

SUN AND ITS STRUCTURE



"SOL OMNIBUS LUCET" :
SUN SHINES FOR EVERYONE!

—the solar interior—
layers drawn to scale

0.0000002
g/cm³

corona

photosphere

5700 K

convective zone

0.2 g/cm³

2 million K

tachocline

radiative zone

20 g/cm³

7 million K

core

150 g/cm³

15.7 million K

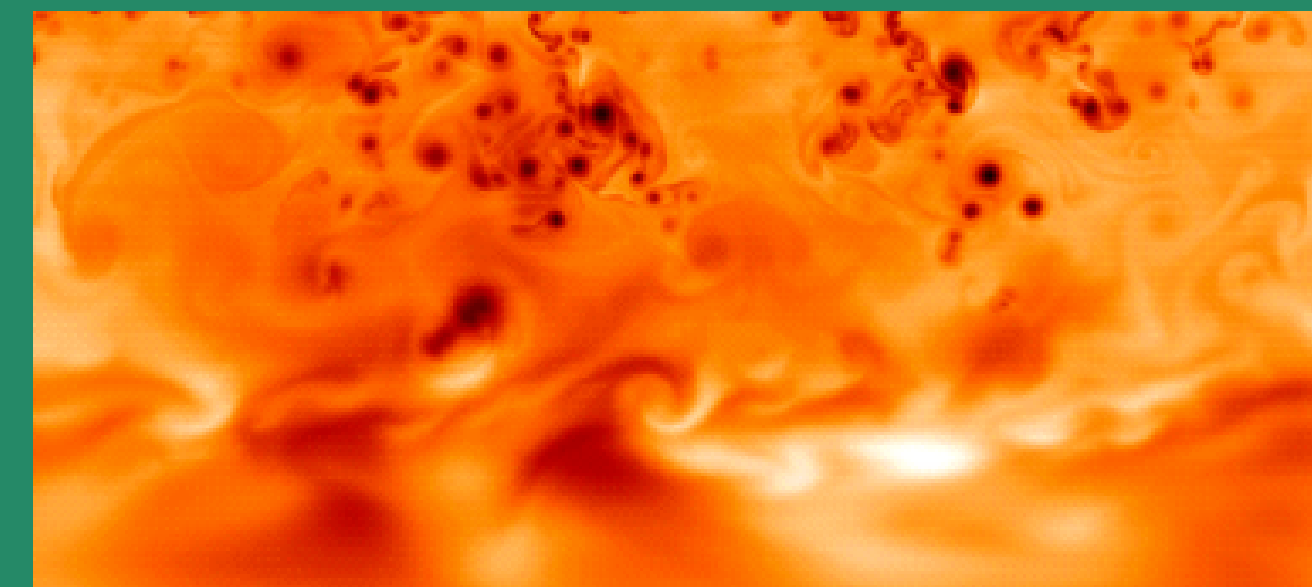
CORE

THE CORE OF THE SUN IS CONSIDERED TO EXTEND FROM THE CENTER TO ABOUT 0.2 TO 0.25 OF SOLAR RADIUS. IT IS THE HOTTEST PART OF THE SUN AND OF THE SOLAR SYSTEM. IT HAS A DENSITY OF 150 G/CM³ AT THE CENTER, AND A TEMPERATURE OF 15 MILLION KELVINS. BOTH THE TEMPERATURE AND THE DENSITY DECREASE AS ONE MOVES OUTWARD FROM THE CENTER OF THE SUN. THE NUCLEAR BURNING IS ALMOST COMPLETELY SHUT OFF BEYOND THE OUTER EDGE OF THE CORE (ABOUT 25% OF THE DISTANCE TO THE SURFACE OR 175,000 KM FROM THE CENTER). AT THAT POINT THE TEMPERATURE IS ONLY HALF ITS CENTRAL VALUE AND THE DENSITY DROPS TO ABOUT 20 G/CM³. ENERGY IS GENERATED IN THE CORE, THE INNERMOST 25%. CORE IS THE CENTRAL REGION WHERE NUCLEAR REACTIONS CONSUME HYDROGEN TO FORM HELIUM. THESE REACTIONS RELEASE THE ENERGY THAT ULTIMATELY LEAVES THE SURFACE AS VISIBLE LIGHT AND ARE HIGHLY SENSITIVE TO TEMPERATURE AND DENSITY.



CONVECTION ZONE

THE MOST EFFICIENT MEANS OF ENERGY TRANSFER IS NOW CONVECTION AND WE FIND OURSELVES IN THE REGION OF THE SUN'S INTERIOR KNOWN AS THE CONVECTION ZONE. THE HOTTER MATERIAL NEAR THE TOP OF THE RADIATION ZONE (THE BOTTOM OF THE CONVECTION ZONE) RISES UP AND THE COOLER MATERIAL SINKS TO THE BOTTOM. AS THE HOT MATERIAL REACHES THE TOP OF THE CONVECTION ZONE IT BEGINS TO COOL AND SINK, AND AS IT SINKS IT HEATS UP AGAIN AND WILL RISE. THIS PRODUCES A ROLLING MOTION MUCH LIKE THAT IN A POT OF BOILING WATER.



RADIATIVE ZONE

THE ENERGY WHICH IS PRODUCED TO THE CORE, DIFFUSES OUTWARD BY RADIATION (MOSTLY GAMMA-RAYS AND X-RAYS) THROUGH THE RADIATIVE ZONE AND BY CONVECTIVE FLUID FLOWS (BOILING MOTION) THROUGH THE CONVECTION ZONE, THE OUTERMOST 30%. THE ENERGY GENERATED IN THE CORE IS CARRIED BY LIGHT (PHOTONS) THAT BOUNCES FROM PARTICLE TO PARTICLE THROUGH THE RADIATIVE ZONE.

ALTHOUGH THE PHOTONS TRAVEL AT THE SPEED OF LIGHT, THEY BOUNCE SO MANY TIMES THROUGH THIS DENSE MATERIAL THAT AN INDIVIDUAL PHOTON TAKES ABOUT A MILLION YEARS TO FINALLY REACH THE INTERFACE LAYER.

PHOTOSPHERE

THE PHOTOSPHERE IS THE VISIBLE SURFACE OF THE SUN THAT WE ARE MOST FAMILIAR WITH. SINCE THE SUN IS A BALL OF GAS, THIS IS NOT A SOLID SURFACE BUT IS ACTUALLY A LAYER ABOUT 100 KM THICK (VERY, VERY, THIN COMPARED TO THE 700,000 KM RADIUS OF THE SUN). A NUMBER OF FEATURES CAN BE OBSERVED IN THE PHOTOSPHERE LIKE DARK SUNSPOTS, THE BRIGHT FACULAE, AND GRANULES.

CHROMOSPHERE

THE CHROMOSPHERE IS AN IRREGULAR LAYER ABOVE THE PHOTOSPHERE WHERE THE TEMPERATURE RISES FROM 6000°C TO ABOUT 20,000°C. AT THESE HIGHER TEMPERATURES HYDROGEN EMITS LIGHT THAT GIVES OFF A REDDISH COLOR (H-ALPHA EMISSION). THIS COLORFUL EMISSION CAN BE SEEN IN PROMINENCES THAT PROJECT ABOVE THE LIMB OF THE SUN DURING TOTAL SOLAR ECLIPSES. THIS IS WHAT GIVES THE CHROMOSPHERE ITS NAME (COLOR-SPHERE).



THE INTERFACE LAYER (TACHOCLINE)

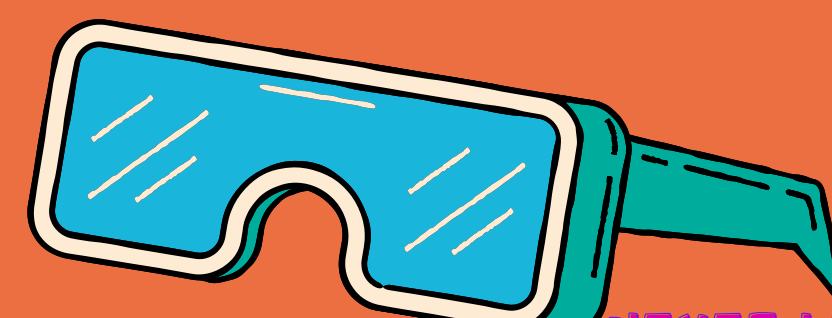


THE INTERFACE LAYER LIES BETWEEN THE RADIATIVE ZONE AND THE CONVECTIVE ZONE. IT IS NOW BELIEVED THAT THE SUN'S MAGNETIC FIELD IS GENERATED BY A MAGNETIC DYNAMO IN THIS LAYER. THE CHANGES IN FLUID FLOW VELOCITIES ACROSS THE LAYER CAN STRETCH MAGNETIC FIELD LINES OF FORCE AND MAKE THEM STRONGER. THIS CHANGE IN FLOW VELOCITY GIVES THIS LAYER ITS ALTERNATIVE NAME - THE TACHOCLINE. THERE ALSO APPEARS TO BE SUDDEN CHANGES IN CHEMICAL COMPOSITION ACROSS THIS LAYER.

CORONA

THE CORONA IS THE OUTERMOST PART OF THE SUN'S ATMOSPHERE. IT IS ABOUT 10 MILLION TIMES LESS DENSE THAN THE SUN'S SURFACE. THIS LOW DENSITY MAKES THE CORONA MUCH LESS BRIGHT THAN THE SURFACE OF THE SUN. IT CAN BE SEEN DURING A TOTAL SOLAR ECLIPSE. ITS TEMPERATURE IS HIGHER THAN THAT OF THE SUN'S SURFACE.

THE SUN'S MAGNETIC FIELDS AFFECT CHARGED PARTICLES IN THE CORONA TO FORM BEAUTIFUL FEATURES LIKE STREAMERS, LOOPS, AND PLUMES. THE CORONA EXTENDS FAR OUT INTO SPACE. FROM IT COMES THE SOLAR WIND THAT TRAVELS THROUGH OUR SOLAR SYSTEM. THE CORONA'S TEMPERATURE CAUSES ITS PARTICLES TO MOVE AT VERY HIGH SPEEDS. THESE SPEEDS ARE SO HIGH THAT THE PARTICLES CAN ESCAPE THE SUN'S GRAVITY.



NEVER LOOK DIRECTLY AT THE SUN DURING AN ECLIPSE WITHOUT GLASSES!