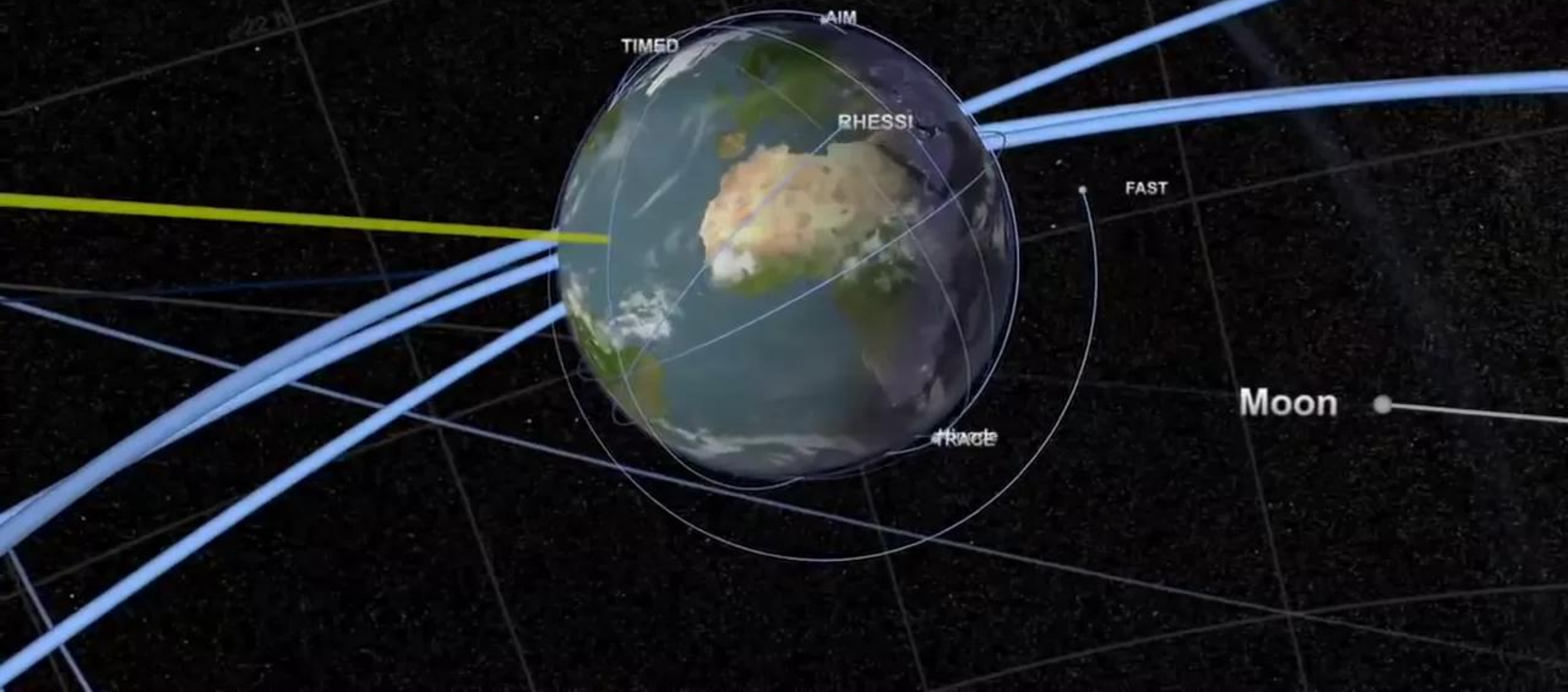


Jun 20, 2008

14:59 UT



1  
00:00:13,430 --> 00:00:11,030  
between the earth and the sun we tend to

2  
00:00:15,030 --> 00:00:13,440  
imagine empty space

3  
00:00:18,310 --> 00:00:15,040  
but every day

4  
00:00:23,189 --> 00:00:18,320  
every moment solar forces fill the void

5  
00:00:28,070 --> 00:00:25,349  
the grey mesh you see here is the

6  
00:00:30,390 --> 00:00:28,080  
magnetosphere it's effectively a bubble

7  
00:00:33,430 --> 00:00:30,400  
around the earth created by our planet's

8  
00:00:35,830 --> 00:00:33,440  
magnetic field squashed and elongated as

9  
00:00:37,350 --> 00:00:35,840  
intensely energized solar particles

10  
00:00:39,910 --> 00:00:37,360  
collide with it without the

11  
00:00:40,869 --> 00:00:39,920  
magnetosphere life on earth would likely

12  
00:00:42,869 --> 00:00:40,879  
cease

13  
00:00:45,510 --> 00:00:42,879

naturally we want to know more about it

14

00:00:47,750 --> 00:00:45,520

so let's start close to home

15

00:00:49,990 --> 00:00:47,760

these near-earth satellites monitor

16

00:00:52,389 --> 00:00:50,000

solar activity interactions with our

17

00:00:54,150 --> 00:00:52,399

planet's atmosphere and other aspects of

18

00:00:55,750 --> 00:00:54,160

the sun's condition

19

00:00:58,389 --> 00:00:55,760

you'll notice how they orbit the earth

20

00:00:59,349 --> 00:00:58,399

quickly about once every 90 minutes or

21

00:01:01,830 --> 00:00:59,359

so

22

00:01:03,830 --> 00:01:01,840

remember this because the rate of times

23

00:01:06,550 --> 00:01:03,840

passage will change as we move through

24

00:01:08,710 --> 00:01:06,560

the solar system

25

00:01:10,469 --> 00:01:08,720

further away we see satellites measuring

26

00:01:12,710 --> 00:01:10,479

the three-dimensional boundaries of the

27

00:01:14,870 --> 00:01:12,720

magnetosphere as it interacts with the

28

00:01:17,190 --> 00:01:14,880

solar wind

29

00:01:20,070 --> 00:01:17,200

and let's be clear this is more than an

30

00:01:22,149 --> 00:01:20,080

academic exercise nasa's fleet of

31

00:01:23,350 --> 00:01:22,159

research satellites gathers vital

32

00:01:25,030 --> 00:01:23,360

information

33

00:01:27,190 --> 00:01:25,040

solar phenomena can jeopardize

34

00:01:29,590 --> 00:01:27,200

astronauts and provoke dramatic

35

00:01:32,710 --> 00:01:29,600

challenges to communications systems and

36

00:01:35,030 --> 00:01:32,720

the electrical grid on the ground

37

00:01:37,350 --> 00:01:35,040

time speeds up as we move out

38

00:01:39,830 --> 00:01:37,360

more space between objects means we have

39

00:01:42,149 --> 00:01:39,840

to travel greater distances and our tour

40

00:01:43,429 --> 00:01:42,159

of the heliosphere only lasts a few

41

00:01:45,270 --> 00:01:43,439

minutes

42

00:01:47,030 --> 00:01:45,280

while we're traveling take note of

43

00:01:47,990 --> 00:01:47,040

something you might not have considered

44

00:01:50,710 --> 00:01:48,000

before

45

00:01:53,270 --> 00:01:50,720

not all orbits look the same

46

00:01:54,550 --> 00:01:53,280

in close satellite paths essentially

47

00:01:56,950 --> 00:01:54,560

circle the earth

48

00:01:59,510 --> 00:01:56,960

but farther away we begin to encounter a

49

00:02:01,350 --> 00:01:59,520

wider variety of orbits designed for

50

00:02:03,270 --> 00:02:01,360

varying purposes

51  
00:02:05,190 --> 00:02:03,280  
the cluster vehicles are on a high

52  
00:02:09,029 --> 00:02:05,200  
elliptical flight path

53  
00:02:11,270 --> 00:02:09,039  
geotail makes a lazy loop all alone

54  
00:02:13,589 --> 00:02:11,280  
the two stereo satellites fly in

55  
00:02:15,830 --> 00:02:13,599  
relatively close formation but they

56  
00:02:18,070 --> 00:02:15,840  
won't stay that way for long

57  
00:02:20,869 --> 00:02:18,080  
i'll show you how in a moment but the

58  
00:02:24,150 --> 00:02:20,879  
point is navigation out here is harder

59  
00:02:26,390 --> 00:02:24,160  
than it looks a vehicle can't simply fly

60  
00:02:29,830 --> 00:02:26,400  
from place to place but for some

61  
00:02:31,910 --> 00:02:29,840  
missions like stereo precise position

62  
00:02:32,869 --> 00:02:31,920  
makes all the difference

63  
00:02:35,350 --> 00:02:32,879

why

64

00:02:38,070 --> 00:02:35,360

the two stereo satellites will deliver

65

00:02:41,350 --> 00:02:38,080

3d pictures of the sun similar to the

66

00:02:43,110 --> 00:02:41,360

way your two eyes perceive 3d

67

00:02:45,190 --> 00:02:43,120

remember i said to keep an eye on

68

00:02:47,589 --> 00:02:45,200

stereo's flight path

69

00:02:49,509 --> 00:02:47,599

watch as one of the two stereo vehicles

70

00:02:50,550 --> 00:02:49,519

intercepts the moon's orbit a second

71

00:02:52,150 --> 00:02:50,560

time

72

00:02:53,670 --> 00:02:52,160

here it comes

73

00:02:55,990 --> 00:02:53,680

as they close the distance the

74

00:02:58,630 --> 00:02:56,000

spacecraft uses the moon's gravity to

75

00:03:00,790 --> 00:02:58,640

execute a cool maneuver like a roller

76  
00:03:03,190 --> 00:03:00,800  
coaster zooming up and into a corkscrew

77  
00:03:04,790 --> 00:03:03,200  
just after hitting a big drop

78  
00:03:06,309 --> 00:03:04,800  
now the vehicles are headed to their

79  
00:03:08,470 --> 00:03:06,319  
final orbits

80  
00:03:11,190 --> 00:03:08,480  
tight loops around the earth loose

81  
00:03:13,830 --> 00:03:11,200  
orbits out into space bank shots off the

82  
00:03:16,710 --> 00:03:13,840  
moon there are many ways to travel from

83  
00:03:20,309 --> 00:03:16,720  
place to place but sometimes travel is

84  
00:03:22,390 --> 00:03:20,319  
not the goal sometimes it pays to park

85  
00:03:25,270 --> 00:03:22,400  
welcome to a lagrange point

86  
00:03:27,270 --> 00:03:25,280  
this one L1 in space speak denotes a

87  
00:03:29,509 --> 00:03:27,280  
relative position between the earth and

88  
00:03:32,550 --> 00:03:29,519

the sun where the gravitational pull of

89

00:03:35,509 --> 00:03:32,560

each object is in approximate balance

90

00:03:37,750 --> 00:03:35,519

these so-called halo orbits around l1

91

00:03:40,070 --> 00:03:37,760

make good places for hovering spacecraft

92

00:03:41,190 --> 00:03:40,080

to take observations of either the earth

93

00:03:42,949 --> 00:03:41,200

or sun

94

00:03:44,550 --> 00:03:42,959

we find a number of observatories

95

00:03:46,710 --> 00:03:44,560

patrolling out here

96

00:03:49,030 --> 00:03:46,720

including an extremely famous and

97

00:03:50,470 --> 00:03:49,040

extremely successful solar observatory

98

00:03:52,869 --> 00:03:50,480

called soho

99

00:03:54,390 --> 00:03:52,879

notice how l1 exists well in front of

100

00:03:56,390 --> 00:03:54,400

the magnetosphere

101

00:03:58,630 --> 00:03:56,400

this part of the solar system is fully

102

00:04:01,190 --> 00:03:58,640

bathed in the solar wind without the

103

00:04:03,350 --> 00:04:01,200

protection of earth's magnetic shield

104

00:04:05,509 --> 00:04:03,360

therefore it's extremely useful for

105

00:04:10,710 --> 00:04:05,519

studying solar activity without

106

00:04:15,990 --> 00:04:13,030

let's briefly revisit the area around

107

00:04:18,710 --> 00:04:16,000

the earth simulated time slows again as

108

00:04:20,870 --> 00:04:18,720

the distance between objects shrinks

109

00:04:23,030 --> 00:04:20,880

but as we once again approach our home

110

00:04:24,469 --> 00:04:23,040

you'll notice the calendar has advanced

111

00:04:26,550 --> 00:04:24,479

two years

112

00:04:29,189 --> 00:04:26,560

new satellites have entered the dance

113

00:04:31,030 --> 00:04:29,199

including the five themis vehicles

114

00:04:33,749 --> 00:04:31,040

the near-earth fleet of satellites

115

00:04:35,990 --> 00:04:33,759

swarms like bees around a hive some

116

00:04:37,909 --> 00:04:36,000

ranging out beyond the magnetosphere

117

00:04:40,230 --> 00:04:37,919

somewhere inside

118

00:04:42,790 --> 00:04:40,240

it's provocative to consider that all

119

00:04:46,150 --> 00:04:42,800

this activity takes place in space

120

00:04:49,110 --> 00:04:46,160

something we generally perceive as empty

121

00:04:51,590 --> 00:04:49,120

but what we find instead from light to

122

00:04:53,909 --> 00:04:51,600

charged particles to magnetic fields

123

00:04:55,830 --> 00:04:53,919

demonstrates a strange and wonderful

124

00:04:57,909 --> 00:04:55,840

solar vitality

125

00:04:59,830 --> 00:04:57,919

in fact there's a particular scientific

126

00:05:01,270 --> 00:04:59,840

discipline that describes the study of

127

00:05:03,909 --> 00:05:01,280

these things

128

00:05:06,310 --> 00:05:03,919

it's heliophysics from the greek word

129

00:05:09,590 --> 00:05:06,320

for sun combined with the word used to

130

00:05:11,670 --> 00:05:09,600

describe the study of matter and energy

131

00:05:13,670 --> 00:05:11,680

heliophysics studies how the sun's

132

00:05:16,310 --> 00:05:13,680

sphere of influence interacts with

133

00:05:19,270 --> 00:05:16,320

planets and the interstellar medium the

134

00:05:22,710 --> 00:05:19,280

barely tangible stuff that fills what we

135

00:05:25,029 --> 00:05:22,720

typically regard as empty space

136

00:05:26,790 --> 00:05:25,039

almost done but we've got to get moving

137

00:05:28,950 --> 00:05:26,800

if we're going to see the full extent of

138

00:05:31,430 --> 00:05:28,960

the sun's influence

139

00:05:34,390 --> 00:05:31,440

pulling way way back earth's

140

00:05:36,950 --> 00:05:34,400

magnetosphere effectively disappears

141

00:05:39,590 --> 00:05:36,960

almost all of our solar observing fleet

142

00:05:40,710 --> 00:05:39,600

shrinks like boats on the horizon

143

00:05:43,110 --> 00:05:40,720

almost

144

00:05:46,710 --> 00:05:43,120

but not all

145

00:05:49,670 --> 00:05:46,720

two legendary spacecraft voyager 1 and 2

146

00:05:51,749 --> 00:05:49,680

are out there still taking measurements

147

00:05:53,590 --> 00:05:51,759

notice the gravity assist bank shots and

148

00:05:57,029 --> 00:05:53,600

their flight paths

149

00:05:59,350 --> 00:05:57,039

launched in 1977 the voyager spacecraft

150

00:06:01,670 --> 00:05:59,360

are the most distant artifacts humanity

151  
00:06:05,029 --> 00:06:01,680  
has ever cast out into space

152  
00:06:07,029 --> 00:06:05,039  
time capsules from a small blue planet

153  
00:06:09,350 --> 00:06:07,039  
they are also the first human objects to

154  
00:06:11,590 --> 00:06:09,360  
encounter the sun's termination shock

155  
00:06:13,430 --> 00:06:11,600  
the area where the solar wind slows down

156  
00:06:15,350 --> 00:06:13,440  
enough to be affected by the flow of

157  
00:06:17,029 --> 00:06:15,360  
interstellar particles

158  
00:06:18,710 --> 00:06:17,039  
in a couple of decades one of the

159  
00:06:21,189 --> 00:06:18,720  
voyager crafts should pass the

160  
00:06:23,670 --> 00:06:21,199  
heliopause the zone where the sun's

161  
00:06:25,270 --> 00:06:23,680  
influence meets the interstellar medium

162  
00:06:27,830 --> 00:06:25,280  
years later it should encounter the

163  
00:06:29,990 --> 00:06:27,840

so-called bow shock that's the wake and

164

00:06:31,749 --> 00:06:30,000

flowing interstellar particles as they

165

00:06:34,550 --> 00:06:31,759

move around the bubble of energy and

166

00:06:37,189 --> 00:06:34,560

particles emanating from our star

167

00:06:39,590 --> 00:06:37,199

our star the sun

168

00:06:42,710 --> 00:06:39,600

neither particularly large nor powerful

169

00:06:45,590 --> 00:06:42,720

as stars go stretches itself out further

170

00:06:47,830 --> 00:06:45,600

than even our most distant probes

171

00:06:50,309 --> 00:06:47,840

as we discover how to coexist with our

172

00:06:53,270 --> 00:06:50,319

own solar dynamo we stretch our