

# I NUOVI OCCHI DELL'ASTROFISICA

COME SCRUTARE IL CIELO ALLA RICERCA DI UN'ALTRA TERRA

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NASA, ESA, AURA/CALTECH, PALOMAR OBSERVATORY

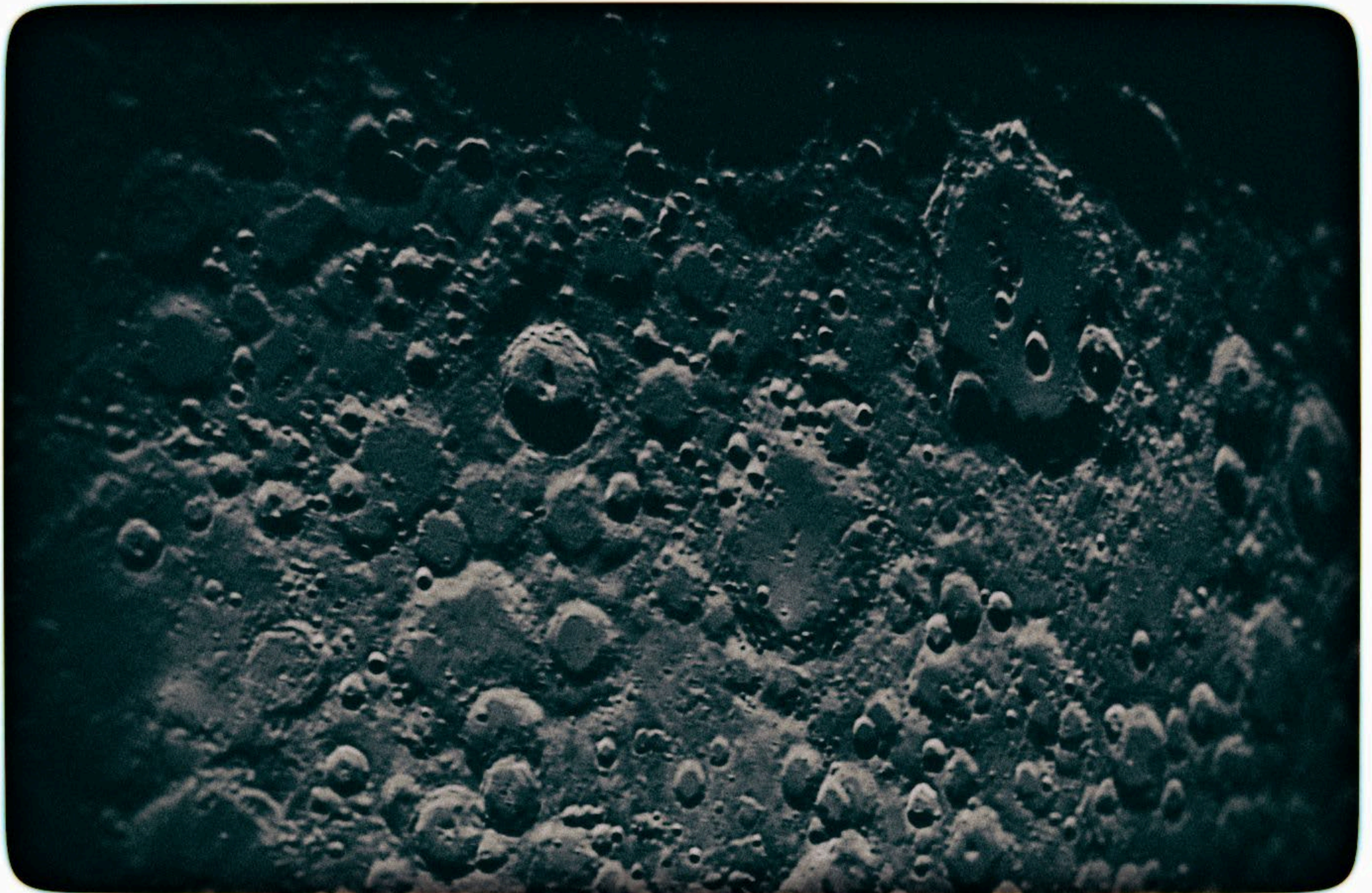




IMAGE CREDIT: NASA, ESA, CSA, AND STSCI



# → COSMIC HISTORY

10<sup>-32</sup> seconds

1 second

100 seconds

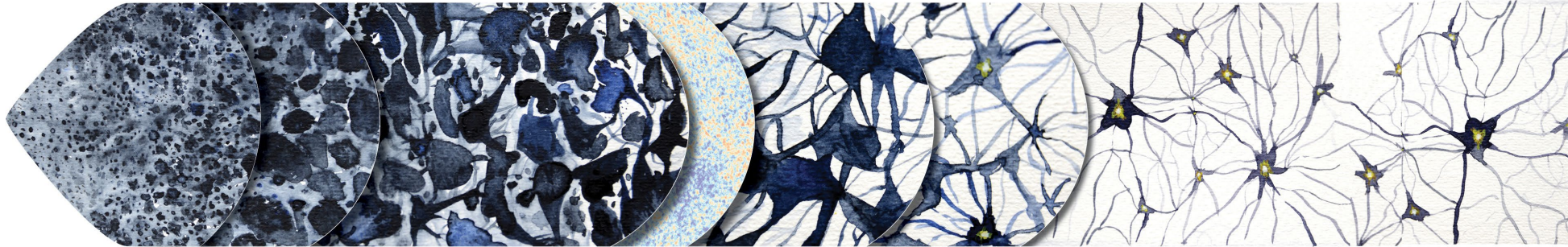
380 000 years

300–500 million years

Billions of years

13.8 billion years

Beginning of the Universe



### Inflation

Accelerated expansion of the Universe

### Formation of light and matter

### Light and matter are coupled

Dark matter evolves independently: it starts clumping and forming a web of structures

### Light and matter separate

• Protons and electrons form atoms  
• Light starts travelling freely: it will become the Cosmic Microwave Background (CMB)

### Dark ages

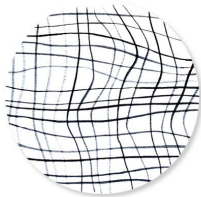
Atoms start feeling the gravity of the cosmic web of dark matter

### First stars

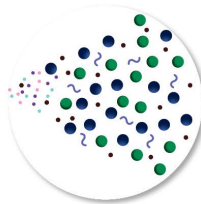
The first stars and galaxies form in the densest knots of the cosmic web

### Galaxy evolution

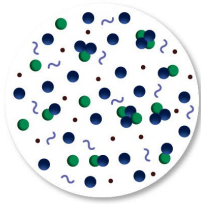
### The present Universe



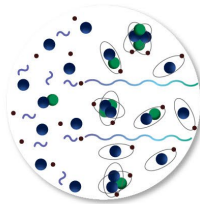
• Tiny fluctuations: the seeds of future structures  
• Gravitational waves?



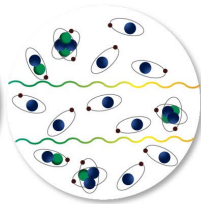
Frequent collisions between normal matter and light



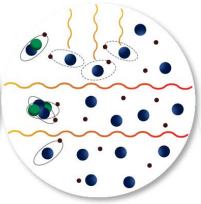
As the Universe expands, particles collide less frequently



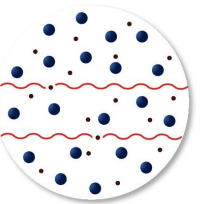
Last scattering of light off electrons  
→ **Polarisation**



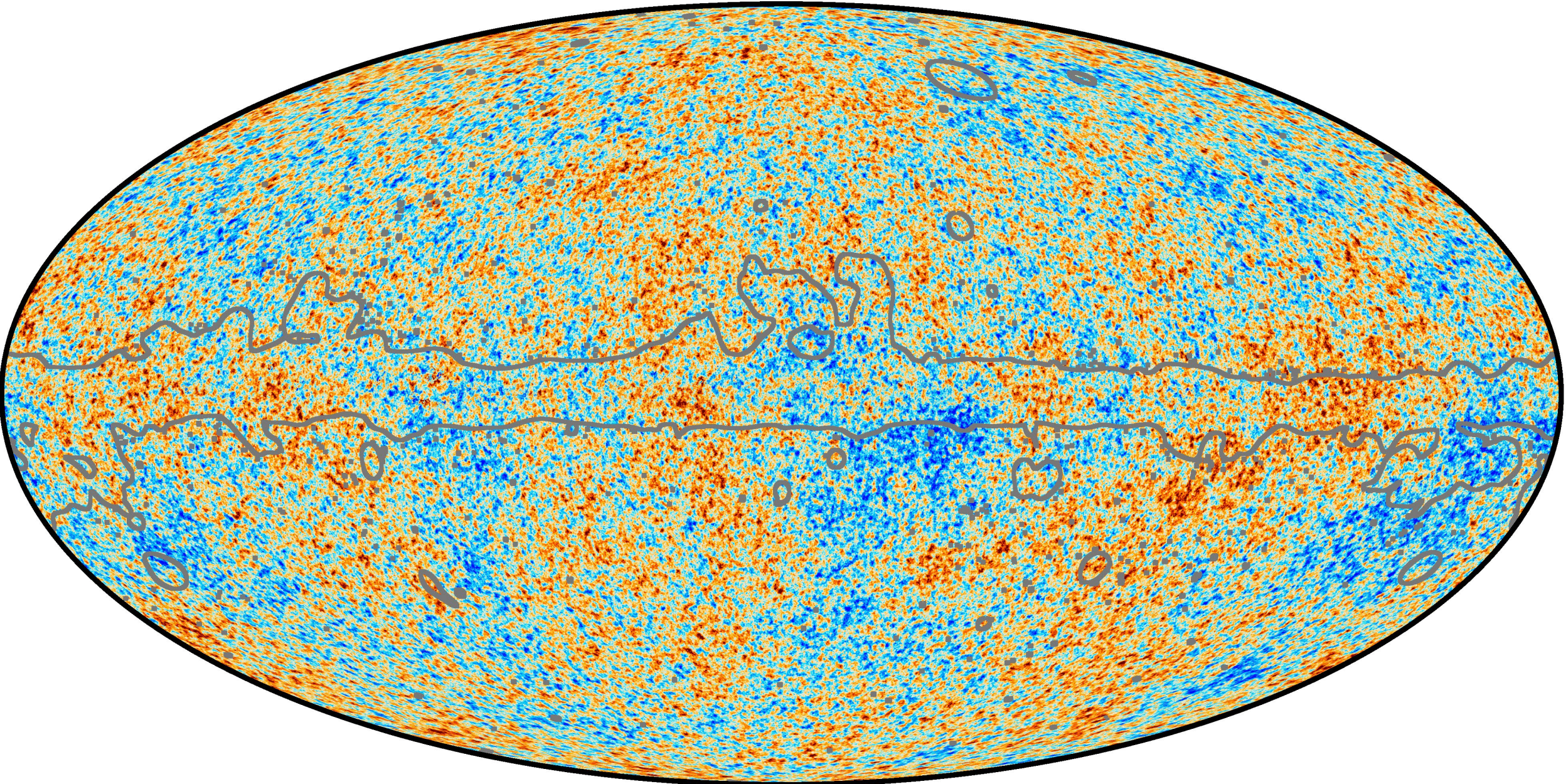
The Universe is dark as stars and galaxies are yet to form

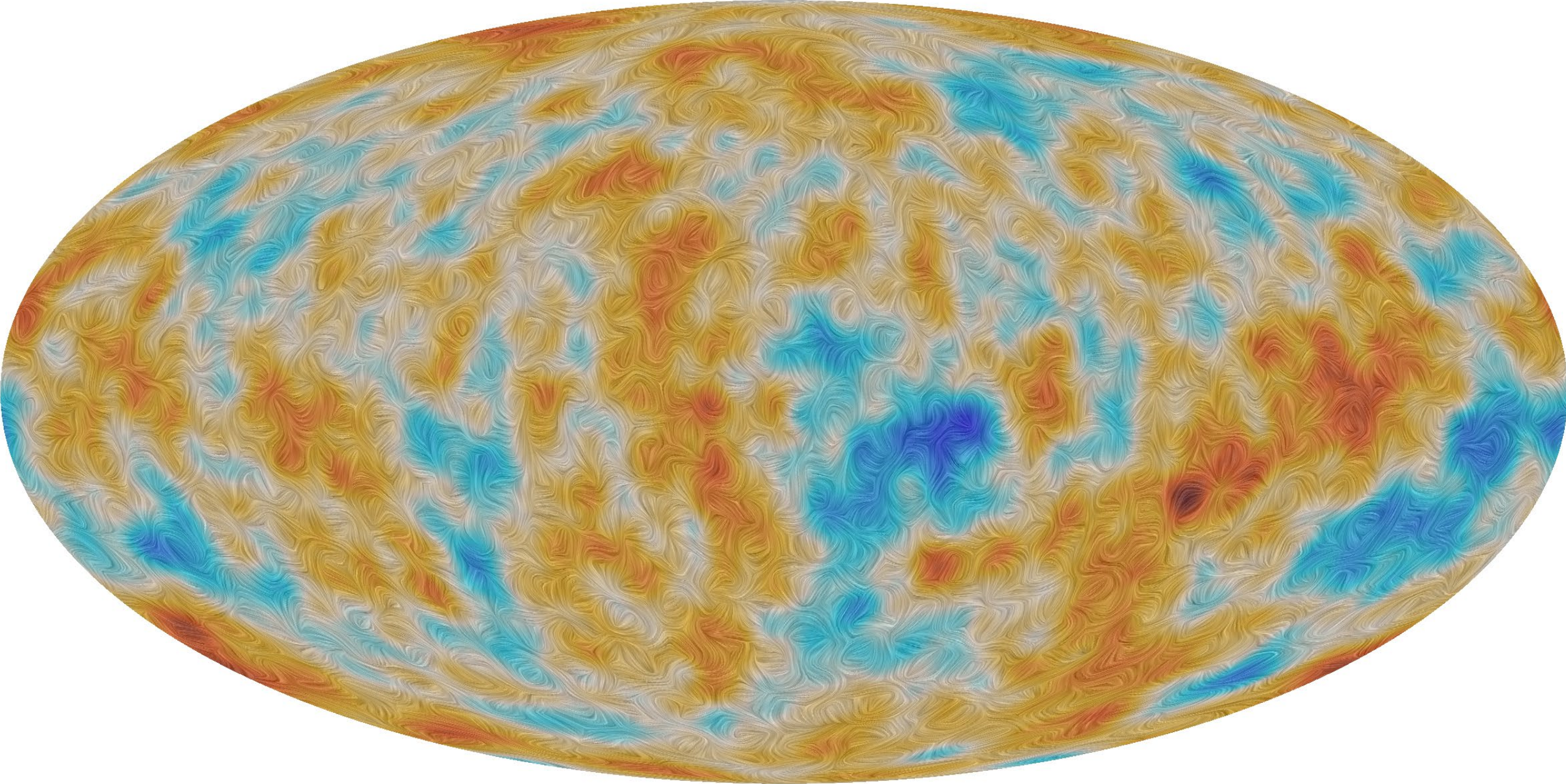


Light from first stars and galaxies breaks atoms apart and "reionises" the Universe



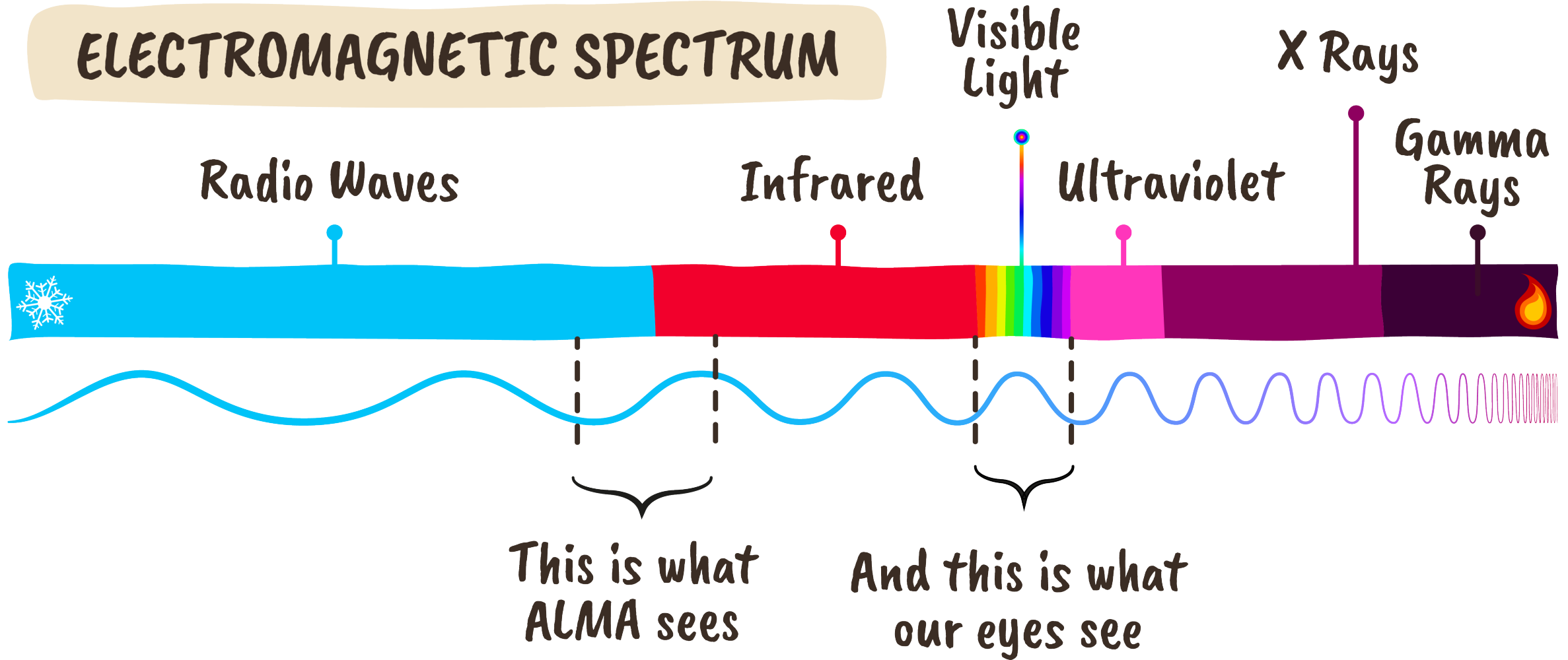
Light can interact again with electrons  
→ **Polarisation**

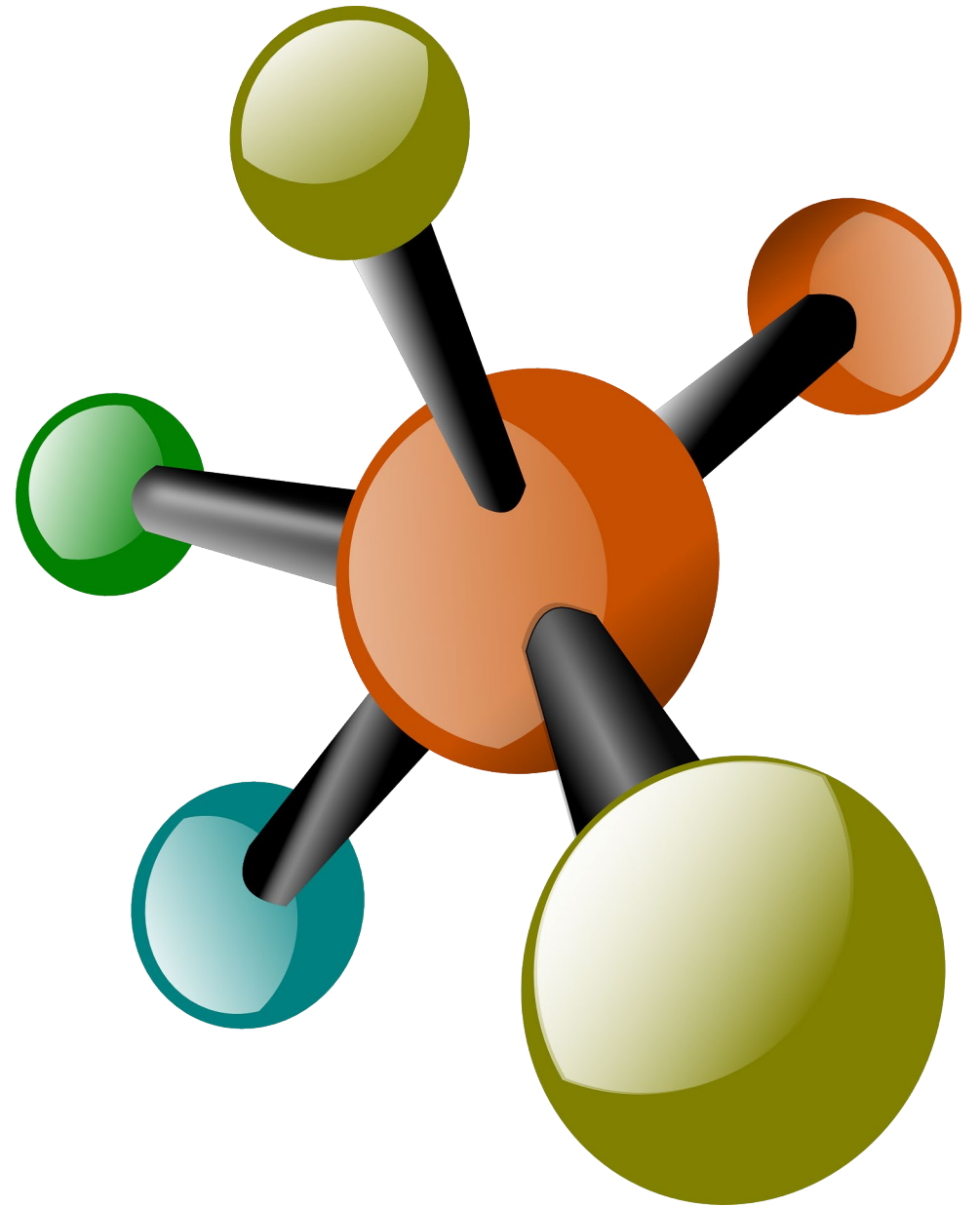


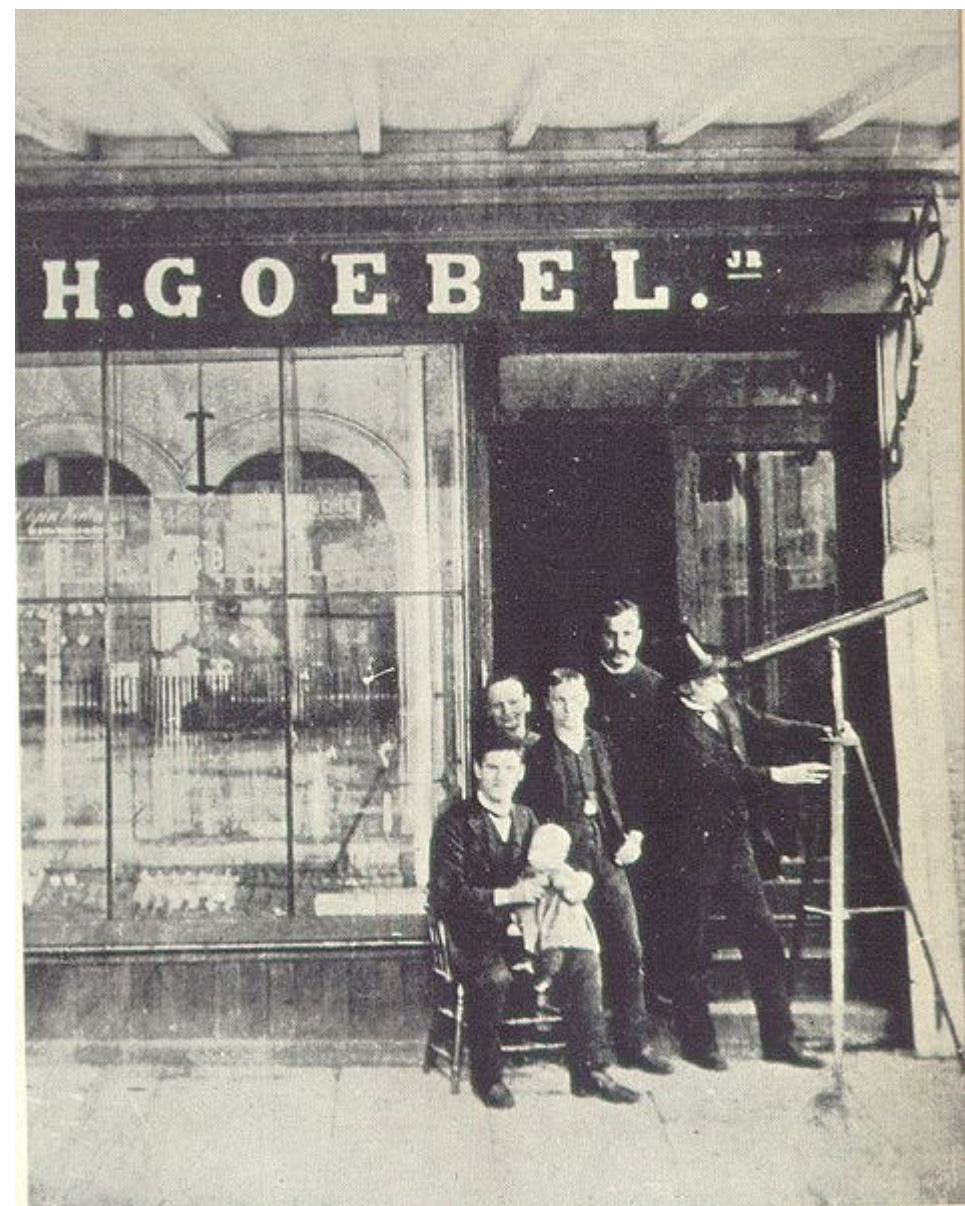




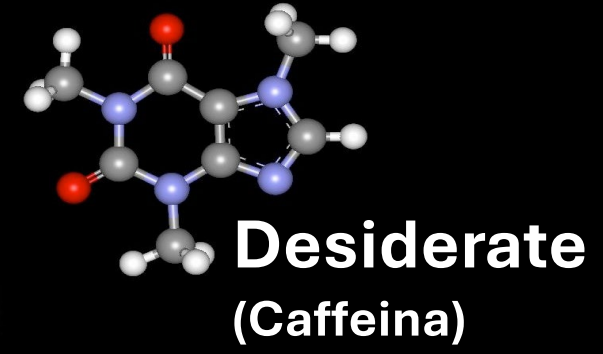
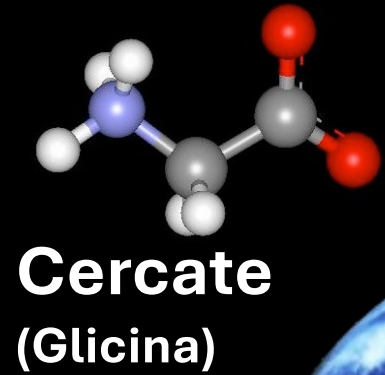
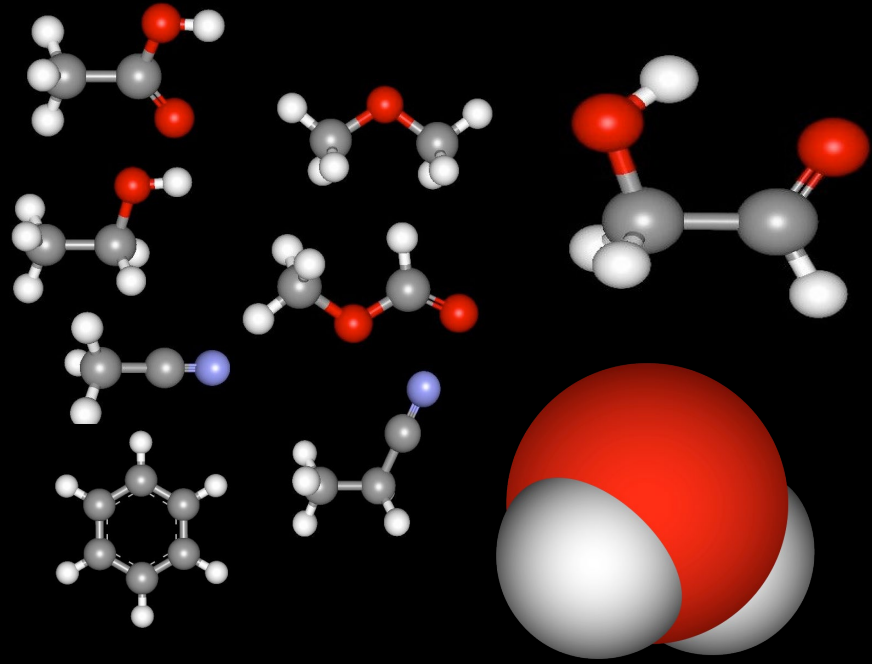
# ELECTROMAGNETIC SPECTRUM







# Come costruirsi un pianeta abitabile

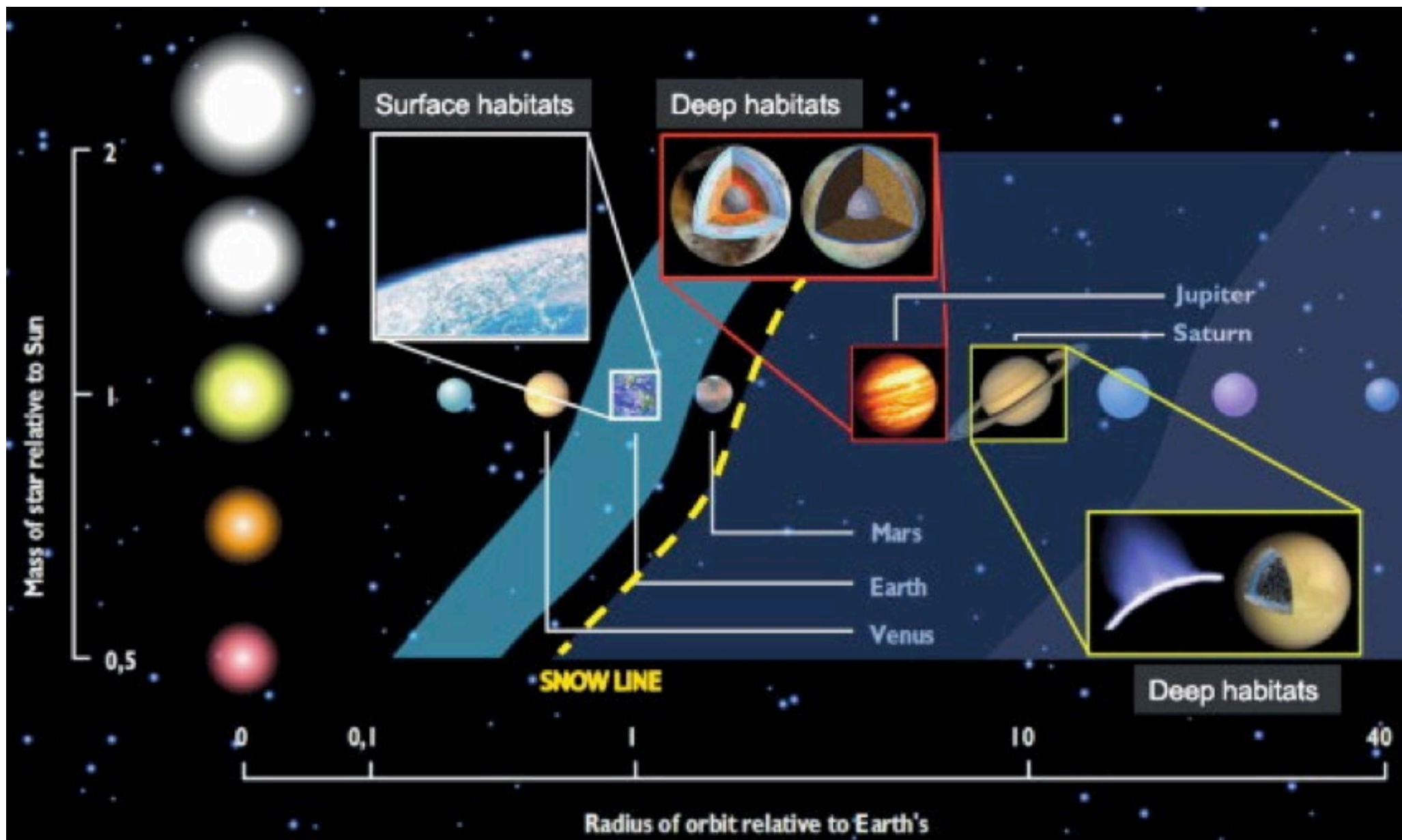


**Osservate nel mezzo interstellare**

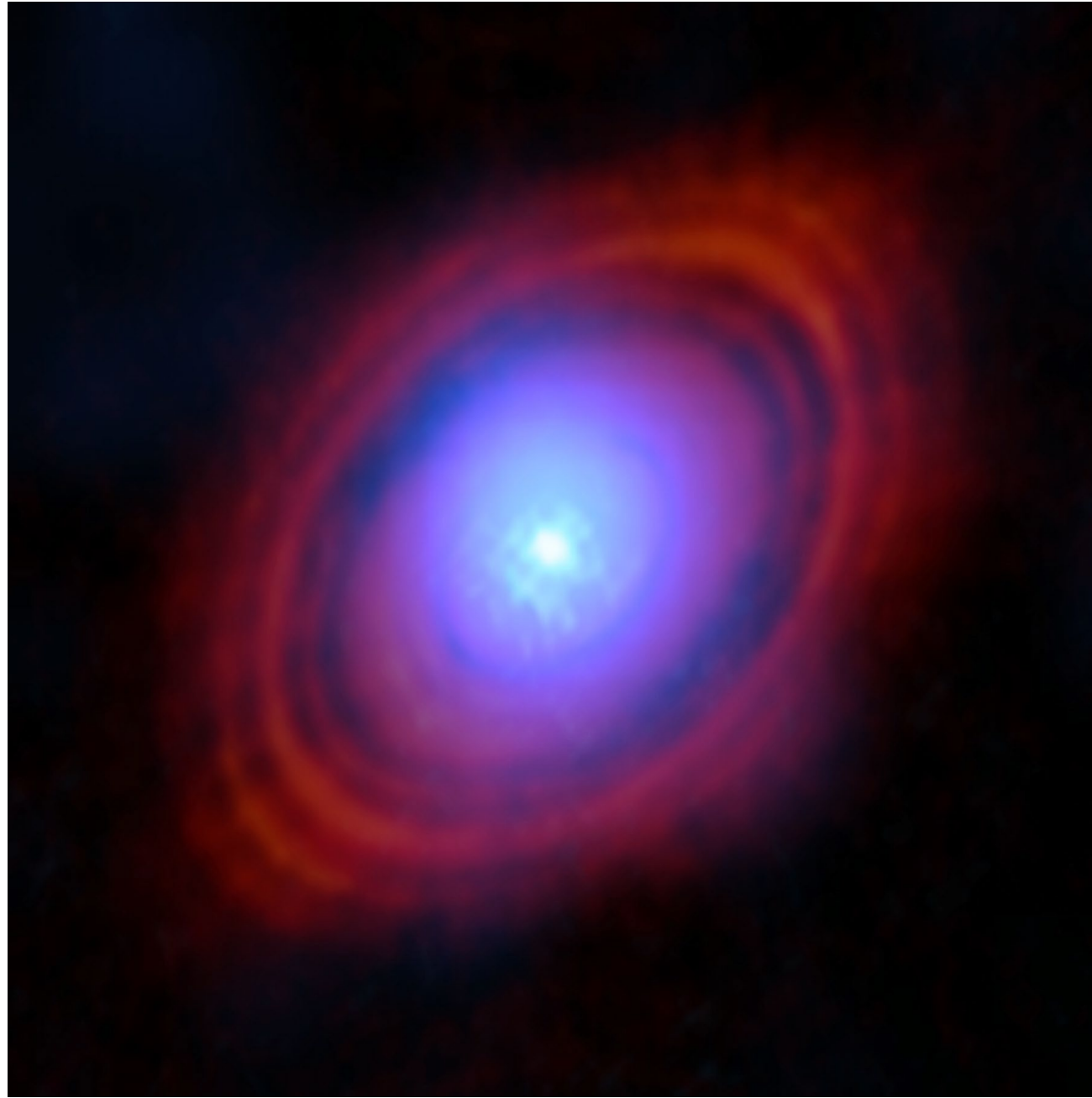
## Ricetta:

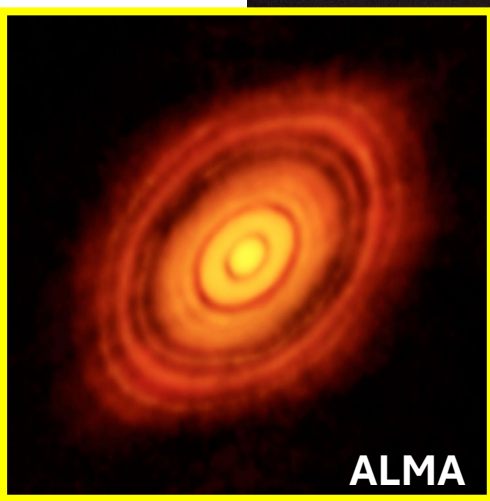
- Comporre un pianeta terrestre
- Porlo alla giusta distanza dalla stella
- Depositarcì sopra materiale pre-biotico

# La “Zona Abitabile”

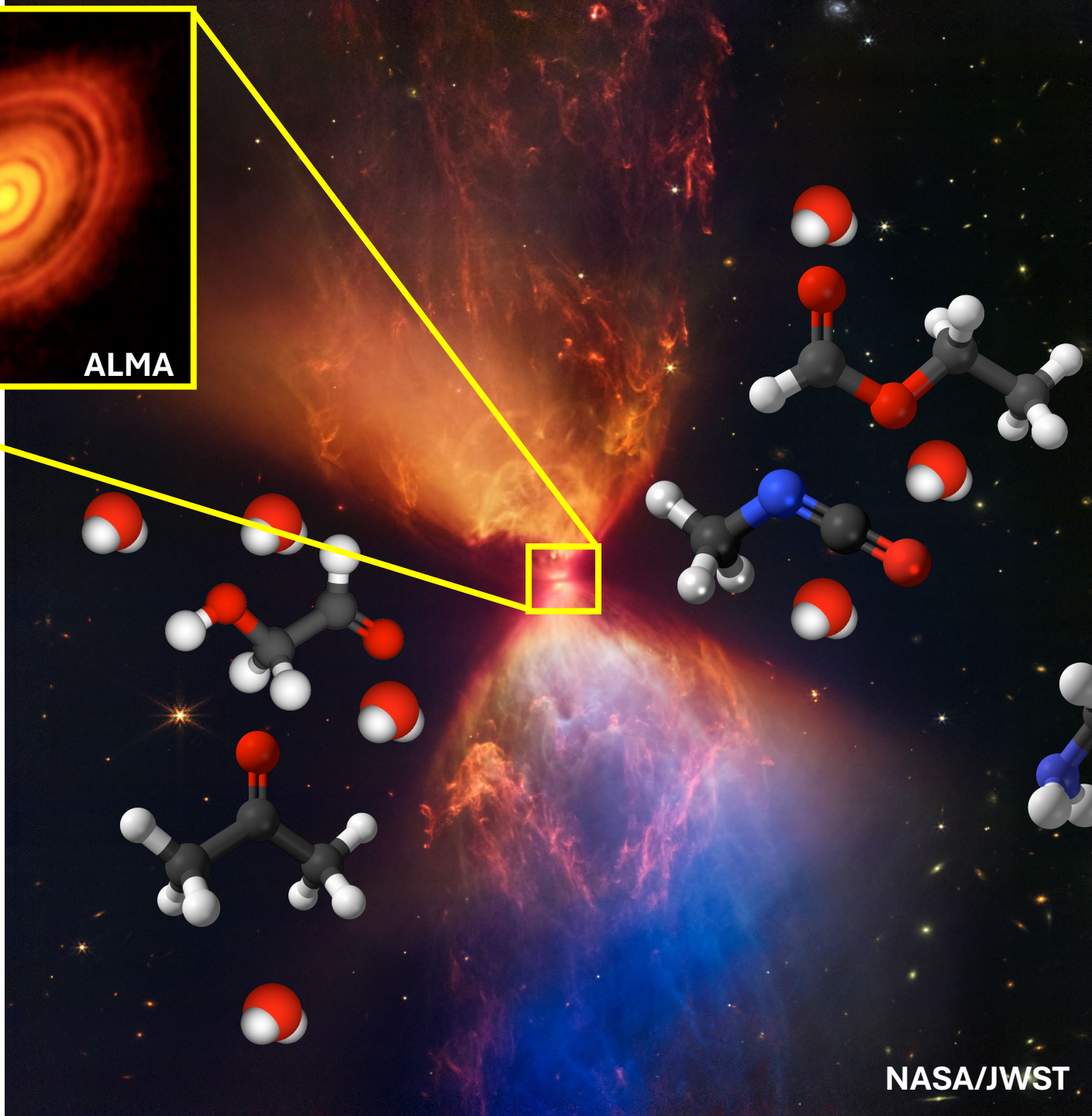


# La culla dei pianeti abitabili: **Polvere** e **Acqua**





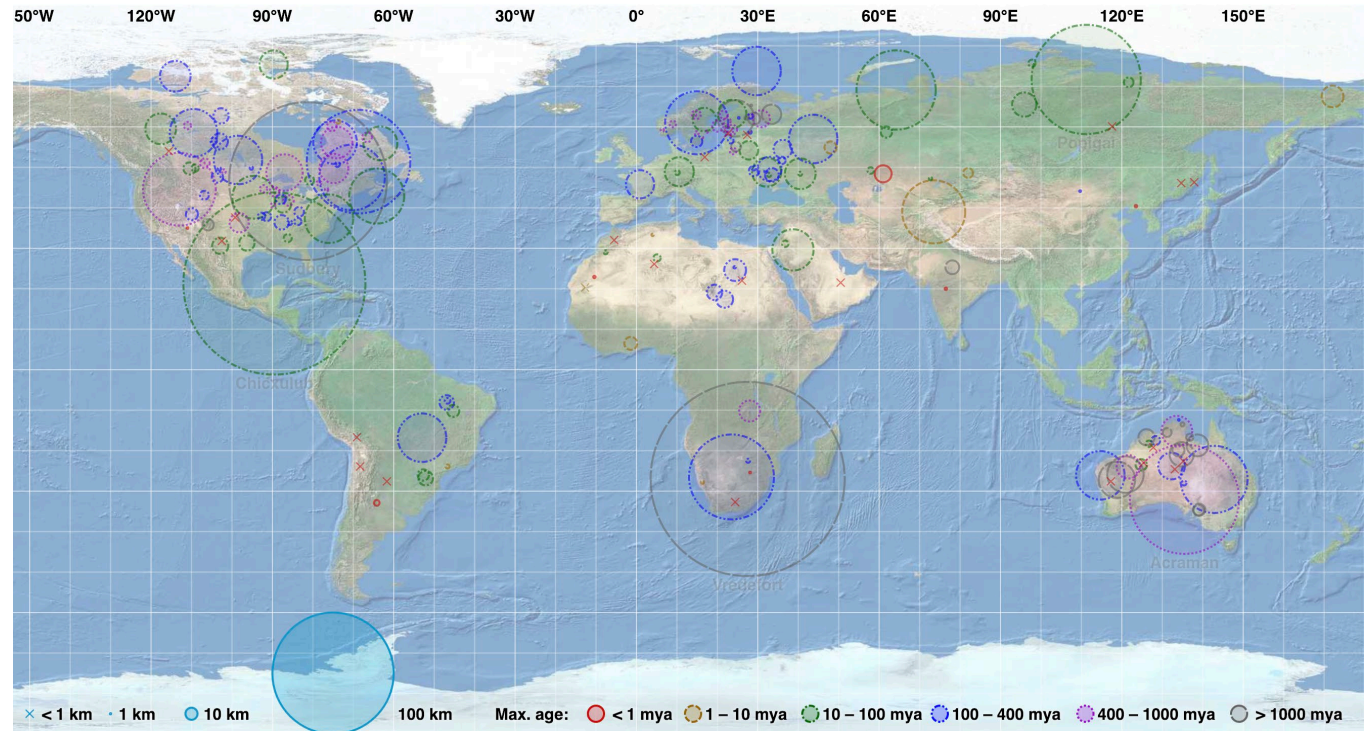
ALMA



NASA/JWST

# Tracce di impatti sulla Terra

Adesso eventi rari  
(per nostra fortuna)



Meteorite di Renazzo (1824), Museo Luigi Bombicci

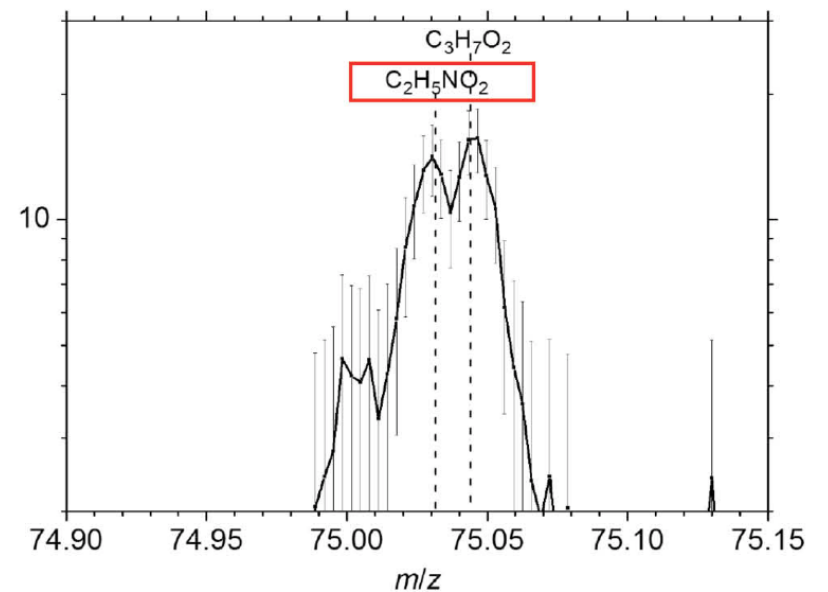
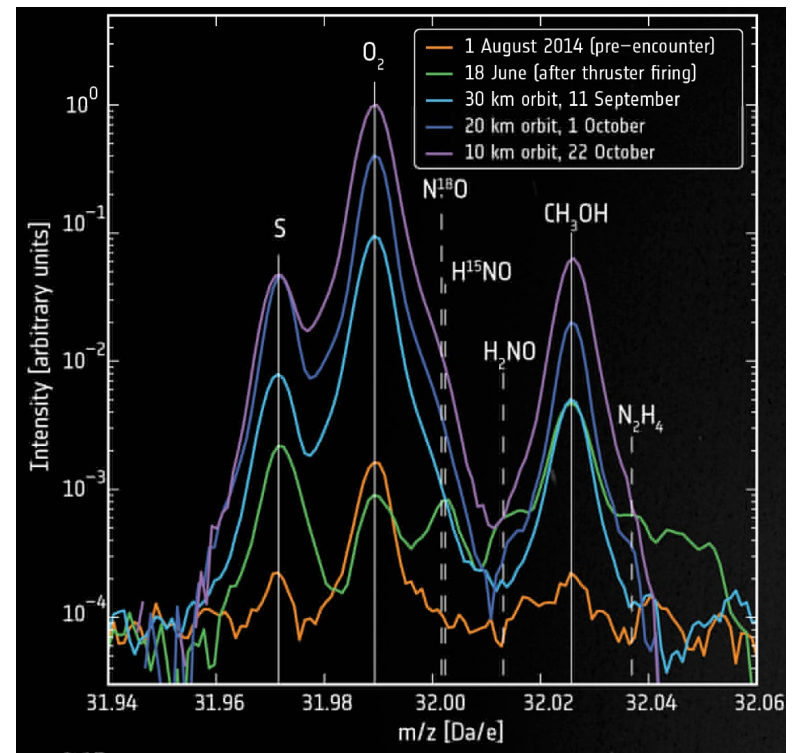


# Comete

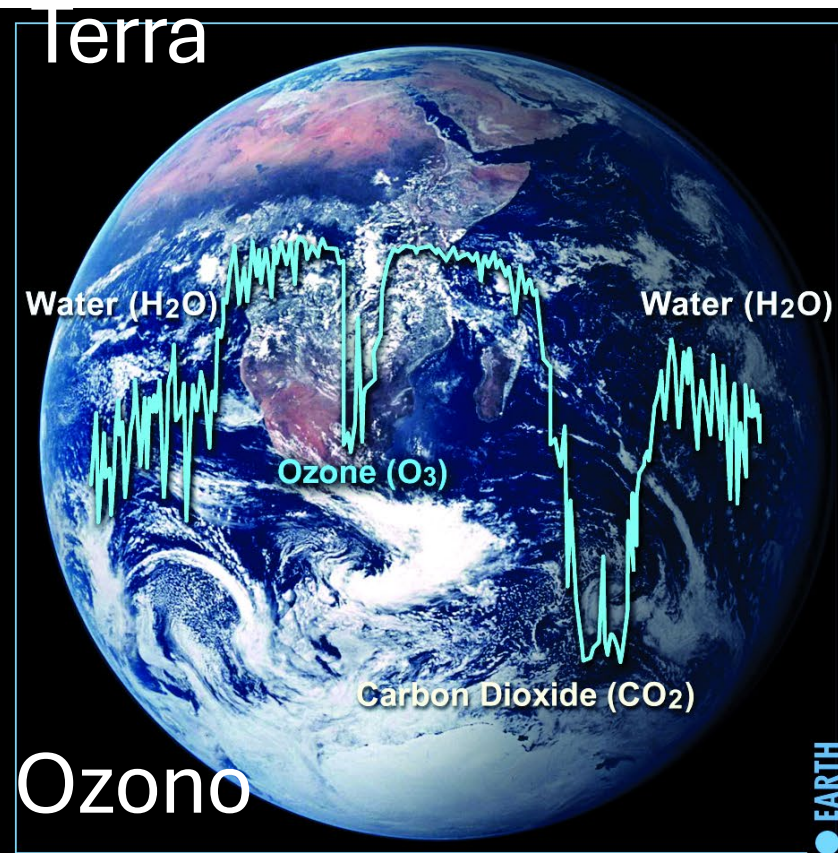
Immagini e misure dalla sonda Rosetta

Presenza di molecole complesse

- Metanolo
- Glicina
- ...



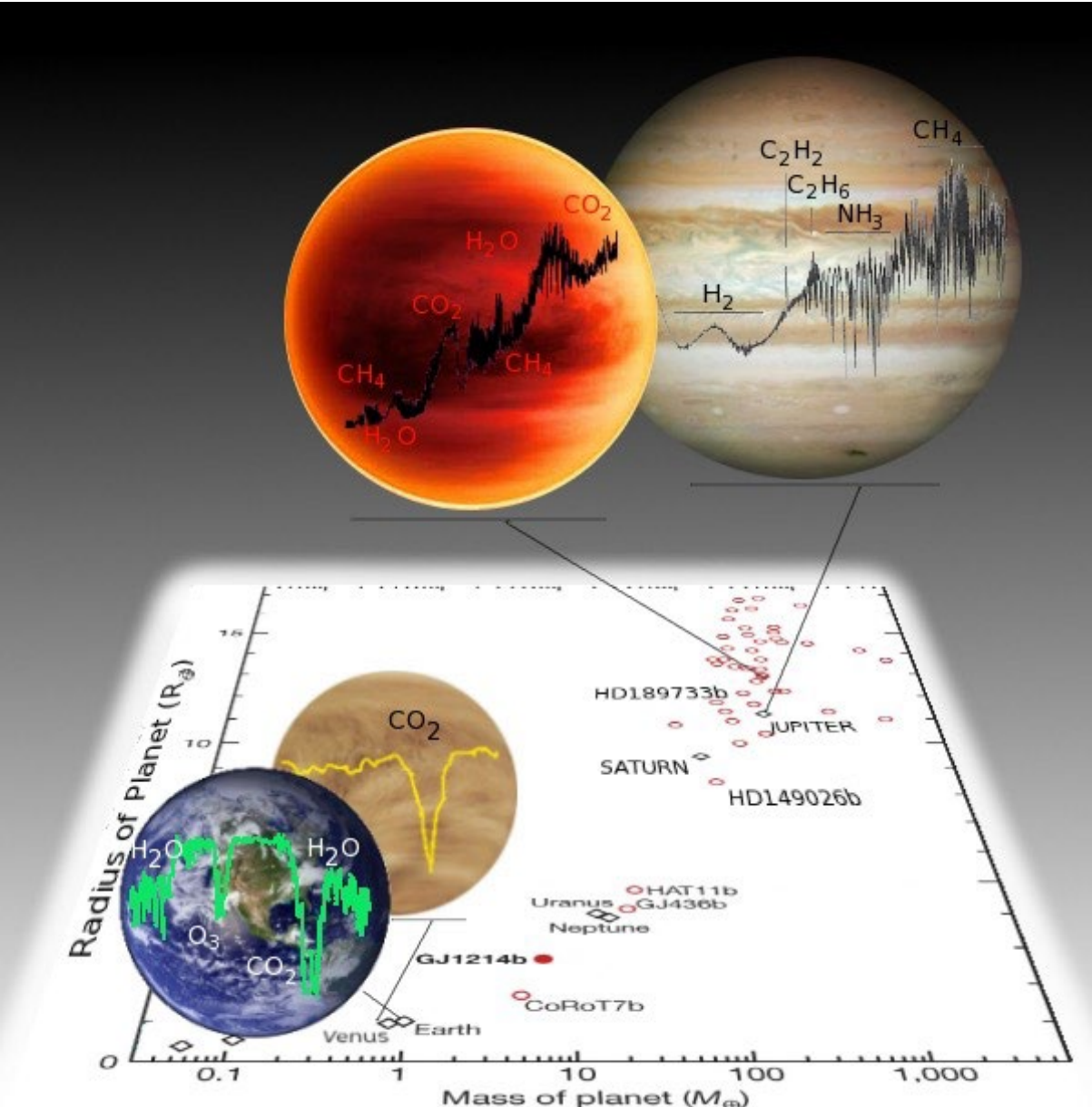
# Storie parallele e divergenti



Speranze e disillusioni nella ricerca della vita nel Sistema Solare

Costruire un pianeta abitabile puo' non bastare: evoluzione delle atmosfere

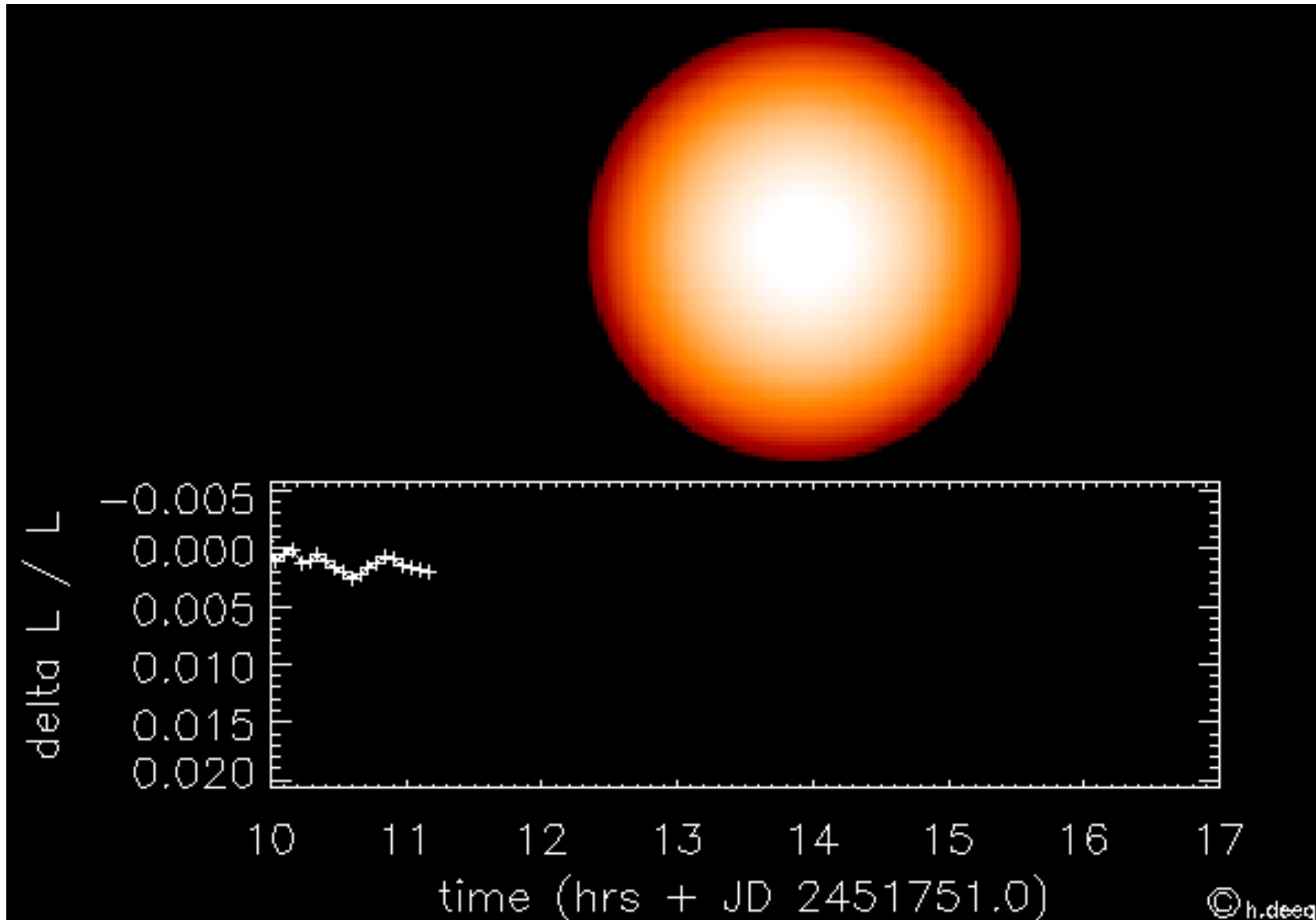
# La frontiera: analisi delle atmosfere esoplanetarie



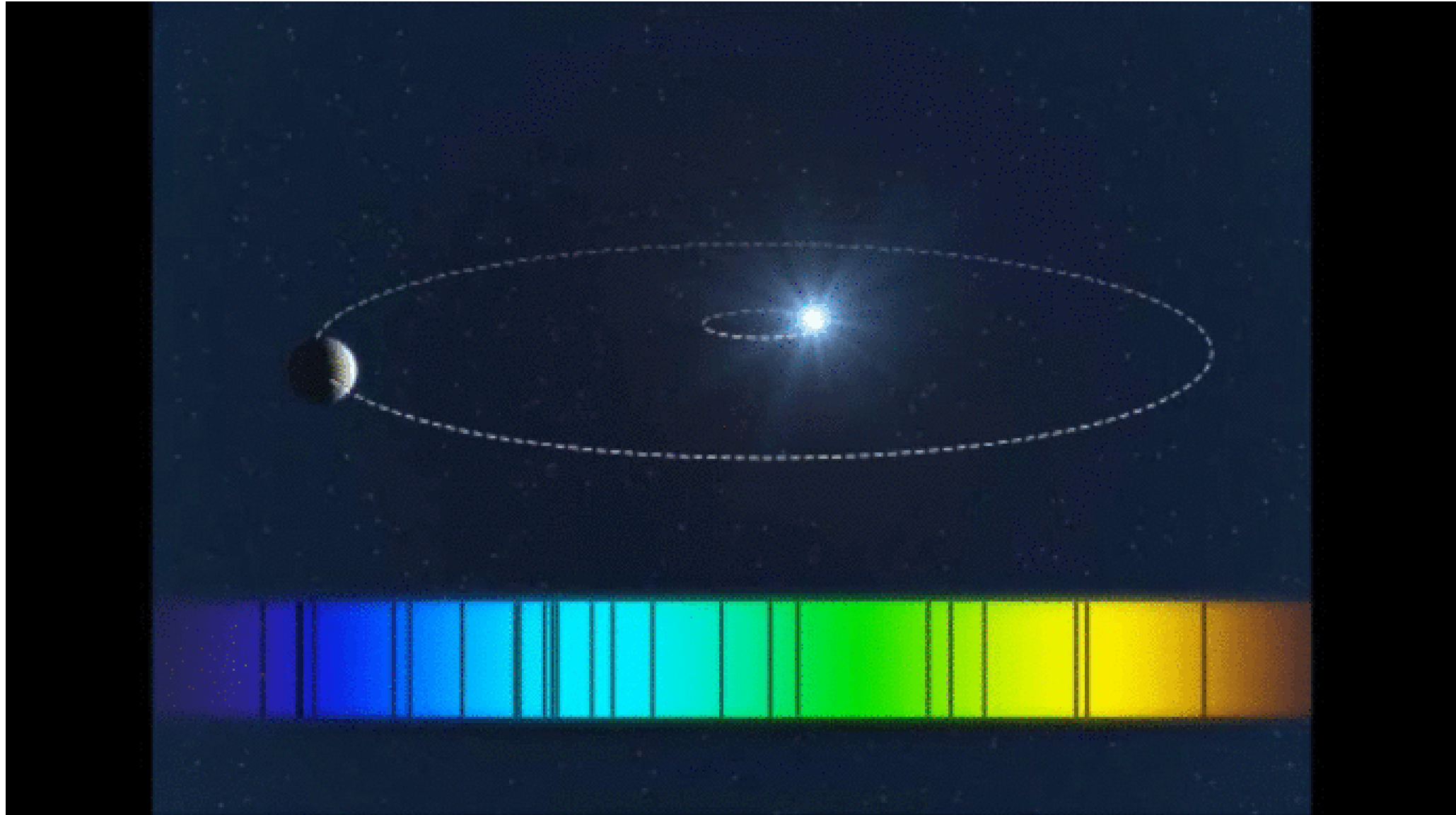
# Paranal Observatory

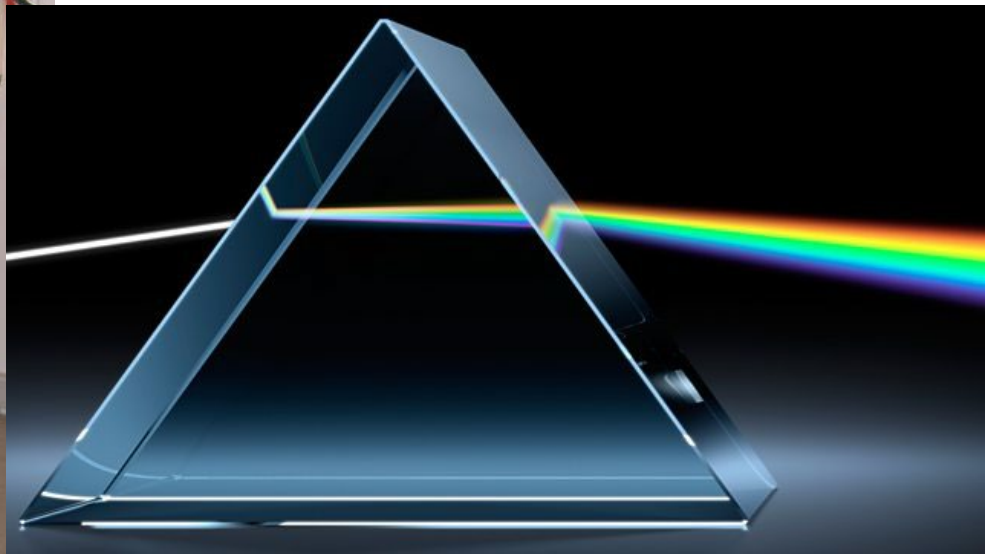
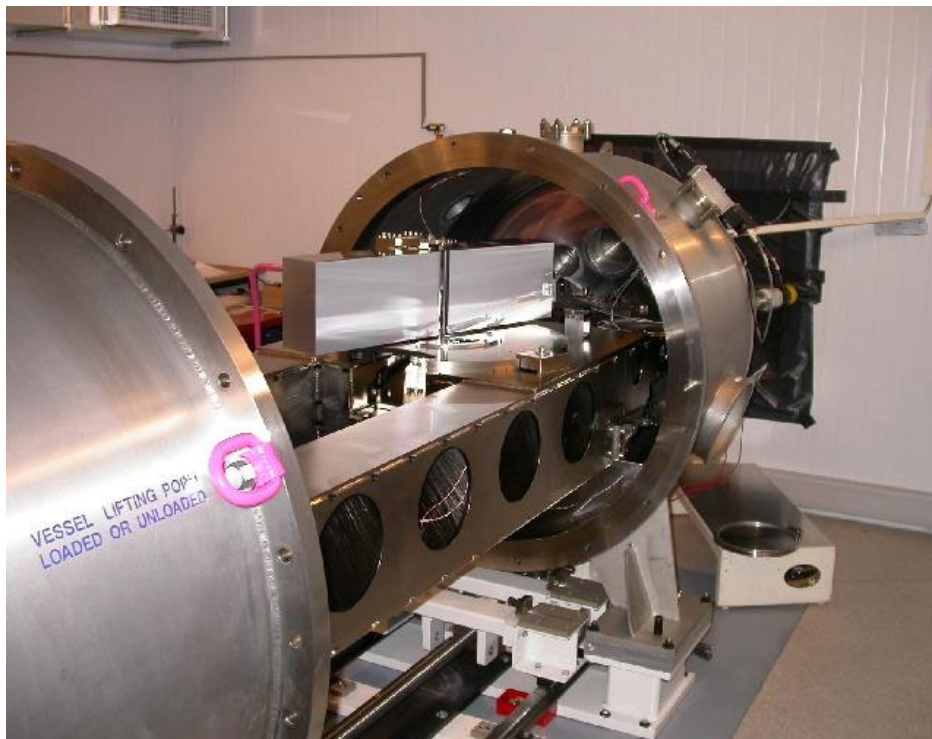
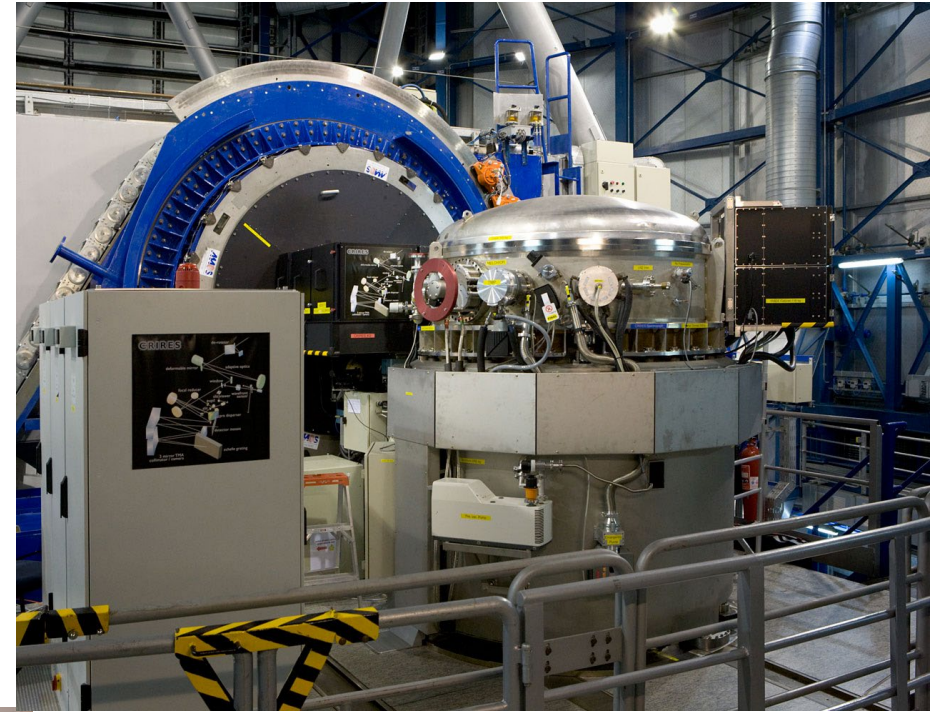
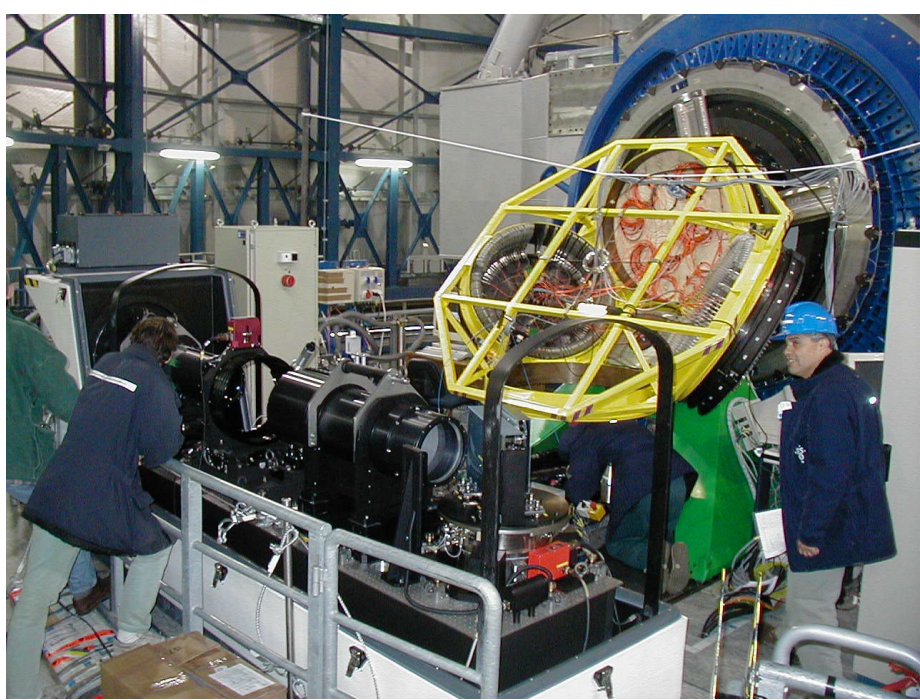


# Pianeti Extrasolari

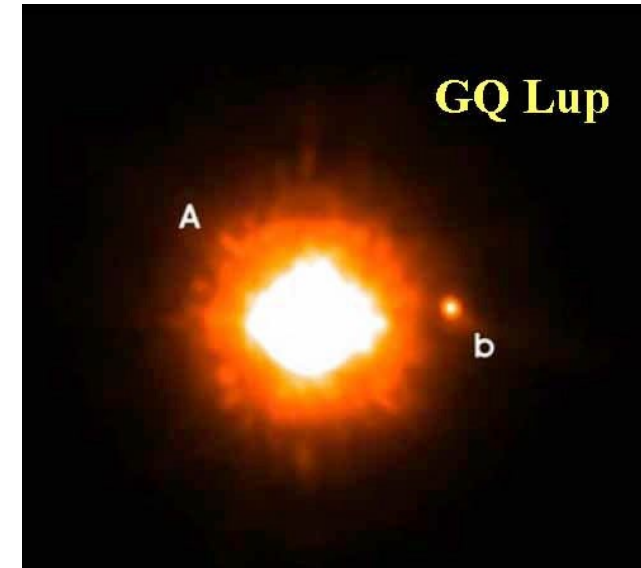
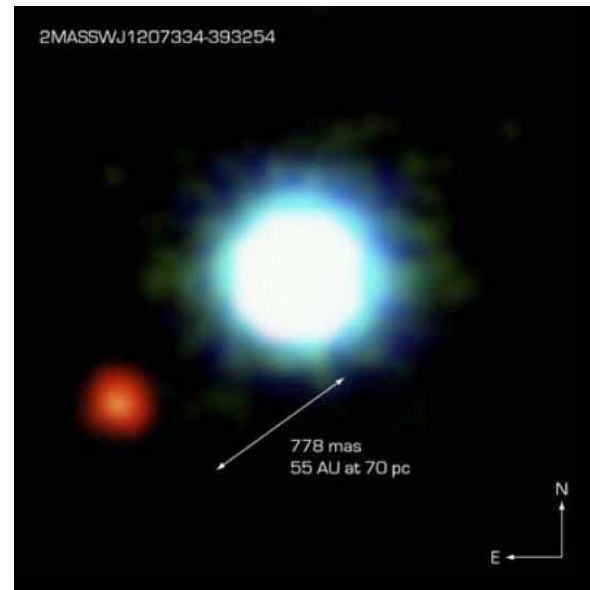
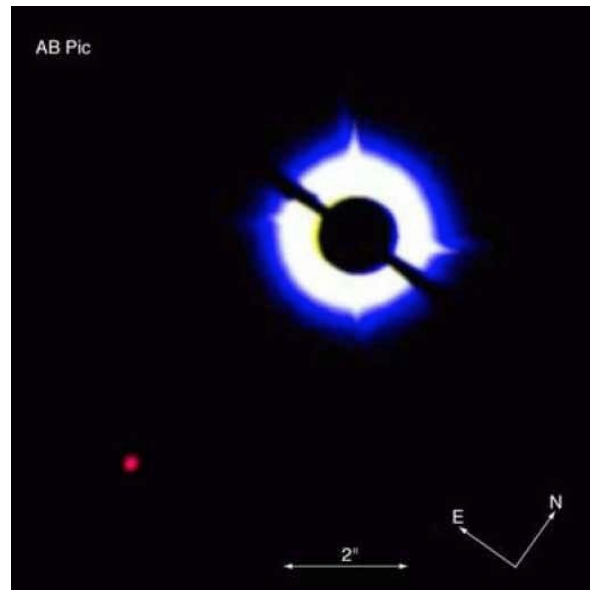


# Pianeti Extrasolari





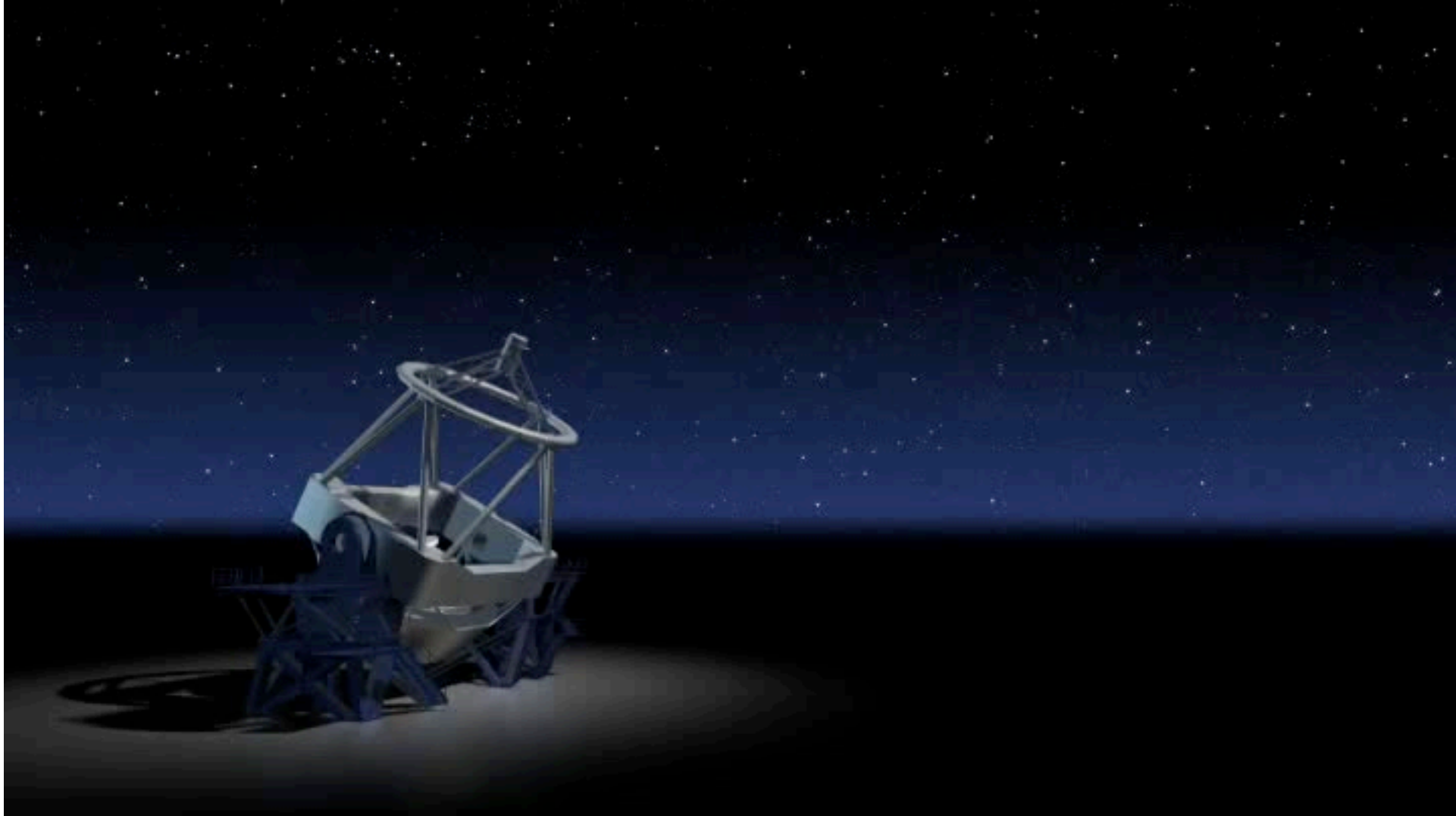
# Pianeti Extrasolari

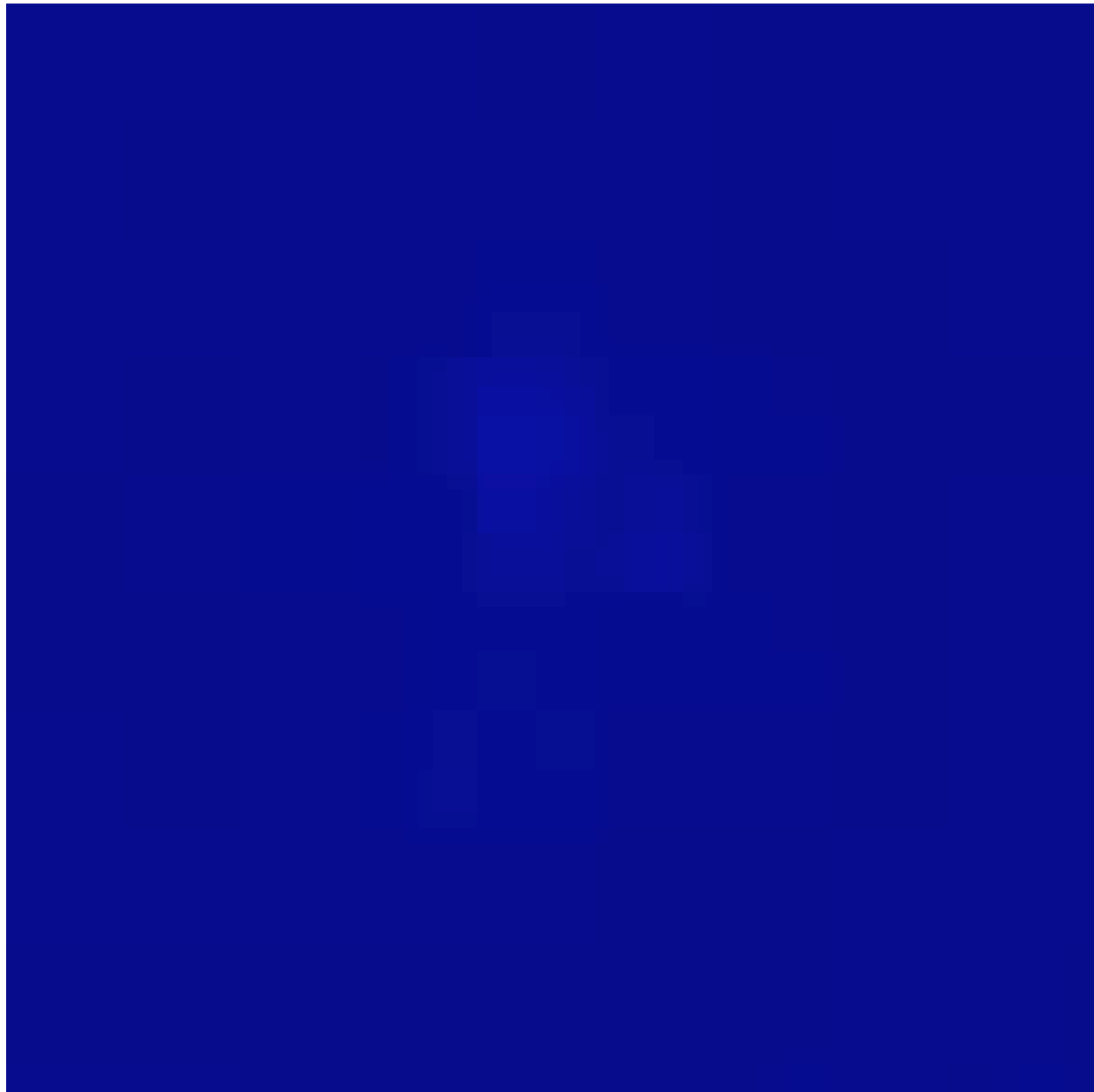


Immagini dirette: ancora molto difficile

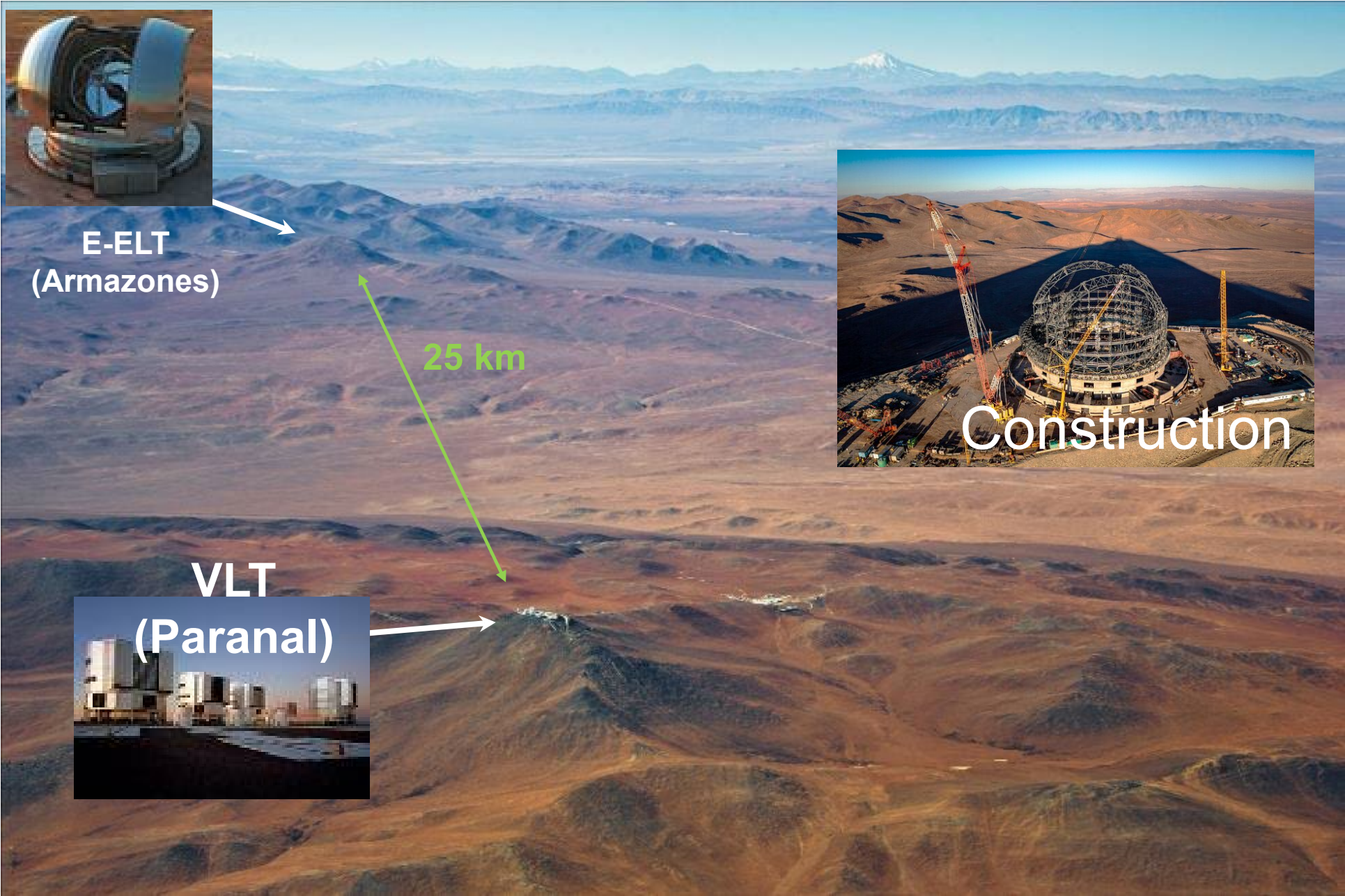


# Principio dell'ottica adattiva





# Armazones e Paranal



E-ELT  
(Armazones)

25 km

VLT  
(Paranal)

Construction





# ATACAMA LARGE MILLIMETRE AND SUBMILLIMETRE ARRAY

In search of our cosmic origins



ALMA È UN RADIO TELESCOPIO COSTITUITO  
DA 66 ANTENNE CHE OSSERVANO INSIEME  
COME UNA SINGOLA ANTENNA  
DAL DIAMETRO DI 16 CHILOMETRI



UN TOTALE  
PIU' GRANDE DELLA SOMMA

OSSERVARE L'UNIVERSO PIÙ FREDDO PER SVELARE  
L'ORIGINE DEL COSMO E DELLA VITA



5,000 METERS DI QUOTA NEL PLATEAU  
DI CHAJNANTOR, NEL DESERTO DI ATACAMA  
DATA L'ALTITUDINE E L'ARIDITÀ È UN SITO  
ECCEZIONALE PER OSSERVAZIONI ASTRONOMICHE

IL BASSISSIMO VALORE DI VAPORE ACQUEO È  
L'IDEALE PER OSSERVAZIONI NELLA PORZIONE  
DELLO SPETTRO ELETTROMAGNETICO TIPICA DELLE  
MICROONDE ED ONDE MILLIMETRICHE.

CBI/QUIET

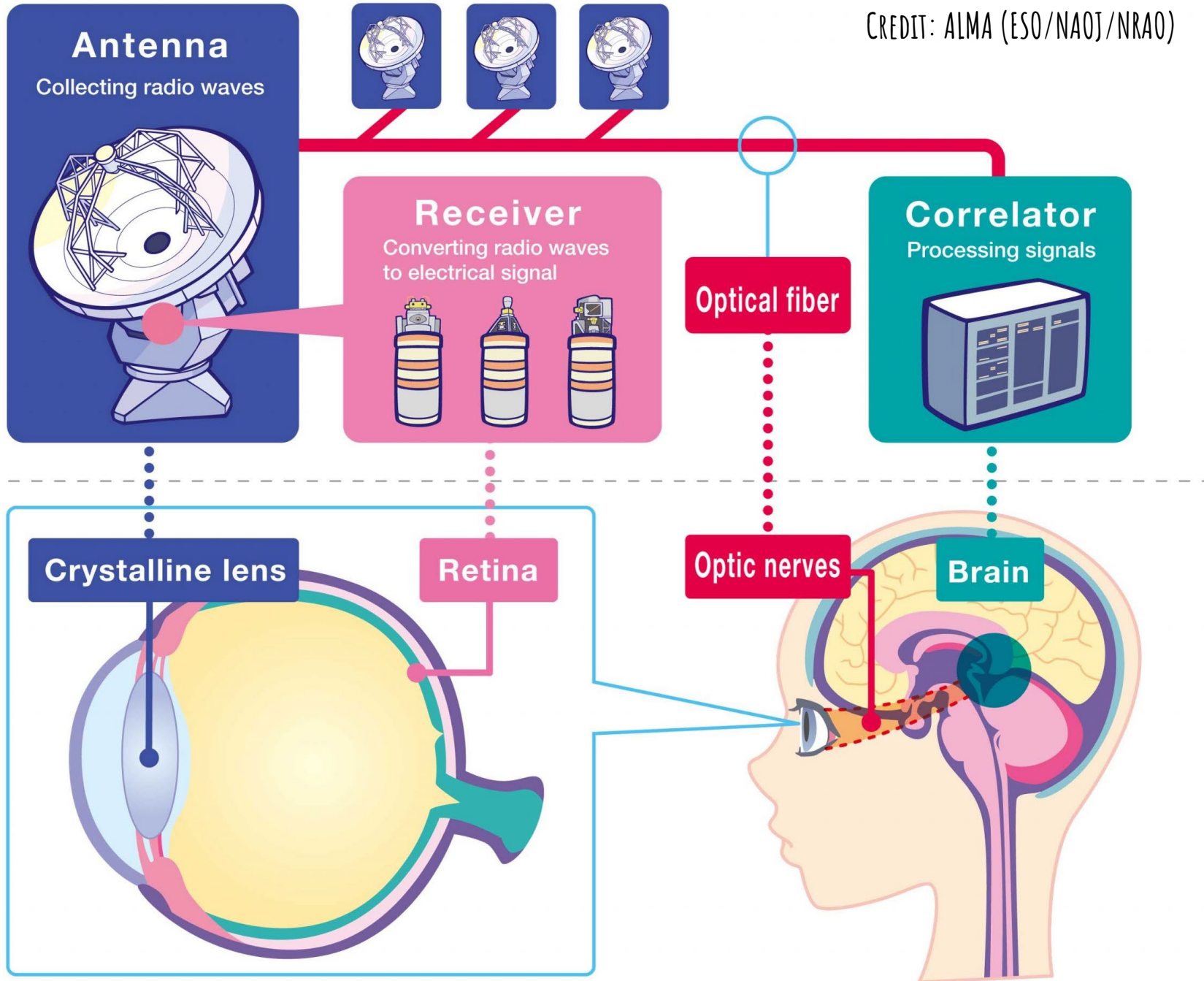


Antenas de ALMA

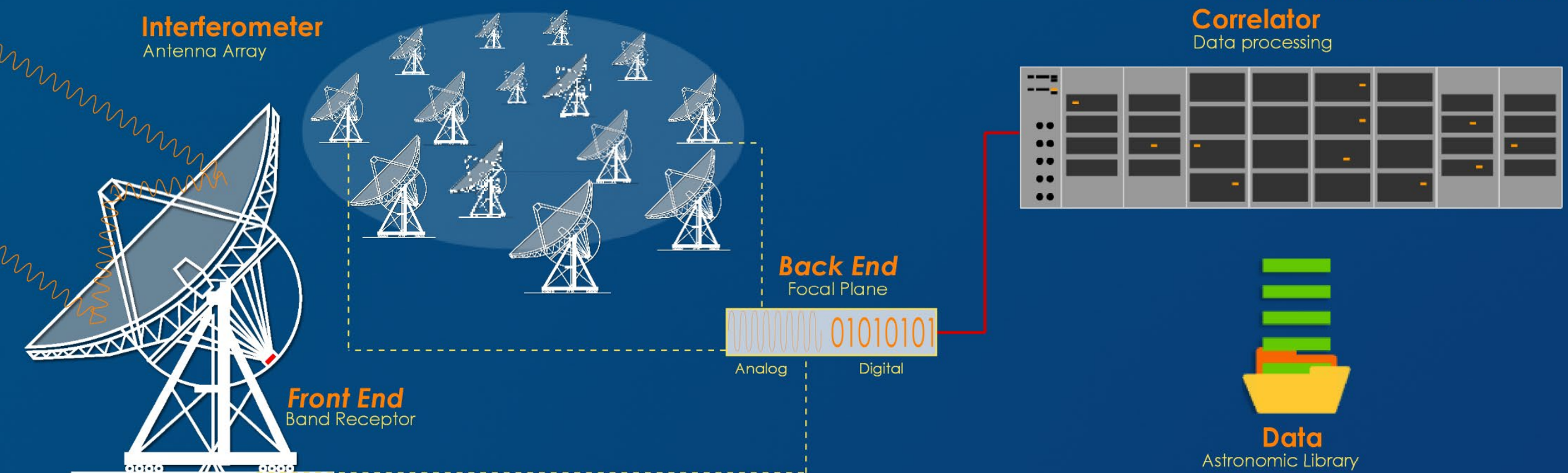
Atacama Large Millimeter Array













# ALMA Antenna Movements

from 2009-09-17 to 2014-12-07

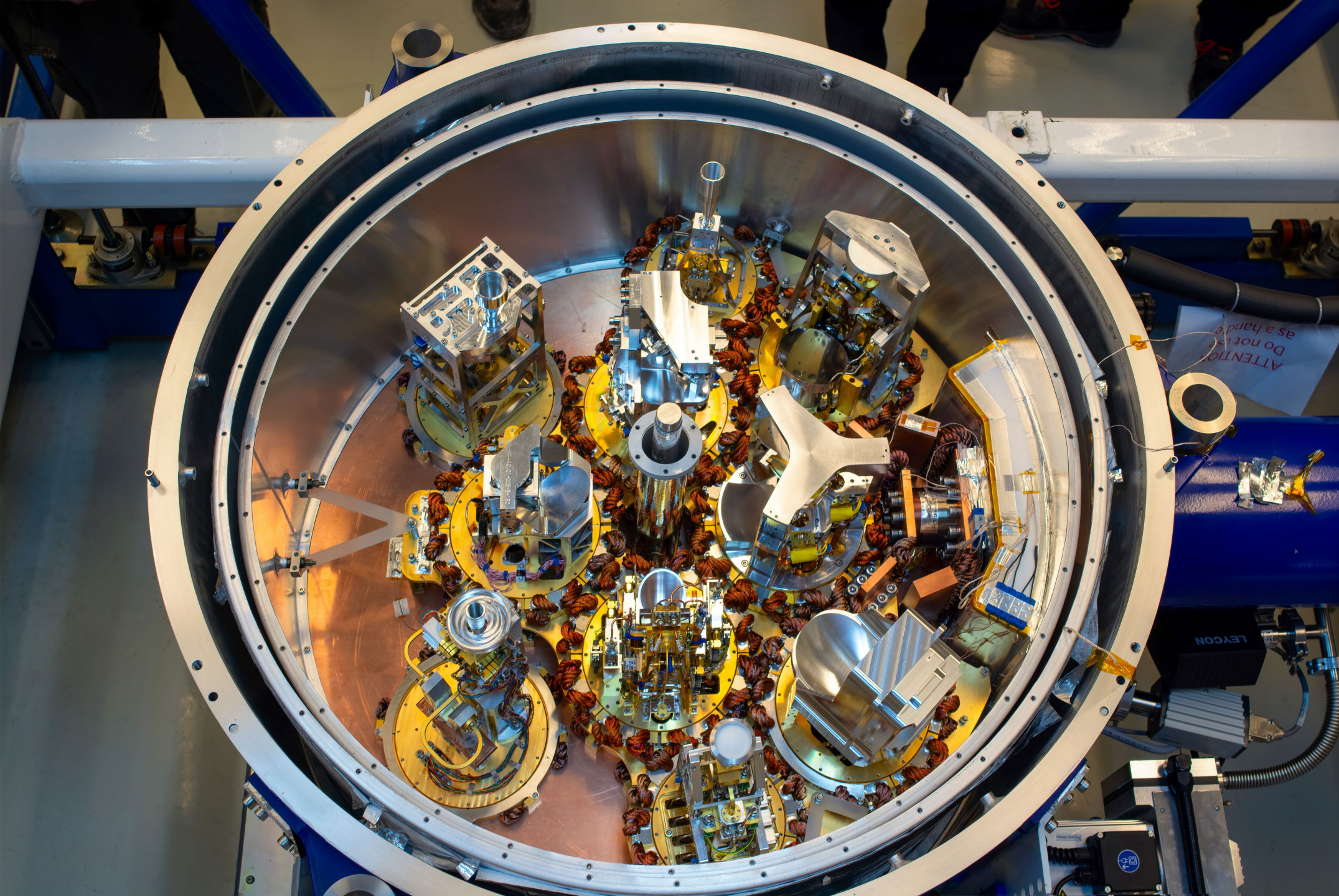










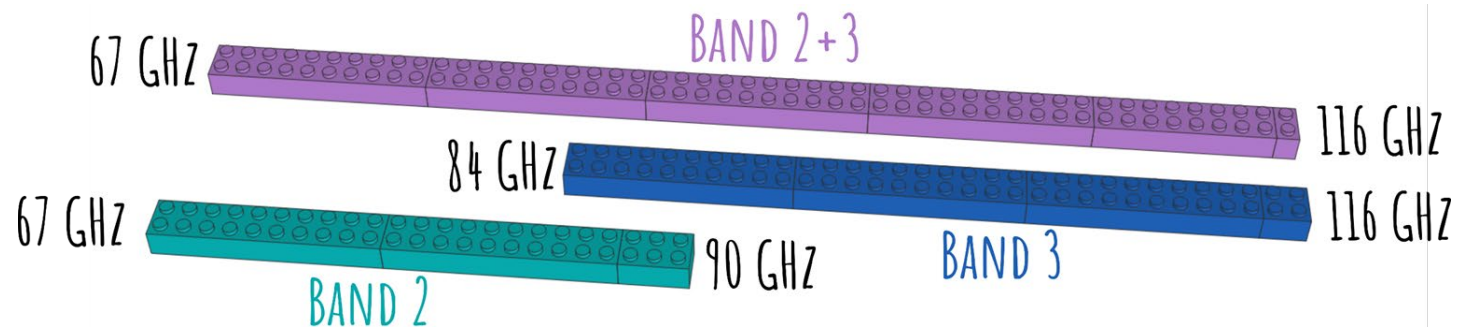
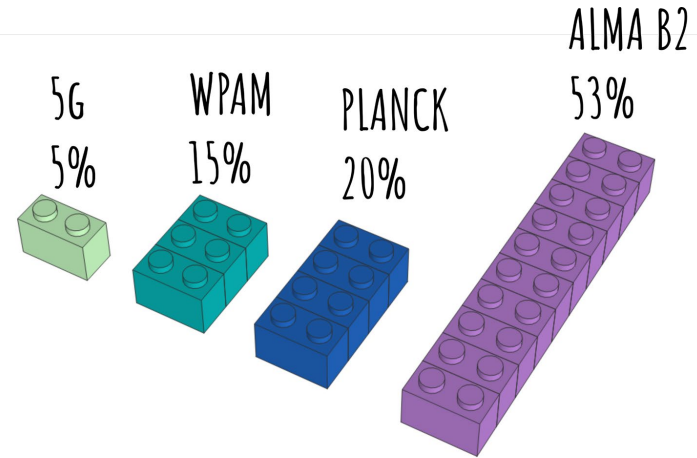
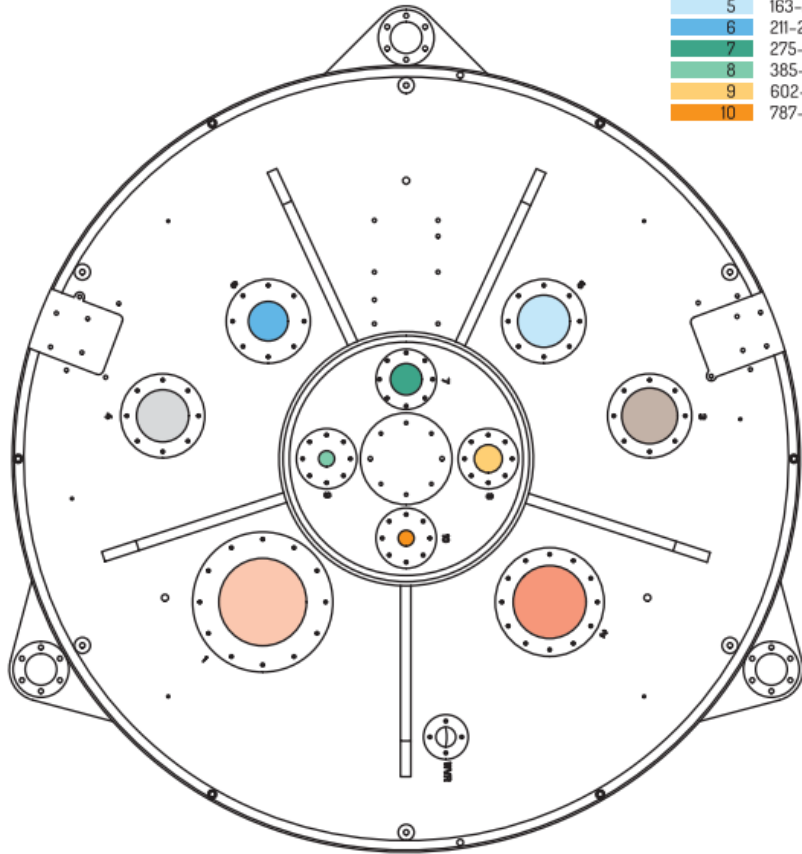


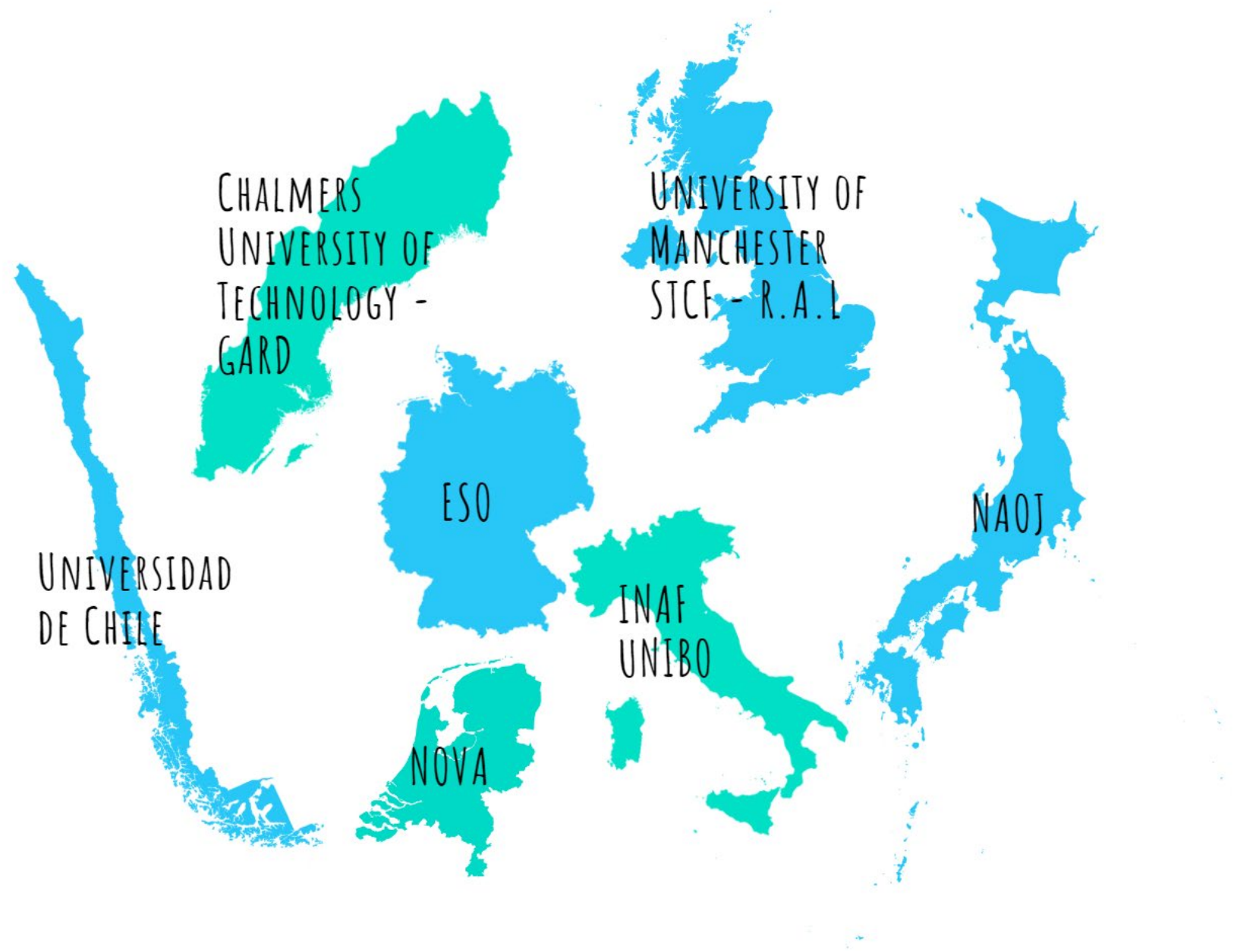
300K  
110K  
15K  
4K

27°  
-163°  
-258°  
-269°

# QUESTIONI DI BANDE DI OSSERVAZIONI

BANDA	GHz
1	35-50
2	65-90
3	84-116
4	125-163
5	163-211
6	211-275
7	275-373
8	385-500
9	602-720
10	787-950





UNIVERSIDAD  
DE CHILE

CHALMERS  
UNIVERSITY OF  
TECHNOLOGY -  
GARD

ESO

UNIVERSITY OF  
MANCHESTER  
STCF - R.A.L.

NAOJ

INAF  
UNIBO

NOVA

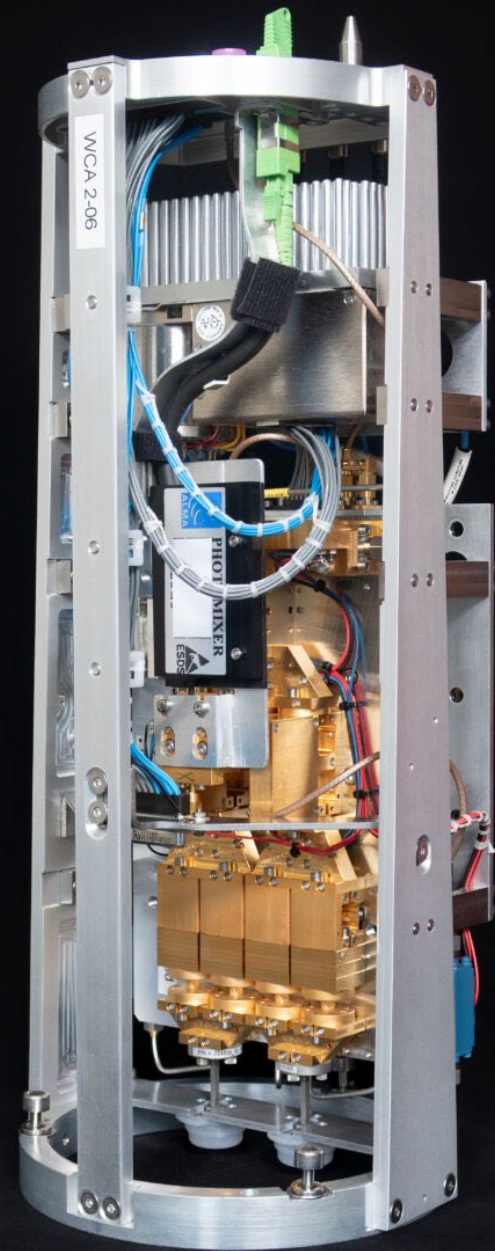
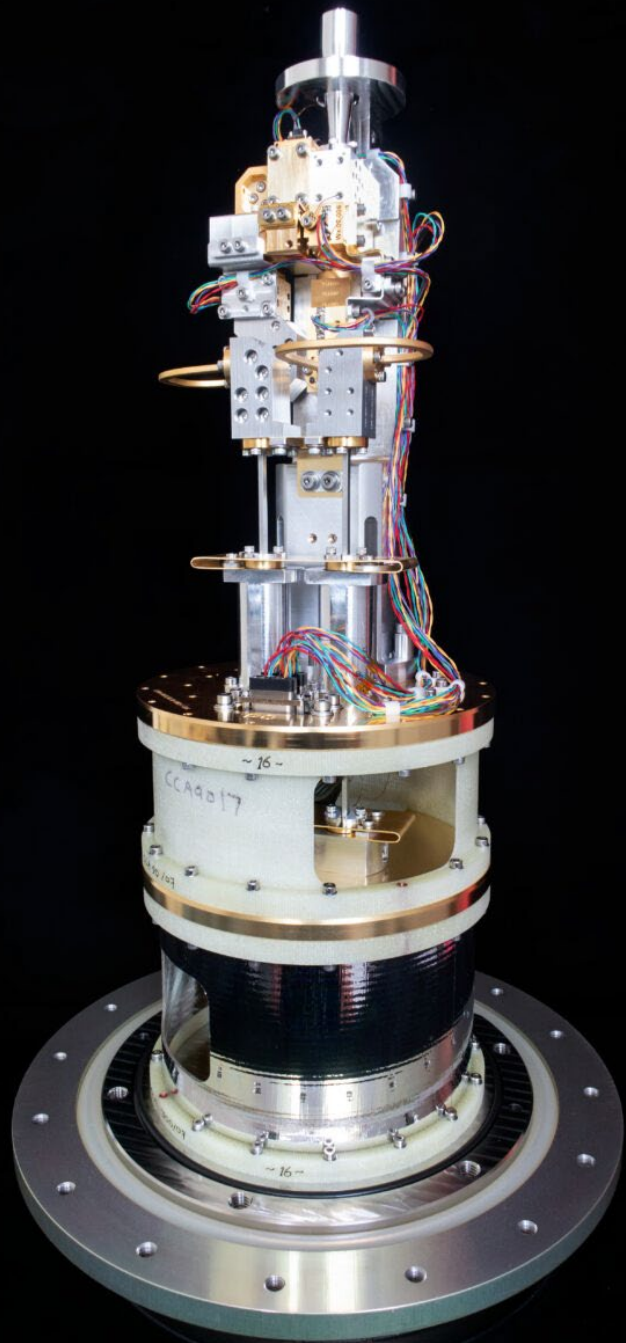
# CDR VS PDR

ONLY FOR TONIGHT

# CRYOWAVES ARENA

STARTING AT 9PM

- 2012  
STUDIO DI FATTIBILITA'
- 2015  
SVILUPPO DI FASE A
- 2016  
SVILUPPO DI FASE B
- 2017  
PRELIMINARY DESIGN REVIEW  
PRE-PROTOTIPO
- 2020  
KICK OFF DI PRODUZIONE
- 2022  
CRITICAL DESIGN REVIEW  
PROTOTIPO
- 2023  
MANUFACTURING READINESS REVIEW  
PRE PRODUZIONE (6 RICEVITORI)
- 2024  
PRODUZIONE DEI RESTANTI RICEVITORI





G R U N D I G

TEST DI SUCCESSO SUI NUOVI RICEVITORI PER SONDARE LE NOSTRE ORIGINI COSMICHE

## Prima luce interferometrica per la Banda 2 di Alma

*Con la misura delle “prime frange” – segno che i nuovi ricevitori riescono a funzionare in modalità interferometrica – la Banda 2 consente ad Alma di osservare su tutto l'intervallo di frequenza da 67 a 116 GHz, fondamentale per l'osservazione di molecole organiche complesse nelle galassie vicine, fornendo indizi su come si creano le condizioni per la vita. Fabrizio Villa (Inaf): «Una tappa che racchiude tutto il lavoro e l'impegno di anni di ricerche»*

 Redazione Media Inaf  14/08/2023







DA-63

DV-23

CM-04

CM-03

CM-10

CM-06