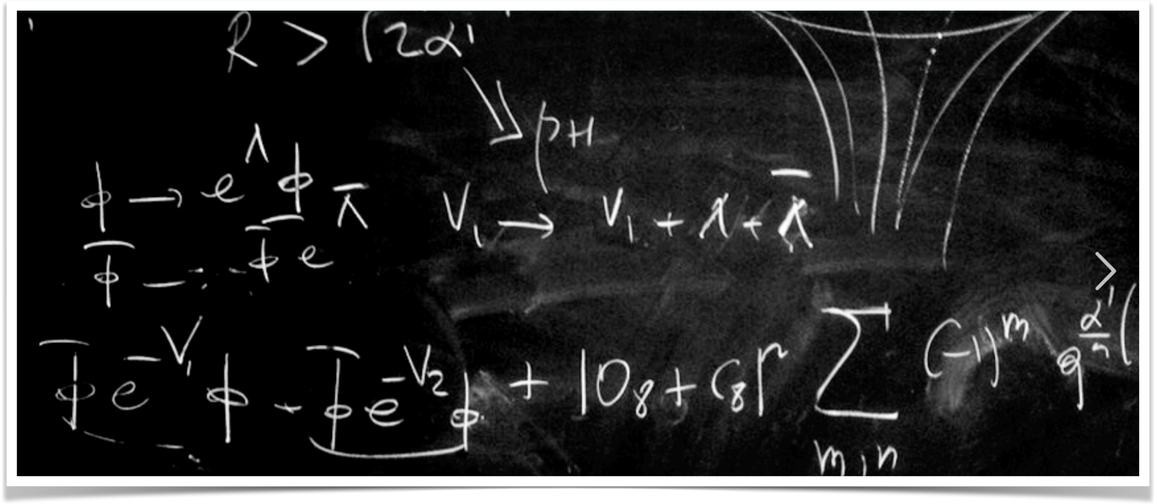


Il Gruppo IV - Fisica Teorica

Coordinatrice: Anna Ceresole
(INFN, Sezione di Torino)

Consiglio di Sezione

Torino, 6 Luglio, 2021

Il Gruppo IV - Composizione 114 (~100 FTE)

60 staff +4 Fellini; 19 Post Doc, 31 PhD

INFN 8 **dipendenti** : Giunti, Ceresole, De Pace, Nardi, Beraudo, Orlando,Taoso e Nagar

UniTO 31 staff **associati (Fisica teorica e Fisica generale+ Math)**

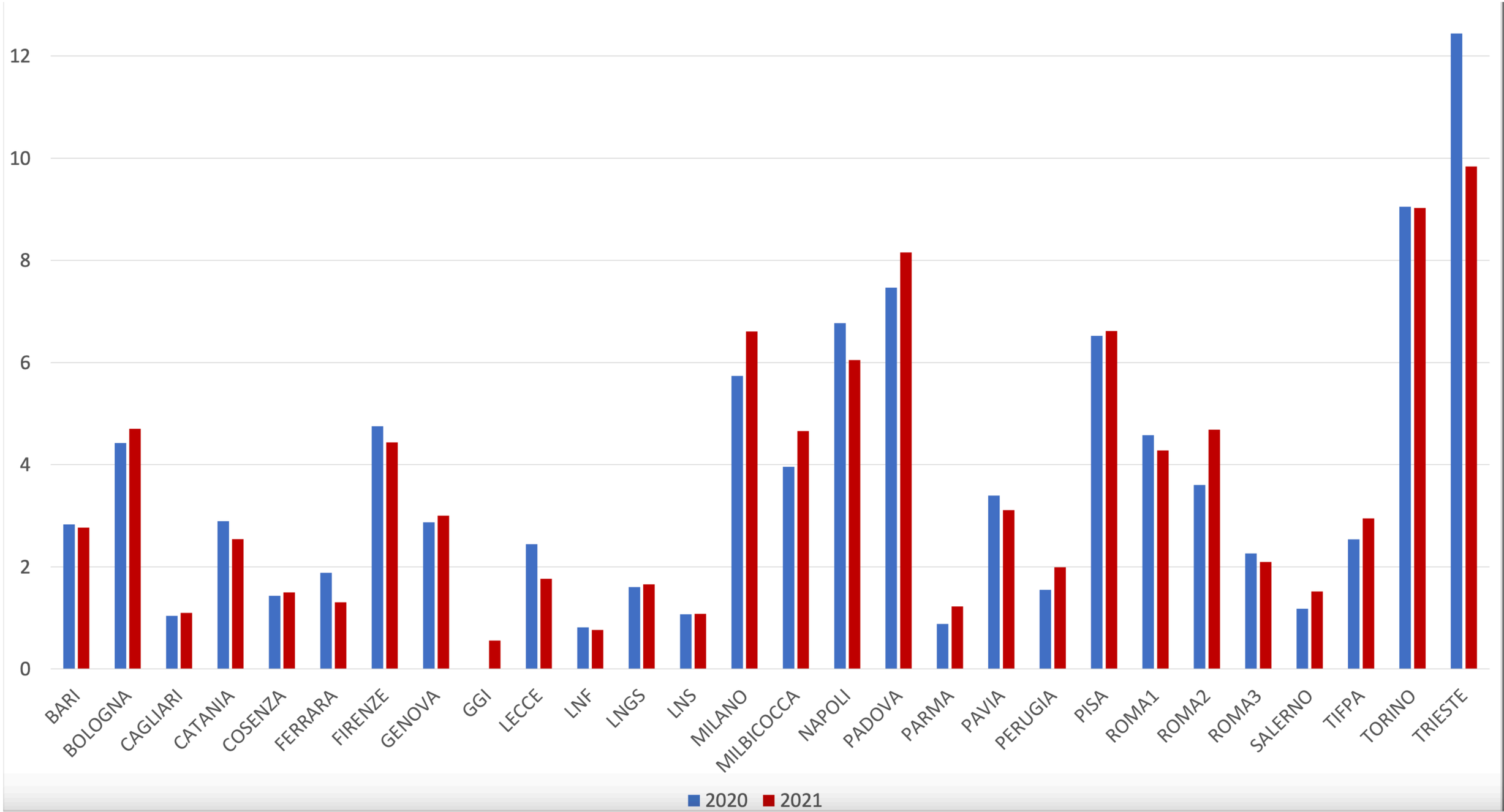
UPO AL 6 staff **associati** (GSS, ST&FI, NINPHA)

PoliTO 10 staff **associati** (GSS, FIELDTURB, BioPHYS)

FELLINI *4:* Di Mauro e Gariazzo (TASP), Vernazza (SPIF), Pablos Alfonso (SIM)

ERC-CoG S. Badger,

“JetDynamics”


12
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BARI
BOLOGNA
CAGLIARI
CATANIA
COSENZA
FERRARA
FIRENZE
GENOVA
GGI
LECCE
LNF
LNGS
LNS
MILANO
MILBICOCCA
NAPOLI
PADOVA
PARMA
PAVIA
PERUGIA
PISA
ROMA1
ROMA2
ROMA3
SALERNO
TIFPA
TORINO
TRIESTE
2020
2021

Gruppo 4

Iniziative Specifiche 2021: ~114 PX/100 FTE , 12/35 IS

Linea 1: teoria dei campi e delle stringhe

- **GSS** Ceresole/ Angelantonj 16 FTE
- **ST & FI** 8.5 FTE Pesando
- **SFT** 3.4 FTE Tateo

Linea 2: fenomenologia delle particelle

- **SPIF** 16 FTE Torrielli

Linea 3: fisica nucleare e adronica

- **NINPHA** 6 FTE Boglione
- **SIM** 3.5 FTE, Nardi
- **NucSYS** 2.5 FTE, Barbaro

Dot 4 2 FTE Nagar (Virgo) Passarino (Higgs)

Linea 5: fisica delle astroparticelle

- **TASP** 12.5 FTE Donato/Giunti
- **INDARK** 7 FTE Diaferio

Linea 6: fisica statistica e teoria dei campi applicata

- **FIELDTURB** 10 FTE, Boffetta
- **BIOPHYS** 9.6 FTE, Caselle
- **ENESMA** 1 FTE, Pagnani

Il Gruppo IV - Budget 2021

—Valutazione internazionale delle IS (rinnovate nel 2021)

—Regole “Becchi” per il finanziamento degli FTE

Iniziative specifiche	Missioni	78.5 kE
Dot4	Missioni	29 kE
	Inviti per **Seminari** [Org Manifestazioni e Convegni,	**22 kE**
	Inviti per **Collaborazioni**	**21 kE**
	Altro SW, materiale non inventariabile, consumo	17 kE
	Computer	25 kE
	Tot	114 kE
2021		**192,5 kE**

GSS (Gauge Theories, Supergravity and String Theories)

RN: Anna Ceresole; RL Angelantonj. Nodes: TO-GE-MI-MIB-PD-PI-LE, 70 FTE, 16 FTE-TO

https://web.infn.it/CSN4/IS/Linea1/GSS/GSS.html

- Supersymmetric Quantum Field Theories for the unification of **Quantum Gravity and Gauge interactions**
- Applications to phenomenology and cosmology; mathematical methods (geometry), supergravity

"Swampland Program"

Main themes:

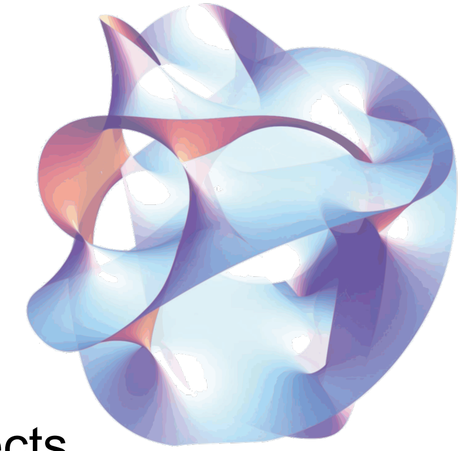
- "The space of consistent theories of Quantum Gravity"
- Holography and dualities
- Black Hole Entropies and Microstate Counting
- Supersymmetry breaking

$$S = \frac{c^3 k A}{4 \hbar G}$$

- Connection with the CNRS-IRN Quantum Fields and Strings e PRIN
- Leonardo Castellani: **Quantum Information Course**—> INFN Quantum Technologies

ST&FI

(String Theory and Fundamental Interactions).
RL: Igor Pesando. Nodes: TO-PD-Sissa-Roma 1- NA-BO-PG



- **Aim**: study string theory and QFT, their connections,

the application of string to cosmological singularities

- **Main themes**:
  - String field theory and string theory
  - Exact results in supersymmetric gauge theories with and without defects
  - Strongly coupled QFT in large charge limit.

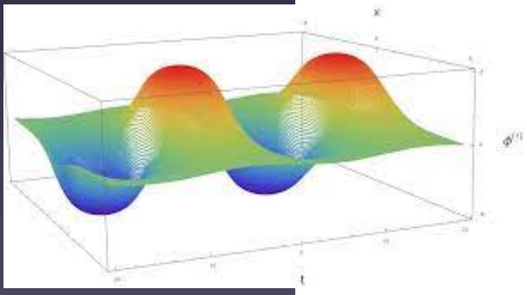
  - Premio Fubini 2021 a F. Galvagno (PhD@ST&FI)

Statistical Field Theory (SFT) scientific initiative

The Turin members of the SFT scientific initiative are active in the fields of integrable models and lattice field theory

Current research projects are focused on:

- ★ Study of irrelevant perturbations of integrable models
- ★ Relation between $T\bar{T}$ perturbations, topological gravity and the AdS/CFT correspondence
- ★ Extension of the correspondence between integrable models and ordinary differential equations in the presence of irrelevant integrable perturbations
- ★ Topological excitations in statistical field theory
- ★ Study of strongly coupled gauge theories at finite temperature via lattice simulations



Home
Signup
Registration
Conference Venue
Accommodation
Social Dinner
About Torino
How to reach Torino
Covid requirements
Transports in Torino
Useful information
Useful links
Contact Us

INTEGRABILITY IN GAUGE AND STRING THEORY 2021

IGST 2021

TORINO, 19 TO 23 JULY

Iscritti: 77 presenti 120 da remoto. Speakers: 18 in presenza

https://www.igst2021.it/uk/page.asp?PID=105

Linea 2: Phenomenology of Elementary Particles

Precision studies of fundamental interactions (SPIF)

- **Nodes**: Milano (national resp. A. Vicini), Genova (local resp. S. Marzani), Roma 3 (local resp. G. Degrassi), Torino (local resp. P. Torrielli)

- **Keywords**: LHC and collider physics, precision tests of the Standard Model (SM), flavour physics, higher-order perturbative calculations, Monte Carlo event generators

✳**Phenomenology of elementary particle physics** at present high-energy facilities such as the LHC, at future colliders, and in neutrino-oscillation experiments

✳**Flavour physics**: analysis of the rare decays of heavy quarks, and the determination of the CKM matrix elements

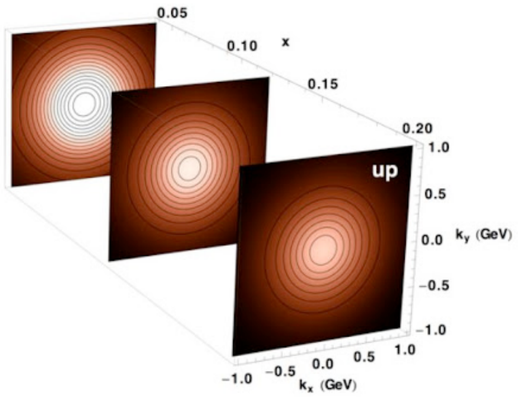
✳**Precision tests of the SM** at colliders through precise predictions for observables relevant to Higgs boson, gauge bosons, and hadronic final states

✳Modern **machine-learning techniques** for a deeper understanding of the proton structure

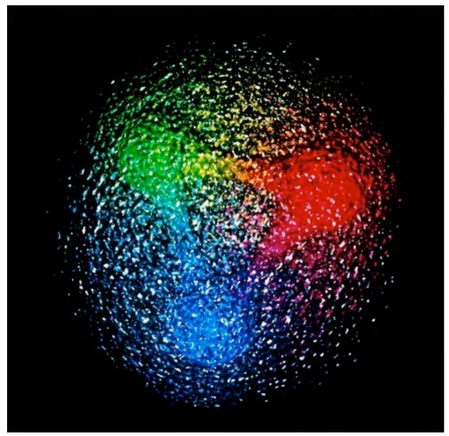
✳Formulation of explicit **SM extensions** to investigate fundamental questions: Dark Matter, strong CP problem, precise phenomenology of the neutrino sector

Linea 3: NINPHA (National Initiative on Physics of Hadrons)

RN: Mariaelena Boglione . Nodi: TO-GE-PV-PG-CA



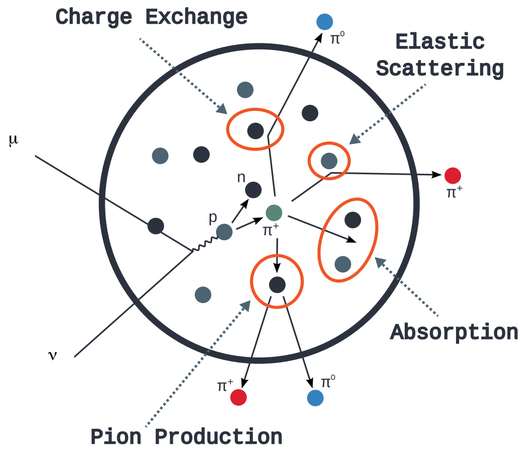
- The study of the **inner structure of hadronic matter** is at the heart of the NINPHA project.
- The focus is on how hadron phenomenology emerges from the interactions generated by the **symmetries of QCD**, and from the breaking of these symmetries.
- Building accurate maps of the **internal dynamics of partons** and of their **mutual interactions** will shed light on the composition of hadronic masses and spins in terms of elementary constituents, and will eventually lead to a **microscopic understanding of confinement.**
- Shaping these maps in momentum and coordinate space requires advanced non-perturbative techniques, as well as highly accurate perturbative computations.



Iniziativa Specifica NucSys (LE-PD-PI-TIFPA-TO)
Staff: M.B. Barbaro, A. De Pace; PhD student: J.M. Franco-Patiño

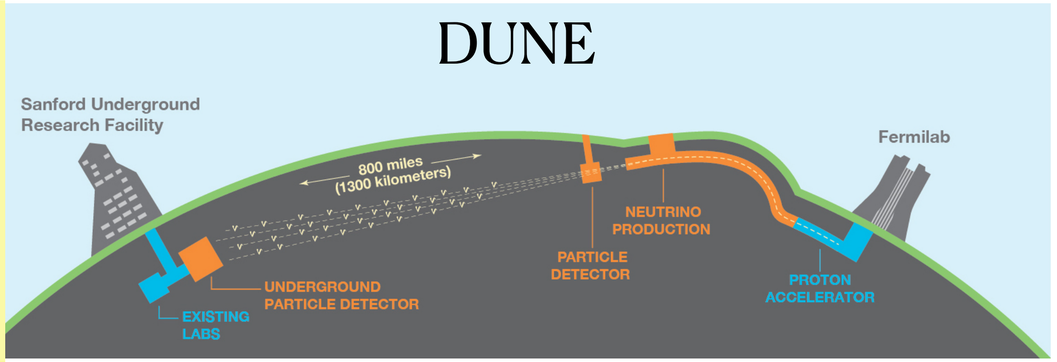
Nuclear theory, Electroweak interactions in medium/heavy nuclei

We work at developing and improving **nuclear models** to be used in the description of **lepton-nucleus scattering** in the **relativistic regime** (1-10 GeV): mean-field models, nucleon-nucleon correlations, final-state interactions, two-body currents, meson production, DIS, etc.



Main application: theoretical support to long-baseline neutrino experiments

Next-generation **long-baseline neutrino experiments** (DUnE, T2K/HyperK), aimed at the precise determination of the oscillation parameters and search for leptonic CP violation, require **accurate modelling of nuclear effects** to minimise systematic errors.



Collaborations

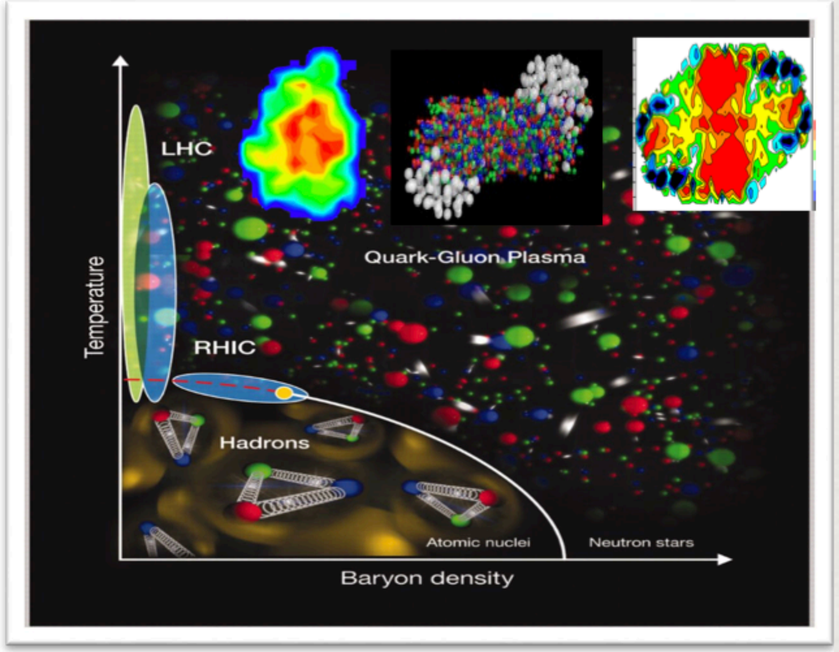
Universities of Seville, Granada, Complutense de Madrid, M.I.T., ODU/JLab, NuSTEC (Neutrino Scattering Theory-Experiment Collaboration)

SIM – Strongly Interacting Matter at high density and temperature

Nat. Coord. - Vincenzo Greco (LNS)

Units/Staff Members/FTE (4/11/19.2):

- CATANIA: P. Castorina, F. Siringo
- FIRENZE: F. Becattini, F. Bigazzi, A. Cotrone, M.P. Lombardo
- LNS: V. Greco, S. Plumari
- TORINO: A. Beraudo, A. De Pace, M. Nardi



Main aim and topics:

- Theoretical study of properties of the Quark-Gluon plasma (including heavy quarks) and direct comparison to experimental data from pp, pA, AA collisions at LHC and RHIC. Develops Quantum Effects in Relativistic Viscous Hydrodynamics for vorticities and polarization; study of equilibration from initial chromodynamical fields and its impact on observables at LHC.
- Analytical non-perturbative approach to Hot QCD: transport properties.
- Hadronization impact on observables: strangeness, open heavy flavor, baryon/meson ratios.

TAsP: Theoretical Astroparticle Physics

Responsabile Nazionale: Fiorenza Donato (Torino) - Responsabile Locale TO: Carlo Giunti

12 nodi: BA, FE, LE, LNF, LNGS, NA, PD, PV, PI, RM1, TO, TS (~ 100 members)

Staff members:

- Alessandro Cuoco
- Fiorenza Donato
- Nicolao Fornengo
- Carlo Giunti
- Marco Regis
- Marco Taoso

Other members:

★ **2 Fellini Postdocs:**
Di Mauro, Gariazzo

★ **5 Postdocs:**
Recchia, Reynoso, Scaffidi, Scholtz, Ternes

★ **2 PhD students:**
Orusa, Pinetti

➢ Dark Matter & Cosmic radiation:
- Cross-correlation studies of anisotropies in dark matter tracers (cosmic shear, galaxies distribution) with the unresolved gamma-ray emission from the same large scale structure, and extension to other wavelength
- Anti-matter and leptons in the cosmic radiation
- Statistical analysis of gamma-rays count maps to identify very faint sources of gamma-ray emission, including a possible DM signal
- Multi-messenger astrophysics with compact and extended sources
- Hadronic cross sections for the production of cosmic rays, and connection with collider experiments
- Phenomenology of DM candidates in the context of BSM theories
- Cosmological bounds on light particles (dark radiation and dark matter)
- Axion-like, sterile neutrino and primordial black hole dark matter

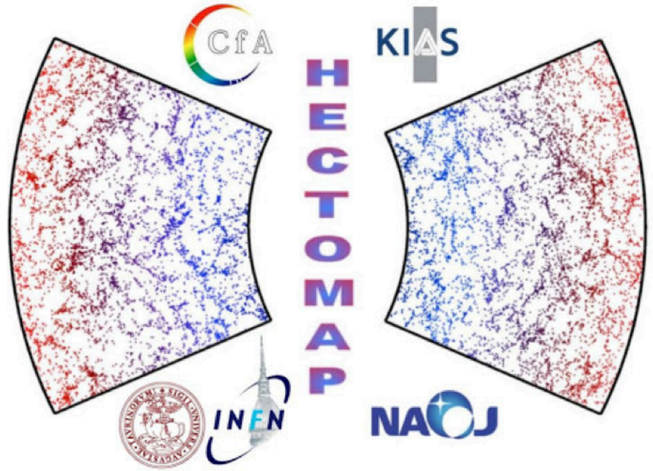
➢ Neutrinos:
- Global data analysis of active-sterile neutrino oscillations
- Theory and phenomenology of BSM neutrino non-standard interactions
- Phenomenology of coherent elastic neutrino-nucleus scattering

InDark

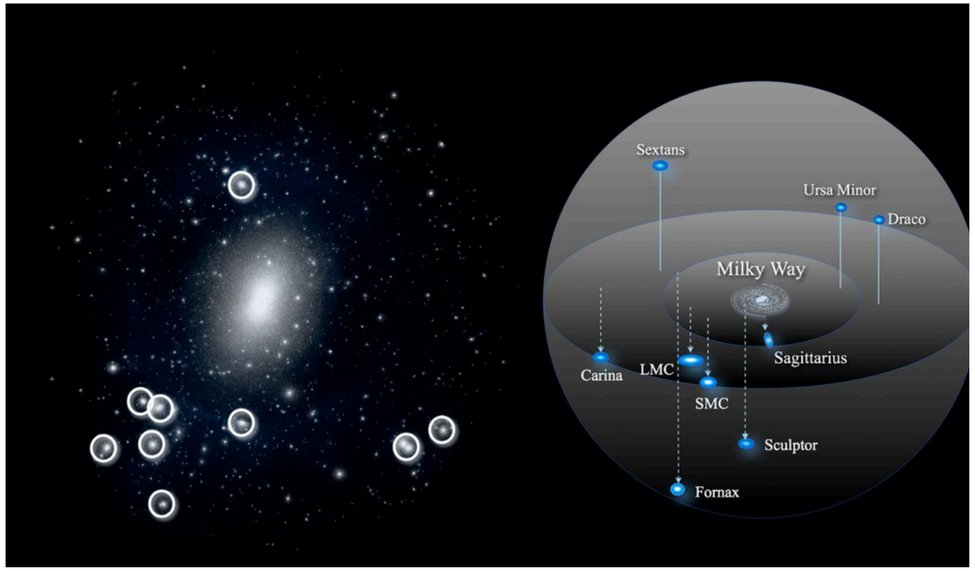
RL: A. Diaferio

Dark Matter and Modified Gravity on the Scales of Galaxies, Galaxy Clusters, and beyond

Clusters of galaxies and redshift surveys



Dark matter distribution in dwarf galaxies

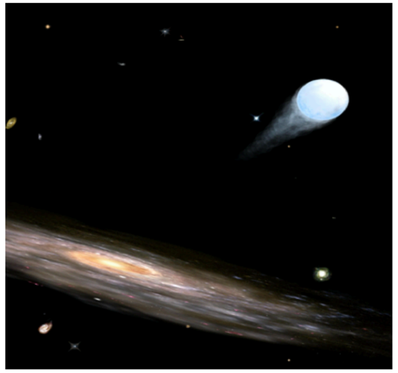


Weinberg et al 2015

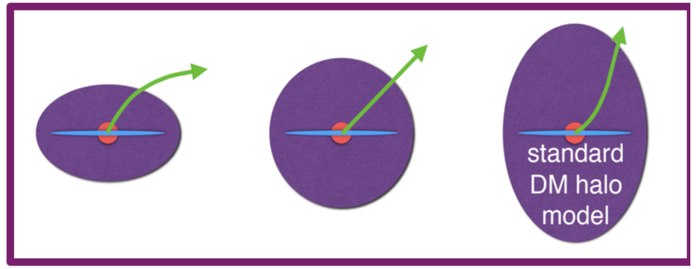
Dynamics of disk galaxies in Refracted Gravity

DiskMass Survey galaxies 2010

Hypervelocity stars in the MW dark matter halo



Arstit's conception of a hypervelocity star
(Credit: Harvard-Smithsonian Center for Astrophysics)



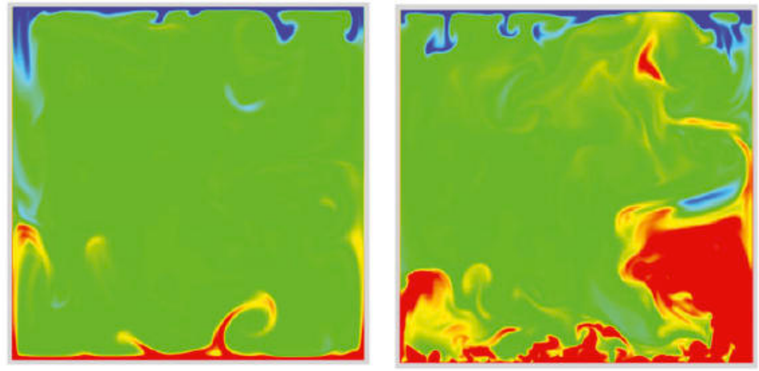
Theia Collaboration 2019

Linea 6 : Statistical Physics and applied Field theory

- FIELDTURB (**PARTICLES AND FIELDS IN TURBULENCE AND IN COMPLEX FLOWS**)

https://web.infn.it/CSN4/IS/Linea6/FIELDTURB/

6.5 FTE, Guido Boffetta, TO-BA-GE-LE-RM2



Focus:

—fundamental questions of **classical field theories of out-of-equilibrium** systems at macro-, micro- and nano-scales

—many applied problems involving, e.g., **atmospheric and ocean dynamics,** energy production and energy transfer, microscopic surface/interface functionalization and **ocean ecology.**

—behavior of complex flows seeded with **polymers, surfactants, bubbles or micro-swimmers**

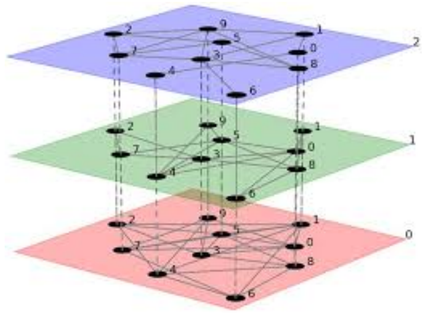
Methods: fundamental theoretical and numerical research and, when possible, in synergy with experiments

BioPhys (Computational Biology), M. Caselle

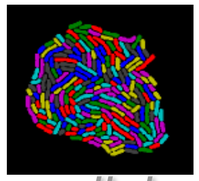
Three main research topics:

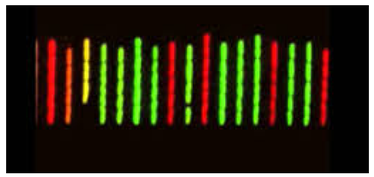
Gene regulatory networks

Structure and function of recurrent regulatory circuits;
Integration of different layers of regulation to identify disease markers;
Tissue/cell-type/disease-type from RNA sequencing data



Quantitative single-cell physiology

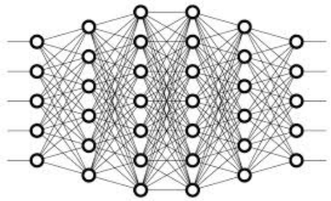




How the cell decides that it is time to divide;
How cell growth/division is coordinated with intracellular processes.

Machine Learning

Role of data structure and neural network architecture for performances improvement.



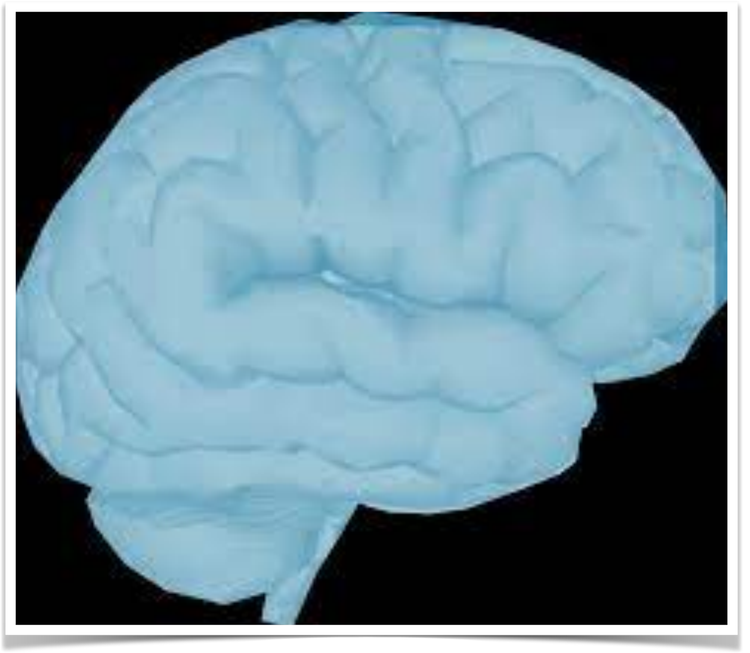
Common denominator is the application of tools from statistical physics and the theory of stochastic processes to large-scale data analysis.

Michele Caselle, 7.66 FTE, http://personalpages.to.infn.it/~caselle/BioPhys/BioPhys.html

ENESMA : Equilibrium and Non-Equilibrium Statistical Mechanics of **complex and disordered systems**. [1.5 FTE]

Applications: the amorphous state, systems biology and brain functioning

RM1-TO (Andrea Pagnani, PoliTO) 3 staff, 2 AdR, 2 PhD 30%



Keywords:
Complex and disordered systems (vetri di spin, random field models), Theoretical neuroscience, Statistical inference

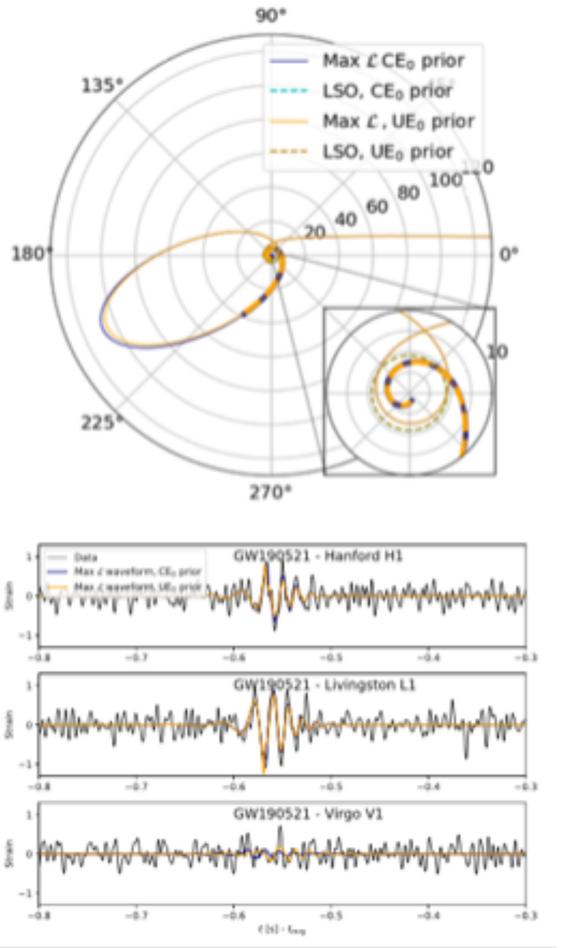
Abstract
Study fundamental problems in equilibrium and non-equilibrium statistical physics with applications in system biology and brain functioning ; realistic brain modelling and machine learning

Extra: Theory of Gravitational Waves (Nagar, Dot4)

Most of the work on modeling noncircular waveforms.
Final goal: analyzing GW190521 as a BBH encounter

GW190521: A dynamical capture of two BHs,
arXiv:2106.05575

EOB model for extreme-mass-ratio eccentric inspires,
S. Albanesi, AN, arXiv:2104.10559
Highly accurate model for quasi-circular BBH binary
G. Riemenschneider, Rettegno +, arXiv: 2104.07533
EOB model for generic orbits, comparable mass case
Nagar +, arXiv:2101.08624
Fast BNS waveform,
Gamba, Bernuzzi & AN, arXiv:2012.00027
Machine Learning EOB model,
Schimdt +, arXiv:2011.01958
Dynamical capture EOB,
AN +, 2009.12857

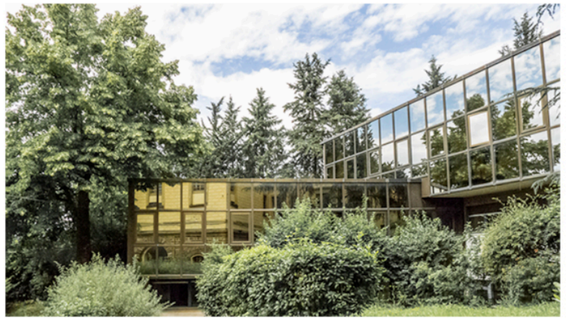


Altre attività

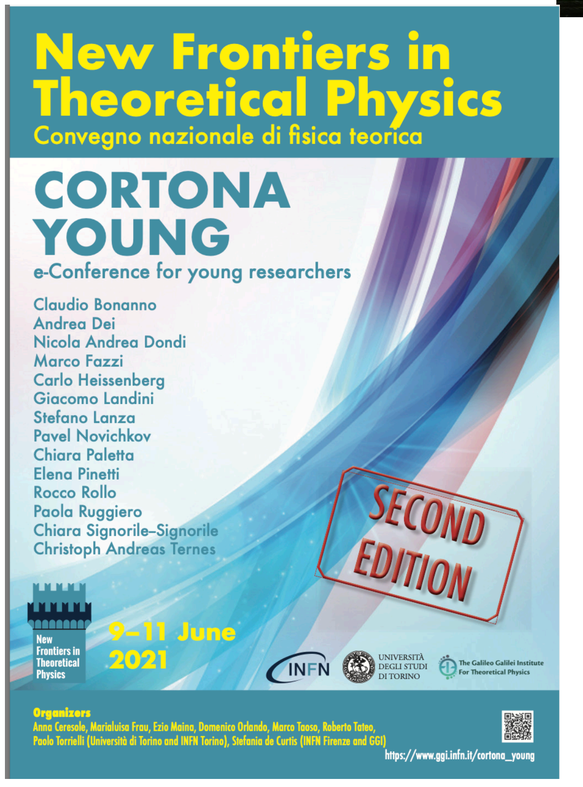
The Galileo Galilei Institute For Theoretical Physics

Centro Nazionale di Studi Avanzati dell'Istituto Nazionale di Fisica Nucleare

Arcetri, Firenze



- Collaborazione con il **Galileo Galilei Institute** di Arcetri per vari Workshops
- **Seminari online** (Domenico Orlando: Italian String Seminars)
- **Cortona Young** 2021



...and more

- Lavoro di Giampiero Passarino su Fisica dell'Higgs, connessione con Gruppo 1
- **CC3M**: Informamenti , Aperiscienza in Barriera... (A. Beraudo)
- Physics **COLLOQUIA** (D. Badger, L. Bianchi and M. Taoso)
- Partecipazione alle selezioni per il **Premio Asimov** per libri di divulgazione scientifica recensiti dai ragazzi del liceo

asimmetrie.it
rivista dell'Istituto Nazionale di Fisica Nucleare

INFN

Enzo Barone (UPO)

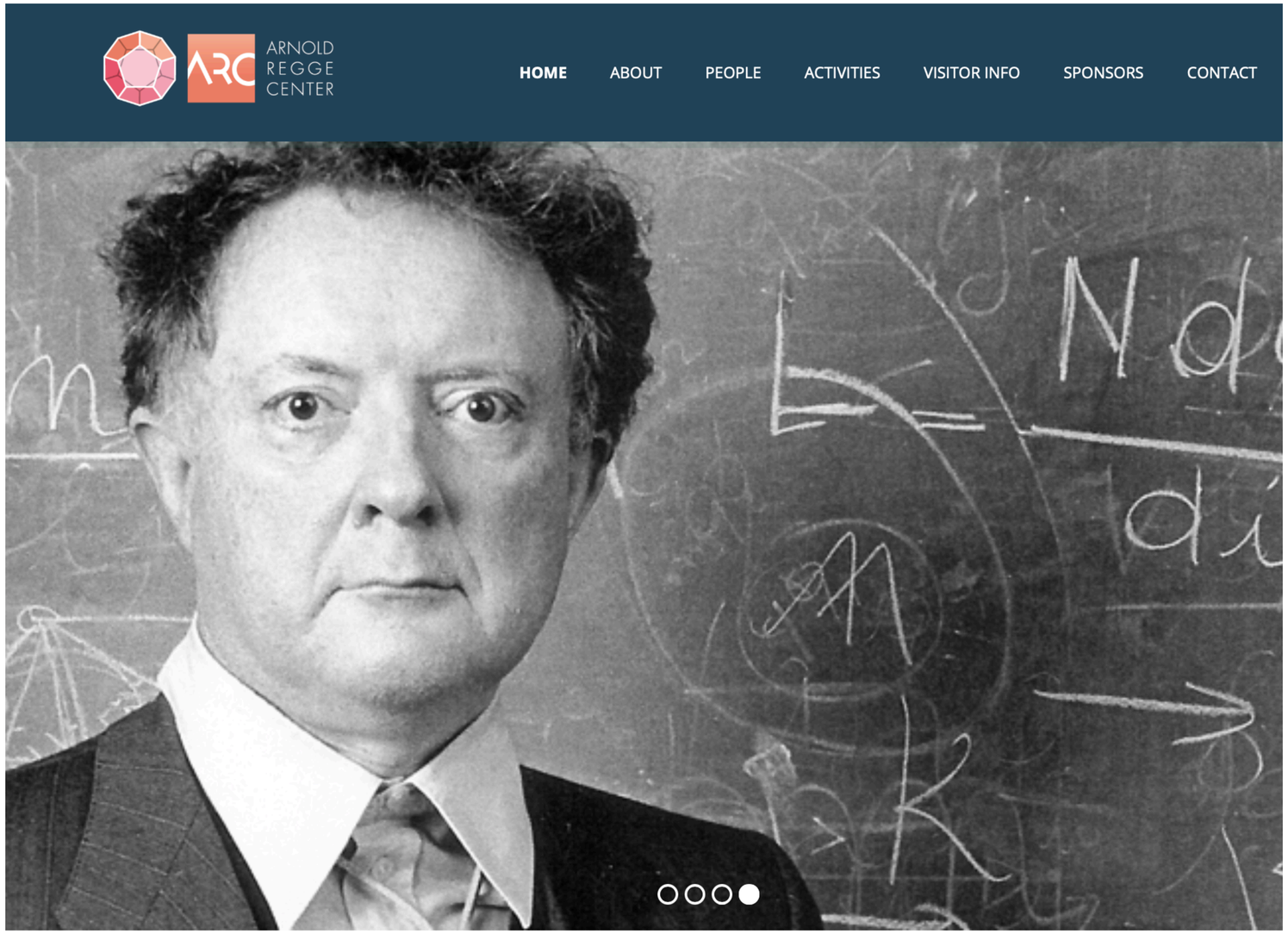
ML. Frau: Le stringhe e la quantizzazione della gravità

A. Nagar: Moto dei 2 corpi in Relatività generale

La Forza Nascosta: opera teatrale sul ruolo femminile nelle grandi rivoluzioni scientifiche del ‘900 (INFN-TO: Ceresole, De Marco, Marcello, Pastrone)

Prossimamente al GGI per il **Premio Milla Baldo Ceolin** (tesi Magistrali) e a TO

https://www.asimmetrie.it/as-spazi-scienziate-sul-palco



Arnold-Regge Center

For Algebra, Geometry

And Theoretical Physics

—90th B-day on July 11th 2021

To Be Continued…

Talk by MB Green:

Conclusioni:

—Richiesta supporto **segreteria** del personale per post doc e AdR

—Richiesta di supporto per farm di **calcolo**

—Richiesta di un aiuto dedicato e continuativo per la **gestione degli ospiti** e degli eventi

(ANCHE A DISTANZA !)

Thank you!