1
00:00:06,509 --> 00:00:10,230
>> GOOD AFTERNOON.
I'M FELICIA CHOU FROM THE OFFICE OF COMMUNICATIONS

2
00:00:10,230 --> 00:00:14,520
LIVE FROM NASA HEADQUARTERS.
WE HAVE EXCITING NEWS ON WORLDS OUTSIDE OF

3
00:00:14,520 --> 00:00:17,830
OUR SOLAR SYSTEM TODAY.
FIRST WE'LL HAVE BRIEF PRESENTATIONS FROM

4
00:00:17,830 --> 00:00:22,780
ALL OF OUR PANELISTS AND THEN ANSWER QUESTIONS
FROM THOSE IN THE STUDIO, ON THE PHONE AND

5
00:00:22,780 --> 00:00:26,430
SOCIAL MEDIA.
TO ASK A QUESTION VIA SOCIAL MEDIA, PLEASE

6
00:00:26,430 --> 00:00:34,180
USE THE HASHTAG ASK NASA.
TODAY'S PARTICIPANTS ARE THOMAS ZURBUCHEN.

7
00:00:34,180 --> 00:00:39,090
ASSOCIATE ADMINISTRATOR OF THE SCIENCE MISSION
DIRECTATE AT NASA HEADQUARTERS IN WASHINGTON.

8
00:00:39,090 --> 00:00:45,999
MICHAEL GILLON, ASTRONOMER AT THE UNIVERSITY
OF LIEGH IN BELGIUM.

9
00:00:45,999 --> 00:00:54,539
SEAN CAREY, MANAGER OF NASA'S SCIENCE CENTER
AT CALTECH IPAC IN PASADENA, CALIFORNIA.

10
00:00:54,539 --> 00:00:59,980
SARA SEAGAR, PROFESSOR OF PLANETARY SCIENCE
AND PHYSICS AT MASSACHUSETTS INSTITUTE OF

11
00:00:59,980 --> 00:01:06,780
TECHNOLOGY IN CAMBRIDGE.
AND, NICKOLE LEWIS, ASTRONOMER AT THE SPACE

12
00:01:06,780 --> 00:01:11,640
SCIENCE INSTITUTE IN BALTIMORE.
AND WITH THAT, THOMAS, CAN YOU START US OFF

13
00:01:11,640 --> 00:01:15,690
WITH WHAT THE BIG NEWS OF THE DAY IS?
>> HEY, THANKS SO MUCH, FELICIA.

14
00:01:15,690 --> 00:01:24,870
LOOK, I'VE BEEN ASSOCIATE ADMINISTRATOR FOR
CLOSE TO FIVE MONTHS AND I AM IN AWE TODAY

15
00:01:24,870 --> 00:01:28,350
ABOUT THE DEPTH AND BREADTH OF THE SCIENCE
THAT WE DO HERE.

16
00:01:28,350 --> 00:01:32,830
WE ARE CHANGING PEOPLE'S LIVES EVERY DAY AND
WE ENLARGEN THE SPACE WE KNOW.

17
00:01:32,830 --> 00:01:35,960
WE STRETCH OUR IMAGINATION.
WE INSPIRE EVERY DAY.

18
00:01:35,960 --> 00:01:40,540
AND TODAY'S STORY IS JUST THAT.
I AM EXCITED TO ANNOUNCE TODAY THAT DR.\hMICHAEL

19
00:01:40,540 --> 00:01:46,780
GILLON AND HIS TEAM HAVE USED OUR SPITZER
SPACE TELESCOPE TO DETERMINE THAT THERE ARE

20
00:01:46,780 --> 00:01:52,760
ACTUALLY SEVEN EARTH■SIZE PLANETS ORBITING
THE NEARBY TRAPPIST■1 STAR ABOUT 40 LIGHT

21
00:01:52,760 --> 00:01:57,870
YEARS AWAY.
WHAT'S MORE AS YOU CAN SEE IN THIS ILLUSTRATION

22
00:01:57,870 --> 00:02:04,180
IS THAT THREE OF THESE PLANETS MARKED IN GREEN
ARE IN THE HABITABLE ZONE WHERE LIQUID WATER

23
00:02:04,180 --> 00:02:08,300
CAN POOL ON THE SURFACE.
IN FACT WITH THE RIGHT ATMOSPHERIC CONDITIONS

24
00:02:08,300 --> 00:02:14,610
THERE COULD BE WATER ON ANY OF THESE PLANETS.
SO FOR THE FIRST TIME, WE FOUND AS MANY TERRESTRIAL

25
00:02:14,610 --> 00:02:19,859
PLANETS AROUND A SINGLE STAR AND THAT'S THE
FIRST TIME WE HAVE BEEN ABLE TO MEASURE.

26
00:02:19,859 --> 00:02:27,430
IN ADDITION TO THAT, BOTH THE MASSES AND THE
RADII OF THESE HABITABLE EARTH■SIZE PLANETS.

27
00:02:27,430 --> 00:02:33,810
THESE PLANETS ARE AMONG THE BEST, OF ALL THE
PLANETS WE KNOW, TO FOLLOW UP.

28
00:02:33,810 --> 00:02:39,680
TO SEE FOR EXAMPLE WITH THE JAMES WEBB SPACE
TELESCOPE THAT LAUNCHED LAST YEAR THE ATMOSPHERES

29
00:02:39,680 --> 00:02:43,209
AND ALSO TO LOOK FOR BIOSIGNATURES IF THERE
ARE ANY.

30
00:02:43,209 --> 00:02:50,299
THE DISCOVERY GIVES US A HINT THAT FINDING
A SECOND EARTH IS NOT JUST A MATTER OF "IF,"

31
00:02:50,299 --> 00:02:55,639
BUT "WHEN."
SCIENTISTS BELIEVE ACTUALLY THAT AROUND EVERY

32
00:02:55,639 --> 00:02:59,560
STAR THERE COULD BE ONE PLANET, TAKE THREE,
TAKE FIVE, TAKE SEVEN.

33
00:02:59,560 --> 00:03:05,590
YOU CAN JUST IMAGINE HOW MANY WORLDS ARE OUT
THERE THAT HAVE A SHOT AT BECOMING A HABITABLE

34
00:03:05,590 --> 00:03:12,180
ECO SYSTEM THAT WE COULD EXPLORE.
AND, WHAT WE REALLY HAVE IN THIS STORY IS

35
00:03:12,180 --> 00:03:17,579
A MAJOR STEP FORWARD TOWARD ANSWERING ONE
OF THESE VERY QUESTIONS THAT ARE AT THE HEART

36
00:03:17,579 --> 00:03:22,730
OF SO MANY OF OUR PHILOSOPHERS OF WHAT WE
ARE THINKING ABOUT WHEN WE ARE BY OUR SELF

37
00:03:22,730 --> 00:03:26,019
AND THAT BASICALLY IS ■■ ARE WE ALONE
OUT THERE?

38
00:03:26,019 --> 00:03:30,370
WE ARE MAKING A STEP FORWARD WITH THIS.
A LEAP FORWARD, IN FACT, TOWARD ANSWERING

39
00:03:30,370 --> 00:03:34,519
THAT QUESTION.
AND I AM REALLY EXCITED FOR YOU TO HEAR ABOUT

40
00:03:34,519 --> 00:03:36,920
IT NOW.
>> THANKS, THOMAS.

41
00:03:36,920 --> 00:03:40,749
SO, MICHAEL, CAN YOU TELL US MORE ABOUT THE
FINDING?

42
00:03:40,749 --> 00:03:44,629
>> SURE.
AS THOMAS MENTIONED, WE USED A SPITZER SPACE

43
00:03:44,629 --> 00:03:52,359
TELESCOPE WITH A GROUND BASED TELESCOPE TO
DISCOVER AROUND THE SAME SUN, NOT ONE, NOT

44
00:03:52,359 --> 00:03:58,090
TWO BUT SEVEN EARTH SIZE PLANETS.
THIS IS THE FIRST TIME THAT SO MANY EARTH

45
00:03:58,090 --> 00:04:03,680
SIZE PLANETS ARE FOUND AROUND THE SAME STAR.
SO THREE OF THEM IN THE HABITABLE ZONE.

46
00:04:03,680 --> 00:04:11,599
THE STAR ITSELF IS THE LEAST MASSIVE KIND
OF STAR.

47
00:04:11,599 --> 00:04:17,449
AND THESE STARS ARE MUCH SMALLER, MUCH COOLER
THAN OUR SUN AND STILL THEY ARE VERY FREQUENT

48
00:04:17,449 --> 00:04:19,709
IN THE SCALE OF OUR GALAXY.
MORE FREQUENT.

49
00:04:19,709 --> 00:04:27,230
AND IF YOU LOOK AT THIS ILLUSTRATION, YOU
SEE THE COMPARISON BETWEEN THE BASKETBALL

50
00:04:27,230 --> 00:04:30,620
AND THE GOLF BALL.
WELL, IN OUR CASE, THE BASKETBALL WOULD BE

51
00:04:30,620 --> 00:04:33,690
THE SUN.
AND THE GOLF BALL, IT WOULD BE TRAPPIST■1.

52
00:04:33,690 --> 00:04:38,940
SO, TRAPPIST■1 IS MUCH COOLER AND SMALLER
THAN OUR SUN.

53
00:04:38,940 --> 00:04:46,420
SO THE PLANETS IN THE HABITABLE ZONE ARE VERY
CLOSE TO IT WITH VERY SHORT ORBITAL AREA.

54
00:04:46,420 --> 00:04:53,820
AND IN THIS GRAPHIC, WHAT YOU CAN SEE ARE
THE PLANETS WHICH WE HAVE FOUND AROUND TRAPPIST■1.

55
00:04:53,820 --> 00:04:59,380
THREE IN THE HABITABLE ZONE.
THEY ARE ALSO CALLED THE GOLDILOCKS ZONE WHERE

56
00:04:59,380 --> 00:05:04,440
LIQUID WATER COULD EXIST.
MOST LIKELY TO EXIST ON THE SURFACE.

57
00:05:04,440 --> 00:05:09,850
THREE OF THESE EARTH SIZE PLANETS AND WITH
A HABITABLE ZONE IS VERY PROMISING IN THE

58
00:05:09,850 --> 00:05:15,100
SEARCH FOR LIFE BEYOND OUR SOLAR SYSTEM.
>> WHAT CAN YOU TELL US ABOUT THESE DISTANT

59
00:05:15,100 --> 00:05:21,270
PLANETS?
>> WELL, WE MEASURE VERY, VERY PRECISELY THE

60
00:05:21,270 --> 00:05:26,260
SIZES.
THANKS TO SPITZER■2, A PRELIMINARY MEASUREMENT

61
00:05:26,260 --> 00:05:31,320
OF THE MASSES FOR SIX OF THEM.
AND FOR ONE OF THEM, OUR MEASUREMENT IS PRECISE

62
00:05:31,320 --> 00:05:40,370
ENOUGH TO STRONGLY SUGGEST WATER■RICH COMPOSITION
BECAUSE THIS IS ONE OF THE HABITS IN THE ■■ ONE

63
00:05:40,370 --> 00:05:48,080
OF THE PLANETS IN THE HABITABLE ZONE.
AND THESE ARE PROBABLY ■■ THEY ALWAYS

64
00:05:48,080 --> 00:05:52,680
FACE THE STAR WITH THE SAME SIDE.
LIKE THE MOON TO THE EARTH.

65
00:05:52,680 --> 00:06:01,240
AND SO, IF YOU LOOK AT WITH ANIMATION, YOU
CAN SEE A VIEW OF A PLANET WITH A PERMANENT

66
00:06:01,240 --> 00:06:04,620
NIGHT SIDE.
IT COULD BE JUST LIKE THIS.

67
00:06:04,620 --> 00:06:10,280
NOW WHAT IS ALSO EXCITING ABOUT THE SYSTEM
IS THAT THE PLANETS ARE SO CLOSE IT EACH OTHER.

68
00:06:10,280 --> 00:06:15,580
IF YOU WERE ON THE SURFACE OF ONE EVER THESE
PLANETS, YOU WOULD HAVE A WONDERFUL VIEW ON

69
00:06:15,580 --> 00:06:19,890
THE OTHER PLANET.
YOU WOULDN'T SEE THEM LIKE WE SEE VENUS OR

70
00:06:19,890 --> 00:06:24,550
MARS LIKE DOTS OF LIGHT.
BUT AS YOU CAN SEE IN THE NEXT ILLUSTRATION,

71
00:06:24,550 --> 00:06:30,160
YOU WOULD SEE THEM REALLY AS WE SEE THE MOON.
YOU WOULD SEE WALLS WHICH ARE VERY BIG.

72
00:06:30,160 --> 00:06:34,770
YOU COULD SEE THE STRUCTURES.
THEY WOULD BE AS LARGE AS THE MOON AND EVEN

73
00:06:34,770 --> 00:06:39,940
LARGER FOR SOME OF THEM.
IT WOULD BE A WONDERFUL VIEW ON THIS PLANET.

74
00:06:39,940 --> 00:06:44,990
>> THANKS, MICHAEL.
SO, SEAN, CAN YOU GIVE US AN IDEA OR MORE

75
00:06:44,990 --> 00:06:49,009
CONTEXT OF THE DISCOVERY AND WHY SPITZER PLAYED
SUCH A VITAL ROLE?

76
00:06:49,009 --> 00:06:52,212
>> ABSOLUTELY, FELICIA.
I WOULD FIRST LIKE IT SAY THAT IN MY OPINION,

77
00:06:52,212 --> 00:06:57,230
THIS IS THE MOST EXCITING DISCOVERY WE HAVE
HAD YET WITH SPITZER IN ITS ALMOST 14 YEARS

78
00:06:57,230 --> 00:07:00,390
OF OPERATION.
AS YOU CAN SEE IN THE GRAPHIC, THE INITIAL

79
00:07:00,390 --> 00:07:05,310
DISCOVERY OF THE RAPIS■1 WAS IN CHILE IN
2016.

80
00:07:05,310 --> 00:07:10,800
IMMEDIATELY FOLLOWING THAT WE STARTED USING
GROUND■BASED TELESCOPES AND MORE THAN 20

81
00:07:10,800 --> 00:07:16,700
CONTINUOUS DAYS WITH SPITZER.
WE CONFIRMED TWO OF THE PLANETS THAT WERE

82
00:07:16,700 --> 00:07:22,140
FOUND IN THE INITIAL DISCOVERY AND FIVE MORE
PLANETS FOR A TOTAL OF SEVEN PLANETS IN THE

83
00:07:22,140 --> 00:07:28,450
SYSTEM, WHICH IS PRETTY EXCITING.
NOW, TRAPPIST■1 IS AN ULTRA COOL DWARF.

84
00:07:28,450 --> 00:07:32,490
IT'S MUCH BRIGHTER IN THE INFRARED THAN IN
THE VISIBLE.

85
00:07:32,490 --> 00:07:38,310
SO IT MAKES IT IDEAL TO USE SPITZER, WHICH
IS INFRARED, TO DO THE FOLLOW■UP IN THIS

86
00:07:38,310 --> 00:07:42,620
SYSTEM.
AS YOU CAN SEE IN THE ANIMATION, SPITZER WAS

87
00:07:42,620 --> 00:07:46,920
LAUNCHED IN 2003 AND NEVER INTENDED TO STUDY
EXO PLANET.

88
00:07:46,920 --> 00:07:53,450
WE HAD TO DO SOME ENGINEERING, MORE THAN AN
ASTRONOMICAL WAY FROM THE EARTH.

89
00:07:53,450 --> 00:07:59,650
SO YOU CAN'T FLY OUT, BUT WE DID ENGINEERING
ON THE GROUND TO COME UP TO ALLOW SPITZER

90
00:07:59,650 --> 00:08:06,620
TO MEASURE STAR BRIGHTNESSES 1,000 TIMES MORE
THAN WE IMAGINED IT WOULD BE ABLE TO DO.

91
00:08:06,620 --> 00:08:12,630
WHAT WE WILL SHOW IN THE NEXT ANIMATION IS
HOW WHEN SPITZER SEES THE PLANETS VERY SIMILAR

92
00:08:12,630 --> 00:08:18,710
TO THE WAY THE KEPLER TELESCOPE DOES, THE
PLANETS PASS IN FRONT OF THE STAR.

93
00:08:18,710 --> 00:08:23,130
WE SEE THE AMOUNT OF LIGHT THAT THE STAR IS
DIMMED BY WHEN THAT PLANET IS BLOCKING IT.

94
00:08:23,130 --> 00:08:27,590
SO, THE DIPS YOU SEE IN THIS ANIMATION ARE
THE PLANETS GOING IN FRONT OF THE STAR, BLOCKING

95
00:08:27,590 --> 00:08:30,920
A LITTLE BIT OF THE LIGHT.
THE SIZE OF THE DIP TELLS YOU THE SIZE OF

96
00:08:30,920 --> 00:08:33,510
THE PLANET.
SO WE CAN GET THE SIZE OF THE PLANET DIRECTLY

97
00:08:33,510 --> 00:08:36,779
FROM MEASURING THE DIP.
NOW, WHEN YOU SEE THE DIFFERENT PLANETS THEY

98
00:08:36,779 --> 00:08:40,870
KEEP ORBITING AROUND AND AROUND AND EVERY
TIME THEY TRANSIT YOU CAN MEASURE THE SPACING

99
00:08:40,870 --> 00:08:44,230
BETWEEN THE TRANSITS AND TELLS YOU THE PERIOD
OF THE ORBIT.

100
00:08:44,230 --> 00:08:48,060
HOW LONG THAT YEAR IS.
AND ONE SWOOP FOR THAT PLANET.

101
00:08:48,060 --> 00:08:54,780
WHEN WE KNOW HOW LONG IT TAKES IT TO GO AROUND
THE STAR, WE ALSO KNOW DISTANCE FROM THE STAR,

102
00:08:54,780 --> 00:08:57,870
TELLING US WHETHER OR NOT IT'S IN THE HABITABLE
ZONE.

103
00:08:57,870 --> 00:09:01,810
NOW THE TRAPPIST■1 SYSTEM AND THE PLANETS
ARE IN AN INTERESTING CONFIGURATION.

104
00:09:01,810 --> 00:09:06,430
PLANETS ARE CLOSE TOGETHER AND THEIR ORBITS
ARE SPACED SUCH THAT GRAVITATIONALLY INTERACT

105
00:09:06,430 --> 00:09:14,150
WITH EACH OTHER.
THAT CHANGES THE TIMING OF THE TRANSITS A

106
00:09:14,150 --> 00:09:18,090
LITTLE BIT AS THE PLANETS ARE TUGGING EACH
OTHER SO THEY DON'T HAPPEN AS REGULARLY AS

107
00:09:18,090 --> 00:09:22,670
YOU WOULD EXPECT WITHOUT THE TUG.
WITH THAT, MEASURING THOSE DIFFERENCES, WHAT

108
00:09:22,670 --> 00:09:25,010
WE ARE ABLE TO DO IS MEASURE THE MASSES OF
THE PLANETS.

109
00:09:25,010 --> 00:09:29,060
SO NOW WE HAVE THE MASS OF THE PLANET, THE
SIZE OF THE PLANET, SO WE CAN MAKE AN ESTIMATE

110
00:09:29,060 --> 00:09:32,940
OF WHAT THE DENSITY OF THE PLANET IS.
THAT GIVES US UNDERSTANDING ABOUT WHAT THE

111
00:09:32,940 --> 00:09:35,970
COMPOSITION OF THE PLANET IS.
FROM THAT, WE CAN TELL WHERE THE PLANETS ARE,

112
00:09:35,970 --> 00:09:40,400
WHETHER THEY ARE ROCKY, GASEOUS OR EVEN WATERY.
>> THANKS, SEAN.

113
00:09:40,400 --> 00:09:46,060
SO, NICKOLE, WHAT CAN YOU TELL US ABOUT STUDYING
THE ATMOSPHERES OF THESE PLANETS?

114
00:09:46,060 --> 00:09:52,122
>> YEAH, SO ATMOSPHERES TELL US A GREAT DEAL
ABOUT THE FORMATION EVOLUTION OF PLANETS AND

115
00:09:52,122 --> 00:09:55,590
THE PHYSICAL PROCESSES THAT ARE OCCURRING
ON THE PLANET'S SURFACE AND THE AIR.

116
00:09:55,590 --> 00:10:00,610
ESPECIALLY THOSE THAT MIGHT MAKE THE PLANET
HABITABLE OR INDICATIVE OF HOSTING LIFE.

117
00:10:00,610 --> 00:10:06,070
WE CAN USE SPACE■BASED TELESCOPES TODAY
TO STUDY THE ATMOSPHERES OF THE PLANETS USING

118
00:10:06,070 --> 00:10:13,860
TRANSMISSION SPECTROSCOPY WHICH COMPARES THE
FINGERPRINTS IN THE AIR SUCH AS WATER OR METHANE,

119
00:10:13,860 --> 00:10:17,740
OZONE OR OXYGEN.
WE ARE CURRENTLY USING THE HUBBLE SPACE TELESCOPE

120
00:10:17,740 --> 00:10:22,430
TO STUDY THE PLANETS IN THE TRAPPIST■1 SYSTEM
TO DETERMINE IF THEY HAVE HYDROGEN HELIUM

121
00:10:22,430 --> 00:10:28,450
ATMOSPHERES.
IF THEY DON'T, IT GIVES US ANOTHER PUSH FORWARD

122
00:10:28,450 --> 00:10:34,820
FOR THE POTENTIAL TO SUPPORT WATER ON THE
SURFACES.

123
00:10:34,820 --> 00:10:39,190
JUST LAST YEAR, HUBBLE ACTUALLY PROBED THE
INNER MOST PLANETS OF THE SYSTEM, TRAPPIST

124
00:10:39,190 --> 00:10:48,490
B. AND C. AND FOUND THEY DIDN'T HAVE■■
HYDROGEN HELIUM.

125
00:10:48,490 --> 00:10:54,800
>> WHAT DO WE KNOW ABOUT THE THREE WORLDS
IN THE HABITABLE ZONE?

126
00:10:54,800 --> 00:11:02,990
>> SURE IF WE ZOOM OUT AWAY FROM THE HOST
STAR, YOU WILL SEE ALL SEVEN PLANETS.

127
00:11:02,990 --> 00:11:07,470
THE HABITABLE ZONE INDICATED IN THE BLUE REGION.
THE INNER MOST PLANET IN THE HABITABLE ZONE

128
00:11:07,470 --> 00:11:14,150
IS TRAPPIST■1E.
IN THIS ILLUSTRATION, YOU WILL SEE AN ARTIST'S

129
00:11:14,150 --> 00:11:17,540
RENDITION OF IT.
IT IT'S AN INTERESTING PLANET FOR A NUMBER

130
00:11:17,540 --> 00:11:20,860
OF REASONS.
IT'S VERY CLOSE IN SIZE TO EARTH AS YOU CAN

131
00:11:20,860 --> 00:11:26,680
SEE HERE.
IT ALSO RECEIVED ABOUT THE SAME AMOUNT OF

132
00:11:26,680 --> 00:11:30,960
LIGHT AS EARTH DOES.
IN OUR OWN SOLAR SYSTEM.

133
00:11:30,960 --> 00:11:34,920
THIS MEANS THAT IN TRAPPIST■1E, YOU COULD
HAVE TEMPERATURES THAT ARE VERY, VERY SIMILAR

134
00:11:34,920 --> 00:11:41,000
TO THE ONES WE HAVE HERE ON EARTH.
THE NEXT PLANET OUT IS TRAPPIST■1F.

135
00:11:41,000 --> 00:11:47,050
NOW THIS IS A POTENTIALLY WATER■RICH WORLD
THAT IS, AGAIN, ABOUT THE SAME SIZE AS EARTH.

136
00:11:47,050 --> 00:11:54,500
HERE'S A COMPARISON.
NOW, TRAPPIST■1F HAS ABOUT A NINE■DAY

137
00:11:54,500 --> 00:11:56,570
ORBIT.
AND DURING THAT TIME, IT RECEIVES ABOUT THE

138
00:11:56,570 --> 00:11:59,560
SAME AMOUNT OF SUNLIGHT AS MARS DOES IN OUR
OWN SOLAR SYSTEM.

139
00:11:59,560 --> 00:12:03,380
AND THE FINAL PLANET IN THE HABITABLE ZONE
OF THE TRAPPIST■1 SYSTEM IS TRAPPIST■1G.

140
00:12:03,380 --> 00:12:11,740
IT'S THE LARGEST PLANET IN THE TRAPPIST■1
SYSTEM.

141
00:12:11,740 --> 00:12:21,690
IT'S ABOUT 13% LARGER RADIUS THAN THAT OF
EARTH AS YOU CAN SEE IN THIS COMPARISON HERE.

142
00:12:21,690 --> 00:12:26,160
AND IT RECEIVES ABOUT THE SAME AMOUNT OF STAR
LIGHT AS SOMEWHERE IN BETWEEN MARS AND THE

143
00:12:26,160 --> 00:12:30,550
ASPREY BELT IN OUR OWN SOLAR SYSTEM.
>> SO WHILE WE DON'T HAVE THE TECHNOLOGY YET

144
00:12:30,550 --> 00:12:36,230
TO REALLY TRAVEL TO ANY OF THESE PLANETS,
HOW LONG WOULD IT TAKE TO TRAVEL HERE?

145
00:12:36,230 --> 00:12:41,670
>> WELL, THANKFULLY WE CAN ASK IZON EXOPLANET.
IF WE WERE ABLE TO TRAVEL AT LIGHT SPEED WE

146
00:12:41,670 --> 00:12:46,200
OF COURSE COULD ARRIVE IN 39 YEARS.
WITH SOMETHING MORE LIKE A JET PLANE WOULD

147
00:12:46,200 --> 00:12:51,000
TAKE FAR LONGER.
SOMETHING IN THE LINE OF 44 MILLION YEARS.

148
00:12:51,000 --> 00:12:54,550
>> WOW.
WELL THEN, THANK YOU SO MUCH, NICKOLE.

149
00:12:54,550 --> 00:13:00,000
NOW SARA, WHY ARE THESE DISCOVERIES SO EXCITING
FOR THE SCIENTIFIC COMMUNITY?

150
00:13:00,000 --> 00:13:04,210
>> WELL WITH THIS DISCOVERY, WE HAVE MADE
A GIANT ACCELERATED LEAP FORWARD IN THE SEARCH

151
00:13:04,210 --> 00:13:08,230
FOR HABITABLE WORLDS AND LIFE ON OTHER WORLDS,
POTENTIALLY SPEAKING.

152
00:13:08,230 --> 00:13:14,140
BECAUSE WITH NOT JUST ONE PLANET BUT SEVERAL,
WE HAVE ROOM THAT IF WE DIDN'T HAVE THE HABITABLE

153
00:13:14,140 --> 00:13:19,270
ZONE QUITE RIGHT OR WEREN'T SURE QUITE WHAT
WE ARE LOOKING FOR, WE HAVE MANY CHANCES OVER.

154
00:13:19,270 --> 00:13:26,040
YOU COULD THINK LOCALLY, LIKE IN THIS PLANETARY
SYSTEM, GOLDILOCKS HAS MANY SISTERS.

155
00:13:26,040 --> 00:13:31,860
WE DON'T KNOW MUCH ABOUT THE PLANETS.
WE KNOW THE MASSES, SIZES, HOW MUCH RADIATION

156
00:13:31,860 --> 00:13:35,649
IS WILL FALLING ON THEM AND THE ORBITS.
SO FOR NOW WE JUST SPECULATE.

157
00:13:35,649 --> 00:13:39,300
FOR THAT, THE TRAPPIST■1 SYSTEM HAS CAPTURED
OUR IMAGINATION.

158
00:13:39,300 --> 00:13:50,720
WE HAVE A NEW POSTER THAT'S CAPTURED SCIENTIFICALLY
ACCURATELY HOW ON ONE OF THE PLANETS YOU COULD

159
00:13:50,720 --> 00:13:56,480
SEE ALL OF THE OTHER PLANETS IN THE SKY.
NOW, HISTORICALLY AN EXOPLANET IN THE BRIEF

160
00:13:56,480 --> 00:14:00,970
HISTORY OF THE LAST 20 YEARS, WHEN THERE'S
ONE, THERE'S MORE.

161
00:14:00,970 --> 00:14:04,850
AND SO THAT'S WHY I AM SO EXCITED TO BE HERE
TODAY TO SHARE IT WITH YOU.

162
00:14:04,850 --> 00:14:10,990
BECAUSE, WITH THIS AMAZING SYSTEM, WE KNOW
THAT THERE MUST BE MANY MORE POTENTIALLY LIFE

163
00:14:10,990 --> 00:14:14,870
WORLDS OUT THERE WAITING TO BE FOUND.
>> THANKS.

164
00:14:14,870 --> 00:14:20,399
SO, WHAT ARE ASTRONOMERS DOING TO LEARN MORE
ABOUT THE SYSTEM AND OTHERS LIKE IT?

165
00:14:20,399 --> 00:14:26,310
>> WELL FIRST OF ALL, MICHAEL AND HIS TEAM
HAVE STARTED TO PUT UP MORE TELESCOPES.

166
00:14:26,310 --> 00:14:30,370
THEY CALL IT SECULAS.
THEY WILL USE FROM THE GROUND USE TELESCOPES

167
00:14:30,370 --> 00:14:39,790
TO SEARCH 1,000 OF THE NEAREST DWARF STARS.
I SHOULD BACK UP A SECOND ABOUT THIS TRAPPIST

168
00:14:39,790 --> 00:14:43,500
SYSTEM BECAUSE I FORGOT TO MENTION THAT ONE
OF THE REASONS ASTRONOMERS ARE SO EXCITED

169
00:14:43,500 --> 00:14:52,350
ABOUT IT IS IT'S A VERITABLE LABORATORY FOR
STUDIES PLANETS ORBITING VERY DIM RED STARS

170
00:14:52,350 --> 00:14:55,830
THAT ARE SO INCREDIBLY DIFFERENT FROM OUR
SUN.

171
00:14:55,830 --> 00:15:01,120
ASTRONOMERS CONSTANTLY GO BACK AND FORTH ABOUT
ALL THE EXCITEMENT ABOUT THESE WORLDS, BECAUSE

172
00:15:01,120 --> 00:15:05,300
THEY ARE VERY EASY TO STUDY.
OTHER PEOPLE HAVE FEARS AND CONCERNS.

173
00:15:05,300 --> 00:15:11,700
AND SO WE ACTUALLY GET TO TEST MANY PEOPLE'S
THEORIES ABOUT THESE WORLDS.

174
00:15:11,700 --> 00:15:13,660
RADIATION FROM THE HOST STAR AND THINGS LIKE
THAT.

175
00:15:13,660 --> 00:15:19,160
SO, HOPEFULLY, WE ARE COUNTING ON SPECULUS
TO FIND MORE SYSTEMS AND PLANETS AROUND THESE

176
00:15:19,160 --> 00:15:23,330
ULTRA COOL DWARFS, THESE VERY COME UPON STARS
THAT WE CAN STUDY.

177
00:15:23,330 --> 00:15:29,930
SO IN ADDITION TO SPECULUS, IN ASTRONOMY WHEN
SOMEONE MAKES A DISCOVERY LIKE THIS, WE PUT

178
00:15:29,930 --> 00:15:33,680
ALMOST ANY TELESCOPE THAT CAN FOLLOW UP TO
FOLLOW UP.

179
00:15:33,680 --> 00:15:38,950
SO IN THAT WAY, WE HAVE, WE HEARD ABOUT HUBBLE
ALREADY FROM NICKOLE, BUT THE HUBBLE, KEPLER

180
00:15:38,950 --> 00:15:44,620
K2, SPITZER AND OTHERS ARE EXPLORING THE SYSTEM
FURTHER.

181
00:15:44,620 --> 00:15:48,750
WHAT THE TEAM IS MOST EXCITED ABOUT, ALTHOUGH
THIS IS STILL IN THE FUTURE, IS THE JAMES

182
00:15:48,750 --> 00:15:55,581
WEBB TELESCOPE WHICH WILL LAUNCH IN 2018.
WITH THIS TELESCOPE AND THE REASON THESE PLANETS

183
00:15:55,581 --> 00:16:03,380
ARE SO SIGNIFICANT, THEY ARE ACCESSIBLE WITH
THIS TELESCOPE.

184
00:16:03,380 --> 00:16:08,850
WITH THE JAMES WEBB WE WILL STUDY THE ATMOSPHERES
AND TRY TO ASSESS THE GREENHOUSE GAS CONTENT

185
00:16:08,850 --> 00:16:12,130
WHICH WILL HELP US UNDERSTAND THE SURFACE
TEMPERATURE OF THE PLANETS.

186
00:16:12,130 --> 00:16:17,220
ARE THEY THE RIGHT TEMPERATURE TO SUPPORT
LIQUID WATER AND LIFE AS WE KNOW IT.

187
00:16:17,220 --> 00:16:22,450
WE WILL EVEN USE THE JAMES WEBB TO SEARCH
FOR GASES THAT DON'T BELONG THAT MIGHT BE

188
00:16:22,450 --> 00:16:27,850
PRODUCED BY LIFE SUCH AS OXYGEN OZONE METHANE
AND A WHOLE HOST OF OTHER GASS.

189
00:16:27,850 --> 00:16:31,570
>> THANKS, SARA.
SO, BEFORE WE GO INTO Q. AND A., THOMAS, DO

190
00:16:31,570 --> 00:16:36,899
YOU HAVE ANY CLOSING THOUGHTS FOR US?
>> YOU KNOW, FOR ME, THE RESEARCH AND EXOPLANET

191
00:16:36,899 --> 00:16:43,010
IS REALLY IN ITS GOLD RUSH PHASE.
IT STARTED SOMETHING LIKE 20 YEARS AGO AND

192
00:16:43,010 --> 00:16:48,630
I JUST COULDN'T HELP BUT NOTICE THAT THE LAST
CLAUSE ON THE PAPER WAS THE SAME AS WERE THERE

193
00:16:48,630 --> 00:16:57,860
ON THE FIRST AND ANNOUNCED IN 1995.
SINCE THEN WE HAVE FOUND THOUSANDS OF THOSE

194
00:16:57,860 --> 00:17:02,940
A LITTLE BIT UNDER 5,000 THE LAST TIME I CHECKED.
THOUSANDS OF THEM ARE IN THE HABITABLE ZONE.

195
00:17:02,940 --> 00:17:09,120
NONE UNTIL NOW HAVE HAD THAT MANY PLANETS
IN THE HABITABLE ZONE AND IT'S ONLY EXPANDING.

196
00:17:09,120 --> 00:17:13,839
THIS IS GOING FORWARD AT A RAPID PACE NOT
JUST BECAUSE OF THE TELESCOPES THAT ARE THERE

197
00:17:13,839 --> 00:17:20,620
NOW, BUT THE TELESCOPES WE ARE LAUNCHING SOON
AND YOU TALKED ABOUT THE JAMES WEBB TELESCOPE,

198
00:17:20,620 --> 00:17:27,480
BUT ALSO TASKS THAT WILL BE THERE AND BEING
PLANNED RIGHT NOW, AGAIN, REALLY OPENING OUR

199
00:17:27,480 --> 00:17:30,300
LENS.
OPENING OUR VIEWPOINTS ON TO TO THE UNIVERSE

200
00:17:30,300 --> 00:17:37,650
AND ESPECIALLY IN MANY CASES THESE EXO PLANETS.
I DO BELIEVE THAT MANY OF THE BEST TELESCOPES

201
00:17:37,650 --> 00:17:41,240
THAT WILL GIVE US THE MOST INFORMATION ARE
YET TO BE INVENTED.

202
00:17:41,240 --> 00:17:46,760
THERE'S MANY THINGS WE DON'T KNOW.
MANY QUESTIONS WE HAVE THAT COME UP WHEN WE

203
00:17:46,760 --> 00:17:50,340
SEE THESE OBSERVATIONS.
WE LOOK AT ALL THESE ANIMATIONS.

204
00:17:50,340 --> 00:17:55,840
VERY LIKELY NATURE IS WAY MORE BEAUTIFUL,
WAY MORE AMAZING, THAN WHAT WE HAVE ANIMATED

205
00:17:55,840 --> 00:17:57,910
HERE.
IT'S ALWAYS THAT WAY.

206
00:17:57,910 --> 00:18:02,560
AND SO, FOR US, THE QUESTION IS ■■ HOW
DO WE ACTUALLY OPEN UP OUR LENS AND SEE THESE

207
00:18:02,560 --> 00:18:05,860
THINGS?
HOW DO WE GET SO MUCH DATA FROM THAT THAT

208
00:18:05,860 --> 00:18:10,520
THE KIND OF QUESTIONS THAT ARE ASKED ARE ABLE
TO BE ANSWERED?

209
00:18:10,520 --> 00:18:15,592
AND FOR ME, AT THE END, IT'S ALL ABOUT THAT
START THAT I HAVE SO OFTEN ■■ THAT THOUGHT

210
00:18:15,592 --> 00:18:21,910
WHEN I GO TO BED AT NIGHT AND REALLY IMAGINE
HOW THESE OTHER WORLDS REALLY LOOK LIKE.

211
00:18:21,910 --> 00:18:28,540
THE FACT THAT THERE ARE WORLDS OUT THERE JUST
LIKE THE EARTH THAT HAVE SOME COMMONALITIES

212
00:18:28,540 --> 00:18:32,850
WITH THE EARTH AND YOU COULD IMAGINE THESE
WORLDS.

213
00:18:32,850 --> 00:18:37,220
IT'S JUST ■■ ONLY HAPPENING RIGHT NOW.
THESE QUESTIONS ABOUT ARE WE ALONE?

214
00:18:37,220 --> 00:18:42,280
THEY ARE BEING ANSWERED AS WE SPEAK IN THIS
DECADE AND NEXT DECADE.

215
00:18:42,280 --> 00:18:45,380
I'M REALLY EXCITED ABOUT THIS.
>> THANKS, THOMAS.

216
00:18:45,380 --> 00:18:50,140
WITH THAT, LET'S TRANSITION TO Q. AND A.
WE HAVE A TON OF QUESTIONS ON SOCIAL MEDIA

217
00:18:50,140 --> 00:18:53,210
SO WE WILL GO THERE FIRST.
IF YOU WOULD LIKE TO ASK A QUESTION USING

218
00:18:53,210 --> 00:18:58,960
SOCIAL MEDIA PLEASE USE THE HASHTAG ASK NASA.
>> ALL RIGHT.

219
00:18:58,960 --> 00:19:01,230
WONDERFUL.
WE HAVE LOTS OF QUESTIONS COMING IN.

220
00:19:01,230 --> 00:19:06,309
THIS FIRST ONE COMES FROM TWITTER USER JJAMS
WHO ASKS ■■ WHAT IS THE TOTAL AMOUNT OF

221
00:19:06,309 --> 00:19:13,230
POSSIBLY HABITABLE PLANETS WE HAVE FOUND INCLUDING
THESE TRAPPIST DISCOVERIES?

222
00:19:13,230 --> 00:19:18,640
>> THE TOTAL NUMBER BELIEVE IT OR NOT IS UNKNOWN.
IT DEPENDS ON WHO YOU ASK AND HOW YOU COUNT

223
00:19:18,640 --> 00:19:21,322
THEM.
WE WOULD SAY THAT THERE ARE, LET'S SAY, A

224
00:19:21,322 --> 00:19:26,800
FEW DOZEN EXO PLANETS THAT YOU MIGHT CONSIDER
HABITABLE, BUT THE BOTTOM LINE IS THAT MANI'

225
00:19:26,800 --> 00:19:29,730
OF THEM MAY BE A BIT TOO HOT OR A BIT TOO
BIG.

226
00:19:29,730 --> 00:19:32,040
WE REALLY HAVE TO WAIT UNTIL WE CAN SEE THE
AT MISFATHERS TO KNOW HOW ■■ ATMOSPHERES

227
00:19:32,040 --> 00:19:37,740
TO KNOW HOW HOT THEY ARE.
THAT'S WHY THE PLANETS ARE SO RELEVANT BECAUSE

228
00:19:37,740 --> 00:19:43,440
UNLIKE A LOT OF OTHERS, WE CAN ACTUALLY ASSESS
THEM IN THE NEAR FUTURE.

229
00:19:43,440 --> 00:19:46,700
>> WONDERFUL.
ALL RIGHT.

230
00:19:46,700 --> 00:19:52,040
NEXT QUESTION HERE COMES FROM SCOTT WHO ASKS
■■ ANY CONFIRMATION OF WATER ON THE PLANETARY

231
00:19:52,040 --> 00:19:55,960
BODIES?
>> I CAN HANDLE THAT ONE.

232
00:19:55,960 --> 00:19:59,500
THERE HAS NOT BEEN ANY CONFIRMATION OF WATER
ON THESE PLANETARY BODIES.

233
00:19:59,500 --> 00:20:06,290
AND IT WILL TAKE A LOT OF, A LOT OF OBSERVATIONS
WITH HUBBLE OR IN THE FUTURE WITH WEBB TO

234
00:20:06,290 --> 00:20:09,419
PROBE THE ATMOSPHERE TO SEE IF WE CAN DETECT
WATER ON THE PLANETS.

235
00:20:09,419 --> 00:20:11,400
>> BUT I THINK IT'S FAIR TO ADD THAT PEOPLE
ARE LOOKING.

236
00:20:11,400 --> 00:20:14,390
>> YES.
THEY ARE CERTAINLY LOOKING.

237
00:20:14,390 --> 00:20:17,360
>> GREAT.
THIS QUESTION COMES FROM TWITTER USER MATTHEW

238
00:20:17,360 --> 00:20:21,760
WHO ASKS ■■ WILL THIS BE ONE OF THE FIRST
OBSERVATIONS FOR JWST AND HOW MUCH CAN WE

239
00:20:21,760 --> 00:20:27,720
LEARN ABOUT TRAPPIST E, F AND G UNTIL THAT
MISSION LAUNCHES?

240
00:20:27,720 --> 00:20:33,110
>> I CAN TAKE THAT ONE, TOO.
YOU KNOW, A LOT OF FOLKS, UM, LEARNING ABOUT

241
00:20:33,110 --> 00:20:38,600
THE SYSTEM HAVE THOUGHT ABOUT OBSERVING IT
WITH JWST AND I AM FAIRLY CERTAIN THAT CYCLE

242
00:20:38,600 --> 00:20:43,269
ONE WILL SEE SOME OBSERVATIONS ON ALMOST ALL
OF THE PLANETS IN THE SYSTEM.

243
00:20:43,269 --> 00:20:48,429
>> AND TO ADD FURTHER EVEN NOW WE ARE TAKING
OBSERVATIONS FROM THE GROUND AND SPITZER TO

244
00:20:48,429 --> 00:20:54,419
LOOK AT THE TIMING.
WE WILL GET BETTER MEASUREMENTS AND NEXT YEAR

245
00:20:54,419 --> 00:20:56,770
WILL HAVE MUCH BETTER MEASUREMENTS THAN WE
HAVE CURRENTLY.

246
00:20:56,770 --> 00:21:02,480
>> WE WILL TAKE ONE QUESTION ON THE PHONE
LINE FROM J. BENNETT FROM POPULAR MECHANICS

247
00:21:02,480 --> 00:21:05,940
AND THEN WE WILL GO BACK TO SOCIAL MEDIA.
SO, JAY?

248
00:21:05,940 --> 00:21:09,929
>> HELLO, EVERYONE.
I WAS WONDERING IF THE FACT THAT TRAPPIST■1

249
00:21:09,929 --> 00:21:16,160
IS A PARTICULARLY COOL RED DWARF MEANS THAT
IT'S MORE LIKELY TO SUPPORT PLANETS THAT ARE

250
00:21:16,160 --> 00:21:20,580
POTENTIALLY HABITABLE BECAUSE IT DOESN'T HAVE
MUCH IN THE WAY OF SOLAR FLARES, ERUPTIONS,

251
00:21:20,580 --> 00:21:24,490
THESE KINDS OF THINGS?
>> I CAN TAKE THIS ONE.

252
00:21:24,490 --> 00:21:29,860
SO ULTRA COOL DWARF ARE KNOWN TO BE VERY ACTIVE
WHEN THEY ARE YOUNG.

253
00:21:29,860 --> 00:21:34,330
THIS IS THE MAIN CONCERN ABOUT THE POTENTIALLY
HABITABLE PLANETS.

254
00:21:34,330 --> 00:21:41,180
THEY COULD HAVE BEEN THE ATMOSPHERE BEEN ERODED
STRONGLY BY THE STAR WHEN IT WAS YOUNG.

255
00:21:41,180 --> 00:21:46,320
NOW IT'S QUIET.
IT'S QUIET, NOT VERY ACTIVE.

256
00:21:46,320 --> 00:21:50,210
BUT, MAYBE WHEN IT WAS YOUNG, THE CONDITIONS
WERE QUITE DIFFERENT.

257
00:21:50,210 --> 00:21:56,490
SO IT WILL BE BY OBSERVATION THAT WE WILL
FIGURE OUT THE PATH OF THESE PLANETS AND WHAT

258
00:21:56,490 --> 00:22:03,540
■■ DURING VERY ACTIVE AND YOUNG PHASE.
>> I'LL JUST ADD TO THAT AND REPHRASE WHAT

259
00:22:03,540 --> 00:22:07,010
MICHAEL SAID TO JUST SAY THE GREAT NEWS IS
WE CAN OBSERVE IN THE NEAR FUTURE.

260
00:22:07,010 --> 00:22:11,540
WE KNOW LONGER HAVE TO RELY ON WHAT WE THINK
AND SPECULATION BECAUSE NATURE USUALLY SMARTER

261
00:22:11,540 --> 00:22:16,380
THAT BE WE ARE AND IF THERE'S ANY WAY FOR
A LIFE TO GET A FOOTHOLD, WE LIKE TO BELIEVE

262
00:22:16,380 --> 00:22:18,920
IT WILL.
>> THANK YOU.

263
00:22:18,920 --> 00:22:22,430
WE WILL GO BACK TO SOCIAL MEDIA.
SO, JASON?

264
00:22:22,430 --> 00:22:24,980
>> ALL RIGHT.
THIS QUESTION COMES FROM TWITTER USER AMARA

265
00:22:24,980 --> 00:22:30,540
WHO ASKS ■■ HAVE YOU DECIDED ON ANY NAMES
FOR THESE PLANETS YET?

266
00:22:30,540 --> 00:22:37,290
>> A NAME?
>> LIKE A POPULAR NAME?

267
00:22:37,290 --> 00:22:41,570
>> WELL, WE HAVE PLENTY OF POSSIBILITIES WHICH
ARE ALL RELATED TO BELGIUM BEERS.

268
00:22:41,570 --> 00:22:46,230
BUT WE DON'T THINK THEY WILL BECOME OFFICIAL.
SO ■■ [LAUGHTER] ■■ FOR NOW LET'S

269
00:22:46,230 --> 00:22:50,660
CALL THEM A, B, C, D AND SO ON.
>> ADMITTEDLY WE HAVE NO WAY TO EASILY GIVE

270
00:22:50,660 --> 00:22:55,730
OFFICIAL NAMES TO EXO PLANETS IN THE SAME
WAY AS ASTEROIDS BUT PERHAPS IT'S SOMETHING

271
00:22:55,730 --> 00:22:58,679
WE SHOULD TRITO CHANGE.
>> GREAT.

272
00:22:58,679 --> 00:23:04,440
IN NEXT QUESTION COMES FROM TWITTER USER WHO
ASKS DOES THE EARTH SIZE PLANET HAVE ANY MOONS

273
00:23:04,440 --> 00:23:10,169
REVOLVING AROUND THEM AND IF NO, HOW CAN THERE
BE POSSIBLE WAVES ON WATER?

274
00:23:10,169 --> 00:23:15,500
>> WELL, IN OUR DATA WE HAVE NO INDICATION
OF THE MOON.

275
00:23:15,500 --> 00:23:24,929
AND, IF WE LOOK AT ■■ IT WOULD BE QUITE
UNLIKELY TO HAVE A MOON SO CLOSE TO THE STAR.

276
00:23:24,929 --> 00:23:31,360
MAYBE IF THERE ARE OTHER PLANETS STILL TO
TO BE FOUND, WE WILL SEE IN THE FUTURE.

277
00:23:31,360 --> 00:23:37,570
STILL MANY NEWS TO COME.
>> I'LL ADD FURTHER THE TIDAL SURGES ARE NOT

278
00:23:37,570 --> 00:23:43,490
NEGLIGIBLE.
THERE WOULD BE TIDES AS WELL.

279
00:23:43,490 --> 00:23:52,100
>> NEXT WE WILL GO TO THE PHONE LINES.
WE HAVE KEITH FROM NASA WATCH.

280
00:23:52,100 --> 00:23:55,590
KEITH?
>> I HAVE A QUESTION, PROBABLY BEST FOR SARA

281
00:23:55,590 --> 00:23:57,730
SEAGAR.
I AM LOOKING AT THESE PLANETS.

282
00:23:57,730 --> 00:24:03,730
I ASSUME THEY ARE REALLY CLOSE TOGETHER.
REMINDS ME OF THE JOVIAN SATURNIAN SYSTEMS

283
00:24:03,730 --> 00:24:11,850
WHERE STUFF IS THROWN FROM ONE TO ANOTHER.
AND SHOULD YOU CONSIDER THESE AS AN ECO SYSTEM.

284
00:24:11,850 --> 00:24:17,850
I AM A BIOLOGIST LOOKING AT THREE POTENTIALLY
HABITABLE WORLDS REAL CLOSE TO EACH OTHER.

285
00:24:17,850 --> 00:24:25,770
SHOULD WE BE THINKING THAT CONCEIVABLY THE
BIOSPHERE MIGHT EXTEND BEYOND ONE PLANET IF

286
00:24:25,770 --> 00:24:29,600
THEY ARE THIS CLOSE TO EACH OTHER?
>> THAT'S A WONDERFUL QUESTION.

287
00:24:29,600 --> 00:24:32,940
AND WE HAVEN'T THOUGHT THAT FAR YET.
BUT I'M SURE THERE'S A STUDENT LISTENING OUT

288
00:24:32,940 --> 00:24:39,559
THERE WHO SHOULD TAKE THIS PROBLEM ON.
WILL BACK UP ONE STEP AND ANSWER A DIFFERENT

289
00:24:39,559 --> 00:24:42,840
QUESTION.
IF WE WANT TO THINK ABOUT INTELLIGENT CIVILIZATION

290
00:24:42,840 --> 00:24:49,520
ROOK ANWAR AL■AWLAKIING AT US, THEY MIGHT
SAY HEY THERE'S THREE PLANETS THERE, VENUS,

291
00:24:49,520 --> 00:24:54,880
EARTH AND MARS.
LET'S WAIT AND SEE WHAT'S OUT THERE.

292
00:24:54,880 --> 00:24:58,330
GREAT QUESTION AND HOPEFULLY SOMEBODY WILL
WORK ON THIS.

293
00:24:58,330 --> 00:25:02,529
>> NEXT ON PHONE LINES WE HAVE MARSHA DUNN
FROM ASSOCIATED PRESS.

294
00:25:02,529 --> 00:25:06,990
>> YES.
I WAS WONDERING HOW MANY YEARS DO YOU THINK

295
00:25:06,990 --> 00:25:14,650
IT MIGHT TAKE TO HAVE A REAL GOOD HANDLE ON
THE ATMOSPHERES OF THESE EXO PLANETS?

296
00:25:14,650 --> 00:25:17,840
AND, I HAVE A FOLLOW■UP QUESTION.
>> YEAH.

297
00:25:17,840 --> 00:25:22,110
UM, SO WE CAN ACTUALLY MAKE A SUBSTANTIAL
AMOUNT OF PROGRESS IN THE NEXT, AFTER THE

298
00:25:22,110 --> 00:25:28,310
LAUNCH OF JWSC, THE NEXT FIVE YEARS' RANGE.
SO STARTING WITH HUBBLE AND MOVING TO JWSC

299
00:25:28,310 --> 00:25:32,980
TO CONTINUE THE EXPLORATION OF THESE ATMOSPHERES
WE COULD SEE RESULTS, YOU KNOW, IN THE EARLY

300
00:25:32,980 --> 00:25:34,660
2020s.
>> AND THANK YOU.

301
00:25:34,660 --> 00:25:42,160
AND I KNOW THIS IS THE FIRST TIME SEVEN EARTH■SIZED
PLANETS HAVE APPEARED AROUND A STAR LIKE THIS.

302
00:25:42,160 --> 00:25:46,020
WHAT IS THE ■■ WHAT IS THE CLOSEST RUNNER■UP
TO THAT?

303
00:25:46,020 --> 00:25:53,630
HOW MANY EARTH■SIZE PLANETS AROUND A STAR
THAT YOU HAVE SEEN PRIOR?

304
00:25:53,630 --> 00:25:55,750
>> I THINK IT'S TWO OR THREE.
>> YEAH.

305
00:25:55,750 --> 00:25:57,580
>> NO MORE.
FOUND BY KEPLER.

306
00:25:57,580 --> 00:26:01,799
>> AND WHICH STAR IS THAT?
>> OH, I DON'T REMEMBER.

307
00:26:01,799 --> 00:26:05,880
THERE ARE SO MANY KEPLER PLANETS.
>> OK.

308
00:26:05,880 --> 00:26:11,190
THANK YOU.
>> SO, LET'S GO BACK TO SOCIAL MEDIA.

309
00:26:11,190 --> 00:26:13,210
JASON?
>> ALL RIGHT.

310
00:26:13,210 --> 00:26:17,870
THIS QUESTION COMES FROM MILES O'BRIEN HERE
ON TWITTER WHO ASKS ■■ WHAT SORT OF INSTRUMENT

311
00:26:17,870 --> 00:26:21,679
COULD BE USED TO ANSWER THE QUESTION WHETHER
THESE PLANETS HARBOR LIFE?

312
00:26:21,679 --> 00:26:31,549
COULD WEBB DO IT?
>> SO, WEBB HAS INSTRUMENTS THAT COVER WAVELENGTHS

313
00:26:31,549 --> 00:26:35,620
FROM SORT OF THE INFRARED ALL THE WAY THROUGH
FARTHER INTO THE INFRARED SPECTRUM.

314
00:26:35,620 --> 00:26:41,539
IN PARTICULAR, IT HAS A LOT OF VERY POWERFUL
SPECTROGRAPHS ABOARD ALLOWING US TO DO THIS

315
00:26:41,539 --> 00:26:51,000
TRANSMISSION S PERKS ECTRTOMY WHERE WE CAN
DETECT MOLECULES LIKE WATER, METHANE, OZONE

316
00:26:51,000 --> 00:26:56,580
AND OXYGEN SO WE CAN START TO DO A LOT OF
WHAT SARA SUGGESTED IN TRYING TO DETERMINE

317
00:26:56,580 --> 00:26:59,540
HABITABILITY AND ALSO THE POTENTIAL OF IT
HARBORING LIFE.

318
00:26:59,540 --> 00:27:04,360
>> I JUST WANT TO ADD ONE THING TO MILES AND
EVERYONE OUT THERE IS WE REALLY TRY TO EMPHASIZE

319
00:27:04,360 --> 00:27:07,730
WE HAVE THE CAPABILITY TO FIND SIGNS IS OF
LIFE ELSEWHERE.

320
00:27:07,730 --> 00:27:11,470
BUT NATURE HAS TO DELIVER.
AND, BECAUSE IT'S ALL SO NEW TO US THESE RED

321
00:27:11,470 --> 00:27:13,980
DWARF STARS WE DON'T NOTELY KNOW WHAT'S OUT
THERE.

322
00:27:13,980 --> 00:27:21,940
SO IF NATURE HAS MADE LIFE UBIQUITOUS AND
THERE ARE LOTS OF ATMOSPHERES WITHOUT STARS,

323
00:27:21,940 --> 00:27:24,880
ACCUMULATION OF GASES WE'LL HAVE NO TROUBLE
FINDING IT AT ALL.

324
00:27:24,880 --> 00:27:28,900
BUT IF IT'S THE OPPOSITE IT MAY BE A WHILE.
I WANTED TO ADD ONE MORE POINT.

325
00:27:28,900 --> 00:27:34,700
WE HAVE TEST MISSION UPCOMING, OTHER GROUND■BASED
SEARCHES.

326
00:27:34,700 --> 00:27:40,210
TRAPPIST■1 IS THE MOST EXCITING ONE SO FAR
BUT WE HOPE TO HAVE MANY MORE OF THESE AND

327
00:27:40,210 --> 00:27:44,799
LOTS OF CHANCES TO FIND SIGNS OF LIFE IN THE
FUTURE.

328
00:27:44,799 --> 00:27:48,950
>> WONDERFUL.
NEXT QUESTION HERE COMES FROM TWITTER USER

329
00:27:48,950 --> 00:27:53,830
CHRIS SIMMS WHO ASKS ■■ IF POSSIBLE TO
LISTEN TO THIS PLANET SYSTEM USING OUR STEADY

330
00:27:53,830 --> 00:27:59,180
STYLE TELESCOPES?
HOW DO WE LEARN AS MUCH AS POSSIBLE?

331
00:27:59,180 --> 00:28:05,900
>> TO MY KNOWLEDGE, IT WAS ALREADY ■■ BY
CITY AND THEY NO SIGNAL, NO ARTIFICIAL SIGNAL

332
00:28:05,900 --> 00:28:14,390
DETECTED.
SO IT'S DOABLE, BUT THERE'S NO SIGNAL DETECTED.

333
00:28:14,390 --> 00:28:18,850
>> NEXT QUESTION COMES FROM TWITTER USER SAWYER
WHO ASKS ■■ HOW FAR INTO THE FORESEEABLE

334
00:28:18,850 --> 00:28:23,290
FUTURE UNTIL WE CAN SEE A CRAFT THAT CAN MAKE
THE JOURNEY TO TRAPPIST■1?

335
00:28:23,290 --> 00:28:28,400
>> THAT'S A REALLY HARD QUESTION BECAUSE IT
REQUIRES SO MANY MIRACLES ON THE WAY.

336
00:28:28,400 --> 00:28:34,360
SEE WHEN JAMES WEBB WAS DEVELOPED, THE WAY
I THINK ABOUT JAMES WEBB, IT REQUIRED SOMETHING

337
00:28:34,360 --> 00:28:37,930
LIKE 10 MIRACLES.
KIND OF THINGS WE HAD NEVER DONE.

338
00:28:37,930 --> 00:28:42,400
AND KIND OF PUT IT TOGETHER INTO A TELESCOPE,
YOU KNOW, WITH SIX AND A HALF METER KIND OF

339
00:28:42,400 --> 00:28:47,110
FOLDABLE MIRROR AND THERMAL SYSTEM THAT'S
A TENNIS COURT IN SIZE.

340
00:28:47,110 --> 00:28:50,520
HOW DO YOU DO THAT?
THE ANSWER IS, YOU START INVENTING YOUR WAY

341
00:28:50,520 --> 00:28:56,440
FORWARD.
THIS QUESTION THAT'S BEING ASKED, MAYBE 100

342
00:28:56,440 --> 00:29:00,620
MIRACLE TYPE OF QUESTION AND SOME PROBABLY
RELATE TO NUCLEAR PROPULSION.

343
00:29:00,620 --> 00:29:07,230
SOME RADIATION PROTECTION, RELATING TO THINGS
THAT WE ARE STARTING TO PUSH AT.

344
00:29:07,230 --> 00:29:11,500
THE GOOD NEWS IS, THERE'S A LOT OF WORK THAT'S
BEING DIMENSION ON KIND OF THE FIRST FIVE

345
00:29:11,500 --> 00:29:17,870
TO 10 MIRACLES THAT ARE BEING LOOKED AT.
NOT NECESSARILY BECAUSE WE HAVE OUR EYES SET

346
00:29:17,870 --> 00:29:24,110
RIGHT NOW ON GOING TO STARS, BUT BECAUSE WE
ARE LOOKING FOR EXAMPLE AT THE OUTER SOLAR

347
00:29:24,110 --> 00:29:26,580
SYSTEM.
WE WANT TO GET THERE A LOT FASTER.

348
00:29:26,580 --> 00:29:31,010
WE WANT TO GET THERE WITH MORE PAYLOAD.
WE WANT TO GET THERE WERE MORE ENERGY.

349
00:29:31,010 --> 00:29:36,909
AND SO THE WAY THIS GAME WORKS, IT'S REALLY
■■ IT'S LEANING FORWARD.

350
00:29:36,909 --> 00:29:42,330
IT'S REALLY JUST BECAUSE IT TAKES 100 MIRACLES
NOT BACKING UP, THAT IT'S REALLY WHAT I WOULD

351
00:29:42,330 --> 00:29:47,299
BELIEVE NASA IS ALL ABOUT.
THAT'S ALSO WHAT LED TO THIS KIND OF DISCOVERY

352
00:29:47,299 --> 00:29:51,190
IN MANY WAYS, YOU KNOW.
SPITZER ITSELF HAD A WHOLE BUNCH OF MIRACLES

353
00:29:51,190 --> 00:29:55,509
ON DETECTERS AND SYSTEMS.
THE SAME IS TRUE FOR THE OTHER QUESTION.

354
00:29:55,509 --> 00:30:01,210
>> I WOULD LICK TO MENTION OUR COLLEAGUES
AT THE BREAKTHROUGH FOUNDATION IN THE PROJECT

355
00:30:01,210 --> 00:30:04,289
CALLED STAR SHOT.
YOU CAN LOOK THAT UP AND SEE THAT THEY ARE

356
00:30:04,289 --> 00:30:10,780
PLANNING 19 MIRACLES TO FIGURE OUT A WAY TO
SEND VERY TINY AND THOUSANDS OF LITTLE TINY

357
00:30:10,780 --> 00:30:16,669
SPACE CRAFTS FLYING BY THE VERY NEAREST STARS.
THAT WOULD BE PROXIMAT NOT QUITE LIKE TRAPPIST.

358
00:30:16,669 --> 00:30:22,120
IT MAY SOUND DISCOURAGING THAT PERHAPS IN
OUR LIFETIME WE WON'T HAVE A WAY TO SEE HOW

359
00:30:22,120 --> 00:30:28,030
TO GET TO TRAPPIST■1, BUT WE ARE HERE BECAUSE
WE HAVE BIG SOPHIST IT I KATEED SPACE TELESCOPES.

360
00:30:28,030 --> 00:30:35,049
HUBBLE, SPACE WEB AND FUTURE.
EVEN THOUGH THAT'S WHAT WE HAVE TO LIVE FOR,

361
00:30:35,049 --> 00:30:40,059
WE ARE STILL EXCITED ABOUT USING THE POSSIBILITY
OF USING OUR TELESCOPES TO SEE WHAT'S THERE.

362
00:30:40,059 --> 00:30:45,989
WE WILL IS TO LEAVE THE TRIPS THERE TO FUTURE
GENERATIONS.

363
00:30:45,989 --> 00:30:49,650
>> WE HAVE A LOT OF QUESTIONS ON SOCIAL MEDIA
SO WE WILL JUST KEEP THEM COMING.

364
00:30:49,650 --> 00:30:52,100
JASON.
WHAT OTHER QUESTIONS ARE WE GETTING?

365
00:30:52,100 --> 00:30:54,800
>> SURE.
THIS NEXT QUESTION COMES FROM AKU WHO ASKS

366
00:30:54,800 --> 00:31:00,169
■■ ANY ESTIMATION ON HOW OLD THESE DISCOVERED
EXO PLANETS ARE?

367
00:31:00,169 --> 00:31:04,130
>> THE AGE OF THE STAR AND SYSTEM ITSELF IS
VERY CON STRAINED.

368
00:31:04,130 --> 00:31:12,669
WE KNOW IT'S NOT VERY YOUNG.
IT'S AT LEAST HALF A BILLION YEARS OLD.

369
00:31:12,669 --> 00:31:17,400
BUT WE CAN'T SAY MORE BECAUSE THESE EVOLVED
SUPER SLOWLY.

370
00:31:17,400 --> 00:31:22,900
THE LIFETIME IS 1,000 TIMES LARGER THAN FOR
A SUN■LIKE STAR.

371
00:31:22,900 --> 00:31:27,270
SO WE DON'T SEE THEM EVOLVING.
SO WE CAN'T CON STRAIN THE AGES.

372
00:31:27,270 --> 00:31:30,980
>> THIS NEXT QUESTION COMES FROM FACEBOOK
LIVE HERE.

373
00:31:30,980 --> 00:31:35,770
WHAT IS THE DISTAN BETWEEN THESE THREE PLANETS?
SOMETHING LIKE 500,000 KILOMETERS?

374
00:31:35,770 --> 00:31:38,960
AND WHAT IS THE DIFFERENCE BETWEEN E. AND
THE STAR?

375
00:31:38,960 --> 00:31:45,140
>> OH, THE DISTANCE BETWEEN THE PLANETS ARE
A FEW TIMES THE DISTANCE BETWEEN THE EARTH

376
00:31:45,140 --> 00:31:49,260
AND THE MOON.
SO, WE ARE TALKING ABOUT SOMETHING LIKE A

377
00:31:49,260 --> 00:31:54,940
THOUSAND ■■ WELL, MILLIONS OF KILOMETERS
AND HUNDREDS OF MILLIONS OF KILOMETERS FOR

378
00:31:54,940 --> 00:32:02,370
AROUND THE SUN LIKE STAR.
AND FOR THE PLANET F. OR E., THE DISTANCE

379
00:32:02,370 --> 00:32:07,360
IS SOMETHING LIKE 5% BETWEEN THE EARTH AND
THE SUN.

380
00:32:07,360 --> 00:32:13,860
SO, IT'S MUCH, MUCH CLOSER TO ITS STAR.
>> GREAT.

381
00:32:13,860 --> 00:32:18,880
THIS NEXT QUESTION COMES FROM TWITTER.
IS THE TRAPPIST■1 SYSTEM THE CLOSEST TO

382
00:32:18,880 --> 00:32:24,360
US WITH PLANETS IN THE HABITABLE ZONE?
>> NO.

383
00:32:24,360 --> 00:32:32,429
IN FACT THE CLOSEST IS PROXIMA CENTER■E.
IT WAS DETECTED BY ANOTHER MEASURE WHICH DOESN'T

384
00:32:32,429 --> 00:32:36,909
TELL US THE SIZE OR THE MATH.
WE DON'T KNOW IF IT'S A ■■ BUT IT IT'S

385
00:32:36,909 --> 00:32:42,610
CLEARLY IN THE HABITABLE ZONE.
IT'S ONLY AT FOUR LIGHT YEARS AWAY.

386
00:32:42,610 --> 00:32:46,279
IT IT'S THE CLOSEST STAR, IN FACT.
>> WONDERFUL.

387
00:32:46,279 --> 00:32:50,429
THIS NEXT QUESTION COMES FROM TWITTER USER
UNCONVENTIONAL TIGER WHO ASKS ■■ I WOULD

388
00:32:50,429 --> 00:32:58,850
LIKE TO KNOW THE RANGE OF ORBITAL PLANETS.
>> THE RANGE GOES FROM 1.5 DAYS FOR THE INNER

389
00:32:58,850 --> 00:33:02,931
MOST PLANET.
WE DON'T KNOW THE PERIOD OF THE OTHER PLANET

390
00:33:02,931 --> 00:33:10,740
BUT IT MUST BE SOMETHING LIKE 23.
SUPER SHORT COMPARED TO THE EARTH.

391
00:33:10,740 --> 00:33:16,669
>> I THINK ■■ I THINK MICHAEL HAS THE
RATIOS.

392
00:33:16,669 --> 00:33:27,909
>> OK, SO, IN DEED, ALSO, THE PERIODS THEMSELVES
ARE RELATED BY RATIOS OF INTEGER NUMBERS.

393
00:33:27,909 --> 00:33:33,710
CONFIGURATION WE FIND IN OUR SOLAR SYSTEM
FOR THE GALION MOON AROUND JUPITER.

394
00:33:33,710 --> 00:33:40,220
IT SHOWS THAT IT INDICATES AT LEAST THAT THESE
PLANETS SHOULD HAVE FORMED AND DEGRADED AND

395
00:33:40,220 --> 00:33:48,110
IT WAS A VERY PECULIAR FORMATION.
IF IT IS THE CASE, THEY ARE SUPER RICH BECAUSE

396
00:33:48,110 --> 00:33:56,780
THEY MUST HAVE FORMED IN RICH ■■ AND SHOULD
BE REFLECTED IN COMPOSITION AND WE WILL KNOW

397
00:33:56,780 --> 00:34:01,450
SOON THANKS TO NEW SPITZER OBSERVATIONS THAT
ARE COMING.

398
00:34:01,450 --> 00:34:05,309
>> BEFORE WE TAKE MORE QUESTIONS FROM SOCIAL
MEDIA, I WOULD LIKE TO ASK EACH OF YOU TO

399
00:34:05,309 --> 00:34:09,909
KIND OF GIVE US SOME THOUGHTS ABOUT WHY THIS
FIND SOMETHING SO EXCITING FOR YOU PERSONALLY

400
00:34:09,909 --> 00:34:13,829
AND WE WILL START WITH NICKOLE AND WORK OUR
WAY TO THOMAS.

401
00:34:13,829 --> 00:34:18,390
>> YEAH, SO, THIS FINDING IS REALLY EXCITING
FOR ME BECAUSE THIS IS A GREAT OPPORTUNITY

402
00:34:18,390 --> 00:34:23,100
TO STUDY EARTH■SIZE PLANETS' ATMOSPHERES
IN GREAT DETAIL.

403
00:34:23,100 --> 00:34:28,010
WE KNOW THAT WE HAVE GOOD, WE CAN GET GOOD
SIGNALS AND RATIOS AND START TO BEGIN THIS

404
00:34:28,010 --> 00:34:33,700
JOURNEY IN TRYING TO UNDERSTAND WHAT THE AIR
IS LIKE AROUND ROCKY PLANETS OUTSIDE OF OUR

405
00:34:33,700 --> 00:34:37,730
SOLAR SYSTEM.
>> WELL I'LL GIVE TWO FAVORITE REASONS.

406
00:34:37,730 --> 00:34:43,359
WHEN I AND OTHERS STARTED EXO PLANETS 20 YEARS
AGO OUR PEERS ALL DISMISSED THE WORK AS JUST

407
00:34:43,359 --> 00:34:48,750
STAMP COLLECTING.
THE FACT THAT WE ARE HERE TODAY WITH SEVEN

408
00:34:48,750 --> 00:34:53,419
PLANETS AND WE KNOW WE CAN STUDY THEIR ATMOSPHERES
IN THE FUTURE IS TREMENDOUS.

409
00:34:53,419 --> 00:34:59,109
THE OTHER POINT I WANT TO MAKE IS WE ARE EXCITED
BECAUSE WE ALL SEE OURSELVES HERE AS JUST,

410
00:34:59,109 --> 00:35:03,420
WE ARE THE GROUP OF PEOPLE, WE, MEANING US
AND ALL OF OUR COLLEAGUES, AS PIONEERS. THIS

411
00:35:03,420 --> 00:35:08,480
IS A SEARCH THAT WILL GO ON FOR MANY GENERATIONS.
JUST THE FACT THAT WE ARE THIS CLOSE TO FINDING

412
00:35:08,480 --> 00:35:14,020
SO MANY HABITABLE WORLDS IS REALLY EXCITING.
>> YEAH, SO FOR ME IT'S MORE OF A VERY KIND

413
00:35:14,020 --> 00:35:17,450
OF A PERSONAL EXPERIENCE BECAUSE I'VE BEEN
WORKING ON SPITZER SINCE 2002.

414
00:35:17,450 --> 00:35:23,810
WE HAD TO DO A FAIR.
A ENGINEERING WORK AND AT THE BEGINNING IT

415
00:35:23,810 --> 00:35:28,520
WASN'T CLEAR NECESSARILY THAT WE WOULD BE
ABLE TO ACHIEVE THE PRECISIONS WE NEED TO

416
00:35:28,520 --> 00:35:32,480
DO UP SCIENCE LIKE THIS.
SO IT'S VERY GRATIFYING THAT ALL OF OUR HARD

417
00:35:32,480 --> 00:35:36,570
WORK, MYSELF, MY COLLEAGUES AT THE SPITZER
SCIENCE CENTER, J.P.L. AND LOCKHEED MARTIN,

418
00:35:36,570 --> 00:35:41,859
THE ENGINEERS THERE, PULLED IT YOU HAVE A.
WE WERE ABLE TO GET GREAT DATA TO SCIENTISTS

419
00:35:41,859 --> 00:35:46,620
AND GET GREAT RESULTS OUT.
I'M VERY HAPPY ABOUT THIS.

420
00:35:46,620 --> 00:35:54,030
>> WELL, ON MY SIDE, I HAVE ALWAYS WONDERED
ABOUT THE DISTANCE OF LIFE ELSEWHERE SINCE

421
00:35:54,030 --> 00:36:00,560
I'M A KID.
SO, WHEN I WENT TO COLLEGE TO STUDY SCIENCE,

422
00:36:00,560 --> 00:36:05,500
I FIRST STUDIED BIOLOGY, BIOCHEMISTRY, BECAUSE
I WANTED TO UNDERSTAND LIFE, BUT I SWITCHED

423
00:36:05,500 --> 00:36:09,570
TO ASTRONOMY BECAUSE IT WAS THE BINNING OF
THE EXO PLANET ADVENTURE.

424
00:36:09,570 --> 00:36:15,251
WE WERE DETECTING PLANETS OUTSIDE THE SOLAR
SYSTEM AND IT WAS CLEAR THAT WE WOULD NOT

425
00:36:15,251 --> 00:36:22,970
BE DETECTING GIANT PLANETS WHICH WERE UNSUITABLE
FOR LIFE, BUT PLANETS THAT PUT LIFE ■■ SO,

426
00:36:22,970 --> 00:36:27,410
I'VE BEEN DEVOTING MY TIME AND SCIENCE TO
THIS GOAL.

427
00:36:27,410 --> 00:36:31,500
AND, THEN WE ARE GETTING NEARLY THERE WITH
THIS RESULT.

428
00:36:31,500 --> 00:36:39,190
IT'S VERY GOOD SATISFACTION FOR ME.
>> TO ME, LOOKING FROM THE POINT OF VIEW OF

429
00:36:39,190 --> 00:36:43,030
NASA SCIENCE PROGRAM, IT'S EXCITING BECAUSE
IT'S OF COURSE A LEAP FORWARD.

430
00:36:43,030 --> 00:36:46,770
BUT IT GOES IN PARALLEL TO THE OTHER LEAPS
WE ARE TAKING RIGHT NOW.

431
00:36:46,770 --> 00:36:51,170
LOOK AT WHAT'S HAPPENING AT MARS WHERE WE
ARE REALLY LOOKING AT THE COMPLEX CHEMISTRY

432
00:36:51,170 --> 00:36:54,210
THAT'S HAPPENING THERE.
LOOK AT THE RECOGNITION THAT MARS ACTUALLY

433
00:36:54,210 --> 00:36:58,420
IS A PLACE WHERE THERE NOT ONLY USED TO BE
WATER BUT THERE'S WATER TODAY.

434
00:36:58,420 --> 00:37:03,040
ABUNDANT WATER.
IN PARALLEL TO THAT, YOU KNOW, THE RECOGNITION

435
00:37:03,040 --> 00:37:08,420
THAT WE NOW HAVE THE TECHNOLOGY, ABILITY OF
GOING TO EUROPA AND LOOKING AT THAT SYSTEM

436
00:37:08,420 --> 00:37:12,560
WHICH IS, IN ITS OWN RIGHT, REALLY AN EXCITING
SYSTEM.

437
00:37:12,560 --> 00:37:17,990
BECAUSE, THERE'S AN OCEAN WORLD THERE THAT
HITS THE ROCK AT THE BOTTOM IN A REALLY UNEXPECTED

438
00:37:17,990 --> 00:37:22,810
PLACE.
THERE'S MANY OTHER PLACES LIKE THAT AND THEN

439
00:37:22,810 --> 00:37:28,950
ON THE CERES SIDE, WE HAVE AN UNDERSTANDING
OF THE BIOLOGY OF LIFE.

440
00:37:28,950 --> 00:37:35,090
KIND OF THERE'S A TREMENDOUS AMOUNT OF PROGRESS.
SO TOGETHER, THESE AREAS REALLY CREATE A CRESCENDO

441
00:37:35,090 --> 00:37:39,770
TOWARD THAT ANSWERING THAT QUESTION THAT HAS
BEEN ON OUR MINDS FOR SO LONG.

442
00:37:39,770 --> 00:37:44,790
THIS IS THE RIGHT TIME TO ASK THAT QUESTION.
IT IS THE RIGHT TIME TO HAVE THIS DISCOVERY

443
00:37:44,790 --> 00:37:46,330
RIGHT NOW.
>> THANK YOU.

444
00:37:46,330 --> 00:37:51,810
I AM AFRAID THAT'S ALL TIME WE HAVE LEFT.
PLEASE KEEP THOSE QUESTIONS COMING BY SENDING

445
00:37:51,810 --> 00:37:59,310
THEM AT THE HASHTAG ASK NASA.
AND, FOR MORE INFORMATION, AND TO DOWNLOAD

446
00:37:59,310 --> 00:38:08,300
THE EXO PLANETS APP THAT NICKOLE WAS JUST
USING EARLIER, PLEASE GO TO NASA.GOV/EXOPLANET