Total Eclipse of the Sun

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Dr Steve Barrett 11 Dec 2008

2 Introduction

Total Eclipse of the Sun

The Sun Core
Surface
Atmosphere

Eclipses Why?
When?

Total Eclipse of 29 Mar 2006

3 Solar Vital Statistics

Total Eclipse of the Sun

Size ~ 100 x Earth ~ 400 x Moon

Distance ~ 370–410 x Moon

Mass ~ 1,000,000 x Earth

Composition ~ 75% hydrogen
25% helium
0.1% other stuff

Power ~ 400,000,000,000,000
000,000,000,000 watts

4 Power Source

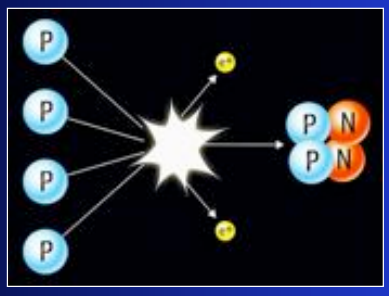
Total Eclipse of the Sun

1871 Hermann von Helmholtz
Burning coal, one ton per hour per square foot of the Sun's surface, would exhaust the fuel in a few **million** years

1919 Sir Arthur Eddington
Conversion of hydrogen to helium could provide enough energy to power the Sun for **billions** of years

5 Fusion

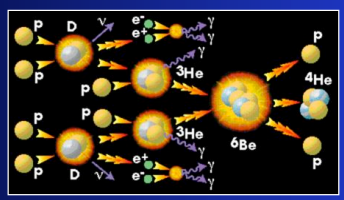
Total Eclipse of the Sun



hydrogen → helium + energy

6 Fusion

Total Eclipse of the Sun



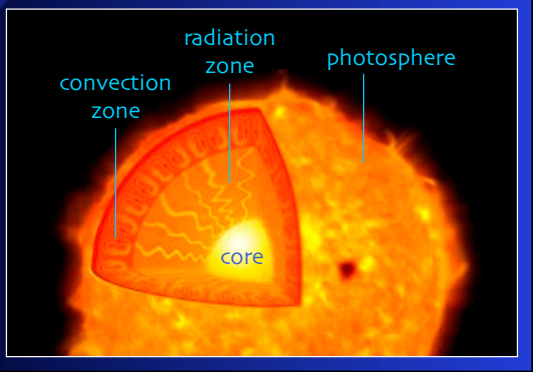
600 Mt of H → 596 Mt of He

Sun loses 4 million tons every second

Mass loss → energy thanks to $E = mc^2$

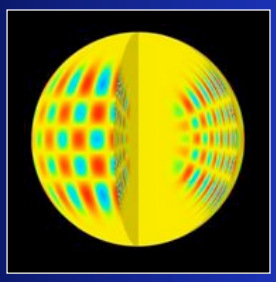
Total Eclipse of the Sun

7 Internal Structure



Total Eclipse of the Sun

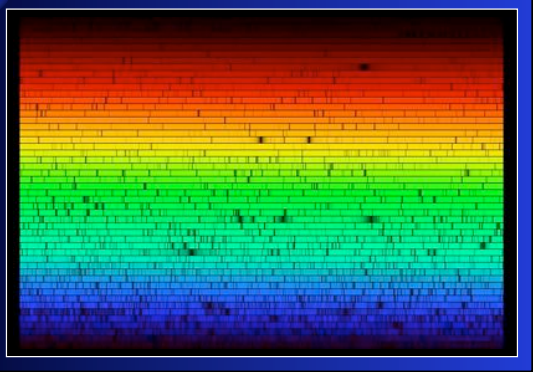
8 Helioseismology (or "Star Quakes")



Convection zone turbulence can be detected through the Doppler shift of lines in the Sun's spectrum

Total Eclipse of the Sun

9 Solar Spectrum



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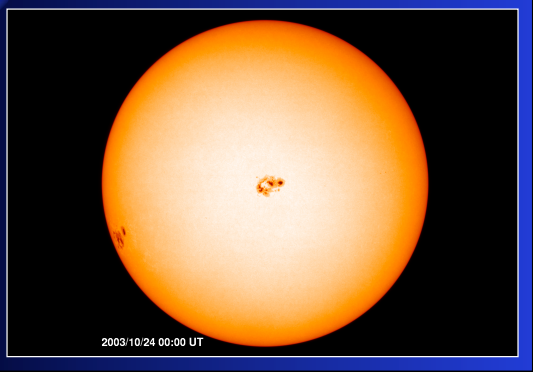
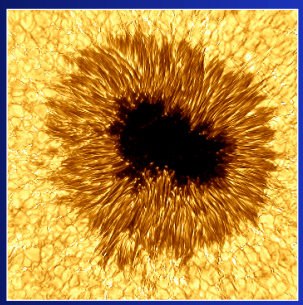
10 Sunspots



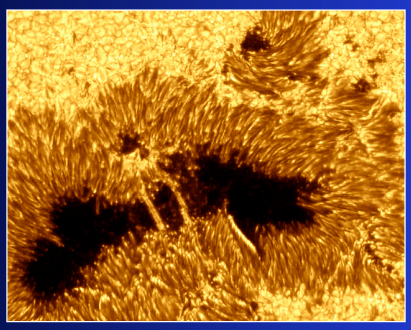
Total Eclipse of the Sun

11 Sunspots



Total Eclipse of the Sun

12 Sunspots

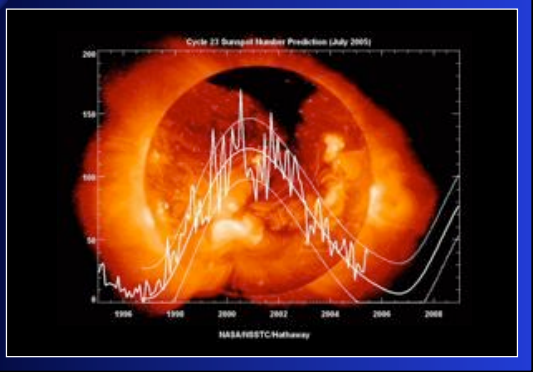


Total Eclipse of the Sun

Total Eclipse of the Sun

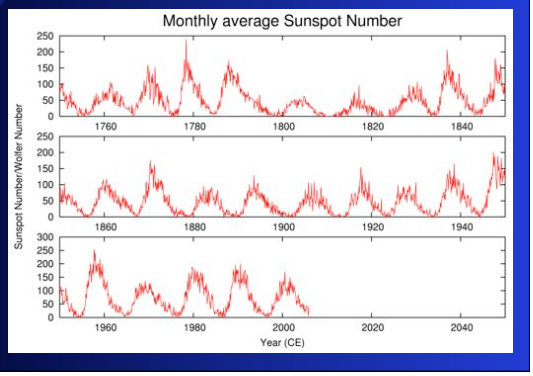
13 Sunspot Cycle

Total Eclipse of the Sun



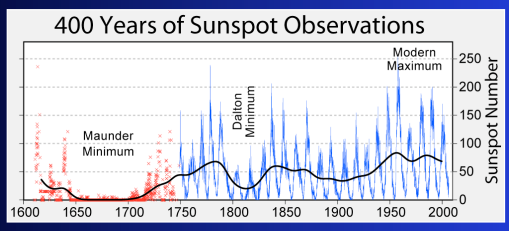
14 Sunspot Cycle

Total Eclipse of the Sun



15 Sunspot Cycle

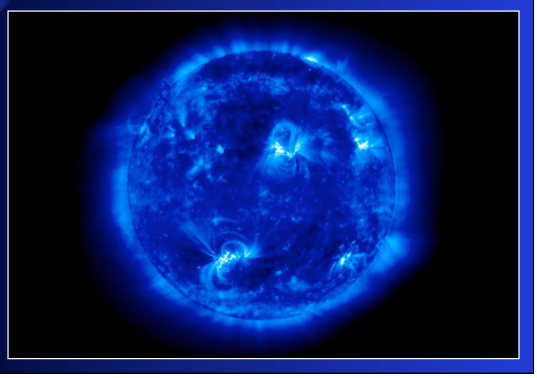
Total Eclipse of the Sun



50 years of very low sunspot activity coincided with the 'Little Ice Age' period of very cold winters

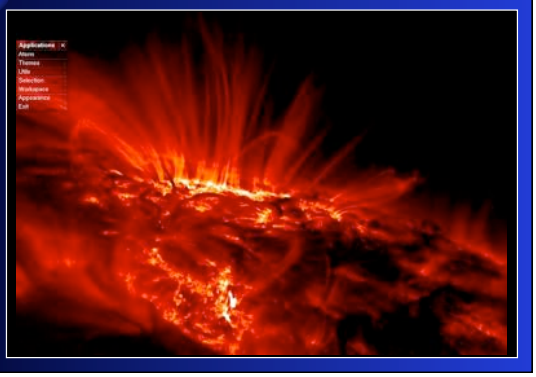
16 Magnetic Loops

Total Eclipse of the Sun



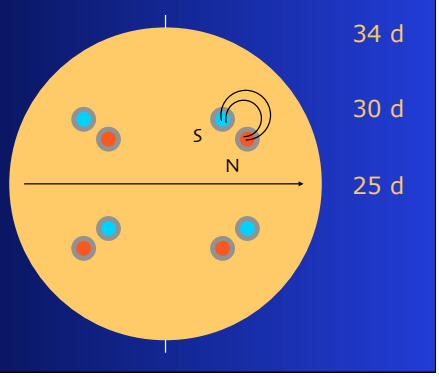
17 Magnetic Loops

Total Eclipse of the Sun



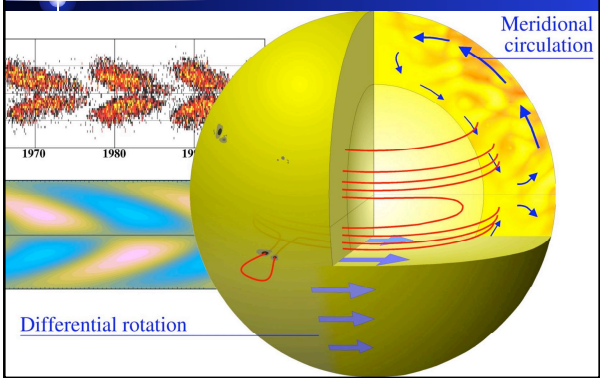
18 Magnetic Polarity

Total Eclipse of the Sun



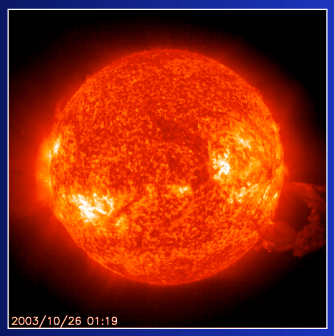
Total Eclipse of the Sun

19 Differential Rotation



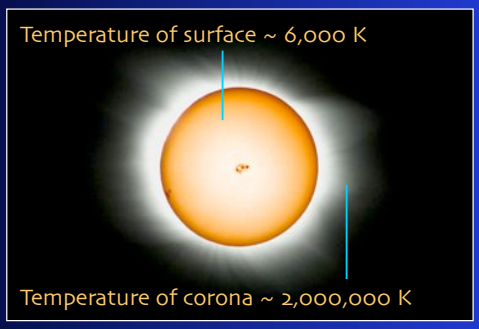
20 Flares and Prominences

Total Eclipse of the Sun



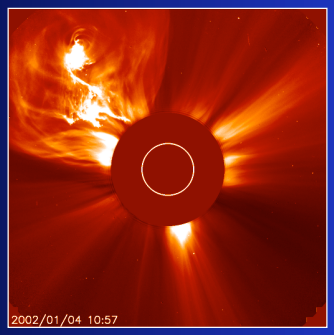
21 Corona

Total Eclipse of the Sun



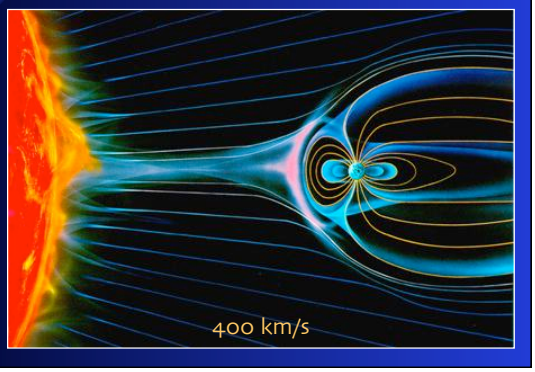
22 Corona

Total Eclipse of the Sun



23 Solar Wind

Total Eclipse of the Sun



24 Aurora Borealis

Total Eclipse of the Sun

Total Eclipse of the Sun

25 Aurora Borealis

Total Eclipse of the Sun

26 Eclipses

Eclipse

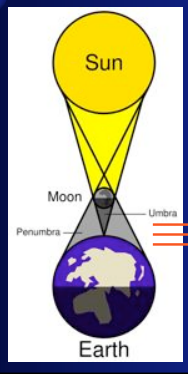
The passage of one object into the shadow cast by another.
Thus an *Eclipse of the Sun* should be called an *Eclipse of the Earth*.

Occultation

The passage of one object in front of another, hiding the latter from view.

Total Eclipse of the Sun

28 Eclipses



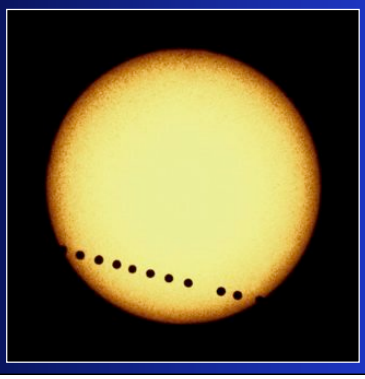
Total Eclipse (long)

Total Eclipse (short)

Annular Eclipse

Total Eclipse of the Sun

29 Transit of Venus 2004



Total Eclipse of the Sun

30 Eclipse Geometry

An eclipse cannot occur at every New Moon because the Moon's orbit is **tilted** by ~5°.

Total Eclipse of the Sun

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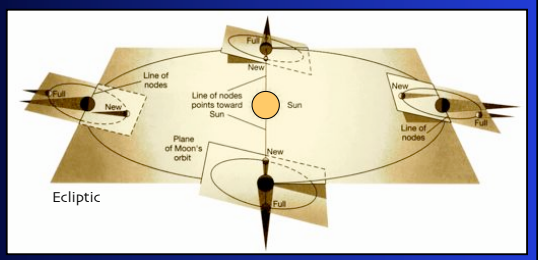
31 Eclipse Geometry



The Moon crosses the plane of the Earth's orbit (the Ecliptic) at a **node**.

32 Eclipse Timing

Synodic Month	
New Moon to New Moon	29.53 days
Draconic Month	
Node to Node	27.21 days
Anomalistic Month	
Perigee to Perigee	27.55 days

33 The Saros Cycle

223 Synodic months =	6585.32 days
242 Draconic months =	6585.36 days
239 Anomalistic months =	6585.54 days

Over this time, the **saros** cycle, the Moon's orbital periods are back in 'synch'.

Two eclipses separated by one saros cycle have similar geometries.

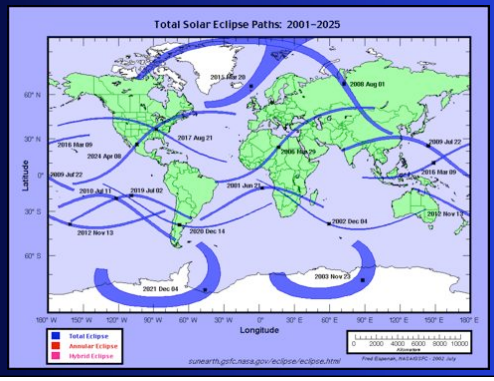
34 Saros 139

Date	ØM/ØS	Length	Seen from
1988 Mar 18	1.046	$3^m 46^s$	Asia
2006 Mar 29	1.052	$4^m 07^s$	Africa
2024 Apr 08	1.057	$4^m 28^s$	Americas
2042 Apr 20	1.061	$4^m 51^s$	Asia
2060 Apr 30	1.066	$5^m 15^s$	Africa
2078 May 11	1.070	$5^m 40^s$	Americas
2096 May 22	1.074	$6^m 06^s$	Asia

35 Eclipses Coming Soon

Date	Saros	Length	Seen from
2006 Mar 29	139	$4^m 07^s$	Africa, Turkey
2008 Aug 01	126	$2^m 27^s$	Greenland, Siberia
2009 Jul 22	136	$6^m 39^s$	India, China
2010 Jul 11	146	$5^m 20^s$	S Pacific, S America
2012 Nov 13	133	$4^m 02^s$	Australia, S Pacific
2013 Nov 03	143	$1^m 40^s$	Africa

36 Eclipses



Total Eclipse of the Sun

37 Eclipses

Total Eclipse of the Sun

1715

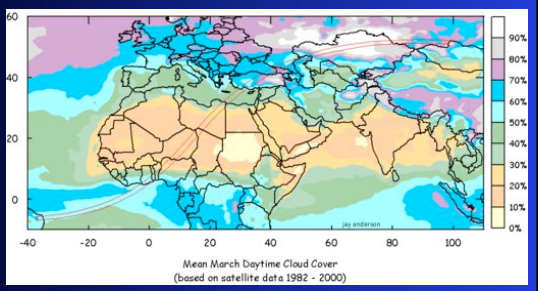
1724

38 Total Eclipse of 29 Mar 2006

Total Eclipse of the Sun

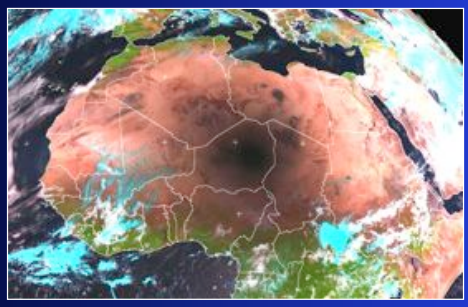
39 Total Eclipse of 29 Mar 2006

Total Eclipse of the Sun



40 Total Eclipse of 29 Mar 2006

Total Eclipse of the Sun



41 Total Eclipse of 29 Mar 2006

Total Eclipse of the Sun

42 Eclipse Cruise

Total Eclipse of the Sun

Total Eclipse of the Sun

43 Libya

Total Eclipse of the Sun

44 Libya

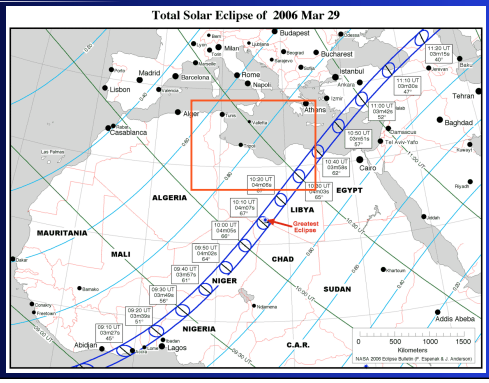
Total Eclipse of the Sun

45 Eclipse Glasses

Total Eclipse of the Sun

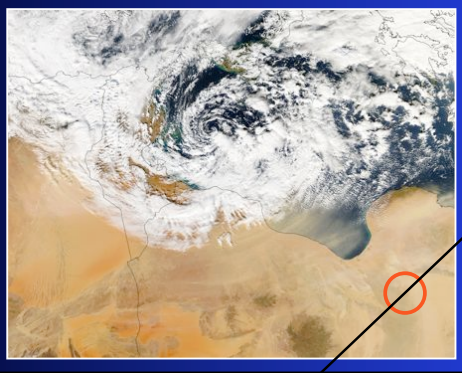
46 Eclipse Track

Total Eclipse of the Sun



47 Eclipse Site

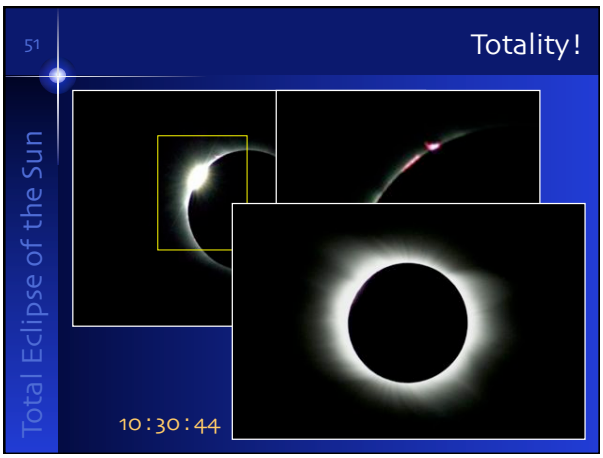
Total Eclipse of the Sun

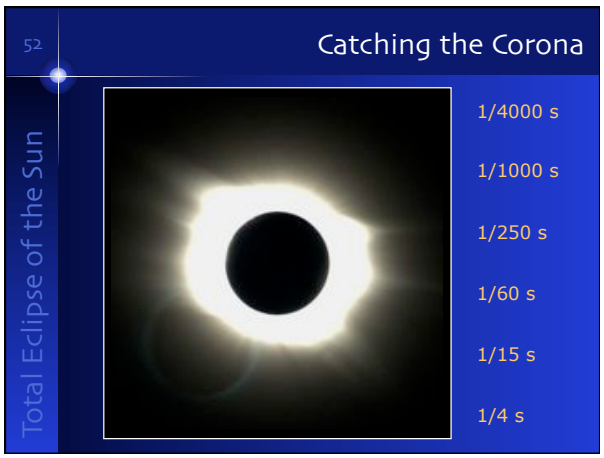


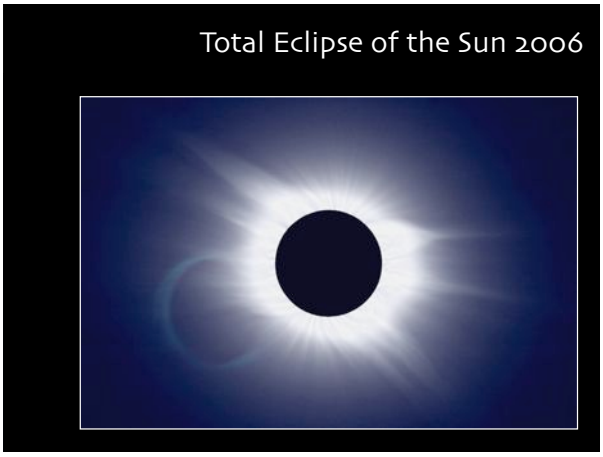
48 Eclipse Track

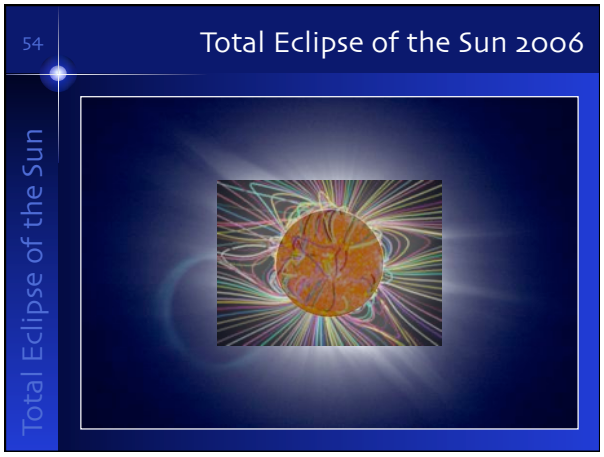
Total Eclipse of the Sun

Total Eclipse of the Sun









Total Eclipse of the Sun