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00:00:01,416 --> 00:00:14,206

NARRATOR: When it comes to understanding the universe, we are only beginning.

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00:00:14,206 --> 00:00:18,806

Humankind continually searches for patterns,

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00:00:19,126 --> 00:00:22,746

trying to figure out what is the universe made of?

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00:00:22,746 --> 00:00:23,386

How does it work?

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00:00:23,386 --> 00:00:27,806

How does our planet, our solar system, our galaxy,

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00:00:27,806 --> 00:00:31,666

fit in with the other pieces...and what don't we know yet?

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00:00:31,666 --> 00:00:40,346

Helping us discover more pieces of the puzzle will be a new instrument onboard the

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00:00:40,496 --> 00:00:48,676

International Space Station called the Alpha Magnetic Spectrometer, or AMS.

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00:00:48,676 --> 00:00:50,046

AMS is not a telescope.

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00:00:50,906 --> 00:00:55,096

Rather than looking at space, it will sift through space,

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00:00:55,096 --> 00:01:00,316

studying the high energy

particles of cosmic rays.

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00:01:00,316 --> 00:01:06,546
From the unique vantage point of Earth orbit, the AMS experiment has the potential

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00:01:06,546 --> 00:01:10,426
to answer questions about the origins of our universe.

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00:01:10,636 --> 00:01:22,206
MUSIC Narrator: It began with a bang...

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00:01:23,496 --> 00:01:33,176
SFX: Explosion sound The Big Bang theory postulates

16
00:01:33,236 --> 00:01:35,946
that the universe was created in a great explosion.

17
00:01:37,086 --> 00:01:40,586
But there are some puzzle pieces missing regarding the big bang...

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00:01:41,996 --> 00:01:46,606
During this explosion, matter and anti-matter should have been created

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00:01:46,766 --> 00:01:52,556
in equal amounts...but we have a hard time finding the anti-matter in the universe.

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00:01:53,336 --> 00:01:53,836
Where is it?

21
00:01:54,246 --> 00:01:56,316
And what exactly is the universe made of?

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00:01:57,236 --> 00:01:58,696

We don't know for certain yet.

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00:01:59,886 --> 00:02:06,036

Here's another missing piece...astronomers have determined that galaxies have ten times the mass

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00:02:06,496 --> 00:02:10,186

than what we see of stars, gas and dust.

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00:02:10,186 --> 00:02:13,526

What accounts for this missing mass in galaxies?

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00:02:13,776 --> 00:02:20,086

The answer may be Dark Matter- a mysterious material that exerts gravitational pull,

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00:02:20,086 --> 00:02:24,926

but does not absorb or emit light.

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00:02:24,926 --> 00:02:29,106

But we have yet to find Dark Matter.

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00:02:29,106 --> 00:02:32,436

The study of high energy particles might help in the search

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00:02:32,436 --> 00:02:34,836

for dark matter and anti-matter in the universe.

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00:02:34,836 --> 00:02:38,416

Nobel Prize winning scientist Prof. Samuel Ting,

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00:02:38,516 --> 00:02:41,986

well known for groundbreaking particle physics work on Earth,

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00:02:42,046 --> 00:02:48,686

has collaborated with an international team

to create the Alpha Magnetic Spectrometer-

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00:02:48,686 --> 00:02:53,036

a high energy particle detector that
takes particle science into space.

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00:02:53,036 --> 00:02:58,226

He and his colleagues hope
the AMS will help answer some

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00:02:58,226 --> 00:03:00,916

of these nagging questions about the universe...

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00:03:00,916 --> 00:03:06,256

Dr. Ting: "If the universe
has come from a big bang...and

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00:03:06,256 --> 00:03:09,266

so you have matter, you must
also have antimatter.

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00:03:10,166 --> 00:03:13,866

Now the universe is close
to 15 billion years old.

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00:03:14,866 --> 00:03:18,546

The question is, where's the other half?

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00:03:18,546 --> 00:03:21,746

Where's the universe made of antimatter?"

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00:03:22,156 --> 00:03:27,896

NARRATOR: An Alpha Magnetic Spectrometer flew
onboard the Space Shuttle in the 1990's,

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00:03:27,896 --> 00:03:32,186

but that mission was only for a few
days, merely proving the concept

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00:03:32,186 --> 00:03:34,646
of flying this type of hardware in space.

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00:03:35,846 --> 00:03:41,496
While valuable science was gleaned from that mission, the AMS on the station will stay

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00:03:41,496 --> 00:03:45,376
for years, with instrumentation that is far more sensitive

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00:03:45,766 --> 00:03:48,786
and far more precise than what was flown before...

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00:03:49,356 --> 00:03:52,706
with over 300 thousand data channels for detection

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00:03:52,706 --> 00:03:57,666
and over 600 on-board microprocessors to analyze the data.

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00:03:58,596 --> 00:04:01,726
NARRATOR: The AMS is sponsored by the Department of Energy,

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00:04:01,726 --> 00:04:06,046
and scientists from 16 countries lent their expertise to create it.

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00:04:06,046 --> 00:04:09,916
Parts from around the world were sent to CERN, the European Organization

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00:04:09,916 --> 00:04:12,556
for Nuclear Research in Geneva, Switzerland.

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00:04:12,796 --> 00:04:18,676
NASA had the job to figure out how to

get the fifteen thousand pound experiment

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00:04:18,676 --> 00:04:24,326

into Earth orbit and have it operate
in the hostile environment of space.

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00:04:24,326 --> 00:04:28,066

The AMS was finally sent to the Kennedy
Space Center where it was readied

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00:04:28,066 --> 00:04:34,746

to fly onboard a space shuttle...the final
large component of the space station to be sent

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00:04:34,746 --> 00:04:36,696

on one of the last shuttle flights.

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00:04:37,506 --> 00:04:42,056

Part of the crew is European Space
Agency astronaut Roberto Vittori,

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00:04:42,056 --> 00:04:47,536

who will operate the shuttle robot arm to
grasp the AMS from the shuttle payload bay...

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00:04:48,176 --> 00:04:53,396

Roberto Vittori: "That means I will have the
responsibility with the shuttle robotic arm

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00:04:53,546 --> 00:04:58,636

to take it from the payload bay
and offer it to the station.

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00:04:59,526 --> 00:05:04,936

But behind that specific operational
task, there is a very long history.

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00:05:05,216 --> 00:05:09,326

I started about 20-25 years
ago to study physics,

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00:05:09,416 --> 00:05:11,726

to think about space, to
think about the universe.

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00:05:12,496 --> 00:05:20,336

The specific, the search for antimatter
was one of my main deep interests.

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00:05:20,336 --> 00:05:25,196

It may appear as a very strange
coincidence that today,

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00:05:25,196 --> 00:05:31,616

I will be the one to take this unique piece of
hardware, take it from the bay of the shuttle

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00:05:31,616 --> 00:05:34,066

and give it to install on the station."

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00:05:34,726 --> 00:05:36,926

NARRATOR: For the AMS, there are many benefits

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00:05:36,926 --> 00:05:40,316

to having a fully functional
space station as your home...

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00:05:40,316 --> 00:05:44,836

Trent Martin: "So AMS weighs fifteen
thousand three hundred pounds.

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00:05:44,836 --> 00:05:47,236

Most of that is science experiments.

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00:05:47,426 --> 00:05:49,746

We do not have to carry our own power.

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00:05:50,076 --> 00:05:54,386

We do not have to carry our own data

systems to transmit that data back to earth

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00:05:54,386 --> 00:05:58,536
because all those systems are provided to us
by the space station, so it's a perfect example

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00:05:58,536 --> 00:06:02,166
of how you can utilize the capabilities
of the International Space Station

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00:06:02,716 --> 00:06:05,276
to fly groundbreaking science experiments."

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00:06:06,016 --> 00:06:08,866
NARRATOR: So how exactly does the AMS work?

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00:06:08,866 --> 00:06:12,206
One thing it is not, is a telescope.

81
00:06:12,206 --> 00:06:18,136
Telescopes measure photons, packages of light
both visible and invisible to the naked eye.

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00:06:18,406 --> 00:06:23,596
This type of astronomy has given us most
of our knowledge of the universe thus far.

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00:06:23,596 --> 00:06:28,996
But the cosmos speaks to us
in languages other than light.

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00:06:28,996 --> 00:06:35,426
For the AMS, this will be the first time
scientists study charged particles...

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00:06:36,876 --> 00:06:43,916
Exploding stars and other celestial phenomena
are thought to produce cosmic rays which travel

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00:06:43,916 --> 00:06:47,866

across the universe and can wash
up on the shores of our planet.

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00:06:47,866 --> 00:06:53,786

The rays are composed of charged particles, but
many of these are absorbed in our atmosphere,

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00:06:53,786 --> 00:06:56,496

making it impossible to study them on Earth.

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00:06:56,566 --> 00:07:02,416

But outside our atmosphere, on the space
station, the AMS will be able to sift

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00:07:02,416 --> 00:07:06,706

through these particles...helping us
search for antimatter, dark matter

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00:07:07,226 --> 00:07:09,616

and the stuff of which the universe is made.

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00:07:11,016 --> 00:07:13,216

A particle will pass into the AMS.

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00:07:13,646 --> 00:07:19,136

Layer upon layer of detectors tells us the
mass, energy, and velocity of the particle.

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00:07:20,436 --> 00:07:26,306

Other detectors tell us which direction or path
the particle took as it passed through the AMS.

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00:07:26,476 --> 00:07:31,686

At the heart of the unit is a magnet
that will make the particle curve one way

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00:07:31,926 --> 00:07:37,466

or another...telling us whether
it is matter...or anti-matter...

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00:07:37,466 --> 00:07:42,236

Narrator: And just how quickly does all this particle detection happen?

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00:07:42,526 --> 00:07:47,146

Trent: " Faster than I can snap my fingers...nanoseconds..."

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00:07:47,516 --> 00:07:52,266

The AMS gathers data at a ridiculously large rate.

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00:07:52,616 --> 00:07:56,376

We will see about twenty-five thousand hits per second

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00:07:56,376 --> 00:08:01,126

of cosmic rays coming into the aperture of AMS.

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00:08:01,126 --> 00:08:04,976

" NARRATOR: If, while sifting through the cosmic sands,

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00:08:05,256 --> 00:08:11,896

the AMS strikes gold...a star tracker onboard the experiment will help scientists determine

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00:08:12,256 --> 00:08:15,536

from where in the universe, the particle came.

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00:08:15,686 --> 00:08:20,766

The AMS can send its volumes of data utilizing the station's communication link with Earth.

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00:08:20,876 --> 00:08:27,056

Teams of scientists all over the world will study that data, looking for particles

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00:08:27,056 --> 00:08:29,886
of dark matter, anti-matter, and the unknown.

108
00:08:29,886 --> 00:08:33,146
So what will we find?

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00:08:33,346 --> 00:08:35,116
Nobody knows.

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00:08:35,116 --> 00:08:41,196
In the science of particle physics,
anything is possible, and often,

111
00:08:41,196 --> 00:08:46,646
the quest for one answer instead reveals
another discovery not dreamed of...

112
00:08:46,646 --> 00:08:51,376
If the cosmos is the ultimate
particle accelerator,

113
00:08:51,376 --> 00:08:54,136
it should provide plenty for the AMS to analyze.

114
00:08:54,136 --> 00:08:59,986
The experiment will stay onboard the space
station for as long as the station is

115
00:09:00,356 --> 00:09:03,406
in orbit...silently sifting
through the particles,

116
00:09:03,406 --> 00:09:09,476
helping scientists find those missing
pieces to the puzzle of our universe,