Panel:
Society Progress and Quantum Technology: Quo vadis?
CENICS 2016
Moderator: Steffen G. Scholz
Quantum Technology

Optical quantum based secure communication

Source: AIT

Quantum computing
Quantum Technology

Single photon quantum light sources

Quantum laser sources
Society Progress
Panelists

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Potentials and Progress in Quantum Technology

What we have done,
What we are doing,
What we will do:

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Why Are We Here?

- Physics & Others
- Nano
- Quantum
- Extreme Technology
- Edge Technology
- Visible
- Graspable
- Tangible

Reciprocal if infinite extreme until 1980
Scientific Knowledge

Epoch

1600 1700 1800 1900 2000

- Newton’s Classical Mechanics (1687)
- Maxwell’s Electromagnetism (1865)
- Einstein’s Photo-Electric (1905)
- Special (1905) & General (1907, 1915) Relativities
- Quantum Mechanics (1924)
- String Theory or Any? (Planck-scale)
- Electron Revolution (Atomic-scale)
- Electric Revolution
- Photon Revolution (Macro-scale)
- Industrial or Mechanical Revolution

Achievements
Definition of Quantum Technology (QT)

✓ By Quantum Physics:
- Discreteness where continuity breaks down and so Probabilistic
- Lack of deterministic causality
- Localism dictates
- Media: Fermion and Boson
- Duality means the Ambiguity between wave-particle
- Uncertainty Principle: Less measurable in momentum-space

The QM underlies many fields, such as condensed matter physics, solid-state physics, atomic physics, molecular physics, computational physics, computational chemistry, quantum chemistry, particle physics, nuclear chemistry, and nuclear physics.

✓ By Dimensional Scale:
- Is the advent of QT a natural consequence after the NT?
- Is anything beyond nano \((10^{-9})\) meter or nano-scale?
- Is it between the nano-scale and Planck scale \((10^{-33} \text{ cm})\)?
Quantum Technology – pico or femto scales?

Diagram showing scales from $10^{-34}$ m to $10^{-10}$ m, with annotations for meso, atomic, and Planck scales.

Graph illustrating regions in probability space.
Definition of Quantum Technology (QT)

✓ By Time Scale:

• Does the spontaneity or transiency dictate in quantum domain?
  Within action, no "Nowness" but "Spontaneity" and "Transiency". The spontaneity is related to ontological state while the transiency to quanta with causality.

• Is QT anything beyond pico ($10^{-12}$) or femto ($10^{-15}$) second? Time is no longer "independent variable", but dependency to quanta (transiency).

• What is the state, including time less than Planck time ($5.391 \times 10^{-44}$ sec)?

Einstein Theories of Time

History: $4.41 \times 10^{17}$ second
Quantum Information Technologies and Social Innovations

Thierry Ferrus
Hitachi Cambridge Laboratory
Outline

Quantum computing: The Copenhagen interpretation

Is it all about going faster...

...or keeping safe ???

Could Quantum Computing solve ‘everything’?
Copenhagen interpretation: principles of Quantum Mechanics

‘Known’ QIP Applications are based on either:

- Entanglement
- Wavefunction collapse

No specific applications based on:

- Heisenberg uncertainty
- Wave-particle duality
Is it all about going faster...???

- Classical computation:
  
  Waste time in sending data across chip
  
  Physical limitations: bandwidth, speed of light/electrons

- Quantum computation:
  
  Problem defines an Hamiltonian
  
  All solutions contained in the Hilbert space
  
  Unitary operations and time evolution
Is it all about going faster...???

- **Medicine**: faster, higher resolution scans, molecules sampling, drug testing

- **Smart cities**: real traffic management (car, plane), intelligent cars

- **Space**: star studies, exoplanet search (resolution, sampling)

- **Robotics**: machine learning, artificial intelligence
Entanglement and measurement:

Wavefunction collapse (projection onto fundamental states)

Quantum → Classical

Measurement modifies the quantum states

Eavesdropping: Bob (receiver), Alice (sender) and Eve (the ‘bad girl’)

Security of data, secure transmissions

Banking

Police (terrorism, real time checks, facial recognition), military
Could Quantum Computing solve ‘everything’?

- Quantum cryptography ➔ weak measurement ➔ counter measures ???

- Eavesdropping in space...

- Cloning and long range communication

- Cost/ practicability : is it worth investing in QIP technologies ?

- Room temperature technologies
Quantum Information Technologies and Social Innovations

Thierry Ferrus
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Inspire the Next