

MPNS COST Action MP1210

# THE STRING THEORY UNIVERSE

(Kick-off meeting March, 4 2013)

**Chair:** Silvia Penati (Milano-Bicocca)

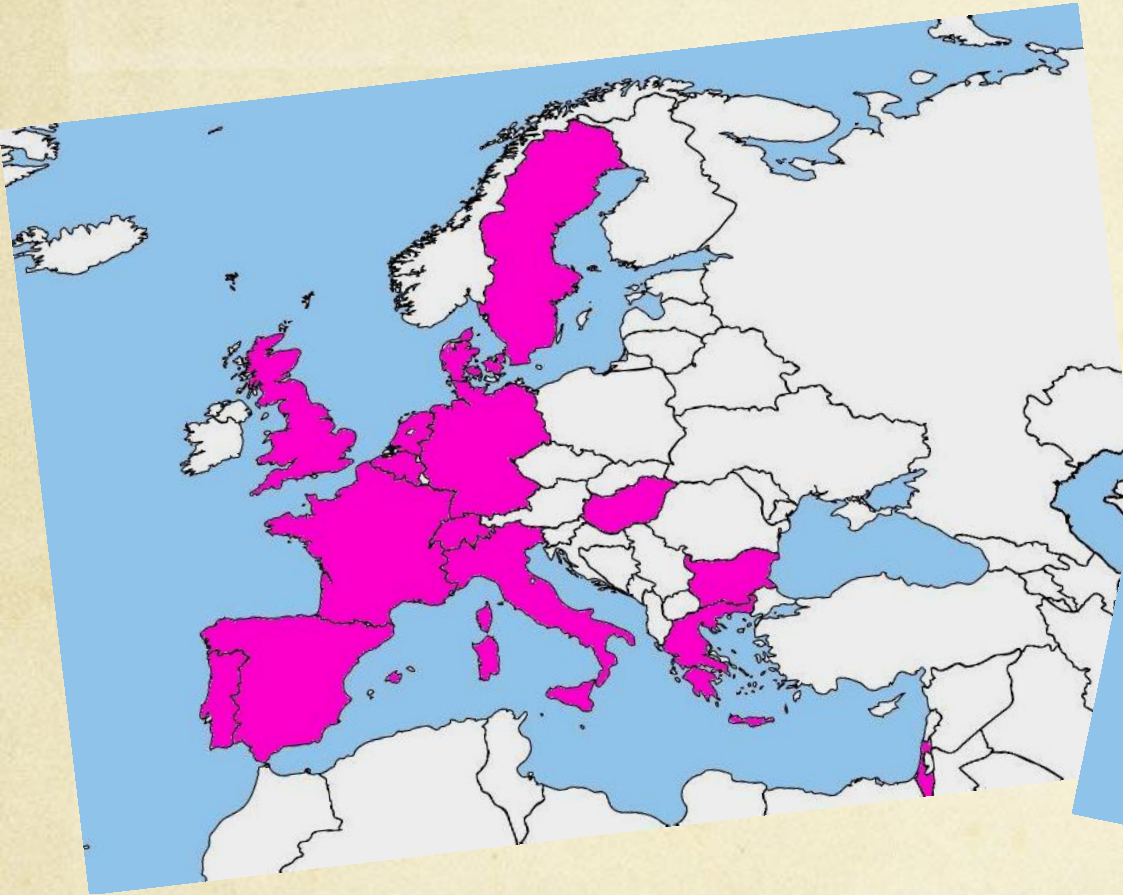
**Vice-chair:** Yolanda Lozano (Oviedo)

**DC Rapporteur:** Laurens Katgerman (NL)

**Science Officer:** Caroline Whelan

**Administrative Officer:** Milena Stoyanova

# Participating Countries



16 COST Countries + CERN



South Africa

126 people actively involved



Already contacts with



About 100 further people have already expressed serious interest in participating to this Action

**Why String Theory  
and  
why now ?**

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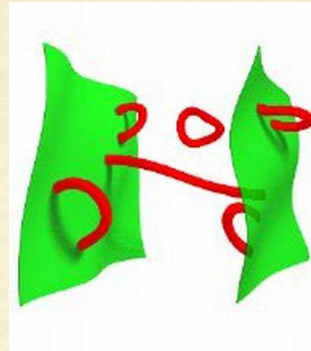


# STRING THEORY

**Original formulation:** Quantum theory of interacting extended objects



**Strings**



**Branes**

- Supersymmetry
- Existence of extra dimensions
- Description of ALL particles, graviton included
- Merging of gravitation with quantum mechanics
- Unification of ALL fundamental forces in Nature

## Modern formulation:

In the last 15 years String Theory has grown as a powerful mathematical FRAMEWORK where

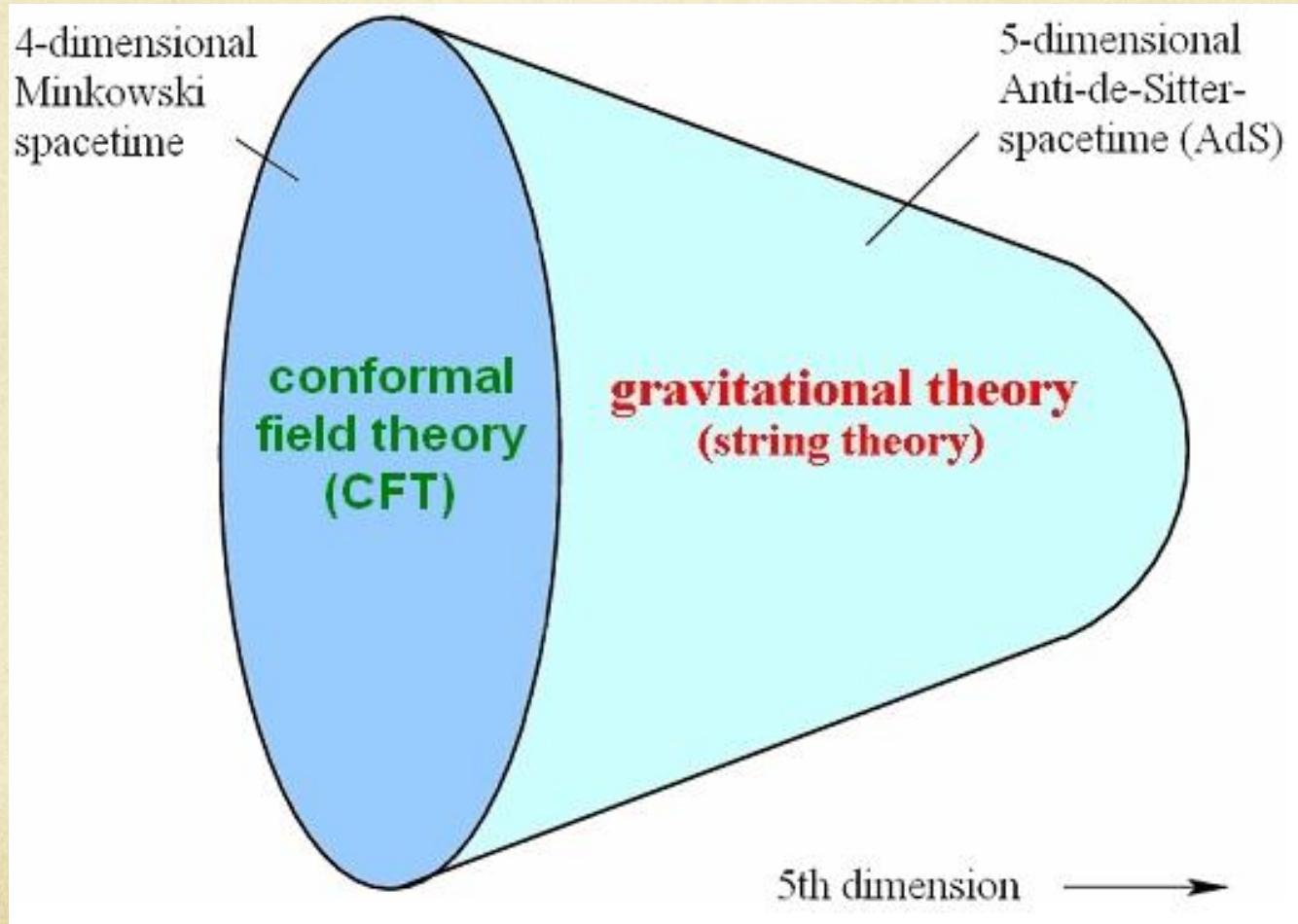
- ✓ many problems become easier to solve
- ✓ several long-standing conceptual puzzles in theoretical physics can be addressed
- ✓ many new ideas for applications well outside of String Theory can be formulated

Picture-changing paradigm .....



# AdS/CFT Correspondence

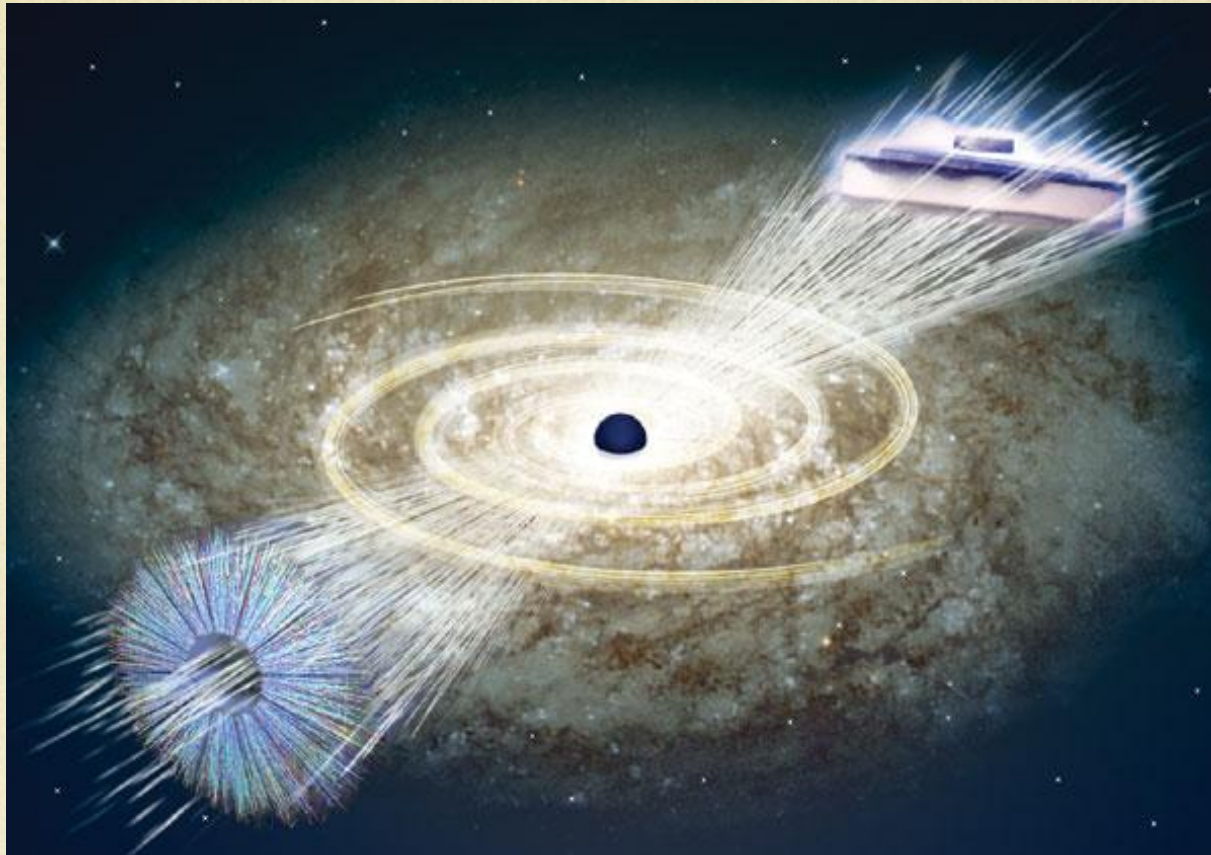
(gauge/gravity duality)



Current research in ST is growing in many different (previously unexpected) directions:

- Besides powerful applications to high-energy particle physics..... **[BlackHat for Higgs discovery]**
- Novel applications to QCD at intermediate energies
- Novel applications to Cosmology
- Unexpected applications to Condensed Matter and Quantum Information

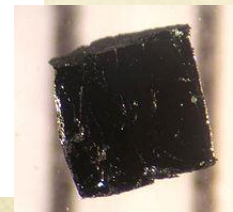
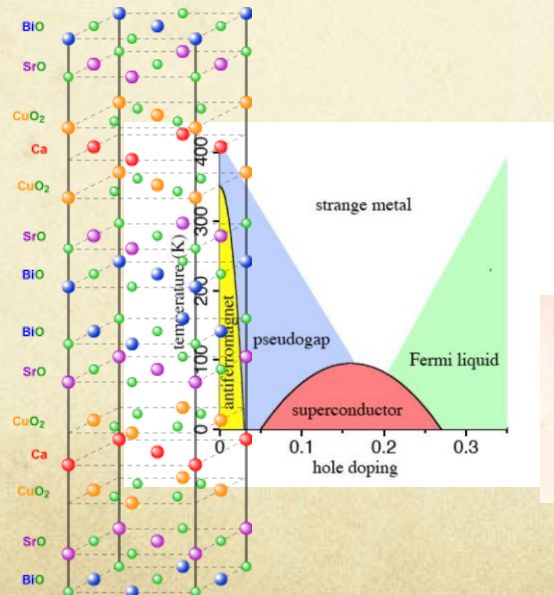
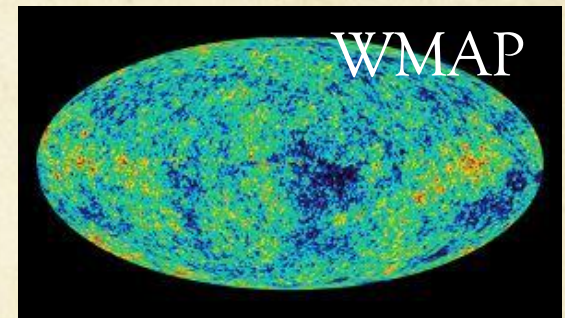
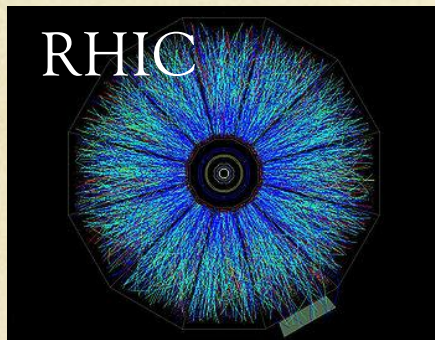
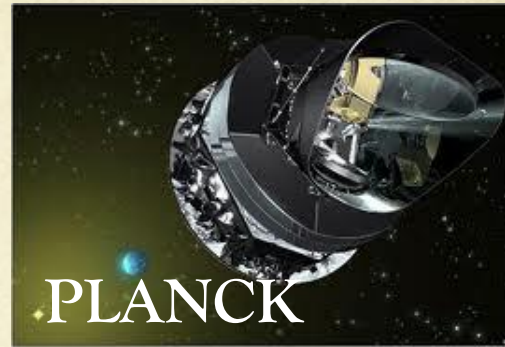




A **black hole** connects the mysterious phenomena of superconduction (levitating magnets) to the quark-gluon plasma (a particular phase of microscopic matter).



# Running Experiments





# Why do we need to launch an Action ?



- **Create** and **reinforce** contacts among quite different communities of string theorists. This will counteract fragmentation of research and reinforce the European leadership in this field.
- **Foster** contacts with other communities (experimentalists, Cosmologists, Condensed Matter physicists).
- **Support** small groups (especially in Eastern Countries, geographically isolated Countries, South Cone Countries).
- **Train** young talents.
- **Undertake** actions to redress the significant gender imbalance.

**Networking, cooperation, scientific progress,  
outcome for society, then.... COST !!**



# The Structure of the Action

This Action aims at creating a strong, interconnected network of experts around three main topics:

## ■ WG1: Gauge/Gravity Duality

**Leader:** Jerome Gauntlett (Imperial College)    **Vice-leader:** Johanna Erdmenger (MPI, Munich)

## ■ WG2: String Phenomenology

**Leader:** Michela Petrini (Paris VI, Jussieu)    **Vice-leader:** Angel Uranga (UAM, Madrid)

## ■ WG3: Cosmology and Quantum Gravity

**Leader:** Roberto Emparan (Barcelona Univ.)    **Vice-leader:** Jean De Boer (Amsterdam Univ.)

- **WG4:** Cross-activities, exchange of knowledge and STSM plan

**Leader:** Anna Ceresole (INFN, Torino) **Vice-leader:** Elias Kiritsis (Crete Univ.)

- **WG5:** Gender issue and outreach activities

**Leader:** Ana Achucarro (Leiden Univ.) **Vice-leader:** Marian Lledo' (Valencia Univ.)



# WG1: Gauge/Gravity Duality

- **Fundamental aspects** => Integrability and hidden symmetries
- **Applied aspects** => Strongly coupled systems in Particle Physics (QCD)
  - => QCD at finite temperature and finite density
  - => Quark Gluon Plasma
  - => Condensed matter systems: quantum phase transitions
  - => High-Tc superconductors (strongly correlated fermions)
  - => Non-equilibrium systems and thermalization  
(entanglement entropy)

**Black Holes are required !!!**

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## WG2: String Phenomenology

String theory model building for describing particle physics beyond Standard Model.

- **Compactification of extra dimensions** (moduli stabilization via fluxes, anti D-branes, non-perturbative effects)
- **Supersymmetry breaking mechanisms** at high and intermediate scales

Theoretical implications for describing Dark Matter

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## WG3: Cosmology and Quantum Gravity

String theory is the only existing framework for describing the evolution of the Universe at ALL scales

- **Cosmology** => Inflation
  - => String theory detection in CMB
- **Quantum gravity** => Black Holes
  - => Holographic principle

# Potential strength of the MP1210 Action

- It involves the most active and well-established string theory groups in Europe PLUS new promising groups.
- It has an extra-european dimension (non-COST countries).
- It specifically plans to increase the number of young talents and the number of women scientists in String Theory.



# Outcomes

- ✓ Overcome of fragmentation of research efforts
- ✓ Reinforcement of European leadership in this field of research
- ✓ New insights into deep central questions in theoretical physics
- ✓ Fertilization of other fields with new ideas
- ✓ Increasing of work opportunities for young researchers
- ✓ More visibility for women scientists inside the Action and beyond
- ✓ Reinforcement of the scientific education in schools
- ✓ Increasing attraction of general public towards this subject

# Synergies with other Networks

- COST MP0905 “Black Holes in a Violent Universe”
- COST MP1006 “Fundamental problems in Quantum Physics”
- ESF Network “Holograv” (Gauge/Gravity duality)
- ITN PITN-GA-2009-237920 ” UNILHC” (String Phenomenology)
- ITN 317089 “GATIS” (Gauge theory as an Integrable System)

We foresee joint activities with these other communities !!!

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# First official COST-MP1210 event

## The String Theory Universe

(19th European Workshop on String Theory + 1st COST-MP1210 Meeting)

BERN, Sept. 2 ~ Sept. 6, 2013

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