The Correlation Between Stellar Radii and the Masses of Stable Atomic Nuclei

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In an analysis motivated by the AdS/CFT correspondence, the radii of nearby stars, including the sun, are shown to be correlated with values of mass equal to those of stable atomic nuclei.

1. Introduction

The 10D/4D correspondence [1] (which was founded on the AdS/CFT correspondence; see below) is applied to nearby stars, including the sun, with confidently known radii. Mass values derived from the correspondence will be shown to coincide with mass levels that descend in geometric progression from the Planck Mass and are occupied by atomic nuclei. Each stellar radius will be shown to be correlated with a value of atomic mass. The gas giants of the solar system are included in the study.

2. The 10D/4D correspondence

Expressions have been deduced for the dark (vacuum) energy density on the boundary of an $AdS_5 \times S^5$ spacetime and in four-dimensional spacetime [2, 3, 4]. Equating the expressions relates the Bohr radius a_0, the assumed characteristic length scale on the boundary of the ten-dimensional spacetime, precisely to the radius r_{ou} of the observable (four-dimensional) universe (14,300 Mpc [5]). In Planck units (ħ=c=G=1), which explains the apparent unbalanced dimensions, the equation is

$$\frac{1}{2}{a_0}^{-5} = {r_{ou}}^{-2} \tag{1}$$

or

$${r_{ou}}^2 = 2{a_0}^5 \tag{2}$$

On the basis of this finding, a study was made of the Big Bang timeline [1]. Events occurring at times t_{event} after the Big Bang have been found to be correlated with mass values $m_{event} < m_{Planck}$ characteristic of the events through the equation:

$${t_{event}}^2 = 2{m_{event}}^{-5} \tag{3}$$

Furthermore, the mass values calculated using (3) coincide with the mass levels and sublevels of the Planck sequences, each of which descends in geometric progression from the Planck Mass, $1.220910(29) \times 10^{19}$ GeV [6]. There are three such sequences in the Planck Model [7]: Sequence 1 of common ratio $1/\pi$, Sequence 2 of common ratio $2/\pi$ and Sequence 3 of common ratio $1/e$; subatomic particles and atomic nuclei occupy the levels and sublevels[1] of each sequence [8]. The sequences may derive from the geometry of spacetime [9].

[1] Half-levels, quarter-levels, eighth-levels etc

3. Stars and the 10D/4D correspondence

Conjecturing, on the basis of (3), that stellar radii r_{star} are correlated with specific mass scales $m_{cr} < m_{Planck}$ within the Planck sequences such that

$$r_{star}{}^2 = 2m_{cr}{}^{-5} \quad (4)$$

where the Planck Length equals 1.616229(38) x 10^{-35} m [6], the locations of the various values of m_{cr} within the Planck sequences will be determined for 12 stars, including the sun, of confidently known radius. The radii are shown in Table 1, as multiples of the solar radius 6.957 x 10^8 m [10]. The uncertainty in radius measurement for these stars is in most cases around 1% and in all cases less than 10%. Twin stars, defined here as binary partners of similar size, are included in the analysis. Tau Ceti is sometimes called 'Sun's twin'. For twins, r_{star} is taken to be the geometric mean of the two radii. Mass level numbers n_1, in Sequence 1, and n_3, in Sequence 3, are calculated for each value of m_{cr} according to

$$n_1 = \ln(m_{Planck}/m_{cr})/\ln(\pi) \quad (5)$$

and

$$n_3 = \ln(m_{Planck}/m_{cr}) \quad (6)$$

Star	Radius in solar radii	Ref.	Comments
Proxima Centauri	0.141(7)	[11]	The nearest star to the sun. A companion of the Alpha Centauri binary system.
Alpha Centauri A and B	1.227(5), 0.865(6)	[12]	Near neighbours of the sun. A binary system. Twin stars.
Tau Ceti	0.793(4)	[13]	Near to the sun. Similar to the sun spectroscopically and in size. 'Sun's twin'.
Sirius A	1.711(13)	[14]	The brightest star other than the sun as seen from earth. Has a dwarf binary partner.
Procyon A	2.048(25)	[15]	One of the brightest stars as seen from earth. Has a dwarf binary partner.
Pollux	8.8(1)	[16]	The nearest giant star to earth.
Capella Aa and Ab	12.2(2), 9.2(4)	[17]	A bright binary system. Twin stars.
Algol Aa1 and Aa2	2.73(20), 3.48(28)	[18]	A celebrated eclipsing binary system. Twin stars.

Table 1: Stars included in the analysis

The calculated values of n_1 and n_3 are shown in Figure 1. The Sun and Tau Ceti will be considered later. The data points lie on a straight line because n_1 and n_3 are in constant ratio. Not only do the values of m_{cr} calculated for the stars lie on the levels, half-levels and quarter levels of Sequences 1 and 3 but they are also equal to multiples of the atomic mass unit 931.5 MeV.

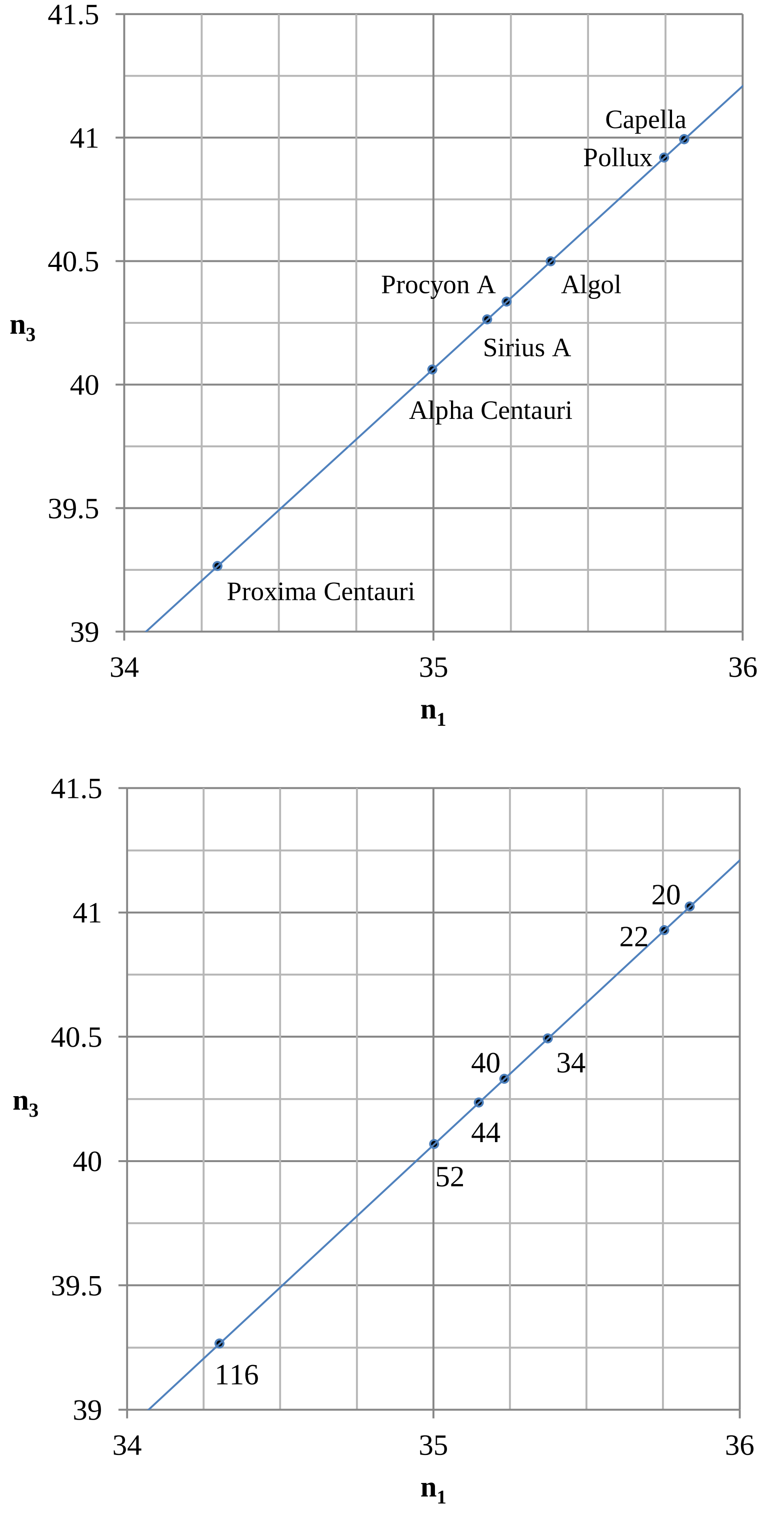


Figure 1
Upper graph: Mass values m_{cr} calculated from stellar radii. Shown in Sequences 1 and 3.
Lower graph: The locations within Sequences 1 and 3 of atomic nuclei with the mass numbers shown.

Most of the stars of Figure 1 are associated with atomic mass numbers that are multiples of 4 and all are associated with atomic mass numbers that are multiples of 2, such as would be found for even-even nuclei.

One can see from Figure 2 that the values of m_{cr} calculated for Alpha Centauri A and B are located symmetrically about Level 35 in Sequence 1. Such symmetrical arrangements are found in the Planck Model for the quark doublets and, about sublevels, for hadronic isospin doublets [9]. The two stars are associated with atomic mass numbers 48 and 56.

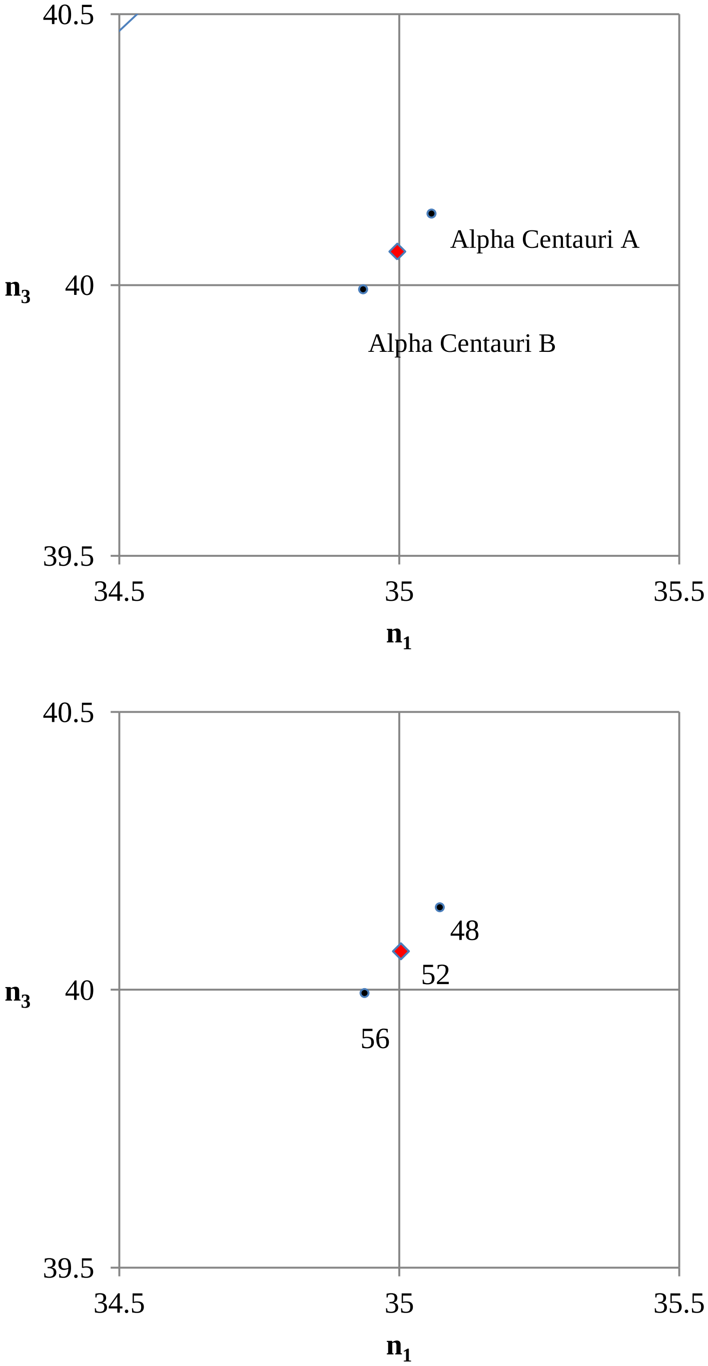


Figure 2
Upper graph: Mass values m_{cr} calculated from the radii of Alpha Centauri A and B. Shown in Sequences 1 and 3. A diamond marks the value of m_{cr} calculated from the geometric mean of the two stellar radii.
Lower graph: The locations within Sequences 1 and 3 of atomic nuclei with the atomic mass numbers 48 and 56.
As a pair, the twin stars are associated with atomic mass number 52.

Moving on to Algol, one can see from Figure 3 that the values of m_{cr} calculated for the two stars are located symmetrically about Level 40.5 in Sequence 3. The twins are associated with atomic mass numbers 32 and 36.

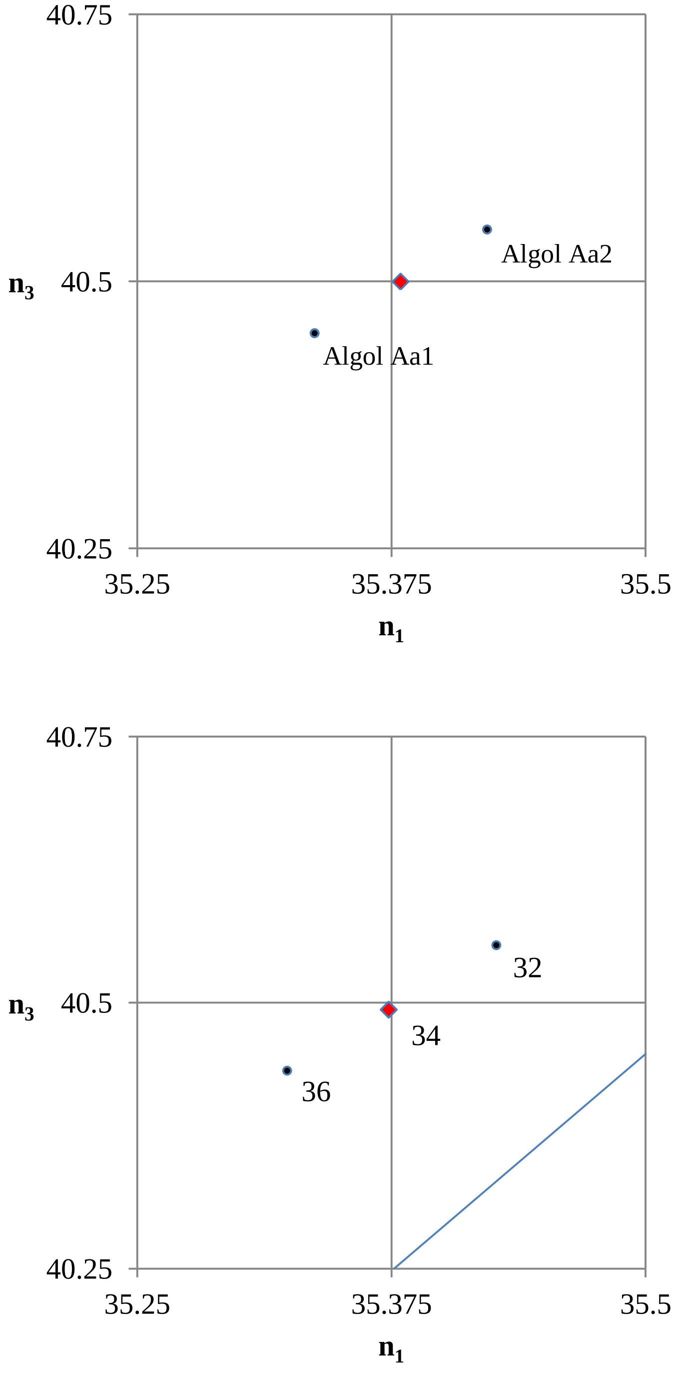
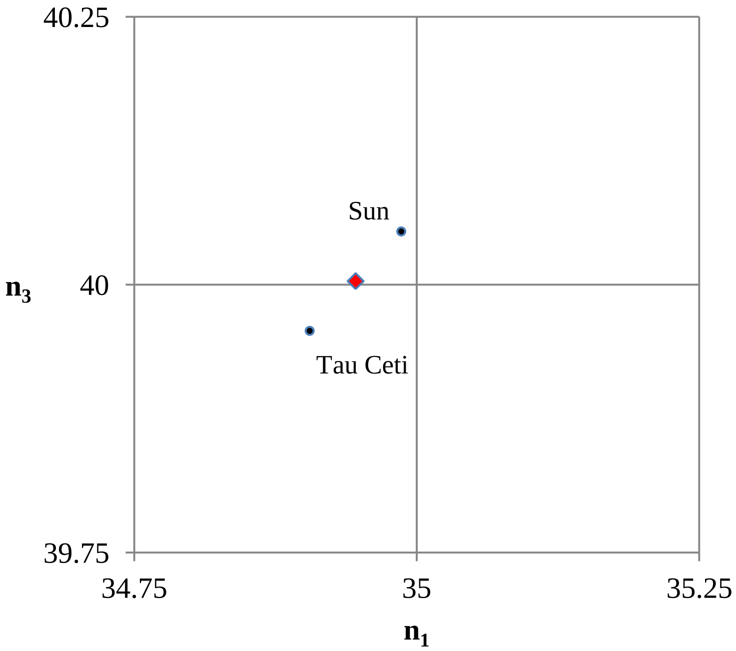


Figure 3
Upper graph: Mass values m_{cr} calculated from the radii of Algol Aa1 and Aa2. Shown in Sequences 1 and 3. A diamond marks the value of m_{cr} calculated from the geometric mean of the two stellar radii.
Lower graph: The locations within Sequences 1 and 3 of atomic nuclei with mass numbers 32 and 36.
As a pair, the twin stars are associated with atomic mass number 34.

Values of m_{cr} calculated for the Sun and Tau Ceti are located symmetrically about Level 40 in Sequence 3, in a twin configuration, as shown in Figure 4. The two stars are associated with atomic mass numbers 53 and 59, respectively. As a pair, the twins are associated with mass number 56.



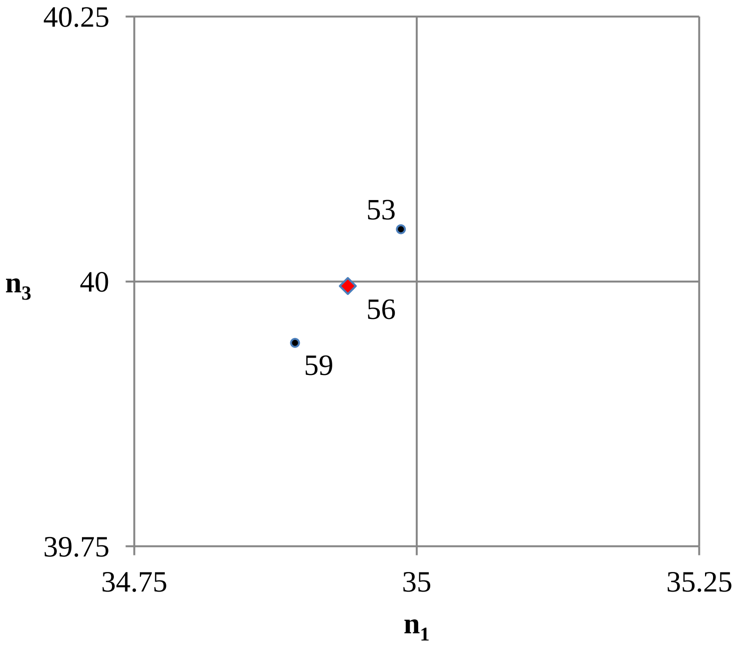


Figure 4
Upper graph: Mass values m_{cr} calculated from the radii of the sun and Tau Ceti. Shown in Sequences 1 and 3. A diamond marks the value of m_{cr} calculated from the geometric mean of the two stellar radii.
Lower graph: The locations within Sequences 1 and 3 of atomic nuclei with mass numbers 53 and 59.
As a pair, the twin stars are associated with atomic mass number 56.

A link between the Sun and Tau Ceti was also found in an analysis of planetary systems [19]. Close parallels were found between the planetary systems of the two stars.

Mass values m_{cr} calculated for (i) the Sun and Tau Ceti and (ii) Alpha Centauri A and B are arranged symmetrically about mass superlevels (levels whose level-numbers are multiples of 5), as are the masses of the quarks of each generation [7]. The two pairs of stellar twins are associated with the location (35, 40) of nearly-coincident superlevels in Sequences 1 and 3, as shown in Figures 2 and 4. The quarks, as doublets, are associated with the locations of nearly-coincident superlevels in Sequences 2 and 3 [20].

4. The gas giants of the solar system and the 10D/4D correspondence

The volumetric mean radius of Jupiter (6.991 x 10^7 m [10]) and that of Saturn (5.283 x 10^7 m [10]) are associated with atomic mass numbers that are multiples of 4, as shown in Figure 5.

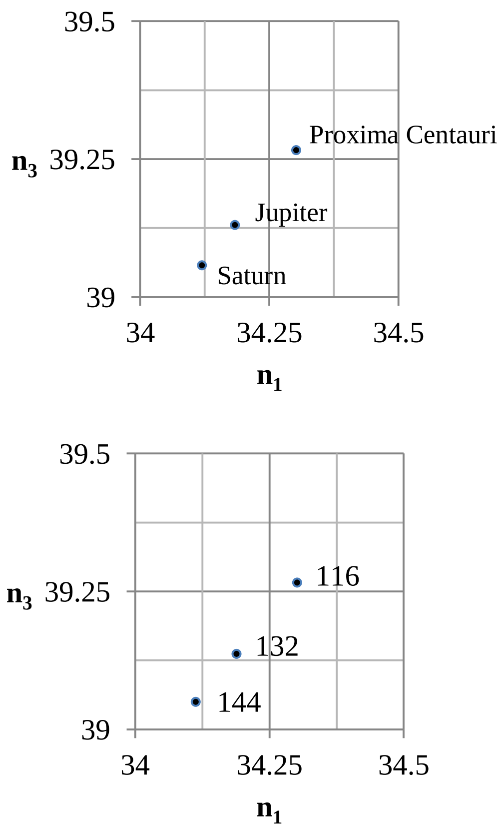


Figure 5
Upper graph: Mass values m_{cr} calculated from the radii of Proxima Centauri, Jupiter and Saturn. Shown in Sequences 1 and 3.
Lower graph: The locations within Sequences 1 and 3 of atomic nuclei with the mass numbers shown

Mass values m_{cr} calculated from the radii of the similarly-sized Uranus (radius 2.536 x 10^7 m [10]) and Neptune (2.462 x 10^7 m [10]) lie either side of the mass of a nucleus of atomic mass number 200.

5. Discussion

Events, e.g. the onset of inflation, that occurred during the evolution of the universe - at times when the radius of the universe had specific values - are correlated, through (3), with mass scales characteristic of the events [1]. Stellar radii have now been found to be correlated, through (4), with the masses of atomic nuclei: particularly nuclei with atomic mass numbers that are multiples of 4. That might suggest the mass values are characteristic of the alpha process of stellar nucleosynthesis, by which carbon produced from helium by the triple-alpha process is converted by fusion with helium into progressively heavier elements. However, that connection is ruled out because it is in the larger stars that helium-burning occurs and it is the smaller stars, and the gas giant planets, that are associated with the heavier nuclei. Curiously, a (helium-burning) red supergiant star with a typical radius 638 times that of the sun is associated with atomic mass number 4, i.e. with ^{4}He. Perhaps, though, the correlation of stellar radii with the masses of stable atomic nuclei occurs because stable particles in general tend to occupy the levels and low-order sublevels[2] of the Planck sequences and since the stars studied have metastable radii, the corresponding mass values, m_{cr}, will also tend to lie on levels and low-order sublevels.

6. Conclusions

1. Stellar radii and the radii of the solar system's gas giants are correlated by way of the 10D/4D correspondence with the masses of stable atomic nuclei on the levels and sublevels of the Planck sequences.
2. Mass values calculated from the radii of twin stars (defined as binary partners of similar size) are arranged symmetrically about mass levels and sublevels in the Planck sequences, as are the quarks and hadronic isospin doublets.
3. The Sun has a twin: Tau Ceti.
4. Together with its twin, the sun is associated with atomic mass number 56: that of the stable ^{56}Fe nucleus.
5. Mass values calculated from the radii of the Sun and Tau Ceti, and also Alpha Centauri A and B, are arranged symmetrically about the superlevels of the Planck sequences, as are the quark masses. The two pairs of twin stars are associated with two nearly-coincident mass superlevels, as is each quark doublet.

[2] Half-levels and quarter-levels are of low-order.

7. References

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