Changing the Born rule [02.07.2025 (the square of the real component); 03.07.2025 (tunneling becomes more intuitive); 06.07.2025 (factor of 2); 07.07.2025 (dark photon interpretation is somewhat similar); 09.07.2025 (how Boas' theory really works); 12.07.2025 (link to non-oscillating flavor mixing & possible link to the Schnoll effect); 14.07.2025 (link to Roger Nelson's work); 18.07.2025 (wave imprint structure & observation); 30.07.2025 (using hole & distance where there is no diffraction); 25.09.2025 (implications for the uncertainty principle); 01.10.2025 (corrected position-impulse uncertainty)]

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In chapter 1.3 we have learned that the waviness of the probability distribution of particles is an emergent property of elementary spaces being oscillating complex number surfaces. This explanation leads to the same kind of interference patterns as in quantum mechanics, but it turns out that a particle phasing in and out of the universe in periodic intervals is not without additional implications.

There is a major difference in how probabilities work in space particle dualism as opposed to regular quantum mechanics. In regular quantum mechanics the probability for detection only goes down to zero when two waves interfere, cancelling to zero at a certain point. In space particle dualism on the other hand, the detection probability is zero every time the real component of the wavefunction reaches zero. That is exactly the same point that is reached when two waves cancel each other.

In quantum mechanics, probabilities are obtained by squaring the absolute value of the complex amplitude. This is known as the Born rule. Max Born proposed this as a way of obtaining predictions for particle positions from Schrödinger's wave mechanics.[1] Schrödinger himself was still hoping to develop quantum mechanics into a deterministic theory, which Born argued is impossible. The Born rule was essentially the nail in the coffin of determinism. However, the fact that the person who formulated the wavefunction was not the same person who as the one who introduced the rule for obtaining probabilities from it, gives us a hint that it is possible to have a different rule for that.

We can write the Born rule as:

$$P = |\psi\, i|^2$$

Or:

$$P = |z|^2$$

In space particle dualism, which is using the similar worlds interpretation, probabilities are instead given by:

$$P = 2\,|\Re(z)|^2$$

Here $\Re(z)$ represents the real component of the complex number z. The factor of 2 is present in order to make sure that probabilities are adding up to one, which is not trivial in SPD, because particles are thought to be 'out of universe' half the time. We will come back to this point later.

The above implies that if we measure a wave coming from a point A impacting a singular detection point B, then the probability of detection will not be constant like it is in regular quantum mechanics, but it will go up and down like a wave. So, if we have a laser emitter that can be made to emit phase-coherent waves, meaning electromagnetic waves that always start in the same phase (the same value for the complex number z), then the detection probability will depend on where the detector intersects the wave. This means that at different constant distances from the emitter, the detection probability will be different.

We cannot really notice this with any high frequency waves, because for those even a detector with very small angular size would still give a photon that has $\Re(z) = 0$ in the center of the detector plenty of other spots to hit where $\Re(z) \neq 0$.

While in quantum mechanics the probability of detection is always the square of the complex number z, in SPD it is instead the square of the real component a or $\Re(z)$. When we are not measuring however, and we are instead calculating how different waves interfere, we are always using the complex number z for all calculations.

So, we have to use laser light that is outside the visible range, in the microwave range. Lasers emitting light in these wavelengths exist and are called 'masers', where the 'm' stands for 'microwave'. The emitter can then be modulated in a way that the real component will drop to zero at exactly the spot where we are measuring. We can also use band pass filters to make sure only the right frequency triggers the detector.

Quantum tunneling

If $\Re(z) = 0$ at our detection point, then the particle in question can either tunnel through the detector, depending on the wavelengths, or reach another point beside the detector. Space particle dualism makes tunneling much more intuitive: if the particle is undetectable whenever the real component goes to zero, then it could pass through walls during that time. It can pass through them, because it is technically not in this universe during the time the real component reaches zero and it is 'mostly' not in this universe when the real component is close to zero.

In standard quantum mechanics we instead say that particles can tunnel because they have a position uncertainty. This seems formally reasonable, but ontologically one has to ask: well, their position might be uncertain, but we know they are in this room, and classically they are not supposed to be able to just get into the other room, so how does this happen?

Wave imprints

What about interference patterns, would anything be different here? Interference is still governed by complex numbers. Using the real component at the screen does not change much, as cancelling waves are still be cancelling waves, and while non-cancelling waves could not reach certain points at the screen, those points are always different, because the waves do not always start their journey in the same phase (with the same z-value), unless they have been modulated accordingly.

What about a single particle reaching a large detector screen with no obstacle at all in between? In standard quantum mechanics we would observe no pattern at all at the screen, except of a concentration of hits at the point corresponding to a straight path. In space particle dualism we would see the same normally, but if we rig the emitter in such a way that it only emits photons that start off with exactly the same z-value, then we could see a pattern of concentric rings.

This pattern is not an interference pattern, because nothing has interfered here. We may instead call it a 'wave imprint'.

The path length to the detector depends on the angle at which the beam hits the detector, according to:

$$L = \frac{d}{\cos \theta}$$

Now we want to calculate by how much θ has to deviate from 0, in order for the pathlength L to increase by a half wavelength, which corresponds to another point where $\Re(z) = 0$. We can calculate that as:

$$d + \frac{\lambda}{2} = \frac{d}{\cos \theta}$$

When we solve for the angle θ, we get:

$$\theta = \cos^{-1}\left(\frac{d}{d + \frac{\lambda}{2}}\right)$$

Typical laser light has a wavelength of 650 nm, which is 6.5×10^{-7} meters. In our example, the distance shall be 0.8 m. That yields an angle of:

$$\theta = 0.000901 \text{ rad}$$

Which is 0.052°. On the screen that is a distance of $\Delta x = d\,\theta = 0.72$ mm. This is well above the smallest distance discernible to the human eye (about 0.1 mm).

The first ten rings are predicted to have the following distances between each other: 0.72 mm (from the center to the first ring), 0.30 mm (from the first to the second ring), 0.23 mm, 0.19 mm, 0.17 mm, 0.15 mm, 0.14 mm, 0.13 mm, 0.12 mm, 0.12 mm.

Of course, a real-world laser has more than one emission point, each with its own corresponding ring structure, and so the resulting structure cannot be a singular concentric ring. Instead, we expect a generic granular structure. At greater distances there are also concentric rings, but those are caused by the well-known phenomenon of diffraction, which is pathways from different emission points interfering with each other.

When looking at laser light that is reflected on a wall, we notice how it appears very granular, like glitter. Brighter and darker spots are clearly discernible even when there is no interference. The laser reflection in fig. 1 was cast from the above-mentioned distance of 0.8 meters, and the wavelength was also as calculated above. We can clearly see a granular structure in the light:

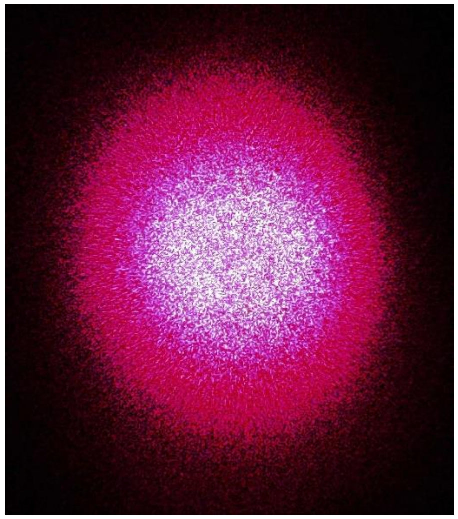

Fig. 1. Granular structure within the reflection of laser light.

When looking at the reflected light without changing perspective, one can see that the bright and dark spots are very stable. They don't move. This suggests that they cannot be caused by the air in between. When sliding back the laser by exactly a half wavelength, then we expect the dark and bright spots to swap positions, and so during the sliding, there should be a lot of flickering motion on the screen which stops when the laser is at rest. It is important that the camera slides back together with the laser, so that the viewing angle is preserved, ruling out that the flickering is caused by a change in perspective.

Normalizing probabilities

Null measurements show that when measuring, particles always need to be found somewhere. So, when applying the measurement rule of SPD-quantum mechanics, then we have to multiply by a factor of two, so that probabilities are again normalized to '1', if not, we get:

$$\sum_i |\Re(z)|^2 = 0.5$$

Whereas in quantum mechanics, we get:

$$\sum_i |\psi\ i|^2 = 1$$

Adding a factor of two fixes this:

$$\sum_i 2\,|\Re(z)|^2 = 1$$

Which implies that detection probabilities are given by:

$$P = 2\,|\Re(z)|^2$$

Or:

$$P = 2\,|\Re(\langle\phi|\psi\rangle)|^2$$

Whereas in regular quantum mechanics it is:

$$P = |z|^2$$

Or:

$$P = |\langle\phi|\psi\rangle|^2$$

If particles always phase in and out of existence when they wave/oscillate, why is it that we will always find them somewhere on a detector screen unless they can tunnel through it? Why is 'not in universe' not a possible measurement outcome? It is because those out-of-universe phases correspond to different particles. As we will learn in chapter 3.3, when the wavefunction waves, a particle goes from particle to antiparticle, then to exotic-antiparticle, then to exotic particle and then to particle. All these phases of course do not really belong to the equivalence group of worlds, and so we can't pick them. They are purely transitory states.

Now this may seem like a handwavy argument, but it is not. Particle type oscillations do happen, but only for neutrinos. For one particle type to be measured as another particle type, the measurement time has to exceed the time for one oscillation. This is only the case for neutrinos. For other particles we can still explore contributions from the other particle type phases, but they are essentially hidden, and inaccessible states. I refer to this phenomenon as 'non-oscillating flavor mixing' (see chapter 3.10).

Patterns in otherwise random systems

Roger Nelson is renowned for his global consciousness project, where he looks at temporal correlations between order within the output of random number generators and big global events.[2] Only when several RNGs display non-randomness at the same time, is that regarded to be a signal. The statistical analysis is of course based on regular quantum mechanics, which does not predict any patterns aside from the basic quantum probabilities.

The RNGs used in his project take measurements at fixed intervals, typically a second. If phase coherence allows us to observe that quantum probabilities vanish when the real component of the wavefunction vanishes, then measuring at fixed intervals can reveal that fact. Based on this we can expect to occasionally see unusually long strings of ones or zeros, that are above what one would expect from random chance.

If such strings of ones or zeros are longer than one would expect from random chance, then it would be easy to mistake them as signals for an observer effect. While such effects are very real, they usually work by assigning specific meanings to the different quantum outcomes, which is not the case in the Nelson's global consciousness project. There the signal is not the prevalence of a particular outcome, but just a lack of randomness in general. It therefore seems to lack the directionality of an observer effect.

Phase coherence is easy to achieve for photons, which are bosons and tend to naturally exhibit macroscopic coherence. However, phase coherence is also possible for fermions, and since radioactive decay depends on the same type of amplitudes as those used for position and impulse, the decay rate too should go down and up again periodically as the real component of the wavefunction disappears and grows back.

The Russian biophysicist Simon Schnoll studied reoccurring patterns within quantum random systems.[3, 4] He observed that even in large data sets, the distributions of values was still far away from being Gaussian. It is likely that Schnoll observed the same phenomenon as Roger Nelson.

When we have phase coherence, then additional patterns appear on top of the otherwise Gaussian distribution.

Somewhat similar work

The Brazilian physicist Celso J. Villas-Boas proposed a framework for understanding why wavefunctions are wavelike in which each photon is entangled with a state in which this photon has not been emitted.[5, 6] These no-photon states could be called dark photon states.

Popular accounts of his theory are often vague enough to fit both his and my theory, because 'dark photon states' sounds a lot like the 'dark photon phases' in space particle dualism. Of course, a state is just part of a superposition, whereas a phase is part of an oscillation of a particle.

Boas' 'dark photon states' do not refer to where to phases where the real component of the wavefunction becomes zero, which would have made his proposal similar to mine, but to binomial states which are states where we look at different total numbers of photons. So basically, the photon is in a superposition of being there and not being there.

While this is an interesting idea, it is sort of blurring the lines between real particles and virtual particles. Sure, one can have superpositions of different numbers of photons, but only as long as one hasn't done the first measurement. There are many experimental setups where photons have already been measured once and still managed to display wave properties. Such experiments appear to disprove Boas' model.

Nonetheless, Boas' theory of dark photon states has striking similarities with space particle dualism. Both theories derive the waviness of probability distributions from something more fundamental, but without trying to get rid of or being bothered by the superposition principle. Most other theories that attempt to derive the wavefunction from something more fundamental are hidden variables theories, constructing wavefunctions from superluminal proto-particles and denying the existence of superpositions and free will.

Both theories accept superpositions as a reality, and both derive the wave nature of wavefunctions by looking at the presence and absence of a particle. In space particle dualism it is a photon oscillating in and out of normal space due to having a complex mass & surface area, while in his theory the photon is in a superposition of being there and not being there.

In his theory, states where there is a photon and the states in which there is no photon just serve as the mountains and valleys of the wave in the interference. So, the theory does not at all suggest that for a single photon the detection probability would go up and down. That is quite different from my theory.

Implications for the uncertainty principle

In standard quantum mechanics, the uncertainty principle relates the uncertainty in the position to the uncertainty in the impulse via:

$$\frac{\hbar}{2} = \Delta x \times \Delta p$$

Solving for position and impulse respectively gives us:

$$\Delta x = \frac{\hbar}{2\,\Delta p}$$

$$\Delta p = \frac{\hbar}{2\,\Delta x}$$

Because the SPD-version of the Born rule is $P = 2\,|\Re(z)|^2$, making the probability dependent on the real component alone and thereby removing half of the possible detection points, the uncertainty in position is reduced by half. We can write that as:

$$\Delta x = \frac{\hbar}{4\,\Delta p}$$

Now we may be tempted to think that the position uncertainty and the impulse uncertainty can no longer be expressed together in a single equation, because the position uncertainty is reduced by half in SPD, and the impulse uncertainty is not, but that is not the case. Since we have reduced the position uncertainty by half, then in order to keep the impulse uncertainty unchanged, we need to compensate for the smaller position uncertainty $\Delta x'$ by multiplying $\Delta x'$ by a factor of 2, to basically undo this change for the impulse, and so that yields $\Delta p' = \hbar/(4\,\Delta x')$. In summary:

$$\Delta x' = \frac{\hbar}{4\,\Delta p'} = \frac{\hbar}{4\,\Delta p}$$

$$\Delta p' = \frac{\hbar}{4\,\Delta x'} = \frac{\hbar}{2\,\Delta x}$$

$$\Delta x' \neq \Delta x$$

$$\Delta p' = \Delta p$$

Here the prime symbol indicates the altered uncertainties in SPD. We can also write:

$$\Delta x_{\text{SPD}} = \frac{\hbar}{4\,\Delta p_{\text{SPD}}} = \frac{\hbar}{4\,\Delta p_{\text{QM}}}$$

$$\Delta p_{\text{SPD}} = \frac{\hbar}{4\,\Delta x_{\text{SPD}}} = \frac{\hbar}{2\,\Delta x_{\text{QM}}}$$

$$\Delta x_{\text{SPD}} \neq \Delta x_{\text{QM}}$$

$$\Delta p_{\text{SPD}} = \Delta p_{\text{QM}}$$

And this yields the SPD-version of the uncertainty principle, namely:

$$\frac{\hbar}{4} = \Delta x \times \Delta p$$

To make clear that in identical physical scenarios, only Δx is reduced, and not Δp, we can additionally clarify that Δp is proportional to the wavelength according to:

$$\Delta p \sim \frac{h}{\lambda^2}\,\Delta\lambda$$

Which is truth both in SPD-quantum mechanics and regular quantum mechanics, and so it implies that $\Delta p_{\text{SPD}} = \Delta p_{\text{QM}}$.

So, in the same physical scenario, we have the same impulse uncertainty Δp, but a smaller corresponding value for Δx. Δp is the one that stays the same and which is essentially determined by the wavefunction and how much it is spread out. It is proportional to the mean impulse $p = h/\lambda$.

This has no impact on the time energy uncertainty, which is still:

$$\frac{\hbar}{2} = \Delta E \times \Delta t$$

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