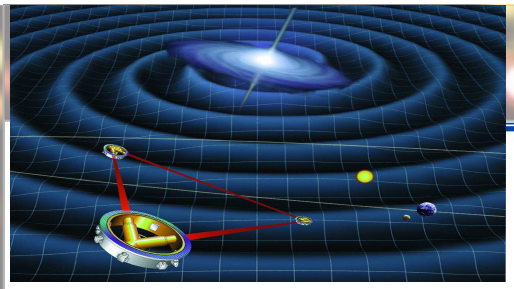
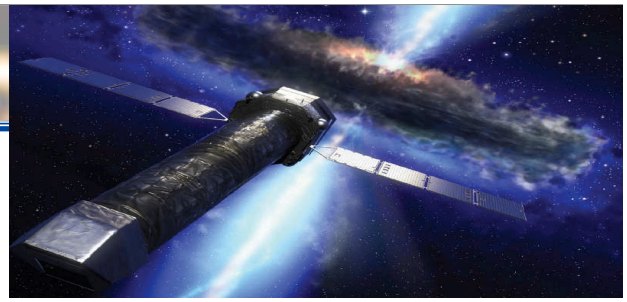
Which Future for Space Astronomy?





Institute for Space Astrophysics and Planetology
Istituto di Astrofisica e Planetologia Spaziali

Space Astronomy Future
Science Prospects for the Next Decades

Vulcano Workshop 2016 - Frontier Objects in Astrophysics and Particle Physics

23 May 2016, Vulcano Island, Sicily, Italy

Which Future for Space Astronomy?

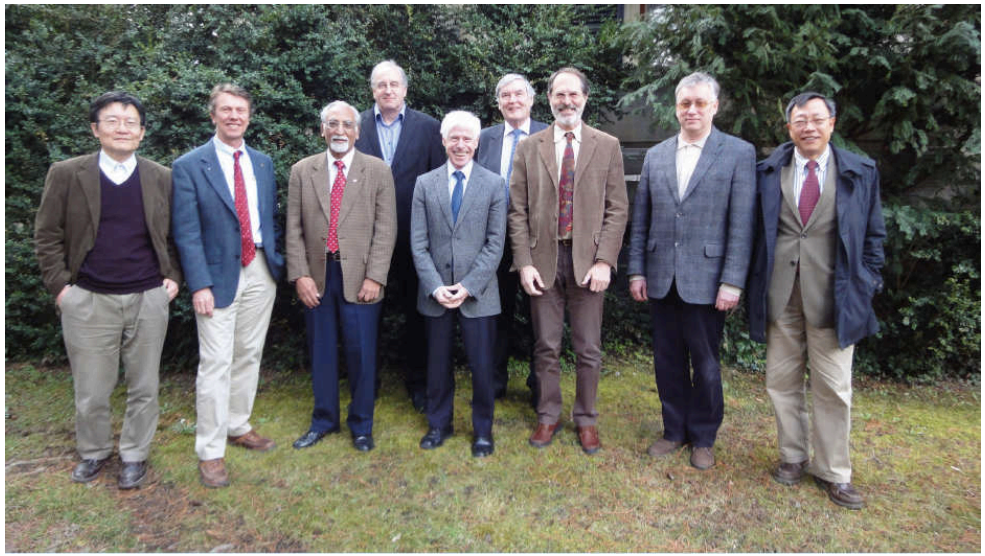
IAU XXVIII General Assembly 20-31 August, 2012 Beijing, China

Cospar Working Group (April 2011)

The Future of Space Astronomy:

A Global Road Map for the Next Decades

Presented @ the 39th COSPAR Assembly, July 14-22, 2012 Mysore, India



Roger Bonnet (COSPAR)

Pietro Ubertini (Chair);

Neil Gehrels (Co-Chair);

Ian Corbett;

Paolo De Bernardis;

Marcos Machado;

Matt Griffin;

Michael Hauser;

Ravinder K. Manchanda;

Nobuyuki Kawai;

Shuang-Nan Zhang;

Mikhail Pavlinsky;

Which Future for Space Astronomy?

Prologue

Space satellites have given astrophysicists a unique opportunity to explore the invisible part of the electromagnetic spectrum and drastically improve our knowledge of the Universe.

From the discovery of the first X-Ray source, in 1962, a factor of 10^{7-8} improvement in sensitivity have been achieved in X-Ray astronomy and of 10^{7} in Cosmic micro wave background data!

…and we have now the first detection of Gravitational Wave, 100 years after their predictoin: a new window open

The increasing size, complexity and cost of large space observatories places a growing emphasis on large international collaboration.

Which Future for Space Astronomy?

Multi Colour Eyes – Present

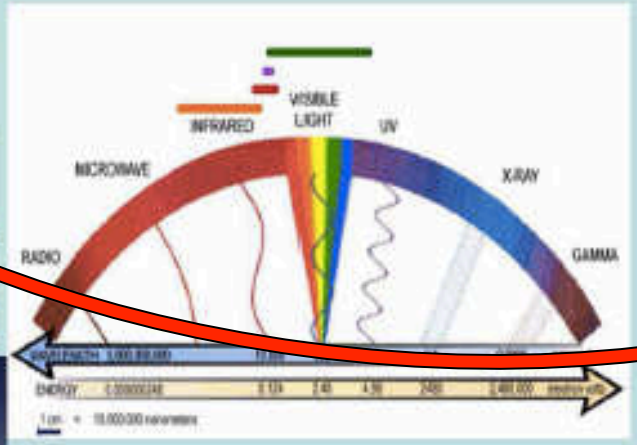
Spitzer

Herschel

Planck

IRAM, CSO
SMA, APEX

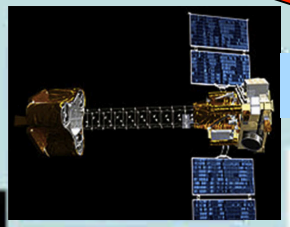
VLA
Merlin
CBT
Jordell
VLBA,
Nancy



GMRT

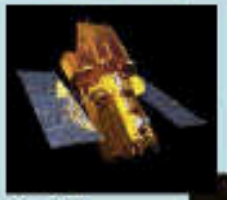
WISE

Hubble



Nustar

Chandra, XMM
RXTE, Suzaku



Swift

Integral

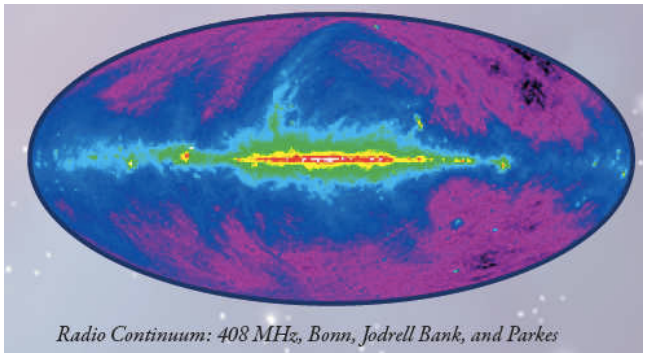
Fermi

Magic
Hess
Milagro
Varitas

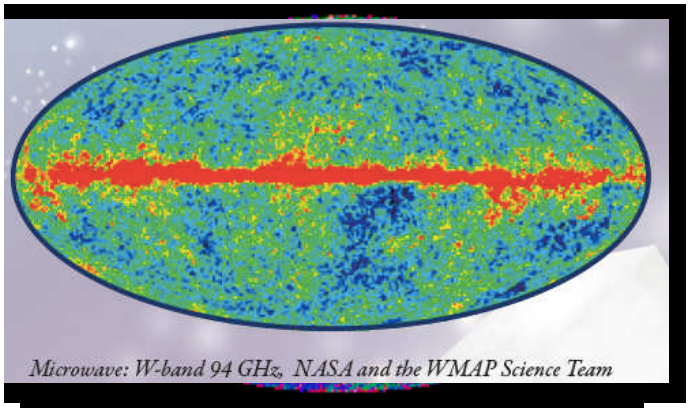
..SPECTACULAR RESULTS FROM SPACE OBSERVATORIES

The multicolor Universe as was known 20 years ago and nowdays

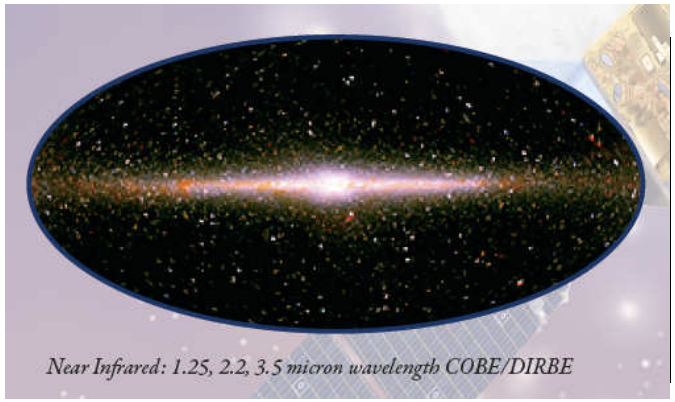
Which Future for Space Astronomy?



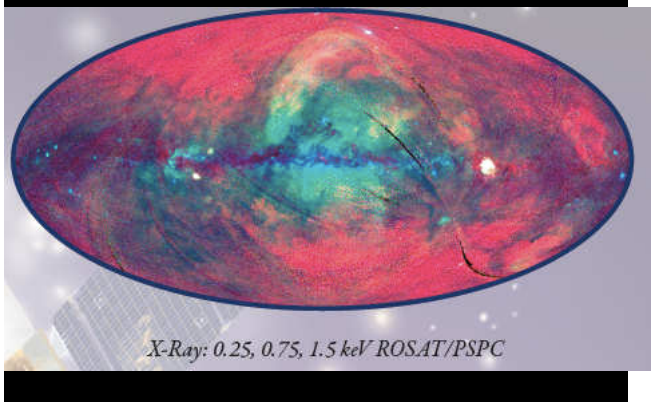
Radio Continuum: 408 MHz, Bonn, Jodrell Bank, and Parkes



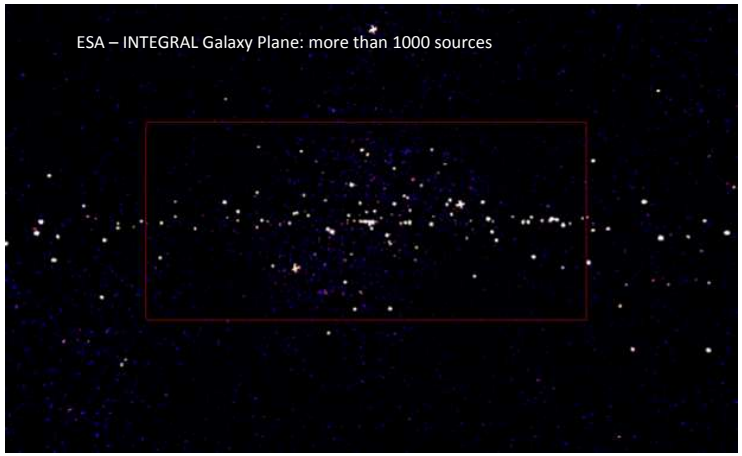
Microwave: W-band 94 GHz, NASA and the WMAP Science Team

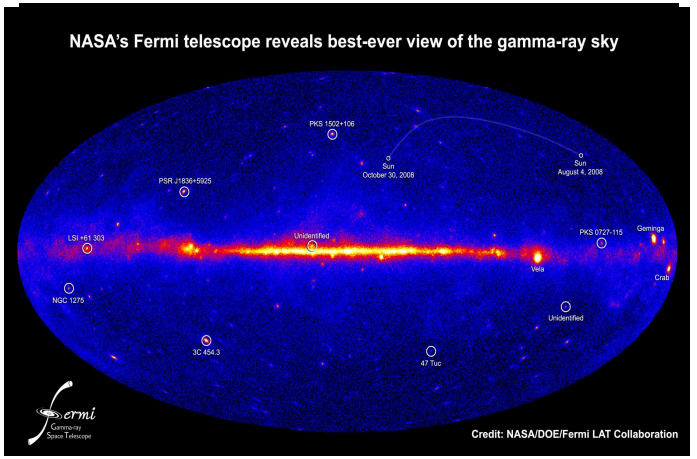


Near Infrared: 1.25, 2.2, 3.5 micron wavelength COBE/DIRBE

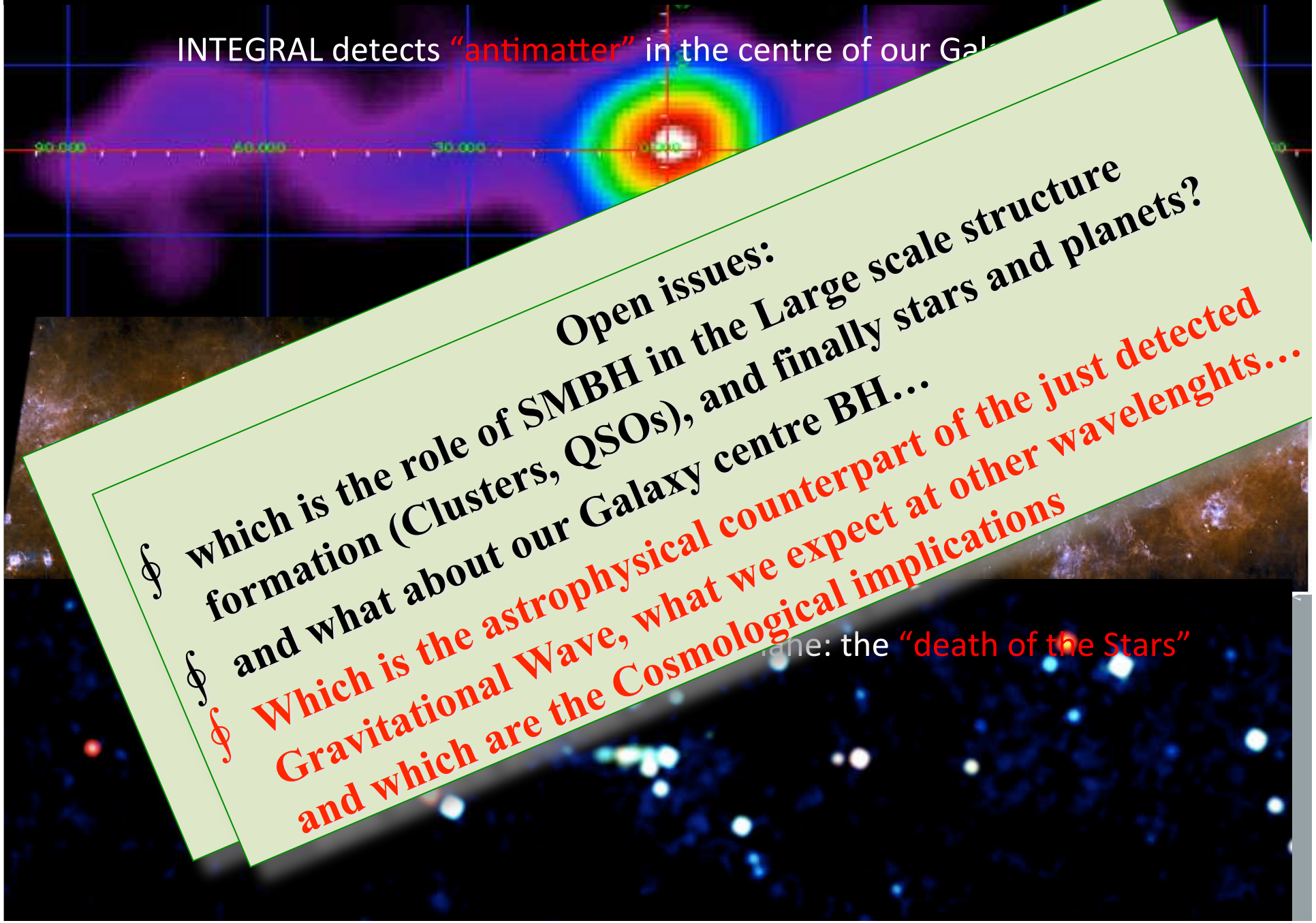


X-Ray: 0.25, 0.75, 1.5 keV ROSAT/PSPC





The different views of the Galaxy



INTEGRAL UL on γ-ray emission from GW150914

Which Future for Space Astronomy?

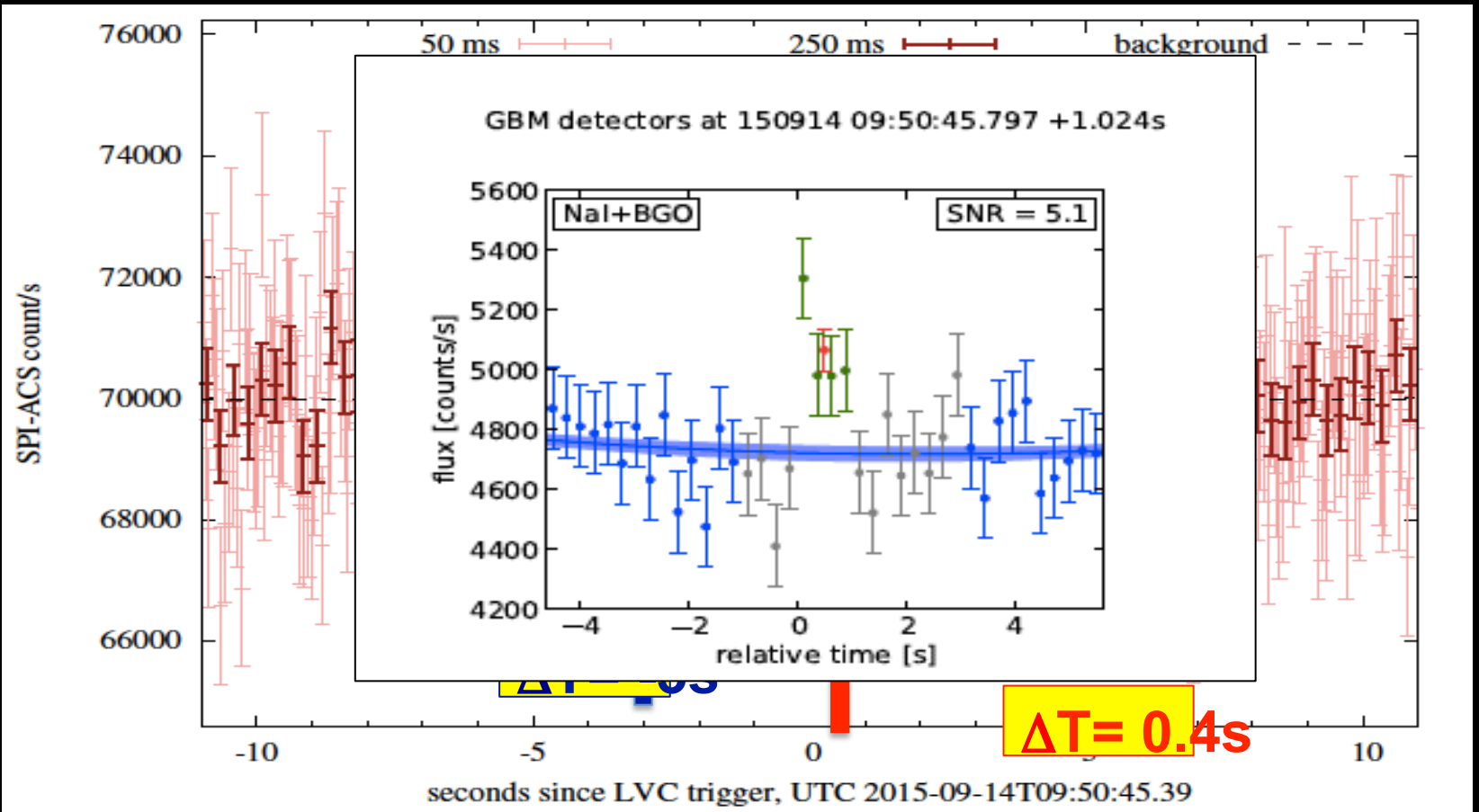
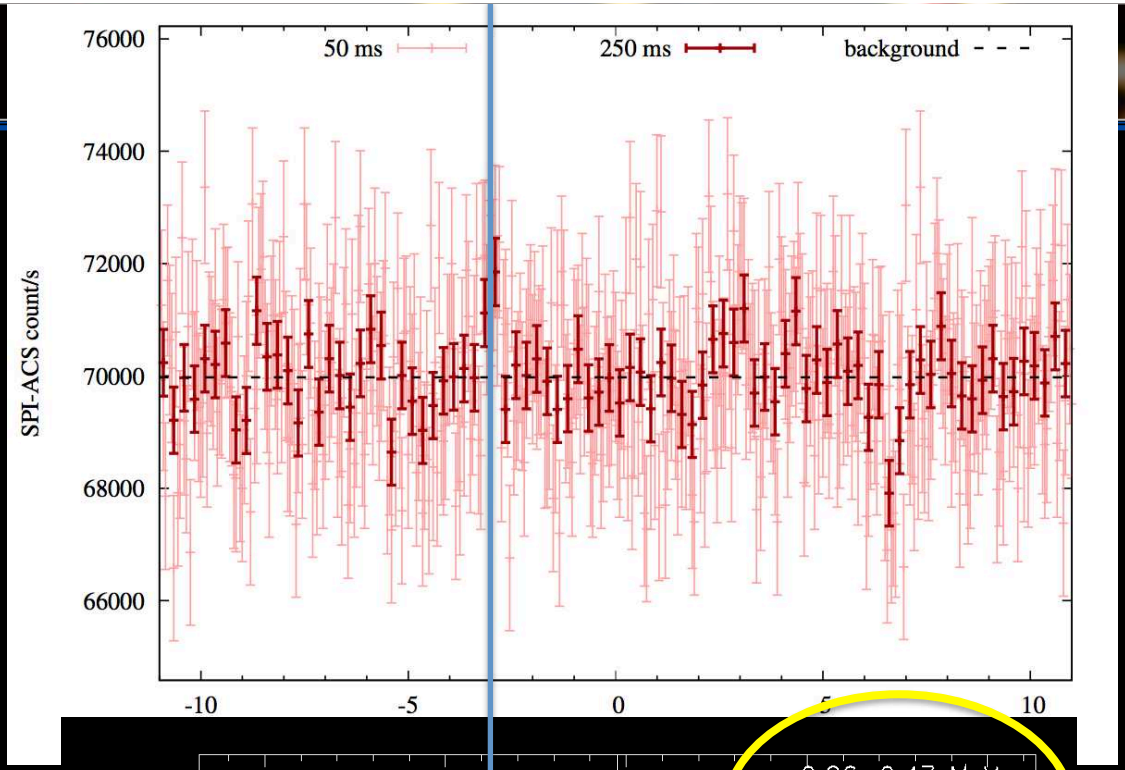
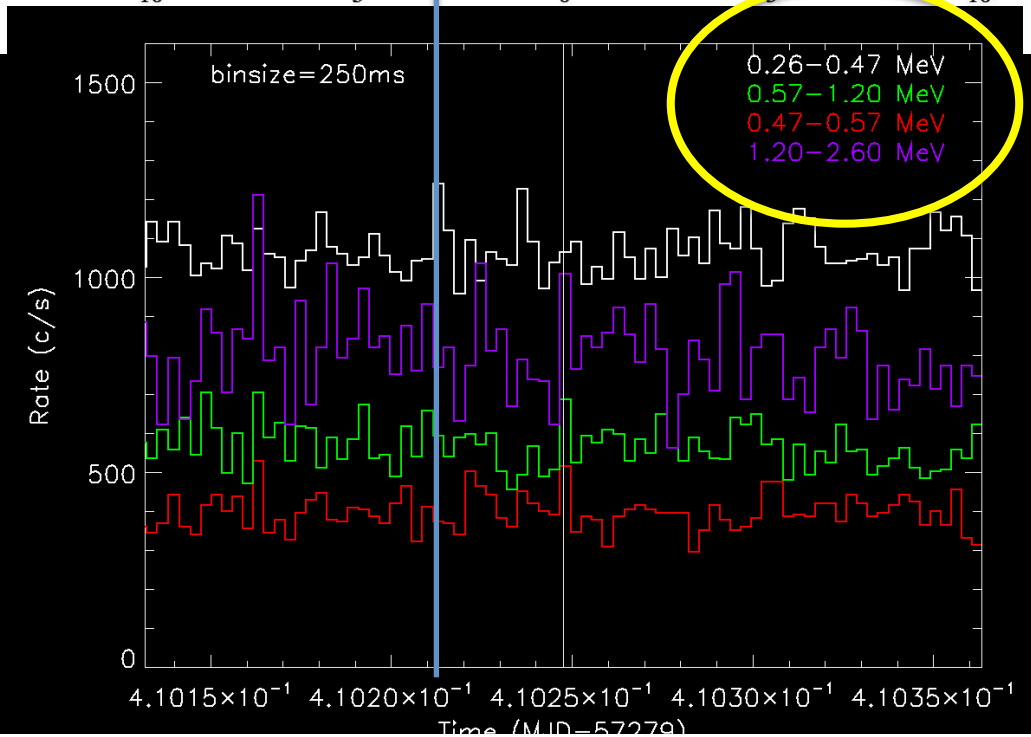


Fig. 1.— INTEGRAL/SPI-ACS lightcurve in ±10 s around GW150914 trigger time. Light red symbols represent the measurements at the natural instrument time resolution of 50 ms; dark red points are rebinned to 250 ms. The dashed black curve is the background level estimated from a long-term average.

http://arxiv.org/abs/1602.04180

Which Future for Space Astronomy?





PICSIT Spectral Timing data
260 keV – 2.6 MeV

16ms time resolution

INTEGRAL UL on γ-ray emission from GW150914

arxiv1602.04180, arxiv1602.08492

Upper limits/detection fluence at the time of the event $\approx 10^{-8}$ erg cm^{-2} in the 75 keV-2MeV energy range, i.e. promptly released in γ-rays

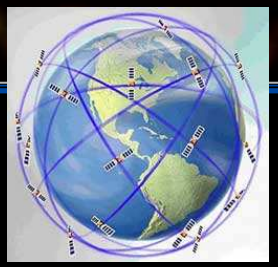
$$E_g/E_{GW} < 10^{-6}$$

What are the implications of this energetic constraint?

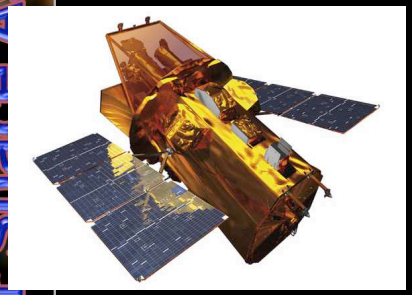
At 240 Mpc this is $L_g = 7 \times 10^{46}$ erg in 1s, if isotropic, or 10^{44} if strongly beamed

Lot of energy to be extracted from disk

What's next:
OP2 →1 trigger/week

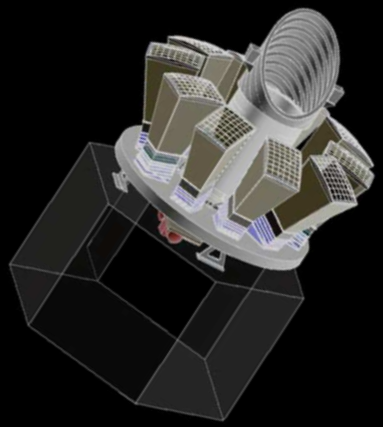


Which Future for Space As



INTEGRAL-SWIFT
Large Observatories
>10 years operations

INTEGRAL and SWIFT operation mode has been changed to IMMEDIATELY follow-up the NEXT GW trigger



LOBSTER (NASA)
Theseus (ESA)

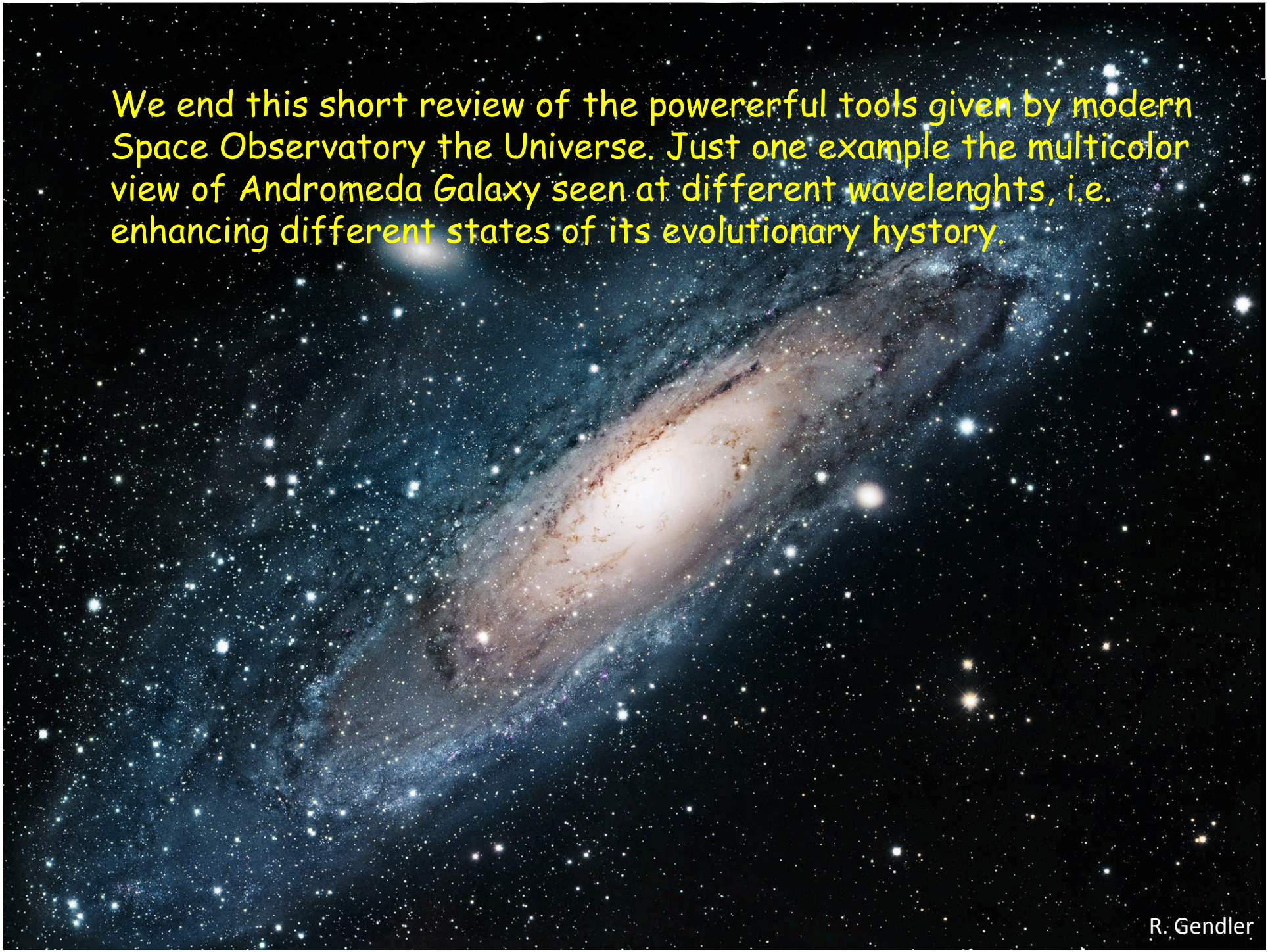
Lobster eye X-Ray + gamma-ray trigger
10-50 grb High Z

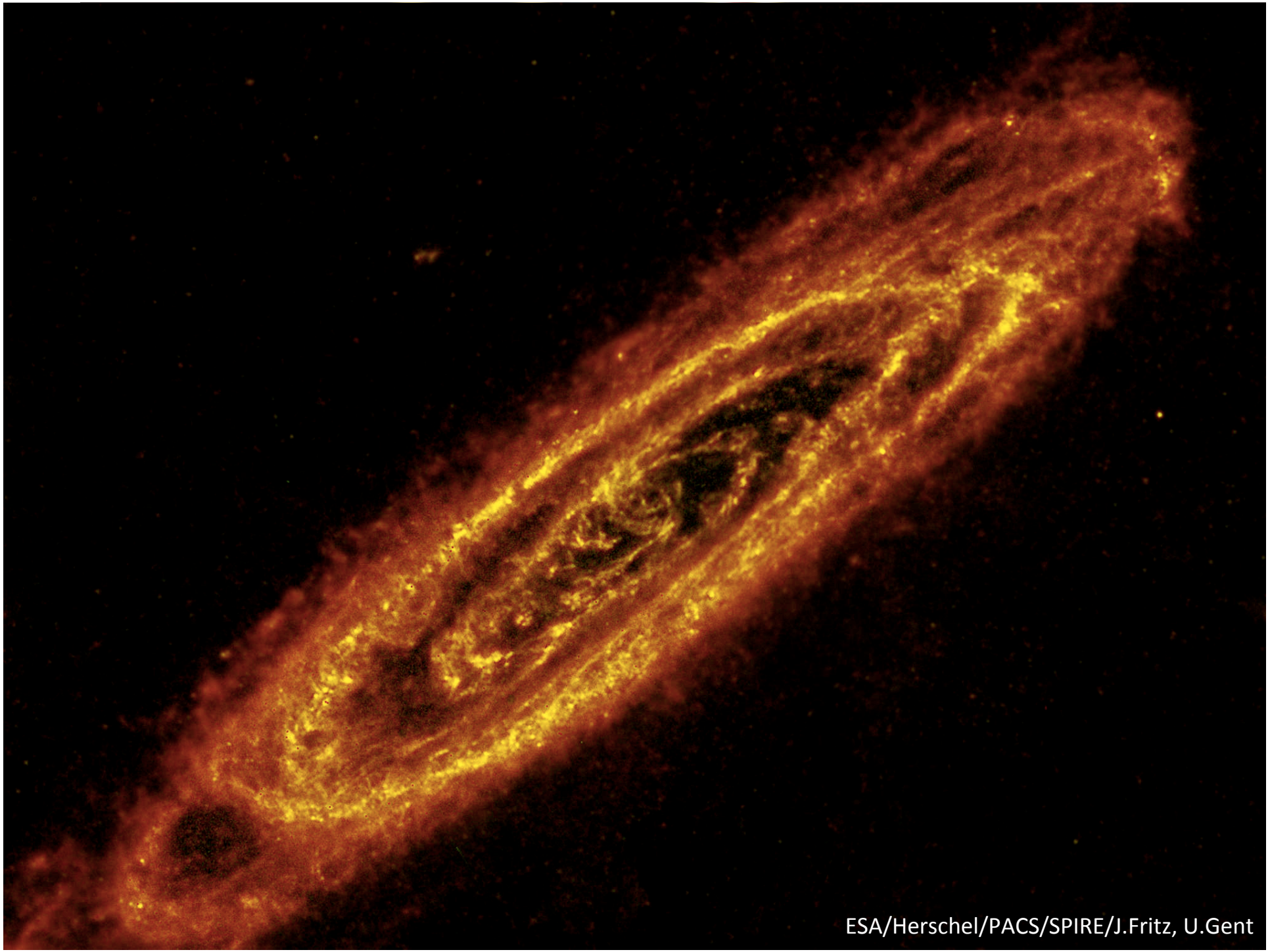
10y dev. Cost
200-500M€

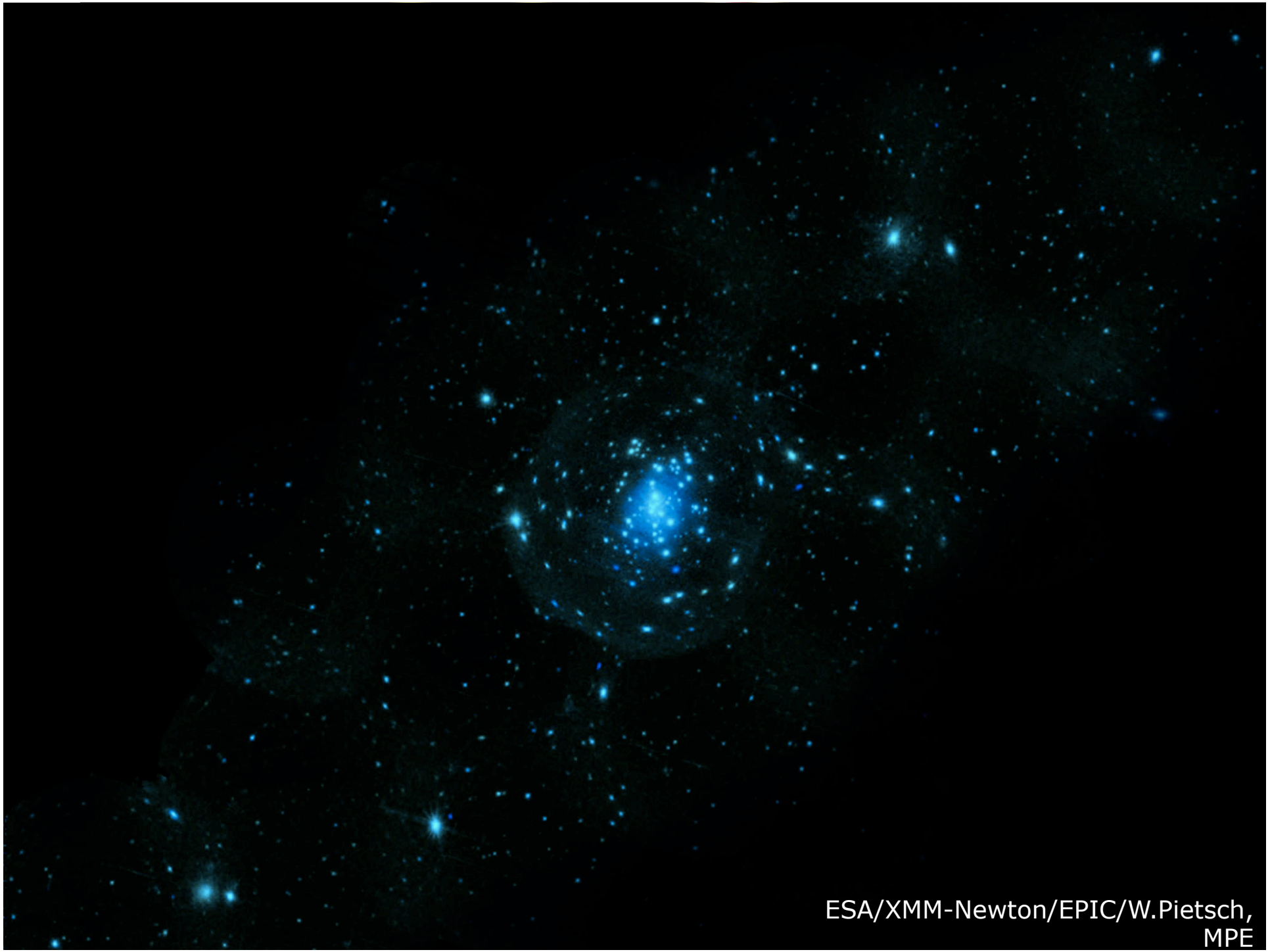
The HERMES mission
High Energy Rapid Modular Experiment Satellites

Cubesat sworm constellation Arcsec positioning

Short turnaround
Moderate cost, modularity: 100cubesat


We end this short review of the powererful tools given by modern Space Observatory the Universe. Just one example the multicolor view of Andromeda Galaxy seen at different wavelenghts, i.e. enhancing different states of its evolutionary hystory.
R. Gendler


ESA/Herschel/PACS/SPIRE/J.Fritz, U.Gent


ESA/XMM-Newton/EPIC/W.Pietsch,
MPE

Visible light: the living stars: living from 6-7 My (100 Ms) to 13 By (0.9 MS)

Infrared: the 'birth' of the stars

X-Rays: the final stage of stars

..in a picture the whole time history of a galaxy..

Powerful space observatories give you the full story of the different components of the Universe at a glance....scientists can do much better understanding the physical processes active in place....

This is the state of art… and open questions?

We need to probe the very early stages of the Universe, to understand how it evolved from the Big Bang, i.e. from the (almost) pure hydrogen in form of gas (and dark matter?), to the 'monster' and 'mini' BHs, clester of Galaxies, Galaxies, Stars, Proto-Planetary systems Planets and finally life!....

✓ how and when the 'first stars' were built is one of the fundamental question → ***now compelling in view of the GW detection 100Ms??***

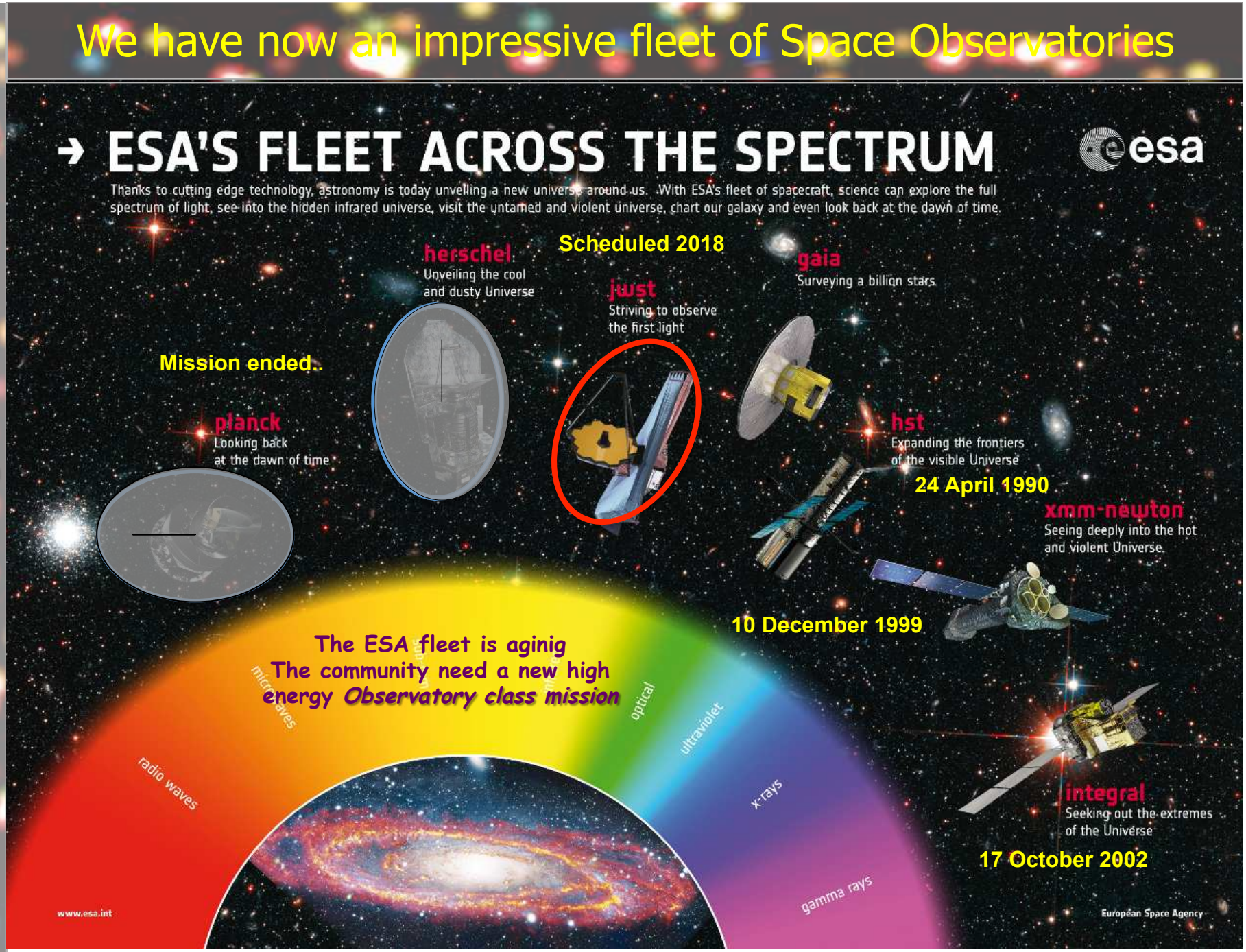
→ Need for more powerful Space Observatories

✓ there is a need to maintain a FULL ACCESS to the whole electromagnetic spectrum from Space

→ There is a solid plan for Ground Based facilities that must be complemented by the space-segment to get the full picture of how the Universe originated and what is it made off.

At the WG time we had a unsecured future for Large missions

We have now an impressive fleet of Space Observatories



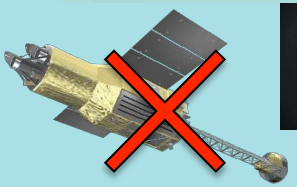
The short term perspective: an aging fleet!

Which Future for Space Astronomy?

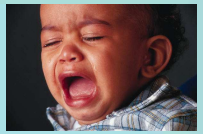
Multi Colour Eyes 2010-2015

SOFIA

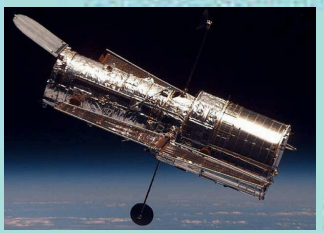
Nicer



Astro H



Gaia 2012-2017



Nustar 2011

SUZAKU

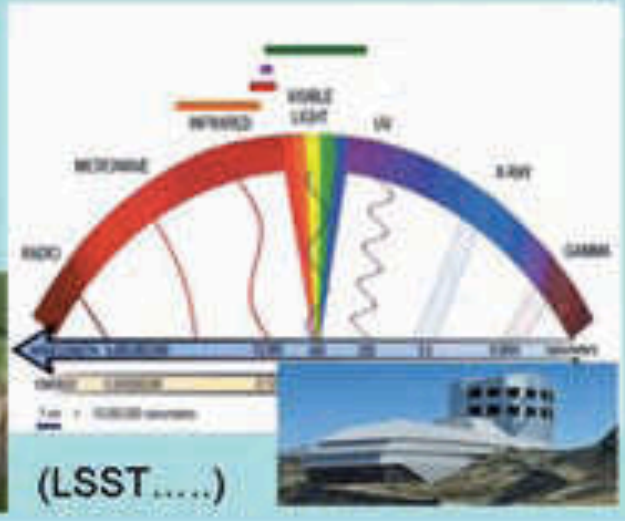
Integral

Swift

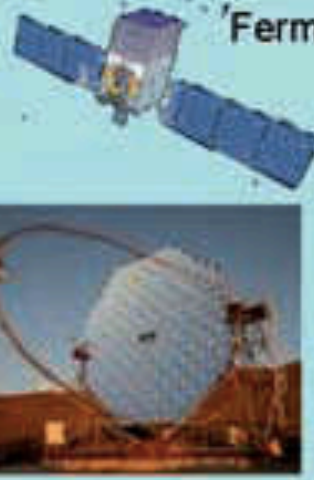
ALAMA, LMT
CCCAT

EVLA

LOFAR



(LSST.....)



'Fermi

MagicII
Hess II
Varitas

Which Future for Space Astronomy?

Multi Colour Eyes 2015-2020


SOFIA


Herschel

Planck


ALAMA, LMT
CCCAT


EVLA


LOFAR


Galex


e-rosita

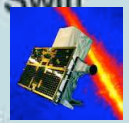

Gaia 2012-201

Hubble


Nustar 2011
ASTRO-H 2013

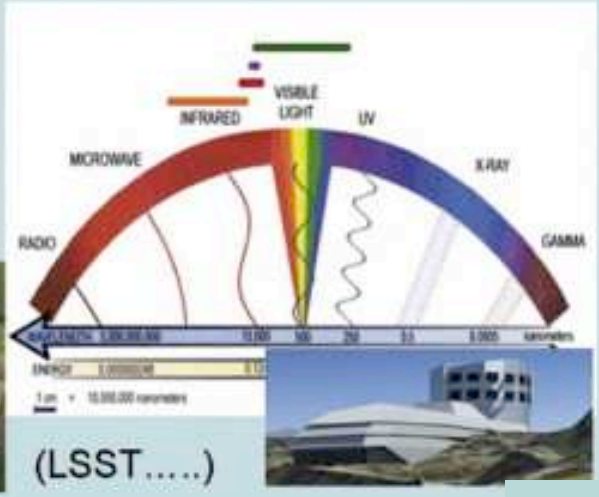

Chandra,XMM
SUZAKU


Integral


Swift


Fermi

Agile

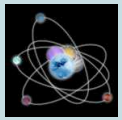


(LSST…..)


MagicII
Hess II
Varitas

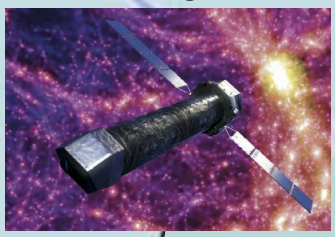
Adapted from Ubertini et al.

Multi Colour Eyes > >2020

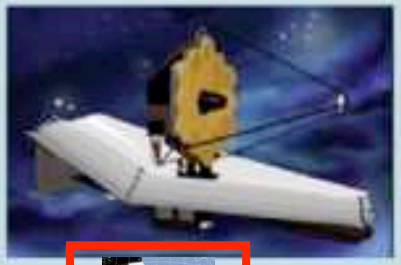


Echo
Plato
ESA

ATHENA
ESA L2



JWST

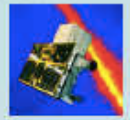


ASTRO-H

Euclid
ESA M2

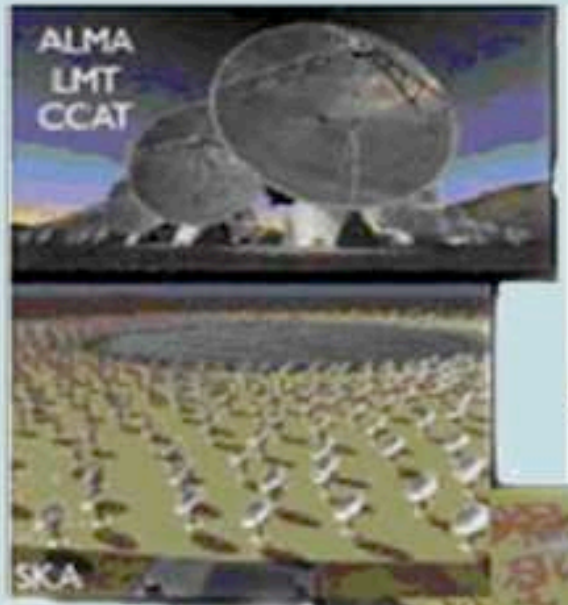
Integral

Swift



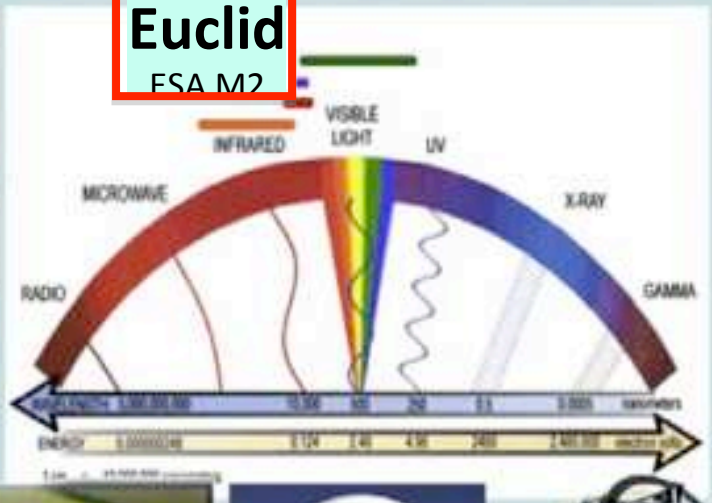
Fermi

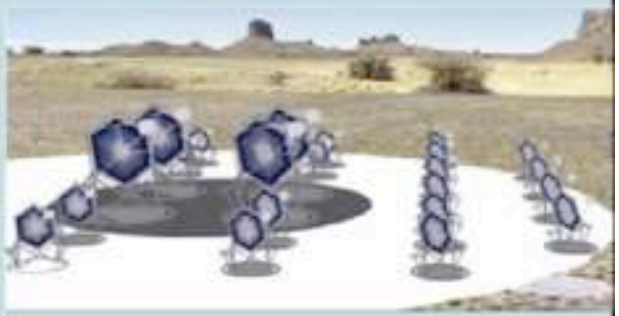
Agile



GBT EVLA

LOFAR





CTA, ACIS
HAWC

Adapted from Ubertini et a


In the last 5 years COSPAR-IAU-IAF
Commissions common action have been implemented to
..find sinergies,
common actions,
Proselitism,
herding the astrophysics community...
L2 Athena & L3 eLISA
programs has been decided and they will drive
the next 2-3 decades scintific activity in space
astrophysics and planetology!

…what's next?

At the IAU GA in Honolulu (2015) was held a Focuss Meeting on Global Coordination.
After several days of open discussion
the result was the Establishment of a WG on:

Global Coordination of Ground and Space Astrophysics

under the IAU Executive Committee

Members and Contact Details

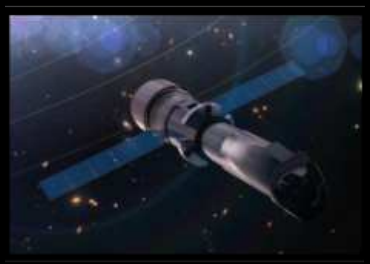
Chairs:

Roger Davies (Roger.Davies@physics.ox.ac.uk) - UK – co-chair
David Spergel (dns@astro.princeton.edu) - USA – co-chair

Major Observational Facilities 2020 -2040

Which Future for Space Astronomy?

ATHENA

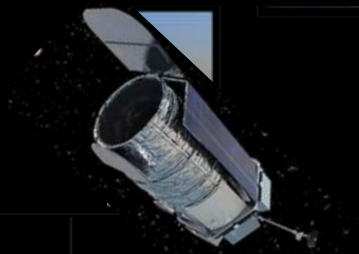


JWST

ALMA

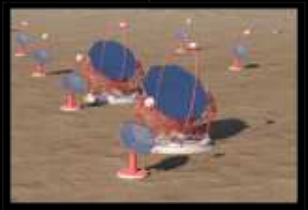
ALMA

WFIRST - EUCLID

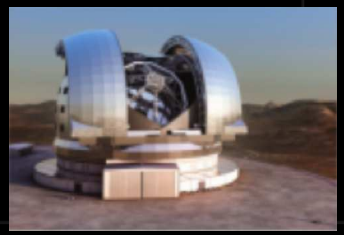


CTA

CTA



ELT - TMT



SKA - FAST, China

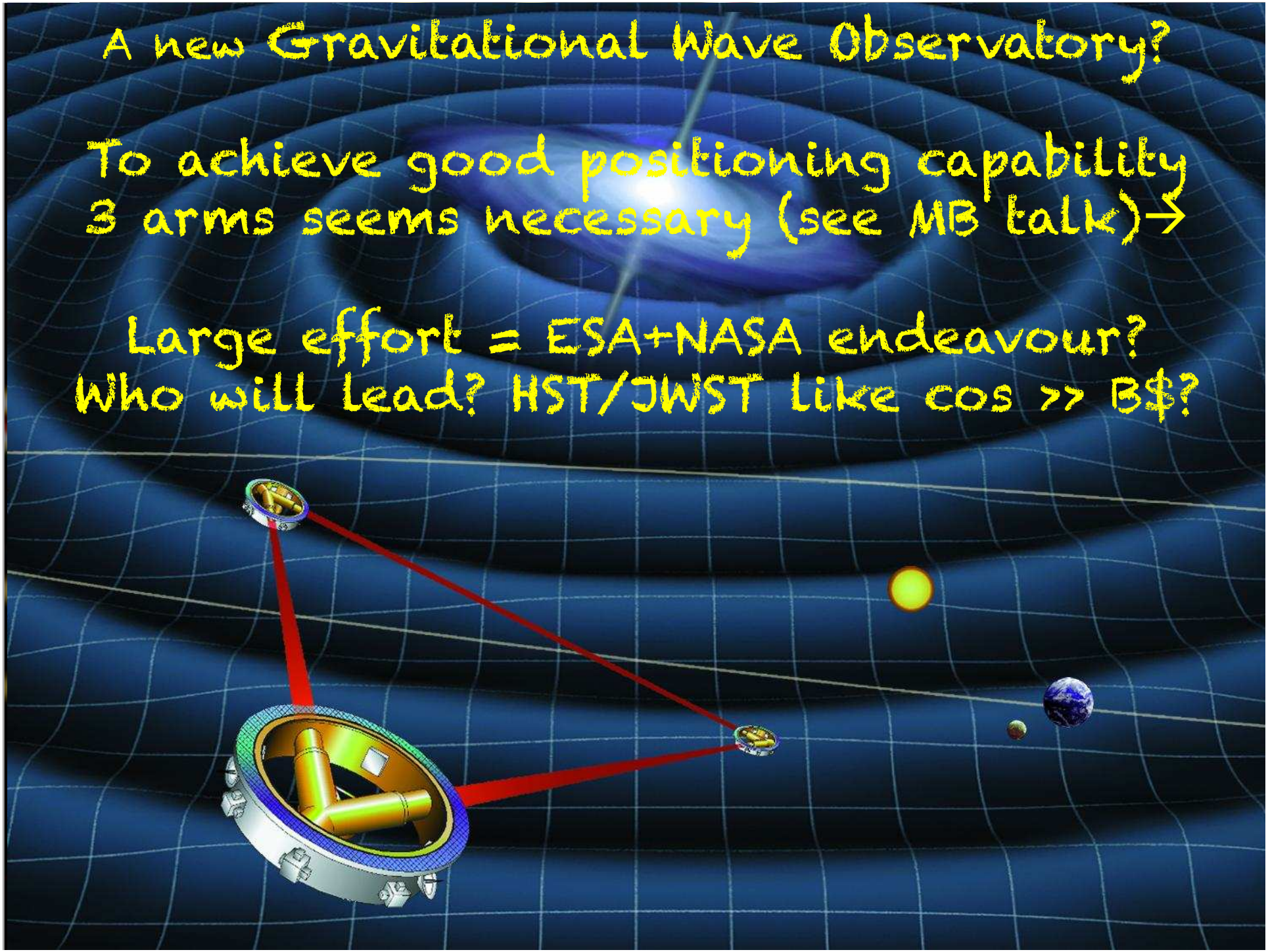
Y-RAY | X-RAY | UV | OPTICAL | IR | SUBMM | RADIO

The new IAU-WG will play a key role in the coordination activity → What's missing'

A new Gravitational Wave Observatory?

To achieve good positioning capability
3 arms seems necessary (see MB talk)→

Large effort = ESA+NASA endeavour?
Who will lead? HST/JWST like cos >> B$?



Thanks for your attention