Relativistic uncertainty principle makes redshift diminish observability: cosmic acceleration is illusion

Jason Gwo
Hansen Experimental Physics Laboratory, Stanford University, Stanford, California 94305, United States of America (former affiliation)

Abstract. Mainstream cosmology proclaims the cosmic expansion is in acceleration by "dark energy." This paper nullifies the acceleration—by reinterpreting supernovae observations via a hidden relativistic law, *free* of parameter fitting. Per the law, the fundamental particle's blue- or redshift diminishes the particle's observation probability, namely, the observability of the event that emitted the particle. The event's observability roots in the observable event-intensity, that is, herein by definition, the multiplicative product (measured in $\hbar$) of conjugate uncertainties, as the (nonrelativistic) Heisenberg uncertainty principle implies. The observability reflects a) *relativistic event-intensity reduction* and, equivalently, b) degree of *resonance in length scale*, between the event and the observer. Though each varying with relativity, redshift and observability covary into the law, per the principle of relativity—and per the *relativistic* uncertainty principle and *'proper'* uncertainty principle, both herein derived. The law holds in particle physics, evaporates (effects of) "dark energy," dissolves an enigma in high-redshift quasar observations and the "photon underproduction crisis" in cosmological observations, and mitigates the infamous cosmological constant problem (i.e., the vacuum energy problem), all without numerical tweak. The law welcomes further lab-testing.

PACS: 03.65.Ta, 04.30.Nk, 98.80.Es

1. Introduction

Redshift z is $(\lambda/\lambda_0)-1$, where λ is the observed wavelength at the observer, and λ_0 the corresponding proper wavelength at the wave-emitting event. Unless otherwise stated in terminology, redshift z: $(-1, \infty)$ covers blueshift z: $(-1, 0)$, and the cosmological redshift is positive. The paper shows, as a law, how the redshift itself compromises the observability—namely, the observation *probability*—of an event, either fundamental or composite. The law dismisses "cosmic acceleration" [1–3] and returns the cosmos to the critical expansion [4,5] of no contribution due to the vacuum energy (*not* 'of no vacuum energy'), to within observational uncertainty.

The most celebrated "evidence of cosmic acceleration" has been Type Ia supernovae's 'luminosity-distance vs. redshift' [1–3]—as interpreted by the cosmological model [4,6] that introduces the vacuum-energy or dark-energy density Ω_Λ. Other "supporting evidence," such as from the cosmic microwave background (CMB) [7], etc. [8], for correlation, also roots in the same parameter-space featuring Ω_Λ. While welcoming the theoretical reasoning of Ω_Λ , we are "solving" the mystery by allowing for another. Moreover, phenomenological correlation unnecessarily implies physical causation.

The event observability $\tilde{\phi}$: $[0, 1]$ is the *effectiveness* of the event's luminosity in emission of any elementary particles, and, being a surprise, the effectiveness is independent of the luminosity distance.

As a preview, figure 1 depicts the law on how $\tilde{\phi}$ decreases from 100% with no blue- or redshift ($z = 0$), down to zero 'at' the extreme of blueshift (z '=' -1) or redshift (z '=' ∞). For instance, in the (quasi) 'universe of special relativity (SR),' a 100-W lightbulb moving away from (or toward) us at half the speed of light 'dims'—but *not* in itself—to of a 60-W (stationary to us). Likewise, in the universe of general relativity (GR), a star 'dims'—not in itself—to 47%, as its redshift z reaches 1.

In short, the compromise on $\tilde{\phi}$ mirrors the mismatch between λ and λ_0. The law agrees with the common knowledge that λ '=' 0 and ∞ be unobservable, as the blackbody radiation has implied. By contrast, behind the "cosmic acceleration," the subliminal belief that $\tilde{\phi}$ is always 100% (i.e., z- independent) fails the sanity check.

We coin such variation as the law of relativistic observability compromise (ROC). The *dimming* effect deceives us to believe the cosmic objects 'were' *farther* than expected, "owing to acceleration."

The law is counterintuitive; in daily life, we see *light* predominantly from *events* moving orders-of-magnitude slower than light, causing no discernible loss of observability. For instance, even in the Large Hadron Collider (LHC) [9], the light-emitting collision *events* (between near–light-speed mass particles) are mostly speedless; even in the synchrotron, the light-emitting events are tangent to the electrons' circulating orbit and 'fixed' to the lab, though the electron speed is relativistic.

The law is imperative; in measuring wavelength, we have neither resolution for zero nor capacity for infinity, that is, cannot observe the extremes of blue- and redshift.

In GR, the ratio λ/λ_0 equals $L_{\mathrm{OB}}/L_{\mathrm{PP}}$, where a) L_{OB} is the *event's observed* length-scale (in the event-observer direction), measured at the observer, and b) L_{PP} the *event's proper* length-scale, measured at the event—and virtual-equivalently at the observer, thanks to the principle of relativity (PoR) [10–12]. Per the 'new' law, with redshift z being $\left(L_{\mathrm{OB}}/L_{\mathrm{PP}}\right)-1$, we will show event observability $\tilde{\phi}$ reflects the degree of *resonance in length-scale*, between a') the *proper-observer*–scaled event and b') the *proper-event*–scaled observer (i.e., the '*proper-observer*–scaled observer,' thanks to the PoR).

The argument begins with **Postulate 0:** *In quantum mechanics (QM), event observability is the probability of occurrence of the structureless event-to-observer vectoring particle (namely, elementary particle) at the generalized observer* (see section 2). *Congruently, event observability is the observable event-fraction, that is, the ratio of the observable event-intensity (manifested by the particle) over the proper event-intensity.* The default unit for event-intensity is $\hbar$, for being *impartial* between any pair of conjugate observables. In 'classical' SR and QM, the observable event-instensity σ_{OB} equals $\Delta(r)\Delta(p)$—i.e., the product of a) uncertainty in position increment r and b) that in momentum p. Likewise, the proper event-intensity σ_{PP} equals $\Delta(\tau)\Delta(m_0)$—i.e., of a') uncertainty in proper-time increment τ and b') that in rest-mass m_0. At face value, the event-fraction $\sigma_{\mathrm{OB}}/\sigma_{\mathrm{PP}}$ $\left(\equiv \bar{\phi}\right)$ becomes the event observability.

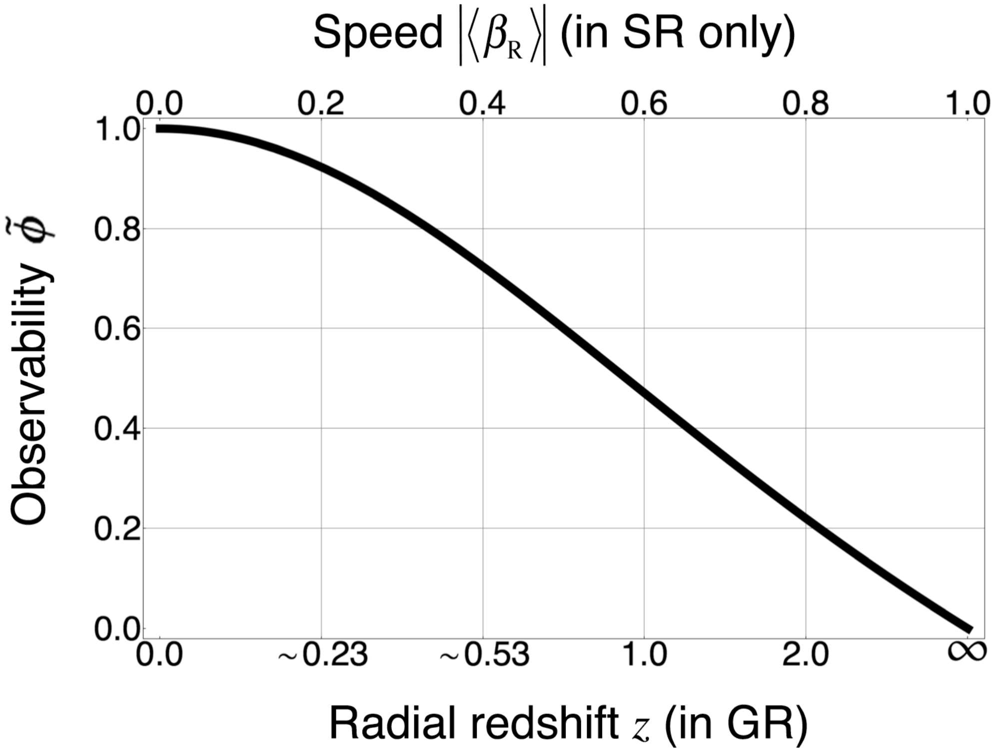


Figure 1. Blue- and redshift diminish event's observability $\tilde{\phi}$. Independent of the (event-to-observer) luminosity distance, $\tilde{\phi}$ is the *effectiveness* of the event's luminosity, in emission of any elementary particle(s). (A) $\tilde{\phi}$ (to the upper abscissa) varies with the radial speed $|\langle \beta_R \rangle|$ of the event in (stochastic) special relativity (SR), per equation (6). (B) $\tilde{\phi}$ (to the lower abscissa) varies with the radial redshift z: $(0, \infty)$ of the event's emission in general relativity (GR), per equation (12). For radial *blueshift* z: $(-1, 0)$, $\tilde{\phi}(z)$ shows the same curve, but left-right reversed.

Introduced herein as a scaffold, stochastic SR modifies the event observability (to $\tilde{\phi}$, in notation) by asserting the speed of light shows not only a) an a priori constant expectation-value shared among all event-observer pairs but further b) an uncertainty inherent and specific to each event-observer pair. The speed of light must manifest its statistical nature in observation.

It is the definition of observability, along with the uncertainty in the speed of light, that unveils the law of ROC, in stochastic SR. Second, it is the principle of relativity that sublimes the law into an integral (but so far unnoticed) aspect of GR.

2. Event network

In QM, we have events and observers; 'event' refers to a fundamental happening (e.g., an interactional collision between fundamental particles), whereas 'observer' to an observation *event* (still an event)—which constitutes a *generalized* observer (as opposed to a conscious observer, such as you or me). On top of its usual context in relativity, 'observation' now emphasizes the observer's 'seeing' an incoming elementary particle in the one dimension (1D) defined by each event-observer pair.

Events are geometric elements of physical reality; elementary particles are the event's 'fragments.' No elementary particle reveals its intact identity alone, in that its existence means already in interaction with, and as part of, the upcoming observer. Any event takes observation for an operational definition. As a model, reality is an evolving network among (observation) events, each of which terminates one set of elementary particles and then emits another set, *entangled* by the emitting event. An observation *event* (an observer) is under subsequent observations. The 'first' of the subsequent observation events a) collapses the wavefunction of the entangled particles and b) determines the observed particle [and the yet-to-be-observed other(s)]. In this particular sense, an elementary particle propagates from event to observer. A composite event or composite particle thus corresponds to a contiguous subsection of the event network.

As **Postulate 1**, *any event observation is along the '1D'—defined by the event-observer pair—that accommodates the quantized projection of the elementary particle's total angular momentum **J** relative to the observer.* For instance, an incident photon projects its orbital angular momentum as well as intrinsic spin (one $\hbar$), with the latter projected as (into) the 1D's *helicity* [13,14]. Observation must otherwise be radial. With no event in between the two defining events, the 1D connection differs from its counterpart in classical geometry. We will focus on the 1D, with the new connotation.

3. Mass and observability

Per the Heisenberg uncertainty principle, events in spacetime are not volumeless mathematical points, that is, not as required of the (fictitious) measurements that would, from a 'point source' to a 'point detector,' always reproduce the speed-of-light constant. Sub- and superluminality must occur because of "quantum noise." Demanding constancy in the speed of light, 'classical' SR offers *no* room for logging incidental (i.e., *prestatistical*, raw) data.

A physical constant is an a priori mathematical constant, but with uncertainty in (statistical) observation. Per incidental (prestatistical) measurement, the speed of light is a *random variable* c_{R} —imaginably needed for us, on further c_{R} measurements, to renormalize the scale of speed by *resetting* the new $\langle c_{\mathrm{R}} \rangle$ to one [and then update $\Delta(c_{\mathrm{R}})$, etc.], where $\langle \_ \rangle$ is the statistical expectation {and $\Delta(\_)$ the standard deviation [15]}. It is our theoretical assertion that $\langle c_{\mathrm{R}} \rangle$ $(\equiv c)$ $=1$. In the similar sense, $\hbar$ is constant.

For logging incidental data, SR becomes *stochastic* (see appendix A, for derivation):

$$\left(\sqrt{c_{\mathrm{R}}}\ t\right)^2 - \left(\frac{r}{\sqrt{c_{\mathrm{R}}}}\right)^2 = \left(\sqrt{c_{\mathrm{R}}}\ \tau\right)^2 \text{ (or } \tilde{t}^2 - \tilde{r}^2 = \tilde{\tau}^2 \text{, by definition),} \tag{1}$$

$$\left(\frac{E}{\sqrt{c_{\mathrm{R}}}}\right)^2 - \left(\sqrt{c_{\mathrm{R}}}\ p\right)^2 = \left(\frac{m_0}{\sqrt{c_{\mathrm{R}}}}\right)^2 \text{ (or } \tilde{E}^2 - \tilde{p}^2 = \tilde{m}_0{}^2 \text{, by definition),} \tag{2}$$

in Planck units, where t is time increment, and E energy—per **Postulate 2**: *Speed-of-light* c_{R} *is a random variable serving as the yardstick (namely,* $\tilde{r}/\tilde{t} = \tilde{E}/\tilde{p} = 1$, or $r/t = E/p = c_{\mathrm{R}}$, *'as'* $\tau = m_0 = 0$*) specific to the incidental (prestatistical) event observation*—which the tilded (i.e., stochastic) dynamic variables describe. Equations (1) and (2) agree with two additional premises: a) convergence of stochastic SR to 'classical' SR, in the non-QM limit, and b) $\tilde{t}$-$\tilde{E}$, $\tilde{r}$-$\tilde{p}$, and $\tilde{\tau}$-$\tilde{m}_0$ conjugation (see appendix B). Equations (1) and (2) represent beyond a unit change of variables, which requires a conversion constant (e.g., c), not a random variable.

Unlike 'classical' SR, stochastic SR offers every <u>*event*</u> (as well as mass particle) life and essence, namely, the *proper-time increment* $\langle \tau \rangle$ *and rest-mass* $\langle m_0 \rangle$, *both dictating (and being quasi dictated by) relations among fundamental uncertainties in the <u>event observation</u>* (see appendix C):

$$\frac{1}{4}\langle \tau \rangle^2 \left[\Delta(c_{1,\mathrm{R}})\right]^2 = \left[\Delta(r)\right]^2 - \left[\Delta(t)\right]^2 , \tag{3}$$

$$\frac{1}{4}\langle m_0 \rangle^2 \left[\Delta(c_{1,\mathrm{R}})\right]^2 = \left[\Delta(p)\right]^2 - \left[\Delta(E)\right]^2 , \tag{4}$$

where $\Delta(c_{1,\mathrm{R}}) \equiv \Delta(c_{\mathrm{R}})/\langle c_{\mathrm{R}} \rangle$. [Per (3) and (4), owing to zero $\Delta(c_{1,\mathrm{R}})$, 'classical' SR a) leaves $\langle \tau \rangle$ and $\langle m_0 \rangle$ indeterminate and b) predicts $\Delta(r) = \Delta(t)$ and $\Delta(p) = \Delta(E)$ (see figure 2, for geometric representation) for *all* entities, erroneously including (mass-carrying) events and mass particles.] In addition, gravity physics mandates the speed of light deviate from constancy in observation if and only if gravity appears [11–13], that is, in observing any quantum event,

$$\Delta(c_{\mathrm{R}}) > 0 \ \Leftrightarrow \ \text{"}\langle m_0 \rangle > 0 \ \left(\text{and } \langle \tau \rangle > 0\right)\text{."} \tag{5}$$

Equations (3)–(5), along with the measurement principle of $\Delta(\_) > 0$, indicate $\Delta(r)\Delta(p) > \Delta(t)\Delta(E)$, as expected of the space-time *asymmetry*. (See figure 2.)

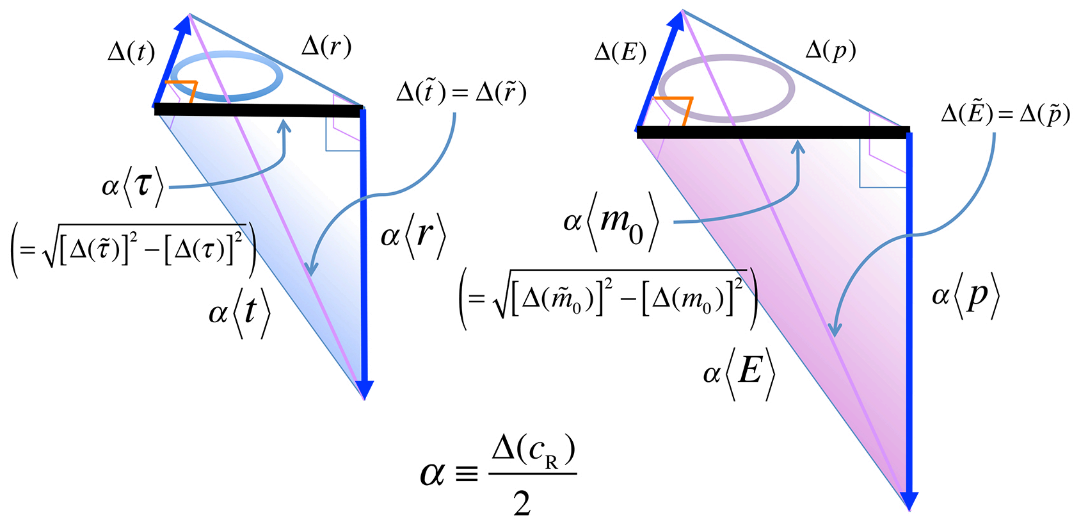


Figure 2. Uncertainty in light-speed is vital to special relativity (SR). In the conjugate tetrahedrons (with all facets being right-triangular), the nonzero α scales, into life*,* a) SR's two fundamental equations (shaded facets) and b) *all* fundamental uncertainties.

Equations (1) and (2) lead to the law of ROC in stochastic SR (see appendix D):

$$\left(1+\langle\beta_{\mathrm{R}}\rangle^{2}\right)\left(1+\tilde{\phi}\right)=2, \tag{6}$$

$$\langle\beta_{\mathrm{R}}\rangle\equiv\frac{\langle\tilde{r}\rangle}{\langle\tilde{t}\rangle}\left(=\frac{\langle r\rangle}{\langle t\rangle}\right)=\frac{\langle\tilde{p}\rangle}{\langle\tilde{E}\rangle}\left(=\frac{\langle p\rangle}{\langle E\rangle}\right), \tag{7}$$

$$\tilde{\phi}\equiv\frac{\tilde{\sigma}_{\mathrm{OB}}\ \left[\equiv\Delta(\tilde{r})\Delta(\tilde{p})\right]}{\tilde{\sigma}_{\mathrm{PP}}\ \left[\equiv\Delta(\tilde{\tau})\Delta(\tilde{m}_{0})\right]}, \tag{8}$$

where $\tilde{\phi}$ is the event observability, with each constituent

$$\Delta(\tilde{X})=\left\{\left[\Delta(X)\right]^{2}+\frac{1}{4}\langle X\rangle^{2}\left[\Delta(c_{1,\mathrm{R}})\right]^{2}\right\}^{1/2}, \tag{9}$$

in (8). As another random variable, β_{R} is the *event*'s incidental velocity, relative to the immediate follow-on *mass* entity, which is either the event-to-observer elementary particle or the observer (to whom the event emits a massless elementary particle). Via (9), $\tilde{\sigma}_{\mathrm{PP}}$ [defined in (8)] becomes proper of—because $\Delta(c_{1,\mathrm{R}})$ is characteristic of—the *event observation*; in comparison, $\sigma_{\mathrm{PP}}\ \left[\equiv\Delta(\tau)\Delta(m_{0})\right]$ is proper only of the *event*, which would be virtual if unobserved, that is, if $\Delta(c_{1,\mathrm{R}})$ undefined.

Equation (6), with $\Delta(\_)>0$, enforces $\langle\beta_{\mathrm{R}}\rangle\neq 0$ (see appendix E), namely, $0<\left|\langle\beta_{\mathrm{R}}\rangle\right|$ (<1) —and $0<\tilde{\phi}<1$. Self observation is therefore infeasible, rendering a) $\langle X\rangle\Delta(c_{1,\mathrm{R}})\neq 0$ in (9) and b) $\tilde{\sigma}_{\mathrm{OB}}>\sigma_{\mathrm{OB}}\ \left[\equiv\Delta(r)\Delta(p)\right]$ and $\tilde{\sigma}_{\mathrm{PP}}>\sigma_{\mathrm{PP}}$. Besides, $\Delta(c_{1,\mathrm{R}})$ couples the entire set of $\Delta(\tilde{X})$, only when none of the corresponding $\langle X\rangle$ is zero, which is always true in stochastic SR. Stationarity, with '$\langle r\rangle=\langle p\rangle=\left|\langle\beta_{\mathrm{R}}\rangle\right|=0$,' refers to an approachable but unreachable limit.

4. Spin and event-intensity

This section verifies (6), in the fiducial (triple-premise) limit where a) $\Delta(c_{1,R})$ vanishes [in (9)], b) the observed elementary particle has quasi 'completed' its interactional redshift 'in' the event, and c) the event is speedless to the observer. Per Postulates 1 and 2, the observed event-intensity $\tilde{\sigma}_{\mathrm{OB}}$ in the limit reduces to σ_{OB} that equals the 1D projection-magnitude of the particle's $\boldsymbol{J}$ [13,14], where $\boldsymbol{J}$ is the vectorial sum of the intrinsic spin $\boldsymbol{S}$ and orbital angular momentum $\boldsymbol{L}$. Observability $\tilde{\phi}$ becomes a rational number, per the quantization of angular momentum.

In the limit, an *elementary* particle free of $\boldsymbol{S}$ and $\boldsymbol{L}$ would violate the Heisenberg uncertainty principle (i.e., $\sigma_{\mathrm{OB}}\geq\hbar/2$), for squeezing $\tilde{\sigma}_{\mathrm{OB}}$ $(>\sigma_{\mathrm{OB}})$ and hence σ_{OB} to zero (that is, to below $\hbar/2$). Owing to never forbidding the projection of $\boldsymbol{L}$ from being zero, *Nature prohibits spin-zero elementary (structureless) particles*—agreeing with E.

Wigner's seminal analysis on the Lorentz group [16,17] of SR. [So the "discovered (spin-zero) Higgs boson" cannot be 'elementary' (see appendix F).] By the same token, a massless elementary particle's $\boldsymbol{S}$ must project onto the 1D, creating the particle's *nonzero* helicity [16,17] to warrant its (nonzero) observability in case the projection of $\boldsymbol{L}$ is zero.

Per the Pauli vector in isotropic 3D space, formal derivation shows (in appendix G)

$$\left[\hat{\tau},\, \hat{m}_0\right] = -2\mathrm{i}\hbar\hat{I} \ , \tag{10}$$

with ^ labeling quantum operators and $\hat{I}$ being the identity operator—and the doubling in commutator 'size' is a mathematical mandate, so far missing in the literature. Equation (10) results in [through (G.10)] the 'proper' uncertainty principle:

$$\sigma_{\mathrm{PP}} \geq \hbar \ . \tag{11}$$

The Heisenberg uncertainty principle $\left(\sigma_{\mathrm{OB}} \geq \hbar/2\right)$ concurs with (11), because a) $\sigma_{\mathrm{PP}} > \sigma_{\mathrm{OB}}$ and b) the smallest nonzero angular momentum is $\hbar/2$.

Consider, in the limit, the *mildest* electron-positron (e^--e^+) pair-production event (speedless to the lab). Per (6), the default event-fraction $\tilde{\phi}$ of $1/2$ 'observed' by either e^- or e^+—or by a 'lab-stationary' observer who detects either e^- or e^+—indeed leads to the proper e^--e^+ energy gap of twice the rest-mass m_{e} of e^- (as verified in appendix H). *Consistently*, the default '$\tilde{\phi} = 1/2$' is also the ratio of $\hbar/2$ over $\hbar$, where a) numerator $\hbar/2$ is the electron-spin magnitude (per Postulate 1) or, equivalently, the mildest σ_{OB} for a speedless event [per the (nonrelativistic) Heisenberg uncertainty principle] and b) denominator $\hbar$ is the mildest σ_{PP} (per the 'proper' uncertainty principle).

In the triple limit, collision between two (spin-1) photons, without relative $\boldsymbol{L}$, may cause $\sigma_{\mathrm{PP}} = 0$ (unobservable; forbidden), $\hbar$ (just discussed), or $2\hbar$. We address the last as another example. With the conservation of linear momentum, equation (6) predicts the two resulting particles (originally entangled) to have $\tilde{\phi} = 1/4$ and $3/4$—the former comes with $\sigma_{\mathrm{OB}} = \hbar/2$, $\left|\left\langle \beta_{\mathrm{R}} \right\rangle\right| = \sqrt{3/5}$, and $\left\langle m_0 \right\rangle = m_{\mathrm{e}}$; the latter with $\sigma_{\mathrm{OB}} = 3\hbar/2$, $\left|\left\langle \beta_{\mathrm{R}} \right\rangle\right| = \sqrt{1/7}$, and quasi 'rest-mass $\left\langle m_0 \right\rangle$' $= 3m_{\mathrm{e}}$ (with the increase due to $\boldsymbol{L}$'s projection magnitude $\hbar$) (see table 1). Still, the two $\tilde{\phi}$'s add up to one, as anticipated of a single event that is speedless to two 'complementary' observers. [When $\sigma_{\mathrm{PP}} = 2\hbar$, the requirement that $|\boldsymbol{L}|$ be an integer multiple of $\hbar$ rules out $\tilde{\phi} = 1/2$ for both particles (see table 1).]

As the event is in (radial) motion [i.e., relaxing Premise 'c' in the triple-premise limit], equation (6) permits 'tuning' $\tilde{\phi}$ from such exemplified rational numbers dictated by $\boldsymbol{S}$ and $\boldsymbol{L}$. For instance, in the event of the mildest e^--e^+ annihilation, the observability $\tilde{\phi}$ via either one of the two resulting photons becomes smaller than $\hbar/(2\hbar)$, whereas the photon, while yet to be observed, retains its helicity $\hbar$ and zero 1D-projection of $\boldsymbol{L}$.

Table 1. Relation between 'rational $\tilde{\phi}$' and $|\langle\beta_R\rangle|$.

Proper event-intensity $\tilde{\sigma}_{PP}$ ($\hbar$)	Observable event-intensity $\tilde{\sigma}_{OB}$ ($\hbar$)	Event observability $\tilde{\phi}$	*Equivalent* speed [a] $\lvert\langle\beta_R\rangle\rvert$	'Complete' interactional redshift [b] z
1	1/2	1/2	$\sqrt{1/3}$	~ 0.932
3/2	1/2	1/3	$\sqrt{2/4}$	~ 1.414
	1	2/3	$\sqrt{1/5}$	~ 0.618
2	1/2	1/4	$\sqrt{3/5}$	~ 1.806
	1	2/4	$\sqrt{2/6}$	~ 0.932
	3/2	3/4	$\sqrt{1/7}$	~ 0.488
etc.				

[a] See equation (6).
[b] See equation (12).

See section 5, for the general meaning of fractional $\tilde{\phi}$ (rational or irrational); section 8, for the significance of compromised $\tilde{\phi}$ in QM.

5. Fractional observability

For observation via, for now, a *massless* elementary particle in stochastic SR, the law of ROC turns into

$$\tilde{\phi}(z) = \frac{2}{(1+z)^2 + (1+z)^{-2}} \text{ (see figure 1),} \tag{12}$$

per (6) and (as a bait) the relativistic Doppler relation [10,11] of $\langle \beta_\mathrm{R} \rangle$ and z—where $\langle \beta_\mathrm{R} \rangle$ is meaningful only between mass entities, and z is of the massless elementary particle travelling in between. Now that the particle-wave duality is universal, equation (12) holds for observation via any event-to-observer particle, *whether massless or not*.

Derivation of (6) and hence (12) does not differentiate the meaning for $\Delta(X)$ between a) of a fundamental quantum event and b) of a composite 'event' spanning, at our choice, a contiguous subsection of the event network. Equation (12) applies to observation of composite cosmic events or objects, in the (quasi) 'universe of stochastic SR' for now [and the universe of GR (see section 6)].

The observability $\tilde{\phi}$ of a fundamental *event* is that of the event-to-observer elementary *particle*, as referenced to the *particle*'s nominal initial state whose wavelength λ_0 is proper to (and 'at') the thereby referenced *event*. Equation (12) permits different definitional choices for the (referenced) *event* from the same physical 'happening' (e.g., an e^--e^+ annihilation). For a *given* observed λ, a different choice for λ_0—namely, a different definitional choice for the (referenced) event—leads to a different pair of z and (fractional) $\tilde{\phi}$, and vice versa. That is, for a given λ, a different z a) corresponds to a different choice for the event and b) results in a different $\tilde{\phi}$ per (12). [Such disciplined flexibility to define the event also holds in GR (see section 6).]

For instance, to a *unidirectional* observer, an e^--e^+ annihilation corresponds to detecting *one* of the two resulting photons, and the photon may have partially fulfilled the happening's redshift, to an arbitrary but specific extent. The 'partial' event may *further* 'redshift' by z' relative to the observer and reveal the z'-dependent observability $\tilde{\phi}'$ (of the 'partial' event), per (12); for z' and $\tilde{\phi}'$, the original 'partial' event is the referenced "complete" event. So we, as observers unidirectional to *any* cosmic event (or object), always get to define the counterpart 'stationary event (or object) for study' as if it had $z = 0$ and $\tilde{\phi} = 1$ [in the universe of GR (see below)]. This is a leap in conception; recall, under the "triple limit" of section 4, it takes two accessible $\tilde{\phi}$'s to sum up to one.

6. True observable

In portraying physical laws, the principle of relativity [10–12] demands 'equivalence' among all observers. From *our* perspective of 'event vs. (generalized) observer,' the principle translates to: *Any (global) physical law is in terms of a set of <u>observer's local observables</u> that all observers nominally share—and thereby share the law—so <u>we</u> can correlate observers for a common event* $\underline{\mathrm{E}}$ (underscored for distinction from energy E), *via its intrinsic property*.

As a single event, the observer (locally) 'owns' its observables v_i (with i being an index). Manifesting the incoming elementary particle to the observer, such local v_i are 'functions' $v_i(\underline{\mathrm{E}}, R_{\underline{\mathrm{E}}\mathrm{O}})$ of a) event $\underline{\mathrm{E}}$ that emitted the elementary particle and b) the relativity context (denoted as a quasi variable $R_{\underline{\mathrm{E}}\mathrm{O}}$, for shorthand) connecting $\underline{\mathrm{E}}$ to the observer. (In this way, we skip the debate on the existence of the graviton.)

To be eligible as a (global) law, the local relation among the v_i involves no $R_{\underline{\mathrm{E}}\mathrm{O}}$ as otherwise it would contradict the default observer-specific localness and disqualify the "law." Namely, each law results from covariance among a set of v_i, regardless of $R_{\underline{\mathrm{E}}\mathrm{O}}$, and corresponds to an equation explicit of v_i , but 'implicit' of $R_{\underline{\mathrm{E}}\mathrm{O}}$ through $v_i(\underline{\mathrm{E}}, R_{\underline{\mathrm{E}}\mathrm{O}})$.

In notation, the above conception condenses to

$$f_{\mathrm{LAW}}\left(v_1,\, v_2,\, v_3,\, ...\right) = 0 \ , \tag{13}$$

where f_{LAW} is the expression describing the law—prohibiting $f_{\mathrm{LAW}}\left(v_1,\, v_2,\, ...,\, R_{\underline{\mathrm{E}}\mathrm{O}}\right) = 0$. To the generalized observer, equation (13) conceals v_i's dependence on $R_{\underline{\mathrm{E}}\mathrm{O}}$. To us,

$$f_{\mathrm{LAW}}\left[v_1(\underline{\mathrm{E}}, R_{\underline{\mathrm{E}}\mathrm{O}}),\, v_2(\underline{\mathrm{E}}, R_{\underline{\mathrm{E}}\mathrm{O}}),\, v_3(\underline{\mathrm{E}}, R_{\underline{\mathrm{E}}\mathrm{O}}),\, ...\right] = 0 \ , \tag{14}$$

in that conscious observers can conceive of the event network, and then of $\underline{\mathrm{E}}$ and $R_{\underline{\mathrm{E}}\mathrm{O}}$.

Because of not explicitly involving $R_{\underline{\mathrm{E}}\mathrm{O}}$, *equation (13) is valid even when* $R_{\underline{\mathrm{E}}\mathrm{O}}$ *is in the asymptotic limit of stochastic SR*, which can therefore serve as a scaffold for helping derive physical laws among *true* v_i. Both $\tilde{\phi}$ $\left(\equiv \tilde{\sigma}_{\mathrm{OB}}/\tilde{\sigma}_{\mathrm{PP}}\right)$ and z $\left[\equiv \left(L_{\mathrm{OB}}/L_{\mathrm{PP}}\right) - 1\right]$ act as $v_i(\underline{\mathrm{E}}, R_{\underline{\mathrm{E}}\mathrm{O}})$, for each involves merely a simple ratio with a) the numerator reflecting only $\underline{\mathrm{E}}$ and $R_{\underline{\mathrm{E}}\mathrm{O}}$ and b) the denominator only $\underline{\mathrm{E}}$. Seemingly trivial, **Postulate 3** states $\tilde{\phi}$ *and* z *are physical observables that comply with the principle of relativity*—warranting $\tilde{\phi}$ and z may covary into a law (invariant to any permissible $R_{\underline{\mathrm{E}}\mathrm{O}}$). Thereby, equation (12) holds in GR, that is, even *after we obliterate all the scaffolding context of stochastic SR*—such as $\tilde{\phi}$'s 'anatomy' in terms of $\Delta(\_)$ [for the observer 'may' be clueless of $\tilde{r}$, $\tilde{p}$, $\tilde{\tau}$, and $\tilde{m}_0$, let alone their $\Delta(\_)$'s], equation (6) [for $\langle \beta_{\mathrm{R}} \rangle$ is a pseudo observable (see appendix I)], etc.

Postulate 3 legitimates the use of SR's Doppler effect as a bait, to put (12) in a beyond-SR context (see section 5), in that the (generalized) observer is oblivious to the nature of the redshift in terms of SR, GR, or quantum gravity.

In GR-based cosmological models, equation (12) ensures a) the observability of the cosmos mathematically *integrable* over the entire domain of redshift and b) 0^+ observability expected of the Big Bang's extreme onset (see appendix J)—though (12) is 'neutral' to any cosmological model, whether involving the Big Bang.

7. No 'cosmic acceleration'

Stochastic SR is an interfacing cornerstone between quantum uncertainties and GR. Stochastic SR embeds (12), and therefore so does (should) quantum gravity, along with GR [as a limit of zero local $\Delta(c_{1,\mathrm{R}})$] (see appendix K). Without our prior awareness, equation (12) is intrinsic to the 'complete' GR-based cosmological model—which our observation along with observational interpretation, as an integral part of the model, helps 'complete.' It remains a must to rectify, with the ROC effect [i.e., equation (12)], the observational interpretation of the otherwise incomplete GR-based model.

Being the major "evidence of cosmic acceleration [1–3]," figure 3 illustrates 'observed-magnitude [5] $\underline{m}$ (underscored for distinction from mass m) vs. redshift z' of Type Ia supernovae. In the figure, the current article depicts the ROC-corrected observed magnitude (curve of blue dots) for the critical cosmic expansion (CCE) of 'no' vacuum energy (i.e., zero Ω_Λ): (see appendix L for derivation)

$$\underline{m}_{\mathrm{CCE}}(ROC;\, z) \equiv \underline{m}_{\mathrm{CCE}}(No\ ROC;\, z) - 2.5\log_{10}\left(\tilde{\phi}(z)\right), \tag{15}$$

where $\underline{m}_{\mathrm{CCE}}(No\ ROC;\, z)$ is the CCE curve as if no ROC associated with the universe traversing photons that our observation terminates. Curve $\underline{m}_{\mathrm{CCE}}(ROC;\, z)$ intersects 21 uncertainty bars—of the 28 data points—only one fewer than Ref. [1]'s *modeled best fit* (thin blue curve, which gives parameter $\Omega_\Lambda \approx 2/3$). In particular, $\underline{m}_{\mathrm{CCE}}(ROC;\, z)$ intersects eight uncertainty bars of all nine data points (red dots) from the High-Z Supernova Search [2]. Denying "cosmic acceleration," the supernovae data coincide with the 'new' CCE curve of zero Ω_Λ, to within observational uncertainty.

The correction is based all on common knowledge (i.e., Postulates 0–3) and free of parameter fitting. By Occam's razor, "cosmic acceleration" appears artifactual.

The law of ROC also dissolves the crisis, identified by Ref. [18], of missing 400% of hydrogen-atom ionizing photons in cosmological observation at z slightly above 2—where $(1-\tilde{\phi})/\tilde{\phi}$, as figure 1 shows, matches the "400%."

A further check on the law of ROC is to account for the enigma raised by Ref. [19]: Why has it been easier to see gas *relativistically* blowing toward than away from us, at all high-z quasars? A strong candidate answer lies in the monotonicity of $\tilde{\phi}(z)$ in figure 1.

8. Concluding remarks

8.1. Relativistic uncertainty

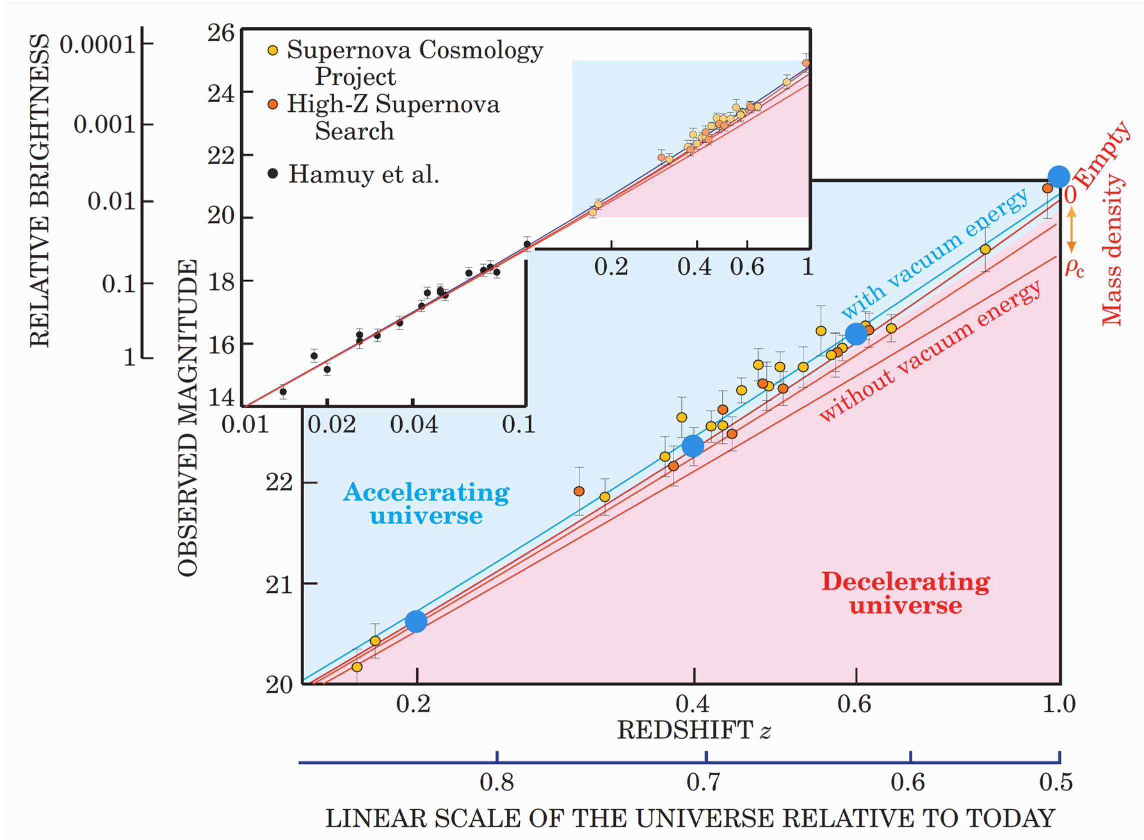


Figure 3. Observed-magnitude [5] $\underline{m}$ **vs. redshift** z **of Type Ia supernovae, denying "cosmic acceleration."** (Part of the figure and legend is reproduced with permission from Ref. [1], Copyright 2003, American Institute of Physics.) The original legend reads

> "*Observed magnitude versus redshift is plotted for well-measured distant and (in the inset) nearby Type Ia supernovae. For clarity, measurements at the same redshift are combined. At redshifts beyond* $z = 0.1$*, the cosmological predictions (indicated by the curves) begin to diverge, depending on the assumed cosmic densities of mass and vacuum energy. The red curves represent models with zero vacuum energy and mass densities ranging from the critical density* ρ_c *down to zero (an empty cosmos). The best fit (blue line) assumes a mass density of about* $\rho_c/3$ *plus a vacuum energy density twice that large—implying an accelerating cosmic expansion.*"

Equation (15) creates the theoretical observed-magnitude $\underline{m}_{\text{CCE}}(ROC;\, z)$ (curve of blue dots) for the *critical* cosmic expansion (CCE) of 'no' vacuum energy (i.e., zero Ω_Λ), after correction for the ROC (for 'relativistic observability compromise') effect. Free of parameter fitting, the effect lifts the "orthodox" zero-Ω_Λ CCE curve (labeled with ρ_c) to $\underline{m}_{\text{CCE}}(ROC;\, z)$, which coincides with the observational data, to within uncertainty.

As $1+z$ is $\Gamma\ \left(\equiv L_{\mathrm{OB}}/L_{\mathrm{PP}}\right)$, equation (12) entails the fundamental quantum event's observability *amplitude* (i.e., observation *probability amplitude*)

$$\psi = \mathrm{e}^{\mathrm{i}\delta}\sqrt{\frac{2}{\Gamma^2+\Gamma^{-2}}}\ , \tag{16}$$

where $\mathrm{e}^{\mathrm{i}\delta}$ is a unitary phase factor—via *the* event-to-observer elementary particle, whether massless or not. Namely, $\tilde{\phi}=\psi^*\psi$. Like $\tilde{\phi}$, amplitude ψ profiles a resonance in Γ (or Γ^{-1}), peaking at $\Gamma=1$.

Regardless of Γ and $\tilde{\phi}$, the particle retains the same total angular momentum $\boldsymbol{J}$ and, once collapsed, imparts the same 1-D projection of $\boldsymbol{J}$—as if the event were speedless—to the observer. This 1D projection magnitude coincides with $\tilde{\sigma}_{\mathrm{OB}}$ in the "triple limit" (see section 4).

Equation (16) leads to the *relativistic* uncertainty principle [via (G.8b) and (G.10), in appendix G]:

$$\tilde{\sigma}_{\mathrm{OB}} \geq \frac{\hbar}{\Gamma^2+\Gamma^{-2}}\ \left(=\tilde{\phi}\ \frac{\hbar}{2}\right), \tag{17}$$

reflecting the general-relativistic *event-intensity reduction*. In 'classical' SR, equation (17) becomes

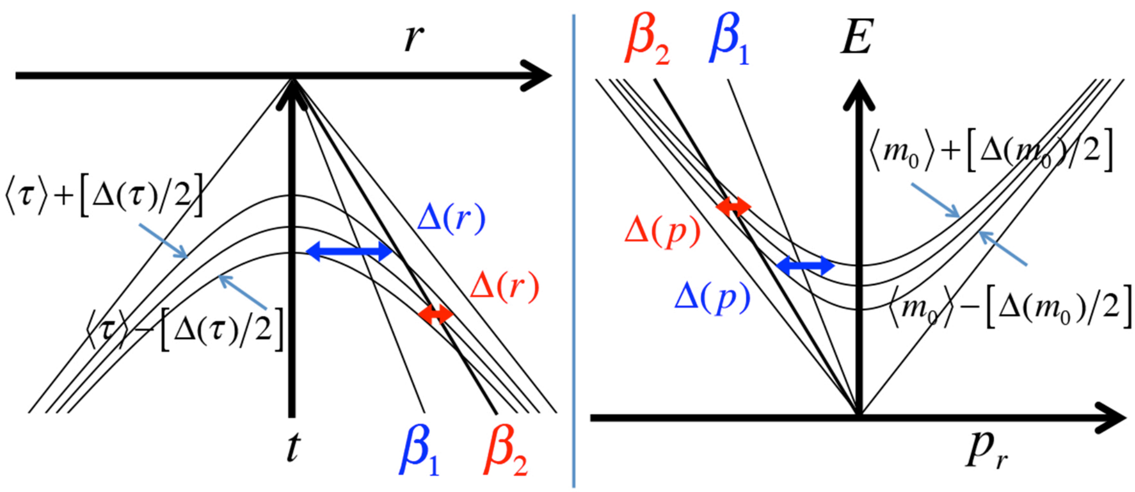
$$\Delta(r)\Delta(p) \geq \begin{cases} \dfrac{\hbar}{\Gamma^2+\Gamma^{-2}} \text{ or, equivalently,} \\ \left(\dfrac{1-\langle\beta_{\mathrm{R}}\rangle^2}{1+\langle\beta_{\mathrm{R}}\rangle^2}\right)\dfrac{\hbar}{2}, \end{cases} \tag{18}$$

with the latter due to (6). The Heisenberg uncertainty principle (in SR) is the *nonrelativistic* limit with $\langle\beta_{\mathrm{R}}\rangle=0$, i.e., $\Gamma=1$. Figure 4 verifies (18)—a straightforward visualization that has slipped through the crack since W. Heisenberg in 1927.

Equation (17) diminishes the observer-effective vacuum energy and thereby drastically mitigates the cosmological constant problem [20]—for at the speed of light in default 'radial-only observations,' the Planck particle is unobservable.

Inequalities (11) and (17) are principles of both uncertainty and event-intensity. It is event-intensity reduction that helps enact the law of ROC.

In any physical measure, the generalized observer must be nonzero finite; it lacks precision for 0 and capacity for ∞. The more λ approaches 0 or ∞, the less discernible the (wave-emitting) event. Accepting "cosmic acceleration,"—namely, denying relativistic event-intensity reduction or the law of ROC—(oxymoronically) connotes 100% statistical observability of an event emitting a wave with λ '$=$' 0 or ∞, that is, a "wave of *no* wave!" It is unsurprising that the law of ROC dissolves all three cosmic enigmas mentioned in section 7, free of parameterization.



$$\underline{\Delta(r)\Delta(p)}_{\beta_1} > \underline{\Delta(r)\Delta(p)}_{\beta_2}$$
$$as\ \beta_1 < \beta_2$$

Figure 4. The Heisenberg uncertainty principle needs relativistic refinement: Reduction of event-intensity $\Delta(r)\Delta(p)$—hint from 'classical' special relativity. A mass entity (either event or particle) possesses its intrinsic $\langle\tau\rangle$, $\Delta(\tau)$, $\langle m_0\rangle$, and $\Delta(m_0)$, all nonzero and Lorentz-invariant. Within the past light-cone in the t-r diagram (upper left), any observed mass entity locates at the intersection of a) the $\langle\tau\rangle$- contour (hyperbolic branch) and b) the β-contour (origin-passing straight line), where β is the entity's unitless speed. Characteristic of the entity, the (hyperbolic) contours of $\langle\tau\rangle+(\Delta(\tau)/2)$ and $\langle\tau\rangle-(\Delta(\tau)/2)$ 'pinch' the entity's $\Delta(t)$ and $\Delta(r)$. Under the pinch, as β varying from 0 to 1^- (that is, the β- line tilting toward either side of the light-cone), the entity progresses with *ever-decreasing* $\Delta(t)$ and $\Delta(r)$, both asymptotically to 0^+. • In the E-p diagram (upper right), the entity likewise progresses with *ever-decreasing* $\Delta(E)$ and $\Delta(p)$. • Per both diagrams, $\Delta(r)\Delta(p)$ diminishes, as β [corresponding to $\langle\beta_R\rangle$ in (18)] deviates from 0. So a') the greatest lower-bound of $\Delta(r)\Delta(p)$ peaks with "Heisenberg's" $\hbar/2$, only at $\beta=0$, and b') the $\Delta(r)\Delta(p)$ and thus the observability of the Planck event vanishes, for the (mass-carrying) Planck particle emitted by the Planck event 'is' at the speed of light. The latter drastically mitigates the cosmological constant problem.

Holding for the cosmological observation and the e^{-}-e^{+} interaction, equation (16) [with (17), i.e., the relativistic uncertainty principle] partly hints on how to address integrability issues of quantum field theory. For instance, the 'spin network' appears incomplete, in contrast to the event network per (16).

8.2. Lab testability

A recommended check on figure 1 follows. We a) generate an electron beam—tunable up to 0.9 in speed (1.2 Mev in energy) or higher—to annihilate positrons steady in number density and 'stationary' (e.g., in an electromagnetic trap) to the lab, and b) observe, at a grazing angle to the collision axis, how the resulting photon intensity varies with the annihilation *event's* speed (i.e., half the incident electron's speed). The intensity measurements at the grazing angle are in opposing directions, one for blueshift, and the other redshift. This experiment checks figure 1 with the event speed below 0.5 to the lab.

Even better will be to employ an e^{-}-e^{+} collider a) tunable in each beam-speed up to 0.9 or higher and also b) reversible in direction for one of the two (nearly coaxial) beams, to further create the catch-up collisions that help check figure 1 with the event speed *above* 0.5 to the lab. Such experiments may settle the debate.

In such *relativistic* EPR (for 'Einstein, Podolsky, and Rosen') correlation experiments [21], the law of ROC may ease the "tension between non-relativistic (current) quantum information theory and non-quantum relativity theory" [22] (parenthesized word by Gwo).

Acknowledgements

The author thanks a) Heavenly Father for the research opportunity and b) Distribution, for review and discussion.

Appendix A: Stochastic special Relativity

This appendix helps section 3 justify replacing 'classical' special relativity (SR):

$$t^2 - r^2 = \tau^2, \tag{A.1}$$

$$E^2 - p^2 = {m_0}^2, \tag{A.2}$$

with stochastic SR:

$$\left(\sqrt{c_{\mathrm{R}}}\ t\right)^2 - \left(\frac{r}{\sqrt{c_{\mathrm{R}}}}\right)^2 = \left(\sqrt{c_{\mathrm{R}}}\ \tau\right)^2, \tag{A.3}$$

(or $\tilde{t}^2 - \tilde{r}^2 = \tilde{\tau}^2,$ by variable definition)

$$\left(\frac{E}{\sqrt{c_{\mathrm{R}}}}\right)^2 - \left(\sqrt{c_{\mathrm{R}}}\ p\right)^2 = \left(\frac{m_0}{\sqrt{c_{\mathrm{R}}}}\right)^2, \tag{A.4}$$

(or $\tilde{E}^2 - \tilde{p}^2 = {\tilde{m}_0}^2,$ by variable definition).

Here begins the derivation. Postulate 2, with the two premises listed below (2), demands 'softening' (A.1) and (A.2) as

$$\left(c_{\mathrm{R}}{}^{a}\ t\right)^2-\left(\frac{r}{c_{\mathrm{R}}{}^{1-a}}\right)^2=\left(c_{\mathrm{R}}{}^{a}\ \tau\right)^2, \tag{A.5}$$

(or $\tilde{t}^2-\tilde{r}^2=\tilde{\tau}^2$, as shown below)

$$\left(\frac{E}{c_{\mathrm{R}}{}^{a}}\right)^2-\left(c_{\mathrm{R}}{}^{1-a}\ p\right)^2=\left(\frac{m_0}{c_{\mathrm{R}}{}^{a}}\right)^2, \tag{A.6}$$

(or $\tilde{E}^2-\tilde{p}^2=\tilde{m}_0{}^2$, as shown below)

leaving statistical theory alone to determine the value of parameter a.

By the definition of $\Delta(\_)$, we have

$$\Delta(\tilde{\tau}^2)=2\left|\langle\tilde{\tau}\rangle\right|\Delta(\tilde{\tau}). \tag{A.7}$$

Owing to the statistical covariance between $\tilde{t}-\tilde{r}$ and $\tilde{t}+\tilde{r}$ being zero, equation (A.5) leads to

$$\Delta(\tilde{\tau}^2)=\sqrt{\left(\langle\tilde{t}\rangle+\langle\tilde{r}\rangle\right)^2\left[\Delta\left(\tilde{t}-\tilde{r}\right)\right]^2+\left(\langle\tilde{t}\rangle-\langle\tilde{r}\rangle\right)^2\left[\Delta\left(\tilde{t}+\tilde{r}\right)\right]^2}, \tag{A.8}$$

which, along with (A.7), becomes

$$\Delta(\tilde{\tau})=\sqrt{\frac{\left[\Delta(\tilde{t})\right]^2+\left[\Delta(\tilde{r})\right]^2}{2}}\sqrt{\frac{1+\langle\beta_{\mathrm{R}}\rangle^2}{1-\langle\beta_{\mathrm{R}}\rangle^2}}, \tag{A.9}$$

with $\langle\beta_{\mathrm{R}}\rangle^2$ substituting for $\left|\langle\tilde{r}\rangle/\langle\tilde{t}\rangle\right|^2$ $\left(=\left|\langle r\rangle/\langle t\rangle\right|^2\langle c_{\mathrm{R}}\rangle^{-2}\right)$. (Recall r and t are each a differential increment in spacetime, by definition.) In (A.9), $\langle\beta_{\mathrm{R}}\rangle$ must be an *expectation* value—of the event's incidental velocity β_{R} (to the observer) as normalized relative to $\langle c_{\mathrm{R}}\rangle$—in that all three other entities [i.e., $\Delta(\tilde{\tau})$, $\Delta(\tilde{t})$, and $\Delta(\tilde{r})$] are statistical values (of the event observation). $\langle\beta_{\mathrm{R}}\rangle$ must also correspond to the *radial* velocity of the event as the event-observer pair defines only the radial 1D. (Similar to that of c_{R}, subscript R reminds β_{R} is a stochastic random variable.)

'Restarting' from $\tilde{\tau}=-(\tilde{t}^2-\tilde{r}^2)^{1/2}$ [seemingly redundant to (A.5)] gives

$$\Delta(\tilde{\tau})=\sqrt{\left[\Delta(\tilde{t})\right]^2+\langle\beta_{\mathrm{R}}\rangle^2\left[\Delta(\tilde{r})\right]^2}\sqrt{\frac{1}{1-\langle\beta_{\mathrm{R}}\rangle^2}}. \tag{A.10}$$

Equating the right-hand sides of (A.9) and (A.10) indicates

$$\Delta(\tilde{t}) = \Delta(\tilde{r}), \tag{A.11}$$

regardless of $\langle \beta_{\mathrm{R}} \rangle$ and $\Delta(\tilde{\tau})$. The mathematical analogy between (A.5) and (A.6) legitimates substituting $\langle \beta_{\mathrm{R}} \rangle^2$ for $\left| \langle \tilde{p} \rangle / \langle \tilde{E} \rangle \right|^2$ $\left(= \left| \langle p \rangle / \langle E \rangle \right|^2 \langle c_{\mathrm{R}} \rangle^2 \right)$ as well and entails

$$\Delta(\tilde{E}) = \Delta(\tilde{p}), \tag{A.12}$$

regardless of $\langle \beta_{\mathrm{R}} \rangle$ and $\Delta(\tilde{m}_0)$.

By definition, equation (A.11) is

$$\Delta\left(c_{\mathrm{R}}{}^{a}\, t \right) = \Delta\left(\frac{r}{c_{\mathrm{R}}{}^{1-a}} \right), \tag{A.13}$$

which expands into

$$\left[\Delta(t)\right]^2 + \left[a^2 \langle \tau \rangle^2 + (2a-1)^2 \langle r \rangle^2 \right] \left[\Delta(c_{1,\,\mathrm{R}}) \right]^2 = \left[\Delta(r) \right]^2, \tag{A.14}$$

with $\Delta(c_{1,\,\mathrm{R}})$ being the ratio of $\Delta(c_{\mathrm{R}}) / \langle c_{\mathrm{R}} \rangle$. Per (A.14) and the measurement principle of $\Delta(\_) > 0$, parameter a—in (A.5) and (A.6)—must be $1/2$ in that $\Delta(r)$ is independent of $\langle r \rangle$ in statistics. So we get (A.3) and (A.4).

Appendix B: Conjugation of time and energy

As defined in Ref. [23], the time operator can be self-adjoint and compatible with the energy operator having a spectrum bounded from below. "On their common domain, the operators of time and energy satisfy the expected canonical commutation relation. Pauli's theorem [24] is bypassed because the correspondence between time and energy is not given by the standard Fourier transformation, but by a variant thereof known as the holomorphic Fourier transformation." [23]

Appendix C: 'Definitions' of $\langle \tau \rangle$ and $\langle m_0 \rangle$

With $a = 1/2$, equation (A.14) reduces to an *operational* 'quasi' definition of $\langle \tau \rangle$:

$$\frac{1}{4} \langle \tau \rangle^2 \left[\Delta(c_{1,\,\mathrm{R}}) \right]^2 = \left[\Delta(r) \right]^2 - \left[\Delta(t) \right]^2. \tag{C.1}$$

One can verify the interplay consistency among the three Δ's in (C.1) on a *classical*-SR spacetime diagram, which reflects $\Delta(c_{1,\mathrm{R}})$ by 'backward' referencing the precise light cone to the fuzzy event 'confined' with $\Delta(t)$, $\Delta(r)$, and invariant $\Delta(\tau)$. Via analogy between (A.3) and (A.4), equation (C.1) implies an *operational* 'quasi' definition of $\langle m_0 \rangle$:

$$\frac{1}{4}\langle m_0\rangle^2 \left[\Delta(c_{1,\mathrm{R}})\right]^2 = \left[\Delta(p)\right]^2 - \left[\Delta(E)\right]^2 . \tag{C.2}$$

$\langle \tau \rangle$ and $\langle m_0 \rangle$ must be a) positive for any physical *event* and b) nonnegative for any elementary *particle*. $\langle \tau \rangle$ and $\langle m_0 \rangle$ dictate the relations among the fundamental Δ's in the event observation—and among those of an observed particle. Still, an elementary particle may be proper-timeless and rest-massless.

Division by zero is indeterminate. It is (nonzero) $\Delta(c_{1,R})$ in (C.1) and (C.2) that turns on the event's and the elementary particle's proper-time and rest-mass as dynamic variables. No $\Delta(c_{1,\mathrm{R}})$ is an intrinsic flaw with 'classical' SR. *By default*, *SR should refer to stochastic SR, not 'classical' SR.*

Appendix D: Observability in stochastic SR

Equation (A.11) converges (A.9) and (A.10) to the same form(s):

$$\Delta(\tilde{\tau}) = \begin{cases} \Delta(\tilde{t})\sqrt{\dfrac{1+\langle\beta_\mathrm{R}\rangle^2}{1-\langle\beta_\mathrm{R}\rangle^2}} \text{ or, equivalently,} \\ \Delta(\tilde{r})\sqrt{\dfrac{1+\langle\beta_\mathrm{R}\rangle^2}{1-\langle\beta_\mathrm{R}\rangle^2}}. \end{cases} \tag{D.1}$$

Likewise, equation (A.12) results in

$$\Delta(\tilde{m}_0) = \begin{cases} \Delta(\tilde{E})\sqrt{\dfrac{1+\langle\beta_\mathrm{R}\rangle^2}{1-\langle\beta_\mathrm{R}\rangle^2}} \text{ or, equivalently,} \\ \Delta(\tilde{p})\sqrt{\dfrac{1+\langle\beta_\mathrm{R}\rangle^2}{1-\langle\beta_\mathrm{R}\rangle^2}}. \end{cases} \tag{D.2}$$

Involving no QM, the derivations of (D.1) and (D.2) depend only on a) the definition of standard deviation $\Delta(\_)$ and b) stochastic SR. At the quantum-event level, $\Delta(\_)$ must correspond to the observational uncertainty. Equations (D.1) and (D.2) are therefore essential in quantum observation, so is their multiplicative combination, which gives

$$\tilde{\phi} = \frac{1 - \langle \beta_{\mathrm{R}} \rangle^2}{1 + \langle \beta_{\mathrm{R}} \rangle^2}, \tag{D.3}$$

or, equivalently,

$$\left(1 + \langle \beta_{\mathrm{R}} \rangle^2\right)\left(1 + \tilde{\phi}\right) = 2 \ , \tag{D.4}$$

where

$$\tilde{\phi} \equiv \frac{\tilde{\sigma}_{\mathrm{OB}} \ \left[\equiv \Delta(\tilde{r})\Delta(\tilde{p})\right]}{\tilde{\sigma}_{\mathrm{PP}} \ \left[\equiv \Delta(\tilde{\tau})\Delta(\tilde{m}_0)\right]} \tag{D.5a}$$

$$= \frac{\Delta(\tilde{t})\Delta(\tilde{E})}{\tilde{\sigma}_{\mathrm{PP}}}, \tag{D5b}$$

with each constituent

$$\Delta(\tilde{X}) = \sqrt{\left[\Delta(X)\right]^2 + \frac{1}{4}\langle X \rangle^2 \left[\Delta(c_{1,\mathrm{R}})\right]^2} \ , \tag{D.6}$$

in (D.5a) and (D.5b). So $\langle X \rangle \Delta(c_{1,\mathrm{R}})$ $(\neq 0)$ increases the event-intensity.

In the limit of zero $\Delta(c_{1,\mathrm{R}})$, $\tilde{\phi}$ becomes $\bar{\phi} \equiv \Delta(r)\Delta(p) \ \left[\Delta(\tau)\Delta(m_0)\right]^{-1}$ or, equivalently, $\Delta(t)\Delta(E) \ \left[\Delta(\tau)\Delta(m_0)\right]^{-1}$, where the two *nonzero* numerators highlight ‘classical’ (nonstochastic) SR’s self-contradiction between a) nonzero event *volumes* [i.e., $\Delta(t)\Delta(r)$’s; not event-intensities] in spacetime and b) the a priori constant speed of light that requires zero event volumes.

Appendix E: No stationarity

Equation (D.4) leads to

$$\left|\langle \beta_{\mathrm{R}} \rangle\right| \Delta\left(\langle \beta_{\mathrm{R}} \rangle\right) = \frac{\Delta(\tilde{\phi})}{\left(1 + \langle \tilde{\phi} \rangle\right)^2}, \tag{E.1}$$

which prohibits $\langle \beta_{\mathrm{R}} \rangle$ from being zero in that $\Delta(\_)$ may never be zero. [No stationarity agrees with the (positive) zero-point energy in QM.] The nominal missing point of $\tilde{\phi}$ at $\langle \beta_{\mathrm{R}} \rangle = 0$ leaves intact the prediction of $\lim_{|\langle \beta_{\mathrm{R}} \rangle| \to 0^+} \tilde{\phi} = 1$, per (6) or (D.4).

Appendix F: 'Discovery' of Higgs boson

By definition, an elementary particle is structureless. The discovery announcement {3 July 2012, at the LHC [9]} of the 'elementary' (spin-0) Higgs boson [25] fell short of verification in this regard. Should it have been structureless, E. Wigner's seminal analysis of the Lorentz group [16]—which forbids spin-zero elementary particles—would be incorrect [17], so would special relativity (SR), of which the Lorentz group is characteristic. It is improper to celebrate the "discovery" with SR.

Did we mistake a meson (i.e., a quark-antiquark pair) for the "Higgs boson," rhyming the history, in the 1940s, we mistook pions for the *elementary* mediators between protons? Popularity vote does not determine physics.

Appendix G: Derivation of $\left[\hat{\tau},\, \hat{m}_0\right] = -2\mathrm{i}\hbar\hat{I}$

Applying the (Hermitian) Pauli matrices [26,27] to two independent operators $\hat{A}$ and $\hat{B}$ of same dimension, one can synthesize two degree-2 algebraic operators that are a) orthogonal to each other and b) antisymmetric in permuting $\hat{A}$ and $\hat{B}$, as follows:

$$\begin{pmatrix} \hat{A} & \hat{B} \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} \hat{A} \\ \hat{B} \end{pmatrix} = \hat{A}^2 - \hat{B}^2, \tag{G.1}$$

$$\begin{pmatrix} \hat{A} & \hat{B} \end{pmatrix} \begin{pmatrix} 0 & -\mathrm{i} \\ \mathrm{i} & 0 \end{pmatrix} \begin{pmatrix} \hat{A} \\ \hat{B} \end{pmatrix} = \mathrm{i}\left[\hat{B},\, \hat{A}\right], \tag{G.2}$$

where $\left[\hat{B},\, \hat{A}\right] \equiv \hat{B}\hat{A} - \hat{A}\hat{B}$.

Operator $\left[\hat{B},\, \hat{A}\right]$ is reminiscent of the canonical commutators in QM, and $\hat{A}^2 - \hat{B}^2$ is of the spacetime interval in SR.

Based on different Pauli matrices, $\hat{A}^2 - \hat{B}^2$ and $\left[\hat{B},\, \hat{A}\right]$ constitute a basis for all antisymmetric degree-2–algebraic operators in $\hat{A}$ and $\hat{B}$. Therefore, algebra among operators $\hat{A}_j{}^2 - \hat{B}_j{}^2$ ($j = 1,\ 2,\ 3,\ \ldots$) 'parallels' that among $\mathrm{i}\left[\hat{B}_j,\, \hat{A}_j\right]$. For instance, when equation $f_{\mathrm{L.C.}}(\_) = 0$ relates operators—as arguments of linear combination $f_{L.C.}(\_)$—that are each in the form of $\hat{A}_j{}^2 - \hat{B}_j{}^2$, $f_{\mathrm{L.C.}}(\_) = 0$ similarly relates all corresponding $\mathrm{i}\left[\hat{B}_j,\, \hat{A}_j\right]$, and vice versa. Namely,

$$f_{\mathrm{L.C.}}\left(\hat{A}_1{}^2 - \hat{B}_1{}^2,\, \hat{A}_2{}^2 - \hat{B}_2{}^2,\, \hat{A}_3{}^2 - \hat{B}_3{}^2,\, \ldots\right) = 0$$

$$\Updownarrow$$

$$f_{\mathrm{L.C.}}\left(\mathrm{i}\left[\hat{B}_1,\, \hat{A}_1\right],\, \mathrm{i}\left[\hat{B}_2,\, \hat{A}_2\right],\, \mathrm{i}\left[\hat{B}_3,\, \hat{A}_3\right],\, \ldots\right) = 0. \tag{G.3}$$

The Pauli matrix ($\hat{\sigma}_z$) in (G.1) and that ($\hat{\sigma}_y$) in (G.2) are components of the Pauli vector in isotropic 3D space. The isotropy also leads to (G.3).

In stochastic SR of 1D space, the following equations of operators hold for QM:

$$\hat{\tilde{t}}^2 - \hat{\tilde{r}}^2 = \hat{\tilde{\tau}}^2 , \tag{G.4}$$

$$\hat{\tilde{E}}^2 - \hat{\tilde{p}}^2 = \hat{\tilde{m}}_0{}^2 . \tag{G.5}$$

When without the hat ^, each symbol may refer to the observed value of the corresponding observable if without confusion. Equations (G.4) and (G.5) accept conjugation between time and energy. (See appendix B, for why to deny Pauli's theorem [24], namely, for why time still corresponds to a self-adjoint operator).

Differencing (G.4) and (G.5),

$$\left(\hat{\tilde{E}}^2 - \hat{\tilde{t}}^2\right) - \left(\hat{\tilde{p}}^2 - \hat{\tilde{r}}^2\right) = \hat{\tilde{m}}_0{}^2 - \hat{\tilde{\tau}}^2 , \tag{G.6}$$

suggests

$$\left[\hat{t},\, \hat{E}\right] - \left[\hat{r},\, \hat{p}\right] = (\equiv)\left[\hat{\tau},\, \hat{m}_0\right], \tag{G.7}$$

per (G.3) and the definitions of tilded (i.e., stochastic) variables [in (A.3) and (A.4)]. [Notice tildes disappear in (G.7).] In addition, characteristic of special-relativistic QM [26],

$$\left[\hat{r},\, \hat{p}\right] = -\left[\hat{t},\, \hat{E}\right] \tag{G.8a}$$

$$= +\mathrm{i}\hbar \hat{I} , \tag{G.8b}$$

where the plus sign is of the prevailing convention in the literature. Equations (G.7)–(G.8b) generate the 'double-sized' commutator:

$$\left[\hat{\tau},\, \hat{m}_0\right] = -2\mathrm{i}\hbar \hat{I} . \tag{G.9}$$

For an arbitrary but specific quantum state W, the Robertson uncertainty relation is valid between two conjugate observables $\hat{A}$ and $\hat{B}$ [28]:

$$\Delta(A)\Delta(B) \geq \frac{1}{2}\left|\left\langle\left[\hat{A},\, \hat{B}\right]\right\rangle_{\mathrm{W}}\right| . \tag{G.10}$$

Combining (G.9) and (G.10) gives the 'proper' uncertainty principle:

$$\left(\tilde{\sigma}_{\mathrm{PP}} >\right)\ \Delta(\tau)\Delta(m_0)\ \left(\equiv \tilde{\sigma}_{\mathrm{PP}}\right)\ \geq \hbar , \tag{G.11}$$

in contrast to the (nonrelativistic) Heisenberg uncertainty principle, ($\tilde{\sigma}_{\mathrm{OB}} >$) $\Delta(r)\Delta(p)$ ($\equiv \sigma_{\mathrm{OB}}$) $\geq \hbar/2$.

Appendix H: Electron-positron energy gap

The energy gap between electron e^- and positron e^+ is twice the electron rest-mass m_e [26]. In the mildest e^--e^+ pair-production event, e^- 'sees' e^+ higher by $2m_e$ in energy, and vice versa, per the charge conjugation.

Below checks (6)'s [or (D.4)'s] validity against this requirement, in the limit of a) $\Delta(c_{1,\mathrm{R}})$ vanishes and b) each elementary particle has quasi 'completed' its interactional redshift 'in' its emitting event. Because e^- 'carriers' $\bar{\phi} = 1/2$ from the mildest e^--e^+ pair-production event, equation (6) predicts the *equivalent* (*pseudo*) relative speed $\left|\langle \beta_{\mathrm{R}} \rangle\right|$ between e^- and the event is $1/\sqrt{3}$. (See appendix I, for why speed is pseudo.) Per SR's velocity addition rule [10,11], the equivalent (pseudo) velocity $\langle \beta_{+-} \rangle$ of e^+ relative to e^- becomes $\sqrt{3}/2$. The relative energy E_{+-} of e^+ to e^- is $m_e\left(1-\langle \beta_{+-} \rangle^2\right)^{-1/2}$, so the minimum E_{+-}, namely, the e^--e^+ energy gap, turns out $2m_e$.

Both $\langle \beta_{\mathrm{R}} \rangle$ and $\langle \beta_{+-} \rangle$ in here are nominal parameters—instead of velocities in SR. The justification of the above calculation is, first, equation (12) holds in between mass entities [i.e., a) between the event and either the resulting e^+ or e^-, and b) between the resulting e^+ and e^-] in GR and QM and, second, equation (12) is equivalent to (6) in stochastic SR.

Appendix I: $\langle \beta_{\mathrm{R}} \rangle$ as pseudo observable

As an "observable," $\langle \beta_{\mathrm{R}} \rangle$ violates the principle of relativity, for the following reasons.

Being a single event, the generalized observer must (locally) 'own' its observables. The observer 'encounters' the elementary particle, not the concerned particle-emitting event (along with its $\langle \beta_{\mathrm{R}} \rangle$). For being nonlocal to the observer, $\langle \beta_{\mathrm{R}} \rangle$ cannot be a true (observer-owned) observable.

Second, the numerical reference of an observable ought to be of the event's intrinsic property; as a reference for $\langle \beta_{\mathrm{R}} \rangle$, neither (nominal) stationarity nor the statistical speed of light is a property intrinsic and specific to the event.

Outside SR, $\langle \beta_{\mathrm{R}} \rangle$ is meaningless.

Appendix J: No observability at dawn of time

In the "standard" cosmological model [4,5,11], we have

$$1 + z = \frac{a(t_{\mathrm{C0}})}{a(t_{\mathrm{C}})}, \tag{J.1}$$

where z is the cosmological redshift, $a(t_{\mathrm{C}})$ the Friedmann scale factor of *then* (at cosmic-time t_{C}), and $a(t_{\mathrm{C0}})$ that of *now* (at cosmic-time t_{C0}). Along with (J.1) and $a(t_{\mathrm{C0}})=1$, equation (12) turns into

$$\tilde{\phi}(t_{\mathrm{C}})=\frac{2}{a(t_{\mathrm{C}})^2+a(t_{\mathrm{C}})^{-2}}, \tag{J.2}$$

showing how the observability of the cosmic history has been fading away over cosmic-time and approaching zero, as t_{C} [and $a(t_{\mathrm{C}})$] (backward) approaching zero. Equation (J.2) indicates 0^+ observability expected of the extreme onset of the Big Bang, agreeing nothing 'before' it is observable.

Appendix K: ROC in GR

Per (D.4)–(D.6),

$$\left(1+\langle\beta_{\mathrm{R}}\rangle^2\right)\left(1+\overline{\phi}\right)=2 \tag{K.1}$$

holds in the limit of zero $\Delta(c_{\mathrm{R}})$. [Notice (K.1) involves $\overline{\phi}$, not $\tilde{\phi}$.] Namely, the law of ROC is inherent to 'classical' SR (which this limit is characteristic of)—so is the law, in the form of (12), to GR, because 'classical' SR anchors GR, *within* the limit per se.

On the other hand, 'classical' SR shows flaws in accommodating quantum uncertainties [see appendix C and comments after (4)]. In this sense, stochastic SR anchors GR (and QM), well before reaching the limit of zero $\Delta(c_{\mathrm{R}})$. The law of ROC [in the form of (12)] is inherent to quantum gravity and, in the limit of zero local $\Delta(c_{\mathrm{R}})$, to GR.

Appendix L: Correction on star magnitude

In astronomy, a cosmic object's observed-magnitude $\underline{m}$ (underscored for distinction from mass m) relates to its absolute magnitude $\underline{M}$ [5]:

$$\underline{m}=\underline{M}+2.5\log_{10}\left(\frac{F_{\underline{M}}}{F}\right), \tag{L.1}$$

where F is the observed flux from the object, and $F_{\underline{M}}$ the expected observed flux as if the same object were ten parsec (pc) from us, which is the defining condition of $\underline{M}$. Both F and $F_{\underline{M}}$ follow the inverse-square law, with the luminosity distance corrected with the GR-based cosmological model [4], which however presumes no ROC in *our* observation.

To reflect the ROC, equation (L.1) becomes

$$\underline{m} = \underline{M} + 2.5\log_{10}\left(\frac{F_{\underline{M}\times}\ \tilde{\phi}(z_{10\ \mathrm{pc}})}{F_{\times}\ \tilde{\phi}(z)}\right) \tag{L.2a}$$

$$\cong \underline{M}_{\times} + 2.5\log_{10}\left(\frac{F_{\underline{M}\times}}{F_{\times}\ \tilde{\phi}(z)}\right) \tag{L.2b}$$

$$= \underline{m}_{\times} - \ 2.5\log_{10}\left(\tilde{\phi}(z)\right), \tag{L.2c}$$

with subscript $\times$ indicating 'as if no ROC associated only with *our* observation,' and $\tilde{\phi}$ being the multiplicative correction for the ROC. The $\cong$ sign in (L.2b) is practically an $=$ sign, as $\tilde{\phi}(z_{10\ \mathrm{pc}})$ is exceedingly near value one and barely affects the scale of the absolute magnitude—so $\underline{M}_{\times}$ substitutes for $\underline{M}$. From (L.2b) to (L.2c) is an application of the $\times$-version of (L.1). Without our prior awareness of the ROC effect, the current literature has mistaken $F_{\times}$ for F, $F_{\underline{M}\times}$ for $F_{\underline{M}}$, and thus $\underline{m}_{\times}$ for $\underline{m}$.

Combining (12) and (L.2c) gives

$$\underline{m}(ROC;\ z) = \underline{m}(No\ ROC;\ z) + \ 2.5\log_{10}\left(\frac{(1+z)^2 + (1+z)^{-2}}{2}\right), \tag{L.3}$$

where $\underline{m}(ROC;\ z) \equiv\ \underline{m}(z)$ and $\underline{m}(No\ ROC;\ z) \equiv\ \underline{m}_{\times}(z)$.

References

[1] Perlmutter S 2003 *Phys. Today* **56** No.4 53 doi:http://dx.doi.org/10.1063/1.1580050
[2] Riess A G *et al* (for the High-Z Supernova Search) 1998 *Astron. J.* **116** 1009
[3] Perlmutter S *et al* (for the Supernova Cosmology Project) 1999 *Astrophys. J.* **517** 565
[4] Peacock J A 1999 *Cosmological Physics* (Cambridge: Cambridge University Press)
[5] Bowers R L and Deeming T 1984 *Astrophysics* (Boston: Jones and Bartlett)
[6] Wikipedia, fee encyclopedia *Lambda-CDM model* http://en.wikipedia.org/wiki/Lambda-CDM_model (accessed 30 June 2014)
[7] NASA *Wilkinson Microwave Anisotropy Probe* http://map.gsfc.nasa.gov/ (accessed 30 June 2014)
[8] Caldwell R R and Kamionkowski M 2009 *Ann. Rev. Nucl. Part. Sci.* **59** 397
[9] UK Science and Technology Facilities Council *Large Hadron Collider* http://www.lhc.ac.uk/ (accessed 30 June 2014)
[10] Ellis G F R and Williams R M 1988 *Flat and Curved Space-Times* (New York: Oxford University Press)
[11] Rindler W 2001 *Relativity: Special, General, and Cosmological* (New York: Oxford University Press)
[12] Misner C W, Thorne K S and Wheeler J A 1973 *Gravitation* (San Francisco: Freeman)

[13] Allen L, Beijersbergen M W, Spreeuw R J C and Woerdman J P 1992 *Phys. Rev.* A **45** 8185
[14] University of Glasgow, School of Physics & Astronomy: Optics Group http://www.physics.gla.ac.uk/Optics/play/photonOAM/ (accessed 30 June 2014)
[15] Bevington P R 1969 *Data Reduction and Error Analysis for Physical Sciences* (New York: McGraw-Hill)
[16] Wigner E 1939 *Ann. Math.* **40** 149
[17] Comay E 2009 *Prog. Phys.* **4** 91
[18] Kollmeier J A *et al* 2014 *Astrophys. J. Lett.* **789** 32 doi:10.1088/2041-8205/789/2/L32
[19] Hall P B *et al* 2013 *Mon. Not. R. Astron. Soc.* **434** 222 doi:10.1093/mnras/stt1012
[20] Weinberg S 1989 *Rev. Mod. Phys.* **61** 1
[21] Einstein A, Podolsky B and Rosen N 1935 *Phys. Rev.* **47**(10): 777
[22] Dowling J http://quantumpundit.blogspot.com/2013/09/on-curious-consistency-of-non.html (accessed 30 June 2014)
[23] Isidro J M 2005 *Phys. Lett.* **334** 5-6 370
[24] Pauli W 1958 *Die allgemeinen prinzipien der wellenmechanik in Handbuch der Physik, Prinzipien der Quantentheorie I* band V teil 1, ed S Flügge (Berlin: Springer)
[25] Wikipedia, fee encyclopedia *1964 PRL symmetry breaking papers* http://en.wikipedia.org/wiki/1964_PRL_symmetry_breaking_papers (accessed 30 June 2014)
[26] Greiner W 1990 *Relativistic Quantum Mechanics* (New York: Springer)
[27] Bohm A 1993 *Quantum Mechanics* 3rd ed (New York: Springer)
[28] Robertson H P 1929 *Phys. Rev.* **34** 163

[End of File]