1
00:00:12,230 --> 00:00:09,830
so the moment arrived

2
00:00:14,390 --> 00:00:12,240
the end of the fifth eva

3
00:00:16,630 --> 00:00:14,400
we'd done everything we accomplished all

4
00:00:18,550 --> 00:00:16,640
of our goals all of the instruments we'd

5
00:00:20,950 --> 00:00:18,560
even put on the extra insulation on the

6
00:00:21,910 --> 00:00:20,960
outside of the telescope

7
00:00:24,150 --> 00:00:21,920
and

8
00:00:26,150 --> 00:00:24,160
to my great surprise in that moment when

9
00:00:27,509 --> 00:00:26,160
i gave hubble one last little pat and a

10
00:00:30,310 --> 00:00:27,519
salute

11
00:00:33,110 --> 00:00:30,320
i wasn't sad at all i felt really happy

12
00:00:34,870 --> 00:00:33,120
that we'd accomplished all of our goals

13
00:00:36,870 --> 00:00:34,880

we'd done our job in a little bit more

14
00:00:39,590 --> 00:00:36,880
and we were sending hubble off in the

15
00:00:43,350 --> 00:00:39,600
best shape of its entire career

16
00:00:44,389 --> 00:00:43,360
orbiting 375 miles above earth is a most

17
00:00:46,549 --> 00:00:44,399
extraordinary

18
00:00:49,270 --> 00:00:46,559
scientific tool that has forever changed

19
00:00:51,270 --> 00:00:49,280
our knowledge of the universe

20
00:00:53,270 --> 00:00:51,280
the hubble space telescope is one of the

21
00:00:55,430 --> 00:00:53,280
greatest technological achievements in

22
00:00:57,590 --> 00:00:55,440
human history

23
00:00:59,670 --> 00:00:57,600
for 20 years the world has marveled at

24
00:01:02,549 --> 00:00:59,680
its astonishing images of our dynamic

25
00:01:05,189 --> 00:01:02,559
solar system and the many wonders beyond

26
00:01:06,149 --> 00:01:05,199
jupiter-sized exoplanets orbiting other

27
00:01:08,630 --> 00:01:06,159
suns

28
00:01:11,750 --> 00:01:08,640
exploding stars and nebulas

29
00:01:13,670 --> 00:01:11,760
massive exotic galaxies

30
00:01:15,830 --> 00:01:13,680
these and other discoveries not only

31
00:01:17,749 --> 00:01:15,840
confirmed many scientific theories

32
00:01:20,070 --> 00:01:17,759
including the existence of mysterious

33
00:01:23,190 --> 00:01:20,080
dark matter and star-devouring black

34
00:01:25,270 --> 00:01:23,200
holes but also raised new questions for

35
00:01:26,950 --> 00:01:25,280
scientists to ponder about the origins

36
00:01:29,100 --> 00:01:26,960
of the universe and the endless

37
00:01:40,630 --> 00:01:29,110
diversity of the cosmos

38
00:01:44,550 --> 00:01:42,630

since the dawn of time we've looked

39
00:01:47,190 --> 00:01:44,560
skyward and wondered

40
00:01:48,870 --> 00:01:47,200
how far away are those stars and how

41
00:01:51,510 --> 00:01:48,880
many are there

42
00:01:53,510 --> 00:01:51,520
how did this all begin

43
00:01:56,469 --> 00:01:53,520
are there other worlds like ours out

44
00:02:01,830 --> 00:01:59,270
it was only 400 years ago a mere blink

45
00:02:04,149 --> 00:02:01,840
in the cosmic timeline that galileo

46
00:02:07,270 --> 00:02:04,159
first observed rings and moons on our

47
00:02:09,830 --> 00:02:07,280
neighboring planets saturn and jupiter

48
00:02:12,309 --> 00:02:09,840
this forever dispelled the myth of earth

49
00:02:16,550 --> 00:02:12,319
as the center of everything

50
00:02:21,110 --> 00:02:19,190
as centuries past telescopes became

51
00:02:23,510 --> 00:02:21,120
larger and more powerful

52
00:02:24,600 --> 00:02:23,520
able to observe far beyond the limits of

53
00:02:26,229 --> 00:02:24,610
our eyes

54
00:02:28,630 --> 00:02:26,239
[Music]

55
00:02:32,229 --> 00:02:28,640
in 1924 from atop mount wilson

56
00:02:34,470 --> 00:02:32,239
california the astronomer edwin hubble

57
00:02:37,350 --> 00:02:34,480
first observed that the universe is made

58
00:02:41,270 --> 00:02:37,360
up of billions of galaxies extending

59
00:02:45,509 --> 00:02:43,509
hubble observed that distant galaxies

60
00:02:46,710 --> 00:02:45,519
appeared to be rapidly moving away from

61
00:02:51,830 --> 00:02:46,720
us

62
00:02:53,589 --> 00:02:51,840
between galaxies hubble confirmed their

63
00:02:56,550 --> 00:02:53,599

retreat

64
00:02:58,710 --> 00:02:56,560
in 1946 the acclaimed astronomer lyman

65
00:03:01,270 --> 00:02:58,720
spitzer proposed building a large

66
00:03:02,949 --> 00:03:01,280
telescope to orbit the earth

67
00:03:05,110 --> 00:03:02,959
free of the atmosphere's blurring

68
00:03:07,750 --> 00:03:05,120
effects it would deliver images and

69
00:03:09,830 --> 00:03:07,760
brilliant new clarity you always need

70
00:03:11,910 --> 00:03:09,840
visionaries who can look out into the

71
00:03:13,670 --> 00:03:11,920
future and and think about what's

72
00:03:15,990 --> 00:03:13,680
possible

73
00:03:17,910 --> 00:03:16,000
and the motivation that

74
00:03:20,390 --> 00:03:17,920
lyman spitzer

75
00:03:22,229 --> 00:03:20,400
and others in his footsteps had was

76
00:03:24,470 --> 00:03:22,239
about getting above the earth's

77
00:03:26,630 --> 00:03:24,480
atmosphere

78
00:03:29,270 --> 00:03:26,640
while spitzer's idea was well received

79
00:03:31,430 --> 00:03:29,280
by astronomers it would be more than 30

80
00:03:33,750 --> 00:03:31,440
years before funding was granted to

81
00:03:36,070 --> 00:03:33,760
begin the design and development

82
00:03:38,710 --> 00:03:36,080
it took time for the technology that

83
00:03:40,949 --> 00:03:38,720
people had to catch up to lymon's

84
00:03:43,110 --> 00:03:40,959
initial conception

85
00:03:45,030 --> 00:03:43,120
named in honor of edwin hubble the

86
00:03:47,990 --> 00:03:45,040
orbiting observatory's construction

87
00:03:50,869 --> 00:03:48,000
began in 1978 with the creation of an

88
00:03:52,949 --> 00:03:50,879

enormous nearly eight-foot mirror to

89
00:03:55,030 --> 00:03:52,959
gather light from objects across the

90
00:03:57,270 --> 00:03:55,040
universe

91
00:03:58,710 --> 00:03:57,280
that's kind of the heart the soul of a

92
00:04:00,390 --> 00:03:58,720
telescope it's

93
00:04:01,830 --> 00:04:00,400
it's the thing that collects the light

94
00:04:02,949 --> 00:04:01,840
without the mirror you don't have a

95
00:04:05,030 --> 00:04:02,959
telescope

96
00:04:07,350 --> 00:04:05,040
when completed the hubble space

97
00:04:08,949 --> 00:04:07,360
telescope would contain a wide field and

98
00:04:11,509 --> 00:04:08,959
planetary camera

99
00:04:13,110 --> 00:04:11,519
a high resolution spectrograph high

100
00:04:15,750 --> 00:04:13,120
speed photometer

101
00:04:18,310 --> 00:04:15,760
a faint object camera and spectrograph

102
00:04:21,509 --> 00:04:18,320
all capable of beaming real-time data

103
00:04:23,990 --> 00:04:21,519
back to earth for analysis by scientists

104
00:04:26,469 --> 00:04:24,000
and all contained within a spacecraft as

105
00:04:30,629 --> 00:04:26,479
large as a school bus and weighing more

106
00:04:36,629 --> 00:04:32,870
hubble's journey finally began on april

107
00:04:38,950 --> 00:04:36,639
24th 1990 at nasa's kennedy space center

108
00:04:42,870 --> 00:04:38,960
in florida aboard space shuttle

109
00:04:47,830 --> 00:04:45,749
after a shuddering bone jarring launch

110
00:04:50,790 --> 00:04:47,840
hubble and its precision instruments was

111
00:04:51,990 --> 00:04:50,800
gingerly placed into orbit

112
00:04:54,469 --> 00:04:52,000
i remember

113
00:04:56,550 --> 00:04:54,479

the crew talked for months leading up to

114
00:04:58,310 --> 00:04:56,560
the flight about what the significance

115
00:05:00,070 --> 00:04:58,320
of the flight was going to be there was

116
00:05:02,150 --> 00:05:00,080
a lot of conversation back then among

117
00:05:03,430 --> 00:05:02,160
the scientific community about the big

118
00:05:05,270 --> 00:05:03,440
bang theory

119
00:05:08,710 --> 00:05:05,280
and there were those who believed that

120
00:05:10,469 --> 00:05:08,720
hubble would provide all the answers

121
00:05:12,950 --> 00:05:10,479
among the crew members we thought that

122
00:05:14,150 --> 00:05:12,960
hubble would provide lots of answers but

123
00:05:16,469 --> 00:05:14,160
that it was probably going to

124
00:05:18,310 --> 00:05:16,479
revolutionize the field of astronomy and

125
00:05:20,070 --> 00:05:18,320
astrophysics

126
00:05:22,469 --> 00:05:20,080
light from the objects it studied would

127
00:05:24,629 --> 00:05:22,479
be focused onto hubble's giant mirror

128
00:05:26,950 --> 00:05:24,639
then converted into data for downlink

129
00:05:29,510 --> 00:05:26,960
through a communications satellite to

130
00:05:32,629 --> 00:05:29,520
60-foot microwave antennas at white

131
00:05:34,950 --> 00:05:32,639
sands test facility in new mexico

132
00:05:37,189 --> 00:05:34,960
from there the data would be relayed to

133
00:05:39,350 --> 00:05:37,199
hubble's operations center at nasa's

134
00:05:41,909 --> 00:05:39,360
goddard space flight center in greenbelt

135
00:05:44,390 --> 00:05:41,919
maryland and on to the space telescope

136
00:05:50,790 --> 00:05:44,400
science institute in baltimore for

137
00:05:55,110 --> 00:05:52,950
now that the telescope was deployed the

138
00:05:57,189 --> 00:05:55,120

promised brilliance of its photography

139
00:05:58,950 --> 00:05:57,199
had astronomers eagerly anticipating

140
00:06:00,870 --> 00:05:58,960
hubble's first images

141
00:06:03,590 --> 00:06:00,880
what they got were pictures rendered

142
00:06:05,350 --> 00:06:03,600
useless by a fuzzy halo around each of

143
00:06:07,029 --> 00:06:05,360
the sided objects

144
00:06:09,430 --> 00:06:07,039
we expected that we would have to make

145
00:06:11,430 --> 00:06:09,440
adjustments to make the images as

146
00:06:13,670 --> 00:06:11,440
clear as as possible

147
00:06:15,510 --> 00:06:13,680
but as hard as we tried we could never

148
00:06:17,749 --> 00:06:15,520
get all of the fuzziness out of these

149
00:06:19,510 --> 00:06:17,759
pictures finally everybody kind of got

150
00:06:22,070 --> 00:06:19,520
around the table and said we've got

151
00:06:23,830 --> 00:06:22,080
severe collaboration and we cannot do

152
00:06:26,230 --> 00:06:23,840
anything on the ground to correct it

153
00:06:28,070 --> 00:06:26,240
well we were confident in the assessment

154
00:06:29,270 --> 00:06:28,080
that was given by the scientists and the

155
00:06:31,029 --> 00:06:29,280
engineers

156
00:06:32,870 --> 00:06:31,039
i always had this nagging feeling that

157
00:06:35,189 --> 00:06:32,880
we may have done something

158
00:06:37,510 --> 00:06:35,199
in our real struggle to get hubble out

159
00:06:40,790 --> 00:06:37,520
of the payload bay that had contributed

160
00:06:44,629 --> 00:06:42,710
the primary mirror had been polished

161
00:06:46,710 --> 00:06:44,639
perfectly but to an incorrect

162
00:06:49,270 --> 00:06:46,720
prescription

163
00:06:51,990 --> 00:06:49,280

a repair plan was needed

164
00:06:53,830 --> 00:06:52,000
nasa engineers focused their expertise

165
00:06:55,110 --> 00:06:53,840
and came up with what they believed was

166
00:06:56,950 --> 00:06:55,120
the solution

167
00:06:59,070 --> 00:06:56,960
[Music]

168
00:07:02,070 --> 00:06:59,080
december 1993

169
00:07:04,629 --> 00:07:02,080
sts-61 astronauts delivered to hubble a

170
00:07:06,309 --> 00:07:04,639
new wide field planetary camera with a

171
00:07:08,710 --> 00:07:06,319
set of internal mirrors that the

172
00:07:10,550 --> 00:07:08,720
telescope would wear like a new pair of

173
00:07:12,710 --> 00:07:10,560
eyeglasses

174
00:07:15,909 --> 00:07:12,720
when we started out on this mission

175
00:07:17,830 --> 00:07:15,919
sts-61 all the failures had not happened

176
00:07:19,990 --> 00:07:17,840
we have to we're redesigning the mission

177
00:07:22,230 --> 00:07:20,000
as more things fail

178
00:07:23,830 --> 00:07:22,240
and they were contemplating splitting

179
00:07:25,990 --> 00:07:23,840
our mission up thinking we couldn't

180
00:07:28,070 --> 00:07:26,000
possibly get all done what we got to get

181
00:07:29,670 --> 00:07:28,080
done and is morphe is happening the

182
00:07:31,510 --> 00:07:29,680
miracle on the ground was getting it all

183
00:07:33,589 --> 00:07:31,520
done and getting it onto the shuttle on

184
00:07:36,550 --> 00:07:33,599
cost and schedule and then the miracle

185
00:07:39,430 --> 00:07:36,560
in space was for the first time ever

186
00:07:41,510 --> 00:07:39,440
servicing a satellite with five evas and

187
00:07:43,990 --> 00:07:41,520
having every single spacewalk go

188
00:07:46,150 --> 00:07:44,000

perfectly

189
00:07:49,110 --> 00:07:46,160
then it all culminated what could only

190
00:07:52,950 --> 00:07:49,120
be called the day of vindication

191
00:07:54,869 --> 00:07:52,960
this time the images disappointed no one

192
00:07:57,430 --> 00:07:54,879
it took years but i finally breathed a

193
00:08:01,830 --> 00:07:57,440
sigh of relief that that i had not been

194
00:08:05,510 --> 00:08:03,830
the newly restored hubble was ready to

195
00:08:07,189 --> 00:08:05,520
work

196
00:08:09,670 --> 00:08:07,199
just nine months prior to hubble's

197
00:08:11,990 --> 00:08:09,680
successful servicing three astronomers

198
00:08:14,390 --> 00:08:12,000
at california's palomar observatory had

199
00:08:15,990 --> 00:08:14,400
discovered a comet whose enormous

200
00:08:18,629 --> 00:08:16,000
fragments now appeared to be on a

201
00:08:21,029 --> 00:08:18,639
collision course with the planet jupiter

202
00:08:23,670 --> 00:08:21,039
for hubble it was a golden opportunity

203
00:08:26,710 --> 00:08:23,680
to watch as the gas giant's atmosphere

204
00:08:29,350 --> 00:08:26,720
was blackened and scarred then racked in

205
00:08:30,020 --> 00:08:29,360
seismic waves by planet-sized chunks of

206
00:08:32,870 --> 00:08:30,030
comet

207
00:08:35,670 --> 00:08:32,880
[Music]

208
00:08:38,230 --> 00:08:35,680
with almost every new observation hubble

209
00:08:43,029 --> 00:08:38,240
was rewriting the science books and

210
00:08:47,269 --> 00:08:45,269
over time nasa would send four more

211
00:08:49,770 --> 00:08:47,279
shuttle crews to service and upgrade the

212
00:08:51,269 --> 00:08:49,780
hubble space telescope

213
00:08:53,389 --> 00:08:51,279

[Music]

214
00:08:55,990 --> 00:08:53,399
in may 2009

215
00:08:58,230 --> 00:08:56,000
sts-125 and its space shuttle atlantis

216
00:09:00,150 --> 00:08:58,240
crew performed the fifth and final

217
00:09:02,790 --> 00:09:00,160
servicing mission

218
00:09:06,310 --> 00:09:02,800
upgrades repairs and new equipment would

219
00:09:07,110 --> 00:09:06,320
give hubble a new lease on life

220
00:09:10,150 --> 00:09:07,120
it's

221
00:09:12,310 --> 00:09:10,160
just really uh a wonderful experience to

222
00:09:13,670 --> 00:09:12,320
to be there and be inside or outside of

223
00:09:16,230 --> 00:09:13,680
the telescope looking at it with the

224
00:09:17,990 --> 00:09:16,240
earth in the background uh working

225
00:09:20,630 --> 00:09:18,000
during a spacewalk is really quite a

226
00:09:21,750 --> 00:09:20,640
privilege so i i those you know those

227
00:09:24,070 --> 00:09:21,760
memories

228
00:09:26,389 --> 00:09:24,080
are the most vivid ones that i have this

229
00:09:28,389 --> 00:09:26,399
was mission specialist john grunsfeld's

230
00:09:31,350 --> 00:09:28,399
third visit to hubble

231
00:09:33,350 --> 00:09:31,360
on his sixth spacewalk grunsfeld became

232
00:09:35,509 --> 00:09:33,360
the last human to lay hands on the

233
00:09:36,790 --> 00:09:35,519
telescope so it's the synergy between

234
00:09:39,750 --> 00:09:36,800
the humans

235
00:09:41,590 --> 00:09:39,760
and the design of hubble to be serviced

236
00:09:44,310 --> 00:09:41,600
that has really given us not one hubble

237
00:09:46,550 --> 00:09:44,320
space telescope or one observatory

238
00:09:48,949 --> 00:09:46,560

but many observatories each time we

239
00:09:51,350 --> 00:09:48,959
visit it and reinvent the telescope

240
00:09:54,230 --> 00:09:51,360
hubble really is an amazing example of

241
00:09:56,870 --> 00:09:54,240
the way people and robotics works

242
00:09:59,030 --> 00:09:56,880
together in space hubble is up there

243
00:10:01,509 --> 00:09:59,040
without people operating it

244
00:10:03,829 --> 00:10:01,519
in space every day taking these great

245
00:10:06,389 --> 00:10:03,839
observations and yet it benefits from

246
00:10:08,389 --> 00:10:06,399
having people come to it and inject new

247
00:10:11,030 --> 00:10:08,399
technology so it's not a 20 year old

248
00:10:12,790 --> 00:10:11,040
telescope it's got brand new technology

249
00:10:15,030 --> 00:10:12,800
i think it's a real lesson and one of

250
00:10:17,670 --> 00:10:15,040
the one of the legacy products of hubble

251
00:10:19,269 --> 00:10:17,680
is that throughout this servicing series

252
00:10:21,190 --> 00:10:19,279
this incredible

253
00:10:23,190 --> 00:10:21,200
series of five servicing missions hubble

254
00:10:24,630 --> 00:10:23,200
has done nothing but get immensely more

255
00:10:26,870 --> 00:10:24,640
powerful

256
00:10:29,269 --> 00:10:26,880
with hubble our neighboring planets now

257
00:10:31,990 --> 00:10:29,279
reveal themselves in never-before-seen

258
00:10:34,230 --> 00:10:32,000
clarity giant gas planets like uranus

259
00:10:36,710 --> 00:10:34,240
and neptune they sound large and they

260
00:10:39,509 --> 00:10:36,720
are large but they're very far away

261
00:10:42,310 --> 00:10:39,519
and to ground-based telescopes they are

262
00:10:44,230 --> 00:10:42,320
small disks of light without a lot of

263
00:10:46,310 --> 00:10:44,240

detail hubble really

264
00:10:49,190 --> 00:10:46,320
zooms in and shows us quite a bit of

265
00:10:52,150 --> 00:10:49,200
detail on those planets surrounding us

266
00:10:54,710 --> 00:10:52,160
we now see billions of galaxies in every

267
00:10:55,750 --> 00:10:54,720
shape imaginable millions of light years

268
00:10:57,509 --> 00:10:55,760
across

269
00:10:59,750 --> 00:10:57,519
it's a single point of the sky we stared

270
00:11:00,630 --> 00:10:59,760
for 10 days with a single blank piece of

271
00:11:02,069 --> 00:11:00,640
sky

272
00:11:03,110 --> 00:11:02,079
no more than a drinking straw so you

273
00:11:05,750 --> 00:11:03,120
look up the sky and look through a

274
00:11:08,790 --> 00:11:05,760
drinking straw and we found 10 000

275
00:11:09,829 --> 00:11:08,800
galaxies in that single pinpoint of dark

276
00:11:12,230 --> 00:11:09,839
sky

277
00:11:14,710 --> 00:11:12,240
10 000 galaxies there some of those

278
00:11:17,269 --> 00:11:14,720
galaxies have been around their light

279
00:11:19,430 --> 00:11:17,279
has taken 13 billion years to reach us

280
00:11:22,389 --> 00:11:19,440
hubble's imaging of exoplanets circling

281
00:11:26,150 --> 00:11:22,399
nearby stars provides direct evidence of

282
00:11:28,630 --> 00:11:26,160
new planet systems under construction

283
00:11:30,550 --> 00:11:28,640
hubble has given us new insights about

284
00:11:32,710 --> 00:11:30,560
how stars die

285
00:11:34,790 --> 00:11:32,720
and how they are born

286
00:11:37,990 --> 00:11:34,800
hubble's discovery of a supermassive

287
00:11:40,150 --> 00:11:38,000
black hole in the center of galaxy m84

288
00:11:43,030 --> 00:11:40,160

has led astronomers to conclude that an

289
00:11:45,509 --> 00:11:43,040
immense black hole is at the center of

290
00:11:46,790 --> 00:11:45,519
most galaxies

291
00:11:48,710 --> 00:11:46,800
what we did was we put the

292
00:11:50,790 --> 00:11:48,720
spectrographic slit

293
00:11:51,750 --> 00:11:50,800
of this instrument down right on the

294
00:11:55,190 --> 00:11:51,760
core

295
00:11:57,350 --> 00:11:55,200
of this elliptical galaxy m84

296
00:11:59,350 --> 00:11:57,360
so what we're looking for is the

297
00:12:01,430 --> 00:11:59,360
signature of a black hole

298
00:12:03,110 --> 00:12:01,440
what happens there what happens in that

299
00:12:06,230 --> 00:12:03,120
environment well

300
00:12:09,269 --> 00:12:06,240
usually what happens is there's a ring

301
00:12:11,030 --> 00:12:09,279
of of gas in a very tight orbit

302
00:12:13,590 --> 00:12:11,040
around that black hole

303
00:12:15,670 --> 00:12:13,600
and that ring of gas is rotating very

304
00:12:18,790 --> 00:12:15,680
very quickly of course because the black

305
00:12:21,430 --> 00:12:18,800
hole mass is huge one way to recognize

306
00:12:24,550 --> 00:12:21,440
the presence of a black hole would be

307
00:12:28,389 --> 00:12:24,560
to measure its influence on the stars

308
00:12:30,389 --> 00:12:28,399
and gas that are that are close to it

309
00:12:33,110 --> 00:12:30,399
hubble has greatly contributed to

310
00:12:35,110 --> 00:12:33,120
astronomers knowledge of dark energy and

311
00:12:38,150 --> 00:12:35,120
how this mysterious little understood

312
00:12:40,150 --> 00:12:38,160
phenomenon is speeding up the very same

313
00:12:43,670 --> 00:12:40,160

expansion of the universe discovered by

314
00:12:45,670 --> 00:12:43,680
edwin hubble decades before

315
00:12:48,389 --> 00:12:45,680
what everybody believed was that the

316
00:12:51,670 --> 00:12:48,399
universal expansion was slowing down due

317
00:12:53,430 --> 00:12:51,680
to gravity i mean it made sense

318
00:12:55,430 --> 00:12:53,440
there are no repulsive there's no

319
00:12:58,470 --> 00:12:55,440
anti-gravity that we know of but there

320
00:13:00,629 --> 00:12:58,480
is now in hubble's 20 short years

321
00:13:03,509 --> 00:13:00,639
we've learned more about our universe

322
00:13:09,670 --> 00:13:03,519
than in the nearly 400 since galileo

323
00:13:14,150 --> 00:13:11,750
hubble's last servicing mission marks

324
00:13:16,470 --> 00:13:14,160
the telescope's new beginning

325
00:13:18,710 --> 00:13:16,480
more powerful than ever it will lead our

326
00:13:21,430 --> 00:13:18,720
exploration of the cosmos for several

327
00:13:22,310 --> 00:13:21,440
years to come to come to the end of that

328
00:13:24,470 --> 00:13:22,320
time

329
00:13:26,310 --> 00:13:24,480
and release hubble and think you know

330
00:13:29,670 --> 00:13:26,320
everything we came to do

331
00:13:31,430 --> 00:13:29,680
got done made me feel really proud about

332
00:13:33,590 --> 00:13:31,440
the whole team the way we'd work

333
00:13:35,110 --> 00:13:33,600
together hopeful for the future with

334
00:13:36,949 --> 00:13:35,120
hubble that everything we've done

335
00:13:37,670 --> 00:13:36,959
actually worked and when they checked it

336
00:13:38,629 --> 00:13:37,680
out

337
00:13:40,550 --> 00:13:38,639
and

338
00:13:42,069 --> 00:13:40,560

just thinking about what hubble could do

339
00:13:44,230 --> 00:13:42,079
now that we've given it a new lease on

340
00:13:46,550 --> 00:13:44,240
life it was very rewarding not many

341
00:13:48,710 --> 00:13:46,560
humans get to work on things

342
00:13:50,870 --> 00:13:48,720
that a hundred years from now

343
00:13:52,389 --> 00:13:50,880
history will remember

344
00:13:54,870 --> 00:13:52,399
hubble is certainly one of them the

345
00:13:57,030 --> 00:13:54,880
hubble touches people not only for the

346
00:14:00,470 --> 00:13:57,040
science but it touches people for its

347
00:14:02,550 --> 00:14:00,480
aesthetics and its beauty and the people

348
00:14:03,590 --> 00:14:02,560
that choose what to study have done the

349
00:14:06,230 --> 00:14:03,600
right thing

350
00:14:08,790 --> 00:14:06,240
they've done an extraordinary job of not

351
00:14:11,030 --> 00:14:08,800
only getting great science but also the

352
00:14:12,710 --> 00:14:11,040
beauty of the universe 400 years from

353
00:14:14,870 --> 00:14:12,720
now they'll look back and they'll say

354
00:14:17,030 --> 00:14:14,880
well the hubble really did change the

355
00:14:18,710 --> 00:14:17,040
way we see the universe

356
00:14:20,629 --> 00:14:18,720
i think the scientific legacy is that

357
00:14:23,110 --> 00:14:20,639
textbooks have been rewritten because of

358
00:14:25,189 --> 00:14:23,120
hubble i think the fact that we didn't

359
00:14:27,509 --> 00:14:25,199
know 20 years ago about black holes or

360
00:14:29,430 --> 00:14:27,519
exosolar planets or galaxy evolution

361
00:14:31,670 --> 00:14:29,440
dark energy we didn't know we could

362
00:14:33,430 --> 00:14:31,680
measure dark matter i mean we're at a

363
00:14:35,189 --> 00:14:33,440

point in our history where we have now

364
00:14:37,110 --> 00:14:35,199
discovered we only understand four

365
00:14:39,430 --> 00:14:37,120
percent of the universe

366
00:14:41,670 --> 00:14:39,440
the rest of it is completely unknown

367
00:14:42,829 --> 00:14:41,680
waiting in the wings is nasa's next

368
00:14:46,629 --> 00:14:42,839
generation

369
00:14:49,910 --> 00:14:46,639
telescope when it is launched in 2014

370
00:14:52,550 --> 00:14:49,920
the james webb space telescope will soar

371
00:14:54,949 --> 00:14:52,560
deeper into space and look even farther

372
00:14:57,030 --> 00:14:54,959
back in time to unexplored territory at

373
00:14:58,629 --> 00:14:57,040
the beginning of our universe

374
00:15:00,230 --> 00:14:58,639
and the hubble has shown us if you like

375
00:15:02,470 --> 00:15:00,240
the peaks of the iceberg those very

376
00:15:04,150 --> 00:15:02,480
first galaxies the james webb is going

377
00:15:06,550 --> 00:15:04,160
to penetrate right into what we call

378
00:15:08,790 --> 00:15:06,560
these dark ages where those very first

379
00:15:10,470 --> 00:15:08,800
galaxies are probably lurking out of

380
00:15:13,030 --> 00:15:10,480
sight from us currently the hubble

381
00:15:14,870 --> 00:15:13,040
telescope has made a remarkable journey

382
00:15:16,949 --> 00:15:14,880
from imagination

383
00:15:19,110 --> 00:15:16,959
to reality

384
00:15:22,150 --> 00:15:19,120
it has not only transformed the way we

385
00:15:24,629 --> 00:15:22,160
view the universe but also fundamentally

386
00:15:27,750 --> 00:15:24,639
changed how we view ourselves

387
00:15:40,480 --> 00:15:27,760
our place in the ever expanding cosmos