Karlsruhe Institute of Technology

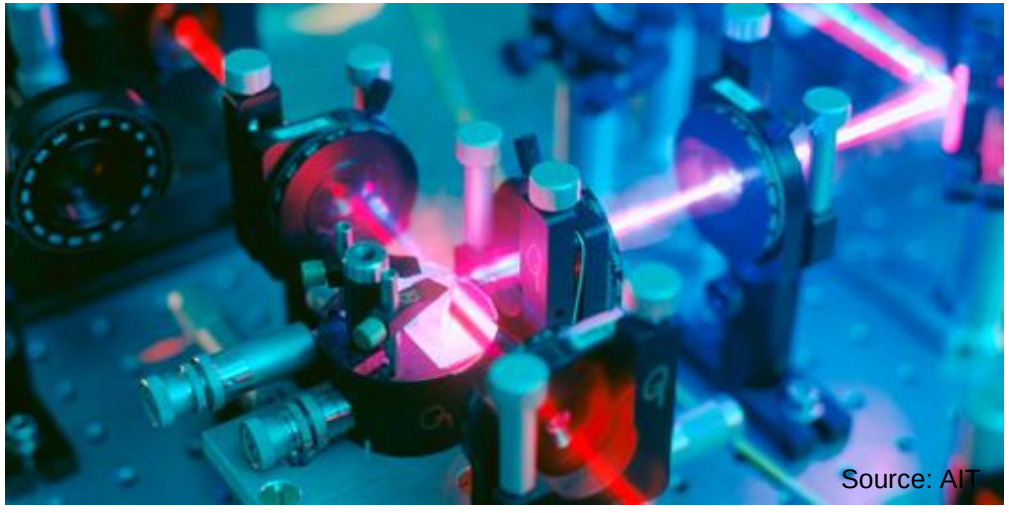
IARIA

Panel:
Society Progress and Quantum Technology : Quo vadis?

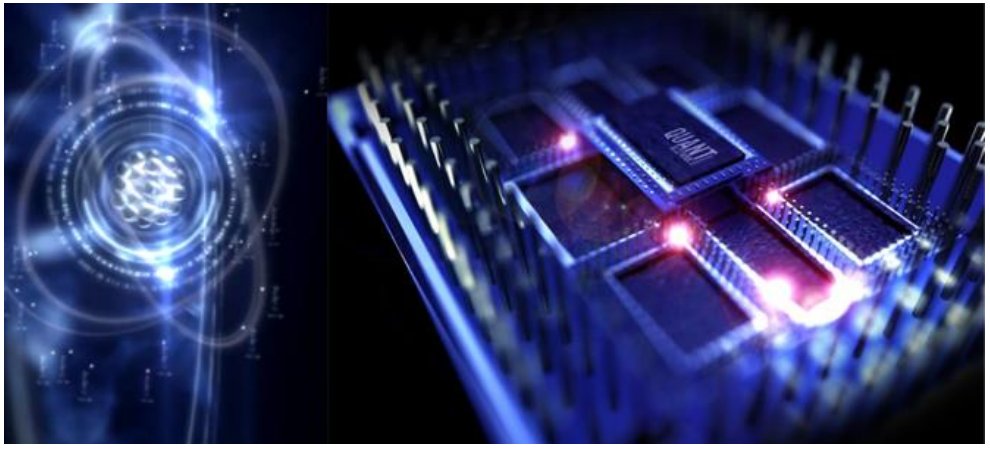
CENICS 2016

Moderator: Steffen G. Scholz

Quantum Technology

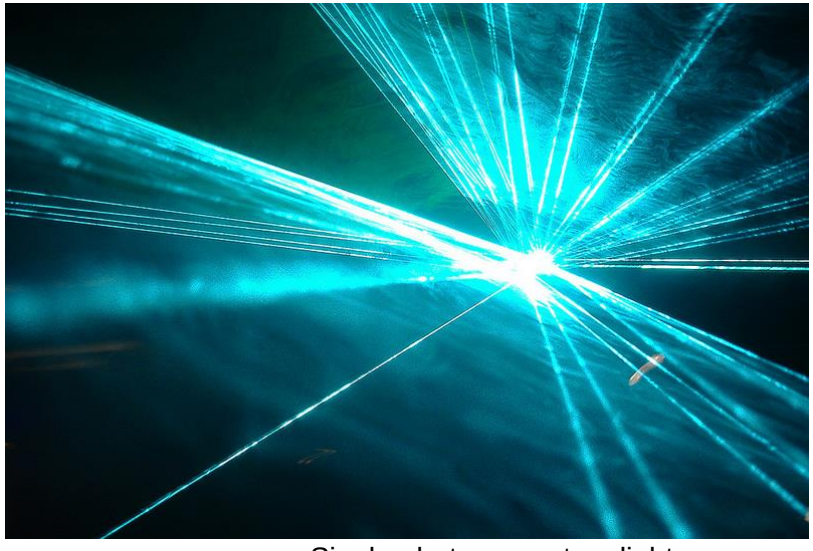


Optical quantum based secure communication

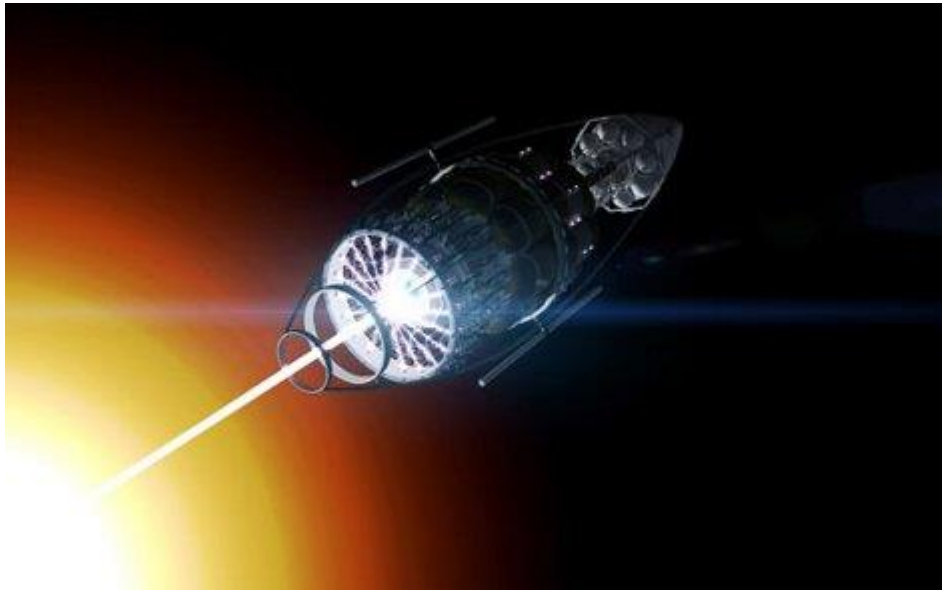


Quantum computing

Quantum Technology

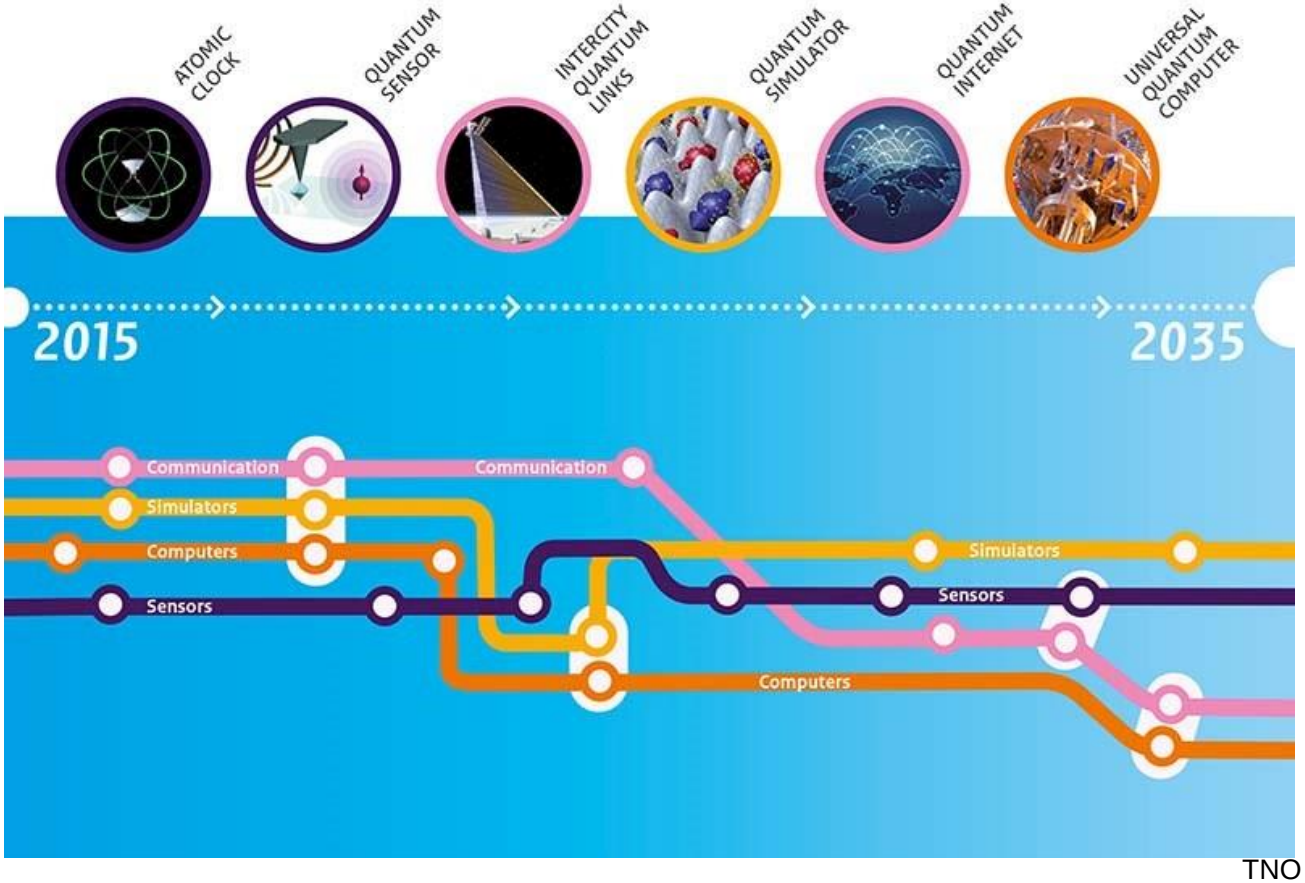


Single photon quantum light sources



Qunatum laser sources

Quantum Technologies Timeline



TNO

Society Progress

Panelists

Sang H. Choi, NASA Langley Research Center, USA

Thierry Ferrus, Hitachi Cambridge Laboratory, UK

Jason Sun, US Army Research Laboratory, USA

Potentials and Progress in Quantum Technology

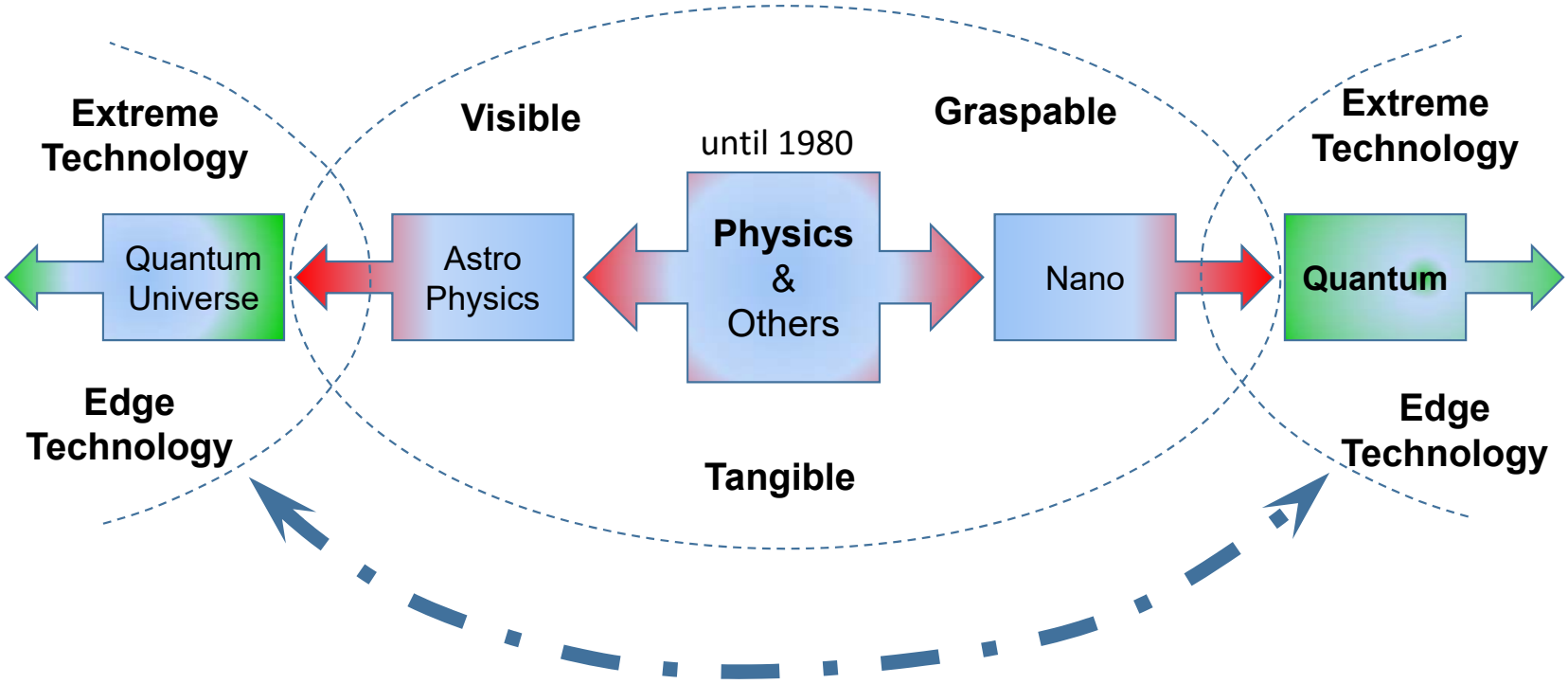
What we have done,
What we are doing,
What we will do:

Sang H. Choi
Senior Scientist

AMPB/RD
NASA Langley Research Center

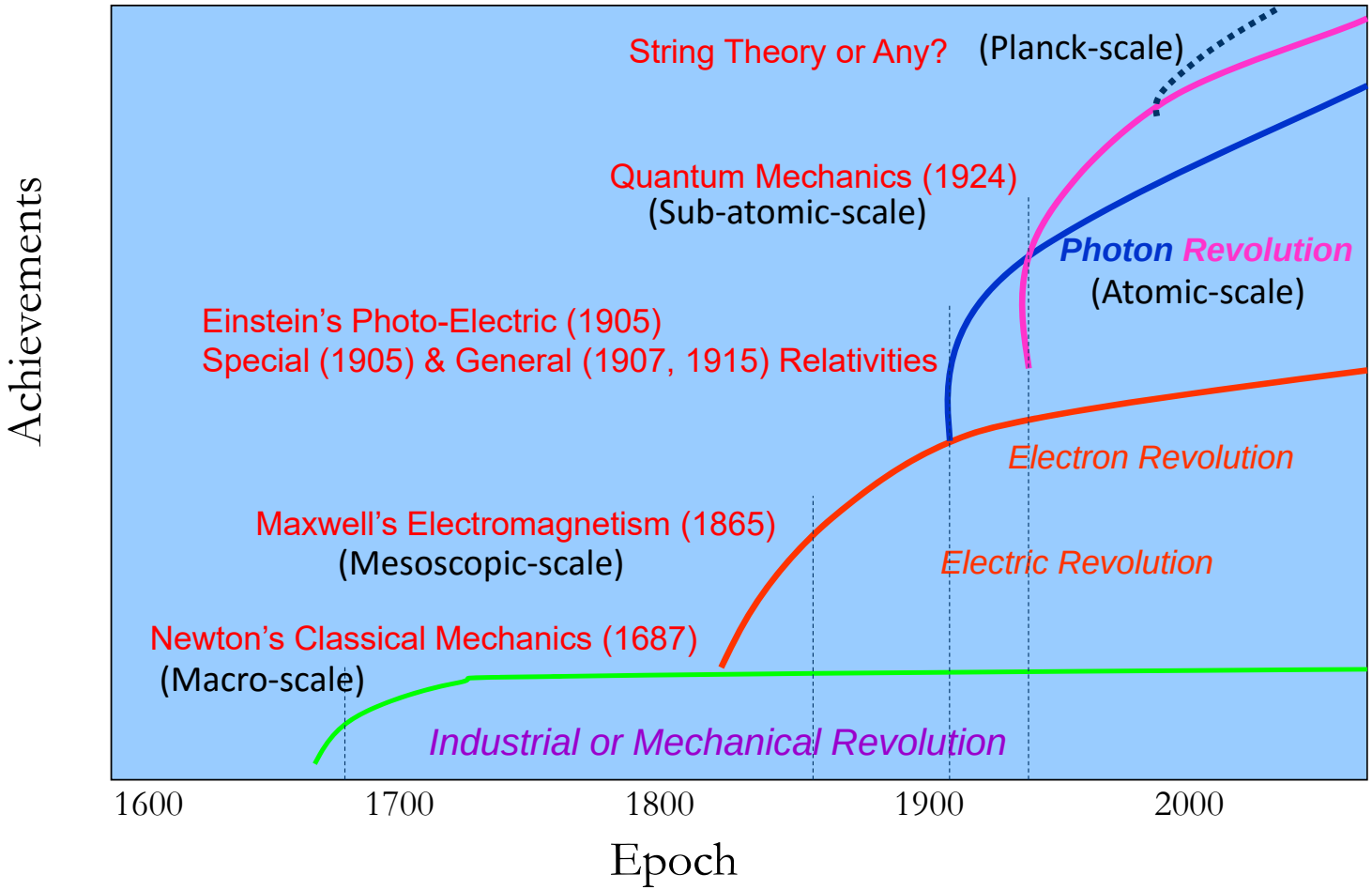
sang.h.choi@nasa.gov

Why Are We Here?



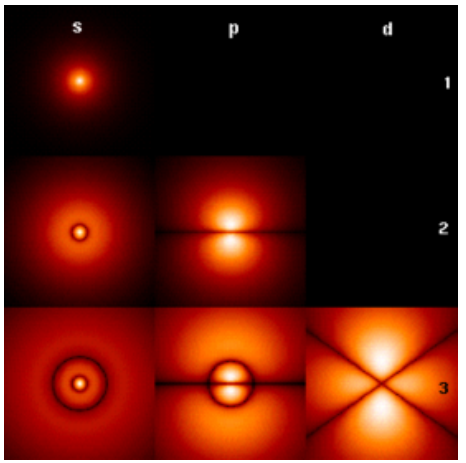
Reciprocal if infinite extreme

Scientific Knowledge



Definition of Quantum Technology (QT)

Probability Space



✓By Quantum Physics:

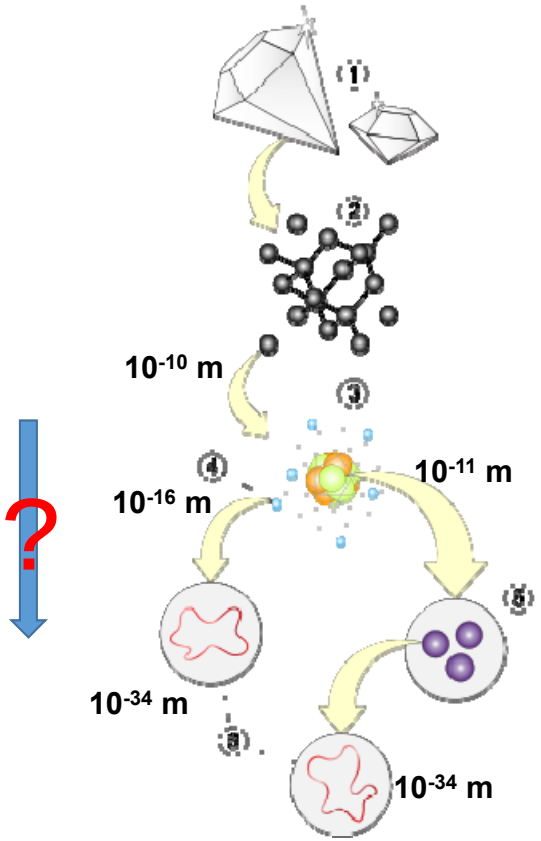
- Discreteness where continuity breaks down and so Probabilistic
- Lack of deterministic causality
- Localism dictates
- Media: Fermion and Boson
- Duality means the Ambiguity between wave-particle
- Uncertainty Principle: Less measurable in momentum-space

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} cm)?

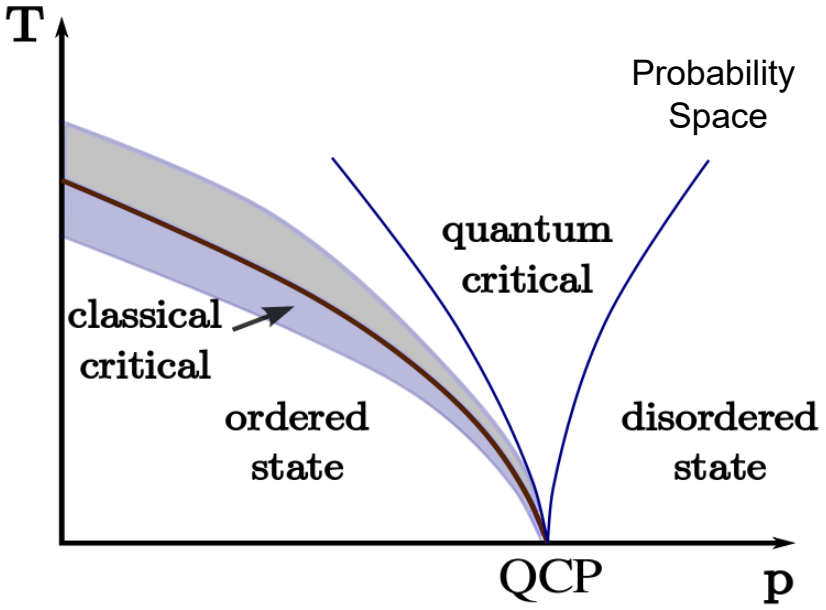
Quantum Technology – pico or femto scales?



meso

atomic

Planck



Definition of Quantum Technology (QT)

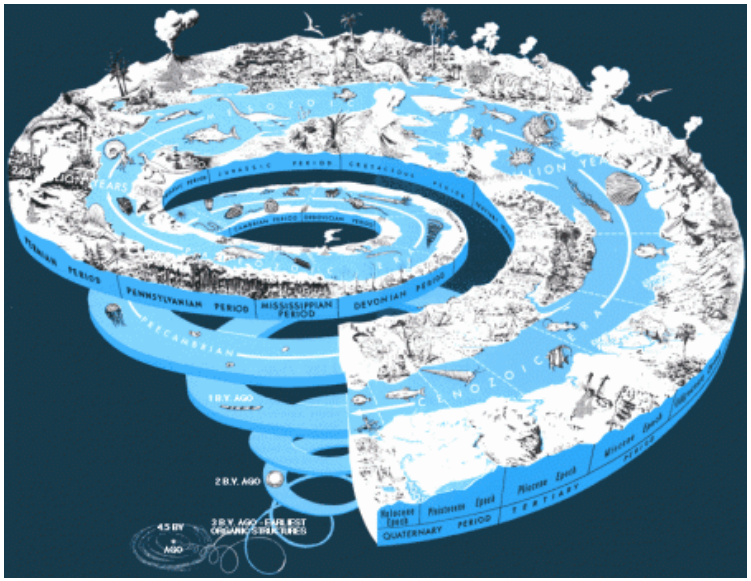
✓By Time Scale:

- 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 (5.391×10^{-44} sec)?



Einstein Theories of Time

History: 4.41×10^{17} second

Quantum Information Technologies and Social Innovations

Thierry Ferrus

Hitachi Cambridge Laboratory

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Outline

Quantum computing : The Copenhague interpretation

Is it all about going faster...

...or keeping safe ???

Could Quantum Computing solve ‘everything’ ?

QIP and the Copenhague interpretation

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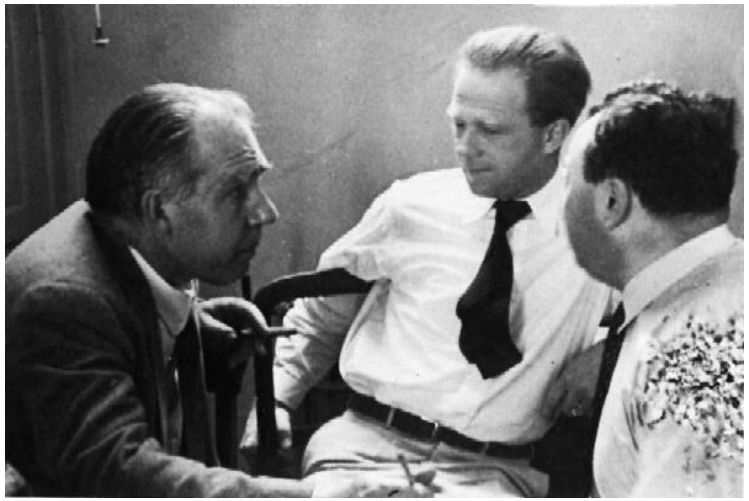
- Copenhagen interpretation : principles of Quantum Mechanics
- ‘Known’ QIP Applications are based on either :

  Entanglement

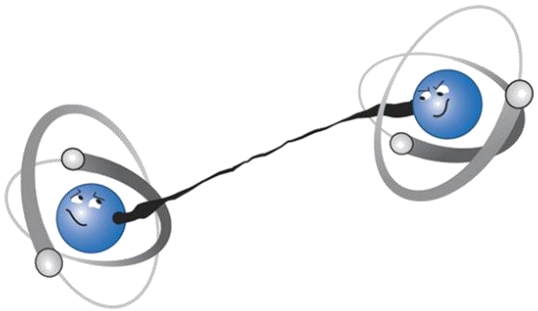
  Wavefunction collapse



- No specific applications based on :

  Heisenberg uncertainty

  Wave-particle duality



Is it all about going faster...???

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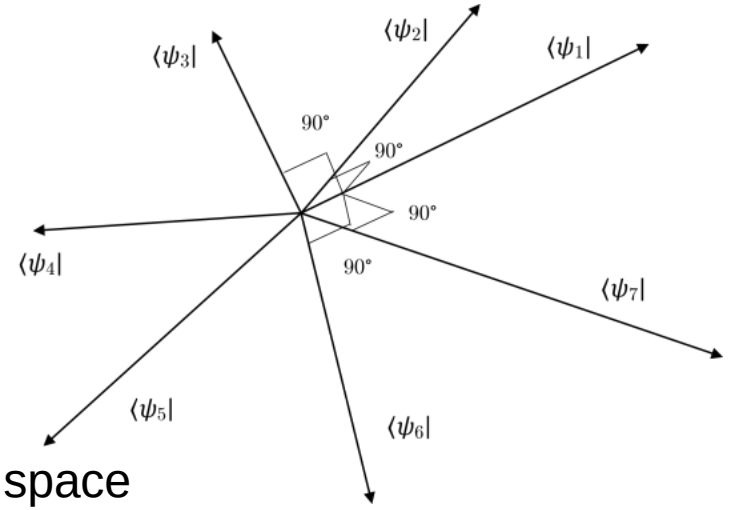
- Classical computation :

  Waste time in sending data across chip

  Physical limitations : bandwidth, speed of light/electrons



- Quantum computation :

  Problem defines an Hamiltonian

  <u>All</u> solutions contained in the Hilbert space

  Unitary operations and time evolution

Is it all about going faster...???

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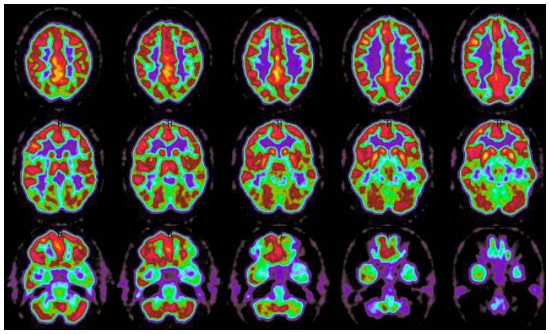
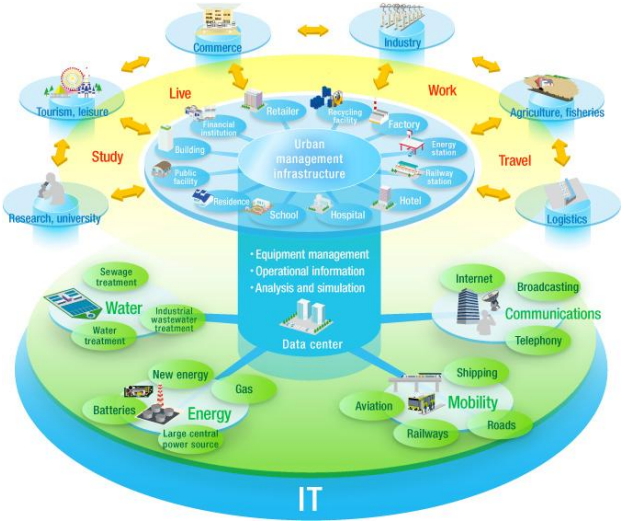
- Medicine : faster, higher resolution scans, molecules sampling
  drug testing

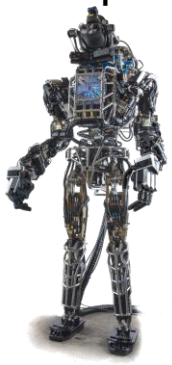




- Smart cities : real traffic management (car, plane)
  intelligent cars

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

- Robotics : machine learning, artificial intelligence



...or keeping safe ???

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- 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’ ?

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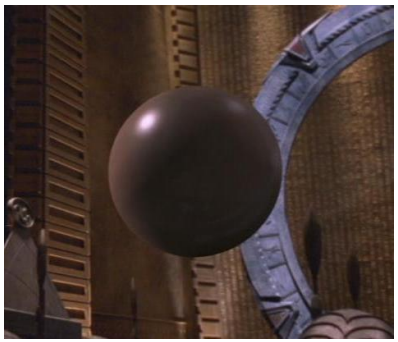
- Quantum cryptography ➔ weak measurement ➔counter measures ???

- Eavesdropping in space...
- Cloning and long range communication



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

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END

Quantum Information Technologies and Social Innovations

Thierry Ferrus
Hitachi Cambridge Laboratory

HITACHI

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