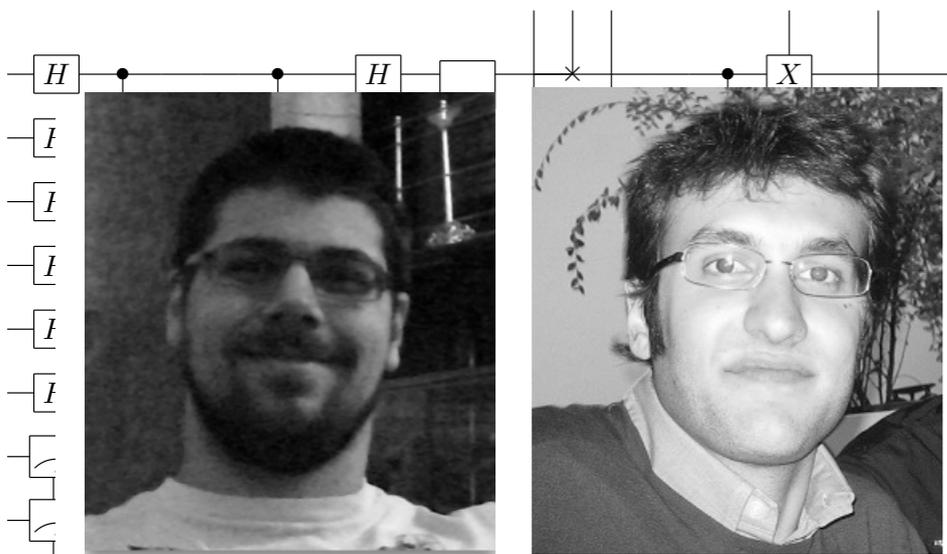


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Informazione Quantistica e Fondamenti della Meccanica Quantistica e dei Campi

- ▶ Teoria Fisica dell'Informazione
- ▶ Fondamenti della Meccanica Quantistica
- ▶ Fisica Quantistica della Computazione
- ▶ Ottica Quantistica
- ▶ Complementi di Meccanica Statistica



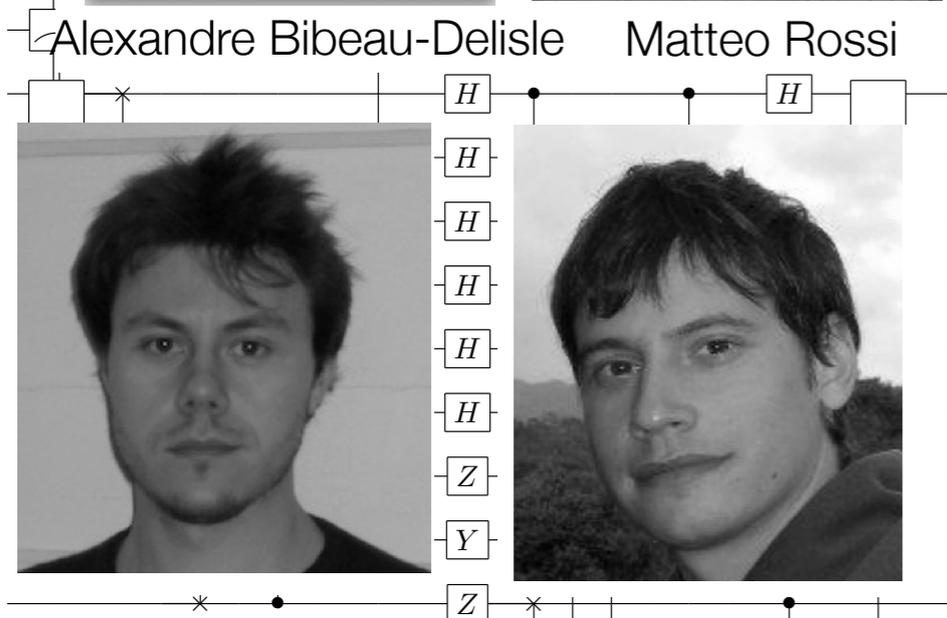
Giacomo Mauro D'Ariano



Paolo Perinotti

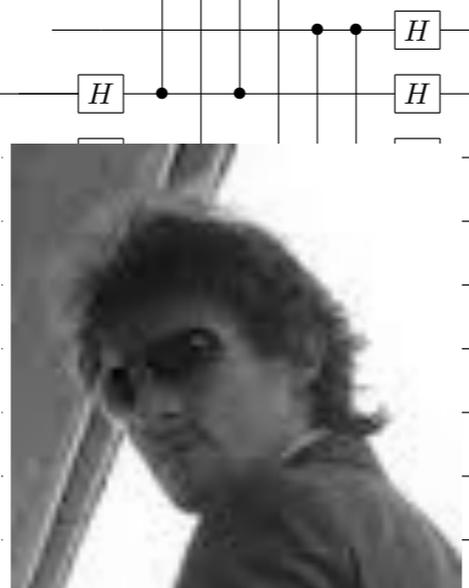


Massimiliano Sacchi



Alessandro Tosini

Alessandro Bisio



Franco Manessi

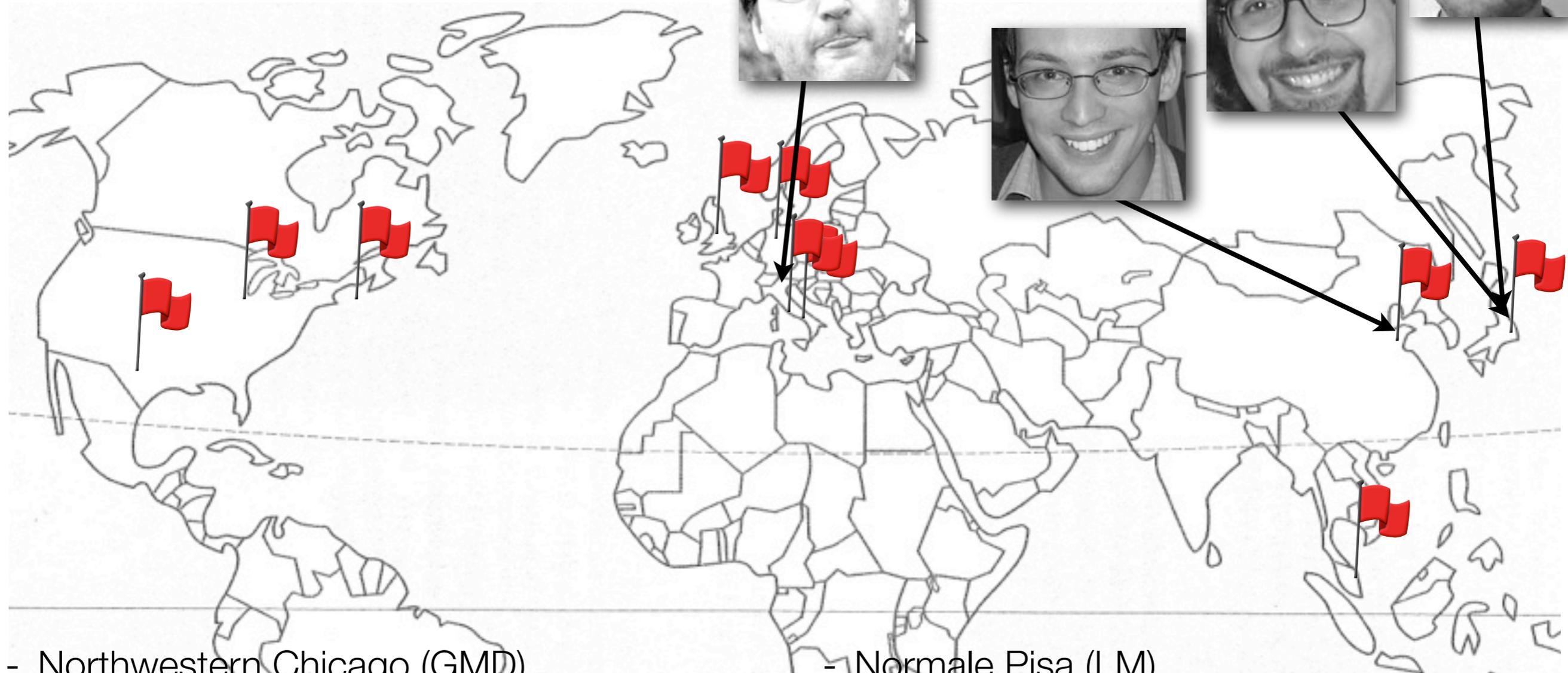


Lorenzo Maccone



Chiara Macchiavello

Collaborations



- Northwestern Chicago (GMD)

- MIT Boston (LM)

- Tsinghua Beijing (GMD,PP)

- Nagoya (GMD,PP)

- Singapore (CM)

- Roma La Sapienza (GMD,CM,LM)

- Dusseldorf (CM)

- Normale Pisa (LM)

- Los Alamos (LM)

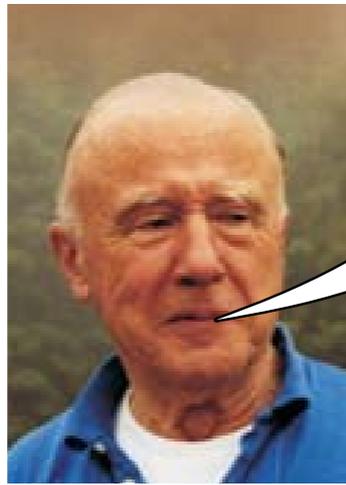
- Fermilab & UChicago (GMD)

- Oxford and Cambridge (GMD,PP,CM)

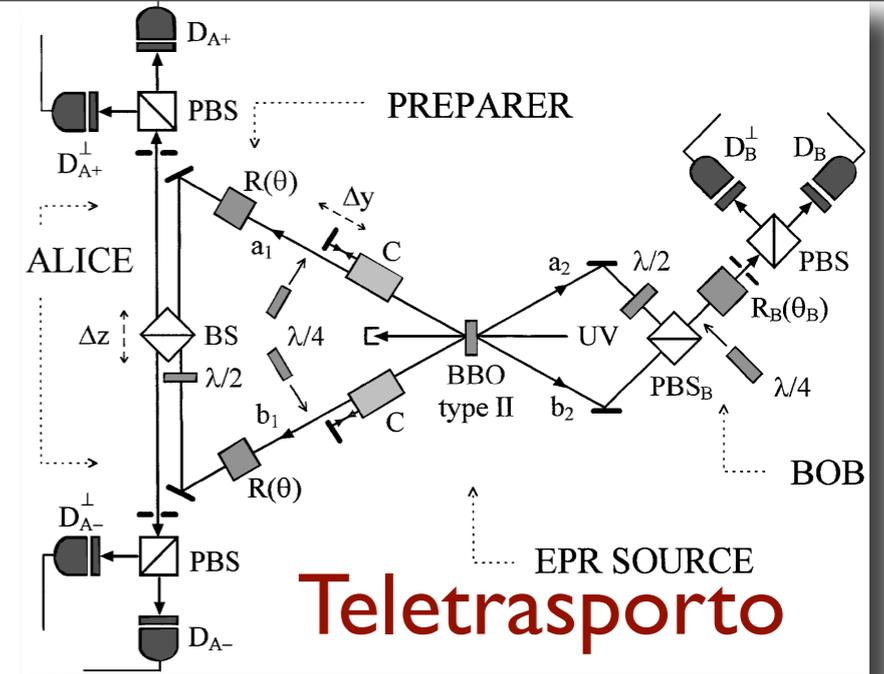
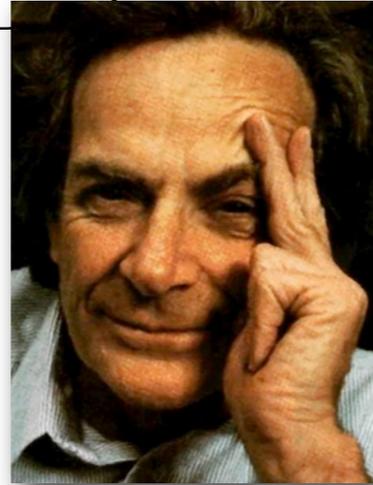
- ETH Zurigo (PP,GMD)

- Bratislava (AB,PP,GMD)

- Edimburgo (CM)

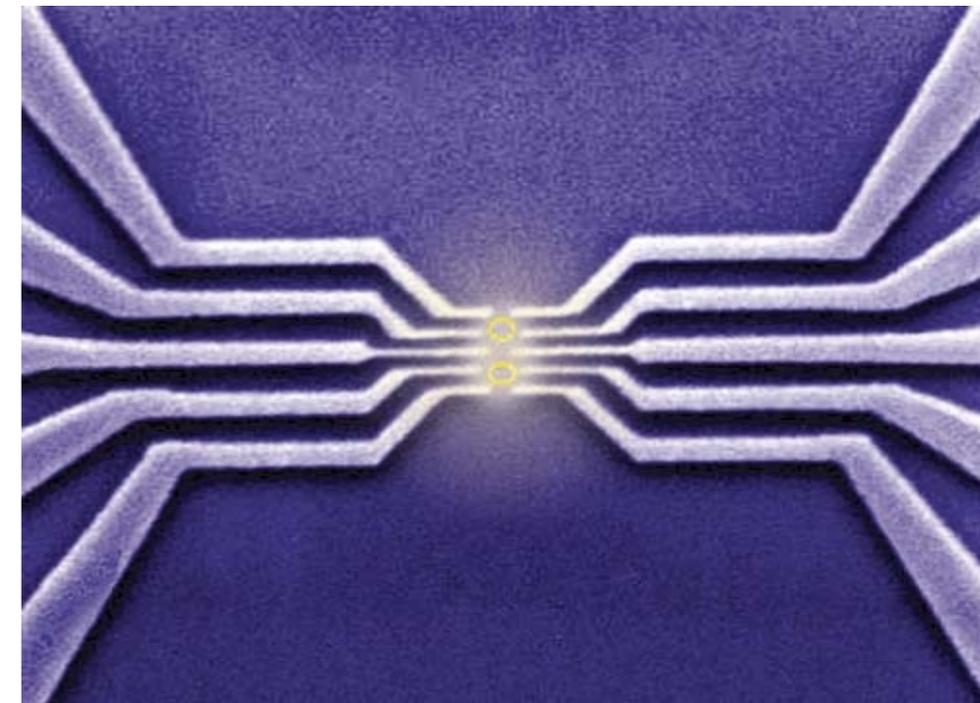
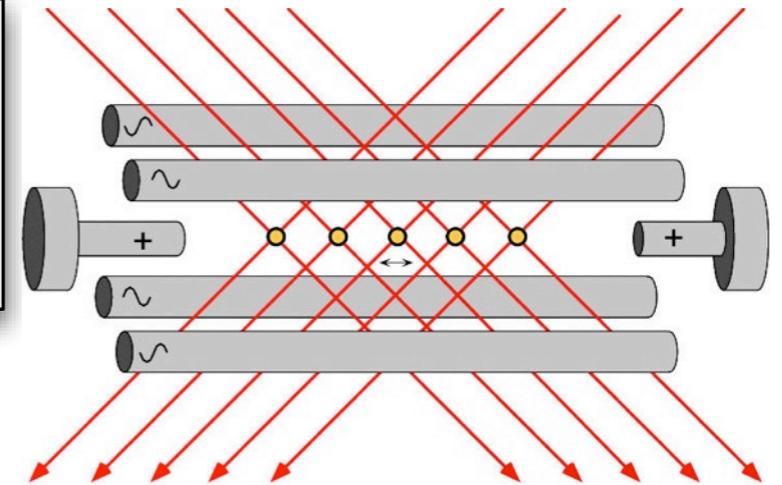
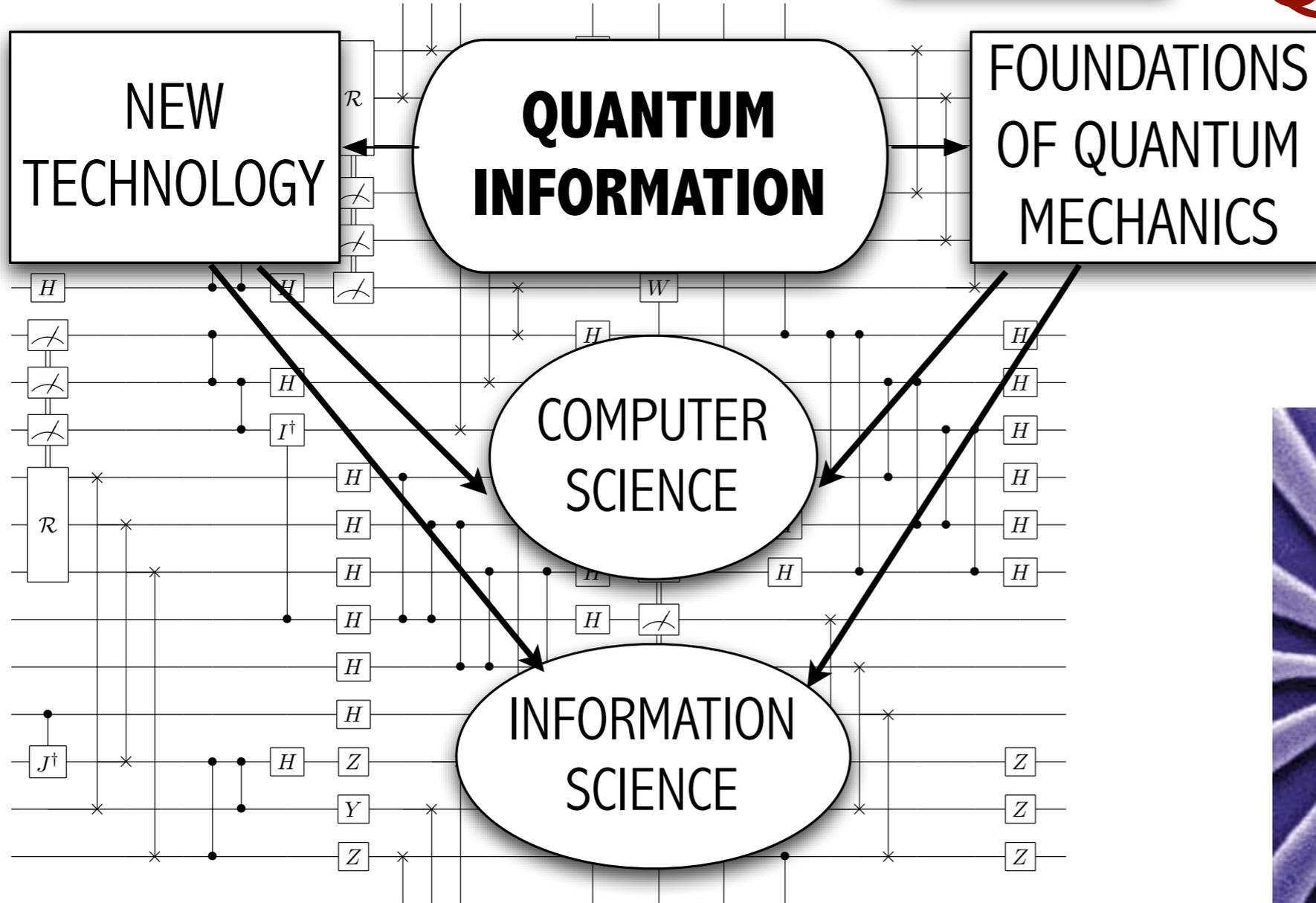


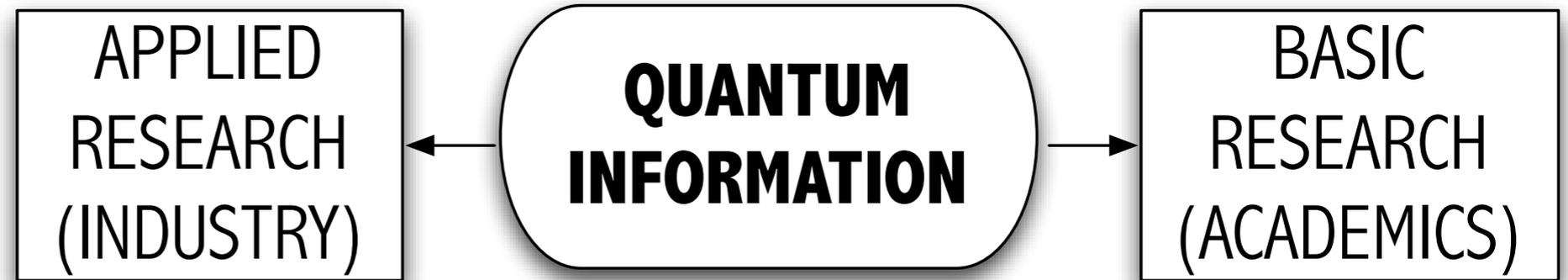
PHYSICS IS INFORMATION



Teletrasporto

Quantum Computer





Cultura generale di Fisica Contemporanea

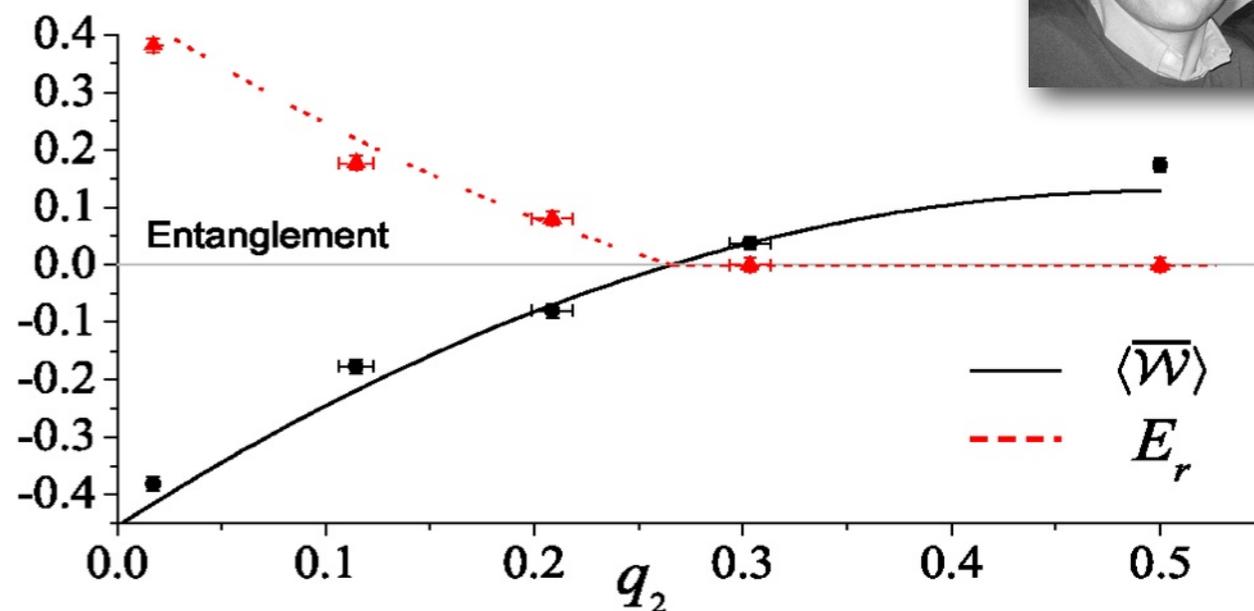
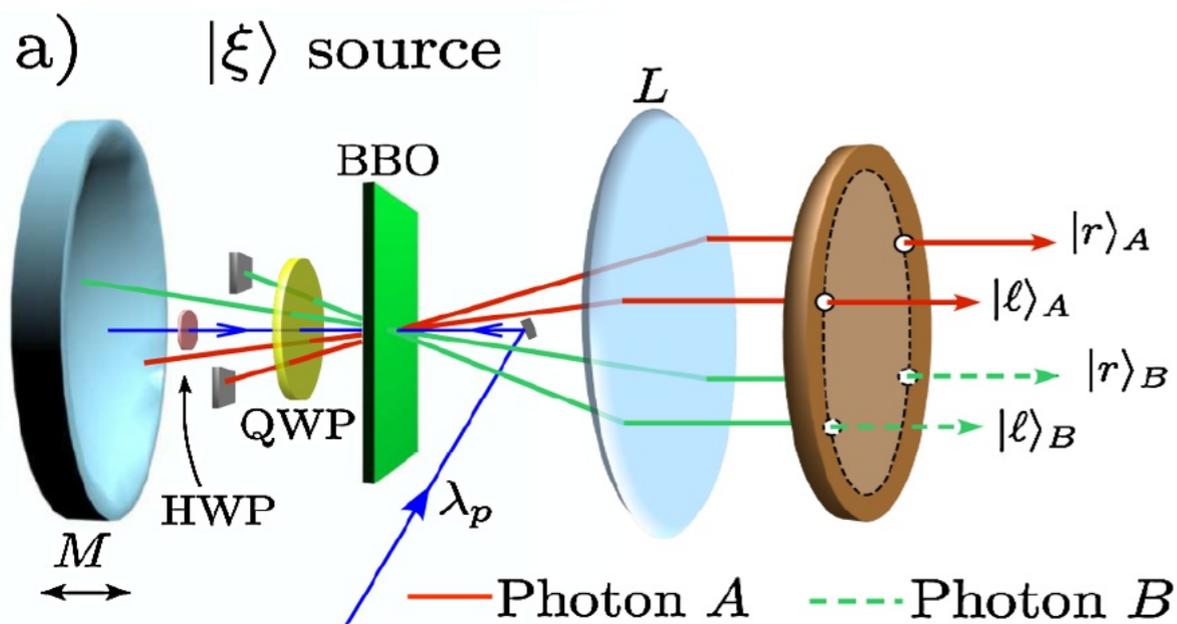
- Meccanica Quantistica sistemi aperti e misurazione, POVMs, ..., Tomografia Quantistica, no-cloning
- Non località e entanglement
- Master Equation
- Metodi ottimizzazione e teoria della stima, approcci Bayesiani
- Teoremi di Shannon, entropie, mutua informazione
- Data-processing theorem
- Complessità computazionale
- Algoritmi
- Crittografia Quantistica
- Ottica nonlineare quantistica
- Misurazioni ottico-quantistiche, congiunte, ...
- Automi cellulari quantistici

Quantum computation and entanglement

Development of entanglement detection methods based on structure factors:

Theory: with Dusseldorf, Vienna and Singapore [Phys. Rev. Lett. 103, 100502 (2009)]

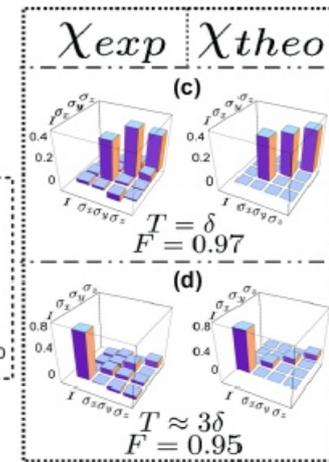
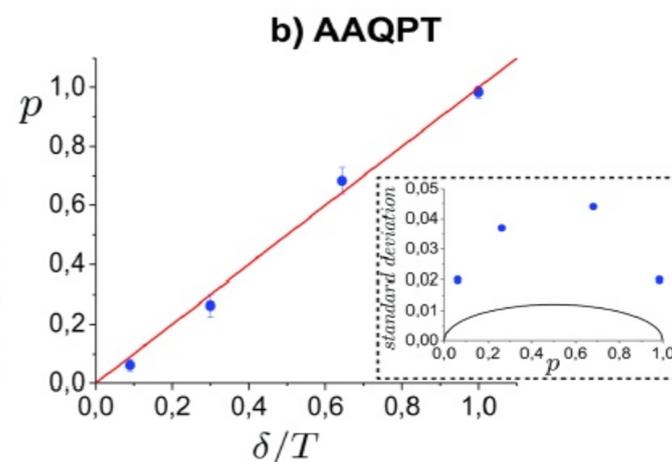
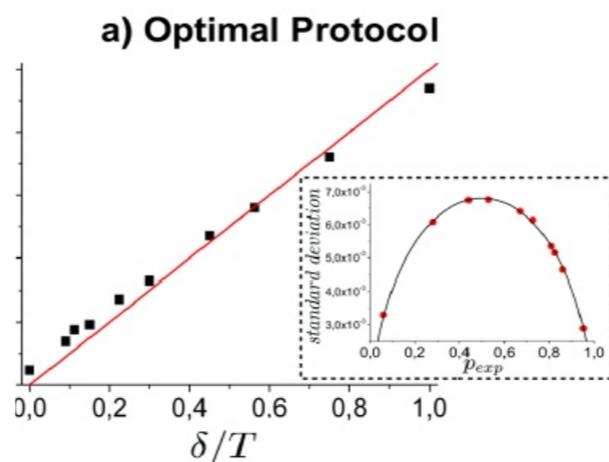
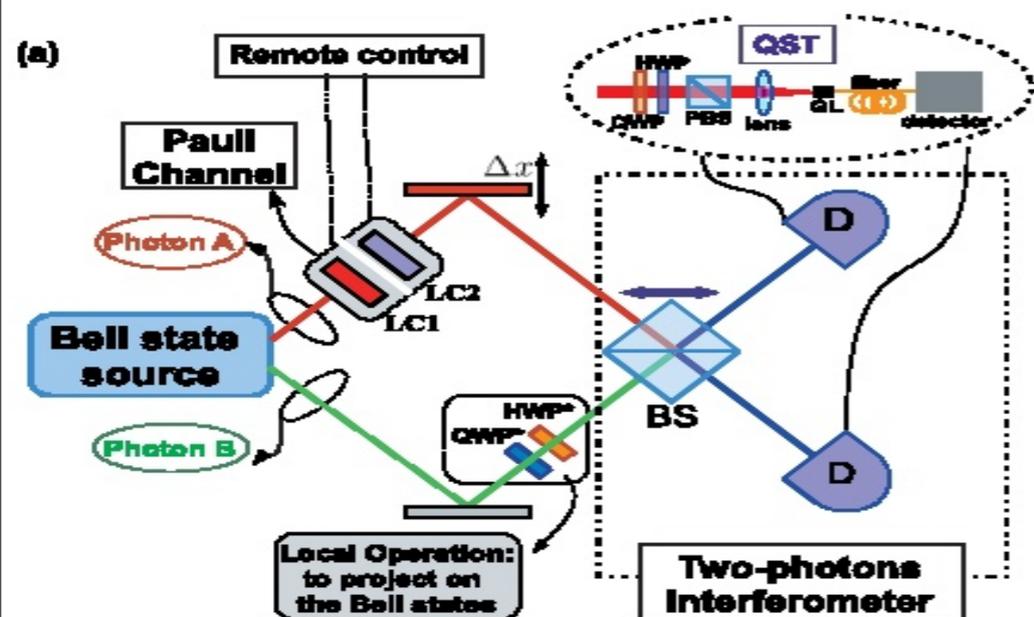
Experiment: with Rome La Sapienza [Phys. Rev. Lett. 105, 250501 (2010)]



Development of optimal methods to detect and estimate quantum noise:

Theory: [Phys. Scripta T153, 014044 (2013)]

Experiment: with Rome La Sapienza [Phys. Rev. Lett. 107, 253602 (2011)]

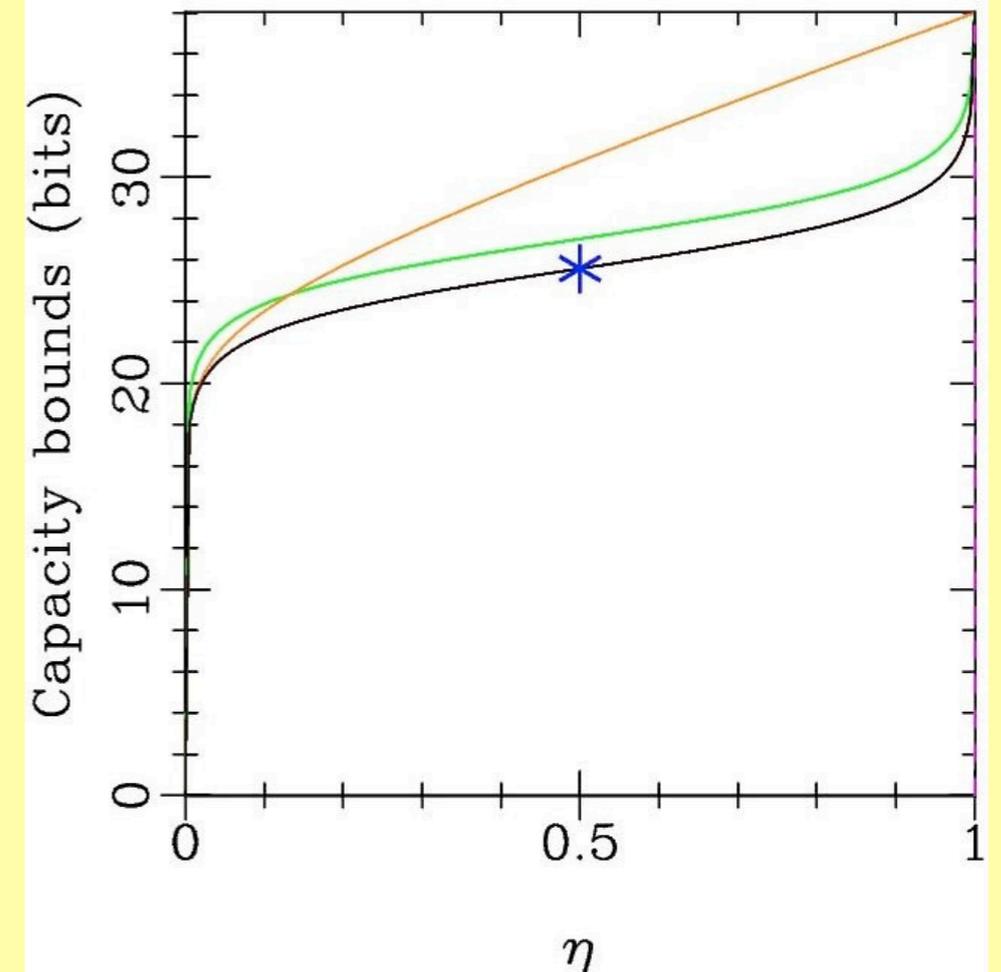


Quantum information and quantum metrology



Analysis of the capacity for transmission of thermal bosonic transmission lines: **how much information can your cell-phone transmit?**

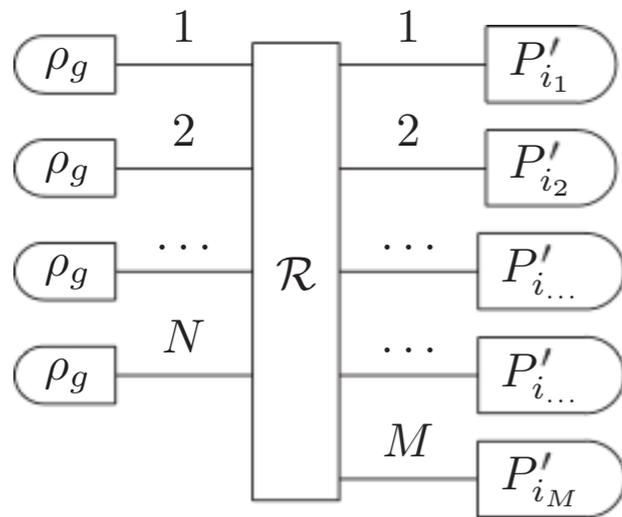
Bits per channel use per single frequency of the channel as a function of the transmission efficiency



Quantum metrology: using quantum entanglement increases the precision of measurements.

[Nature Photonics 5, 222 (2011)]

Purificazione di misure quantistiche inefficienti



Un rivelatore inefficiente P'_i corrisponde ad un rivelatore ideale P_i preceduto da un canale di rumore \mathcal{E}

$$\text{---} \boxed{P'_i} = \text{---} \boxed{\mathcal{E}} \text{---} \boxed{P_i}$$

Determinare il migliore **pre-processing** (canale quantistico \mathcal{R}) per compensare l'inefficienza \mathcal{E} .

Tipicamente, \mathcal{R} uno strumento di **clonazione** e/o **amplificazione** quantistici

Potere informativo delle misure quantistiche

Per quale ensemble di stati R una data misura Π fornisce più informazione ?

$$W(\Pi) = \max_R I(R, \Pi)$$

$W(\Pi)$ è equivalente alla **capacità** del canale q-c $\Phi_{\Pi}(\rho) := \sum_j \text{Tr}[\rho \Pi_j] |j\rangle\langle j|$

$W(\Pi)$ è additiva: $W\left(\bigotimes_{n=1}^N \Pi^n\right) = \sum_{n=1}^N W(\Pi^n)$

Un **efficiente** algoritmo iterativo consente di valutare $W(\Pi)$ e trovare un corrispondente ensemble massimamente informativo

Letture ottimali di compact disk



Fondamenti della Meccanica Quantistica (GMD,PP)

 Selected for a [Viewpoint](#) in *Physics*

PHYSICAL REVIEW A **84**, 012311 (2011)

Informational derivation of quantum theory

Giulio Chiribella*

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Giacomo Mauro D'Ariano[‡] and Paolo Perinotti[§]

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(Received 29 November 2010; published 11 July 2011)

We derive quantum theory from purely informational principles. Five elementary axioms—causality, perfect distinguishability, ideal compression, local distinguishability, and pure conditioning—define a broad class of theories of information processing that can be regarded as standard. One postulate—purification—singles out quantum theory within this class.

- Studio della ***teoria quantistica “dall’esterno”***
- Confronto con toy-theories probabilistiche
- Ruolo dei principi informazionali, interpretazioni realistiche a variabili nascoste
- Località, causalità, reversibilità, entropia
- Interpretazione informazionale di concetti fisici



Quantum Cellular Automata for Quantum Field Theory

Dirac emerges from the large-scale dynamics of the minimal-dimension QCA satisfying *unitarity, locality, homogeneity, and discrete isotropy, without using Relativity*. The Dirac is recovered for small k and small m , whereas Lorentz covariance is distorted in the ultra-relativistic limit of very large k .

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