

# 2012

## THE END:

Gregorian: 11:11 UT, 21 December  
Long Count: 13.0.0.0.0 (Bak'tun 13)  
Calendar Round: 4 Ajaw 3 K'anin



*Movie poster for '2012', released in November 2009. The movie features worldwide tectonic activity and natural disasters, triggered by neutrinos emitted by the Sun during a massive solar flare.*

<http://www.youtube.com/watch?v=1jDhMQqggpw&feature=related>

# Will the World End in 2012?

- 'Doomsday' rumors have been proliferating recently -- fueled by books, TV programs, movies, web sites
- Most rumors cite the 'end' of the Mayan 'Long Count' calendar on 2012 Winter Solstice, 21 December
- Doomsday scenarios include:
  - <http://www.youtube.com/watch?v=vgM65EOfyGU&lohs320=ThisIsTheEnd+YoutubeAnimation>
  - Collision of a rogue planet with Earth (Nibiru/Planet X)
  - Planetary alignment
  - Galactic alignment
  - Violent solar storms
  - Sudden geomagnetic reversal
  - 'Earth crust displacement': Sudden violent shifting of continents and poles
- New Age interpretation: 'cosmic shifting' -- spiritual transformation of human consciousness



*Artist rendition of two planets undergoing a catastrophic collision. Such collisions do happen in planetary systems, but are highly unlikely after the system has formed.*

**NO!!!**

# Mayan Civilization

- Preclassic (c. 2600 BCE – 250 CE)
  - Mythical creation date: 11 August, 3114 BCE
  - Earliest occupation, c. 2600 BCE
  - 1<sup>st</sup> clearly Mayan settlements, c. 1800 BCE
  - Development of mid-size communities
  - 1<sup>st</sup> written hieroglyphics (c. 250 BCE)
  - Overlap with other Mesoamerican civilizations (Toltec, Olmec, Zapotec, Mixtec)
  
- Classic (c. 250 CE – 900 CE; Bak'tun 8-10)
  - Large-scale architectural construction & urbanism, intellectual & artistic development, religion, intensive agriculture
  - Independent city-states, rather than centrally administered empire (Aztec, Inca)
  - Notable temples & monuments include stepped pyramids – religious centers, palaces of rulers
  - Astronomy: Numerous calendars used including 'Long Count'; Dresden Codex – contains highly accurate astronomical tables
  - Long-distance trade with other Mesoamerican cultures (Teotihuacán, Zapotec) & non-Mesoamerican groups (Tainos in Caribbean)
  - Traded goods: cacao, salt, sea shells, jade, obsidian



# Mayan Civilization

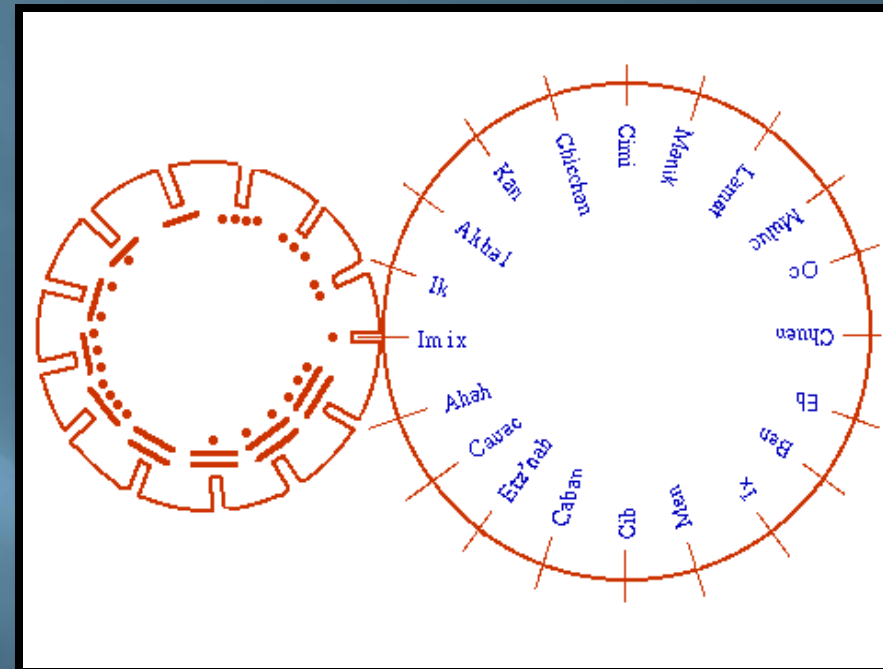
- Collapse (southern lowlands, c. 900 CE)
  - Overpopulation
  - Carrying capacity exceeded -- population growth outstripped available resources
  - Deforestation
  - Soil erosion & depletion
  - Chronic warfare among kingdoms
  - Civil war within kingdoms
  - Peasant revolt
  - Climate change -- 200 year period with multiple episodes of severe droughts
  - Malnutrition, starvation, disease
  
- Postclassical (c. 900 CE – early 16<sup>th</sup> century CE)
  - Development in northern centers persisted
  - Mayan cities of northern lowlands flourished
  - Increasing diversity of external influences
  - Spanish conquest: 16<sup>th</sup> – 17<sup>th</sup> centuries



*Temple in Tikal*

# Mayan Calendars

- Mayan concepts of time
  - Cyclical nature
  - Rituals & ceremonies closely associated with terrestrial & celestial cycles which Maya observed & inscribed as separate calendars
- Tzolk'in ('Sacred Round')
  - 260 days: 13 months, 20 days/month
  - Interlocking 13 & 20 day cycles produce 260 day sacred year
  - Used to determine time of religious & ceremonial events, also for divination
- Haab' ('vague year')
  - Civil year
  - 365 days, 'vague': does not include a leap year
  - 18 months, 20 days/month + 5 nameless days at end of year 'Wayeb' -- 'dangerous time'
  - Ignored approximate extra quarter day/year, seasons wandered with respect to calendar year
  - Equivalent to Egyptian wandering 365 day year
  - Julian calendar more accurate
- Other calendars
  - Lunar series
  - Synodic period of Venus
  - Nine lords of the night


















## The Calendar Round

- Combination of a Tzolk'in date & Haab' date
- 52 Haab' or solar year cycle (18,980 days)
- End of calendar round: period of unrest & bad luck; Maya waited to see if gods would grant another 52 year cycle
- 'Long Count' calendar devised to measure dates longer than 52 years

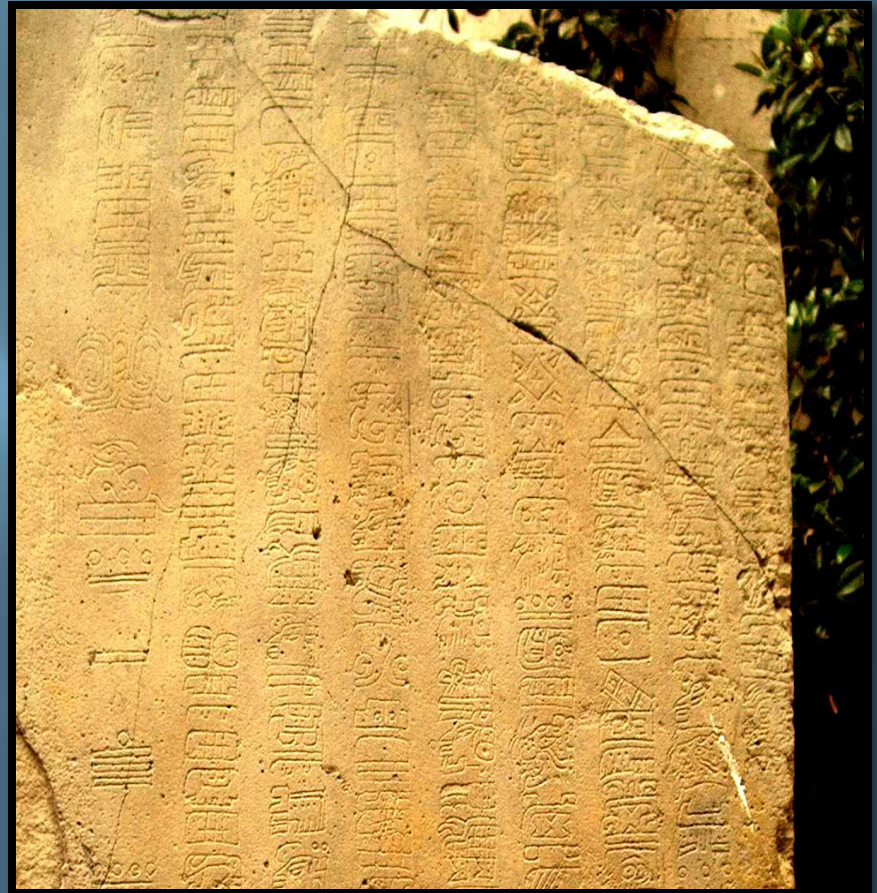
# Long Count Calendar

- Used by Maya during classic period – likely invented by Olmec, possibly Zapotec or Mixtec
  - Linear through Mayan history
  - Greater cycle: ‘The Great Circle’
  - Base 20 (vigesimal)
- Zero or Creation Date: 11 August, 3114 BCE -- Long Count date: 13.0.0.0.0
- 21 December, 2012:13.0.0.0.0
  - Completion of Bak’tun 13 (*Pik*); calendar partly ‘resets’
  - 1,872,000 days, 5126 years
  - Like New Year’s when both day & month reset; 13 (of at least 20) Mayan time increments reset
  - Just another day – life goes on...
- Google App:
  - <http://www.azteccalendar.com/downloads.html>
- NY Times App:
  - <http://www.nytimes.com/interactive/2009/11/16/science/20091116-maya.html>

	Symbolic Variant	Head Variant	Head Variant	
B'aktun				144,000 days (20 K'atuns)
K'atun				7200 days (20 Tuns)
Tun				360 days (18 Winal)
Winal				20 days (20 kins)
K'in				1 Day

# Long Count Calendar

- Mayans recorded recurring astronomical events relating to the Sun, Moon, & five visible planets
  - Did not predict natural disasters or undiscovered astronomical objects
  - Did not predict the collapse of their own civilization or rise of later empires (Aztec, Inca) or subsequent conquest by Spanish
- Significance of Bak'tun 13 to classic Maya uncertain; no prophetic declarations
  - Possibly a time of celebration
  - Tortuguero Monument 6: Sole reference to Bak'tun 13 as 'end date' – not prophetic
  - Priest timekeepers at Palenque believed cycle would end after 20 Bak'tun, not 13
  - Present day Maya attach no significance to this date; they have practical concerns, like when will it rain
- Other 'Long Count' cycles: Piktun, Kalabtun, K'inchiltun, Alautun
  - Allows dates trillions of years into past or future
  - Maya not concerned about a specific end date

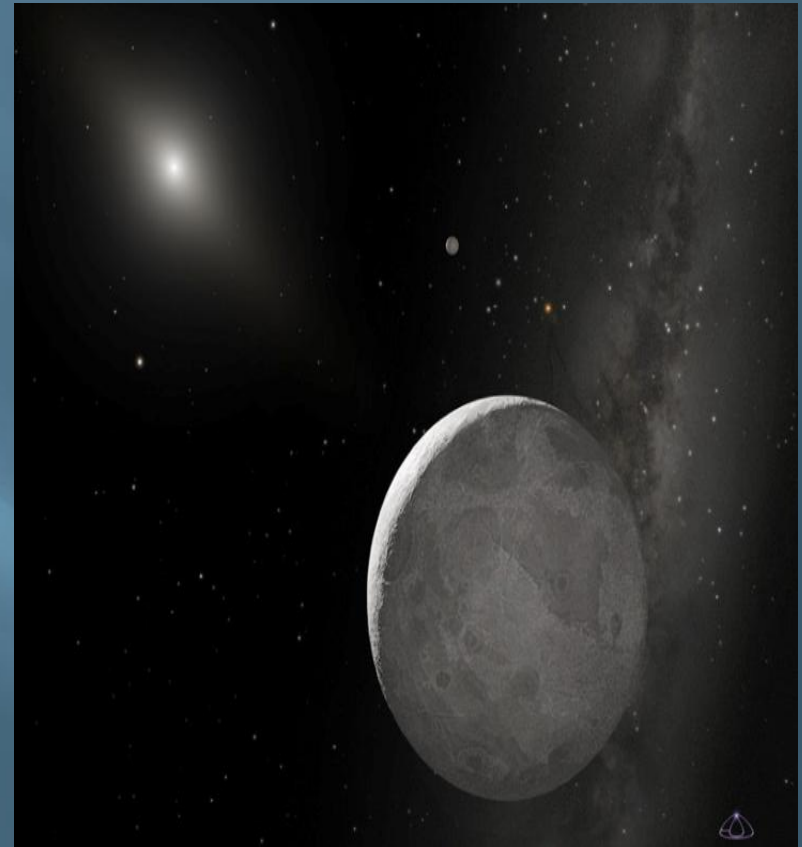


*Photo of a 'Long Count' calendar*



# Nibiru/Planet X

- There is no known 'Planet X' that will impact Earth in the near or far future
  - According to legend, Nibiru discovered by ancient Sumerians (not really)
  - Catastrophic collision with Earth originally forecast for May 2003
  - When nothing happened, doomsday date was advanced to 2012 winter solstice
  - Merging of 2 fables
  - A few Pluto-like dwarf planets have been discovered in our outer solar system recently; none have orbits that bring them inside ~ 35 AU
  - A planet headed toward Earth would be easily visible
  - Given alleged characteristics of Nibiru's orbit:
    - ❖ Current position: 7 AU from Sun
    - ❖ Current magnitude: 4.5 (Earth sized object)
  - Conspiracies in astronomy are nearly impossible given the large number of highly skilled amateurs who regularly pioneer new discoveries
  
- For more information:
  - <http://www.astrosociety.org/2012/index.html>



*Artist's conception of dwarf planet Eris. From NASA / ESA / A. Schaller*

# Galactic Alignment

- 'Black Road' (*John Major Jenkins, 1990s*)
  - Claim: Sun precisely aligns with intersection point of ecliptic plane & 'Black Road' (near center of Milky Way galaxy) on 21 December, 2012
  - Jenkins claimed classical Mayans anticipated this conjunction & celebrated it as the harbinger of a profound spiritual transition for mankind
  
- Nothing special about so-called alignment
  - Earth-Sun aligns (approximately) with galactic center every winter solstice for past 1,000 years
  - Ecliptic: Apparent path of Sun & planets across the sky over course of year
  - Zodiac: 12 constellations (13 really) lining ecliptic through which Sun appears to pass each year
  - Spring Equinox: Pisces ('Age of Pisces')
  - Winter Solstice: Sagittarius – zodiac constellation intersected by galactic center
  - Sagittarius A\*: Supermassive black hole ( $4 \times 10^6$  solar mass) 26,000 ly from Earth – much too far away to have any possible effect

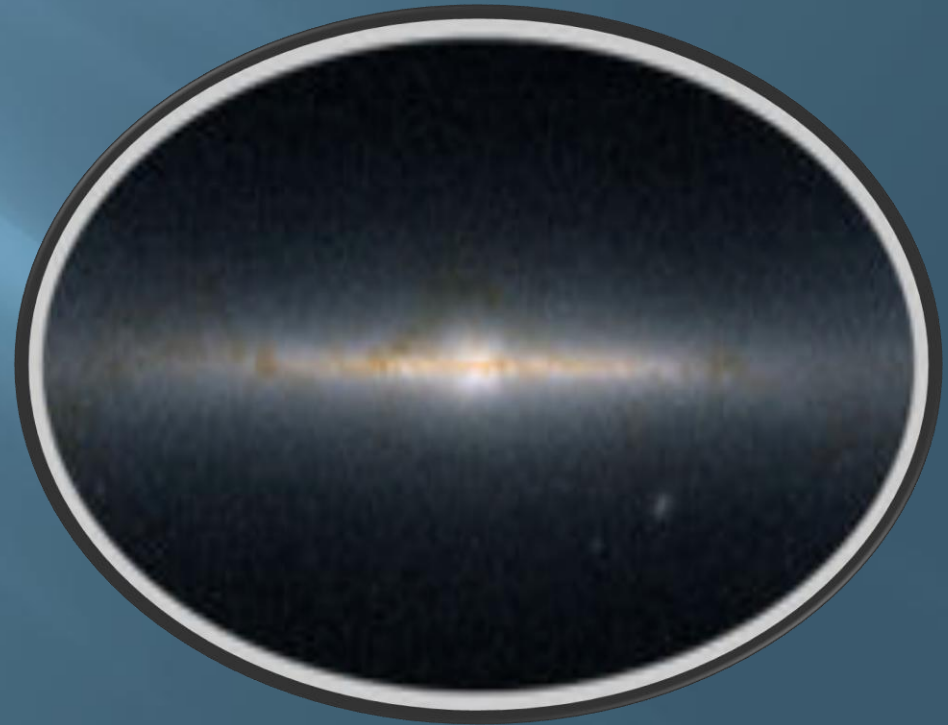


*The Milky Way near Cygnus showing the lane of the Dark Rift, which the Maya called the Xibalba be or 'Black Road'*



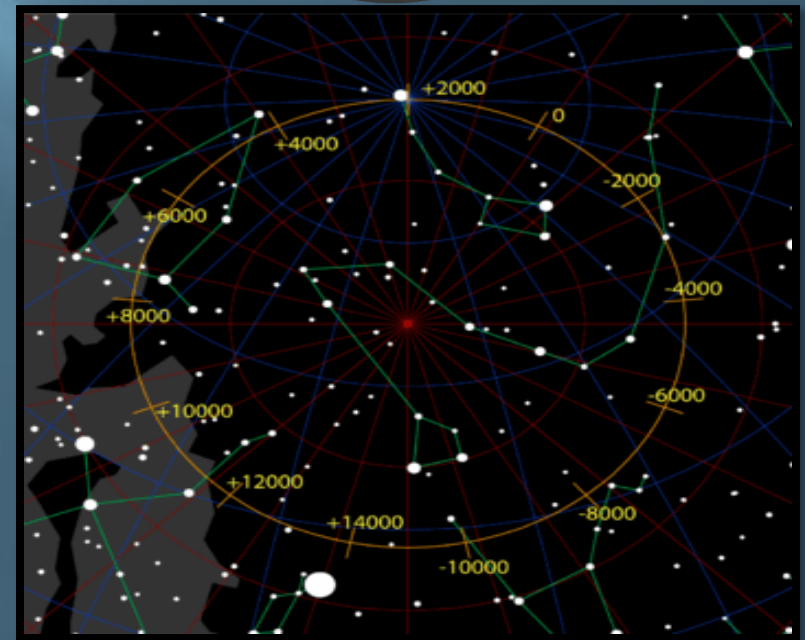
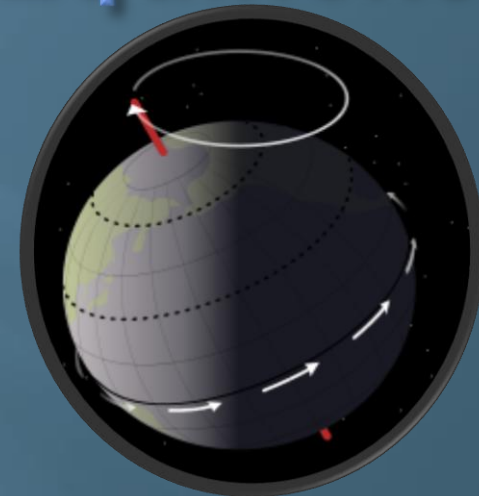
# Galactic Alignment

- Galactic equator
  - Arbitrary line -- no way to precisely determine position
  - Where does galaxy begin & end?
  - Precessional alignment of Sun is not a point but takes place over 36 years due to Sun's diameter
  - By Jenkins own account, most precise convergence of Sun with line of galactic equator occurred in 1998
  
- *"Clearing Up the Sky of 2012"*, James Smith

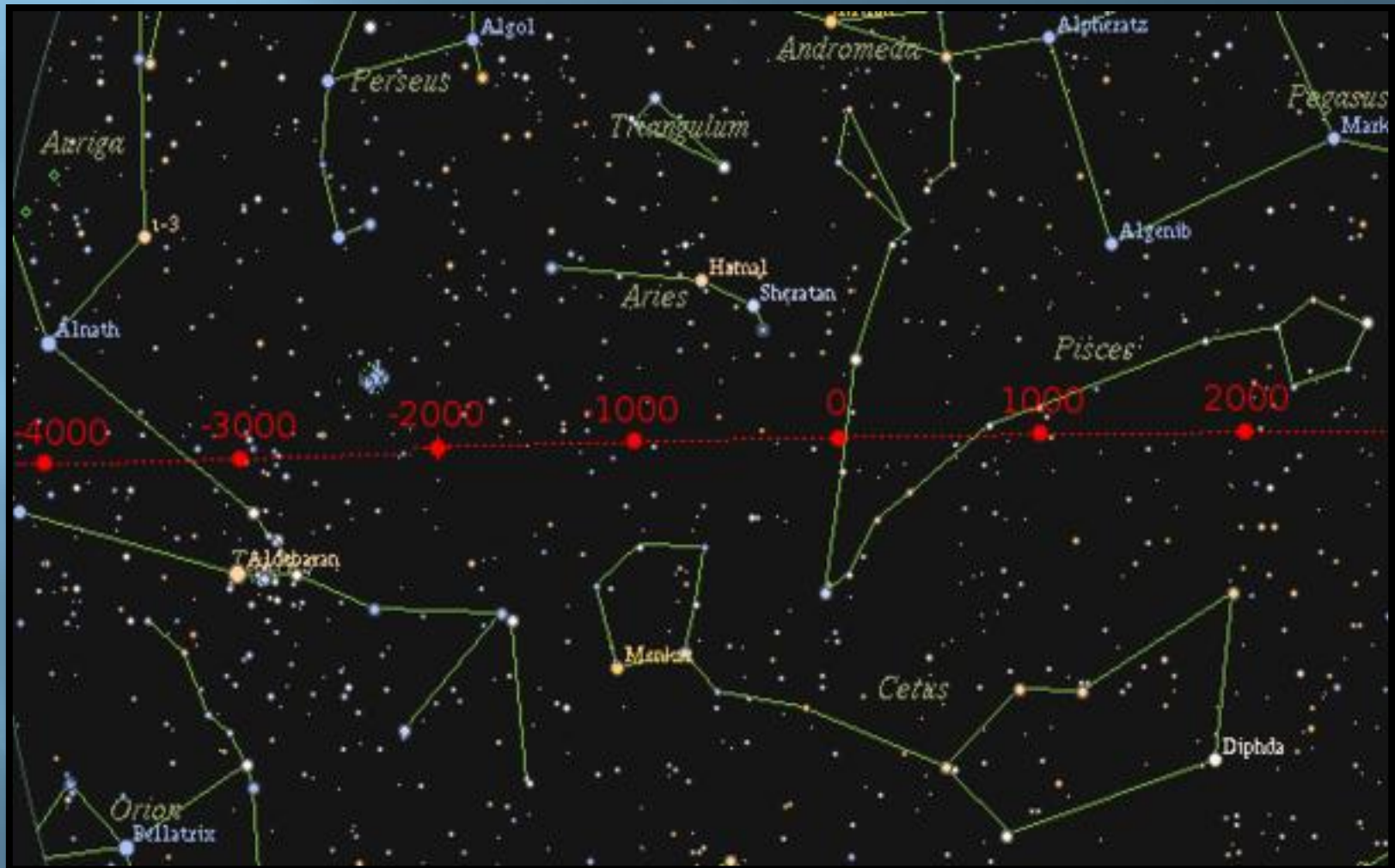


# Precession of the Equinoxes

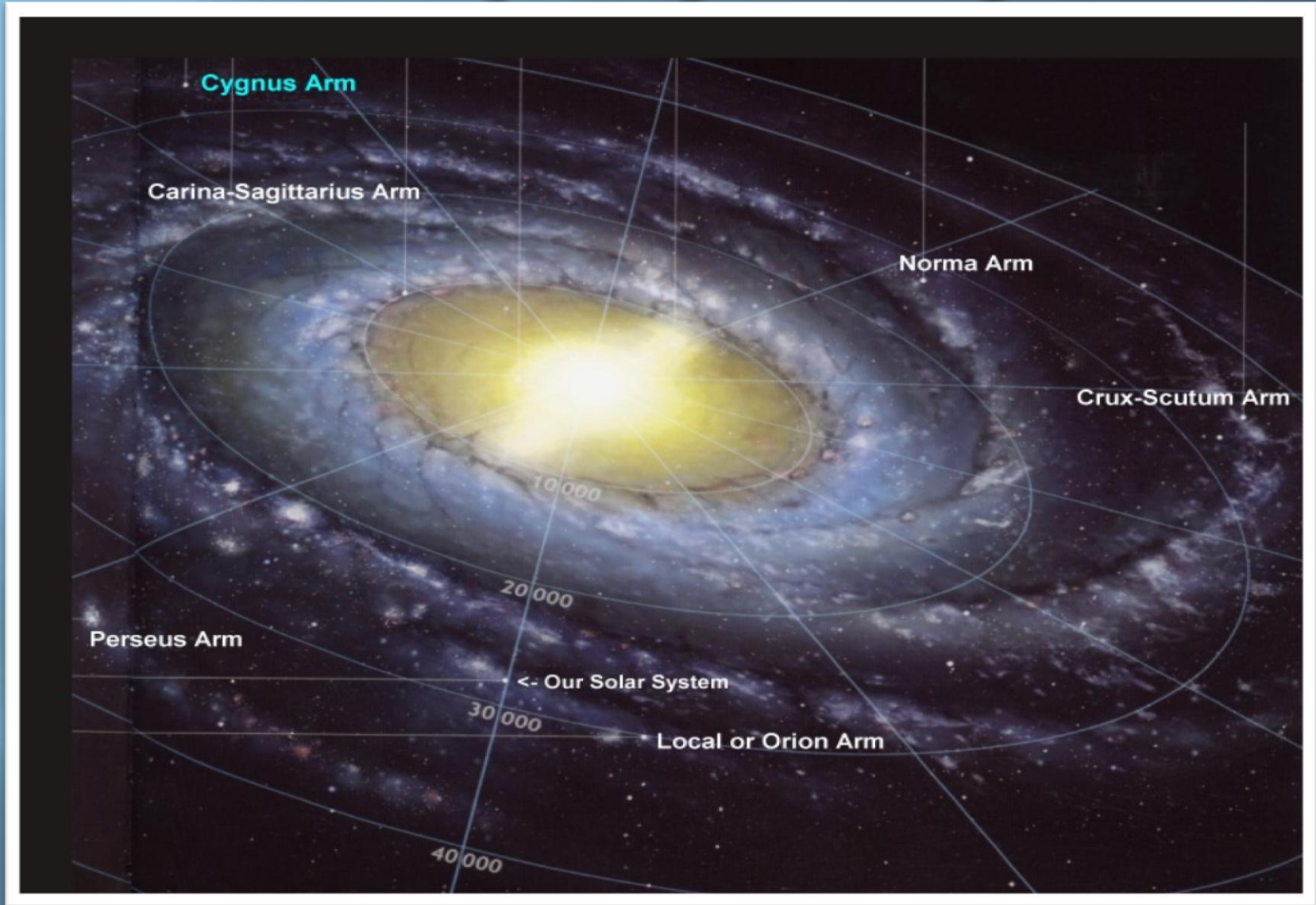
- Slight wobble in Earth's spin axis
  - Earth not quite spherical (oblate spheroid)
  - Gravitational pull of Sun & Moon tugs on Earth's equatorial bulge causing the wobble:  
*<http://www.2012hoax.org/precession>*
  
- Sun's annual passage recedes CCW about  $1^\circ$  every 72 years (from POV of Earth frame)
  - Sun appears to drift westward against background of fixed stars
  - $\approx 2,160$  years for Sun to pass through each zodiac constellation
  - Astrological age
  - 'Age of Aquarius' follows 'Age of Pisces'
  
- $\approx 26,000$  years for precession cycle -- Sun to complete one trip around ecliptic
  - Mayans possibly aware of precession cycle from observations of Pleiades
  - 5 Long Counts  $\approx 26,000$  years
  - Scholarly opinion divided -- most dismiss such claims
  - Maya seldom chose a solstice or equinox to commemorate an important event so unlikely to set an 'end date' at a solstice



# Precession of the Equinoxes



# Milky Way Galaxy



# 2012: Insultingly Stupid Movie Physics

- ❑ Increased output of neutrinos emitted during massive solar flare/coronal mass ejection
- ❑ Neutrinos 'mutate' into nuclear particles & start interacting with matter
- ❑ Causes earth's core to heat rapidly
- ❑ Triggers a catastrophic chain of natural disasters:
  - Super volcanoes
  - Earth crust displacement
  - Geographic pole shifting
  - Geomagnetic pole reversal
  - Worldwide tsunamis

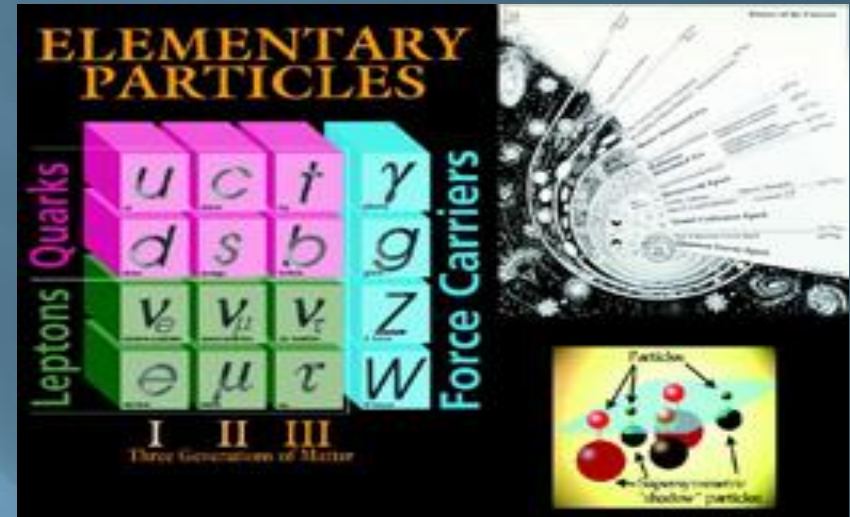


*Solar flare*

# 2012: Insultingly Stupid Movie Physics

## Neutrinos ('ghost particle'):

- Elementary particles (Standard Model)
- 1<sup>st</sup> postulated to preserve conservation laws – energy, momentum, angular momentum
- Properties:
  - Miniscule but non-zero mass
  - Electrically neutral
  - 3 flavors: electron, muon, tau (or lightest, middle, heaviest)
  - Travel near speed of light ( $c = 3.0 \times 10^8$  m/s)
  - Minimal interaction with matter:  $\approx 50$  trillion solar neutrinos pass through your body per second, more from other sources
- Difficult to detect – requires complex experiments
- 50% of solar neutrinos would pass through  $\approx 70$  ly of Pb without interacting with any atoms
- Neutrino oscillation: Oscillate between 3 available flavors, still neutrinos though
- Movie blunders:
  - Neutrinos produced by fusion in sun's core, not at surface in solar flares
  - Neutrinos do not suddenly 'mutate' into nuclear particles ; any such violation of fundamental physics would have been observed by now
  - If neutrinos interacted with & heated matter like microwave as claimed in movie, not just core but everything would be cooked

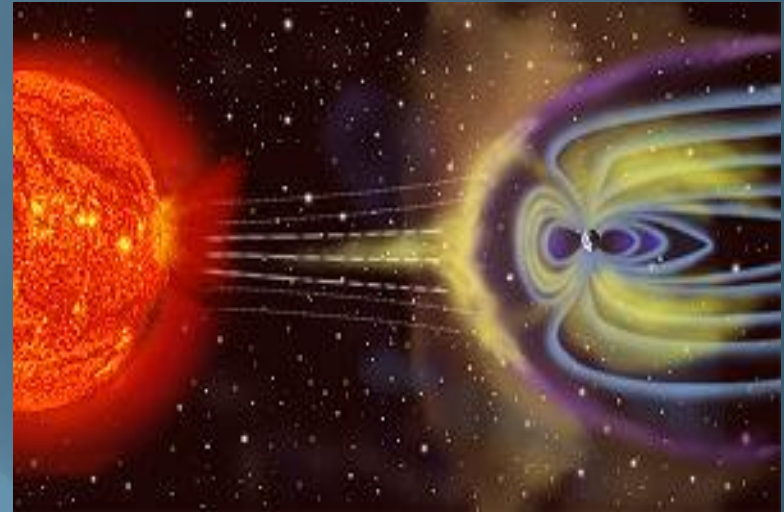


FERMIONS			matter constituents spin = 1/2, 3/2, 5/2, ...		
Leptons spin = 1/2			Quarks spin = 1/2		
Flavor	Mass GeV/c <sup>2</sup>	Electric charge	Flavor	Approx. Mass GeV/c <sup>2</sup>	Electric charge
$\nu_L$ lightest neutrino*	$(0-0.13) \times 10^{-9}$	0	<b>u</b> up	0.002	2/3
<b>e</b> electron	0.000511	-1	<b>d</b> down	0.005	-1/3
$\nu_M$ middle neutrino*	$(0.009-0.13) \times 10^{-9}$	0	<b>c</b> charm	1.3	2/3
$\mu$ muon	0.106	-1	<b>s</b> strange	0.1	-1/3
$\nu_H$ heaviest neutrino*	$(0.04-0.14) \times 10^{-9}$	0	<b>t</b> top	173	2/3
$\tau$ tau	1.777	-1	<b>b</b> bottom	4.2	-1/3

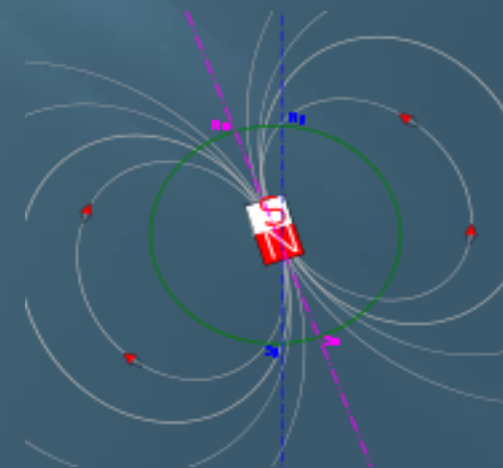


# 2012: Insultingly Stupid Movie Physics

- Geomagnetic reversal
  - Claim: Earth's magnetic field weakening -- massive solar flare during next solar maximum will cause sudden reversal of magnetic north & south poles
  - Reversals do occur: 400,000 years on average, last one 780,000 years ago
  - Possibly overdue for reversal; however, reversals take up to 5,000 years & do not start on any particular date
  - Cycle 24 Solar Maximum: 2013-2014 (not 2012) -- fairly weak with below average # of sunspots so far
  - So what? No evidence for biological extinctions, human ancestors survived numerous previous reversals
- Earth crust displacement ('pole shift hypothesis')
  - Charles Hapgood: "The Earth's Shifting Crust" (1958)
  - Speculated that ice mass at one or both poles over-accumulates and destabilizes the Earth's rotational balance
  - Causes slippage of all or much of Earth's outer crust around the Earth's core (retains axial orientation)
  - Shift took  $\approx$  5,000 years, then 20,000-30,000 year period of no polar movements
  - Foreword by Albert Einstein (1953): Written before theory of plate tectonics was widely accepted; pointed out that weight of polar ice insufficient to cause shift
  - Nothing to do with movie scenario anyway
  - True polar wander:  $1^\circ$  per million years or less



*The magnetosphere shields the surface of the Earth from the charged particles of the solar wind and is generated by electric currents located in many different parts of the Earth. It is compressed on the day (Sun) side due to the force of the arriving particles, and extended on the night side. (Image not to scale.)*



# 2012: Insultingly Stupid Movie Physics

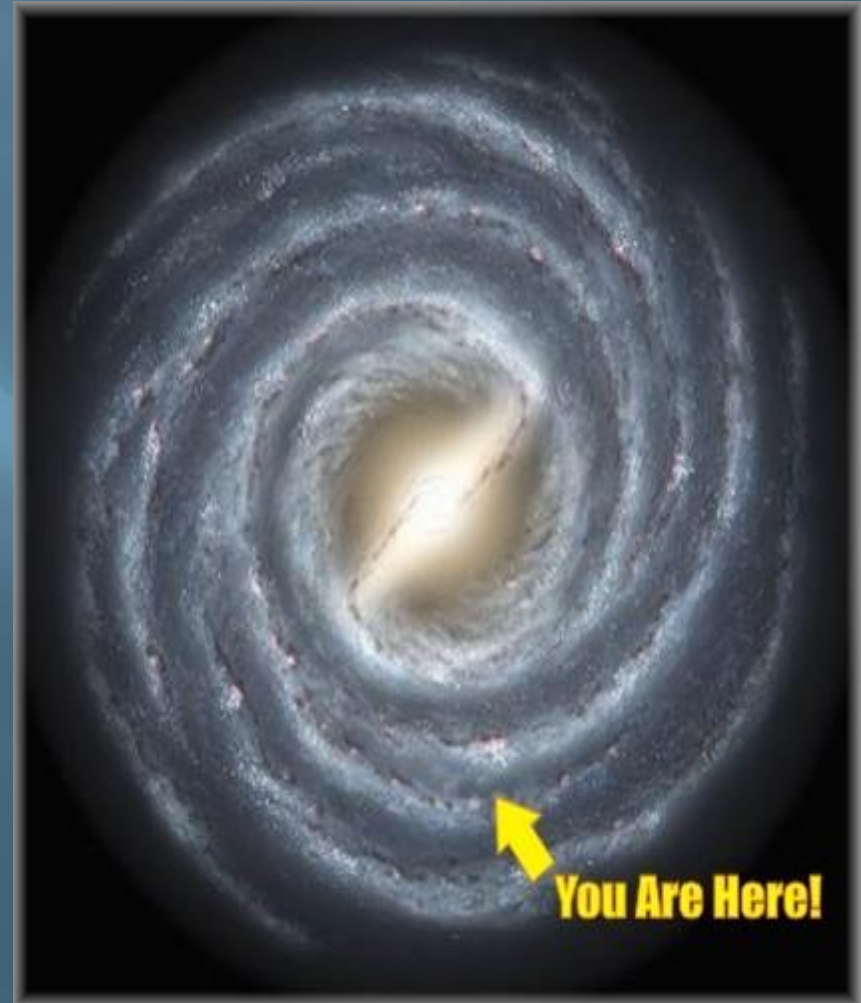
## Verdict on 2012 movie:

- Doomsday hoax, fraud, con job -- doesn't even qualify as pseudoscience
- Viral marketing (hoax sites)
  - Institute for Human Continuity
  - <http://www.instituteforhumancontinuity.org/>
- \$200 million budget -- how much for science advisors?
- Movie 'science': steaming piles of crap



# The Big Picture

- Many of these doomsday scenarios are not new, but have been recycled for many years (remember Y2K?)
- 2012 doomsday hoax promotes “cosmophobia”: Fear of the cosmos – unfortunate & sad to cause people to be fearful of astronomy and of the cosmos
- Ancient (and modern) astronomers could not predict the future, beyond *repeated* events (e.g. lunar cycles, eclipses, planetary positions) based on *observations*
- One advantage of studying science at any level is that one learns how to think critically about any topic, such as the 2012 hoax
- Taking this course has empowered you to distinguish science from pseudoscience, hoaxes, and all other sorts of nonsense



# References

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