
E
O
G.Tempel

1
00:00:00,000 --> 00:00:06,350
Studying total solar eclipses have revealed some of the most fundamental discoveries in science today.

2
00:00:06,370 --> 00:00:07,760
During these celestial events,

3
00:00:07,780 --> 00:00:10,310
scientists discovered the sun’s structure,

4
00:00:10,330 --> 00:00:13,800
the first proof of Einstein’s theory of general relativity,

5
00:00:13,820 --> 00:00:17,960
and the element helium – 30 years before it was found on Earth.

6
00:00:17,980 --> 00:00:23,030
They also discovered huge solar explosions called coronal mass ejections

7
00:00:23,050 --> 00:00:28,220
- eruptions on the sun that continue to be an important component of NASA’s research.

8
00:00:28,240 --> 00:00:30,820
Coronal mass ejections, or CMEs,

9
00:00:30,840 --> 00:00:34,170
are giant eruptions made up of hot gas and plasma.

10
00:00:34,190 --> 00:00:39,220
From the sun’s surface, they propel immense clouds of solar material into space,

11
00:00:39,240 --> 00:00:42,090
speeding at up to a million miles per hour

12
00:00:42,110 --> 00:00:46,430
and carrying enough energy to power the world for 10,000 years.

13
00:00:46,450 --> 00:00:48,820

Sometimes, they’re directed towards Earth

14
00:00:48,840 --> 00:00:53,210
when they can affect our planet's space environment, causing space weather.

15
00:00:53,230 --> 00:00:55,380
Scientists track and study CMEs, because

16
00:00:55,400 --> 00:00:58,460
they can trigger global changes in Earth’s magnetic field.

17
00:00:58,480 --> 00:01:02,980
When intense, these can create magnetic storms that can cause aurora,

18
00:01:03,000 --> 00:01:08,070
but can also affect satellite electronics and power grids on the ground.

19
00:01:08,090 --> 00:01:10,830
Scientists discovered these eruptions in the 1970s

20
00:01:10,850 --> 00:01:13,510
during the beginning of the modern satellite era

21
00:01:13,530 --> 00:01:15,640
– a time when satellites in space

22
00:01:15,660 --> 00:01:18,710
were able to capture thousands of images of solar activity

23
00:01:18,730 --> 00:01:20,730
that had never been seen before.

24
00:01:20,750 --> 00:01:23,530
But, in hindsight, these might not have been

25
00:01:23,550 --> 00:01:27,480
the first time scientists had noticed these solar features.

26
00:01:27,500 --> 00:01:29,560
Soon after they discovered CMEs,

27
00:01:29,580 --> 00:01:33,880
scientists came across reports of a total solar eclipse in 1860

28
00:01:33,900 --> 00:01:37,180
that looked very similar to their satellite images.

29
00:01:37,200 --> 00:01:41,900
On July 18, 1860, the shadow of the moon traveled over North America,

30
00:01:41,920 --> 00:01:45,450
Spain, and North Africa before departing Earth.

31
00:01:45,470 --> 00:01:48,940
Much of the path of totality traveled over populated land

32
00:01:48,960 --> 00:01:51,580
resulting in a wealth of observations.

33
00:01:51,600 --> 00:01:54,580
Back then, astronomical photography was still new,

34
00:01:54,600 --> 00:01:57,980
so many scientists recorded their observations by hand.

35
00:01:58,000 --> 00:02:01,430
The drawings show the large white fingers of the corona

36
00:02:01,450 --> 00:02:04,620
and also a distinctive arc-like feature.

37
00:02:04,640 --> 00:02:10,520
With multiple images drawn from different locations across Europe it appears to evolve over time.

38
00:02:10,540 --> 00:02:12,680

But not all of the images showed this.

39
00:02:12,700 --> 00:02:16,150
About two thirds of people saw the tulip head-like shape,

40
00:02:16,170 --> 00:02:18,690
but one third didn’t see anything at all

41
00:02:18,710 --> 00:02:21,560
including renowned scientist Angelo Secchi.

42
00:02:21,580 --> 00:02:25,180
It wasn’t until over 100 years later with regular satellite imagery

43
00:02:25,200 --> 00:02:29,890
that scientists reopened the debate about what was seen in the 1860 eclipse.

44
00:02:29,910 --> 00:02:35,360
The strong resemblance shows that this eclipse may be the first record of a CME.

45
00:02:35,380 --> 00:02:39,450
While satellites in the space age exploded the field of CME research,

46
00:02:39,470 --> 00:02:42,000
total solar eclipses seen from the ground

47
00:02:42,020 --> 00:02:45,430
still provide unique views of the sun’s atmosphere

48
00:02:45,450 --> 00:02:49,070
that help our understanding of what causes these explosions.

49
00:02:49,090 --> 00:02:51,770
Current instruments in space studying the corona

50
00:02:51,790 --> 00:02:55,880
need to block the sun’s bright body with an occulting disk.

51
00:02:55,900 --> 00:02:59,420
The disk covers up the sun and a portion of the lower corona

52
00:02:59,440 --> 00:03:05,980
- an important region that scientists believe is responsible for accelerating CMEs and forming solar wind.

53
00:03:06,000 --> 00:03:08,250
So when eclipses happen to fall on land,

54
00:03:08,270 --> 00:03:11,000
scientists take advantage of these rare events.