



If We Postulate Atomic and \pm Subatomic Particles are Size Particles and Satisfy the Schrodinger Equation, what will be the Inferences?

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ABSTRACT

In quantum mechanics, atomic and subatomic particles are treated as waves. The idea of wave function and wave function collapse brought us great success but left us different opinions. Is there a way it can avoid the different opinions and give us more? We try to postulate directly that these particles are size particles and satisfy the Schrodinger equation. Start from the general solution of free particle's Schrodinger equation, we will prove: (i) To satisfy the Schrodinger equation, the size particle must possess a circular polarized structure of the plane vector ψ (a complex number) like the electric vector E in the circular polarized light; its modular is mass density. (ii) These particles fall into two categories: they have the same sign of negative charge e or positive charge e, but different directions of mass density and charged helices, like left handed electron and right handed electron etc. (iii) The spin of the particle has its mechanism, it is formed by the motion of the helices structure of mass plus intrinsic self rotation. (iv) Negative charge e (or positive charge e) distributes double helically on the particle side boundary. It produces and carries a circular polarized electric field E with the same velocity of the particle. It forms a circular polarized E-wave. This wave will be proved is just the de Broglie wave and the E-wave function is just the particle's state function in quantum mechanics. Such \pm charged particle is consisted of the particle itself and the de Broglie wave; they form a particle-wave hybrid structure. The E- wave exhibits all possible states with possibility in the atom, molecule or interference pattern; as for the particle itself, it cannot split into

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two or move with two velocity at the same time. It can only locate at one basic state any moment, such as in an eigen state of the atom or at a point in the interference pattern. It is the self-interference of the hybrid structure of the particle makes the one after one single particle form double-slits interference.

Keywords: Circular polarized structure; inertia vector; particle-wave hybrid structure; self-interference of the particle-wave hybrid structure.

1. INTRODUCTION

In quantum mechanics, \pm atomic and \pm subatomic particles are treated as waves; the state of the particle is completely specified by the wave (state) function; the function is postulated to satisfy the Schrodinger equation; the modular of the function is probability density. The idea of wave function and wave function collapse have brought us to great success, but it also left us some different opinions until now, for example [1]. Does there exist a way it can also explain all the experimental facts and avoid the different opinions? We now try to treat these particles as size particles and suppose they satisfy the Schrodinger equation to see what will happen, Start from the general solution of free particle's Schrodinger equation, we will prove that in order to satisfy the Schrodinger equation, the size particle must possess a circular polarized structure of a plane vector ψ (ψ_x, ψ_y) like the electric vector E (E_x, E_y) in the circular polarized light. The modular square is its mass density. Next, we will prove the size particle falls into two categories: it has the same sign of charge $-e$ or $+e$, but different directions of mass structure and charged helices, like left handed electron and right handed electron etc.; charge $-e$ (or $+e$) is distributed double helically on the particle side boundary. It produces and carries a circular polarized E-wave. Then we will prove further that the E-wave is really the de Broglie wave. So, any of these particles possesses a hybrid structure; it is consisted of the particle itself and the de Broglie wave it carries. At last, we will show it is such hybrid structure make these particles to exhibit particle character and wave character simultaneously in the atom, molecular and interference, such as the self-interference in the "single particle double-slit experiment.

2. GENERAL SOLUTION OF FREE SCHRODINGER EQUATION AND THE NECESSARY CONDITION FOR A RESEARCH OBJECT TO SATISFY THE SCHRODINGER EQUATION

For the free particle (It has no relation with any other particles, its energy E and momentum P in wave function $\psi(z, t) = N e^{2\pi i(pz - Et)} = N e^{\frac{2\pi hi}{\lambda}(\frac{z}{\lambda} - vt)}$ are constant). The Schrodinger equation in one space dimension is

$$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial z^2} \quad (1)$$

And

$$-i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial z^2} \quad (2)$$

They equal to $E\psi$ or $(E-V)\psi$. Usually, Eq. (1) and Eq. (2) are of no difference in quantum mechanics.

As a differential wave equation in mathematics, it must have a general solution of the type $\psi(x, y, z, t) = \psi_0(x, y)\psi(z - Vt) + \psi_0(x, y)\psi(z + Vt)$. Take $\psi(x, y, z, t) = \psi_0(x, y)\psi(z - Vt) = \psi_0(x, y)\psi(\zeta)$ as an example, the Eq. (1) ("Eq." is the abbreviation of equation) gives

$$i\hbar \frac{\partial \psi(x, y, z, t)}{\partial t} = i\hbar \psi_0(x, y) \frac{\partial \psi(\zeta)}{\partial t} = i\hbar \psi_0(x, y) \frac{d\psi(\zeta)}{d\zeta} (-V) \quad (\zeta = z - Vt) \quad (3)$$

$$-\frac{\hbar^2}{2m} \frac{\partial^2 \psi(x, y, z, t)}{\partial z^2} = -\frac{\hbar^2}{2m} \psi_0(x, y) \frac{\partial^2 \psi(\zeta)}{\partial \zeta^2} \left(\frac{\partial \zeta}{\partial z}\right)^2 = -\frac{\hbar^2}{2m} \psi_0(x, y) \frac{d^2 \psi(\zeta)}{d\zeta^2} \quad (\zeta = z - Vt) \quad (4)$$

Let $B = \frac{d\psi}{d\zeta}$ and Eq. (3) = Eq. (4), we have $-i\hbar VB = -\frac{\hbar^2}{2m} \frac{dB}{d\zeta}$ and $B = \frac{d\psi}{d\zeta} = B_0 e^{\frac{4\pi mV}{h}(z - Vt)}$, then

$$\psi(\zeta) = \eta_0 e^{i \frac{4\pi mV}{h} (z-Vt)} \quad (\zeta = z - Vt) \quad (5)$$

The general solution of the Schrodinger equation, Eq. (1) is a complex number:

$$\psi(x, y, z, t) = \psi_0(x, y, z_0) \psi(\zeta) = \psi_0(x, y, z_0) e^{2\pi i \left(\frac{2mV}{h} z - \frac{2mV^2}{h} t \right)} = \psi_x + i\psi_y \quad (6)$$

The general solution of the Schrodinger equation, Eq. (2) is also a complex number: the only difference is there is a negative “-” sign add to the exponent before $2\pi i$.

Where $\frac{2mV^2}{h}$ is frequency; $\frac{h}{2mV}$ is wave length and $V = \lambda_V \nu_V$ is phase velocity. Quantity $2mV^2 = h\nu_V$ has energy dimension and is proportional to V^2 , it must correspond to the kinetic energy of the non-relativistic object.

As the motion of a plane vector, wave function, Eq. (6) is similar to the electric vector E in the circular polarized light. It is a right circular polarized “ $\psi(x, y, z, t)$ wave”; The solution $\psi(x, y, z, t)$ of Eq. (2) is left circular polarized “ $\psi(x, y, z, t)$ wave”. So, the necessary condition for a wave function $\psi(x, y, z, t)$ to satisfy the Schrodinger equation is that it must be a function of circular polarized wave, not plane wave. Of course, for the special solution of the Schrodinger equation, it must be also a circular polarized wave,

Direct verification shows that Eq. (6) satisfies the Schrodinger equation, Eq. (1) but any component

of it, the plane wave ψ_x and ψ_y does not. Circular polarized wave, Eq. (6) is also a sufficient condition for a wave function to satisfy the Schrodinger equation.

In quantum mechanics, the state of an atomic or subatomic particle is completely specified by the wave (state) function. In order to be connected wave with the motion of the research object, let \vec{dr} be the displacement of the object’s mass center; treat the object as a whole and use the mass center to represent the object and call it as a “particle”. Then, the particle energy is

$$d\epsilon = \vec{F} \cdot d\vec{r} = \frac{d\vec{p}}{dt} \cdot d\vec{r} = d\vec{p} \cdot \vec{U} = U dp \quad \text{Where} \quad \vec{U} = \frac{d\vec{r}}{dt}$$

$U = \frac{d\epsilon}{dp}$ () is group velocity, It is also the particle’s

velocity. And $\epsilon_U = \frac{mU^2}{2} = \frac{p_U^2}{2m}$ is the kinetic energy of the non-relativistic particle. Two expressions

of the kinetic energy must be equal $2mV^2 = \frac{1}{2} mU^2$,

so $U = 2V$. Then $\nu_U = \frac{mU^2}{2h} = \frac{\epsilon_U}{h}$ and

$\lambda_U = \frac{h}{2mV} = \frac{h}{mU} = \lambda_U$. ν_U And λ_U are the frequency and wave length of the particle expressed with its velocity U . Quantity $p_U = mU$ is particle’s momentum.

The general solution of the Schrodinger equation Eq. (6) can be rewritten as

$$\psi(x, y, z, t) = \psi_x + i\psi_y = \psi_0(a, z_0) e^{2\pi i \left(\frac{z}{\lambda_U} - \nu_U t \right)}$$

$$\left(a = \sqrt{x^2 + y^2} \leq R, \lambda_U = \frac{h}{mU} = \frac{h}{p_U}, \nu_U = \frac{mU^2}{2h} = \frac{\epsilon_U}{h} \right) \quad (7)$$

Or

$$\psi(x, y, z, t) = \psi_x + i\psi_y = \psi_0(a, z_0) e^{\frac{2\pi i}{\lambda_U} (z - U t)}$$

$$= \psi_0(a, z_0) \left[\cos \frac{2\pi i}{\lambda_U} (z - U t) + i \sin \frac{2\pi i}{\lambda_U} (z - U t) \right] \quad (8)$$

Where

$$\lambda_U = \frac{h}{mU} = \frac{h}{p_U}, \nu_U = \frac{mU^2}{2h} = \frac{\epsilon_U}{h} \quad (9)$$

And $a \leq R < \infty$ is the radius of cross section of the circular polarized wave $\psi(x, y, z, t)$ beam.

In reality, what research object can satisfy the Schrodinger equation? As well known in quantum mechanics, any atomic and subatomic particles is treated as a wave, its function $\psi(x, y, z, t)$, named wave function or state function is postulated to satisfy the Schrodinger equation; it completely specifies the state of the particle. Function $\psi(x, y, z, t)$, Eq. (7) and (8) have an important property: $\psi^* \psi d\tau$ is the probability that the particle lies in the volume element $d\tau$ located at (x, y, z) , at time t .

Near hundred years of practice has proved that the idea of wave function and wave function collapse have brought us to great success, it also left us some different opinions until now, E.g. [1]. Is there any other way to avoid the different opinions?

If we now treat atomic and subatomic particles as the particles of size and directly postulate that it satisfies the Schrodinger equation, what are the inferences? Of course, the correctness of this postulate and its inferences depend on the verification of future practice.

Because only the circular polarized wave can satisfy the Schrodinger equation, can a uniform moving size particle form such a wave and satisfy the Schrodinger equation?

It is easy to verify if the particle has size, its mass structure is like a many head screw and can be represented by the plane vector:

$$\psi(x, y, z) = \psi_0(a, z_0)e^{\frac{2\pi i m U}{h} z} \quad (a = \sqrt{x^2 + y^2}) \quad (10)$$

The amplitude square is particle's mass density at the point $a = \sqrt{x^2 + y^2}$ on the particle's cross section. Translation motion $z = z_0 - Ut$ of the particle can form and does form the wave, Eq. (7) directly and satisfy the Schrodinger equation.

The pitch $\lambda_U = \frac{h}{mU} = \frac{h}{p_U}$ of the particle's plane vector $\psi(x, y, z)$ (and mass density) helix, Eq. (10) is also the wave length in Eq. (7) and (8). So $T_U = \frac{1}{\nu_U} = \frac{\lambda_U}{U}$ is the time for the particle to move a pitch, a wave length. It is also the time period for the vector $\psi(x, y, z)$ and mass elements dq from the same equal density helix to rotate a circle on the coordinate planes.

Owing to the relation between the vector $\psi(x, y, z)$ and mass density, let us call the vector $\psi(x, y, z)$ as inertia vector for convenience.

There is no contradiction when we treat the same eq. (7) as (i) the wave (state) function of the particle in quantum mechanics, it completely specifies the state of the particle, or (ii) the equation of motion of the size particle with structure $\psi(x, y, z) = \psi_0(a, z_0)e^{\frac{2\pi i m U}{h} z}$ when it moves $z = z_0 - Ut$ along the z-axis. This is because the amplitude square represents different meaning:

Probability density or mass density. The way(ii) is a supplement, it exhibits the particle inner structure that (i) has not exhibited. Next, their domains of definition are different they are whole

space($a = \sqrt{x^2 + y^2} < \infty$, $-\infty < z < \infty$) and $(a = \sqrt{x^2 + y^2} \leq R$ (R finite) , $-\infty < z < \infty$) respectively.

Besides, way (ii) will give us much more in the following.

3. SUPPOSE ATOMIC AND SUBATOMIC PARTICLES ARE THE PARTICLES OF SIZE AND SATISFY THE SCHRODINGER EQUATION, EITHER EQ. (1) OR EQ. (2), WHAT ARE THE INFERENCEES?

If we now suppose atomic and subatomic particles are size particles and satisfy the Schrodinger equation, Eq. (1); owing to symmetry, we must also suppose it satisfy the Schrodinger equation, Eq. (2). Then, we have the following inferences: (A)...(H) in section III and (I) in section IV: [2,3,4,5].

(A) According to the necessary condition, in order to satisfy the Schrodinger equation, an atomic or subatomic particle must have a helices structure like a multi-head screw; the structure can be expressed by the plane vector $\psi(x, y, z) = \psi_0(a, z_0)e^{\frac{2\pi i m U}{h} z}$ or $\psi(x, y, z) = \psi_0(a, z_0)e^{-\frac{2\pi i m U}{h} z}$; the amplitude square $\psi_0^* \psi_0(x, y, z_0)$ is its mass density.

(B) Because all these particles possess intrinsic spin, E.g. $\hbar/2$ and the frequency ν_U varies with particle velocity $U < c$, Eq. (9); there must exist a constant and maximum frequency ν the constant spin corresponds to. It makes $\nu_U \leq \nu$.

What is the extra frequency? Obviously, only an intrinsic self-rotation of the particle can be. So according to the conservation law of angular momentum, there must be a self-rotation frequency ν_{self} of the particle to make the relation:

$$\nu_{self} = \nu - \nu_U \quad (11)$$

(C) Quantity $h\nu = \epsilon$ is a constant. It has energy dimension. Compare to the expression of the kinetic energy of non-relativistic particle $\epsilon_U = \frac{mU^2}{2} = h\nu_U$, Eq. (9), the quantity

$$\epsilon = h\nu \quad (U < c) \quad (12)$$

must be the maximum energy, the total energy of the particle with intrinsic spin under any $U < c$.

(D) Then, the equation of motion of the atomic and subatomic particles that possesses both circular polarized structure of the inertia vector

$$\psi(x, y, z) = \psi_0(a, z_0)e^{2\pi i \frac{mU}{h}z} \quad \text{and intrinsic constant spin is}$$

$$\psi(x, y, z, t) = \psi_x + i\psi_y = \psi_0(a) e^{2\pi i(\frac{z}{\lambda_U} - \nu t)}$$

$$(\epsilon = h\nu, \quad p_U = mU = \frac{h}{\lambda_U}, \quad U < c) \quad (13)$$

It implies if the particle possesses both circular polarized structure and intrinsic spin, ϵ, p_U of the particle and ν, λ_U of the wave that the moving atomic or subatomic particle forms naturally satisfy the de Broglie relation.

(E) Direct verification shows the equation of motion, Eq. (13) satisfies the Klein-Gordon equation

$$\frac{\partial^2 \psi}{c^2 \partial t^2} = \frac{\partial^2 \psi}{\partial z^2} - \frac{m_0^2 c^2}{\hbar^2} \psi \quad (\psi = \psi(x, y, z, t)) \quad (14)$$

So, if the size particle just possesses circular polarized structure of the inertia vector

$$\psi(x, y, z) = \psi_0(a, z_0)e^{2\pi i \frac{mU}{h}z}, \quad \text{it satisfies the non-relativistic Schrodinger equation. If the size particle possesses both circular polarized$$

structure $\psi(x, y, z) = \psi_0(a, z_0)e^{2\pi i \frac{mU}{h}z}$ and intrinsic constant spin simultaneously, it satisfies the Schrodinger equation in the whole speed region $U < c$.

Long time ago, someone has ever thought that the elementary particle's spin is totally dependent on the self-rotation. But, it led to the superluminal difficulty as Pauling ever pointed out. Using pure self-rotation to explain atomic and subatomic particles spin is not available. So, if a particle possesses intrinsic spin, it must possess the circular polarized structure simultaneously. Therefore, intrinsic constant spin is really a sufficient condition for the particle or system to have the wave function, Eq. (13) and satisfy the Schrodinger equation in the whole speed region.

(F) It is evident that the Schrodinger equation

$-i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial z^2}$, Eq. (2) has a left-handed general solution. Since we have postulated that the mentioned particles satisfy the Schrodinger equation, either Eq. (1) or Eq. (2), so they must have two directions of structures. All charged atomic and subatomic particles fall into two categories: they possess the same sign of charge $-e$ or $+e$, but different directions of inertia vector and mass density helices and double helices distribution of charge $-e$ or $+e$, such as left handed electron and right handed electron, etc.

(G) Owing to the B (magnetic induction intensity) effect, two categories of such charged particle are distinguishable. They satisfy F-D statistics. As for the photons, according to the papers such as [6,7,8], the far field of E (electric field intensity) and B of a photon will offset each other, they are undistinguishable and obey B-E statistics

(H) Owing to the B effect, we can imagine that for these charged particles, a pair of left-handed and right-handed particles can become "entanglement", if they are placed closely parallel to each other and become a "B neutral pair". Because the spin direction is decided by the direction of helices structure, so the "entanglement" is like a pair of gloves; left-handed part is still left-handed; right-handed part is still right-handed no matter how far the distance they are apart from each other.

In order to check this conclusion, we think we can make just a pair of left-handed and right-handed particles and place them at two places A and B; Then we always observe the particle at the same place A or B to see if the direction of the particle will keep unchanged or random.

4. \pm CHARGED ATOMIC AND SUBATOMIC PARTICLES ARE CONSISTED OF THE PARTICLE ITSELF AND THE DE BROGLIE WAVE IT PRODUCES AND CARRIES. THEY FORM A PARTICLE-WAVE HYBRID STRUCTURE

(I) For the \pm charged atomic and subatomic particles, they possess circular polarized structure of the inertia vector

$$\psi(x, y, z) = \psi_0(a, z_0)e^{2\pi i \frac{mU}{h}z} \quad \text{or} \quad \psi(x, y, z) = \psi_0(a, z_0)e^{-2\pi i \frac{mU}{h}z}$$

and charge $-e$ (or $+e$) simultaneously. Repulsion

between the same sign of charge will split the charge element dq into $2 \times \frac{dq}{2}$ and located at two ends of the diameter on all cross sections. Owing to the similarity among the cross sections, charge $-e$ (or $+e$) will become a pair of charged double helices on the particle's side boundary. It will make the particle inside material symmetrically polarized and produces a double helices external E-field. This E-field will become a circular polarized E-wave when the particle moves with $z = z_0 - Ut$ along the z-axis. The E-wave and the circular polarization structure of the moving particle have the same velocity, the same wavelength, and the same frequency, so the equation of motion of the size particle, eq. (13) and the function of E-wave are of the same form except the amplitude. In order to show the differences between them, we use

$$E(x, y, z, t) = E_x + iE_y + E_0(a, z_0)e^{2\pi i(\frac{z}{\lambda_U} - \nu t)}$$

$$(\epsilon = h\nu, \quad p_U = mU = \frac{h}{\lambda_U}, \quad U < c) \quad (15)$$

To express the function of E-wave, The domain of definition of this function is the whole space ($a = \sqrt{x^2 + y^2} < \infty, -\infty < z < \infty$); the amplitude square is probability density. As for the wave, Eq. (13), its domain of definition is ($a = \sqrt{x^2 + y^2} \leq R$ (R finite), $-\infty < z < \infty$). The amplitude square is its mass density, although they have the same ν, λ_U and the same wave functions Eq. (13) and Eq. (15).

According to Eq. (13), ϵ, p_U of the moving particle and ν, λ_U of the E-wave naturally satisfy the de

Broglie relation $\epsilon = h\nu, \quad p_U = mU = \frac{h}{\lambda_U}$, E-wave is really the de Broglie wave in the quantum mechanics. It means the de Broglie wave in quantum mechanics is produced and carried by the charged atomic and subatomic particles themselves. The function of E-wave, Eq. (15) is really the state function of these particles in the quantum mechanics.

These charged particles itself and the de Broglie E-wave it carries form a particle-wave hybrid structure. The E-wave is outside and covers the particle. They move with the same phase until meeting the obstacle.

5. SELF-INTERFERENCE OF THE CHARGED ATOMIC AND SUBATOMIC PARTICLES IN SINGLE PARTICLE DOUBLE-SLITS EXPERIMENT

For the single particle double slit interference, the charged particle itself cannot split into two parts to pass two slits. Only the particle itself together with its E-wave beam and another E-wave beam through the second slit (that is split from the same original E-wave) can form the distribution of phase differences, it is also the probability distribution pattern on the screen behind the slits. As for the particle itself, owing to the symmetrical momentum of the Heisenberg uncertainty

principle $\Delta x \Delta p_x \geq \frac{\hbar}{2}$ at slit Δx , it will be deflected in general and locates randomly at a point on the screen. Total particles one by one arrive at the screen will form the interference pattern at last. So, the interference of \pm charged atomic and subatomic particles are all based on the self-interference of the particle-wave hybrid structure of the particle [9,10,11].

Generally speaking, owing to the particle-wave hybrid structure, the superposition principle of Schrodinger equation for the E-wave will make the particle in all possible states at the same time. As for the particle itself, since it cannot split into two parts or move with two velocity (two energy) at the same time; it can take only one basis state at any time t , such as at an eigen state in the atom (or molecule) or at a point in the interference pattern. The superposition principle of Schrodinger equation for the particle itself is just to bring in the integral constants and general solution [1]. Depending on the given conditions, like the normalized condition and boundary condition... etc. the state of the particle itself, like electron in the atom or molecule can be decided definitely by its quantum numbers. So, for the particle-wave hybrid structure, it shows particle like character and wave like character in the same time, not exhibits different character for different phenomena [12,13,14,15].

6. CONCLUSION

Since the general solution of Schrodinger equation is a circular polarized wave and we suppose directly the atomic and subatomic particles are the particle of size and satisfy the Schrodinger equations with - sign and + sign, Eq. (1), (2), we have the following main inferences: (i) we can predict that these particles possess

circular polarized structure of the inertia vector

$\psi(x, y, z) = \psi_0(a, z_0)e^{-2\pi i \frac{mU}{h} z}$ and mass density like a multi-threaded screw. Translation motion $z = z_0 - Ut$ makes it formed a circular polarized wave it satisfies the Schrodinger equation; (ii) Every one of these particles falls into two categories: it has the same sign of charge $-e$ or $+e$, but different directions of mass density and charged helices, like left handed electron and right handed electron etc.; (iii) Charge $-e$ (or $+e$) distributes double helically on the particle side boundary. It produces and carries a circular polarized E-wave. The E-wave being proved is just the de Broglie wave. So, the de Broglie wave in quantum physics is produced and carried by the charged atomic and subatomic particles themselves. (iv) The function of E-wave, eq. (15) is just the state function of the particle. (v) The charged atomic and subatomic particle itself and the de Broglie (E-)wave it carries form a particle-wave hybrid structure. For such hybrid structure, the E -wave will exhibit all possible states and probability for the particle to take. As for the particle itself, it can take only one basis state randomly, such as at an eigen state in the atom (or molecule) or at a point in the interference pattern. (vi) Depending on the given conditions, the state of the electron in the atom or molecule can be decided definitely by its quantum numbers. (vii) For the electron itself in the atom or molecule, as its moving history, the orbit idea corresponding to a set of definite quantum numbers must be available. (viii) The spin of the particle has its mechanism, it forms by the motion of the helices structure of mass plus intrinsic self rotation.

So, for the particle-wave hybrid structure, it shows particle like character and wave like character in the same time, not exhibits different character for different phenomena.

It is obvious this paper is a complement to the quantum physics, not the opposite.

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Author has declared that no competing interests exist.

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