Informazione Quantistica e Fondamenti della Meccanica Quantistica e dei Campi

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Corsi

Teoria Fisica dell'Informazione (F03)

Fondamenti della Meccanica Quantistica (F02)

Fisica Quantistica della Computazione (F03)

Ottica Quantistica (F03)

Complementi di Meccanica Statistica (F02)

Linee di ricerca

Quantum Information & Quantum Metrology

Foundations of Quantum Theory & Quantum Field Theory

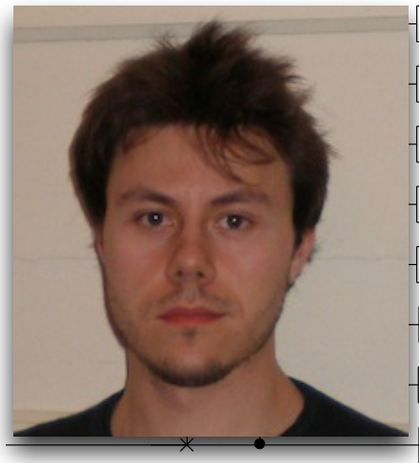
Nicola Mosco

Marco Erba

Giacomo Mauro D'Ariano

Paolo Perinotti

Massimiliano Sacchi



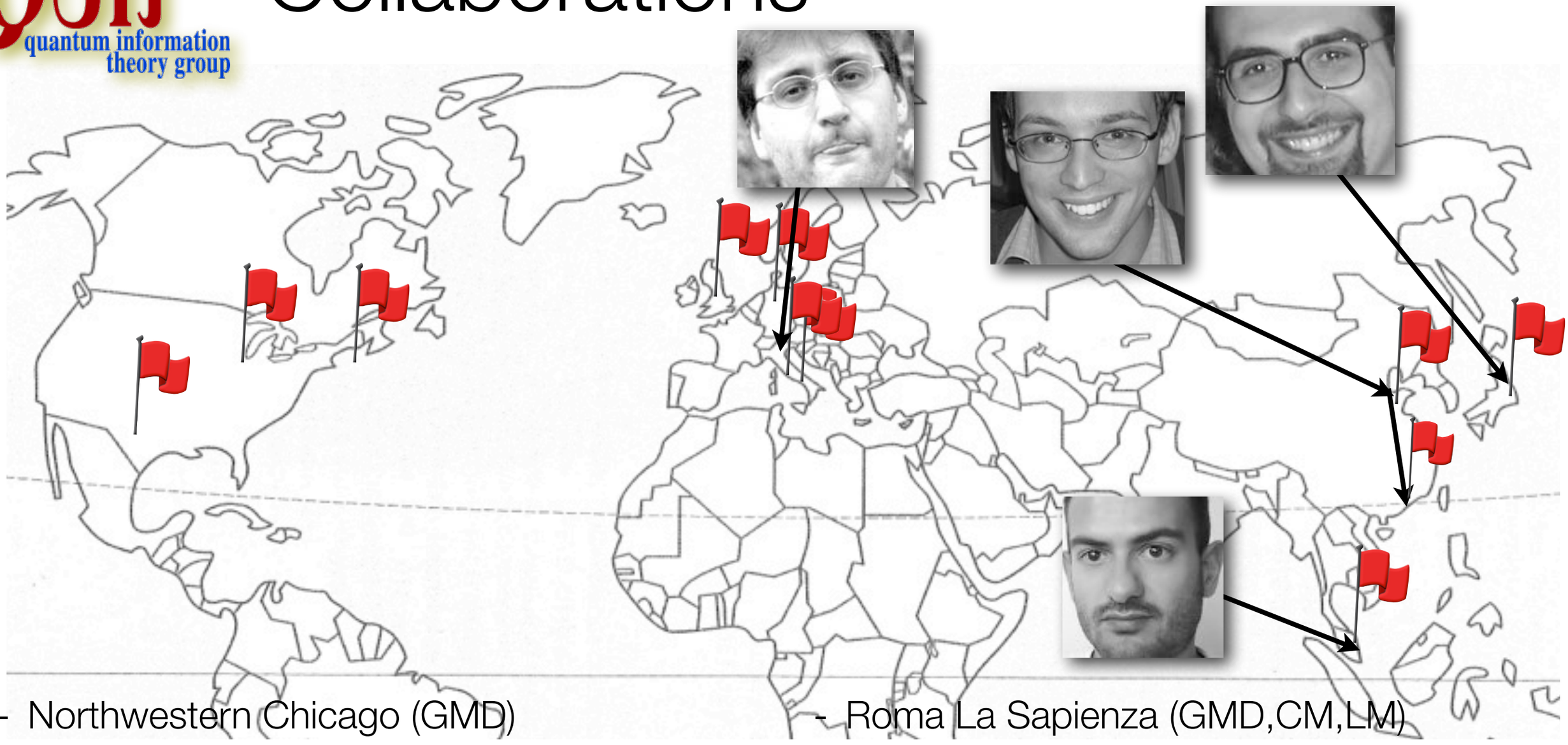
Alessandro Tosini

Alessandro Bisio

Lorenzo Maccone

Chiara Macchiavello

Collaborations



- Northwestern Chicago (GMD)
- U. Chicago, U. Illinois Chicago (GMD)
- Hannover (GMD,PP)
- MIT Boston (LM)
- Tsinghua Beijing (GMD,PP)
- Nagoya (GMD,PP)
- Singapore (CM)
- Roma La Sapienza (GMD,CM,LM)
- Dusseldorf, Edimburgo (CM)
- Normale Pisa (LM)
- Los Alamos (LM)
- Oxford, Cambridge (GMD,PP,CM)
- ETH Zurigo (PP,GMD)
- Bratislava (PP,GMD)

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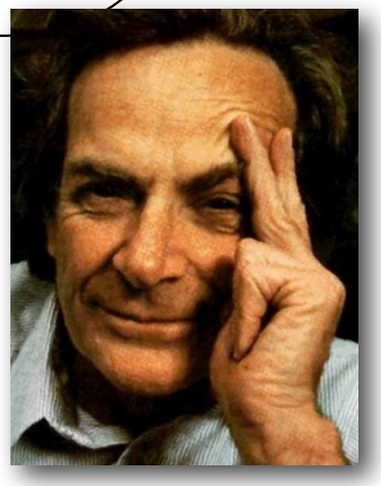
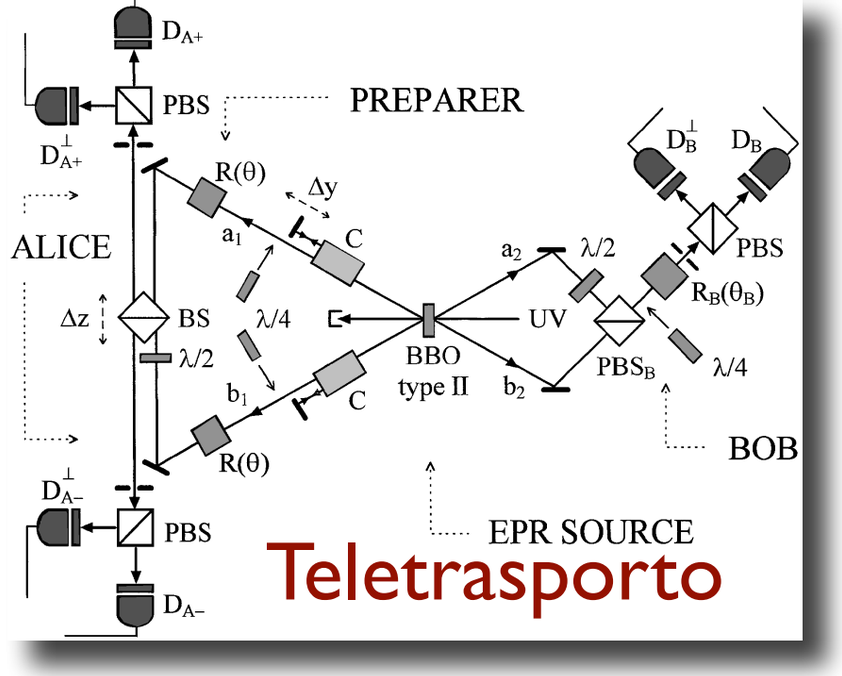
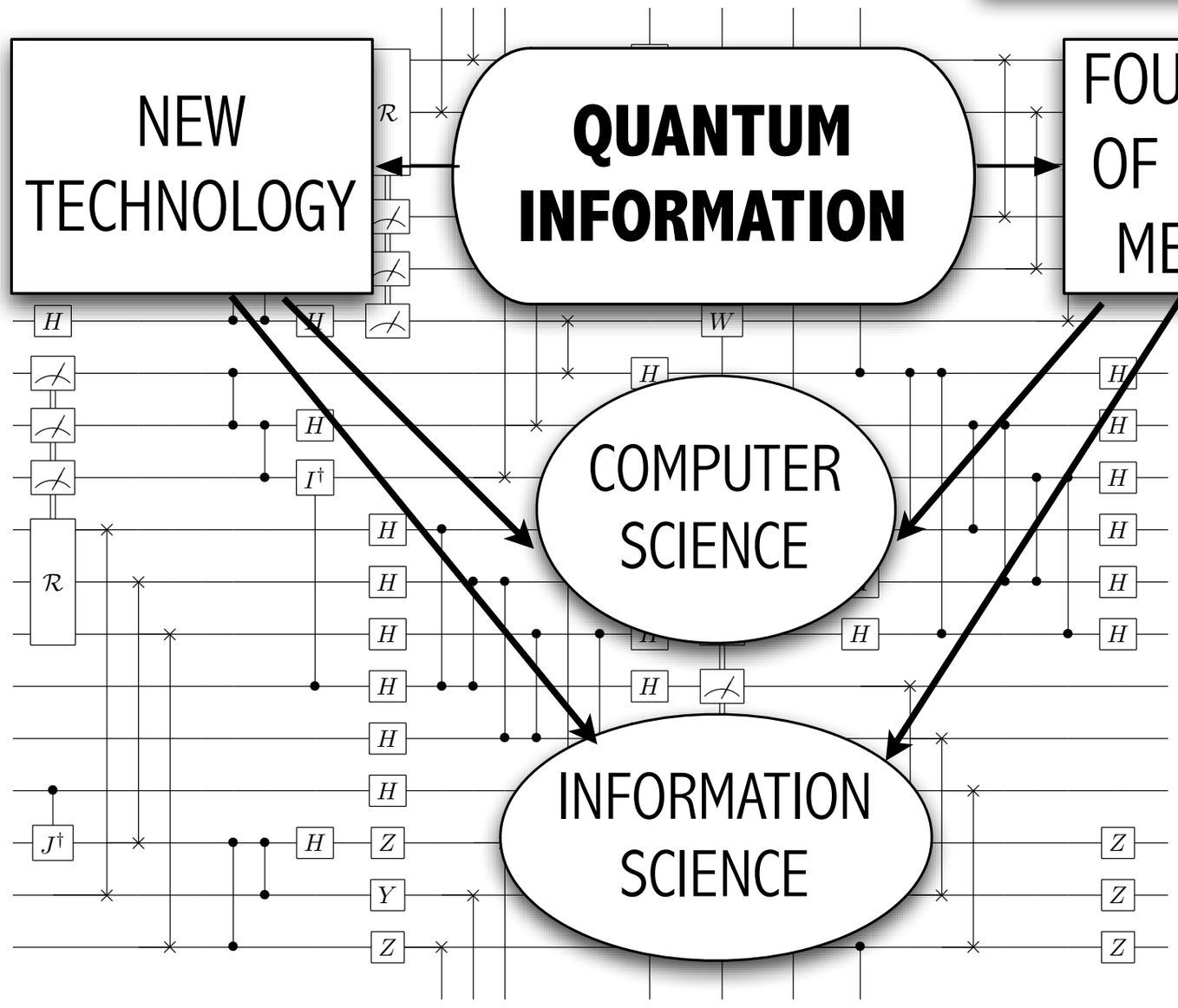
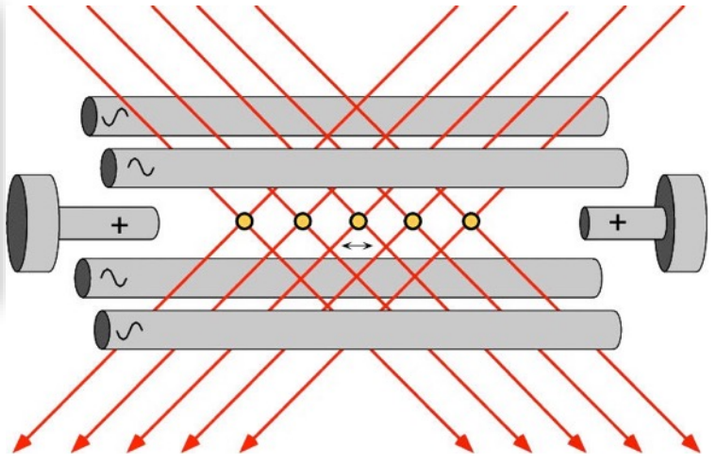


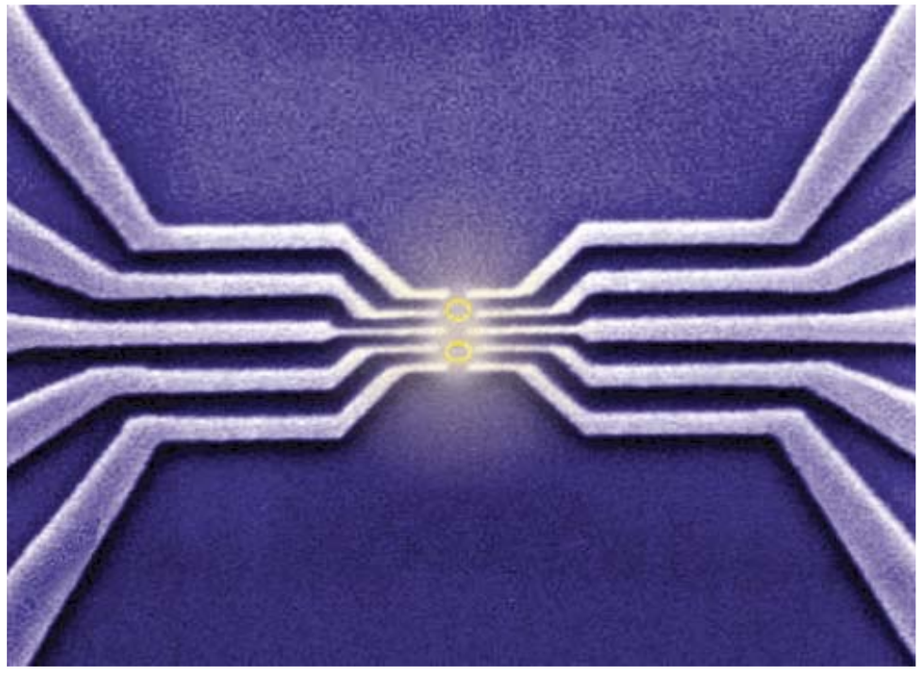


Teletrasporto

Quantum Computer







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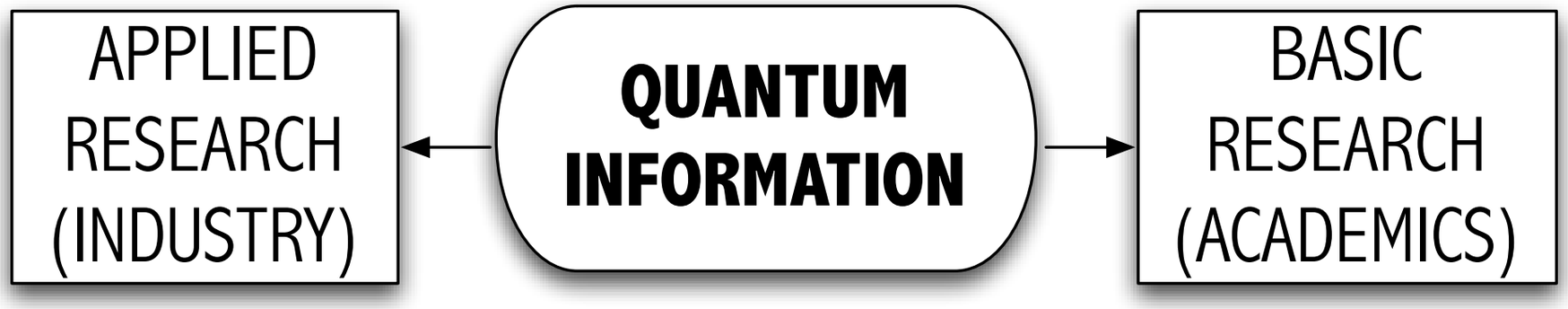

Cultura generale di Fisica Contemporanea

- Meccanica Quantistica sistemi aperti e misurazione, POVMs, ..., Tomografia Quantistica, cloning
- Non località e entanglement
- Master Equation
- Metodi ottimizzazione e teoria della stima, approcci Bayesiani
- Teoremi di Shannon, entropie, mutua informazione
- Data-processing theorems, channel capacity
- Algoritmi e complessità computazionale
- Crittografia Quantistica
- Ottica non lineare quantistica, misurazioni quantistiche ottiche
- Fondamenti della teoria quantistica e della teoria di campo
- Automi cellulari quantistici

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Lorenzo Maccone

Quantum Metrology

Nuova relazione di indeterminazione
[Lorenzo Maccone and Arun K. Pati, PRL **113** 260401 (2014)]

Strategie metrologiche che usano l'entanglement contro il noise
[R. Demkowicz-Dobrzański and L. Maccone, PRL **113** 250801 (2014)]

Quantum Information

Relazione tra entanglement e complementarietà
[L. Maccone, D. Bruß, and C. Macchiavello, PRL **114** 130401 (2015)]

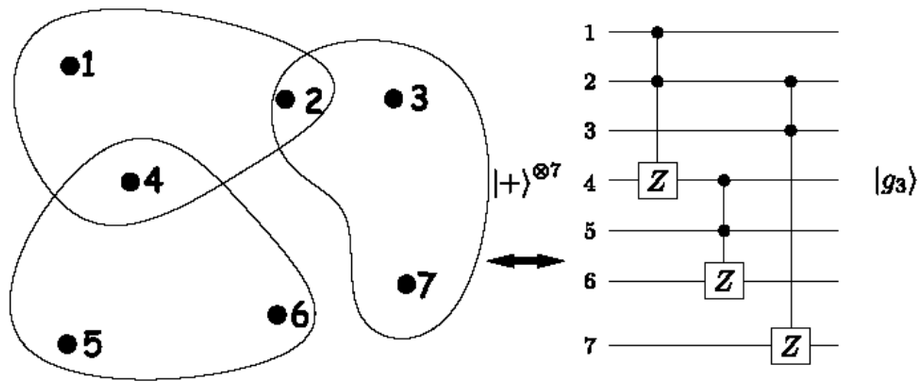
Foundations of QM

Quantizzazione del tempo
[V. Giovannetti, S. Lloyd, L. Maccone arXiv:1504.04215]

Chiara Macchiavello

Study of entanglement in quantum computation via hypergraph states

Rossi, Huber, Bruss and Macchiavello, NJP 15 (2013)



Study of entanglement via complementary properties

Maccone, Bruss & Macchiavello, Phys. Rev. Lett. 114, 130401 (2015)

Noisy quantum channels: developing methods to detect them and optimizing information transmission

C. Macchiavello and M. Rossi, Phys. Rev. A 88 (2013); Orieoux, Sansoni, Persechino, Mataloni, Rossi & Macchiavello, Phys. Rev. Lett. 111 (2013); D'Arrigo, Benenti, Falci & Macchiavello, Phys. Rev. A 88 (2013)

Quantum information with non Markovian noise

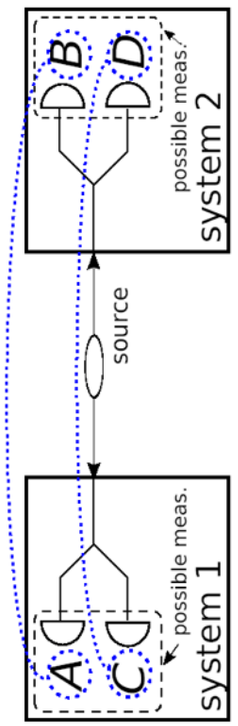
Addis, Haikka, McEndoo, Macchiavello & Maniscalco, Phys. Rev. A 87 (2013);
Liu, Hu, Huang, Li, Guo, Karlsson, Laine, Maniscalco, Macchiavello & Piilo, arxiv:1504.07572

Methods for entanglement detection

Macchiavello & Morigi, Phys. Rev. A 87 (2013); Borrelli, Rossi, Macchiavello & Maniscalco, Phys. Rev. A 90 (2014)

Quantum correlations without entanglement

Orieux, Ciampini, Mataloni, Bruss, Rossi & Macchiavello, arxiv:1503.05084



Massimiliano Sacchi

(con C. Macchiavello)

Stima della capacità quantistica di canali con set limitati di misure

procedura sperimentale facilmente accessibile e versatile

stato di ingresso fissato, poche misure locali, senza necessità di tomografia completa

fornisce limiti inferiori alla capacità quantistica per canali ignoti, di cui anche teoricamente non si conosce la capacità

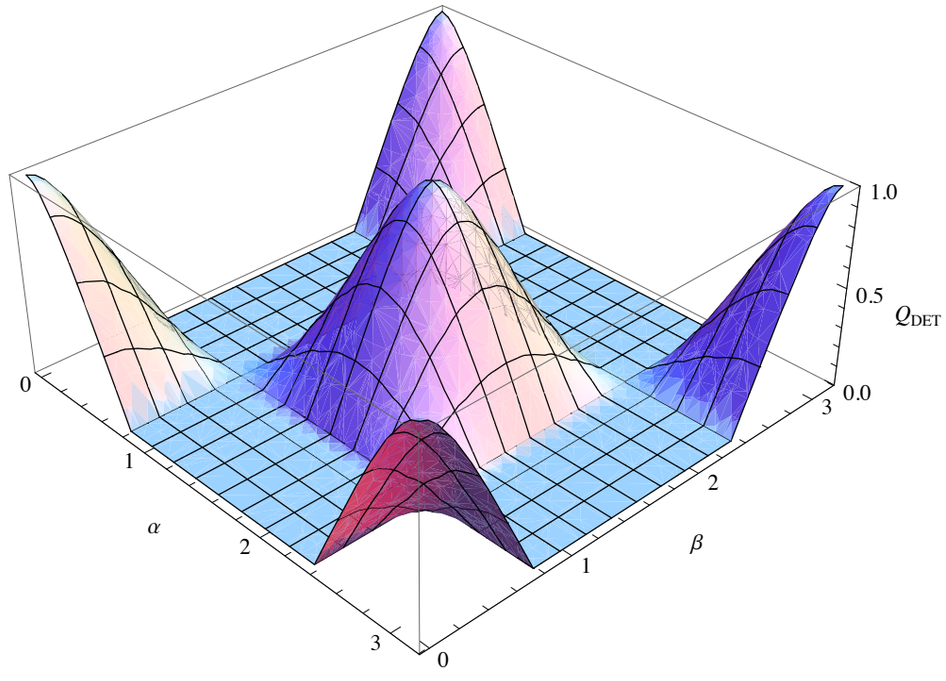
applicabile anche a canali correlati e con memoria

$$\mathcal{E}(\rho) = \sum_{i=1}^{2} A_i \rho A_i^\dagger \ ,$$

$$A_1 = \begin{pmatrix} \cos\alpha & 0 \\ 0 & \cos\beta \end{pmatrix}, \quad A_2 = \begin{pmatrix} 0 & \sin\beta \\ \sin\alpha & 0 \end{pmatrix}$$

$\alpha = \beta$ ‘dephasing’

$\beta = 0$ ‘damping’



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Giacomo Mauro D'Ariano, Paolo Perinotti

Foundations of QT and QFT

Book from CUP

Selected for a Viewpoint in *Physics*

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

Informational derivation of quantum theory

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Perimeter Institute for Theoretical Physics, 31 Caroline Street North, Ontario, Canada N2L 2Y5†

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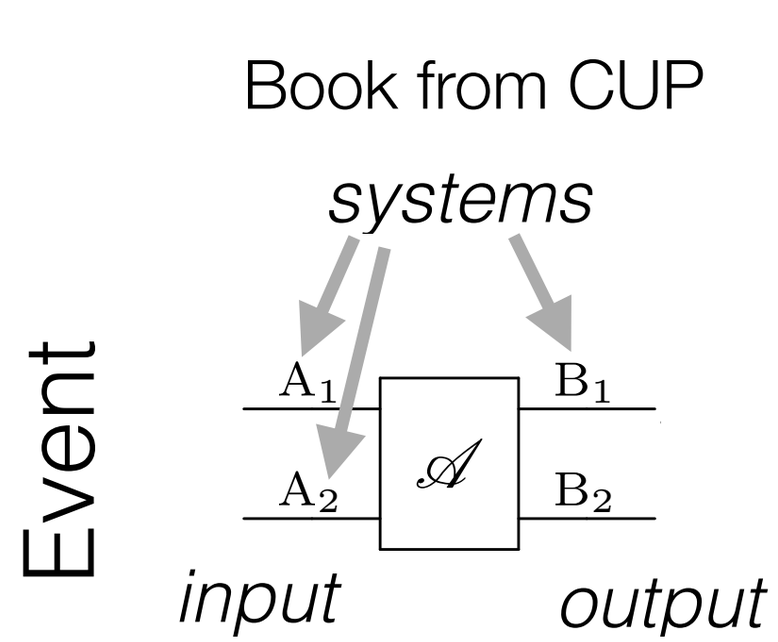
QUIT Group, Dipartimento di Fisica "A. Volta" and INFN Sezione di Pavia, via Bassi 6, I-27100 Pavia, Italy
(Received 29 November 2010; published 11 July 2011)



Principles for Quantum Theory

P1. Causality

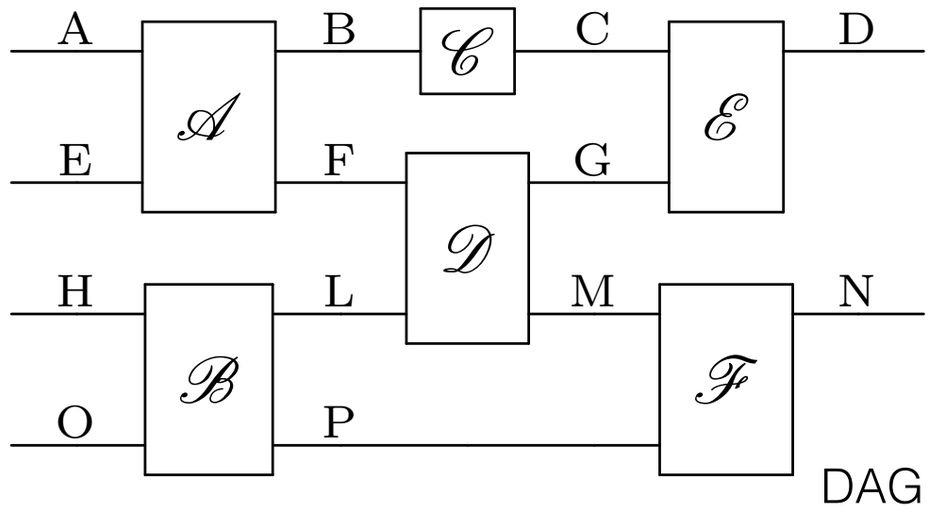
P2. Local discriminability

P3. Purification

P4. Atomicity of composition

P5. Perfect distinguishability

P6. Lossless Compressibility



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SUPPORTING SCIENCE~INVESTING IN THE BIG QUESTIONS

Principles for Physics

- *Mechanics (QFT) derived in terms of countably many quantum systems in interaction*

add principles

Min algorithmic complexity principle

- linearity
- unitarity
- locality
- homogeneity
- isotropy

- Quantum Cellular Automata (QCA) theory

Restrict to:
minimal-dimension
qi-embedding in Euclidean space

- *Relativistic regime (k≪1):* free QFT (Weyl, Dirac, and Maxwell)
- *Ultra-relativistic regime (k~1):* [Planck scale]: nonlinear Lorentz

- QFT derived:
- without assuming Special Rel.
- without assuming mechanics (quantum *ab-initio)*

- QCA is a *discrete* theory.

Motivations to keep it discrete:

1. Continuum is special case of discrete
2. Testing mechanisms in quantum simulations
3. Falsifiable Planck-scale hypothesis
4. Natural scenario for holographic principle
5. Solves all issues in QFT originating from continuum:

i) uv divergencies
ii) localization issue
iii) Computability and path-integral






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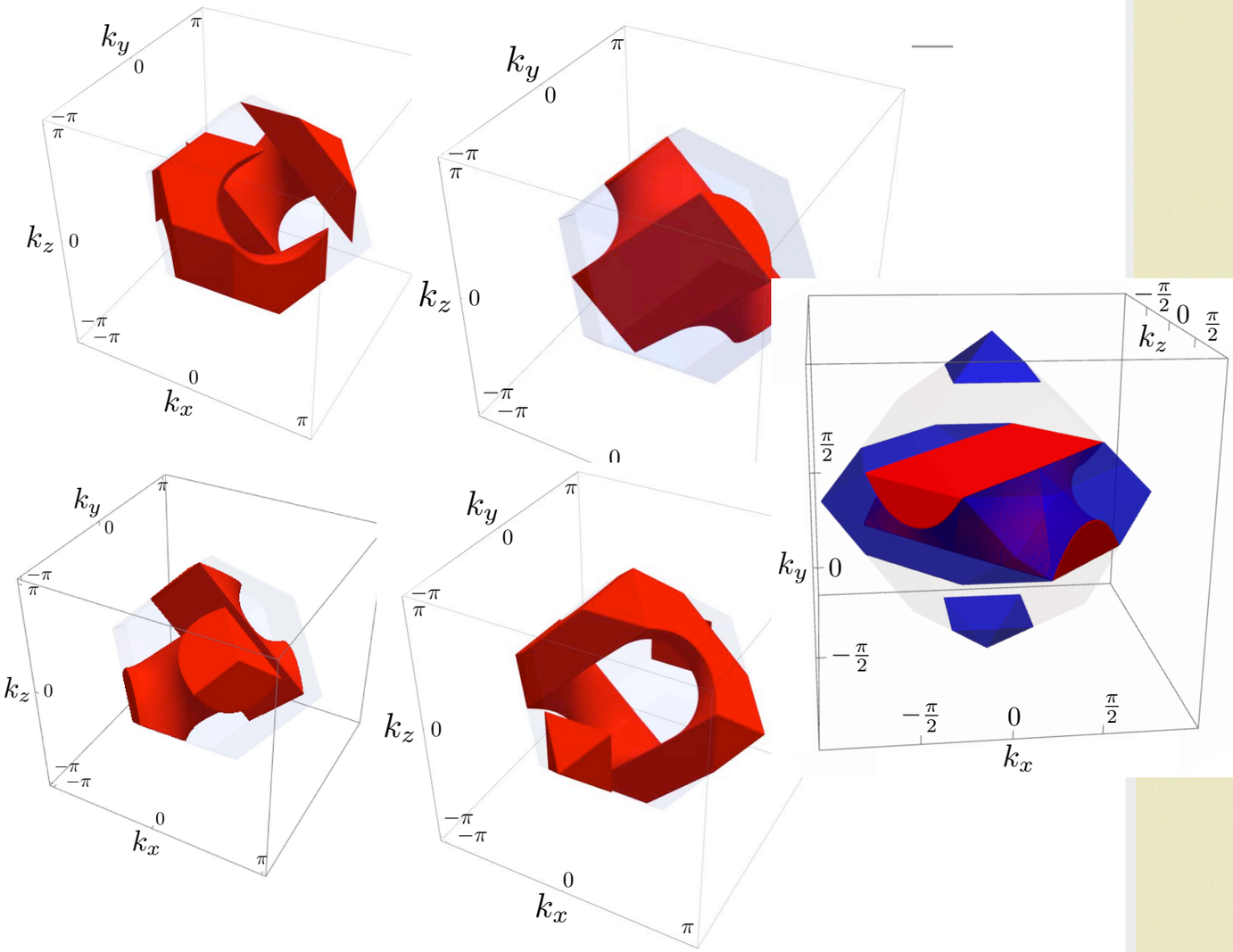
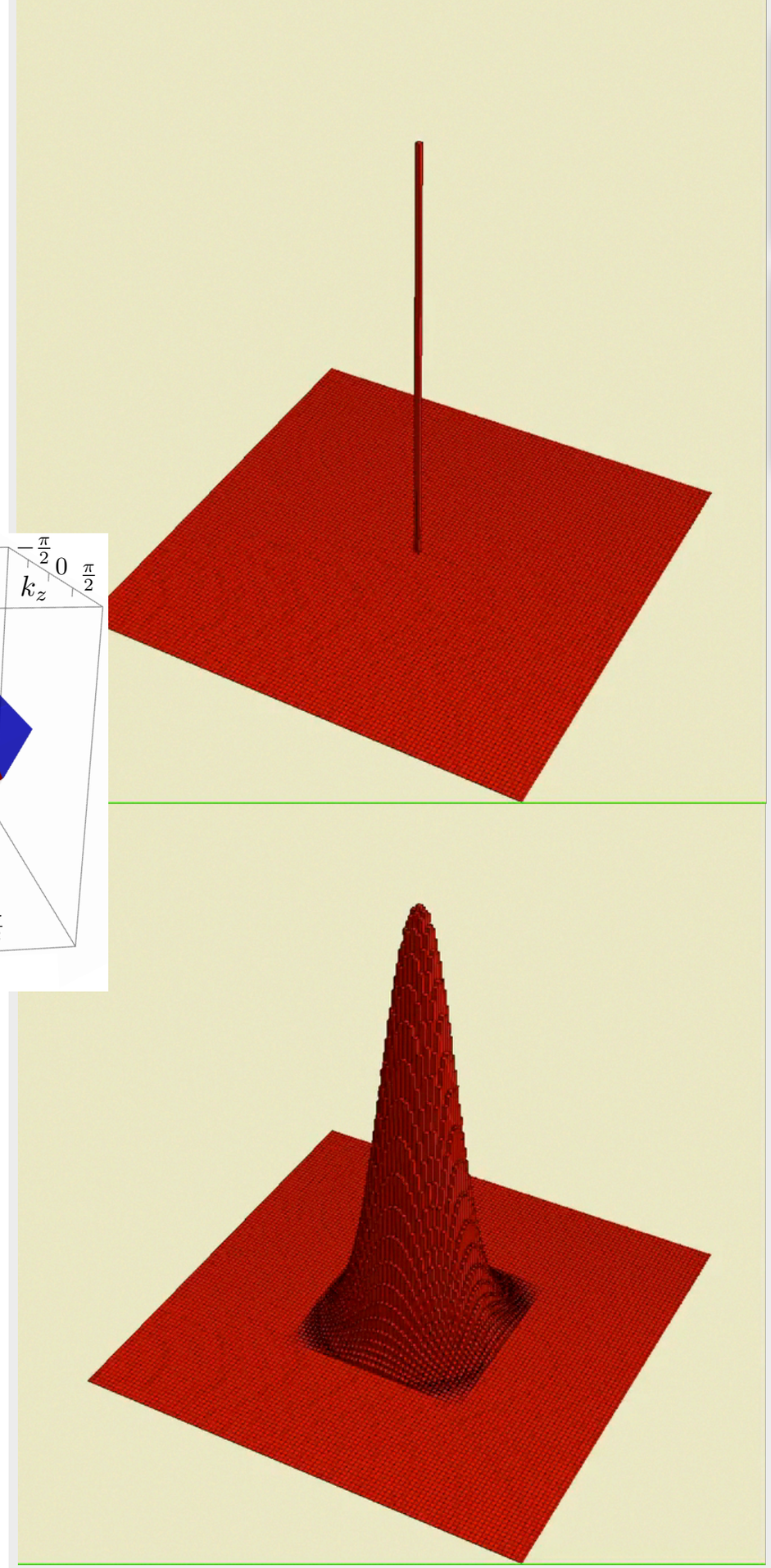
Principles for Physics







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D'Ariano, Mosco, Perinotti, Tosini, PLA **378** 3165 (2014)
D'Ariano, Mosco, Perinotti, Tosini, EPL **109** 40012 (2015)
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Bibeau-Delisle, Bisio, D'Ariano, Perinotti, Tosini, EPL **109** 50003 (2015)
Bisio, D'Ariano, Perinotti, arXiv:1407.6928, arXiv:1503.01017
D'Ariano, Il Nuovo Saggiatore **28** 13 (2012)
D'Ariano, Phys. Lett. A **376** 697 (2012)
D'Ariano, in AIP CP1232 (2010), AIP CP1327 7 (2011)