Error in Modern Astronomy

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The conservation of the interference pattern from double slit interference proves that the wavelength is conserved in all inertial reference frames. However, there is a popular belief in modern astronomy that the wavelength can be changed by the choice of reference frame. This erroneous belief results in the problematic prediction of the radial speed of galaxy. The reflection symmetry shows that the elapsed time is conserved in all inertial reference frames. From both conservation properties, the velocity of the light is proved to be different in a different reference frame. This different velocity was confirmed by lunar laser ranging test at NASA in 2009. The relative motion between the light source and the light detector bears great similarity to the magnetic force on a moving charge. The motion changes the interference pattern but not the wavelength in the rest frame of the star. This is known as the blueshift or the redshift in astronomy. The speed of light in the rest frame of the grism determines how the spectrum is shifted. Wide Field Camera 3 in Hubble Space Telescope provides an excellent example on how the speed of light can change the spectrum.

I. INTRODUCTION

The double slit interference can be formulated with the principle of superposition[1]. The interference pattern is a function of the incident wavelength. The pattern is conserved in all inertial reference frames. This conservation determines how the wavelength may change in a different inertial reference frame.

The spectrum from a diffraction grating can be formulated from the double slit interference. It exhibits the same conservation property. The spectrum is also a function of the wavelengths.

However, the spectrum changes if there is relative motion between the light source and the diffraction grating. In the rest frame of the light source, the wavelength is intact but the spectrum becomes different. Therefore, the spectrum is actually a function of both the wavelength and the relative motion.

The correct equation for double slit interference will be derived to include the relative motion. This is similar to the magnetic force on a moving charge. The relative motion must be incorporated to account for the spectral shift.

II. PROOF

A. Double Slit Interference

A light emitter emits coherent light along the x-direction through a plate with two parallel slits to reach a projection screen. Both the plate and the screen are aligned with the y-z plane. The emitter, the plate, and the screen are all stationary relative to a reference frame F_1.

A series of alternating light and dark bands appear on the projection screen along the y-direction. Let the distance between the plate and the screen be D_1. The location of the light band is y_1. The separation between the parallel slits is d_1.

If $d_1 << y_1$ and $d_1 << D_1$, the constructive interference can be described by the equation of phase shift[1] for the constructive phase difference as

$$y_1 = m * \lambda_1 * \frac{\sqrt{D_1^2 + y_1^2}}{d_1} \tag{1}$$

λ_1 is the wavelength in F_1. m is a positive integer.

$$\lambda_1 = \sqrt{\lambda_{1x}^2 + \lambda_{1y}^2} \tag{2}$$

The derivation of equation (1) is located next to the conclusion section.

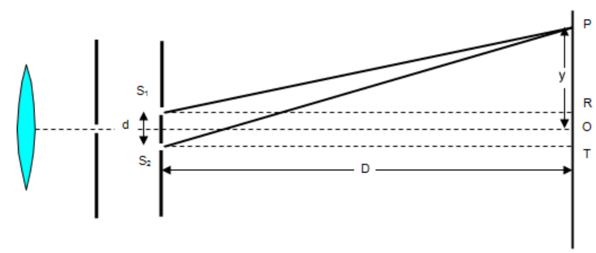

FIG. 1. Double Slit Interference

Let another reference frame F_2 move at a velocity of (-v,0) relative to F_1. The interference pattern is conserved in all inertial reference frames because the emitter is stationary relative to F_1. In F_2, the conservation of phase shift is represented by

$$y_2 = m * \lambda_2 * \frac{\sqrt{D_2^2 + y_2^2}}{d_2} \tag{3}$$

$$\lambda_2 = \sqrt{\lambda_{2x}^2 + \lambda_{2y}^2} \tag{4}$$

The choice of inertial reference frame along the x-direction has no effect on the measurement along the y-direction.

$$y_2 = y_1 \tag{5}$$

$$d_2 = d_1 \tag{6}$$

$$\lambda_{2y} = \lambda_{1y} \tag{7}$$

From equations (1,3,5,6),

$$\lambda_2 \sqrt{D_2^2 + y_2^2} = \lambda_1 \sqrt{D_1^2 + y_1^2} \tag{8}$$

The choice of inertial reference frame along the x-direction may alter the measurement along the x-direction. Let γ be the proportional factor between the original measurement in F_1 and the new measurement in F_2.

$$D_2 = \gamma * D_1 \tag{9}$$

$$\lambda_{2x} = \gamma * \lambda_{1x} \tag{10}$$

From equations (4,7,10),

$$\lambda_2 = \sqrt{\gamma^2 * \lambda_{1x}^2 + \lambda_{1y}^2} \tag{11}$$

From equation (8,9,11),

$$(\gamma^2 \lambda_{1x}^2 + \lambda_{1y}^2)((\gamma * D_1)^2 + y_1^2) = (\lambda_{1x}^2 + \lambda_{1y}^2)(D_1^2 + y_1^2) \tag{12}$$

$$\gamma^4 \lambda_{1x}^2 D_1^2 + \gamma^2 (\lambda_{1y}^2 D_1^2 + y_1^2 \lambda_{1x}^2) + \lambda_{1y}^2 y_1^2 \tag{13}$$

$$= (\lambda_{1x}^2 + \lambda_{1y}^2)(D_1^2 + y_1^2) \tag{14}$$

$$(\gamma^4 - 1)\lambda_{1x}^2 D_1^2 + (\gamma^2 - 1)(\lambda_{1y}^2 D_1^2 + y_1^2 \lambda_{1x}^2) = 0 \tag{15}$$

$$(\gamma^2 - 1)(\lambda_{1x}^2 D_1^2 (\gamma^2 + 1) + \lambda_{1y}^2 D_1^2 + y_1^2 \lambda_{1x}^2) = 0 \tag{16}$$

$$\gamma^2 - 1 = 0 \tag{17}$$

The choice of inertial reference frame along the x-direction does not alter the measurement along the x-direction.

B. Conservation of Wavelength

From equations (2,11,17),

$$\lambda_2 = \lambda_1 \tag{18}$$

The wavelength is conserved in all inertial reference frames.

C. Doppler Effect

Let an observer P_1 be stationary relative to F_1. The emitter is stationary relative to P_1. The frequency of the light is f_1 for P_1

Let another observer P_2 be stationary relative to F_2. The emitter moves toward P_2. The frequency of the light is f_2 for P_2.

According to the Doppler effect[2],

$$f_2 > f_1 \tag{19}$$

The speed of light for P_1 is

$$c_1 = f_1 * \lambda_1 \tag{20}$$

The speed of light for P_2 is

$$c_2 = f_2 * \lambda_2 \tag{21}$$

From equations (18,19,20,21),

$$c_2 > c_1 \tag{22}$$

The speed of light increases if the light emitter moves toward the observer.

D. Conservation of Length

From equations (9,17),

$$D_2 = D_1 \tag{23}$$

The length is conserved in all inertial reference frames. Therefore, length contraction from Lorentz transformation is proved to be incorrect.

E. Elapsed Time

Let t_2 be the time of F_2. Let the projection screen be at the location of (r,0) in F_2. The projection moves at the velocity of (v,0) in F_2.

$$v = \frac{dr}{dt_2} \tag{24}$$

Let t_1 be the time of F_1. Let the projection screen be at the origin in F_1. The origin of F_2 is located at (-r,0) in F_1 and moves at the velocity of (-v,0) in F_1.

$$-v = \frac{d(-r)}{dt_1} \tag{25}$$

From equations (24,25),

$$dt_1 = dt_2 \tag{26}$$

The elapsed time is conserved in all inertial reference frames. Therefore, time dilation from Lorentz transformation is proved to be incorrect.

F. Velocity of Light

Let $\vec{c_1} = (c_{1x}, c_{1y})$ be the velocity of light in F_1. Let T_1 be the elapsed time for the light to travel from the slit plate to the projection screen in F_1.

$$c_{1y} * T_1 = y_1 \tag{27}$$

$$c_{1x} * T_1 = D_1 \tag{28}$$

Let $\vec{c_2} = (c_{2x}, c_{2y})$ be the velocity of light in F_2. Let T_2 be the elapsed time for the light to travel from the slit plate to the projection screen in F_2.

$$c_{2y} * T_2 = y_2 \tag{29}$$

$$c_{2x} * T_2 = D_1 + v * T_2 \tag{30}$$

The screen has moved an extra distance of $v * T_2$ during T_2.

From equations (5,27,29),

$$c_{1y} * T_1 = c_{2y} * T_2 \tag{31}$$

From equations (28,30),

$$c_{2x} * T_2 = c_{1x} * T_1 + v * T_2 \tag{32}$$

From equation (26), the elapsed time is conserved in all inertial reference frames.

$$T_1 = T_2 \tag{33}$$

From equations (32,33),

$$c_{2x} = c_{1x} + v \tag{34}$$

From equations (31,33),

$$c_{2y} = c_{1y} \tag{35}$$

From equations (34,35),

$$\vec{c_2} = \vec{c_1} + (v, 0) \tag{36}$$

The speed of light in F_2 is greater than the speed of light in F_1 if $v > 0$.

The velocity of light is $\vec{c_1}$ and is constant in the rest frame of the emitter. It changes to $\vec{c_2}$ only in another inertial reference frame.

In 2009, the speed of laser was measured with lunar laser ranging at NASA Goddard Space Flight Center[10]. The result confirmed that the speed of laser exceeds the canonical value 299,792,458 m/s by 200+/-10 m/s.

G. Isotropy of Light

The speed of light in F_2 depends on the choice of reference frame and also the orientation.

$$c_1 * T_1 = \sqrt{D_1^2 + y_1^2} \tag{37}$$

$$c_2 * T_2 = \sqrt{(D_2 + v * T_2)^2 + y_2^2} \tag{38}$$

Place a rod of length $\sqrt{D_1^2 + y_1^2}$ along the x-direction in F_1. Let the light pass through the whole length of this rod.

T_3 is the elapsed time for the light to travel from end to end of the rod in F_1.

$$c_1 * T_3 = \sqrt{D_1^2 + y_1^2} \tag{39}$$

T_4 is the elapsed time for the light to travel from end to end of the rod in F_2. Let c_0 be the speed of light in the x-direction in F_2.

$$c_0 * T_4 = \sqrt{D_1^2 + y_1^2} + v * T_4 \tag{40}$$

$$T_4 = \frac{\sqrt{D_1^2 + y_1^2}}{c_0 - v} \tag{41}$$

From equations (37,39),

$$T_3 = T_1 \tag{42}$$

Therefore,

$$T_4 = T_2 \tag{43}$$

From equations (38,40),

$$\frac{c_2 * T_2}{c_0 * T_4} = \frac{\sqrt{(D_2 + v * T_2)^2 + y_2^2}}{\sqrt{D_1^2 + y_1^2} + v * T_4} \tag{44}$$

From equation (43,44),

$$\frac{c_2}{c_0} = \frac{\sqrt{(D_2 + v * T_2)^2 + y_2^2}}{\sqrt{D_1^2 + y_1^2} + v * T_2} \tag{45}$$

From equation (5,45),

$$c_2 = c_0 \frac{\sqrt{(D_2 + v * T_2)^2 + y_2^2}}{\sqrt{D_2^2 + y_2^2} + v * T_2} \tag{46}$$

Let the diffraction angle θ_2 be

$$tan(\theta_2) = \frac{y_2}{D_2} \tag{47}$$

From equations (46,47),

$$c_2 = c_0 \frac{\sqrt{(1 + \frac{v*T_2}{D_2})^2 + tan(\theta_2)^2}}{\sqrt{1 + tan(\theta_2)^2} + \frac{v*T_2}{D_2}} < c_0 \tag{48}$$

c_2 is equal to c_0 only if θ_2 is zero. The speed of light becomes a function of the diffraction angle in F_2. The maximum speed is in the direction of the relative motion, (v,0).

H. Blueshift and Redshift

Let the emitter be stationary relative to F_2 instead of F_1. Both the slit plate and the projection screen are stationary relative to F_1. The shifted interference pattern is represented by

$$y_3 = m * \lambda_3 * \frac{\sqrt{D_3^2 + y_3^2}}{d_3} \quad (49)$$

Let the velocity of the emitted light be $\vec{c_3}$ in F_2. T_3 is the elapsed time for the light to travel from the plate to the screen in F_2. The horizontal distance for the light to travel from the plate to the screen is D_3 in F_2.

$$D_3 = c_{3x} * T_3 = D_1 + v * T_3 \quad (50)$$

From equations (6,18,49,50),

$$y_3 = m * \lambda_1 * \frac{\sqrt{(D_1 + v * T_3)^2 + y_3^2}}{d_1} \quad (51)$$

The angle formed by the x-direction and the path of light is θ_3.

$$sin(\theta_3) = \frac{y_3}{\sqrt{(D_1 + v * T_3)^2 + y_3^2}} = \frac{m * \lambda_1}{d_1} \quad (52)$$

$$\theta_3 = sin^{-1}(\frac{m * \lambda_1}{d_1}) \quad (53)$$

From equations (51,52),

$$y_3 = \frac{m * \lambda_1}{d_1} \frac{(D_1 + v * T_3)}{cos(\theta_3)} \quad (54)$$

From equations (50,54),

$$y_3 = \frac{m * \lambda_1}{d_1 * cos(\theta_3)} (D_1 + v \frac{D_1}{c_3 * cos(\theta_3) - v}) \quad (55)$$

The spectrum is a function of both the wavelength and the relative motion, v.

$$y_3 = tan(\theta_3) D_1 \frac{c_3 * cos(\theta_3)}{c_3 * cos(\theta_3) - v}) \quad (56)$$

If $v > 0$, the interference pattern expands from y_1 to y_3. This is known as redshift in astronomy.

If $v < 0$, the interference pattern shrinks from y_1 to y_3. This is known as blueshift in astronomy.

If $v = 0$, the interference pattern returns to y_1. This is known as reference spectrum in astronomy.

Instead of equation (1), equation (55) should be the correct equation for double slit interference. Similar to the equation for magnetic force on a moving electron, the relative motion is incorporated into equation (55).

I. Spectral Shift Ratio

From equation (1,53),

$$y_1 = sin(\theta_3) * \sqrt{D_1^2 + y_1^2} \quad (57)$$

Let z be the spectral shift ratio.

$$z = \frac{y_3 - y_1}{y_1} = \frac{y_3}{y_1} - 1 \quad (58)$$

From equations (51,53,57,58),

$$z = \frac{\sqrt{(D_1 + v * T_3)^2 + y_3^2}}{\sqrt{D_1^2 + y_1^2}} - 1 \quad (59)$$

$$z = \frac{D_1 + v * T_3}{cos(\theta_3)} * \frac{cos(\theta_3)}{D_1} - 1 \quad (60)$$

$$z = \frac{v * T_3}{D_1} \quad (61)$$

From equation (50,61),

$$z = \frac{v}{c_3 * cos(\theta_3) - v} \quad (62)$$

The spectral shift ratio is different from the definition of redshift in modern astronomy.

Without verification, modern astronomy assumes the wavelength is changed by the relative motion between F_1 and F_2. This is an error according to equation (18).

J. Radial Speed

From equation (62), the radial speed of a remote galaxy is

$$v = \frac{z}{1 + z} c_3 * cos(\theta_3) \quad (63)$$

For $z >> 1$,

$$v = c_3 * cos(\theta_3) \quad (64)$$

For z very close to zero,

$$v = z * c_3 * cos(\theta_3) \quad (65)$$

From equation (59), $z > -1$. As z approaches -1, v approaches negative infinity. There is no minimum radial speed in blueshift.

However, there is a maximum radial speed for redshift because the speed of light, c_3, is constant in the rest frame of star. The earth moves away at v in the rest frame of the star. If v is greater than c_3, no light can reach the earth. This is dark galaxy whose radial speed exceeds $c_3 * cos(\theta_3)$.

K. Error in Modern Astronomy

Modern astronomy believes the wavelength can be changed by the relative motion of the galaxy. This error becomes significant in wide angle diffraction.

The spectral shift ratio, z, is related to the popular definition of redshift, z'.

$$z' = \frac{\lambda_{obs}}{\lambda_1} - 1 \quad (66)$$

From equation (1), the original spectrum is represented by

$$y_1 = m * \lambda_1 * \frac{\sqrt{D_1^2 + y_1^2}}{d_1} \quad (67)$$

Modern astronomy assumes that the wavelength is changed from λ_1 to λ_{obs} while both D_1 and d_1 remain intact. The shifted spectrum is represented by

$$y_3 = m * \lambda_{obs} * \frac{\sqrt{D_1^2 + y_3^2}}{d_1} \quad (68)$$

From equations (58,67,68),

$$z = \frac{y_3}{y_1} - 1 = \frac{\lambda_{obs}}{\lambda_1} \frac{\sqrt{D_1^2 + y_3^2}}{\sqrt{D_1^2 + y_1^2}} - 1 \quad (69)$$

From equations (66,69),

$$z = (z' + 1) \frac{\sqrt{D_1^2 + y_3^2}}{\sqrt{D_1^2 + y_1^2}} - 1 \quad (70)$$

From equation (67),

$$sin(\theta_1) = \frac{y_1}{\sqrt{D_1^2 + y_1^2}} = \frac{m * \lambda_1}{d_1} \quad (71)$$

From equation (68),

$$sin(\theta_{obs}) = \frac{y_3}{\sqrt{D_1^2 + y_3^2}} = \frac{m * \lambda_{obs}}{d_1} \quad (72)$$

From equations (70,71,72),

$$z + 1 = (z' + 1) \frac{cos(\theta_1)}{cos(\theta_{obs})} \quad (73)$$

z' is not an accurate value for z if $cos(\theta_{obs})$ decreases significantly. z' can not represent the spectrum accurately in wide angle diffraction.

This problem arises from the assumption that the wavelength is not constant. This is clearly an error according to equation (18). Without any verification, modern astronomy believes the wavelength has changed from λ_1 to λ_{obs}.

The first table shows the predicted radial velocity for large z. The difference between z and z' is significant for galaxy GN-108036 which is detected with wide angle diffraction.

The second table shows the first order angle related to the wavelength.

TABLE I. Radial Velocity and Comparison of z and z'

Galaxy	**z**	**z'**	**Radial Velocity**
GN-z11[4]	11.18	11.148	0.9179C
GN-108036[6]	9.27	7.247	0.9026C
ULAS J1120+0641[7]	7.086	7.082	0.8763C
IOK-1[8,9]	6.905	6.603	0.8735C

TABLE II. Wavelength and Angle

Galaxy	**Grating** line/mm	λ_1 nm	$sin(\theta_1)$	λ_{obs} nm	$sin(\theta_{obs})$
GN-z11	30.8	121	0.00372	1470	0.0452
GN-108036	600	121	0.0726	998	0.5988
ULAS J1120+0641	32	121	0.00387	978	0.0313
IOK-1	300	121	0.0363	920	0.276

L. Wide Field Camera 3

The light becomes slower or faster only in a reference frame different from the rest frame of the light source. In the rest frame of a star, the speed of light is constant. In the rest frame of the earth, the speed of light is a function of the relative motion of the star.

Wide Field Camera 3 (WFC3)[3] is a camera installed on Hubble Space Telescope. The grism G141 in WFC3 detected a remote galaxy moving away from the earth at a radial speed of 0.92 C. This galaxy is named GN-z11 and is the most remote galaxy ever detected from the earth by 2019.

In the rest frame of GN-z11, the speed of light is C. The earth moves away at the speed of 0.92 C. The speed difference between the light and the earth is 0.08 C. The light slowly catches up with the earth.

In the rest frame of the earth, the apparent speed of light is 0.08 C[5]. This slow light enters Hubble Space Telescope to reach the pickoff mirror which reflects it at about 90 degrees into WFC3.

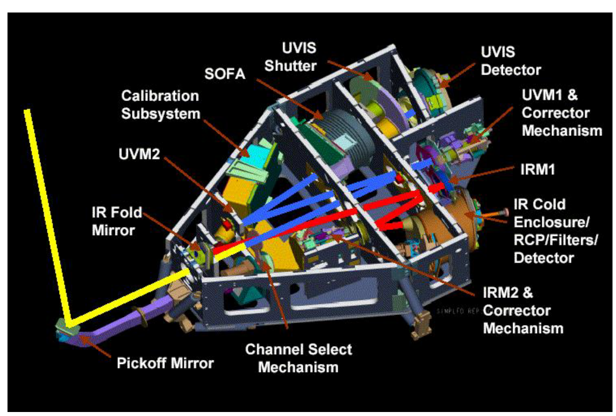

FIG. 2. Wide Field Camera 3

The slow light is reflected by two more internal mirrors in WFC3 before entering G141. The detection of a slow light in the G141 demands the transformation from the rest frame of CCD to another inertial reference frame in which the speed of light is C. In this reference frame, the relative motion of CCD causes the spectrum to expand.

From equation (62), c_3 represents the original light in the rest frame of GN-z11. $(c_3 * cos(\theta_3) - v)$ represents the slow light moving from G141 to the camera CCD. From equation (63), v is estimated to be about 0.92 C.

M. Derivation of Equation of Phase Shift

The interference is the intersection of two light paths, L_- and L_+, on the projection screen.

The distance from the upper slit to the intersection point is

$$L_- = \sqrt{D_1^2 + (y_1 - \frac{d_1}{2})^2} \tag{74}$$

The distance from the lower slit to the intersection point is

$$L_+ = \sqrt{D_1^2 + (y_1 + \frac{d_1}{2})^2} \tag{75}$$

The condition for a constructive interference is

$$L_+ - L_- = m\lambda_1 \tag{76}$$

From equations (74,75),

$$L_+^2 - L_-^2 = 2d_1 * y_1 \tag{77}$$

$$L_+ - L_- = \frac{2d_1 * y_1}{L_+ + L_-} \tag{78}$$

If $d_1 << y_1$,

$$L_+ + L_- = 2\sqrt{D_1^2 + y_1^2} \tag{79}$$

From equations (78,79),

$$L_+ - L_- = \frac{d_1 * y_1}{\sqrt{D_1^2 + y_1^2}} \tag{80}$$

From equations (76,80),

$$y_1 = m * \lambda_1 \frac{\sqrt{D_1^2 + y_1^2}}{d_1} \tag{81}$$

III. CONCLUSION

The conservation of double slit interference provides an excellent evidence that the wavelength is conserved in all inertial reference frames. The conservation of wavelength together with the Doppler effect proves that the speed of light is different in a different inertial reference frame. The relative motion between the light source and the light detector alters the speed of light in the rest frame of the light detector. This was confirmed with lunar laser ranging test at NASA Goddard Space Flight Center in 2009. The speed of laser was verified to be a function of the rotational speed of the earth.

However, the speed of light is constant in the rest frame of the light source. In the rest frame of the light detector, the speed of light increases if the light source moves toward the light detector. The speed of light decreases if the light source moves away from the light detector.

A slower light is equivalent to a receding light source which expands the spectrum from a diffraction grating. This is called redshift. A faster light is equivalent to an approaching light source which shrinks the spectrum. This is called blueshift. In both blueshift and redshift, the wavelength is conserved in all inertial reference frames.

Without verification, modern astronomy assumes there is a new wavelength. This error results in a wrong prediction of radial speed greater than the speed of light. The relativistic prediction of radial speed is also wrong because it is based on the invalid Lorentz transformation.

The spectral shift is a clear evidence that the speed of light has been altered in the rest frame of the grism. Wide Field Camera 3 in Hubble Space Telescope serves as an excellent example. Without facing GN-z11, WFC3 still can detect the relative motion between GN-z11 and Hubble Space Telescope. The star light in the rest frame of the telescope is slower than the original light in the rest frame of the star. The reflection by any stationary mirror inside WFC3 preserves the speed of the slower light. As a result, redshift is detected by the grism at any orientation of the camera.

The correct equation for double slit interference should be equation (55) instead of equation (1). This is similar to the equation of magnetic force on a moving charge. The velocity is required in the equation representing a diffraction grating.

[1] "Double Slit Interference", http://www.schoolphysics.co.uk/age16-19/Wave

[2] Possel, Markus (2017). "Waves, motion and frequency: the Doppler effect". Einstein Online, Vol. 5. Max Planck

Institute for Gravitational Physics, Potsdam, Germany. Retrieved September 4, 2017.
[3] "Wide Field Camera 3", http://www.stsci.edu/hst/wfc3
[4] "A Remarkably Luminous Galaxy at z= 11.1 Measured with Hubble", https://arxiv.org/pdf/1603.00461
[5] Su, Eric: Velocity Transformation in Reference Frame. viXra: Relativity and Cosmology/1801.0108 (2018). http://vixra.org/abs/1801.0108
[6] "Spectroscopic Confirmation of Three z-Dropout Galaxies at z= 6.844", https://arxiv.org/pdf/1107.3159
[7] "Spectrum of ULAS J1120+0641", https://www.researchgate.net/figure/Spectrum-of-ULAS-J1120-0641-compared-to-a-composite-spectrum-derived-from_fig_258558790
[8] "Subaru Telescope Information", https://subarutelescope.org/Pressrelease/2006/09/13/index.html
[9] "The SUBARU Deep Field Project: Lymanα Emitters at a Redshift of 6.6", https://academic.oup.com/pasj/article/57/1/165/1483452
[10] "Lunar Laser Ranging Test of the Invariance of c", https://arxiv.org/abs/0912.3934
[11] Eric Su: List of Publications, http://vixra.org/author/eric_su