innovacs
innovation, connaissances, société

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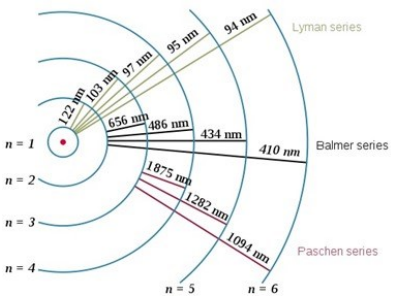
immersion dans les enjeux du quantique

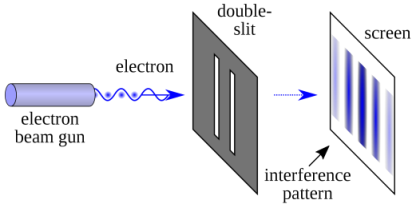
olivier ezratty
⟨consultant | auteur | QEI cofounder⟩
Grenoble, 21 novembre 2022
olivier@oezratty.net www.oezratty.net **@olivez**

qu’est-ce qu’être « quantique » ?



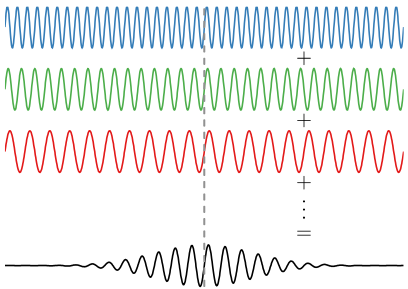
quantification

propriétés discontinues d’objets quantiques (énergie, fréquences, …)



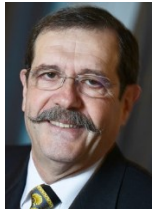
dualité onde-particule

qui dépend du contexte



superposition d’états

liée à la dimension ondulatoire des objets quantiques

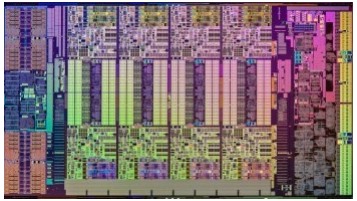


intrication

états aléatoires et corrélés d’objets quantiques

1ère et 2nde révolutions quantiques

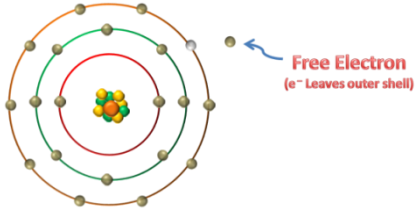
interactions **groupées** entre
électrons, **photons** et **atomes**

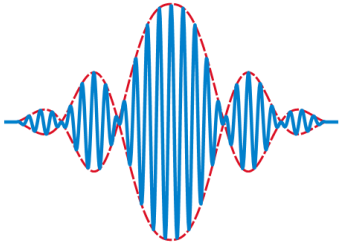


tout le numérique d'aujourd'hui !
cellules photovoltaïques
imagerie médicale
horloges atomiques

1947-*

superposition et **intrication**
de **particules individuelles**

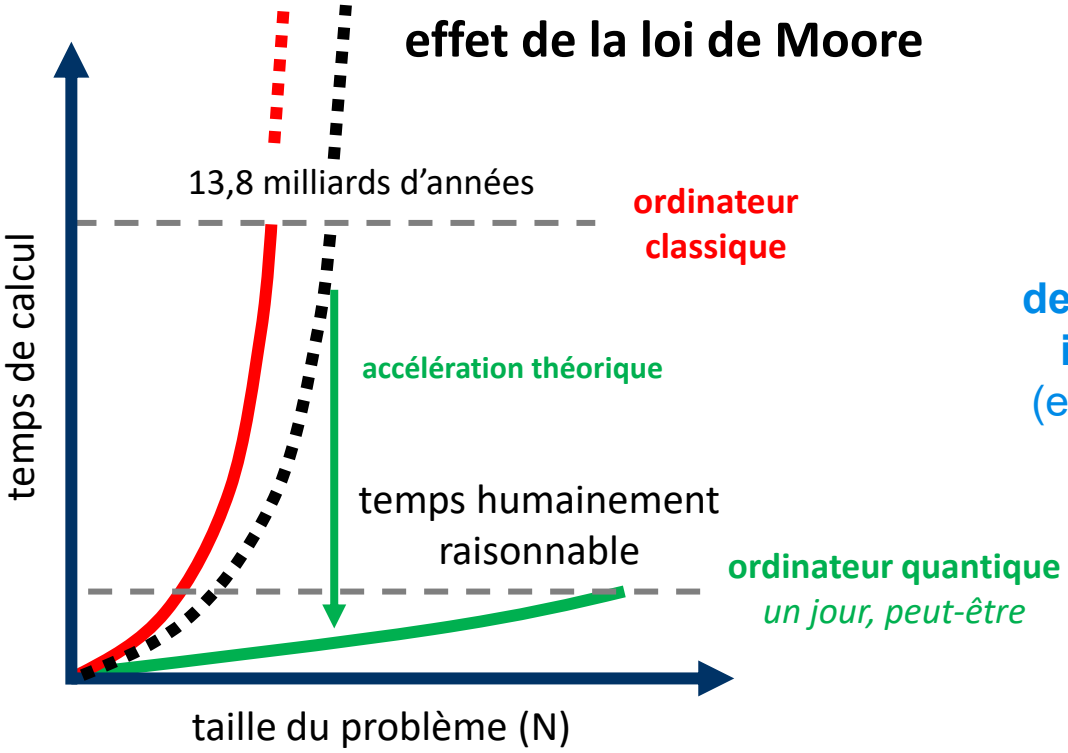




capteurs quantiques
calcul quantique
cryptographie quantique
communications quantiques

1982-*

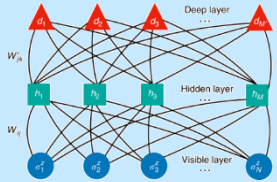
promesse du **calcul quantique**



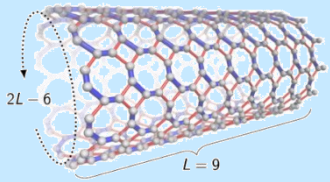
résolution de problèmes intractables (exponentiels)

optimisations

machine learning

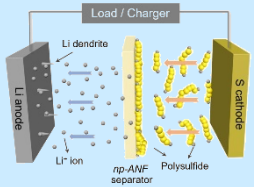


simulations physiques

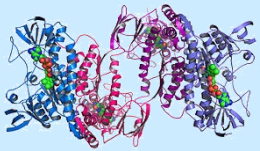


quelques cas d’usages du calcul quantique

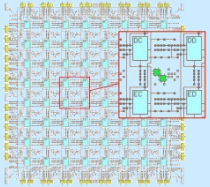
recherche



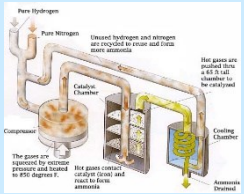
batteries



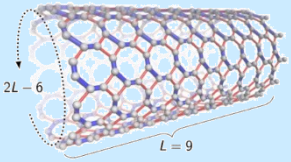
santé



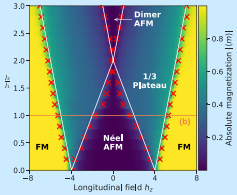
semiconducteurs



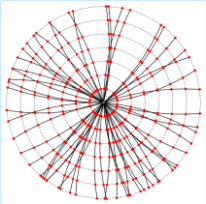
production d’engrais



matériaux

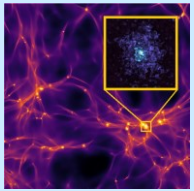


matière condensée

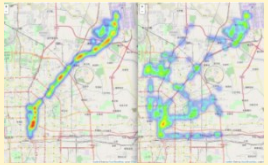


physique des particules à haute énergie

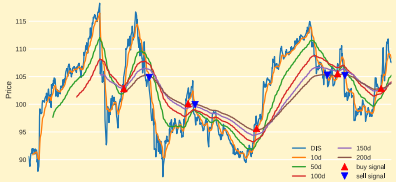
astrophysique



opérations

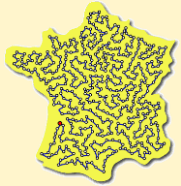


transports

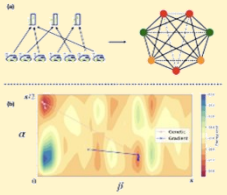


services financiers

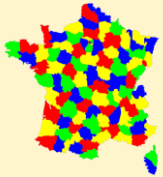
logistique



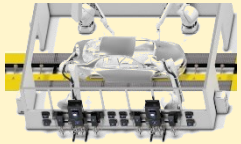
livraisons



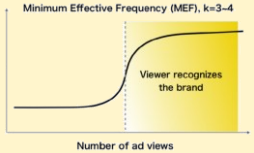
énergie



télécoms



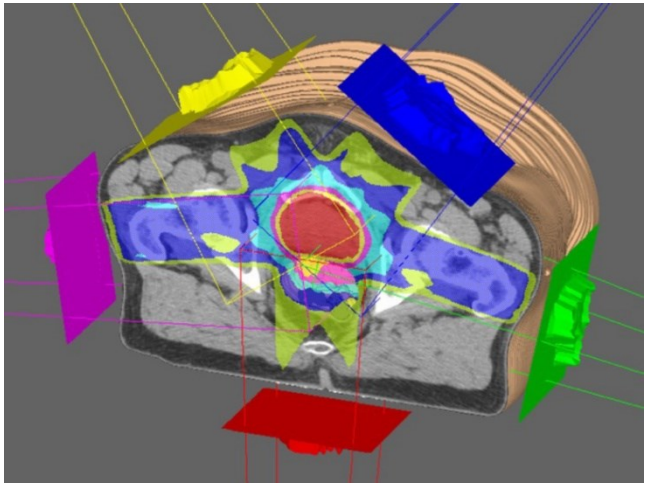
industrie



marketing

il s’agit d’une vision prospective, pas de véritables cas d’usages réels réalisés avec les ordinateurs quantiques actuels

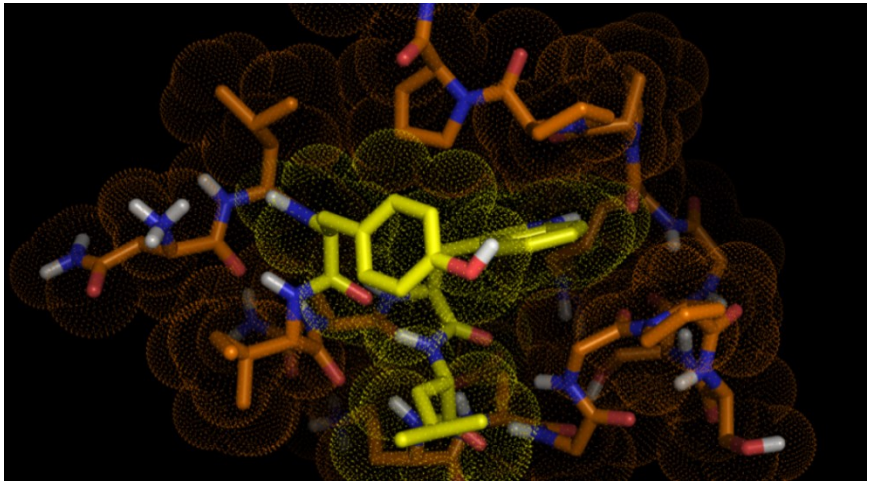
calcul quantique dans la santé



optimisation de radiothérapie

pour minimiser l'exposition aux rayons X

source: Roswell Park, D-Wave

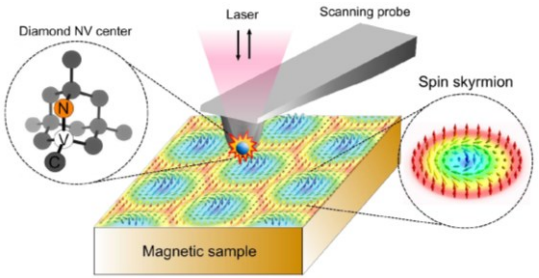


création de protéines et polypeptides de-novo

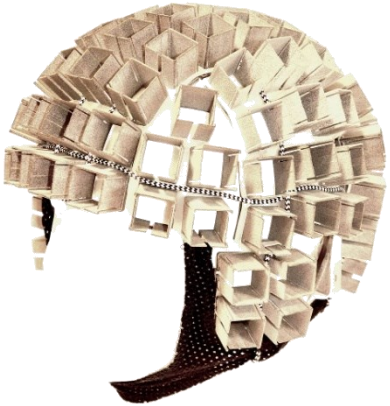
calcul hybride

source: D-Wave

cas d'usage de capteurs quantiques



magnétomètres ultrasensibles
contrôle non destructif
imagerie médicale
$210\ \mathrm{fT}/\sqrt{\mathrm{Hz}}$



magnéto-encéphalographie portable
avec 96 capteurs, sans cryogénie

gravimètres quantiques
absolus à atomes neutres,
détection de cavités sous-terraines, nappes phréatiques
et … énergies fossiles

des fictions déjà conjuguées au présent

Eos

ABOUT SPECIAL REPORTS TOPICS PROJECTS NEWSLETTER SUBMIT TO EOS

WORLDFUND

DANIJEL VISEVIC · JULY 22, 2022

Why we invested in IQM, the leading European company building superconducting quantum computers to help tackle the climate crisis

How Quantum Computing Can Tackle Climate and Energy Challenges

The day is coming when quantum computers, once the stuff of sci problems that are proving intractable to classical computing.

By Annarita Giani and Zachary Goff-Eldredge 21 October 2022

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Release 2022.01.19 22:00:00 | No. 16785

IonQ and Hyundai Motor Partner To Use Quantum Computing To Advance Effectiveness Of Next-Gen Batteries

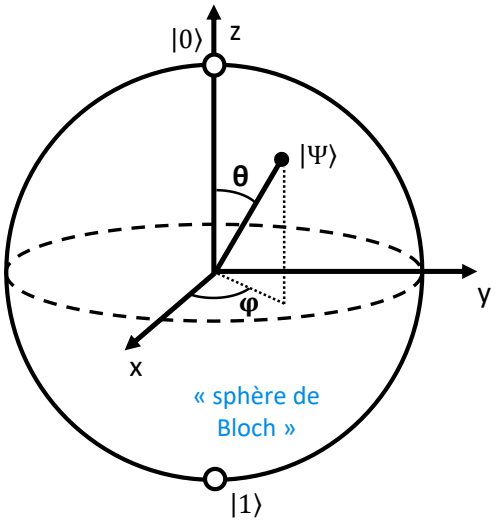
Learn to Leap: Green Business Building Edition #4

How quantum computing can help tackle global warming

May 27, 2022 | Interview

Jeremy O'Brien, PsiQuantum CEO

origine de l'accélération quantique ?

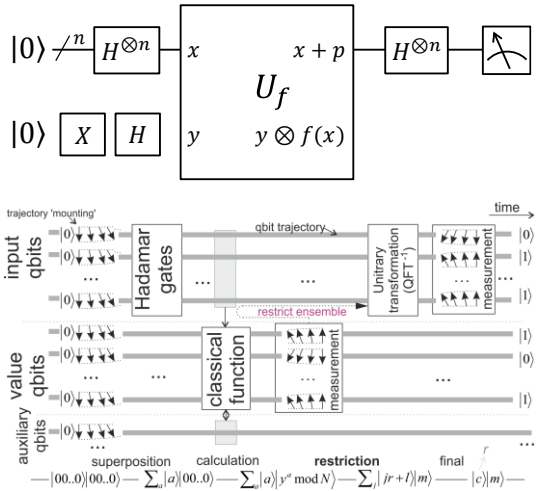


amplitudes complexes

combinaisons de 0 et 1

$$\begin{bmatrix} \alpha_1 \\ \dots \\ \dots \\ \dots \\ \dots \\ \alpha_{2^N} \end{bmatrix} \quad \begin{matrix} |00\dots00\rangle \\ \\ |10\dots01\rangle \\ \\ |11\dots11\rangle \end{matrix}$$

« circuit quantique »

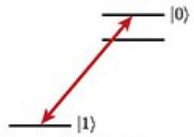
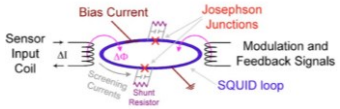
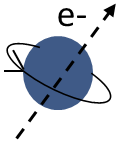
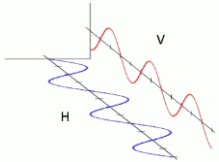
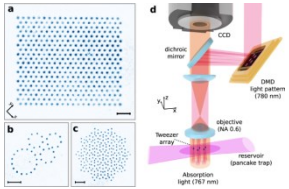
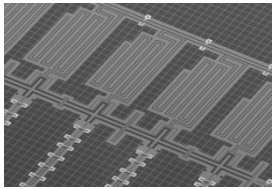
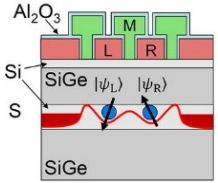
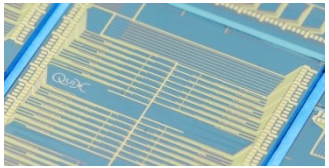


un qubit est un objet quantique avec deux états en superposition, qui manipule l'équivalent de 2 nombres réels

N qubits manipulent l'équivalent de 2^{N+1} nombres réels

l'intrication rend les qubits interdépendants et apporte la puissance du calcul…
sous certaines conditions

grande variété de types de qubits

	atome	supraconducteurs	spin d'électron	photon
				
états quantiques	niveau d'énergie de l'atome	énergie et phase de la boucle de courant	orientation de spin d'un électron	polarisation (ou autre propriété) d'un photon
aspect physique				
contrôle	lasers et/ou micro-ondes	pulsations de micro-ondes envoyées sur des câbles coaxiaux et tensions continues		polariseurs, interféromètres, etc.
cryogénie	atomes refroidis par lasers à <1mK	circuit des qubits @ 15 mK	circuit des qubits @ 100mK-1K	sources et détecteurs de photons @ 3-10K

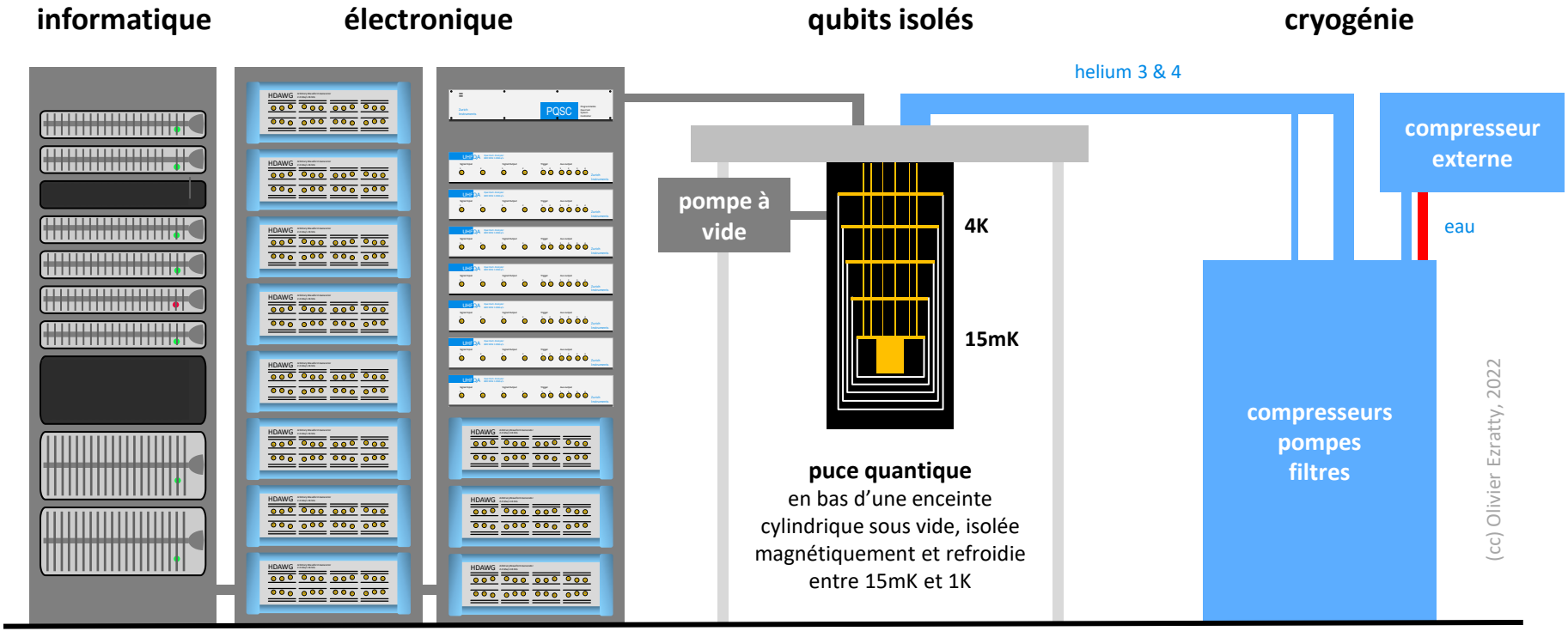
IBM

D-Wave
The Quantum Computing Company™

IONQ

PASQAL

composantes d’un ordinateur quantique

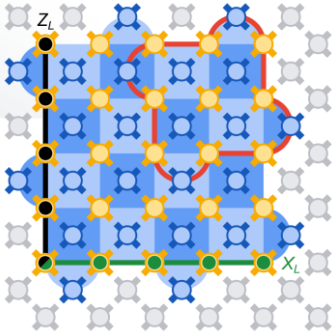


pour les qubits supraconducteurs ou à spin d’électrons

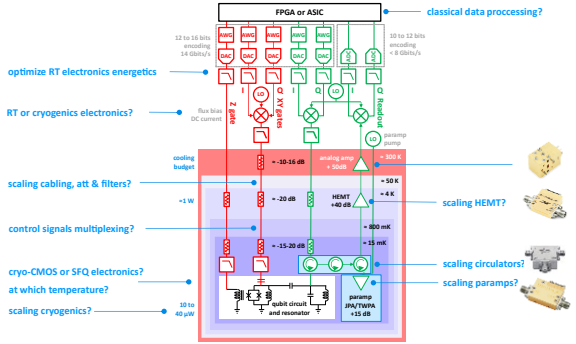
défis scientifiques et technologiques

fidélités des qubits

qubit logique



système « full-stack »



erreurs → **correction d'erreurs** → **montée à l'échelle**

0.1% à 8% d'erreurs par opération quantique

33 à 10 000 qubits physiques par qubit logique

>100 qubits logiques pour atteindre un avantage quantique

qualité des qubits, connectivité entre qubits, contrôle d'états intriqués de grande taille, électronique de contrôle, cryogénie, interconnexions, mémoire quantique, algorithmes, codes de correction d'erreur…

simulation de la molécule FeMoCo

besoin…

2142 qubits logiques

4M qubits physiques

temps de calcul de 4 jours

pour comprendre comment la nature créé efficacement de l'ammoniaque

PRX QUANTUM **2,** 030305 (2021)

Even More Efficient Quantum Computations of Chemistry Through Tensor Hypercontraction

Joonho Lee,[1,*,§] Dominic W. Berry,[2,†,§] Craig Gidney,[3] William J. Huggins,[3] Jarrod R. McClean,[3] Nathan Wiebe,[4,5] and Ryan Babbush[3,‡]

[1] *Department of Chemistry, Columbia University, New York, New York, USA*
[2] *Department of Physics and Astronomy, Macquarie University, Sydney, NSW, Australia*
[3] *Google Quantum AI, Venice, California, USA*
[4] *Department of Physics, University of Washington, Seattle, Washington, USA*
[5] *Pacific Northwest National Laboratory, Richland, Washington, USA*

(Received 12 December 2020; revised 7 April 2021; accepted 24 May 2021; published 8 July 2021)

	Reiher *et al.* FeMoCo [23]		Li *et al.* FeMoCo [36]	
Algorithm	Logical qubits	Toffoli count	Logical qubits	Toffoli count
Reiher *et al.* [23] (Trotter)	111	5.0×10^{13}	—	—
Campbell and Kivlichan *et al.* [52,53] (qDRIFT) (D16), (D17)	288	5.2×10^{27}	328	1.8×10^{28}
qDRIFT with 95% confidence interval (D34)	270	1.9×10^{16}	310	1.0×10^{16}
Berry *et al.* [9] (single factorization) (B16), (B17)	3,320	9.5×10^{10}	3,628	1.2×10^{11}
Berry *et al.* [9] (sparse) (A17), (A18)	2,190	8.8×10^{10}	2,489	4.4×10^{10}
von Burg *et al.* [10] (double factorization) (C39), (C40)	3,725	1.0×10^{10}	6,404	6.4×10^{10}
This work (tensor hypercontraction) (44) (46)	2,142	5.3×10^{9}	2,196	3.2×10^{10}

source: Even More Efficient Quantum Computations of Chemistry Through Tensor Hypercontraction by Joonho Lee, Craig Gidney et al, July 2021 (62 pages).
https://journals.aps.org/prxquantum/pdf/10.1103/PRXQuantum.2.030305

simulation de batteries Li-Ion

besoin…

6652 qubits logiques

fidélité de 10^{-12}

VOLKSWAGEN

XANADU

source: How to simulate key properties of lithium-ion batteries with a fault-tolerant quantum computer by Alain Delgado et al, April-September 2022 (31 pages).

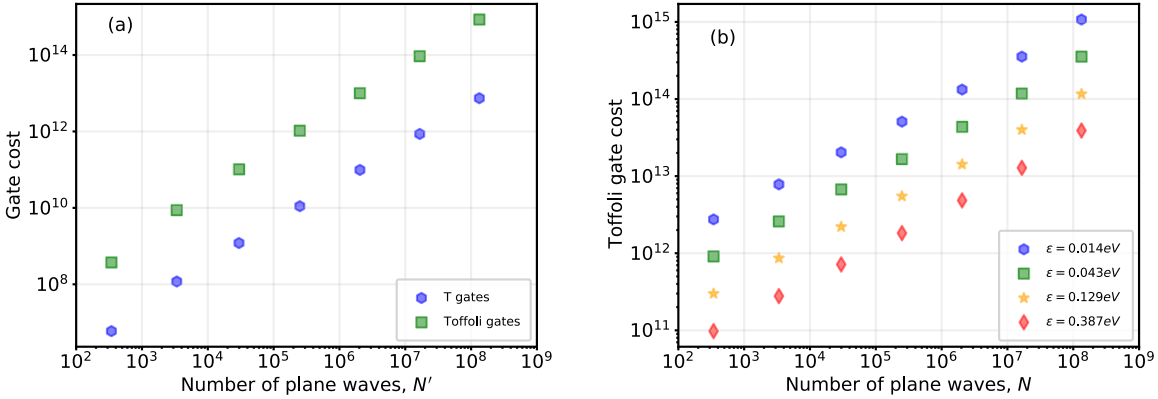
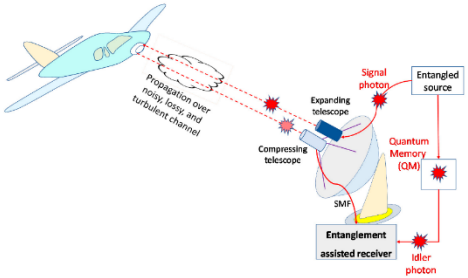


FIG. 11. **Non-Clifford gate cost for initial state preparation and quantum phase estimation**. (a) The non-Clifford gate cost due to Givens rotations used in the circuit for initial state preparation. (b) Toffoli gate cost of the quantum phase estimation algorithm. All calculations are done for the unit cell of Li_2FeSiO_4 with 156 electrons. The total number of qubits is 2,375 for $n_p = 4$ and 6,652 for $n_p = 9$. In the right figure we only depict Toffoli gate count, as the number of T gates is much smaller ($< 3 \times 10^5$). The total error ε includes contributions from different approximations throughout the algorithm, but it does not take into account the error derived from a finite basis set. The slope of the Toffoli gate cost for fixed target precision is a consequence of the leading cost term in (100), $12\eta n_p \lceil(\pi\lambda)/(2\varepsilon_{QPE})\rceil$, where $n_p = \lceil\log(N^{1/3}+1)\rceil$. These calculations were performed with the T-Fermion library [38].

usages « régaliens »

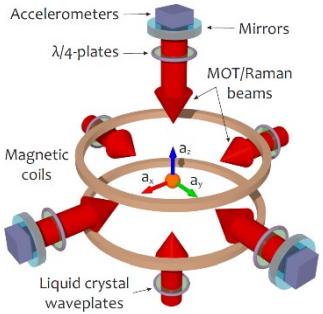
optimisation de parcours de drones



radars quantiques

code breaking

optimisation de la logistique



centrales inertielles quantiques


December 26, 2021 | *Topic:* Security, Submarine | *Region:* Asia | *Blog Brand:* The Reboot
Military, Technology, Weapons, War, Submarines

Can China's Quantum Radar Detect Any Submarine?

détection de sous-marins

rouge: faisabilité réelle sujette à caution

une fiction sécuritaire

Connectivity

Quantum Computing Paranoia Creates a New Industry

Even though quantum computers don't exist yet, security companies are preparing to protect against them.

by Tom Simonite January 30, 2017

MIT Technology Review

Fear sells in the computer security business. And in late 2015 Massachusetts-based Security Innovation got an unexpected boost from one of the scariest organizations around—the National Security Agency.

MIT Technology Review

Business Impact

Quantum Computers Pose Imminent Threat to Bitcoin Security

The massive calculating power of quantum computers will be able to break Bitcoin security within 10 years, say security experts.

by Emerging Technology from the arXiv November 8, 2017

TechCrunch

The quantum computing apocalypse is imminent

Shlomi Dolev January 2018

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GOOGLE'S "QUANTUM SUPREMACY" TO RENDER ALL CRYPTOCURRENCY & MILITARY SECRETS BREAKABLE

Supercomputer breakthrough will allow Big Tech giant to control the world.

Paul Joseph Watson | Infowars.com - SEPTEMBER 21, 2019 47 Commentaires

une fiction sur la fiction

Figure 1: *The price of bitcoin in USD in a period of 4 weeks around 9/23/2019. Source: CoinDesk*

"However, the cryptocurrency **plummeted on September 24**, declining more than 15% in roughly two hours **after the newly released Bakkt futures failed to produce significant trading volume**, additional CoinDesk data reveals".

from "Bitcoin Broke Free From Its Malaise In September" by Charles Bovaird, Forbes, October 7, 2019

Google's 2019 Quantum Supremacy' Claims Data, Documentation, and Discussion, by Gil Kalai et al, October 2022 (32 pages)

Usbek & Rica

#cybersécurité

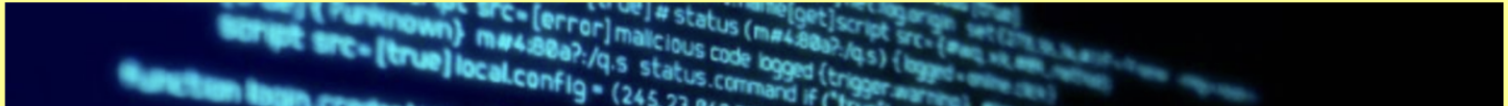
#science-fiction

Faut-il craindre l'émergence du terrorisme quantique ?

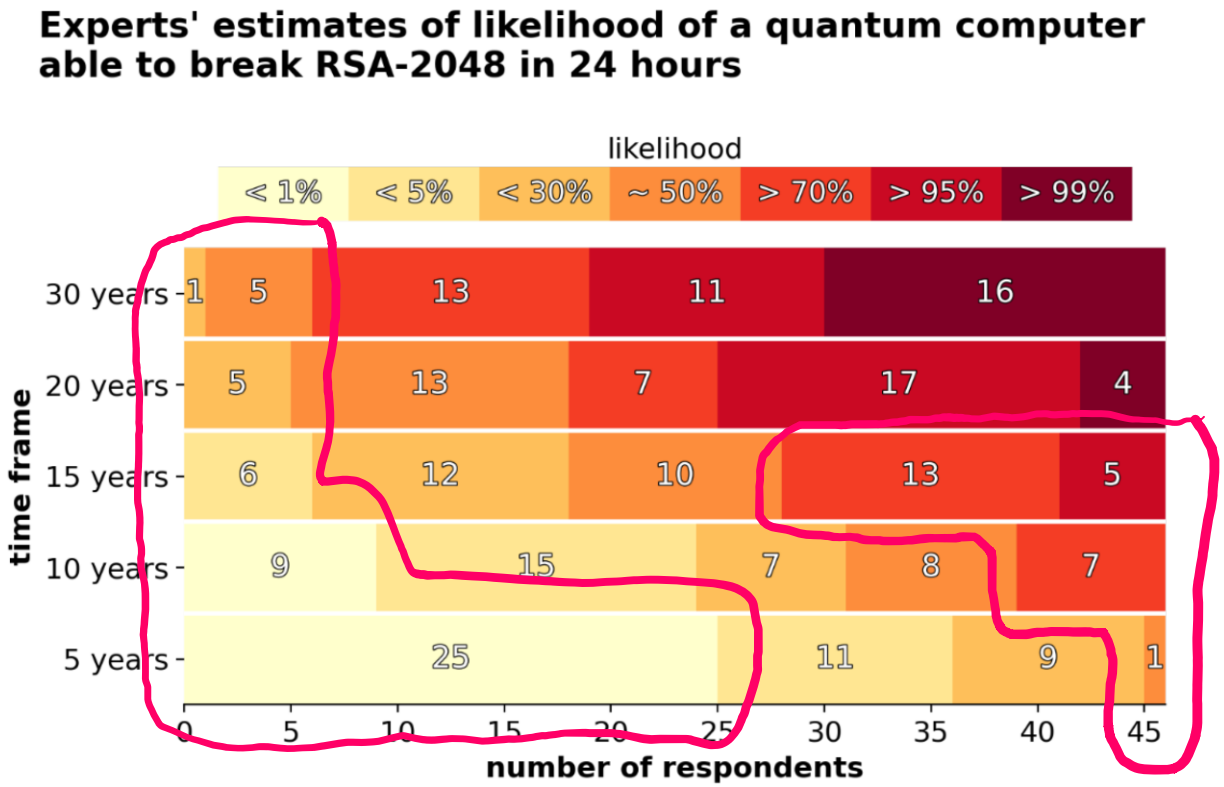
Et si une organisation terroriste réussissait à mener des cyberattaques dévastatrices grâce à des ordinateurs quantiques ? Ce scénario de science-fiction n'en est (malheureusement) plus un, comme l'analyse pour Usbek & Rica Mathieu Chéret, lecteur fidèle de notre média et ingénieur de formation.

Mathieu Chéret

– 17 octobre 2022



interrogeons les « experts »



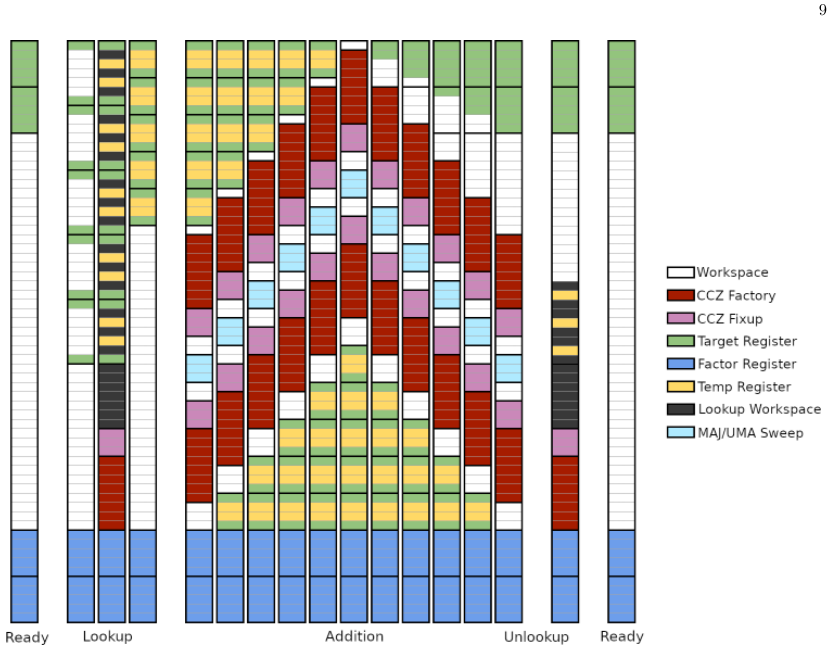
en pratique…

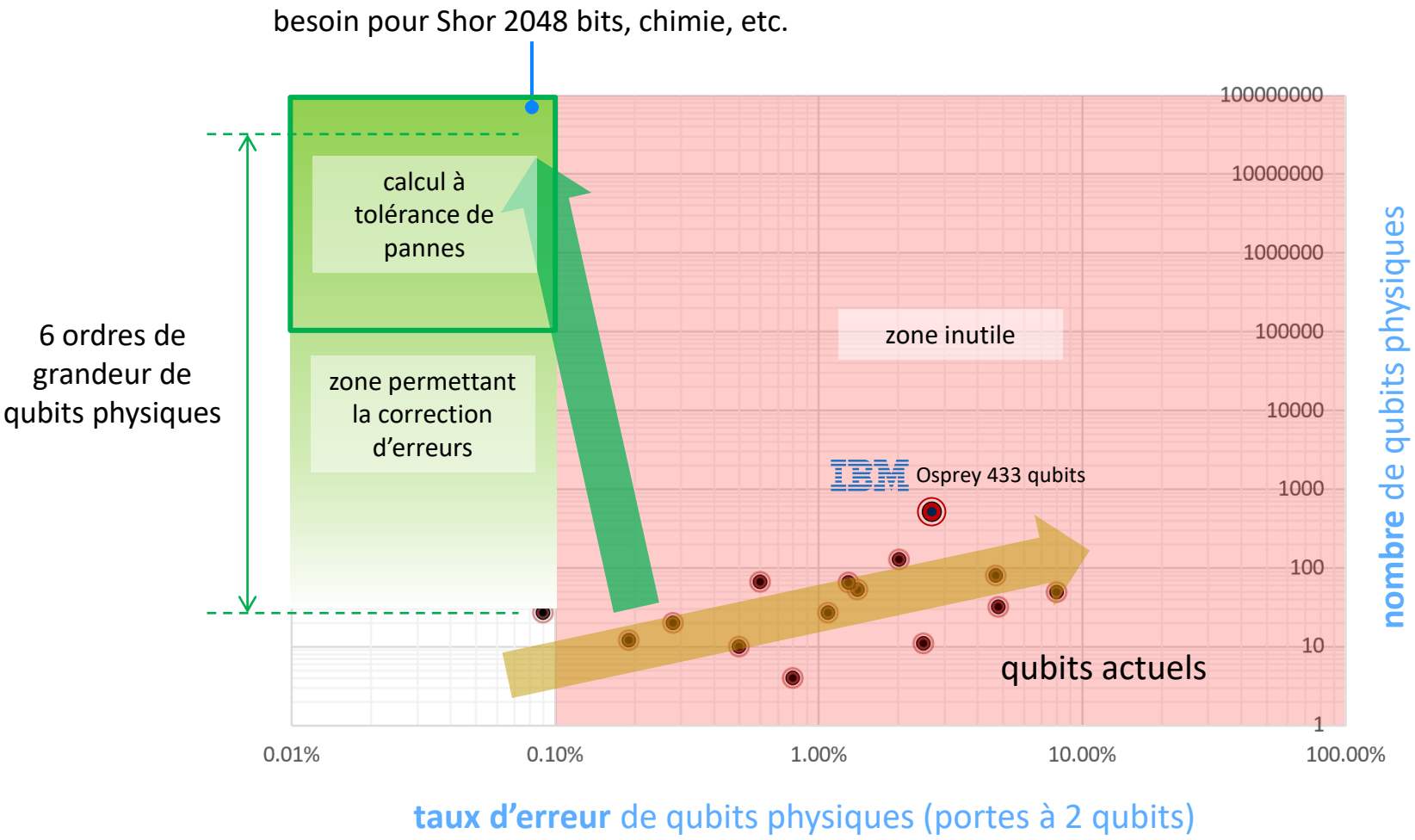
How to factor 2048 bit RSA integers in 8 hours using 20 million noisy qubits

Craig Gidney[1] and Martin Ekerå[2]

[1]Google Inc., Santa Barbara, California 93117, USA
[2]KTH Royal Institute of Technology, SE-100 44 Stockholm, Sweden
Swedish NCSA, Swedish Armed Forces, SE-107 85 Stockholm, Sweden

2019




besoin pour Shor 2048 bits, chimie, etc.
calcul à tolérance de pannes
zone permettant la correction d'erreurs
zone inutile
6 ordres de grandeur de qubits physiques
IBM Osprey 433 qubits
qubits actuels
100000000
10000000
1000000
100000
10000
1000
100
10
1
0.01%
0.10%
1.00%
10.00%
100.00%
nombre de qubits physiques
taux d'erreur de qubits physiques (portes à 2 qubits)

et la consommation d'énergie ?

RESEARCH-ARTICLE

Energy Cost of Quantum Circuit Optimisation: Predicting That Optimising Shor's Algorithm Circuit Uses 1 GWh

gouffre ?

Authors: Alexandru Paler, Robert Basmadjian Authors Info & Claims

ACM Transactions on Quantum Computing, Volume 3, Issue 1 • March 2022 • Article No.: 3, pp 1–14 • https://doi.org/10.1145/3490172

ou gain ?

Optimizing resource efficiencies for scalable full-stack quantum computers

Marco Fellous-Asiani,[1,2,*] Jing Hao Chai,[2,3] Yvain Thonnart,[4] Hui Khoon Ng,[5,3,6,†] Robert S. Whitney,[7,‡] and Alexia Auffèves[2,6,§]

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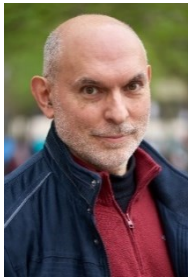
[4] *Université Grenoble Alpes, CEA-LIST, F-38000 Grenoble, France*
[5] *Yale-NUS College, Singapore*
[6] *MajuLab, International Joint Research Unit UMI 3654, CNRS, Université Côte d'Azur, Sorbonne Université, National University of Singapore, Nanyang Technological University, Singapore*
[7] *Université Grenoble Alpes, CNRS, LPMMC, 38000 Grenoble, France.*

#QEI

the quantum energy initiative

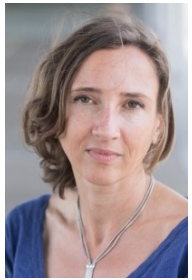
quantum-energy-initiative.org

228 signataires du Manifesto, 34 pays



Olivier Ezratty

Consultant and Author
olivier@oezratty.net



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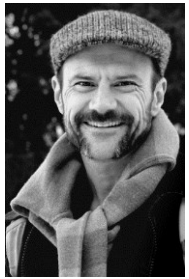
Janine Splettstoesser

Professor
Chalmers University
janines@chalmers.se



Robert Whitney

Researcher
CNRS LPMMC Grenoble
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Quantum Technologies Need a Quantum Energy Initiative

Alexia Auffèves
PRX Quantum **3**, 020101 – Published 1 June 2022

questions

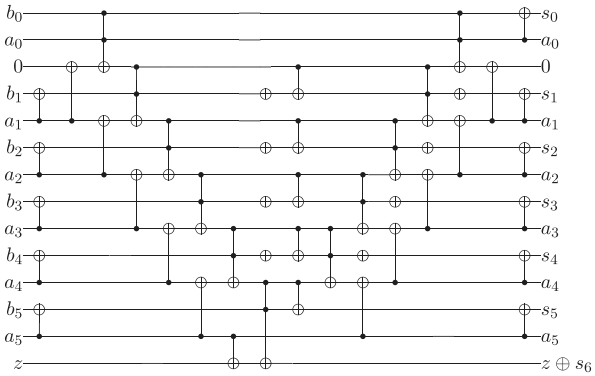
- comment **éviter des impasses** technologiques de nature énergétique et environnementales ?
- existe-t-il un **avantage quantique énergétique** ?

mission + objectifs

- créer une **ligne transversale** de recherche et lancer des projets collaboratifs.
- créer et animer une **communauté** européenne et mondiale sur le sujet associant recherche et industrie.
- créer des **modèle d'optimisation** de la performance énergétique des technologies quantiques et des **benchmarks**.

paradigmes de calcul quantique

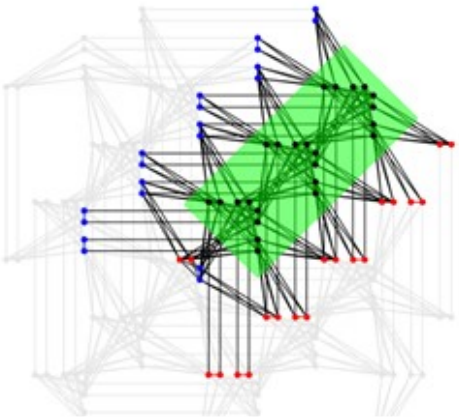
calcul à **portes quantiques**



The ripple-carry adder for $n = 6$.

programmation séquentielle de portes quantiques qui agissent sur un ou deux qubits, résolution d'une grande variété de problèmes

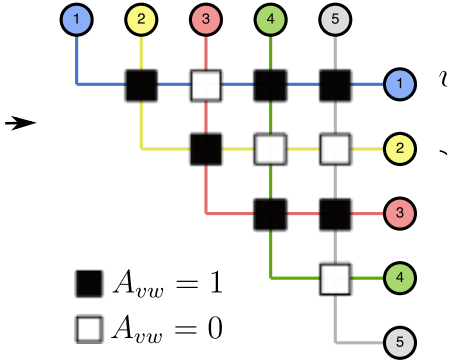
recuit quantique



recherche d'un minimum d'un modèle d'Ising, adapté à la résolution de divers problèmes d'optimisation

D-Wave
The Quantum Computing Company™

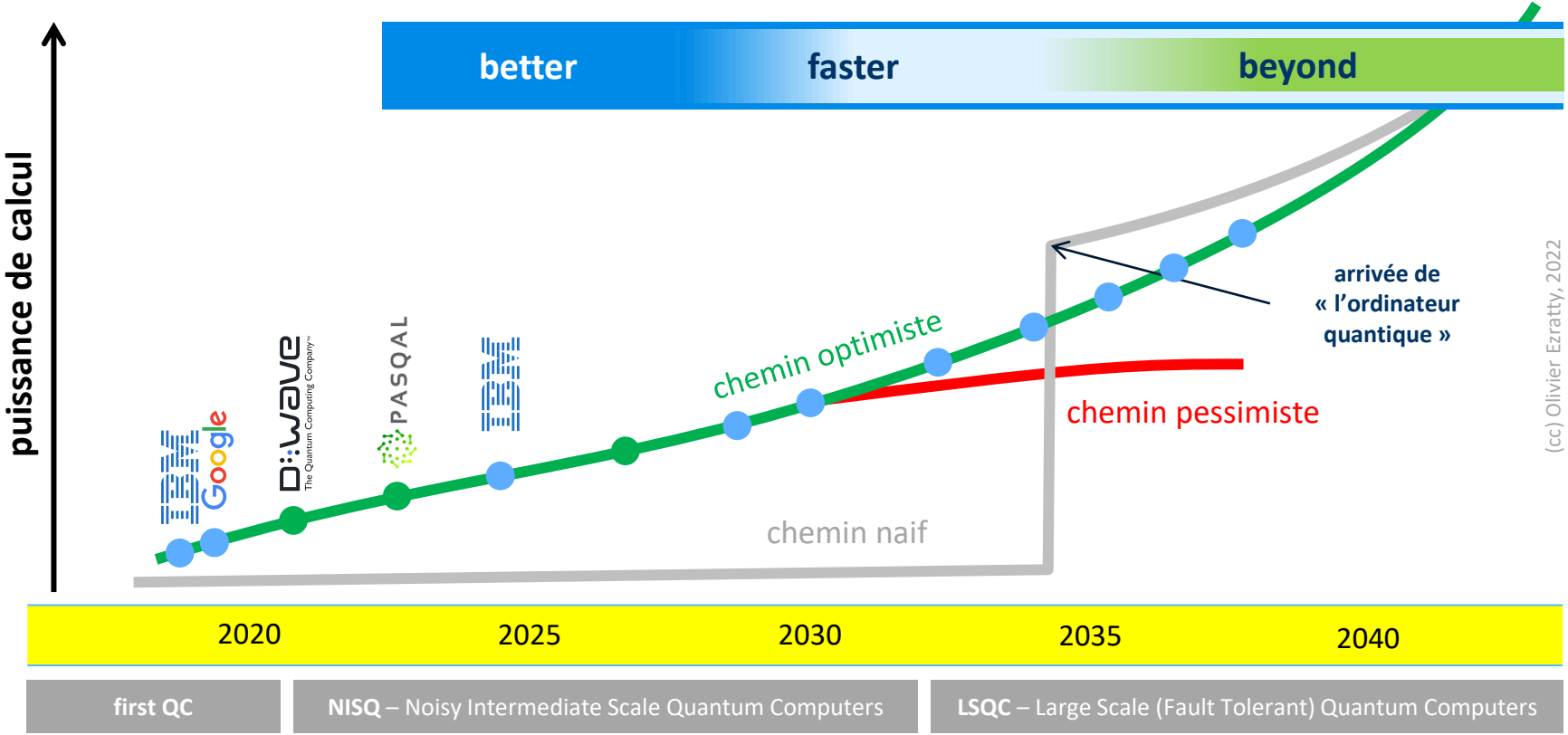
simulation quantique

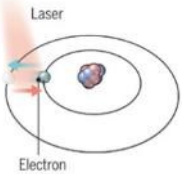
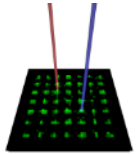
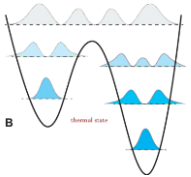
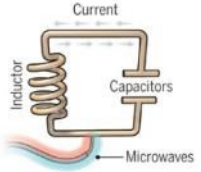
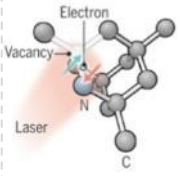
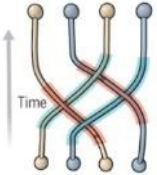
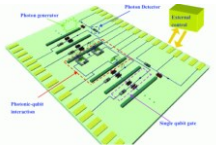


recherche d'un minimum d'un modèle d'Ising ou modèles "XY" avec plus de degrés de liberté, permet une plus grande flexibilité

PASQAL

quand arrivera « l'ordinateur quantique » ?



	atomes		électrons *boucles supraconductrices ou contrôle de spin*					photons
								
industrie	**trapped ions** QUANTINUUM IONQ AQT OXFORD IONICS eleQtron FOXCONN CRYSTAL QUANTUM COMPUTING	**cold atoms** PASQAL ColdQuanta ATOM COMPUTING QuEra Computing Inc. planqc	**quantum annealing** D-Wave The Quantum Computing Company QILIMANJARO QUANTUM-TECH NEC	**super-conducting** IBM rigetti amazon Google OQC qci Nord Quantique OXFORD QUANTUM IQM ALICE & BOB ANYON Alibaba ATLANTIC Origin Quantum EeroQ Baidu 百度 bleximo FUJITSU	**silicon** QUANTUM MOTION intel C12 Silicon Quantum Computing NTT diraq equal1.labs QuTech ARCHER	**spin vacancies** TURING QUANTUM BRILLIANCE photonic XEED The Quantum Transcendence	**topological** Microsoft NOKIA	**photons** PsiQuantum QUANDELA XANADU ORCA Computing DUALITY QUANTUM PHOTONICS QuiX QUANTUM BardeenQ LABS QBoson QCi Ready-to-Run Quantum Systems TUNDRA SYSTEMS GLOBAL LTD
laboratoires	IQST University of Maryland MIT KIT Karlsruher Institut für Technologie IQI universität innsbruck Sandia National Laboratories JGU Johannes Gutenberg Universität Mainz NIST Harvard University US University of Sussex	cnrs Institut d'Optique Graduate School Harvard University Caltech JÜLICH Forschungszentrum PennState EPFL The Ohio State University	NEDO Stanford University MIT KIT Karlsruher Institut für Technologie MCQST ETH zürich (*) non exhaustive inventory, missing Chinese labs among others	cea cnrs MIT Inria UCSB QuTech MCQST UMassAmherst ETH zürich Universität des Saarlandes Berkeley Yale University of California Caltech 東京大学 The University of Tokyo	cea cnrs University of Bristol University of Oxford UNSW Sydney Yale HRL Laboratories ETH zürich The University of Wisconsin Madison EPFL RIKEN Princeton University	cea cnrs MIT University of Maryland TU Delft Harvard University Universität Stuttgart The University of Chicago	cea cnrs University of Maryland UCSB TU Delft QuTech Niels Bohr Institutet The University of Sydney	cnrs University of Bristol University of Oxford Sapienza Università di Roma Università degli Studi di Milano universität wien 東京大学 The University of Tokyo

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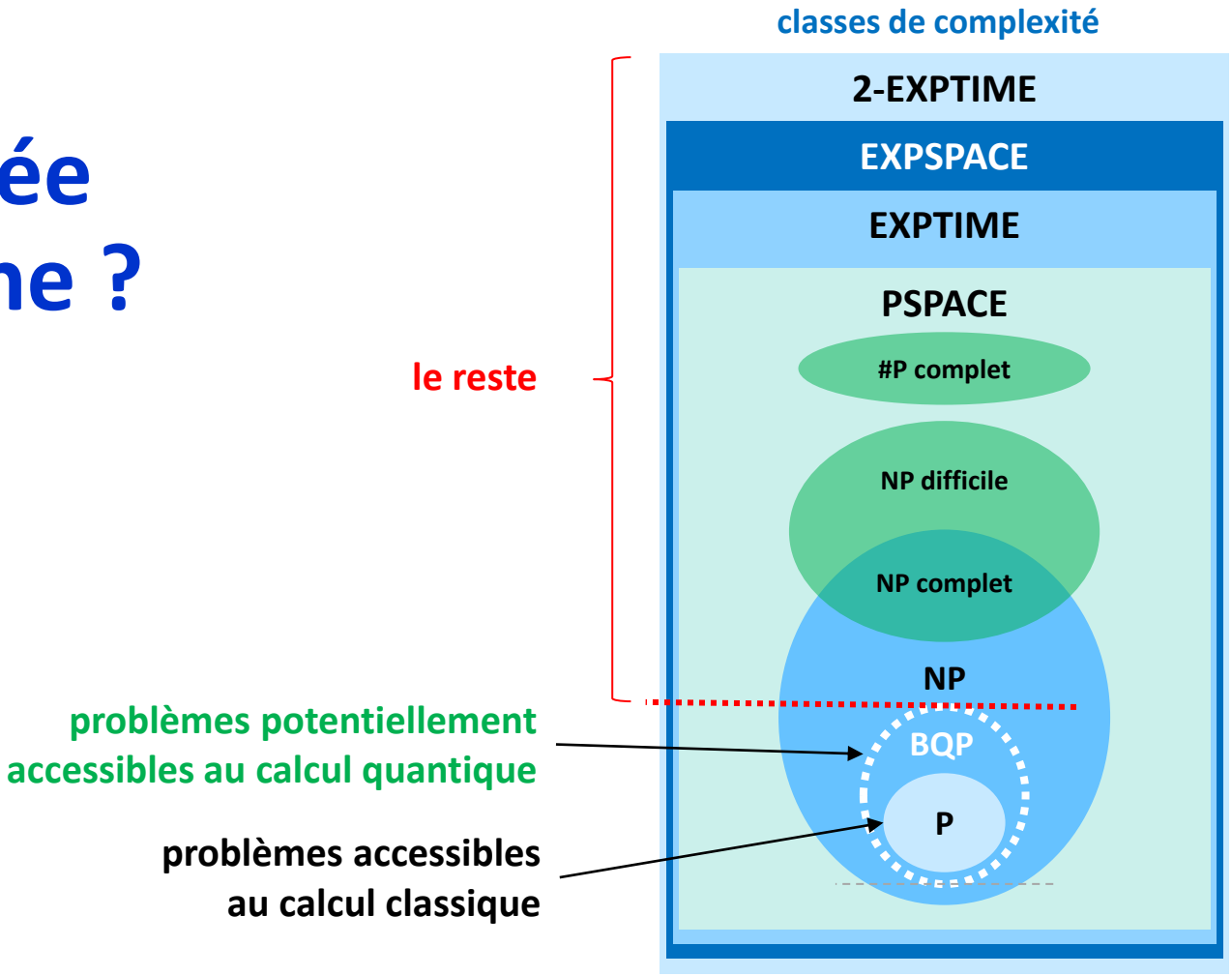
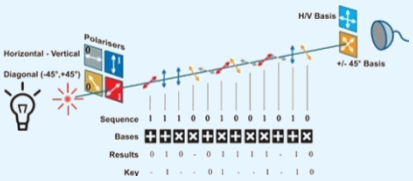
Icare, Prométhée ou Sisyphe ?



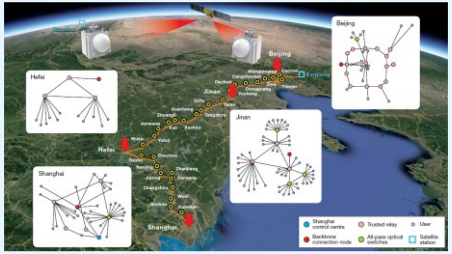
télécoms et cryptographie quantiques

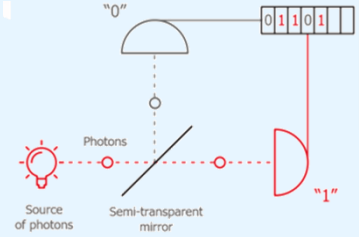
technologies quantiques



distribution de clés quantiques (QKD)
clés de chiffrement protégées par liaison optique quantique

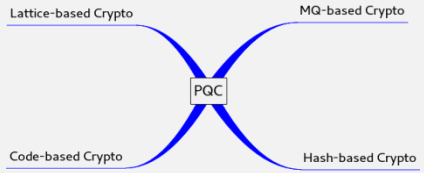
télécommunications quantiques
traitements quantiques distribués, relations calcul et capteurs quantiques, capteurs quantiques plus précis, Internet quantique





générateurs quantiques de clés aléatoires
assurent la qualité des clés utilisés dans divers usages classiques et quantiques

cryptographie post-quantique
chiffrement classique résilient aux attaques à base d'ordinateurs quantiques



technologies classiques

géopolitique quantique

USA vs Chine et l'Europe
entre les deux

pénurie de talents

contrôle des exportations
sur les technologies duales

collaboration
internationale ou locale ?

vers une innovation responsable ?

Ethical Quantum Computing: A Roadmap

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University of Technology, Sydney
Sydney NSW 2000
[2] Humanising Machine Intelligence Program
The Australian National University, Canberra
elija.t.perrier@student.uts.edu.au

Abstract

Quantum computing is among the most significant technologies to emerge in recent decades, offering the promise of paradigm-shifting computational capacity with significant ethical consequences. On a technical level, the unique features of quantum computation have technical consequences for the imposition of fairness and ethical criteria on computation. Despite its significance, little if no structured research

how computing is undertaken in quantum systems and (b) the consequences of quantum computing which distinguish research programmes into quantum ethics.

At the technical level, the distinct (by contrast with classical computing) characteristics of quantum computation, including its inherently probabilistic nature, the availability of superposition states and resources such as entanglement have distinct implications for the technical implementa-

TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
https://doi.org/10.1080/09537325.2021.1988070

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Reading the road: challenges and opportunities on the path to responsible innovation in quantum computing

Carolyn Ten Holter, Philip Inglesant and Marina Jirotka

University of Oxford, Oxford, UK

ABSTRACT
Novel technologies such as quantum computing present new opportunities to support societal needs, but societal engagement is vital to secure public trust. Quantum computing technologies are at a pivotal point in their journey from foundational research to

ARTICLE HISTORY
Received 29 June 2021
Revised 8 September 2021
Accepted 27 September 2021

en résumé…

beaucoup de
science

systèmes
complexes

opportunités
scientifiques et industrielles

grande diversité
technologique

incertitudes
élevées

cas d'usage
nombreux

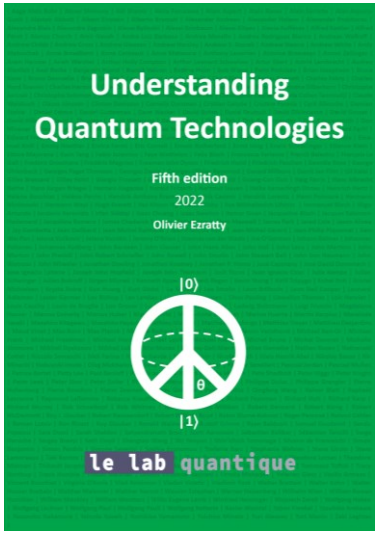
limites
physiques

sur
promesses

souveraineté
technologique

dualité
des usages

pour en savoir plus



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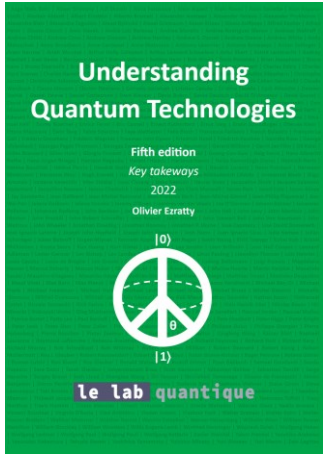

key takeways
24 pages

QUANTUM by O.Ezratty et F.Bouton
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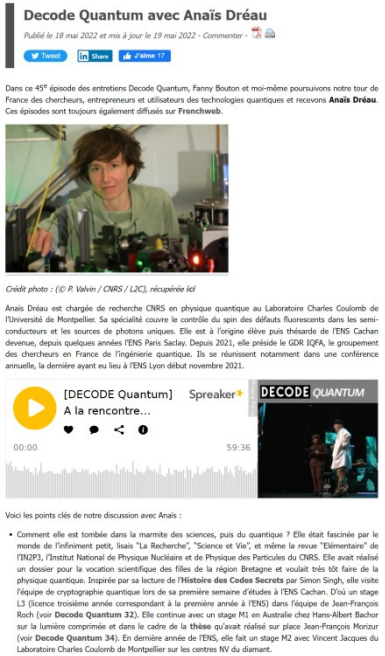
Quantum *: le podcast de l'actualité quantique*
un épisode tous les mois
Fanny Bouton et Olivier Ezratty



Decode Quantum avec Anaïs Dréau

Publié le 18 mai 2022 et mis à jour le 19 mai 2022 - Commenter -

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Dans ce 45e épisode des entretiens Decode Quantum, Fanny Bouton et moi-même poursuivons notre tour de France des chercheurs, entrepreneurs et utilisateurs des technologies quantiques et recevons **Anaïs Dréau**. Ces épisodes sont toujours également diffusés sur **Frenchweb**.

Crédit photo : (© P. Valvin / CNRS / L2C), récupérée ici

Anaïs Dréau est chargée de recherche CNRS en physique quantique au Laboratoire Charles Coulomb de l'Université de Montpellier. Sa spécialité couvre le contrôle du spin des défauts fluorescents dans les semi-conducteurs et les sources de photons uniques. Elle est à l'origine élève puis thésarde de l'ENS Cachan devenue, depuis quelques années l'ENS Paris Saclay. Depuis 2021, elle préside le GDR IQFA, le groupement des chercheurs en France de l'ingénierie quantique. Ils se réunissent notamment dans une conférence annuelle, la dernière ayant eu lieu à l'ENS Lyon début novembre 2021.

[DECODE Quantum] A la rencontre... Spreaker
00:00 59:36
DECODE QUANTUM

Voici les points clés de notre discussion avec Anaïs :

- Comment elle est tombée dans la marmite des sciences, puis du quantique ? Elle était fascinée par le monde de l'infiniment petit, lisais "La Recherche", "Science et Vie", et même la revue "Elémentaire" de l'IN2P3, l'Institut National de Physique Nucléaire et de Physique des Particules du CNRS. Elle avait réalisé un dossier pour la vocation scientifique des filles de la région Bretagne et voulait très tôt faire de la physique quantique. Inspirée par sa lecture de l'**Histoire des Codes Secrets** par Simon Singh, elle visite l'équipe de cryptographie quantique lors de sa première semaine d'études à l'ENS Cachan. D'où un stage L3 (licence troisième année correspondant à la première année à l'ENS) dans l'équipe de Jean-François Roch (voir **Decode Quantum 32**). Elle continue avec un stage M1 en Australie chez Hans-Albert Bachor sur la lumière comprimée et dans le cadre de la **thèse** qu'avait réalisé sur place Jean-François Morizur (voir **Decode Quantum 34**). En dernière année de l'ENS, elle fait un stage M2 avec Vincent Jacques du Laboratoire Charles Coulomb de Montpellier sur les centres NV du diamant.

Decode Quantum *: les entretiens du quantique*
deux épisodes par mois
avec les chercheurs et entrepreneurs du quantique
Fanny Bouton et Olivier Ezratty
diffusés sur Frenchweb / Decode Media

discussion

slides non projetés, idées, backups

MOTHERBOARD

ROBOTS | By Jason Koebler | Oct 8 2014, 9:25pm

2014 !

Quantum Robots Will Do Your Job Better Than You Can

Quantum computing will be powerful enough to create artificial intelligence that can learn and react in real time.

International Business Times

Technology

Quantum Robotics will Create Artificial Intelligence 'Capable of Creativity'

By Anthony Cuthbertson

October 9, 2014 11:46 BST

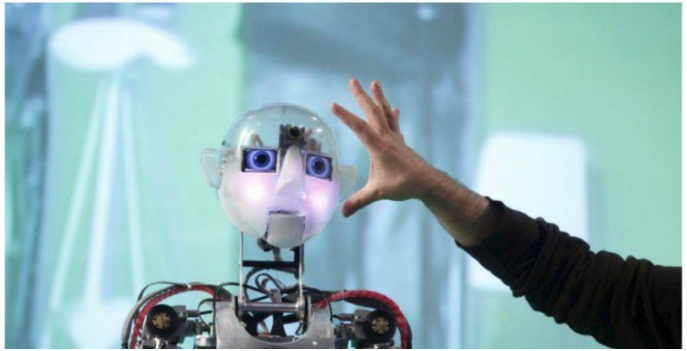
mappingignorance

Home | Science | Technology | Humanities & Social Sciences | Archive

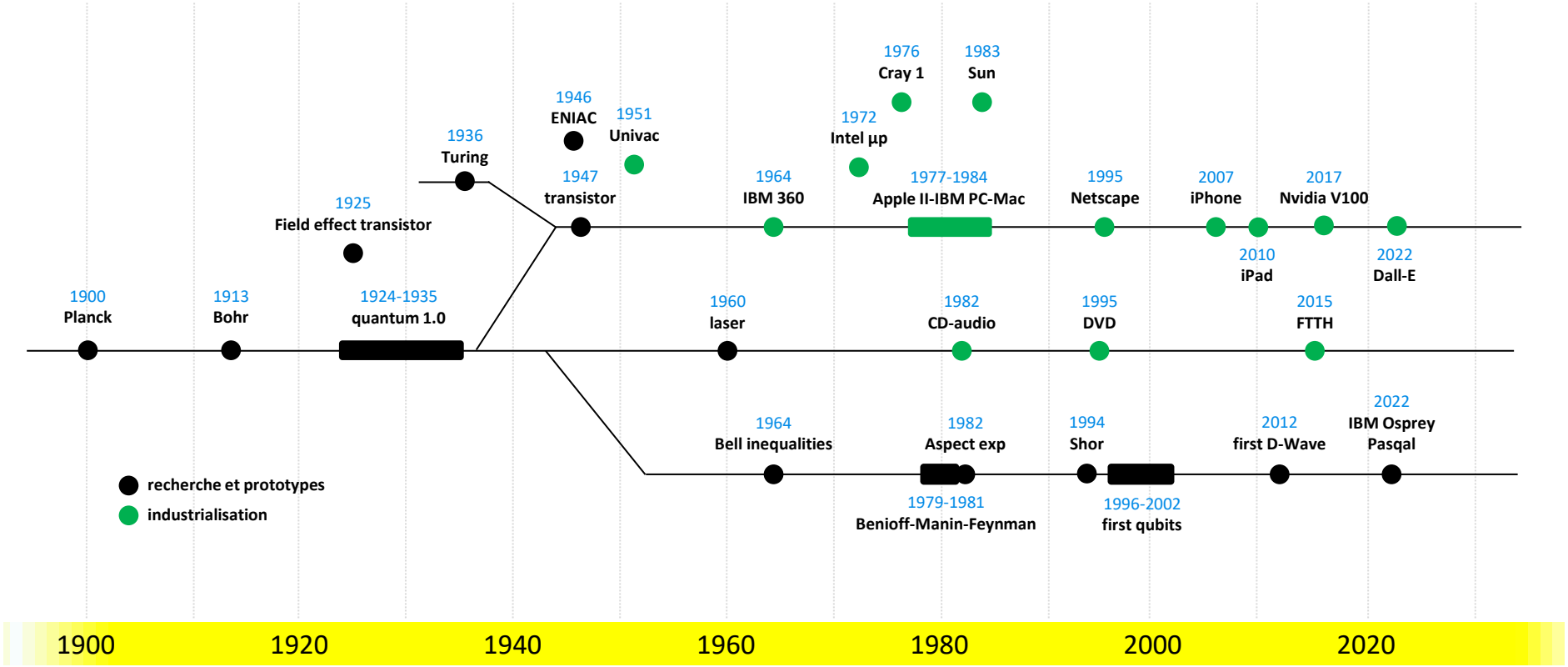
The Rise of Quantum Robots

Daniel Manzano | April 4, 2018

Quantum physics | Robotics | 0 Comments



parallèles historiques



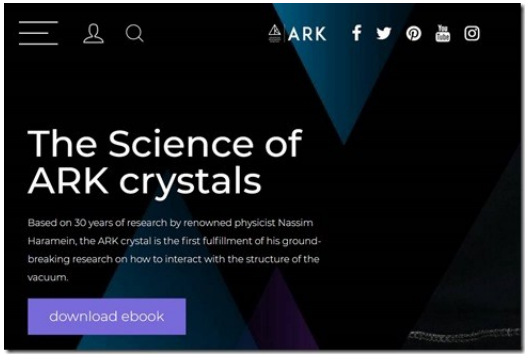
New Research Suggests Our Brains Use Quantum Computation

BY JAMES DARGAN • OCTOBER 20, 2022 • DAILY, RESEARCH

5. Conclusion

The aim of this study was to show that the brain is non-classical. We assumed that unknown brain functions exist which can mediate entanglement between auxiliary quantum systems. The experimental detection of such an entanglement created by the brain would then be sufficient to prove cerebral non-classicality. We found experimental evidence that such entanglement creation occurs as part of physiological and cognitive processes. We argued that the ZQC signals were non-local because (a) ZQC signals were above the classical bound, and (b) the signals had no SQC and MQC[2] correlates. Further, we could confirm that the signals were only detectable in combination with reduced classical signals (necessary condition), and that they resembled HEPs which are below verifiability in conventional MRI (sufficient condition). Our findings may disapprove the statement that quantum entanglement or coherence can't survive in the hot and wet environment of the brain [48]. Beyond the fundamental question we tried to answer here, we found an undiscovered NMR contrast, which can detect brain activity beyond conventional functional MRI. It may have interesting applications in psychology and medicine.

Scalar waves generators



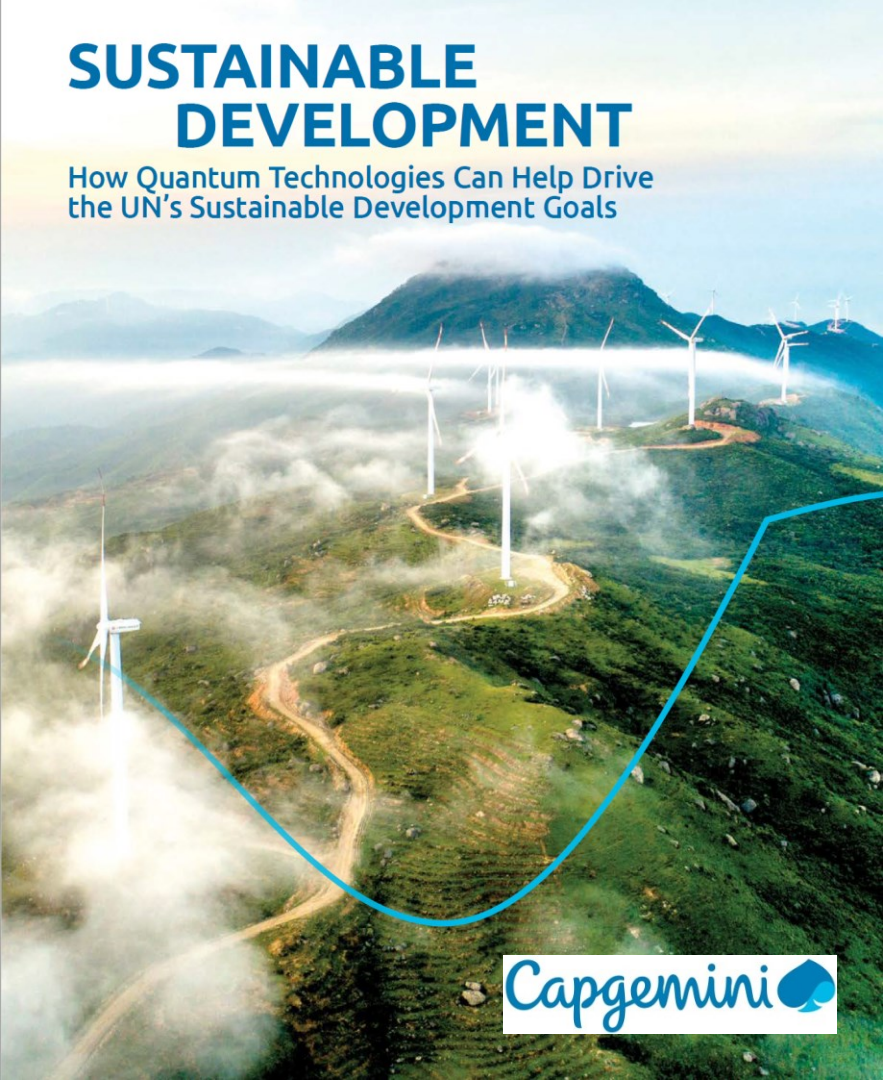
Magic quantum crystals

Quantum Shield medallions

5G BioShield
"quantum holographic catalyst"

SUSTAINABLE DEVELOPMENT

How Quantum Technologies Can Help Drive the UN's Sustainable Development Goals



SDG Goal	Optimization	Simulation	Quantum Machine Learning	Quantum Sensing
SDG 1: No Poverty	Low impact	Low impact	Low impact	No direct impact
SDG 2: Zero Hunger	High impact	Large impact	High impact	Medium impact
SDG 3: Good Health and Well-being	High impact	Large impact	Medium impact	Large impact
SDG 4: Quality Education	Low impact	No direct impact	Low impact	No direct impact
SDG 5: Gender Equality	Low impact	No direct impact	Low impact	No direct impact
SDG 6: Clean Water and Sanitation	Medium impact	Medium impact	Low impact	Low impact
SDG 7: Affordable and Clean Energy	Large impact	Large impact	Large impact	Large impact
SDG 8: Decent Work and Economic Growth	Low impact	Low impact	Low impact	No direct impact
SDG 9: Industry, Innovation and Infrastructure	Large impact	Large impact	Large impact	Medium impact
SDG 10: Reduced Inequalities	No direct impact	Low impact	Low impact	No direct impact
SDG 11: Sustainable Cities and Communities	Large impact	Medium impact	Large impact	Medium impact
SDG 12: Responsible Consumption and Production	Medium impact	Medium impact	Medium impact	Low impact
SDG 13: Climate Action	Low impact	Medium impact	Medium impact	High impact
SDG 14: Life below Water	Low impact	Low impact	Medium impact	Low impact
SDG 15: Life on Land	Low impact	No direct impact	Medium impact	No direct impact
SDG 16: Peace, Justice and Strong Institutions	No direct impact	No direct impact	Medium impact	No direct impact
SDG 17: Partnerships for the Goals	No direct impact	Low impact	Low impact	No direct impact

Legend:

- No direct impact
- Low impact
- Medium impact
- High impact
- Large impact

SDG 5: Gender Equality
Achieve gender equality and empower all women and girls.

This goal aims to achieve equal rights for women and girls and opportunities to live freely without discrimination, including workplace discrimination or any violence. This includes providing women and girls with equal access to education, health care, decent work, and representation in political and economic decision-making processes, which will fuel sustainable economies and benefit societies and humanity at large.

Any advanced technology, like QML or AI, is essentially a power tool that can be harnessed to enhance equality. For example, AI-powered gender decoders could help employers use more gender-sensitive and more inclusive language to increase diversity. Quantum optimization can also be used in efficient allocation of economic and other resources for various initiatives empowering women and their development. QML can be utilized to derive insights from various data sources across nations for effective decision-making.

The question of quantum computing in video analytics and surveillance is perhaps more problematic. Quantum computing can be used for intelligent video surveillance, with video analytics capabilities leveraging machine learning to increase the safety of the public and more specifically that of women and girls in public spaces.

However, it can also be argued that QML/AI could pose a significant threat, as evidenced by some experiences of AI-powered recruitment software that has been found to discriminate against women or in video surveillance more generally by certain types of states and governments applying a high degree of control and discrimination.

quantum hype et hiver quantique ?

arXiv > physics > arXiv:2202.01925

Physics > Physics and Society

[Submitted on 23 Jan 2022 (v1), last revised 10 Feb 2022 (this version, v3)]

Mitigating the quantum hype

Olivier Ezratty

quantum hype systemic effects