A Moving Sphere Does Not Look Contracted: Light Delay and Contraction Cancel as a Sum of Squares

— from light delay alone the outline stretches by $\sqrt{1+\beta^2}$ along the motion, from contraction alone it shrinks by $\sqrt{1-\beta^2}$, and with both it is a circle again — the separator is whether one measures positions at one instant or looks at light arriving at one instant — [Paper 901]

Yuuki YAMAGISHI (山岸 勇輝)
Yamagishi Complexity Torus Lab, Japan
September 2026

— From thinking to syncing. —

Abstract

It is easy to assume that a fast-moving sphere looks flattened along its motion by Lorentz contraction.This paper forms the image from light that leaves the surface and arrives at one instant, and counts separately how light delay and contraction each change the outline.No new theorem or law is claimed. First, light delay alone stretches the outline——seen from afar, the ratio of the outline's widths is 1.118034 at $\beta = 0.5$, 1.345361 at 0.9 and 1.407159 at 0.99, matching $\sqrt{1+\beta^2}$ (Section 2). **Second, contraction alone shrinks it——0.866025, 0.435890 and 0.141067, matching $\sqrt{1-\beta^2}$** (Section 2). **Third, and this is the core. With both, the circle returns, and the cancellation is a sum of squares, not a product——the width ratio becomes 0.999999, 1.000000 and 1.000000. The product of the two factors is 0.968246, 0.586429 and 0.198504, not 1; the outline's radius is $\sqrt{\beta^2 + 1/\gamma^2} = 1$** (Section 2). **Fourth, seen from nearby, only the outline with both effects is a circle——on the celestial sphere of observers at distances 3 and 10 from the centre, the outline with both effects lies on one plane to the order of 10^{-15}, while delay alone and contraction alone deviate by 4.386×10^{-4} to 1.507×10^{-2}** (Section 3). **Fifth, aberration keeps the whole sky's 4π but rearranges it——the transformed solid angle still sums to 12.566371, and the front half of the sources falls into a cone of half-angle $\arccos\beta$ (25.841933 degrees at $\beta = 0.9$, 0.050000 of the sky). Projected to a plane, aberration is a uniform scaling, and circles map to circles** (Section 4). **Sixth, the separator is whether one measures positions at one instant or looks at light arriving at one instant——measured, the sphere is flattened to $\sqrt{1-\beta^2}$; seen, it stays a circle, rotated by $\arcsin\beta$ (64.158067 degrees at $\beta = 0.9$)** (Section 5). **Keywords**: apparent shape, Lorentz contraction, light-travel delay, aberration, celestial sphere, Möbius transformation.

Scope of this paper (scope note): **No new theorem or law is claimed——that the outline of a moving sphere stays a circle, that the apparent shape is a rotation rather than a contraction, and that aberration is a Möbius transformation of the celestial sphere mapping circles to circles are all known (Penrose 1959, Terrell 1959, Weisskopf 1960).No real object is claimed——only the geometry of a unit sphere at speed β ($c = 1$) is treated, matching no celestial body or particle.Colour and brightness are not entered——Doppler shifts of colour, changes of brightness by aberration, and finite exposure times are not included.Only spheres are treated——the apparent rotation of cubes or rods is not counted.Only two observers are placed——a distant observer (parallel rays, orthographic image) and pinhole observers at distances 3 and 10 from the centre are computed.Relation to earlier papers**: **Paper 108 showed that the geometry where the invariant lives is Minkowski's spacetime, and kept the geometries of relativity apart——here, within that spacetime, the delayed arrival of light sets what is seen.Paper 524 showed that the wind on a sail and the apparent place of a star are one and the same formula, and measured the gap between Galilean and relativistic aberration for each β——here only the relativistic formula is used, and what is counted is not the change of direction but the density of solid angle and how circles on the sky are mapped.Paper 83 showed from Galileo's relativity principle alone that there are only two relativities——here, within the one with a maximum speed, it is counted how light delay and contraction combine.Paper 33 showed that the Wigner angle is an area in velocity space——here it is counted, on the celestial sphere, that aberration maps circles to circles.**What is added is **measuring the effects of light delay and contraction separately and showing that both together restore the circle**, **showing in numbers that the cancellation is a sum of squares rather than a product**, **confirming that for nearby observers too only the outline with both effects is a circle**, **giving the numbers for aberration keeping 4π while packing the front half into a cone**, and **placing the separator on measuring versus seeing**.

1. Notation and the Question

Setting: **the centre of a unit sphere moves along the x axis at speed β ($c = 1$). In the observer's frame the sphere is an ellipsoid contracted along x to $1/\gamma = \sqrt{1-\beta^2}$.The image is formed from light leaving each surface point and reaching the observer at one time t_a. For a distant observer (toward $+z$, parallel rays) the emission time is $t_e = t_a - L + z$, so the nearer side (larger z) emits later and the x coordinate of a surface point is displaced by the centre's motion, βz.**

$$x = \frac{s_x}{\gamma} + \beta s_z, \qquad y = s_y \qquad \left(s_x^2 + s_y^2 + s_z^2 = 1\right)$$

"Delay alone" sets $1/\gamma$ to 1; "contraction alone" sets βs_z to 0.The width ratio of the outline is the width in x divided by the width in y.For a nearby observer (distance D from the centre), whether a ray leaving the observer in direction n meets the sphere at some distance s at emission time $t_e = t_a - s$ is decided by the discriminant of a quadratic; the boundary between hitting and missing directions was found by bisection in 720 azimuths, and it was measured whether those directions lie on one plane of the celestial sphere (a circle).Aberration maps a source direction s to the

direction seen by an observer moving toward $+z$ at speed β; the density of solid angle was obtained both from $(1-\beta^2)/(1+\beta\cos\theta)^2$ and from the area ratio of a small patch.

Question: does a fast-moving sphere look contracted?

2. The Outline Seen from Afar

Computation 2.1: for three speeds, the width ratio of the outline was obtained in three ways.

β	delay alone	contraction alone	both	product of the two
0.5	1.118034	0.866025	0.999999	0.968246
0.9	1.345361	0.435890	1.000000	0.586429
0.99	1.407159	0.141067	1.000000	0.198504

> **Observation 2.2**
>
> this is the core. With both, the circle returns, and the cancellation is a sum of squares, not a product.Delay alone stretches by $\sqrt{1+\beta^2}$ and contraction alone shrinks by $\sqrt{1-\beta^2}$——multiplied, they give $\sqrt{1-\beta^4}$, not 1. With both, the width in x is set by the length of the single vector $(1/\gamma, \beta)$, and since $\beta^2 + 1/\gamma^2 = 1$, the width is 1 at every speed.

> **Observation 2.3**
>
> instead of shrinking, it appears rotated.The surface point at the centre of the image is the one rotated back from the line of sight by $\arcsin\beta$: 30.000000 degrees at $\beta = 0.5$, 64.158067 at 0.9, 81.890386 at 0.99——the point directly facing the observer appears not at the centre but displaced forward by β (the image radius being 1).

3. The Outline Seen from Nearby

Computation 3.1: on the celestial sphere of an observer at distance D from the centre, it was measured by the root-mean-square deviation whether the 720 outline directions lie on one plane.

D	β	both	delay alone	contraction alone	angular radius of the circle (degrees)
3	0.5	1.440×10^{-15}	4.579×10^{-3}	4.718×10^{-3}	19.463067
3	0.9	1.274×10^{-15}	1.507×10^{-2}	1.490×10^{-2}	19.445679
10	0.5	1.453×10^{-15}	4.386×10^{-4}	4.394×10^{-4}	5.739152
10	0.9	1.401×10^{-15}	1.411×10^{-3}	1.319×10^{-3}	5.739112

Observation 3.2

seen from nearby too, only the outline with both effects is a circle.Neither the outline from delay alone nor that from contraction alone (the shadow of the ellipsoid photographed at one instant) lies on one plane of the celestial sphere——the circle with both effects has an angular radius slightly smaller than a sphere at rest, 19.471221 degrees ($D = 3$) or 5.739170 degrees ($D = 10$), by -0.008154, -0.025542, -0.000018 and -0.000058 degrees, and its centre is displaced forward (at $D = 3$, $\beta = 0.5$ the forward rim is at 21.088795 degrees and the rear rim at 17.837339 degrees).

4. Aberration and the Celestial Sphere

Computation 4.1: **source directions were mapped to the directions seen by an observer moving toward $+z$ at speed β**.

	$\beta = 0.5$	$\beta = 0.9$
sum of transformed solid angle ($4\pi = 12.566371$)	12.566371	12.566371
half-angle $\arccos\beta$ of the cone holding the front half (degrees)	60.000000	25.841933
solid angle of that cone (sr) and share of the sky	3.141593, 0.250000	0.628319, 0.050000
density of solid angle (polar angle 30, 90, 150 degrees)	0.365226, 0.750000, 2.332999	0.060006, 0.190000, 3.905104
stereographic ratio $\tan(\theta'/2)/\tan(\theta/2)$	0.577350	0.229416
image of a circle of angular radius 40 degrees: deviation from a plane, angular radius (degrees)	6.93×10^{-16}, 30.713024	3.36×10^{-16}, 14.623200

Observation 4.2

aberration keeps the whole sky's 4π but rearranges it.The density of solid angle is below 1 ahead and above 1 behind, and its sum is 4π at every speed——sources in the front half in their rest frame fall, at $\beta = 0.9$, into a cone of half-angle 25.841933 degrees, 0.050000 of the sky. The density obtained from the area ratio of a small patch agreed with the formula.

Observation 4.3

projected to a plane, aberration is a uniform scaling.Under stereographic projection with the direction of motion as pole, $\tan(\theta'/2)/\tan(\theta/2)$ is the same at every polar angle (spread of the order of 10^{-14}) and equals $\sqrt{(1-\beta)/(1+\beta)}$, the inverse of the Doppler factor $k = \sqrt{(1+\beta)/(1-\beta)}$ (1.732051 at $\beta = 0.5$, 4.358899 at 0.9)——a uniform scaling maps circles to circles, so circles on the sky (a circle of angular radius 40 degrees and a great circle alike) map to circles. That the outline of a moving sphere stays a circle is also a property of this map.

5. The Separator

Observation 5.1

the separator is whether one measures positions at one instant or looks at light arriving at one instant.Measuring the surface points at one instant in the observer's frame, the sphere is an ellipsoid flattened to $\sqrt{1-\beta^2}$——looking at light arriving at one instant, the nearer side, emitted later, is displaced forward, and that stretch cancels the contraction as a sum of squares, leaving a circle.

Observation 5.2

placed among the earlier papers.Paper 108 kept apart the geometry where the invariant lives, and Paper 83 showed that the relativity with a maximum speed is one of only two——here, within that geometry, the delayed arrival of light sets what is seen. Paper 524 showed that the aberration formula has the same form as the wind on a sail; here the same formula maps circles on the sky to circles and rearranges the 4π it keeps. Paper 33 showed that the Wigner angle is an area; here it is counted that circles on the sky stay circles.

Observation 5.3

what is not said.Real objects and speeds, changes of colour and brightness, exposure time, shapes other than spheres, and any explanation of why this appearance arises are not treated——what is shown is how light delay and contraction each change the outline, that both restore the circle, and that the cancellation is a sum of squares.

6. Census and Closing

1. $x = s_x/\gamma + \beta s_z$ (Section 1): **delay and contraction.**
2. **delay alone** $\mathbf{1.345361}$ (Computation 2.1): $\sqrt{1+\beta^2}$ **at** $\beta = 0.9$**.**
3. **contraction alone** $\mathbf{0.435890}$ (Computation 2.1): $\sqrt{1-\beta^2}$**.**
4. **both** $\mathbf{1.000000}$ (Computation 2.1): **the core.**
5. **product** $\mathbf{0.586429}$ (Observation 2.2): **sum of squares** $\beta^2 + 1/\gamma^2 = 1$**.**
6. **rotated by** $\mathbf{64.158067}$ **degrees** (Observation 2.3): $\arcsin\beta$**.**
7. **only both make a circle from nearby** (Computation 3.1): 10^{-15} **against** 10^{-4} **to** 10^{-2}**.**
8. 4π **kept:** 12.566371 (Computation 4.1): **the arrangement changes.**
9. **front half into a** $\mathbf{25.841933}$**-degree cone** (Observation 4.2): 0.050000 **of the sky.**
10. **measuring, or seeing** (Observation 5.1): **the separator; Papers 108, 524, 83, 33.**

Closing: **A moving sphere does not look contracted: what light delay stretches and what contraction shrinks cancel not as a product but as a sum of squares.Seen from afar, the outline's width is** $\sqrt{1+\beta^2}$ **times from delay alone (** 1.345361 **at** $\beta = 0.9$**) and** $\sqrt{1-\beta^2}$ **times from contraction alone (**0.435890**), and with both it returned to a circle of** 1.000000**——the product** 0.586429 **is not** 1**; what cancels is the sum of squares** $\beta^2 + 1/\gamma^2 = 1$**.Seen from nearby, only the outline with both effects lay on a circle of the celestial sphere, and aberration kept the sky's** 4π **while packing the front half of the sources into a cone of** 25.841933 **degrees and mapping circles on the sky to circles——the sphere does not shrink; it appears rotated by** $\arcsin\beta$**.Placed among the earlier papers——within the geometry of Papers 108 and 83, light delay sets what is seen, and the aberration formula of Paper 524 maps circles to circles.To be honest——only a unit sphere and two observers were computed, with neither colour nor brightness nor exposure time included.**

References

1. Yamagishi, Y. (2026). *The Geometry Where the Invariant Lives* [Paper 108]. Zenodo. 10.5281/zenodo.21837313
2. Yamagishi, Y. (2026). *The Wind on a Sail and the Apparent Place of a Star Are One and the Same Formula* [Paper 524]. Zenodo. 10.5281/zenodo.22805190
3. Yamagishi, Y. (2026). *Why Does a "Maximum Speed" Exist?* [Paper 83]. Zenodo. 10.5281/zenodo.21741190
4. Yamagishi, Y. (2026). *The Wigner Angle Is an Area* [Paper 33]. Zenodo. 10.5281/zenodo.22090872
5. Penrose, R. (1959). The apparent shape of a relativistically moving sphere. *Proceedings of the Cambridge Philosophical Society*.
6. Terrell, J. (1959). Invisibility of the Lorentz contraction. *Physical Review*.
7. Weisskopf, V. F. (1960). The visual appearance of rapidly moving objects. *Physics Today*.

— *From thinking to syncing.* —

Yuuki YAMAGISHI (山岸 勇輝)

© 2026 Yamagishi Complexity Torus Lab, Japan · Licensed under Creative Commons Attribution 4.0 International (CC BY 4.0)