Curvature of the Hubble Diagram for Type Ia Supernovae and Gamma-ray Bursts as Empirical Evidence of a Curved, Static and Spatially Closed Cosmos

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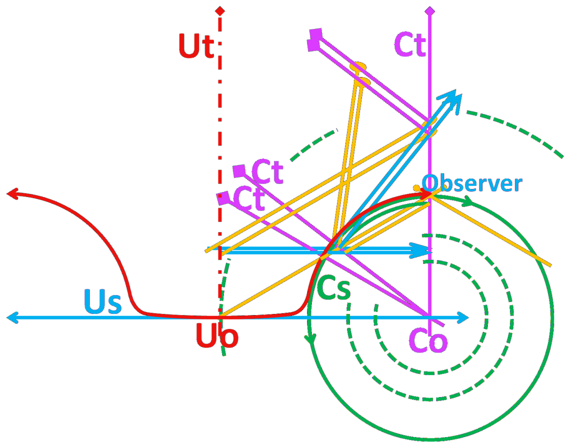
The Big Bang paradigm observed universe is hypothesised as virtual lens effect. The observer's flat light cone used to observe the sky would generate this by intersecting an actual curved, static and spatially closed cosmos. Its curved space-time would have tilting time axis and be fractal in time. The Hubble length is the only empirical data input needed in the topology, tangent to the curved frame at 60° time axis tilting from the observer, for reciprocal transferability between curved space-time and lens effect. This specifies a 30° angle between the space axis and the speed of light c vector, and a 60° angle between the time axis and the speed of light c vector. These allow measuring the curved frame. Here, brightness would discount fractality remaining unaffected, while redshift would be affected. Their relative differences are transferred from the curved frame to the observed universe frame. Here, they represent the curvature of the Hubble diagram for the Type Ia Supernovae and Gamma-ray bursts empirical data. This provides empirical evidence of a lens effect and a curved, static and spatially closed cosmos.

O Mary conceived without sin, pray for us who have recourse to thee
Spirit of truth, enlighten and guide our research

*This paper adds a lens effect factor to and synthesises the paper published in Tidningen Kulturen on 3 Nov. 2012.



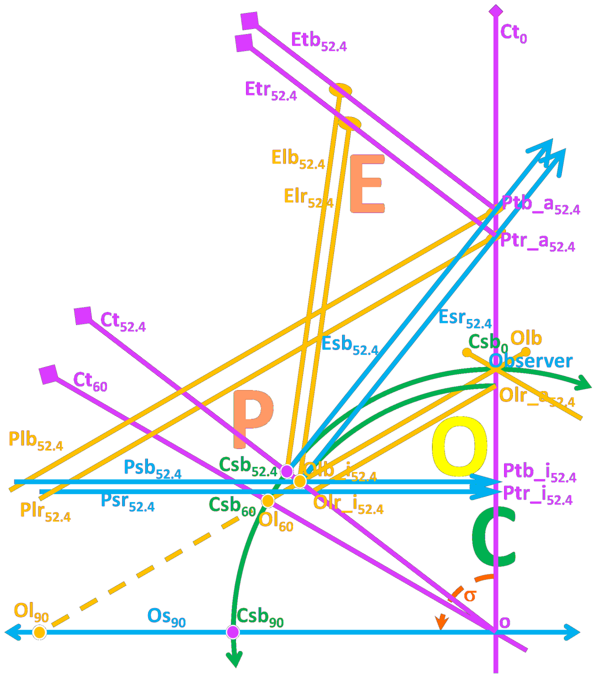


Figure 1: Curved Static Cosmos (*green*), seen as - here scaled down - Big Bang (*red*), due to a lens effect generated by the intersecting observer's light cone (Uo-Observer in *yellow*)

Figure 2: Virtual space: *blue* $\rightarrow$; actual space: *green* $\frown$; time: *magenta* $\diamond$; light vectors: *yellow* $\circ$. *Frame O*: observer's light cone past: vertical time axis *Cto*, horizontal space (e.g. Os_{90}), light cone vector as observation instrument. *Frame C*: hidden curved cosmos space-time: curved green circle arch *Csb* with radial time axes $Ct(\sigma)$. *Frame E*: faraway hidden local flat light cone physics, with local future light vector towards the observer, e.g. $Elb_{52.4}$ and $Elr_{52.4}$. *Frame P*: virtual transformation, flattening projection, distorting how the observer receives empirically data from the hidden *Frame E*, through the observer's light cone *Frame O*.

1. Hypothesis

Hypothesis: redshift would be due to a revolving of the space-time axes for static space [1, 2, 3]. The faraway increasingly tilted light emission would be redshifted to travel on the slope of the observer's past light cone. Feoli et al. [10] subtract virtual effects in the Big Bang paradigm. The alternative paradigm is hypothesised (Figure 2), in a four reference frames topology, as virtual lens effect due to a static curved and spatially closed cosmos seen through the observer's flat light cone.

2. Alternative topology: curved, static and spatially closed cosmos

The hidden aggregate of the observed universe with the light-cone used for its observation is defined as static, in agreement with Einstein's [8] static cosmology. This would lack a fixed maximum speed of light c [16, 15, 9, 4], which would rather apply as before to the directly observable universe. Frame 'C' (Cosmos) has revolving radial tilting time axes 'Ct' (magenta) around a static curved space 'Cs' (green) that enlarges only fractally in time (Figure 1 and 2), with static space. This fractality determines two similar triangles with parallel light vectors (yellow parallels //), measuring brightness of the standard candles (triangles b) and redshift (triangles r). Colour coding in

Figure 2 helps distinguish. Variables present subsequent letters: 1^{st}) the Frame of reference O for Observer, C for Cosmos, E for Expanded or P for Projected; 2^{nd}) space s, time t or light vector l; 3^{rd}) r for redshifted and b for brightness attenuation; 4^{th}) vector, from 1^{st} to 2^{nd} letter: *ia*, *oi*, *oa*; or point; o = origin; i = intersection; a = arrival on the observer's time axis; 5^{th}) (σ) or (0°) or (60°) etc. for tilted time axis angle at the centre considered.

3. Calculations

The topology uses the $Hubble\ lenght$ to calculate the $curvature\ of\ the\ Hubble\ diagram$ for Type Ia Supernovae (SNIa) and Gamma-ray bursts (GRB) as particular type of supernovae [23].

$0 < \sigma < 90^\circ$ = angle at the centre: tilted time axis $\overset{|}{Ct}(\sigma)$ vs observer's vertical time axis $\overset{|}{Ct}(0^\circ)$.

Reciprocal transferability, between the defined cosmos curved space-time and Big Bang lens effect, needs the light null cone to be tilted 60° from the observer's vertical time axis $\overset{|}{Ct}(0^\circ)$ (Figure 1 and 2). A 60° tilted light cone has a time axis $\overset{|}{Ct}(60^\circ)$ laying on such null cone, where time thus runs at the speed of light c. The $Hubble\ Lenght$ needs thus to occurs in $Frame\ E$ at $\overset{\bullet}{Csb\_i}(60^\circ)$, where the observer's $Frame\ O$ past null cone $\overrightarrow{Olb\_ia}(\sigma)$ intersects the curved space $\overset{\bigcirc}{Csb}$.

$$\overrightarrow{Esb\_ia}(60^\circ) = \overrightarrow{Esr\_ia}(60^\circ) = 13.70 * 10^9\ light\, years\ [12,\ 17] = Hubble\, Length \tag{3.1}$$

$$\overrightarrow{Ctb\_oa}(60^\circ) = \frac{\overrightarrow{Esb\_ia}(60^\circ)}{\sin(rad(60))} * \sin(rad(180-90-60)) = 7.909698688 * 10^9\ ly \tag{3.2}$$

is measured from $Frame\, E$ in terms of space. $\overrightarrow{Ctb\_oa}(60^\circ)$ equals $\overrightarrow{Ctb\_oa}(0^\circ)$ as radius of $\overset{\bigcirc}{Csb}$ and measures also, in $Frame\ O$, on the $\overset{|}{Ct}(0^\circ)$ axis, the $13.70 * 10^9 years$ time span from the Big Bang in such paradigm, represented with the triangle $\overset{\bullet}{Ol}(90^\circ)\_\overset{\triangle}{\overset{\bullet}{0}}\_\overset{\bullet}{Csb}(0^\circ)$, without neither acceleration nor an initial inflation , as both would be features of curvature in the curved $Frame\, C$. Thus:

$$13.70 * 10^9 y\ of\ Frame\ O = \overrightarrow{Ctb\_oa}(\sigma) = 7.909698688 * 10^9 ly\ of\ Frame\ E \tag{3.3}$$

$$1 * 10^9\ years = 0,577350269 * 10^9\ light{-}years \tag{3.3}$$

This allows expressing different measures units with one of them. Research devises the pruning of time [22, 21]. The following equations express time and light vectors with space units [2].

$\overrightarrow{Ctb\_oi}(\sigma)$ = radius of the $\overset{\bigcirc}{Csr}$ circumference (smaller in Figure 2) passing at the intercept of the light cone vector $\overrightarrow{Olb\_ia}(\sigma)$ with the time axis $\overset{|}{Ct}(\sigma)$. $\overrightarrow{Ctr\_oi}(\sigma)$ = radius of the internal (start cosmological time) where the light cone vector $\overrightarrow{Olr\_ia}(\sigma)$ intercepts the time axis $\overset{|}{Ct}(\sigma)$.

$$\overrightarrow{Ctb\_oi}(\sigma) = \frac{\overrightarrow{Ctb\_oa}(\sigma)\ * \sin(rad(60))}{\sin(rad(180-60-\sigma))} \qquad \overrightarrow{Ctr\_oi}(\sigma) = \frac{\overrightarrow{Ctb\_oi}(\sigma)\ * \sin(rad(60))}{\sin(rad(180-60-\sigma))} \tag{3.4}$$

Time span $\overrightarrow{Etr\_ia}(\sigma)$ of the redshifted *Frame E* projects onto *Frame P*, because this is parallel to *Frame O* ($\overset{/}{Pl}(\sigma)$ *is* $\parallel$ *to* $\overset{/}{Ol}(\sigma)$): 1) from $\overset{\bullet}{Ctr\_i}(\sigma) \equiv \overset{\bullet}{Olr\_i}(\sigma)$, the horizontal $\overrightarrow{Psr\_ia}(\sigma)$ intersects the observer's time axis $\overset{|}{Ct}(0^\circ)$ in the start time $\overset{\bullet}{Ptr\_i}(\sigma)$; 2) from $\overset{\bullet}{Ctb\_i}(\sigma) \equiv \overset{\bullet}{Olb\_i}(\sigma)$, the tangent $\overrightarrow{Esr\_ia}(\sigma)$ intersects the Observer's time axis $\overset{|}{Ct}(0^\circ)$ in the arrival time $\overset{\bullet}{Ptr\_a}(\sigma)$.

$$\overrightarrow{Ptr\_ia}(\sigma) = \overset{\bullet}{Ptr\_a}(\sigma) - \overset{\bullet}{Ptr\_i}(\sigma) = \overrightarrow{Ptr\_oa}(\sigma) - \overrightarrow{Ptr\_oi}(\sigma) \tag{3.5}$$

$$\overrightarrow{Ptr\_ia}(\sigma) = \frac{\overrightarrow{Ctb\_oi}(\sigma) * \sin(rad(90))}{\sin(rad(180-90-\sigma))} - \frac{\overrightarrow{Ctr\_oi}(\sigma) * \sin(rad(180-90-\sigma))}{\sin(rad(90))} \tag{3.5}$$

Redshifted wavelength vector $\overrightarrow{Plr\_ia}(\sigma)$ in *Frame P* is:

$$\overrightarrow{Plr\_ia}(\sigma) = \frac{\overrightarrow{Ptr\_ia}(\sigma)}{\sin(rad(30))} * \sin(rad(90)) \tag{3.6}$$

Observer's wavelenght vector $\overrightarrow{Olr\_ia}(\sigma)$ in *Frame O* (with $\overrightarrow{Otr\_ia}(\sigma)$ in parentheses) is:

$$\overrightarrow{Olr\_ia}(\sigma) = \left(\overrightarrow{Ctb\_oi}(\sigma) - \frac{\overrightarrow{Ctr\_oi}(\sigma)}{\sin(rad(90))} * \sin(rad(180-90-\sigma)) \right) * \frac{\sin(rad(90))}{\sin(rad(30))} \tag{3.7}$$

Observer's brightness vector $\overrightarrow{Olb\_ia}(\sigma)$ in *Frame O* is :

$$\overrightarrow{Olb\_ia}(\sigma) = \left(\overrightarrow{Otb\_ia}(\sigma) \right) * \frac{\sin(rad(90))}{\sin(rad(30))} = \frac{\overrightarrow{Ctb\_oi}(\sigma)}{\sin(rad(60))} * \sin(rad(\sigma)) \tag{3.8}$$

Redshifted wavelenght vector $\overrightarrow{Elr\_ia}(\sigma)$ in *Frame E* (with $\overrightarrow{Esr\_ia}(\sigma)$ in parentheses) is:

$$\overrightarrow{Elr\_ia}(\sigma) = \left(\frac{\overrightarrow{Ctb\_oi}(\sigma)}{\sin(rad(180-90-\sigma))} * \sin(rad(\sigma)) \right) * \frac{\sin(rad(90))}{\sin(rad(60))} \tag{3.9}$$

The below inner brackets scale $\overrightarrow{Olr\_ia}(\sigma)$ in parallel to $\overrightarrow{Elr\_ia}(\sigma)$, for comparing 'kiwis' to 'kiwis'. The denominator considers the radiation observed for nearby bodies, for $\lim_{\sigma\to 0}$, thus in *FrameO* where $\overrightarrow{Olb\_ia}(\sigma) \cong \overrightarrow{Olr\_ia}(\sigma)$. Thus *Frame E* redshift Ez is equation 3.10 or 3.11:

$$\frac{received\ \lambda - emitted\ \lambda}{local\ reference\ \lambda} = Ezr(\sigma) = \frac{\overrightarrow{Elr\_ia}(\sigma) - \left(\overrightarrow{Olr\_ia}(\sigma) * \left(\frac{\overrightarrow{Elr\_ia}(\sigma)}{\overrightarrow{Plr\_ia}(\sigma)} \right) \right)}{\overrightarrow{Olr\_ia}(\sigma)} \tag{3.10}$$

$$\frac{received\ \lambda - emitted\ \lambda}{local\ reference\ \lambda} = Ezb(\sigma) = \frac{\overrightarrow{Elr\_ia}(\sigma) - \left(\overrightarrow{Olr\_ia}(\sigma) * \left(\frac{\overrightarrow{Elr\_ia}(\sigma)}{\overrightarrow{Plr\_ia}(\sigma)} \right) \right)}{\overrightarrow{Olb\_ia}(\sigma)} \tag{3.11}$$

The curvature of the static *Frame C* generates the other plotting variable: the relative discrepancy $\Delta Cs(\sigma)$ between brightness and redshift measurements. It coincides with ΔOs in *Frame O*.

$$\widehat{dCs(\sigma)} = \widehat{Csb\_ia}(\sigma) - \widehat{Csr\_ia}(\sigma) = (\overrightarrow{Ctb\_oa}(\sigma) * rad(\sigma)) - (\overrightarrow{Ctb\_oi}(\sigma) * rad(\sigma)) \quad (3.12)$$

$$\overrightarrow{dOs(\sigma)} = \overrightarrow{Osb\_ia}(\sigma) - \overrightarrow{Osr\_ia}(\sigma) = \left(\overrightarrow{Olb\_ia}(\sigma) - \overrightarrow{Olr\_ia}(\sigma) \right) * \frac{\sin(rad(60))}{\sin(rad(90))} \quad (3.13)$$

$$relative\,discrepancy \quad \Delta Csr(\sigma) = \frac{\widehat{dCs(\sigma)}}{\widehat{Csr\_ia}(\sigma)} = \Delta Osr(\sigma) = \frac{\overrightarrow{dOs(\sigma)}}{\overrightarrow{Osr\_ia}(\sigma)} \quad (3.14)$$

$$relative\,discrepancy \quad \Delta Csb(\sigma) = \frac{\widehat{dCs(\sigma)}}{\widehat{Csb\_ia}(\sigma)} = \Delta Osb(\sigma) = \frac{\overrightarrow{dOs(\sigma)}}{\overrightarrow{Osb\_ia}(\sigma)} \quad (3.15)$$

Frame E represents empirical data used in the Big Bang paradigm [14]. $\Delta Os(\sigma)$ is expanded to *Frame E* by a scaling factor between *Frame E* and *Frame O* in the second brackets, and made parallel to *FrameE* by the scaling factor of the third brackets, as in equations 3.10 and 3.11:

$$\Delta Esr(\sigma) = \left(\frac{\overrightarrow{Osb\_ia}(\sigma) - \overrightarrow{Osr\_ia}(\sigma)}{\overrightarrow{Osr\_ia}(\sigma)} \right) * \left(\frac{\overrightarrow{Esr\_ia}(\sigma)}{\overrightarrow{Osr\_ia}(\sigma)} \right) * \left(\frac{\overrightarrow{Elr\_ia}(\sigma)}{\overrightarrow{Plr\_ia}(\sigma)} \right) \quad (3.16)$$

$$\Delta Esb(\sigma) = \left(\frac{\overrightarrow{Osb\_ia}(\sigma) - \overrightarrow{Osr\_ia}(\sigma)}{\overrightarrow{Osb\_ia}(\sigma)} \right) * \left(\frac{\overrightarrow{Esr\_ia}(\sigma)}{\overrightarrow{Osb\_ia}(\sigma)} \right) * \left(\frac{\overrightarrow{Elr\_ia}(\sigma)}{\overrightarrow{Plr\_ia}(\sigma)} \right) \quad (3.17)$$

The Hubble diagram curvature [24] differs with different parameters of dark matter and dark energy [19]. Each of $Ezr(\sigma)$ and $Ezb(\sigma)$ may be combined with $\Delta Esr(\sigma)$ or $\Delta Esb(\sigma)$, determining four curves. They are superposed to the curvature of the Hubble diagram: the one plotted by Wright [24] in 2011 (Figure 3), up to $z = 2$ (from Conley et al. [6] and Kowalski et al. [13] on the Supernovae Legacy Survey and Kowalski et al. on the ESSENCE survey); and the one plotted by Wright in 2006 [24] (Figure 3), up to $z = 7$. $Ezr\_\Delta Esr(\sigma)$ in intense green uses redshift at denominators for both $Ezr(\sigma)$ and $\Delta Esr(\sigma)$. $Ezb\_\Delta Esb(\sigma)$ in light blue uses brightness at denominators for both $Ezb(\sigma)$ and $\Delta Esb(\sigma)$. Both match the magenta curve of the Flat Dark Energy Model [24]. The first green one in addition matches closely the Evolving SNe curve (in the right figure for $0 < z \leq 7$) and represents well the GRBs empirical data at redshifts $z > 1$. For the other two combinations, $Ezb\_\Delta Esr(\sigma)$ represents also quite well GRBs empirical data at redshifts $z > 1$. $Ezr\_\Delta Esb(\sigma)$ matches the Closed Dark Energy Model of the left figure for $0 < z \leq 2$ and somehow also the Non-Flat Dark Energy Model of the right figure. Further analysis could better clarify among them. The SNIa and GRB discrepancies [18, 20, 13, 6] provide as such empirical evidence of static space-time curvature. Dark energy and inflation result as virtual lens effects.

Gurzadyan and Penrose [11] find concentric structures in the CMB radiation, and read them as continuation of the universe from aeon eras before the Big Bang. The herewith alternative paradigm reads them as twilight from spherical structures beyond the horizon in a 4D curved space-time (as analogue to the horizon twilight on the 3D Earth). The CMB is read thus as cosmic twilight.

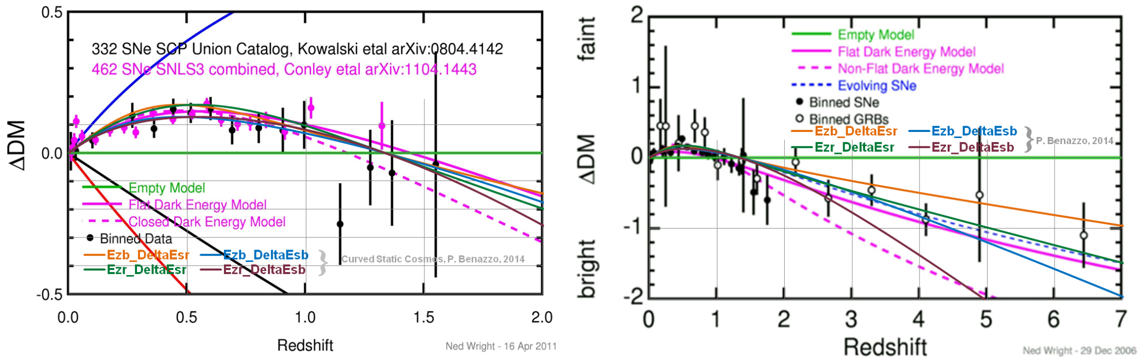


Figure 3: ΔDM (Δ Distance Modulus). Models: Flat & Closed Dark Energy with SNIa data $z \leq 2$ left (credit: Wright, 2011); Flat & Non-Flat Dark Energy with SNIa+GRB data $z \leq 7$ right (credit: Wright, 2006); Curved Static Cosmos (superposed intense green, light blue, orange, violet, curves) (Benazzo, 2014)

Brown [5] recalls Einstein's Equivalence Principle for general relativity: "A complete physical equivalence of a gravitational field and a corresponding acceleration of the reference system" [7]. The fractality in time constitutes such an accelerated reference system that would provide gravity.

Further research could include updating the data and investigating angles $\sigma > 90°$and gravity.

4. Concluding Remarks

The defined cosmos static curvature (rather than flat space accelerated expansion) generates theoretically the curvature of the Hubble diagram for SNIa and GRB. This represents the empirical data and the alternative topology also explains the CMB radiation and the principle of gravity.

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