The Sun

Basic Solar Data

100 times larger than the Earth
One million times as massive as Earth
Surface Temperature ~10,500 F (5,800 K)
Rotates once per month
Is half a degree in size on the sky
Basic Solar Data

### Sun Data

- **Distance from the Earth:**
  - Mean: 1 AU = 149,598,000 km
  - Maximum: 152,000,000 km
  - Minimum: 147,000,000 km
- **Light travel time to the Earth:** 8.32 mins
- **Mean angular diameter:** 32 arcmin
- **Radius:** 696,000 km = 109 Earth radii
- **Mass:** $1.989 	imes 10^{30}$ kg
  - $3.34 	imes 10^{10}$ Earth masses
- **Composition (by mass):**
  - 74% hydrogen
  - 25% helium
  - 1% other elements
- **Composition (by number of atoms):**
  - 92.1% hydrogen
  - 7.6% helium
  - 0.3% other elements
- **Mean density:** 1410 kg/m³
- **Mean temperatures:**
  - Surface: 5800 K
  - Center: 1500 K
- **Luminosity:** $3.84 	imes 10^{26}$ W
- **Distance from center of Galaxy:** 8000 pc = 25,000 ly
- **Orbital period around center of Galaxy:** 220 million years
- **Orbital speed around center of Galaxy:** 220 km/s

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Solar Atmosphere

- **Photosphere**
  - (“Light” region)
- **Chromosphere**
  - (“Color” region)
- **Corona**
  - (“Crown”)
Photosphere

The photosphere is the “surface” that we see. It is not a physical boundary but an optical one. The absorption of light by the H\textsuperscript{+} molecule produces the sharp edge.

Height 400 km
Temperature 5800 K (down to 4500 K)
Surface is covered with granules.

Granulation
Size of Texas + Oklahoma
Centers are 50 – 100 K hotter than edges
Persist for ~8 minutes
Photosphere

Convection

Hot gas rising upward produces the bright granules. Cooler gas sinks downward along the boundaries between granules. This gas is about 50 K cooler, so it is slightly less bright.

Rotation of the Sun

Sunspots were used by Galileo to determine the Sun’s rotation

Differential Rotation

25 days 0° latitude
28 days 40° latitude
36 days 80° latitude
Chromosphere

The chromosphere is the region of color. Namely, helium, which has red emission lines, was first detected in this region during solar eclipses.

Height 2000 km to 3000 km
Temperature 4,500 K to 10,000 K
Contains millions of spicules

Spicules
As much as 10,000 km high
Temperature quickly rises to 1,000,000 K
Lasts for about 15 minutes
About 300,000 spicules exist at any given time
Corona

The corona is the “crown” of the Sun. It is best seen during a total solar eclipse.

Height  millions of km

Temperature  millions of K

Heated by magnetic fields. Best viewed in the X-ray. Can be a very violent region.
Images of the Corona

Solar Wind

Composed of charged particles, mainly electrons. The solar wind exists because the gases in the corona are too hot to be confined by solar gravity.

The speed of the solar wind near the Earth’s orbit averages about 400 km/s, and its density is usually two to ten ions per cubic centimeter. But both are highly variable.

The solar wind’s interaction with the Earth’s atmosphere creates aurora.