1
00:00:11,311 --> 00:03:13,726
>> TAKE A LOOK.

2
00:03:13,726 --> 00:03:16,896
THIS IS AN ASTEROID CLOSE TO

3
00:03:16,896 --> 00:03:19,966
EARTH.

4
00:03:19,966 --> 00:03:21,901
2014JO25 CAME WITHIN 1.2 MILLION

5
00:03:21,901 --> 00:03:23,937
MILES OF EARTH.

6
00:03:23,937 --> 00:03:25,338
IT WAS A KILOMETER OR TWO-THIRDS

7
00:03:25,338 --> 00:03:27,040
OF A MILE WIDE, THE LARGEST TO

8
00:03:27,040 --> 00:03:28,608
COME SO CLOSE TO OUR PLANET IN

9
00:03:28,608 --> 00:03:33,313
THE PAST 13 YEARS.

10
00:03:33,313 --> 00:03:33,713
HELLO.

11
00:03:33,713 --> 00:03:37,450
WE'RE AT NASA'S JET

12
00:03:37,450 --> 00:03:39,385
PROPOPULATION LABORATORY.

13
00:03:39,385 --> 00:03:42,355

WE TAKE THE HUNT FOR ASTEROIDS

14
00:03:42,355 --> 00:03:44,657
AND COMETS VERY SERIOUSLY.

15
00:03:44,657 --> 00:03:47,360
IT'S BEEN FUNDED FOR OVER 90% OF

16
00:03:47,360 --> 00:03:49,562
WORLDWIDE EFFORTS TO FIND,

17
00:03:49,562 --> 00:03:54,067
TRACK, AND CHARACTERIZE

18
00:03:54,067 --> 00:03:56,169
NEAR-EARTH OBJECTS THAT GET TOO

19
00:03:56,169 --> 00:03:58,504
CLOSE FOR COMFORT.

20
00:03:58,504 --> 00:04:01,007
TINY ASTEROIDS HIT OUR EARTH ALL

21
00:04:01,007 --> 00:04:01,374
THE TIME.

22
00:04:01,374 --> 00:04:04,077
THIS CHART SHOWS THE HUNDREDS OF

23
00:04:04,077 --> 00:04:05,745
SIGNIFICANT FIRE BALLS

24
00:04:05,745 --> 00:04:06,946
DETECTIVED BY U.S. GOVERNMENT

25
00:04:06,946 --> 00:04:08,948
SENSORS FROM 1988 UNTIL NOW.

26
00:04:08,948 --> 00:04:11,851
IT DOESN'T HAPPEN OFTEN, BUT

27
00:04:11,851 --> 00:04:13,486
BIGGER ASTEROIDS HIT EARTH TOO.

28
00:04:13,486 --> 00:04:18,291
IT HAPPENED A FEW YEARS AGO.

29
00:04:18,291 --> 00:04:19,826
A 20-METER ASTEROID EXPLODED IN

30
00:04:19,826 --> 00:04:21,961
THE ATMOSPHERE ABOVE RUSSIA.

31
00:04:21,961 --> 00:04:24,130
SO IT'S IMPORTANT TO BE ON THE

32
00:04:24,130 --> 00:04:24,464
LOOKOUT.

33
00:04:24,464 --> 00:04:27,266
TO START THINGS OFF, LET'S GIVE

34
00:04:27,266 --> 00:04:33,539
YOU A SIMPLE -- SIMPLIFIED

35
00:04:33,539 --> 00:04:35,341
EXPLANATION OF HOW WE SEARCH FOR

36
00:04:35,341 --> 00:04:35,642
ROCKS.

37
00:04:35,642 --> 00:04:38,911
>> TO START, SURVEY TELESCOPES

38
00:04:38,911 --> 00:04:39,879

SCAN THE SKY.

39
00:04:39,879 --> 00:04:42,448
WHEN MULTIPLE PICTURES OF THE

40
00:04:42,448 --> 00:04:45,351
SAME SPOT SHOW A SPEC THAT'S

41
00:04:45,351 --> 00:04:47,920
MOVING, COMPUTERS AUTOMATICALLY

42
00:04:47,920 --> 00:04:49,922
CHECK IT AGAINST THE COMPUTER

43
00:04:49,922 --> 00:04:51,190
DATABASE KNOWN OBJECTS.

44
00:04:51,190 --> 00:04:53,226
IF THERE'S NO MATCH, IT GETS

45
00:04:53,226 --> 00:04:54,661
ADDED TO A LIST OF OBJECTS TO

46
00:04:54,661 --> 00:04:54,994
CONFIRM.

47
00:04:54,994 --> 00:04:56,329
IF IT LOOKS LIKE IT WILL PASS

48
00:04:56,329 --> 00:04:59,132
VERY CLOSE TO US, WE GIVE IT TOP

49
00:04:59,132 --> 00:04:59,499
PRIORITY.

50
00:04:59,499 --> 00:05:02,035
THEN IT'S TIME TO CALL IN

51
00:05:05,438 --> 00:05:04,671
REINFORCEMENT

52
00:05:05,438 --> 00:05:06,873
ASTRONOMERS FROM NASA AND OTHER

53
00:05:06,873 --> 00:05:08,808
INSTITUTIONS AND EVEN THE

54
00:05:08,808 --> 00:05:11,544
AMATEURS MAKE ADDITIONAL

55
00:05:11,544 --> 00:05:11,944
OBSERVATION.

56
00:05:11,944 --> 00:05:13,880
EACH NEW DATA POINT HELPS FIND

57
00:05:13,880 --> 00:05:15,214
THE PROJECTED PATH.

58
00:05:15,214 --> 00:05:16,149
THIS ASTEROID IS GOING TO FLY

59
00:05:16,149 --> 00:05:18,451
RIGHT ON BY.

60
00:05:18,451 --> 00:05:20,053
ALL THE INFO WILL BE POSTED

61
00:05:20,053 --> 00:05:24,390
ONLINE, SO IT CAN CONTINUE TO BE

62
00:05:24,390 --> 00:05:25,858
TRACKED AND MONITORED.

63
00:05:25,858 --> 00:05:26,859

NICE WORK, TEAM.

64
00:05:26,859 --> 00:05:32,165
KEEP WATCHING THE SKY.

65
00:05:32,165 --> 00:05:34,567
>> NOW, NASA IS DIRECTED BY

66
00:05:34,567 --> 00:05:38,671
CONGRESS TO FIND 90% OF

67
00:05:38,671 --> 00:05:42,375
ASTEROIDS 460 FEET, THAT'S 140

68
00:05:42,375 --> 00:05:44,477
METERS, OR GREATER IN SIZE.

69
00:05:44,477 --> 00:05:45,478
NASA'S DEFENSE COORDINATION

70
00:05:45,478 --> 00:05:46,979
OFFICE IS RESPONSIBLE FOR

71
00:05:46,979 --> 00:05:49,048
FINDING, TRACKING AND

72
00:05:49,048 --> 00:05:50,416
CHARACTERIZING POTENTIALLY

73
00:05:50,416 --> 00:05:52,785
HAZARDOUS ASTEROIDS AND COMETS

74
00:05:52,785 --> 00:05:59,258
COMING NEAR EARTH.

75
00:05:59,258 --> 00:06:03,763
KELLY FAST IS THE MANAGER OF THE

76
00:06:03,763 --> 00:06:06,499
NEAR-EARTH OBJECT -- OBSERVATION

77
00:06:06,499 --> 00:06:06,899
PROGRAM.

78
00:06:06,899 --> 00:06:08,935
THEY JOIN US IN WASHINGTON, DC

79
00:06:08,935 --> 00:06:18,344
WHERE ALL EFFORTS ARE MANAGED.

80
00:06:18,344 --> 00:06:20,713
>> LET'S START OFF WITH A

81
00:06:20,713 --> 00:06:23,483
QUESTION FOR LYNNLEY.

82
00:06:23,483 --> 00:06:25,485
WHAT IS NASA GOING TO PROTECT

83
00:06:25,485 --> 00:06:26,819
EARTH FROM DANGEROUS ASTEROIDS

84
00:06:26,819 --> 00:06:28,254
AND COMETS?

85
00:06:28,254 --> 00:06:31,057
>> WELL, THAT'S THE WHOLE

86
00:06:31,057 --> 00:06:33,493
PURPOSE OF OUR OFFICE, TO

87
00:06:33,493 --> 00:06:34,994
OVERSEE THE EFFORTS OF NASA AND

88
00:06:34,994 --> 00:06:36,562

OUR OBSERVATORIES THAT ARE

89
00:06:36,562 --> 00:06:39,532
FINDING, TRACKING, AND

90
00:06:39,532 --> 00:06:40,933
CHARACTERIZING NEAR-EARTH

91
00:06:40,933 --> 00:06:42,602
OBJECTS AND TO WORK WITH OTHER

92
00:06:42,602 --> 00:06:44,871
GOVERNMENT AGENCIES TO DEVELOP A

93
00:06:44,871 --> 00:06:46,839
RESPONSE IF WE HAPPEN TO FIND

94
00:06:46,839 --> 00:06:49,675
ONE THAT IS ON AN IMPACT

95
00:06:49,675 --> 00:06:50,810
TRAJECTORY WITH EARTH.

96
00:06:50,810 --> 00:06:53,679
WE WORK WITH THE FEDERAL

97
00:06:53,679 --> 00:06:54,781
EMERGENCY MANAGEMENT AGENCY AND

98
00:06:54,781 --> 00:06:56,716
OTHER GOVERNMENT AGENCIES TO

99
00:06:56,716 --> 00:06:58,851
DEVELOP THE PLANS AND THE

100
00:06:58,851 --> 00:07:01,187
STRATEGIES THAT WOULD BE USED TO

101
00:07:01,187 --> 00:07:05,391
RESPOND TO A DETECTED IMPACT.

102
00:07:05,391 --> 00:07:07,727
BUT THE MOST IMPORTANT PART OF

103
00:07:07,727 --> 00:07:09,862
OUR BUSINESS IS TO FIND -- WE

104
00:07:09,862 --> 00:07:11,697
HAVE TO FIND THEM TO BE ABLE TO

105
00:07:11,697 --> 00:07:13,332
DO ANYTHING ABOUT THEM.

106
00:07:13,332 --> 00:07:14,700
SO OUR MAIN PRIORITY IS TO FIND

107
00:07:14,700 --> 00:07:17,270
THEM AS EARLY AS WE CAN.

108
00:07:17,270 --> 00:07:19,338
THAT'S WHAT THE NEAR EARTH

109
00:07:19,338 --> 00:07:23,609
OBSERVATION PROJECT IS ALL

110
00:07:23,609 --> 00:07:24,377
PACKET

111
00:07:24,377 --> 00:07:24,677
ABOUT.

112
00:07:24,677 --> 00:07:25,511
>> QUESTION FOR KELLY.

113
00:07:25,511 --> 00:07:27,847

HOW ARE WE FINDING THEM?

114
00:07:27,847 --> 00:07:34,353
>> WELL, KAY, NASA FUNDS

115
00:07:34,353 --> 00:07:35,755
OBSERVATORIES TO SCAN THE SKY AT

116
00:07:35,755 --> 00:07:36,856
NIGHT TO DISCOVER THEM.

117
00:07:36,856 --> 00:07:40,326
WE ALSO FUND A NUMBER OF

118
00:07:40,326 --> 00:07:41,861
ASTRONOMERS TO FOLLOW UP THOSE

119
00:07:41,861 --> 00:07:43,663
DISCOVERIES TO TRY TO GET MORE

120
00:07:43,663 --> 00:07:45,064
OBSERVATIONS OF THE POSITIONS OF

121
00:07:45,064 --> 00:07:46,232
THOSE OBJECTS TO BETTER

122
00:07:46,232 --> 00:07:48,067
UNDERSTAND HOW THEY'RE MOVING.

123
00:07:48,067 --> 00:07:50,436
NOW, ALL OF THESE OBSERVES FROM

124
00:07:50,436 --> 00:07:53,039
THE -- OBSERVATIONS WE FUND GO

125
00:07:53,039 --> 00:07:55,308
TO THE MINOR PLANET CENTER WHERE

126
00:07:55,308 --> 00:07:56,776
THEY CATALOG AND KEEP ALL OF

127
00:07:56,776 --> 00:08:02,949
THOSE OBSERVATIONS, BUT, ALSO,

128
00:08:02,949 --> 00:08:06,252
THEY DO A CALCULATION TO FIGURE

129
00:08:06,252 --> 00:08:07,253
OUT WHERE IT'S GOING TO BE IN

130
00:08:07,253 --> 00:08:09,589
THE FUTURE AND IF THERE'S A

131
00:08:09,589 --> 00:08:11,858
NEAR-TERM IMPACT RISK TO EARTH,

132
00:08:11,858 --> 00:08:12,892
THEY WILL LET NASA KNOW ABOUT

133
00:08:12,892 --> 00:08:14,060
IT.

134
00:08:14,060 --> 00:08:17,096
ALSO, JPL STUDIES, THEY ALSO

135
00:08:17,096 --> 00:08:19,832
TAKE THOSE POSITIONS, THOSE

136
00:08:19,832 --> 00:08:21,667
OBSERVATIONS, AND THEY DO

137
00:08:21,667 --> 00:08:23,002
CALCULATIONS, LOOKING AT WHERE

138
00:08:23,002 --> 00:08:24,203

THOSE ASTEROIDS WILL BE IN THE

139
00:08:24,203 --> 00:08:25,605
NEAR TERM BUT ALSO IN THE

140
00:08:25,605 --> 00:08:28,341
FUTURE, DECADES INTO THE FUTURE

141
00:08:28,341 --> 00:08:29,775
BECAUSE IF THERE WAS SOMETHING

142
00:08:29,775 --> 00:08:31,444
THAT POSED AN IMPACT RISK, YOU

143
00:08:31,444 --> 00:08:32,979
WOULD WANT TO KNOW ABOUT IT WELL

144
00:08:32,979 --> 00:08:35,314
AHEAD OF TIME SO YOU COULD PLAN

145
00:08:35,314 --> 00:08:36,582
YOUR RESPONSE TO IT.

146
00:08:36,582 --> 00:08:40,386
>> AND, KELLY, ARE WE ALONE IN

147
00:08:40,386 --> 00:08:41,621
THIS WHOLE PROCESS?

148
00:08:41,621 --> 00:08:42,955
ARE OTHER COUNTRIES INVOLVED AT

149
00:08:42,955 --> 00:08:43,389
ALL?

150
00:08:43,389 --> 00:08:44,390
>> OH, YEAH.

151
00:08:44,390 --> 00:08:45,491
THERE ARE OTHER COUNTRIES

152
00:08:45,491 --> 00:08:45,992
INVOLVED.

153
00:08:45,992 --> 00:08:48,127
IN FACT, THERE'S AN

154
00:08:48,127 --> 00:08:49,929
INTERNATIONAL ASTEROID WARNING

155
00:08:49,929 --> 00:08:51,397
NETWORK THAT IS A U.N.

156
00:08:51,397 --> 00:08:53,432
SANCTIONED GROUP AND NASA IS A

157
00:08:53,432 --> 00:08:55,635
SIGNATORY TO THAT GROUP.

158
00:08:55,635 --> 00:09:00,406
IT'S A GROUP INVOLVING SPACE

159
00:09:00,406 --> 00:09:02,241
AGENCIES AND INSTITUTES AND

160
00:09:02,241 --> 00:09:04,510
OBSERVATORIES THAT COORDINATE ON

161
00:09:04,510 --> 00:09:07,747
THE SEARCH, THE DISCOVERY,

162
00:09:07,747 --> 00:09:10,716
FOLLOW-UP, CHARACTERIZIZATION

163
00:09:10,716 --> 00:09:12,952

FOR THESE OBJECTS SO WE HAVE ALL

164
00:09:12,952 --> 00:09:15,388
THE INFORMATION THAT'S POSSIBLE

165
00:09:15,388 --> 00:09:16,589
OUT THERE CONTRIBUTING TO THE

166
00:09:16,589 --> 00:09:16,923
TASK.

167
00:09:16,923 --> 00:09:20,293
SO, YEAH, THERE'S SIGNIFICANT

168
00:09:20,293 --> 00:09:23,529
INTERNATIONAL PARTICIPATION.

169
00:09:23,529 --> 00:09:24,130
>> ONE MORE QUESTION.

170
00:09:24,130 --> 00:09:27,166
IF THERE'S A DANGEROUS ASTEROID

171
00:09:27,166 --> 00:09:30,770
THAT'S ON A COLLISION COURSE

172
00:09:30,770 --> 00:09:32,038
WITH EARTH, CAN WE REALLY DO

173
00:09:32,038 --> 00:09:32,805
ANYTHING ABOUT IT?

174
00:09:32,805 --> 00:09:34,106
>> WELL, THAT WOULD DEPEND ON

175
00:09:34,106 --> 00:09:35,708
HOW BIG IT IS AND HOW MUCH TIME

176
00:09:35,708 --> 00:09:38,277
WE HAVE BEFORE THE PREDICTED

177
00:09:38,277 --> 00:09:39,946
IMPACT.

178
00:09:39,946 --> 00:09:42,248
WE WOULD ASSESS THE SIZE OF THE

179
00:09:42,248 --> 00:09:44,717
OBJECT AND TRY TO DETERMINE WHAT

180
00:09:44,717 --> 00:09:46,152
THE MASS IS.

181
00:09:46,152 --> 00:09:47,720
THAT WOULD DETERMINE WHAT

182
00:09:47,720 --> 00:09:49,855
TECHNIQUES MIGHT BE ABLE TO BE

183
00:09:49,855 --> 00:09:50,423
USED ON IT.

184
00:09:50,423 --> 00:09:53,092
WE HAVE, AS PART OF OUR PROGRAM,

185
00:09:53,092 --> 00:09:54,694
DEVELOPING THOSE KIND OF

186
00:09:54,694 --> 00:09:55,628
CAPABILITIES, BUT IT ALL DEPENDS

187
00:09:55,628 --> 00:09:56,862
ON HOW MUCH TIME WE HAVE.

188
00:09:56,862 --> 00:09:58,764

IF WE ONLY HAD DAYS OR WEEKS,

189
00:09:58,764 --> 00:10:00,499
THAT'S NOT MUST HAVE TIME TO

190
00:10:00,499 --> 00:10:01,968
MOUNT A SPACE MISSION TO DEFLECT

191
00:10:01,968 --> 00:10:02,802
IT IN SPACE.

192
00:10:02,802 --> 00:10:05,237
AND SO WE WOULD JUST HAVE TO

193
00:10:05,237 --> 00:10:07,773
PREPARE WITH FEMA TO TAKE THE

194
00:10:07,773 --> 00:10:09,508
IMPACT, IF IT WAS ON U.S.

195
00:10:09,508 --> 00:10:09,909
TERRITORY.

196
00:10:09,909 --> 00:10:12,411
SO THE KEY TO OUR PROGRAM IS TO

197
00:10:12,411 --> 00:10:13,446
FIND THEM EARLY.

198
00:10:13,446 --> 00:10:13,946
>> ALL RIGHT.

199
00:10:13,946 --> 00:10:15,848
SO WE HAVE JUST A FEW MORE

200
00:10:15,848 --> 00:10:16,215
MINUTES.

201
00:10:16,215 --> 00:10:18,084
I WOULD LIKE TO TAKE SOME TIME

202
00:10:18,084 --> 00:10:19,652
FOR A COUPLE OF SOCIAL MEDIA

203
00:10:19,652 --> 00:10:20,553
QUESTIONS.

204
00:10:20,553 --> 00:10:22,188
I HAVE ONE FOR LYNNLEY FIRST.

205
00:10:22,188 --> 00:10:25,257
DAVID AND OTHERS ON TWITTER ARE

206
00:10:25,257 --> 00:10:27,860
ASKING: ARE THERE ANY NEAR-EARTH

207
00:10:27,860 --> 00:10:31,831
OBJECTS THAT POSE A DANGER TO

208
00:10:31,831 --> 00:10:32,131
EARTH?

209
00:10:32,131 --> 00:10:34,667
>> WELL, OF THE CATALOG WE HAVE

210
00:10:34,667 --> 00:10:37,570
NOW, OVER 16,000 NEAR-EARTH

211
00:10:37,570 --> 00:10:40,973
OBJECTS, THERE'S NONE THAT HAVE

212
00:10:40,973 --> 00:10:41,907
A SIGNIFICANT IMPACT

213
00:10:41,907 --> 00:10:42,341

PROBABILITY.

214
00:10:42,341 --> 00:10:43,476
YES, THERE ARE OBJECTS THAT WILL

215
00:10:43,476 --> 00:10:46,979
COME NEAR EARTH, BUT THE

216
00:10:46,979 --> 00:10:49,048
DETERMINATION FROM FOLKS AT JPL

217
00:10:49,048 --> 00:10:50,016
HAVE SHOWN THAT THE PROBABILITY

218
00:10:50,016 --> 00:10:53,919
OF ANY OF THOSE IS REALLY LOW.

219
00:10:53,919 --> 00:10:55,621
SO THERE'S NO IMMEDIATE THREAT

220
00:10:55,621 --> 00:10:56,889
TO THE EARTH BEING IMPACTED BY

221
00:10:56,889 --> 00:10:59,492
THE OBJECTS THAT WE KNOW ABOUT.

222
00:10:59,492 --> 00:11:01,360
WE HAVE A LOT MORE OF THEM TO

223
00:11:01,360 --> 00:11:02,361
FIND, THOUGH.

224
00:11:02,361 --> 00:11:02,828
>> ALL RIGHT.

225
00:11:02,828 --> 00:11:03,696
HERE'S ANOTHER ONE.

226
00:11:03,696 --> 00:11:05,631
THIS ONE IS FOR KELLEY.

227
00:11:05,631 --> 00:11:07,633
LISA ON TWITTER WANTS TO KNOW IF

228
00:11:07,633 --> 00:11:09,335
THERE WAS AN ASTEROID HEADED FOR

229
00:11:09,335 --> 00:11:11,103
EARTH, WOULD WE BE TOLD, OR

230
00:11:11,103 --> 00:11:13,606
WOULD NASA KEEP IT QUIET?

231
00:11:13,606 --> 00:11:21,414
>> AND KHALID ASK, WOULD YOU

232
00:11:21,414 --> 00:11:22,348
TWEET IT?

233
00:11:22,348 --> 00:11:24,050
>> ABSOLUTELY.

234
00:11:24,050 --> 00:11:25,718
IN FACT, THE PUBLIC WOULD BE

235
00:11:25,718 --> 00:11:26,018
TOLD.

236
00:11:26,018 --> 00:11:28,821
IT WOULDN'T BE ABLE TO KEEP IT

237
00:11:28,821 --> 00:11:29,188
QUIET.

238
00:11:29,188 --> 00:11:32,158

WE TALK WITH ASTRONOMERS ALL

239
00:11:32,158 --> 00:11:33,759
OVER THE WORLD AND THE INTERNET.

240
00:11:33,759 --> 00:11:36,195
IT WOULD BE OUT THERE.

241
00:11:36,195 --> 00:11:39,331
IT'S ON THE WEBSITE, AND THE

242
00:11:39,331 --> 00:11:40,833
PREDICTIONS THAT ARE DETERMINED

243
00:11:40,833 --> 00:11:43,169
OUT AT THE CENTER FOR NEAR-EARTH

244
00:11:43,169 --> 00:11:45,171
OBJECTS STUDIES, IT'S ON THEIR

245
00:11:45,171 --> 00:11:49,075
WEBSITE AT JPL, AND WE HAVE A

246
00:11:49,075 --> 00:11:53,979
COMMUNICATION PLAN AT NASA TO

247
00:11:53,979 --> 00:11:54,847
COMMUNICATE WITHIN OUR

248
00:11:54,847 --> 00:11:55,247
GOVERNMENT.

249
00:11:55,247 --> 00:11:57,083
THIS WOULD GO OUT TO THE PUBLIC

250
00:11:57,083 --> 00:11:59,618
AND EVENTUALLY END UP ON TWITTER

251
00:11:59,618 --> 00:11:59,885
TOO.

252
00:11:59,885 --> 00:12:00,352
>> ALL RIGHT.

253
00:12:00,352 --> 00:12:01,320
THANK YOU, WE'LL BE CHECKING IN

254
00:12:01,320 --> 00:12:03,122
WITH YOU AGAIN LATER ON IN THIS

255
00:12:03,122 --> 00:12:03,422
SHOW.

256
00:12:03,422 --> 00:12:06,192
AND YOU CAN FIND OUT MORE ABOUT

257
00:12:06,192 --> 00:12:08,227
NASA'S PLANETARY DEFENSE

258
00:12:08,227 --> 00:12:20,206
COORDINATION OFFICE BY GOING TO

259
00:12:20,206 --> 00:12:20,906
www.nasa.gov/PLANETARYDEFENSE.

260
00:12:20,906 --> 00:12:31,183
[MUSIC PLAYING]

261
00:12:31,183 --> 00:12:34,987
>> AS YOU HEARD EARLIER, NASA

262
00:12:34,987 --> 00:12:37,490
HAS TO BE ON THE CONSTANT

263
00:12:37,490 --> 00:12:39,325

LOOKOUT FOR POTENTIAL HAZARDOUS

264
00:12:39,325 --> 00:12:40,226
SPACE ROCKS.

265
00:12:40,226 --> 00:12:42,161
THE GOAL IS TO DISCOVER THEM

266
00:12:42,161 --> 00:12:43,496
EARLY ENOUGH TO BE ABLE TO DO

267
00:12:43,496 --> 00:12:44,797
SOMETHING ABOUT THEM.

268
00:12:44,797 --> 00:12:49,034
ON AVERAGE, NASA-SPONSORED

269
00:12:49,034 --> 00:12:51,270
PROJECTS SPOT FIVE NEAR-EARTH

270
00:12:51,270 --> 00:12:51,837
OBJECTS A NIGHT.

271
00:12:51,837 --> 00:12:59,712
NASA HAS ADOPTED THE NEO.

272
00:12:59,712 --> 00:13:07,987
THE UNIQUE GROUND SURVEILLANCE.

273
00:13:07,987 --> 00:13:34,013
PAN STAR IS LOCATED IN HAWAII.

274
00:13:34,013 --> 00:13:34,480
[MUSIC PLAYING]

275
00:13:34,480 --> 00:13:36,882
>> SURVEY PROGRAMS ARE REALLY

276
00:13:36,882 --> 00:13:39,752
THE START OF THE WHOLE PLANETARY

277
00:13:39,752 --> 00:13:40,119
ECOSYSTEM.

278
00:13:40,119 --> 00:13:42,188
IT STARTS WITH DISCOVERY AND

279
00:13:42,188 --> 00:13:45,558
GOES ON TO FOLLOW-UP,

280
00:13:45,558 --> 00:13:48,093
CHARACTERIZATION, IMPACT RISK

281
00:13:48,093 --> 00:13:48,460
ANALYSIS.

282
00:13:48,460 --> 00:13:52,298
BUT YOU CAN'T FOLLOW UP AND

283
00:13:52,298 --> 00:13:54,567
CHARACTERIZE, AND YOU CAN'T

284
00:13:54,567 --> 00:13:55,734
CALCULATE THE IMPACT OF

285
00:13:55,734 --> 00:13:57,136
SOMETHING YOU DON'T DISCOVER.

286
00:13:57,136 --> 00:13:59,004
IN ORDER TO FIND THE NEAREST

287
00:13:59,004 --> 00:14:03,142
ASTEROID, WE TAKE FOUR IMAGES OF

288
00:14:03,142 --> 00:14:08,013

SKY, SEPARATED BY --

289
00:14:08,013 --> 00:14:10,049
>> WE CREATE THIS IMAGE AND THE

290
00:14:10,049 --> 00:14:11,283
STARS ARE SET AS THEY SHOULD BE.

291
00:14:11,283 --> 00:14:14,119
IF THERE'S ANYTHING THAT'S

292
00:14:14,119 --> 00:14:15,821
MOVING, IT WILL POP OUT.

293
00:14:15,821 --> 00:14:17,723
>> OUR SOFTWARE COMPARES THOSE

294
00:14:17,723 --> 00:14:19,325
IMAGES AND IDENTIFIES THINGS

295
00:14:19,325 --> 00:14:22,461
THAT ARE NOT MOVING, STARS, AND

296
00:14:22,461 --> 00:14:23,996
REMOVES THOSE.

297
00:14:23,996 --> 00:14:26,665
ELIMINATES THINGS THAT ARE

298
00:14:26,665 --> 00:14:27,066
TRANSIENT.

299
00:14:27,066 --> 00:14:31,036
THEY'RE LINKED UP.

300
00:14:31,036 --> 00:14:32,871
>> WE'VE PROBABLY SEEN ABOUT A

301
00:14:32,871 --> 00:14:35,407
MILLION ASTEROIDS IN THE LAST

302
00:14:35,407 --> 00:14:36,575
SEVEN YEARS.

303
00:14:36,575 --> 00:14:39,778
IT'S LIKE TAKING A NEEDLE OUT OF

304
00:14:39,778 --> 00:14:42,081
A HAYSTACK.

305
00:14:42,081 --> 00:14:43,949
WE'RE LOOKING AT DISTINCTIVE

306
00:14:43,949 --> 00:14:44,617
MOTION.

307
00:14:44,617 --> 00:14:48,320
WHEN WE SEE IT IN ASTEROIDS, WE

308
00:14:48,320 --> 00:14:51,490
REPORT THEM TO THE WORLD

309
00:14:51,490 --> 00:14:55,694
CLEARINGHOUSE FOR NEAR-EARTH

310
00:14:55,694 --> 00:14:56,061
ASTEROIDS.

311
00:14:56,061 --> 00:14:57,096
>> THE CENTER FOR NEO STUDIES

312
00:14:57,096 --> 00:15:00,032
TAKES THE OBSERVATIONS FROM THE

313
00:15:00,032 --> 00:15:03,168

MINOR PLANET CENTER AND CON

314
00:15:03,168 --> 00:15:04,703
PUTTS THE HIGH -- COMPUTES THE

315
00:15:04,703 --> 00:15:07,206
HIGH ORBITS WE USE.

316
00:15:07,206 --> 00:15:09,008
NEO IS AN EARLY WARNING SYSTEM

317
00:15:09,008 --> 00:15:11,343
FOR A NEWLY DISCOVERED ASTEROID.

318
00:15:11,343 --> 00:15:14,179
WE TAKE THE EARLY DATA AND

319
00:15:14,179 --> 00:15:15,281
COMPUTE WHETHER OR NOT THE

320
00:15:15,281 --> 00:15:16,015
ASTEROID COULD HIT THE EARTH.

321
00:15:16,015 --> 00:15:17,883
IF THERE'S A CHANCE, WE'LL SEND

322
00:15:17,883 --> 00:15:20,152
OUT AN EARLY WARNING AND ALERT

323
00:15:20,152 --> 00:15:21,820
FOR FOLLOW-UP OBSERVATIONS SO WE

324
00:15:21,820 --> 00:15:22,888
COULD GET MORE DATA, AND WE

325
00:15:22,888 --> 00:15:24,790
WOULD KNOW, PERHAPS, IF IT COULD

326
00:15:24,790 --> 00:15:28,427
HIT THE EARTH OR NOT.

327
00:15:28,427 --> 00:15:30,029
>> ASTEROID IMPACTS ARE A FACT

328
00:15:30,029 --> 00:15:30,529
OF LIFE.

329
00:15:30,529 --> 00:15:34,533
THE EARTH HAS BEEN IMPACTED BY

330
00:15:34,533 --> 00:15:35,834
ASTEROIDS CONTINUALLY THROUGH

331
00:15:35,834 --> 00:15:36,168
HISTORY.

332
00:15:36,168 --> 00:15:39,171
WE SAW IN 2013, IN RUSSIA, A

333
00:15:39,171 --> 00:15:40,673
FAIRLY SMALL BY STANDARDS OF

334
00:15:40,673 --> 00:15:43,042
WHAT WE'RE FINDING, ASTEROID

335
00:15:43,042 --> 00:15:44,443
THAT DID HIT THE EARTH.

336
00:15:44,443 --> 00:15:46,545
>> I FEEL LIKE WE'RE GUARDING

337
00:15:46,545 --> 00:15:47,346
THE PLANET.

338
00:15:47,346 --> 00:15:49,081

WE'RE DOING OUR BEST TO PROTECT

339
00:15:49,081 --> 00:15:49,515
PEOPLE.

340
00:15:49,515 --> 00:15:51,784
IT IS A LONG-TERM PROJECT.

341
00:15:51,784 --> 00:15:52,985
IT'S GOING TO TAKE MANY YEARS TO

342
00:15:52,985 --> 00:15:54,987
FIND ALL THE DANGEROUS

343
00:15:54,987 --> 00:15:55,354
ASTEROIDS.

344
00:15:55,354 --> 00:15:58,657
THE GOAL IS TO FIND THE

345
00:15:58,657 --> 00:16:07,466
ASTEROIDS BEFORE THEY FIND US.

346
00:16:07,466 --> 00:16:10,202
>> WELL, TRACKING ASTEROIDS

347
00:16:10,202 --> 00:16:11,837
TAKES A WORLDWIDE EFFORT.

348
00:16:11,837 --> 00:16:18,210
HERE IS A MAP OF NASA-SPONSORED

349
00:16:18,210 --> 00:16:18,877
PROJECTS.

350
00:16:18,877 --> 00:16:20,446
THERE'S MORE TO IT THAN THAT.

351
00:16:20,446 --> 00:16:22,948
ADD IN ALL THE OBSERVERS AND

352
00:16:22,948 --> 00:16:23,949
PROFESSIONALS AROUND THE WORLD,

353
00:16:23,949 --> 00:16:25,351
AND NOW THERE ARE HUNDREDS OF

354
00:16:25,351 --> 00:16:26,719
ADDITIONAL EYES LOOKING FOR

355
00:16:26,719 --> 00:16:28,187
ASTEROIDS ALL AROUND THE PLANET.

356
00:16:28,187 --> 00:16:30,222
THESE OBSERVERS WILL REPORT

357
00:16:30,222 --> 00:16:32,324
THEIR ASTEROID SIGHTINGS TO THE

358
00:16:32,324 --> 00:16:33,625
MINOR PLANET CENTER IN

359
00:16:33,625 --> 00:16:35,227
CAMBRIDGE, MASSACHUSETTS.

360
00:16:35,227 --> 00:16:37,262
THAT IS A KEY PLAYER IN

361
00:16:37,262 --> 00:16:37,796
PLANETARY DEFENSE.

362
00:16:37,796 --> 00:16:39,798
THE MINOR PLANET CENTER SHARES

363
00:16:39,798 --> 00:16:41,967

INFORMATION WITH ASTRONOMERS

364
00:16:41,967 --> 00:16:42,935
WORLDWIDE ABOUT POTENTIALLY

365
00:16:42,935 --> 00:16:43,702
HAZARDOUS OBJECTS.

366
00:16:43,702 --> 00:16:47,740
THIS ALLOWS FOR MULTIPLE

367
00:16:47,740 --> 00:16:49,041
OBSERVATIONS OF THE SAME

368
00:16:49,041 --> 00:16:49,708
ASTEROID.

369
00:16:49,708 --> 00:16:52,244
MATT HOLMAN IS THE DIRECTOR OF

370
00:16:52,244 --> 00:16:53,112
THE CENTER.

371
00:16:53,112 --> 00:16:55,781
HE JOINS US LIVE NOW.

372
00:16:55,781 --> 00:16:56,415
HI, MATT.

373
00:16:56,415 --> 00:16:57,616
>> HI, KAY.

374
00:16:57,616 --> 00:16:58,350
>> ALREADY.

375
00:16:58,350 --> 00:16:59,485
YOU TOLD ME EARLIER THIS IS

376
00:16:59,485 --> 00:17:01,487
ABOUT FOLLOWING ALL THE DOTS.

377
00:17:01,487 --> 00:17:04,590
SO TELL ME EXACTLY, WHAT IS THE

378
00:17:04,590 --> 00:17:06,258
EMPTY SEA.

379
00:17:06,258 --> 00:17:08,160
>> THE PLANET CENTER IS THE

380
00:17:08,160 --> 00:17:10,496
WORLD'S CLEARINGHOUSE FOR THE

381
00:17:10,496 --> 00:17:11,563
ASTEROID OBSERVATIONS.

382
00:17:11,563 --> 00:17:13,899
WE GET OBSERVATIONS OF ASTEROIDS

383
00:17:13,899 --> 00:17:15,300
FROM HUNDREDS AND THOUSANDS OF

384
00:17:15,300 --> 00:17:17,970
DIFFERENT OBSERVATORIES.

385
00:17:17,970 --> 00:17:19,605
WE COLLECT ALL OF THAT DATA

386
00:17:19,605 --> 00:17:20,973
TOGETHER AND DISTRIBUTES IT TO

387
00:17:20,973 --> 00:17:22,341
ANYONE WHO'S INTERESTED.

388
00:17:22,341 --> 00:17:24,076

WE'RE ALSO BUSYING OURSELVES

389
00:17:24,076 --> 00:17:25,544
TRYING TO DETERMINE WHICH OF

390
00:17:25,544 --> 00:17:28,547
THOSE ASTEROID OBSERVATIONS

391
00:17:28,547 --> 00:17:29,681
ACCORDING SPEND TO SOMETHING

392
00:17:29,681 --> 00:17:31,049
THAT NEEDS OBSERVATION.

393
00:17:31,049 --> 00:17:32,785
>> TELL ME WHY YOU EVEN NEED A

394
00:17:32,785 --> 00:17:34,219
CLEARINGHOUSE FOR ALL OF THESE

395
00:17:34,219 --> 00:17:35,087
OBJECTS.

396
00:17:35,087 --> 00:17:35,888
WHY IS IT NECESSARY?

397
00:17:35,888 --> 00:17:38,090
>> WELL, THERE'S SO MANY PEOPLE

398
00:17:38,090 --> 00:17:39,792
INVOLVED THAT REALLY WOULD NOT

399
00:17:39,792 --> 00:17:41,960
BE EFFICIENT TO HAVE THEM TRY TO

400
00:17:41,960 --> 00:17:44,229
DISTRIBUTE THEIR DATA TO EACH

401
00:17:44,229 --> 00:17:44,530
OTHER.

402
00:17:44,530 --> 00:17:46,832
IT'S MUCH MORE EFFICIENT IF THEY

403
00:17:46,832 --> 00:17:48,367
SEND IT ALL TO US.

404
00:17:48,367 --> 00:17:49,635
THEN WE CAN BRING IT TOGETHER.

405
00:17:49,635 --> 00:17:53,872
WE'RE TRYING TO SEE IF PEOPLE --

406
00:17:53,872 --> 00:17:56,308
IF IT'S THE SAME OBJECT.

407
00:17:56,308 --> 00:17:57,509
YOU COULD CORRELATE THAT DATA

408
00:17:57,509 --> 00:17:59,044
AND QUICKLY FEED IT BACK TO

409
00:17:59,044 --> 00:17:59,378
THEM.

410
00:17:59,378 --> 00:17:59,678
OKAY.

411
00:17:59,678 --> 00:18:00,879
THESE ARE THE THINGS THAT NEED

412
00:18:00,879 --> 00:18:02,147
MORE OBSERVATIONS.

413
00:18:02,147 --> 00:18:03,582

>> ALL RIGHT.

414
00:18:03,582 --> 00:18:06,151
SO IT'S A CONTACT SO YOU WORK

415
00:18:06,151 --> 00:18:06,919
MORE EFFICIENTLY.

416
00:18:06,919 --> 00:18:08,287
CAN YOU GO AHEAD AND JUST WALK

417
00:18:08,287 --> 00:18:09,488
ME THROUGH THE PROCESS?

418
00:18:09,488 --> 00:18:10,656
HOW DOES IT ALL WORK?

419
00:18:10,656 --> 00:18:14,560
>> WELL, ON ANY GIVEN NIGHT, THE

420
00:18:14,560 --> 00:18:16,361
MINOR PLANET CENTER RECEIVES

421
00:18:16,361 --> 00:18:18,630
SOMETHING LIKE 100,000

422
00:18:18,630 --> 00:18:20,966
INDIVIDUAL OBSERVATIONS OF

423
00:18:20,966 --> 00:18:21,366
ASTEROIDS.

424
00:18:21,366 --> 00:18:26,071
AND WE ASK OURSELVES IMMEDIATE

425
00:18:26,071 --> 00:18:27,473
IMMEDIATELY, WHICH OF THESE

426
00:18:27,473 --> 00:18:29,174
OBSERVATIONS CORRESPOND TO AN

427
00:18:29,174 --> 00:18:30,275
OBJECT WE'VE SEEN BEFORE AND

428
00:18:30,275 --> 00:18:32,711
WHICH OF THEM CORRESPOND TO A

429
00:18:32,711 --> 00:18:35,614
NEW DISCOVERY THAT'S A

430
00:18:35,614 --> 00:18:38,951
POTENTIALLY HAZARDOUS NEAR-EARTH

431
00:18:38,951 --> 00:18:39,284
OBJECT?

432
00:18:39,284 --> 00:18:40,152
BELIEVE IT OR NOT, 90% OF THE

433
00:18:40,152 --> 00:18:41,987
TIME, WE KNOW WHAT THOSE OBJECTS

434
00:18:41,987 --> 00:18:42,588
ARE.

435
00:18:42,588 --> 00:18:45,491
WE'VE SEEN THEM BEFORE, AND WE

436
00:18:45,491 --> 00:18:48,594
KNOW THE TERM OF ORBIT.

437
00:18:48,594 --> 00:18:50,429
WE PUT THOSE ASIDE AND FOCUS ON

438
00:18:50,429 --> 00:18:52,764

THE REMAINING 10% AND DETERMINE

439
00:18:52,764 --> 00:18:56,935
IF THEY'RE POTENTIALLY HAZARDOUS

440
00:18:56,935 --> 00:18:58,937
NEAR-EARTH OBJECTS OR GARDEN

441
00:18:58,937 --> 00:19:00,138
MAIN BELT ASTEROIDS.

442
00:19:00,138 --> 00:19:01,573
>> HOW DO YOU TELL THE DIFFERENT

443
00:19:01,573 --> 00:19:03,342
FROM THE MAIN BELT ASTEROIDS

444
00:19:03,342 --> 00:19:04,843
THAT ARE FAR, FAR AWAY AND THE

445
00:19:04,843 --> 00:19:06,545
ONES THAT ARE ACTUALLY KIND OF

446
00:19:06,545 --> 00:19:06,879
CLOSE?

447
00:19:06,879 --> 00:19:09,147
>> WELL, AS RICHARD WAYNE SAYS,

448
00:19:09,147 --> 00:19:11,583
WE USE THE PATTERN OF MOTION.

449
00:19:11,583 --> 00:19:13,919
LET ME GIVE YOU AN ANALOGY.

450
00:19:13,919 --> 00:19:16,788
IMAGINE YOU'RE IN A CAR AND

451
00:19:16,788 --> 00:19:17,823
DRIVING ALONG A ROAD.

452
00:19:17,823 --> 00:19:19,391
YOU LOOK AT THE WINDOW.

453
00:19:19,391 --> 00:19:22,261
YOU LOOK AT THE FENCE POSTS.

454
00:19:22,261 --> 00:19:23,662
THOSE FENCE POSTS APPEAR TO BE

455
00:19:23,662 --> 00:19:24,196
MOVING QUICKLY.

456
00:19:24,196 --> 00:19:25,264
LOOK AT THE TREES.

457
00:19:25,264 --> 00:19:27,099
THE TREES APPEAR TO BE MOVING

458
00:19:27,099 --> 00:19:27,733
LESS QUICKLY.

459
00:19:27,733 --> 00:19:29,167
THEN YOU LOOK AT THE MOUNTAINS

460
00:19:29,167 --> 00:19:30,469
WAY IN THE BACKGROUND, THEY

461
00:19:30,469 --> 00:19:32,204
DON'T APPEAR TO BE MOVING AT

462
00:19:32,204 --> 00:19:32,471
ALL.

463
00:19:32,471 --> 00:19:33,572

IN FACT, NONE OF THOSE THINGS

464
00:19:33,572 --> 00:19:34,373
ARE MOVING.

465
00:19:34,373 --> 00:19:35,807
IT'S THE CAR THAT'S MOVING.

466
00:19:35,807 --> 00:19:39,144
AND THE APPARENT RATE OF MOTION

467
00:19:39,144 --> 00:19:41,213
IS APPROXIMATE PER DISTANCE.

468
00:19:41,213 --> 00:19:42,514
THE THINGS CLOSE TO YOU APPEAR

469
00:19:42,514 --> 00:19:44,016
TO BE MOVING DIFFERENTLY.

470
00:19:44,016 --> 00:19:45,717
THAT'S SOMETHING GOING ON WITH

471
00:19:45,717 --> 00:19:46,285
ASTEROIDS.

472
00:19:46,285 --> 00:19:47,719
IT'S SOMETHING WE CALL PARADOX.

473
00:19:47,719 --> 00:19:51,089
INSTEAD OF DOTS MOVING QUICKLY

474
00:19:51,089 --> 00:19:53,125
ALONG THE SIDE, THEY ARE VERY

475
00:19:53,125 --> 00:19:54,493
LIKELY CLOSER TO EARTH.

476
00:19:54,493 --> 00:19:55,961
THAT'S WHAT WE CONCENTRATE ON.

477
00:19:55,961 --> 00:19:58,897
>> IF YOU FIND SOMETHING THAT

478
00:19:58,897 --> 00:20:02,200
NEEDS A LITTLE BIT MORE

479
00:20:02,200 --> 00:20:02,968
DOUBLE-CHECKING, HOW DO YOU TELL

480
00:20:02,968 --> 00:20:04,836
YOUR OBSERVERS?

481
00:20:04,836 --> 00:20:07,372
>> WE HAVE THE NEO PAGE.

482
00:20:07,372 --> 00:20:09,074
IT'S A WEBSITE THAT THE CENTER

483
00:20:09,074 --> 00:20:10,542
IS CONSTANTLY UPDATING.

484
00:20:10,542 --> 00:20:14,279
THAT'S WHERE WE MAINTAIN A

485
00:20:14,279 --> 00:20:15,981
PRIORITIZED LIST OF OBJECTS THAT

486
00:20:15,981 --> 00:20:16,848
NEED OBSERVATION.

487
00:20:16,848 --> 00:20:18,417
>> ALL RIGHT.

488
00:20:18,417 --> 00:20:19,985

WELL, WE HAVE A LITTLE BIT OF

489
00:20:19,985 --> 00:20:21,486
TIME LEFT, AND I HAVE A SOCIAL

490
00:20:21,486 --> 00:20:23,789
MEDIA QUESTION FOR YOU.

491
00:20:23,789 --> 00:20:26,959
THIS ONE IS: WHAT'S THE LARGEST

492
00:20:26,959 --> 00:20:29,661
ASTEROID YOU'VE FOUND SO FAR?

493
00:20:29,661 --> 00:20:33,632
>> WELL, THE LARGEST ASTEROIDS

494
00:20:33,632 --> 00:20:38,270
ARE REALLY IN A CATEGORY OF

495
00:20:38,270 --> 00:20:38,637
PLANETS.

496
00:20:38,637 --> 00:20:41,306
THOSE ARE THINGS THAT WE'RE

497
00:20:41,306 --> 00:20:46,244
WORKING ON.

498
00:20:46,244 --> 00:20:48,513
THOSE ARE HUNDREDS OF

499
00:20:48,513 --> 00:20:48,914
KILOMETERS.

500
00:20:48,914 --> 00:20:49,314
>> ALL RIGHT.

501
00:20:49,314 --> 00:20:51,650
WELL, WE LEARNED A LOT, MATT.

502
00:20:51,650 --> 00:20:54,419
THANK YOU SO MUCH FOR JOINING

503
00:20:54,419 --> 00:20:54,686
US.

504
00:20:54,686 --> 00:20:55,821
>> MY PLEASURE.

505
00:20:55,821 --> 00:20:56,555
>> AND IF YOU WOULD LIKE TO

506
00:20:56,555 --> 00:20:58,390
LEARN MORE, YOU CAN CHECK OUT

507
00:20:58,390 --> 00:21:00,993
THE MINOR PLANET CENTER.

508
00:21:00,993 --> 00:21:18,510
THE WEBSITE, THAT IS.

509
00:21:18,510 --> 00:21:28,220
IT'S www.minorplanetcenterdotet.

510
00:21:28,220 --> 00:21:28,553
.COM.

511
00:21:28,553 --> 00:21:31,890
>> OCTOBER 6, 2008, WAS A DAY

512
00:21:31,890 --> 00:21:33,125
WHEN NASA'S HUNTING TEAM WAS PUT

513
00:21:33,125 --> 00:21:34,559

TO THE TEST.

514
00:21:34,559 --> 00:21:37,429
THE CATALINA SKY SURVEY TEAM

515
00:21:37,429 --> 00:21:38,797
SPOTTED AN ASTEROID THAT

516
00:21:38,797 --> 00:21:41,500
EVENTUALLY WOULD HIT EARTH JUST

517
00:21:41,500 --> 00:21:43,068
19 HOURS BEFORE IT WAS PREDICTED

518
00:21:43,068 --> 00:21:44,603
TO ENTER THE ATMOSPHERE.

519
00:21:44,603 --> 00:21:46,638
THE NEAR-EARTH OBJECTS TEAM AND

520
00:21:46,638 --> 00:21:49,307
ASTRONOMERS ALL OVER THE WORLD

521
00:21:49,307 --> 00:21:49,908
SPRANG INTO ACTION.

522
00:21:49,908 --> 00:21:52,644
THEIR OBSERVATIONS ALLOWED US TO

523
00:21:52,644 --> 00:21:53,745
FIGURE OUT EXACTLY WHERE AND

524
00:21:53,745 --> 00:21:56,415
WHEN THE OBJECT WOULD HIT.

525
00:21:56,415 --> 00:21:58,884
AT ONLY A FEW METERS ACROSS, IT

526
00:21:58,884 --> 00:22:00,852
POSED NO DANGER.

527
00:22:00,852 --> 00:22:03,255
IT WAS SMALL AND POSED NO

528
00:22:03,255 --> 00:22:07,459
THREAT.

529
00:22:07,459 --> 00:22:09,161
ON OCTOBER 7TH, 2008, THE

530
00:22:09,161 --> 00:22:10,796
ASTEROID PLUNGED THROUGH OUR

531
00:22:10,796 --> 00:22:12,931
ATMOSPHERE AND EXPLODED 23 MILES

532
00:22:12,931 --> 00:22:16,702
I ABOVE THE REMOTE DESERT IN THE

533
00:22:16,702 --> 00:22:17,269
SUDAN.

534
00:22:17,269 --> 00:22:19,204
HUNDREDS OF METEORITES WERE

535
00:22:19,204 --> 00:22:20,172
LATER RECOVERED.

536
00:22:20,172 --> 00:22:21,840
NOW, THIS WAS THE FIRST TIME AN

537
00:22:21,840 --> 00:22:26,211
ASTEROID WAS SPOTTED AND ITS

538
00:22:28,280 --> 00:22:27,145

LOCATION

539
00:22:28,280 --> 00:22:29,481
HITTING EARTH.

540
00:22:29,481 --> 00:22:31,149
THE SYSTEM WORKED.

541
00:22:31,149 --> 00:22:33,185
HERE AT THE JET PROPULSION

542
00:22:33,185 --> 00:22:36,455
LABORATORY, THEY PLAYED A BIG

543
00:22:36,455 --> 00:22:36,755
ROLE.

544
00:22:36,755 --> 00:22:38,757
THE CENTER COMPUTES NEAR-EARTH

545
00:22:38,757 --> 00:22:41,760
OBJECTS AND PREDICTS THE FUTURE

546
00:22:41,760 --> 00:22:43,662
PATH AND ASSESSES WHETHER OR NOT

547
00:22:43,662 --> 00:22:46,098
THEY WILL ACTUALLY IMPACT THE

548
00:22:46,098 --> 00:22:46,498
EARTH.

549
00:22:46,498 --> 00:22:48,033
PAUL IS THE MANAGER.

550
00:22:48,033 --> 00:22:50,736
WHAT WAS THAT DAY LIKE FOR TC3?

551
00:22:50,736 --> 00:22:52,204
>> THAT WAS AN EXCITING DAY,

552
00:22:52,204 --> 00:22:52,637
BELIEVE ME.

553
00:22:52,637 --> 00:22:53,905
IT WAS ALL COMPRESSED INTO A

554
00:22:53,905 --> 00:22:54,306
SINGLE DAY.

555
00:22:54,306 --> 00:22:55,173
IT WAS DISCOVERED.

556
00:22:55,173 --> 00:22:56,842
WE HAD TO RUN THE NUMBERS AND

557
00:22:56,842 --> 00:22:58,276
REALIZE IT WAS GOING TO HIT THE

558
00:22:58,276 --> 00:23:00,378
EARTH, AND THEN WE HAD TO FIGURE

559
00:23:00,378 --> 00:23:02,447
OUT WHERE IT WAS GOING TO HIT

560
00:23:02,447 --> 00:23:03,882
THE EARTH, NOTIFY PEOPLE.

561
00:23:03,882 --> 00:23:06,017
IT WAS ALL COMPRESSED INTO ONE

562
00:23:06,017 --> 00:23:06,885
DAY.

563
00:23:06,885 --> 00:23:08,153

FORTUNATELY WE KNEW IT WAS

564
00:23:08,153 --> 00:23:08,453
SMALL.

565
00:23:08,453 --> 00:23:09,521
THAT WAS THE FIRST QUESTION TO

566
00:23:09,521 --> 00:23:10,889
ASK, AND WE COULD SEE IT WAS

567
00:23:10,889 --> 00:23:11,189
SMALL.

568
00:23:11,189 --> 00:23:13,058
>> YOU BE IT MUST HAVE BEEN JUST

569
00:23:13,058 --> 00:23:15,160
GATHERING TOGETHER AND PICKING

570
00:23:15,160 --> 00:23:18,363
UP THE PHONE CALL AND HEARING.

571
00:23:18,363 --> 00:23:21,133
I MEAN, YOU GUYS JUST JUMPED ON

572
00:23:21,133 --> 00:23:22,033
IT, EVERYBODY.

573
00:23:22,033 --> 00:23:22,734
>> YEAH.

574
00:23:22,734 --> 00:23:24,269
ALL THE TEAMS DID.

575
00:23:24,269 --> 00:23:27,472
MINOR PLANET CENTER, OUR TEAM,

576
00:23:27,472 --> 00:23:31,443
AND LYNNLEY JOHNSON WAS INVOLVED

577
00:23:31,443 --> 00:23:34,179
IN COMMUNICATING THIS INTO THE

578
00:23:34,179 --> 00:23:35,180
HIGHER-UPS IN NASA AND OUR

579
00:23:35,180 --> 00:23:35,580
GOVERNMENT.

580
00:23:35,580 --> 00:23:36,982
IT WAS A BUSY DAY FOR EVERYONE.

581
00:23:36,982 --> 00:23:38,183
>> WHY DO YOU SAY THIS WAS A

582
00:23:38,183 --> 00:23:40,452
REAL TEST AND YOU GUYS PASSED?

583
00:23:40,452 --> 00:23:42,154
>> WELL, OUR CALCULATIONS EARLY

584
00:23:42,154 --> 00:23:44,756
ON INDICATED IT WOULD HIT IN THE

585
00:23:44,756 --> 00:23:48,193
NUBIAN DESERT IN THE SUDAN.

586
00:23:48,193 --> 00:23:49,628
WE IDENTIFIED THE LOCATION

587
00:23:49,628 --> 00:23:49,928
EARLY.

588
00:23:49,928 --> 00:23:51,830

AS WE GOT MORE AND MORE

589
00:23:51,830 --> 00:23:53,832
OBSERVATIONS, WE IDENTIFIED THE

590
00:23:53,832 --> 00:23:55,667
GROUND TRACK SO WELL THAT TWO

591
00:23:55,667 --> 00:23:57,202
MONTHS LATER WHEN SOME

592
00:23:57,202 --> 00:23:59,971
ASTRONOMERS WENT OUT TO LOOK FOR

593
00:23:59,971 --> 00:24:04,609
THE METEORITES, WE KNEW WHERE

594
00:24:04,609 --> 00:24:05,010
THEY WERE.

595
00:24:05,010 --> 00:24:08,580
THEY WERE RIGHT THERE IN THE

596
00:24:08,580 --> 00:24:08,880
PATH.

597
00:24:08,880 --> 00:24:11,883
>> SO I THINK WE SHOULD ALSO

598
00:24:11,883 --> 00:24:15,253
EXPLAIN TO PEOPLE SOME PEOPLE

599
00:24:15,253 --> 00:24:16,655
DON'T REALIZE THAT NEAR-EARTH

600
00:24:16,655 --> 00:24:19,024
OBJECTS ARE ORBITING THE SUN

601
00:24:19,024 --> 00:24:21,026
JUST LIKE EARTH IS, AND WHAT

602
00:24:21,026 --> 00:24:23,094
YOU'RE FIGURING OUT THE ORBIT OF

603
00:24:23,094 --> 00:24:25,263
THIS BODY AND WHETHER OR NOT IT

604
00:24:25,263 --> 00:24:27,599
WILL ONE DAY INTERCEPT WITH

605
00:24:27,599 --> 00:24:29,835
EARTH EAST ORBIT.

606
00:24:29,835 --> 00:24:31,837
>> -- EARTH'S ORBIT.

607
00:24:31,837 --> 00:24:32,838
>> YES.

608
00:24:32,838 --> 00:24:36,408
SOMETIMES SOME OF THESE ELLIPSES

609
00:24:36,408 --> 00:24:38,810
COME CLOSE TO THE ORBIT.

610
00:24:38,810 --> 00:24:41,046
IF THERE'S AN INTERSECTION, THE

611
00:24:41,046 --> 00:24:43,515
QUESTION IS WILL THE EARTH BE

612
00:24:43,515 --> 00:24:45,917
THERE WHEN THE ASTEROID GETS

613
00:24:45,917 --> 00:24:47,319

THERE.

614
00:24:47,319 --> 00:24:48,286
THAT'S A PRECISION CALCULATION

615
00:24:48,286 --> 00:24:49,087
WE WANT TO RUN.

616
00:24:49,087 --> 00:24:51,056
WE WANT TO DO THAT MANY DECADES

617
00:24:51,056 --> 00:24:53,225
INTO THE FUTURE.

618
00:24:53,225 --> 00:24:55,794
APOTH SIS WAS AN EARLY

619
00:24:55,794 --> 00:24:57,329
INDICATION OF THAT.

620
00:24:57,329 --> 00:25:01,766
THE ORBIT OF IT, A LARGE

621
00:25:01,766 --> 00:25:08,673
ASTEROID, APOTHTHY, IT LOOKED

622
00:25:08,673 --> 00:25:11,376
BIKE AT 2029 THERE WAS A CHANCE

623
00:25:11,376 --> 00:25:13,078
IT COULD HIT EARTH AT THAT

624
00:25:13,078 --> 00:25:13,778
INTERSECTION POINT.

625
00:25:13,778 --> 00:25:15,247
THE PROBABILITY KEPT GETTING A

626
00:25:15,247 --> 00:25:16,715
LITTLE HIGHER AND HIGHER AS WE

627
00:25:16,715 --> 00:25:17,983
TOOK MORE OBSERVATIONS.

628
00:25:17,983 --> 00:25:21,186
>> SO LET'S TAKE APOTHTHY AS AN

629
00:25:21,186 --> 00:25:21,519
EXAMPLE.

630
00:25:21,519 --> 00:25:22,520
VERY EARLY ON, I REMEMBER

631
00:25:22,520 --> 00:25:23,622
HEARING THE REPORTS THAT IT

632
00:25:23,622 --> 00:25:26,391
LOOKS LIKE THERE'S A 4% CHANCE

633
00:25:26,391 --> 00:25:27,158
THAT IT COULD HIT.

634
00:25:27,158 --> 00:25:29,861
AND THEN AS THE TIME WENT BY,

635
00:25:29,861 --> 00:25:30,729
MAYBE NOT.

636
00:25:30,729 --> 00:25:32,764
AND THEN FINALLY THERE WAS A

637
00:25:32,764 --> 00:25:36,668
REPORT SAYING ABSOLUTELY NOT.

638
00:25:36,668 --> 00:25:39,337

WAS NASA WRONG AT THE START?

639
00:25:39,337 --> 00:25:42,173
>> NO, BECAUSE WE ADD DATA.

640
00:25:42,173 --> 00:25:43,875
WE GET MORE AND MORE

641
00:25:43,875 --> 00:25:44,309
INFORMATION.

642
00:25:44,309 --> 00:25:46,811
WE ADD OUR PROJECTIONS.

643
00:25:46,811 --> 00:25:49,948
IT'S KIND OF LIKE SHINING A

644
00:25:49,948 --> 00:25:50,348
FLASHLIGHT.

645
00:25:50,348 --> 00:25:51,483
>> AND SEEING AN IMAGE.

646
00:25:51,483 --> 00:25:54,452
>> HERE'S WHAT IT LOOKS LIKE IN

647
00:25:54,452 --> 00:25:54,953
2029.

648
00:25:54,953 --> 00:25:56,621
WE FEEL THE ASTEROID COULD PASS

649
00:25:56,621 --> 00:25:58,657
SOMEWHERE IN THE ELLIPSE.

650
00:25:58,657 --> 00:26:00,525
WE GET A PROBABILITY OF MAYBE IT

651
00:26:00,525 --> 00:26:01,626
WAS 2%.

652
00:26:01,626 --> 00:26:03,862
THEN A DAY LATER, WE GET MORE

653
00:26:03,862 --> 00:26:05,330
DATA AND THE NEXT STEP THERE'S

654
00:26:05,330 --> 00:26:05,931
ANOTHER ELLIPSE.

655
00:26:05,931 --> 00:26:08,099
AND THEN, LOOK, IT'S MORE LIKELY

656
00:26:08,099 --> 00:26:09,935
TO HIT THE EARTH AS YOU GET MORE

657
00:26:09,935 --> 00:26:10,302
DATA.

658
00:26:10,302 --> 00:26:11,536
4% NOW.

659
00:26:11,536 --> 00:26:13,305
THEN WE FOUND SOME MORE

660
00:26:13,305 --> 00:26:15,807
OBSERVATIONS, ACTUALLY IN THE

661
00:26:15,807 --> 00:26:18,576
ARCHIVES OF APOTHTHY, AND WE RAN

662
00:26:18,576 --> 00:26:19,511
THE CALCULATION AGAIN.

663
00:26:19,511 --> 00:26:25,350

WE GET AN EVEN MORE PRECISE

664
00:26:25,350 --> 00:26:27,652
PREDICTION, AND IT CAN'T HIT.

665
00:26:27,652 --> 00:26:29,421
>> SO IT'S A MATTER OF GETTING

666
00:26:29,421 --> 00:26:30,288
MORE AND MORE INFORMATION.

667
00:26:30,288 --> 00:26:32,123
HOW DO YOU GET THAT INFORMATION

668
00:26:32,123 --> 00:26:34,693
TO DIAL IN THE ORBIT AND GET A

669
00:26:34,693 --> 00:26:35,260
MORE EXACT IDEA?

670
00:26:35,260 --> 00:26:37,095
>> WHAT I LIKE TO SAY IS WE TAKE

671
00:26:37,095 --> 00:26:39,965
ALL THE NUMBERS, AND WE PLOT THE

672
00:26:39,965 --> 00:26:40,265
PATH.

673
00:26:40,265 --> 00:26:42,901
YOU KNOW, WE'RE TRYING TO SEE IN

674
00:26:42,901 --> 00:26:44,869
THE FUTURE HOW CLOSE IT CAN

675
00:26:44,869 --> 00:26:45,337
COME.

676
00:26:45,337 --> 00:26:46,738
BASICALLY WE'RE PLOTTING THE

677
00:26:46,738 --> 00:26:48,206
PATH AND RUNNING THE NUMBERS IN

678
00:26:48,206 --> 00:26:48,873
HIGH PRECISION.

679
00:26:48,873 --> 00:26:49,174
>> OKAY.

680
00:26:49,174 --> 00:26:51,109
SO WHEN YOU'RE RUNNING THE

681
00:26:51,109 --> 00:26:52,978
NUMBERS ON ALL THESE SIGHTINGS

682
00:26:52,978 --> 00:26:54,779
THAT ARE COMING IN EVERY SINGLE

683
00:26:54,779 --> 00:26:57,382
DAY, HOW DO YOU FIGURE OUT AND

684
00:26:57,382 --> 00:26:59,117
HOW DO YOU GIVE AN EARLY WARNING

685
00:26:59,117 --> 00:27:01,753
TO FOLKS AND FLAG THEM THAT, OH,

686
00:27:01,753 --> 00:27:03,254
THIS IS SOMETHING TO KEEP AN EYE

687
00:27:03,254 --> 00:27:03,555
ON.

688
00:27:03,555 --> 00:27:05,457

OH, THAT'S NOT GOING TO BE A

689
00:27:05,457 --> 00:27:07,492
PROBLEM FOR AT LEAST 100 YEARS?

690
00:27:07,492 --> 00:27:09,327
I MEAN, HOW DO YOU DO THAT?

691
00:27:09,327 --> 00:27:12,964
>> WELL, WE DO A CALCULATED

692
00:27:12,964 --> 00:27:13,365
PROBABILITY.

693
00:27:13,365 --> 00:27:15,533
WE HAVE TWOM ISES TO DO THIS.

694
00:27:15,533 --> 00:27:17,736
-- TWO SYSTEMS TO DO THIS.

695
00:27:17,736 --> 00:27:18,770
THIS IS A HUNDRED-YEAR

696
00:27:18,770 --> 00:27:19,637
CALCULATION, RUNNING THE NUMBERS

697
00:27:19,637 --> 00:27:21,172
AND SEEING HOW CLOSE THE

698
00:27:21,172 --> 00:27:22,173
ASTEROIDS COULD GET.

699
00:27:22,173 --> 00:27:24,642
WE HAVE A SHORT-TERM SYSTEM FOR

700
00:27:24,642 --> 00:27:29,881
THE NEO CP, THE NEAR-EARTH

701
00:27:29,881 --> 00:27:32,550
OBJECT PAGE, THIS IS FOR BRAND

702
00:27:32,550 --> 00:27:34,786
NEWLY DISCOVERED OBJECTS.

703
00:27:34,786 --> 00:27:37,155
WE LIKE TO KNOW.

704
00:27:37,155 --> 00:27:38,690
OBJECTS ARE USUALLY DISCOVERED

705
00:27:38,690 --> 00:27:40,859
WHEN THEY'RE CLOSE TO EARTH.

706
00:27:40,859 --> 00:27:44,729
COULD IT HIT THE EARTH, EVEN

707
00:27:44,729 --> 00:27:47,832
BEFORE WE DISCOVER IT?

708
00:27:47,832 --> 00:27:49,434
WE RUN THE NUMBERS BOTH IN

709
00:27:49,434 --> 00:27:54,406
SHORT-TERM AND LONG-TERM.

710
00:27:54,406 --> 00:27:56,808
>> WE CAN PUT UP THE NUMBER YOU

711
00:27:56,808 --> 00:27:58,476
HAVE SIGHTED SO FAR.

712
00:27:58,476 --> 00:28:00,545
>> WELL, THIS IS NASA.

713
00:28:00,545 --> 00:28:06,251

THE ENTIRE CATALOG IS NOW AT

714
00:28:06,251 --> 00:28:07,685
16245 ASTEROIDS.

715
00:28:07,685 --> 00:28:09,487
THAT'S THE BLUE GRAPH THERE.

716
00:28:09,487 --> 00:28:12,557
IN 2017, THAT'S ON THE RIGHT

717
00:28:12,557 --> 00:28:13,858
ACCESS THERE.

718
00:28:13,858 --> 00:28:14,959
WE'RE AT ABOUT 1,800 PER YEAR

719
00:28:14,959 --> 00:28:15,360
RIGHT NOW.

720
00:28:15,360 --> 00:28:17,128
>> YOU NO, SOME PEOPLE ARE

721
00:28:17,128 --> 00:28:17,529
CONCERNED.

722
00:28:17,529 --> 00:28:20,765
THEY SAY LOOK HOW FAST WE'RE

723
00:28:20,765 --> 00:28:22,267
DISCOVERING THEM.

724
00:28:22,267 --> 00:28:23,468
WHY ARE ALL OF A SUDDEN

725
00:28:23,468 --> 00:28:24,602
ASTEROIDS HITTING THE EARTH?

726
00:28:24,602 --> 00:28:25,570
THAT WASN'T HAPPENING BEFORE,

727
00:28:25,570 --> 00:28:26,071
WAS IT?

728
00:28:26,071 --> 00:28:26,771
>> IT WAS.

729
00:28:26,771 --> 00:28:28,506
WE'RE JUST GETTING BETTER AT

730
00:28:28,506 --> 00:28:29,040
FINDING THEM.

731
00:28:29,040 --> 00:28:30,475
WE WANT TO KEEP THAT DISCOVERY

732
00:28:30,475 --> 00:28:31,643
RATE INCREASING.

733
00:28:31,643 --> 00:28:34,045
>> WELL, I HAVE A SOCIAL MEDIA

734
00:28:34,045 --> 00:28:36,314
QUESTION FOR YOU.

735
00:28:36,314 --> 00:28:37,849
BOB WANTS TO KNOW HOW EXACTLY DO

736
00:28:37,849 --> 00:28:39,818
YOU KNOW THE SIZE OF PASSING

737
00:28:39,818 --> 00:28:42,320
ASTEROIDS?

738
00:28:42,320 --> 00:28:44,589

>> IF THEY ARE ONLY A POINT OF

739
00:28:44,589 --> 00:28:46,291
LIGHT IN THE TELESCOPE, ALL WE

740
00:28:46,291 --> 00:28:48,359
KNOW IS HOW BRIGHT THEY ARE.

741
00:28:48,359 --> 00:28:52,497
SO WE HAVE TO ASSUME A CERTAIN

742
00:28:52,497 --> 00:28:53,465
REFLECTED ACTIVITY.

743
00:28:53,465 --> 00:28:55,967
WE OBSERVE THEM BY REFLECTIVE

744
00:28:55,967 --> 00:28:56,668
LIGHT.

745
00:28:56,668 --> 00:28:59,437
SO 14% OF THE SUNSHINE IS BEING

746
00:28:59,437 --> 00:29:01,372
REFLECTED, SO WE CALCULATE A

747
00:29:01,372 --> 00:29:03,441
ROUGH SIZE JUST BASED ON

748
00:29:03,441 --> 00:29:03,842
BRIGHTNESS.

749
00:29:03,842 --> 00:29:04,476
>> ALL RIGHT.

750
00:29:04,476 --> 00:29:05,743
THANK YOU SO MUCH, PAUL.

751
00:29:05,743 --> 00:29:07,445
AND WE HAVE A WEBSITE FOR YOU.

752
00:29:07,445 --> 00:29:11,850
IF YOU WANT MORE INFORMATION, GO

753
00:29:11,850 --> 00:29:22,861
TO CENOS DITTY JPL DITTY

754
00:29:22,861 --> 00:29:37,542
NASA.GOV.

755
00:29:37,542 --> 00:29:41,913
>> NASA RELIES ON TRUSTED

756
00:29:41,913 --> 00:29:43,548
ASTRONOMERS TO GIVE TRUSTED

757
00:29:43,548 --> 00:29:45,116
INFORMATION ON WHETHER A

758
00:29:45,116 --> 00:29:46,284
NEAR-EARTH OBJECT IS ACTUALLY

759
00:29:46,284 --> 00:29:48,386
THERE AND HELP US REFINE THE

760
00:29:48,386 --> 00:29:48,720
ORBIT.

761
00:29:48,720 --> 00:29:50,555
ONE OBSERVER IS ROBERT HOLMES.

762
00:29:50,555 --> 00:29:53,458
BOB STARTED AS A VOLUNTEER

763
00:29:53,458 --> 00:29:55,426

OBSERVER, BUT HE'S SO GOOD NASA

764
00:29:55,426 --> 00:29:57,228
NOW PAYS HIM TO HUNT ASTEROIDS

765
00:29:57,228 --> 00:29:58,129
FULL TIME.

766
00:29:58,129 --> 00:30:00,198
HE'S ONE OF THE WORLD'S MOST

767
00:30:00,198 --> 00:30:01,065
PROLIFIC OBSERVERS.

768
00:30:01,065 --> 00:30:03,101
HOW DOES HE DO IT?

769
00:30:03,101 --> 00:30:04,769
WE WENT TO HIS HOME IN ILLINOIS

770
00:30:04,769 --> 00:30:22,520
FARM COUNTRY TO FIND OUT.

771
00:30:22,520 --> 00:30:26,624
>> WE DO FOLLOW-UP OBSERVATIONS

772
00:30:26,624 --> 00:30:27,659
WITH NASA'S PROGRAM.

773
00:30:27,659 --> 00:30:30,595
ALL NIGHT LONG, I'M RUNNING BIG

774
00:30:30,595 --> 00:30:30,995
TELESCOPES.

775
00:30:30,995 --> 00:30:34,199
ONE IS A 24-INCH, A 30-INCH, AND

776
00:30:34,199 --> 00:30:36,434
A 32-INCH, AND THEN THE 50-INCH

777
00:30:36,434 --> 00:30:39,237
IS MY BIGGEST.

778
00:30:39,237 --> 00:30:41,072
HAVING FOUR TELESCOPES ALLOWS ME

779
00:30:41,072 --> 00:30:43,174
TO REALLY DO FOUR TIMES AS MUCH

780
00:30:43,174 --> 00:30:45,643
WORK AS THE TYPICAL OBSERVATORY

781
00:30:45,643 --> 00:30:47,645
THAT JUST HAS ONE TELESCOPE.

782
00:30:47,645 --> 00:30:52,083
SO IT IS A HUGE ADVANTAGE.

783
00:30:52,083 --> 00:30:54,319
I WORK ON A NIGHTLY BASIS, AND I

784
00:30:54,319 --> 00:30:57,255
USE THESE TELESCOPES TO LOOK AT

785
00:30:57,255 --> 00:30:57,622
ASTEROIDS.

786
00:30:57,622 --> 00:30:59,791
WE DO FOLLOW-UP OBSERVATIONS FOR

787
00:30:59,791 --> 00:31:01,726
THE DISCOVERIES THAT ARE MADE BY

788
00:31:01,726 --> 00:31:04,095

THE LARGE SKY SURVEYS.

789
00:31:04,095 --> 00:31:06,064
BY LOOKING AT THESE ASTEROIDS

790
00:31:06,064 --> 00:31:08,132
AND MEASURING THESE ASTEROIDS,

791
00:31:08,132 --> 00:31:09,467
WE CAN DETERMINE WHAT THEIR

792
00:31:09,467 --> 00:31:10,702
POSSIBILITIES OF ACTUALLY

793
00:31:10,702 --> 00:31:12,971
HITTING THE EARTH IN THE FUTURE

794
00:31:12,971 --> 00:31:15,039
ARE GOING TO BE.

795
00:31:15,039 --> 00:31:17,642
NASA PROVIDES COORDINATES OF

796
00:31:17,642 --> 00:31:18,910
SPECIFIC ITEMS THEY NEED

797
00:31:18,910 --> 00:31:19,978
OBSERVATIONS ON.

798
00:31:19,978 --> 00:31:21,713
I'M GOING TO PUNCH IN THE

799
00:31:21,713 --> 00:31:22,480
COORDINATES HERE.

800
00:31:22,480 --> 00:31:24,582
I'M DOING THIS REMOTELY FROM

801
00:31:24,582 --> 00:31:26,751
INSIDE A CONTROL ROOM, NOT AT

802
00:31:26,751 --> 00:31:27,585
THE TELESCOPE.

803
00:31:27,585 --> 00:31:31,289
AND SO WE LOOK THESE OBJECTS UP

804
00:31:31,289 --> 00:31:33,024
AND USE THOSE COORDINATES TO

805
00:31:33,024 --> 00:31:35,493
LOOK AT A TINY PIECE OF SKY THAT

806
00:31:35,493 --> 00:31:36,828
THIS OBJECT HAPPENS TO BE IN.

807
00:31:36,828 --> 00:31:39,564
THEN WE FOLLOW THOSE OBJECTS AND

808
00:31:39,564 --> 00:31:41,199
DEFINE AND REFINE ORBITS FOR

809
00:31:41,199 --> 00:31:42,734
THOSE OBJECTS AND REDUCE THE

810
00:31:42,734 --> 00:31:44,402
UNCERTAINTY OF WHERE IT'S GOING

811
00:31:44,402 --> 00:31:46,104
TO GO IN THE NEAR FUTURE.

812
00:31:46,104 --> 00:31:49,207
I STARTED OFF AS A VOLUNTEER IN

813
00:31:49,207 --> 00:31:49,574

2006.

814
00:31:49,574 --> 00:31:54,712
IT'S JUST BLOSSOMED INTO A

815
00:31:54,712 --> 00:31:55,980
FULL-TIME OPPORTUNITY TO WORK

816
00:31:55,980 --> 00:31:57,181
FOR NASA UNDER THEIR GRANT

817
00:31:57,181 --> 00:31:58,783
PROGRAM WHERE I'M NOW DOING THIS

818
00:31:58,783 --> 00:32:00,184
EVERY SINGLE CLEAR NIGHT, AND

819
00:32:00,184 --> 00:32:05,523
WE'RE STARTING THE OBSERVING RUN

820
00:32:05,523 --> 00:32:07,825
FOR 2017 KK3.

821
00:32:07,825 --> 00:32:10,328
YOU DON'T BUILD A TELESCOPE

822
00:32:10,328 --> 00:32:12,830
THAT'S THIS BIG WITHOUT BEING

823
00:32:12,830 --> 00:32:14,966
PASSIONATE ABOUT WHAT YOU DO.

824
00:32:14,966 --> 00:32:16,467
I'M REALLY DRIVEN TO BE PART OF

825
00:32:16,467 --> 00:32:18,069
A PROGRAM THAT'S IMPORTANT AND

826
00:32:18,069 --> 00:32:19,637
HAS IMPORTANCE TO THE FUTURE.

827
00:32:19,637 --> 00:32:20,838
WE'RE NOT TALKING ABOUT NEXT

828
00:32:20,838 --> 00:32:23,274
YEAR OR THE YEAR AFTER.

829
00:32:23,274 --> 00:32:24,075
WE'RE TALKING ABOUT ASTEROIDS

830
00:32:24,075 --> 00:32:25,109
THAT COULD POTENTIALLY HIT THE

831
00:32:25,109 --> 00:32:27,512
EARTH 100 YEARS FROM NOW, AND

832
00:32:27,512 --> 00:32:30,114
THE WORK WE DO TODAY MAY MAKE A

833
00:32:30,114 --> 00:32:37,088
DIFFERENCE 100 YEARS FROM NOW.

834
00:32:37,088 --> 00:32:42,293
>> LIKE BOB HOLMES, THE MAG

835
00:32:42,293 --> 00:32:45,129
DELENNA RIDGE FOLLOWS UP ON THE

836
00:32:45,129 --> 00:32:45,863
OBSERVATION.

837
00:32:45,863 --> 00:32:47,632
IT'S LOCATED IN THE MOUNTAINS OF

838
00:32:47,632 --> 00:32:52,370

SO ACCORDINGRO, NEW MEXICO.

839
00:32:52,370 --> 00:32:54,839
HOW FAST IS THE ASTEROID

840
00:32:54,839 --> 00:32:56,908
SPINNING, WHAT SHAPE DOES IT

841
00:32:56,908 --> 00:32:57,208
HAVE?

842
00:32:57,208 --> 00:32:59,444
WHAT IS IT MADE OF?

843
00:32:59,444 --> 00:33:03,614
THE OBSERVATORY HAS A TELESCOPE

844
00:33:03,614 --> 00:33:07,719
CAPABLE OF TRACKING ROCKETS,

845
00:33:07,719 --> 00:33:09,187
ASTEROIDS, AND SPACE JUNK.

846
00:33:09,187 --> 00:33:12,890
EILEEN JOINS US NOW BY SKYPE.

847
00:33:12,890 --> 00:33:13,658
>> HELLO.

848
00:33:13,658 --> 00:33:18,596
>> EXPLAIN TO ME THIS FAST

849
00:33:18,596 --> 00:33:18,996
TELESCOPE.

850
00:33:18,996 --> 00:33:20,865
CAN IT WHIP IN A DIRECTION AND

851
00:33:20,865 --> 00:33:25,002
TRACK SOMETHING REALLY QUICKLY

852
00:33:25,002 --> 00:33:25,803
WHAT ARE WE TALKING ABOUT?

853
00:33:25,803 --> 00:33:28,873
>> WE'RE TALKING ABOUT THE

854
00:33:28,873 --> 00:33:29,407
TELESCOPE MOTION?

855
00:33:29,407 --> 00:33:32,410
IT CAN MOVE FASTER THAN A NORMAL

856
00:33:32,410 --> 00:33:34,545
ASTRONOMICAL TELESCOPE.

857
00:33:34,545 --> 00:33:36,647
THAT'S PRETTY FAST.

858
00:33:36,647 --> 00:33:39,150
WE'RE AT AN ADVANTAGE WHEN

859
00:33:39,150 --> 00:33:40,451
LOOKING AT ASTEROIDS MOVING

860
00:33:40,451 --> 00:33:41,652
CLOSE TO EARTH BECAUSE THEY CAN

861
00:33:41,652 --> 00:33:43,421
MOVE RAPIDLY THROUGH THE SKY.

862
00:33:43,421 --> 00:33:44,889
IF WE WANT TO DEMONSTRATE THIS,

863
00:33:44,889 --> 00:33:46,524

WE CAN WATCH A MOVIE THAT WE

864
00:33:46,524 --> 00:33:47,692
TOOK OF AN ASTEROID THAT CAME

865
00:33:47,692 --> 00:33:51,462
VERY CLOSE TO THE EARTH IN

866
00:33:51,462 --> 00:33:52,463
NOVEMBER 2015.

867
00:33:52,463 --> 00:33:54,866
ASTEROID 2015105.BY

868
00:33:54,866 --> 00:33:56,667
SO THE RIGHT CENTRAL DOT IN THE

869
00:33:56,667 --> 00:33:59,337
MOVIE IS WHAT OUR 2.4 METER

870
00:33:59,337 --> 00:34:00,605
TELESCOPE IS LOCKED ON AND

871
00:34:00,605 --> 00:34:00,972
TRACKING.

872
00:34:00,972 --> 00:34:04,275
AS YOU CAN SEE THE STREAKS THAT

873
00:34:04,275 --> 00:34:10,548
ARE GOING BY, THEY'RE BACKGROUND

874
00:34:10,548 --> 00:34:11,249
STARS.

875
00:34:11,249 --> 00:34:13,351
IT'S PRETTY FAST.

876
00:34:13,351 --> 00:34:15,586
IT'S PRETTY AMAZING THAT WE CAN

877
00:34:15,586 --> 00:34:19,424
LOOK AT THIS AND ANALYZE A

878
00:34:19,424 --> 00:34:20,825
CLOSE-APPROACHING ASTEROID.

879
00:34:20,825 --> 00:34:21,659
WHAT'S MOST INTERESTING ABOUT

880
00:34:21,659 --> 00:34:23,594
THE MOVIE, IF YOU LOOK AT THE

881
00:34:23,594 --> 00:34:26,130
FINAL FRAME, WE HAVE URED

882
00:34:26,130 --> 00:34:30,234
ASTEROID 105 THAT IT ACTUALLY

883
00:34:30,234 --> 00:34:36,340
PASTED THROUGH OUR GEO ZONE.

884
00:34:36,340 --> 00:34:38,976
YOU CAN SEE AN ODD-ANGLE STREAK

885
00:34:38,976 --> 00:34:41,212
AT THE BOTTOM OF THE FRAME.

886
00:34:41,212 --> 00:34:44,248
THAT'S NOT A STAR STREAKING BY.

887
00:34:44,248 --> 00:34:47,752
I IS ONE OF NASA'S COMMUNICATION

888
00:34:47,752 --> 00:34:48,152

SATELLITES.

889
00:34:48,152 --> 00:34:50,955
SO IT PASSED BY THIS SATELLITE

890
00:34:50,955 --> 00:34:53,057
AS WELL AS SEVERAL OTHERS, BUT

891
00:34:53,057 --> 00:34:54,492
LUCKILY, IT DIDN'T HIT.

892
00:34:54,492 --> 00:34:55,960
>> WOW.

893
00:34:55,960 --> 00:34:58,096
THAT WAS CLOSE.

894
00:34:58,096 --> 00:35:02,500
YOU'RE LOOKING AT LITTLE POINTS

895
00:35:02,500 --> 00:35:02,867
OF LIGHT.

896
00:35:02,867 --> 00:35:08,272
HOW ARE YOU ABLE TO GET ANY

897
00:35:08,272 --> 00:35:09,307
CHARACTERISTIC INFORMATION ON

898
00:35:09,307 --> 00:35:10,541
SOMETHING SO SMALL?

899
00:35:10,541 --> 00:35:11,442
>>IT'S AMAZING HOW MUCH WE CAN

900
00:35:11,442 --> 00:35:12,443
LEARN FROM A POINT OF LIGHT.

901
00:35:12,443 --> 00:35:16,347
ONE OF THE THINGS WE STUDY AND

902
00:35:16,347 --> 00:35:17,882
SPECIALIZE AT IS LOOKING AT

903
00:35:17,882 --> 00:35:19,484
ASTEROID ROTATION RATE.

904
00:35:19,484 --> 00:35:22,420
SO ASTEROIDS SPIN ON THEIR AXIS

905
00:35:22,420 --> 00:35:23,921
AS THEY'RE MOVING AROUND THE

906
00:35:23,921 --> 00:35:24,388
SUN.

907
00:35:24,388 --> 00:35:25,590
HERE I HAVE A MODEL ASTEROID.

908
00:35:25,590 --> 00:35:28,693
YOU NOTICE IT'S NOT VERY ROUND.

909
00:35:28,693 --> 00:35:33,898
MOST ASTEROIDS ARE POE TAY TO

910
00:35:33,898 --> 00:35:36,400
SHAPED -- POTATO SHAPED.

911
00:35:36,400 --> 00:35:42,073
HOW CAN WE SEE A LIGHT VARIATION

912
00:35:42,073 --> 00:35:42,440
VARIATION?

913
00:35:42,440 --> 00:35:45,109

WELL, THERE'S REFLECTIVE

914
00:35:45,109 --> 00:35:45,476
SUNLIGHT.

915
00:35:45,476 --> 00:35:48,079
AS IT ROTATES, YOU CAN SEE THE

916
00:35:48,079 --> 00:35:49,947
SURFACE AREA IS CHANGING.

917
00:35:49,947 --> 00:35:50,982
WE MAY HAVE A LITTLE BIT OF

918
00:35:50,982 --> 00:35:52,984
LIGHT REFLECTED BACK TO OUR

919
00:35:52,984 --> 00:35:54,519
TELESCOPE WHEN THE ASTEROID IS

920
00:35:54,519 --> 00:35:56,420
IN THIS POSITION.

921
00:35:56,420 --> 00:35:58,055
THEN WE GET A LITTLE BIT OF

922
00:35:58,055 --> 00:36:00,057
LIGHT AND A LOT OF LIGHT AND A

923
00:36:00,057 --> 00:36:00,458
LITTLE BIT.

924
00:36:00,458 --> 00:36:02,326
LET'S LOOK AT THIS.

925
00:36:02,326 --> 00:36:04,896
WE CAN SEE IT SCHEMATICALLY

926
00:36:04,896 --> 00:36:07,765
REPRESENTED BY AN EGG-SHAPED

927
00:36:07,765 --> 00:36:08,533
ASTEROID.

928
00:36:08,533 --> 00:36:11,936
YOU CAN SEE AS IT ROTATES, THE

929
00:36:11,936 --> 00:36:13,037
ASTEROID IS CHANGING.

930
00:36:13,037 --> 00:36:14,906
YOU GET TWO PEAKS AND TWO DIPS.

931
00:36:14,906 --> 00:36:16,240
THIS IS A ROTATION CYCLE.

932
00:36:16,240 --> 00:36:18,109
THIS IS ACTUALLY A LIGHT CURVE

933
00:36:18,109 --> 00:36:19,310
THAT'S CHANGING BRIGHTNESS.

934
00:36:19,310 --> 00:36:20,845
WHEN WE GO THROUGH THIS WHOLE

935
00:36:20,845 --> 00:36:24,248
CYCLE, WE GET ONE ROTATION RATE.

936
00:36:24,248 --> 00:36:26,617
WE CAN HAVE ASTEROIDS SPINNING

937
00:36:26,617 --> 00:36:28,719
AT AS SHORT OF TIME AS TENS OF

938
00:36:28,719 --> 00:36:29,954

SECONDS TO MANY, MANY HOURS.

939
00:36:29,954 --> 00:36:33,558
WE CAN LOOK AT THIS AND ANALYZE

940
00:36:33,558 --> 00:36:35,159
THE ASTEROID TO UNDERSTAND

941
00:36:35,159 --> 00:36:37,228
POTENTIALLY ITS STRENGTH,

942
00:36:37,228 --> 00:36:39,230
WHETHER IT'S A RUBBLE PILE OR

943
00:36:39,230 --> 00:36:39,764
INTACT OBJECT.

944
00:36:39,764 --> 00:36:42,600
WE LOOK AT THE PEAKS AND DIPS TO

945
00:36:42,600 --> 00:36:45,970
SEE IF WE CAN ALSO SEE THE

946
00:36:45,970 --> 00:36:48,306
ACTUAL SHAPE OF THE ASTEROID.

947
00:36:48,306 --> 00:36:49,173
>> I REMEMBER WHEN WE WERE FIRST

948
00:36:49,173 --> 00:36:56,714
TALKING THAT YOU SEE THESE

949
00:36:56,714 --> 00:36:59,483
FLY-BYES AS A MISSION COMING TO

950
00:36:59,483 --> 00:36:59,750
YOU.

951
00:36:59,750 --> 00:37:01,452
WE SEND SPACE CRAFT FAR AWAY TO

952
00:37:01,452 --> 00:37:04,355
EXPLORE COMETS AND ASTEROIDS AND

953
00:37:04,355 --> 00:37:06,390
PLANETS, BUT HERE IS THIS

954
00:37:06,390 --> 00:37:07,224
WONDERFUL MOMENT WHERE THEY COME

955
00:37:07,224 --> 00:37:09,160
TO YOU, AND YOU'RE SAYING YOU'RE

956
00:37:09,160 --> 00:37:10,394
HITTING IT WITH EVERYTHING

957
00:37:10,394 --> 00:37:10,895
YOU'VE GOT.

958
00:37:10,895 --> 00:37:11,662
>> RIGHT.

959
00:37:11,662 --> 00:37:14,332
>> SO THERE'S MANY INSTRUMENTS.

960
00:37:14,332 --> 00:37:19,770
WHAT ELSE DO YOU FIND, AS IT'S

961
00:37:19,770 --> 00:37:20,938
SWINGING BY YOU?

962
00:37:20,938 --> 00:37:22,406
WHAT OTHER INFORMATION CAN YOU

963
00:37:22,406 --> 00:37:22,740

GATHER?

964
00:37:22,740 --> 00:37:24,408
>> IN ADDITION TO SPIN RAYS, WE

965
00:37:24,408 --> 00:37:25,343
WANT TO GET EVERYTHING WHILE WE

966
00:37:25,343 --> 00:37:27,111
HAVE IT, AS YOU SAID, IN OUR

967
00:37:27,111 --> 00:37:27,812
SIGHTS.

968
00:37:27,812 --> 00:37:30,448
SO WE CAN LOOK AT AN ASTEROID

969
00:37:30,448 --> 00:37:32,783
AND ALSO DETERMINE ITS

970
00:37:32,783 --> 00:37:33,217
COMPOSITION.

971
00:37:33,217 --> 00:37:35,786
ONE ADVANTAGE WE HAVE AT MRO IS

972
00:37:35,786 --> 00:37:39,023
WE CAN MOUNT MULTIPLE

973
00:37:39,023 --> 00:37:40,057
INSTRUMENTS AT THE SAME TIME ON

974
00:37:40,057 --> 00:37:41,225
THE TELESCOPE.

975
00:37:41,225 --> 00:37:43,694
WITH CAN CHANGE FROM A LIGHT

976
00:37:43,694 --> 00:37:46,030
INSTRUMENT TO A SPECK TROP TERRE

977
00:37:46,030 --> 00:37:47,932
THAT WILL SEPARATE LIGHT INTO

978
00:37:47,932 --> 00:37:50,034
DIFFERENT WAVELENGTHS.

979
00:37:50,034 --> 00:37:53,070
WE CAN THEN ANALYZE AND GET A

980
00:37:53,070 --> 00:37:54,472
FINGERPRINT OF AN ASTEROID.

981
00:37:54,472 --> 00:37:56,774
IT CAN BE METAL, ROCK, OR

982
00:37:56,774 --> 00:37:57,441
COMBINATIONS OF THE TWO.

983
00:37:57,441 --> 00:38:00,344
AS PAUL MENTIONED EARLIER IN THE

984
00:38:00,344 --> 00:38:02,413
BROADCAST, WHEN WE KNOW THE

985
00:38:02,413 --> 00:38:05,016
OVERALL REFLEXIVITY BASED ON THE

986
00:38:05,016 --> 00:38:06,217
COMPOSITION, WE CAN GET AN

987
00:38:06,217 --> 00:38:08,386
ESTIMATE OF SIZE, WHICH IS VERY

988
00:38:08,386 --> 00:38:08,786

IMPORTANT.

989
00:38:08,786 --> 00:38:10,721
AND SPECIFICALLY, DIFFERENT

990
00:38:10,721 --> 00:38:13,491
TYPES OF ASTEROIDS, DIFFERENT

991
00:38:13,491 --> 00:38:14,225
COMPOSITIONS WOULD REQUIRE

992
00:38:14,225 --> 00:38:16,160
DIFFERENT APPROACHES FOR

993
00:38:16,160 --> 00:38:17,528
DEFLECTION IF WE EVER FOUND A

994
00:38:17,528 --> 00:38:19,864
HAZARD DOES ONE THAT WE NEEDED

995
00:38:19,864 --> 00:38:20,665
TO DO SOMETHING ABOUT WHILE IT

996
00:38:20,665 --> 00:38:22,199
WAS STILL IN SPACE.

997
00:38:22,199 --> 00:38:25,436
SO A VERY VITAL INFORMATION

998
00:38:25,436 --> 00:38:27,138
CHARACTERIZATION AND AN

999
00:38:27,138 --> 00:38:28,873
IMPORTANT PRACTICAL ROLE IT CAN

1000
00:38:28,873 --> 00:38:29,173
PLAY.

1001
00:38:29,173 --> 00:38:29,807
>> SO GETTING AS MUCH

1002
00:38:29,807 --> 00:38:30,841
INFORMATION AS YOU CAN SO YOU

1003
00:38:30,841 --> 00:38:32,243
KNOW WHAT YOU'RE DEALING WITH.

1004
00:38:32,243 --> 00:38:33,044
>> ABSOLUTELY.

1005
00:38:33,044 --> 00:38:33,944
>> ALL RIGHT.

1006
00:38:33,944 --> 00:38:36,047
WELL, I UNDERSTAND YOU TOLD ME

1007
00:38:36,047 --> 00:38:37,915
THAT THERE IS A LITTLE FLAG

1008
00:38:37,915 --> 00:38:39,684
STORY THAT YOU HAVE A MIRROR

1009
00:38:39,684 --> 00:38:41,652
THAT YOU USE.

1010
00:38:41,652 --> 00:38:44,221
IT'S GOT A LITTLE BIT OF A

1011
00:38:44,221 --> 00:38:45,322
LEGACY, A LITTLE BIT OF HERITAGE

1012
00:38:45,322 --> 00:38:45,623
THERE.

1013
00:38:45,623 --> 00:38:48,426

>> ACTUALLY, IT'S PRETTY

1014
00:38:48,426 --> 00:38:48,793
EXCITING.

1015
00:38:48,793 --> 00:38:50,728
OUR TELESCOPE NEAR IS ONE OF TWO

1016
00:38:50,728 --> 00:38:52,630
SPARES LEFT OVER FROM THE HUBBLE

1017
00:38:52,630 --> 00:38:53,464
SPACE TELESCOPE PROGRAM.

1018
00:38:53,464 --> 00:38:56,000
SO WE HAVE THE ONLY WORKING

1019
00:38:56,000 --> 00:38:57,935
SPARE INCORPORATED INTO OUR

1020
00:38:57,935 --> 00:38:58,335
TELESCOPE.

1021
00:38:58,335 --> 00:39:02,773
THE OTHER SPARE WENT TO THE

1022
00:39:02,773 --> 00:39:04,909
SMITHSONIAN IN WASHINGTON, DC

1023
00:39:04,909 --> 00:39:07,511
AFTER IT WASN'T NEEDED FOR

1024
00:39:07,511 --> 00:39:08,279
HUBBLE.

1025
00:39:08,279 --> 00:39:10,514
IT PERFORMS ABSOLUTELY

1026
00:39:10,514 --> 00:39:10,948
BEAUTIFULLY.

1027
00:39:10,948 --> 00:39:12,349
NEW MEXICO TECH UNIVERSITY,

1028
00:39:12,349 --> 00:39:13,951
WHICH RUNS THE OBSERVATORY

1029
00:39:13,951 --> 00:39:15,252
ACTUALLY GOT IT FOR FREE.

1030
00:39:15,252 --> 00:39:16,187
>> WOW.

1031
00:39:16,187 --> 00:39:17,922
GREAT STORY.

1032
00:39:17,922 --> 00:39:19,256
I HAVE A SOCIAL MEDIA QUESTION

1033
00:39:19,256 --> 00:39:20,758
FOR YOU, EILEEN.

1034
00:39:20,758 --> 00:39:22,159
HERE IT IS.

1035
00:39:22,159 --> 00:39:24,161
MANY OUT THERE ON SOCIAL MEDIA

1036
00:39:24,161 --> 00:39:26,097
WANT TO KNOW WHEN THERE ARE

1037
00:39:26,097 --> 00:39:28,733
CLOSE APPROACHES BY PASSING

1038
00:39:28,733 --> 00:39:29,133

ASTEROIDS?

1039
00:39:29,133 --> 00:39:31,402
CAN YOU SEE THEM WITH YOUR

1040
00:39:31,402 --> 00:39:31,902
NEIGHBORHOOD EYE?

1041
00:39:31,902 --> 00:39:33,838
>> SOMETIMES YOU CAN.

1042
00:39:33,838 --> 00:39:35,306
IT DEPENDS ON HOW BRIGHT THEY

1043
00:39:35,306 --> 00:39:35,673
ARE.

1044
00:39:35,673 --> 00:39:37,341
MOST OF THE TIME WE NEED EVEN

1045
00:39:37,341 --> 00:39:39,744
JUST A SMALL BACKYARD TELESCOPE.

1046
00:39:39,744 --> 00:39:41,078
NATURALLY, IF YOU WENT OUTSIDE

1047
00:39:41,078 --> 00:39:42,613
AND LOOKED IN THE NIGHT SKY, YOU

1048
00:39:42,613 --> 00:39:45,916
MIGHT SEE THINGS OF A VISUAL

1049
00:39:45,916 --> 00:39:49,286
MAGNITUDE OF FIVE OR SIX, EVEN

1050
00:39:49,286 --> 00:39:50,054
ASTEROIDS THAT COME VERY CLOSE

1051
00:39:50,054 --> 00:39:52,690
TO THE EARTH, WE MIGHT HAVE THEM

1052
00:39:52,690 --> 00:39:54,558
BEING AS BRIGHT AS 10 OR 12 ON

1053
00:39:54,558 --> 00:39:55,893
OUR BRIGHTNESS SCALE.

1054
00:39:55,893 --> 00:39:57,094
YOU CAN SEE THEM SOMETIMES

1055
00:39:57,094 --> 00:39:58,963
THROUGH YOUR BACKYARD TELESCOPE.

1056
00:39:58,963 --> 00:40:00,731
SOMETIMES THEY'RE VERY FAINT

1057
00:40:00,731 --> 00:40:04,235
STILL, AND WE NEED OUR BIG

1058
00:40:04,235 --> 00:40:06,771
TELESCOPES TO ACTUALLY STUDY

1059
00:40:06,771 --> 00:40:07,071
THEM.

1060
00:40:07,071 --> 00:40:07,872
>> ALL RIGHT.

1061
00:40:07,872 --> 00:40:09,406
EILEEN, IT'S A PLEASURE TO TALK

1062
00:40:09,406 --> 00:40:09,907
TO YOU.

1063
00:40:09,907 --> 00:40:11,208

THANK YOU SO MUCH FOR HELPING US

1064
00:40:11,208 --> 00:40:12,276
OUT TODAY.

1065
00:40:12,276 --> 00:40:12,910
>> THANKS, KAY.

1066
00:40:12,910 --> 00:40:15,613
>> ALL RIGHT.

1067
00:40:15,613 --> 00:40:30,294
[MUSIC PLAYING]

1068
00:40:30,294 --> 00:40:32,630
>> AT THE START OF THE SHOW, WE

1069
00:40:32,630 --> 00:40:38,302
SHOWED A RADAR MOVIE OF ASTEROID

1070
00:40:38,302 --> 00:40:41,005
2014JO25 MADE USING THE 70 METER

1071
00:40:41,005 --> 00:40:43,407
ANTENNA AT THE STATION IN THE

1072
00:40:43,407 --> 00:40:44,441
MOHAVE DESERT.

1073
00:40:44,441 --> 00:40:47,411
IT'S PART OF NASA'S DEEP SPACE

1074
00:40:47,411 --> 00:40:49,413
NETWORK THAT COMMUNICATES WITH

1075
00:40:49,413 --> 00:40:51,982
OUR NETWORK FROM ACROSS THE

1076
00:40:51,982 --> 00:40:53,050
SOLAR SYSTEM FROM THIS ROOM, IN

1077
00:40:53,050 --> 00:40:54,151
FACT.

1078
00:40:54,151 --> 00:40:56,187
IT'S ACTUALLY A TERRIFIC

1079
00:40:56,187 --> 00:40:57,054
SCIENTIFIC INSTRUMENT AS WELL.

1080
00:40:57,054 --> 00:41:00,457
USING IT FOR RADAR GIVES US A

1081
00:41:00,457 --> 00:41:02,359
CHANCE TO SEE ASTEROIDS IN GREAT

1082
00:41:02,359 --> 00:41:02,693
DETAIL.

1083
00:41:02,693 --> 00:41:05,529
LET ME INTRODUCE YOU TO RADAR

1084
00:41:05,529 --> 00:41:08,332
SCIENTIST HERE AT NASA'S JET

1085
00:41:08,332 --> 00:41:10,100
PROPULSION LABORATORY.

1086
00:41:10,100 --> 00:41:11,035
HI, MARINA.

1087
00:41:11,035 --> 00:41:11,402
>> HI.

1088
00:41:11,402 --> 00:41:13,637

>> EXPLAIN TO US HOW RADAR WORKS

1089
00:41:13,637 --> 00:41:15,406
IN THE FIRST PLACE.

1090
00:41:15,406 --> 00:41:18,342
>> WELL, OUR PLANETARY RADAR IS

1091
00:41:18,342 --> 00:41:19,777
MUCH LIKE THE AIRPORT RADARS

1092
00:41:19,777 --> 00:41:22,246
THAT TRACK AIRPLANES IN THE SKY.

1093
00:41:22,246 --> 00:41:24,815
BUT THEY TRACK AIRPLANES WITHIN

1094
00:41:24,815 --> 00:41:26,884
A 60-MILE RADIUS.

1095
00:41:26,884 --> 00:41:29,320
OUR PLANETARY RADARS TRACK

1096
00:41:29,320 --> 00:41:30,721
THINGS THAT ARE HUNDREDS OF

1097
00:41:30,721 --> 00:41:31,689
THOUSANDS, SOMETIMES MILLIONS OF

1098
00:41:31,689 --> 00:41:32,656
MILES AWAY FROM EARTH.

1099
00:41:32,656 --> 00:41:34,692
AND FOR THIS, YOU NEED REALLY

1100
00:41:34,692 --> 00:41:36,861
POWERFUL TRANSMITTERS AND VERY

1101
00:41:36,861 --> 00:41:40,197
LARGE ANTENNAS.

1102
00:41:40,197 --> 00:41:41,699
THERE'S A 300 METER DISH IN

1103
00:41:41,699 --> 00:41:42,132
PUERTO RICO.

1104
00:41:42,132 --> 00:41:45,369
THEN WE ALSO HAVE OUR 70-METER

1105
00:41:45,369 --> 00:41:46,637
ANTENNA AT GOLDSTONE.

1106
00:41:46,637 --> 00:41:49,240
SO LET ME SHOW YOU THERE'S A

1107
00:41:49,240 --> 00:41:51,909
BRIEF ANIMATION OF HOW RADAR

1108
00:41:51,909 --> 00:41:52,309
WORKS.

1109
00:41:52,309 --> 00:41:54,178
IT TRANSMITS RADIO WAVES, AND

1110
00:41:54,178 --> 00:41:55,212
THEY BOUNCE OFF THE ASTEROID.

1111
00:41:55,212 --> 00:41:57,848
THE ECHO THAT COMES BACK CARRIES

1112
00:41:57,848 --> 00:41:59,216
A LOT OF INFORMATION ABOUT THAT

1113
00:41:59,216 --> 00:41:59,583

ASTEROID.

1114
00:41:59,583 --> 00:42:01,919
SO, FOR EXAMPLE, WHEN WE OBSERVE

1115
00:42:01,919 --> 00:42:07,892
THE ASTEROID APOTH THINKS DURING

1116
00:42:07,892 --> 00:42:14,131
THE 2013FLY BY.

1117
00:42:14,131 --> 00:42:15,165
WE WANT TO MEASURE WHERE IT IS

1118
00:42:15,165 --> 00:42:17,101
AND HOW FAST IT'S MOVING.

1119
00:42:17,101 --> 00:42:19,003
AND WE USE THESE MEASUREMENTS IN

1120
00:42:19,003 --> 00:42:21,405
ORDER TO IMPROVE OUR ORBITAL

1121
00:42:21,405 --> 00:42:22,806
CALCULATIONS BECAUSE BETTER DATA

1122
00:42:22,806 --> 00:42:24,208
MEANS BETTER ORBITS.

1123
00:42:24,208 --> 00:42:25,609
>> SO WHAT DOES RADAR, THEN,

1124
00:42:25,609 --> 00:42:26,744
BRING TO THE TABLE?

1125
00:42:26,744 --> 00:42:30,047
>> WELL, YOU KNOW, RADAR IS A

1126
00:42:30,047 --> 00:42:31,015
LITTLE BIT LIKE A SWISS ARMY

1127
00:42:31,015 --> 00:42:31,315
KNIFE.

1128
00:42:31,315 --> 00:42:34,585
IT REVEALS SO MUCH ABOUT

1129
00:42:34,585 --> 00:42:36,353
ASTEROIDS AT ONCE.

1130
00:42:36,353 --> 00:42:38,322
OPTICAL TELESCOPES, ASTEROIDS

1131
00:42:38,322 --> 00:42:39,790
ARE THESE SPECKS OF LIGHT, BUT

1132
00:42:39,790 --> 00:42:41,992
IN RADAR IMAGES, THEY BECOME A

1133
00:42:41,992 --> 00:42:42,927
WORLD OF THEIR OWN.

1134
00:42:42,927 --> 00:42:45,562
YOU CAN SEE ALLHESE DETAILS IN

1135
00:42:45,562 --> 00:42:45,863
THEM.

1136
00:42:45,863 --> 00:42:48,265
RADAR IMAGES, YOU DIRECTLY SEE

1137
00:42:48,265 --> 00:42:50,200
HOW AN ASTEROID LOOKS LIKE, IF

1138
00:42:50,200 --> 00:42:52,870

IT HAS A SATELLITE, HOW LARGE IT

1139
00:42:52,870 --> 00:42:56,240
IS, AND HOW IT'S ROTATING.

1140
00:42:56,240 --> 00:42:57,975
WE CAN SEE SURFACE FEATURES ON

1141
00:42:57,975 --> 00:42:58,242
IT.

1142
00:42:58,242 --> 00:43:02,746
WE SEE RIDGES AND FACETS AND

1143
00:43:02,746 --> 00:43:05,015
CAVITIES, AND BOULDERS.

1144
00:43:05,015 --> 00:43:07,217
BASICALLY ALL THE NOOKS AND

1145
00:43:07,217 --> 00:43:07,584
CRANNIES.

1146
00:43:07,584 --> 00:43:10,087
WE HAVE SUCH AN EXAMPLE, VIDEO

1147
00:43:10,087 --> 00:43:11,488
THAT YOU'VE SHOWN.

1148
00:43:11,488 --> 00:43:13,991
THIS IS THE ASTEROID WE OBSERVED

1149
00:43:13,991 --> 00:43:16,694
MONTHS AGO, JO205.

1150
00:43:16,694 --> 00:43:20,230
IT TURNED OUT TO BE A MILE LONG

1151
00:43:20,230 --> 00:43:20,998
SPACE PEANUT.

1152
00:43:20,998 --> 00:43:23,434
WE WERE JUST WATCHING IT ROTATE

1153
00:43:23,434 --> 00:43:26,837
IN FRONT OF OUR EYES DURING

1154
00:43:26,837 --> 00:43:27,271
OBSERVATIONS.

1155
00:43:27,271 --> 00:43:28,172
IT WAS FASCINATING BECAUSE YOU

1156
00:43:28,172 --> 00:43:29,773
CAN SEE HOW THE FRONT LOBE IS

1157
00:43:29,773 --> 00:43:31,408
CASTING SHADOW AND THE BACK

1158
00:43:31,408 --> 00:43:33,043
LOBE, YOU CAN SEE ALL THE

1159
00:43:33,043 --> 00:43:34,111
CAVITIES AND RIDGES.

1160
00:43:34,111 --> 00:43:35,813
IF YOU LOOK VERY CAREFULLY,

1161
00:43:35,813 --> 00:43:37,114
THERE ARE THESE RADAR BRIGHT

1162
00:43:37,114 --> 00:43:38,482
SPECKS THAT ARE ROTATING WITH

1163
00:43:38,482 --> 00:43:39,383

THE ASTEROIDS.

1164
00:43:39,383 --> 00:43:41,752
WE BELIEVE THESE ARE METER SIZED

1165
00:43:41,752 --> 00:43:42,119
BOULDERS.

1166
00:43:42,119 --> 00:43:43,988
ALL OF THIS IS VISIBLE WHILE THE

1167
00:43:43,988 --> 00:43:46,790
ASTEROID WAS 1.8 MILLION MILES

1168
00:43:46,790 --> 00:43:47,524
AWAY FROM EARTH.

1169
00:43:47,524 --> 00:43:49,093
>> WELL, IT'S INTERESTING.

1170
00:43:49,093 --> 00:43:50,627
SOMETIMES YOU CAN, INC. SEE IF

1171
00:43:50,627 --> 00:43:51,795
THERE'S MORE THAN -- YOU CAN

1172
00:43:51,795 --> 00:43:54,164
EVEN SEE IF THERE'S MORE THAN

1173
00:43:54,164 --> 00:43:55,766
ONE ASTEROID AND THEY'RE

1174
00:43:55,766 --> 00:43:56,133
TOGETHER.

1175
00:43:56,133 --> 00:44:00,070
>> YES, THESE ARE BINARY

1176
00:44:00,070 --> 00:44:02,106
ASTEROIDS, AND WE KNOW THANKS TO

1177
00:44:02,106 --> 00:44:04,274
OPTICAL AND RADAR TELESCOPES, WE

1178
00:44:04,274 --> 00:44:06,343
KNOW THE NEAREST ASTEROIDS,

1179
00:44:06,343 --> 00:44:07,277
ASTEROIDS THAT ARE LARGER THAN

1180
00:44:07,277 --> 00:44:09,847
140 METERS IN SIZE, THEY HAVE A

1181
00:44:09,847 --> 00:44:10,214
COMPANION.

1182
00:44:10,214 --> 00:44:13,450
SO WE EVEN FOUND TWO TRIPLE

1183
00:44:13,450 --> 00:44:14,251
SYSTEMS.

1184
00:44:14,251 --> 00:44:16,120
THERE ARE ACTUALLY TWO ASTEROIDS

1185
00:44:16,120 --> 00:44:18,589
THAT WE KNOW OF THAT HAVE TWO

1186
00:44:18,589 --> 00:44:18,989
SATELLITES.

1187
00:44:18,989 --> 00:44:20,357
>> SO ALL OF THIS FOCUS HAS BEEN

1188
00:44:20,357 --> 00:44:22,826

ON GETTING AN UNDERSTANDING OF

1189
00:44:22,826 --> 00:44:25,295
AN ASTEROID THAT MAY BE COMING

1190
00:44:25,295 --> 00:44:28,098
TO US, HEADED THIS WAY.

1191
00:44:28,098 --> 00:44:29,099
COULD WE USE THIS INFORMATION TO

1192
00:44:29,099 --> 00:44:31,335
HELP US IF WE WANT TO GO

1193
00:44:31,335 --> 00:44:32,102
EXPLORING ASTEROIDS?

1194
00:44:32,102 --> 00:44:33,037
>> ABSOLUTELY.

1195
00:44:33,037 --> 00:44:34,972
SO RADAR OBSERVATIONS, THEY HAVE

1196
00:44:34,972 --> 00:44:36,673
BEEN USED IN THE PAST TO SUPPORT

1197
00:44:36,673 --> 00:44:38,609
SPACE CRAFT MISSIONS.

1198
00:44:38,609 --> 00:44:43,147
IN FACT, MISSION THAT'S ON ITS

1199
00:44:43,147 --> 00:44:45,516
WAY TO RENDEZVOUS ASTEROID VENUE

1200
00:44:45,516 --> 00:44:48,652
IN 2018 HAS DEFINITELY

1201
00:44:48,652 --> 00:44:49,520
BENEFITTED FROM THE EXISTING

1202
00:44:49,520 --> 00:44:50,487
RADAR OBSERVATIONS.

1203
00:44:50,487 --> 00:44:54,425
BASED ON THAT, WE HAD A FULL

1204
00:44:54,425 --> 00:44:57,461
RECONSTRUCTION OF BENNU'S SHAPE

1205
00:44:57,461 --> 00:44:58,362
AND SIZE AND MASS.

1206
00:44:58,362 --> 00:44:59,797
YOU CAN IMAGINE ALL OF THIS

1207
00:44:59,797 --> 00:45:01,031
INFORMATION IS REALLY USEFUL

1208
00:45:01,031 --> 00:45:04,134
WHEN YOU'RE PLANNING PROXIMITY

1209
00:45:04,134 --> 00:45:05,903
SPACE CRAFT OBSERVATION AROUND

1210
00:45:05,903 --> 00:45:06,270
ASTEROIDS.

1211
00:45:06,270 --> 00:45:07,704
IT JUST GIVES YOU A LEVEL OF

1212
00:45:07,704 --> 00:45:08,872
SAFETY FOR THE MISSION, AND IT

1213
00:45:08,872 --> 00:45:11,175

ALSO ALLOWS FOR YOU TO BETTER

1214
00:45:11,175 --> 00:45:12,776
PLAN THE SCIENTIFIC

1215
00:45:12,776 --> 00:45:13,210
OBSERVATIONS.

1216
00:45:13,210 --> 00:45:14,111
>> OKAY.

1217
00:45:14,111 --> 00:45:15,813
I HAVE A SOCIAL MEDIA QUESTION.

1218
00:45:15,813 --> 00:45:19,650
THIS ONE IS SOMEONE WHO IS

1219
00:45:19,650 --> 00:45:21,585
TRYING TO UNDERSTAND WHY DO

1220
00:45:21,585 --> 00:45:23,754
ASTEROIDS HAVE THESE ODD NAMES

1221
00:45:23,754 --> 00:45:26,557
LIKE 2014JO25.

1222
00:45:26,557 --> 00:45:31,161
WHY DON'T YOU CALL IT MADGE?

1223
00:45:31,161 --> 00:45:33,230
WHY DO YOU HAVE THESE NAMES?

1224
00:45:33,230 --> 00:45:36,567
>> YEAH, SO THERE'S ACTUALLY A

1225
00:45:36,567 --> 00:45:40,104
GOOD REASON FOR IT.

1226
00:45:40,104 --> 00:45:41,371
THESE DESIGNATIONS MEAN

1227
00:45:41,371 --> 00:45:42,973
SOMETHING TO US.

1228
00:45:42,973 --> 00:45:45,843
SO 2014JO25, THIS MEANS IT WAS

1229
00:45:45,843 --> 00:45:47,044
DISCOVERED IN 2014.

1230
00:45:47,044 --> 00:45:48,679
LETTER J TELLS ME THAT IT WAS

1231
00:45:48,679 --> 00:45:50,781
DISCOVERED IN THE FIRST TWO

1232
00:45:50,781 --> 00:45:52,516
WEEKS AFTER MAY.

1233
00:45:52,516 --> 00:45:54,918
AND THEN 025, THERE'S A LITTLE

1234
00:45:54,918 --> 00:45:55,252
FORMULA.

1235
00:45:55,252 --> 00:45:59,923
THAT TELLS ME IT WAS 639 PLANETS

1236
00:45:59,923 --> 00:46:01,091
THAT WAS DISCOVERED IN THE

1237
00:46:01,091 --> 00:46:02,326
TWO-WEEK PEERED YOU.

1238
00:46:02,326 --> 00:46:06,897

SO THERE'S A -- PERIOD SO

1239
00:46:06,897 --> 00:46:08,632
THERE'S A METHOD TO THE MADNESS.

1240
00:46:08,632 --> 00:46:10,134
>> SO WHEN PEOPLE SEE THAT, THEY

1241
00:46:10,134 --> 00:46:10,534
UNDERSTAND.

1242
00:46:10,534 --> 00:46:10,934
>> YES.

1243
00:46:10,934 --> 00:46:12,903
THERE'S ACTUALLY A MEANING.

1244
00:46:12,903 --> 00:46:16,106
>> THANKS, MARINA.

1245
00:46:16,106 --> 00:46:18,976
>> ABSOLUTELY.

1246
00:46:18,976 --> 00:46:32,956
[MUSIC PLAYING]

1247
00:46:32,956 --> 00:46:34,591
>> ALL RIGHT.

1248
00:46:34,591 --> 00:46:38,695
WE MENTIONED NASA'S NEO SPACE

1249
00:46:38,695 --> 00:46:39,963
TELESCOPE LATER.

1250
00:46:39,963 --> 00:46:41,832
IT'S A SPACE TELESCOPE THAT WAS

1251
00:46:41,832 --> 00:46:43,867
ORIGINALLY DESIGNED TO IMAGE THE

1252
00:46:43,867 --> 00:46:48,539
SKY IN THE INFRARED SPECTRUM.

1253
00:46:48,539 --> 00:46:52,309
THAT'S THE SPECTRUM THAT DETECTS

1254
00:46:52,309 --> 00:46:52,676
THINGS.

1255
00:46:52,676 --> 00:46:55,612
NOW, ORIGINALLY, THIS WAS THE

1256
00:46:55,612 --> 00:46:57,614
WEISS TELESCOPE THAT WAS SENT TO

1257
00:46:57,614 --> 00:46:59,383
SURVEY THE SKIES.

1258
00:46:59,383 --> 00:47:02,052
THEN IT COMPLETED ITS JOB AND

1259
00:47:02,052 --> 00:47:05,522
THEN IT WAS MOTH BALLED AND IT

1260
00:47:05,522 --> 00:47:09,226
WAS REALIZED THAT IT WAS GOOD AT

1261
00:47:09,226 --> 00:47:10,194
DETECTING ASTEROIDS.

1262
00:47:10,194 --> 00:47:13,063
SO IT WAS TAKEN OUT AND BECAME

1263
00:47:13,063 --> 00:47:15,532

THE NEO MISSION IN WHICH IT

1264
00:47:15,532 --> 00:47:17,301
ALLOWED US TO ACTUALLY SEARCH

1265
00:47:17,301 --> 00:47:17,834
FOR ASTEROIDS.

1266
00:47:17,834 --> 00:47:21,338
THE FOCUS NOW, TO CHARACTERIZING

1267
00:47:21,338 --> 00:47:23,340
AND FINDING NEAR-EARTH

1268
00:47:23,340 --> 00:47:23,707
ASTEROIDS.

1269
00:47:23,707 --> 00:47:25,576
IT TURNS OUT THAT INFRARED IS

1270
00:47:25,576 --> 00:47:26,743
JUST A GREAT TOOL FOR HUNTING

1271
00:47:26,743 --> 00:47:29,947
SPACE ROCKS, ESPECIALLY THE DARK

1272
00:47:29,947 --> 00:47:31,215
ONES THAT ARE DIFFICULT FOR THE

1273
00:47:31,215 --> 00:47:34,518
GROUND TELESCOPES TO SPOT.

1274
00:47:34,518 --> 00:47:38,055
WE HAVE THE PRINCIPAL

1275
00:47:38,055 --> 00:47:38,789
INVESTIGATOR.

1276
00:47:38,789 --> 00:47:40,691
AMY, CAN YOU EXPLAIN TO ME WHY

1277
00:47:40,691 --> 00:47:42,459
THIS IS SUCH A GREAT TOOL?

1278
00:47:42,459 --> 00:47:44,828
WHY IS INFRARED SO GREAT?

1279
00:47:44,828 --> 00:47:47,231
>> WELL, THANKS, KAY.

1280
00:47:47,231 --> 00:47:49,866
ONE OF THE DIFFERENT WAYS IS TO

1281
00:47:49,866 --> 00:47:50,601
USE LIGHT.

1282
00:47:50,601 --> 00:47:52,669
WE LEARN SOMETHING DIFFERENT AND

1283
00:47:52,669 --> 00:47:54,771
UNIQUE FROM EACH NEW WAY WE LOOK

1284
00:47:54,771 --> 00:47:58,175
AT IT WE LEARNED HOW RADAR

1285
00:47:58,175 --> 00:47:59,209
PROVIDES USEFUL INFORMATION

1286
00:47:59,209 --> 00:48:01,245
ABOUT ASTEROIDS.

1287
00:48:01,245 --> 00:48:02,512
INFRARED LIGHT IS DIFFERENT FROM

1288
00:48:02,512 --> 00:48:04,047

LIGHT AND RADAR WHEN IT RETURNS

1289
00:48:04,047 --> 00:48:04,748
TO US.

1290
00:48:04,748 --> 00:48:06,283
WITH INVISIBLE LIGHT, WE'RE

1291
00:48:06,283 --> 00:48:07,784
SEEING LIGHT BOUNCING OFF THE

1292
00:48:07,784 --> 00:48:08,619
SURFACE OF THE ASTEROID AND

1293
00:48:08,619 --> 00:48:09,953
COMING INTO OUR TELESCOPES.

1294
00:48:09,953 --> 00:48:11,855
SO WE'RE VERY SENSITIVE TO THE

1295
00:48:11,855 --> 00:48:12,756
PROPERTIES OF THE SURFACE.

1296
00:48:12,756 --> 00:48:14,491
IF THE SURFACE IS REALLY DARK,

1297
00:48:14,491 --> 00:48:17,127
IT'S HARD TO SEE WITH VISIBLE

1298
00:48:17,127 --> 00:48:17,527
WAVELENGTHS.

1299
00:48:17,527 --> 00:48:22,399
WE ACTUALLY HAVE AN INFRARED

1300
00:48:22,399 --> 00:48:23,634
CAMERA IN THE ROOM WITH YOU.

1301
00:48:23,634 --> 00:48:25,402
WHAT IS IT DOING?

1302
00:48:25,402 --> 00:48:26,436
DETECTING THE HEAT?

1303
00:48:26,436 --> 00:48:27,471
>> YEAH, THAT'S RIGHT.

1304
00:48:27,471 --> 00:48:29,139
WHAT YOU'RE SEEING IS THE HEAT

1305
00:48:29,139 --> 00:48:30,274
COMING OFF OF ME.

1306
00:48:30,274 --> 00:48:33,010
YOU CAN SEE MY NOSE IS COLD, MY

1307
00:48:33,010 --> 00:48:34,177
FINGERS ARE A LITTLE COLD, BUT

1308
00:48:34,177 --> 00:48:35,879
THIS IS THE KIND OF IMAGING WE

1309
00:48:35,879 --> 00:48:37,314
USE WITH THE ASTEROIDS.

1310
00:48:37,314 --> 00:48:39,650
WE LOOK FOR THEM USING THEIR

1311
00:48:39,650 --> 00:48:40,217
HEAT SIGNATURE.

1312
00:48:40,217 --> 00:48:42,019
SO THIS LETS US SEE THEM

1313
00:48:42,019 --> 00:48:42,953

REGARDLESS OF WHETHER THEY'RE

1314
00:48:42,953 --> 00:48:44,488
LIGHT IN COLOR ON THEIR SURFACES

1315
00:48:44,488 --> 00:48:47,257
OR DARKER IN COLOR ON THEIR

1316
00:48:47,257 --> 00:48:47,624
SURFACES.

1317
00:48:47,624 --> 00:48:48,892
>> HOW IS THAT HELPFUL IN TERMS

1318
00:48:48,892 --> 00:48:51,528
OF BEING ABLE TO SPOT THE

1319
00:48:51,528 --> 00:48:51,928
ASTEROIDS?

1320
00:48:51,928 --> 00:48:54,131
>> WELL, THERE ARE DEFINITELY

1321
00:48:54,131 --> 00:48:55,098
ASTEROIDS OUT THERE IN THE

1322
00:48:55,098 --> 00:48:57,301
POPULATION THAT WE KNOW ARE MADE

1323
00:48:57,301 --> 00:49:01,371
OF CASH NASHS MATERIALS AS WELL

1324
00:49:01,371 --> 00:49:01,905
AS STONE MATERIALS.

1325
00:49:01,905 --> 00:49:04,007
THESE DARK-COLORED OBJECTS ARE

1326
00:49:04,007 --> 00:49:05,309
HARD TO SPOT WITH LIGHT, BUT IF

1327
00:49:05,309 --> 00:49:09,413
WE LOOK FOR THEM WITH THEIR HEAT

1328
00:49:09,413 --> 00:49:10,747
SIGNATURES, THEY POP OUT.

1329
00:49:10,747 --> 00:49:12,049
>> ALL RIGHT.

1330
00:49:12,049 --> 00:49:15,786
SO TELL ME MORE ABOUT NEO WISE.

1331
00:49:15,786 --> 00:49:18,588
I TRIED TO RELAY THIS STORY THAT

1332
00:49:18,588 --> 00:49:20,157
IT WASN'T ORIGINALLY SENT OUT

1333
00:49:20,157 --> 00:49:22,426
THERE TO LOOK FOR ASTEROIDS.

1334
00:49:22,426 --> 00:49:22,993
>> THAT'S RIGHT.

1335
00:49:22,993 --> 00:49:25,829
THE ORIGINAL MISSION IS THE

1336
00:49:25,829 --> 00:49:28,265
SURVEY EXPLORER MISSION.

1337
00:49:28,265 --> 00:49:31,101
DR. WRIGHT OF UCLA, THE MISSION

1338
00:49:31,101 --> 00:49:32,736

WAS DESIGNED TO OBSERVE THE

1339
00:49:32,736 --> 00:49:35,472
WHOLE SKY IN INFRARED LIGHT TO

1340
00:49:35,472 --> 00:49:37,808
SEARCH FOR BRIGHT GALAXIES AND

1341
00:49:37,808 --> 00:49:39,443
COOL STARS.

1342
00:49:39,443 --> 00:49:41,645
IT DID THAT WONDERFULLY AND

1343
00:49:41,645 --> 00:49:43,613
FINISHED ITS MISSION, BUT IN THE

1344
00:49:43,613 --> 00:49:45,449
PROCESS, WE FOUND IT WAS GOOD AT

1345
00:49:45,449 --> 00:49:46,850
SPOTTING ASTEROIDS, PARTICULARLY

1346
00:49:46,850 --> 00:49:47,784
THESE DARK OBJECTS.

1347
00:49:47,784 --> 00:49:49,186
SO WHEN THE MISSION WAS

1348
00:49:49,186 --> 00:49:50,887
COMPLETED IN 2011, WE THOUGHT

1349
00:49:50,887 --> 00:49:52,622
THAT WAS THE END OF THE STORY.

1350
00:49:52,622 --> 00:49:53,690
BUT WE WERE LUCKY WE WERE ABLE

1351
00:49:53,690 --> 00:49:55,392
TO BRING IT BACK TO LIFE.

1352
00:49:55,392 --> 00:49:56,860
>> ABSOLUTELY NOT.

1353
00:49:56,860 --> 00:49:58,662
WE HAVE A GRAPHIC THAT I CAN

1354
00:49:58,662 --> 00:49:59,930
PULL UP.

1355
00:49:59,930 --> 00:50:02,999
IT SHOWS ALL THE DISCOVERIES

1356
00:50:02,999 --> 00:50:04,501
THAT NEO HAS MADE.

1357
00:50:04,501 --> 00:50:07,537
HOW MANY DISCOVERIES HAS NEO

1358
00:50:07,537 --> 00:50:08,338
WIDE MADE?

1359
00:50:08,338 --> 00:50:09,906
>> YEAH, THE GRAPHIC SHOWS YOU

1360
00:50:09,906 --> 00:50:12,142
THE ASTEROIDS THAT WE'VE

1361
00:50:12,142 --> 00:50:13,910
DETECTED SINCE THE RESTART OF

1362
00:50:13,910 --> 00:50:14,845
THE MISSION IN 2013.

1363
00:50:14,845 --> 00:50:17,814

SO IF WE INCLUDE THE PRIME

1364
00:50:17,814 --> 00:50:19,182
MISSION AS WELL AS THE RESTART

1365
00:50:19,182 --> 00:50:22,252
YEARS, WE HAVE A TOTAL OF 20,000

1366
00:50:22,252 --> 00:50:24,421
NEW DISCOVERIES.

1367
00:50:24,421 --> 00:50:25,922
>> 34,000.

1368
00:50:25,922 --> 00:50:29,659
SO WE'VE OBVIOUSLY SHOWN THIS

1369
00:50:29,659 --> 00:50:30,460
TECHNOLOGY WORKS.

1370
00:50:30,460 --> 00:50:33,029
WHAT DO WE SEE AS FUTURE

1371
00:50:33,029 --> 00:50:34,297
TECHNOLOGY, KIND OF MAXIMIZING

1372
00:50:34,297 --> 00:50:35,632
ON WHAT WE'VE LEARNED?

1373
00:50:35,632 --> 00:50:36,299
>> RIGHT.

1374
00:50:36,299 --> 00:50:37,401
ONE OF THE GREAT THINGS ABOUT

1375
00:50:37,401 --> 00:50:39,069
HAVING GOTTEN TO USE THIS SPACE

1376
00:50:39,069 --> 00:50:40,604
CRAFT FOR A NEW PURPOSE, WHICH

1377
00:50:40,604 --> 00:50:42,572
IS TO SEARCH FOR ASTEROIDS AND

1378
00:50:42,572 --> 00:50:43,874
COMETS, WE'VE LEARNED A GREAT

1379
00:50:43,874 --> 00:50:45,776
DEAL ABOUT HO HOW TO DO THIS WO

1380
00:50:45,776 --> 00:50:48,845
USING A SPACE-BASED TELESCOPE,

1381
00:50:48,845 --> 00:50:50,914
AN INFRARED TELESCOPE FOR

1382
00:50:50,914 --> 00:50:54,151
DISCOVERY IN LARGE NUMBERS.

1383
00:50:54,151 --> 00:50:55,852
NOW, ORIGINALLY IT WASN'T

1384
00:50:55,852 --> 00:50:57,888
DESIGNED FOR THIS PURPOSE.

1385
00:50:57,888 --> 00:50:59,289
EVENTUALLY ALL GOOD THINGS COME

1386
00:50:59,289 --> 00:50:59,790
TO AN END.

1387
00:50:59,790 --> 00:51:03,226
IT WAS NOT DESIGNED TO LAST THIS

1388
00:51:03,226 --> 00:51:03,527

LONG.

1389
00:51:03,527 --> 00:51:05,562
IT WASN'T DESIGNED FROM THE

1390
00:51:05,562 --> 00:51:07,063
GET-GO TO LOOK FOR ASTEROIDS.

1391
00:51:07,063 --> 00:51:09,766
HOWEVER, WE'VE BEEN LOOKING FOR

1392
00:51:09,766 --> 00:51:12,002
NEW WAYS TO SEARCH FOR ASTEROIDS

1393
00:51:12,002 --> 00:51:13,470
WITH A TELESCOPE THAT'S DESIGNED

1394
00:51:13,470 --> 00:51:15,105
FOR THIS PURPOSE.

1395
00:51:15,105 --> 00:51:17,240
WE CALL THAT A NEO CAM.

1396
00:51:17,240 --> 00:51:19,576
>> AND THERE'S A PICTURE OF IT.

1397
00:51:19,576 --> 00:51:20,010
>> RIGHT.

1398
00:51:20,010 --> 00:51:22,846
SO IT'S BASICALLY DESIGNED TO GO

1399
00:51:22,846 --> 00:51:26,116
OUT AND SPEND ALL OF ITS TIME

1400
00:51:26,116 --> 00:51:28,185
SEARCHING FOR ASTEROIDS AND

1401
00:51:28,185 --> 00:51:29,186
COMETS THAT COULD POTENTIALLY

1402
00:51:29,186 --> 00:51:30,420
GET CLOSE TO EARTH.

1403
00:51:30,420 --> 00:51:31,621
THE MAIN DIFFERENCE IS IT'S

1404
00:51:31,621 --> 00:51:33,790
GOING TO HAVE A LONGER LIFETIME.

1405
00:51:33,790 --> 00:51:35,392
IT CAN SEARCH A MUCH WIDER AREA

1406
00:51:35,392 --> 00:51:37,928
OF THE SKY, AND IT HAS MODERN

1407
00:51:37,928 --> 00:51:39,196
NEXT GENERATION DETECTORS.

1408
00:51:39,196 --> 00:51:41,598
SO BASICALLY, THESE ARE THE

1409
00:51:41,598 --> 00:51:43,467
CAMERA CHIPS THAT ARE CAPABLE OF

1410
00:51:43,467 --> 00:51:44,835
SENSING THE ASTEROIDS AT THE

1411
00:51:44,835 --> 00:51:47,871
WAVELENGTHS WHERE THEY'RE REALLY

1412
00:51:47,871 --> 00:51:49,673
BRIGHT, WHICH IS INFRARED.

1413
00:51:49,673 --> 00:51:50,173

>> GREAT.

1414
00:51:50,173 --> 00:51:51,274
WE HAVE A SOCIAL MEDIA QUESTION,

1415
00:51:51,274 --> 00:51:52,242
AND WE HAVE GOTTEN SEVERAL ABOUT

1416
00:51:52,242 --> 00:51:55,512
HOW THINGS ARE NAMED.

1417
00:51:55,512 --> 00:51:57,647
I UNDERSTAND THAT YOU HAVE BEEN

1418
00:51:57,647 --> 00:52:01,351
INVOLVED IN NAMING ASTEROIDS IN

1419
00:52:01,351 --> 00:52:04,387
THE PAST AFTER WOMEN WHO WERE

1420
00:52:04,387 --> 00:52:05,388
VERY STRONG.

1421
00:52:05,388 --> 00:52:07,491
>> YOU KNOW, ONE OF THE GREAT

1422
00:52:07,491 --> 00:52:08,558
PRIVILEGES OF DISCOVERING

1423
00:52:08,558 --> 00:52:10,126
ASTEROIDS IS THAT WE DO GET TO

1424
00:52:10,126 --> 00:52:11,094
NAME THEM.

1425
00:52:11,094 --> 00:52:13,864
THE DISCOVERER HAS THE --

1426
00:52:13,864 --> 00:52:15,599
THEY'RE ABLE TO PICK NAMES AND

1427
00:52:15,599 --> 00:52:16,066
SUBMIT THEM.

1428
00:52:16,066 --> 00:52:17,601
IF THEY APPROVE THEM, THEN

1429
00:52:17,601 --> 00:52:19,669
THAT'S THE NAME OF THE OBJECT.

1430
00:52:19,669 --> 00:52:21,238
THERE'S SOME REALLY FANTASTIC

1431
00:52:21,238 --> 00:52:23,106
PEOPLE OUT THERE WHO I THINK

1432
00:52:23,106 --> 00:52:25,375
DESERVE ASTEROID NAMES.

1433
00:52:25,375 --> 00:52:27,310
>> GIVE US AN EXAMPLE.

1434
00:52:27,310 --> 00:52:31,681
>> WELL, MALALA WAS ONE.

1435
00:52:31,681 --> 00:52:33,717
ONE OF MY COLLEAGUES AND I WERE

1436
00:52:33,717 --> 00:52:35,051
TALKING ABOUT HER.

1437
00:52:35,051 --> 00:52:36,386
WE WERE LIKE, SHE'S AMAZING.

1438
00:52:36,386 --> 00:52:37,554

SHE NEEDS AN ASTEROID.

1439
00:52:37,554 --> 00:52:39,756
>> WELL, YES, THAT'S A GREAT

1440
00:52:39,756 --> 00:52:40,056
PERK.

1441
00:52:40,056 --> 00:52:40,824
THANK YOU SO MUCH, AMY.

1442
00:52:40,824 --> 00:52:46,496
>> THANK YOU, KAY.

1443
00:52:46,496 --> 00:53:02,579
[MUSIC PLAYING]

1444
00:53:02,579 --> 00:53:03,413
>> OKAY.

1445
00:53:03,413 --> 00:53:04,514
SO WHAT IF WE IDENTIFY AN OBJECT

1446
00:53:04,514 --> 00:53:07,484
THAT ACTUALLY IS HEADED OUR WAY?

1447
00:53:07,484 --> 00:53:09,753
NASA HAS TO DEAL WITH THAT TOO.

1448
00:53:09,753 --> 00:53:12,956
LET'S CHECK IN AGAIN WITH NASA'S

1449
00:53:12,956 --> 00:53:14,724
PLANETARY DEFENSE OFFICER

1450
00:53:14,724 --> 00:53:17,260
LYNNLEY JOHNSON AND KELLY FAST,

1451
00:53:17,260 --> 00:53:19,529
MANAGER OF THE NEAR-EARTH

1452
00:53:19,529 --> 00:53:21,364
OBSERVATION PROGRAM.

1453
00:53:21,364 --> 00:53:24,034
SO, WE HAVE PLENTY OF TIME RIGHT

1454
00:53:24,034 --> 00:53:24,301
NOW.

1455
00:53:24,301 --> 00:53:25,835
LET'S LOOK AT THIS STEP OF THE

1456
00:53:25,835 --> 00:53:26,636
WHOLE PHASE THAT YOU HAVE TO

1457
00:53:26,636 --> 00:53:27,337
DEAL WITH.

1458
00:53:27,337 --> 00:53:29,539
I MEAN, FIRST OF ALL, KELLY, SAY

1459
00:53:29,539 --> 00:53:33,310
AN ASTEROID IS HEADED FOR EARTH,

1460
00:53:33,310 --> 00:53:35,111
WOULD WE TELL THE PUBLIC ABOUT

1461
00:53:35,111 --> 00:53:35,378
IT?

1462
00:53:35,378 --> 00:53:37,180
PEOPLE SEEM TO BE REALLY

1463
00:53:37,180 --> 00:53:39,182

CONCERNED ABOUT THAT.

1464
00:53:39,182 --> 00:53:42,018
>> YES, KAY, WE WOULD TELL THE

1465
00:53:42,018 --> 00:53:44,287
PUBLIC BECAUSE, FIRST OF ALL,

1466
00:53:44,287 --> 00:53:46,489
THE DATA GOES TO THE MINOR

1467
00:53:46,489 --> 00:53:47,791
PLANET CENTER, THE INFORMATION

1468
00:53:47,791 --> 00:53:49,926
SHOWS UP ON THE CENTER THERE IS

1469
00:53:49,926 --> 00:53:53,129
AND THE CENTER FOR NEAR-EARTH

1470
00:53:53,129 --> 00:53:53,463
OBJECTS.

1471
00:53:53,463 --> 00:53:56,800
WE WANT TO DO A CONFIRMATION

1472
00:53:56,800 --> 00:53:58,768
WITH NASA AND WORK WITH THE

1473
00:53:58,768 --> 00:54:00,370
PARTNERS IN THE WARNING NETWORK

1474
00:54:00,370 --> 00:54:01,805
TO LOOK AT ORBIT DETERMINATION

1475
00:54:01,805 --> 00:54:04,541
AND LOOK AT THE RISK OF IMPACT

1476
00:54:04,541 --> 00:54:07,077
AND THE EFFECTS OF THE IMPACT

1477
00:54:07,077 --> 00:54:08,244
AND TO MAKE SURE EVERYBODY IS ON

1478
00:54:08,244 --> 00:54:10,714
THE SAME PAGE AND GETTING

1479
00:54:10,714 --> 00:54:12,215
CONSISTENT ANSWERS.

1480
00:54:12,215 --> 00:54:13,550
MAKE SURE THE MOST ACCURATE

1481
00:54:13,550 --> 00:54:15,719
INFORMATION IS GOING OUT THERE.

1482
00:54:15,719 --> 00:54:18,254
ALSO AT NASA, THERE'S A

1483
00:54:18,254 --> 00:54:19,089
NOTIFICATION PROCEDURE IN PLACE

1484
00:54:19,089 --> 00:54:20,423
WHERE THERE WOULD BE A

1485
00:54:20,423 --> 00:54:22,258
NOTIFICATION THAT WOULD GO UP

1486
00:54:22,258 --> 00:54:24,494
THROUGH THE NASA ADMINISTRATOR

1487
00:54:24,494 --> 00:54:26,997
TO THE WHITE HOUSE AND ON TO

1488
00:54:26,997 --> 00:54:32,636

OTHER U.S. AGENCIES, ON TO

1489
00:54:32,636 --> 00:54:33,870
CONGRESS, AND ALSO ULTIMATELY TO

1490
00:54:33,870 --> 00:54:35,105
OTHER COUNTRIES.

1491
00:54:35,105 --> 00:54:36,539
SO, YES, IT WOULD BECOME VERY

1492
00:54:36,539 --> 00:54:38,141
PUBLIC VERY QUICKLY, SO WE JUST

1493
00:54:38,141 --> 00:54:39,542
WANT TO MAKE SURE THAT HAPPENS

1494
00:54:39,542 --> 00:54:41,044
IN THE RIGHT AND ACCURATE WAY.

1495
00:54:41,044 --> 00:54:42,112
>> ALL RIGHT.

1496
00:54:42,112 --> 00:54:44,080
SO PEOPLE SHOULD BE REST ASSURED

1497
00:54:44,080 --> 00:54:45,982
THAT THAT INFORMATION WOULD

1498
00:54:45,982 --> 00:54:49,252
NEVER BE WITHHELD?

1499
00:54:49,252 --> 00:54:50,153
>> RIGHT.

1500
00:54:50,153 --> 00:54:50,854
THAT'S CORRECT.

1501
00:54:50,854 --> 00:54:53,189
IT REALLY WOULDN'T.

1502
00:54:53,189 --> 00:54:55,425
AGAIN, THE INFORMATION IS ON

1503
00:54:55,425 --> 00:54:56,960
WEBSITES, AND PEOPLE WITH THE

1504
00:54:56,960 --> 00:54:58,628
RIGHT TELESCOPES, I MEAN, THE

1505
00:54:58,628 --> 00:54:59,863
SKIES ARE OPEN.

1506
00:54:59,863 --> 00:55:01,431
THEY CAN LOOK THEMSELVES.

1507
00:55:01,431 --> 00:55:05,068
>> SO THE NEXT QUESTION GOES TO

1508
00:55:05,068 --> 00:55:05,435
LYNNLEY.

1509
00:55:05,435 --> 00:55:06,269
WHAT HAPPENS NEXT?

1510
00:55:06,269 --> 00:55:12,575
IF YOU SEE SOMETHING THAT

1511
00:55:12,575 --> 00:55:16,413
APPEARS TO BE ABLE TO IMPACT THE

1512
00:55:16,413 --> 00:55:16,746
EARTH?

1513
00:55:16,746 --> 00:55:18,415

>> THAT DEPENDS ON HOW BIG IT

1514
00:55:18,415 --> 00:55:19,649
IS.

1515
00:55:19,649 --> 00:55:22,252
WE'VE SEEN AN EXAMPLE OF THE

1516
00:55:22,252 --> 00:55:24,554
2008 OBJECT THAT WE KNEW THE

1517
00:55:24,554 --> 00:55:25,355
EARTH'S ATMOSPHERE WOULD PROTECT

1518
00:55:25,355 --> 00:55:27,924
US FROM IT, SO WE WEREN'T

1519
00:55:27,924 --> 00:55:29,693
WORRIED ABOUT IT.

1520
00:55:29,693 --> 00:55:31,027
WE JUST WANTED TO KNOW WHEN IT

1521
00:55:31,027 --> 00:55:34,197
WAS GOING TO IMPACT AND WHERE SO

1522
00:55:34,197 --> 00:55:37,200
WE COULD COLLECT ALL THE

1523
00:55:37,200 --> 00:55:37,934
METEORITES.

1524
00:55:37,934 --> 00:55:39,903
IT'S GOOD FOR THE SCIENTISTS TO

1525
00:55:39,903 --> 00:55:40,937
LEARN MORE ABOUT ASTEROIDS.

1526
00:55:40,937 --> 00:55:43,773
SO IT'S A FREE SAMPLE RETURN, SO

1527
00:55:43,773 --> 00:55:46,242
TO SPEAK, BUT IF IT'S A LARGER

1528
00:55:46,242 --> 00:55:48,178
OBJECT, A FEW TENS OF METERS IN

1529
00:55:48,178 --> 00:55:49,412
SIZE, THAT'S WHERE WE HAVE TO

1530
00:55:49,412 --> 00:55:51,614
GET THE OTHER FEDERAL AGENCIES

1531
00:55:51,614 --> 00:55:54,751
INVOLVED AND THEIR COUNTERPARTS

1532
00:55:54,751 --> 00:55:57,187
AROUND THE WORLD TO, FIRST OF

1533
00:55:57,187 --> 00:55:58,188
ALL, DETERMINE THE

1534
00:55:58,188 --> 00:56:01,357
EARTH IT'S GOING TO IMPACT SO

1535
00:56:01,357 --> 00:56:03,159
THAT WE CAN ALERT THEM.

1536
00:56:03,159 --> 00:56:05,395
ONE THING ABOUT PREDICTING

1537
00:56:05,395 --> 00:56:07,597
ASTEROID IMPACTS IS THAT WE CAN

1538
00:56:07,597 --> 00:56:08,898

DETERMINE PRECISELY THE TIME

1539
00:56:08,898 --> 00:56:11,668
THAT THEY'RE GOING TO IMPACT.

1540
00:56:11,668 --> 00:56:14,537
WITH OBSERVATIONS, AS IT COMES

1541
00:56:14,537 --> 00:56:17,006
IN, WE CAN DETERMINE A LOCATION

1542
00:56:17,006 --> 00:56:18,341
VERY ACCURATELY TOO.

1543
00:56:18,341 --> 00:56:20,910
SO THIS IS KIND OF A UNIQUE

1544
00:56:20,910 --> 00:56:24,347
THING FOR FEMA AND OTHER

1545
00:56:24,347 --> 00:56:25,415
EMERGENCY RESPONSE COMMUNITIES,

1546
00:56:25,415 --> 00:56:27,917
WE CAN TELL THEM THE TIME AND

1547
00:56:27,917 --> 00:56:29,152
LOCATION OF A POTENTIAL DISASTER

1548
00:56:29,152 --> 00:56:31,721
BEFORE IT'S GOING TO HAPPEN.

1549
00:56:31,721 --> 00:56:33,823
SO IT'S VERY VALUABLE

1550
00:56:33,823 --> 00:56:34,657
INFORMATION FOR THEM TO PREPARE

1551
00:56:34,657 --> 00:56:36,626
THE AREA, THE COMMUNITIES THAT

1552
00:56:36,626 --> 00:56:39,996
MIGHT BE AFFECTED BY IT SO THAT

1553
00:56:39,996 --> 00:56:43,333
POPULATIONS CAN BE EVACUATED AND

1554
00:56:43,333 --> 00:56:44,267
INFRASTRUCTURE LOCKED DOWN.

1555
00:56:44,267 --> 00:56:46,770
NOW, IF IT'S BIGGER THAN THAT,

1556
00:56:46,770 --> 00:56:49,439
AND THIS IS ACTUALLY OUR MAIN

1557
00:56:49,439 --> 00:56:50,707
OBJECTIVE AT THE PLANETARY

1558
00:56:50,707 --> 00:56:51,875
DEFENSE COORDINATION OFFICE AND

1559
00:56:51,875 --> 00:56:54,511
ALL OF THE PROJECTS THAT WE WORK

1560
00:56:54,511 --> 00:56:56,613
WITH, ALL THAT YOU'VE SEEN

1561
00:56:56,613 --> 00:56:58,615
TODAY, IS THAT WE FIND AN OBJECT

1562
00:56:58,615 --> 00:57:01,885
THAT IS LARGE ENOUGH THAT IT

1563
00:57:01,885 --> 00:57:04,888

COULD AFFECT A MAJOR

1564
00:57:04,888 --> 00:57:07,023
METROPOLITAN OR STATEWIDE AREA,

1565
00:57:07,023 --> 00:57:09,292
FIND IT FAR ENOUGH OUT IN TIME

1566
00:57:09,292 --> 00:57:11,227
THAT WE HAVE TIME TO INITIATE A

1567
00:57:11,227 --> 00:57:13,730
SPACE MISSION TO GO OUT AND

1568
00:57:13,730 --> 00:57:18,101
DEFLECT IT OFF OF THAT IMPACT

1569
00:57:18,101 --> 00:57:18,501
TRAJECTORY.

1570
00:57:18,501 --> 00:57:20,904
SO WE'RE LOOKING AT VARIOUS

1571
00:57:20,904 --> 00:57:23,406
TECHNIQUES AND TECHNOLOGIES LIKE

1572
00:57:23,406 --> 00:57:25,775
THE GRAVITY TRACTOR THAT WE CAN

1573
00:57:25,775 --> 00:57:27,944
SEND UTE SEVERAL YEARS INNED A

1574
00:57:27,944 --> 00:57:30,013
-- SEND OUT SEVERAL YEARS IN

1575
00:57:30,013 --> 00:57:31,314
ADVANCE TO PREVENT THE IMPACT IN

1576
00:57:31,314 --> 00:57:31,848
THE FIRST PLACE.

1577
00:57:31,848 --> 00:57:34,284
>> SO LET'S TAKE THAT AS AN

1578
00:57:34,284 --> 00:57:34,951
EXAMPLE.

1579
00:57:34,951 --> 00:57:36,085
KELLY, IF THERE WAS SOMETHING AS

1580
00:57:36,085 --> 00:57:37,787
BIG AS A FOOTBALL STADIUM, IS

1581
00:57:37,787 --> 00:57:38,555
THAT SOMETHING THAT CAN BE DEALT

1582
00:57:38,555 --> 00:57:41,257
WITH?

1583
00:57:41,257 --> 00:57:44,227
>> ACTUALLY, I'M GOING TO KICK

1584
00:57:44,227 --> 00:57:48,164
THAT ONE TO LYNNLEY AND LET HIM

1585
00:57:48,164 --> 00:57:49,599
ADDRESS THAT.

1586
00:57:49,599 --> 00:57:52,001
>> AS BIG AS A FOOTBALL STADIUM,

1587
00:57:52,001 --> 00:57:53,002
IS THAT SOMETHING THAT WE'VE

1588
00:57:53,002 --> 00:57:54,938

EVEN THOUGHT ABOUT?

1589
00:57:54,938 --> 00:57:57,207
>> OH, YES.

1590
00:57:57,207 --> 00:57:59,042
THAT IS THE TYPE OF SCENARIO

1591
00:57:59,042 --> 00:58:02,478
THAT WE'RE MAINLY LOOKING AT

1592
00:58:02,478 --> 00:58:07,417
BECAUSE THE MOST COMMON

1593
00:58:07,417 --> 00:58:08,852
HAZARDOUS ASTEROID THAT WE MIGHT

1594
00:58:08,852 --> 00:58:10,019
HAVE TO FACE WITH THAT WE WOULD

1595
00:58:10,019 --> 00:58:13,556
WANT TO DEFLECT IN SPACE IS THE

1596
00:58:13,556 --> 00:58:16,292
SIZE OF A FEW HUNDRED METERS OR

1597
00:58:16,292 --> 00:58:17,126
SO.

1598
00:58:17,126 --> 00:58:18,995
IF WE FIND IT SEVERAL YEARS IN

1599
00:58:18,995 --> 00:58:20,196
ADVANCE AND ARE ABLE TO GET

1600
00:58:20,196 --> 00:58:22,999
SPACE MISSIONS OUT TO IT, AN

1601
00:58:22,999 --> 00:58:26,002
OBJECT THAT SIZE, WE ONLY HAVE

1602
00:58:26,002 --> 00:58:27,637
TO CHANGE THE SPEED OF THE

1603
00:58:27,637 --> 00:58:29,172
ASTEROID BY A FEW CENTIMETERS

1604
00:58:29,172 --> 00:58:29,839
PER SECOND.

1605
00:58:29,839 --> 00:58:33,343
IF WE DO THAT SEVERAL YEARS IN

1606
00:58:33,343 --> 00:58:35,345
ADVANCE, IT WILL NOT REACH THE

1607
00:58:35,345 --> 00:58:37,480
SAME POINT IN SPACE OF THE EARTH

1608
00:58:37,480 --> 00:58:39,749
THAT THAT PREDICTED IMPACT TIME.

1609
00:58:39,749 --> 00:58:42,185
WE WOULD HAVE SLOWED IT DOWN, SO

1610
00:58:42,185 --> 00:58:43,186
THE EARTH WOULD HAVE ALREADY

1611
00:58:43,186 --> 00:58:44,254
PASSED THAT POINT IN SPACE.

1612
00:58:44,254 --> 00:58:48,024
SO THAT'S THE PRINCIPLE THAT'S

1613
00:58:48,024 --> 00:58:52,462

USED IN ALL OF OUR TECHNIQUES.

1614
00:58:52,462 --> 00:58:55,231
SO THE IMPACTER, WE HIT IT HARD

1615
00:58:55,231 --> 00:58:55,899
WITH THE SPACE CRAFT.

1616
00:58:55,899 --> 00:58:58,835
THAT KNOCKS OFF A FEW INCHES PER

1617
00:58:58,835 --> 00:59:01,938
SECOND IN SPEED IN ITS VELOCITY

1618
00:59:01,938 --> 00:59:03,172
AND CAUSES IT TO BE A MISS

1619
00:59:03,172 --> 00:59:05,174
INSTEAD OF A HIT.

1620
00:59:05,174 --> 00:59:11,981
THE GRAVITY -- OPERATES

1621
00:59:11,981 --> 00:59:13,216
SIMILARLY.

1622
00:59:13,216 --> 00:59:16,185
SLOWLY USING NATURES TUG ROPE,

1623
00:59:16,185 --> 00:59:18,021
GRAVITY SLOWLY TUGS THAT

1624
00:59:18,021 --> 00:59:20,089
ASTEROID OFF THE IMPACT

1625
00:59:20,089 --> 00:59:21,457
TRAJECTORY AND PREVENTS IT FROM

1626
00:59:21,457 --> 00:59:22,258
IMPACTING THE EARTH.

1627
00:59:22,258 --> 00:59:23,927
>> SO WE HAVE JUST A FEW MINUTES

1628
00:59:23,927 --> 00:59:25,995
LEFT, IF WE COULD TALK ABOUT

1629
00:59:25,995 --> 00:59:31,434
THIS IN OUR LAST THREE MINUTES,

1630
00:59:31,434 --> 00:59:36,806
THE FACT THAT ASTEROIDS ARE A

1631
00:59:36,806 --> 00:59:41,811
NATURAL HAZARD, AND WHAT WE'RE

1632
00:59:41,811 --> 00:59:42,679
TALKING ABOUT THROUGH THIS

1633
00:59:42,679 --> 00:59:44,547
PROGRAM, IT'S A HAZARD THAT

1634
00:59:44,547 --> 00:59:45,481
APPEARS TO BE PREVENTABLE.

1635
00:59:45,481 --> 00:59:48,084
>> WELL, THAT'S VERY TRUE.

1636
00:59:48,084 --> 00:59:49,319
IT'S ONE OF THE FEW NATURAL

1637
00:59:49,319 --> 00:59:52,822
DISASTERS THAT WE KNOW HOW TO

1638
00:59:52,822 --> 00:59:57,126

PREVENT IF WE DETECT THEM FAR

1639
00:59:57,126 --> 00:59:58,428
ENOUGH OUT INTO THE FUTURE.

1640
00:59:58,428 --> 01:00:00,396
SO THAT IS THE OBJECTIVE OF OUR

1641
01:00:00,396 --> 01:00:01,764
PROGRAM HERE AT NASA, IS FIND

1642
01:00:01,764 --> 01:00:04,133
THEM EARLY, AS WE SAY.

1643
01:00:04,133 --> 01:00:06,636
SO ONE MORE QUESTION FOR KELLY.

1644
01:00:06,636 --> 01:00:08,171
IF THERE WERE SOME KEY MESSAGES

1645
01:00:08,171 --> 01:00:10,807
THAT YOU WOULD WANT OUT THERE TO

1646
01:00:10,807 --> 01:00:12,241
TELL THE PUBLIC, WHAT WOULD

1647
01:00:12,241 --> 01:00:18,381
THOSE KEY MESSAGES BE REGARDING

1648
01:00:18,381 --> 01:00:19,148
ASTEROIDS?

1649
01:00:19,148 --> 01:00:21,851
>> WELL, LIKE WE'VE BEEN HEARING

1650
01:00:21,851 --> 01:00:22,652
OVER AND OVER AGAIN THROUGHOUT

1651
01:00:22,652 --> 01:00:23,987
THE PROGRAM, YOU WANT TO FIND

1652
01:00:23,987 --> 01:00:25,388
THEM, FIND THEM EARLY.

1653
01:00:25,388 --> 01:00:27,724
YOU WANT TO FIND THEM FIRST.

1654
01:00:27,724 --> 01:00:29,158
THEN YOU CAN DETERMINE WHAT THE

1655
01:00:29,158 --> 01:00:30,259
RESPONSE MIGHT BE, BUT IF YOU

1656
01:00:30,259 --> 01:00:31,794
DON'T KNOW THEY'RE THERE, YOU'RE

1657
01:00:31,794 --> 01:00:33,496
NOT GOING TO KNOW WHAT TO DO

1658
01:00:33,496 --> 01:00:34,597
ABOUT THEM.

1659
01:00:34,597 --> 01:00:35,698
HOWEVER, AT THE SAME TIME, AS I

1660
01:00:35,698 --> 01:00:36,599
ALWAYS TELL PEOPLE, IT'S NOT

1661
01:00:36,599 --> 01:00:39,102
SOMETHING WE'RE LYING AWAKE AT

1662
01:00:39,102 --> 01:00:42,205
NIGHT WORRYING ABOUT.

1663
01:00:42,205 --> 01:00:43,573

WE'RE DOING ALL WE CAN AND

1664
01:00:43,573 --> 01:00:44,440
THERE'S MORE TO BE DONE.

1665
01:00:44,440 --> 01:00:46,576
WHEN WE PUT IT IN CONTEXT, WE'RE

1666
01:00:46,576 --> 01:00:48,244
HARD AT WORK AT NASA AND OUR

1667
01:00:48,244 --> 01:00:49,045
COLLEAGUES ALL THROUGH THE U.S.

1668
01:00:49,045 --> 01:00:50,279
AND WORLD, THEY'RE WORKING HARD

1669
01:00:50,279 --> 01:00:52,648
ON THE PROBLEM, BUT, AGAIN,

1670
01:00:52,648 --> 01:00:55,218
PEOPLE SHOULDN'T BE WORRIED AND

1671
01:00:55,218 --> 01:00:56,686
FEARFUL IF WE'RE WORKING ON IT.

1672
01:00:56,686 --> 01:00:58,821
>> AND THAT'S WHAT I SEEM TO BE

1673
01:00:58,821 --> 01:01:00,757
HEARING, THAT IT'S POSSIBLE TO

1674
01:01:00,757 --> 01:01:03,393
TAKE A PROACTIVE SORT OF STANCE

1675
01:01:03,393 --> 01:01:05,661
IN ALL OF THIS THAT WE DO KNOW

1676
01:01:05,661 --> 01:01:07,330
THAT ASTEROIDS ARE OUT THERE.

1677
01:01:07,330 --> 01:01:09,766
WE DO KNOW THAT THEY COULD POSE

1678
01:01:09,766 --> 01:01:12,902
A REAL HAZARD, BUT WHAT I'M

1679
01:01:12,902 --> 01:01:14,437
HEARING HERE IS THIS IS SORT OF

1680
01:01:14,437 --> 01:01:17,673
A PROACTIVE APPROACH THAT IF

1681
01:01:17,673 --> 01:01:18,641
THEY ARE OUT THERE, LET'S FIND

1682
01:01:18,641 --> 01:01:21,377
THEM AND LET'S SEE WHAT WE'RE

1683
01:01:21,377 --> 01:01:23,913
DEALING WITH.

1684
01:01:23,913 --> 01:01:27,517
>> YES, KAY.

1685
01:01:27,517 --> 01:01:30,553
BECAUSE WE HAVE A SPACE PROGRAM,

1686
01:01:30,553 --> 01:01:35,258
AND WE HAVE THE TECHNOLOGIES

1687
01:01:35,258 --> 01:01:37,326
BEGIN TO MOVE THESE SMALL BODIES

1688
01:01:37,326 --> 01:01:39,595

IN SPACE NOW, THIS IS SOMETHING

1689
01:01:39,595 --> 01:01:41,798
WE CAN PREVENT.

1690
01:01:41,798 --> 01:01:52,341
WE JUST NEED TO HAVE TO FIND

1691
01:01:52,341 --> 01:01:54,010
THEM WELL BEFORE THE IMPACTS AND

1692
01:01:54,010 --> 01:01:56,512
HAVE THE CAPABILITIES

1693
01:01:56,512 --> 01:01:58,681
DEMONSTRATED THAT WOULD BE ABLE

1694
01:01:58,681 --> 01:02:01,651
TO DIVERT THE OBJECTS.

1695
01:02:01,651 --> 01:02:04,287
ONE OF THE PROGRAMS WE'RE TRYING

1696
01:02:04,287 --> 01:02:05,488
TO --

1697
01:02:05,488 --> 01:02:06,789
>> ALL RIGHT.

1698
01:02:06,789 --> 01:02:08,624
WELL, THANK YOU SO MUCH.

1699
01:02:08,624 --> 01:02:10,393
THIS WAS A VERY, VERY

1700
01:02:10,393 --> 01:02:10,960
INFORMATIVE PROGRAM.

1701
01:02:10,960 --> 01:02:12,462
THANK YOU SO MUCH FOR YOUR

1702
01:02:12,462 --> 01:02:13,362
INFORMATION.

1703
01:02:13,362 --> 01:02:16,432
HERE ARE THE WEBSITES ONCE

1704
01:02:16,432 --> 01:02:18,101
AGAIN, THE PLANETARY DEFENSE

1705
01:02:18,101 --> 01:02:21,137
WEBSITE, THE MINOR PLANET CENTER

1706
01:02:21,137 --> 01:02:24,140
WEBSITE, AND CENTER NEOS.

1707
01:02:24,140 --> 01:02:25,475
THANK YOU FOR JOINING US.

1708
01:02:25,475 --> 01:02:26,609
WE HOPE YOUR QUESTION WERE

1709
01:02:26,609 --> 01:02:26,976
ANSWERED.

1710
01:02:26,976 --> 01:02:29,378
THAT WRAPS THINGS UP FROM HERE

1711
01:02:29,378 --> 01:02:30,046
AT THE JET PROPULSION