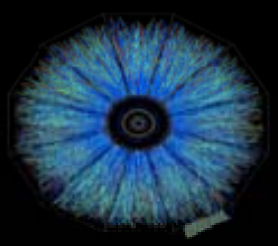
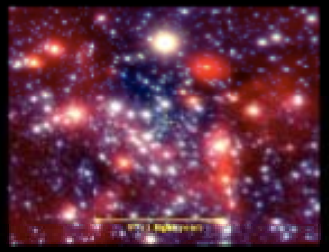
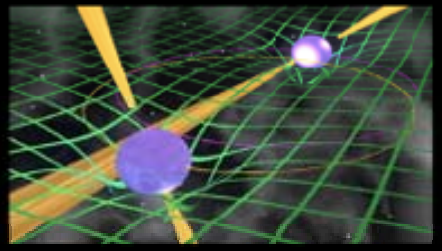
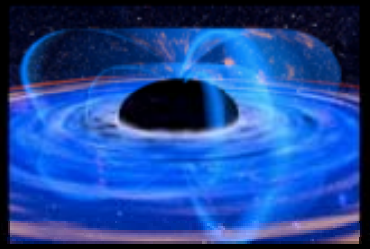
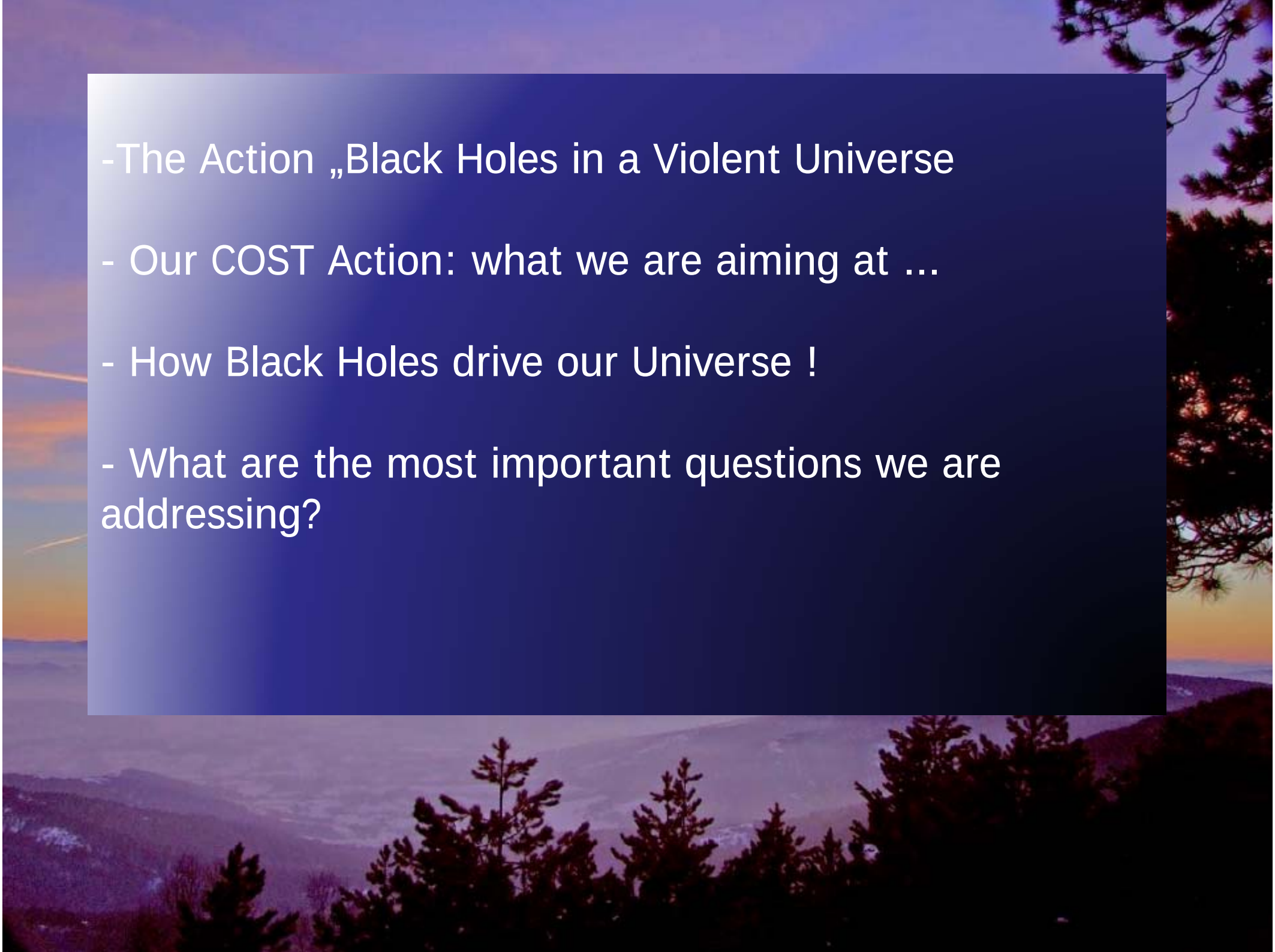
cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

BLACK HOLES IN A VIOLENT UNIVERSE
ACTION MP0905

Silke Britzen

Max-Planck-Institut für Radioastronomie
Bonn



-The Action „Black Holes in a Violent Universe

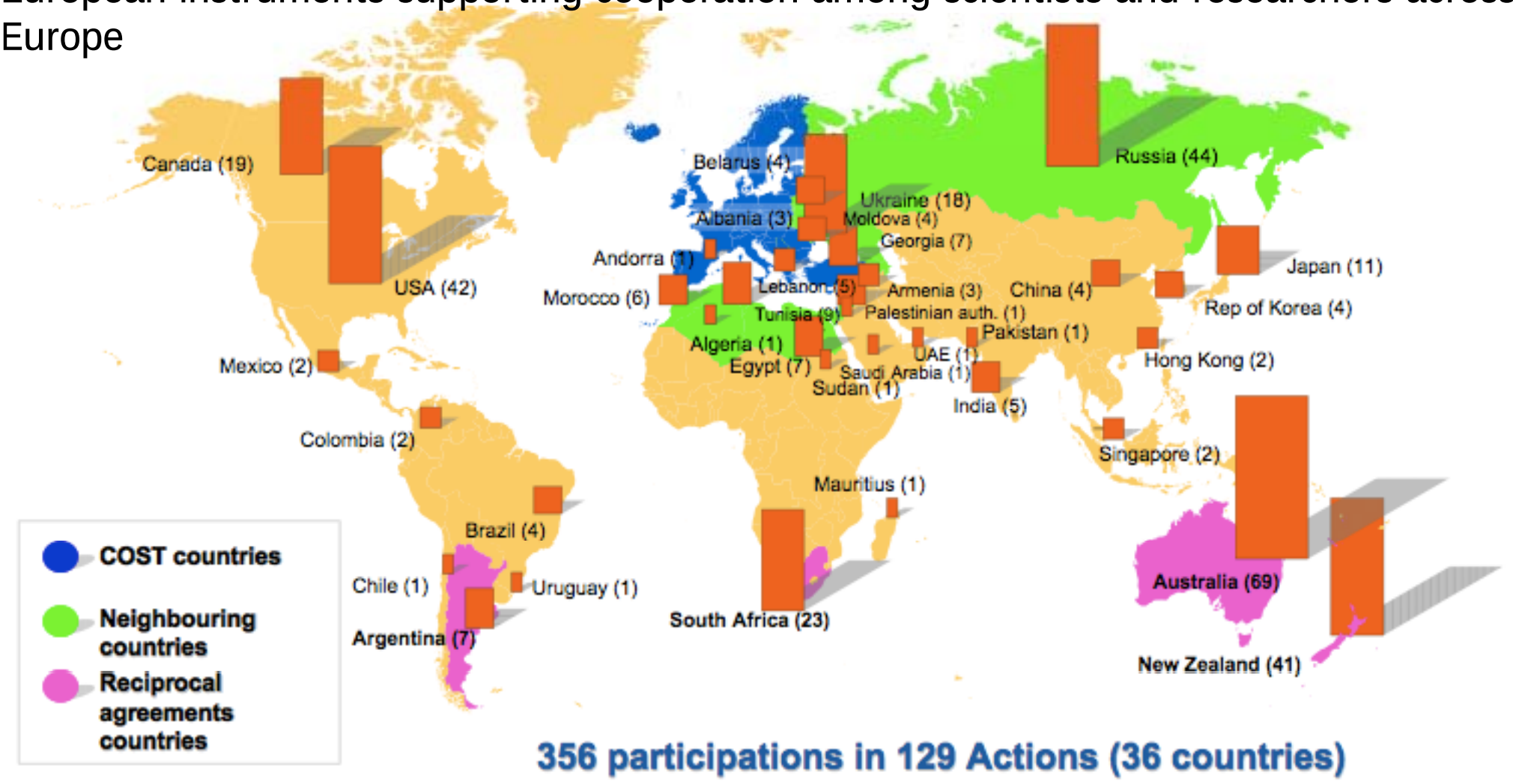
- Our COST Action: what we are aiming at ...

- How Black Holes drive our Universe !

- What are the most important questions we are addressing?

COST Actions: global participation (status: June 2010)

COST (European Cooperation in Science and Technology) is one of the longest-running European instruments supporting cooperation among scientists and researchers across Europe



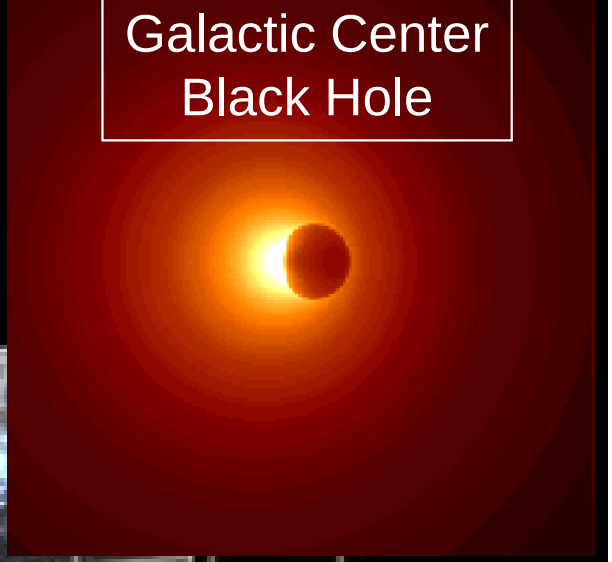
356 participations in 129 Actions (36 countries)

Who we are ……

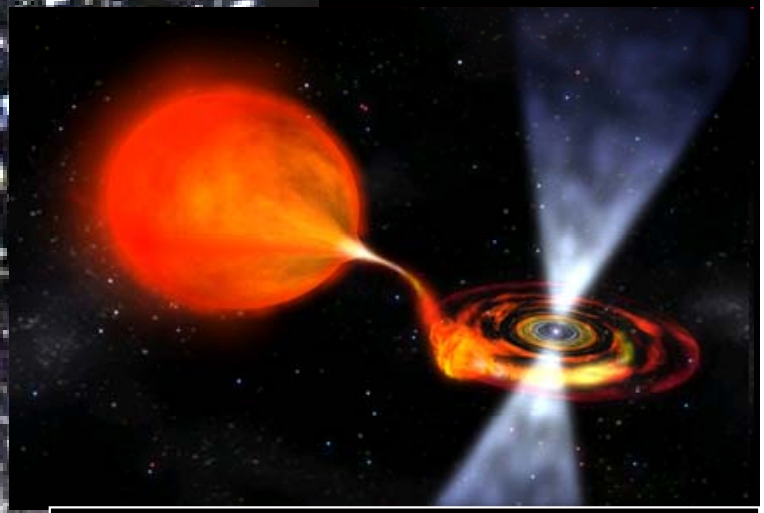
Black Hole scientists
from 22 countries

Black Holes are the engines of our Universe‘s history

Primordial Black Holes



Galactic Center Black Hole



Stellar Black Holes / Pulsars

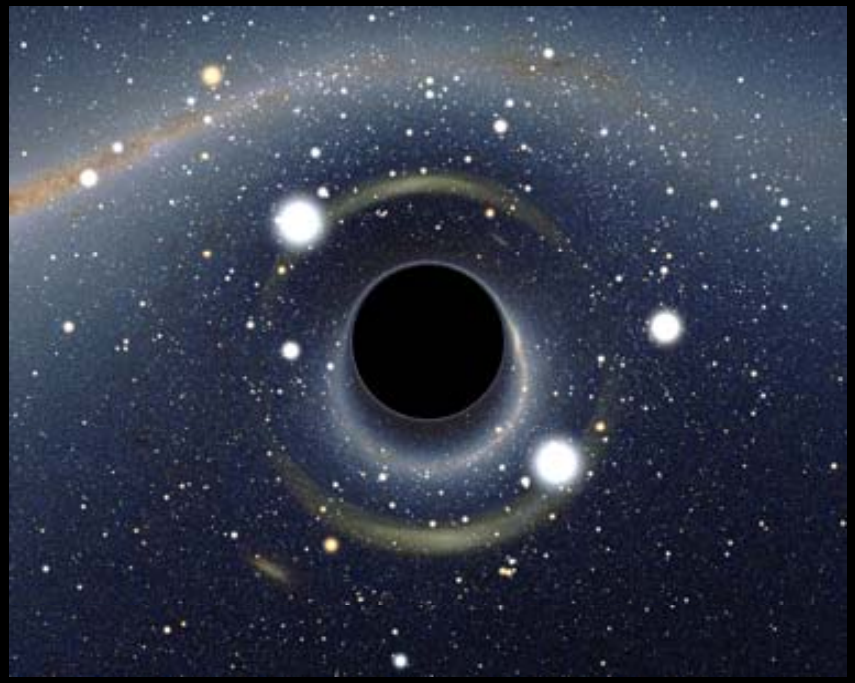
Supermassive Black Holes

How did BHs form in the early Universe?

Primordial BHs – were they formed? Can their existence be proven ?

How do mergers work?

How do BHs grow?
Merger?
Accretion?

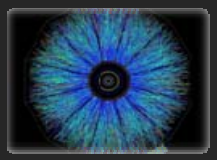


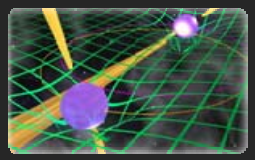
What kind of new physics describes BHs ?

How can we directly proof the Galactic Center BH?

How massive can stellar BHs be? How do they form?

What will gravitational waves tell us about the BHs?
And when will they be detected?

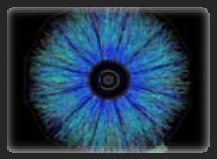


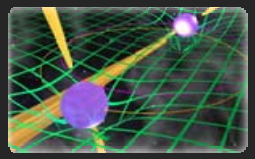



Our Primary Objectives

- To enhance the understanding of the BH-phenomenon and its impact on the evolution of our Universe
  - To study the fundamental laws of nature using an multi-disciplinary and multi-dimensional approach to BH-research
  - To use BHs as „laboratories“ to test new physical concepts

The Working Groups and Science

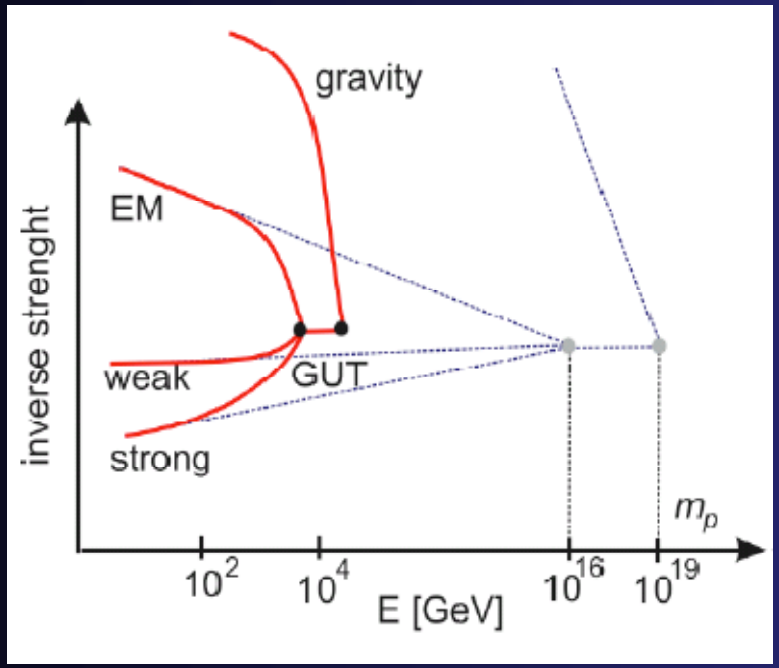





WG1: Quantum BHs

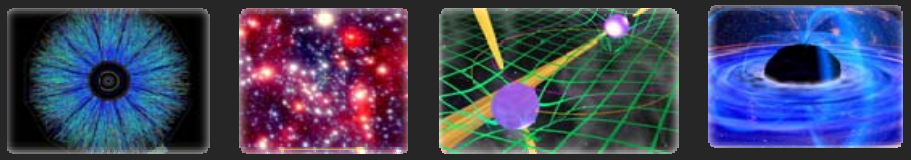
Quantum Black Holes at the LHC
$M_{BH} \sim 10^{-24}$g

- The Theory of Everything
- Constraints about the energy scale of the Universe
- How many dimensions ?



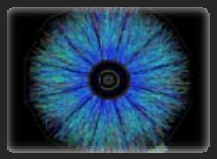
Primordial Black Holes
$M_{BH} \sim 10^{18}$ g

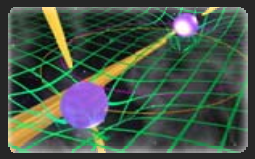
- Possible remnants of early Universe from initial density fluctuations
- Hawking radiation, possible detection by Fermi?



WG1: Quantum BHs

- Questions to be addressed by this WG include:
  - What is the possibility of detecting the primordial black holes evaporating in our Galaxy and close neighbourhood to our Earth?
  - How can the evaporation of the primordial black holes be modelled?
  - Can Quantum Black Holes play a key role in the search for a quantum theory of gravity?
  - What is the role of Black Hole entropy?
  - Any evidence or constraints for GRB observations originating in the evaporation from Quantum Black Holes?






WG2: Stellar Black Holes / Pulsars ($1\ M_\odot < M_{BH} < 100\ M_\odot$)

Crab Nebula

optical

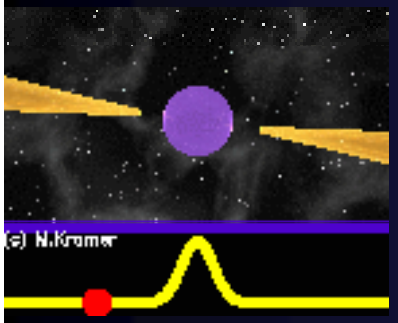
NASA/ESA

infrared

Spitzer

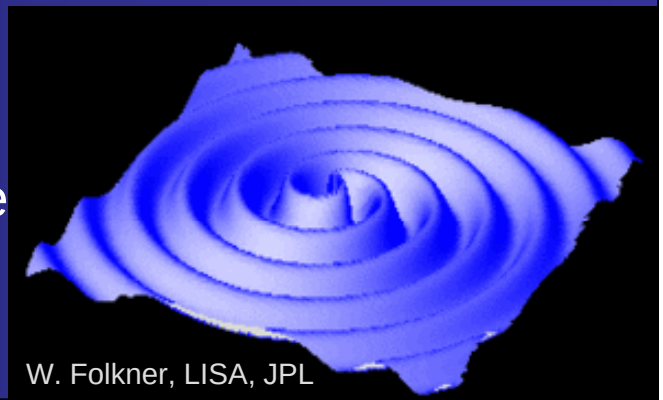
X-rays &optical

Hubble & Chandra

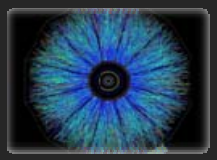


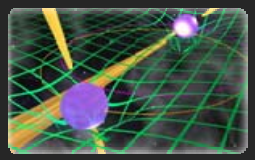
- Pulsars as precise cosmical clocks
- probes for strong gravity : space-time in violent conditions

- Direct Detection & study of gravitational wave background by pulsar- timing arrays



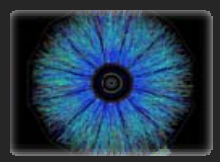
W. Folkner, LISA, JPL

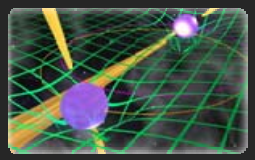




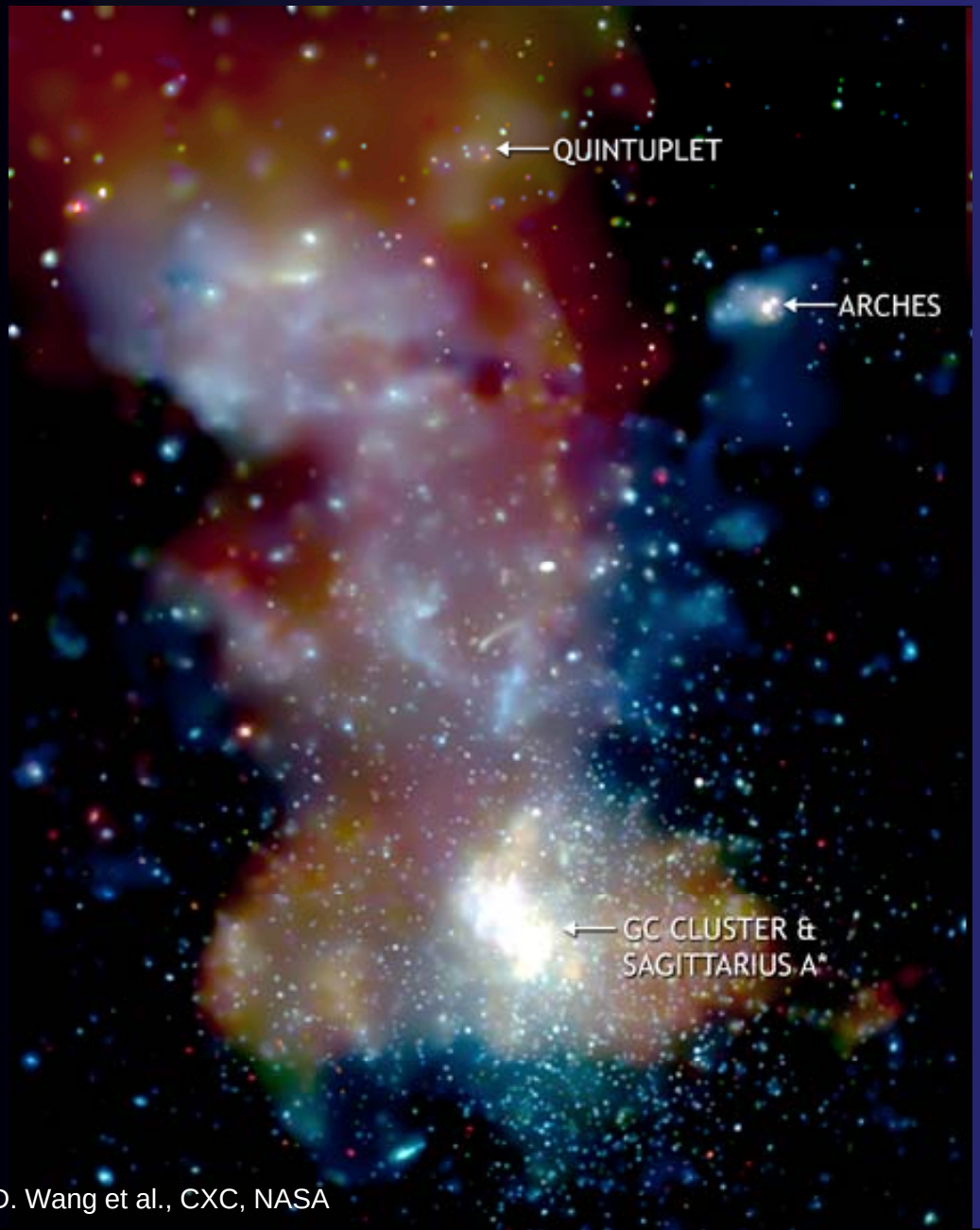

WG2: Stellar Black Holes / Pulsars ($1\ M_{\odot} < M_{BH} < 100\ M_{\odot}$)

- Science topics for this WG:
  - Search for a pulsar orbiting a Black Hole to probe how space and time behave under extreme conditions
  - Search for a pulsar in orbit around the Galactic Centre Black Hole to probe its curved spacetime
  - Investigate the gravitational wave background produced by the ensemble of SMBH binaries (nano-Hz gravitational wave signals) and gain insight into the history of SMBH mergers throughout the history of the Universe
  - Detect single merger events of SMBH binaries (with 100 million to one billion solar masses out to a distance of several 100 million light years)

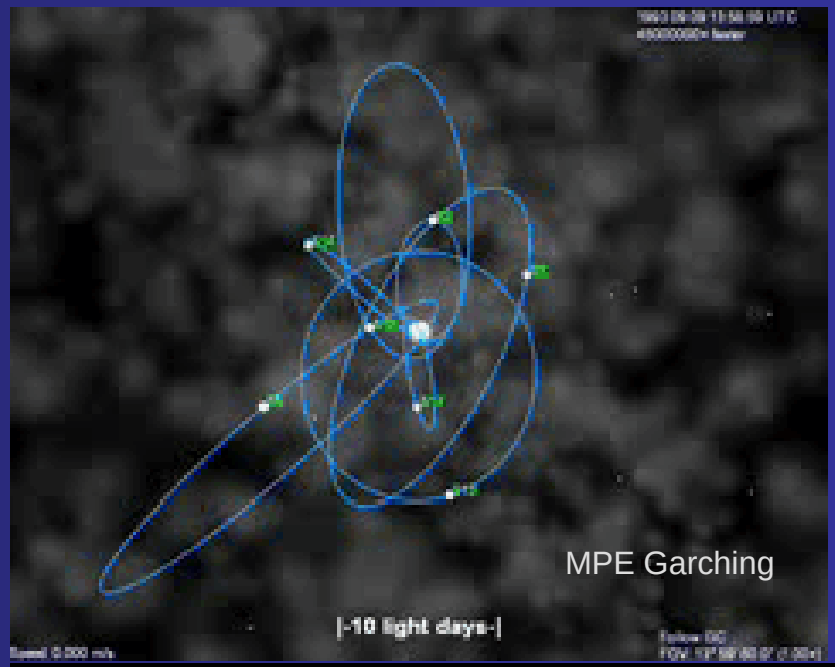


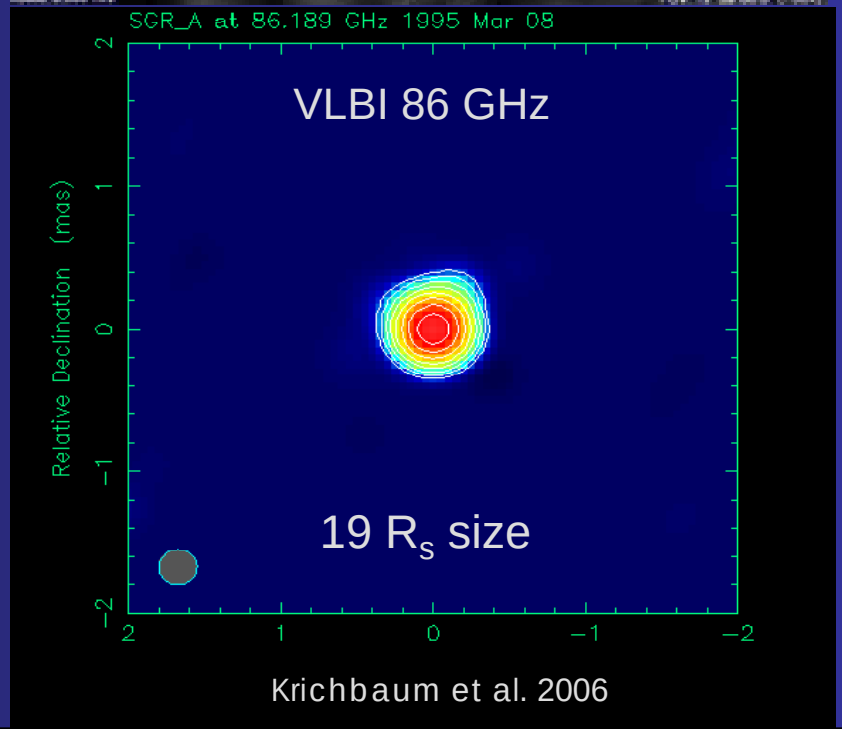



WG3: Galactic Center BH (~4x10^6 M$_\odot$)

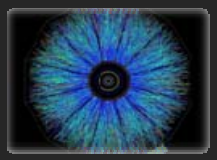


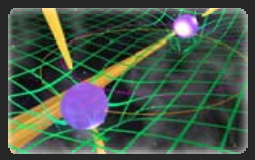
D. Wang et al., CXC, NASA





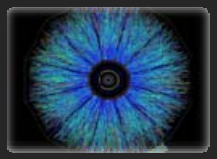
Krichbaum et al. 2006

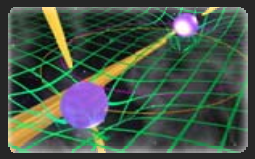





WG3: Galactic Center BH (~4x10^6 M$_\odot$)

- This WG is interested in:
  - High resolution 1mm-VLBI observations of SgrA* - the event horizon – the Black Hole and the silhouette of radiation surrounding it
  - Investigations of the extremely rapidly variable (near-infrared and X-ray) emission of SgrA* to understand accretion and emission of this most weakly accreting Black Hole
  - Prepare observations of the nuclear star cluster
  - Strong overlap with WG2 and WG4 – synergies wanted!!






WG4: Supermassive Black Holes (10^6-10^9 $M_\odot$)

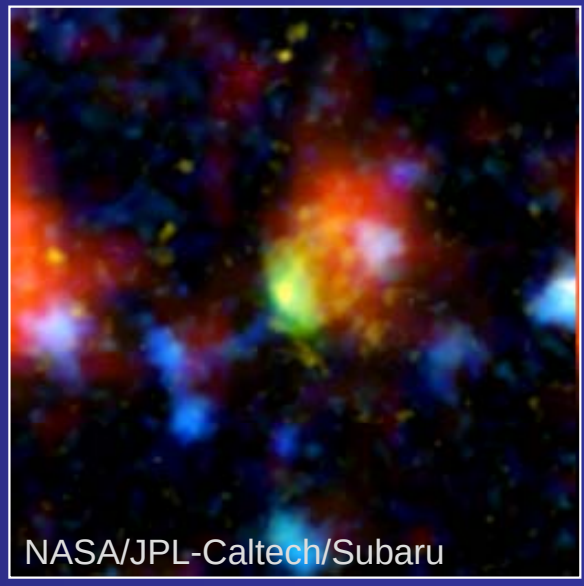

Robert Gendler

Normal Galaxies

Colliding Galaxies

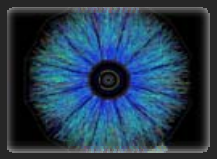

NASA, ESA, and the Hubble SM4 ERO Team

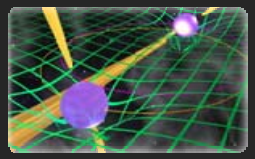
Starburst galaxies


NASA/JPL-Caltech/Subaru

Active Galactic Nuclei


NASA/CXC, NRAO/VLA, Digitized Sky Survey,






WG4: Supermassive Black Holes (10^6-10^9 $M_\odot$)

- This WG deals with questions such as:
  - When and how did the first SMBHs form in the early Universe?
  - What is the relative importance of accretion and mergers in the growth of the SMBH masses and in the evolution of their spin?
  - How are jets formed, accelerated and collimated?
  - What do jets consist of?
  - How to find SMBH binary systems observationally?
  - How to model SMBH binary merger? With conservative dynamics and including dissipative elements

How our COST-Action works

How COST works

WG meetings

Conferences

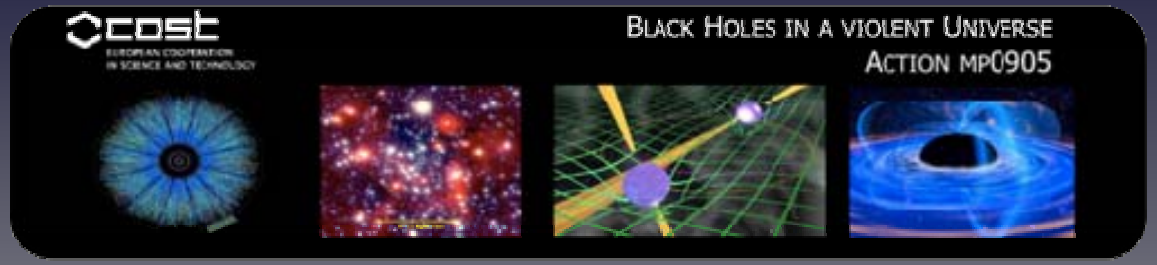
Webpage

Gender Forum

Short Term Scientific Missions=
„scientific travelling“

Training Schools

Encyclopedia

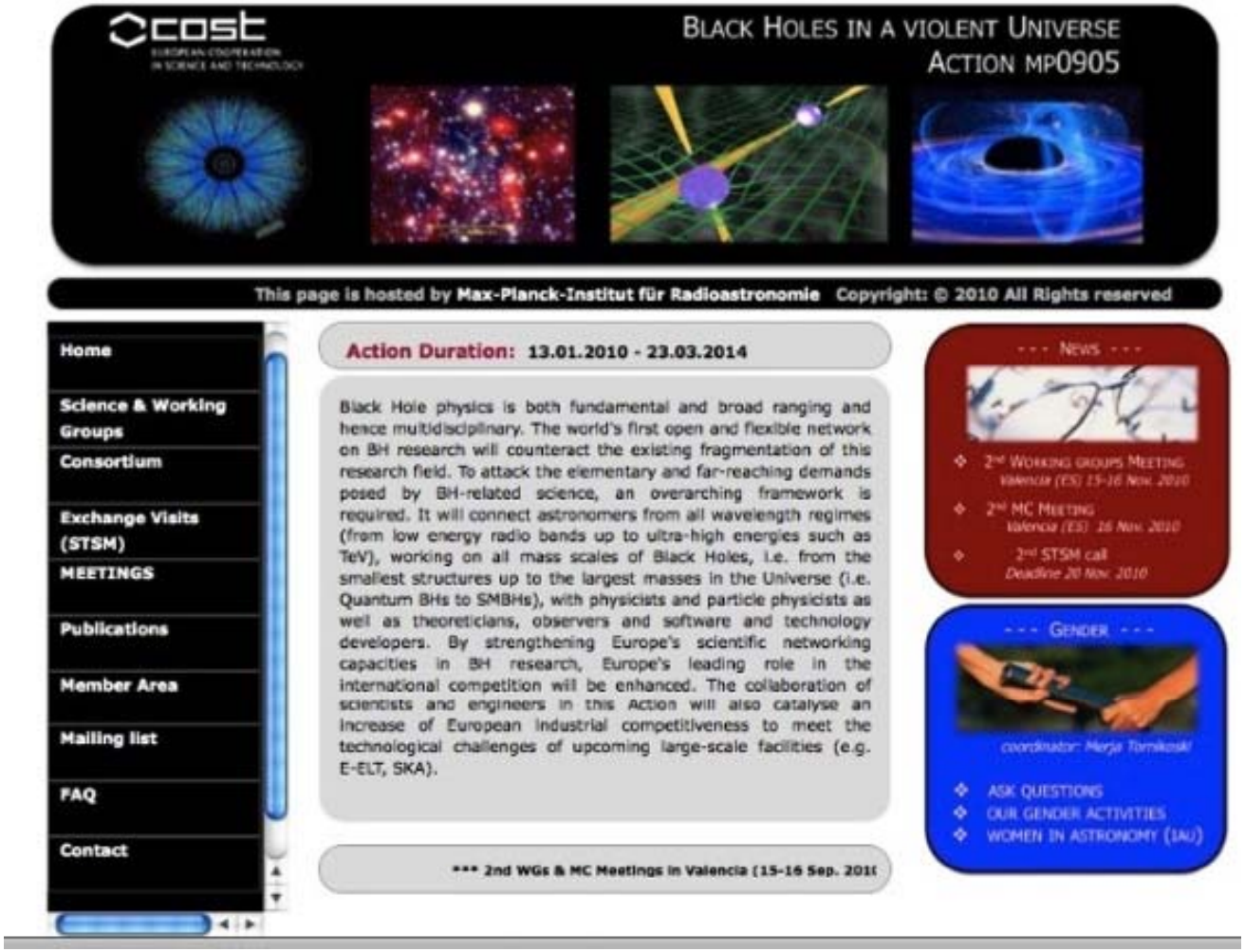


"The goal of COST is to ensure that Europe holds a strong position in the field of scientific and technical research for peaceful purposes, by **increasing European cooperation and interaction** in this field..."

Hence the funding and support for:

Short **T**erm **S**cientific **M**issions **(STSMs)**

Find out more about our Action MP0905 at:
http://www.mpifr-bonn.mpg.de/div/vlbi/COST/



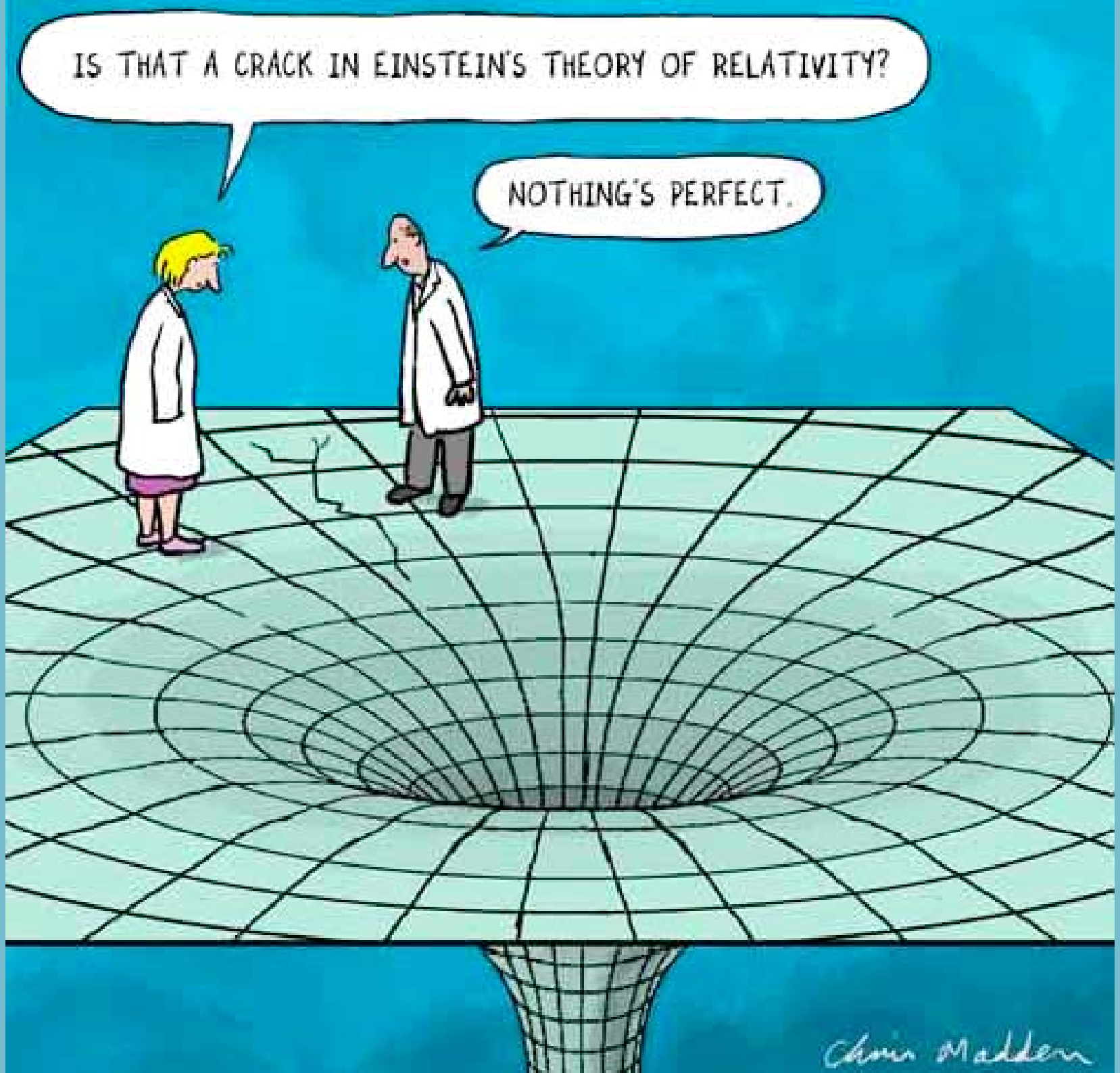
Soon to come:

- Blog on latest Black Hole News (worldwide)

- Gender Forum

- Results from STSM travellers

-.....


IS THAT A CRACK IN EINSTEIN'S THEORY OF RELATIVITY?
NOTHING'S PERFECT.
Chris Madden