



1
00:00:19,750 --> 00:00:16,950
in his epic saga the inferno the italian

2
00:00:21,830 --> 00:00:19,760
poet dante tells of ulysses the greek

3
00:00:25,029 --> 00:00:21,840
hero who fought in the trojan war and

4
00:00:27,910 --> 00:00:25,039
spent 20 adventurous years wandering the

5
00:00:30,870 --> 00:00:27,920
earth before returning home

6
00:00:33,350 --> 00:00:30,880
but as dante relates it ulysses bored

7
00:00:35,510 --> 00:00:33,360
with domestic life set off on still

8
00:00:37,830 --> 00:00:35,520
another voyage of discovery

9
00:00:42,950 --> 00:00:37,840
a voids taught an uninhabited world

10
00:00:47,830 --> 00:00:45,990
in october of 1990 another ulysses will

11
00:00:49,670 --> 00:00:47,840
begin an unprecedented voyage of

12
00:00:52,869 --> 00:00:49,680
exploration

13
00:00:55,029 --> 00:00:52,879

this modern ulysses is a spacecraft

14

00:00:57,430 --> 00:00:55,039

bound for a region of our solar system

15

00:01:13,030 --> 00:00:57,440

never before explored

16

00:01:18,950 --> 00:01:14,870

stars

17

00:01:21,350 --> 00:01:18,960

uncounted billions grace our night skies

18

00:01:22,390 --> 00:01:21,360

but only one holds dominion over the

19

00:01:25,670 --> 00:01:22,400

earth

20

00:01:27,190 --> 00:01:25,680

it is the star we call the sun

21

00:01:28,550 --> 00:01:27,200

the giver of light

22

00:01:30,550 --> 00:01:28,560

of warmth

23

00:01:34,630 --> 00:01:30,560

of life itself

24

00:01:37,030 --> 00:01:34,640

the ancients called it the perfect fire

25

00:01:39,350 --> 00:01:37,040

the sun is the only star we can see in

26

00:01:41,749 --> 00:01:39,360

the daytime and the only one close

27

00:01:43,910 --> 00:01:41,759

enough to study in detail

28

00:01:46,710 --> 00:01:43,920

it therefore provides scientists a

29

00:01:48,950 --> 00:01:46,720

unique window for the study of stars

30

00:01:52,310 --> 00:01:48,960

and the complex processes that go on

31

00:01:55,109 --> 00:01:52,320

within and around them

32

00:01:57,749 --> 00:01:55,119

in recent decades astronomers aided by

33

00:02:00,950 --> 00:01:57,759

increasingly sophisticated instruments

34

00:02:03,510 --> 00:02:00,960

some earth-based some lofted into space

35

00:02:05,830 --> 00:02:03,520

above earth's obscuring atmosphere

36

00:02:17,190 --> 00:02:05,840

have found our sun to be an exceedingly

37

00:02:21,430 --> 00:02:19,110

but scientists have never been able to

38

00:02:23,589 --> 00:02:21,440

observe a most important region of the

39

00:02:25,589 --> 00:02:23,599

sun its poles

40

00:02:27,589 --> 00:02:25,599

even instruments on spacecraft are

41

00:02:28,630 --> 00:02:27,599

unable to see over the top of this great

42

00:02:30,630 --> 00:02:28,640

sphere

43

00:02:32,630 --> 00:02:30,640

that's because until now we could study

44

00:02:33,509 --> 00:02:32,640

the sun only from within the ecliptic

45

00:02:41,350 --> 00:02:33,519

plane

46

00:02:46,070 --> 00:02:43,430

yet scientists think our understanding

47

00:02:50,229 --> 00:02:46,080

of the sun would be vastly increased if

48

00:02:52,949 --> 00:02:50,239

we could observe it from above its poles

49

00:02:55,350 --> 00:02:52,959

that is the goal of ulysses a joint

50

00:02:57,910 --> 00:02:55,360

mission between nasa and the european

51
00:03:00,550 --> 00:02:57,920
space agency eason

52
00:03:01,589 --> 00:03:00,560
willis meeks is american ulysses project

53
00:03:03,430 --> 00:03:01,599
manager

54
00:03:05,350 --> 00:03:03,440
ulysses is a one of a kind mission in

55
00:03:07,670 --> 00:03:05,360
that it's the first time that we have a

56
00:03:09,990 --> 00:03:07,680
chance to fly spacecraft over the sun's

57
00:03:11,670 --> 00:03:10,000
poles to give us a look at the solar

58
00:03:14,390 --> 00:03:11,680
system from that direction

59
00:03:15,910 --> 00:03:14,400
we're also going to look at the total

60
00:03:17,270 --> 00:03:15,920
sun's environment

61
00:03:19,830 --> 00:03:17,280
we're studying something called a

62
00:03:22,309 --> 00:03:19,840
heliosphere which is made up of all the

63
00:03:25,430 --> 00:03:22,319

things influenced by our sun

64

00:03:27,910 --> 00:03:25,440

it's a joint mission with nasa and the

65

00:03:29,589 --> 00:03:27,920

european space agency the europeans

66

00:03:31,990 --> 00:03:29,599

provide a spacecraft

67

00:03:33,110 --> 00:03:32,000

we provide a launch vehicle and a launch

68

00:03:35,190 --> 00:03:33,120

facility

69

00:03:37,430 --> 00:03:35,200

the science investigations are split

70

00:03:38,869 --> 00:03:37,440

right down the middle the instruments

71

00:03:40,630 --> 00:03:38,879

there are nine of them hardware

72

00:03:42,789 --> 00:03:40,640

instruments we provide half and the

73

00:03:44,229 --> 00:03:42,799

europeans provide the other half

74

00:03:55,190 --> 00:03:44,239

the mission will be flown from right

75

00:04:01,429 --> 00:03:59,270

launch is scheduled for october 1990.

76

00:04:03,589 --> 00:04:01,439

the american space shuttle discovery

77

00:04:05,110 --> 00:04:03,599

will first carry ulysses into orbit

78

00:04:07,190 --> 00:04:05,120

around the earth

79

00:04:10,470 --> 00:04:07,200

there ulysses will be released from the

80

00:04:13,750 --> 00:04:12,309

after the shuttle has withdrawn to a

81

00:04:16,310 --> 00:04:13,760

safe distance

82

00:04:20,390 --> 00:04:16,320

two powerful rocket motors will fire and

83

00:04:23,830 --> 00:04:22,550

it will take nearly four years to get to

84

00:04:25,909 --> 00:04:23,840

the sun

85

00:04:28,150 --> 00:04:25,919

this long journey is made necessary by

86

00:04:29,590 --> 00:04:28,160

the earth's own orbital motion around

87

00:04:32,150 --> 00:04:29,600

the sun

88

00:04:34,070 --> 00:04:32,160

dr edgar page european science

89

00:04:36,230 --> 00:04:34,080

coordinator explains

90

00:04:38,950 --> 00:04:36,240

well getting out of the ecliptic plane

91

00:04:40,870 --> 00:04:38,960

is not very easy it requires a lot of

92

00:04:42,469 --> 00:04:40,880

launch vehicle energy

93

00:04:44,870 --> 00:04:42,479

and i suppose that's one of the reasons

94

00:04:47,189 --> 00:04:44,880

we haven't done the mission before now

95

00:04:49,030 --> 00:04:47,199

now what's the reason for this well most

96

00:04:51,590 --> 00:04:49,040

normal launches

97

00:04:53,990 --> 00:04:51,600

take advantage of the orbital velocity

98

00:04:55,030 --> 00:04:54,000

of the earth they go along in the same

99

00:04:57,030 --> 00:04:55,040

direction

100

00:04:59,110 --> 00:04:57,040

but this time of course we can't do that

101
00:05:01,270 --> 00:04:59,120
we have to get ourselves perpendicular

102
00:05:03,670 --> 00:05:01,280
to the velocity of the earth we want out

103
00:05:06,310 --> 00:05:03,680
of the ecliptic plane

104
00:05:08,550 --> 00:05:06,320
now the energy available from even a

105
00:05:11,029 --> 00:05:08,560
nasa shuttle launch is not sufficient to

106
00:05:13,350 --> 00:05:11,039
do that so we have to ask for some help

107
00:05:17,430 --> 00:05:13,360
and we get that from the giant planet

108
00:05:21,110 --> 00:05:19,990
we start from earth we go fast towards

109
00:05:28,070 --> 00:05:21,120
jupiter

110
00:05:31,270 --> 00:05:28,080
grabs us and pulls us around from its

111
00:05:32,390 --> 00:05:31,280
north pole to its south pole and sends

112
00:05:34,550 --> 00:05:32,400
us off

113
00:05:36,390 --> 00:05:34,560

south of the ecliptic plain back towards

114

00:05:37,830 --> 00:05:36,400

the sun

115

00:05:40,150 --> 00:05:37,840

throughout the mission

116

00:05:42,870 --> 00:05:40,160

nasa's deep space network will track

117

00:05:45,430 --> 00:05:42,880

ulysses receiving data from previously

118

00:05:53,430 --> 00:05:45,440

unexplored regions of our solar system

119

00:05:58,469 --> 00:05:55,590

scientists are sure to reap a rich

120

00:06:00,790 --> 00:05:58,479

scientific harvest as ulysses and its

121

00:06:09,189 --> 00:06:00,800

nine instruments explore previously

122

00:06:14,469 --> 00:06:11,909

basically we're interested in uh

123

00:06:16,790 --> 00:06:14,479

making observations over the poles of

124

00:06:18,390 --> 00:06:16,800

the sun something which has never been

125

00:06:20,469 --> 00:06:18,400

done before

126

00:06:21,990 --> 00:06:20,479

we have a lot of reasons for

127

00:06:24,230 --> 00:06:22,000

wanting to do that

128

00:06:25,350 --> 00:06:24,240

and many reasons for thinking that

129

00:06:26,469 --> 00:06:25,360

conditions

130

00:06:27,909 --> 00:06:26,479

in that

131

00:06:29,909 --> 00:06:27,919

particular region of space are going to

132

00:06:31,510 --> 00:06:29,919

be very different than the kinds of

133

00:06:33,350 --> 00:06:31,520

conditions we've been sampling over the

134

00:06:36,070 --> 00:06:33,360

last 20 or 30 years

135

00:06:38,870 --> 00:06:36,080

we have been making measurements

136

00:06:40,390 --> 00:06:38,880

in a flat two-dimensional plane

137

00:06:41,670 --> 00:06:40,400

when the object we're really trying to

138

00:06:43,430 --> 00:06:41,680

understand is basically

139

00:06:45,909 --> 00:06:43,440

three-dimensional

140

00:06:47,510 --> 00:06:45,919

and the object of this mission now is to

141

00:06:49,110 --> 00:06:47,520

extend our knowledge into that third

142

00:06:51,110 --> 00:06:49,120

dimension

143

00:06:53,830 --> 00:06:51,120

once we have that knowledge we'll be in

144

00:06:57,029 --> 00:06:53,840

a better position to reevaluate the

145

00:06:59,830 --> 00:06:57,039

complicated conditions that we find near

146

00:07:02,309 --> 00:06:59,840

the solar equator

147

00:07:04,870 --> 00:07:02,319

its mission will carry ulysses over both

148

00:07:07,749 --> 00:07:04,880

of the sun's poles to probe the sun's

149

00:07:11,029 --> 00:07:07,759

corona the diaphanous crown that we see

150

00:07:13,830 --> 00:07:11,039

only during an eclipse

151

00:07:16,950 --> 00:07:13,840

the solar wind a gale of charged

152

00:07:19,270 --> 00:07:16,960

particles that stream away from the sun

153

00:07:22,550 --> 00:07:19,280

and the tangled magnetic field which is

154

00:07:25,270 --> 00:07:22,560

carried into space by the solar wind

155

00:07:27,990 --> 00:07:25,280

finally some of ulysses instruments will

156

00:07:30,469 --> 00:07:28,000

detect and measure cosmic rays coming

157

00:07:34,070 --> 00:07:30,479

from the deeper reaches of our milky way

158

00:07:38,629 --> 00:07:36,629

the sun as we've come to know is far

159

00:07:40,390 --> 00:07:38,639

from being the perfect fire the ancients

160

00:07:43,510 --> 00:07:40,400

believed it to be

161

00:07:44,869 --> 00:07:43,520

it is instead a seething thermonuclear

162

00:07:47,430 --> 00:07:44,879

cauldron

163

00:07:50,309 --> 00:07:47,440

vast quantities of energy burst from the

164

00:07:51,909 --> 00:07:50,319

interior to create unimaginable turmoil

165

00:07:54,070 --> 00:07:51,919

at the surface

166

00:07:57,350 --> 00:07:54,080

and as the energy pours outward across

167

00:07:59,749 --> 00:07:57,360

space it carries ever-shifting electric

168

00:08:02,950 --> 00:07:59,759

and magnetic fields throughout the solar

169

00:08:08,550 --> 00:08:05,189

what complicates matters even more is

170

00:08:11,029 --> 00:08:08,560

that the sun rotates every 27 days

171

00:08:13,990 --> 00:08:11,039

and material at the equator rotates

172

00:08:15,350 --> 00:08:14,000

faster than material at the poles

173

00:08:17,830 --> 00:08:15,360

as a result

174

00:08:20,230 --> 00:08:17,840

the sun's magnetic and electrical fields

175

00:08:23,589 --> 00:08:20,240

at the equator become tangled and

176

00:08:25,670 --> 00:08:23,599

hopelessly complex

177

00:08:28,230 --> 00:08:25,680

still more complexities arise in the

178

00:08:30,710 --> 00:08:28,240

constantly shifting corona

179

00:08:32,389 --> 00:08:30,720

even before spacecraft scientists

180

00:08:34,389 --> 00:08:32,399

theorized that there was a strong

181

00:08:36,709 --> 00:08:34,399

relation between the corona and the

182

00:08:38,550 --> 00:08:36,719

solar wind

183

00:08:40,709 --> 00:08:38,560

this relation became clear after

184

00:08:42,310 --> 00:08:40,719

spacecraft made it possible to observe

185

00:08:44,070 --> 00:08:42,320

the sun from above the earth's

186

00:08:46,949 --> 00:08:44,080

atmosphere

187

00:08:49,030 --> 00:08:46,959

that's when scientists discovered huge

188

00:08:51,750 --> 00:08:49,040

tears in the corona

189

00:08:55,350 --> 00:08:51,760

these coronal holes here seen as dark

190

00:08:57,670 --> 00:08:55,360

patches are the source of the solar wind

191

00:09:00,070 --> 00:08:57,680

low and high energy particles burst

192

00:09:02,550 --> 00:09:00,080

outward from these vast regions at

193

00:09:04,870 --> 00:09:02,560

speeds of up to a thousand kilometers

194

00:09:06,790 --> 00:09:04,880

per second

195

00:09:09,190 --> 00:09:06,800

solar wind particles move at many

196

00:09:11,110 --> 00:09:09,200

different speeds and so the fast

197

00:09:13,590 --> 00:09:11,120

particles bunch up behind the slower

198

00:09:15,990 --> 00:09:13,600

ones and overtake them

199

00:09:17,829 --> 00:09:16,000

the result is a traffic jam that snarls

200

00:09:20,470 --> 00:09:17,839

the magnetic field lines around the

201
00:09:23,190 --> 00:09:20,480
sun's equator into a tangle that twists

202
00:09:26,470 --> 00:09:23,200
and knots and becomes ever harder to

203
00:09:30,790 --> 00:09:28,710
ulysses scientists will also study

204
00:09:33,670 --> 00:09:30,800
particles that originate during solar

205
00:09:38,710 --> 00:09:36,150
solar flares are the most catastrophic

206
00:09:41,269 --> 00:09:38,720
and energetic events on the sun

207
00:09:43,430 --> 00:09:41,279
the particles they yield have extremely

208
00:09:45,829 --> 00:09:43,440
high energies

209
00:09:46,870 --> 00:09:45,839
these high energy particles explode

210
00:09:49,269 --> 00:09:46,880
outward

211
00:09:51,590 --> 00:09:49,279
leaping from one magnetic field line to

212
00:09:54,790 --> 00:09:51,600
another further distorting the picture

213
00:09:56,949 --> 00:09:54,800

around the sun's equator

214

00:10:00,630 --> 00:09:56,959

but over the poles there should be less

215

00:10:02,790 --> 00:10:00,640

turmoil and therefore greater simplicity

216

00:10:09,350 --> 00:10:02,800

that simplicity should bring valuable

217

00:10:14,230 --> 00:10:11,990

while ulysses is near the poles it will

218

00:10:16,790 --> 00:10:14,240

also measure cosmic rays

219

00:10:19,430 --> 00:10:16,800

particles from dying suns far more

220

00:10:22,069 --> 00:10:19,440

distant than our own

221

00:10:23,670 --> 00:10:22,079

cosmic rays are born in the cataclysm of

222

00:10:26,310 --> 00:10:23,680

supernovas

223

00:10:28,630 --> 00:10:26,320

old stars which suddenly explode with

224

00:10:30,630 --> 00:10:28,640

unimaginable violence

225

00:10:33,670 --> 00:10:30,640

hurled across space with incredible

226

00:10:36,389 --> 00:10:33,680

energy cosmic rays bear the signature of

227

00:10:38,550 --> 00:10:36,399

the events that formed

228

00:10:41,190 --> 00:10:38,560

but cosmic rays entering the solar

229

00:10:43,829 --> 00:10:41,200

system near the equator interact with

230

00:10:44,870 --> 00:10:43,839

the solar wind and the sun's magnetic

231

00:10:47,269 --> 00:10:44,880

field

232

00:10:48,790 --> 00:10:47,279

as a result they are changed so

233

00:10:52,550 --> 00:10:48,800

dramatically as to be nearly

234

00:10:57,590 --> 00:10:55,030

above the poles however cosmic rays

235

00:11:00,150 --> 00:10:57,600

should change very little enabling us to

236

00:11:03,990 --> 00:11:00,160

understand the messages of cosmic events

237

00:11:07,670 --> 00:11:06,230

i sometimes get asked why we do missions

238

00:11:10,310 --> 00:11:07,680

like ulysses

239

00:11:11,910 --> 00:11:10,320

well humans are curious beings and we

240

00:11:13,350 --> 00:11:11,920

like to know what's over the next hill

241

00:11:15,750 --> 00:11:13,360

so to speak

242

00:11:18,310 --> 00:11:15,760

and just like in dante's story ulysses

243

00:11:20,470 --> 00:11:18,320

went off to explore unknown lands

244

00:11:23,269 --> 00:11:20,480

the ulysses spacecraft is our way of

245

00:11:24,949 --> 00:11:23,279

exploring unknown regions of space

246

00:11:26,630 --> 00:11:24,959

and our reward will be a better

247

00:11:28,389 --> 00:11:26,640

understanding of the environment in

248

00:11:30,630 --> 00:11:28,399

which the earth moves