GPS Satellite Clocks Clock Rates Adjusted for Inertial Motion and Gravitational Motion

By James Carter

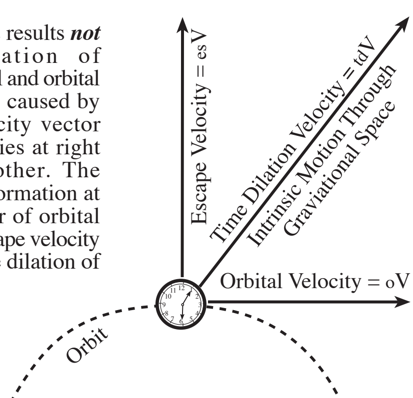
In the 1980s, it was discovered that atomic clocks run at different rates in different orbits. Clocks run slowest in low space shuttle orbits and then run faster and faster in higher and higher orbits until, at an orbit of about 1.5 times Earth's radii, they surpass the rates of sea level clocks. Physicists were able to use the equations of Einstein's special and general theories relativity to calculate the correct rates for orbiting clocks but these equations were based on unmeasured metaphysical assumptions of relative motion. It is shown here that the same accurate calculations can be made using physical principles of measurements of absolute motion.

It is obvious and simple physics that clocks must change the length of their measured intervals as the mass of their component parts change. A clock's time interval is based on its conservation of angular momentum. Consider the 24 hour clock of the rotating Earth. If Earth could be accelerated to a higher velocity, its mass would increase and it would slow its rotation in order to conserve its angular momentum. This is true for any rotational clock regardless of the design of its mechanism.

The beauty of satellite clock measurements is that they combine the satellite clock's inertial orbital velocity and its gravitational escape surface velocity to form the single vector of absolute motion for the Lorentz transformation of the clock's mass and time. Thus, there is no need for metaphysical assumptions and undetectable parameters such as the potentials of a gravitational field or the invention of a four-dimensional spacetime continuum. Changes in satellite clock rates are the result of the Lorentz transformations in mass. As a clock's mass and momentum is increased, it rate slows due to the conservation of angular momentum.

Orbiting Atomic Clock Rate Equations

Orbital time dilation results ***not*** from a combination of gravitational potential and orbital motion. Rather, it is caused by the combined velocity vector ($_{td}V$) of two velocities at right angles to one another. The Lorentz mass transformation at the combined vector of orbital velocity ($_oV$) and escape velocity ($_{es}V$) causes the time dilation of orbiting clocks,



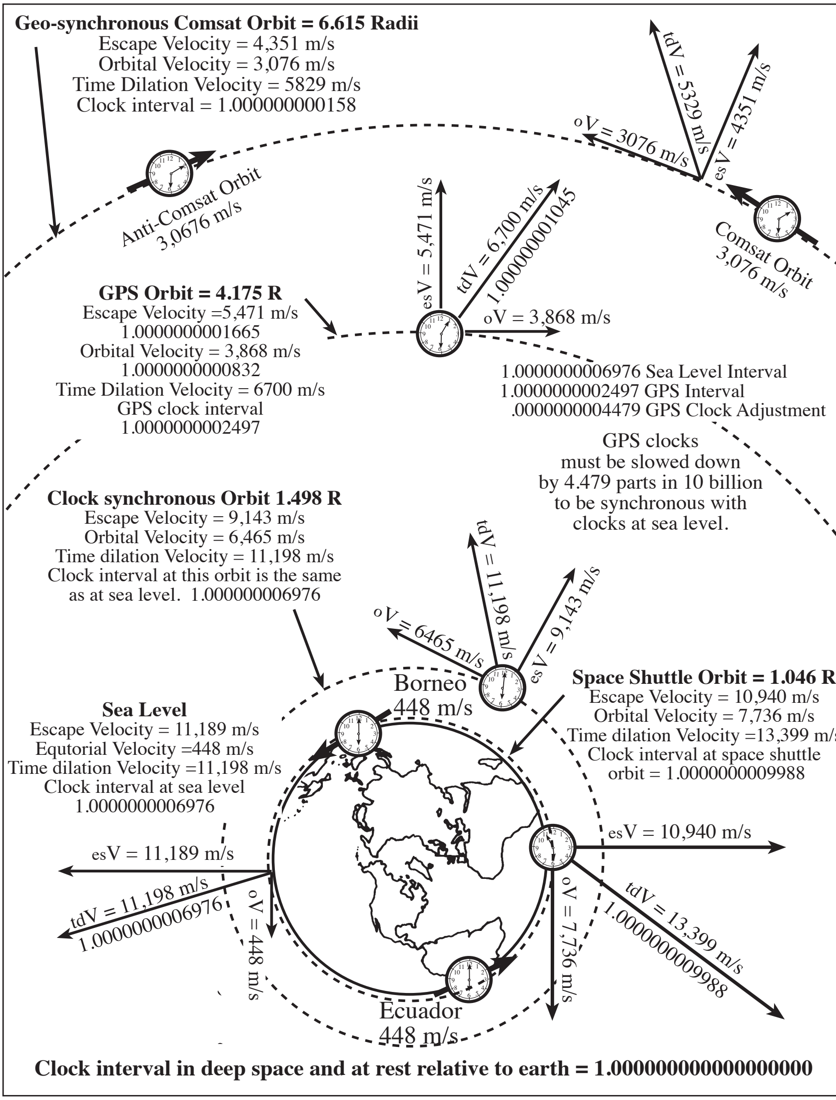
$$_{td}V = \sqrt{_{es}V^2 + {_o}V^2}$$

Time dilation velocity ($_{td}V$) of an orbit is equal to the square root of the sum of the escape velocity squared ($_{es}V^2$) and the orbital velocity squared ($_oV^2$).

$$T_k = \frac{T_0}{\sqrt{1 - \frac{_{es}V^2 + {_o}V^2}{C^2}}}$$

A clock's kinetic time interval (T_k) is equal to its rest time interval (T_0) divided by the square root of one minus the escape velocity squared ($_{es}V^2$) plus the orbital velocity squared ($_oV^2$) divided by the speed of light squared (C^2).

Orbiting Clocks



GPS Time Dilation Equations

Newton Escape Velocity

$$_{es}V = \sqrt{\frac{2GM}{R}}$$

Absolute Motion Time Dilation

$$T_k = \frac{T_0}{\sqrt{1 - \frac{V^2}{C^2}}}$$

Special Relativity Time Dilation

$$T_k = \frac{T_0}{\sqrt{1 - \frac{V^2}{C^2}}}$$

General Relativity Time Dilation

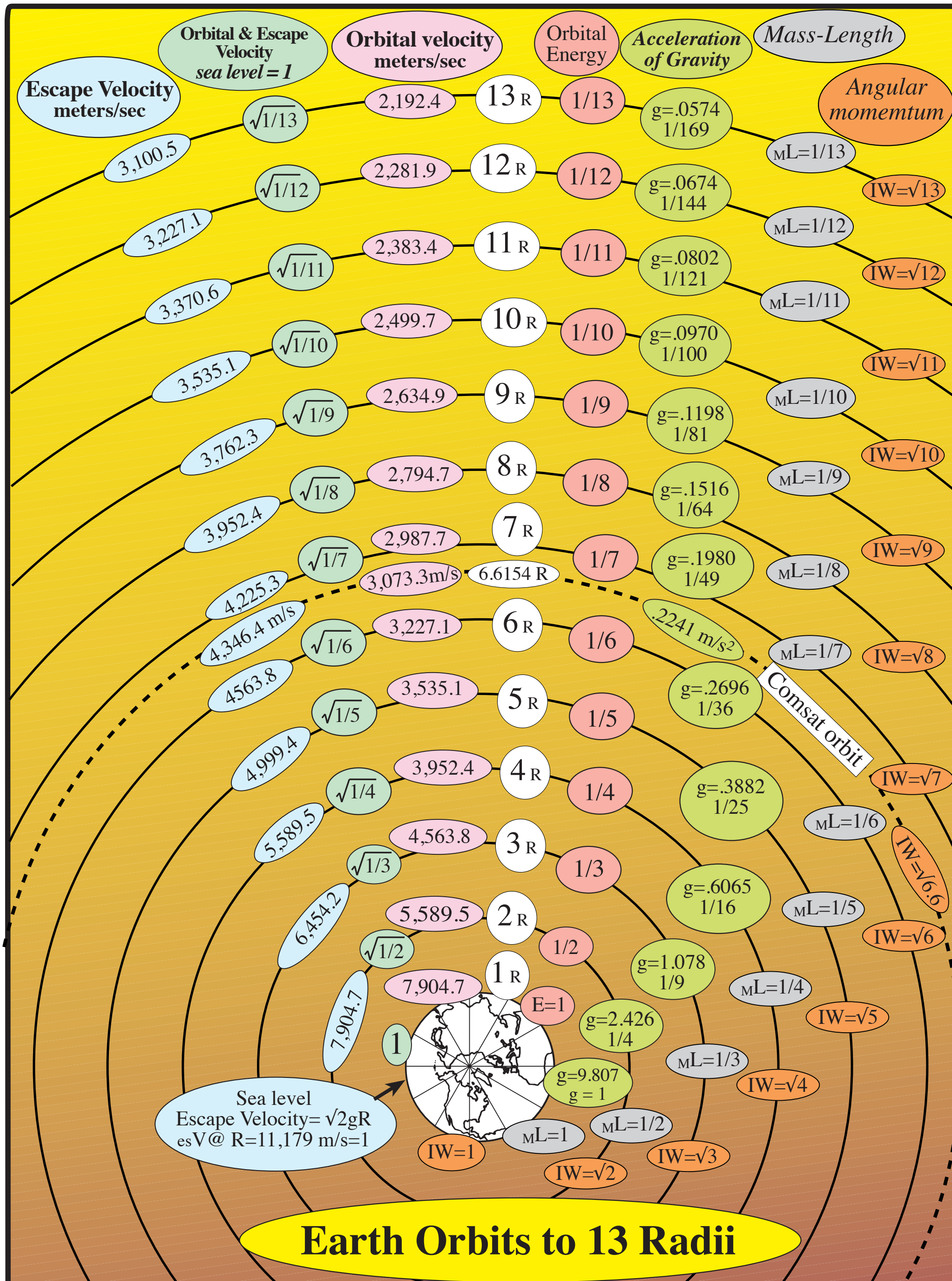
$$T_k = \frac{T_0}{\sqrt{1 - \frac{2GM}{RC^2}}}$$

Absolute Motion Gravitational Time Dilation

$$T_k = \frac{T_0}{\sqrt{1 - \frac{_{es}V^2 + {_o}V^2}{C^2}}}$$

Escape velocity ($_{es}V$) is equal to the square root of two times the gravitational constant (G) times the mass of the earth (M) divided by the distance to the earth's center (R).

The duration of an interval of Kinetic Time (T_k) measured by a clock experiencing gravitational acceleration is equal to the duration of an interval of Inertial Time (T_0) measured by a clock at rest in deep space divided by the square root of one ($\sqrt{1}$) minus the escape velocity squared ($_{es}V^2$) plus the orbital velocity squared ($_oV^2$) divided by the speed of light squared (C^2).


Escape Velocity meters/sec
Orbital & Escape Velocity sea level = 1
Orbital velocity meters/sec
Orbital Energy
Acceleration of Gravity
Mass-Length
Angular momemtum
3,100.5
√1/13
2,192.4
13 R
1/13
g=.0574 1/169
ML=1/13
IW=√13
3,227.1
√1/12
2,281.9
12 R
1/12
g=.0674 1/144
ML=1/12
IW=√12
3,370.6
√1/11
2,383.4
11 R
1/11
g=.0802 1/121
ML=1/11
IW=√11
3,535.1
√1/10
2,499.7
10 R
1/10
g=.0970 1/100
ML=1/10
IW=√10
3,762.3
√1/9
2,634.9
9 R
1/9
g=.1198 1/81
ML=1/9
IW=√9
3,952.4
√1/8
2,794.7
8 R
1/8
g=.1516 1/64
ML=1/8
IW=√8
4,225.3
√1/7
2,987.7
7 R
1/7
g=.1980 1/49
ML=1/7
4,346.4 m/s
3,073.3m/s
6.6154 R
.2241 m/s²
Comsat orbit
IW=√6.6
4563.8
√1/6
3,227.1
6 R
1/6
g=.2696 1/36
ML=1/6
IW=√7
4,999.4
√1/5
3,535.1
5 R
1/5
g=.3882 1/25
ML=1/5
IW=√6
5,589.5
√1/4
3,952.4
4 R
1/4
g=.6065 1/16
ML=1/4
IW=√5
6,454.2
√1/3
4,563.8
3 R
1/3
g=1.078 1/9
ML=1/3
IW=√4
7,904.7
√1/2
5,589.5
2 R
1/2
g=2.426 1/4
ML=1/2
IW=√3
1
7,904.7
1 R
E=1
g=9.807 g = 1
ML=1
IW=1
IW=√2
Sea level Escape Velocity= √2gR esV@ R=11,179 m/s=1
Earth Orbits to 13 Radii