**Article**

# On Astrometric Data & Time Varying Sun-Earth Distance in Light of Carmeli Metric

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## Abstract

In this note, we describe shortly time varying Sun-Earth distance in the light of Carmeli metric and compare the result with recent astrometric data. The graphical plot suggests that there should be linear-linear correspondence between Sun-planets distances and their time variation. Carmeli metric simply adds a momentum term to the normal 4-d spacetime formulation, to give us a 5-d working space, but actually the original Carmeli metric replaces time dimension in Minkowski metric to become momentum term divided by quadratic Hubble constant. One obvious advantage from Carmeli metric is that it can be used to derive Tully-Fisher law, which can explain galaxy motion without invoking dark matter.

**Key Words**: astrometric data, time varying, Sun-Earth distance, Carmeli metric.

## Introduction

Recent astrometric data suggest that there is time variation of Sun-Earth distance at the order of 15 cm/year [1]. This observed effect can shed light on restriction in astronomy modeling.

In this regard we discuss how this time varying Sun-Earth distance can be explained by virtue of Carmeli metric [2]. In the first section we explain how Carmeli metric can be shown to be derivable from quaternion group, and in turn there are a number of new effects which can be observed as part of Carmeli metric. Carmeli metric simply adds a momentum term to the normal 4-d spacetime formulation, to give us a 5-d working space, but actually the original Carmeli metric replaces time dimension in Minkowski metric to become momentum term divided by quadratic Hubble constant. One obvious advantage from Carmeli metric is that it can be used to derive Tully-Fisher law, which can explain galaxy motion without invoking dark matter [2]. There are other advantages from the viewpoint of clarity of modeling,

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including that one can expect to explain the presently un-described Earth geochronometry [4].

## FLRW-metric from quaternion group and Carmeli metric

The quaternion algebra is one of the most important and most studied objects in mathematics and physics; and it has natural Hermitian form which induces Euclidean metric [3].

In this regards Trifonov has obtained that by using a natural extension of the structure tensors using nonzero quaternion bases then they will yield a metric as follows [3]:

$$g_{\alpha\beta} = \begin{pmatrix} \tau(\eta)\left(\frac{\dot{R}}{R}\right)^2 & 0 & 0 & 0 \\ 0 & -\tau(\eta) & 0 & 0 \\ 0 & 0 & -\tau(\eta)\sin^2(\chi) & 0 \\ 0 & 0 & 0 & -\tau(\eta)\sin^2(\chi)\sin^2(\vartheta) \end{pmatrix}. \quad (1)$$

In order to obtain a closed-FLRW metric, one assume that [3]:

$$\tau(\eta)\left(\frac{\dot{R}}{R}\right)^2 = 1, \quad (2)$$

which can be rewritten in the form of a metric:[4]

$$\tau(\eta)(\dot{R})^2 = R^2 = dx^2 + dy^2 + dz^2, \quad (3)$$

or

$$ds^2 = dx^2 + dy^2 + dz^2 - \tau(\eta)(\dot{R})^2, \quad (4)$$

which in turn this metric can be compared with Carmeli metric:[2]

$$ds^2 = dR^2 - \frac{1}{H^2}dv^2 = dx^2 + dy^2 + dz^2 - \tau^2 dv^2, \quad (5)$$

where $\tau$ symbol denotes inverse of Hubble constant, H.

The standard procedure of Carmeli metric, however, is to begin with Hubble law [2]:

$$x = H_0^{-1} v, \tag{5a}$$

Where H and v are Hubble constant and velocity, respectively. Quote: "But one cannot use this law directly to obtain a relation between z and t. So we start by assuming that the Universe is empty of gravitation. One can then describe the property of expansion as a null-vector in the flat four dimensions of space and expanding velocity v." [2a] From a viewpoint, one can say for clarity that Carmeli metric simply adds a momentum term to the normal 4-d spacetime formulation, to give us a 5-d working space, but actually the original Carmeli metric (see eq.(5)) replaces time dimension in Minkowski metric $ds^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2$, to become momentum term divided by quadratic Hubble constant. One obvious advantage from Carmeli metric is that it can be used to derive Tully-Fisher law, which can explain galaxy motion without invoking dark matter.[2] There are other advantages from the viewpoint of clarity of modeling, including that one can expect to explain the presently un-described Earth geochronometry.[4] That is why we think that Carmeli metric can be one good candidate to explain galaxy motion without necessity to include dark matter.

One shall note here that this $\tau$ (tau) symbol is given different meaning compared with its meaning in equation (4), that is:

$$\tau^2 = \tau(\eta) = \frac{1}{\alpha H^n}. \tag{6}$$

One implication of this proposition has been found in [4], that there is such a proportionality which can be written as follows:

$$\left(\frac{R_1}{\dot{R}_1}\right) = \left(\frac{R_2}{\dot{R}_2}\right) = \sqrt{\tau(\eta)}. \tag{7}$$

The aforementioned proportionality corresponds to the observed Earth geochronometry phenomena which can be attributed to an expansion of Earth radius at the order of ~0.166 cm/yr [4].

## Plausible explanation of time varying Sun-Earth distance

In order to explain time varying Sun-Earth distance, one can use similar analogies, but with introducing a coefficient in order to match with the observed data of Anderson et al. (that is around 15 cm /yr) [1]. The virtue of this calculation is that one can also expect to observe the time varying displacement of the other planets too, compared to their distances to the Sun.

Given we accept approximate radius of earth to be around 6367.5 km, or around $6.3675 \times 10^6$ meter, and that is why: elongation of metric scale can be estimated to be around: $\frac{0.166 meter/cy}{6367500 meter} \approx 0.2607x10^{-7} m.cy^{-1}/m \approx 2.607x10^{-10} m.year^{-1}/m$. And that is approximately what one should find in a metrology device in order one can observe the effect of Hubble expansion to SI metric length scale. After conversion, this number amount to: $8.26674 \times 10^{-18}$ m/sec/m'. Now times this amount with $1.4959 \times 10^{11}$ m of distance between the Sun and the earth, and we will obtain estimate of displacement per second. After conversion to displacement each year, one gets= 39.0 meter per year of displacement. In order to match this number with the observed, one multiply this number with 1/274, and then one gets: 14.23 cm/year of displacement of the Earth from the Sun. While the value above appears to be a retrodiction compared to the observed value, the virtue here is one gets simplicity of framework to get estimate of displacement for other planets. The proportionality now for the planets could be written instead of (7):

$$\left(\frac{\dot{R}_1}{R_1}\right) = \left(\frac{\varepsilon \dot{R}_2}{R_2}\right), or \tag{8}$$

$$\left(\frac{\dot{R}_1}{R_1}\right)\frac{R_2}{\varepsilon} = \left(\dot{R}_2\right), \tag{8a}$$

where the $R_2$ mean distance from planet to the Sun, and $R_1$ mean earth radius respectively. The symbol ε denotes factor 274 to match the observed data. This number in turn can be associated with the well-known fine structure constant, therefore equation (8a) can be rewritten for convenience as follows:

$$\left(\frac{\dot{R}_1}{R_1}\right)\frac{\alpha R_2}{2} = \left(\dot{R}_2\right), \tag{8b}$$

where α represents fine structure constant = 1/137,... That would be interesting to observe the actual time-varying distance between other planets to the Sun, in order to verify or refute the aforementioned proposition (8b).

The result of the above procedure is presented in the table 1 below.

Table 1. calculation of the time varying displacement of planets from the Sun

| | distance | displcmt | | log scale | log scale | log scale |
|---|---|---|---|---|---|---|
| planet | dist( 10^11m) | displac(in cm) | observd(in cm) | dist( 10^11m) | displac(in m) | observd(in m) |
| mercury | 5,7894 | 5,51 | | 0,7626 | 0,74 | |
| venus | 10,9506 | 10,42 | | 1,0394 | 1,02 | |
| earth | 14,9598 | 14,23 | 15 | 1,1749 | 1,15 | 1,176 |
| mars | 22,7389 | 21,64 | | 1,3568 | 1,34 | |
| hungarias | 31,4006 | 29,88 | | 1,4969 | 1,48 | |
| asteroid | 40,3914 | 38,43 | | 1,6063 | 1,58 | |
| camilla | 47,1233 | 44,84 | | 1,6732 | 1,65 | |
| | | | | | | |
| jupiter | 77,8358 | 74,06 | | 1,8912 | 1,87 | |
| saturn | 142,7014 | 135,77 | | 2,1544 | 2,13 | |
| uranus | 287,0783 | 273,14 | | 2,4580 | 2,44 | |
| neptune | 450,2896 | 428,43 | | 2,6535 | 2,63 | |
| pluto | 590,9116 | 562,23 | | 2,7715 | 2,75 | |
| 2003ub313 | 777,9089 | 740,15 | | 2,8909 | 2,87 | |

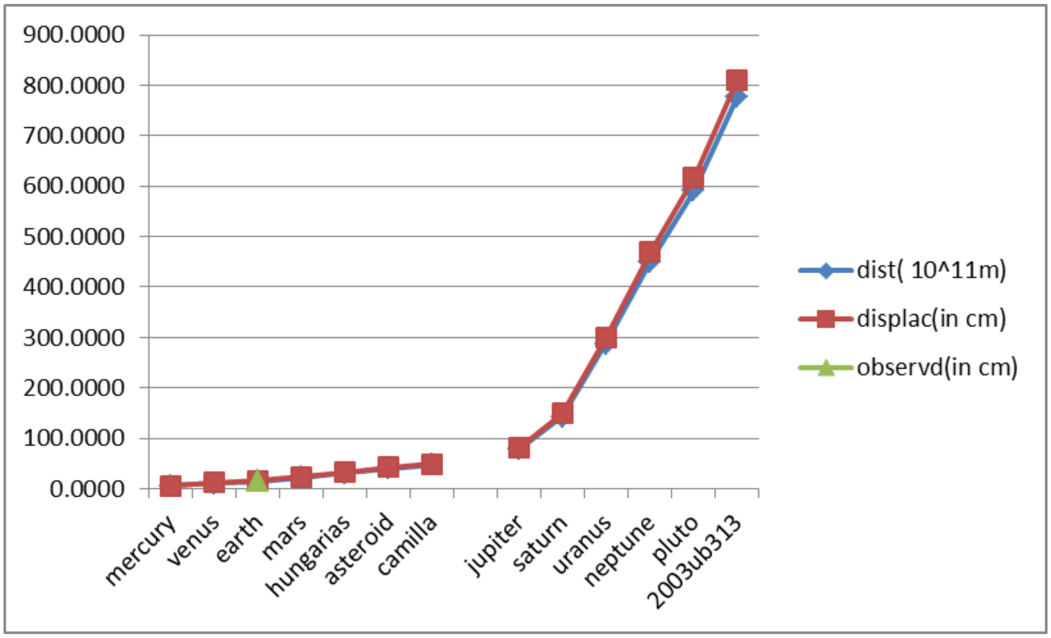


Figure 1. Graphical plot of time varying displacement of planets from the Sun

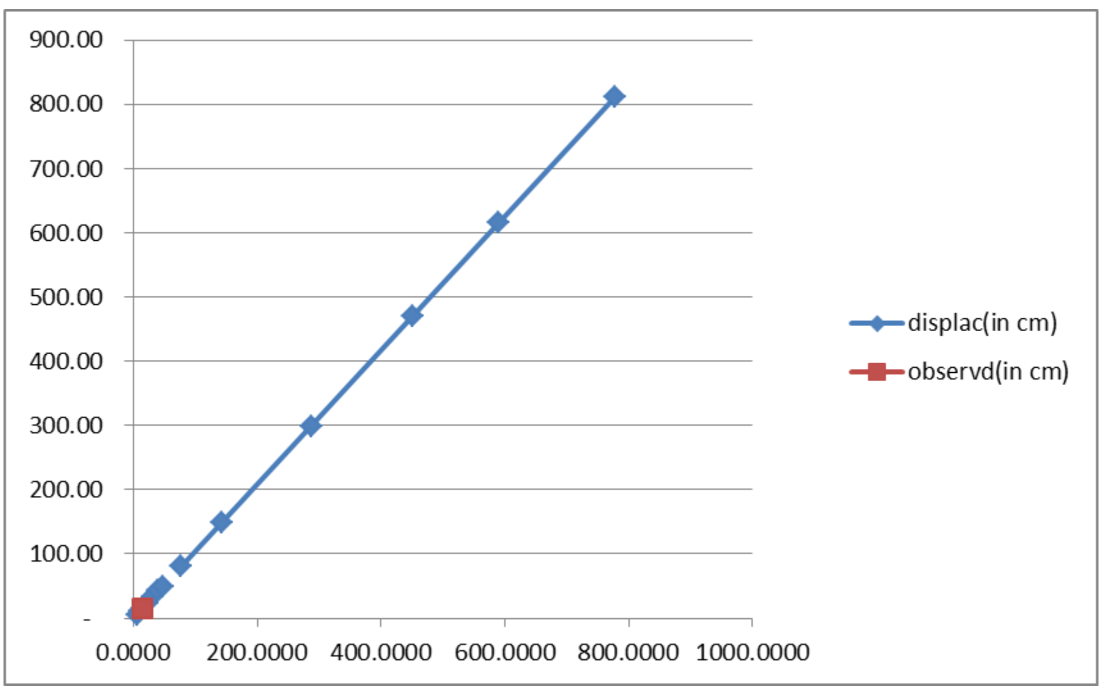


Figure 2. Graphical plot of distance vs. displacement of various planets from the Sun

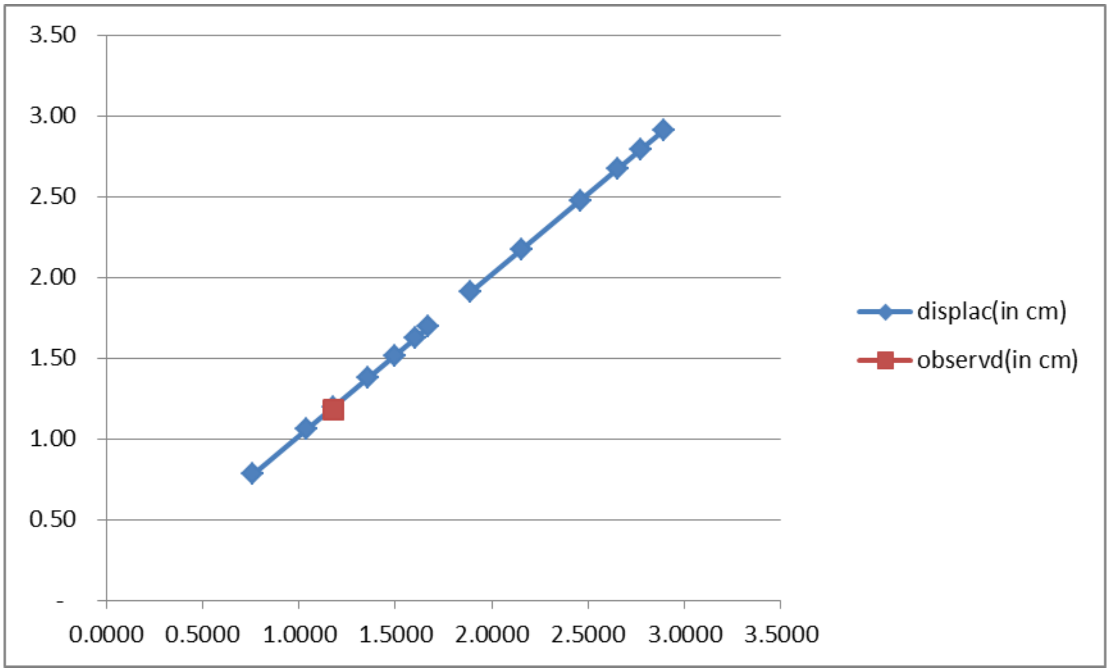


Figure 3. Graphical log-log plot of distance vs. displacement of various planets from the Sun.

## Concluding remarks

In this note, we describe shortly time varying Sun-Earth distance in the light of Carmeli metric and compare the result with recent astrometric data. The graphical plot suggests that there should be linear-linear correspondence between Sun-planets distances and their time variation.

Not only that, the prediction made here suggests that Carmeli metric can be the sought after framework in order to describe the astrometric anomaly pertaining to the time varying distance of the Sun-Earth distance, and furthermore there are expected time varying distance effect between the Sun and other planets as well.

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