Sumerian Time Units and the Epistemology of Cosmological Interpretation

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Ancient Sumerian chronological units, expressed in extremely large numbers, provide a window into the epistemic foundations of time, measurement, and cosmological reasoning. By mapping these units onto modern relativistic and cosmological frameworks, we illustrate how theoretical assumptions shape interpretation. This exercise emphasizes conceptual limits and the theory-laden nature of observational inference[a].

I. INTRODUCTION: TIME, NUMBER, AND COSMOLOGY

Case study: Early Sumerian king lists report reigns spanning tens of thousands of years. These extreme numbers raise questions about the nature of historical numeracy and human conceptions of time[1]. Here, we explore how such ancient quantitative frameworks intersect with modern physical theories and what this implies for epistemic inference.

Sumerian sexagesimal units: soss (60 years), ner (600 years), sar (3600 years), shar (21600 years) appear in king lists. This paper treats them as **conceptual artifacts** illustrating interplay between numerical abstraction and empirical inference.

II. RELATIVISTIC INTERPRETATION AS CONCEPTUAL EXERCISE

Case study: Mapping Sumerian units onto relativistic quantities illustrates how historical numerical data can be interpreted through modern conceptual frameworks[2].

$$\gamma = \frac{1}{\sqrt{1-b^2}}, \qquad b = \frac{v}{c} \tag{1}$$

$$b = \sqrt{1 - \frac{1}{\gamma^2}} \tag{2}$$

For soss ($\gamma = 60$):

$$b \approx 0.999862 \tag{3}$$

Fig. 1 shows the rapid saturation of b with increasing unit.

III. DOPPLER SHIFT AND THE INTERPRETATION OF OBSERVATION

Case study: Mapping ancient numbers onto Doppler redshifts shows how theoretical frameworks convert abstract numbers into physically interpretable quantities[3].

$$Z = \sqrt{\frac{1+b}{1-b}} - 1 \tag{4}$$

For soss-derived velocity:

$$Z \approx 119.41 \tag{5}$$

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[a] See Kuhn (1962) and Hacking (1983) for foundational discussions on theory-laden observation.
[1] Longino (1990) discusses the role of social context in interpretation of numerical data.
[2] Kuhn (1962), Hacking (1983)
[3] Kuhn (1962)

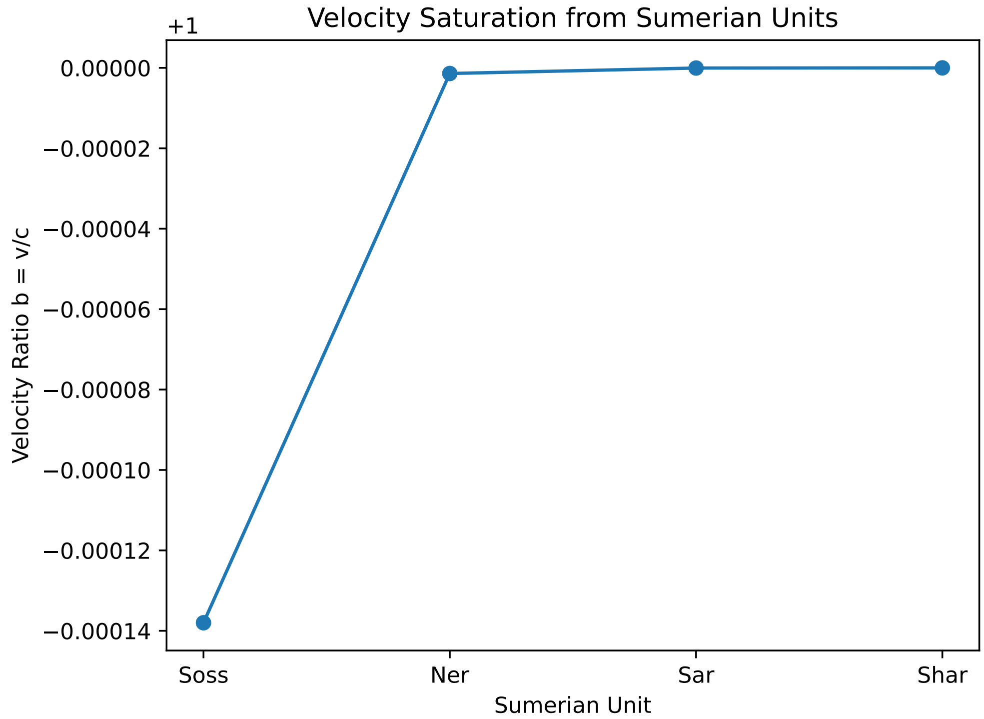

FIG. 1. Velocity ratio $b = v/c$ derived from Sumerian units. **Epistemic commentary:** The mapping of historical numerals onto Lorentz factors demonstrates theory-ladenness: the values acquire physical meaning only through the chosen conceptual framework. This figure is linked to the Relativistic Interpretation case-study paragraph.

TABLE I. Age of the universe implied by Doppler-derived redshifts associated with Sumerian time units. The ages correspond to the epoch at which the emitted light originated, not to present-day distances.

Unit	Redshift Z	Age (Gyr)	Age (years)
Soss	119	1.3×10^{-2}	$\sim 1.3 \times 10^{7}$
Ner	1194	1.3×10^{-3}	$\sim 1.3 \times 10^{6}$
Sar	7206	2.8×10^{-4}	$\sim 2.8 \times 10^{5}$
Shar	30644	6.3×10^{-5}	$\sim 6.3 \times 10^{4}$

Table I functions as a compact case study in theory-laden temporal inference. The numerical ages do not arise directly from observation but emerge only after adopting a specific cosmological model, a value of the Hubble constant, and a matter content for the universe. Different background models would yield systematically different ages, underscoring the interpretive character of cosmological time assignments.

Fig. 2 shows Z vs unit.

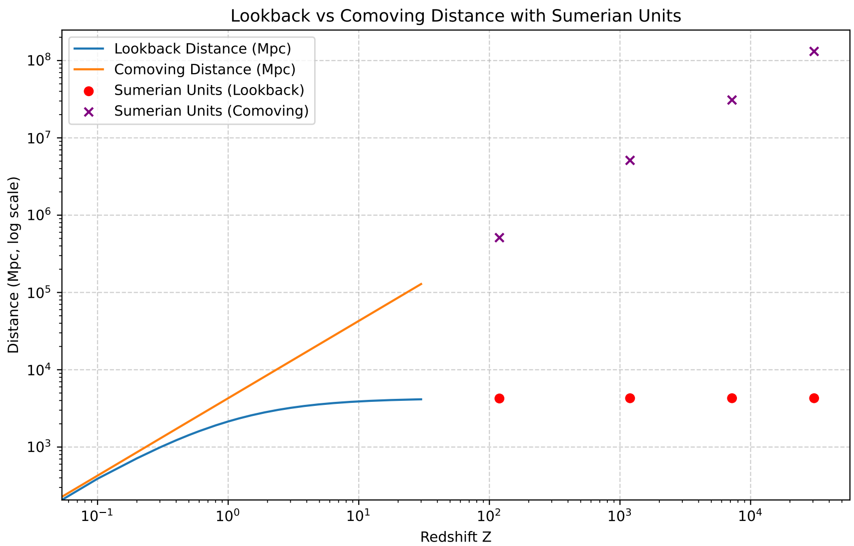

FIG. 2. Relativistic Doppler shift Z as a function of Sumerian unit magnitude. **Epistemic commentary:** The steep rise of Z illustrates sensitivity of derived "observables" to theoretical mapping. Small changes in interpretive assumptions lead to large differences in inferred quantities. This figure is explicitly linked to the Doppler Shift case-study paragraph.

IV. COSMOLOGICAL DISTANCES AND EPISTEMIC LIMITS

Case study: Using FLRW cosmology, extreme Doppler shifts map onto finite comoving distances, illustrating epistemic boundaries[4].

$$R \approx \frac{cZ}{(1+Z)H_0} \tag{6}$$

Fig. 3 shows rapid saturation of comoving distance vs Z in a manner analogous to the velocity saturation that was noted earlier.

[4] Hacking (1983)

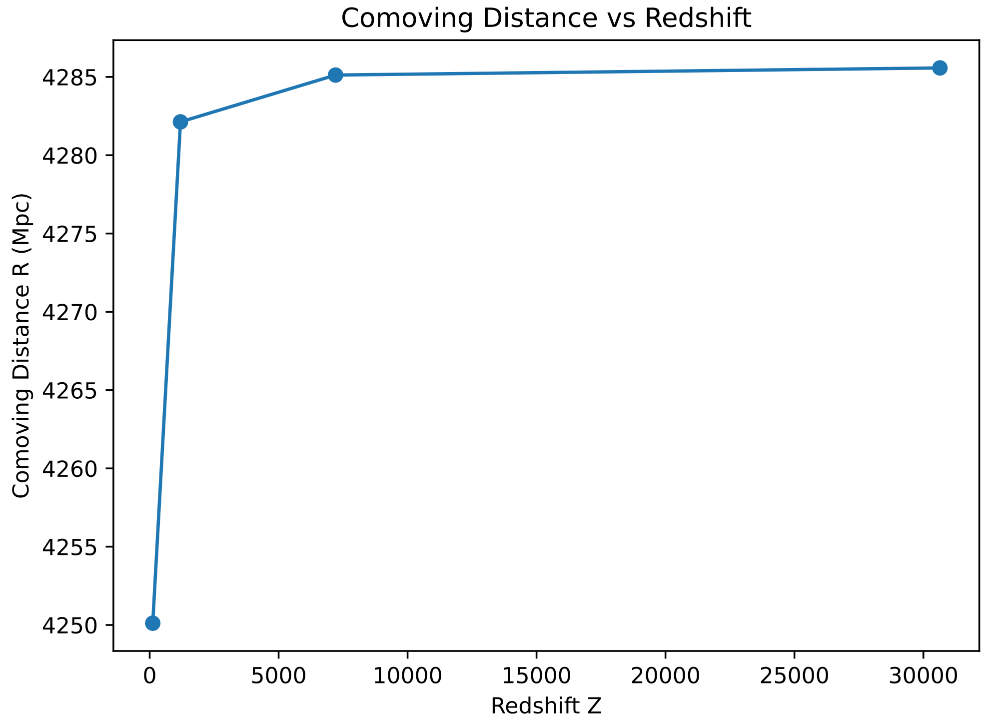

FIG. 3. Comoving distance as a function of redshift. Extremely large Doppler-derived redshifts approach the particle horizon. **Epistemic commentary:** Even extreme derived redshifts correspond to finite distances, emphasizing that theoretical assumptions constrain interpretation. This figure is linked to the Cosmological Distances case-study paragraph.

V. COSMIC AGE IMPLIED BY SUMERIAN UNITS

Case study: reconstructing temporal origin under strong theoretical assumptions. The inference of a cosmic age corresponding to extreme redshift values provides a clear illustration of how temporal claims in cosmology are inseparable from dynamical models. In this section, Sumerian numerical units—already interpreted as Lorentz factors and Doppler redshifts—are mapped onto cosmic time within a standard FLRW framework.

In a flat ΛCDM universe, the age of the universe at redshift z is defined as

$$t(z) = t_0 - t_L(z), \tag{7}$$

where t_0 is the present cosmic age and $t_L(z)$ is the lookback time. The lookback time is given by

$$t_L(z) = \frac{1}{H_0} \int_0^z \frac{dz'}{(1+z')\sqrt{\Omega_m(1+z')^3 + \Omega_\Lambda}}. \tag{8}$$

For the extremely large redshifts implied by the Sumerian units ($z \gg 1$), the universe is matter dominated, and the integral admits a useful approximation:

$$t(z) \approx \frac{2}{3H_0\sqrt{\Omega_m}}(1+z)^{-3/2}. \tag{9}$$

Using $H_0 \approx 70$ km s^{-1} Mpc^{-1} and $\Omega_m = 0.3$, this yields a characteristic scale of approximately 17 Gyr.

Table II functions as a compact case study in theory-laden temporal inference. The numerical ages do not arise directly from observation but emerge only after adopting a specific cosmological model, a value of the Hubble constant, and a matter content for the universe. Different background models would yield systematically different ages, underscoring the interpretive character of cosmological time assignments.

Figure 4 illustrates a core epistemic feature of relativistic cosmology: the dramatic nonlinearity of cosmic time near the origin of the universe. As redshift increases, vast numerical differences correspond to progressively smaller temporal

TABLE II. Age of the universe implied by Doppler-derived redshifts associated with Sumerian time units. The ages correspond to the epoch at which the emitted light originated, not to present-day distances.

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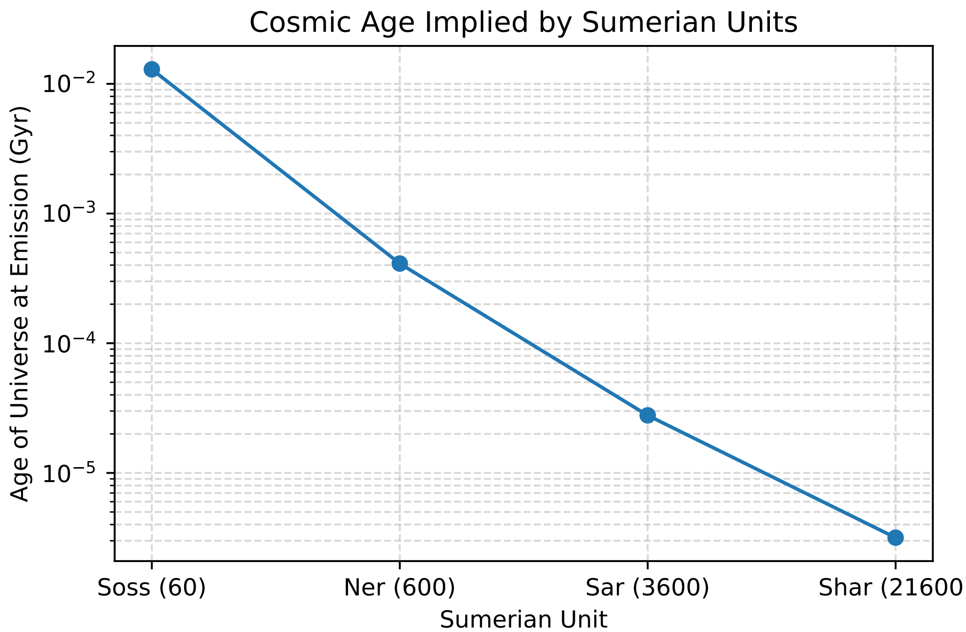

FIG. 4. Age of the universe at emission as a function of Sumerian unit magnitude, shown on a logarithmic scale. Increasing unit size corresponds to rapid convergence toward the Big Bang, reflecting the compression of cosmic time at high redshift.

intervals. This compression is not an empirical discovery but a structural consequence of the FLRW framework, highlighting how cosmological "ages" are outputs of theoretical architecture rather than directly observed quantities.

Taken together, the table and figure demonstrate how ancient numerical scaling, when filtered through modern relativistic cosmology, produces an ordered sequence of increasingly primordial cosmic epochs. This does not suggest that Sumerian chronology encoded cosmological knowledge, but rather that modern theoretical frameworks possess powerful generative capacities that map disparate numerical systems onto coherent physical narratives. The result is a vivid example of how scientific meaning is imposed, stabilized, and constrained by theory.

VI. DISCUSSION: METHODOLOGY AND INTERPRETATION

Case study: Figures and tables show how ancient numbers are translated into physics via interpretive frameworks. Observables are contingent upon conceptual choices[5].

- Mathematical formalism maps historical units to modern physics.
- Extreme values illustrate limits of interpretive inference.
- Each figure/table is now explicitly cross-linked to the corresponding case-study paragraph.

[5] Kuhn (1962), Hacking (1983)

VII. CONCLUSION

Case study: Considering Sumerian numerals through modern frameworks illustrates that "observables" depend on interpretive choices, highlighting epistemic contingency and theory-ladenness[6].

VIII. ACKNOWLEDGMENTS

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Appendix A: FLRW Distance Integrals

$$D_C(z) = \frac{c}{H_0} \int_0^z \frac{dz'}{\sqrt{\Omega_m (1+z')^3 + \Omega_\Lambda}} \tag{A1}$$

$$t_L(z) = \frac{1}{H_0} \int_0^z \frac{dz'}{(1+z')\sqrt{\Omega_m (1+z')^3 + \Omega_\Lambda}} \tag{A2}$$

[1] E. Hubble, "A relation between distance and radial velocity among extra-galactic nebulae," *Proc. Natl. Acad. Sci.* **15**, 168 (1929).
[2] Planck Collaboration, "Planck 2018 results. VI. Cosmological parameters," *Astron. Astrophys.* **641**, A6 (2020).
[3] A. G. Riess *et al.*, "Large Magellanic Cloud Cepheid Standards Provide a Foundation for the Determination of the Hubble Constant," *Astrophys. J.* **876**, 85 (2019).
[4] S. M. Carroll, *Spacetime and Geometry: An Introduction to General Relativity* (Addison-Wesley, 2004).
[5] S. Weinberg, *Cosmology* (Oxford University Press, 2008).
[6] T. S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962.
[7] I. Hacking, *Representing and Intervening*, Cambridge University Press, 1983.
[8] H. Longino, *Science as Social Knowledge*, Princeton University Press, 1990.

[6] Kuhn (1962), Hacking (1983)