The background features a dark blue gradient with a starry space pattern. On the left side, there are several technical diagrams, including a large circular scale with numerical markings from 140 to 260 and various circular paths with arrows indicating direction. The main title is centered in the right half of the image.

THE SUN: WHAT HAMS SHOULD KNOW ABOUT IT

DR. LISA SHIER

JANUARY 8, 2021

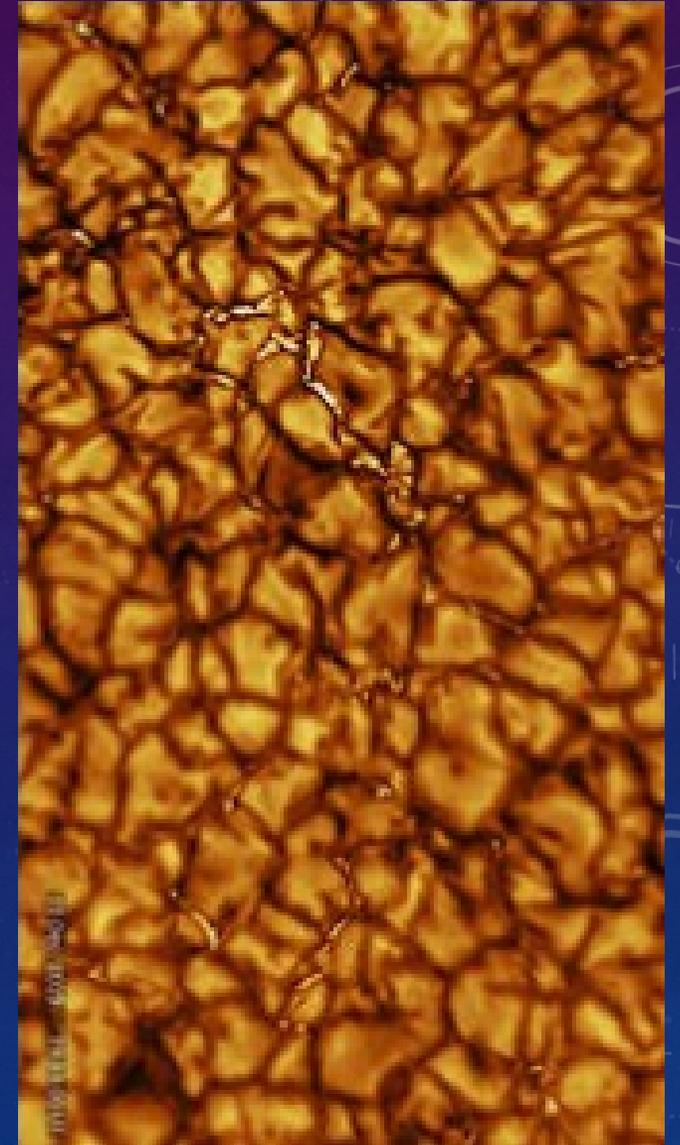
THE BASICS



- A very large ball of very hot charged particles and magnetic fields
 - Motions of the charged particles and magnetic fields are not independent
- Of the positively charged particles, 88% are protons, 10% are helium, and 2% are everything else
- Kept hot by fusion reactions in the core
- Exhibits differential rotation – the equator rotates faster than the poles – 25 days vs 35 days
 - This tends to wrap up the magnetic fields over time

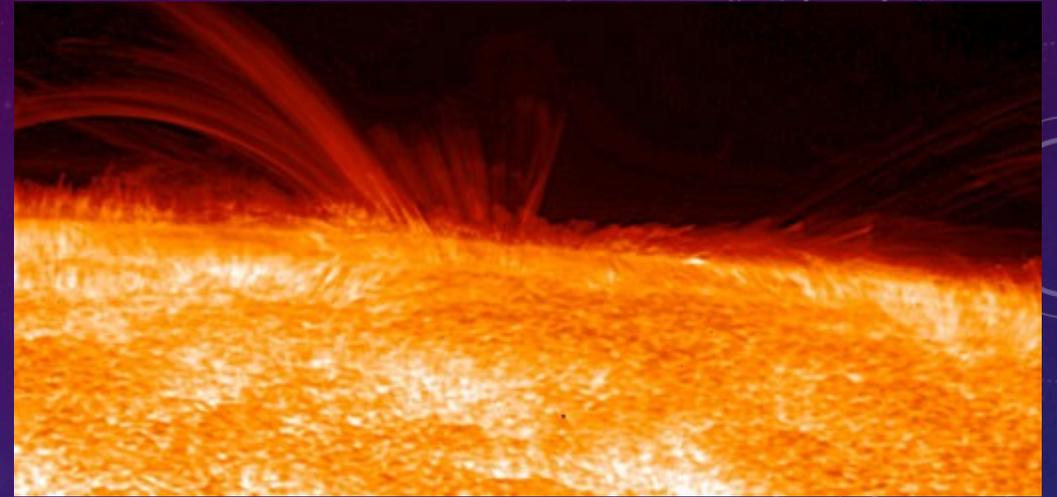
CONVECTION

- The outer 1/3 of the sun has convective energy transport
- It's pretty much like a pot of boiling water
 - Visible as granules and supergranules
- Chaotic motion in the plasma drags the magnetic field along
 - The surface of the sun has areas of stronger and weaker magnetic fields
- Areas of particularly strong magnetic field are sunspots. They are dark because the strong magnetic field tends to inhibit hot plasma from boiling up in that spot



Actual image of sun

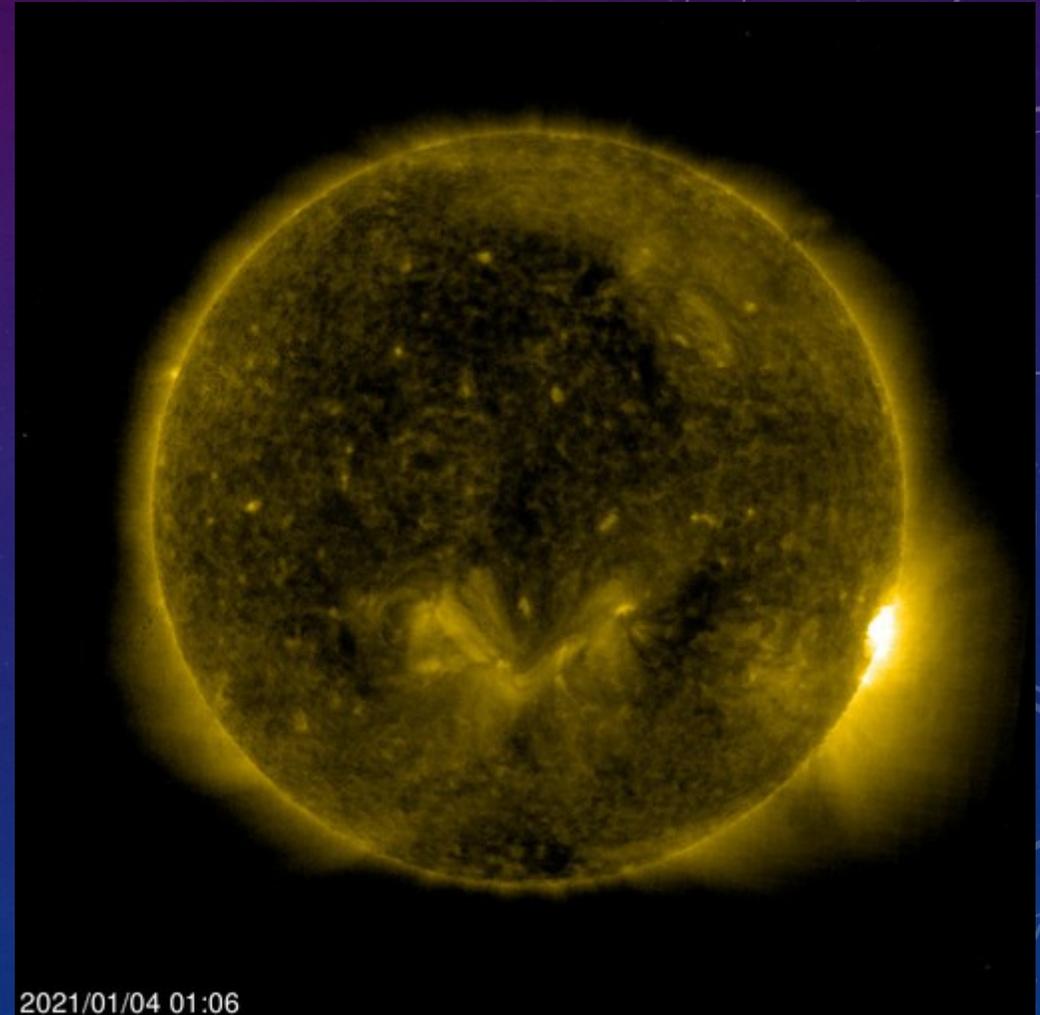
THE CHROMOSPHERE



- The chromosphere is the region of the sun just above the photosphere, or visible surface
- Strongly linked to the surface via magnetic fields
- In this region, we see massive releases of energy due to electromagnetic fields
- Very energetic charged particles accelerating in a region of magnetic fields creates a whole lot of both high energy (UV – X-ray) photons and also RF. The two go together because they are created by the same processes.
- Because the chromosphere is transparent, the photons created here are free to travel into space.

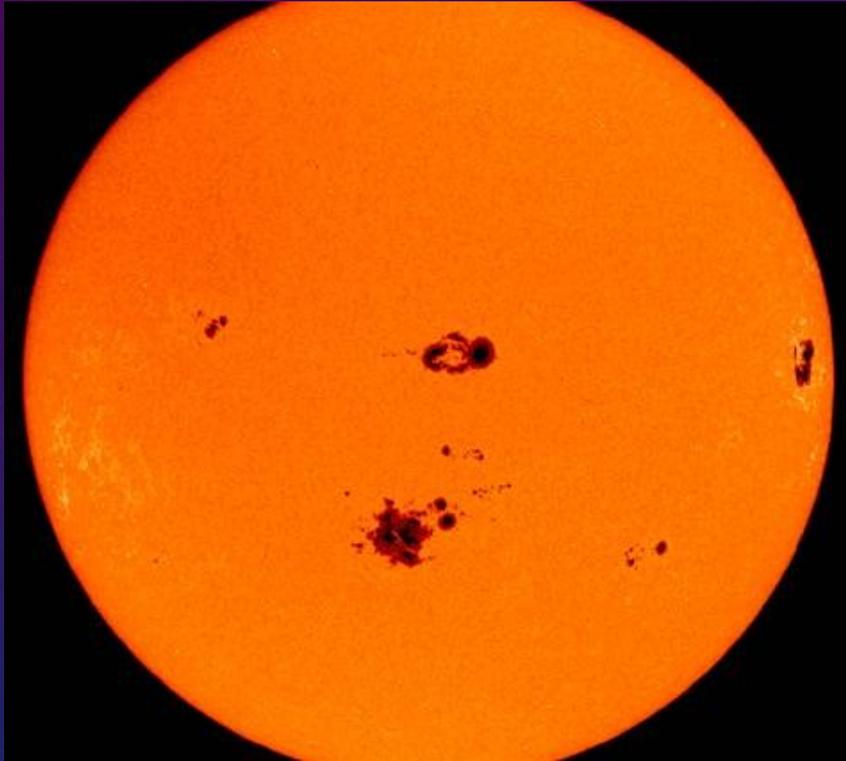
SOLAR LUMINOSITY VS FREQUENCY

- Most of the energy emitted by the sun is blackbody radiation.
 - Peaks in the visible, significant amounts in the infrared
 - Very little variation in intensity over time
 - Comes from the photosphere
 - Critical for life on Earth
- A small but important part of the sun's energy is wildly non-blackbody
 - More important than the blackbody radiation at high energy and radio frequencies
 - Massive variation in intensity over time is observed
 - Comes from the chromosphere and corona
 - Of great interest to amateur radio because it impacts HF propagation



The sun in far UV light.

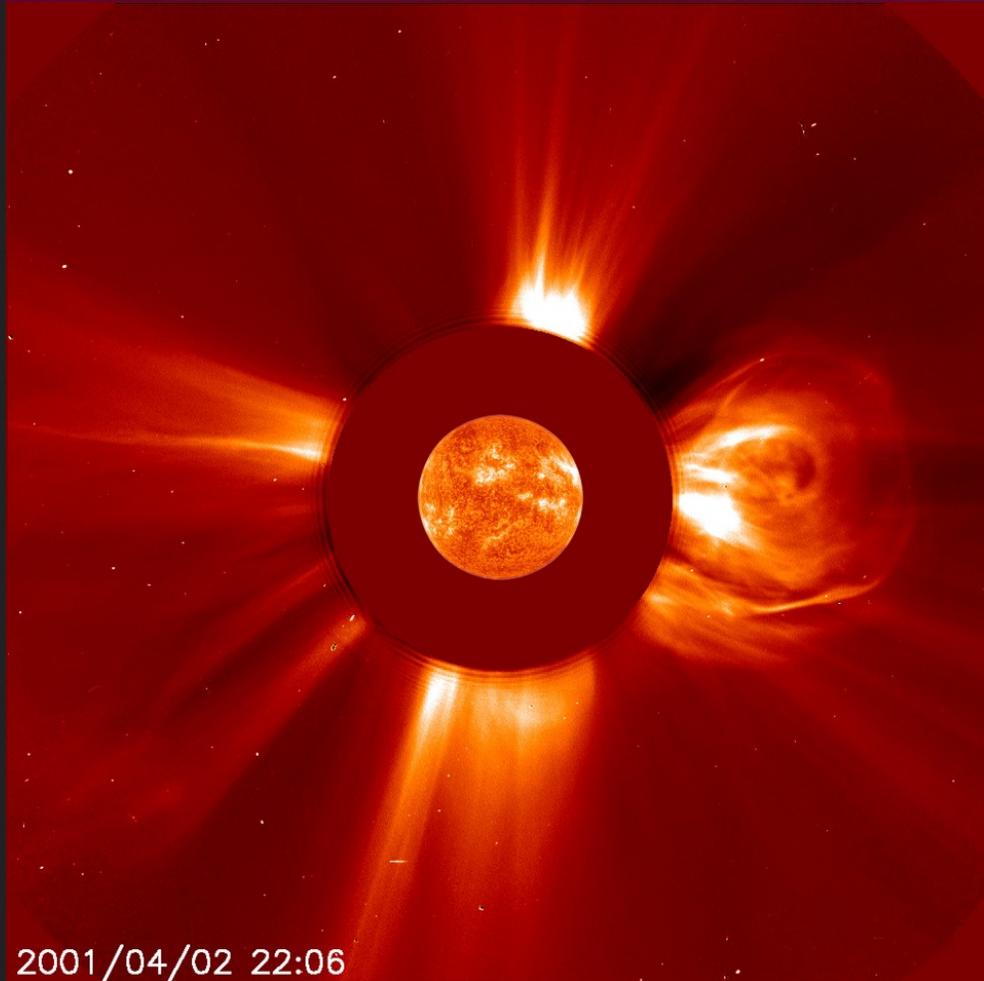
SUNSPOTS



Visible light image

- Dark regions on the sun
- Areas of strong magnetic fields
- Very common, sun usually has some

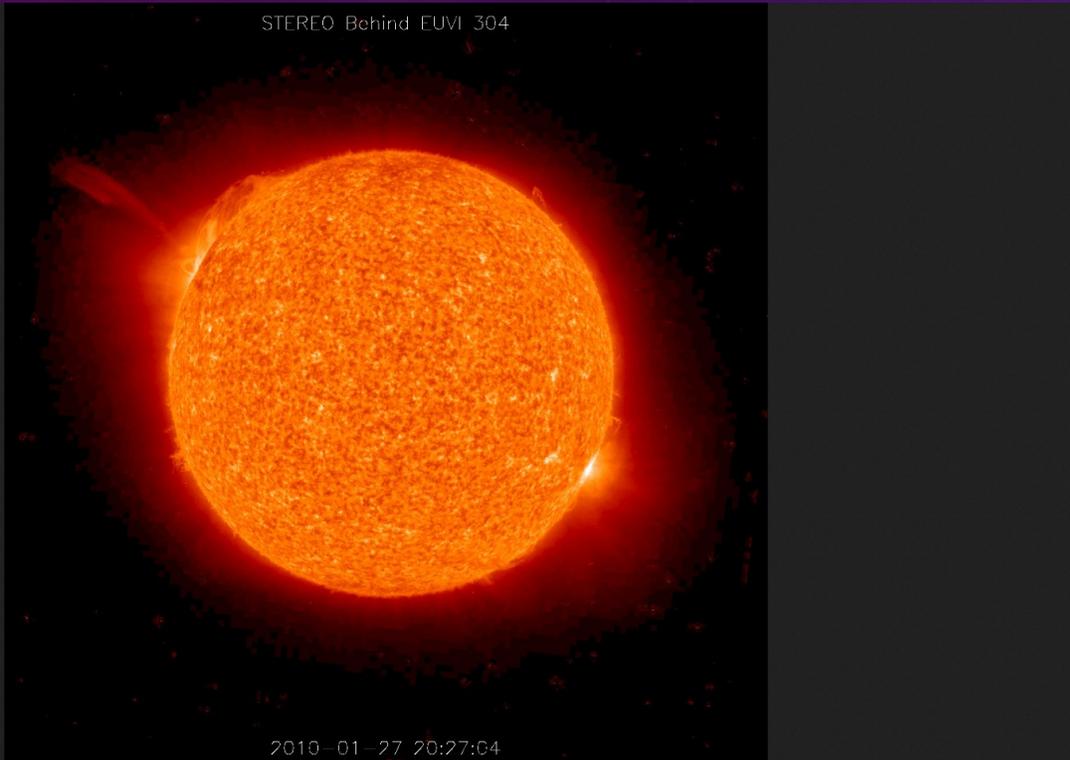
SOLAR FLARES



Strong magnetic fields with very hot trapped gasses
Often well above the sun's surface
Usually loops
Tends to create a lot of UV emission

Image in narrowband hydrogen alpha, shows very hot gas

CORONAL MASS EJECTION

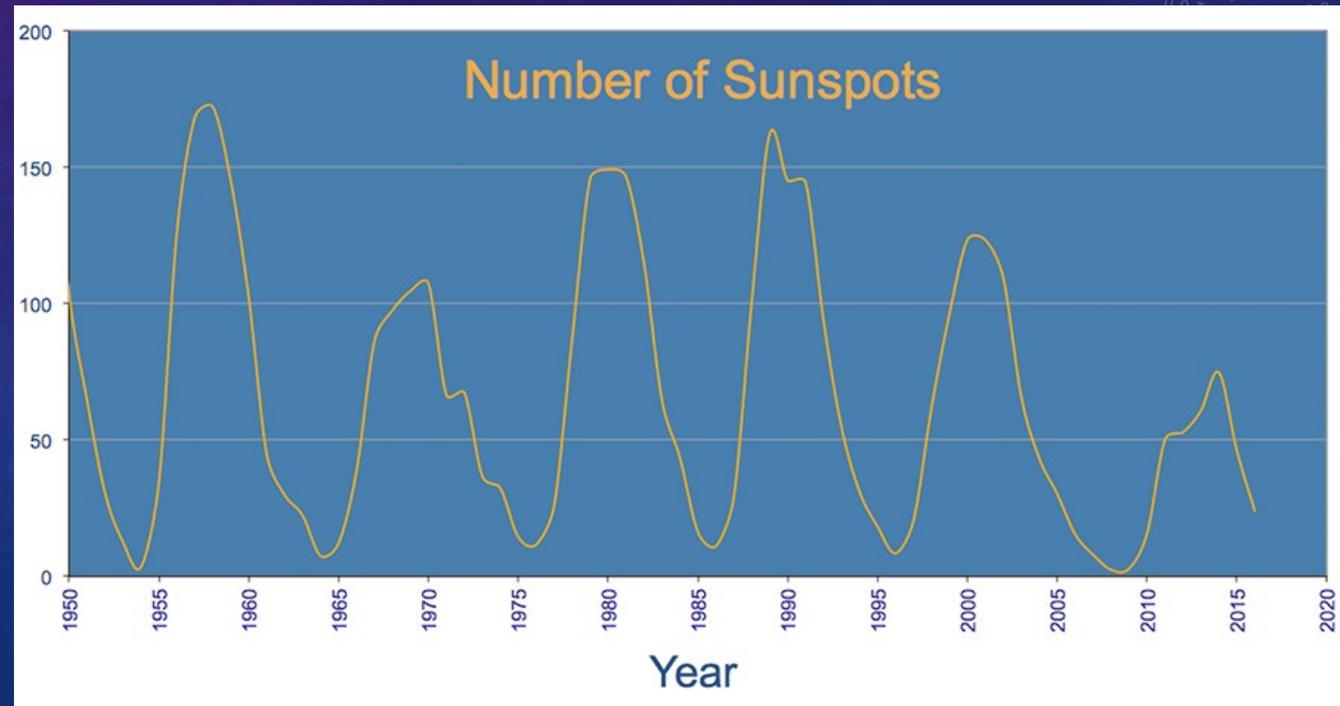
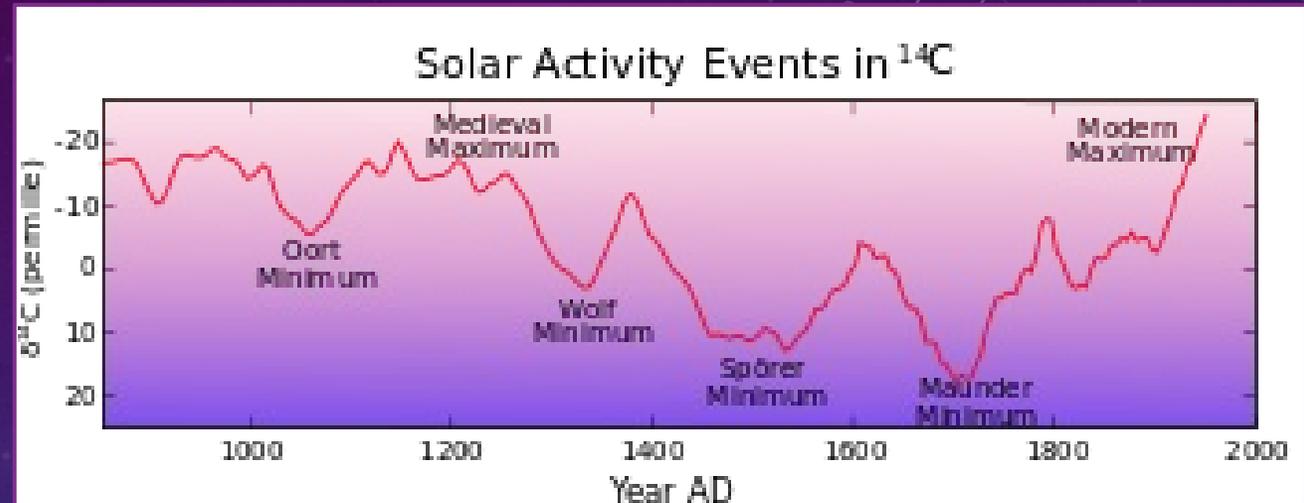


- Like a solar flare that doesn't reconnect to the sun's surface.
- Produces a lot of UV and higher energy photons.
- Sends a large plume of charged particles out into space.
- If the plume is oriented just right, it will hit the Earth's magnetosphere, with significant effects

Image in narrowband hydrogen alpha, shows very hot gas

CYCLES IN SOLAR ACTIVITY

- The amount of solar activity is definitely not constant over time
 - Long-term, lots of variation but not much structure, maybe 400 year cycles?
 - Shorter-term, strong 11 and 22 year periods
- At solar max, the peak of the solar activity, the sun's magnetic field is at it's most twisted.
- At solar minimum, the sun's magnetic field is the weakest
- The sun's magnetic poles flip about once every 11 years.



MEASURES OF SOLAR ACTIVITY

- Sunspot number – a daily record of the number of sunspots
 - The longest continually recorded data on solar activity
 - Today's number is 0
- 10.7 cm flux (2800 MHz)
 - Remember how radio and high energy emission are related?
 - Radio flux is much easier to measure on the ground
- Ap and Kp indices are actually a measure of the sun's direct influence on the Earth's magnetic field.
 - Planetary averages, A is mostly linear, while K is logarithmic
 - Current Kp is 1, which means nothing much is happening