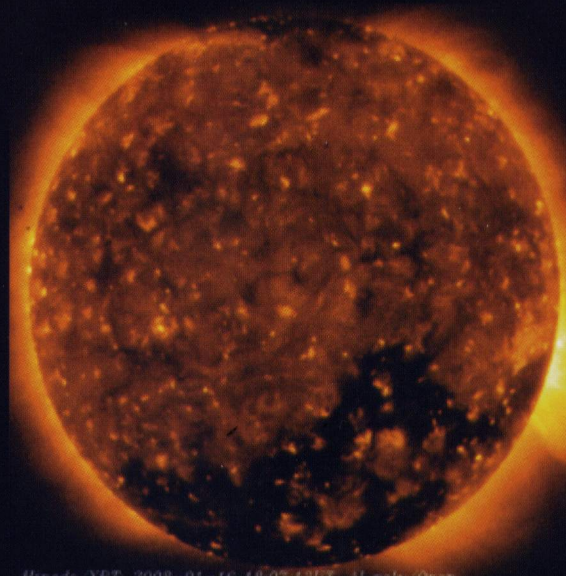
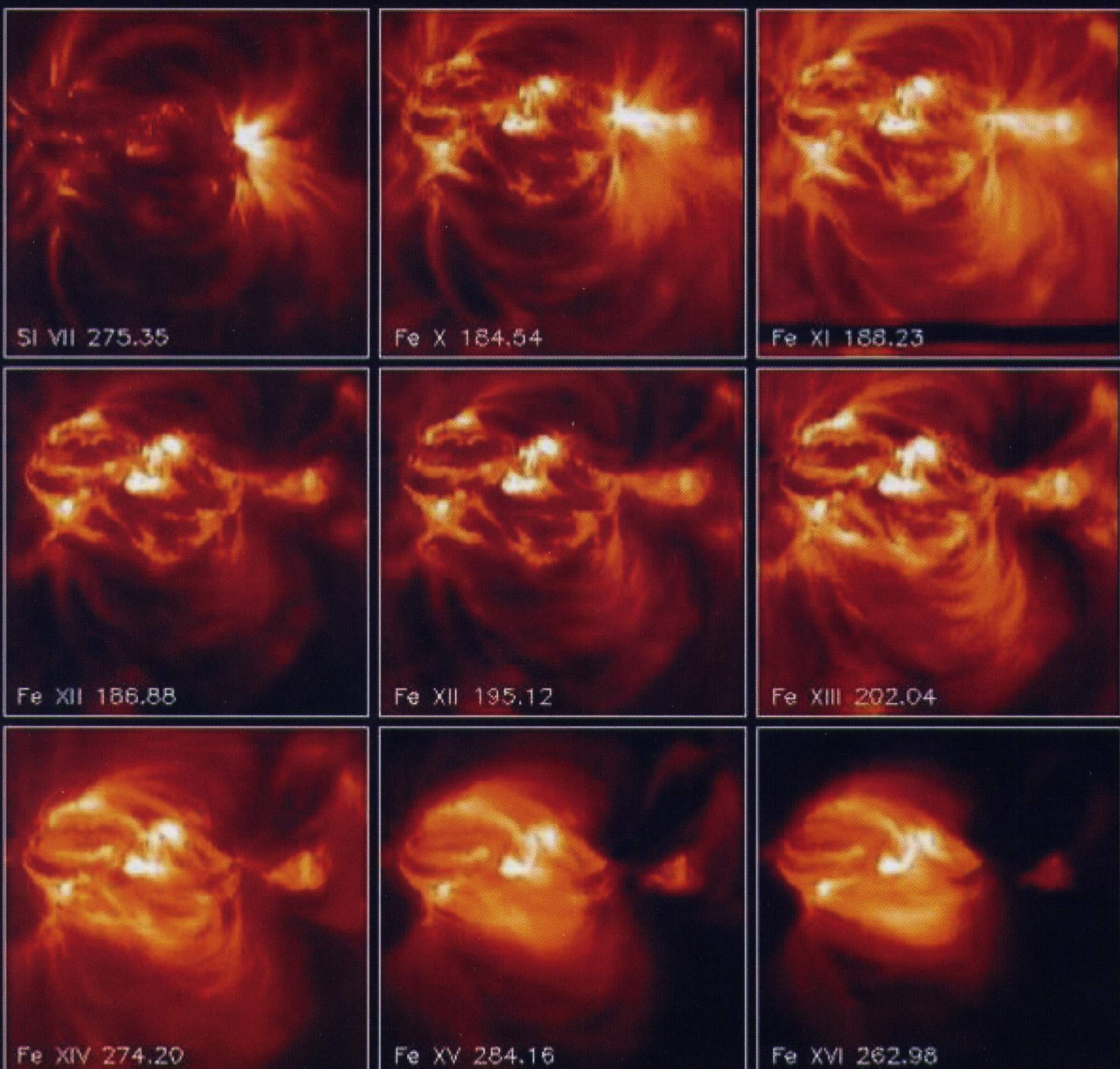
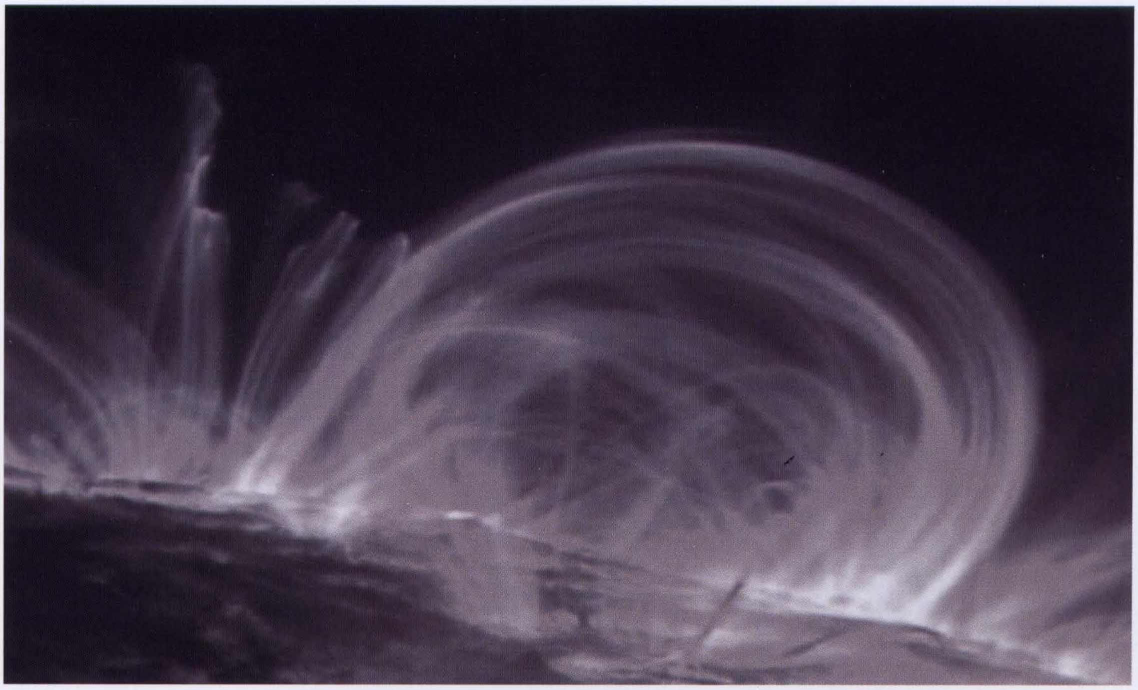




Hinode EIS - Unlocking the mystery of solar flares



Problem 1: The Hinode satellite studied a coronal loop on January 20, 2007 associated with Active Region AR 10938, which was shaped like a semi-circle with a radius of 20,000 kilometers, forming a cylindrical tube with a base radius of 1000 kilometers. What was the total volume of this magnetic loop in cubic centimeters assuming that it is shaped like a cylinder?

Problem 2: The Hinode EIS instrument was able to determine that the density of the gas within this magnetic loop was about 2 billion hydrogen atoms per cubic centimeter. If a hydrogen atom has a mass of 1.6×10^{-24} grams, what was the total mass of the gas trapped within this cylindrical loop in metric tons?

Answer 1: The length (h) of the cylinder is 1/2 the circumference of the circle with a radius of 20,000 km or $h = 1/2\ (2\pi R) = 3.14 \times 20{,}000$ km = 62,800 km. The volume of a cylinder is $V = \pi R^2 h$ so that the volume of the loop is

$$V = \pi\ (1000\ \text{km})^2 \times 62{,}800\ \text{km}$$
$$= 2.0 \times 10^{11}\ \text{cubic kilometers.}$$

1 cubic kilometer = 10^{15} cubic centimeters so

= **2.0×10^{26} cubic centimeters**

Answer 2: The total mass is the product of the density times the volume, so Density = 2×10^{9} particles/cc x (1.6×10^{-24} grams/particle) = 3.2×10^{-15} grams/cm^3

The approximate volume of the magnetic loop in cubic centimeters is

$$V = (2.0 \times 10^{11}\ km^3) \times (1.0 \times 10^{15}\ cm^3/km^3)$$
$$= 2.0 \times 10^{26}\ cm^3$$

Mass = Density x Volume = (3.2×10^{-15} grams/cm^3) x (2.0×10^{26} cm^3) = $6.4 \times 10^{26-15}$ = 6.4×10^{11} grams or 6.4×10^{8} kilograms or **640,000 metric tons.**

The solar surface is not only a hot, convecting ocean of gas, but is laced with magnetism. The sun's magnetic field can be concentrated into sunspots. The horseshoe shape of the magnetic field has endpoints that coincide with dark sunspot regions. Heated gases become trapped by the magnetic forces in these loops, which act like magnetic bottles. The light from these gases lets scientists study the complex 'loopy' patterns that the magnetic fields make as they expand into space like the above image from NASA's TRACE satellite.

Images only tell scientists where the gases are, and the shape of the magnetic field. This isn't enough information to fully understand the physical conditions within these magnetic loops. Satellites such as Hinode carry instruments like the EUV Imaging Spectrometer (EIS), which let scientists measure the temperatures of the gases and their densities as well.

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Dr. Sten Odenwald