The Stars at Night – Deep in the Heart of Texas

1
00:00:18,952 --> 00:00:23,223
Earth is our home and our vantage point
for viewing the universe.

2
00:00:23,790 --> 00:00:26,393
Abundant water,
and a protective atmosphere,

3
00:00:26,393 --> 00:00:29,396
give our planet
its distinctive blue color.

4
00:00:29,662 --> 00:00:33,233
Life flourishes and humanity
thrives on its surface.

5
00:00:33,867 --> 00:00:37,170
Even with our feet firmly planted,
we travel.

6
00:00:37,470 --> 00:00:42,142
We travel nine hundred forty million
kilometers around the Sun each year.

7
00:00:42,909 --> 00:00:45,345
Along the way, as Earth spins,

8
00:00:45,345 --> 00:00:49,082
we move from day to night and back again.

9
00:00:49,582 --> 00:00:53,119
In daytime,
sunlight bathes our planet with heat

10
00:00:53,119 --> 00:00:58,224
and light.
As it passes through
the atmosphere, sunlight is scattered.

11
00:00:58,391 --> 00:01:01,394
The blue sky we see is refracted light.

12
00:01:01,461 --> 00:01:05,598
The effect is stronger by the horizon,
so each evening as Sun sets,

13
00:01:05,799 --> 00:01:08,802
we get a natural, colorful light show.

14
00:01:11,371 --> 00:01:14,707
When we rotate out of the light,
the atmosphere above us

15
00:01:14,707 --> 00:01:17,010
is no longer illuminated.

16
00:01:17,010 --> 00:01:19,379
We see through to the stars above.

17
00:01:20,547 --> 00:01:21,581
All we know

18
00:01:21,581 --> 00:01:23,883
about these stars,
we have learned from looking.

19
00:01:24,184 --> 00:01:26,319

They are too far away to touch.

20
00:01:26,319 --> 00:01:28,988
Humanity’s most distant spacecraft, Voyager 1

21
00:01:28,988 --> 00:01:32,192
was launched in 1977.

22
00:01:32,392 --> 00:01:35,395
Yet it has only just exited
our solar system.

23
00:01:35,595 --> 00:01:41,401
Speeding at over 17,000 kilometers
per hour, Voyager would have to travel

24
00:01:41,434 --> 00:01:44,737
tens of thousands of years
to reach another star.

25
00:01:51,411 --> 00:01:53,780
Let’s survey our night sky.

26
00:01:53,780 --> 00:01:56,783
We’ll see how the ancients viewed
these stars, and we’ll

27
00:01:56,783 --> 00:01:59,953
find secrets
uncovered with modern science.

28
00:02:00,420 --> 00:02:03,189
We start with a clear spring evening.

29

00:02:03,189 --> 00:02:08,027
To orient ourselves, we find a prominent
pattern of stars called the Big Dipper.

30
00:02:08,595 --> 00:02:11,064
Extending a line using the two stars

31
00:02:11,064 --> 00:02:14,701
farthest from the handle,
we identify the star Polaris.

32
00:02:14,901 --> 00:02:18,972
This is also called the North Star
because we can reliably use it

33
00:02:18,972 --> 00:02:23,510
to identify the directions
North, South, East, and West.

34
00:02:26,479 --> 00:02:28,114
The Big Dipper itself is part

35
00:02:28,114 --> 00:02:32,318
of a constellation known as
Ursa Major, or the great bear.

36
00:02:32,619 --> 00:02:37,724
In antiquity it was one of the original 48
constellations listed by Ptolemy

37
00:02:38,124 --> 00:02:42,595
in the 2nd century AD,
drawing on earlier works by Greeks,

38
00:02:42,629 --> 00:02:46,499

Egyptian, Babylonian
and Assyrian astronomers.

39
00:02:46,499 --> 00:02:50,870
This constellation taught us
an astonishing lesson about our universe

40
00:02:50,870 --> 00:02:54,307
in 1995 when the Hubble Space Telescope

41
00:02:54,340 --> 00:02:58,011
spent 10 days
staring at this tiny area of the sky.

42
00:02:58,678 --> 00:03:01,981
The result was the deepest
look into the universe at that time.

43
00:03:02,415 --> 00:03:06,753
Astronomers were amazed to find over
3,000 galaxies.

44
00:03:06,920 --> 00:03:11,291
Some of the galaxies are estimated
to be 12 billion light years away,

45
00:03:11,291 --> 00:03:15,094
and the information in this and later
Deep Field images

46
00:03:15,161 --> 00:03:18,198
led to a better understanding
of the universe.

47
00:03:28,541 --> 00:03:30,510

Hundreds of years before the Hubble Space

48
00:03:30,510 --> 00:03:34,380
Telescope, astronomers
didn’t know other galaxies existed.

49
00:03:34,814 --> 00:03:39,185
18th-century astronomers found fuzzy,
nebulous objects that they assumed

50
00:03:39,185 --> 00:03:43,256
were part of our Milky Way, but
now we know that some of their discoveries

51
00:03:43,323 --> 00:03:47,093
are galaxies
with billions of stars of their own.

52
00:03:48,962 --> 00:03:53,533
In 1781, Pierre Méchain
discovered the Sombrero Galaxy.

53
00:03:53,666 --> 00:03:54,801
This is regarded

54
00:03:54,801 --> 00:03:58,137
as one of the most beautiful galaxies
to observe in a backyard telescope.

55
00:03:59,505 --> 00:04:03,142
The Sombrero’s name
comes from its dramatic, dark dust lane,

56
00:04:03,142 --> 00:04:06,879
which is one of the primary star-forming

regions of this galaxy.

57
00:04:07,480 --> 00:04:10,416
Though it is just one-third
the size or our Milky Way,

58
00:04:10,416 --> 00:04:13,453
the Sombrero is the brightest nearby
galaxy

59
00:04:13,453 --> 00:04:16,456
in the universe.

60
00:04:18,458 --> 00:04:19,392
To identify

61
00:04:19,392 --> 00:04:22,395
stars and constellations
in this part of the sky,

62
00:04:22,495 --> 00:04:26,499
use the tail of the bear, which is also
the handle of the Big Dipper.

63
00:04:26,933 --> 00:04:30,737
Hopping from one star to another
is a common way to find stars

64
00:04:30,737 --> 00:04:33,740
and constellations when stargazing.

65
00:04:35,041 --> 00:04:37,343
Extending the curve of the bear’s tail,

66

00:04:37,343 --> 00:04:40,346
we Arc to Arcturus...

67
00:04:40,580 --> 00:04:43,583
Spike to Spika...

68
00:04:43,783 --> 00:04:45,518
and Run to Regulus.

69
00:04:45,518 --> 00:04:48,755
These are the brightest stars
in three constellations.

70
00:04:48,821 --> 00:04:51,824
Bootes the Herdsman
watches the Great Bear.

71
00:04:51,824 --> 00:04:56,062
The goddess Virgo holds a grain of wheat
as a symbol of the harvest,

72
00:04:56,062 --> 00:04:59,065
and these stars form Leo.

73
00:04:59,198 --> 00:05:02,068
Archeological evidence suggests
many cultures

74
00:05:02,068 --> 00:05:06,706
imagined a powerful lion
here for over 6,000 years.

75
00:05:11,477 --> 00:05:14,580
Throughout the year, our view of the stars
changes.

76
00:05:14,614 --> 00:05:17,016
The change is difficult
to notice day-to-day

77
00:05:17,016 --> 00:05:21,754
and week-to-week,
but each evening after dark, the Herdsman,

78
00:05:21,788 --> 00:05:26,059
the Goddess, the Lion, and the Bear march
a little farther

79
00:05:26,059 --> 00:05:30,330
across the sky.
By summer, new
constellations have come into view.

80
00:05:30,363 --> 00:05:33,333
The eastern sky
now has three prominent stars

81
00:05:33,333 --> 00:05:36,636
that form the Summer Triangle: Deneb,
Altair,

82
00:05:36,636 --> 00:05:39,639
and Vega.

83
00:05:40,540 --> 00:05:42,175
The brightest star, Vega,

84
00:05:42,175 --> 00:05:45,144
marks the constellation Lyra, the Lyre.

85
00:05:45,144 --> 00:05:48,881
In mythology,
this is the instrument played by Orpheus,

86
00:05:48,881 --> 00:05:53,786
who was said to make such beautiful music
that even rocks and trees

87
00:05:53,820 --> 00:05:56,823
were soothed.

88
00:06:02,495 --> 00:06:04,430
Astronomer Charles Messier

89
00:06:04,430 --> 00:06:09,702
was searching for comets in 1779
when he discovered a new nebulosity.

90
00:06:09,736 --> 00:06:12,739
He called it Messier 57 and added it to

91
00:06:12,739 --> 00:06:16,042
his growing list of “nebulae”
and star clusters.

92
00:06:16,175 --> 00:06:20,146
Even though Messier was a comet hunter,
he is most famous today

93
00:06:20,146 --> 00:06:23,483
for his list of one hundred
ten deep space objects

94
00:06:23,483 --> 00:06:26,452

that are not comets.

95
00:06:26,519 --> 00:06:31,391
M57 is also known as the Ring Nebula
because of its distinct shape.

96
00:06:31,457 --> 00:06:36,562
This is not a galaxy; instead,
we see expanding layers of a dying star.

97
00:06:37,029 --> 00:06:39,432
Not all stars go out with a bang.

98
00:06:39,432 --> 00:06:43,603
Stars like our Sun eventually
give up ghostly outer layers

99
00:06:43,803 --> 00:06:47,039
that are ionized by exposed stellar cores.

100
00:06:47,306 --> 00:06:51,310
No matter how a star ends,
it can be a mesmerizing sight.

101
00:07:00,453 --> 00:07:02,355
Several prominent constellations

102
00:07:02,355 --> 00:07:05,224
are found in the southern sky each summer.

103
00:07:05,625 --> 00:07:10,263
When looking to the south, search
for a large “fish hook” of stars.

104

00:07:10,263 --> 00:07:13,933
This forms
the body of the constellation Scorpius.

105
00:07:14,233 --> 00:07:17,737
The heart of the scorpion is marked
by a bright,

106
00:07:17,737 --> 00:07:20,740
red-orange star.

107
00:07:24,610 --> 00:07:26,479
Not visible from the north,

108
00:07:26,479 --> 00:07:30,216
the famous Southern Cross, Crux, is below
the scorpion.

109
00:07:30,483 --> 00:07:34,754
Crux has two “pointer stars” of its own,
and it is tucked under the constellation

110
00:07:34,754 --> 00:07:38,057
Centaurus, a creature that is half-man,

111
00:07:38,057 --> 00:07:41,060
half-horse.

112
00:07:41,394 --> 00:07:44,297
To the left of the scorpion
is a collection of stars

113
00:07:44,297 --> 00:07:46,199
in the shape of a teapot.

114
00:07:46,199 --> 00:07:49,602
This is part of the constellation
Sagittarius, the Archer.

115
00:07:50,002 --> 00:07:53,139
Sagittarius appears to aim
an arrow at the scorpion,

116
00:07:53,139 --> 00:07:56,342
but by wonderful coincidence,
he points to something

117
00:07:56,342 --> 00:07:59,946
even more incredible—the
center of our Galaxy.

118
00:08:02,682 --> 00:08:05,985
A great band of hazy light stretches
across the sky.

119
00:08:06,018 --> 00:08:09,188
It is called the Milky Way
because of an ancient story

120
00:08:09,188 --> 00:08:13,993
that says milk was spilled when Heracles,
the infant child of the Greek

121
00:08:13,993 --> 00:08:17,230
God Zeus, was fed by the Goddess Hera.

122
00:08:17,864 --> 00:08:22,935
The ancient Greek philosopher Democritus
thought the Milky Way was made of stars

123
00:08:23,002 --> 00:08:25,972
almost too faint to see, but proof of this
idea came over 2,000 years later.

124
00:08:29,375 --> 00:08:31,143
In 1610,

125
00:08:31,143 --> 00:08:34,747
Galileo looked through
one of the first telescopes ever invented,

126
00:08:34,747 --> 00:08:38,251
and he saw that it is, indeed,
made of stars.

127
00:08:54,834 --> 00:08:57,203
Eventually, summer makes way for autumn.

128
00:08:57,203 --> 00:09:00,573
In the south is a “sea” of fainter stars.

129
00:09:00,640 --> 00:09:04,777
Several constellations are related
to water and aquatic creatures.

130
00:09:06,546 --> 00:09:10,383
The brightest star
in this region marks the mouth of a fish.

131
00:09:12,585 --> 00:09:14,120
Observers below 25

132
00:09:14,120 --> 00:09:17,790
degrees latitude can view

the shining star Achernar.

133
00:09:18,090 --> 00:09:22,061
The 10th brightest star in the night sky,
Achernar can be used

134
00:09:22,061 --> 00:09:26,532
as a guide post to find fainter stars
that form the constellation Tucana.

135
00:09:26,599 --> 00:09:31,971
Since these stars could not be seen
from ancient Greece, the Greeks didn't

136
00:09:31,971 --> 00:09:35,975
create this constellation
or mythology for these stars.

137
00:09:36,676 --> 00:09:40,346
The constellation of the toucan,
a South American bird, was placed

138
00:09:40,346 --> 00:09:44,283
here in the late 16th century
by astronomer Plancius.

139
00:09:57,697 --> 00:10:00,700
Prominent stars of autumn
can be found in the northeast.

140
00:10:00,833 --> 00:10:04,770
A zig-zag of bright stars forms
the constellation Cassiopeia.

141
00:10:05,304 --> 00:10:08,574

Cassiopeia was a vain queen
who compared her beauty,

142
00:10:08,574 --> 00:10:12,144
and that of her daughter
Andromeda, to the sea nymphs.

143
00:10:12,612 --> 00:10:16,015
This angered Poseidon,
God of the sea and waters.

144
00:10:16,282 --> 00:10:20,653
Poseidon gave Cassiopeia
a harsh punishment, requiring her

145
00:10:20,653 --> 00:10:24,890
to chain her daughter to the rocks
as a sacrifice to the sea monster.

146
00:10:25,625 --> 00:10:29,595
Luckily,
the hero Perseus, who killed the Medusa

147
00:10:29,595 --> 00:10:34,266
and caused the birth of Pegasus,
found Andromeda and saved her.

148
00:10:34,500 --> 00:10:37,903
Perseus holds in his hand
the head of the gorgon Medusa.

149
00:10:38,137 --> 00:10:42,508
Ancients regarded this star, Algol,
as an “evil eye” in the sky.

150

00:10:42,775 --> 00:10:46,479
The brightness of this star changes
every few days, making the star

151
00:10:46,479 --> 00:10:47,780
appear to “blink”.

152
00:10:47,780 --> 00:10:52,184
We’ll find out later what modern astronomy
tells us about this odd autumn sight.

153
00:10:52,318 --> 00:10:57,023
Meanwhile, months pass,
taking us to our final season, winter.

154
00:10:57,256 --> 00:11:00,993
The most famous constellation, Orion,
appears in the east.

155
00:11:01,093 --> 00:11:05,831
Orion is found directly by searching
the sky for his belt of three stars.

156
00:11:05,898 --> 00:11:11,270
On the southern side of the belt is
a visible nebula at the hilt of his sword.

157
00:11:19,478 --> 00:11:22,815
Extending
Orion’s belt toward the eastern horizon

158
00:11:22,948 --> 00:11:26,552
points to the brightest star
in the evening sky, Sirius.

159

00:11:26,786 --> 00:11:29,855
This “dog star” belongs to Orion’s hunting

160
00:11:29,855 --> 00:11:32,858
dog, Canis Major.

161
00:11:33,426 --> 00:11:37,563
Extending Orion’s belt in the other
direction takes your eye to the bright

162
00:11:37,596 --> 00:11:42,068
star Aldebaran and the group of stars
known as the Pleiades.

163
00:11:42,868 --> 00:11:47,106
The orange star Aldebaran marks
the eye of Taurus the bull.

164
00:11:47,139 --> 00:11:50,976
The Pleiades,
also known as the Seven Sisters, rest

165
00:11:50,976 --> 00:11:55,715
on the bull’s shoulder as he engages
Orion in epic battle.

166
00:11:56,582 --> 00:11:59,585
Taurus may be the oldest constellation
in our show.

167
00:11:59,952 --> 00:12:03,823
The association of a bull with these stars
may go back to the Upper

168
00:12:03,823 --> 00:12:07,026

Paleolithic age, 10,000 years ago.

169
00:12:15,067 --> 00:12:17,203
West and south of Orion lies

170
00:12:17,203 --> 00:12:21,040
an open expanse of sky
which is home to Eri d an us, the River.

171
00:12:21,040 --> 00:12:24,910
In this region a second target for a long
look by the Hubble Space

172
00:12:24,910 --> 00:12:28,981
Telescope was selected to test a key
astronomical idea.

173
00:12:29,215 --> 00:12:32,718
The cosmological principle
says that on large enough scales

174
00:12:32,718 --> 00:12:35,654
the universe should look the same in
any direction.

175
00:12:35,654 --> 00:12:38,357
Would astronomers
find thousands more galaxies?

176
00:12:38,824 --> 00:12:40,092
Indeed they did.

177
00:12:40,092 --> 00:12:45,197
The Ultra Deep Field reached galaxies
that are 13 billion light years away.

178
00:12:45,464 --> 00:12:48,334
The image took more than 10 days
to record the faint

179
00:12:48,334 --> 00:12:51,337
galaxies.

180
00:12:56,742 --> 00:12:58,944
The James Webb Space Telescope

181
00:12:58,944 --> 00:13:01,881
returned to this same area
of sky 20 years later,

182
00:13:01,881 --> 00:13:06,018
and in less than one day recorded
an even deeper image,

183
00:13:06,318 --> 00:13:10,589
The breathtaking detail reveals
small galaxies in the process of merging

184
00:13:10,623 --> 00:13:14,593
to build larger ones,
confirming details of how galaxies

185
00:13:14,593 --> 00:13:17,596
form.

186
00:13:22,635 --> 00:13:25,638
The stars
have been our reliable companions.

187

00:13:25,638 --> 00:13:29,642
Each year, we see these same star patterns
from season to season.

188
00:13:29,875 --> 00:13:32,378
Other objects move among the stars.

189
00:13:32,378 --> 00:13:36,482
When we speed the passage of time,
we see the motion easily.

190
00:13:36,682 --> 00:13:40,853
Some ancients interpreted
the ability to move as a special power

191
00:13:40,986 --> 00:13:44,623
and associated the wandering stars
with gods and goddesses.

192
00:13:44,824 --> 00:13:50,496
Today, we know them to be planets.

193
00:13:50,563 --> 00:13:54,033
Along with the Moon, these objects
all stay near a line called the Ecliptic.

194
00:13:54,466 --> 00:13:58,771
The Ecliptic is the path the Sun appears
to take through our sky each year.

195
00:13:59,772 --> 00:14:02,942
Planets stay near the Ecliptic
and inside the boundaries

196
00:14:02,942 --> 00:14:05,945

of the classical Zodiacal constellations.

197
00:14:06,912 --> 00:14:11,150
Ancient astronomers were excellent
observers of subtle changes in the sky.

198
00:14:11,450 --> 00:14:16,956
They were rather clever to figure out
which stars the Sun and planets were near,

199
00:14:17,223 --> 00:14:20,159
even during the day
when the stars are hidden

200
00:14:20,159 --> 00:14:23,162
by the blue sky.

201
00:14:39,545 --> 00:14:42,381
Next, we'll travel into space
and take a closer

202
00:14:42,381 --> 00:14:46,619
look at four modern wonders,
one for each our seasons

203
00:14:46,619 --> 00:14:49,622
in the sky.

204
00:15:04,470 --> 00:15:08,073
From space,
we can further appreciate the relationship

205
00:15:08,107 --> 00:15:11,110
between the ecliptic and our solar system.

206
00:15:11,176 --> 00:15:14,580
When we look toward Saturn from Earth,
we see Saturn

207
00:15:14,580 --> 00:15:17,149
in a constellation of the Zodiac.

208
00:15:17,149 --> 00:15:22,388
Leaving Earth and our companion Moon,
we must travel over a billion kilometers

209
00:15:22,388 --> 00:15:25,391
to reach the planet Saturn.

210
00:15:48,614 --> 00:15:50,549
Only a dot of reflected sunlight

211
00:15:50,549 --> 00:15:55,621
to our eyes on Earth,
Saturn is a magnificent gas giant planet.

212
00:15:55,654 --> 00:15:59,558
Its bright
ring system, filled with icy debris

213
00:15:59,558 --> 00:16:03,362
that readily reflects sunlight,
puzzled early astronomers

214
00:16:03,362 --> 00:16:08,867
and even today remains a subject worthy
of scientific research and exploration.

215
00:16:09,601 --> 00:16:12,705

Most of the ring
particles are smaller than your fist,

216
00:16:12,738 --> 00:16:17,476
but the sheer number make them seem solid
when viewed from a distance.

217
00:16:17,876 --> 00:16:22,715
Just as the Milky Way is really many stars
that our eyes cannot resolve,

218
00:16:22,881 --> 00:16:26,919
Saturn’s rings are individual particles
which appear solid when

219
00:16:26,952 --> 00:16:28,387
viewed from a distance.

220
00:16:31,357 --> 00:16:33,959
From Saturn, we look back toward Earth

221
00:16:33,959 --> 00:16:37,596
and see that it is in another Zodiacal
constellation.

222
00:16:38,230 --> 00:16:41,867
Though there are 88 different
constellations in the sky,

223
00:16:42,001 --> 00:16:45,471
whatever planet in our solar system
we visit,

224
00:16:45,471 --> 00:16:48,907
the other planets

will always appear in the Zodiac.

225
00:16:49,174 --> 00:16:52,311
This is due to our flattened solar system.

226
00:16:52,411 --> 00:16:56,348
All the major planets orbit
the Sun in a neat, flat

227
00:16:56,348 --> 00:16:59,351
disk.

228
00:17:00,185 --> 00:17:03,355
As it turns out,
many other stars in the sky

229
00:17:03,389 --> 00:17:06,392
have their own planetary systems.

230
00:17:09,361 --> 00:17:11,163
The star 61 Virginis

231
00:17:11,163 --> 00:17:15,667
is seen from Earth in the springtime
in the constellation Virgo.

232
00:17:16,135 --> 00:17:18,771
It’s bright enough
to be seen with the naked eye,

233
00:17:18,771 --> 00:17:22,674
but its planets were completely unknown
to our ancestors.

234

00:17:22,741 --> 00:17:25,744
In fact,
the three planets now known to orbit

235
00:17:25,744 --> 00:17:29,748
this star were just discovered in 2009.

236
00:17:32,551 --> 00:17:34,920
The closest planet is larger than Earth

237
00:17:34,920 --> 00:17:38,023
but extremely hot due to its proximity
to this star.

238
00:17:38,257 --> 00:17:41,093
Compared to our solar system,
this planet is eight

239
00:17:41,093 --> 00:17:44,096
times closer than Mercury is to our Sun.

240
00:17:44,363 --> 00:17:49,301
The second planet in this system is also
close to its star, and its mass suggests

241
00:17:49,301 --> 00:17:53,439
it may be more like a gas giant planet,
perhaps the size of Neptune.

242
00:17:54,440 --> 00:17:55,441
Some planets in

243
00:17:55,441 --> 00:17:59,511
other solar systems may find themselves
at a distance that could be conducive

244
00:17:59,511 --> 00:18:02,748
to liquid water
and other requirements to life

245
00:18:02,748 --> 00:18:05,751
as we know it…

246
00:18:11,423 --> 00:18:13,792
In the autumn sky, we saw from Earth

247
00:18:13,792 --> 00:18:18,730
a star that appeared to early ancestors
as an “evil eye” blinking in the sky.

248
00:18:18,831 --> 00:18:21,900
Now we can visit this star and discover
what astronomy

249
00:18:21,900 --> 00:18:24,903
has taught us about this ancient legend.

250
00:18:25,471 --> 00:18:29,908
The star, Algol, is not simply one star
but a binary system.

251
00:18:29,975 --> 00:18:34,580
Two stars of different temperatures
and brightnesses orbit each other.

252
00:18:34,580 --> 00:18:35,981
From Earth, our eyes can see the change

253
00:18:35,981 --> 00:18:39,351

in overall brightness
as the stars move in front of each other.

254
00:18:39,618 --> 00:18:43,856
This astronomical mystery
hid in plain sight for thousands of years.

255
00:18:43,956 --> 00:18:47,559
Eventually our technology
and scientific proficiency

256
00:18:47,593 --> 00:18:50,863
revealed
the true nature of the “evil eye” star.

257
00:18:59,371 --> 00:19:02,908
In Earth's
winter sky is the mighty hunter Orion.

258
00:19:03,075 --> 00:19:06,111
Within
his boundaries is the great Orion Nebula.

259
00:19:06,378 --> 00:19:10,716
Today we know this to be a stellar nursery
in a gigantic, interstellar

260
00:19:10,716 --> 00:19:12,217
cloud of gas.

261
00:19:12,217 --> 00:19:15,587
Toward the center of the Great Nebula
is a trapezium of four

262
00:19:15,587 --> 00:19:19,391

relatively young stars,
and with closer investigation,

263
00:19:19,424 --> 00:19:22,761
astronomers
have found numerous new planetary systems

264
00:19:22,761 --> 00:19:25,731
just starting to form.

265
00:19:38,911 --> 00:19:39,678
One modern

266
00:19:39,678 --> 00:19:42,681
marvel is a black hole remains to be seen.

267
00:19:42,714 --> 00:19:46,451
In fact it is the most elusive
because it is very difficult

268
00:19:46,451 --> 00:19:48,120
to cannot be view directly.

269
00:19:48,120 --> 00:19:51,123
Our ancestors had no lore
about black holes

270
00:19:51,123 --> 00:19:54,059
because they are entirely modern
discoveries.

271
00:19:54,059 --> 00:19:59,631
Today, we know that some massive stars end
their lives in catastrophic explosions.

272
00:19:59,831 --> 00:20:03,468
The result is a core that collapses
to such a compact state

273
00:20:03,468 --> 00:20:06,939
that its gravity
can change the direction of light itself.

274
00:20:07,372 --> 00:20:11,810
We can't see "this" black hole,
but we can see the warping of space

275
00:20:11,810 --> 00:20:13,879
and distortion of light from objects
behind the black hole.

276
00:20:13,879 --> 00:20:14,146
These characteristic effects
alert us to the presence

277
00:20:14,146 --> 00:20:14,379
of one of astronomy's
most intriguing modern discoveries.

278
00:20:17,616 --> 00:20:20,752
Viewing this black hole in another
wavelength of light

279
00:20:20,786 --> 00:20:23,855
reveals a disk of matter
swirling around the black hole.

280
00:20:24,223 --> 00:20:28,827
The presence of an accretion disk is how
we usually find stellar black holes.

281
00:20:29,394 --> 00:20:33,198
The superheated material emits x-rays
as it orbits a force

282
00:20:33,198 --> 00:20:36,201
too powerful to ever escape.

283
00:20:39,471 --> 00:20:43,709
We've come a long way from primitive human
observation of the sky,

284
00:20:43,742 --> 00:20:48,013
but like our ancestors, we continue
to ask questions about the universe.

285
00:20:48,413 --> 00:20:51,516
Our modern understanding of astronomy
was built over

286
00:20:51,550 --> 00:20:56,321
generations of intrepid observers
and theoretical scientists. Yet,

287
00:20:56,321 --> 00:20:59,858
it seems we are still in our "springtime"
of understanding the universe.

288
00:21:00,592 --> 00:21:04,763
Many mysteries remain unsolved,
and it seems certain we haven't yet

289
00:21:04,796 --> 00:21:07,799
asked all the questions.

290
00:21:14,573 --> 00:21:18,176
As scientists continue
to unravel mysteries of the cosmos,

291
00:21:18,210 --> 00:21:22,381
we can enjoy with quiet
wonder each season of the sky.

292
00:21:24,616 --> 00:21:27,019
The constellations reappear each year

293
00:21:27,019 --> 00:21:30,555
to remind us of our past while fresh discoveries

294
00:21:30,555 --> 00:21:34,993
keep us wondering what
new understanding tomorrow will bring.