FYI Sunspots

When the sun is viewed through a solar telescope, dark spots can be observed on its surface. These continuously changing dark regions are called **sunspots**. Sunspots can be quite small (1500 km in diameter), or can reach sizes of up to 50,000 km (Figure 2-5). The inner part of a sunspot is very dark and is called the **umbra**, the Latin word for shadow. The lighter region surrounding the umbra is known as the **penumbra**. Sunspots tell us a lot about the sun, including its rotation rate and changes in its strong magnetic field.

The dark sunspots indicate regions of cool gas—or at least cooler than the surrounding hot gas—near the surface of the sun. Typically the gas would mix quickly, so cooler regions would not last long enough to be observable. The fact that sunspots commonly occur in pairs led astronomers to look at magnetic fields as a factor in sunspots. One explanation is that the magnetic field lines bunch up at certain regions on the sun and create small magnetic loops near the sun's surface, where each end of the loop is a magnetic pole (Figure 2-6).

Sunspots provide evidence of dramatic changes in the sun's magnetic field. The sun's entire magnetic field flips every 11 years, taking a total of 22 years to return to its original orientation. This 22-year cycle is called the **solar cycle**. At the beginning of a new solar cycle, sunspots appear mainly at high solar latitudes, close to the sun's north and south poles. As the magnetic field changes its orientation, sunspots form closer to the sun's equator, and then return to the poles. Within the cycle, there is one 11-year period that has high activity, called the **solar maximum**, and one with low activity, the **solar minimum**. During the solar maximum the sun is very active; it has many sunspots, solar flares, and **coronal mass ejections** (called "**CMEs**"), which can affect life here on Earth. For centuries it has been known

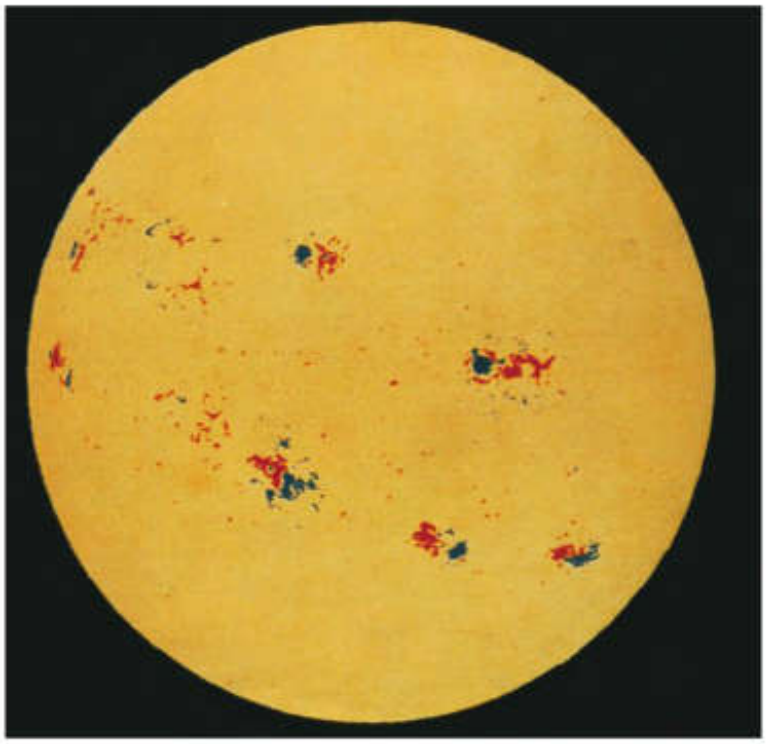


Figure 2-5: Color-enhanced image of sunspots

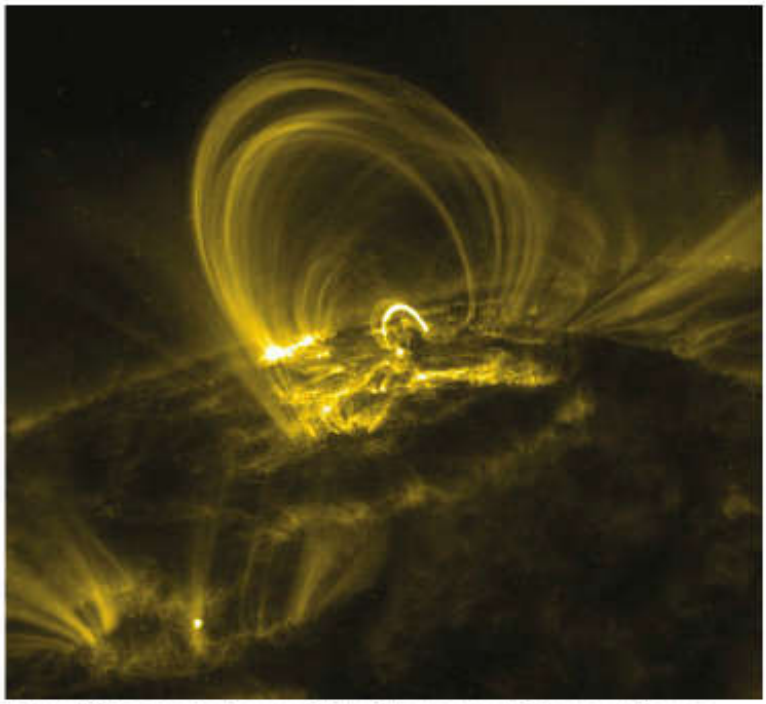
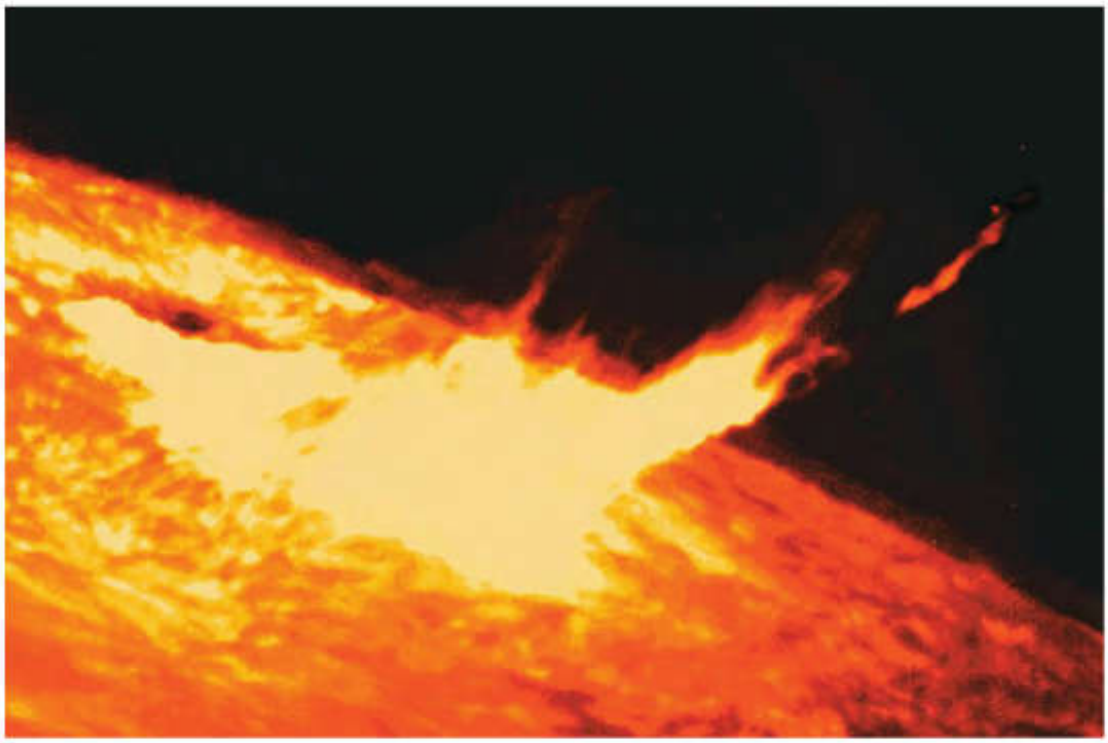


Figure 2-6: Image of solar material tracing out magnetic loops on the sun's surface

that the solar cycle has an impact on Earth's weather, and in the modern era, solar activity can seriously influence electrical devices and communication systems. Solar storms can send huge waves of electrical energy surging along power lines, shorting circuits and burning out equipment. A solar storm in 1989 caused a blackout in Quebec, and coils in a transformer station in Salem, New Jersey melted and caught fire, causing a regional power outage. There is always concern about the effect of CMEs on orbiting satellites and astronauts who are exposed to the elements of outer space during space walks.

Checking In

1. In what ways do sunspots help us learn more about the magnetic field of the sun?
2. In what ways does the solar cycle of activity on the sun's surface pose potential concerns for activity on Earth?



An image of a solar flare on the sun