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00:00:00,860 --> 00:00:07,856

This series presents information based in part on theory and conjecture.

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00:00:07,856 --> 00:00:17,850

The producer's purpose is to suggest some possible explanations but not necessarily the only ones to the mysteries we will examine.

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00:00:19,849 --> 00:00:28,843

In 1895, H. G. Wells published a fantastic novel about time travel. He entitled it, The Time Machine.

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00:00:31,842 --> 00:00:41,836

The book ushered in a fanciful era of imaginary trips to awe-inspiring events of history.

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00:00:48,831 --> 00:00:52,829

79 A.D. The Eruption of Mount Vesuvius.

6

00:01:00,824 --> 00:01:03,822

26 A.D. The Resurrection of Christ.

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00:01:10,818 --> 00:01:15,815

15 Billion B.C. The very creation of the universe.

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00:01:24,810 --> 00:01:28,808

Today, science is reshaping our concept of the cosmos.

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00:01:29,807 --> 00:01:35,803

Are we at last ready to journey to the stars and conquer the barriers of time and space travel?

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00:01:46,797 --> 00:01:51,794

We are witness to the last leg of a hypothetical journey to the stars and back again.

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00:01:52,793 --> 00:01:56,791

Our crew has been traveling through the galaxy very near the speed of light.

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00:01:59,789 --> 00:02:02,787

They have finally returned to Earth.

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00:02:03,787 --> 00:02:08,784

Due to an effect called time dilation, first described by Albert Einstein,

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00:02:09,783 --> 00:02:14,780

hundreds of years have passed on Earth while only a few years have passed in the spaceship.

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00:02:18,778 --> 00:02:23,775

Once they have landed, what will the crew find when they open the portal of their ship?

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00:02:29,771 --> 00:02:36,767

The Earth has reached undreamed heights of technology or seared itself back into stone age emptiness.

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00:02:39,765 --> 00:02:42,763

It is easy to conceive of the astronauts' journey through space.

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00:02:43,763 --> 00:02:46,761

It is harder to comprehend their travel through time.

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00:02:47,760 --> 00:02:51,758

The Earth has reached undreamed heights of technology or seared itself back into stone age emptiness.

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00:02:51,758 --> 00:02:54,756

It is easy to conceive of the astronauts' journey through space.

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00:02:55,756 --> 00:02:58,754

It is harder to comprehend their travel through time.

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00:03:00,753 --> 00:03:04,750

How far-fetched is the idea of actually traveling through time?

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00:03:05,750 --> 00:03:10,747

Today, we accept the concept of distance space travel because we have journey to the moon and back.

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00:03:11,746 --> 00:03:17,743

Now, scientists are preparing for a world where both time and space travel are inseparably linked.

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00:03:18,742 --> 00:03:22,740

One expert on the subject of time and space is William Kaufman,

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00:03:23,739 --> 00:03:29,735

author, lecturer and adjunct professor in the Department of Physics at San Diego State University.

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00:03:30,735 --> 00:03:35,732

We all live in space and time. We're all familiar with the three dimensions of space,

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00:03:36,731 --> 00:03:38,730

forward and back, left and right, up and down.

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00:03:39,729 --> 00:03:41,728

And time, time is what clocks measure.

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00:03:41,728 --> 00:03:44,726

As the clock ticks on, it's measuring time.

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00:03:45,726 --> 00:03:49,724

And of course, as we go from the cradle to the grave, you're also moving through time.

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00:03:50,723 --> 00:03:52,722

It's kind of like looking up at the stars.

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00:03:53,721 --> 00:03:57,719

When you look up at the stars during the night, you see stars scattered across the sky.

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00:03:58,718 --> 00:04:02,716

If you think about what you're seeing, if you look at a star that's 10 light years away,

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00:04:03,715 --> 00:04:09,712

you're really seeing how that star looked 10 years ago because it took the light 10 years to get to you.

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00:04:09,712 --> 00:04:16,707

And therefore, to me, one of the great lessons of the nighttime sky is that as we are looking out into space,

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00:04:17,707 --> 00:04:25,702

we're also looking backwards in time, that we must incorporate time on an equal footing with our three dimensions of space

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00:04:26,701 --> 00:04:32,698

and talk about something that we call space-time, one of the things that was given to us by Albert Einstein.

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00:04:32,698 --> 00:04:43,691

Albert Einstein changed all conventional thinking in physics when he published his famous theory of relativity in 1905.

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00:04:44,691 --> 00:04:51,687

He is equal mc^2 in which energy is per equal to mass.

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00:04:51,687 --> 00:05:03,679

Multiply this square of the velocity of light showed that very small amount of mass may be converted into a very large amount of energy.

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00:05:04,679 --> 00:05:11,675

Albert Einstein approached all of reality with a deep personal conviction, almost a religious belief,

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00:05:12,674 --> 00:05:17,671

that if we're doing anything right in science, if we're discovering anything of any real value,

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00:05:17,671 --> 00:05:21,669

then the way we write down our discoveries, the way we write down our equations,

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00:05:22,668 --> 00:05:29,664

should not depend on things like the color of your skin or your religion or how fast you happen to be moving,

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00:05:30,663 --> 00:05:35,660

whether you're sitting here on the earth or zooming through the solar system at three quarters the speed of light.

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00:05:36,660 --> 00:05:44,655

And all Einstein did in 1905 was take everything we knew about electricity and magnetism

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00:05:44,655 --> 00:05:48,653

and rewrite it in a form such that it would be the same for everyone.

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00:05:49,652 --> 00:05:56,648

For an example, suppose you have a rocket ship moving through the solar system at three quarters of the speed of light

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00:05:57,647 --> 00:06:06,642

in order for you on earth and your colleague in that spaceship to have a complete, coherent, rational understanding of how things work.

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00:06:06,642 --> 00:06:17,635

You have to say, his rulers are shrinking. You have to say that the very mass of his spaceship is behaving as though it's much more massive than it normally is.

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00:06:18,635 --> 00:06:26,630

You have to say, his clocks are ticking more slowly than normal. Not only do the clocks tick more slowly,

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00:06:27,629 --> 00:06:32,626

but every process proceeds more slowly, like the rate at which a man's beard grows

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00:06:32,626 --> 00:06:38,623

or the rate at which your heart beats or even the rate at which you age.

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00:06:39,622 --> 00:06:44,619

One of the results of all of this is that you can't travel faster than the speed of light.

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00:06:45,619 --> 00:06:53,614

And the reason why this is so is if you think about moving out in a rocket ship, say a rocket ship even with an infinite supply of fuel,

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00:06:54,613 --> 00:06:58,611

as that rocket ship goes faster and faster and faster, its clocks slow down.

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00:06:58,611 --> 00:07:02,608

And as a result, it burns that fuel more and more slowly.

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00:07:03,608 --> 00:07:10,604

And the slowing down of time is so powerful that at the speed of light clocks stop, time stops.

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00:07:11,603 --> 00:07:19,598

And as a result, you never are able to burn that final drop of fuel, that final precious drop of fuel that would put you over the speed of light.

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00:07:20,598 --> 00:07:28,593

While Albert Einstein was exploring many of the hypothetical and mathematical aspects of space and time,

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00:07:29,592 --> 00:07:36,588

people in the United States and in Germany were actually building machines to take us up off of the surface of the Earth.

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00:07:41,585 --> 00:07:46,582

Early experiments in rocketry appear almost comic compared to today's accomplishments in space.

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00:07:50,580 --> 00:07:59,574

But improvements in rocket design came rapidly, especially in America under Robert Goddard and in Germany with the work of Werner von Braun.

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00:08:00,574 --> 00:08:09,569

By 1932, von Braun had taken charge of Germany's rocket program and had begun the tests that would lead to the infamous V-2 missiles.

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00:08:10,568 --> 00:08:18,563

During World War II, Adolf Hitler used the V-2 rocket as a weapon of terror against the civilian population of London.

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00:08:27,558 --> 00:08:32,555

For better or for worse, rockets have always had a military application.

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00:08:33,554 --> 00:08:44,548

But underlying all of this in the minds of everyone who works on these projects is the vision of using these machines to take us beyond the confines of our own planet.

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00:08:45,547 --> 00:08:53,542

To explore the moon, we've walked on the lunar surface to use reusable rocket ships like the Space Shuttle to make many trips,

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00:08:54,542 --> 00:08:58,539

to make use of the full potential of what actually exists out there in space.

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00:08:58,539 --> 00:09:06,535

And you know, perhaps not us, but our children may very well be able to put flights to space stations or to the moon and beyond.

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00:09:09,533 --> 00:09:16,529

One group that hopes to be among the first to utilize the Space Shuttle when it opens up to civilians calls itself OASIS.

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00:09:17,528 --> 00:09:23,524

They gather together on weekends to share food and their enthusiasm for space travel.

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00:09:24,524 --> 00:09:28,521

I'm Charlie Carr and I'm with the California Museum of Science and Industries.

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00:09:29,521 --> 00:09:31,520

This group is doing something that's really unique.

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00:09:31,520 --> 00:09:39,515

It's getting together a lot of people from different backgrounds, from technical fields, from social fields, people working in the community,

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00:09:39,515 --> 00:09:45,511

all different sorts of people and they're all thinking and talking about space, they're talking about what's going to happen in the future,

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00:09:45,511 --> 00:09:51,508

talking about what's going to happen personally with their lives as more people move out into space.

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00:09:53,507 --> 00:10:01,502

A frequent lecturer to the group is Dr. B. J. Bluth, sociologist and expert on long duration space flight.

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00:10:02,501 --> 00:10:10,496

The work that I do really focuses in on how people can live in space, how they can get along together,

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00:10:10,496 --> 00:10:19,491

what kinds of general problems, stresses, factors make it easier and harder for them to have a viable, successful mission.

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00:10:19,491 --> 00:10:23,489

The human is going to have certain kinds of problems when he goes to space.

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00:10:23,489 --> 00:10:31,484

There are stresses, there are physiological problems, there are fears, there are incidents that occur, there's the interpersonal relationship,

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00:10:31,484 --> 00:10:36,481

there's being holed up all alone, no place to go, no way to get away.

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00:10:36,481 --> 00:10:44,476

If you can imagine yourself being in a camper with no privacy curtains with another person for six months and no place to go and you can't walk out of the camper,

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00:10:44,476 --> 00:10:47,474

what kinds of things happen in that kind of situation?

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00:10:48,474 --> 00:10:55,470

We have a very human problem in going to space. The technology is only one aspect.

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00:10:55,470 --> 00:11:02,465

And if the human part of this space travel isn't as carefully solved as the technology problem,

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00:11:02,465 --> 00:11:06,463

all of the technology in the world isn't going to make it possible to do what we want to do.

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00:11:06,463 --> 00:11:10,461

Obviously there are a lot of technical problems with space travel.

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00:11:10,461 --> 00:11:16,457

It's a difficult business getting someone there and back and healthy and sane during the process.

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00:11:16,457 --> 00:11:20,455

But there's another whole aspect to this business.

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00:11:20,455 --> 00:11:25,452

Because sitting around in the scientific journals for the past 15 or 20 years now

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00:11:25,452 --> 00:11:31,448

have been things like time machines and time tunnels, wormholes in space,

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00:11:31,448 --> 00:11:37,445

highly warped regions of space where you could go in some place in our universe and come out in another universe,

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00:11:37,445 --> 00:11:42,442

or go in one of these holes and come out back in our own universe at a different time,

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00:11:42,442 --> 00:11:45,440

a billion years ago or a billion years in the future.

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00:11:45,440 --> 00:11:51,436

And these are some of the most fantastic hypothetical things that science has ever given us.

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00:11:52,436 --> 00:11:57,433

In our future explorations of the galaxy, will we one day make the discovery

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00:11:57,433 --> 00:12:01,430

that will fulfill H.G. Wells' dream of time travel?

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00:12:07,427 --> 00:12:12,424

Will we find the mechanism to travel backwards and forwards through time?

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00:12:16,421 --> 00:12:22,418

I am afraid I cannot convey the peculiar sensations of time traveling.

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00:12:22,418 --> 00:12:26,415

There is a feeling of helpless headlong motion.

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00:12:26,415 --> 00:12:32,412

As I put on pace, night followed day like the flapping of a black wing.

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00:12:32,412 --> 00:12:39,408

So wrote H.G. Wells in 1895 in his incredible novel, *The Time Machine*.

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00:12:39,408 --> 00:12:44,405

Wells described a machine of brand new technology.

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00:12:44,405 --> 00:12:50,401

He described a machine of brass, ebony, ivory and translucent glimmering quartz.

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00:12:50,401 --> 00:12:55,398

It was designed to take man on a journey through time.

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00:13:01,394 --> 00:13:07,391

Wells clearly understood the implication of traveling backwards and forwards through the centuries

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00:13:07,391 --> 00:13:11,389

and depicted it as a wonderful adventure.

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00:13:14,387 --> 00:13:19,384

The time machine was designed to travel backwards and forwards through time.

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00:13:19,384 --> 00:13:24,381

It was designed to travel backwards and forwards through time.

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00:13:24,381 --> 00:13:29,378

It was designed to travel backwards and forwards through time.

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00:13:29,378 --> 00:13:34,375

It was designed to travel backwards and forwards through time.

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00:13:34,375 --> 00:13:39,372

It was designed to travel backwards and forwards through time.

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00:13:39,372 --> 00:13:44,369

It was designed to travel backwards and forwards through time.

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00:13:44,369 --> 00:13:49,366

It was designed to travel backwards and forwards through time.

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00:13:49,366 --> 00:13:54,363

It was designed to travel backwards and forwards through time.

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00:13:54,363 --> 00:13:59,360

It was designed to travel backwards and forwards through time.

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00:13:59,360 --> 00:14:04,357

It was designed to travel backwards and forwards through time.

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00:14:04,357 --> 00:14:09,354

It was designed to travel backwards and forwards through time.

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00:14:09,354 --> 00:14:14,351

It was designed to travel backwards and forwards through time.

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00:14:14,351 --> 00:14:23,346

In an effort to accurately predict the future, H.G. Wells strove to utilize the latest scientific theories of his day.

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00:14:23,346 --> 00:14:30,341

A strong proponent of the theory of evolution, Wells suggested that the environment of industrialized England

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00:14:30,341 --> 00:14:35,338

caused the factory workers to evolve into what he called Morlocks.

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00:14:35,338 --> 00:14:44,333

The Morlocks were pale, pink-eyed, carnivorous creatures who inhabited underground caverns of complex machinery.

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00:14:44,333 --> 00:14:50,330

Wells saw a different fate for those who lived the life of leisure in society.

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00:14:50,330 --> 00:14:59,324

After thousands of years of living without need or conflict, Wells proposed that they would evolve into what he called the Eloi.

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00:14:59,324 --> 00:15:07,319

The Eloi were childlike creatures of limited intelligence who would frolic and gather fruit on the surface of the earth.

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00:15:07,319 --> 00:15:14,315

Today, the evolutionary prophecies of H.G. Wells seem to many unlikely.

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00:15:14,315 --> 00:15:21,311

But is it possible that someday science may actually build a time machine?

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00:15:21,311 --> 00:15:28,307

Having a time machine is a very attractive idea. We all have things we'd like to go back and change about our lives,

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00:15:28,307 --> 00:15:31,305

or maybe affect history somehow.

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00:15:31,305 --> 00:15:37,302

But scientists have trouble with time machines. There are a lot of illogical inconsistencies that develop.

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00:15:37,302 --> 00:15:42,299

For example, if you had a time machine that could take you back a billion years in the past,

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00:15:42,299 --> 00:15:48,295

well then you should certainly have no difficulty going five minutes back into the past.

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00:15:48,295 --> 00:15:57,290

And if you could go back five minutes, you could meet yourself and tell yourself, literally, what kind of a nice trip you had.

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00:15:57,290 --> 00:16:04,285

And then both of you could do the same thing. And then all four of you could do it. And then all eight of you could do it.

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00:16:04,285 --> 00:16:08,283

In other words, there's an inherent inconsistency that suddenly comes up.

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00:16:08,283 --> 00:16:13,280

If you could travel back into the past, then reality must be irrational.

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00:16:13,280 --> 00:16:18,277

There must be a very irrational part to how the universe works.

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00:16:18,277 --> 00:16:20,276

And we don't see this going on around us.

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00:16:20,276 --> 00:16:25,273

And for this reason, when scientists find time machines popping up in their calculations,

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00:16:25,273 --> 00:16:30,270

a lot of flags go up and they begin suspecting that they've done something wrong.

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00:16:30,270 --> 00:16:37,266

If there is any chance of a time travel mechanism existing, it will probably be found in distant space.

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00:16:37,266 --> 00:16:49,259

Some scientists believe that when a giant red star explodes, the remaining core may collapse down to an incredibly dense ball of matter called a black hole.

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00:16:49,259 --> 00:16:56,254

The gravitational field around a black hole is so intense that not even light can escape it.

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00:16:58,253 --> 00:17:04,250

The full description of how black holes work also include white holes.

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00:17:04,250 --> 00:17:09,247

The full description actually is a set of black holes and white holes back to back.

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00:17:09,247 --> 00:17:17,242

What's a black hole for one universe where things fall in is a white hole in the next universe where stuff gushes out.

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00:17:17,242 --> 00:17:23,238

But the interesting thing in all of these pictures where you have a black hole, white hole situation

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00:17:23,238 --> 00:17:31,234

is that if you take into account the effects of rotation on the black hole, the entire structure inside the black hole change.

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00:17:31,234 --> 00:17:39,229

In particular, one of the things to come out of this theoretically is that you could possibly use this black hole as a portal,

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00:17:39,229 --> 00:17:46,225

as a time tunnel from our universe to some future universe, or perhaps even some past universe.

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00:17:48,223 --> 00:17:52,221

Such a journey into a black hole would be fraught with dangers.

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00:18:02,215 --> 00:18:09,211

If you can go through that wormhole in space and time, then you can travel very, very near the center of the hole.

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00:18:09,211 --> 00:18:16,207

You can travel very near where the matter of the star collapsed down to, where you have this tremendous curvature,

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00:18:16,207 --> 00:18:21,204

this high warping of space and time. And there are problems with that.

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00:18:21,204 --> 00:18:26,201

For example, if you could travel very near that place where we have infinite space-time warping,

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00:18:26,201 --> 00:18:34,196

according to Einstein's famous equation $E = mc^2$, the energy in the gravitational field of the hole

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00:18:34,196 --> 00:18:42,191

produces a lot of matter that fills up the wormhole and chokes off any possibility of space travel to future universes.

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00:18:42,191 --> 00:18:48,188

And this is one of the ways in which we think nature prohibits time machines.

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00:18:48,188 --> 00:18:54,184

Nature takes care of things and makes sure that things won't come out too irrational by having a time machine.

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00:18:54,184 --> 00:18:58,182

It chokes off the possibility of getting through the wormhole.

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00:18:58,182 --> 00:19:06,177

Perhaps the tunnel through a black hole will forever remain blocked, but the possibility always remains that someday

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00:19:06,177 --> 00:19:13,173

someone will make a discovery which will allow us to visit Earth's distant past or glittering future.

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00:19:15,172 --> 00:19:20,169

Carol Amato has a background in social science and is a member of OASIS.

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00:19:20,169 --> 00:19:25,166

She has a special plan for accomplishing her goal of space travel.

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00:19:25,166 --> 00:19:32,161

I use the computer in my work and I'm hoping that by doing so this will provide a career path for me to get into space.

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00:19:32,161 --> 00:19:38,158

My children I'm trying to prepare just by being adaptive to new situations.

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00:19:38,158 --> 00:19:44,154

Tracy has a tremendous interest in growing things, plants and baby animals.

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00:19:44,154 --> 00:19:50,151

I'm hoping she'll take this interest into space because it's going to be necessary to want to nurture things

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00:19:50,151 --> 00:19:56,147

in order to make the environment be a psychologically pleasing one and to recreate something of the Earth.

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00:19:56,147 --> 00:20:03,143

Damon's a very active boy. I hope he can utilize that energy that he has in some constructive way.

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00:20:03,143 --> 00:20:06,141

Maybe he can go into space and become one of the pioneers.

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00:20:07,141 --> 00:20:15,136

With the successful flight of the space shuttle and the likelihood of civilian space travel on the horizon,

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00:20:15,136 --> 00:20:22,132

it is not difficult to imagine families like Carol Amato's someday traveling into space.

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00:20:22,132 --> 00:20:30,127

Perhaps one day a boy Damon's age will solve the mystery of what lies on the other side of a black hole

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00:20:30,127 --> 00:20:33,125

or at the place beyond the stars.

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00:20:37,123 --> 00:20:48,116

What are the limitations of the galaxy? Will we ever travel faster than the speed of light or backward and forward through time?

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00:20:51,114 --> 00:20:55,112

I don't think that any scientist would categorically say,

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00:20:55,112 --> 00:21:00,109

no we will never travel faster than the speed of light, no we'll never have time travel.

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00:21:00,109 --> 00:21:08,104

But if we ever do, then this would have to come from a whole new view of science, a new super science,

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00:21:08,104 --> 00:21:13,101

whereby we understand today's limitations as one separate little case.

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00:21:13,101 --> 00:21:21,096

In other words, the kind of science that would give us travel into the past or travel faster than the speed of light

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00:21:21,096 --> 00:21:27,093

would be as advanced over us today as we are over Neanderthal land.

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00:21:30,091 --> 00:21:32,090

Derek last Schsprünger

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00:21:32,090 --> 00:21:36,887

continued

189

00:22:00,073 --> 00:22:04,071

here on the History Channel, where the past comes alive.