Failure of the standard interpretation of quantum mechanics: Three experimental falsifications, and a consistent alternative interpretation

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Abstract: For the first time in the history of quantum physics, at least three unrecognized (or ignored) experimental falsifications of fundamental postulates of quantum mechanics are presented. Quantum mechanics postulates that quantum objects are already influenced by the pure intention of researchers to examine a certain quantum phenomenon, that quantum phenomenon have no defined status, until they are measured, that quantum objects being observed by researchers can change afterward what has already happened to another quantum object before, and that particles can have opposite spins at the same time. Although these imaginations are mathematically well founded, they seem to be quite mystical, while the assumptions of the author in contrast are apparent to our reason and cognition. © *2017 Physics Essays Publication*.
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Résumé: Pour la première fois dans l'histoire de la physique quantique, au moins trois falsifications expérimentales non reconnues (ou ignorées) de postulats fondamentaux de la mécanique quantique vont être présentées. La mécanique quantique s'appuie sur l'hypothèse que les objets quantiques sont déjà influencés par la simple intention des chercheurs d'examiner un phénomène quantique donnée, que les phénomènes quantiques n'ont pas de statut défini tant qu'ils ne sont pas mesurés, que les objets quantiques observés par les chercheurs peuvent changer après ce qui est déjà arrivé à un autre objet quantique auparavant et que les particules peuvent tourner dans des sens contraires en même temps. Bien que ces hypothèses soient mathématiquement fondées, elles semblent plutôt ésotériques, tandis que les suppositions de l'auteur, en revanche, peuvent être appréhendées par notre raison et notre connaissance.

Key words: Einstein Podolsky Rosen Paradox; Bell's theorem; Double slit experiments; Quantum eraser; Quantum mechanics; Quantum physics; Binary Quantum Theory (BQT); New Theory of Gravitation (NGT); Special Theory of Relativity; General Theory of Relativity.

I. INTRODUCTION

Before three falsifications of the standard interpretation of quantum mechanics are presented in Sec. IV, I have to explain the essential assumptions of the "Binary Quantum Theory (BQT)." But, what is the motivation for an alternative quantum model beyond today's quantum mechanics? All forces of nature are represented by quanta, what should also be the case with gravitation. But the theory of relativity describes gravitation as a geometric change in space-time. This is the reason why the current concept for gravitation of the theory of relativity cannot be integrated into the theory of quantum mechanics. The BQT allows not only to describe gravitation as a force caused by quanta, by which the gravitation can be unified with the other forces of nature, but also makes it possible to explain the known "quantum mysteries" rationally. As the theory of relativity and the current version of quantum mechanics are very successful in application, most physicists see no need to question these popular theories. But in philosophical terms, there is an urgent need to doubt these theories. The BQT[1] discriminates between free "space particles," which I called "basic-space-particles" (bs-particles) and bound space-particle building up matter, which I called "basic-particles" (b-particles). The bs-particles exist within space "filling up the vacuum" moving randomly through space at the velocity of light. I postulated that bs-particles can adhere to a particle or a mass consisting of b-particles. After a certain time, the b-particles can be emitted again by the mass. The impulse or energy the mass might get by the absorption or adherence of a space-particle is lost again by the emission of the bs-particle. Therefore, according to the BQT, each particle must be accompanied by some kind of "cloud of bs-particles," which consists of bs-particles adhering to the particle. This cloud of bs-particles can be regarded as a "phantom-particle," which represents some kind of three-dimensional imprint of the particle. These particles have not yet manifested as material particles, as we usually realize them. Obviously, phantom-particles can only be detected indirectly by meticulous quantum experiments. If material particles collide with high velocity, the phantom particles get condensed and can then be manifested as usual material particles, what we can see in particle colliders.

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Today's quantum physicists say in this case that energy has been transformed into material particles, not knowing what stands behind the physical construct "energy." According to the BQT, energy is nothing else than moving free bs-particles, unorganized or organized as electromagnetic waves or electrical or gravitational fields, respectively, bound b-particles building up material particles. The emission of bs-particles by electric fields could be interpreted as a "weak" kind of electric field with an opposite polarization, which is historically named "magnetic field." Today, the magnetic force is regarded to be a so-called relativistic effect. By the "New Theory of Gravitation (NGT)," all so-called special and general relativistic phenomena could be calculated and explained easily within a three-dimensional space by using the knowledge that there must exist gravitational effects caused by the movement of photons or particles, respectively, masses within gravitational fields.[1–5] As I am going to point out in detail in the following, also the standard interpretation of Quantum Mechanics cannot correspond with reality.

II. THE BQT INDICATES THAT WE HAVE TO INTERPRET DOUBLE-SLIT (AND TRIPLE SLIT) EXPERIMENTS IN A NEW WAY

In the classical double-slit experiment, first carried out by Young,[6] a single electromagnetic source is split into two, to generate two coherent electromagnetic sources. When the light from the two sources is projected on a screen, an interference pattern is observed. At the center of the screen, the electromagnetic waves from the two sources are in phase. As the distance increases from the center, the path traveled by the light from one source is larger than that traveled by the light from the other source. When the difference in path length is equal to half a wavelength, destructive interference occurs. When the difference in path length is equal to a wavelength, constructive interference occurs. If we do the same double-slit experiment by only "shooting" one electromagnetic wave (photon) after the other through the double-slit over time also an interference pattern emerges. The original explanation of the double-slit experiment mentioned earlier was that the light from one slit was interfering with the light from the other slit, effectively canceling each other out at those points. That made sense because light was continually streaming through both slits. But in this case that only one photon has gone through at a time, what could have interfered with it? If we put a measuring device by each slit, that will record, when a photon goes through the slit the wave interference pattern vanishes. Instead of an interference pattern in this case, we just see a simple particle pattern on the screen. These results of one-photon-at-a-time slit experiments are interpreted by today's physicists as follows: When we do not know which slit the photons are going through, we get a wave interference pattern. When we know which slit each photon traveled through, no interference pattern occurs. The Copenhagen interpretation of such strange quantum phenomena is a consensus among most of the pioneers and today's quantum physicists in the field of quantum mechanics that it is undesirable to postulate anything that goes beyond the mathematical formulae. One of the mathematical conceptions that enables experimenters to predict very accurately certain experimental results is the so-called probability wave. In its mathematical form, it is analogous to the description of a physical wave, but its waves indicate levels of probability for the occurrence of certain phenomena that can be observed, e.g., on a detector screen.

Over the years, the double-slit experiments have been conducted in different ways. In 1961, Jönsson performed the experiment with electrons, and it conformed with Young's experimental results, creating interference patterns on the observation screen.[7] In 1974, technology became able to perform the experiment by releasing a single electron at a time.[8] Again, the interference patterns showed up. But when a detector was placed at the slit, the interference once again disappeared. The experiment has been performed with photons, electrons, and atoms, and each time the same result became obvious—something about measuring the position of the particle at the slit obviously removes the wave behavior. Classical physics draws a distinction between particles and electromagnetic energy, holding that only the latter exhibit waveform characteristics, whereas today's interpretation of quantum mechanics is based on the fact that matter has both wave and particle aspects. This so-called wave-particle duality is the actual accepted principle of quantum mechanics, which implies that light (and particles) sometimes act like a wave, and sometimes act like a particle, depending on the experiment that is performed. The requirement for the appearance of an interference pattern is that particles are emitted, and that there is a screen with at least two slits between the emission apparatus and the detection screen. It is essential that both slits have an equal distance from the center line, and that they are within a certain maximum distance of each other that is related to the wavelength of the particle being emitted. It is postulated that one can know nothing about what a light particle or elemental particle is doing between the time it is emitted and the time it triggers a reaction on the screen. If one does anything to try to locate a photon or a particle between the emission and the detection screen will change the result of the experiment. If, for example, a device is used in any way that can determine whether a particle has passed through one slit or the other, the interference pattern formerly produced will disappear.

According to the BQT, each particle must be accompanied by some kind of phantom-particle, which consists of bs-particles adhering to the particle for a certain time. This phantom-particle consisting of bs-particles represents some kind of three-dimensional imprint of the particle. We can postulate at least some qualities of these phantom-particles: 1. The phantom-particle adhered to a photon or other particles, respectively, matter, consists of bs-particles, which get emitted from the photon or other particles after a certain time, whereas the adherence and the emission of bs-particles are balanced. 2. The phantom-particle must be invisible, as the bs-particles filling up space are invisible. 3. As the **cloudlike** phantom-particle is not manifested as an electromagnetic wave or a material particle, it is unable to cause a pattern on the screen of a slit experiment itself. 4. A phantom-particle should occupy space.

If a photon or another particle is accompanied by an adhered cloudy phantom-particle consisting of bs-particles, one needs not much fantasy to imagine that there results a problem, if one shoots a photon or another particle through a very small slit. As the invisible phantom-particle occupies space, both "particles" should not fit through the slit together. So, the phantom-particle is forced to give up the adherence to the photon (or particle), so that the photon, respectively, the particle, is passing though the slit alone. If there is a second slit, just beside the other slit, as it is the case at double-slit experiments, the phantom-particle is able to pass through the second slit, while the photon, respectively, the particle, is passing through the other slit or contrariwise. Behind the two slits, the photon (or particle) and its phantom-particle will try to adhere to each other again, so that the photon (or particle) and the phantom-particle move toward each other, which causes on the one hand an increased number of photons (particles) in a certain area on the detector screen behind the double-slit and on the other hand a decreased number of photons (particles) on the detector screen beside the area with an increased number of photons. As the flying-direction of photons (particles) and phantom-particles behind the double-slit is not always exactly the same, but is spread over a certain range with a smaller number of photons toward the periphery, there must result not only one band but a pattern of bands, with the largest band of arriving photons (particles) in the middle of the screen and smaller bands beside. This band pattern is interpreted as an interference pattern. If there is only one slit, of course no interaction between the photon, respectively, the particle, and its phantom-particle can result, so that there cannot happen an interference pattern. This explains why single photons or elemental particles seem to behave like particles, if they are shot through one small slit, and behave seemingly like waves, if they are shot through a double-slit. If we block one of the paths between the two slits and the screen, after the photon (particle) or phantom-particle has already passed through one of the two slits, of course we cannot notice an interference pattern on the detecting screen, because we hinder the interaction between the photon (particle) and the phantom-particle. This is explained by today's quantum physics, as if the observer influences the result of the experiment in such a way that the nature of the studied particle is undetermined until it is measured or observed. Only by measurement or observation should be determined, whether the photon or elementary particle has gone through one of the two slits as a particle or through both slits as a wave. The observation or measurement should ultimately decide whether the photon or elementary particle behaves as a particle or as a wave. Hereafter, quantum states are undetermined, until an observation or measurement is made, which is in contrast to our experiences in the macroscopic world.

In 1926, the German physicist Max Born postulated that interference can only happen between pairs of quantum objects, causing their wavelike forms to boost and diminish one another. Triplets, quadruplets, or more shall not be able to interfere. Therefore, Born put interference contributed by a third slit (and any more slits) at exactly zero. The result of a triple-slit experiment by Sinha *et al*. published in 2010 in Science confirmed the postulate of Born.[9] In the experiment, only pairwise interferences could be measured, but no three-way interference. The reason why quantum interference stops at two slits is not clear and till now it is not able to derive "Born's rule" from a deeper principle about the way the quantum world is structured. According to the imaginations introduced here, a quantum object (particle or photon) is always accompanied by a phantom-particle, so that one can speak of a "paired quantum object," whereas only the usual particle is realized as matter and can cause a pattern at a detection screen. This explains why particles can only interfere "pairwise" at double-slits and also more slits, as it is postulated by Born's rule and confirmed by the experiment of Sinha *et al*.[9] In this experiment, 8 opening combinations with different probability terms were measured: A open, B open, C open, AB open, AC open, BC open, ABC open, and all slits blocked. My interpretation of the experimental result is simple: If only one slit is open, the particle passes through the slit and gets separated from its phantom-particle, as the slit is too small for the particle and the phantom-particle to pass through the slit together, so that no interference can happen. If two slits are open, the particle passes through one of the slits and the phantom-particle passes through the other slit. After the slit, the particle and its phantom-particle cause an interference pattern. If all three slits are open (A, B, C), the particle passes through one of the slits and the phantom-particle through another slit, so that the third slit does not contribute an additional interference compared with the situation that only two slits are open.

Physicists often think that with a successful mathematical description of a phenomenon, the phenomenon is already sufficiently explained, as in the example of Born's rule. But for philosophers, this is not satisfactory, as they want to understand the reason, why reality behaves like that, as it can be described by a certain mathematical calculation.

III. THE BQT INDICATES THAT WE HAVE TO INTERPRET QUANTUM EXPERIMENTS USING BEAM SPLITTERS (BS) IN A NEW WAY

A photon directed at tilted glass either goes through, bounces off, or sometimes gets absorbed; the angle of the glass makes the difference. One can adjust the angle of the glass to get a 50:50 chance of reflect or go through. If you use further BS in an experimental arrangement to put the two beams together again, after the beam has passed the first BS, you can get an interference pattern, not unlike the one depicted in a double-slit experiment. However, if you use only one photon to go through the experimental arrangement at a time, you still see the same effect, implying that the photons go both ways also causing a well-defined interference pattern on the detection screen. How can single photon interfere with itself? The indication is that: if no detectors are present, the individual photons somehow split. If detectors are not present, the individual photons do not split. In an experiment of Alley *et al*.,[10] there had been realized a delayed choice experiment with BS with fast detectors that could be switched into the photon beam after it went through the

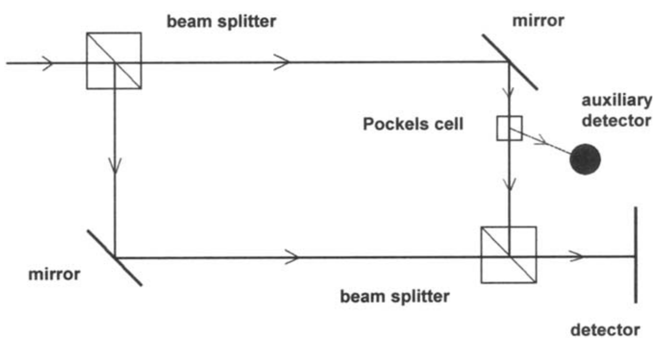

FIG. 1. Setup of the delayed-random-choice quantum mechanics experiment of Alley *et al*. (Ref. 10).

splitter (see Fig. 1). In this experiment, a so-called Pockels cell was installed in the middle of one route. Pockel cells are voltage-controlled wave plates, which may rotate the polarization of a passing electromagnetic wave or may diffract the passing electromagnetic wave from its path. Switching between no optical rotation and 90° rotation can create a fast shutter capable of "opening" and "closing." See about the setup of the experiment in Fig. 1. If an electric current was applied to the Pockels cell, it diffracted photons to an auxiliary detector. Otherwise, photons passed through the cell unhindered. A random signal generator made it possible to turn the cell on or off after the photon had already passed the BS but before it reached the detector. When the Pockels cell detector was switched on, the photon seemed to behave like a particle and traveled one route or the other, triggering either the auxiliary detector or the primary detector, but not both at once. If the Pockels cell detector was off, an interference pattern appeared in the detector at the end of both paths, seemingly indicating that the photon had traveled both routes. The result of this and similar experiments (so-called experimental realizations of Wheeler's delayed-choice Gedanken experiment[11]) seem to indicate that even if you try to make a measurement after a photon has already passed a BS and chosen a certain path, the measurement will destroy the wave character of the photon or a particle. In the experiment described here, whenever an auxiliary detector is present, it results in an interference pattern at the detector, whenever the auxiliary detector is absent, there results an interference pattern.[10] We have to consider that a phantom-photon is relatively loosely attached to a photon. Because of its inclination to move on its way at a BS and pass through it, but also because of its inclination to get reflected at a BS, we expect the following. If a photon is reflected at a BS, one part of the phantom-photon keeps attached to the photon, another part moves through the BS as a "free phantom-photon." If the photon moves through the BS (Fig. 1), one part of the phantom-photon passes through the BS with the photon and one part gets reflected at the BS as a free phantom-photon. Let us first examine the situation the Pockels cell is switched off: If the reflected photon moves the lower path after the BS with its phantom-particle and the other free part of the phantom particle moves the upper path, there can result an interference pattern at the detector screen. In this case, the free part of the phantom-photon will try to adhere to the photon again in front of the detector screen causing an interference pattern. If the photon moves the upper path through the BS with its part of the phantom-particle, while the free part of the phantom-particle moves the lower path, the free part of the phantom-particle will try to adhere to the photon again. If the Pockels cell is switched on by applying an electric field to the crystal medium, either the photon moving the upper path gets diffracted toward the auxiliary detector, so that of course no interference pattern can emerge, or the free part of the phantom-particle moving the upper path is hindered on its way toward the detector screen, so that also in this case no interference can emerge.

IV. FALSIFICATION OF FUNDAMENTAL POSTULATES OF QUANTUM MECHANICS BY EXPERIMENTS USING PARAMETRIC CONVERTERS IN COMBINATION WITH BS AND INTRODUCTION OF AN CONSISTENT ALTERNATIVE INTERPRETATION

Since the famous laser experiments of Mandel of the University of Rochester in the Nineties of the last century, who operated with entangled photons instead of double-slit experiments, generated by so-called parametric down-conversion in nonlinear optical crystal, classical interpretations of double-slit and similar quantum experiments are widely regarded to be obsolete. For the so-called down conversion, he used nonlinear optical crystals, for example, consisting of Beta-Barium borate (BaB_2O_4), whereas the crystal converts a high-energy photon in an entangled pair of photons of lower energy (half the energy of the original photon), so that the wave-length of the primary photon is doubled. The photons generated in a parametric converter are strongly correlated with each other regarding direction, energy, and polarization. For this reason, they are used by quantum physics to investigate the behavior of so-called "twin-photons." (Why the so-called Bell's theorem and the basic assumptions of Bell's inequality must be wrong is pointed out in Sec. VII.)

But before we discuss an important quantum experiment of Mandel and coworkers[12] using parametric converters, we have to examine the experiments of Kim *et al.*[13] The delayed choice quantum eraser experiment of Kim *et al.*[13] is realized, as shown in Fig. 2. A pump laser beam passes a double slit.

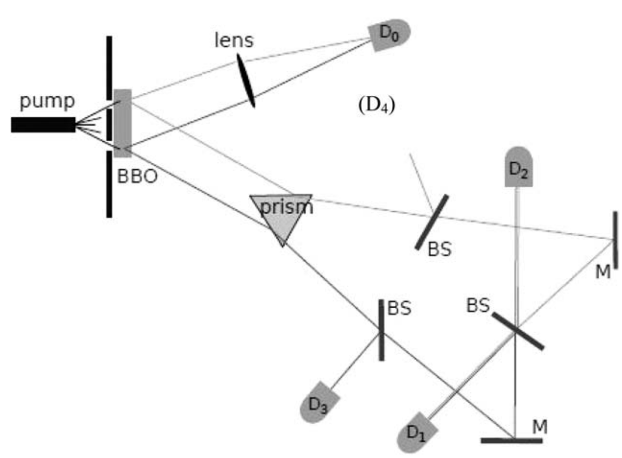

FIG. 2. Setup of the "quantum eraser" experiment of Kim *et al*. (Ref. 13).

A (BaB_2O_4) (BBO) crystal splits each photon in two entangled photons. The detector D_0 is moveable and detects the photon traveling upward ("signal photon") and can scan over various positions to detect an interference pattern. The photon going downward ("idler photon") is received by a prism and a set of BS and mirrors (M). If the idler is detected by D_3 (the detector D_4 was not realized in the experiment), it can only have come through one of the two slits. If it is detected by D_1 or D_2, it may have traveled via either of the two ways, and does not reveal any which-path information. The arrangement is such that the detection of each signal photon always occurs before the detection of the corresponding idler photon. The outcome of the experiment was as follows: signal photons for which the corresponding idler photon later reveals which-path information, do not show an interference pattern. Their detection rates are precisely those of collapsed, single slit paths. Signal photons for which the idler does not reveal any path-information form an untouched interference pattern. So, interference at D_0 only occurs for events where the idler photon is detected at D_1 or D_2.

The actual accepted interpretation of this experiment goes from the imagination that without the possibility to get which-way information one single photon moves through both slits of the double-slit in front of the BBO crystal. After the double-slit, each "part of this single photon" is then split at the BBO crystal into an idler photon moving downward in the direction of the detectors D_1, D_2, D_3, (D_4), and a signal photon moving upward toward the detector D_0, in front of which the signal photon interferes with itself (the detector D_4 was not realized in the experiment). But this interference can only happen if the idler photon moving downward is detected at the detector D_1 or the detector D_2, because then we are not able to get which-path information. If the idler photon is detected at the detector D_3, we are able get which-path information, what shall destroy the possibility of the signal photon to interfere with itself. In this case, the original photon has gone only through one of the double-slits in front of the BBO crystal although it had gone through both double-slits before the idler photon was detected at the detector D_1 or D_2. In this case, the signal photon cannot interfere with itself, although it shall have gone through both slits of the double-slits in front of the BBO crystal before the idler photon was detected at the detector D_1 or D_2. The joint detection rates found between detectors D_0 and D_1 ($=R_{01}$), between D_0 and D_2 ($=R_{02}$), and between D_0 and D_3 ($=R_{03}$) are shown in Figs. 3–5. The joint detection rates found between detectors D_0 and D_4 ($=R_{04}$) would be the same as those found between D_0 and D_3 ($=R_{03}$), if the detector D_4 was realized in the experiment.

In the experiment of Kim *et al.*,[13] the detector D_4 was not realized. This seems to have a reason and that Kim wanted to conceal a contradiction: If we added the interference pattern of the joint detection rates between the detector D_0 and D_1 and the joint detection rates between detectors D_0 and D_2, we would get a pattern comparable to the noninterference pattern registered between detectors D_0 and D_3. But if we added the joint detection rate between detectors D_0 and D_3 and the same join detection rate we would have measured, if the detection between detectors D_0 and D_4 had been realized, we would get a noninterference pattern with a twice as high joint detection rate in comparison to the joint detection rate between detectors D_0 and D_1 and the joint detection rate between detectors D_0 and D_2. According to today's interpretation of quantum physics, there must result a 50% probability of the joint detection between the detectors D_0 and D_3 and the (not realized) detectors D_0 and D_4 and also a 50% probability of the joint detection between detectors D_0 and D_1 and D_0 and D_2. But if we get a noninterference pattern with a twice as high joint detection rate between detectors D_0 and D_3 and D_0 and D_4 in comparison to the sum of the joint detection rates between detectors D_0 and D_1 and D_0 and D_2, the probability of the joint detection of an idler photon at detectors D_3 and D_4 must be twice as high than the probability of the joint detection of an idler photon at detectors D_1 and D_2. If Kim had realized detector D_4 in the experiment, this contradiction against today's interpretation of quantum physics would have been easy to notice.

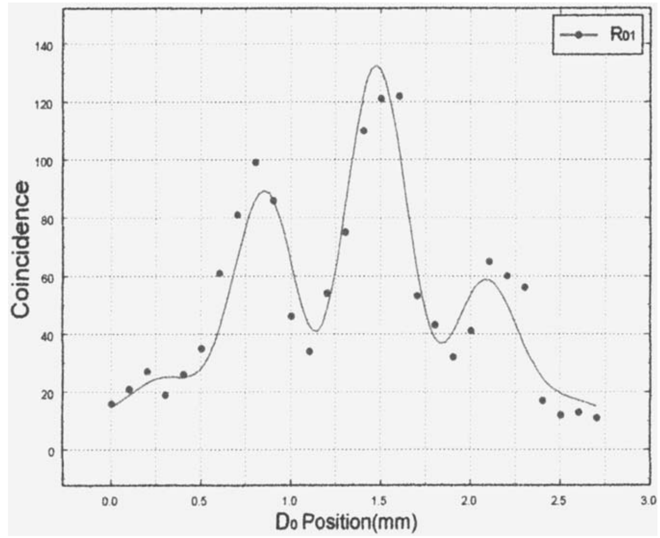

FIG. 3. R_{01} (joint detection rate between detectors D_0 and D_1) (Ref. 13).

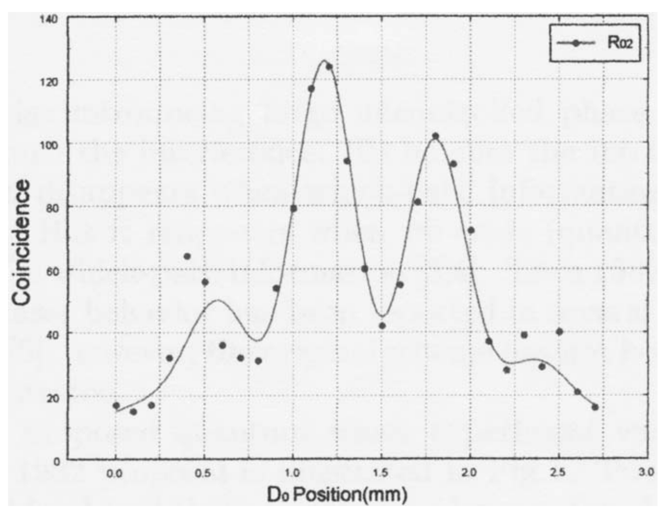

FIG. 4. R_{02} (joint detection rate between detectors D_0 and D_2) (Ref. 13).

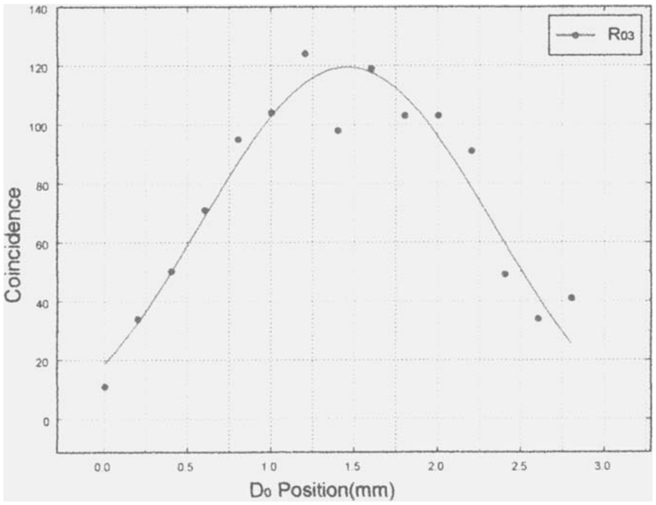

FIG. 5. R_{03} (joint detection rate between detectors D_0 and D_3) (Ref. 13).

My interpretation of the experiment is again very simple: At the double-slit, the single photon is parted from its accompanying phantom-photon, as already explained earlier. At the BBO crystal, the photon is split into two photons with half of the energy of the former photon, one moving downward in the direction of detectors D_1, D_2, D_3, and (D_4) as an idler photon and one photon moving upward to the detector D_0 as a signal photon. But the phantom-photon has no exactly defined energy and therefore cannot be divided at the BBO crystal, so that it either moves downward in the direction of detectors D_1, D_2, D_3, and (D_4) or upward in the direction of the detector D_0. If the phantom-photon moves the lower paths toward the detectors D_1 or D_2, no interference between the signal photon and the phantom-photon in front of the detector D_0 is possible. But in this case, the phantom-photon will cross the path of the idler photon at the BS between detector D_1 or D_2 and will hereby collide with the idler photon that gets diffracted from its path, so that the idler photon cannot be registered at the detector D_1 or D_2. In this case, no interference pattern can emerge and only a joint detection of the signal photon at the detector D_0 and the idler photon at the detector D_3 is still possible. If the phantom-photon moves the upper paths toward the detector D_0, the phantom-photon and the signal photon also moving the upper path try to adhere to each other again, so that they move toward each other, which causes on the one hand an increased number of photons in a certain area on the detector screen and on the other hand a decreased number of photons on the detector screen beside the area with an increased number of photons. As the flying direction of the photons and the phantom-photon is not always exactly the same at the time they are attracting each other, but is spread over a certain range with a smaller number of photons toward the periphery, there must result not only one band, but a pattern of bands, with the largest band of arriving photons in the middle of the screen and smaller bands beside. This band pattern is interpreted as an interference pattern. In this case, the phantom-photon does not cross the path of the idler photon at the BS between the detector D_1 or D_2, so that the idler photon can move unhindered toward the detectors and can be registered at the detector D_1 or D_2. But in this case, it is also possible that the idler photon gets deflected from its path and be registered at the detector D_3 and the not realized detector D_4.

If the phantom-photon moves the upper paths toward the detector D_0, the probability that detectors D_0 and D_3 is triggered by the signal photon and its entangled idler photon is 25%, as well as the probability that detectors D_0 and D_4 would be triggered by the signal photon and its entangled idler photon (if realized in the experiment). Also, the probability that detectors D_0 and D_1 is triggered by the signal photon and its entangled idler photon is 25%, as well as the probability that detectors D_0 and D_2 is triggered by the signal photon and its entangled idler photon. If the phantom-photon moves the lower paths toward the detector D_1 or D_2, the probability that detectors D_0 and D_3 is triggered by the signal photon and its entangled idler photon is still 25%, as well as the probability that detectors D_0 and D_4 would be triggered by the signal photon and its entangled idler photon (if realized in the experiment). But the probability that detectors D_0 and D_1 or D_0 and D_2 is triggered by the signal photon and its entangled idler photon is 0%, as the phantom-photon will cross the path of the idler photon at the BS between detector D_1 or D_2 and will hereby collide with the idler photon that gets diffracted from its path, so that it cannot be registered at the detector D_1 or D_2. As the interference pattern, which should result by the joint detection at the detector D_0 and D_3 (if the phantom-photon moves the upper paths) is overlapped by the noninterference pattern, which results by the joint detection at the detector D_0 and D_3 (if the phantom-photon moves the lower paths), no interference pattern on the whole can result in the case of a joint detection at the detector D_0 and D_3, apart from a small fluctuation in the middle of the curve, what becomes visible in the fact in Fig. 5.

According to my imagination, the probability of a photon to be registered at detectors D_3 and D_0 is 25%, as well as the probability to be registered at detectors D_4 and D_0 (not realized in the experiment) is 25%, no matter if the phantom-photon moves the upper paths toward the detector D_0 or the lower paths toward the detector D_1, respectively, D_2. The probability of a photon to be registered at detectors D_1 and D_0 is 25%, as well as the probability to be registered at detectors D_2 and D_0 is 25%, if the phantom-photon moves the upper paths toward the detector D_0. But the probability of a photon to be registered at detectors D_1 and D_0 is 0%, as well as the probability to be registered at detectors D_2 and D_0 is 0%, if the phantom-photon moves lower paths toward the detector D_1, respectively, D_2. Adding the probabilities of the joint detections at detectors D_3 and D_0, we get a $2 \times 25\%$ probability for both possible paths of the phantom-photon. Adding the probabilities of the joint detections at detectors D_4 and D_0, we also get a $2 \times 25\%$ probability for both possible paths of the phantom-photon. But adding the probabilities of the joint detections at detectors D_1 and D_0, we get only a $1 \times 25\%$ probability for both possible paths of the phantom-photon. Adding the probabilities of the joint detections at detectors D_2 and D_0, we also get only a $1 \times 25\%$ probability for both possible paths of the phantom-photon. On the whole, the probabilities of the joint detections at

TABLE I. Joint detection rates of the experiment of Kim *et al.*[13]

Position D_0 (mm)	Coincidence D_0 and D_1 (about)	Coincidence D_0 and D_2 (about)	Coincidence D_0 and D_3 (about)	Coincidence D_0 and D_4 (about)
0.25	20	20	40	40
0.5	30	50	60	60
0.75	80	30	80	80
1.0	40	80	105	105
1.25	50	100	125	125
1.5	120	40	120	120
1.75	40	100	115	115
2.0	40	60	100	100
2.25	40	30	90	90
2.5	15	30	50	50
2.75	15	15	30	30
Sum	490	560	925	925

detectors D_1 and D_0 and at D_2 and D_0 are also $2 \times 25\%$ for both possible paths of the phantom-photon. This is the reason why we get a pattern comparable to the noninterference pattern registered between detectors D_0 and D_3, if we added the interference pattern of the joint detection rate between detectors D_0 and D_1 and the joint detection rate between detectors D_0 and D_2. But there remains the sum of the probability of the joint detections at the D_4 and D_0 of $2 \times 25\%$ (not realized in the experiment). For the sum of the probabilities of the joint detections at detectors D_3 and D_0 and D_4 and D_0, we get double the values ($4 \times 25\%$) compared to the sum of the probabilities of the joint detections at detectors D_1 and D_0 and D_2 and D_0 ($2 \times 25\%$). This corresponds with the result of the experiment of Kim *et al.*[13] See Table I. **The experimental result therefore represents a first falsification** of today's interpretation of fundamental quantum phenomena by quantum mechanics.

A second falsification of the current interpretation of double slit and similar experiments using BSs results from the following considerations: BSs are optical components used to split light at a certain ratio into two separate beams. One photon reaching a BS has, for example, a 50/50 probability to pass through the BS or to be reflected at the BS. According to today's quantum physics, the photon must have passed both paths, if we do not measure or are not able to measure which path the photon has taken at the BS. But if we tried to get which-path information, we would find out that the photon has either been reflected or has been passed through the BS. Using the assumption that photons behave like probability waves that collapse when we try to measure them, there is no contradiction against today's physics.

But there results another problem: If we do not measure which way the photon has used through the BS, the photon must have passed both paths. This means that the BS must have split the photon into two parts, each with half of the original energy, so that the BS must have functioned as a converter. But if we, for example, after one second, examined one of the two ways of the half photons, we would find a photon with the whole energy of the original photon. In this case, both halves of the original photon must already have been departed by a large distance from each other, before we register the photon. If this corresponds with reality, by our measurement, one half of the energy of the original photon must immediately be transported through space, with a faster velocity than the speed of light toward the other half of the original photon. Where should the energy come from that should be needed for this transport, beside the necessary unrealistic high velocity. All that is no problem for today's quantum physicists by postulating that the property of quantum objects remains undefined, until we measure it, so that the property of the measured quantum object gets a well-defined meaning only when analyzed. According to quantum physics, no energy transport is needed, as quantum phenomena shall be only probability waves, of which one of the probability waves collapses, if we want to measure one of it. By such arguments, quantum physics must always be right.

Analyzing the experiment of Kim *et al.*[13] meticulously, we find a second falsification and not a verification of today's interpretation of quantum physics of the behavior of quantum phenomena. In the experiment, the joint detection rate between detectors D_0 and D_1 and between D_0 and D_2 was measured separately, but not at the same time. If we go from the imagination of today's quantum physics, that at a 50/50 BS a photon moves both paths, if we are not able to get which-path information, always when the photon moves both paths through the BS between the two detectors D_1, D_2 there must happen a detection at the detector D_1 and the detector D_2 at the same time. In other words, it can never happen that only the detector D_1 or the detector D_2 measures a joint detection rate, if we are not able to get which-path information. If today's interpretation of this quantum experiments was right, the joint detection rate between detectors D_0 and D_1 and between detectors D_0 and D_2 should each have double the value than the joint detection rates measured between detectors D_0 and D_3 or between detectors D_0 and D_4. But as we already pointed out earlier, the opposite is right. This is again an undeniable contradiction against the postulates of today's quantum physics, in this case primary with respect to the behavior of a quantum object at BSs, but secondary also with respect to the fundamental postulates of today's quantum physics on the whole.

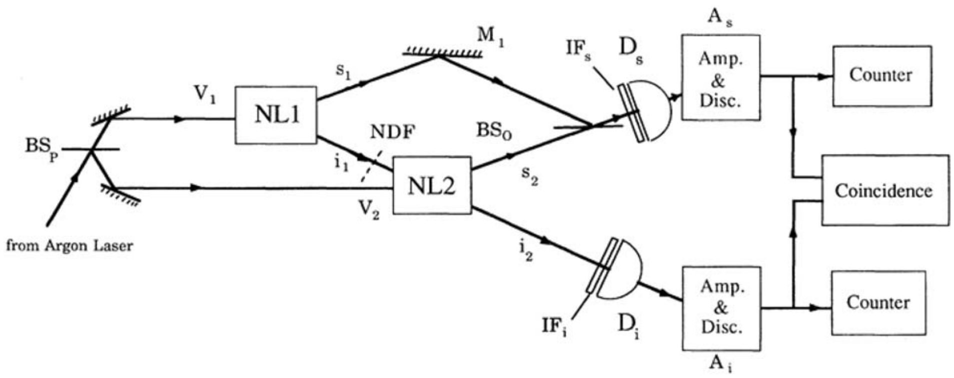

FIG. 6. Setup of the experiment of Mandel and coworkers (Ref. 12).

Today's quantum physics of basic quantum phenomena postulates that at a BS, a photon or another quantum object moves both paths, if we do not try to measure which-path the photon moves and also, if we cannot determine which path the photon has moved. Only if we are able to gain which-path information, the photon is forced to take one path and either gets reflected at the BS or passes through it. Without the possibility of gaining which-path information, the postulated probability wave representing a quantum object shall not collapse and the status of the quantum object shall keep being undefined. But as explained earlier, each idler photon could have always moved only one path of the possible two paths at the BS between detectors D_1 and D_2, either toward the detector D_1 or the detector D_2. Therefore, in reality, the postulated probability wave representing a quantum object (photon) does not collapse at the BS between detectors D1 and D2 and the status of the quantum object (photon) must be well defined at the BS between detectors D1 and D2, if we can or cannot get which-path information does not matter.

Now we are able to discuss an important experiment of Mandel and coworkers[12] of the University of Rochester in the nineties of the last century. In one of his experiments, a laser fires light at a BS (see Fig. 6). In the experiment, Mandel could either register only the counting rate at the detector D_s ($=R_s$) or register only the counting rate at the detector D_i ($=R_i$), but also the coincidence counting rate between detectors D_s and D_i, (R_{si}). Typical counting rates are about 5000/s for R_i, 400/s for R_s, and 4/s for the coincidence rate R_{si}. In the experiment, Mandel examined a second-order interference by counting the detections at the detector D_s. Reflected photons are directed to one down-converter (NL2), while transmitted photons go to another down-converter (NL1). Each down-converter splits any photon impinging on it into two lower-frequency photons one called the signal and the other called the idler. The two down-converters are arranged so that the two idler beams merge into a single beam. Mirrors steer the overlapping idlers to one detector and the two signal beams to a separate detector. In front of the detector D_s, an interference can happen at the beam splitter BS_0. This design does not permit an observer to tell which way any single photon went after encountering the BS. According to established quantum physics, each photon therefore seems to go both ways, right and left at the beam splitter BS_p like a wave and passes through both down-converters, producing two signal wavelets and two idler wavelets. Subsequently, the signal wavelets generate an interference pattern at the detector D_s. The pattern is revealed by gradually lengthening the distance that signals from one down-converter must go to reach the detector. As the down conversion happens spontaneously, the signal photons and the idler photons, once emitted by the down-converters, never again cross paths. Nevertheless, simply by blocking the path of one set of idler photons or by misalignment of the two idlers, the researchers destroy the interference pattern of the signal photons (see Fig. 7). Misalignment of the two idler photons—the researchers can destroy the interference pattern of the signal photons—indicates a causal process. But the only answer Mandel can give us is that the observer's potential knowledge has changed. In this case, one can determine the route taken by the signal photons to their detector by comparing their arrival times with those of the remaining, unblocked idler photons. The original photon seems therefore no longer able to go both ways at the BS, like a wave, but must either bounce off or pass through like a particle. A quite mystical interpretation, which today's quantum physicists still believe to be real.

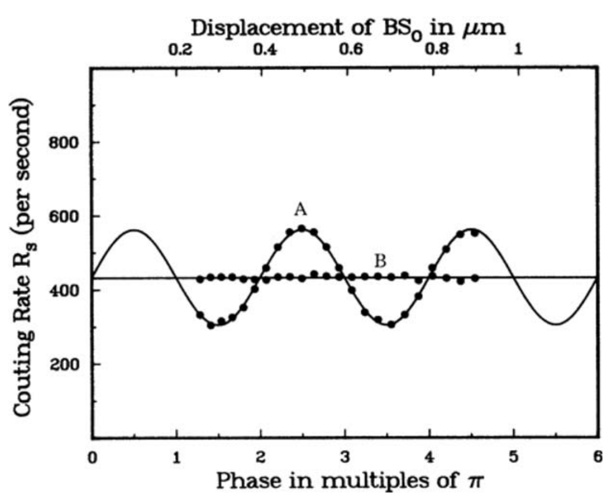

FIG. 7. Measured photon counting rate as a function of beam splitter BS_0 displacement. Curve A: NDF between NL1 and NL2 (interference). Curve B: beam stop inserted between NL1 and NL2 (no interference) (Ref. 12).

Mandel writes in his article on p. 3 (p. 320 of the paper)[12]: "All interference effects vanish, when the idlers i_1 and i_2 are effectively disconnected from each other. This phenomenon appears strange. Moreover, (as) i_1 emission by NL1 and s_2 emission by NL2 almost never accompany each other." In other words, the emission of the idler photon i_1 by NL1 is almost never accompanied with the emission of the idler photon i_2 by NL2, as the emission of the signal photon s_2 by NL2 must always happen at the same time with the emission of the idler photon i_2 by NL2. If the original photon would move both paths at the BS, as it is the dogma of today's quantum physics, every emission of an idler photon i_1 by NL1 must be accompanied with the emission of an idler photon i_2 by NL2. In the experiment, the idler photon i_1 by NL1 is almost never accompanied by the idler photon i_2 by NL2. In other words, Mandel's experimental result contradicts his own postulation that each photon must have moved both paths at a BS at the beginning of the experimental device, at least if an interference happened.

This represents a third falsification of the imagination of today's quantum physics. The postulation of Mandel that a photon gets either reflected at a BS or passes through a BS, but not both paths, is again verified also by Mandel's experiment. Mandel felt the contradiction or was at least astonished, but he wrote the hint in a manner that one could easily overlook it, as he would not have had an imagination about another than the usual explanation.

Our interpretation of the experiment of Mandel and coworkers[12] therefore has to go from what we found out at our analysis of the experiment of Kim *et al.*[13] and from what we are able to measure about the behavior of photons at BSs: Photons either get reflected at a 50/50 BS or pass through a BS. We do not want to go out from what we will never be able to measure, as today's quantum physicists do, namely, that one single photon might also take both paths, being reflected at a BS and passing through the BS.

We can now also postulate more qualities of the phantom-particles, with which all optical quantum experiments can be explained understandably: 1. The phantom-particle adhered to a photon or other particles, respectively, matter, consists of bs-particles, which get emitted from the photon or other particles after a certain time, whereas the adherence and the emission of bs-particles are balanced. 2. The phantom-particle must be invisible, as the bs-particles filling up space are invisible. 3. As the **cloudlike** phantom-particle is not manifested as an electromagnetic wave or a material particle, it is not able to cause a pattern itself on a screen or detector of a slit or similar experiment. 4. A phantom-particle should occupy space. 5. If a photon gets reflected at a BS a part of the phantom-particle gets reflected with the photon, while another part moves through the BS as a free phantom-particle. 6. If the photon moves through the BS, one part of the phantom-particle keeps attached to the photon and passes through the BS with the photon, while the other gets reflected at the BS as a free phantom-particle. 7. A free phantom-particle should partially move through and partially be reflected at the BS. 8. At a BBO crystal, the phantom-photon cannot be divided, as it has no exactly defined energy, so that it either moves the one or the other way at the BBO crystal. 9. At a usual mirror, which reflects all photons, also a phantom-particle should get reflected. 10. At a lens, a free phantom-photon gets deflected the same way, as the photon it was attached. Let us first analyze the experimental situation with an inserted beam stop by a neutral-density filter (NDF) with a transmission rate of 0. Taking the first case: A photon gets reflected at the BS and moves with its attached phantom-particle toward the down-converter NL2, where they get split, so that the idler photon i_2 with its phantom-photon can be detected at the detector D_i and the signal s_2 photon with its phantom-photon can be detected at the detector D_s. In front of the detector D_s, the signal s_2 photon can interfere with the free part of the original phantom-particle, if it moves the upper way through the down-converter NL1 either toward the detector D_i or the detector D_s: An interference pattern can be registered in half of the cases. Taking the second case: A photon and its part of the phantom-particle moves through the BS toward the down-converter NL1, where they get split. In this case, a part of the phantom-particle gets reflected at the BS as a free phantom-particle and moves toward the down-converter NL2 and afterward either toward the detector D_s or the detector D_i. If the free phantom-particle moves toward the detector D_s, it could interfere with the signal photon s_1 coming from the down-converter NL1: An interference pattern can be registered in half of the cases. But why could not Mandel register an interference pattern, as I postulated it earlier for the case that a beam stop by a NDF with a transmission rate of 0 was inserted between the down-converters NL1 and NL2 or with a misalignment of the path of the idler photon i_1 and the idler photon i_2?

This is easy to explain: It is important to consider that Mandel examined a second-order interference by counting the detections only at the detector D_s (no coincidence rate.) Typical counting rates were about 400/s for R_s. In case the photons move through the BS toward the down converter NL1, the signal photons s_1 interfere with the beam of free parts of phantom-particles coming from the down converter NL2, so that the signal photons s_1 get deviated in front of the detector Ds toward the left. In case the photons get reflected at the BS and move toward the down converter NL2, the signal photons s_2 interfere with the beam of free parts of phantom-particles coming from the down converter NL1, so that the signal photons s_2 get deviated in front of the detector Ds toward the right. A higher counting rate at the one interference pattern is therefore compensated by a lower counting rate at the other interference pattern. A lower counting rate at the one interference pattern is compensated by a higher counting rate at the other interference pattern. On the whole, we cannot see both interference pattern, as they cancel out each other, what was interpreted by Mandel that no interference happened at all.

Let us next analyze the experimental situation **without** a beam stop by a NDF with a transmission rate of 0 inserted between the down-converters NL1 and NL2 or **without** a misalignment of the path of the idler photon i_1 and the idler photon i_2. A laser fires photons toward the beam splitter BS_p (see Fig. 6). Reflected photons are directed to one down-converter (NL2), while transmitted photons go to another down-converter (NL1). If the photon moves through the BS, the phantom-photon will partially keep attached toward its photon, but partially will be reflected at the BS as a free phantom-particle. If the photon gets reflected at the BS, the phantom-photon will partially keep attached toward the reflected photon, but partially will move through the BS as a free phantom-particle. The down-converter NL1 splits any photon impinging on it into two lower-frequency photons one called the signal photon and the other called the idler photon. The down-converter NL2 splits any photon impinging on it into two lower-frequency photons one called the signal and the other called the idler photon. But the free phantom-photon has no exactly defined energy and therefore cannot be divided at the BBO crystal, so after the down-converter NL1 or NL2, the free phantom-photon either moves upward in the direction of the detector D_s or it moves downward toward the detector D_i.

Taking the first case: A photon with its part of the phantom-particle moves through the BS toward the down-converter NL1, where the photon gets split. In this case, a part of the phantom-particle gets reflected at the BS as a free phantom-particle and moves toward the down-converter NL2 and afterward either toward the detector D_s or D_i. But we have to consider, that without a beam stop on the path of the idler photons i_1 or without a misalignment of the path of the idler photon i_1, the beam of parts of free phantom-particles, which move toward the detector D_S after the down converter NL2, must pass the beam of idler photons i_1 (very close), which is necessary to keep the path of the idler photon i_1 and i_2 connected. In this case, we must expect that the beam of free parts of phantom-particles gets scattered by the beam of idler photons i_1. The scattered beam of free phantom-particles that moves toward the detector D_s after the down converter NL2 cannot interfere with the signal photon s_1 coming from the down-converter NL1 any more: No deviation of the signal photons s_1 toward the left happens in front of the detector, and no interference pattern can be registered in this case.

Taking the second case: A photon gets reflected at the BS and moves with its part of the phantom-particle toward the down-converter NL2, where the photon gets split, so that the idler photon i_2 can be detected at the detector D_i and the signal photon s_2 at the detector D_s. Without a beam stop on the path of the idler photons i_1 or without a misalignment of the path of the idler photon i_1, the beam of parts of free phantom-particles, which moves toward the detector D_i after the down converter NL1, must pass the beam of signal photons s_2 (very close), which is necessary to keep the path of the idler photons i_1 and i_2 connected. But this does not influence the no-interference detection of the signal photon s_2 at the detector D_s. But if the beam of parts of free phantom-particles moves toward the detector D_s after the down converter NL1, the beam of parts of free phantom-particles can still interfere with the signal photons s_2 at the detector D_s as usual: A deviation of signal photons s_2 toward the right happens in front of the detector as usual and an interference pattern can be registered in this case. The not visible interference pattern of the experimental setting without a beam stop gets unmasked.

The counting rate shown in Fig. 7 at the detector D_s is about 430/s for R_s. According to my interpretation of the experiment, half of the photons detected at D_s can interfere with free parts of phantom-particles, if there is a beam stop inserted between the down converter NL1 and NL2, but the opposite two interference pattern cancel out each other, as described earlier, so that we get a line for the detection rates, measured at certain positions of the detector D_s, as shown as curve B in Fig. 7. If there is no beam stop inserted, only a quarter of the counting rate (about 110/s) can cause an interference pattern by an interference between the beam of free parts of phantom-particles moving from the down converter NL1 toward the detector D_s and the beam of signal photons s_2 moving from the NL1 toward the detector D_s. As the total counting rate at the detector D_s does not change and is still about 430/s for R_s, the counting rate varies between a counting rate of about 540 and 320/s and we get a wave shaped curve for the detection rates, measured at certain positions of the detector D_s, as shown as curve A in Fig. 7. This corresponds with the result of the experiment. According to my imaginations, there can only happen a deviation of signal photons s_2 toward the right, but not a deviation of signal photons s_1 toward the left. Starting from the left side of Fig. 7, for the detection curve A, we expect a higher detection rate shifted to the right side and a corresponding lower detection rate shifted to the left side in comparison to the detection curve B. This explains exactly the registered interference pattern of second order, as measured by the experiment of Mandel and shown as curve A in Fig. 7. Again, my interpretation of fundamental quantum phenomena is verified by the experiment of Mandel.

If we apply our knowledge of phantom-particles consisting of bs-particles, as postulated by the BQT, we do not need the strange and mystic interpretation of today's quantum physics, but must explain these quantum phenomena in a causal and classical way. Today's quantum physicists interpret experiments like that of Kim[13] and Mandel and coworkers[12] that "which-way" information is not obtainable, if we examine quantum phenomena. Even after a particle has already taken a certain path, it should be able to change its formerly taken path afterward.

Walborn *et al.*[14] published another so-called "quantum eraser experiment": One photon of an entangled pair is incident on a double slit to create an interference pattern in a distant detection region. Quarter-wave plates, oriented so that their fast axes are orthogonal, are placed in front of each slit to serve as which-path markers. The quarter-wave plates mark the polarization of the interfering photon and thus destroy the interference pattern. To recover interference, we measure the polarization of the other entangled photon. In addition, we perform the experiment under "delayed erasure circumstances."[14] The experimental setup is shown in Fig. 8. An argon laser is used to pump a BBO crystal, generating entangled photons by spontaneous parametric down-conversion. The pump beam is focused onto the crystal plane using a 1 m focal length lens to increase the transverse coherence length at the double slit. The width of the pump beam at the focus is approximately 0.5 mm. The orthogonally polarized entangled photons leave the BBO crystal

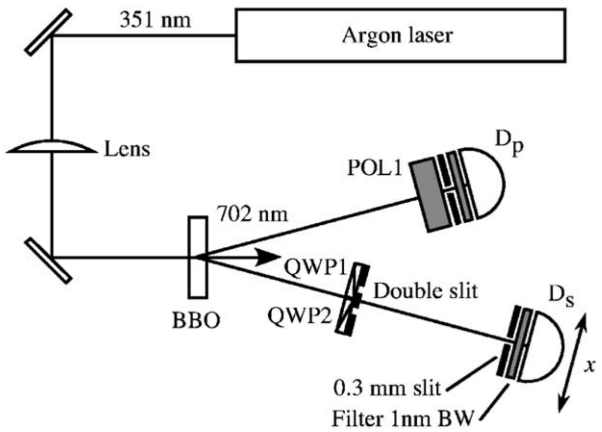

FIG. 8. Setup of the quantum eraser experiment of Walborn *et al.* (Ref. 14).

each at an angle of 3° with the pump beam. In the path of photon p a polarizer cube POL1 can be inserted in order to perform the quantum erasure. The double slit and quarter-wave plates are placed in path s. Ds and Dp are the photodetectors. QWP1 and QWP2 are quarter-wave plates with fast axes at an angle of 45°. For the so-called delayed erasure setup, the detector Dp and POL1 were placed at a farther distance from the BBO crystal than before.

Figure 9 shows the standard Young interference pattern obtained with the double slit placed in the path of photon s, without quarter-wave plates QWP1 (θ) and QWP2 ($\theta + \pi/2$) and with POL1 absent in front of the detector Dp. Next, the path of photon s was marked by placing the quarter-wave plates QWP1 and QWP2 in front of the double slit. Figure 10 shows the absence of interference due to the quarter-wave plates. Nearly all interference present in Fig. 9 was destroyed. The which-path information was erased, and interference recovered by placing the linear polarizer POL1 in front of detector Dp. To recover interference, the polarization angle of POL1 was set to θ, the angle of the fast axis of quarter-wave plate QWP1. Interference fringes were obtained as shown in Fig. 11. The detection time was doubled in order to compensate for the decrease in coincidence counts due to POL1. In Fig. 12, POL1 was set to $\theta + \pi/2$, the angle of the fast axis of QWP2, which produced a pattern of interference antifringes. The averaged sum of these two interference patterns gives a pattern roughly equal to that of Fig. 10. The same experimental procedure was used to produce the so-called delayed-erasure situation.

The conclusions of the authors: "We have presented a quantum eraser that uses a Young double slit to create

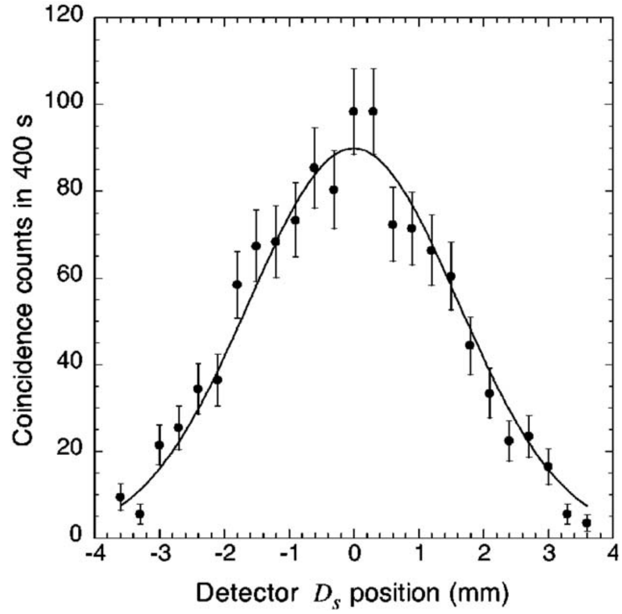

FIG. 10. Coincidence counts when QWP1 and QWP2 are placed in front of the double slit. "Interference has been destroyed" (Ref. 14).

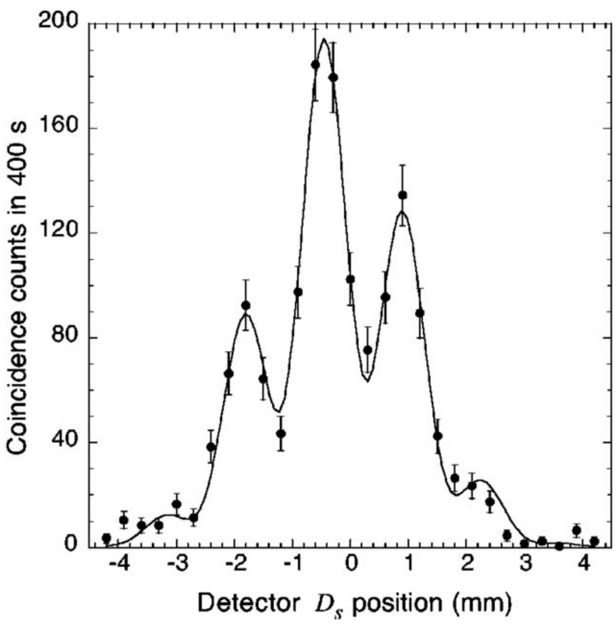

FIG. 9. Coincidence counts with QWP1 and QWP2 removed. An interference pattern due to the double slit is observed (Ref. 14).

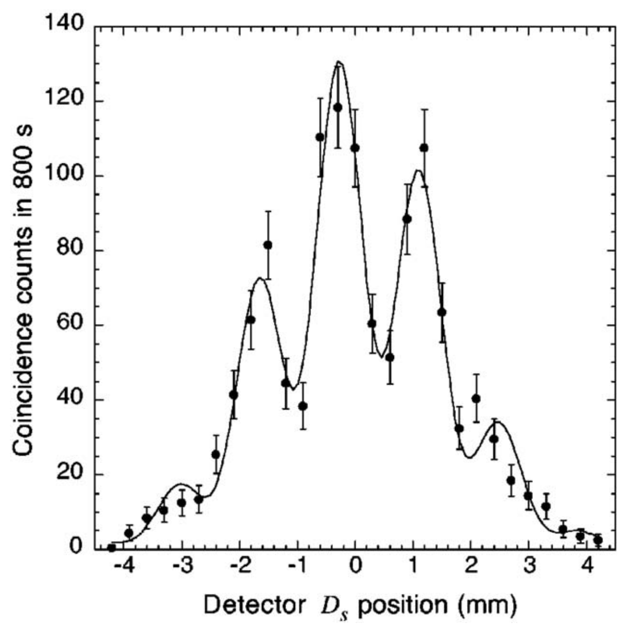

FIG. 11. Coincidence counts when QPW1, QWP2, and POL1 are in place. POL1 was set to θ, the angle of the fast axis of QWP1. "Interference has been restored" in the fringe pattern (Ref. 14).

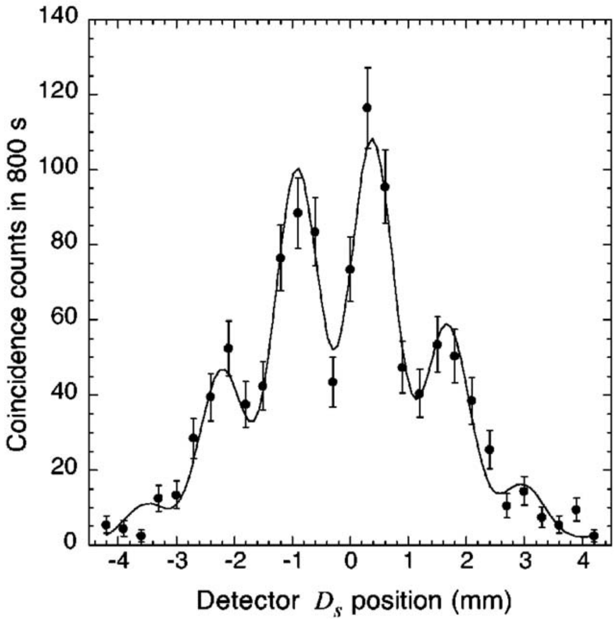

FIG. 12. Coincidence counts when QPW1, QWP2, and POL1 are in place. POL1 was set to $\theta + \pi/2$, the angle of the fast axis of QWP2. Interference has been restored in the antifringe pattern (Ref. 14).

interference. The quarter-wave plates in our experiment served as the which-path markers to destroy interference. We recovered interference using the entanglement of photons *s* and *p*. We have shown that interference can be destroyed, by marking the path of the interfering photon, and recovered, by making an appropriate measurement on the other entangled photon. We have also investigated this experiment under the conditions of delayed erasure, in which the interfering photon s is detected before photon p. In as much as our experiment did not allow for the observer to choose the polarization angle in the time period after photon *s* was detected and before detection our experiment served as the which-path markers to destroy interference. We recovered interference using the entanglement of photons *s* and *p*." If the conclusions of the authors of this "delayed eraser" experiment corresponds with reality, we have to accept that a photon s, which has already passed one of the double slits, can be influenced by measuring the polarization of the entangled photon p, so that the photon s passes through both double slits, after it has already passed only through one of the double slits. This means that the photon s has passed through one double slit and (later) also both double slits.

But my interpretation of the so-called "eraser experiment" of Walborn *et al.*[14] must be completely different: An argon laser is used to pump a BBO crystal, generating entangled photons, each accompanied by a phantom-photon. In each case, one of the entangled photons and its phantom-photon moves the path s in the direction of the detector Ds, the other entangled photon and its phantom-photon moves the path p in the direction of the detector Dp. The two-detector system is called a coincidence counter, which means that it is only recording detection signals that reach both detectors simultaneously. This makes sure, that only entangled photons are recorded. In the first part of the experiment the entangled photon s is separated at the double slit from its phantom-photon. While the photon s passes the one double slit, its phantom-photon passes the other double slit. After the double-slit, the photon and its phantom-photon interfere with each other, as described earlier (see Fig. 9). In the second case, two different polarizers (quater-wave plates) orientated at an angle θ (QWP1) and $\theta + \pi/2$ (QWP2) with its fast axis are positioned in front of the double slit, one in front of each slit. While the photon s passes through one of the double slits, its phantom-photon passes through the other double slit. After the double-slit, the photon and its phantom-photon interfere with each other, as described earlier, because still both have the same polarization. We should therefore in this case also be able to measure an interference pattern, which does not seem the case, as the scientists measure "a destroyed Interference," as shown in Fig. 10. If this is really true, we will see shortly.

In the third and fourth case, two different polarizers (quater-wave plates) orientated at an angle θ (QWP1) and $\theta + \pi/2$ (QWP2) with its fast axis are positioned in front of the double slit, one in front of each slit. In the third case, the scientists in addition positioned a polarization filter with an angle θ in front of the detector Dp. This causes that only photons with a polarization angle θ can be measured simultaneously at the detector Ds and the detector Dp. In this case, only a photon s can be recorded, if it passed the slit behind the polarizer QWP1 orientated at an angle θ with its fast axis, so we need double the time (800 s instead of 400 s) to get a comparable counting rate. While the photon s passes the slit behind the polarizer (quarter-wave plate 1) oriented at an angle θ with its fast axis, its phantom-photon (also oriented at an angle θ) passes the other double slit. After the double-slit, the photon and its phantom-photon interfere with each other, as described earlier, so that we are not surprised, that we measure an interference pattern at the detector Ds, as shown in Fig. 11.

In the fourth case, the scientists positioned a polarization filter with an angle $\theta + \pi/2$ in front of the detector Dp. This causes that only photons with a polarization angle $\theta + \pi/2$ can be measured simultaneously at detectors Ds and Dp. In this case, only a photon s can be recorded, if it passed the slit behind the polarizer QWP2 oriented at an angle $\theta + \pi/2$ with its fast axis, so we need double the time (800 s instead of 400 s) to get a comparable counting rate. While the photon s passes the slit behind the polarizer (quater-wave plate 2) orientated at an angle $\theta + \pi/2$ with its fast axis, its phantom-photon (also orientated at an angle $\theta + \pi/2$) passes the other double slit. After the double-slit, the photon and its phantom-photon interfere with each other, as described earlier, so that we are not surprised, that we measure an interference pattern at the detector Ds, as shown in Fig. 12.

Let us now go back to the second case: Two different polarizers (quarter-wave plates) oriented at an angle θ (QWP1) and $\theta + \pi/2$ (QWP2) with its fast axis are positioned in front of the double slit, one in front of each slit. In front of the detector D_P, no polarization filter is positioned. A photon s passes one of the double slits, and its phantom-photon passes the other double slit. After the double-slit, the photon and its phantom-photon interfere with each other, as described earlier, because still both have the same polarization. According to our considerations, we should in this case

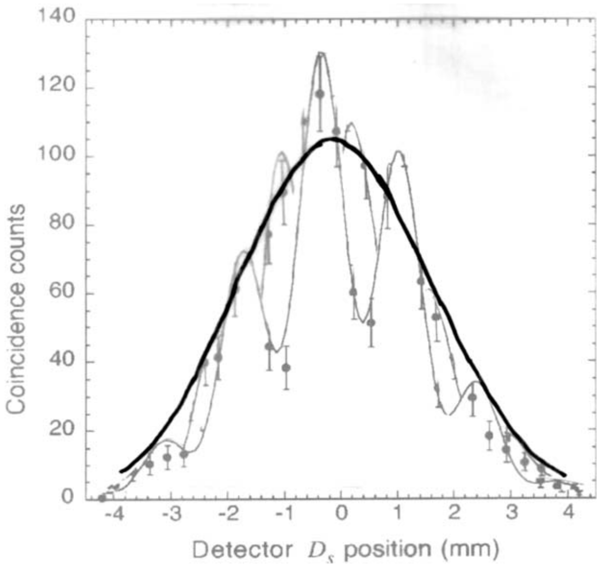

FIG. 13. The sum of these two interference patterns gives a pattern quite similar to that of Fig. 10, what can well be seen, if the interference patterns of Figs. 11 and 12 are projected over each other (Ref. 14).

also be able to record an interference pattern, which does not seem the case, as the scientists recorded "a destroyed Interference," as shown in Fig. 10. But if we project the interference pattern of Fig. 11 and the interference pattern of Fig. 12 over each other, we get the destroyed Interference of Fig. 10. The authors wrote: "The averaged sum of these two interference patterns gives a pattern roughly equal to that of Fig. 10." But, "roughly" is not the correct description in this case. As shown in Figs. 11, 12, and 13 projected over each other match very well with Fig. 10 of the authors. In reality, in the second case, there also results an interference pattern, but the two interference patterns complete each other to a "destroyed" interference pattern. We can see that, if a polarization filter is positioned in front of the detector D_P, the interference pattern gets unmasked, because then only half of the photons **s** can be recorded at the detector Ds. As the authors exclude the existence of a hidden phantom-particle, they must of course interpret the experimental results of their experiment in a mystical way. For the so-called delayed erasure setup, in which the detector Dp and POL1 were placed at a farther distance from the BBO crystal than before, also in this case, we measure the photon s at the detector Ds before the photon p at the detector Dp by the coincidence counter with a correspondingly different setting, but also in this case, we must of course get the same results. But this has nothing to do with any kind of so-called delayed eraser.

In another experiment done at the University of California at Berkeley, pairs of highly correlated photons are produced in a nonlinear crystal by spontaneous parametric down-conversion, generated by an argon-ion laser, which are reflected by mirrors and converge again at a BS and pass toward two detectors (see Fig. 14).[15] At a10-cm-long potassium dihydrogen phosphate (KDP) crystal pump, photons are spontaneously split into conjugate photons, which are horizontally polarized. The 50:50 BS is used. In the experiment, only the coincidence counts were considered. When the BS was placed such that the two photons reached the BS simultaneously, an interference resulted so that no coincidence could be measured and the coincidence counter recorded a coincidence dip, indicating that an interference had happened. The coincidence dip is interpreted by the scientists in such a way that by the interference both photons are now exiting the same detector, whereas we could not know which detector. When the path lengths to the BS was not equal, which was realized by the translation of a trombone prism, the photons did not reach the BS simultaneously, so that there could not result an interference of the photons and no coincidence dip was registered. When the path lengths were equal, the two photons "destructively" interfered, causing a null in the coincidence rate. If it was in this case a usual (so-called "classical") interference, the photon wave packets of both interfering photons overlapping each other would amplify each other. Therefore, in this case, the interference between the photons is a so-called nonclassical interference. The destructive interference resulting in a recorded null coincidence dip, if the path lengths of the beams to the BS are equal, is explained by today's quantum physicists, that in this case, each photon has gone both paths at the BS at the same time, through the beam-splitter and being reflected by the BS, so that we cannot say which path the photons have gone, respectively, that in this case we cannot yield a which way information. But when the path lengths are not equal, the entangled photons cannot interfere at the BS, so that a coincidence at detectors D1 and D2 can be measured and no coincidence dip can be measured. The probabilities of the so-called "nonclassical" interference can

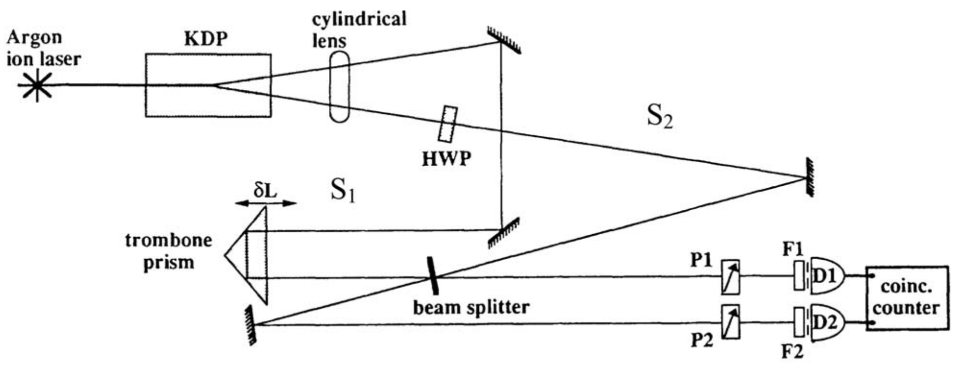

FIG. 14. Measured photon counting rate as a function of BS displacement. Without a HWP, whose optic axis is at an angle of $\varphi/2$ to the horizontal polarization, there results an interference pattern. With a HWP there results no interference pattern (Ref. 15).

be calculated by the Feynman amplitude representing the probability of detecting a coincidence rate, which is in this case zero. "Probability amplitudes of indistinguishable paths are summed, then absolute squared, to yield the probability, this leads to interference terms. Probabilities of distinguishable paths are summed yielding no interference. Thus, it is the distinguishability of alternative paths which prevents interference. When information exists about which way the particle went, the paths are distinguishable, and no interference is possible. Interference may be regained, however, if one somehow manages to ease the distinguishing information.[15]

According to our knowledge, we have to go from the fact that a photon is either reflected at a 50:50 BS or passes through the BS, but not both at the same time. So, we get for possibilities: 1. The photon moving the path S_1 gets reflected at the BS, while the photon moving the path S_2 gets transmitted through the BS, so that both photons reach the detector D_2, which means that no coincidence at detectors D_1 and D_2 can result. 2. The photon moving the path S_1 gets transmitted through the BS and the photon moving the path S_2 gets reflected at the BS, so that both photons reach the detector D_1, which means that no coincidence at the detector D_1 and D_2 can result. 3. The photon moving the path S_1 gets reflected at the BS reaching the detector D_2 and the photon moving the path S_2 gets also reflected at the BS reaching the detector D_1 so that there could result a coincidence at the detector D_1 and D_2. But as a free part of the phantom-particle separated from the photon moving S_1 at the BS moves through the BS, there happens an interference between the photon S_2 and the free part of the phantom-particle S_1. As a free part of the phantom-particle separated from the photon moving S_2 at the BS moves through the BS, there also happens to be an interference between the photon S_1 and the free part of the phantom-particle S_1, so that no coincidence can be detected. There results a coincidence dip. 4. The photon moving the path S_1 gets transmitted through the BS reaching the detector D_1 and the photon moving the path S_2 gets also transmitted through the BS reaching the detector D_2 so that there also could result a coincidence at detectors D_1 and D_2. But as a free part of the phantom-particle separated from the photon moving S_1 at the BS gets reflected at the BS, there happens to be an interference between the photon S_2 and the free part of the phantom-particle S_1. As a free part of the phantom-particle separated from the photon moving S_2 gets also reflected at the BS, there also happens to be an interference between the photon S_1 and the free part of the phantom-particle S_1, so that also no coincidence can be detected.

There results a coincidence dip. But if a half wave plate (HWP) is inserted into the path S_2, the rotation of the polarization of the photon S_2 is changed by the HWP by $\theta/2$. In the extreme case ($90°/2 = 45°$), the photon S_2 has the polarization 45° and the photon S_1 has the polarization 90°. In this case, the coincidence dip vanishes. The interpretation of today's quantum physics is again that we would now be able to yield which way information, so that the interference between the photons S_1 and S_2 at the BS gets destroyed, so that coincidence at detectors D_1 and D_2 can be measured and no coincidence dip results.

My interpretation must again be different: If a HWP is inserted into the path S_2, the rotation of the polarization of the photon S_2 is changed by the HWP by $\theta/2$. In the extreme case, the photon S_2 has the polarization 45°, so that also the free part of the phantom-particle with the polarization 45°, which gets separated from the photon S_2 at the BS and passing through the BS, cannot interfere with the photon S_1 with the polarization 90°, which gets reflected at the BS. And the free part of the phantom-particle, which gets separated from the photon S_1 at the BS and passing through the BS, cannot interfere with the photon S_2 with polarization 45°, which gets reflected at the BS. In this case, we can measure coincidence at detectors D_1 and D_2 and no coincidence dip results. If there are two polarizers inserted in front of the detectors, with polarizer 1 at 45° in front of the detector D_1 and polarizer 2 at 45° in front of the detector D_2, the coincidence dip representing an interference pattern can be restored. The interpretation of today's quantum physics is again that we would now be not able to yield which way information, so that there results an interference between the photons S_1 and S_2 at the BS and we cannot measure a coincidence at detectors D_1 and D_2. In this case, a coincidence dip can again be registered.

My interpretation must again be different: If there are two polarizers inserted in front of the detectors, with polarizer 1 at 45° in front of the detector D_1 and polarizer 2 at 45° in front of the detector D_2, we get the following situation. The free part of the phantom-particle with the polarization 45°, which gets separated from the photon S_2 at the BS and passing through the BS, cannot interfere with the photon S_1 with the polarization 90°, which gets reflected at the BS. But the photon S_1 with the polarization 90°, that polarization is changed in front of the detector D_2 into a polarization of 45°, can now interfere in front of the D_2 with the free part of the phantom-photon S_2 in, which also has a polarization of 45°. One can imagine that the photon S_1 is screwed into the free part of the phantom-photon S_2 with the polarization of 45° in front of the detector D_2, so that the photon S_1 is deflected from its path and cannot be registered at the detector D_2. No coincidence can be measured at the detector D_1 and D_2. In this case, a coincidence dip can again be registered. But as free phantom-particles have a very loose structure, I do not think that an isolated free phantom-particle can also change its polarization angle, if it passes a polarizer. I expect that the free part of the phantom-particle from the photon S_1 passing the BS toward the detector D1 does not interfere with the photon S_2 in front of the detector D_1, so that there results a registration of the photon S1 at the detector D1, but not a coincidence registration of both entangled photons.

Twin-photons caused by down-conversion or in other settings resulting "twin-electrons" are said to be in a folded state and all classically conceivable possibilities for these particles are said to be superimposed. Without a measurement of the two particles, they shall have no individual properties and no individual existence. In a two-particle state, only by measuring the properties of a particle the properties of the particle get determined, before the measurement all classically conceivable possibilities are said to be realized by the two particles. If, for example, a pair of identical particles with a certain total momentum is generated and for one of the particle is measured a certain momentum p, then one shall know instantly that the second particle in the greatest distance must also have the momentum p. If a pair of particles is generated with the total spin 0 and for one of the particle is measured the spin $-1/2$, one shall know instantly that the second particle in the greatest distance must have the spin $1/2$. The direction and polarization of the two photons emitted are also correlated with each other. If one measures the polarization of one photon, the polarization of the other photon is defined either (e.g., parallel or rotated by 90°). For electrons or atoms, the entanglement relates to their spin. However, it is impossible to predict which of the two entangled electrons or atoms has a positive half spin and which has a negative half spin. But if one measures the spin of one of the electrons or atoms, the spin of the other particle is also defined. Today's quantum physics goes from the indetermination of quantum objects like photons or elemental particles until they are measured. According to my postulates, the interpretation of such an experiment must be completely different: When twin-photons or twin-electrons are created, their properties like spin, polarization, and momentum are defined from the beginning of their existence. Only if we interpret double-slit experiments and similar experiments in the way quantum physics still does today, going from the wrong imagination that the description of the particles acting in quantum experiments is complete, the properties of the "twin-particles" must be considered to be undefined until the properties are measured. In this case, it cannot be known, if an interference pattern results at double-slit or similar experiments before it is measured. But there is no need to apply the wrong interpretation of double-slit and similar experiments of today's quantum physics on the behavior of the properties of twin-photons or twin-particles. According to my postulates there do not exist "nonlocal" interactions, as the definition of the properties of the twin-particles of today's quantum physics is incomplete.

V. BELL'S THEOREM MUST BE WRONG, BECAUSE IT GOES FROM THE POSTULATE THAT EVERY RESULT OF A QUANTUM EXPERIMENT MUST BE ASSOCIATED WITH A DIFFERENT UNKNOWN "HIDDEN VARIABLE," BUT THERE EXISTS ONLY ONE HIDDEN VARIABLE

Quantum entanglement occurs when, for example, a pair of electrons or photons results from a physical process and then becomes separated. According to today's interpretation of quantum mechanics the pair of particles or photons is indefinite in state with respect to, for example, position, momentum, spin, polarization, etc. Quantum entanglement shall therefore be a form of quantum superposition. When a measurement is made, it causes one member of such a pair to take on a definite value (e.g., clockwise spin of the electron or a certain polarization of the photon), the other member of this entangled pair will at any subsequent time be found to have taken the complementary value (e.g., counterclockwise spin of the electron or the same polarization of the photon). Thus, there is a correlation between the results of measurements performed on entangled pairs, and this occurs even though the entangled pair may have been separated by arbitrarily large distances. This behavior has been demonstrated experimentally, and it is accepted by the physics community. There was a debate about a possible underlying mechanism (hidden variable) that enables this correlation to occur even when the separation distance is large. Research into quantum entanglement was initiated by the Einstein–Podolsky–Rosen (EPR) paradox paper of Albert Einstein, Boris Podolsky, and Nathan Rosen in 1935.[16] Einstein later famously derided entanglement as a "spooky action at a distance."

John Bell's famous paper titled "On the Einstein Podolsky Rosen paradox," was published 1964.[17] He started from the same assumptions as did Einstein, Podolsky, and Rosen: 1. The principle of reality: That microscopic objects have real properties determining the outcomes of quantum mechanical measurements, so that there might exist so-called unknown hidden variables. 2. The principle of locality: That an object is influenced directly only by its immediate surroundings, which means that reality is not influenced by measurements performed simultaneously at a large distance. 3. Another basic assumption, which is usually not explicitly mentioned within this context, but which is necessary for Bell's theorem: Like the Copenhagen interpretation of quantum mechanics a pair of particles or photons shall be in an indefinite state with respect to the spin, respectively polarization, until it is measured. From these assumptions, Bell was able to derive the so-called Bell's inequality, implying that at least the assumption of reality or of locality must be false. For his derivation of inequality, Bell went from the imagination that every outcome of an experiment is associated with a certain unknown hidden variable. He went from an experiment with three potential experimental results like from an experiment examining the polarization of two entangled photons in three different directions of polarization, whereas for each of the three examined polarization directions, different hidden variables should be the cause for the measured result. The Bell test experiments have been interpreted to show that the Bell inequalities are violated in favor of the standard interpretation of Quantum Mechanics. Therefore, according to Bell's theorem, either quantum mechanics or local realism is wrong, as they are mutually exclusive. Bell's Theorem also the imagination that a pair of entangled particles or photons shall in an indefinite state with respect to the spin, respectively, the polarization, until it is measured. But according to my imagination, the states of objects used in quantum experiments are determined already before a measurement is performed, but of course the states cannot be known, before they are measured. The spin of entangled electrons are hereafter determined already before the measurement of the spin, the one electron has the spin $1/2$, the other the spin $-1/2$, but of course only after we have measured the spin of one of the entangled electrons, we can know the spin of this and the other electron. The polarization of entangled photons is determined from them coming into being—the one has a certain polarization angle, and the other photon the same polarization angle. But which polarization both of the entangled photons have, we can of course only know, after we have measured the polarization angle of one of the entangled photons.

It is not the case, as Bell postulated, that each experimental result of quantum polarization experiments must be the result of a different hidden variable. If we examine the polarization angles of entangled photons in three directions of angles, three different hidden variables for the three different polarization angles are not needed. According to my considerations, there exists only one kind of hidden variable, namely, phantom-particles, respectively, phantom-photons, consisting of adhered bs-particles. From one kind of hidden variable, a so-called "Bell's equation of inequality" cannot be derived

VI. BECAUSE OF THE HIDDEN VARIABLE OF PHANTOM-PARTICLES "THE QUANTUM EXPERIMENTS EXAMINING ELECTRON SPINS MUST ALSO BE INTERPRETED IN A NEW WAY

At the example of "double slit" and similar experiments, it was perceptible that the postulated phantom-particles, which accompany particles or photons, can be relatively easily departed from the particles or photons. This has to be considered if we want to interpret the result of experiments examining the spin of particles, for example, the spin of electrons, whereas the "spin" of electrons must be considered as some kind of "intrinsic angular momentum." The spin of electrons is realized in only two states, what we can call "spin up" and "spin down," if electrons move through a strong magnetic field, which is orientated vertical, or what we can call "spin right" and "spin left," if electrons move through a strong magnetic field, which is orientated horizontal. With the word spin, there is meant the "intrinsic angular momentum" of an electron. In a so-called spin filter with a magnetic field, which is oriented vertical, one-half of an electron beam will follow an upper path while the other half will follow a lower path. If within the spin filter a small block of lead is inserted in the path of the spin down electrons, one-half of the incident electron beam, the spin down electrons, will be stopped inside the apparatus, while all the spin up electrons will emerge in the same direction as before they entered the magnets and at the same speed. In this case, we get a "filter" that selects spin up electrons (see Fig. 15). If we insert a small block of lead in the path of the spin up electrons, the spin-up electrons will be stopped inside the apparatus, while all the spin down electrons will emerge in the same direction as before they entered the magnets and at the same speed. In this case, we get a filter that selects spin down electrons. In a spin filter with a magnetic field, which is orientated horizontal, one-half of an electron beam will follow a right path, while the other half will follow a left path. If within the spin filter a small block of lead is inserted in the path of the spin right electrons, one-half of the incident electron beam, the spin right electrons, will be stopped inside the apparatus, while all the spin left electrons will emerge in the same direction as before they entered the magnets and at the same speed. In this case, we get a filter that selects spin left electrons. If we insert a small block of lead in the path of the spin left electrons, the spin left electrons will be stopped inside the apparatus, while all the spin right electrons will emerge in the same direction as before they entered the magnets and at the same speed. In this case, we get a filter that selects spin right electrons.[18]

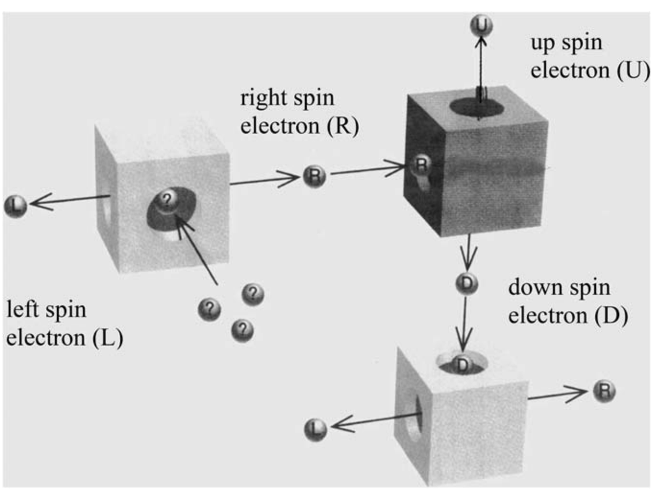

FIG. 15. If spin down or spin up electrons are routed again through a second horizontal box, we would expect that 100% spin right electrons are emerging from the horizontal box, but there result 50% spin right and 50% spin left electrons (Ref. 18).

If we insert a second filter behind the first with the same orientation, the second filter has no effect. Half of the electrons from the electron beam emerge from the first box, and all of those electrons pass through the second filter emerging with the same spin orientation after the second filter. So, once down spin is defined by the first filter, it is the same as the down spin defined by the second. If we now insert the second filter behind the first upside down relative to the first filter, half of the beam of electrons from the electron gun emerges from the first filter, and none of those electrons emerge from the second filter. If the second filter is oriented at 90° relative to the first one, half of the beam of electrons emerges from the first filter and half of those electrons emerge from the second filter. If we slowly rotate the orientation of the second filter with respect to the first one from zero degrees to 180°, the fraction of the electrons that passed the first filter and go through the second filter gets continuously from 100% to 0%. So far, the results are not strange, but now we want to examine the situation using spin filters without an inserted small block of lead. In a spin filter with a magnetic field, which is orientated horizontal, one-half of an electron beam will follow a right path, while the other half will follow a left path, so that this filter, called a "horizontal box," parts the spin right electrons from the spin left electrons. In a spin filter with a magnetic field, which is orientated vertical, one-half of an electron beam will follow an upper path while and other half will follow a lower path, so that this filter, called a "vertical box," parts the spin down electrons from the spin down electrons. If spin right electrons emerging from a horizontal box are routed through a second horizontal box 100% of the spin right electrons keep their spin right orientation. If spin right electrons emerging from a horizontal box are routed through a vertical box, 50% of the former spin right electrons leave the vertical box as spin up electrons and 50% as spin down electrons. Now comes the strange result: If spin right electrons emerging from a horizontal box are routed through a vertical box, 50% of the former spin right electrons leave the vertical box as spin up electrons and 50% as spin down electrons. If this spin down or spin up electrons are routed again through a second horizontal box, we would expect that again 100% spin right electrons are emerging from the horizontal box, but there result 50% spin right and 50% spin left electrons (see Fig. 15). It seems that each measurement of the electron spin with a second filter of a different orientation than the first filter erases the information of the measurement of the first filter. Quantum physicists interpret this strange result again in the way that an electron spin is indefinite as long as it is not measured.[18]

According to my postulates, the interpretation of the experiment must be completely different: Each particle is accompanied by a phantom particle consisting of "bs-particles," which represent some kind of three-dimensional imprint of the particle. Like the "material particle" the phantom particle should have some kind of intrinsic angular momentum. The intrinsic angular momentum of the phantom particle must have a stabilizing effect on the intrinsic angular momentum of the electron. If spin right electrons emerging from a horizontal box are routed through a vertical box, the spin of the electron gets turned, which causes a separation of the "electron particle" from its phantom particle, so that the stabilizing effect of the phantom particle on the spin of the electron gets lost. By the measurement of the electron spin by another horizontal box, we therefore must get again a coincidental result of 50% spin right and 50% of spin left electrons.

VII. THERE ALREADY EXIST EXPERIMENTS, WHICH EVIDENTLY PROOF THE NONCOINCIDENTAL INTERPRETATION OF BASIC QUANTUM PHENOMENA BY THE BQT

About a quantum experiment investigating electron spins of electrons, Albert said that is one of the strangest results of quantum physics.[18] In this experiment, right spin electrons are sent through a vertical box, which causes 50% up spin and 50% down spin electrons (see Fig. 16). By reflectors, the electrons are led to a "unification box" and afterward to a horizontal box. From the horizontal box, there emerge in this case 100% right spin electrons. Then, an absorber is inserted in the path of the up spin electrons between the vertical box and the reflector, so that the path to the unification box is blocked for the up spin electrons. In this case, there emerge 50% right spin and 50% left spin electrons, which is "unexpected" (see Fig. 17). According to the imaginations in my article, the absorber does not only block the up spin electrons, but also the "down spin phantom-particles", which accompanied the down spin electrons, before the down spin electrons were seperated from them in the vertical box. In this case, the "down spin phantom-particles" cannot be unified with the down spin electrons in the unification box, so that the spin of the down spin electrons cannot be stabilized any more by the down spin phantom-particles. This causes 50% of right and 50% left spin particles at the horizontal box corresponding to the statistic probability.[18]

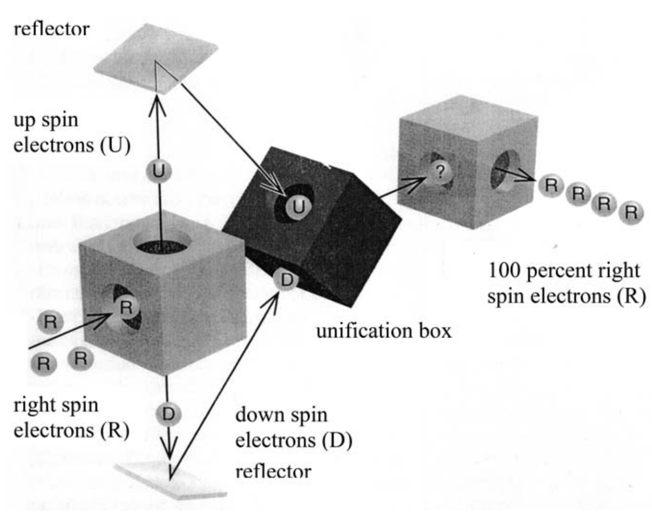

FIG. 16. The phantom particle stabilizes the spin of a material particle (e.g., electron), so that after the unification of the phantom particle with its material particle there result 100% of right spin particles at the horizontal box (Ref. 18).

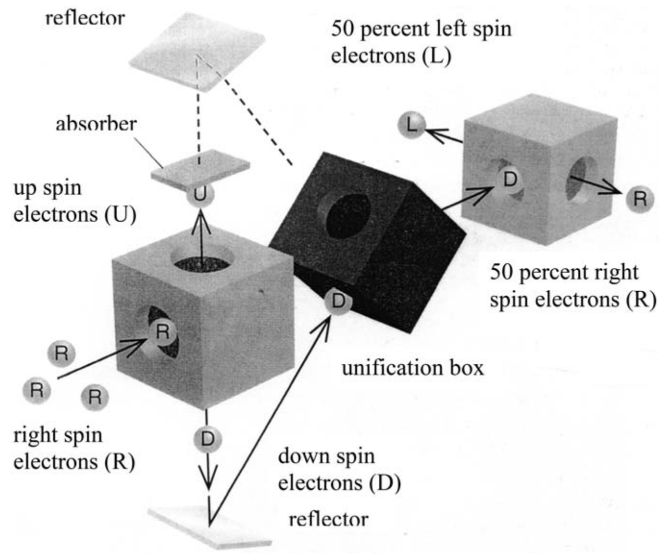

FIG. 17. If an absorber is inserted in front of a reflector the phantom particle is not able to stabilize the spin of a material particle (e.g., electron), because the unification of the phantom particle with its material particle is not able in this case. This causes 50% of right and 50% left spin particles at the horizontal box corresponding to the statistic probability (Ref. 18).

VIII. TODAY'S QUANTUM PHYSICS IS CONTRADICTORY, AS EXPLAINED AT THE EXAMPLE OF AN EXPERIMENT BY ZEILINGER *ET AL.*: "EXPERIMENTAL DELAYED-CHOICE ENTANGLEMENT SWAPPING"

In the experiment of Zeilinger *et al.*, published 2012 in *Nature Physics*, they realized a so-called delayed-choice of entanglement swapping.[19] They interpret their experimental result as follows: "With our ideal realization of the delayed-choice entanglement swapping gedanken experiment, we have demonstrated a generalization of Wheeler's "delayed-choice" tests, going from the wave-duality of two particles. Whether two particles are entangled or separable has been decided after they have been measured. If one viewed the quantum state as a real physical object, one could get the paradoxical situation that future actions seem to have an influence on past and already irrevocably recorded events. However, there is never a paradox if the quantum state is viewed as no more than a catalog of our knowledge. Then, the state is a probability list for all possible measurement outcomes, the relative temporal order of the three observers' events is irrelevant, and no physical interactions whatsoever between these events, especially into the past, are necessary to explain the delayed-choice entanglement swapping. What, however, is important is to relate the lists of Alice, Bob, and Victor's measurement results. On the basis of Victor's measurement settings and results, Alice and Bob can group their earlier and locally totally random results into subsets that each have a different meaning and interpretation. This formation of subsets is independent of the temporal order of the measurements. Analyzing and summarizing the result of the experiment, we can note that if Victor performs the experiment the way that photons 2 and 3 interfere with each other (so-called Bell-state measurement, BSM), photons 2 and 3 get entangled, which means that photons 1 (Alice) and 4 (Bob) must also be entangled, so that the entanglement is said to swap to photons 1 and 4, whereas photons 1 and 2, respectively, 3 and 4, shall not be entangled any more in this case. But if Victor performs the experiment the way that photons 2 and 3 do not interfere with each other, but measure the polarization of the photons separately (so-called separable-state measurement), photons 2 and 3 do not become entangled, so that the photon 1 and 2, respectively, 3 and 4, keep their entanglement.[19]

In the supplement information of the article they additionally write: When Victor performs a BSM, photons 1 and 4 are only entangled (the swapping of the entanglement only happens), if there exists the information necessary for Victor to specify into which subensembles the data are to be sorted. Without the ability for this specification, he would have to assign a mixture of these two Bell states to his output state which is separable, and thus, he could not correctly sort Alice's and Bob's data into subensembles. "This means that the BSM can result in entanglement of photons 1 and 2 (and photons 3 and 4) or in entanglement of photons 2 and 3 (and photons 1 and 4). Therefore, the same experimental setting (BSM) can result in two mutually excluding results. Which photons are entangled by the BSM depends on the possibility of Victor to specify into which subensembles the data are sorted. According to Wheeler, Bohr said that no elementary phenomenon is a phenomenon until it is a registered phenomenon. We would like to extend this by saying that some registered phenomena do not have a meaning unless they are put in relationship with other registered phenomena."[19]

As I proved in this article, a photon either gets reflected at a BS or passes through the BS, but never takes both paths, as it is postulated by Zeilinger and today's quantum physics. This means that the interpretation of the experiment by Zeilinger cannot correspond with reality. Zeilinger said that the quantum physicists are still waiting for a philosopher, who is able to explain the experimental results in an intelligible way. But this philosopher will never be found, because he would have to realize the impossibility of explaining contradictory experimental results stringently.

IX. THE IMAGINATION OF COLLAPSING WAVE-FUNCTIONS IS VALUELESS, IF WE INTERPRET QUANTUM PHENOMENA BY THE BQT

According to today's quantum mechanics, quantum phenomena exist in a superposition state, until a certain state is measured. Quantum superposition means that a physical system, like an electron, exists partly in all its particular theoretically possible states simultaneously. Only when measured, one can get a result corresponding to only one of the possible configurations of the superposition state. With this concept, it is possible to calculate the probability of all theoretically possible states. Because this is possible, today's quantum physicists insist that their quantum theory should correspond with reality. To calculate, for example, whether a photon has passed a double slit as a particle or a wave, one uses the mathematical term of a wave-function, which collapses, if one tries to measure, through which of the two slits the photon has moved. This phenomenon, in which a wave-function, initially is in a superposition of different possible "eigenstates," appears to reduce to a single one of those states after interaction with an observer. In simplified terms, it is the reduction of the physical possibilities into a single possibility by the interaction with an observer. When, for example, a photon propagates through a double-slit apparatus, it behaves like a wave. Yet, if it is observed, the nonlocal wave collapses into a single localized particle. Quantum physics deals with wave-functions, which describe the probability amplitude of the quantum state of a particle and how it behaves. Typically, its values are complex numbers and, for a single particle, it is a function of space and time. The laws of quantum mechanics (the Schrödinger equation) describe how the wave function evolves over time. The most common symbols for a wave function are ψ or Ψ. Although ψ is a complex number, $|\psi|2$ is real and corresponds to the probability density of finding a particle in a given place at a given time, if the particle's position is measured.

The probability to find either a photon behind the one or behind the other slit of the double-slit is according to quantum physics

$$1 = \left(\frac{1}{\sqrt{2}}|\psi(x_{1,2},t)|\right)^2 + \left(\frac{1}{\sqrt{2}}|\psi(x_{1,2},t)|\right)^2. \quad (1)$$

In other words, $|\Psi(x_1,t)|^2$ and $|\Psi(x_1,t)|^2$ are the probability densities that the particle is at the position x_1 or x_2 behind the double slit. When the particle is measured behind one of the slits, according to quantum physics, one of the wave-functions are said to collapse, so that the probability to find one of the photons behind one of the slits of the double-slit is

$$0.5 = \left(\frac{1}{\sqrt{2}}|\psi(x_{1,2},t)|\right)^2, \quad (2)$$

This corresponds with the classical probability to measure a particle behind one of the double slits. According to my considerations above, we have to give up the Copenhagen interpretation of quantum mechanics that a pair of particles or photons has an indefinite state with respect to the spin or polarization, until it is measured. Because the states of objects used in quantum experiments are determined before the measurement is performed, whereas the states cannot be known, before they are measured, we do not need the imagination of a collapsing wave-function any more. For example, it is determined before the measurement, through which slit of the double-slit the photon (particle, atom, and molecule) and the phantom-photon ("phantom-particle, phantom-atom, and phantom-molecule") has been moving. The classical probability to find either a photon behind the one or behind the other slit of the double-slit is sufficient

$$1 = \frac{1}{2}|\psi(x_1, t)| + \frac{1}{2}|\psi(x_2, t)|, \tag{3}$$

when the particle is measured behind one of the slits the classical probability to find one of the photons behind one of the slits of the double-slit is also 0.5, which also corresponds with the correct result

$$0.5 = \frac{1}{2}|\psi(x_{1,2}, t)|. \tag{4}$$

X. CONCLUSIONS

Some fundamental standard interpretations of quantum mechanics could be disproved by unrecognized or ignored experimental results. I introduced the "hidden variable" of so-called phantom-particles resulting from the imaginations of the BQT. Until now it is not realized that the hidden variables found at cosmological scales, which cause the phenomena of the so-called "dark energy" and "dark matter," represent the same hidden variable physicists were searching for during the last century to explain strange quantum phenomena. The BQT and the "NGT"[1,2] bring together the hidden variables registered at cosmological scales with the hidden variables at quantum scales, what makes it possible to interpret the results of quantum experiments, like the double-slit experiments and similar basic experiments of quantum physics, in a noncoincidental way. As I proofed in this article, the interpretation of fundamental quantum phenomena by quantum physics does not correspond with reality, despite its success in predicting of experimental results.

As I explained in my former articles, the interpretations of so-called relativistic phenomena by relativistic physics are also contradictory and can be explained easily with equal accurate results by only using the imagination of a three-dimensional space instead of a four-dimensional space-time.[1,3,4] Therefore today's interpretation of so-called relativistic phenomena also does not correspond with reality, despite its success in predicting of experimental results. But the theoretical physicists of established physics use their position to guard the dogmas of quantum mechanics and relativistic physics by preventing and even defaming alternative imaginations. There remains the hope that later generations of physicists will realize this fact and that the current period of physics will be described as what it is: a mathematical-mystical epoch of physics.

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