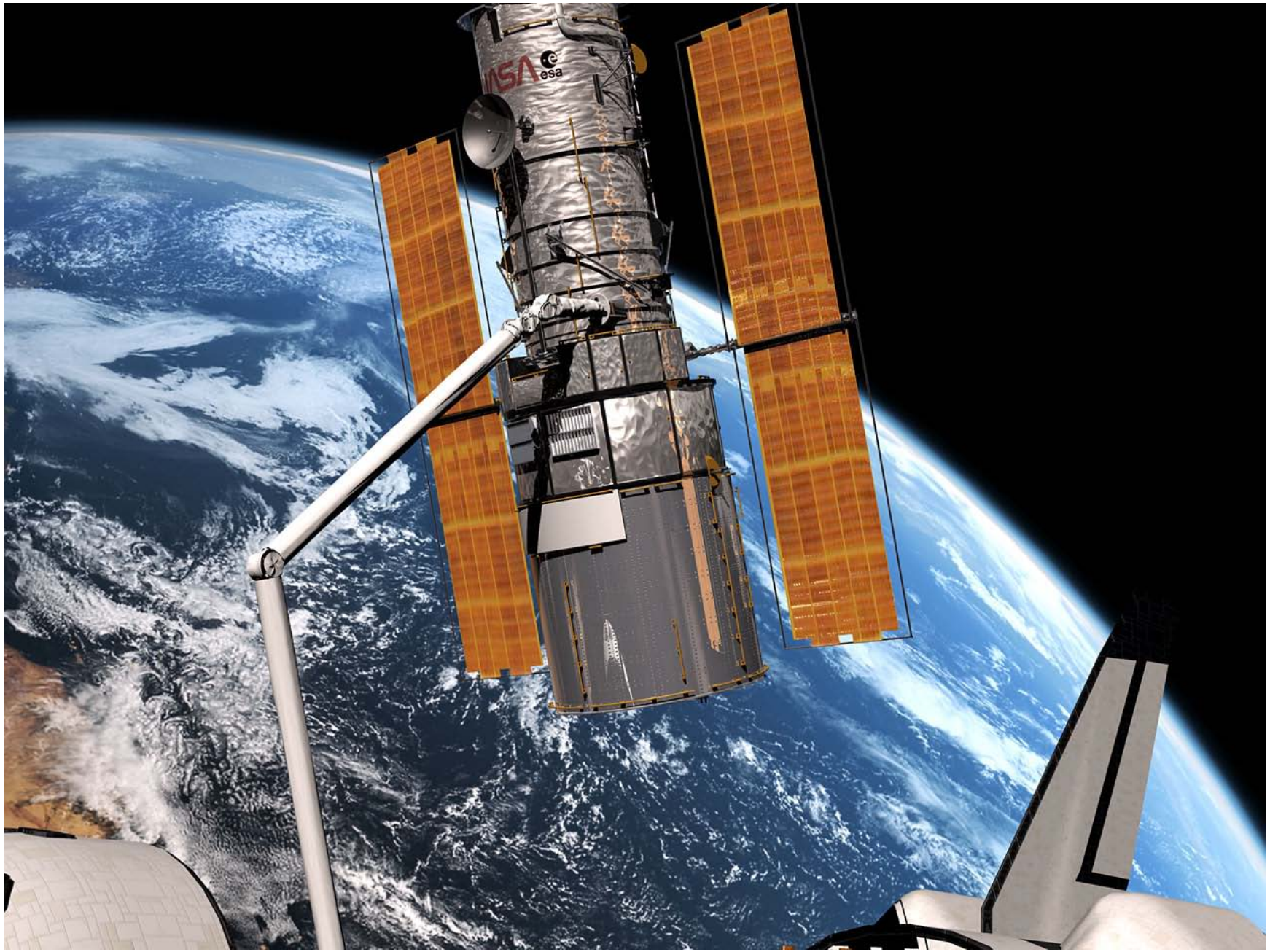


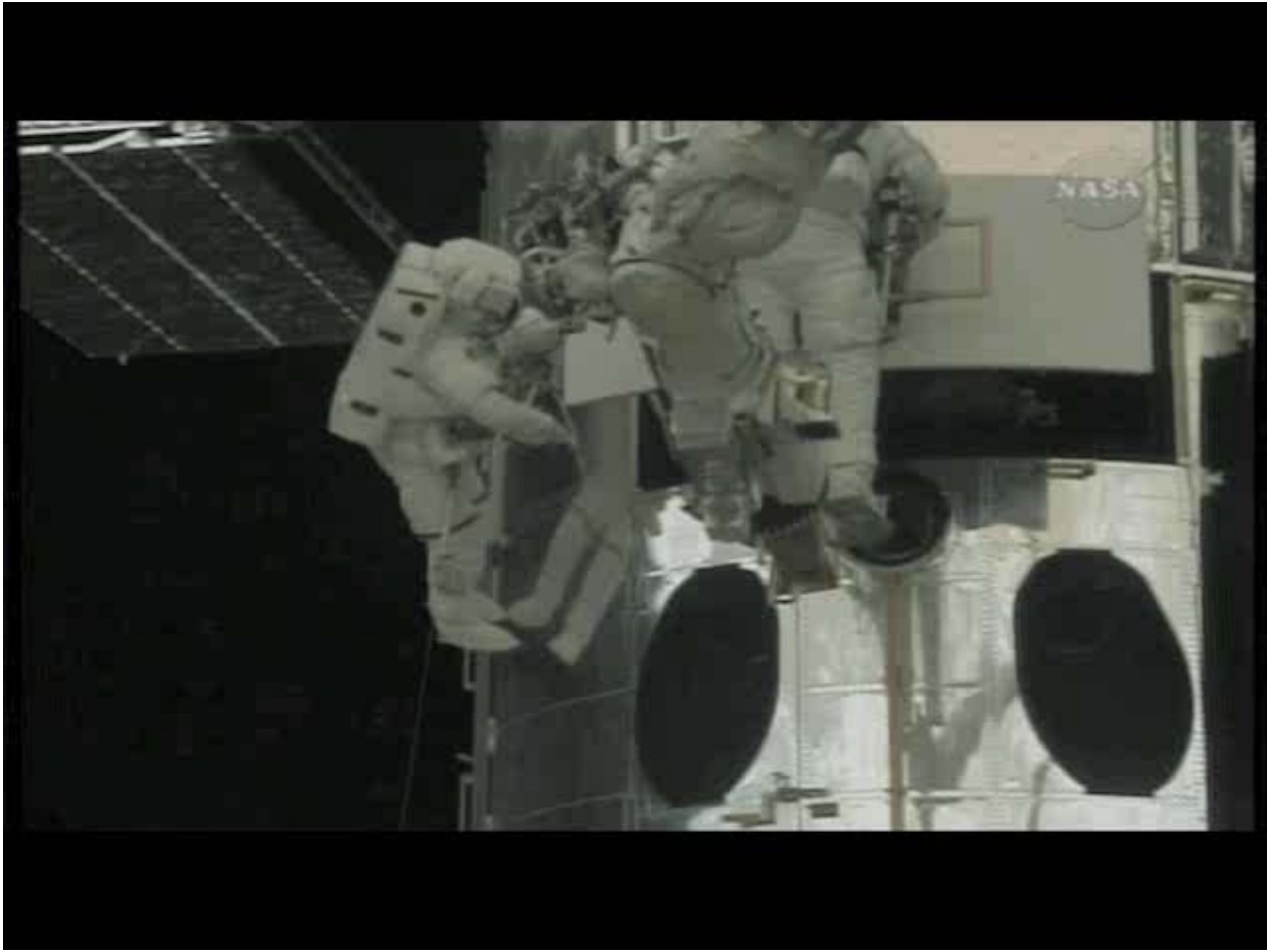
M51

A new “eye”: WFC3 on HST



NASA


NASA
esa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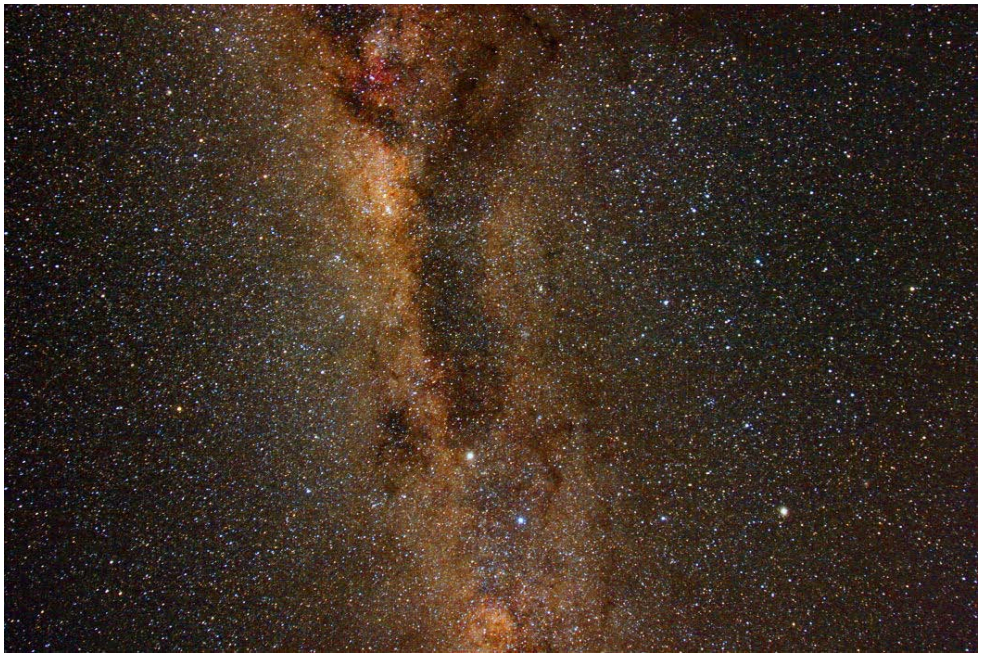
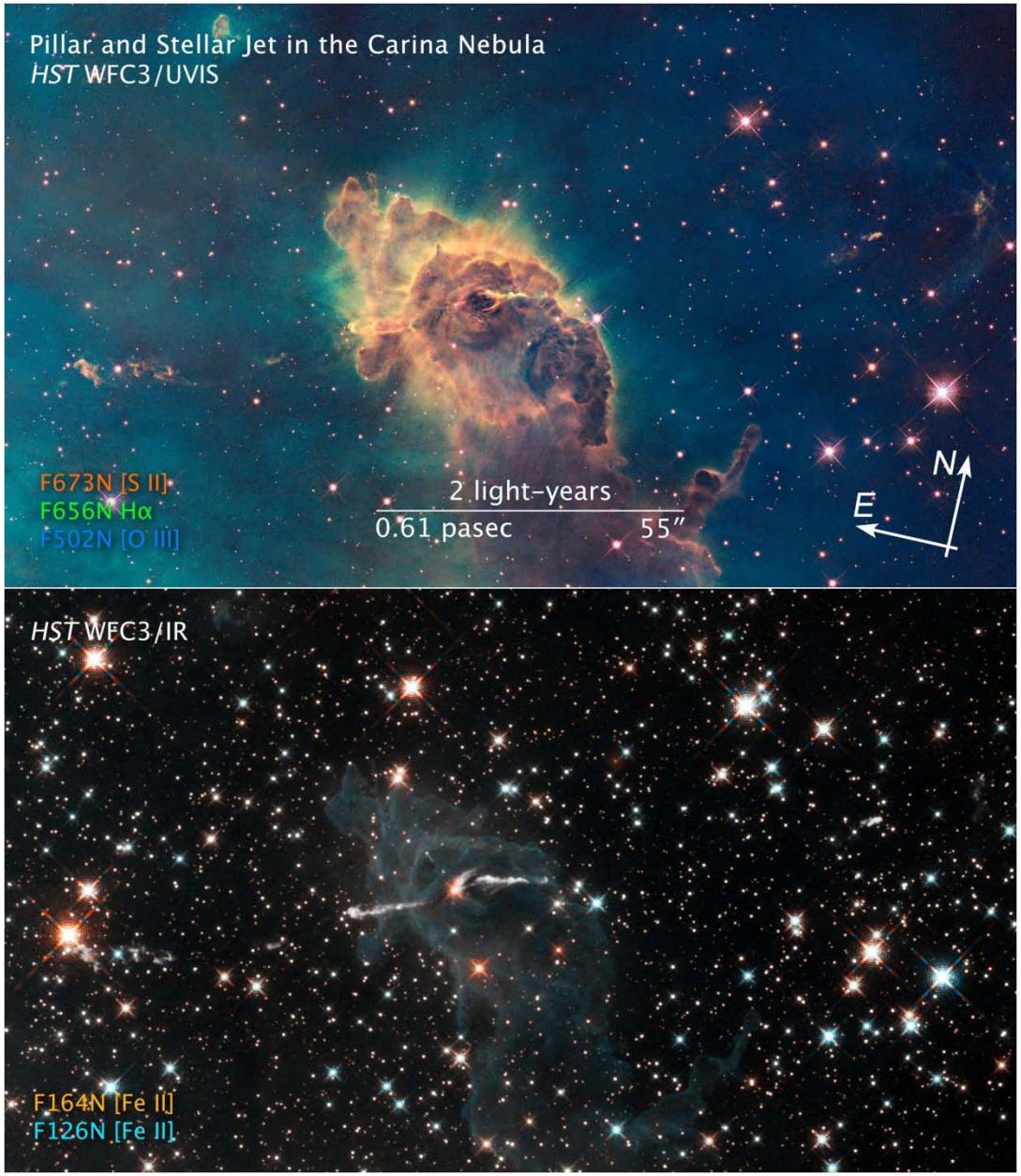
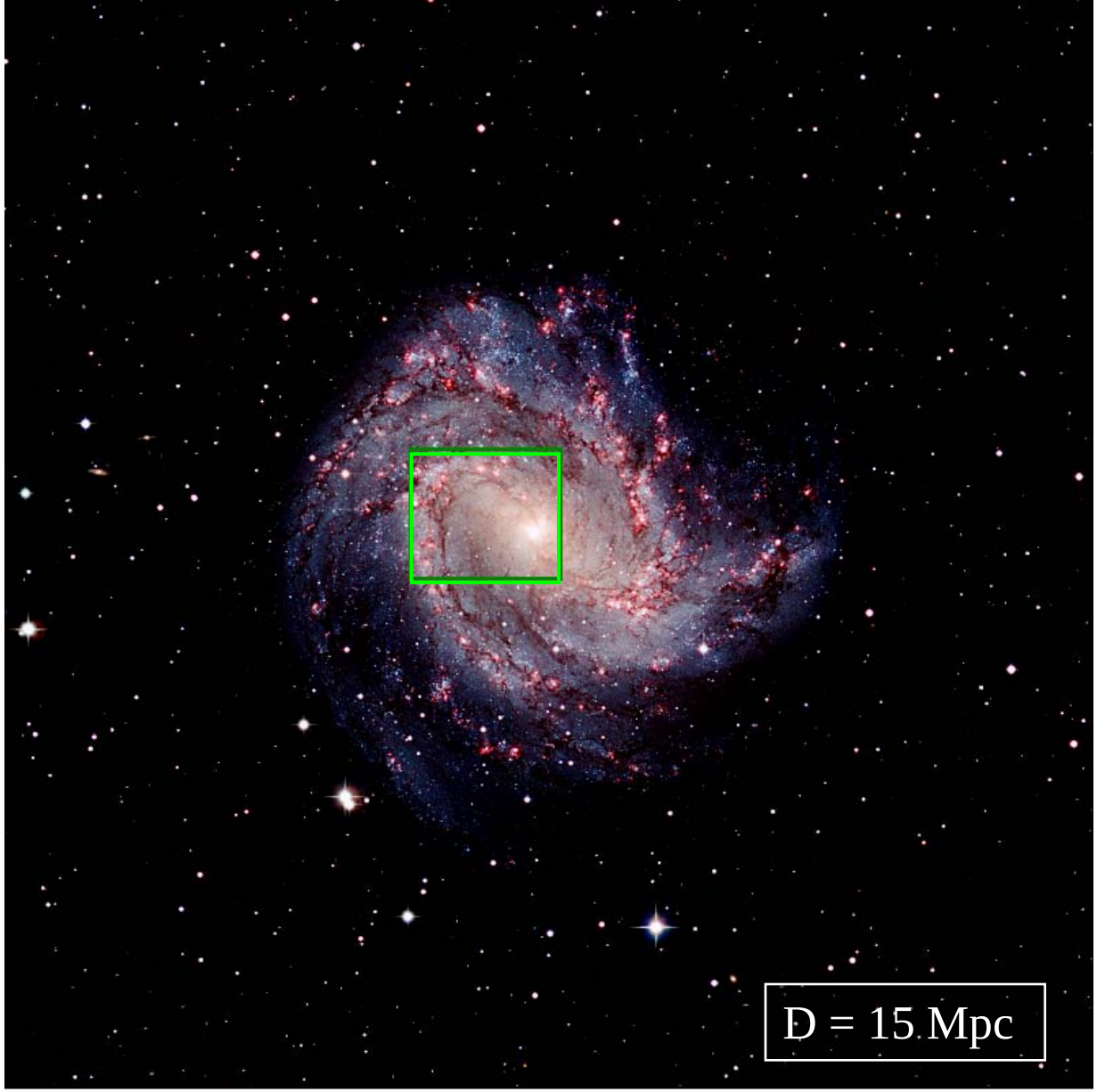



Pillar and Stellar Jet in the Carina Nebula
HST WFC3/UVIS
F673N [S II]
F656N Hα
F502N [O III]
2 light-years
0.61 pasec
55″
N
E
HST WFC3/IR
F164N [Fe II]
F126N [Fe II]



Spiral Galaxy Messier 83
(WFI/2.2-m)

ESO PR Photo 25/08 (2 September 2008)

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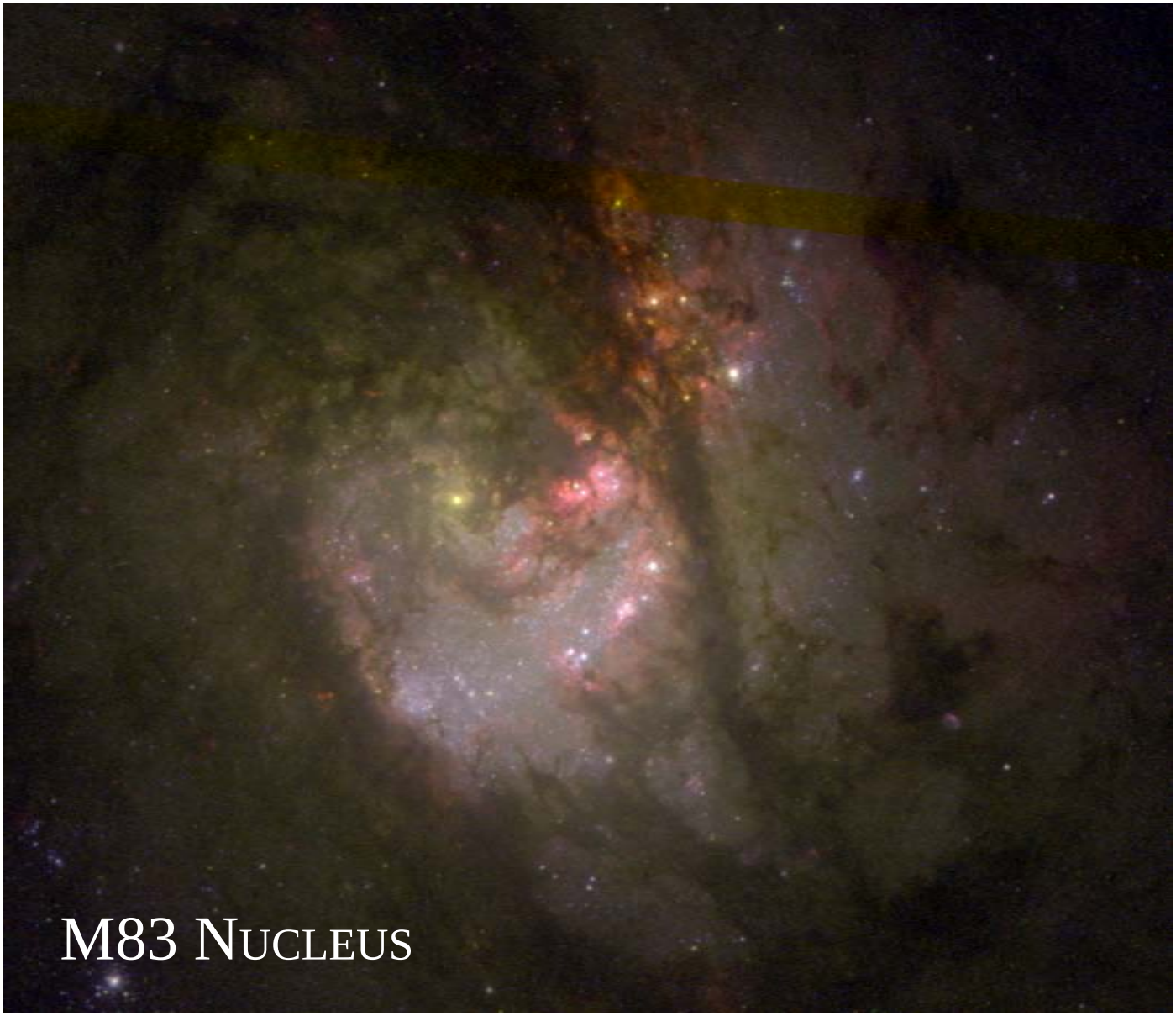
M83

F657N
F555W
F336W
1/4 scale

WFC3
science
oversight
Committee



F657N F673N F373N

“Quel sol che pria d’amor mi scaldò il petto
Di bella verità m’avea scoverto
Provando e riprovando, il dolce aspetto.”
Dante, Paradiso

"Mi par che nelle dispute di problemi naturali non si dovrebbe cominciare dalle autorità di luoghi delle Scritture, ma dalle **sensate esperienze e dalle dimostrazioni necessarie**".
Galileo, Quarta lettera copernicana

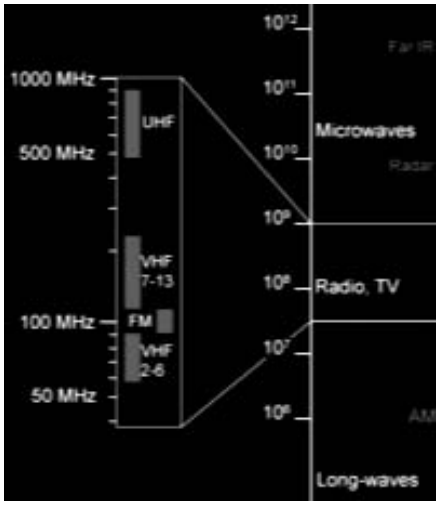
“There are more things in heaven and earth than are dreamt of in your philosophy”
Shakespeare, Hamlet

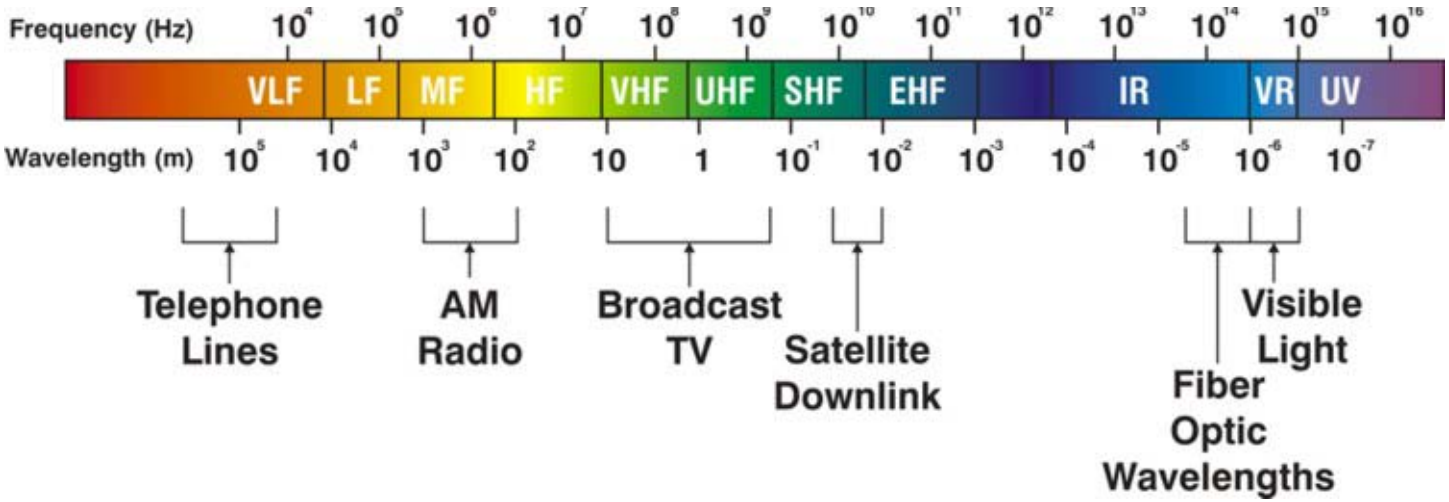
Ringraziamenti

- I miei colleghi del WFC3 Science Oversight Committee
- Gli astronauti di STS-125 Atlantis: Megan McArthur, John Grunsfeld, Andrew Feustel, Mike Massimino, Scott Altman, Gregory Johnson, Michael Good
- NASA/GSFC e STScI instrument teams
- European Space Agency
- Last but not least: Guglielmo Marconi

DR
Di Renzo Editore

Di Renzo Editore


1000 MHz
500 MHz
100 MHz
50 MHz
UHF
VHF 7-13
FM
VHF 2-6
Microwaves
Radio, TV
Long-waves


Frequency (Hz)
VLF
LF
MF
HF
VHF
UHF
SHF
EHF
IR
VR
UV
Wavelength (m)
Telephone Lines
AM Radio
Broadcast TV
Satellite Downlink
Fiber Optic Wavelengths
Visible Light