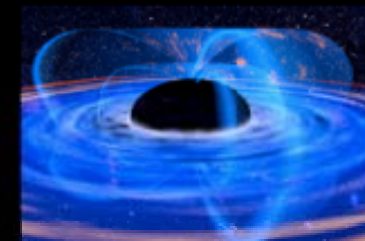
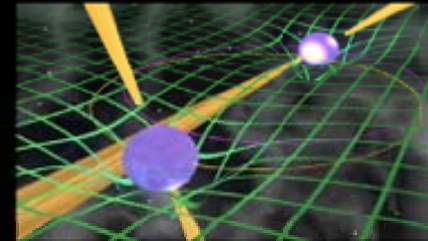
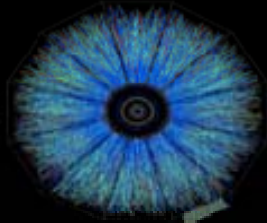


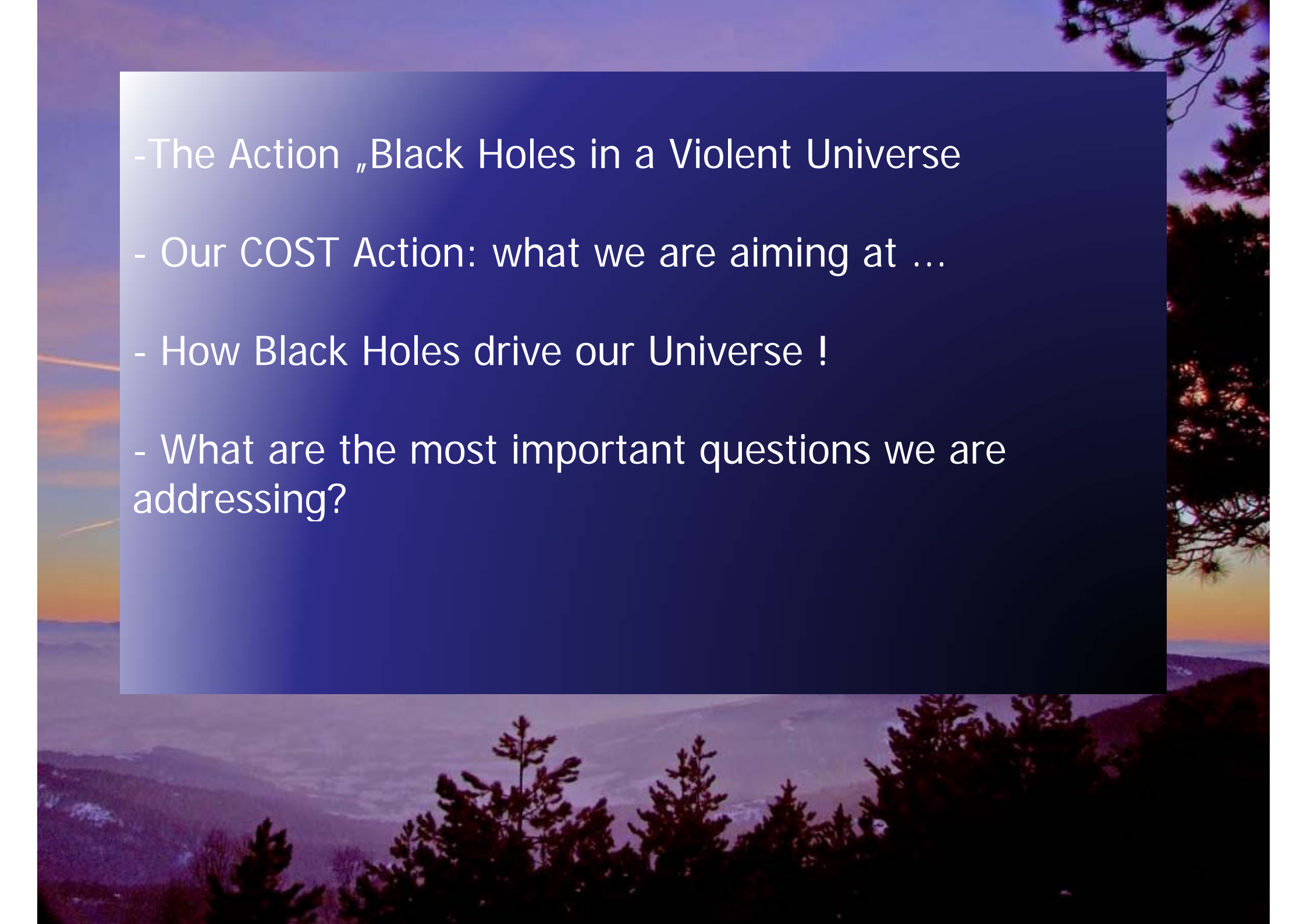
**cost**  
EUROPEAN COOPERATION  
IN SCIENCE AND TECHNOLOGY

BLACK HOLES IN A VIOLENT UNIVERSE  
ACTION MP0905



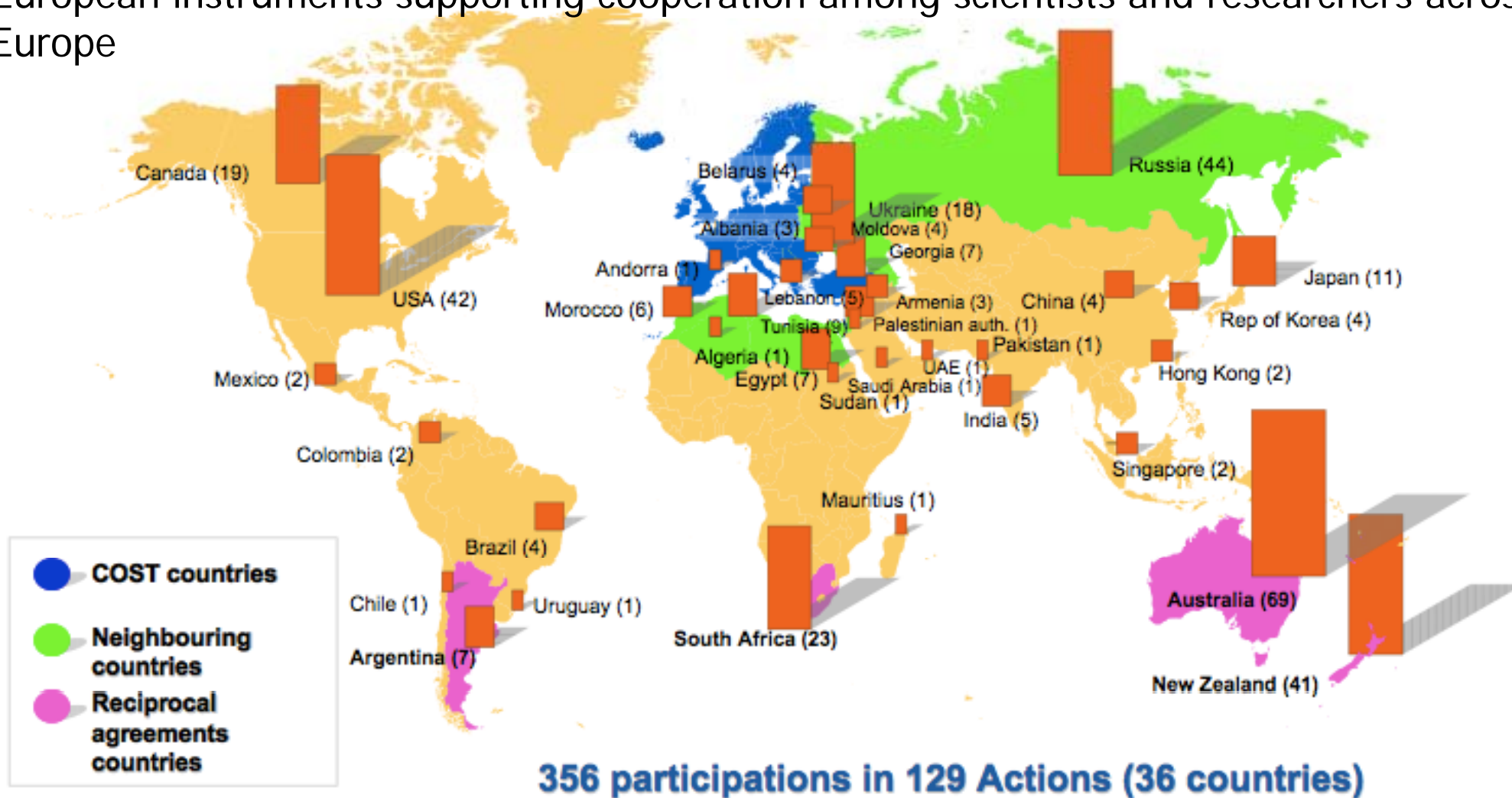
Silke Britzen

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



Who we are .....

Black Hole scientists  
from 22 countries



# Black Holes are the engines of our Universe's history



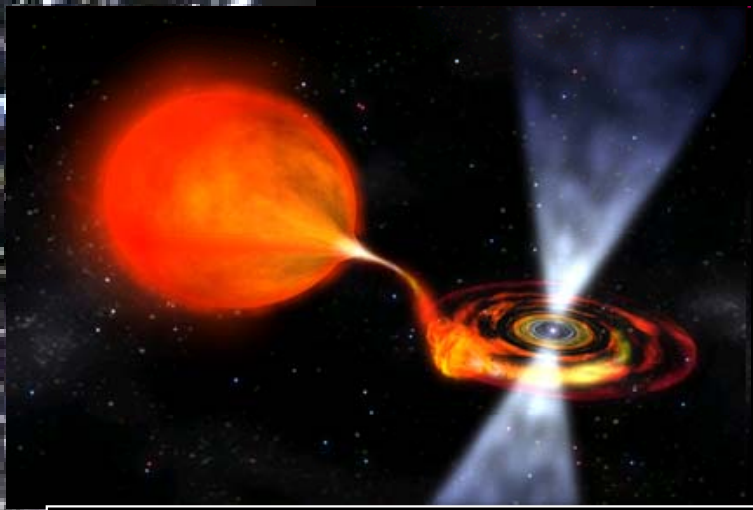
Primordial Black Holes



Galactic Center Black Hole



Supermassive Black Holes

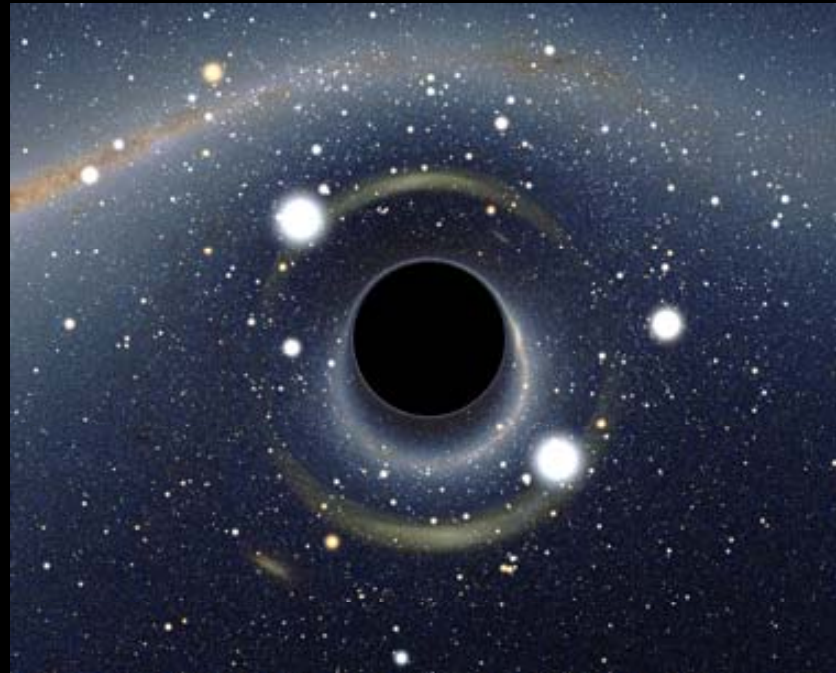


Stellar Black Holes / Pulsars

How did BHs form in the early Universe?

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

How do BHs grow?  
Merger?  
Accretion?



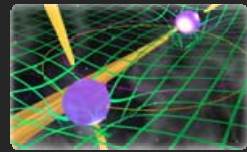
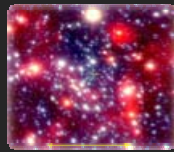
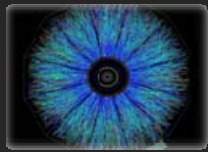
How do mergers work?

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?

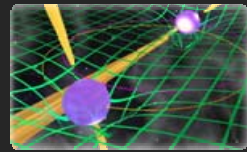
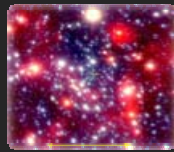
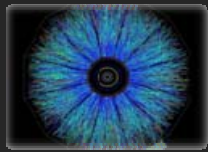


## Our Primary Objectives

- 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



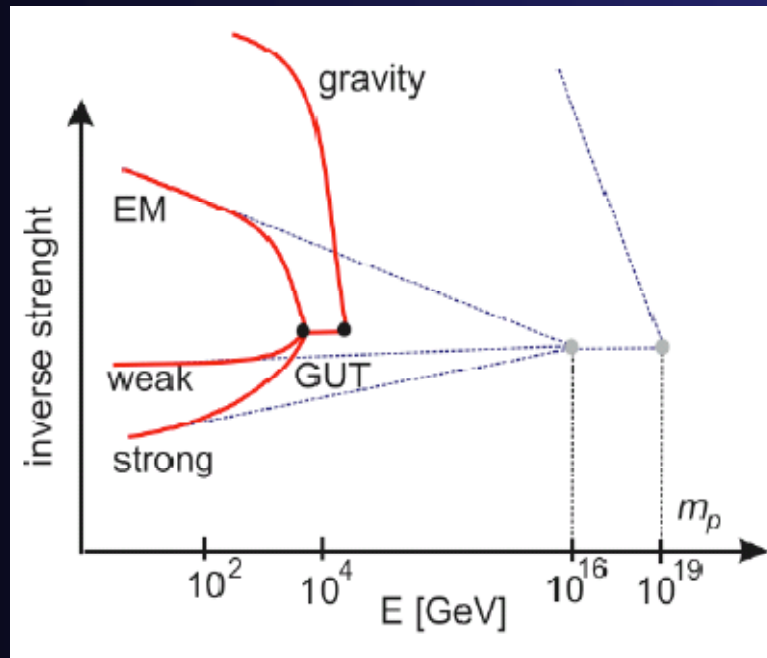


# WG1: Quantum BHs

## Quantum Black Holes at the LHC

$$M_{\text{BH}} \sim 10^{-24} \text{g}$$

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



## Primordial Black Holes

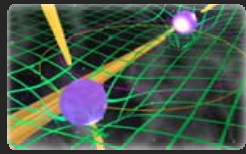
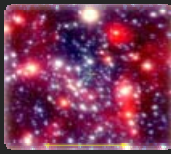
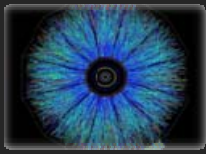
$$M_{\text{BH}} \sim 10^{18} \text{g}$$

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

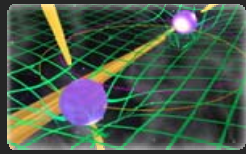
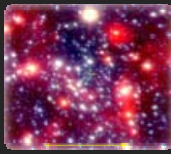
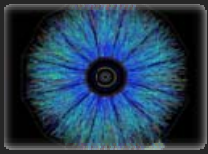
Fermi

Gamma-ray Space Telescope





- 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 ( $1 M_{\odot} < M_{\text{BH}} < 100 M_{\odot}$ )

## Crab Nebula



optical

NASA/ESA



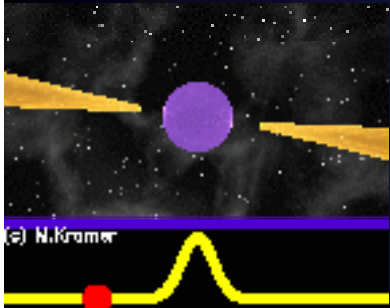
infrared

Spitzer



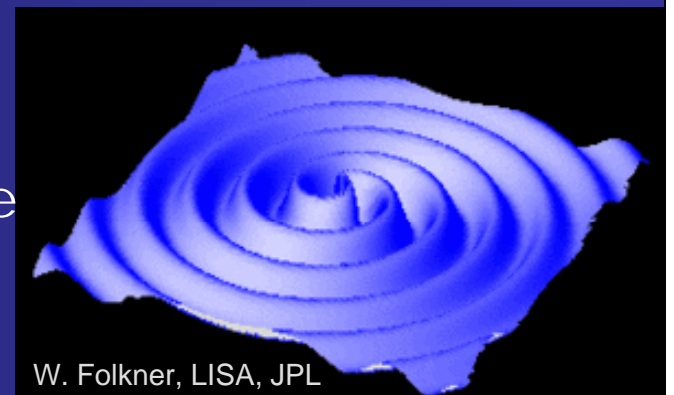
X-rays & optical

Hubble & Chandra

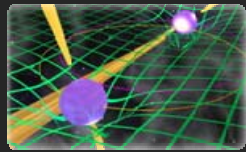
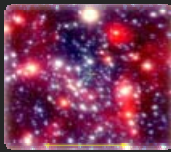
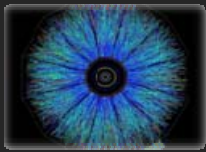


- Pulsars as precise cosmic clocks
- probes for strong gravity : space-time in violent conditions

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

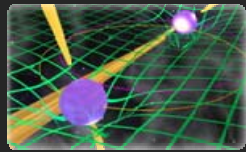
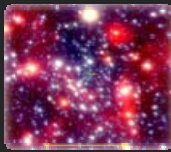
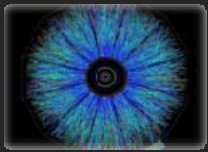


W. Folkner, LISA, JPL

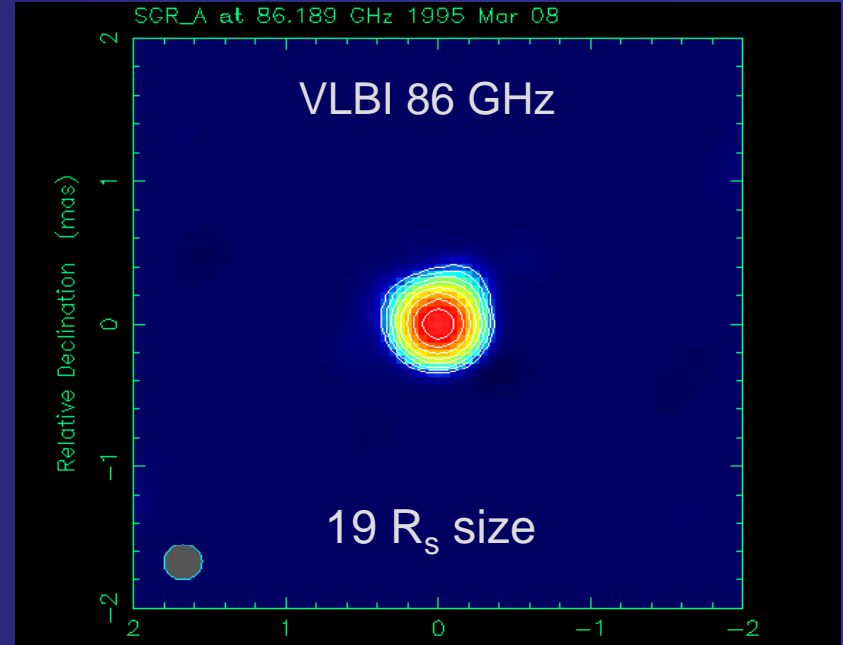
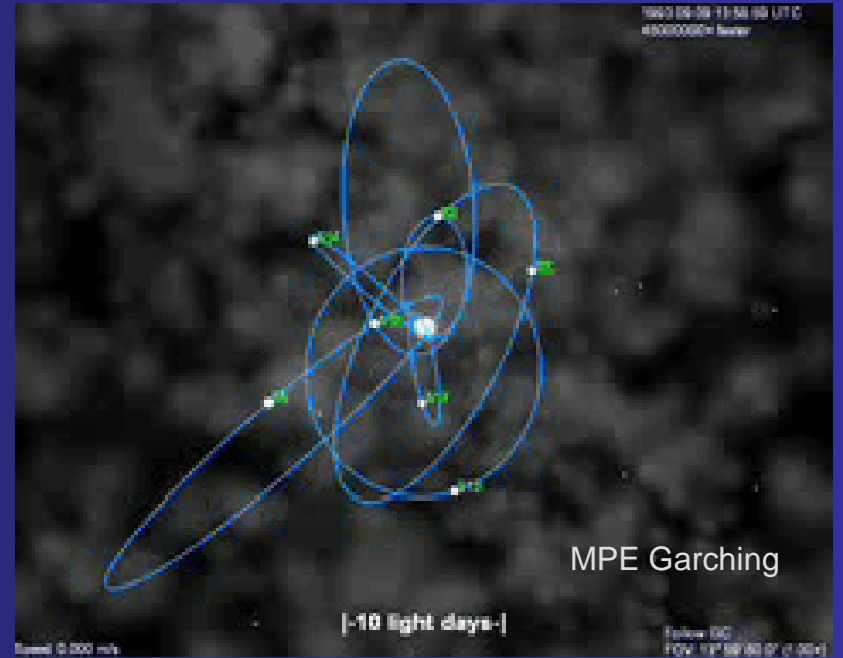
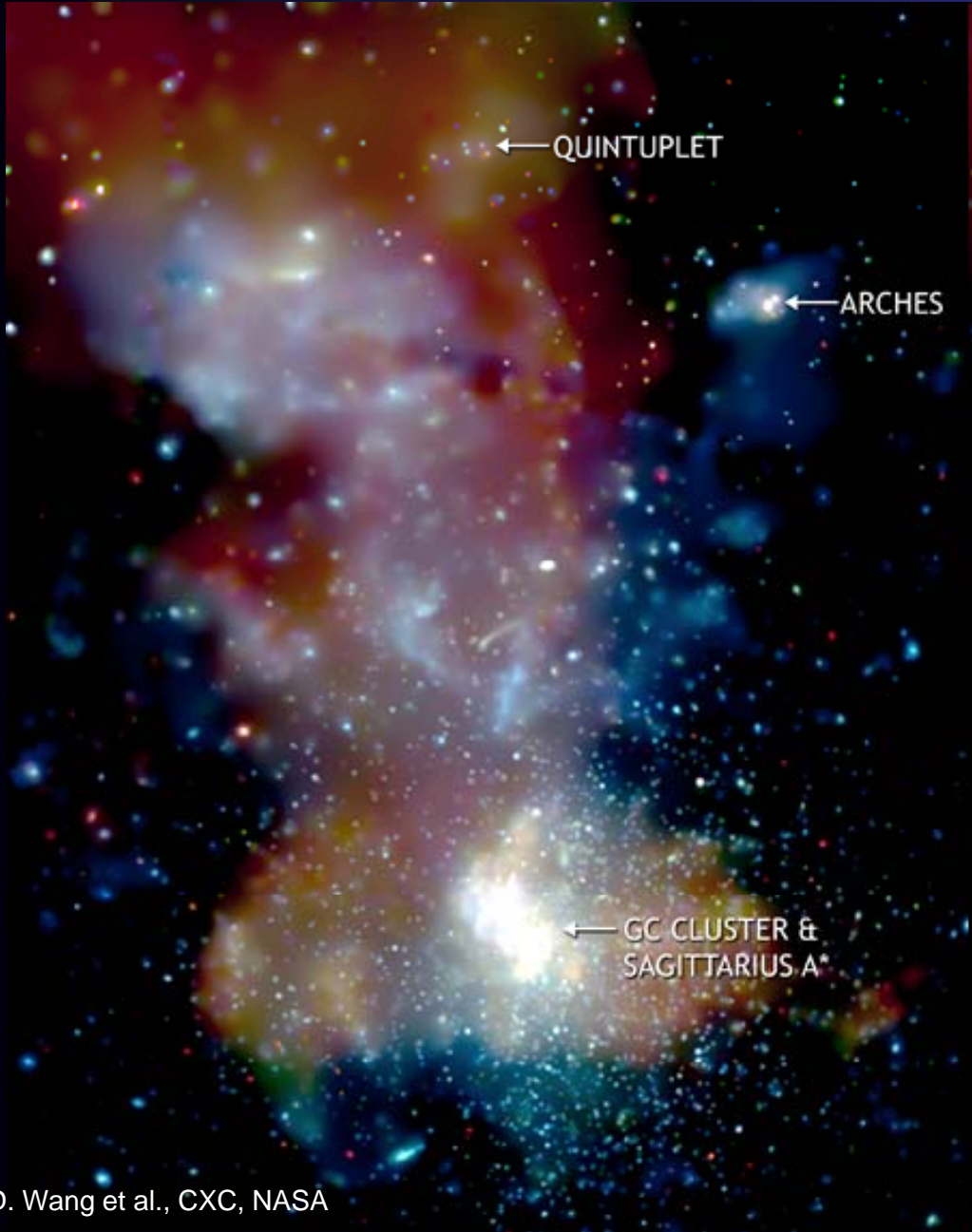


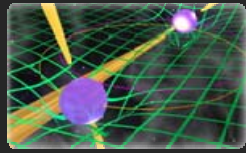
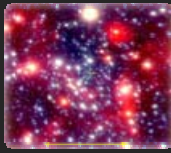
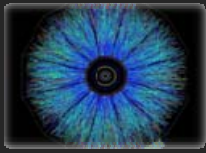
## WG2: Stellar Black Holes / Pulsars ( $1 M_{\odot} < M_{\text{BH}} < 100 M_{\odot}$ )

- 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)



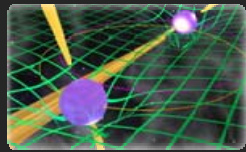
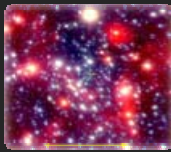
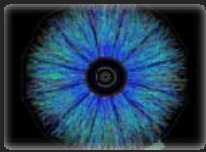
# WG3: Galactic Center BH ( $\sim 4 \times 10^6 M_{\odot}$ )





## WG3: Galactic Center BH ( $\sim 4 \times 10^6 M_{\odot}$ )

- 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!!

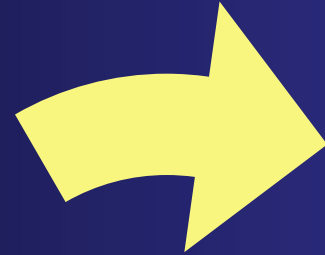


# WG4: Supermassive Black Holes ( $10^6$ - $10^9 M_{\odot}$ )



Robert Gendler

Normal  
Galaxies



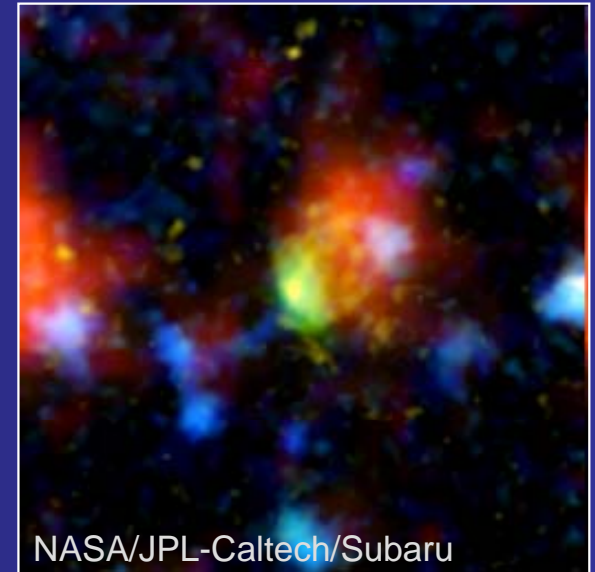
Colliding  
Galaxies



NASA, ESA, and the  
Hubble SM4 ERO Team



Starburst  
galaxies



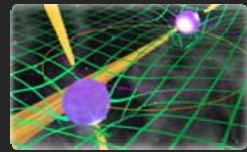
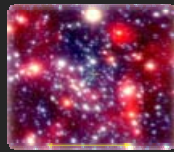
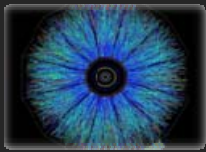
NASA/JPL-Caltech/Subaru



Active  
Galactic Nuclei



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

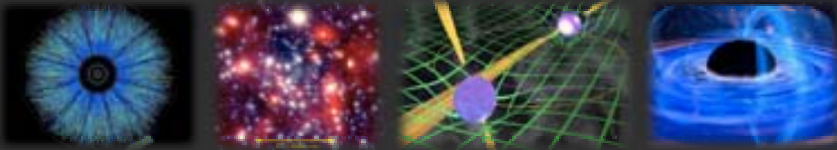


## WG4: Supermassive Black Holes ( $10^6$ - $10^9 M_{\odot}$ )

- 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

Short Term Scientific Missions=  
„scientific travelling“

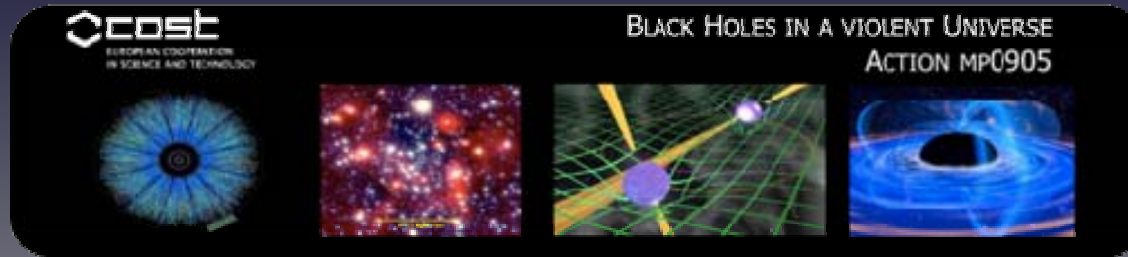
Encyclopedia



Webpage

Gender Forum

Training Schools



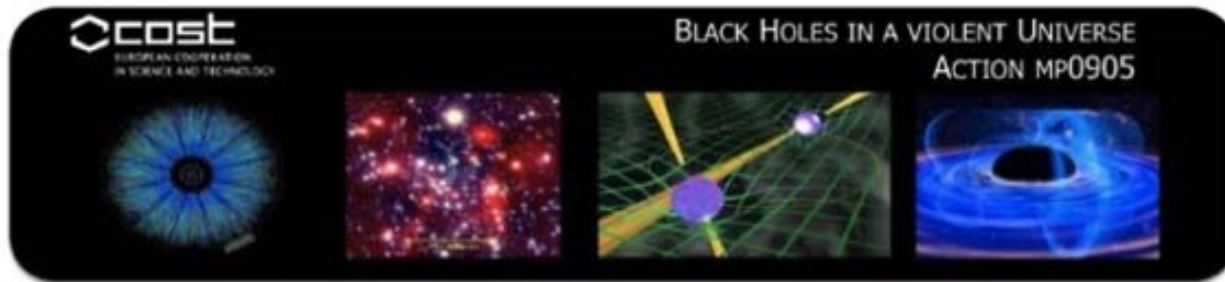
“The goal of COST is to ensure that Europe holds a strong position in the field of scientific and technical research for peaceful purposes, by increasing European cooperation and interaction in this field..”



Hence the funding and support for:

**Short Term Scientific Missions (STSMs)**

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



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- Home
- Science & Working Groups
- Consortium
- Exchange Visits (STSM)
- MEETINGS
- Publications
- Member Area
- Mailing list
- FAQ
- Contact

**Action Duration:** 13.01.2010 - 23.03.2014

Black Hole physics is both fundamental and broad ranging and hence multidisciplinary. The world's first open and flexible network on BH research will counteract the existing fragmentation of this research field. To attack the elementary and far-reaching demands posed by BH-related science, an overarching framework is required. It will connect astronomers from all wavelength regimes (from low energy radio bands up to ultra-high energies such as TeV), working on all mass scales of Black Holes, i.e. from the smallest structures up to the largest masses in the Universe (i.e. Quantum BHs to SMBHs), with physicists and particle physicists as well as theoreticians, observers and software and technology developers. By strengthening Europe's scientific networking capacities in BH research, Europe's leading role in the international competition will be enhanced. The collaboration of scientists and engineers in this Action will also catalyse an increase of European industrial competitiveness to meet the technological challenges of upcoming large-scale facilities (e.g. E-ELT, SKA).

\*\*\* 2nd WGs & MC Meetings in Valencia (15-16 Sep. 2011)

--- News ---



- ◆ 2<sup>nd</sup> WORKING GROUPS MEETING Valencia (ES) 13-16 Nov. 2010
- ◆ 2<sup>nd</sup> MC MEETING Valencia (ES) 16 Nov. 2010
- ◆ 2<sup>nd</sup> STSM call Deadline 20 Nov. 2010

--- GENDER ---



coordinator: Merja Toimikoski

- ◆ ASK QUESTIONS
- ◆ OUR GENDER ACTIVITIES
- ◆ WOMEN IN ASTRONOMY (IAU)

Soon to come:

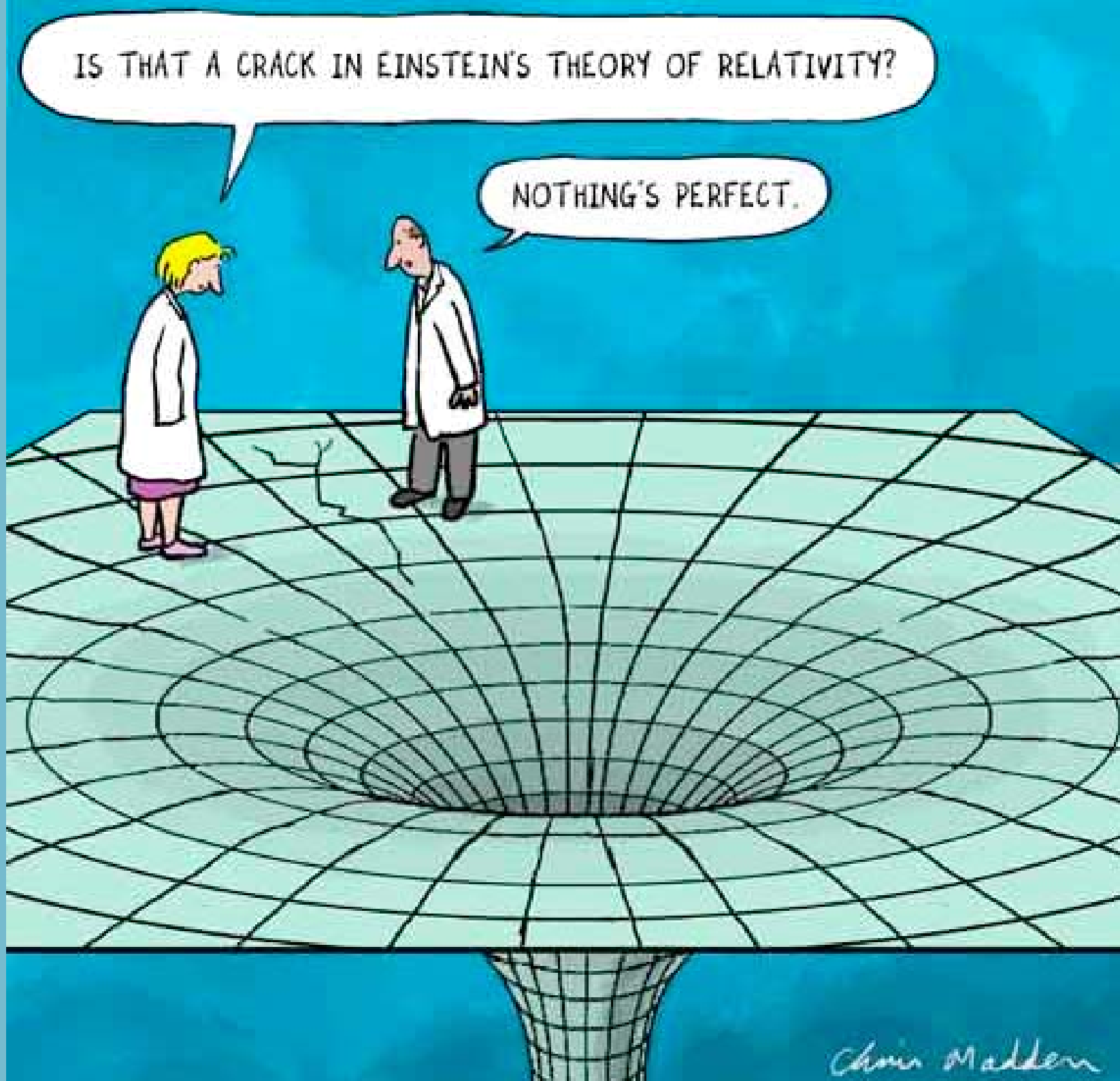
- Blog on latest Black Hole News (worldwide)
- Gender Forum
- Results from STSM travellers

-.....



IS THAT A CRACK IN EINSTEIN'S THEORY OF RELATIVITY?

NOTHING'S PERFECT.



Chris Madden