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Patents and Quantum Technology

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1. What is a patent?

- Patents are granted for any inventions, in all fields of technology, […]

cf. §1 PatG*; Art. 52 (1) EPC**

- Patents have the effect that the proprietor of the patent alone is entitled to use the patented invention cf. §9 PatG*

→protection of inventions

- Patent applications and files are published cf. §31, 32 PatG*; Art. 93 (1), 128 EPC

→knowledge-sharing

- number of patent applications in the field of QT shows a double-digit growth rate

Lewis, A. M., Scudo, P., Cerutti, I., Travagnin, M., Marcantonini, C. et al., Future Directions for Quantum Technology in Europe - An analysis of policy questions, Publications Office of the European Union, Luxembourg, 2025, https://data.europa.eu/doi/10.2760/0891087, JRC141050.

*PatG: Patentgesetzt/German Patent Act
**EPC: European Patent Convention

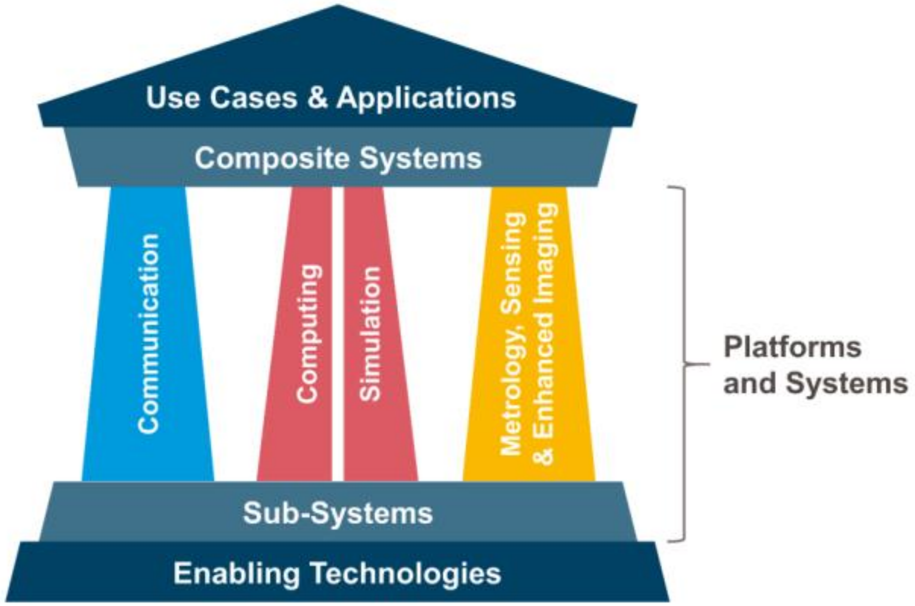
2. Why do we need patents?

- protection of inventions
  - simplifies collaborations, technology transaction and licensing arrangements and secures investments
  - used to organise the exploitation of joint results and to share the associated benefits
- knowledge-sharing
  - patents convey valuable information about technological activities
  - patent filings are effective indicators of the technical capabilities
- patents give confidence to fund R&D: an empirical study* shows that the filing of patent applications
  - "[…] in the seed or early growth stage is associated with a <u>higher likelihood of subsequent VC funding</u>."
  - "[…] is associated with a more than twice as <u>high likelihood of successful exit</u> for investors."

* „Patents, trade marks and startup finance Funding and exit performance of European startups", October 2023, Published and edited by the EPO and the EUIPO, Munich (Germany) and Alicante (Spain)

3.1. Patents and Quantum Technology - Overview

- QT relates to technology that uses quantum phenomena



Quantum Technologies Standardization Roadmap (CEN-CENELEC Focus Group on QT's)

- Cooperative Patent Classification (CPC); search phrase „quantum"

B82Y 10/00	**Nanotechnology for information processing, storage or transmission, e.g. quantum computing or single electron logic** [2017-08]
B82Y 20/00	**Nanooptics, e.g. quantum optics or photonic crystals** [2017-08]
G16C 10/00	**Computational theoretical chemistry, i.e. ICT specially adapted for theoretical aspects of quantum chemistry, molecular mechanics, molecular dynamics or the like** [2019-02]
C09K 11/00	**Luminescent, e.g. electroluminescent, chemiluminescent materials** [2013-01]
G06N 10/00	**Quantum computing, i.e. information processing based on quantum-mechanical phenomena** [2022-01]
H04L 9/00	{Cryptographic mechanisms or cryptographic} **arrangements for secret or secure communications; Network security protocols** [2022-05]
B82Y 30/00	**Nanotechnology for materials or surface science, e.g. nanocomposites** [2017-08]

3.2. Patents and Quantum Technology – Case Study I

- Title: „METHOD […] FOR DETERMINING THE COMPONENT OF A MAGNETIC FIELD IN A PREDETERMINED DIRECTION"

[0002] In classical metrology, a method for determining a magnetic field value typically involves several independent measurements. Thereby, the scaling behaviour of the determination uncertainty is given by the standard quantum limit (or shot noise limit) $\delta x \propto 1/R^{\alpha}$ with α=1/2, where R denotes a measure for the required resources, e.g., the number of measurements, a characteristic measurement time or a characteristic measurement energy. However, it is conjectured that in the framework of quantum metrology the standard quantum limit can be overcome and the precision of the method can be improved considerably using quantum resources.

[0003] For example, phase estimation protocols have been proposed based on the Fourier algorithm or the Kitaev algorithm for achieving the fundamental Heisenberg scaling limit of quantum metrology with the scaling exponent α=1.

- [an] object of the invention is to overcome […] limitations and provide a simple and practical method […] for determining magnetic fields with high precision (cf. para. [0008] of patent specification)

(19) Europäisches Patentamt European Patent Office Office européen des brevets

(11) **EP 3 886 003 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.12.2024 Bulletin 2024/49

(21) Application number: **20165571.9**

(22) Date of filing: **25.03.2020**

(51) International Patent Classification (IPC):
G06N 10/60 *(2022.01)* ***G01R 33/035*** *(2006.01)*
G06N 7/01 *(2023.01)*

(52) Cooperative Patent Classification (CPC):
G01R 33/035; G06N 7/01; G06N 10/60

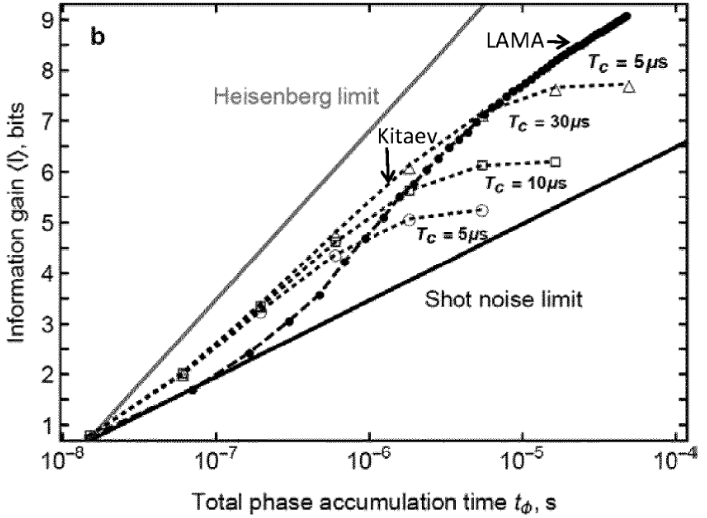
(54) **METHOD, APPARATUS AND COMPUTER PROGRAM PRODUCT FOR DETERMINING THE COMPONENT OF A MAGNETIC FIELD IN A PREDETERMINED DIRECTION**

VERFAHREN, VORRICHTUNG UND COMPUTERPROGRAMMPRODUKT ZUR BESTIMMUNG DER KOMPONENTE EINES MAGNETFELDES IN EINER VORBESTIMMTEN RICHTUNG

PROCÉDÉ, APPAREIL ET PRODUIT PROGRAMME INFORMATIQUE POUR DÉTERMINER LE COMPOSANT D'UN CHAMP MAGNÉTIQUE DANS UNE DIRECTION PRÉDÉTERMINÉE

3.2. Patents and Quantum Technology – Case Study I

- What is claimed is: 1. A method for determining the component of a magnetic field in a predetermined direction, comprising the steps of:
  - (S1) preparing a quantum system (Q) […];
  - (S2) letting the quantum system (Q) evolve for a delay time period, wherein the quantum system (Q) interacts with the magnetic field in the predetermined direction, […]
  - (S3) performing […] a projective measurement […] and iteratively repeating steps (S1), (S2) and (S3) […],
  - (S4) determining the component of the magnetic field in the predetermined direction according to the outcomes of the projective measurements, wherein […]
  - the delay time period increases linearly […].



[0011] The steps of the method are carried out by a control and measurement unit. The proposed method allows determining the component of a magnetic field with high precision. Thereby, the preparation of the quantum system in a coherent superposition state and the linear increase of the delay time period after each iteration ensures the quantum advantage compared to classical metrological protocols. Moreover, since the delay time period increases only linearly, a large number of iterations and a large total phase accumulation time can be realized. Consequently, a high determination accuracy can be achieved and the proposed method can be carried out efficiently even in the case of continuous magnetic fields and in the presence of dissipation and decoherence. Moreover, the proposed method is far less complex and requires less experimental and computational resources. In particular, the delay time periods of the iteration loop may be predetermined.

3.3. Patents and Quantum Technology – Case Study II

- What is claimed is: 1. A method comprising:
  - arranging a plurality of atomic qubits (202, 204, 212, 214, 216) into a 2-dimensional spatial structure to encode an NP-complete quantum computing problem […];
  - initializing […];
  - evolving the plurality of atomic qubits into a final state […]; and
  - measuring at least some of the plurality of atomic qubits in the final state, characterized in that: […]
  - the evolving […] comprises driving the plurality of qubits by applying a sequence of resonant laser pulses […].
- Para. [0113]: In some embodiments, without being bound by theory, this QAOA [quantum approximate optimization algorithms] framework can be applied to general combinatorial optimization problems. In one example, an archetypical problem called MaxCut can be considered.
- Para. [0115]: [I]t achieves a guaranteed minimum approximation ratio when p = 1. Additionally, under some reasonable complexity-theoretic assumptions, QAOA may not be efficiently simulated by any classical computer even when p = 1, making a candidate algorithm for "quantum supremacy," or the ability of a quantum computer to perform calculations that a traditional computer cannot.

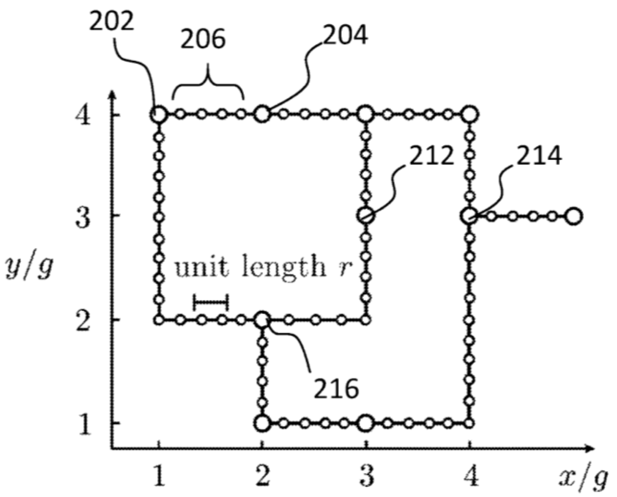
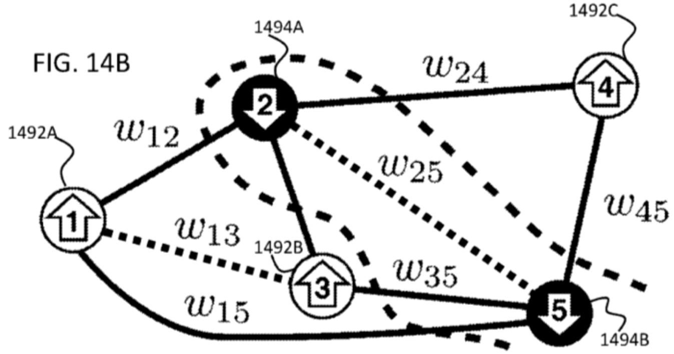


FIG. 14B



4. Summary

- patents help to protect innovation and to share knowlede
- patents are available for inventions in all fields of technology
- new SME fund for protection of IP! https://www.euipo.europa.eu/en/sme-corner/

Thank you!

- Questions? Comments?
- Experiences?

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