
WHAT IS
PLASMA?
NASA

1
00:00:00,600 --> 00:00:01,835
Out in space,

2
00:00:01,835 --> 00:00:05,905
particles play by a different set of rules
than we are familiar with at home.

3
00:00:06,606 --> 00:00:09,476
The expanse beyond Earth
is almost entirely

4
00:00:09,476 --> 00:00:11,811
filled with a mysterious state of matter.

5
00:00:12,512 --> 00:00:14,581
This matter is the least understood.

6
00:00:14,981 --> 00:00:17,017
It's rarely encountered on Earth.

7
00:00:17,017 --> 00:00:21,221
Yet it triggers auroras
and even impacts our exploration of space.

8
00:00:21,755 --> 00:00:23,890
This is plasma.

9
00:00:23,890 --> 00:00:28,228
After solid, liquid and gas
Plasma is the fourth state of matter.

10
00:00:28,561 --> 00:00:30,964
It is made of particles
that have been ionized.

11
00:00:31,297 --> 00:00:34,534
This means the particles
have been given so much energy

12
00:00:34,534 --> 00:00:39,339
that electrons separate from their atoms,
making a subatomic soup.

13
00:00:39,406 --> 00:00:42,642
Unlike gas, plasma easily conducts
electricity.

14
00:00:42,876 --> 00:00:45,945
This allows it to move along invisible
pathways

15
00:00:45,945 --> 00:00:49,082
charted by the electromagnetic fields
that fill space.

16
00:00:50,183 --> 00:00:52,052
While plasma is rare on earth,

17
00:00:52,052 --> 00:00:55,822
it makes up 99.9% of the visible universe,

18
00:00:55,922 --> 00:00:58,024
including the sun and other stars.

19
00:00:58,892 --> 00:01:01,394
It's also spread out across the universe

20
00:01:01,394 --> 00:01:03,830
in the space separating planets and stars.

21
00:01:04,464 --> 00:01:06,199
This space is not empty.

22
00:01:06,199 --> 00:01:09,436
It's filled with a weak soup of plasma.

23
00:01:09,436 --> 00:01:14,307

Those vast expanses of space are also
filled with electromagnetic fields,

24
00:01:14,340 --> 00:01:16,943
such as those created
by the sun and earth.

25
00:01:17,610 --> 00:01:21,381
In these places where
plasma and electromagnetic fields play.

26
00:01:21,481 --> 00:01:26,586
Plasma can undergo a unique, explosive
phenomenon called magnetic reconnection.

27
00:01:27,921 --> 00:01:28,488
Magnetic

28
00:01:28,488 --> 00:01:32,292
reconnection occurs where magnetic field
lines are constantly shifting.

29
00:01:32,559 --> 00:01:36,729
When the lines become tangled,
they explosively snap and realign.

30
00:01:36,963 --> 00:01:41,401
This transfers energy and sends nearby
plasma particles flying through space.

31
00:01:42,635 --> 00:01:44,437
Magnetic reconnection triggers

32
00:01:44,437 --> 00:01:49,209
solar flares on the surface of the sun,
creates shockwaves near supernovae,

33
00:01:49,442 --> 00:01:52,212
and violently twists
plasma around black holes.

34
00:01:53,012 --> 00:01:56,683
Closer to home, magnetic reconnection
between the sun and Earth's

35
00:01:56,683 --> 00:02:01,454
magnetic fields is a critical way
energy is transferred around our planet.

36
00:02:01,988 --> 00:02:06,025
For example, when magnetic reconnection
occurs on the nightside of Earth,

37
00:02:06,226 --> 00:02:09,896
it can push particles down
toward the poles, triggering auroras.

38
00:02:10,964 --> 00:02:15,034
Near Earth space is the easiest place
to study magnetic reconnection.

39
00:02:15,268 --> 00:02:20,073
NASA does this with its Magnetospheric
Multiscale mission or MMS.

40
00:02:20,874 --> 00:02:24,878
MMS uses four identical spacecraft
to measure magnetic fields

41
00:02:24,878 --> 00:02:28,982
and particles in 3D 100 times
faster than previous missions.

42
00:02:29,282 --> 00:02:32,385
This has revealed new insights
on the small scale details

43
00:02:32,385 --> 00:02:35,622
of magnetic reconnection
and the nature of plasma itself.

44
00:02:36,956 --> 00:02:38,391
Other NASA missions like

45
00:02:38,391 --> 00:02:42,128
Parker Solar Probe, ARTEMIS, and Voyager

46
00:02:42,195 --> 00:02:45,098
also study plasma across our solar system.

47
00:02:46,132 --> 00:02:50,670
From the surface of the sun to the space
between the planets, NASA continues