
ASTEROID
CLOSE
APPROACH
NASA
SCIENCE LIVE
VIRTUAL EDITION

1
00:00:10,110 --> 00:00:11,378
>> ON APRIL 29TH,

2
00:00:11,378 --> 00:00:12,946
A MILE-LONG ASTEROID WILL MAKE

3
00:00:12,946 --> 00:00:14,614
A CLOSE APPROACH TO EARTH

4
00:00:14,614 --> 00:00:17,450
AS IT PASSES SAFELY BY.

5
00:00:17,450 --> 00:00:18,785
THERE'S NO NEED TO WORRY.

6
00:00:18,785 --> 00:00:20,019
THIS ASTEROID WILL NOT EVEN

7
00:00:20,019 --> 00:00:22,055
COME CLOSE TO HITTING EARTH.

8
00:00:23,690 --> 00:00:25,024
OUR SOLAR SYSTEM IS ACTUALLY

9
00:00:25,024 --> 00:00:26,226
LITTERED WITH ASTEROIDS

10
00:00:26,226 --> 00:00:27,827
AND COMETS, AND SOMETIMES,

11
00:00:27,827 --> 00:00:29,028
THEY DO COME VERY CLOSE

12
00:00:29,028 --> 00:00:30,630
TO EARTH.

13
00:00:31,698 --> 00:00:32,866

WHEN AN ASTEROID OR COMET

14
00:00:32,866 --> 00:00:33,933
COULD ONE DAY COME CLOSE

15
00:00:33,933 --> 00:00:35,902
TO OUR PLANET, IT'S KNOWN

16
00:00:35,902 --> 00:00:38,471
AS A NEAR-EARTH OBJECT.

17
00:00:38,471 --> 00:00:40,340
BUT HOW CLOSE IS CLOSE?

18
00:00:41,508 --> 00:00:43,343
A NEAR-EARTH OBJECT IS DEFINED

19
00:00:43,343 --> 00:00:44,444
AS AN OBJECT THAT COULD

20
00:00:44,444 --> 00:00:45,678
PASS BY OUR PLANET WITHIN

21
00:00:45,678 --> 00:00:48,648
30 MILLION MILES.

22
00:00:48,648 --> 00:00:50,583
NASA BEGINS TO KEEP CLOSE WATCH

23
00:00:50,583 --> 00:00:51,885
ON OBJECTS THAT COULD PASS

24
00:00:51,885 --> 00:00:53,253
WITHIN FIVE MILLION MILES

25
00:00:53,253 --> 00:00:55,588
OF EARTH.

26
00:00:55,588 --> 00:00:57,524
TO PUT THAT IN PERSPECTIVE,

27
00:00:57,524 --> 00:00:58,491
OUR MOON IS ONLY

28
00:00:58,491 --> 00:01:01,561
238,900 MILES AWAY.

29
00:01:03,296 --> 00:01:04,297
NOW THIS DOESN'T MEAN THAT

30
00:01:04,297 --> 00:01:05,765
OBJECTS DON'T PASS CLOSER TO US

31
00:01:05,765 --> 00:01:06,933
THAN OUR MOON.

32
00:01:06,933 --> 00:01:08,134
THEY DO.

33
00:01:08,134 --> 00:01:09,135
BUT THE MOON IS STILL

34
00:01:09,135 --> 00:01:11,037
VERY FAR AWAY.

35
00:01:12,739 --> 00:01:14,808
HOWEVER UNLIKELY AN IMPACT IS,

36
00:01:14,808 --> 00:01:16,242
NASA WANTS TO KNOW ABOUT

37
00:01:16,242 --> 00:01:17,777
ALL NEAR-EARTH OBJECTS,

38
00:01:17,777 --> 00:01:18,812

SO THAT WE CAN TRACK

39
00:01:18,812 --> 00:01:19,679
THEIR MOVEMENT THROUGH

40
00:01:19,679 --> 00:01:21,481
NEAR-EARTH SPACE AND PREDICT

41
00:01:21,481 --> 00:01:22,615
THEIR TRAJECTORIES

42
00:01:22,615 --> 00:01:24,451
WELL INTO THE FUTURE.

43
00:01:26,820 --> 00:01:27,854
THE SPACE AGENCY HAS

44
00:01:27,854 --> 00:01:28,855
A PLANETARY DEFENSE

45
00:01:28,855 --> 00:01:30,190
COORDINATION OFFICE

46
00:01:30,190 --> 00:01:31,458
THAT MAINTAINS WATCH

47
00:01:31,458 --> 00:01:32,926
FOR ASTEROIDS AND COMETS

48
00:01:32,926 --> 00:01:34,360
COMING CLOSE TO EARTH

49
00:01:34,360 --> 00:01:35,261
IN ORDER TO WARN OF

50
00:01:35,261 --> 00:01:38,031
ANY POTENTIAL IMPACTS.

51
00:01:38,031 --> 00:01:39,332
ALONG WITH ITS PARTNERS,

52
00:01:39,332 --> 00:01:40,633
THEY DISCOVER, CATALOG

53
00:01:40,633 --> 00:01:42,902
AND CHARACTERIZE THESE BODIES.

54
00:01:44,437 --> 00:01:45,905
BUT WHAT IF ONE OF THESE OBJECTS

55
00:01:45,905 --> 00:01:47,874
DID POSE A THREAT?

56
00:01:49,242 --> 00:01:50,410
IF AN ASTEROID WERE ON

57
00:01:50,410 --> 00:01:51,911
A COLLISION COURSE WITH EARTH,

58
00:01:51,911 --> 00:01:54,547
WE WANT TO BE PREPARED.

59
00:01:54,547 --> 00:01:55,815
THAT'S WHY NASA IS WORKING

60
00:01:55,815 --> 00:01:56,916
ON SEVERAL TECHNIQUES

61
00:01:56,916 --> 00:01:58,084
AND TECHNOLOGIES TO HELP

62
00:01:58,084 --> 00:01:59,419
DEFLECT AN ASTEROID ON

63
00:01:59,419 --> 00:02:02,422

A COLLISION COURSE WITH EARTH.

64
00:02:02,422 --> 00:02:04,791
JOIN US AS NASA EXPERTS DISCUSS

65
00:02:04,791 --> 00:02:06,860
APRIL 29TH'S CLOSE APPROACH,

66
00:02:06,860 --> 00:02:09,062
AND WHAT NASA IS DOING EVERYDAY

67
00:02:09,062 --> 00:02:11,264
TO HELP PROTECT OUR PLANET.

68
00:02:13,566 --> 00:02:15,134
HELLO, AND WELCOME TO

69
00:02:15,134 --> 00:02:16,569
A SPECIAL VIRTUAL EDITION

70
00:02:16,569 --> 00:02:18,605
OF NASA SCIENCE LIVE.

71
00:02:18,605 --> 00:02:20,273
I'M YOUR HOST, KELLY FAST,

72
00:02:20,273 --> 00:02:21,975
AND I MANAGE A PROGRAM HERE

73
00:02:21,975 --> 00:02:23,576
AT NASA TO HELP DETECT

74
00:02:23,576 --> 00:02:25,278
AND PROTECT OUR PLANET

75
00:02:25,278 --> 00:02:27,113
FROM NEAR-EARTH OBJECTS.

76
00:02:27,113 --> 00:02:28,081
AS YOU MIGHT HAVE HEARD

77
00:02:28,081 --> 00:02:29,048
IN THE NEWS, AN ASTEROID

78
00:02:29,048 --> 00:02:30,450
WILL BE MAKING A CLOSE APPROACH

79
00:02:30,450 --> 00:02:32,318
TO OUR PLANET THIS WEEK.

80
00:02:32,318 --> 00:02:33,686
AND WHILE WE CAN'T BE TOGETHER

81
00:02:33,686 --> 00:02:35,255
DUE TO SOCIAL DISTANCING,

82
00:02:35,255 --> 00:02:36,823
WE HAVE NASA SCIENTISTS HERE TO

83
00:02:36,823 --> 00:02:38,758
VIRTUALLY ANSWER YOUR QUESTIONS

84
00:02:38,758 --> 00:02:40,527
ABOUT THIS ASTEROID APPROACH.

85
00:02:40,527 --> 00:02:41,861
AND HELP US UNDERSTAND HOW

86
00:02:41,861 --> 00:02:43,196
NASA KEEPS TRACK OF

87
00:02:43,196 --> 00:02:45,532
ALL NEAR-EARTH OBJECTS.

88
00:02:45,532 --> 00:02:47,200

FIRST OF ALL THIS CLOSE APPROACH

89
00:02:47,200 --> 00:02:48,535
REALLY ISN'T SO CLOSE,

90
00:02:48,535 --> 00:02:49,669
SINCE IT WILL PASS BY

91
00:02:49,669 --> 00:02:50,837
MILLIONS OF MILES

92
00:02:50,837 --> 00:02:52,138
AWAY FROM EARTH.

93
00:02:52,138 --> 00:02:53,406
BUT BEFORE WE CAN PREDICT

94
00:02:53,406 --> 00:02:55,174
ASTEROID CLOSE APPROACHES,

95
00:02:55,174 --> 00:02:57,610
WE HAVE TO FIND THEM FIRST.

96
00:02:57,610 --> 00:02:58,845
LET'S WATCH THIS VIDEO

97
00:02:58,845 --> 00:03:00,480
THAT EXPLAINS HOW WE SPOT

98
00:03:00,480 --> 00:03:03,283
NEAR-EARTH OBJECTS.

99
00:03:03,283 --> 00:03:04,150
>> HOW DO WE SPOT

100
00:03:04,150 --> 00:03:05,618
NEAR-EARTH ASTEROIDS?

101
00:03:05,618 --> 00:03:07,253
TO START, SURVEY TELESCOPES

102
00:03:07,253 --> 00:03:09,622
SCAN THE SKY.

103
00:03:09,622 --> 00:03:10,690
WHEN MULTIPLE PICTURES

104
00:03:10,690 --> 00:03:11,891
OF THE SAME SPOT SHOW

105
00:03:11,891 --> 00:03:13,459
A SPECK THAT'S MOVING,

106
00:03:13,459 --> 00:03:15,395
COMPUTERS AUTOMATICALLY CHECK IT

107
00:03:15,395 --> 00:03:16,429
AGAINST A DATABASE

108
00:03:16,429 --> 00:03:18,298
OF KNOWN OBJECTS.

109
00:03:19,399 --> 00:03:20,533
IF THERE'S NO MATCH,

110
00:03:20,533 --> 00:03:21,501
IT GETS ADDED TO A LIST

111
00:03:21,501 --> 00:03:24,003
OF OBJECTS TO CONFIRM.

112
00:03:24,003 --> 00:03:24,938
AND IF IT LOOKS LIKE

113
00:03:24,938 --> 00:03:26,639

IT'LL PASS VERY CLOSE TO US,

114
00:03:26,639 --> 00:03:29,809
WE GIVE IT TOP PRIORITY.

115
00:03:29,809 --> 00:03:30,977
THEN IT'S TIME TO CALL IN

116
00:03:30,977 --> 00:03:33,413
THE REINFORCEMENTS.

117
00:03:33,413 --> 00:03:35,114
MORE ASTRONOMERS FROM NASA,

118
00:03:35,114 --> 00:03:36,883
OTHER INSTITUTIONS, AND EVEN

119
00:03:36,883 --> 00:03:38,618
THE AMATEUR COMMUNITY SUBMIT

120
00:03:38,618 --> 00:03:41,020
ADDITIONAL OBSERVATIONS.

121
00:03:41,020 --> 00:03:42,422
EACH NEW DATA POINT HELPS

122
00:03:42,422 --> 00:03:44,424
REFINE A PROJECTED PATH.

123
00:03:44,424 --> 00:03:45,692
THIS ASTEROID IS GONNA FLY

124
00:03:45,692 --> 00:03:47,961
RIGHT ON BY.

125
00:03:47,961 --> 00:03:49,762
ALL THE INFO WILL BE POSTED

126
00:03:49,762 --> 00:03:51,230
ONLINE, SO IT CAN CONTINUE

127
00:03:51,230 --> 00:03:53,733
TO BE TRACKED AND MONITORED.

128
00:03:53,733 --> 00:03:54,634
NICE WORK,

129
00:03:54,634 --> 00:03:55,735
PLANETARY DEFENSE TEAM.

130
00:03:55,735 --> 00:03:57,904
KEEP WATCHING THE SKIES.

131
00:04:01,174 --> 00:04:02,208
>> THAT WAS REALLY HELPFUL IN

132
00:04:02,208 --> 00:04:03,710
UNDERSTANDING THE VARIOUS TOOLS

133
00:04:03,710 --> 00:04:05,678
NASA AND ITS PARTNERS USE

134
00:04:05,678 --> 00:04:08,214
TO DISCOVER, TRACK AND MONITOR

135
00:04:08,214 --> 00:04:11,351
NEAR-EARTH OBJECTS, OR NEOs.

136
00:04:11,351 --> 00:04:12,952
ASTEROIDS OR COMETS

137
00:04:12,952 --> 00:04:14,487
WHOSE ORBITS BRING THEM

138
00:04:14,487 --> 00:04:16,422

INTO EARTH'S NEIGHBORHOOD.

139
00:04:16,422 --> 00:04:18,458
I'M JOINED BY TWO VERY SPECIAL

140
00:04:18,458 --> 00:04:21,194
GUESTS, LINDLEY JOHNSON, NASA'S

141
00:04:21,194 --> 00:04:23,196
PLANETARY DEFENSE OFFICER,

142
00:04:23,196 --> 00:04:24,497
LEADING THE PLANETARY DEFENSE

143
00:04:24,497 --> 00:04:25,632
COORDINATION OFFICE

144
00:04:25,632 --> 00:04:27,300
AT NASA HEADQUARTERS,

145
00:04:27,300 --> 00:04:29,402
AND PAUL CHODAS, THE DIRECTOR

146
00:04:29,402 --> 00:04:31,270
OF NASA'S CENTER FOR

147
00:04:31,270 --> 00:04:32,605
NEAR-EARTH OBJECT STUDIES AT

148
00:04:32,605 --> 00:04:34,674
THE JET PROPULSION LABORATORY.

149
00:04:34,674 --> 00:04:36,409
SO LET'S FIRST TALK ABOUT

150
00:04:36,409 --> 00:04:37,844
THIS LARGE ASTEROID THAT IS

151
00:04:37,844 --> 00:04:40,113
COMING BY EARTH ON APRIL 29TH,

152
00:04:40,113 --> 00:04:42,815
UH, 1998 OR2.

153
00:04:42,815 --> 00:04:45,518
PAUL, WHAT IS THAT ALL ABOUT?

154
00:04:45,518 --> 00:04:46,686
>> WELL, THIS IS AN ASTEROID

155
00:04:46,686 --> 00:04:47,687
THAT WE'VE BEEN TRACKING

156
00:04:47,687 --> 00:04:49,155
FOR OVER 20 YEARS,

157
00:04:49,155 --> 00:04:50,189
AND WE'VE BEEN PREDICTING

158
00:04:50,189 --> 00:04:51,124
THIS CLOSE APPROACH

159
00:04:51,124 --> 00:04:52,158
FOR A LONG TIME.

160
00:04:52,158 --> 00:04:53,359
IT'S ONE OF THE LARGER

161
00:04:53,359 --> 00:04:54,560
NEAR-EARTH ASTEROIDS,

162
00:04:54,560 --> 00:04:55,695
SO IT'S KIND OF NOTABLE.

163
00:04:55,695 --> 00:04:57,230

IT'S AROUND TWO TO THREE

164
00:04:57,230 --> 00:04:58,564
KILOMETERS IN DIAMETER.

165
00:04:58,564 --> 00:05:01,934
MAYBE 1.5 TO 2 MILES ACROSS.

166
00:05:01,934 --> 00:05:03,569
SO THAT MAKES IT, UH,

167
00:05:03,569 --> 00:05:04,771
YOU KNOW, PRETTY SIGNIFICANT,

168
00:05:04,771 --> 00:05:05,772
BUT IT'S PASSING

169
00:05:05,772 --> 00:05:07,240
PRETTY FAR AWAY.

170
00:05:07,240 --> 00:05:08,174
IT'S PASSING ABOUT

171
00:05:08,174 --> 00:05:09,075
FOUR MILLION MILES AWAY

172
00:05:09,075 --> 00:05:09,976
FROM THE EARTH,

173
00:05:09,976 --> 00:05:10,943
SO IT'S VERY DISTANT

174
00:05:10,943 --> 00:05:12,011
CLOSE APPROACH.

175
00:05:12,011 --> 00:05:13,146
BUT IT'S NOTABLE, BECAUSE

176
00:05:13,146 --> 00:05:15,615
IT'S ONE OF THE LARGER ONES.

177
00:05:15,615 --> 00:05:16,649
>> WOW, AND DISCOVERED

178
00:05:16,649 --> 00:05:18,217
20 YEARS AGO.

179
00:05:18,217 --> 00:05:19,585
WELL, LINDLEY, WHY IS IT

180
00:05:19,585 --> 00:05:21,154
SO IMPORTANT TO FIND

181
00:05:21,154 --> 00:05:23,923
NEAR-EARTH ASTEROIDS EARLY?

182
00:05:23,923 --> 00:05:25,091
>> WELL, IT'S IMPORTANT THAT

183
00:05:25,091 --> 00:05:26,693
WE FIND THESE ASTEROIDS

184
00:05:26,693 --> 00:05:29,062
AS FAR OUT IN TIME AS WE CAN,

185
00:05:29,062 --> 00:05:31,264
UH, 20 YEARS FOR

186
00:05:31,264 --> 00:05:32,999
THIS PARTICULAR ONE,

187
00:05:32,999 --> 00:05:34,801
UH, BECAUSE THE MORE TIME,

188
00:05:34,801 --> 00:05:37,103

UH, THAT WE, UH, HAVE,

189
00:05:37,103 --> 00:05:39,372
UH, TO DETERMINE WHETHER

190
00:05:39,372 --> 00:05:40,573
THE ASTEROID IS ON

191
00:05:40,573 --> 00:05:42,508
A, UH, TRAJECTORY THAT COULD

192
00:05:42,508 --> 00:05:43,976
IMPACT THE EARTH,

193
00:05:43,976 --> 00:05:45,211
THE MORE TIME WE WILL HAVE

194
00:05:45,211 --> 00:05:47,447
TO PREPARE FOR THAT AND PERHAPS

195
00:05:47,447 --> 00:05:49,082
DO SOMETHING ABOUT IT,

196
00:05:49,082 --> 00:05:51,117
UH, BE ABLE TO LAUNCH MISSIONS

197
00:05:51,117 --> 00:05:52,919
TO DEFLECT THE ASTEROID OFF

198
00:05:52,919 --> 00:05:54,921
OF THAT IMPACTING TRAJECTORY.

199
00:05:54,921 --> 00:05:56,355
WE HAVE TO FIND THEM EARLY,

200
00:05:56,355 --> 00:05:57,890
AS EARLY AS WE CAN,

201
00:05:57,890 --> 00:06:00,026
SO THAT WE GOT THE TIME

202
00:06:00,026 --> 00:06:02,695
TO SELECT THE RIGHT OPTION

203
00:06:02,695 --> 00:06:04,497
AND-AND DO THE RIGHT,

204
00:06:04,497 --> 00:06:06,232
UH, MITIGATION MEASURES,

205
00:06:06,232 --> 00:06:08,301
UH, TO PREVENT THE IMPACT

206
00:06:08,301 --> 00:06:10,236
IF AT ALL POSSIBLE.

207
00:06:10,236 --> 00:06:12,572
>> HMM, WELL, SO PAUL,

208
00:06:12,572 --> 00:06:14,373
EVERYONE IS WAITING TO HEAR,

209
00:06:14,373 --> 00:06:16,142
HOW OFTEN DO ASTEROID

210
00:06:16,142 --> 00:06:17,744
CLOSE APPROACHES HAPPEN?

211
00:06:17,744 --> 00:06:18,678
ARE THEY SOMETHING

212
00:06:18,678 --> 00:06:20,747
TO WORRY ABOUT?

213
00:06:20,747 --> 00:06:22,515

>> UH, NO, UH, THEY HAPPEN

214
00:06:22,515 --> 00:06:24,050
ALMOST EVERYDAY, UH,

215
00:06:24,050 --> 00:06:25,084
BECAUSE THERE'S JUST SO MANY

216
00:06:25,084 --> 00:06:26,352
NEAR-EARTH ASTEROIDS.

217
00:06:26,352 --> 00:06:27,754
BUT THE VAST MAJORITY OF THEM

218
00:06:27,754 --> 00:06:29,522
ARE REALLY FAR AWAY,

219
00:06:29,522 --> 00:06:31,257
SO, UH, THEY'RE NOT THAT CLOSE

220
00:06:31,257 --> 00:06:32,325
IN HUMAN TERMS.

221
00:06:32,325 --> 00:06:33,392
FOR ASTRONOMERS, THEY MAY

222
00:06:33,392 --> 00:06:34,327
BE, YOU KNOW, CLOSE,

223
00:06:34,327 --> 00:06:35,328
A MILLION MILES IS PRETTY

224
00:06:35,328 --> 00:06:36,662
CLOSE FOR AN ASTRONOMER.

225
00:06:36,662 --> 00:06:38,765
BUT, UM, OH, AND THERE ARE

226
00:06:38,765 --> 00:06:39,966
SOME-- UH, A LOT OF

227
00:06:39,966 --> 00:06:41,100
SMALL ASTEROIDS,

228
00:06:41,100 --> 00:06:43,102
I MEAN, REALLY TINY ASTEROIDS,

229
00:06:43,102 --> 00:06:44,871
WHICH CAN PASS, LIKE,

230
00:06:44,871 --> 00:06:46,172
INSIDE THE MOON'S ORBIT

231
00:06:46,172 --> 00:06:47,540
AND COME PRETTY CLOSE.

232
00:06:47,540 --> 00:06:48,975
BUT THESE ONES ARE SO TINY,

233
00:06:48,975 --> 00:06:50,376
YOU KNOW, EVEN IF THEY WERE

234
00:06:50,376 --> 00:06:51,544
HEADED FOR THE EARTH,

235
00:06:51,544 --> 00:06:52,612
WHICH THEY'RE NOT,

236
00:06:52,612 --> 00:06:53,479
THEY WOULD BURN UP

237
00:06:53,479 --> 00:06:54,413
IN THE ATMOSPHERE.

238
00:06:54,413 --> 00:06:55,414

SO THERE'S THESE TWO,

239
00:06:55,414 --> 00:06:56,282
YOU KNOW, CATEGORIES.

240
00:06:56,282 --> 00:06:57,450
MOST OF THEM ARE REALLY

241
00:06:57,450 --> 00:06:58,417
DISTANT CLOSE--

242
00:06:58,417 --> 00:06:59,819
UH, CLOSE APPROACHES.

243
00:06:59,819 --> 00:07:01,120
THEY'RE NOT THAT CLOSE AT ALL.

244
00:07:01,120 --> 00:07:02,388
AND THEN THERE'S A WHOLE BUNCH

245
00:07:02,388 --> 00:07:03,756
OF REALLY, REALLY SMALL ONES

246
00:07:03,756 --> 00:07:05,091
THAT WE'RE TRACKING THAT,

247
00:07:05,091 --> 00:07:07,326
UM, THAT, YOU KNOW, ARE REALLY

248
00:07:07,326 --> 00:07:08,861
NOT HAZARDOUS TO THE--

249
00:07:08,861 --> 00:07:10,096
TO THE EARTH IF THEY SHOULD

250
00:07:10,096 --> 00:07:12,298
HAPPEN TO HIT THE EARTH.

251
00:07:12,298 --> 00:07:14,300
>> WELL, PAUL, OFTEN PEOPLE

252
00:07:14,300 --> 00:07:16,402
SEE ARTICLES ONLINE CLAIMING

253
00:07:16,402 --> 00:07:17,303
THERE'S AN ASTEROID

254
00:07:17,303 --> 00:07:18,471
HEADED FOR EARTH.

255
00:07:18,471 --> 00:07:20,039
AND AT THE VERY END,

256
00:07:20,039 --> 00:07:21,340
MOST USUALLY ADMIT THERE'S

257
00:07:21,340 --> 00:07:23,075
NO THREAT OF AN IMPACT,

258
00:07:23,075 --> 00:07:25,278
BUT WHAT CAN SOMEONE DO

259
00:07:25,278 --> 00:07:26,312
IF THEY HEAR ABOUT A CLOSE

260
00:07:26,312 --> 00:07:27,713
APPROACH IN THE NEWS

261
00:07:27,713 --> 00:07:28,714
AND THEY WANT TO FIND OUT

262
00:07:28,714 --> 00:07:30,917
FOR THEMSELVES?

263
00:07:30,917 --> 00:07:32,318

>> WELL, THE FIRST THING, UH,

264
00:07:32,318 --> 00:07:33,820
YOU SHOULD KNOW IS THAT WE'RE--

265
00:07:33,820 --> 00:07:34,887
WE'VE BEEN TRACKING THE--

266
00:07:34,887 --> 00:07:35,822
MOST OF THESE ASTEROIDS

267
00:07:35,822 --> 00:07:36,789
FOR A LONG TIME,

268
00:07:36,789 --> 00:07:37,890
ESPECIALLY THE BIG ONES.

269
00:07:37,890 --> 00:07:38,858
AND SO WE REALLY KNOW

270
00:07:38,858 --> 00:07:40,960
THEIR TRAJECTORIES ACCURATELY.

271
00:07:40,960 --> 00:07:42,195
THESE STORIES YOU HEAR

272
00:07:42,195 --> 00:07:43,396
ON THE WEB, A LOT OF THEM

273
00:07:43,396 --> 00:07:44,564
SEEM TO IMPLY, OH, THERE'S

274
00:07:44,564 --> 00:07:45,898
SOME KIND OF THREAT

275
00:07:45,898 --> 00:07:47,400
OR UNCERTAINTY THAT, YOU KNOW,

276
00:07:47,400 --> 00:07:48,367
THE ASTEROID COULD

277
00:07:48,367 --> 00:07:49,335
HIT THE EARTH.

278
00:07:49,335 --> 00:07:50,303
AND THAT'S JUST NOT TRUE.

279
00:07:50,303 --> 00:07:51,504
WE KNOW THE PATH

280
00:07:51,504 --> 00:07:52,872
REALLY ACCURATELY.

281
00:07:52,872 --> 00:07:55,875
AT CNEOS, UH, WE HAVE A WEBSITE.

282
00:07:55,875 --> 00:07:57,143
AND SO PEOPLE CAN GO TO

283
00:07:57,143 --> 00:07:58,945
OUR WEBSITE AND GET THE TABLE

284
00:07:58,945 --> 00:08:00,713
OF ALL THE CLOSE APPROACHES,

285
00:08:00,713 --> 00:08:03,482
UH, AND CAN SORT AND SORT THEM

286
00:08:03,482 --> 00:08:04,817
BY DATE, LET'S SAY.

287
00:08:04,817 --> 00:08:06,118
AND YOU CAN SEE, UH,

288
00:08:06,118 --> 00:08:07,220

WHICH ASTEROIDS.

289
00:08:07,220 --> 00:08:08,487
YOU CAN SEE THEIR NAMES,

290
00:08:08,487 --> 00:08:09,455
YOU CAN SEE HOW CLOSE

291
00:08:11,290 --> 00:08:10,289
THEY'RE COMING,

292
00:08:11,290 --> 00:08:12,859
AND HOW BIG THE ASTEROIDS ARE.

293
00:08:12,859 --> 00:08:14,427
SO WE PROVIDE, UH, A TAB--

294
00:08:14,427 --> 00:08:15,661
A CLOSE APPROACH TABLE,

295
00:08:15,661 --> 00:08:16,896
AND IT'S OPEN TO THE PUBLIC.

296
00:08:16,896 --> 00:08:19,165
EVERYONE CAN TAKE A LOOK.

297
00:08:19,165 --> 00:08:20,600
>> OKAY, WOW, SO ANYONE

298
00:08:20,600 --> 00:08:22,635
AT HOME CAN VISIT THAT WEBSITE

299
00:08:22,635 --> 00:08:24,103
AND LOOK UP CLOSE APPROACHES

300
00:08:24,103 --> 00:08:25,338
FOR THEMSELVES.

301
00:08:25,338 --> 00:08:26,505
THAT'S REALLY COOL.

302
00:08:26,505 --> 00:08:28,441
AND SO LET'S WATCH THIS VIDEO

303
00:08:28,441 --> 00:08:29,876
THAT YOUR TEAM MADE,

304
00:08:29,876 --> 00:08:31,811
UH, TO LEARN MORE ABOUT IT.

305
00:08:34,647 --> 00:08:35,615
>> THE CENTER FOR NEAR EARTH

306
00:08:35,615 --> 00:08:37,450
OBJECT STUDIES, OR CNEOS,

307
00:08:37,450 --> 00:08:38,718
AT THE JET PROPULSION LABORATORY

308
00:08:38,718 --> 00:08:39,986
IN SOUTHERN CALIFORNIA

309
00:08:39,986 --> 00:08:41,387
IS NASA'S CENTER FOR COMPUTING

310
00:08:41,387 --> 00:08:43,222
HIGHLY ACCURATE ORBITAL DATA

311
00:08:43,222 --> 00:08:44,357
FOR THOUSANDS OF ASTEROIDS

312
00:08:44,357 --> 00:08:45,591
AND COMETS THAT FLY CLOSE TO

313
00:08:45,591 --> 00:08:47,093

OUR PLANETARY NEIGHBORHOOD.

314
00:08:47,093 --> 00:08:48,427
CNEOS COLLECTS ITS INFORMATION

315
00:08:48,427 --> 00:08:49,762
FROM THE MINOR PLANET CENTER,

316
00:08:49,762 --> 00:08:51,063
WHICH INCLUDES ORBITAL DATA

317
00:08:51,063 --> 00:08:52,398
AND BASIC PHYSICAL PROPERTIES

318
00:08:52,398 --> 00:08:54,400
LIKE SIZE AND ROTATION RATE.

319
00:08:54,400 --> 00:08:55,201
IF YOU'D LIKE TO FIND OUT

320
00:08:55,201 --> 00:08:56,168
MORE ABOUT THESE FASCINATING

321
00:08:56,168 --> 00:08:57,136
NEAR-EARTH OBJECTS, YOU CAN

322
00:08:57,136 --> 00:08:58,537
GO TO THE CNEOS WEBSITE

323
00:08:58,537 --> 00:09:00,039
AND CHECK THEM OUT FOR YOURSELF.

324
00:09:00,039 --> 00:09:00,973
THE FIRST THING YOU'LL NOTICE

325
00:09:00,973 --> 00:09:02,208
ON THE CNEOS HOMEPAGE

326
00:09:02,208 --> 00:09:03,442
ARE THE TOP NEWS STORIES.

327
00:09:03,442 --> 00:09:04,510
THESE ARTICLES DESCRIBE

328
00:09:04,510 --> 00:09:05,444
SOME OF THE MORE RECENT

329
00:09:05,444 --> 00:09:06,779
AND NOTABLE NEAR-EARTH OBJECTS,

330
00:09:06,779 --> 00:09:07,880
OR NEOs, THAT HAVE CAUGHT

331
00:09:07,880 --> 00:09:10,182
THE EYE OF NASA ASTRONOMERS.

332
00:09:10,182 --> 00:09:11,984
BUT ONE OF THE MOST USEFUL PAGES

333
00:09:11,984 --> 00:09:13,052
IS THE ONE THAT LISTS ALL

334
00:09:13,052 --> 00:09:14,754
THE UPCOMING CLOSE APPROACHES.

335
00:09:14,754 --> 00:09:15,922
UNDERSTANDING FUTURE NEAR-EARTH

336
00:09:15,922 --> 00:09:17,089
OBJECT CLOSE APPROACHES

337
00:09:17,089 --> 00:09:18,424
IS IMPORTANT BECAUSE ASTRONOMERS

338
00:09:18,424 --> 00:09:19,692

CAN THEN BETTER PLAN WHEN TO

339
00:09:19,692 --> 00:09:22,395
STUDY THEM AS THEY FLY PAST.

340
00:09:22,395 --> 00:09:23,629
CLICK ON CLOSE APPROACHES,

341
00:09:23,629 --> 00:09:24,730
AND THEN NEOs IN

342
00:09:24,730 --> 00:09:27,300
THE NAVIGATION BAR.

343
00:09:27,300 --> 00:09:28,601
EACH LINE PROVIDES INFORMATION

344
00:09:28,601 --> 00:09:29,502
ABOUT THE CLOSE APPROACH

345
00:09:29,502 --> 00:09:30,970
OF AN NEO, AND BY DEFAULT,

346
00:09:30,970 --> 00:09:32,538
THEY ARE SORTED BY TIME.

347
00:09:32,538 --> 00:09:33,406
THE FIRST COLUMN GIVES

348
00:09:33,406 --> 00:09:34,373
THE NAME OF THE NEO,

349
00:09:34,373 --> 00:09:35,174
AND THE SECOND GIVES

350
00:09:35,174 --> 00:09:35,942
THE DATE AND TIME OF

351
00:09:35,942 --> 00:09:37,376
ITS CLOSEST APPROACH.

352
00:09:37,376 --> 00:09:39,412
IT'S WORTH NOTING THAT 99.9%

353
00:09:39,412 --> 00:09:40,713
OF THE OBJECTS LISTED HERE

354
00:09:40,713 --> 00:09:42,081
ARE ASTEROIDS AND A VERY SMALL

355
00:09:42,081 --> 00:09:44,383
NUMBER OF THEM ARE COMETS.

356
00:09:44,383 --> 00:09:45,518
THE NEXT TWO COLUMNS TELL US

357
00:09:45,518 --> 00:09:47,086
HOW CLOSE EACH NEAR-EARTH OBJECT

358
00:09:47,086 --> 00:09:48,254
WILL GET TO US.

359
00:09:48,254 --> 00:09:49,322
NOTE THAT THE CLOSE APPROACHES

360
00:09:49,322 --> 00:09:50,890
ARE MEASURED IN LUNAR DISTANCES,

361
00:09:50,890 --> 00:09:52,091
OR THE AVERAGE DISTANCE

362
00:09:52,091 --> 00:09:53,726
BETWEEN THE EARTH AND THE MOON,

363
00:09:53,726 --> 00:09:56,562

WHICH IS ABOUT 239,000 MILES,

364
00:09:56,562 --> 00:09:59,031
OR 384,000 KILOMETERS.

365
00:10:00,099 --> 00:10:01,701
WE ALSO USE AU, WHICH IS

366
00:10:01,701 --> 00:10:03,169
THE ASTRONOMICAL UNIT.

367
00:10:03,169 --> 00:10:04,337
THIS IS THE AVERAGE DISTANCE

368
00:10:04,337 --> 00:10:05,571
BETWEEN THE EARTH AND THE SUN,

369
00:10:05,571 --> 00:10:07,340
WHICH IS ABOUT 93 MILLION MILES,

370
00:10:07,340 --> 00:10:10,076
OR 150 MILLION KILOMETERS.

371
00:10:10,076 --> 00:10:11,143
THIS FIRST COLUMN IS

372
00:10:11,143 --> 00:10:12,445
THE NOMINAL DISTANCE AT WHICH

373
00:10:12,445 --> 00:10:14,046
THE OBJECT WILL COME TO EARTH.

374
00:10:14,046 --> 00:10:15,381
THIS IS THE MOST LIKELY

375
00:10:15,381 --> 00:10:16,649
CLOSEST DISTANCE AS IT

376
00:10:16,649 --> 00:10:18,718
ZOOMS PAST OUR PLANET.

377
00:10:18,718 --> 00:10:19,919
THE MINIMUM DISTANCE COLUMN

378
00:10:19,919 --> 00:10:21,053
PROVIDES INFORMATION

379
00:10:21,053 --> 00:10:22,254
ON THE CLOSET THE OBJECT CAN

380
00:10:22,254 --> 00:10:24,156
POSSIBLY COME DURING ITS FLYBY,

381
00:10:24,156 --> 00:10:25,191
CONSIDERING ALL POSSIBLE

382
00:10:25,191 --> 00:10:27,059
UNCERTAINTIES.

383
00:10:27,059 --> 00:10:28,060
THIS STATE OF THE ART

384
00:10:28,060 --> 00:10:29,462
CNEOS ORBITAL MODELING IS

385
00:10:29,462 --> 00:10:31,263
VERY, VERY PRECISE.

386
00:10:31,263 --> 00:10:32,264
WE KNOW THE ORBITS OF

387
00:10:32,264 --> 00:10:33,299
MOST OF THESE OBJECTS WITH

388
00:10:33,299 --> 00:10:35,434

A VERY HIGH DEGREE OF ACCURACY.

389
00:10:35,434 --> 00:10:36,435
THE FINAL COLUMN PROVIDES

390
00:10:36,435 --> 00:10:37,336
ESTIMATE OF THE OBJECT'S

391
00:10:37,336 --> 00:10:38,237
DIAMETER, BASED ON

392
00:10:38,237 --> 00:10:39,405
HOW BRIGHT IT IS.

393
00:10:39,405 --> 00:10:40,673
THESE OBJECTS RANGE IN SIZE

394
00:10:40,673 --> 00:10:41,640
FROM A FEW METERS TO

395
00:10:41,640 --> 00:10:43,142
A FEW TENS OF KILOMETERS.

396
00:10:43,142 --> 00:10:44,443
BUT KEEP IN MIND THAT THERE ARE

397
00:10:44,443 --> 00:10:46,078
MANY, MANY MORE CLOSE APPROACHES

398
00:10:46,078 --> 00:10:47,413
BY SMALLER OBJECTS MEASURING

399
00:10:47,413 --> 00:10:48,814
ONLY A FEW METERS ACROSS

400
00:10:48,814 --> 00:10:49,715
WHEN COMPARED TO

401
00:10:49,715 --> 00:10:50,583
THE BIGGEST NEOs

402
00:10:50,583 --> 00:10:52,852
MEASURING KILOMETERS ACROSS.

403
00:10:52,852 --> 00:10:54,220
AS THIS DATABASE CONTAINS

404
00:10:54,220 --> 00:10:55,254
A LOT OF INFORMATION,

405
00:10:55,254 --> 00:10:56,222
YOU MAY ALSO WANT TO FILTER

406
00:10:56,222 --> 00:10:57,556
THE TABLE BY TIME,

407
00:10:57,556 --> 00:10:58,524
NOMINAL DISTANCE

408
00:10:58,524 --> 00:10:59,859
AND ABSOLUTE MAGNITUDE,

409
00:10:59,859 --> 00:11:01,327
WHICH RELATES THE OBJECT'S SIZE

410
00:11:01,327 --> 00:11:02,228
BY USING

411
00:11:02,228 --> 00:11:04,030
THE TABLE SETTINGS OPTIONS.

412
00:11:04,030 --> 00:11:04,930
NOW YOU'RE FAMILIAR WITH

413
00:11:04,930 --> 00:11:05,931

HOW THIS PAGE WORKS,

414
00:11:05,931 --> 00:11:06,866
YOU CAN GET MORE INFORMATION

415
00:11:06,866 --> 00:11:07,767
ABOUT EACH OF THE OBJECTS

416
00:11:07,767 --> 00:11:09,035
LISTED ON THE LEFT.

417
00:11:09,035 --> 00:11:10,302
SO CLICK ON ONE OF THE NEOs

418
00:11:10,302 --> 00:11:11,370
TO TAKE YOU TO THE OBJECT'S

419
00:11:11,370 --> 00:11:13,372
SMALL-BODY DATABASE LISTING.

420
00:11:13,372 --> 00:11:15,141
HERE YOU'LL FIND A GOLD MINE

421
00:11:15,141 --> 00:11:16,409
OF ORBITAL DATA.

422
00:11:16,409 --> 00:11:17,309
CLICK ON ANY OF

423
00:11:17,309 --> 00:11:18,210
THE PARAMETER NAMES TO

424
00:11:18,210 --> 00:11:19,445
FIND OUT WHAT THEY MEAN.

425
00:11:19,445 --> 00:11:20,346
FROM HERE, YOU CAN EVEN

426
00:11:20,346 --> 00:11:21,313
DISPLAY AN ANIMATION

427
00:11:21,313 --> 00:11:22,348
OF YOUR FAVORITE ASTEROID

428
00:11:22,348 --> 00:11:23,883
OR COMET ORBITING THE SUN.

429
00:11:23,883 --> 00:11:24,917
SO IF YOU HEAR ABOUT

430
00:11:24,917 --> 00:11:25,851
AN INTERESTING ASTEROID

431
00:11:25,851 --> 00:11:27,153
IN THE NEWS, COME TO THE CNEOS

432
00:11:27,153 --> 00:11:28,654
WEBSITE AND LOOK IT UP.

433
00:11:28,654 --> 00:11:29,555
NOW YOU CAN VERIFY

434
00:11:29,555 --> 00:11:30,756
THE OBJECT'S FLYBY DISTANCE

435
00:11:30,756 --> 00:11:32,725
AND LOTS MORE BESIDES.

436
00:11:36,595 --> 00:11:37,496
>> WELL, THANK YOU, PAUL.

437
00:11:37,496 --> 00:11:39,265
THAT VIDEO WAS REALLY HELPFUL.

438
00:11:39,265 --> 00:11:41,667

SO LET'S SHIFT GEARS SLIGHTLY

439
00:11:41,667 --> 00:11:43,636
AND TALK ABOUT NASA'S PLANETARY

440
00:11:43,636 --> 00:11:45,571
DEFENSE COORDINATION OFFICE.

441
00:11:45,571 --> 00:11:46,972
LINDLEY, YOU ARE NASA'S

442
00:11:46,972 --> 00:11:49,075
PLANETARY DEFENSE OFFICER.

443
00:11:49,075 --> 00:11:52,111
AND THAT'S ONE COOL JOB TITLE.

444
00:11:52,111 --> 00:11:53,579
CAN YOU TELL US MORE ABOUT

445
00:11:53,579 --> 00:11:55,781
WHAT YOU DO?

446
00:11:55,781 --> 00:11:57,316
>> WELL, AS NASA'S

447
00:11:57,316 --> 00:11:58,884
PLANETARY DEFENSE OFFICER

448
00:11:58,884 --> 00:12:00,252
IN CHARGE OF THE PLANETARY

449
00:12:00,252 --> 00:12:01,954
DEFENSE COORDINATION OFFICE,

450
00:12:01,954 --> 00:12:04,123
I OVERSEE THE AGENCY'S,

451
00:12:04,123 --> 00:12:06,258
UH, PROGRAM AND ALL THE PROJECTS

452
00:12:06,258 --> 00:12:07,893
THAT WE HAVE FOR DETECTING,

453
00:12:07,893 --> 00:12:09,795
TRACKING AND CHARACTERIZING

454
00:12:09,795 --> 00:12:11,430
THE NEAR-EARTH OBJECTS.

455
00:12:11,430 --> 00:12:13,399
BUT ALSO IN DEVELOPING PLANS

456
00:12:13,399 --> 00:12:15,267
FOR WHAT WE WOULD DO

457
00:12:15,267 --> 00:12:18,170
IF A ASTEROID WAS DETECTED

458
00:12:18,170 --> 00:12:20,339
TO BE ON A IMPACTING, UH,

459
00:12:20,339 --> 00:12:22,174
TRAJECTORY WITH THE EARTH.

460
00:12:22,174 --> 00:12:24,243
UH, SO THE WORD COORDINATION IN

461
00:12:24,243 --> 00:12:26,078
OUR NAME IS, UH, VERY IMPORTANT,

462
00:12:26,078 --> 00:12:28,380
BECAUSE NASA WILL NOT DO IT ALL.

463
00:12:28,380 --> 00:12:30,116

UH, NASA WILL WORK WITH OTHER

464
00:12:30,116 --> 00:12:32,084
U.S., UH, GOVERNMENT AGENCIES,

465
00:12:32,084 --> 00:12:33,385
LIKE THE DEPARTMENT OF DEFENSE,

466
00:12:33,385 --> 00:12:34,753
UH, DEPARTMENT OF ENERGY,

467
00:12:34,753 --> 00:12:36,222
AND EVEN THE DEPARTMENT

468
00:12:36,222 --> 00:12:37,857
OF HOMELAND SECURITY,

469
00:12:37,857 --> 00:12:40,693
UH, TO TELL-- DEVELOP

470
00:12:40,693 --> 00:12:42,795
THE GOVERNMENT'S, UH, RESPONSE,

471
00:12:42,795 --> 00:12:44,864
UH, TO A, UH, POTENTIAL

472
00:12:44,864 --> 00:12:46,232
IMPACT THREAT.

473
00:12:46,232 --> 00:12:47,366
UH, BUT WE ALSO WORK

474
00:12:47,366 --> 00:12:48,534
INTERNATIONALLY AS WELL.

475
00:12:48,534 --> 00:12:50,002
WE WORK WITH OUR COLLEAGUES

476
00:12:50,002 --> 00:12:51,337
IN, UH, THE EUROPEAN

477
00:12:51,337 --> 00:12:52,705
SPACE AGENCY, UH,

478
00:12:52,705 --> 00:12:54,306
THE JAPANESE SPACE AGENCY,

479
00:12:54,306 --> 00:12:56,108
AND EVEN, UH, RUSSIA

480
00:12:56,108 --> 00:12:57,643
AND THE, UH, CHINESE

481
00:12:57,643 --> 00:12:59,712
IN LOOKING AT WHAT WE WOULD DO

482
00:12:59,712 --> 00:13:02,148
AS A, UH, WORLD, UH,

483
00:13:02,148 --> 00:13:03,616
SPACE-CAPABLE NATIONS,

484
00:13:03,616 --> 00:13:06,285
UH, TO, UH, RESPOND TO

485
00:13:06,285 --> 00:13:08,921
A POTENTIAL IMPACT THREAT.

486
00:13:08,921 --> 00:13:10,356
OH, THAT'S REALLY GIVING ME

487
00:13:10,356 --> 00:13:11,790
A SENSE FOR WHAT

488
00:13:11,790 --> 00:13:13,192

THE COORDINATION MEANS IN

489
00:13:13,192 --> 00:13:14,193
PLANETARY DEFENSE

490
00:13:14,193 --> 00:13:16,028
COORDINATION OFFICE.

491
00:13:16,028 --> 00:13:16,996
WELL, WE'VE GOT A LOT OF

492
00:13:16,996 --> 00:13:18,697
QUESTIONS FROM #askNASA,

493
00:13:18,697 --> 00:13:20,666
SO LET'S GET TO SOME OF THEM.

494
00:13:20,666 --> 00:13:24,270
SO, UH, UM, MART--

495
00:13:24,270 --> 00:13:26,539
UH, MARTIAN MANISH ASKS

496
00:13:26,539 --> 00:13:27,940
HOW MANY NEAR-EARTH ASTEROIDS

497
00:13:27,940 --> 00:13:31,443
HAVE BEEN DISCOVERED SO FAR?

498
00:13:31,443 --> 00:13:32,811
>> WELL, THAT'S AN EASY ONE.

499
00:13:32,811 --> 00:13:35,281
IT'S ABOUT 23,000 NEAR-EARTH

500
00:13:35,281 --> 00:13:36,582
ASTEROIDS ALTOGETHER,

501
00:13:36,582 --> 00:13:38,117
SO THAT'S A LOT.

502
00:13:38,117 --> 00:13:39,785
UH, MO-- THE VAST MAJORITY

503
00:13:39,785 --> 00:13:40,886
HAVE BEEN DISCOVERED BY

504
00:13:40,886 --> 00:13:43,422
NASA-FUNDED ASTEROID SURVEYS,

505
00:13:43,422 --> 00:13:45,424
SCANNING THE SKIES EVERY NIGHT,

506
00:13:45,424 --> 00:13:47,226
LOOKING FOR MOVING OBJECTS.

507
00:13:47,226 --> 00:13:49,695
AND, UH, AND-AND FINDING

508
00:13:49,695 --> 00:13:51,530
ALL KINDS OF, UH, ASTEROIDS,

509
00:13:51,530 --> 00:13:54,133
AND MANY NEAR-EARTH ASTEROIDS.

510
00:13:54,133 --> 00:13:55,868
I WOULD POINT OUT THAT, UH,

511
00:13:55,868 --> 00:13:57,536
CONGRESS HAS ASSIGNED THE GOAL

512
00:13:57,536 --> 00:13:59,738
FOR NASA TO FIND 90%

513
00:13:59,738 --> 00:14:01,006

OF THE ASTEROIDS THAT ARE

514
00:14:01,006 --> 00:14:02,841
140 METERS AND LARGER.

515
00:14:02,841 --> 00:14:04,343
SO THIS-- THERE'S ACTUAL

516
00:14:04,343 --> 00:14:05,878
CONGRESSIONAL GOAL AND LANGUAGE

517
00:14:05,878 --> 00:14:07,580
THAT, UM, DICTATES THAT NASA

518
00:14:07,580 --> 00:14:09,348
NEEDS TO BE SEARCHING FOR THESE.

519
00:14:09,348 --> 00:14:10,649
AND, UH, AND THE DISCOVERIES

520
00:14:10,649 --> 00:14:12,318
ARE GOING UP PRETTY RAPIDLY,

521
00:14:12,318 --> 00:14:14,053
ABOUT 2,000 OR-OR EVEN MORE

522
00:14:14,053 --> 00:14:15,354
EVERY YEAR.

523
00:14:15,354 --> 00:14:17,122
SO WE'RE FINDING A LOT.

524
00:14:17,122 --> 00:14:18,691
>> HMM, AND, UH, LIKE WE

525
00:14:18,691 --> 00:14:19,925
KEEP HEARING THEM, FIND THEM,

526
00:14:19,925 --> 00:14:22,194
FIND THEM, AND, UH, UH--

527
00:14:22,194 --> 00:14:23,495
SO WE'VE GOT SOME MORE QUESTIONS

528
00:14:23,495 --> 00:14:25,231
HERE THAT ARE KIND OF RELATED.

529
00:14:25,231 --> 00:14:28,067
UH, ROBBIE [INDISTINCT] ASKS

530
00:14:28,067 --> 00:14:29,134
WHICH ASTEROID IN

531
00:14:29,134 --> 00:14:30,035
THE NEAR FUTURE HAS

532
00:14:30,035 --> 00:14:31,170
THE CHANCE TO HIT EARTH?

533
00:14:31,170 --> 00:14:32,571
MILADYSHADOW ASKS,

534
00:14:32,571 --> 00:14:33,739
LET'S SAY THERE'S A HUGE

535
00:14:33,739 --> 00:14:34,873
ASTEROID HITTING THE EARTH.

536
00:14:34,873 --> 00:14:36,809
WILL NASA INFORM US IF YES?

537
00:14:36,809 --> 00:14:37,710
WHAT WILL THE WORLD LEADERS

538
00:14:37,710 --> 00:14:38,944

DO AFTERWARDS?

539
00:14:38,944 --> 00:14:40,212
AND PATTYZENOS ASKS,

540
00:14:40,212 --> 00:14:41,647
HEY, NASA, HOW FAR IN THE FUTURE

541
00:14:41,647 --> 00:14:42,581
CAN YOU PREDICT

542
00:14:42,581 --> 00:14:43,816
AN ASTEROID WHICH WILL

543
00:14:43,816 --> 00:14:45,117
COLLIDE WITH THE EARTH?

544
00:14:45,117 --> 00:14:46,552
UH, SO LINDLEY, WHAT DO WE

545
00:14:46,552 --> 00:14:47,653
DO ABOUT IT, YOU KNOW,

546
00:14:47,653 --> 00:14:48,954
IF WE FIND SOMETHING, UH,

547
00:14:48,954 --> 00:14:49,989
THAT MIGHT POSE A THREAT IN--

548
00:14:49,989 --> 00:14:51,490
AND WILL PEOPLE BE TOLD

549
00:14:51,490 --> 00:14:55,928
OR ARE THERE DATA OUT THERE?

550
00:14:55,928 --> 00:14:57,730
>> WELL, FIRST OF ALL,

551
00:14:57,730 --> 00:14:59,198
WE HAVE TO TAKE

552
00:15:01,467 --> 00:15:00,332
ENOUGH OBSERVATIONS,

553
00:15:01,467 --> 00:15:03,035
TO REALLY BE ABLE TO PREDICT

554
00:15:03,035 --> 00:15:04,503
WHEN IN THE FUTURE

555
00:15:04,503 --> 00:15:05,871
AN ASTEROID MIGHT BE

556
00:15:05,871 --> 00:15:07,373
AN IMPACT THREAT.

557
00:15:07,373 --> 00:15:08,941
AND-AND THAT'S THE JOB

558
00:15:08,941 --> 00:15:10,709
THAT PAUL IS IN CHARGE OF

559
00:15:10,709 --> 00:15:11,777
OUT AT THE, UH,

560
00:15:11,777 --> 00:15:13,846
CENTER FOR NEO STUDIES.

561
00:15:13,846 --> 00:15:16,415
UH, THEN, UH, ONCE THE, UH,

562
00:15:16,415 --> 00:15:18,450
LEVEL OF POTENTIAL IMPACT THREAT

563
00:15:18,450 --> 00:15:20,185

IS DETERMINED, UH, YOU KNOW,

564
00:15:20,185 --> 00:15:22,821
THEN WE WORK WITH OUR COLLEAGUES

565
00:15:22,821 --> 00:15:24,390
IN THE U.S. GOVERNMENT

566
00:15:24,390 --> 00:15:25,991
AND, UH, INTERNATIONAL--

567
00:15:25,991 --> 00:15:27,893
UH, OTHER SPACE AGENCIES

568
00:15:27,893 --> 00:15:30,329
TO DETERMINE WHAT MIGHT BE

569
00:15:30,329 --> 00:15:32,131
THE PROPER RESPONSE.

570
00:15:32,131 --> 00:15:33,666
BUT PAUL CAN ANSWER ABOUT,

571
00:15:33,666 --> 00:15:35,200
YOU KNOW, HOW FAR IN ADVANCE

572
00:15:35,200 --> 00:15:37,603
WE CAN PREDICT THESE THINGS.

573
00:15:37,603 --> 00:15:38,804
AND, YOU KNOW,

574
00:15:38,804 --> 00:15:40,539
WHAT ARE THE HAZARDOUS OBJECTS

575
00:15:40,539 --> 00:15:42,241
THAT ARE OUT THERE?

576
00:15:42,241 --> 00:15:44,610
>> WELL, WE CAN PREDICT, UH,

577
00:15:44,610 --> 00:15:45,911
CENTURIES IN ADVANCE,

578
00:15:45,911 --> 00:15:47,046
IF WE HAVE AN ACCURATE

579
00:15:47,046 --> 00:15:48,013
ENOUGH ORBIT,

580
00:15:48,013 --> 00:15:48,914
AND IF WE HAVE OBSERVED

581
00:15:48,914 --> 00:15:49,915
AN ASTEROID LONG ENOUGH.

582
00:15:49,915 --> 00:15:50,883
SO IT REALLY DEPENDS ON

583
00:15:50,883 --> 00:15:51,750
HOW LONG WE'VE BEEN

584
00:15:51,750 --> 00:15:53,152
OBSERVING AN ASTEROID.

585
00:15:53,152 --> 00:15:55,321
UM, BUT, AS I SAY, WE CAN--

586
00:15:55,321 --> 00:15:57,222
THAT'S THE KEY THING.

587
00:15:57,222 --> 00:15:58,857
WE'LL HAVE A LONG WARNING TIME.

588
00:15:58,857 --> 00:16:01,427

UM, NOW, ASTEROID BENNU,

589
00:16:01,427 --> 00:16:02,528
THE ONE THAT, UH,

590
00:16:02,528 --> 00:16:04,330
THE OSIRUS-REX SPACECRAFT IS AT,

591
00:16:04,330 --> 00:16:05,798
IS ONE OF THE MORE HAZARDOUS

592
00:16:05,798 --> 00:16:07,032
ASTEROIDS, BUT IT'S, LIKE,

593
00:16:07,032 --> 00:16:09,101
FOR 200 YEARS INTO THE FUTURE.

594
00:16:09,101 --> 00:16:10,502
SO WE HAVE A LOT OF TIME

595
00:16:10,502 --> 00:16:12,037
TO STUDY THAT ASTEROID AND

596
00:16:12,037 --> 00:16:13,939
IMPROVE THE ORBIT OF BENNU.

597
00:16:13,939 --> 00:16:16,608
UM, BUT IT-- THE CHANCE OF EVEN

598
00:16:16,608 --> 00:16:17,810
BENNU HITTING THE EARTH

599
00:16:17,810 --> 00:16:19,278
ARE REALLY, REALLY SMALL.

600
00:16:19,278 --> 00:16:22,981
UM, YOU KNOW, 1 IN 10,000 OR SO.

601
00:16:22,981 --> 00:16:25,084
UM, APOPHIS IS ANOTHER ASTEROID

602
00:16:25,084 --> 00:16:26,919
THAT, IN THE DISTANT FUTURE,

603
00:16:26,919 --> 00:16:28,587
MAY BE-- WITHIN MANY DECADES--

604
00:16:28,587 --> 00:16:30,155
THERE'S A SMALL, TINY CHANCE

605
00:16:30,155 --> 00:16:31,623
THAT IT COULD HIT THE EARTH.

606
00:16:31,623 --> 00:16:33,158
BUT, AGAIN, AS WE CONTINUE TO

607
00:16:33,158 --> 00:16:34,693
OBSERVE THOSE ASTEROIDS,

608
00:16:34,693 --> 00:16:36,095
WE'LL PROBABLY BE ABLE TO

609
00:16:36,095 --> 00:16:38,330
ELIMINATE EVEN THESE TINY,

610
00:16:38,330 --> 00:16:39,331
LITTLE CHANCES--

611
00:16:39,331 --> 00:16:41,500
1 IN 10,000, 1 IN 60,000--

612
00:16:41,500 --> 00:16:43,135
CHANCE OF HITTING THE EARTH.

613
00:16:43,135 --> 00:16:44,570

SO, UH, AND AS I SAY,

614
00:16:44,570 --> 00:16:46,271
THEY ARE IN THE DISTANT FUTURE.

615
00:16:46,271 --> 00:16:48,440
THERE ARE NO ASTEROIDS WHICH

616
00:16:48,440 --> 00:16:50,075
HAVE ANY SIGNIFICANT CHANCE

617
00:16:50,075 --> 00:16:51,210
OF HITTING THE EARTH THAT ARE

618
00:16:51,210 --> 00:16:53,045
OF ANY SIGNIFICANT SIZE.

619
00:16:53,045 --> 00:16:55,147
THERE ARE NONE ON OUR LIST.

620
00:16:55,147 --> 00:16:56,215
>> AND THAT'S THE WHOLE POINT.

621
00:16:56,215 --> 00:16:57,316
NONE ON THE LIST.

622
00:16:57,316 --> 00:16:58,550
NONE THAT WE ACTUALLY KNOW OF,

623
00:16:58,550 --> 00:16:59,551
WHICH IS WHY WE KEEP

624
00:16:59,551 --> 00:17:00,452
GETTING BACK TO

625
00:17:00,452 --> 00:17:01,920
WE GOTTA FIND THEM FIRST.

626
00:17:01,920 --> 00:17:03,856
UM, BUT YOU MENTIONED APOPHIS--

627
00:17:03,856 --> 00:17:05,791
OH, GO AHEAD, LINDLEY.

628
00:17:05,791 --> 00:17:06,992
>> WELL, LET ME JUST POINT OUT

629
00:17:06,992 --> 00:17:09,294
THAT IMPACT OF THE EARTH

630
00:17:09,294 --> 00:17:11,130
BY AN ASTEROID LARGE ENOUGH

631
00:17:11,130 --> 00:17:13,031
TO DO DAMAGE AT THE SURFACE

632
00:17:13,031 --> 00:17:15,334
IS AN EXTREMELY RARE EVENT.

633
00:17:15,334 --> 00:17:18,704
BUT IT'S AN INEVITABLE EVENT.

634
00:17:18,704 --> 00:17:21,473
WE HAVE-- KNOW THAT THERE ARE

635
00:17:21,473 --> 00:17:23,075
THOUSANDS OF NEAR-EARTH

636
00:17:23,075 --> 00:17:24,410
ASTEROIDS OUT THERE,

637
00:17:24,410 --> 00:17:25,811
AND THERE ARE THOUSANDS MORE

638
00:17:25,811 --> 00:17:27,112

THAT WE DON'T KNOW ABOUT.

639
00:17:27,112 --> 00:17:28,547
AND THAT'S WHY WE NEED TO

640
00:17:28,547 --> 00:17:29,948
CONTINUE THIS PROGRAM,

641
00:17:29,948 --> 00:17:31,850
FOR DETECTION AND TRACKING OF

642
00:17:31,850 --> 00:17:32,785
THE NEAR-EARTH OBJECT

643
00:17:32,785 --> 00:17:35,087
POPULATION, TO DETERMINE

644
00:17:35,087 --> 00:17:36,855
WHERE AND WHEN

645
00:17:36,855 --> 00:17:38,924
THE NEXT SIGNIFICANT IMPACT

646
00:17:38,924 --> 00:17:40,592
COULD OCCUR.

647
00:17:40,592 --> 00:17:43,395
>> AND, UH, WELL, EARLIER,

648
00:17:43,395 --> 00:17:45,297
PAUL MENTIONED APOPHIS.

649
00:17:45,297 --> 00:17:47,065
AND THAT IS ANOTHER ASTEROID

650
00:17:47,065 --> 00:17:48,367
THAT, UH, PEOPLE

651
00:17:48,367 --> 00:17:49,635
ASK ABOUT A LOT.

652
00:17:49,635 --> 00:17:54,106
AND, UH, @LIELLE8351356 ASKS,

653
00:17:54,106 --> 00:17:55,307
"HI, I WONDER IF THERE IS

654
00:17:55,307 --> 00:17:56,675
"A CHANCE THAT ASTEROID APOPHIS

655
00:17:56,675 --> 00:17:59,178
"COULD HIT EARTH BY NEXT FLYBY

656
00:17:59,178 --> 00:18:01,046
"ON 2035, DEPENDING ON GRAVITY

657
00:18:01,046 --> 00:18:02,581
"OR YARKOVSKY EFFECT?

658
00:18:02,581 --> 00:18:03,482
"OR DID NASA

659
00:18:03,482 --> 00:18:04,349
"AND OTHER RESEARCHERS

660
00:18:04,349 --> 00:18:05,851
"CALCULATE THAT BEFORE THEY

661
00:18:05,851 --> 00:18:07,152
"RULED OUT ANY POSSIBLE EFFECT?

662
00:18:07,152 --> 00:18:08,220
"AND IS IT SAFE ON

663
00:18:08,220 --> 00:18:09,822

"THE 2060 FLYBY?

664
00:18:09,822 --> 00:18:11,156
"CAN YOU TELL US SOMETHING

665
00:18:11,156 --> 00:18:13,559
MORE ABOUT APOPHIS

666
00:18:13,559 --> 00:18:15,928
"AND WHAT PEOPLE SHOULD EXPECT?"

667
00:18:15,928 --> 00:18:17,095
>> I CAN ADDRESS THAT ONE.

668
00:18:17,095 --> 00:18:19,231
YEAH, UM, APOPHIS WILL COME

669
00:18:19,231 --> 00:18:20,299
REALLY, REALLY CLOSE

670
00:18:20,299 --> 00:18:21,700
IN THE YEAR 2029.

671
00:18:21,700 --> 00:18:22,768
SO, THAT'S COMING UP,

672
00:18:22,768 --> 00:18:24,269
YOU KNOW, LESS THAN 9 YEARS

673
00:18:24,269 --> 00:18:26,004
FROM NOW, ON APRIL THE 13TH.

674
00:18:26,004 --> 00:18:27,272
AND WE-WE KNOW THAT

675
00:18:27,272 --> 00:18:28,407
IT WILL MISS THE EARTH.

676
00:18:28,407 --> 00:18:29,475
WE'RE, YOU KNOW,

677
00:18:29,475 --> 00:18:30,809
WE KNOW ITS ORBIT SO WELL

678
00:18:30,809 --> 00:18:31,977
THAT WE KNOW ITS ORBIT

679
00:18:31,977 --> 00:18:33,145
WITHIN A FEW MILES

680
00:18:33,145 --> 00:18:34,746
AS IT GOES BY THE EARTH THEN.

681
00:18:34,746 --> 00:18:36,048
IT'S HARDER TO PREDICT

682
00:18:36,048 --> 00:18:37,049
FARTHER OUT.

683
00:18:37,049 --> 00:18:39,084
YEAR 2035, WE'RE ALSO SURE THAT

684
00:18:39,084 --> 00:18:40,552
IT'LL MISS THE EARTH THAT YEAR.

685
00:18:40,552 --> 00:18:41,987
AND THE YEAR 2068,

686
00:18:41,987 --> 00:18:44,690
WE'RE ALMOST CERTAIN THAT IT

687
00:18:44,690 --> 00:18:46,358
WILL MISS IN THAT YEAR AS WELL.

688
00:18:46,358 --> 00:18:47,793

BUT IT WILL COME CLOSE,

689
00:18:47,793 --> 00:18:48,727
AND WE DON'T KNOW

690
00:18:48,727 --> 00:18:49,661
EXACTLY HOW CLOSE.

691
00:18:49,661 --> 00:18:50,829
SO, PROJECTING THE ASTEROID

692
00:18:50,829 --> 00:18:52,698
ORBIT THAT FAR IN ADVANCE,

693
00:18:52,698 --> 00:18:54,833
MANY DECADES, ESPECIALLY WHEN

694
00:18:54,833 --> 00:18:57,536
IT IS PASSING BY--

695
00:18:57,536 --> 00:18:59,004
REPEATEDLY BY THE EARTH,

696
00:18:59,004 --> 00:19:00,205
IS A DIFFICULT PROBLEM.

697
00:19:00,205 --> 00:19:02,007
BUT WE CAN SEE NO CHANCE

698
00:19:02,007 --> 00:19:03,308
OF IT HITTING THE EARTH FOR,

699
00:19:03,308 --> 00:19:06,645
UM, MANY, MANY, MANY DECADES.

700
00:19:06,645 --> 00:19:07,713
>> WELL, THAT'S WHY IT'S

701
00:19:07,713 --> 00:19:08,847
IMPORTANT TO OBSERVE IT, TOO.

702
00:19:08,847 --> 00:19:10,749
AND I KNOW THAT, EVEN NOW,

703
00:19:10,749 --> 00:19:12,217
OBSERVERS AROUND THE WORLD

704
00:19:12,217 --> 00:19:13,585
ARE ALREADY PREPPING FOR

705
00:19:13,585 --> 00:19:15,153
WHAT THEY'LL DO AT THE TIME,

706
00:19:15,153 --> 00:19:16,555
AND FOR POSSIBLE MISSIONS,

707
00:19:16,555 --> 00:19:18,390
AND JUST BRAINSTORMING ON THAT.

708
00:19:18,390 --> 00:19:20,125
BECAUSE IT DOES TAKE TIME TO,

709
00:19:20,125 --> 00:19:23,428
UH, TO LAUNCH SUCH A CAMPAIGN.

710
00:19:23,428 --> 00:19:24,363
>> SO, APOPHIS IS

711
00:19:24,363 --> 00:19:25,297
COMING SO CLOSE TO THE EARTH,

712
00:19:25,297 --> 00:19:26,131
WE'LL BE ABLE TO SEE IT

713
00:19:26,131 --> 00:19:27,165

WITH THE NAKED EYE.

714
00:19:27,165 --> 00:19:28,734
YOU KNOW, IN 9 YEARS FROM NOW.

715
00:19:28,734 --> 00:19:30,569
THAT'LL BE AN EXCITING EVENT.

716
00:19:30,569 --> 00:19:31,904
>> EXACTLY, YEAH.

717
00:19:31,904 --> 00:19:32,838
THAT WILL BE VISIBLE

718
00:19:32,838 --> 00:19:33,672
WITH THE NAKED EYE,

719
00:19:33,672 --> 00:19:35,307
WHICH WILL BE, UH, A REALLY

720
00:19:35,307 --> 00:19:37,643
OVERWHELMING EXPERIENCE.

721
00:19:37,643 --> 00:19:38,777
BUT THAT KINDA BRINGS US BACK

722
00:19:38,777 --> 00:19:41,313
TO 1998 OR2 THIS WEEK.

723
00:19:41,313 --> 00:19:43,715
BECAUSE @THEDOCTOR_06 ASKS,

724
00:19:43,715 --> 00:19:45,484
"WILL THE ASTEROID BE VISIBLE?"

725
00:19:45,484 --> 00:19:47,719
AND THIS ONE WON'T BE BECAUSE,

726
00:19:47,719 --> 00:19:48,754
WHEREAS APOPHIS IS GOING TO

727
00:19:48,754 --> 00:19:50,222
COME QUITE CLOSE TO THE EARTH,

728
00:19:50,222 --> 00:19:52,324
UH, 1998 OR2 IS GOING TO BE

729
00:19:52,324 --> 00:19:54,927
ABOUT 16 TIMES THE DISTANCE

730
00:19:54,927 --> 00:19:56,194
FROM THE EARTH TO THE MOON

731
00:19:56,194 --> 00:19:57,162
AWAY FROM US.

732
00:19:57,162 --> 00:19:58,297
IT'S QUITE FAR.

733
00:19:58,297 --> 00:19:59,865
SO, ASTRONOMERS WITH TELESCOPES

734
00:19:59,865 --> 00:20:03,068
WILL BE-WILL BE STUDYING IT

735
00:20:03,068 --> 00:20:04,136
FROM THE GROUND.

736
00:20:04,136 --> 00:20:05,704
BUT, UH, UNFORTUNATELY,

737
00:20:05,704 --> 00:20:06,538
YOU WON'T BE ABLE TO

738
00:20:06,538 --> 00:20:07,372

GO OUT IN YOUR BACKYARD

739
00:20:07,372 --> 00:20:10,976
AND-AND SEE 1998 OR2 PASS BY.

740
00:20:10,976 --> 00:20:11,977
UH, BUT THERE'S ANOTHER

741
00:20:11,977 --> 00:20:12,844
QUESTION HERE FROM

742
00:20:12,844 --> 00:20:14,546
@STACYPARSONS89 ASKING,

743
00:20:14,546 --> 00:20:16,515
"DOES THE NAME 1998 OR2

744
00:20:16,515 --> 00:20:17,516
"COME FROM THE FACT

745
00:20:17,516 --> 00:20:20,652
"IT WAS DETECTED IN 1998?"

746
00:20:20,652 --> 00:20:22,521
>> YES, YES.

747
00:20:22,521 --> 00:20:24,156
UH, THE-THE YEAR IS USED

748
00:20:24,156 --> 00:20:25,257
AS THE FIRST PART OF

749
00:20:25,257 --> 00:20:26,658
THE DESIGNATION.

750
00:20:26,658 --> 00:20:27,593
UH, SO IT WAS

751
00:20:27,593 --> 00:20:28,727
DISCOVERED IN 1998.

752
00:20:28,727 --> 00:20:29,561
AND THEN WE FOUND

753
00:20:29,561 --> 00:20:30,462
EARLIER OBSERVATIONS.

754
00:20:30,462 --> 00:20:31,830
SO WE ACTUALLY KNOW WHERE

755
00:20:31,830 --> 00:20:33,065
IT WAS EARLIER THAN THAT.

756
00:20:33,065 --> 00:20:34,399
AND WE'VE BEEN TRACKING IT

757
00:20:34,399 --> 00:20:35,233
FOR THAT LONG.

758
00:20:35,233 --> 00:20:36,068
YOU KNOW, THAT'S MORE THAN,

759
00:20:36,068 --> 00:20:37,469
YOU KNOW, 20 YEARS WE'VE BEEN

760
00:20:37,469 --> 00:20:38,971
TRACKING THIS ASTEROID.

761
00:20:38,971 --> 00:20:39,838
AND THAT'S WHY WE KNOW

762
00:20:39,838 --> 00:20:42,374
ITS ORBIT SO, SO WELL.

763
00:20:42,374 --> 00:20:43,308

>> OKAY, WELL,

764
00:20:43,308 --> 00:20:44,676
MAYBE ONE MORE QUESTION HERE.

765
00:20:44,676 --> 00:20:48,113
UM, [INDISTINCT] ASKS,

766
00:20:48,113 --> 00:20:49,348
"SUPPOSE THIS ASTEROID

767
00:20:49,348 --> 00:20:50,282
"IS GOING TO HIT EARTH.

768
00:20:50,282 --> 00:20:51,516
"HAVE WE TECHNOLOGY IN PRESENT

769
00:20:51,516 --> 00:20:53,385
"THAT WE CAN DESTROY THIS, UH,

770
00:20:53,385 --> 00:20:54,620
"IN THIS WAY BEFORE

771
00:20:54,620 --> 00:20:56,088
"STRIKING THE EARTH?"

772
00:20:56,088 --> 00:20:56,888
LINDLEY, DO YOU HAVE

773
00:20:56,888 --> 00:20:58,957
ANY COMMENTS ON THAT?

774
00:20:58,957 --> 00:21:01,293
WELL, UH, THIS ASTEROID IS

775
00:21:01,293 --> 00:21:03,228
FAIRLY LARGE AND, INDEED,

776
00:21:03,228 --> 00:21:04,396
WOULD BE A CHALLENGE.

777
00:21:04,396 --> 00:21:07,599
BUT, UH, NASA AND OUR COLLEAGUES

778
00:21:07,599 --> 00:21:09,301
AT OTHER SPACE AGENCIES,

779
00:21:09,301 --> 00:21:11,069
WE ARE WORKING ON TECHNOLOGIES

780
00:21:11,069 --> 00:21:13,105
AND TECHNIQUES TO BE USED

781
00:21:13,105 --> 00:21:15,107
TO DEFLECT AN ASTEROID, UH,

782
00:21:15,107 --> 00:21:16,174
THAT WE DISCOVER ON

783
00:21:16,174 --> 00:21:17,643
AN IMPACTING TRAJECTORY.

784
00:21:17,643 --> 00:21:19,344
UH, THE KEY TO IT IS FINDING IT

785
00:21:19,344 --> 00:21:20,912
SEVERAL YEARS IN ADVANCE,

786
00:21:20,912 --> 00:21:22,381
SO THAT, UH,

787
00:21:22,381 --> 00:21:24,216
JUST A SLIGHT CHANGE THAT

788
00:21:24,216 --> 00:21:25,984

WE WOULD IMPART TO ITS VELOCITY

789
00:21:25,984 --> 00:21:27,452
WILL CAUSE IT TO, UH,

790
00:21:27,452 --> 00:21:29,054
MISS THE EARTH.

791
00:21:29,054 --> 00:21:33,659
BUT, UH, THE TECHNOLOGY THAT

792
00:21:33,659 --> 00:21:35,394
WE'RE WORKING ON RIGHT NOW

793
00:21:35,394 --> 00:21:38,263
IS OUR FIRST, UH,

794
00:21:38,263 --> 00:21:40,866
DEMONSTRATION OF OUR CAPABILITY

795
00:21:40,866 --> 00:21:43,268
TO DEFLECT AN ASTEROID BEFORE

796
00:21:43,268 --> 00:21:45,437
IT COULD IMPACT THE EARTH.

797
00:21:45,437 --> 00:21:46,872
>> HMM, WELL,

798
00:21:46,872 --> 00:21:47,773
IT KEEPS COMING BACK TO

799
00:21:47,773 --> 00:21:48,607
FIND THEM EARLY,

800
00:21:48,607 --> 00:21:49,708
AND SO WE DON'T END UP

801
00:21:49,708 --> 00:21:50,876
NEEDING THE SCENARIOS THAT

802
00:21:50,876 --> 00:21:52,010
SHOW UP IN THE MOVIES

803
00:21:52,010 --> 00:21:52,944
AND EVERYTHING,

804
00:21:52,944 --> 00:21:53,945
WHERE WE CAN DO IT

805
00:21:53,945 --> 00:21:55,147
IN A REASONABLE MANNER.

806
00:21:55,147 --> 00:21:56,081
AND YOU ALL HAVE SOME

807
00:21:56,081 --> 00:21:57,215
REALLY GREAT QUESTIONS.

808
00:21:57,215 --> 00:21:58,483
KEEP SENDING THEM IN.

809
00:21:58,483 --> 00:21:59,751
UH, SOME OF THE QUESTIONS

810
00:21:59,751 --> 00:22:01,086
WE'RE GETTING ARE ASKING WHAT

811
00:22:01,086 --> 00:22:02,087
NASA WOULD DO IF THERE WAS

812
00:22:02,087 --> 00:22:03,755
A THREAT OF AN ASTEROID IMPACT.

813
00:22:03,755 --> 00:22:05,357

AND THERE IS AN EXCITING MISSION

814
00:22:05,357 --> 00:22:06,491
THAT NASA IS DEVELOPING

815
00:22:06,491 --> 00:22:07,626
TO TEST AN ASTEROID

816
00:22:07,626 --> 00:22:08,660
DEFLECTION TECHNIQUE,

817
00:22:08,660 --> 00:22:10,228
IN CASE WE ARE EVER FACED WITH

818
00:22:10,228 --> 00:22:11,229
AN ASTEROID THAT COULD

819
00:22:11,229 --> 00:22:13,065
IMPACT EARTH IN THE FUTURE.

820
00:22:13,065 --> 00:22:14,733
SO LET'S TAKE A LOOK.

821
00:22:16,835 --> 00:22:18,103
>> DART IS THE DOUBLE ASTEROID

822
00:22:18,103 --> 00:22:19,538
REDIRECTION TEST.

823
00:22:19,538 --> 00:22:22,074
THE EARTH IS HIT BY ASTEROIDS

824
00:22:22,074 --> 00:22:23,575
AND PIECES OF ASTEROIDS

825
00:22:23,575 --> 00:22:24,743
ALL THE TIME.

826
00:22:24,743 --> 00:22:25,744
EVERY YEAR OR SO,

827
00:22:25,744 --> 00:22:26,978
WE GET HIT BY THINGS

828
00:22:26,978 --> 00:22:28,747
MAYBE THE SIZE OF A TABLE.

829
00:22:28,747 --> 00:22:29,848
THE KIND OF OBJECT THAT

830
00:22:29,848 --> 00:22:31,583
DART IS GOING TO VISIT IS

831
00:22:31,583 --> 00:22:32,751
AN OBJECT THAT'S ABOUT THE SIZE

832
00:22:32,751 --> 00:22:34,352
OF THE WASHINGTON MONUMENT.

833
00:22:34,352 --> 00:22:35,654
THOSE KINDS OF OBJECTS HIT US

834
00:22:35,654 --> 00:22:37,622
EVERY FEW THOUSAND YEARS,

835
00:22:37,622 --> 00:22:39,091
AND THEY WOULD CAUSE SEVERE

836
00:22:39,091 --> 00:22:41,460
DAMAGE ON A REGIONAL SCALE.

837
00:22:41,460 --> 00:22:42,494
>> WE CHOSE TO DO

838
00:22:42,494 --> 00:22:43,662

THIS DEMONSTRATION

839
00:22:43,662 --> 00:22:45,263
AT A BINARY ASTEROID.

840
00:22:45,263 --> 00:22:46,498
IT'S CALLED DIDYMOS.

841
00:22:46,498 --> 00:22:48,700
THIS IS ACTUALLY APPROXIMATELY

842
00:22:48,700 --> 00:22:51,403
THE SHAPE OF THE MAIN ASTEROID,

843
00:22:51,403 --> 00:22:53,071
IT'S CALLED DIDYMOS A,

844
00:22:53,071 --> 00:22:55,507
AND ITS MOON, DIDYMOS B.

845
00:22:55,507 --> 00:22:56,641
WHAT DART WILL DO,

846
00:22:56,641 --> 00:22:57,876
IS DART WILL HIT

847
00:22:57,876 --> 00:23:00,612
THE SECONDARY MOON.

848
00:23:00,612 --> 00:23:01,480
WHEN IT HITS THE MOON,

849
00:23:01,480 --> 00:23:03,081
IT WILL CHANGE THE ORBIT PERIOD.

850
00:23:03,081 --> 00:23:04,249
AND WHEN IT CHANGES

851
00:23:04,249 --> 00:23:05,317
THE ORBIT PERIOD,

852
00:23:05,317 --> 00:23:07,319
IT AFFECTS THE TIMING OF WHEN

853
00:23:07,319 --> 00:23:09,721
THE MOON MOVES IN FRONT OF

854
00:23:09,721 --> 00:23:13,158
OR BEHIND THE PRIMARY.

855
00:23:13,158 --> 00:23:14,126
>> MOSTLY, WHAT WE'RE LOOKING

856
00:23:14,126 --> 00:23:15,861
TO DO IS CHANGE THE SPEED

857
00:23:15,861 --> 00:23:17,395
OF THE INCOMING OBJECT

858
00:23:17,395 --> 00:23:18,730
BY MAYBE A CENTIMETER

859
00:23:18,730 --> 00:23:20,532
PER SECOND OR SO.

860
00:23:20,532 --> 00:23:21,633
THAT'S NOT VERY FAST,

861
00:23:21,633 --> 00:23:22,467
BUT IF YOU DO IT

862
00:23:22,467 --> 00:23:23,735
ENOUGH SECONDS IN ADVANCE,

863
00:23:23,735 --> 00:23:24,770

YOU CAN CAUSE IT TO

864
00:23:24,770 --> 00:23:26,471
MISS THE EARTH ENTIRELY.

865
00:23:27,706 --> 00:23:29,341
>> SO WE JUST HEARD ABOUT DART,

866
00:23:29,341 --> 00:23:30,308
WHICH SEEMS LIKE

867
00:23:30,308 --> 00:23:31,209
A REALLY COOL MISSION.

868
00:23:31,209 --> 00:23:32,811
ALMOST LIKE SCI-FI.

869
00:23:32,811 --> 00:23:33,712
BUT, LINDLEY,

870
00:23:33,712 --> 00:23:35,147
WHEN IS THIS ALL HAPPENING?

871
00:23:35,147 --> 00:23:36,748
DART'S LAUNCH AND THE IMPACT

872
00:23:36,748 --> 00:23:37,682
WITH DIDYMOS B,

873
00:23:37,682 --> 00:23:39,818
WHEN IS THAT HAPPENING?

874
00:23:39,818 --> 00:23:41,520
>> OKAY, WELL, UH,

875
00:23:41,520 --> 00:23:43,088
DART RIGHT NOW IS, UH,

876
00:23:43,088 --> 00:23:44,289
IN DEVELOPMENT.

877
00:23:44,289 --> 00:23:45,423
IT'S BEING-- THE SPACECRAFT

878
00:23:45,423 --> 00:23:46,792
IS BEING BUILT UP

879
00:23:46,792 --> 00:23:47,793
AND BEING PREPARED

880
00:23:47,793 --> 00:23:49,528
FOR LAUNCH IN JULY.

881
00:23:49,528 --> 00:23:50,562
THE END OF JULY

882
00:23:50,562 --> 00:23:52,898
OF NEXT YEAR, 2021.

883
00:23:52,898 --> 00:23:54,933
IT WILL THEN CRUISE TO

884
00:23:54,933 --> 00:23:56,535
THE ASTEROID FOR ABOUT

885
00:23:56,535 --> 00:23:58,470
A YEAR-AND-A-HALF.

886
00:23:58,470 --> 00:23:59,404
NOT QUITE.

887
00:23:59,404 --> 00:24:01,706
14 MONTHS OR SO.

888
00:24:01,706 --> 00:24:03,341

AND THE ENCOUNTER WITH

889
00:24:03,341 --> 00:24:05,477
THE DIDYMOS ASTEROID,

890
00:24:05,477 --> 00:24:07,579
DIDYMOS ASTEROID AND ITS MOON,

891
00:24:07,579 --> 00:24:08,980
WILL BE THE END OF

892
00:24:08,980 --> 00:24:12,884
SEPTEMBER OF 2022.

893
00:24:12,884 --> 00:24:13,985
>> WELL, EVERYTHING SEEMS

894
00:24:13,985 --> 00:24:15,220
REALLY WELL TIMED.

895
00:24:15,220 --> 00:24:16,955
EVERYTHING SEEMS-SEEMS, UH,

896
00:24:16,955 --> 00:24:18,123
PRECISELY TIMED.

897
00:24:18,123 --> 00:24:19,724
WHY DIDYMOS?

898
00:24:19,724 --> 00:24:20,826
WE ARE HEARING ABOUT

899
00:24:20,826 --> 00:24:21,593
HOW THERE'S ALL THESE

900
00:24:21,593 --> 00:24:22,460
ASTEROIDS OUT THERE.

901
00:24:22,460 --> 00:24:24,729
WHY DIDYMOS?

902
00:24:24,729 --> 00:24:25,831
>> WELL, WHEN WE'RE

903
00:24:25,831 --> 00:24:26,932
ENCOUNTERING ASTEROIDS,

904
00:24:26,932 --> 00:24:27,933
EVERYTHING DOES HAVE TO

905
00:24:27,933 --> 00:24:29,034
BE PRECISELY TIMED.

906
00:24:29,034 --> 00:24:30,435
WE HAVE TO CATCH THEM AT, UH,

907
00:24:30,435 --> 00:24:32,103
AT THE APPROPRIATE TIME

908
00:24:32,103 --> 00:24:33,104
WHEN THEY, UH,

909
00:24:33,104 --> 00:24:35,140
COME CLOSE TO THE EARTH.

910
00:24:35,140 --> 00:24:37,375
UH, IN THIS CASE, DIDYMOS--

911
00:24:37,375 --> 00:24:39,344
NATURE HAS PROVIDED US THIS,

912
00:24:39,344 --> 00:24:42,080
UH, PERFECT OPPORTUNITY ALMOST

913
00:24:42,080 --> 00:24:44,149

TO TEST THE KINETIC IMPACT

914
00:24:44,149 --> 00:24:46,384
OR TECHNIQUE FOR CHANGING

915
00:24:46,384 --> 00:24:48,887
THE ORBIT OF AN ASTEROID.

916
00:24:48,887 --> 00:24:50,989
DIDYMOS IS WHAT WE CALL

917
00:24:50,989 --> 00:24:52,357
A BINARY ASTEROID.

918
00:24:52,357 --> 00:24:54,226
IT, UH, PRIMARY--

919
00:24:54,226 --> 00:24:56,595
THE PRIMARY ASTEROID IS

920
00:24:56,595 --> 00:24:58,663
ABOUT HALF A MILE ACROSS.

921
00:24:58,663 --> 00:25:00,131
AND IT HAS A SMALL MOON,

922
00:25:00,131 --> 00:25:01,933
WHICH IS ABOUT THE SIZE OF

923
00:25:01,933 --> 00:25:03,902
A-OF A FOOTBALL STADIUM.

924
00:25:03,902 --> 00:25:06,771
160 METERS OR SO IN SIZE.

925
00:25:06,771 --> 00:25:10,909
THE, UH, DART IMPACTOR WILL

926
00:25:10,909 --> 00:25:13,879
IMPACT THE MOON OF DIDYMOS

927
00:25:13,879 --> 00:25:16,214
AND CHANGE THE MOON'S ORBIT

928
00:25:16,214 --> 00:25:18,383
ABOUT THE PRIMARY.

929
00:25:18,383 --> 00:25:21,686
THIS IS A TEST DEMONSTRATION

930
00:25:21,686 --> 00:25:23,588
OF THIS CAPABILITY.

931
00:25:23,588 --> 00:25:24,623
BUT WE'RE DOING IT

932
00:25:24,623 --> 00:25:25,557
IN A SAFE MANNER,

933
00:25:25,557 --> 00:25:26,691
IN THAT WE'LL ONLY BE CHANGING

934
00:25:26,691 --> 00:25:28,159
THE ORBIT OF THE MOON

935
00:25:28,159 --> 00:25:29,694
AND NOT THE ORBIT OF

936
00:25:29,694 --> 00:25:31,429
THE ASTEROID AROUND THE SUN.

937
00:25:31,429 --> 00:25:33,832
SO WE DON'T INCREASE, UH,

938
00:25:33,832 --> 00:25:35,467

THE HAZARD TO THE EARTH

939
00:25:35,467 --> 00:25:37,035
FROM THIS PARTICULAR ASTEROID

940
00:25:37,035 --> 00:25:39,204
BY DOING THIS TEST.

941
00:25:39,204 --> 00:25:41,106
SO, NATURE'S PROVIDED US

942
00:25:41,106 --> 00:25:44,309
A VERY GOOD TEST OPPORTUNITY

943
00:25:44,309 --> 00:25:46,912
FOR THE KINETIC IMPACTOR.

944
00:25:46,912 --> 00:25:49,681
AT THE TIME OF THE, UH,

945
00:25:49,681 --> 00:25:51,783
ENCOUNTER, DIDYMOS WILL BE

946
00:25:51,783 --> 00:25:54,619
ABOUT 8 MILLION MILES AWAY

947
00:25:54,619 --> 00:25:55,987
FROM THE EARTH.

948
00:25:55,987 --> 00:25:59,324
AND SO, THIS ALLOWS US TO

949
00:25:59,324 --> 00:26:02,494
OBSERVE THE EFFECTS OF THIS

950
00:26:02,494 --> 00:26:06,131
IMPACT FROM EARTH OBSERVATORIES.

951
00:26:06,131 --> 00:26:08,600
LARGE TELESCOPE OPTICAL

952
00:26:08,600 --> 00:26:11,036
OBSERVATORIES ON THE EARTH

953
00:26:11,036 --> 00:26:13,738
CAN THEN DETERMINE HOW MUCH

954
00:26:13,738 --> 00:26:15,273
WE HAVE CHANGED THE ORBIT

955
00:26:15,273 --> 00:26:19,611
OF THE MOON ABOUT DIDYMOS.

956
00:26:19,611 --> 00:26:21,780
WE ALSO, UH, SHOW THAT

957
00:26:21,780 --> 00:26:22,948
IT WOULD BE CLOSE ENOUGH THAT

958
00:26:22,948 --> 00:26:24,182
IT CAN ALSO BE DETECTED

959
00:26:24,182 --> 00:26:26,584
BY RADAR AS WELL.

960
00:26:26,584 --> 00:26:28,019
>> WELL, IT'S NICE THAT NATURE'S

961
00:26:28,019 --> 00:26:29,321
GIVING US THIS OPPORTUNITY

962
00:26:29,321 --> 00:26:31,056
TO TEST SUCH A MISSION.

963
00:26:31,056 --> 00:26:31,890

AND, HOPEFULLY,

964
00:26:31,890 --> 00:26:32,857
WE'LL NEVER NEED IT.

965
00:26:32,857 --> 00:26:34,192
BUT, PAUL, HOW FAR IN ADVANCE

966
00:26:34,192 --> 00:26:35,293
WOULD WE NEED TO

967
00:26:35,293 --> 00:26:36,261
DETECT A THREAT,

968
00:26:36,261 --> 00:26:37,195
IN ORDER FOR A DEFLECTION

969
00:26:37,195 --> 00:26:38,496
MISSION LIKE DART

970
00:26:38,496 --> 00:26:39,798
TO DO ITS JOB SUCCESSFULLY,

971
00:26:39,798 --> 00:26:42,534
IF WE EVER NEEDED THAT?

972
00:26:42,534 --> 00:26:44,536
>> WELL, IT TAKES TIME FOR A,

973
00:26:44,536 --> 00:26:46,371
UH, A KINETIC IMPACT OR MISSION

974
00:26:46,371 --> 00:26:47,672
TO GET TO THE ASTEROID,

975
00:26:47,672 --> 00:26:48,606
OF COURSE.

976
00:26:48,606 --> 00:26:49,474
AND IT TAKES TIME TO

977
00:26:49,474 --> 00:26:50,508
BUILD THE MISSION.

978
00:26:50,508 --> 00:26:52,944
IT TAKES TIME FOR ANY CHANGE

979
00:26:52,944 --> 00:26:54,946
IN VELOCITY TO TAKE AN EFFECT

980
00:26:54,946 --> 00:26:56,314
AND MOVE A TRAJECTORY, YOU KNOW,

981
00:26:56,314 --> 00:26:57,682
AWAY FROM THE EARTH.

982
00:26:57,682 --> 00:26:59,718
SO, UM, WE THINK THAT

983
00:26:59,718 --> 00:27:00,919
IT TAKES AT LEAST--

984
00:27:00,919 --> 00:27:02,120
YOU NEED A WARNING OF AT LEAST

985
00:27:02,120 --> 00:27:05,457
FIVE YEARS TO PROBABLY SEVEN,

986
00:27:05,457 --> 00:27:07,592
EIGHT YEARS, MINIMUM,

987
00:27:07,592 --> 00:27:08,893
IF YOU WANNA EXECUTE

988
00:27:08,893 --> 00:27:10,061

A DEFLECTION OF

989
00:27:10,061 --> 00:27:11,830
A SIZABLE ASTEROID.

990
00:27:11,830 --> 00:27:13,732
SO, THAT IS, UH,

991
00:27:13,732 --> 00:27:15,300
I THINK A MINIMUM.

992
00:27:15,300 --> 00:27:17,035
WE'D LIKE TO FIND, UH--

993
00:27:17,035 --> 00:27:18,069
HAVE A WARNING TIME

994
00:27:18,069 --> 00:27:19,437
THAT'S DECADES IN LENGTH.

995
00:27:19,437 --> 00:27:20,805
WE'D LIKE TO-WE'D LIKE TO,

996
00:27:20,805 --> 00:27:22,507
YOU KNOW, KNOW DECADES AHEAD.

997
00:27:22,507 --> 00:27:23,875
AND THEN YOU DON'T REALLY NEED

998
00:27:23,875 --> 00:27:25,810
TO HIT THE ASTEROID AS HARD.

999
00:27:25,810 --> 00:27:26,911
YOU CAN JUST, YOU KNOW,

1000
00:27:26,911 --> 00:27:27,846
HIT IT A LITTLE BIT.

1001
00:27:27,846 --> 00:27:28,947
AND OVER THE TIME,

1002
00:27:28,947 --> 00:27:30,782
AFTER THE-AFTER THE DEFLECTION,

1003
00:27:30,782 --> 00:27:32,250
THAT WILL BUILD UP AND MAKE

1004
00:27:32,250 --> 00:27:33,451
THE ASTEROID TRAJECTORY

1005
00:27:33,451 --> 00:27:34,619
MISS THE EARTH.

1006
00:27:34,619 --> 00:27:36,488
SO, THE ANSWER TO YOUR QUESTION

1007
00:27:36,488 --> 00:27:38,223
IS MAYBE FIVE TO EIGHT,

1008
00:27:38,223 --> 00:27:40,058
TO PERHAPS TEN YEARS,

1009
00:27:40,058 --> 00:27:41,459
IS THE KIND OF WARNING TIME

1010
00:27:41,459 --> 00:27:42,994
YOU NEED IN ORDER TO

1011
00:27:42,994 --> 00:27:44,396
DEFLECT AN ASTEROID.

1012
00:27:44,396 --> 00:27:45,797
>> THAT'S WHAT WE KEEP HEARING,

1013
00:27:45,797 --> 00:27:47,465

IS FIND THEM EARLY.

1014
00:27:47,465 --> 00:27:48,833
WELL, THAT'S ALL

1015
00:27:48,833 --> 00:27:50,135
FOR OUR SHOW TODAY.

1016
00:27:50,135 --> 00:27:51,669
PAUL, THANK YOU FOR BEING HERE

1017
00:27:51,669 --> 00:27:53,538
AND TO TALK ABOUT ASTEROIDS

1018
00:27:53,538 --> 00:27:54,706
AND THE CENTER FOR

1019
00:27:54,706 --> 00:27:56,941
NEAR-EARTH OBJECT STUDIES.

1020
00:27:56,941 --> 00:27:58,810
>> THANKS FOR HAVING ME, KELLY.

1021
00:27:58,810 --> 00:27:59,677
>> LINDLEY, THANK YOU

1022
00:27:59,677 --> 00:28:00,779
FOR JOINING US TO TALK ABOUT

1023
00:28:00,779 --> 00:28:02,047
NASA'S PLANETARY DEFENSE

1024
00:28:02,047 --> 00:28:03,248
COORDINATION OFFICE

1025
00:28:03,248 --> 00:28:04,282
AND WAYS WE'RE

1026
00:28:04,282 --> 00:28:06,885
PROTECTING OUR PLANET.

1027
00:28:06,885 --> 00:28:08,019
>> YOU'RE WELCOME, KELLY.

1028
00:28:08,019 --> 00:28:09,554
I'M VERY HAPPY TO DO IT.

1029
00:28:09,554 --> 00:28:11,089
>> AND THANK YOU SO MUCH

1030
00:28:11,089 --> 00:28:12,390
FOR JOINING US TO TALK ABOUT

1031
00:28:12,390 --> 00:28:13,725
THIS WEEK'S ASTEROIDS

1032
00:28:13,725 --> 00:28:14,993
CLOSE APPROACH.

1033
00:28:14,993 --> 00:28:16,227
THE NEXT TIME YOU HEAR THAT

1034
00:28:16,227 --> 00:28:17,595
AN ASTEROID IS COMING CLOSE

1035
00:28:17,595 --> 00:28:18,763
TO OUR PLANET,

1036
00:28:18,763 --> 00:28:19,831
REMEMBER THAT NASA

1037
00:28:19,831 --> 00:28:21,066
AND ITS INTERNATIONAL PARTNERS

1038
00:28:21,066 --> 00:28:23,301

ARE ACTIVELY SCANNING THE SKIES

1039
00:28:23,301 --> 00:28:25,103
AND STUDYING WAYS TO DEFLECT

1040
00:28:25,103 --> 00:28:26,337
ANY POTENTIALLY HAZARDOUS