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**ON UNIT OF LENGTH MEASUREMENT IN THE INDUS-SARASWATI
CIVILIZATION AND SPEED OF LIGHT IN THE VEDIC LITERATURE**

By

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ABSTRACT

An exact value of the unit of length measurement used in Indus-Saraswati Civilization, has been determined from the precise scale discovered by Ernest Mackay in the 1930-31 season excavation at Mohenjodaro and further correlated with the present day units of measurement. It has been calculated and shown that the speed of light as given in the Vedic literature, when referenced with this erstwhile unit of length measurement (used in Indus-Saraswati Civilization), works out to be precisely equal to the speed of light as per modern measurements. The present paper is a step-wise process followed to unveil this equality.

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1. The Precise Scale. In his 1930-31 season at Mohanjo-daro, Ernest Mackay discovered a broken piece of shell bearing 8 divisions of precisely 6.7056mm each, with a dot and circle five graduations apart, which suggests a decimal system. However, attempts by Mackay, to relate such a unit to dimensions in Mohanjo-daro, were not very successful (Michel Danino [2]) and thus were abandoned.

2. Units of Length in Chanakya's Arthashastra. Chanakya was the political of the legendary monarch Chandragupta Maurya of 4th century BC. He was aman learned in may disciplines and wrote the famous treatise on economics called the Arthashastra-meaning the books of money). In Arthashastra, Chanakya mentions two types of *Dhanushas* as units for measuring length and distances. One is the ordinary *Dhanusha*, consisting of 96 *Angulas*, and the other *Dhanusha* is mentioned as *Garhpatya Dhanusha* and consists of 108 *Angulas*. Chanakya also mentions many other units including a *Dhanurgraha*, which consists of 4 *Angulas* and a *Yojana* (In Sanskrit-English dictionary, by Moniere William, a Yojana has been defined as a mesure of distance=4 Kosas or about 9 miles. Apart from the Moniere William dictionary, several other books/sources also give the Yojana as eqal to about 9 miles.), as consisting of 8000 *Dhanushas*.

3. Decoding the Mohan-jo-daro Scale. If we keep 10 divisions of the Mohanjo-daro scale as equal to a *Dhanurgraha* or 4 *Angulas*, the precise length of an *Angula* works out to be 16.764mm.

$$\text{A Dhanusha of 96 Angulas} = 96 \times 16.764\text{mm} = 1.609344\text{m} \quad (1)$$

and

$$\text{A Dhanusha of 108 Angulas} = 108 \times 16.764\text{mm} = 1.810512\text{meters}. \quad (2)$$

$$1 \text{ Yojana} = 8000 \text{ Dhanushas (of 108 Angulas each)} \quad (3)$$

Thus

$$1 \text{ Yojana} = 8000 \times 1.810512\text{m} = 14.484096\text{km}. \quad (4)$$

Further

$$14.484096\text{km} = 9 \text{ miles, (exactly!)}. \quad (5)$$

Also

$$1000 \text{ Dhanushas of 96 Angulas each} = 1\text{mile} \quad (6)$$

Interestingly, when we look into the history of *mile*, we find that the word *mile* is derived from *mile*, which means a *thousand*. This points to universal adaptation of ancient units of length.

4. Corroboration from Other Sources

The Indus Inch: The Indus civilisation unit of length, widely known as *Indus Inch* was 1.32 Inches which is exactly equal to 2 *Angulas* of 16.76mm each.

Mohenjo-daro's Great Bath: The height of the corbelled drain forming the outlet of Mohenjo-daro's Great Bath [6, pp. 133-142] is about 1.8m, which is equal to a *Dhanusha* of 108 *Angulas* of 16.764mm each.

Standard Street-Widths. Kalibangam, a city in the Indus-Saraswati Civilization (in Rajasthan) had street widths [8] of 1.8m, 3.6m, 5.4m and 7.2m i.e. built to the standard dimensions being equal to 1 *Dhanusha*, 2 *Dhanushas*, 3 *Dhanushas* and 4 *Dhanushas* respectively. Such widths are found at other sites also. Bigger streets of Banawali [8] another town in Indus-Saraswati Civilization (in Haryana) measure 5.4m i.e. they were built with the unit of 3 *Dhanushas*.

Taj Mahal. A Persian manuscript "*Shah Jahan Nama*" contains a very particular description of three principal buildings of Agra-the Taj Mahal, Moti Masjid and Jamah Masjid. In the "*Shah Jahan Nama*", the dimensions of these three buildings are given in *Gaz*. These dimensions were got measured by col. J.A. Hodgson in December, 1825, in feet and inches. The various (28) dimensions, in feet and inches, as well as in *Gaz*, are given by Hodgson in his article [5], in *Table A*. He has also given *Table B* (25 dimensions) excluding 3 dimensions which he thought were not very dependable. The weighted mean length of a *Gaz* works out to 31.70 inches, (80.52cm) from *Table A* and 31.66 inches=80.42cm from *Table B*. The average of the two values is 31.68 inches=80.47cm. It is pertinent to mention here that Barraud [1, pp. 108-109, 258-259] in *The complete Taj Mahal and the River front*

Columns of Agra, has taken a *Gaz* as equal to 80.5cm which is very nearly equal to 80.47cm as worked out above. Taking a *Dhanusha* of 96 *Angulas* to be equal to 2 *Gaz*, the length of an *Angula* works out to 16.764mm. It shows that a *Gaz* of 48 *Indus-Saraswati Angulas* was being used, even in the days of Shah Jahan's rule i.e. 17th Century A.D.

The Gudea's Rule. The *Gudea's* rule (2175 B.C.) preserved in the Louvre shows intervals in Sumerian Shusi of 0.66 inches, which is exactly equal to the *Indus-Saraswati Angula* of 16.764mm.

Mayan Units of Measurement. Drewitt [3] and Drucker [4] made a study of the ancient city of Teotihuacan, belonging to *Mayan* Civilization, in Mexico, and hypothesised a unit of 80.5cm, which is very nearly equal to the Indian *Guz* of 48 *Angulas*=80.47cm.

Temple Wall-Engravings. Nearer home, two engravings on a wall of the temple at Tiruputtkali (12th Century A.D.) near Kanchipuram, show two scales [7] one measuring 7.24 metres in length, with marketing dividing the scale into 4 equal parts, and the second one measuring 5.69 metres in length and marking dividing the scale into 4 equal parts. It may be observed that each division of the first scale is precisely equal to a *Dhanusha* of 108 *Angulas* of 16.764mm each. Interestingly, the second scale is precisely equal to π times *Dhanusha* i.e. equal to the circumference of a circle with one *Dhanusha* as its Diameter.

It is interesting to note here that Mackay reports [9] at Mohenjo-daro, a lane and a doorway having both a width of 1.42m, which is precisely equal to one division of the second scale at the Tiruputtkali Temple, indicating that both the scales were prevalent in *Indus-Saraswati Civilization* as well as in South India.

It proves beyond doubt that the Units of measurement as derived from the precise scale found at Mohenjo-daro were prevalent not only in the *Indus-Saraswati Civilization*, but also in South India and in the ancient *Sumerian, Egyptian and Mayan Civilizations*.

5. Speed of Light in Vedic Literature. In the commentary on Rig-Veda. Mandal 1, Sukta 50, Mantra 4, which is in praise of the Sun god, Sayanacharya (14th Century AD) writes:

तथा च स्मर्यते...

योजनानां सहस्रं द्वे द्वे शते द्वे च योजने ।

एकेन निमिषार्धेन क्रममाण नमोस्तु ते ॥

Meaning... "It is remembered that...

Salutations to Thee (the Sun) who approacheth (at a speed of) 2202 yojanas in a *nimishardha* (*half nimisha*)."

Clearly it is the Speed of light (or sunrays) that is mentioned in the *Shloka*.

This *shloka* is attributed [10, pp. 67] to the son of Kanva Maharshi (4000 B.C.). *Bhatta Bhaskara* (10th Century) mentions [11] this *shlok* in his commentary on the *Taitreya Brahamana*.

To put it in mathematical terms, as stated by the above shlok, the speed of light would be :

$$\text{Speed of Light} = 2202 \text{ Yojanas/Nimishardha} \quad (7)$$

We have already calculated the value of Yojana in modern unit of km in the previous step (Equation 4), but we still do not know, what the *Nimishardha* translates into. Let us dig into another Vedic text the *Vishnu Puran* to find how the erstwhile units of time can be related to the modern units of time.

In the *Vishnu Puran* (Book 1, Chapter 3, Shloka 8,9), it is stated that:

15 <i>Nimishas</i>	= 1 <i>Kashtha</i>
30 <i>Kashthas</i>	= 1 <i>Kala</i>
30 <i>Kalas</i>	= 1 <i>Mahurta</i>
30 <i>Mahurtas</i>	= 1 <i>day and night</i> (अहोरात्रम्)

Thus

$$\text{one day and night} = 405,000 \text{ Nimishas} = 810,000 \text{ Nimishardhas.} \quad (8)$$

(Literal meaning of *Nimishardha* being half of *Nimisha*).

In *Surya Sidhant* (Chapter 1, Shloka 12), it is mentioned that 60 *Nadis* constitute one *Sidereal Day and Night* (नाक्षत्रम् अहोरात्रम्). It is also well known that 1 *Mahurta* = 2 *Ghatis* or 2 *Nadis*. It is clear from this that in Astronomical calculations, the sidereal day was taken as the unit of time. A sidereal day is the time taken by the stellar constellations to complete one revolution around the Earth. A sidereal day is equal to 23 hours, 56 minutes and 4.1 seconds or equivalent sec (Wikipedia [12]).

Thus

$$\text{Nimishardha} = 86164.1/810000 \text{ sec} = 0.1063754 \text{ sec} \quad (9)$$

The speed of light as given in the Vedic Literature therefor comes out to be;

$$\frac{2202 * 14.484096 \text{ km}}{0.1063754 \text{ sec}} = 2.998 * 10^5 \text{ km/sec} . \quad (10)$$

which is precisely equal to the speed of light as per modern measurements.

6. Conclusions. The calculations and references in the article endeavor to establish the vast reach of the Indus Valley scholars, not only academically, but also geographically. Thousands of years before the modern scientists rediscovered the speed of light; our ancestors knew of the exact same value and referred to it as an exalted property of the Sun-God to salute Him. It is also heartening to know that the modern-age concept of globalization and sharing of ideas between cultures

was also an established way of life in their era, as proven by the shared units of measurement found across far-flung cultures. When and how these ancient civilization lost their influence is still a mystery, but for now we can celebrate the knowledge that :

1. The Speed of Light as given in the Vedic literature, is precisely equal to the Speed of Light as per modern measurements.
2. The basic unit of length measurement in the Indus-Saraswati Civilization was an *Angul* of 16.764mm. This unit was used not only in the Indus-Saraswati Civilization, but also in South India, and other ancient world Civilizations including *Sumerian*, *Egyptian* and *Mayan* Civilizations.

REFERENCES

- [1] R.A. Barraud, *The Complete Taj Mahal and The Riverfront Gardens of Agra* (ed. Koch E.) Thames and Hudson. London, 2006.
- [2] Danino, Michel, *The Lost River-On the Trail of Saraswati*, Penguin Books, 2010.
- [3] Drewitt, *Measurement Units and Building Areas at Teotihuacan*, 1987
- [4] R. David Drucker, *Precolumbian Mesoamerican Measurment Systems: Unit Standards for Length*, 1977.
- [5] Col. J.A. Hodgson, *Memoir on the Length of the Illahi, Guz*, Journal of the Royal Asiatic Society of Great Britain and Ireland., 1840.
- [6] Jansen, Michael *Mohenjo-daro: architecture et urbanisme*, Les cités oubliées de l'Indus: Archéologie due Pakistan, 1988.
- [7] James Heitzman and S. Rajagopal, *Urban Geography and Land Measurement in the Twelfth Century: The Case of Kanchipuram*. The Indian Economic and Social History Review, SAGE, 2004.
- [8] B.B. Lal, *The Earlist Civilization of South Asia*, Aryan Books International, New Delhi, 1997.
- [9] E.J.H. Mackey, *Further Excavations at Mohenjo-daro*, Govt. of India. Vol. I republished Munshiram Manoharlal, 1998.
- [10] *Pride of India*, Published by Sanskrit Bharati, 2006.
- [11] Subhash Kak, *The speed of Light and Puranic Cosmology*, 2001.
- [12] Wikipedia Article on Sidereal Time, http://en.wikipedia.org/wiki/Sidereal_time.