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American Journal of Engineering and Applied Sciences

Original Research Paper

The 'Celalettin-Field Quantum Observation Tunnel' a Quantum Communication Countermeasure Speculative Structure

M. Celalettin and H. King

College of Engineering and Science, Victoria University, Ballarat Road, Footscray, Australia

Article history
Received: 20-12-2018
Revised: 15-01-2019
Accepted: 04-02-2019

Email: horace.king@vu.edu.au

Abstract: The 'Celalettin-Field Quantum Observation Tunnel' (COT) is a speculative structure produced in an ensemble of Orbital Angular Momentum (OAM) polarized outer 's' shell electrons, whereby an incoming photon, depolarizes 's' shell electrons as it burrows through the ensemble, creating a tunnel. The depolarized particles when viewed as a single quantum system can theoretically be used to acquire information on the incoming photon which in effect, measures it satisfying the criterion for 'quantum observation'. Enabling equations are discussed which describe the behaviour of the photon/electron interactions in the tunnel, the medium in which the tunnel is produced and the information the medium acquires on the photon as it tunnels through. The Schrodinger wave equation, Math ieu differential equation, Lagrangian QED plasma equation and the Lorentz quantum parameter (OAM coupling) simultaneously describe the COT phenomenon. This study proposes the COT as a quantum communication countermeasure, be it a quantum radar or spy satellite utilizing quantum computing.

Keywords: Military Quantum Communications, Quantum Entanglement, Quantum Radar, Spy Satellites

Introduction

Quantum communications operate unaffected by extant signal countermeasures (Liu *et al*., 2014). Using a quantum radar as an example, where as in the past, electromagnetic waves from a conventional radar would rebound off a jet and return to the radar, fighter jets had options to counter such attacks by absorbing or reflecting the electromagnetic waves. In addition to other jet borne stealth capabilities, plasma stealth clouds are highly researched and consist of ionised atoms which trap electrons, preventing them from returning to a conventional radar. In a quantum radar, the entangled photons are not as affected by electromagnetic absorption as the photons are not drawn to ionized atoms in the way electrons are. Information is acquired by monitoring the retained idler photon (γIdler) (Lanzagorta, 2011).

The cause of quantum observation is a topic of global scientific, religious and philosophical debate, with the most widely accepted scientific understanding being the 'Copenhagen interpretation'. This interpretation states that when a photon's spin, OAM or frequency is measured then the entangled photon in a superposition collapses to a single position. Introducing quantum observation into the function of a quantum radar, or spy satellite harnessing quantum communications would inhibit its ability to function (Adler, 2003).

This study introduces quantum observation to cause quantum decoherence, to military quantum communications devices. In a quantum radar, its entangled signaller photon (γ_{sig}) is observed via a proposed 'Celalettin-Field Quantum Observation Tunnel' (COT). At Equation 11 the proposed COT would enable stealth fighter jets to remain stealth in the presence of a quantum radar. A proposed Polarized Electron Cloud (Pe.Cloud) is required to enshroud the jet to provide a medium for which γ_{sig}, would leave an ensemble of depolarized electrons as it attempts to reach and rebound off the jet. When viewed as a single quantum system, information on γ_{sig} is acquired by the production of the COT through the medium enabled by OAM coupling between the entangled photon and the polarized electrons in the presence of an electric field,

DOI: 10.3844/ajeassp.2019.111.117

made of depolarized electrons in the Pe.Cloud. This is discussed further in detail.

Discussion

The aerodynamic complications that the Soviet Sputnik program encountered and those that the U.S are tirelessly trying to overcome by enshrouding a supersonic fighter jet with an airborne ionized chemical plasma cloud are all avoided (Panarella, 1987; Osborne and Wilson, 2011). This is because the Pe.Cloud is not an on-board plasma, nor is it deployed via a continuous flow via on board canisters. Rather, it polarizes local outer 's' shell electrons; there is no requirement to entrap electrons beamed from a conventional radar, but rather, treat local photon-photon quantum entanglement via a COT.

The COT would be caused by a high energy photon tunnelling into the Pe.Cloud, namely a scalar quantum electrodynamics (QED) Lagrangian operation with OAM coupling. This is the crux of the idea behind the COT as enables the interaction between the photon and the OAM polarized electrons in the Pe.Cloud in order to allow a COT to be produced (Gallatin and McMorran, 2012). The COT exists when considering the intrinsic OAM's of all affected depolarized electrons as a single quantum system whereby the individual depolarized electrons cannot be described independently of each other. The γsig's size would be evidenced by depolarizing the intrinsic OAM of Pe.Cloud's electrons tunnelling through the Pe.Cloud and the Pe.Cloud density would increase as the photons scatter the electrons during tunnelling; essentially enabling the Pe.Cloud to be provided with information on the γ_{sig}. This satisfies Werner Heisenberg's quantum observation requirement and therefore would cause quantum decoherence between the quantum radar's entangled photon's, subsequently inhibiting its function (Heisenberg, 1985).

Figure 1, an extant plasma stealth cloud currently used to absorb electromagnetic radiation is illustrated. The plasma stealth cloud is made of ionized atoms which attract the electrons beamed from a conventional radar (Zeng *et al*., 2008; Singh *et al*., 2015). This plasma stealth cloud would have no effect on a quantum radar, as photons would not interact with ionized atoms and the γ_{sig}, would penetrate the plasma stealth cloud striking the jet (Lanzagorta, 2011; Brandsema *et al*., 2014).

There are two objectives of this research:

- To mathematically investigate quantum observation via a proposed COT
- Ascertain whether a Pe.Cloud can be engineered to inhibit a quantum radar's ability to detect a stealth fighter jet

Achieving these aforementioned objectives would theoretically keep the jet stealthily in the presence of a quantum radar. The capability to enshroud a supersonic jet with a plasma stealth cloud already exists (Fiszer and Gruszczynski, 2002) and Lockheed Martin already have a patent on a military grade quantum radar (Brandsema *et al*., 2014; Allen and Karageorgis, 2008).

Fig. 1: Plasma stealth cloud

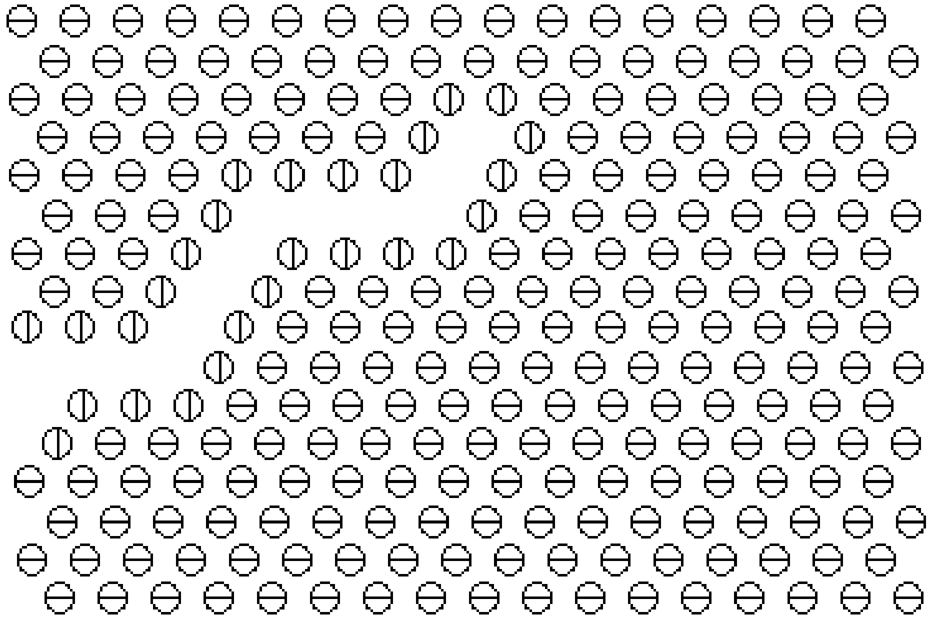

Fig. 2: 'Celalettin-Field Quantum Observation Tunnel' (COT)

Concept

Celalettin-Field Quantum Observation Tunnel

Figure 2, the proposed COT is illustrated as being produced in the proposed Pe.Cloud. OAM coupling is proposed to be caused by the tunnelling γ_{sig}, leaving an ensemble of depolarized electrons. When considered as a single quantum system, the γ_{sig} could be measured (Heisenberg, 1985), monitoring the density of the Pe.Cloud or imaging the COT; a form of quantum observation (Joos *et al.*, 2013).

This study investigates a phenomena that is expected to take place within fractions of a millionth of a second prior to the fighter jet's on-board electromagnet repolarizing the depolarized COT electrons, into their initial Pe.Cloud. continue style.

Mathematical Proof of Concept

The mathematical proof of concept does not attempt to reconcile quantum equations with classical physical equations to formulate an equation for the COT. Rather, an ensemble of parent equations have been manipulated to describe the behaviour of photonic and electric behaviour with regards to the functionality of a military quantum communications devices such as a quantum radar and once ensembled, these equations as a system enable the COT to introduce quantum decoherence to the entangled photons utilized by a quantum radar. Therefore no COT equation is formulated, however there are five equations that when run simultaneously under typical military capabilities and applied to the COT, it is enabled (Stewart, 2005). These equations are:

1. The scalar Quantum Electrodynamics (QED) Lagrangian operation with OAM coupling at Equation 10, which enables the interaction between γ_{sig} and the OAM polarized electrons in the Pe.Cloud in order to allow a COT to be produced (Gallatin and McMorran, 2012).
2. The Klein-Gordon Equation 13, which proposes that when a γ_{sig} of sufficient energy enters a Pe.Cloud, it will produce a COT via both Compton scattering and OAM coupling and is the conduit in this circumstance for the Lagrangian formulation being used in a quantum setting (Varró, 2013).
3. The wave function for quantum entanglement at Equation 1, which described the entangled photons employed in quantum communications as and mathematically describes γ_{sig}.
4. The Boltzmann Equation for a plasma at Equation 3, to accommodate the density of the environment in which the photon-electron interactions will occur in the presence of an electric field. The density of the Pe.Cloud is paramount as depending on the size of γ_{sig}, enough medium is required to acquire information on it.
5. The quantum parameter χ in units of Schwinger acceleration as ≡ m, at Equation 8. If it is greater than 1, then it is determined that γ_{sig} has a quantum nature, which is why the Lagrangian formulation of the scalar and spinor in an electron reservoir is relevant as under special conditions later mentioned, this equation is appropriate.

6. Time. Whilst not an equation, the power output of the electromagnet it known and the COT will only exist for the amount of time it takes for the electromagnet to re-polarize the OAM's of the depolarized electrons.

Therefore the new learning is not that there is a new mathematical formulation, but rather that the correct equations are present, running simultaneously under the correct condition to enable the production of a COT.

Derivations

Here the Schrodinger equation is introduced as the fundamental equation of physics for describing quantum mechanical behaviour which is the physics which describes quantum entanglement; the fundamental phenomena underlying a quantum radar:

$$i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle = \hat{H}|\psi(t)\rangle \tag{1}$$

The wave function for quantum entanglement is expressed (Haroche, 1999):

$$|\psi\rangle = \frac{1}{\sqrt{2}}\left(|e,\alpha e^{i\phi}\rangle + |g,\alpha e^{-i\phi}\rangle\right) \tag{2}$$

Where:
αe = Eigenvalues
e = γsig
g = γidler

The quantum mechanical operator used to operate on the wave function for the purpose of the COT is the Hamiltonian, for which solutions for time independent quantum equations exist as eigenvalues (Shirley, 1965). Quantum observation has also been defined by Werner Heisenberg as 'sampling the observable' (Heisenberg, 1985; Panarella, 1987). Therefore if the observer can sample the state, then the state of the observable changes and the observer can no longer be factored out (Gaëtan *et al*., 2009).

Rubidium isotope 87 (Rb 87) atoms have a complete shell structure plus one electron in its outer 's' shell (Steck, 2001). If atoms with one electron in its outer shell are passed through a non-homogenous, vertical magnetic field, their polarizations are aligned upwards and downwards (Ternov *et al*., 1962; Uchida and Tonomura, 2010). This is due to the randomly opposite spin states of their outer s electrons (Steck, 2001). When sending Rb 87 atoms in a superposition of two states through a microwave cavity, the two quantum states shift phases causing quantum decoherence (Haroche, 1999). Observing quantum decoherence by OAM coupling within a polarized Rb 87 atomic gas chamber as opposed to pumping quantum entangled Rb 87 atoms into a microwave cavity is therefore a plausible experiment.

Plasma stealth clouds rely on the density of ionized atoms to affect the reflection, absorption and transmission of the electromagnetic energy from conventional radars to entrap as many radar transmitted electrons as possible (Zeng *et al*., 2008; Wang *et al*., 2011). The proposed Pe.Cloud needs to be dense enough and the γ_{sig} needs to be high energy enough to depolarize electrons in the Pe.Cloud to produce the COT to cause quantum observation and protect the jet from quantum radar detection (Liu *et al*., 2014). Given the Boltzmann equation for a plasma to accommodate the density of the environment in which the photon-electron interactions will occur in the presence of an electric field as in Equation (3):

$$n_e(\phi_2) = n_e(\phi_1)e^{e(\phi_2-\phi_1)/k_B Te} \tag{3}$$

Where:
ne = Electron number density
Te = Temperature of the plasma and
kB = Boltzmann constant.
φ = Work function

In addition, the electron radius (re) is given by:

$$r_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e c^2} \tag{4}$$

$$r_e = 2.8 * 10^{-15} m \tag{5}$$

Where:
e = Electric charge
m = Mass
$\varepsilon 0$ = Permittivity of free space

As such, the average spacing between Rb 87 atoms in an experimental Pe.Cloud would need to be <4.94 nm, given the atomic radius of Rb 87 is 4.94 nm. This would be dense enough for a 400 nm γ_{sig} to produce a COT if it is high energy enough to tunnel deep enough into the Pe.Cloud, indicated via the photoelectric effect via Compton scattering when not absorbed (Glover *et al*., 1996):

$$K_{max} = hf - \varphi \tag{6}$$

Where:
K = Kinetic energy of the signaller entangled photon
h = Planck constant
f = Frequency of the incident photon

Which denotes the minimum energy required to move a delocalised electron as per Einstein's work on photon/electron interaction.

If the quantum radar's γ_{sig} were 200nm, at Equation (4) there will be enough energy in the Pe.Cloud for it to produce a COT.

The quantum entangled Idler (e) and Signaller (g) photons are given by:

$$|\psi\rangle = \frac{1}{\sqrt{2}}\left(|e,\alpha e^{i\phi}\rangle + |g,\alpha e^{-i\phi}\rangle\right) \quad (7)$$

We begin with the Schrodinger wave function equation:

$$\nabla^2\psi + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0 \quad (8)$$

Where:
E = Energy
V = Potential energy

$$\chi \equiv \frac{1}{m}\sqrt{\left(\frac{du}{ds}\right)^2} > 1 \quad (9)$$

The quantum parameter χ in units of Schwinger acceleration as $\equiv m$. If it is greater than 1, the particle motion in the electromagnetic field has a quantum nature, hence this research will consider the Lagrangian formulation of the scalar and spinor in an electron reservoir (Raicher *et al*., 2014).

Where:
s = Proper time of the particle
m = Particle mass

Equation (9) considers a plasma and in particular the photoelectric attributes of γ_{sig} interacting with a Pe.Cloud. Lagrangian mechanics is a label given to a situation where the Lagrange classical equation is applicable to certain quantum mechanical situations. In this study the Lagrangian formulation will be considered to 'exist with' ( ):

- OAM coupling equation and
- Schrodinger equation (Hamilton, 1834)

The behaviour of atomic Rb 87 and the γsig's energy required to depolarize atomic Rb87 outer 's' shell electrons have been derived at Equation (14). An ensemble of polarized atomic Rb 87 is governed by the Lorentz invariant parameters which consist of both classical and quantum, for which Equation (9) is the quantum parameter (Kirk *et al*., 2009).

Considering the electron motion in a quantum parameter (χ>1), QED describes the γ_{sig} emission process. This study re-visits Raicher *et al*. (2014) construction of the Lagrangian scalar formulation of QED in a plasma. It is not possible to describe electrons in terms of a scalar due to Faraday's Law of Induction, unless a magnetic vector potential is included (Yang and McDonald, 2015). So therefore magnetic vector potential is included through the inclusion of an electromagnet, enabling the use of this equation. The electromagnet is required to be high energy enough to OAM polarize the electrons that enables the Lagrangian scalar formulation to investigate the required kinetic energy of the laser to cause the COT.

Thus, the scalar QED plasma Lagrangian required for a Pe.Cloud is given by the Lagrangian formalization for scalars equation (Raicher *et al*., 2014):

$$\mathcal{L}_{sQED} = \frac{1}{2}\left[\left(\partial_\mu + ieA_\mu\right)\Phi^*\right]\left[\left(\partial^\mu - ieA^\mu\right)\Phi\right] - \frac{1}{2}M^2\Phi*\Phi - \frac{1}{16\pi}F_{\mu\nu}F^{\mu\nu} \quad (10)$$

Where:
Φ = Charged scalar field,
$\Phi*$ = Its complex conjugate and where the electromagnetic strength is given by:

$$F_{\mu\nu} = \partial_\nu A_\mu - \partial_\mu A_\nu \quad (11)$$

Where:
A_μ = vector potential

In Lagrangian mechanics, the trajectory of an ensemble of particles is derived from the Lagrange equations, where the Euler-Lagrange equation describes the motion for the scalar field (Raicher *et al*., 2014; Fox, 1987):

$$\frac{\delta\mathcal{L}}{\delta\Phi*} = \partial_\mu \frac{\delta\mathcal{L}}{\delta\left(\partial_\mu\Phi*\right)} \quad (12)$$

The Euler-Lagrange Equation (12), yields the Klein-Gordon equation:

$$\left[-\partial^2 + M^2\right]\Phi = \left[-e^2A^2 + 2ieA\cdot\partial\right]\Phi \quad (13)$$

Where:
$\partial^2 \equiv \partial\mu\partial\mu$,
$A^2 \equiv A\mu A\mu$
$A\cdot\partial \equiv A\mu\partial\mu$

Further, the Dirac/Klein-Gordon equation reduces to the Mathieu ordinary differential equation under special conditions.

The special conditions are:

- The motion for the Pe.Cloud is in the presence of an electromagnetic field
- The required electric charge of the electromagnet to polarize the Pe.Cloud is known

- The γ_{sig} tunnels through the Pe.Cloud, depolarizing electrons in its wake via Compton scattering (Varró, 2013).

This equation proposes that when a γ_{sig} of sufficient energy enters a Pe.Cloud, it will produce a COT via both Compton scattering and OAM coupling. The Pe.Cloud can then be imaged and the COT is proposed to acquire information on the γsig's size/frequency and the Pe.Cloud's change in density which would prove that the depolarized electrons have been pushed aside during γsig's tunnelling through the proposed COT as discussed.

Given the COT approximation equation:

$$\frac{\begin{gathered}\nabla^2\psi + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0 \\ +\frac{d^2y}{dx^2} + \left[a - 2q\cos(2x)\right] | \, y = 0 \\ \exists \, \mathcal{L}_{SQED} \exists X\end{gathered}}{t} \tag{14}$$

Where:

- The γ_{sig} as the wave equation
- 'And' the Mathieu differential equation
- 'Existing with ($\exists$)' the Lagrangian plasma QED equation which describes an I Cloud as an approximation to describing a plasma,
- 'Existing with ($\exists$)' the Lorentz quantum parameter causing OAM polarization in the presence of an electromagnet,
- 'Over' time

Conclusion

The mathematical proof of concept that a Pe.Cloud causing quantum decoherence via a proposed COT is mathematically feasible. Calibration of said variables will be performed in future papers to achieve quantum observation via a COT and the aforementioned apparatus has been designed to test the theory, combining the quantum system, quantum electrodynamics for a plasma and OAM coupling to achieve quantum observation and if so, it will be hypothesized that introducing this new learning combined with extant plasma stealth cloud jet canisters would defeat a soon to be deployed military quantum radar and other quantum communication devices. This research has provided an enabling equation which could be used to progress the development of a Pe.Cloud to counter a quantum radar just as the plasma stealth cloud and other non-quantum engineered stealth capabilities operated in secrecy in the presence of radars in the past.

Acknowledgement

I want to thank Dr Horace King for encouraging me not to stick within the boundaries of known science and push me to pursue my suspicions; push me beyond my limits, and encouraging such bold research. I also want to thank my beautiful wife Dr Hasret Celalettin, without her expertise in research not to mention her support and encouragement in my abilities gave me the clarity of thought I needed.

Author's Contributions

Both the authors have equally contributed to this manuscript.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and there are no ethical issues involved.

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