EARTH ORIENTATION:
DOES SOLAR SYSTEM MOTION MATTER?

HELIOPAUSE
BOW SHOCK
VOYAGER 1
SOLAR WIND
HELIOSHEATH
TERMINATION SHOCK
INTERSTELLAR WIND
VOYAGER 2

A STATIC SOLAR SYSTEM MODEL

Changes in the earth's orientation are measured to VLBI reference points far outside the moving frame of the solar system – yet do not account for motion of that frame.
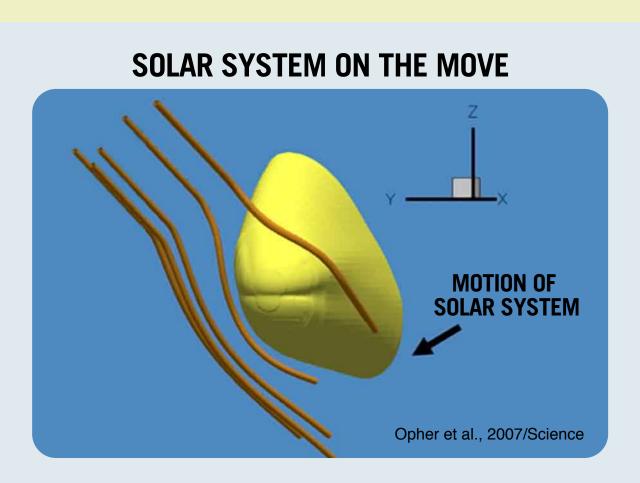
When the lunisolar theory of precession was developed astronomers were unaware the SS moved. SS motion is now accepted, and while its magnitude is unknown, it is artificially constrained by lunisolar theory that requires all changes in earth orientation to be attributed to "local" dynamics. This legacy argument forces a static solar system model, and a quasi pre-Copernican assumption "it does not move".

VERY LONG BASELINE INTERFEROMETRY

QUASAR
NOISE
RADIO TELESCOPE
NOISE
NOISE
HYDROGEN MASER CLOCK
(ACCURACY 1 SEC IN 1 MILLION YEARS)
MARK III · MAGNETIC TAPE · CORRELATOR · MAGNETIC TAPE · MARK III

ACCORDING TO JPL VLBI

"Changes in the Earth's orientation in inertial space have two causes: the gravitational forces of the Sun and Moon and the redistribution of total angular momentum among the solid Earth, ocean, and atmosphere. VLBI makes a direct measurement of the Earth's orientation in space from which geoscientists then model such phenomena as atmospheric angular momentum, ocean tides and currents, and the elastic response of the solid Earth."

METHODOLOGY IGNORES MOTION OF THE MOVING FRAME

SOLAR SYSTEM ON THE MOVE

MOTION OF SOLAR SYSTEM

Cipher et al., 2007/Science

Our solar system flies through space in the shape of a speeding bullet, according to data from NASA's two Voyager spacecraft.

WHAT ARE WE OBSERVING?

The observable of the stars moving across the sky at approximately 30 degrees per month is obviously due to orbital motion - the earth's orbit around the sun. Could the observable of the stars moving retrograde across the sky at the rate of about 30 degrees per 2000 years, (a.k.a. the precession of the equinox) also be due mainly to orbital motion; the orbit of our solar system around another star?

If so, it would produce the observable we now call the "precession of the equinox" yet have little to do with local dynamics. (See Possible Kepler Solution)

If this is the case then the observable of the stars moving across the sky at 50+"p/y (a.k.a. precession) may actually contain some geometric effect (similar to parallax) – as seen from a moving SS. According to the USNO, this type of observable could be seen from any planet that is part of a binary or multiple star system. The motion of the stellar system around its common center of mass would cause a change in orientation to points outside that moving frame commensurate with the periodicity of the binary orbit, plus or minus local effects.

PARALLAX OR PRECESSION?

The observable known as precession may include a component of geometric effect - seen from a moving solar system.

RATE INCREASING
RATE DECREASING
APOAPSIS
3500 AD
2500 AD
1500 AD
500 AD
500 BC
1500 BC
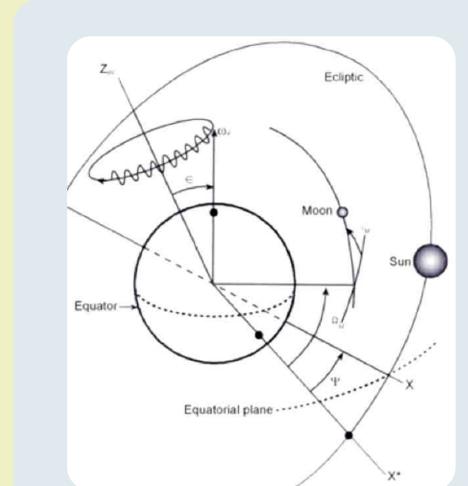2500 BC

PROBLEMS WITH CURRENT THEORY

The history of the lunisolar precession model suggests something is wrong: Newtons' equations did not work. D'Alembert and others since have added and changed input values until they fit the observable of approximately 50" p/y. Designed to fit the data they appear accurate but lack predictability.

Consequently the model has been changed repeatedly over the last few hundred years and now (the 2000A version) includes almost 1400 terms yet it still fails to accurately predict "changes" in the precession rate. While the continued revisions are written to get us ever closer to the observed number they have failed a key test: dynamic equivalence.

In 2006 the IAU declared the precession nutation model is **"not consistent with dynamical theory"** (IAU P03).

SEPARATING THE COMPONENTS

Nutation is obviously driven by local dynamics as its 18.6-year signature reflects the timing of the moon's orbit parameters. And Chandler wobble and other short-term polar motions would also appear to have a basis in local dynamics.

NUTATION IS LOCAL - PRECESSION MAY NOT BE

But all of these are relatively small compared to the 50+"p/y precession observable, which causes the tropical year to differ from the sidereal year by more than 20 minutes. This delta is comparable to the delta we see between the tropical day and sidereal day due to the earth's orbital motion.

SIDEREAL / TROPICAL DAY DELTA - EARTH

4 MIN x 365 = 1 ROTATION

STAR OVERHEAD
SUN AND STAR OVERHEAD
0.986° SUN OVERHEAD
DAY 2
DAY 1

SIDEREAL / TROPICAL YEAR DELTA - SUN

20 MIN x 25,700 = 1 REVOLUTION

STAR OVERHEAD
1.397°
TOWARD CENTER OF MASS
2100 AD
STAR OVERHEAD AND TOWARD CENTER OF MASS
2000 AD

BINARY MODEL - KEPLER SOLUTION

An observer on a planet in a binary system would notice a change in orientation at a rate commensurate to the orbit period around the common center of mass. (USNO)

With minor local effects and no eccentricity, this type of change in orientation at 50" p/y would equate to an orbit periodicity of 25,920 years. (1,296,000/50 = 25,920).

At 54" p/y, again with minor local effects and no eccentricity, this type of change in orientation would equate to 24,000 years (1,296,000/54 = 24,000).

In 1894, about the same time that the great astronomer Simon Newcomb gave us a precession formula with a constant of .000222 p/y (designed to predict changes in the precession rate), an Indian astronomer, Sri Yukteswar, explained that the moving equinox (precession) was a result of a moving solar system and he gave us a binary orbit periodicity of 24,000 years, with apoapsis at 500 A.D. Thus, one scientist gave us a strictly local dynamics model and the other a strictly non-local dynamic SS model. **Which model was more accurate over the next 100 years?**

100 YEAR TEST

From Yukteswar's orbit parameters, and utilizing the same rate of change numbers that Newcomb used for the period before 1900, we can apply Kepler's laws to Yukteswar's orbit data (constrained by a 24,000 year orbit period and apoapsis at 500A.D.) to come up with a forced eccentricity and expected rate of change for the 100 year period between 1900 and 2000 of .000349"p/y.

Yukteswar = .000349 "p/y

Newcomb = .000222 "p/y
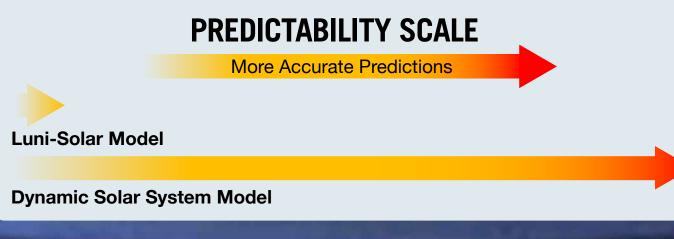
The actual rate of change for the precession observable (or change in angular velocity traveled by the solar system along its binary orbit path in the dynamic SS model – seen as parallax) was .000346"p/y.

.000346 - .000349 = .000003"
.000346 - .000222 = .000124"
.000124 / .000003 = 41

Comparing Yukteswar's and Newcomb's predictions to the actual we find the dynamic SS model to be **41 times more accurate** than the lunisolar precession model over the last 100 years.

PREDICTABILITY SCALE

More Accurate Predictions
Luni-Solar Model
Dynamic Solar System Model

PRECESSION RATE TRENDS ANALYSIS - LAST 100 YEARS

The first nine points are from Newcomb (or use Newcomb's methodology) and the last three are from the Astronomical Almanac. The red line is a plot of the rate of increase (in arc length) required for a body in a 24,000 year orbit (Dynamic Solar System Model). Note the slope of the red line better fits the long term precession observable.

Change in arc length travelled p/y by a body in a 24,000 year elliptical orbit from 1700 AD to 2100 AD.

Change in arc length traveled p/y by a body in a 24,000 year elliptical orbit from apoapsis, 500 AD, to periapsis, 12,500 AD.

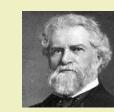Rate should range from a low of about 50" p/y to a high of about 62" p/y.

IMPLICATIONS

Given the fact the moving solar system model can create all the same observables of the change in orientation called "precession", and given the fact a moving solar system model is a more accurate predictor of changes in the rate of reorientation, we have to seriously consider if there might be something wrong with lunisolar dynamics.

One possibility is that the moon causes nutation, but the sun may have no effect on the oblate earth at the time of the equinox (when the sun's gravity acting on the oblate spheroid is equalized), and the slight tug that peaks on the solstices may be offset by a third body aligned in the solstial direction. If this is correct then the major forces are accounted for, but they result mainly in nutation, requiring much of the so called precession observable to have another cause – solar system motion.

A dynamic SS model addresses many problems:

Solves precession observation paradox. Understanding the SS is a moving frame explains the difference in precession measurements to local objects vs. VLBI measurements to distant objects.

Explains why the precession rate change is presently increasing (even though the moon is not getting any closer) and puts limits on the maximum and minimum precession rate over any given 24,000 year cycle.

Provides a simple, reliable and accurate way to predict incremental changes in the precession rate. Solves predictability problem.

Simplifies earth orientation and coordinate systems issues: the earth goes around the sun 360 degrees in a tropical year with a relatively stable axis (except for nutation and purely local effects). Most of its major motion (50.290966 "p/y in J2000) is because the solar system moved by this amount NOT because the earth wobbled by this amount.

It might also answer the sun's loss of angular momentum (AM) relative to the planets problem and possibly shed light on anomalous acceleration of spacecraft flybys, Gravity Probe B problems, Voyager 1 and 2 results, IBEX data, stellar position software, etc.
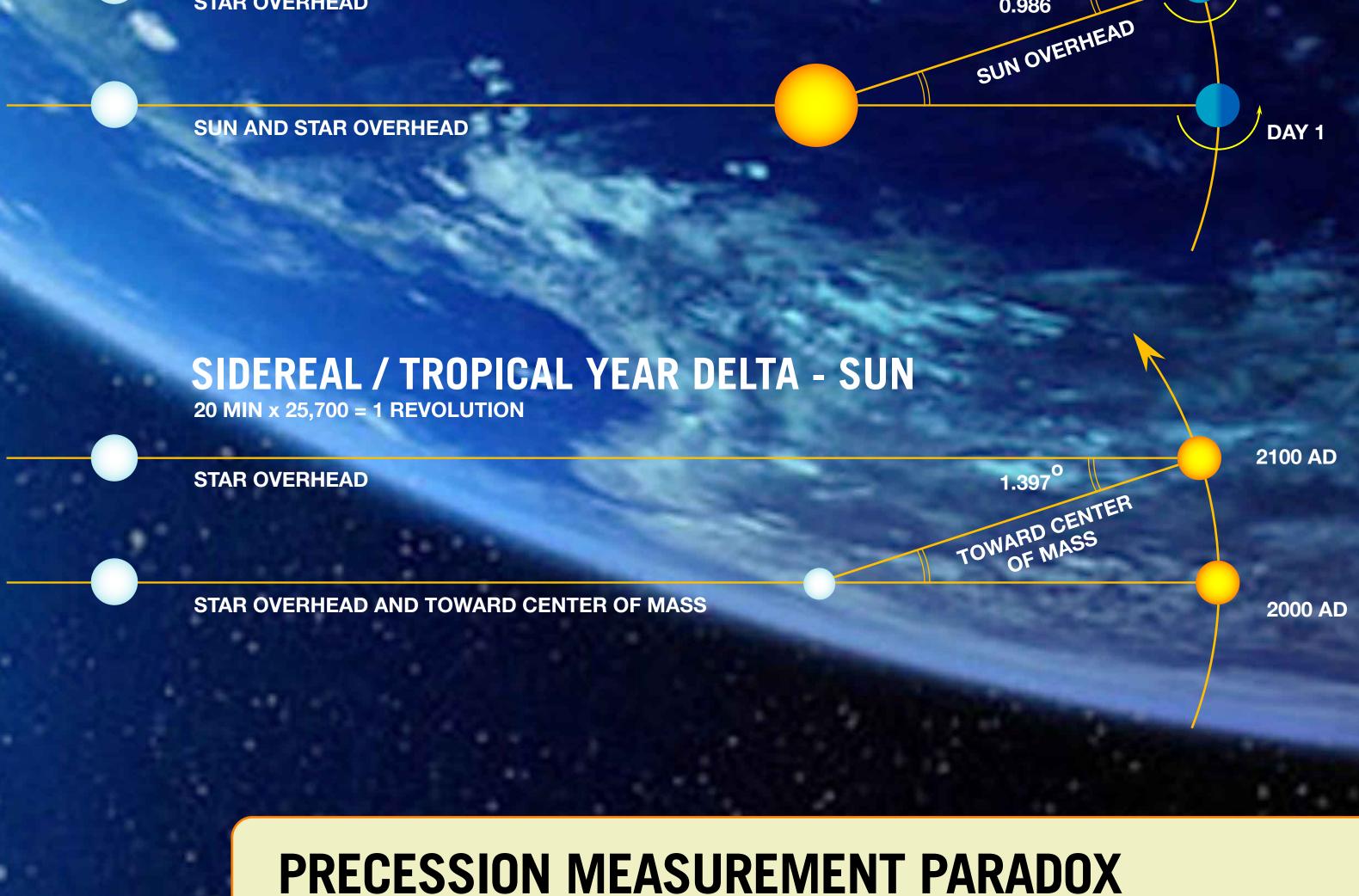
CONCLUSION

Motion of the frame of the solar system must be accounted for when measuring changes in the earth's orientation to points outside that moving frame.

The observable of the stars moving across the sky by about 30 degrees per 2000 years (a.k.a. precession) is most likely a geometric effect like parallax (due to the motion of the SS), having very little to do with local dynamics. With this knowledge the precession nutation model can be simplified and problems can be solved.

Most will argue that a dynamic SS model cannot be taken seriously until the cause of its motion is found (a companion star?). But given the far greater accuracy of this model we should not ignore the advice of a certain 16th century astronomer that once said:

"E pur si muove"

PRECESSION MEASUREMENT PARADOX

Studies show that changes in earth's orientation relative to objects "inside" the SS (i.e. Sun, Moon, Venus, etc.) are negligible (less than an arc second or two p/y), whereas changes in earth orientation relative to objects "outside" the moving frame of the SS (fixed stars, quasars, etc.) are over 50"p/y. In fact, rotation time equivalence studies and lunar studies show the earth hardly "precesses" at all relative to objects within the SS.

Most astronomers acknowledge this in practice by using a non-precessing tropical frame to locate objects "inside" the SS, whereas they require a precessing sidereal frame (or T[J2000]+PxY) to find objects "outside" the moving SS.

ROTATION-TIME EQUIVALENCE

365.24219878 x 86400s = 366.24219878 x 86164.0905382s = 31,556,925.97s

This equation describes Earth's complete 360° period of revolution of 31,556,925.97s relative to a fixed frame of reference, implying that the position of the vernal equinox remains fixed with respect to the orientation of Earth's axis in space. The total number of rotations of Earth in such a complete orbit is expressed by the equations:

1 ÷ (1- (86164.0905382 s ÷ 86400 s)) = 366.24219878

86400 s ÷ 235.9094618 s = 366.24219878

No precession with respect to the SS frame.