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Mémoire de Master

Laser à fibre quantique

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Abstract:

Laser phenomena can be identified by matter that amplifies light (“active medium”) and device that traps the light around the space filled with the medium (“cavity”). In order to activate the amplifying medium, energy is pumped into it. The gain medium is thus a converter between the pump energy and the light emission. The feedback mechanism in fiber laser is needed because the light would otherwise escape from the medium.

Theoretical and simulated Fiber laser and quantum intersection can be identified also as: Quantum mechanics and Laser operation, stimulated Emission, spontaneous emission, population inversion and coherence and quantum States.

Quantum computing is one of the emerging technologies. Huge research groups are working to bring quantum computing applications into reality. The main objective of this project is to find out the impact of quantum laser on other applications such as AI. The intersection of lasers and quantum phenomena is a rich and multidisciplinary field with profound and deep implications for both fundamental physics and practical applications in technology, including quantum computing, communications, and modern laser applications. Quantum demonstrates how our understanding of quantum mechanics has led to the development of revolutionary technologies.

At the end, using Kiskit software to simulate the quantum phenome and understand the future revolution of quantum application especially with AI. Quantum simulators are software programs that run on classical computers and make it possible to run and test quantum programs in an environment that predicts how qubits react to different operations.

Résumé:

Les phénomènes laser peuvent être identifiés par la matière qui amplifie la lumière « milieu actif » et par un dispositif qui confine la lumière dans le milieu « cavité ». Afin d'activer le milieu amplificateur, de l'énergie y est pompée. Le milieu de gain est donc un convertisseur entre l'énergie de la pompe et l'émission lumineuse. Le mécanisme de rétroaction dans le laser à fibre est nécessaire car sinon la lumière s'échapperait.

L'intersection laser et quantique peut également être identifiée comme suit : mécanique quantique et fonctionnement du laser, émission stimulée, inversion et cohérence de population et états quantiques.

L'informatique quantique fait partie des technologies émergentes. Différents groupes de recherche s'efforcent de concrétiser les applications de l'informatique quantique. L'objectif principal de ce projet est de découvrir l'impact du laser quantique sur d'autres applications telles que l'IA. L'intersection des lasers et des phénomènes quantiques constitue un domaine riche et multidisciplinaire ayant des implications profondes et profondes à la fois pour la physique fondamentale et les applications pratiques de la technologie, notamment l'informatique quantique, les communications et les applications laser modernes. Quantum démontre comment notre compréhension de la mécanique quantique a conduit au développement de technologies révolutionnaires.

Au final, utiliser le logiciel Kiskit pour simuler le phénomène quantique et comprendre la future révolution des applications quantiques notamment avec l'IA. Les simulateurs quantiques sont des logiciels qui s'exécutent sur des ordinateurs classiques et permettent d'exécuter et de tester des programmes quantiques dans un environnement qui prédit la réaction des qubits à différentes opérations.

ملخص:

يمكن التعرف على ظواهر الليزر من خلال المادة التي تضخم الضوء ("الوسط النشط") والجهاز الذي يحصر الضوء حيز مغلق يسمى "التجويف". ومن أجل تنشيط وسط التضخيم، يتم ضخ الطاقة فيه. وبالتالي فإن وسيلة الكسب هي التحول من طاقة المضخة إلى انبعاث الضوء. هناك حاجة إلى آلية التغذية المرتدة في ليزر الألياف لأن الضوء قد يتسرب من الوسط.

تم كذلك التطرق نظريا الى ما يمكن تعريفه بالتقاطع الكمي وألياف الليزر على النحو التالي: ميكانيكا الكم وتشغيل الليزر، والانبعاث المحفز، والانعكاس والتماسك، والحالات الكمومية.

الحوسبة الكمومية هي واحدة من التقنيات الناشئة. تعمل مجموعات بحثية كثيرة ومختلفة على تحويل تطبيقات الحوسبة الكمومية إلى واقع ملموس. الهدف الرئيسي من هذا المشروع هو معرفة تأثير الليزر الكمي على التطبيقات الأخرى مثل الذكاء الاصطناعي. يعد تقاطع الليزر والظواهر الكمومية مجالاً غنياً ومتعدد التخصصات وله آثار عميقة ومتعددة على كل الفيزياء الأساسية والتطبيقات العملية في التكنولوجيا، بما في ذلك الحوسبة الكمومية والاتصالات وتطبيقات الليزر الحديثة. يوضح تحليل الكم كيف أدى فهمنا لميكانيكا الكم إلى تطوير تقنيات ثورية.

وفي النهاية، تم استخدام برنامج Kiskit لمحاكاة الظاهرة الكمومية وفهم الثورة المستقبلية للتطبيقات الكمومية خاصة مع الذكاء الاصطناعي. المحاكاة الكمومية هي برامج تعمل على أجهزة الكمبيوتر الكلاسيكية وتجعل من الممكن تشغيل واختبار البرامج الكمومية في بيئة تتنبأ بكيفية تفاعل الكيوبتات مع العمليات المختلفة.

SUMMARY

GENERAL INTRODUCTION.....	1
GENERAL INTRODUCTION:.....	2
I.1 QUANTUM OPTICS, VIEW, BUILD AND EDIT MAPS – ON YOUR DESKTOP	6
I.2 INDUSTRY CO-OPERATION – FOR THE BENEFIT OF THE USER	6
I.3 QUANTUM COMPUTING	6
I.3.1 Elements of quantum computing	6
I.3.2 bits or ‘qubits’	7
I.3.3 The Ket $ >$	8
I.3.4 Entangled States.....	8
I.3.5 Quantum Gates:	9
I.3.6 Quantum Circuits.....	10
I.3.7 Quantum computing algorithms	10
I.4 QUANTUM AI	11
I.4.1 Companies that use Intelligence.....	11
I.4.2 The intersection of artificial intelligence and quantum computing.....	12
CHAPTRE II : QUANTUM AND FIBER LASER.....	13
II.1 II.1 DEFINITION OF A LASER	14
II.2 THE ESSENTIAL ELEMENTS OF A LASER.....	14
II.6.2 Single photon generation based on cavity QED.....	18
II.7 PRESENT STATUS OF LASER-COOLEDION-PHOTON QUANTUM NETWORK	19
II.7.1 Steady coupling between single ion and cavity	19
II.7.2 Single photon generation by single-ion-cavity system	20
II.7.3 Conditions for implementing ion-photon quantum interface.....	21
II. 8 INTERSECTION BETWEEN LASERS AND QUANTUM PHENOMENA	21
II.8.2 STIMULATED EMISSION:	22
II.8.3 POPULATION INVERSION:	22
II.9 QUANTUM FIBER LASERS.....	23
II.10 EXPERIMENTATION AND SIMULATION OF FIBER LASER	24
CHAPTER III: QUANTUM THEORY	27
III.1 DEFINITION OF QUANTUM:.....	28
III.2 THE PHYSICS OF QUANTUM SYSTEMS:	28
III.2.1 When Is a Physical System a Quantum System?	28
III.2.2 Basic Properties of Quantum Systems	28
III.3 THE FUNDAMENTAL CONCEPTS OF QUANTUM THEORY:.....	29
III.3.1 Wilson photographs:	29
III.3.2 Diffraction of matter waves:	30
III.3.3 The diffraction of X-rays:	31
III.4 PRINCIPLES OF QUANTUM THEORY	32
III.4.1 Superposition	32
III.4.2 Interference	32
III.4.3 Quantum entanglement	32
III.5 INTERACTION BETWEEN LIGHT AND MATTER	35
III.5.1 Rabi Model	35
CHAPTER IV: QUANTUM SIMULATION	36
IV.1 INTRODUCTION:	37
IV.2 ENTANGLEMENT	38

IV.4 CRYPTOGRAPHY.....	41
IV.5 PHOTON WAVEFORM.....	44
<i>IV.5.1 Single photon waveform</i>	44
GENERAL CONCLUSION	47
GENERAL CONCLUSION:.....	48
REFERENCES	49
BIBLIOGRAPHIE :	50

List of Figures

Figure I. 1: Quantum physics Manid Map	7
Figure I. 2: Representation of a two-level Quantum State	8
Figure I. 3: Generalized Quantum Circuit	10
Figure II. 1: Laser Design.....	14
Figure II. 2: The principle behind the operation of a laser	15
Figure II. 3: Fiber laser in laser cavity configuration.....	16
Figure II. 4: Fiber laser in a MOPA configuration single stage version.....	16
Figure II. 5: Quantum interface based on cavity QED	17
Figure II. 6: Atom placed in cavity	18
Figure II. 7: Single photon generation based on cavity QED	19
Figure II. 8: Experimental equipment for verifying coupling between ion and cavity	20
Figure II. 9: a-Experimental equipment for generating single photon and b-energy levels of Ca^+ ion .	20
Figure II. 10: Single photon waveform simulation	21
Figure II. 11: Structure of Ring Fiber Laser	25
Figure II. 12: ASE of Ring Fiber Laser	25
Figure II. 13: Output Signal of Ring Fiber Laser	25
Figure II. 14: Experimental Configuration of ring Fiber Laser	26
Figure III. 1: Tracks of α -particles in Wilson chamber	30
Figure III. 2: Diffraction of electrons on passing through a thin foil of matter	31
Figure III. 3: Diffraction of X-rays by MgO powder.....	31
Figure III. 4: Quantum Entanglement	32
Figure III. 5: The fundamental protocol of quantum teleportation	33
Figure III. 6: Schematic of a crypto-system.	34
Figure III. 7: Weak Coupling Light matter	35
Figure IV. 1: Quantum Circuit	38
Figure IV. 2: Measurement Outcome	39
Figure IV. 3: Quantum States	40
Figure IV. 4: Quantum Circuit1	41
Figure IV. 5: Quantum Circuit	43
Figure IV. 6: Measurement Outcome	43
Figure IV. 7: Single Photon Waveform	45
Figure IV. 8: Multiwave form.....	46

General Introduction

General Introduction:

The birth of quantum mechanics was undoubtedly a cornerstone in the history of physics. Having being crafted by the great minds of the 20th century, quantum theory underwent intensive studying and testing after being established as one, if not the most, fundamental theory in physics.

With theoretical predictions agreeing to experimental data with up to 10^{-12} accuracy, it is no wonder that quantum electrodynamics, itself a child of quantum theory, is probably the most accurate theory physicists ever came up with. Indeed, even today, physicist all around the world use the mathematical formalism presented by Paul Dirac [1] and John Von Neumann [2] in seemingly diverse areas of physics: particle physics, solid state physics, nuclear physics etc- with great success. Because of its success even skeptics who criticized quantum theory over time now realize its importance. However, there are still questions about the simplicity of quantum theory. Consider the no-cloning theorem [3] and the quantum teleportation protocol [4]. Even though they now seem simple and trivial to prove, they were discovered considerably late, in 1982 and in 1993 respectively.

The new research trend of quantum informatics, partly initialized by the two theorems mentioned, put at the Centre of attention what quantum theory can do, in the world of classical computation. It was not long after quantum information revealed some its enormous power: Shor's factoring algorithm [5] and Grover's searching algorithm [6] provide exponential speed-ups compared with their traditional classical counterparts. With all the experimentalists agreeing that a viable quantum computer could be made reality within the next decades, it is perhaps the right time to step back and re-visit the fundamentals of quantum theory, in order to establish a conceptually clear model.

Category theory provides an abstract mathematical environment in which mathematical structures can be expressed – with the concepts of compositionality and type having a central role. The benefit of having a single mathematical framework in which we can express theories on a more abstract level will prove to be very beneficial. Of course, this is not the only advantage that categories have. One of the most distinct features of monoidal categories is that they admit graphical calculations, in the sense that all mathematical expressions can be reduced to pictures.