

# 2012

## THE END:

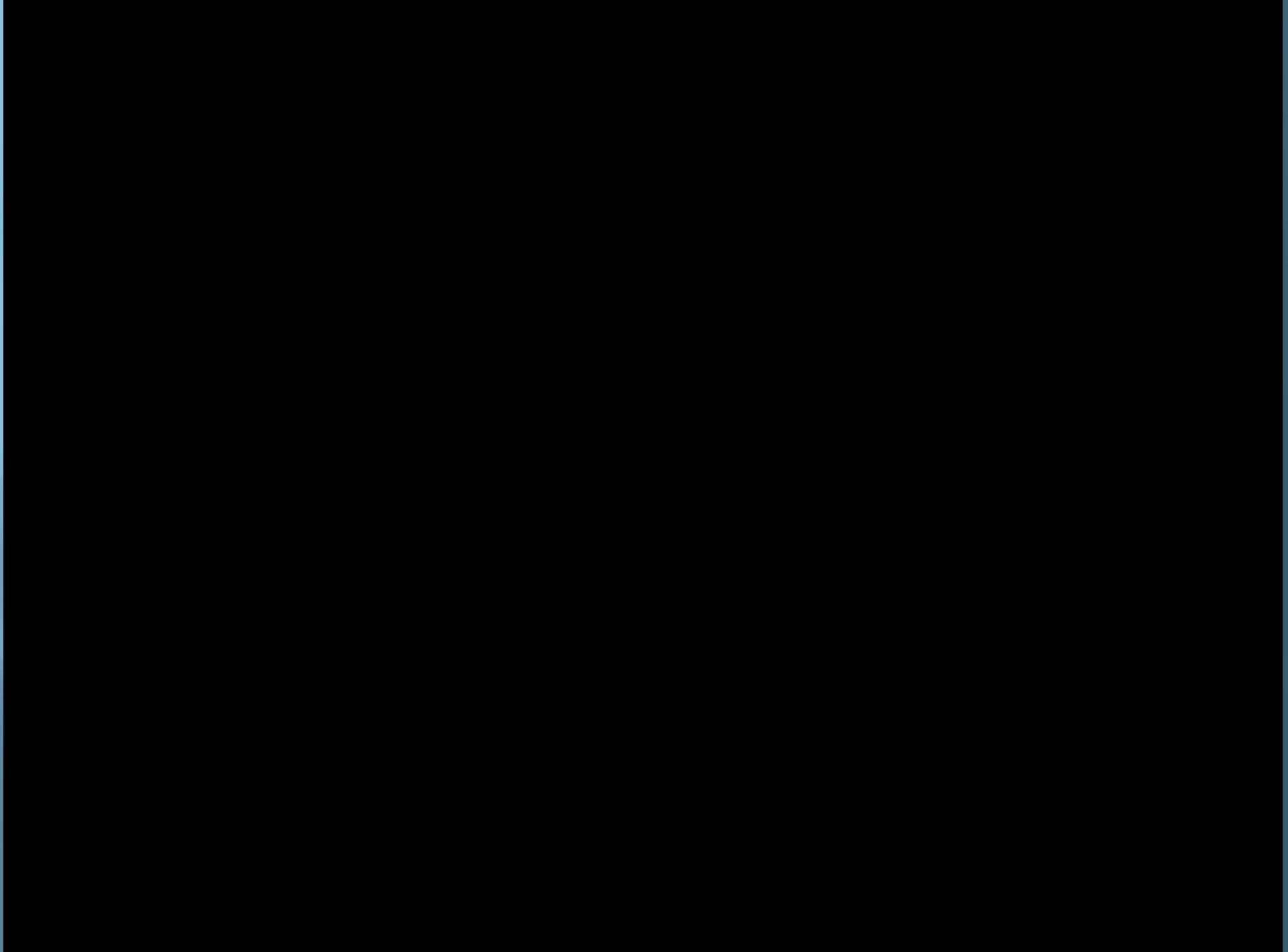
Gregorian: 11:11:37 (UTC) 21 December

Long Count: 13.0.0.0.0 (B'ak'tun 13)

Calendar Round: 4 Ajaw 3 K'ank'in

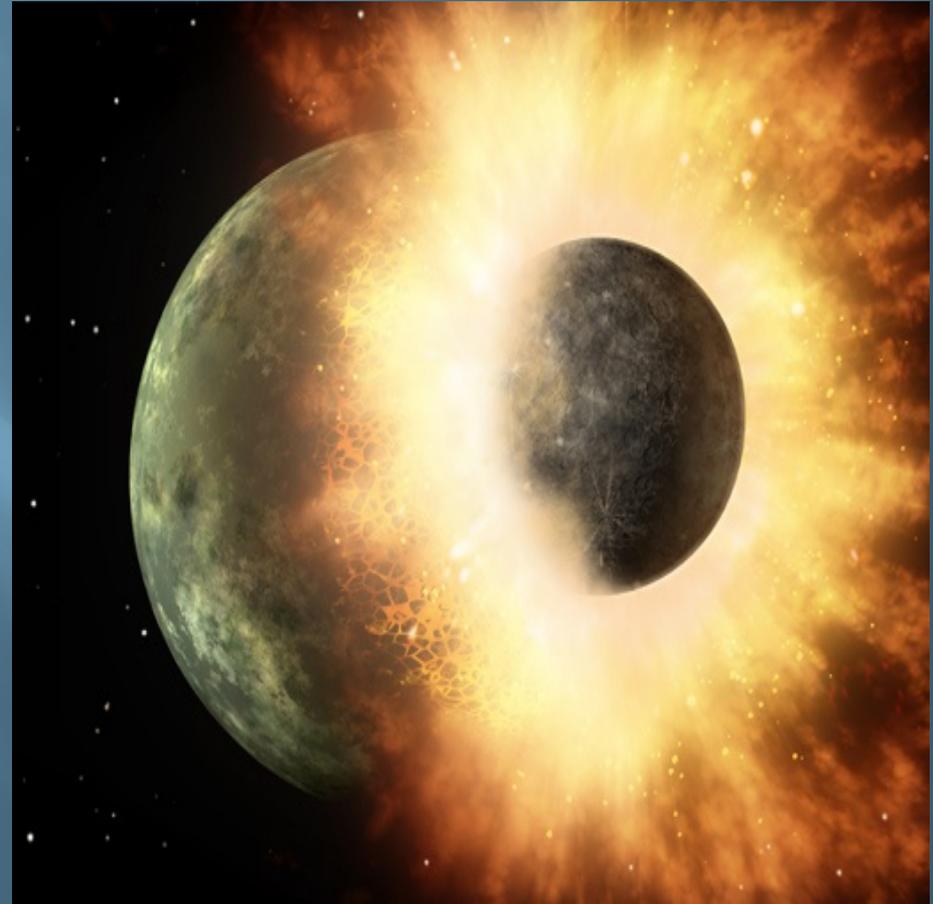


*Movie poster for "2012", released in November 2009. The movie features worldwide tectonic activity and natural disasters, triggered by neutrinos emitted by the Sun during a massive solar flare.*



# Did the World End in 2012?

- ❑ Doomsday rumors abounded: books, TV, movies, Internet
- ❑ Most rumors cited the 'end' of the Maya Long Count calendar on the Winter Solstice that occurred on 21 December 2012
- ❑ Doomsday scenarios included:
  - Collision of a rogue planet with Earth (Nibiru/Planet X)
  - Planetary alignment
  - Galactic alignment
  - Violent solar storms
  - Sudden geomagnetic reversal
  - 'Earth crust displacement'
  - Earthquakes, tsunamis, supervolcanoes
- ❑ 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.*





3.20 THE MESOAMERICAN CULTURE AREA, showing approximate tribal locations (with modern boundaries)

# Mesoamerican Time Line

Gulf Coast

Olmec



Valley of Oaxaca



Zapotec



Mistec

Valley of Mexico



Teotihuacan



Toltec



Aztec

Maya Area



Maya



1500 B.C.

1000 B.C.

500 B.C.

B.C.A.D.

500 A.D.

1000 A.D.

1500 A.D.

Voyage of  
Columbus

Arrival of the Spanish

# Maya Civilization

## Preclassic (c. 2600 BC – 250 AD):

- Mythical creation date: 11 August 3114 BC
- Earliest occupation, c. 2600 BC
- 1<sup>st</sup> clearly Maya settlements, c. 1800 BC
- Development of mid-size communities
- 1<sup>st</sup> written hieroglyphics (c. 250 BC)
- Overlap with other Mesoamerican civilizations

## Classic (c. 250 AD – 950 AD; 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 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



# Maya Civilization

## Collapse (southern lowlands, c. 900 AD):

- ❑ 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 AD – early 16<sup>th</sup> century AD):

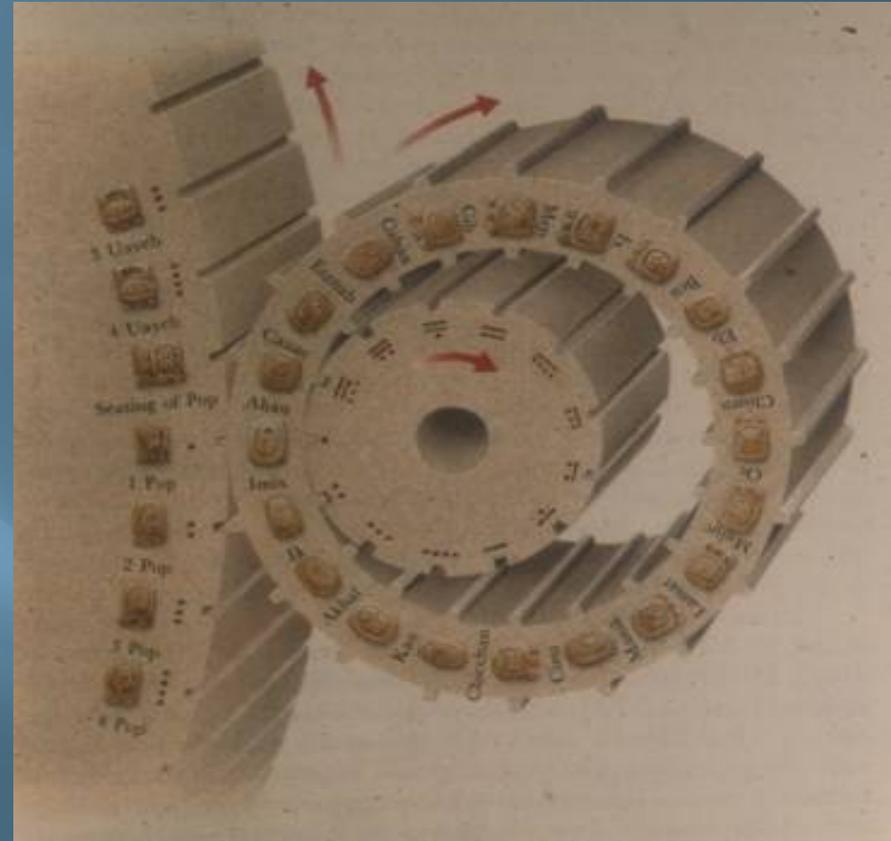
- ❑ Development in northern centers persisted
- ❑ Maya cities of northern lowlands flourished
- ❑ Increasing diversity of external influences
- ❑ Spanish conquest: 16<sup>th</sup> – 17<sup>th</sup> centuries





# Maya Calendars

- Maya 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/Gregorian calendars more accurate
  
- Other calendars
  - Short count
  - 819 day
  - Moon, Mercury, Venus



## 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 or Zapotec
  - Linear on scale of human lifetime
  - Greater cycle: 'The Great Circle'
  - Base 20 (vigesimal): Based on human anatomy (10 fingers + 10 toes)
- Zero or Creation Date: 11 August, 3114 BC  
Long Count date: 13.0.0.0.0
- 21 December, 2012:13.0.0.0.0
  - Completion of B'aktun 13 (*Pik*)
  - Calendar 'resets'
  - 1,872,000 days = 5,126 years
  - Like New Year's when both day & month reset
  - Just another day – life goes on...
- [\*Maya Calendar: NY Times App\*](#)

	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

# Why was 21 December 2012 Important?

**11 August 3114 BC**

**13.0.0.0.0 4 Ahaw 8 Cumku**

**Baktuns**

**Katuns**

**Tuns**

**Uinals**

**Kins**

**Tzolkin**

**Haab**

# Why was 21 December 2012 Important?

## 21 December 2012 AD

13.0.0.0.0 4 Ahaw 3 K'ank'in

Baktuns

Katuns

Tuns

Uinals

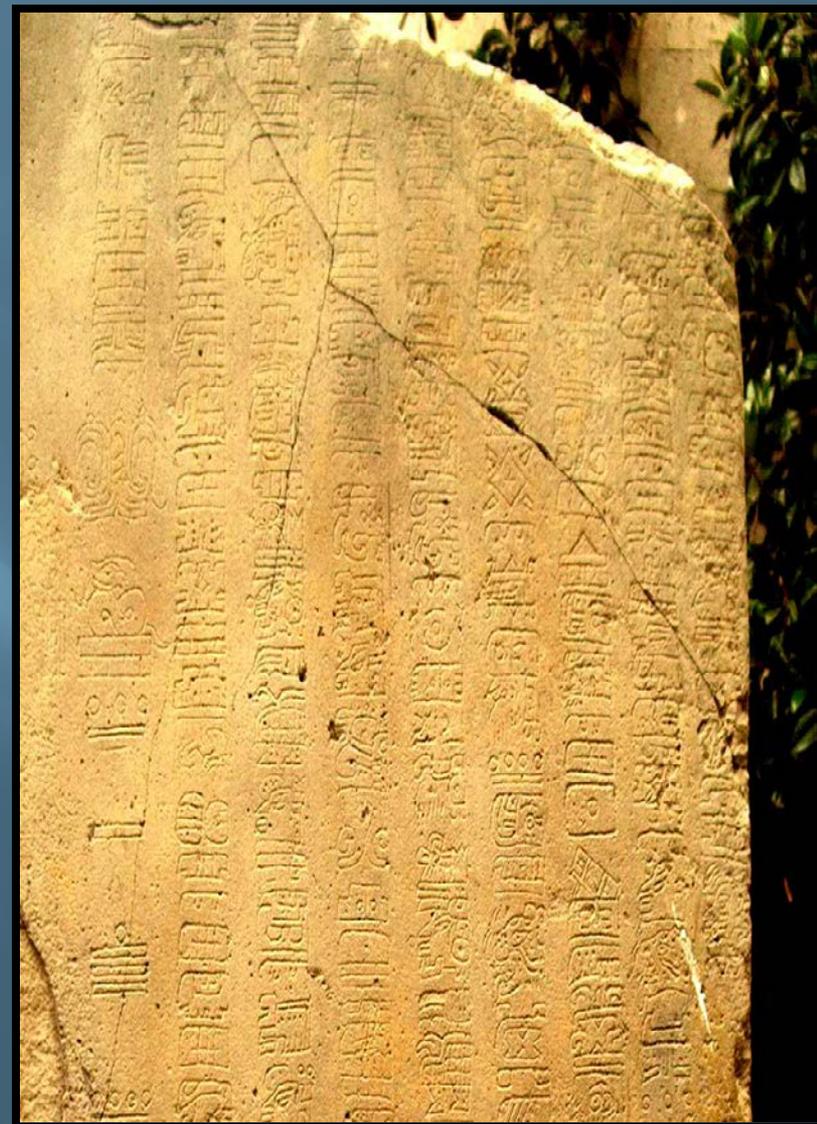
Kins

Tzolkin

Haab

# Long Count Calendar

- Maya 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, or subsequent Spanish conquest
- Significance of B'aktun13 to classic Maya uncertain
  - Tortuguero Monument 6:
    - Reference to patron deity of 'period endings' who descends to oversee ceremonies on that day
    - PARTY!!!
  - La Corona Hieroglyphs Stairway 2, Block V:
    - Political history of a Mayan king named Jaguar Paw
    - Linked his reign to B'aktun 13 to promote continuity & stability
    - Not a prophetic declaration
  - Priest timekeepers at Palenque believed cycle would end after 20 B'aktun, not 13; temple inscription refers to a date in 4772 AD
  - Present day Maya attached no significance to this date; they have practical concerns like crops, 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



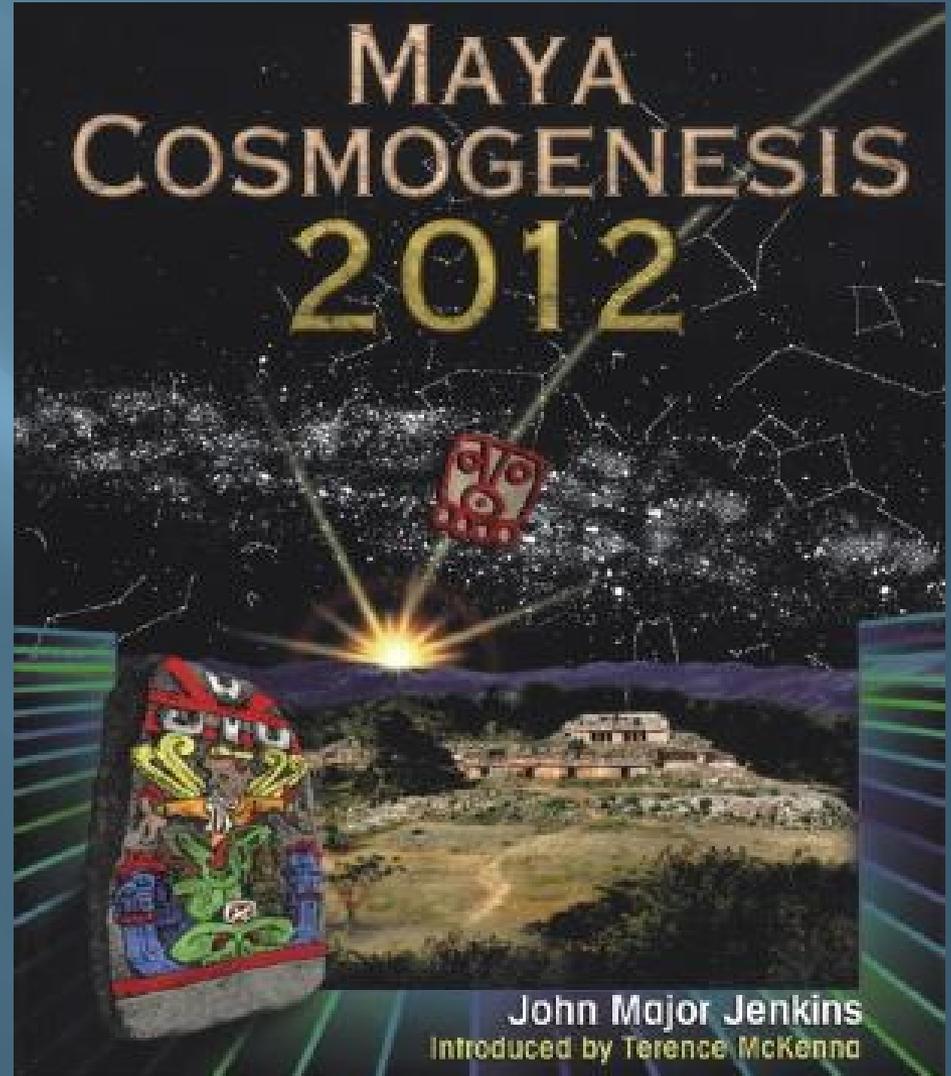
*A date inscription for the Long Count*



# Galactic Alignment and Transcendence



**John Major Jenkins**



# Galactic Alignment

“Black Road”: J.M. Jenkins (1990s):

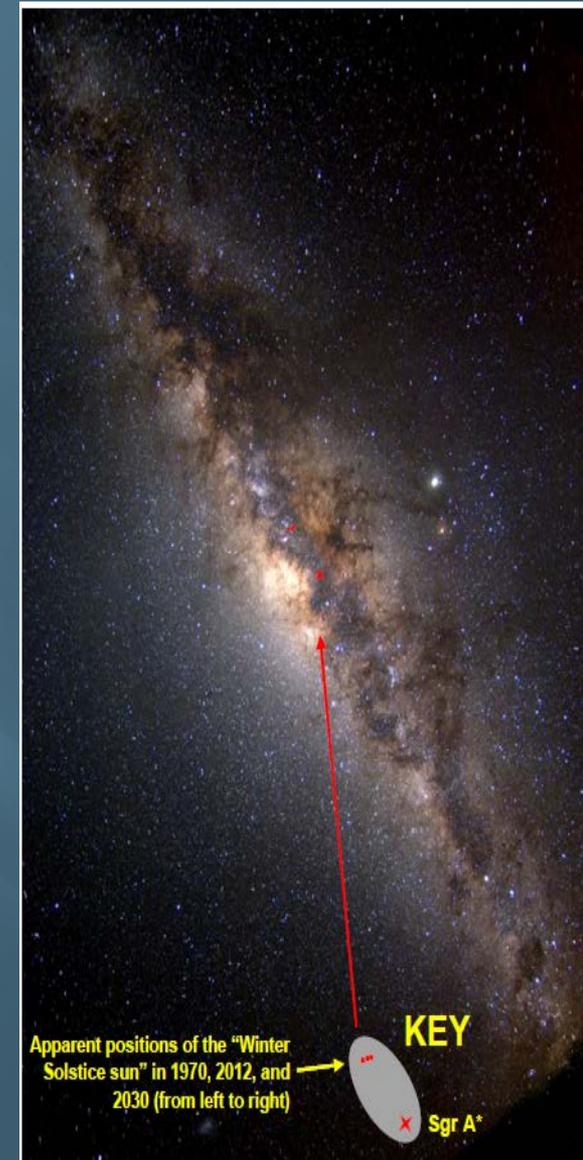
- Claim: Sun precisely aligned with intersection point of ecliptic plane & ‘Black Road’ on 21 December 2012
- Jenkins claimed classical Maya anticipated this conjunction & celebrated it as the harbinger of a profound spiritual transition for mankind

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 during a year
- Zodiac: 12 constellations (13 really) along ecliptic through which Sun appears to pass each year
- Spring Equinox: Pisces
- Winter Solstice: Sagittarius (direction of 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”*



Cygnus Arm

Carina-Sagittarius Arm

Norma Arm

Crux-Scutum Arm

Perseus Arm

10 000

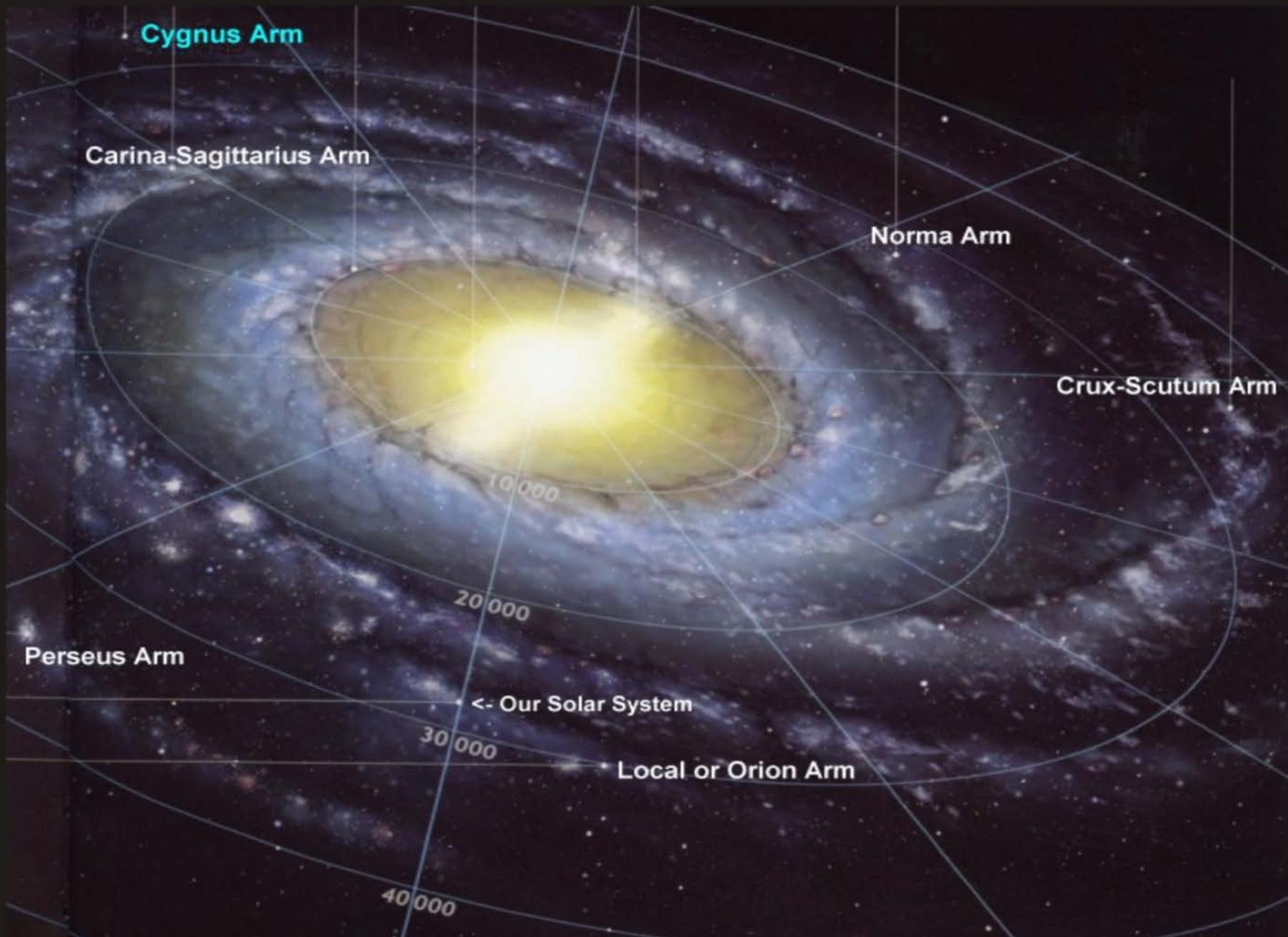
20 000

<- Our Solar System

30 000

Local or Orion Arm

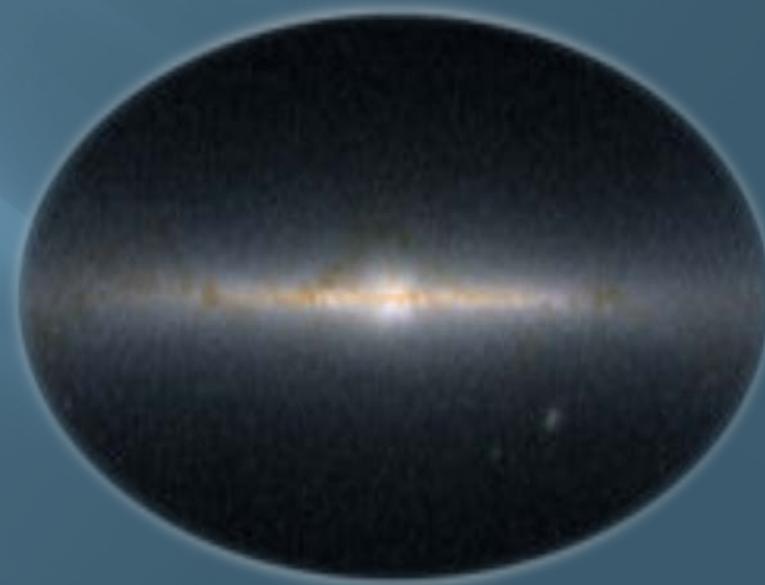
40 000



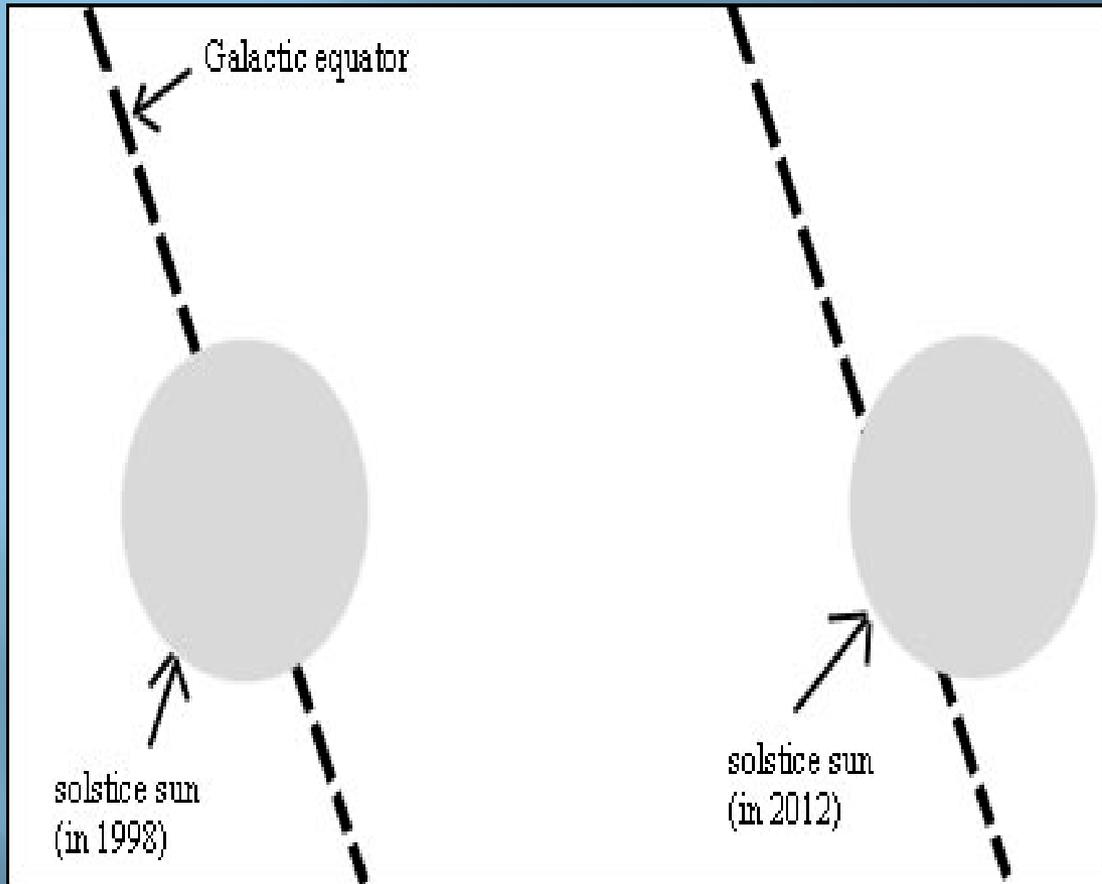
# Galactic Alignment



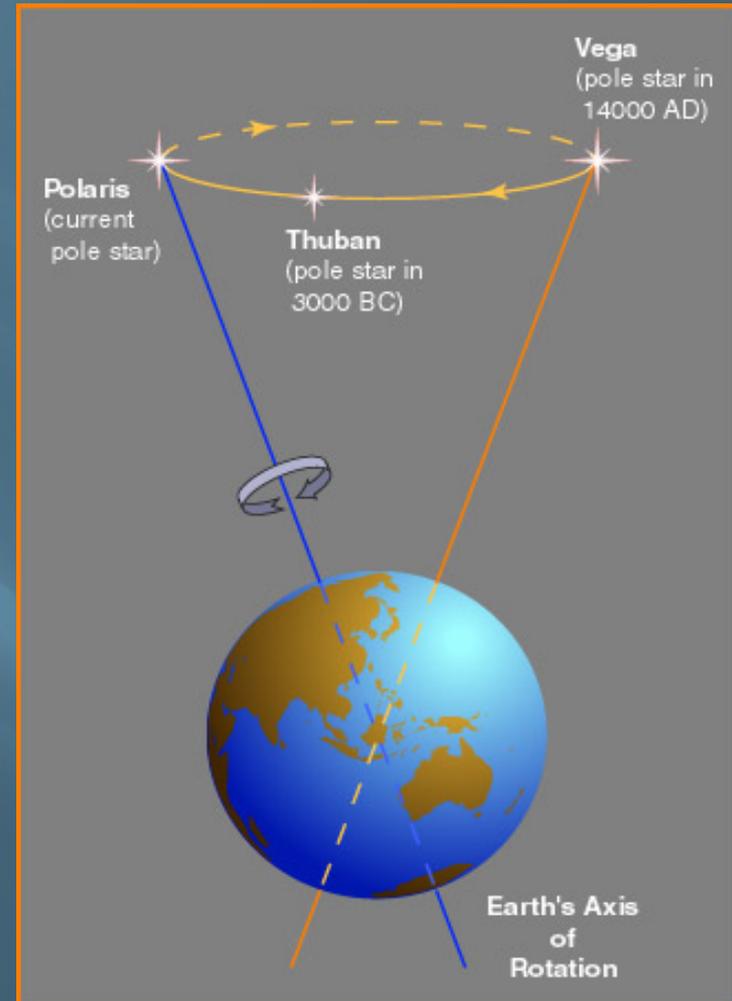
- Galactic Equator: Sun-centered, mathematically convenient reference frame based on H1 plane
- Sun never crosses galactic equator; Sun by definition (IAU) is on the galactic equator
- Galactic Alignment: Solstice occurring closest to the time when the Sun is aligned with the intersection of the ecliptic & the galactic equator (from Earth frame)
- Actually, it is Earth that is getting in line
- 1998: Date of the solstice point crossing the galactic equator
- No significance in the direction in which the axis or line of solstices happens to be pointing
- Galactic plane: a plane of symmetry of the whole Galaxy's distribution of mass
  - Sun is ~100 ly 'above' galactic plane & moving farther away
  - Sun last passed through galactic disk  $\approx$  3 Myr ago; 30 Myr until Sun again passes through galactic disk



# Galactic Alignment



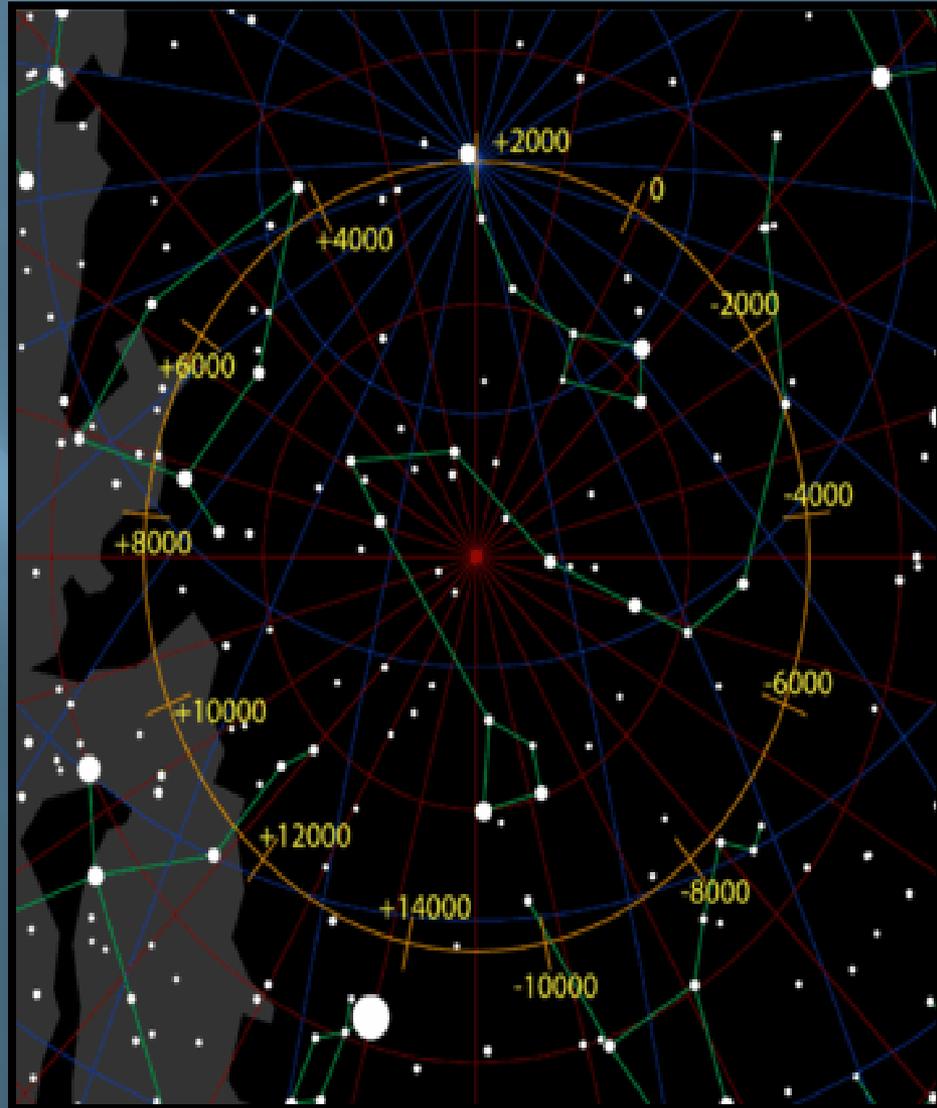
Fact: The sun is one-half a degree wide. Therefore, the sun, on the December solstice, will take approximately 36 years to precess through the Galactic equator.



**Precession: 25,800 years**

# 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
- 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
  - About 2,160 years for Sun to pass through each zodiac constellation
  - Astrological age: 'Age of Aquarius' follows 'Age of Pisces'
- About 26,000 years for precession cycle : Sun to complete one trip around ecliptic
  - Claim: Maya aware of precession cycle from observations of Pleiades
  - 5 Long Counts  $\approx$  25,800 years
  - Scholarly opinion mostly dismisses such claims
  - Maya seldom chose a solstice or equinox to commemorate an important event so unlikely to set an 'end date' at a solstice





# Problems with Galactic Alignment Hypothesis

- Happened already
- Jenkins now says “The era of 2012”
- Uncertain if Maya knew about precession
- Solstices and equinoxes not so important to Maya

# Nibiru/Planet X

Claim: Nibiru/Planet X/brown dwarf passed near Earth in 2012; conspiracy withheld information

- Zecharia Sitchin, “The 12<sup>th</sup> Planet” (1976):
  - Interprets Babylonian texts to claim that Nibiru passes by Earth every 3,600 years
  - Sentient inhabitants (Anunnaki of Sumerian myth) interact with humanity as Nibiru passes
  - Sitchin’s scientifically illiterate work is filled with poor scholarship, poor translations, & poor science
- [Nancy Lieder \(1996\)](#):
  - Claim: Brain implants allow her to communicate telepathically with gray aliens from Zeta Reticuli (binary star system, no confirmed planets yet)
  - Conflated Nibiru with Planet X
  - Claimed Nibiru is 4X size of Earth; others claimed Nibiru is a brown dwarf
  - Catastrophic collision with Earth originally forecast for May 2003
  - When nothing happened doomsday date was advanced to 2012 winter solstice & ‘end’ of Maya calendar (merging of 2 fables)
  - Sitchin disavowed any association with Lieder; claimed Nibiru would not return until 2900 AD



*V838 Monocerotis: variable star in constellation Monoceros 20,000 ly from Sun. Some Nibiru believers claimed that this was Nibiru & that NASA , other agencies, & world governments engaged in a vast conspiracy to hide the truth.*



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## Frequently Asked Questions

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### 2012: Beginning of the End or Why the World Won't End?

12.22.11

Remember the Y2K scare? It came and went without much of a whimper because of adequate planning and analysis of the situation. Impressive movie special effects aside, Dec. 21, 2012, won't be the end of the world as we know. It will, however, be another winter solstice.

Much like Y2K, 2012 has been analyzed and the science of the end of the Earth thoroughly studied. Contrary to some of the common beliefs out there, the science behind the end of the world quickly unravels when pinned down to the 2012 timeline. Below, NASA Scientists answer several questions that we're frequently asked regarding 2012.

**Question (Q):** Are there any threats to the Earth in 2012? Many Internet websites say the world will end in December 2012.

**Answer (A):** Nothing bad will happen to the Earth in 2012. Our planet has been getting along just fine for more than 4 billion years, and credible scientists worldwide know of no threat associated with 2012.

**Q:** What is the origin of the prediction that the world will end in 2012?

**A:** The story started with claims that Nibiru, a supposed planet discovered by the Sumerians, is headed toward Earth. This catastrophe was initially predicted for May 2003, but when nothing happened the doomsday date was moved forward to December 2012. Then these two fables were linked to the end of one of the cycles in the ancient Mayan calendar at the winter solstice in 2012 – hence the predicted doomsday date of December 21, 2012.



Scenes from the motion picture "2012." Courtesy Columbia Pictures.

# Nibiru/Planet X

- A planet that had headed toward Earth would have been easily visible:
  - Table assumes an Earth-sized object
  - For object 4X Earth diameter, subtract 3.0 from magnitude
  - For Jupiter-sized brown dwarf, subtract 5.0 from magnitude
  - Claim: Nibiru was 'invisible', or hidden behind Sun, or only visible from Antarctica -- seriously? (fallacy of special pleading)
- No such planet exists:
  - A few Pluto-like dwarf planets have been discovered in our outer solar system recently (Eris, Sedna)
  - None have orbits that bring them inside ~35 AU
  - Nibiru's orbit would be impossibly elliptic & highly unstable
- Conspiracies in astronomy?
  - Can 10,000 professional astronomers & 100,000+ highly skilled amateurs who regularly pioneer new discoveries keep a secret?
  - Impossible to conceal existence of such a planet if it actually existed

Date	Distance from Sun (AU)	Magnitude
1/1/2012	4.72	3.1
4/1/2012	3.78	2.2
7/1/2012	2.76	0.2
10/1/2012	1.65	-3.8
12/1/2012	0.98	-17.9



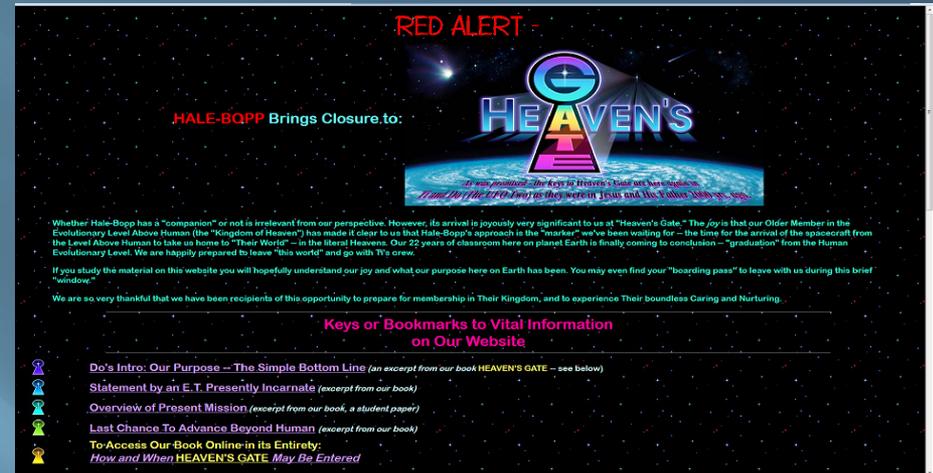
*Artist's conception of dwarf planet Eris. From NASA / ESA / A. Schaller*

[Doomsday 2012, the Planet Nibiru, and Cosmophobia](#)



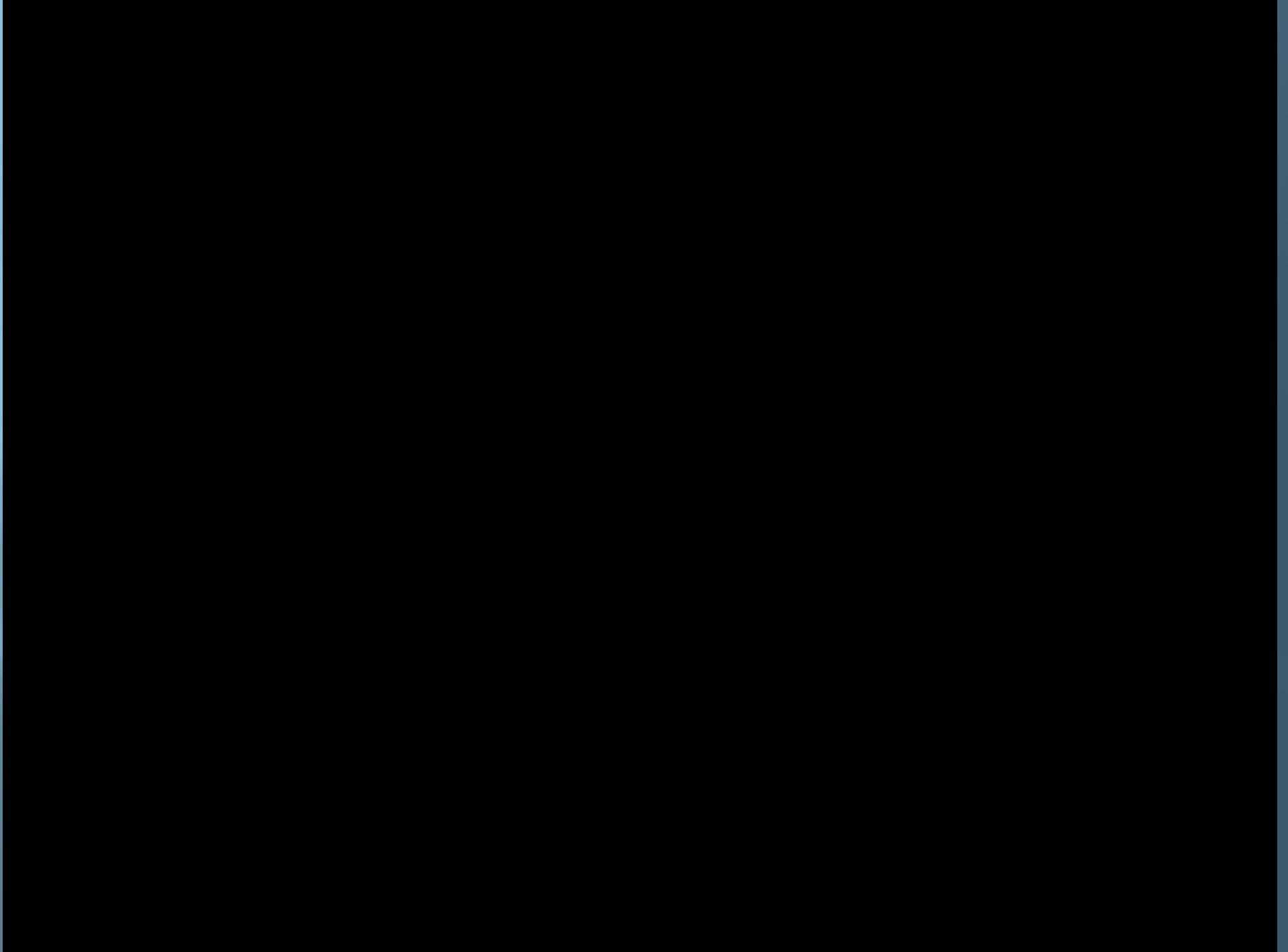
# Heaven's Gate (1997)

- ❑ UFO religious Millenarian group based in San Diego; founded in early 1970s & Marshall Applewhite and Bonnie Nettles
  - Believed they were the 'two witnesses' (Revelation 11:3)
  - Believed Earth was about to be 'recycled' (wiped clean, renewed, refurbished, rejuvenated); only chance to survive was to leave immediately
  - Applewhite believed that he was directly related to Jesus -- "Evolutionary Kingdom Level Above Human"
- ❑ 1997: Applewhite claimed that a spacecraft was trailing Comet Hale-Bopp
  - Asserted that mass suicide was "the only way to evacuate this Earth"
  - Convinced 38 followers to commit suicide so that their souls could board it
  - Applewhite believed that after their deaths, the spacecraft would take their souls to another "level of existence above human" -- both physical and spiritual
  - Note: Nancy Lieder claimed that Hale-Bopp was a NASA conspiracy to conceal the approach of Nibiru
- ❑ Mass suicide:
  - Rented a mansion in a gated community near San Diego
  - 39 members took phenobarbital mixed with apple sauce & washed down with vodka; secured plastic bags around their heads after ingesting the mix to induce asphyxiation
  - All bodies were discovered wearing matching black shirts & sweat pants with brand new Nike shoes and a square of purple cloth covering their faces and torsos
  - Wore armband patches: "Heaven's Gate Away Team"



Comet Hale-Bopp

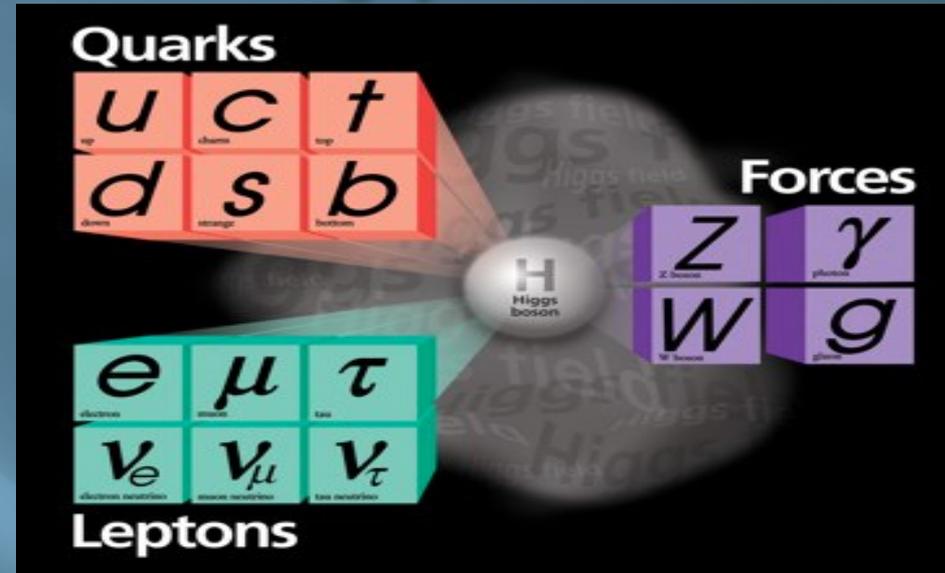




# Are the Electrons Angry?

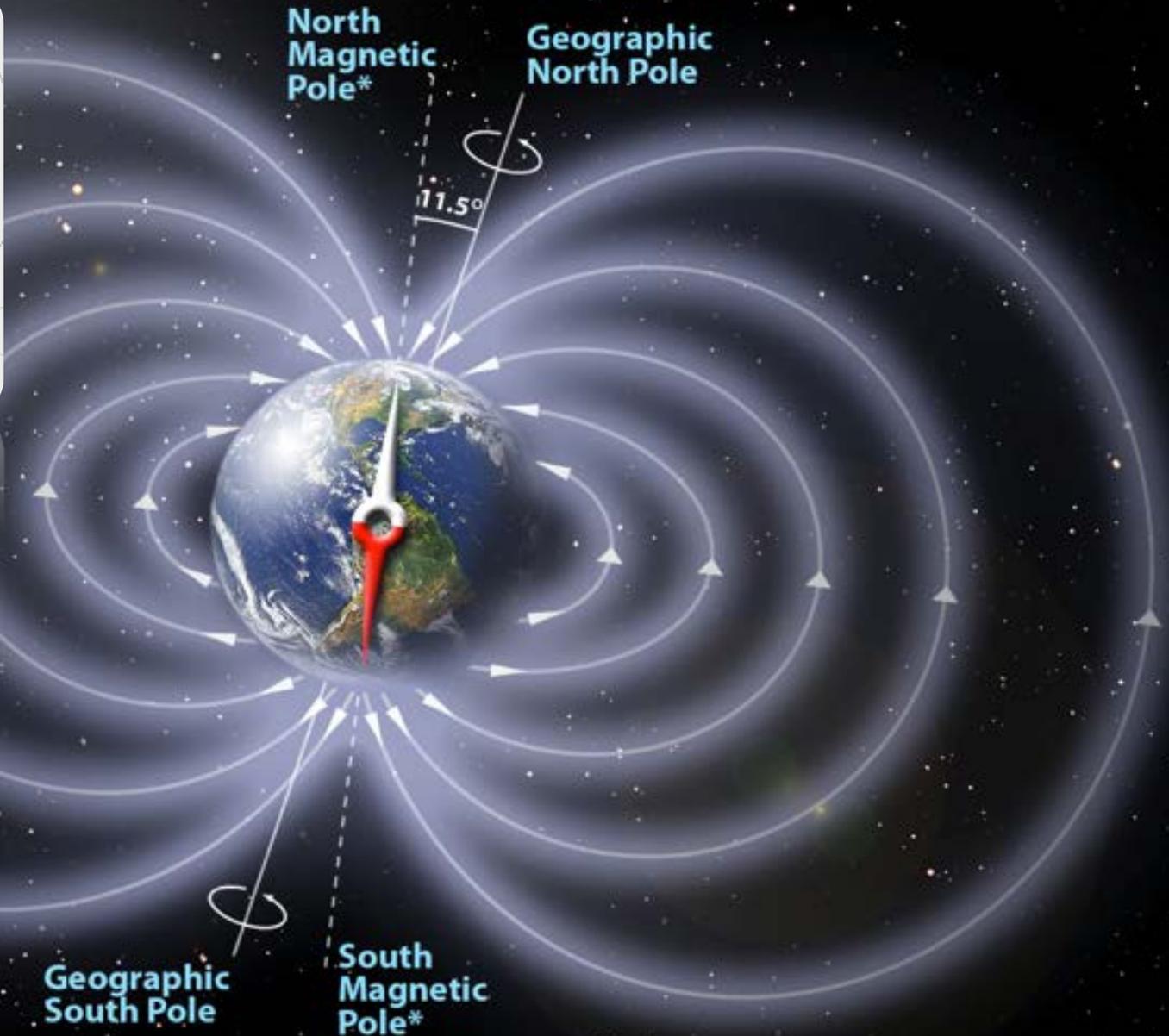
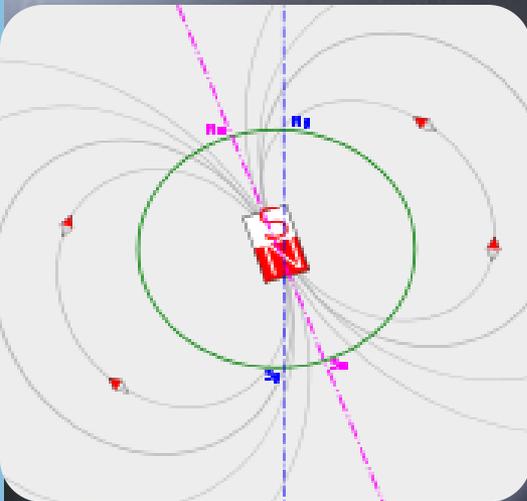
## Neutrinos ('ghost particle'):

- Elementary particles (Standard Model)
- 1<sup>st</sup> postulated to preserve conservation laws (energy, momentum, angular momentum)
- Properties:
  - Tiny but non-zero mass
  - Electrically neutral
  - 3 flavors: electron, muon, tau (or lightest, middle, heaviest)
  - Travel near speed of light ( $c \approx 3.0 \times 10^8$  m/s)
  - Minimal interaction with matter: ~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 ~10 ly of Pb without interacting with any atoms
- Neutrino oscillation: oscillate between 3 flavors, but still neutrinos
- 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, ...		
<b>Leptons</b> spin = 1/2			<b>Quarks</b> 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

# The Earth's Magnetic Field



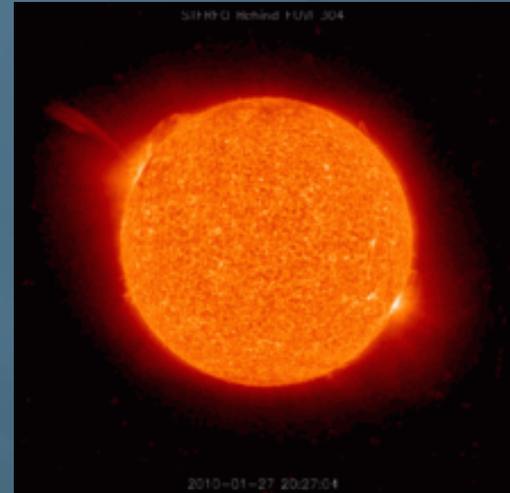
\*The Earth's North Magnetic Pole is, in fact, a south pole. (North poles on compasses point towards it.) Notice that the compass needle in the picture has the white (south) tip pointing north, and the field line arrows point from south to north.

Larger versions of this image are available: contact [peter.reid@ed.ac.uk](mailto:peter.reid@ed.ac.uk)

# Earthquakes, Tsunamis, Super volcanoes, oh my!

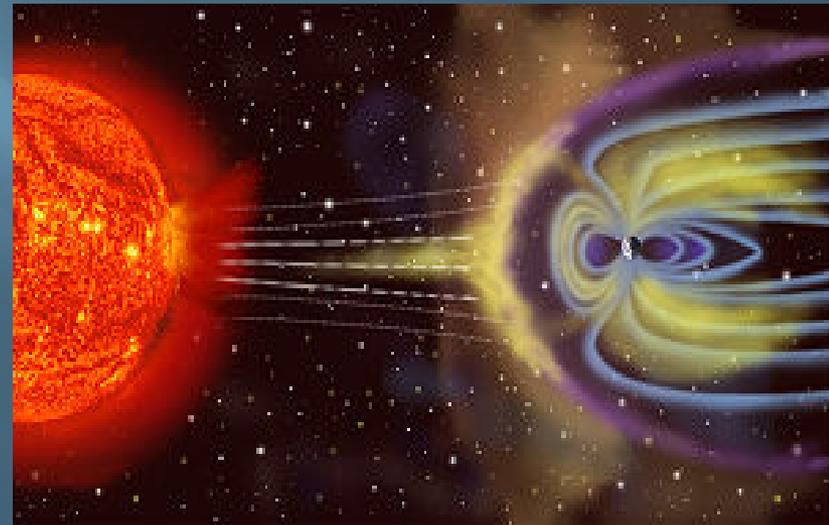
## Geomagnetic reversal:

- Claim: Earth's magnetic field weakening; massive solar flare during next solar maximum will cause sudden reversal of magnetic north & south poles
- Reversals: 400,000 years on average, last one occurred about 780,000 years ago
- Possibly overdue for reversal: Reversals take up to 5,000 years & do not start on any particular date
- 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: sudden violent shifting of continents and poles
- Causes slippage of all or much of Earth's outer crust around the Earth's core (retains axial orientation)
- Shift took about 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
- Fallacy of appeal to authority
- True polar wander:  $\sim 1^\circ$  per million years



*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.)*

# Solar Storms

- ❑ Carrington Event (Solar Cycle 10):
  - Powerful geomagnetic solar storm in 1859
  - A solar CME hit Earth's magnetosphere & induced one of the largest geomagnetic storms on record
  - Associated 'white light flare' in the solar photosphere observed & recorded by English astronomers Richard C. Carrington and Richard Hodgson
  - Aurorae observed as far south as Cuba & Hawaii
  - Telegraph systems all over Europe and North America failed -- electric shocks, throwing sparks, setting fires
  - In June 2013, a joint venture from researchers at Lloyd's of London and Atmospheric and Environmental Research (AER) in the United States used data from the Carrington Event to estimate the current cost of a similar event to the US alone at \$0.6–2.6 trillion

- ❑ Recent Events (Solar Cycle 24):
  - 1 August 2010: 4 large CMEs emanated from the Earth-facing hemisphere of the Sun; significant aurorae on Earth three days later
  - 23 July 2012: NASA satellites recorded a massive, and potentially damaging, Solar Superstorm (Solar flare, CME, Solar EMP) missed Earth by one week
    - Physicist Pete Riley (Predictive Science Inc.) estimates a 12% chance of a similar event hitting Earth between 2012 and 2022
  - 31 August 2012: CME connected with Earth's magnetosphere in a glancing blow causing aurora to appear on the night of 3 September

NEAR MISS: THE SOLAR SUPERSTORM OF JULY 2012

July 23, 2012. If an asteroid big enough to knock modern civilization back to the 19th century appeared out of deep space and buzzed the Earth-Moon system, the near-miss would be instant worldwide headline news.

Two years ago, Earth experienced a close shave just as perilous, but most newspapers didn't mention it. The "impactor" was an extreme solar storm, the most powerful in as much as 150+ years.

"If it had hit, we would still be picking up the pieces," says Daniel Baker of the University of Colorado.

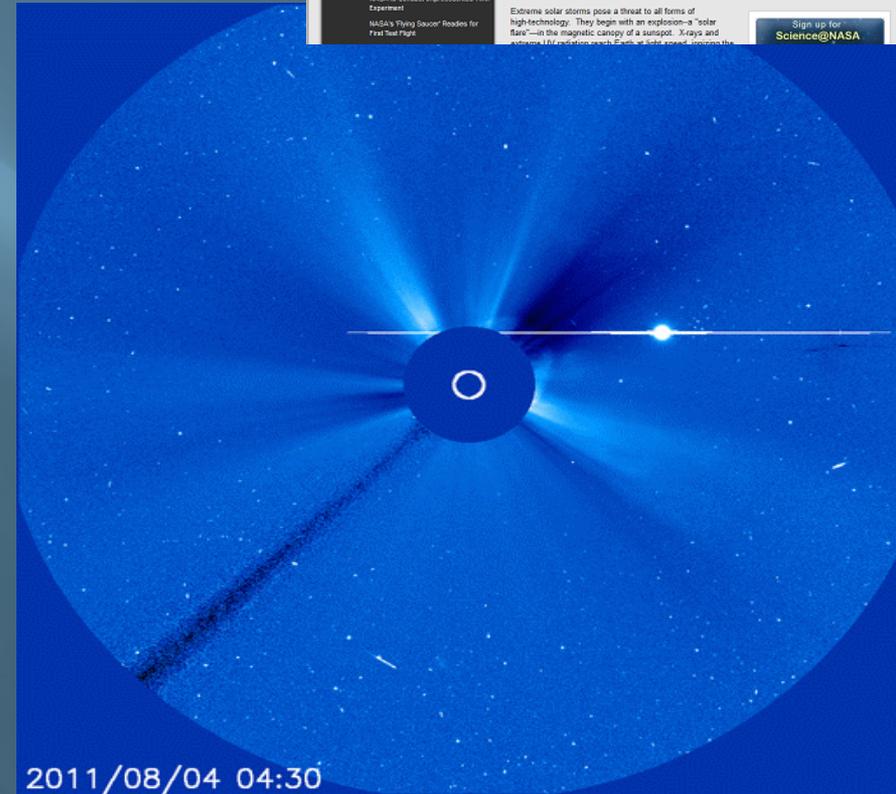
A ScienceCast video recounts the near-miss of a solar superstorm in July 2012. [View it](#)

Baker, along with colleagues from NASA and other universities, published a seminal study of the storm in the December 2013 issue of the journal *Space Weather*. Their paper, entitled "A major solar eruptive event in July 2012," describes how a powerful coronal mass ejection (CME) tore through Earth orbit on July 23, 2012. Fortunately Earth wasn't there. Instead, the storm closed by the STEREO-A spacecraft.

"I have come away from our recent studies more convinced than ever that Earth and its inhabitants were incredibly fortunate that the 2012 eruption happened when it did," says Baker. "If the eruption had occurred only one week earlier, Earth would have been in the line of fire."

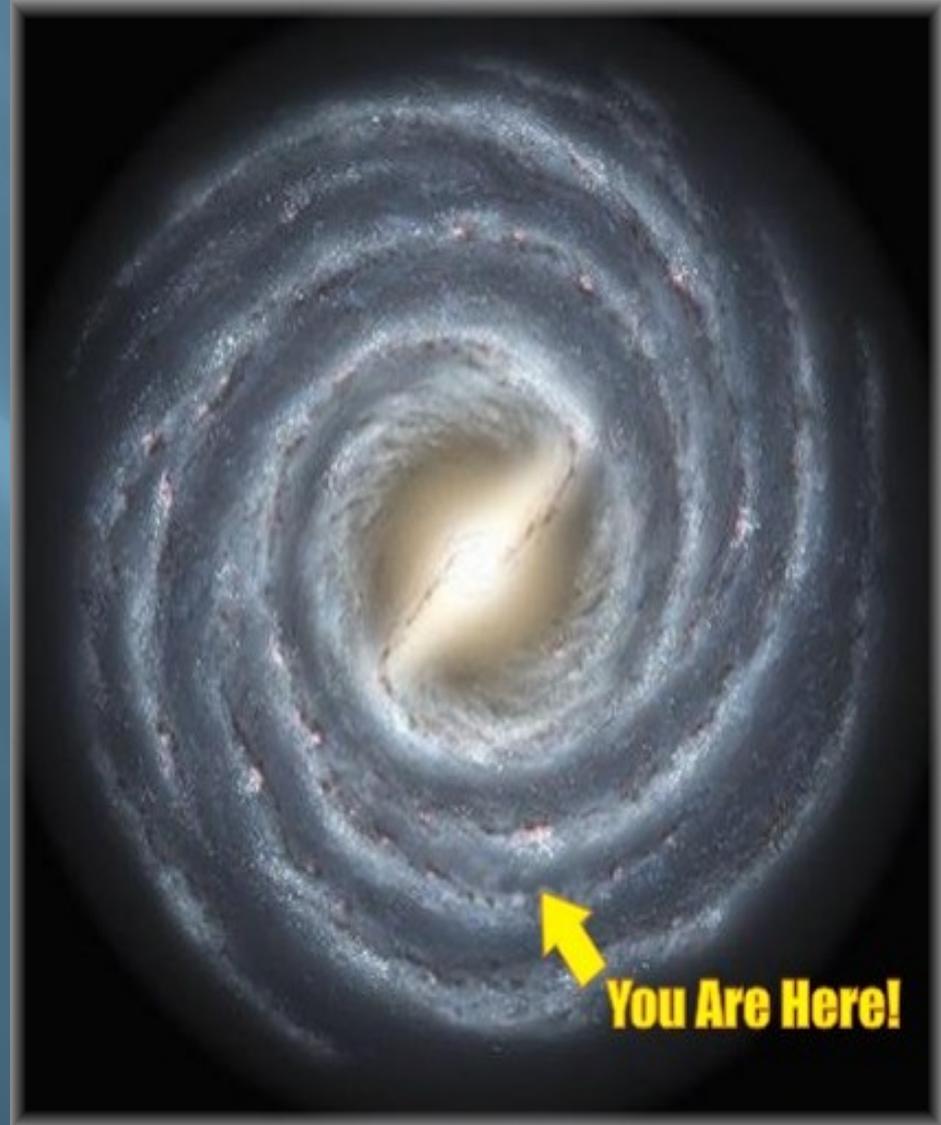
Extreme solar storms pose a threat to all forms of high-technology. They begin with an explosion—a "solar flare"—in the magnetic canopy of a sunspot. It rips and erupts, launching a scorching Earth-killing plasma superstorm.

Sign up for Science@NASA



# The Big Picture

- Many of these doomsday scenarios are not new but have been recycled for many years
  - Nostradamus, Millerites, Jupiter Effect, Heaven's Gate, Y2K, Harold Camping...
- 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 empowers you to distinguish science from pseudoscience, hoaxes, and all other sorts of nonsense



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