Understanding the universe… is space the only solution?

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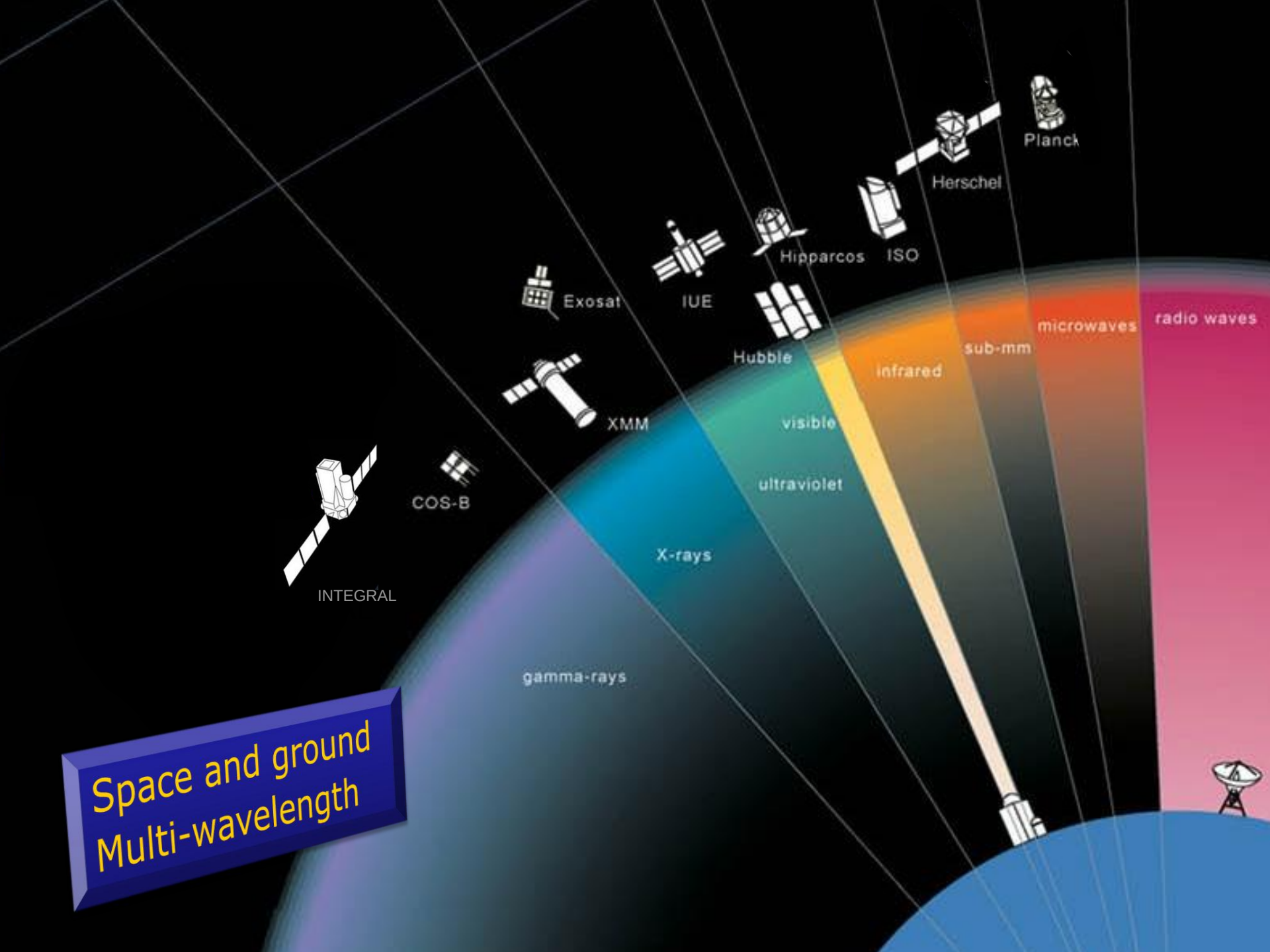
with collaboration from J.C. Worms, ESF

Study the Universe…

- From the Big-Bang to today
- Use of space unencumbered by ground constraints
- Universe as a laboratory

Why go to space…for astronomy…?

- i.e. other than for (human or not) exploration
- ‘Early’ days arguments: no atmosphere, no turbulence ➔ new spectral windows, perfect conditions
- Enables multi-wavelength approach ➔ choose scientific topic (e.g. quasars) and observe from γ rays to radio


Space and ground
Multi-wavelength
INTEGRAL
COS-B
XMM
Exosat
IUE
Hubble
Hipparcos
ISO
Herschel
Planck
gamma-rays
X-rays
ultraviolet
visible
infrared
sub-mm
microwaves
radio waves

Space ‘platform’, “flying” or not

- No: Moon ➔ far-side = ‘final’ protected window to open: VLFs
- Flying: micro-g environments
  - research experiments
  - preparation for solar system exploration
  - study (and mitigation?) of radiation and space debris
- Flying : satellites
- Lagrange

Big science → Planning

- Necessity of “visions”
  - Decadal survey in the US
  - Mandatory ‘long-term’ programmes in Europe
    - Horizons 2000 ➔ what’s now flying
    - Cosmic Vision 2015-2025
  - Solar system exploration
- But visions need sustained efforts (or a doctor)…

European satellites in orbit

What is it all about? .

Space science looks out at the grand questions…..

How did our Earth, our solar system evolve?

Where are we in the Universe?

Where did life come from?

Where are we going?

Are we alone?

Missions in Operations

Proba 2

Corot

Double Star

Akari

Hinode

Chandrayaan

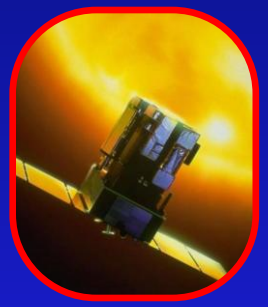
Hubble

Integral

Newton

Rosetta

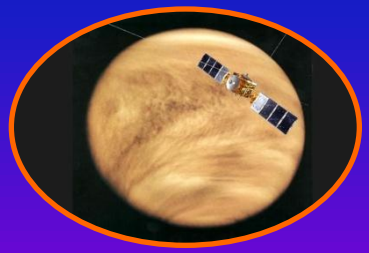
Cassini/Huygens



SOHO

Mars Express

Cluster



Venus Express

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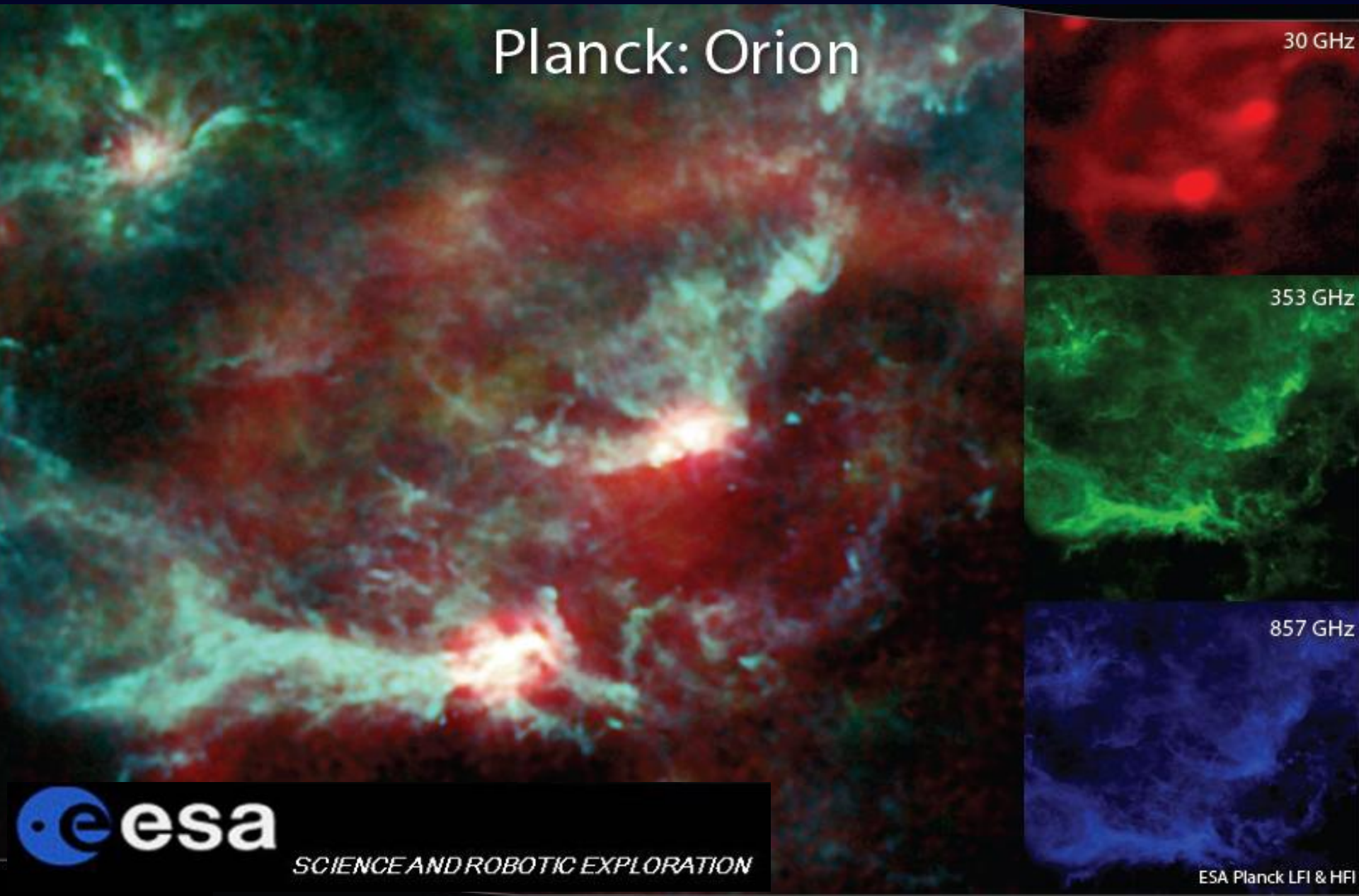
Planck: Orion
30 GHz
353 GHz
857 GHz
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SCIENCE AND ROBOTIC EXPLORATION
ESA Planck LFI & HFI

Galactic star-forming regions with Herschel


RCW120 / PACS+SPIRE / Zavagno et al., HOBYS


Galactic plane towards Aquila / PACS+SPIRE / Molinari et al., HiGAL


Galactic plane towards Vulpecula / PACS+SPIRE / Molinari et al., HiGAL


Rosette Nebula / PACS+SPIRE / Motte et al., HOBYS

Online gallery of Herschel images: oshi.esa.int

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SCIENCE AND ROBOTIC EXPLORATION

Contrasting aesthetics

Putting Hubble in a Cultural Context
Venice 2010

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Putting Hubble in a Cultural Context
Venice 2010

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Research in space

Anything besides beautiful pictures?

Have we made up our mind on what to tell?

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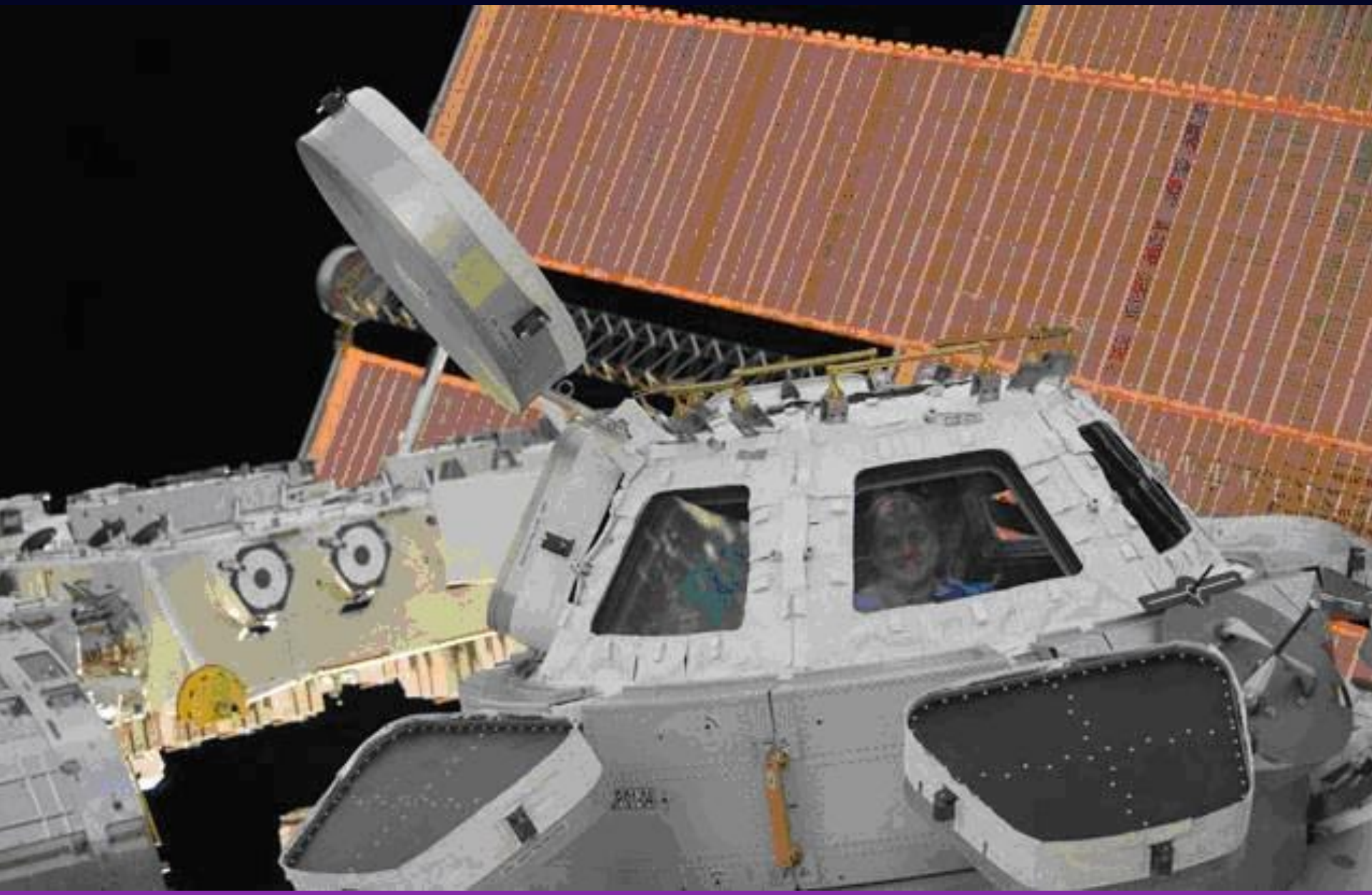
COLUMBUS



…and yet there's good research done there

www.esf.org/essc

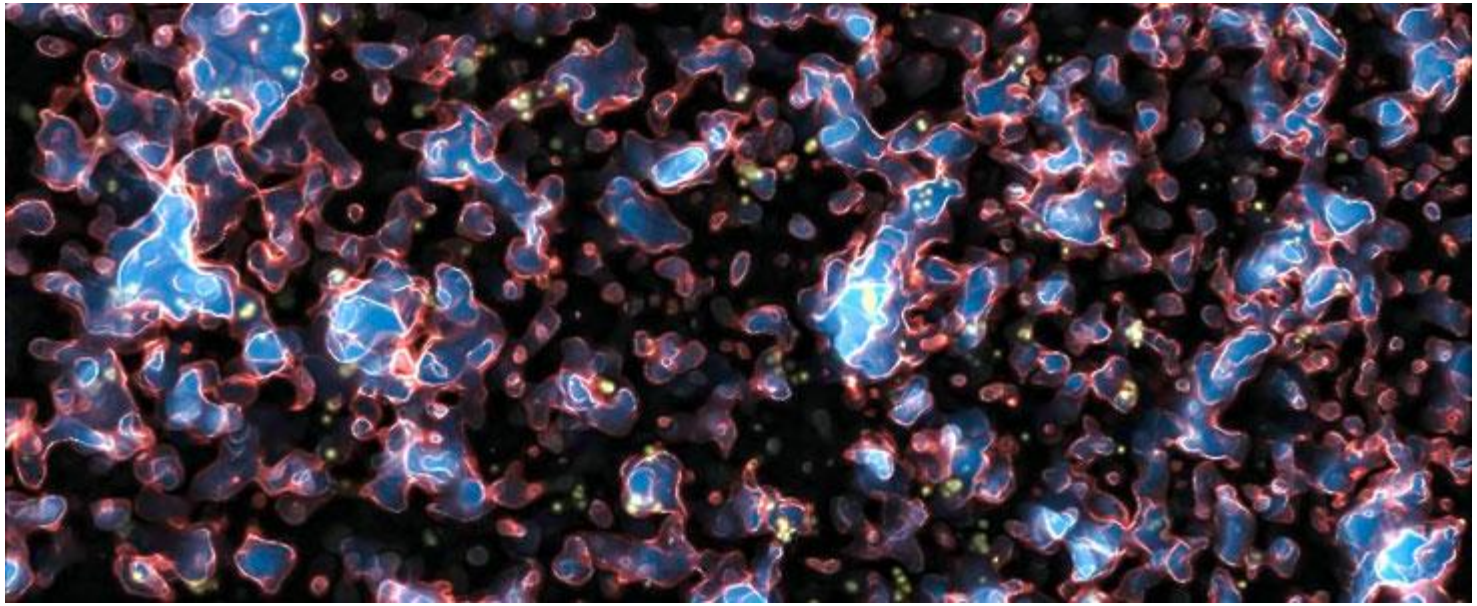
Is space the only solution?

- REMINDER: radio-astronomy “syndrome” in the mid-2000s
- NO: ground / space complementarity ➔ two recent examples

Space and ground 1

From survey detection to spectroscopy (→ physics)

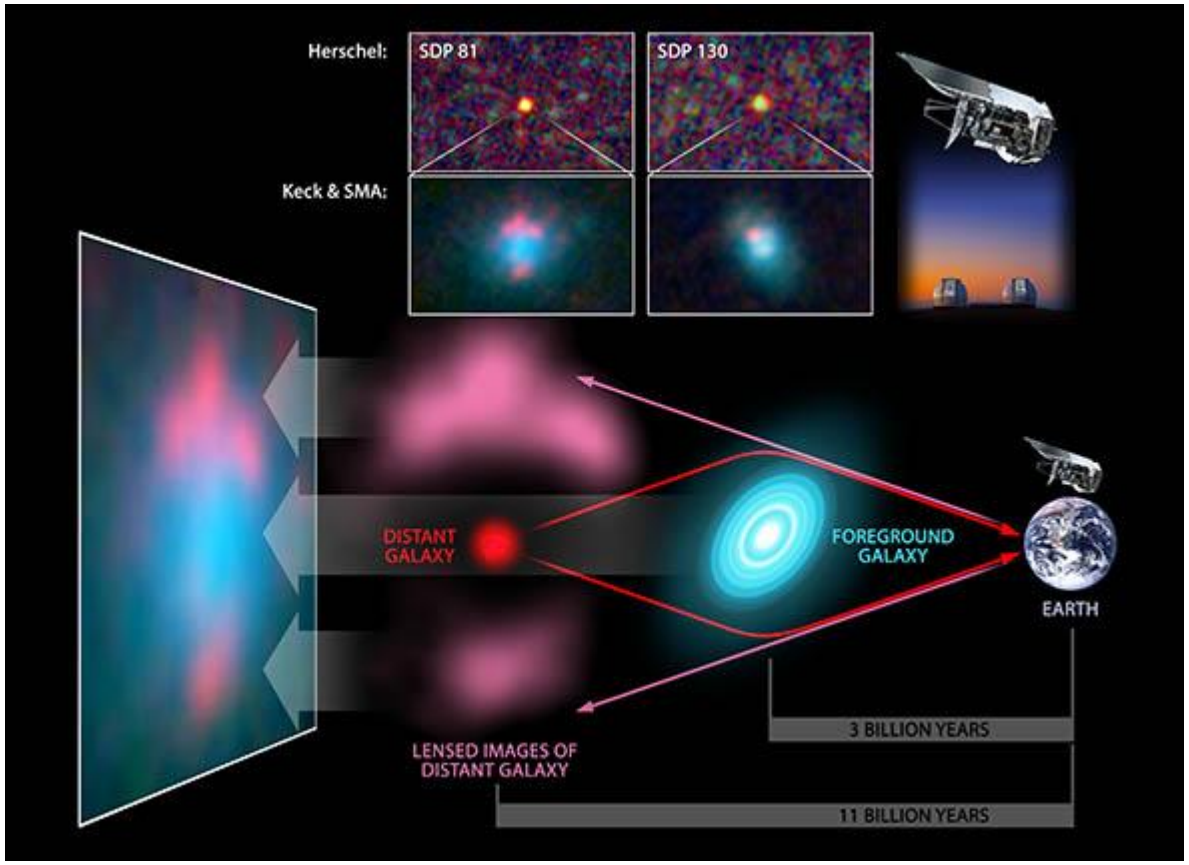
Press release ESO 1040 HST + VLT



z = 8.6 !

Space and ground 2
Universe as a laboratory

= optical bench !



Herschel + ground-based facilities: digging up magnified galaxies (gravitational lenses)
NASA/JPL-Caltech-T. Pyle (SSC/Caltech)

The future: continue complementarity!

- From detection to morphology
  - Herschel (far-IR, star-forming regions) + ALMA (interferometry)
- From detection to physical and "geometrical" parameters
  - HST/JWST/VLT + E-ELT (high red shifts)

The future: international “coopetition”

- ‘Grand challenges’ ➔ Go Global !
  - GPS, Galileo, GMES, GES
  - No other way than international collaboration
- Decadal survey + Cosmic Vision (but what’s next after 2025 for space astronomy?)
- Solar system exploration (cf. Session 4)
- Emerging countries: what IC model?

Needs - How to…

- Attract young scientists and engineers?
- Maintain expert instrumentation teams?
  - more missions (not the actual trend)…but
  - in Europe: EC FP8?

What do we communicate to the general public?

- Agencies prefer results but also tend to raise expectations in order to generate motivation of the general public
- Anything besides ‘a sense of awe and beauty’?
- For Europe, there is not a single public, not yet
- Outreach and communication: better in the US! ➔ is “more money” the only reason?

THANK YOU VERY MUCH!