

# The Sun & Space Weather



# Space Science Institute (SSI) Boulder, Colorado





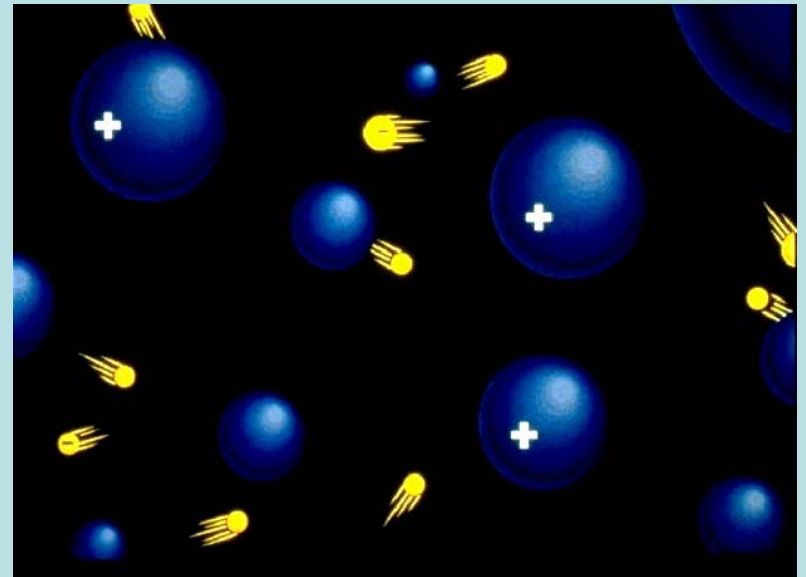




# The Fourth State of Matter

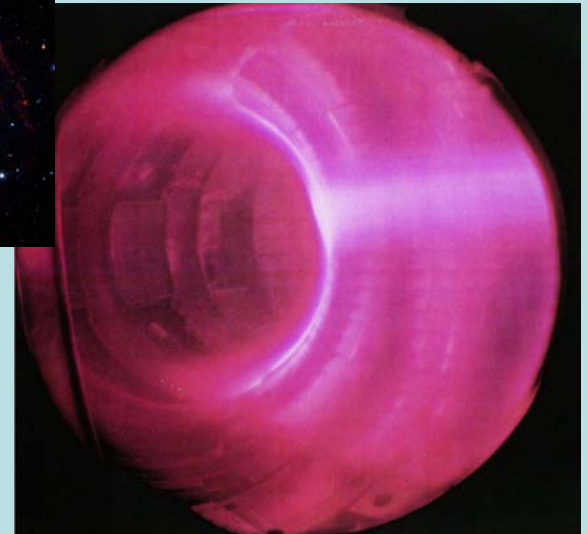


Neutral Gas



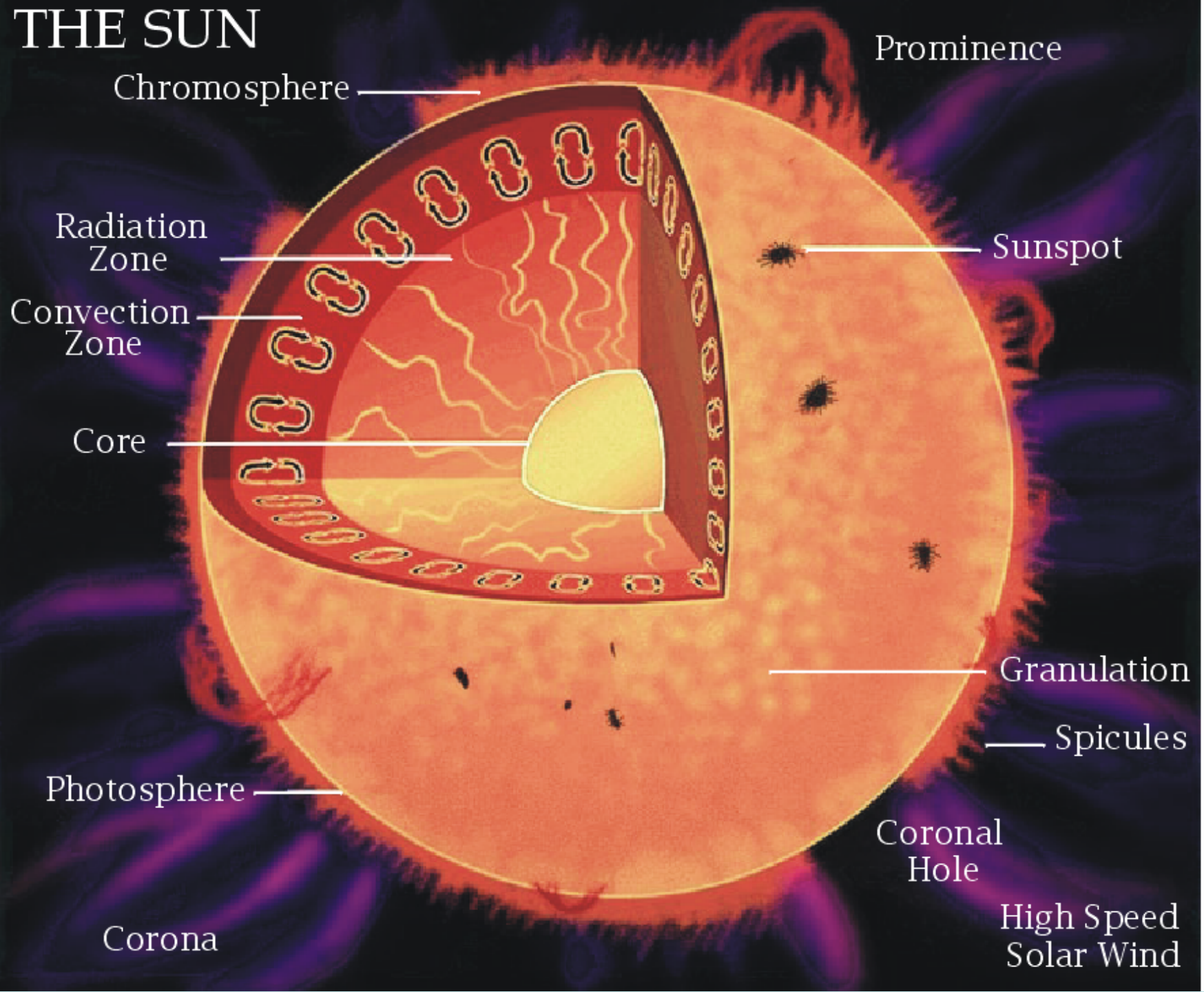
Plasma

# Plasmas Come in Many Varieties

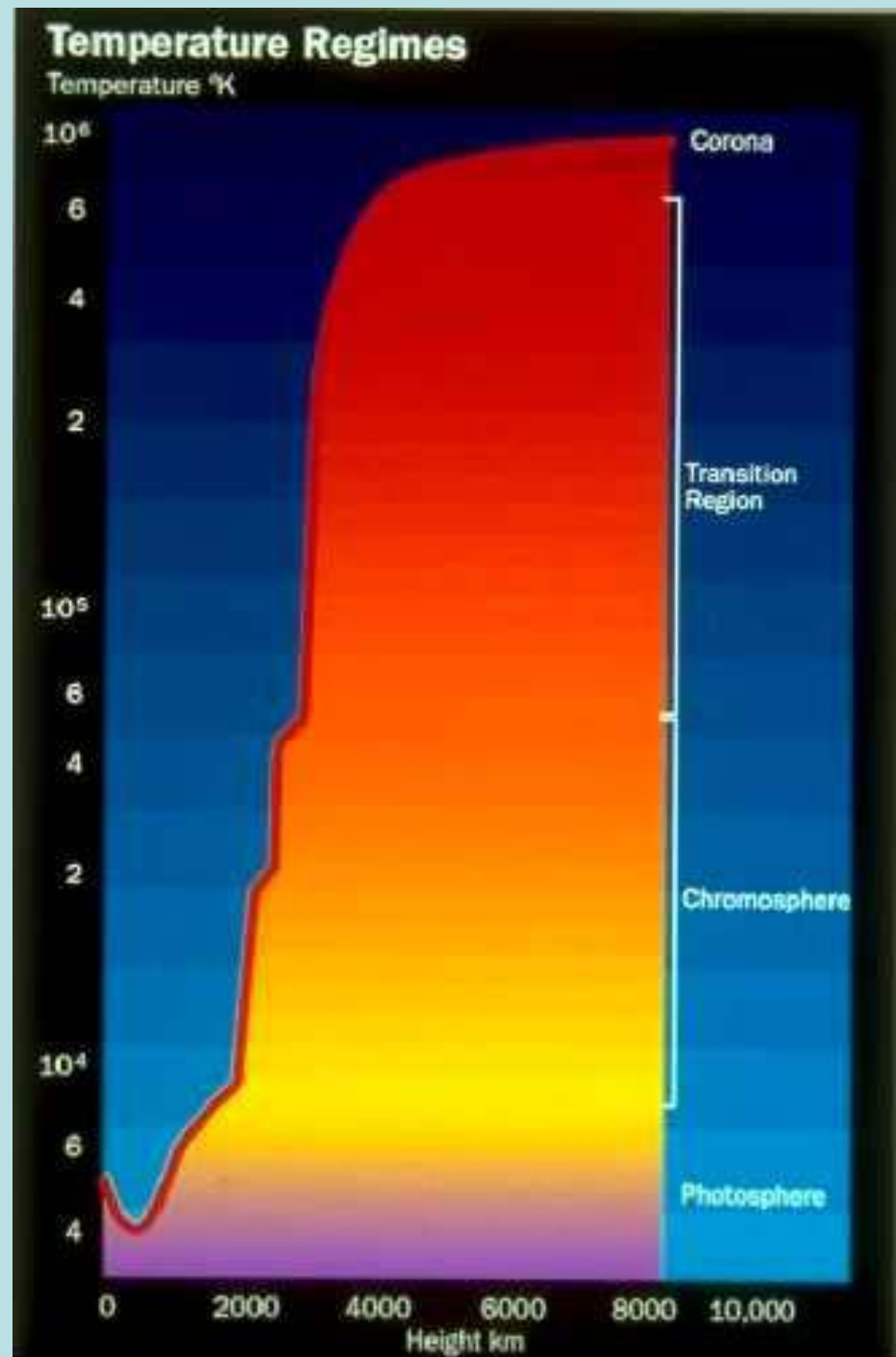




# THE SUN

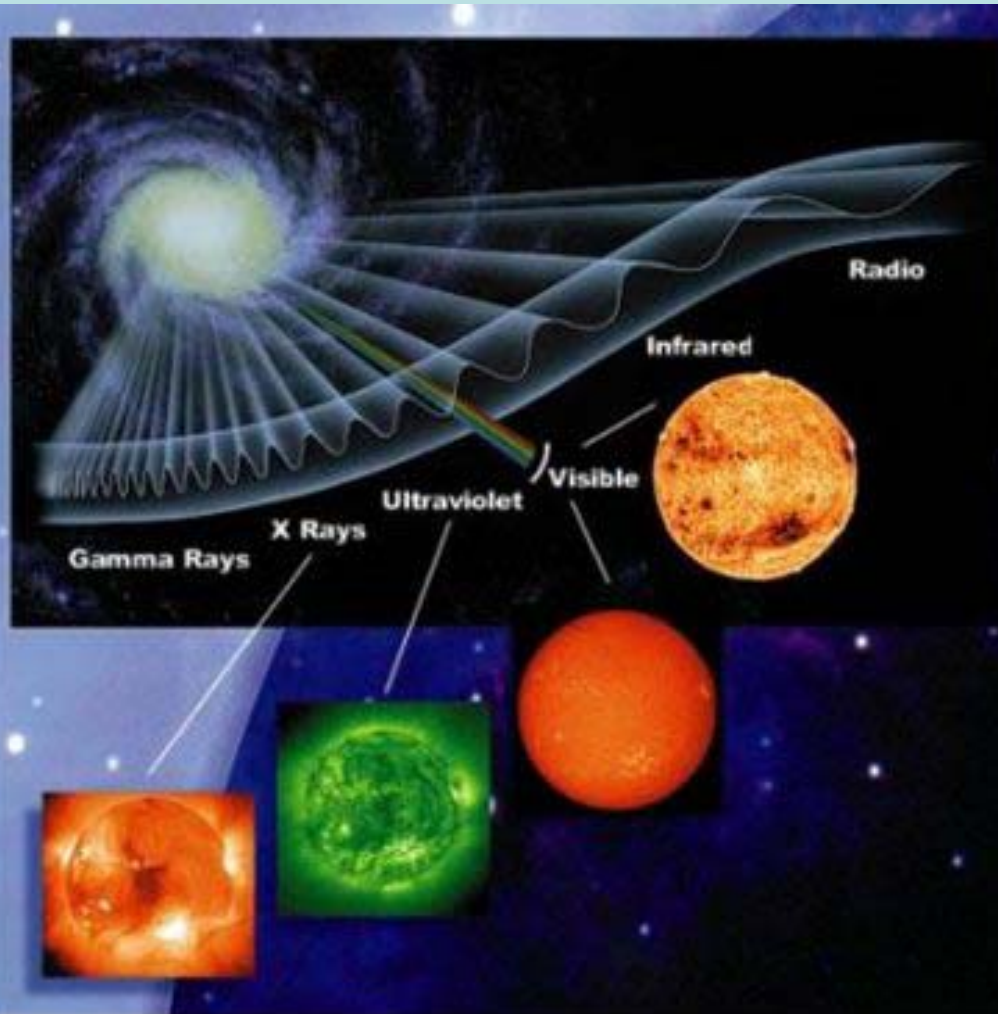


# Taking the Sun's Temperature





# Fingerprinting the Sun

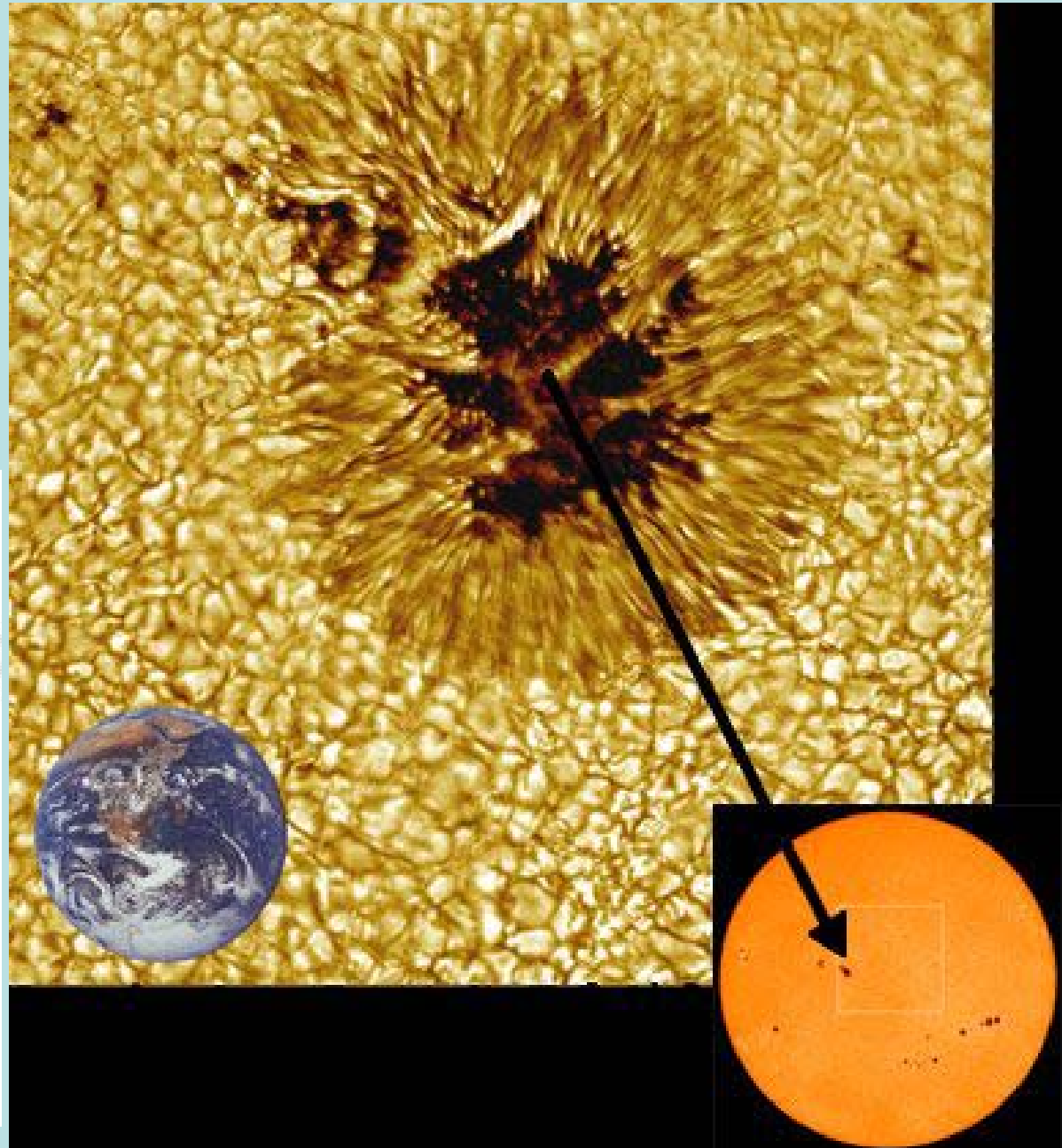
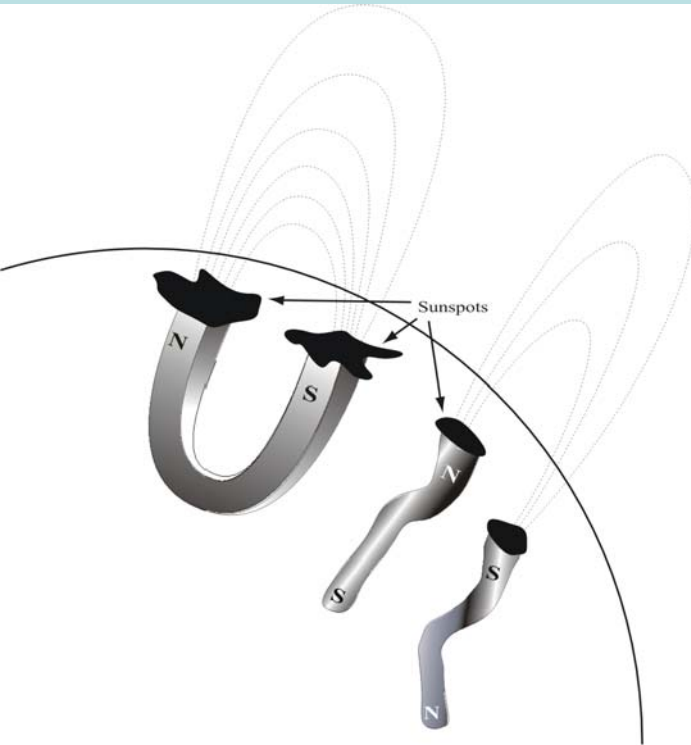


From left to right in this diagram:

- A solar X-ray image reveals plasma at 3 million degrees in the upper corona. (Courtesy Japan/Yohkoh)
- A solar extreme ultraviolet image reveals plasma at 1.5 million degrees in the lower corona. (Courtesy NASA/SOHO)
- Ground-based image of the Sun as seen in an emission line of Helium. (Courtesy Kitt Peak National Solar Observatory)
- Image of the Sun's photosphere from ionized hydrogen at about 10,000 degrees (Courtesy Kanzelhöhe Solar Observatory)

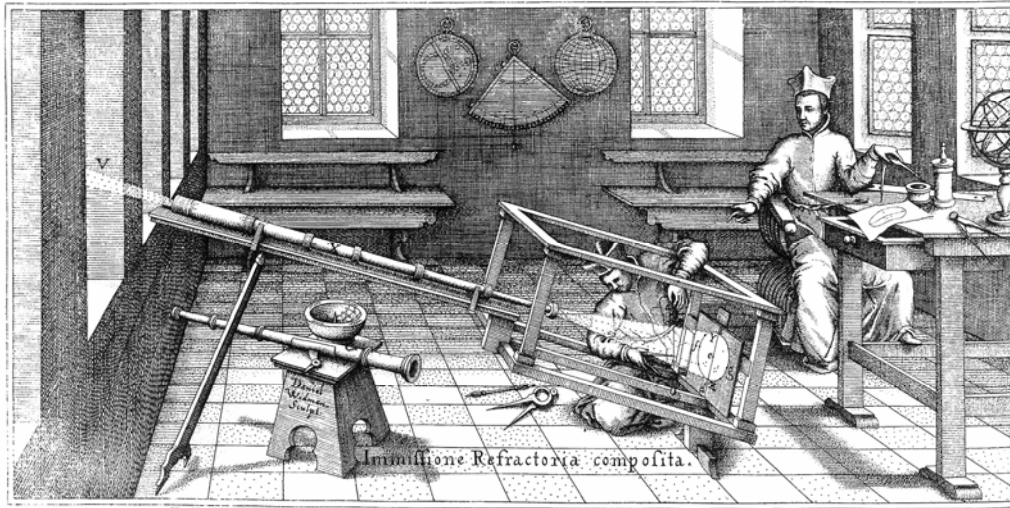
The electromagnetic spectrum

Sunspots:  
cool, dark,  
& magnetic

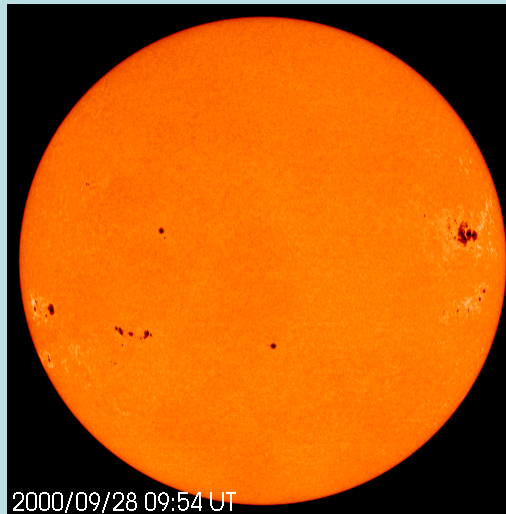
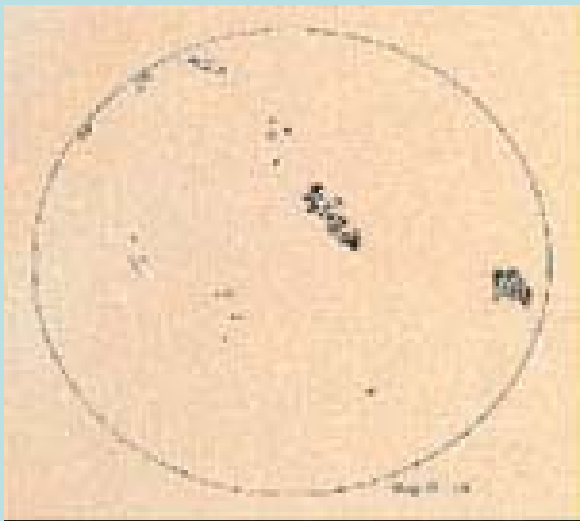




# Observing Sunspots



Maculae et Faculae ex uariis obseruandi modis stabiliuntur.

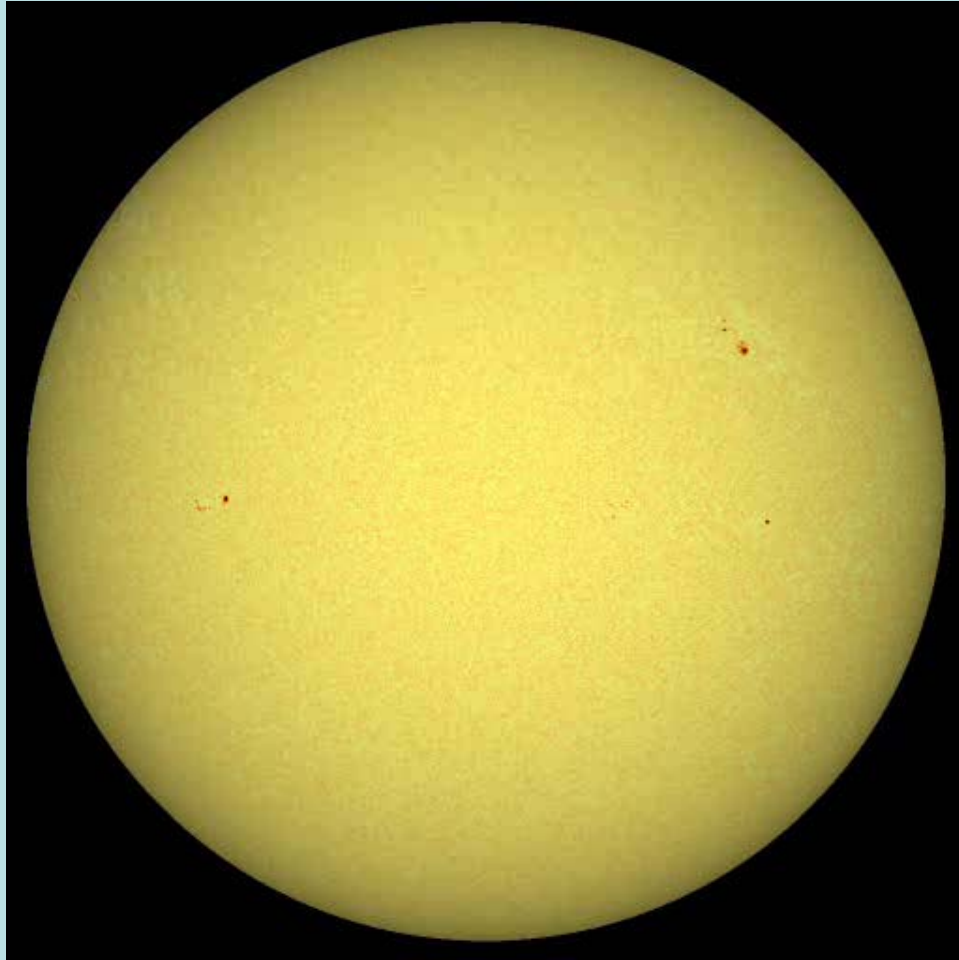


2000/09/28 09:54 UT

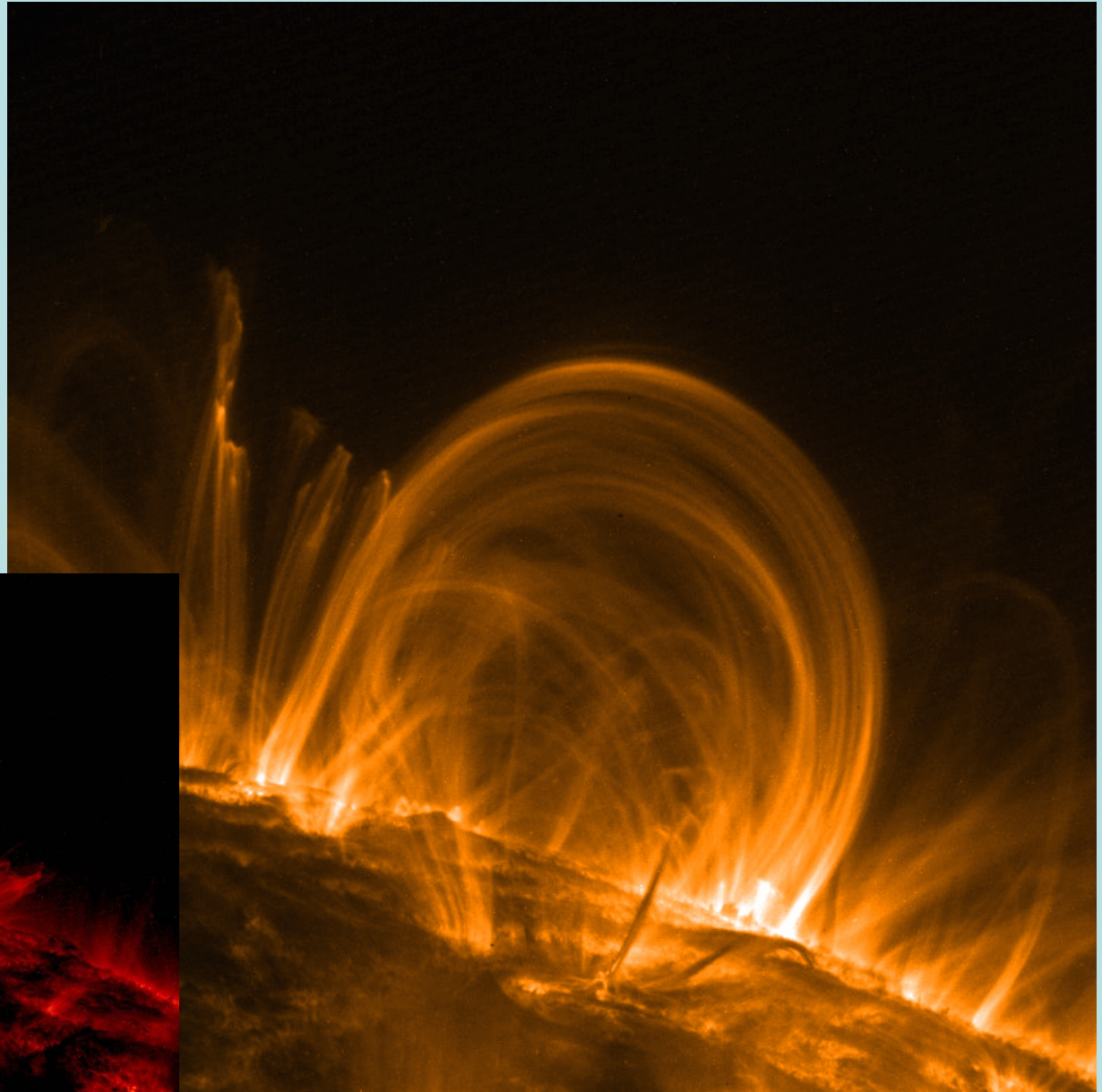
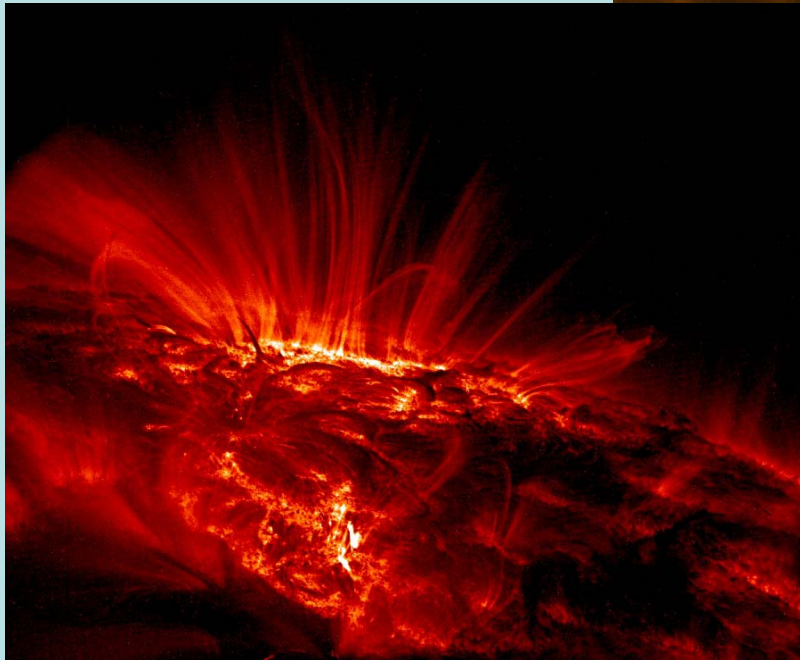




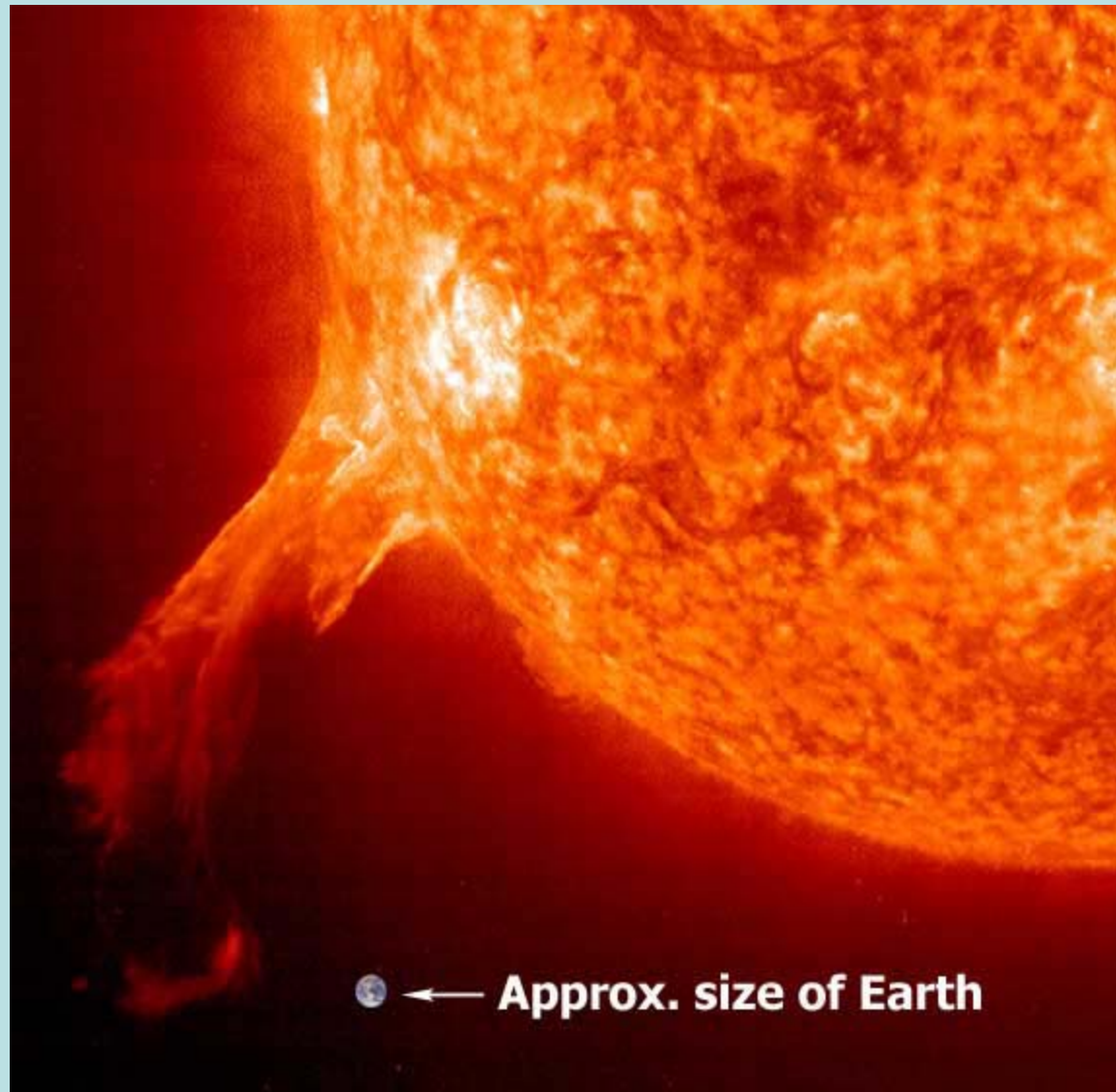
# Seeing Spots



# Magnetic Loops

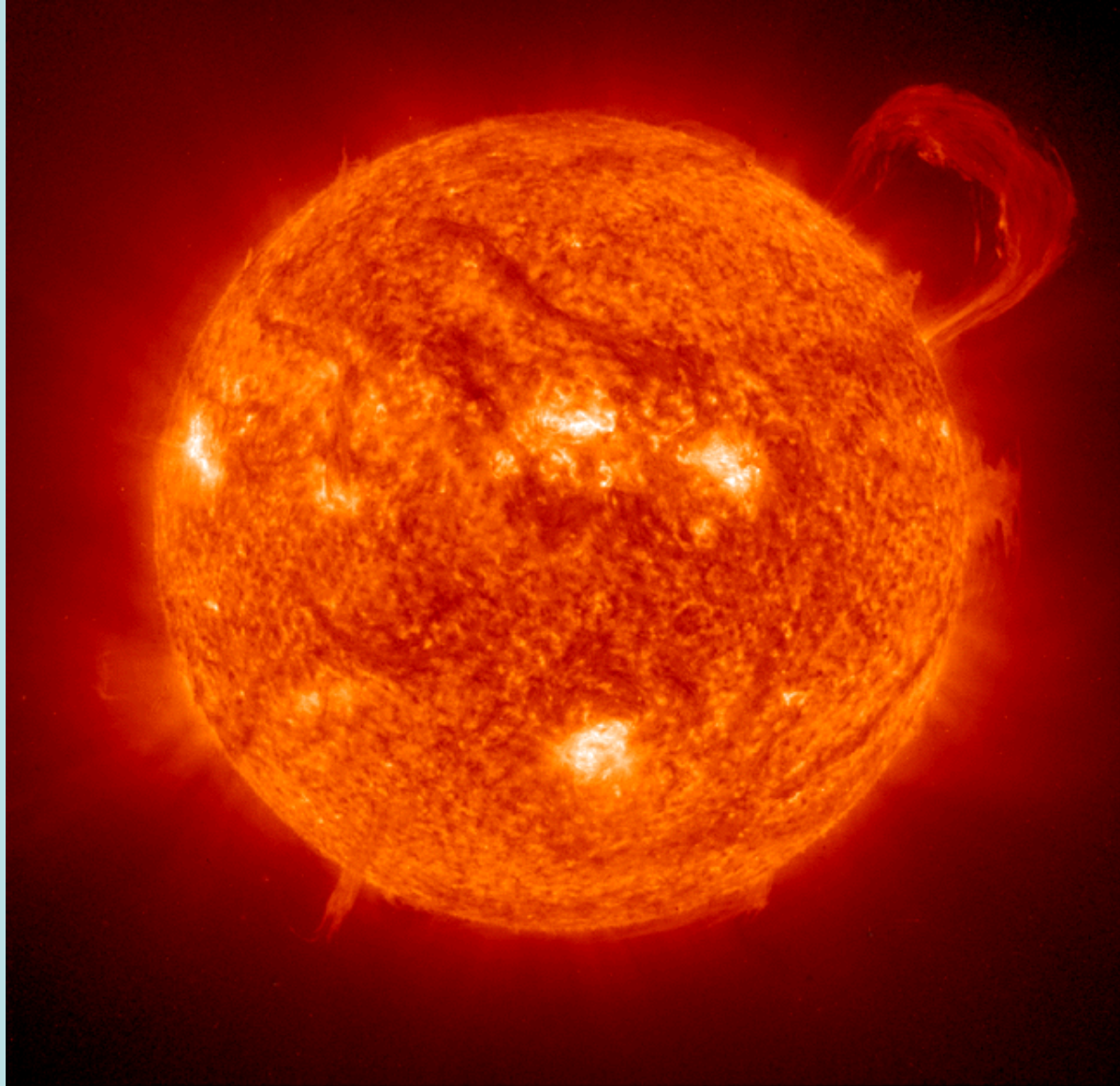


# Solar Flares

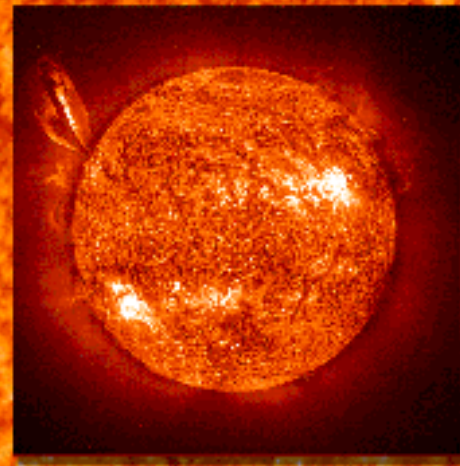




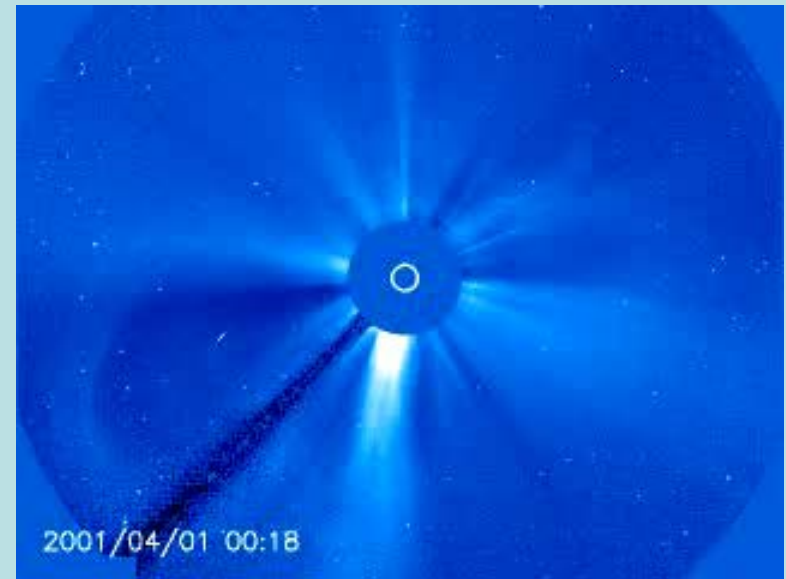
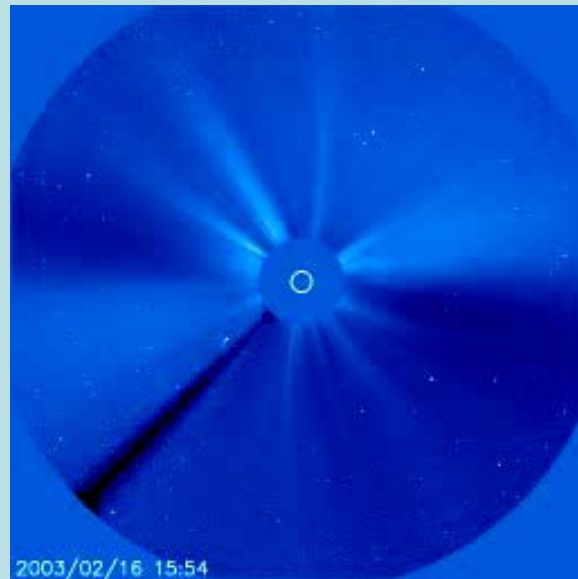
# Prominences



Earth shown  
for size comparison

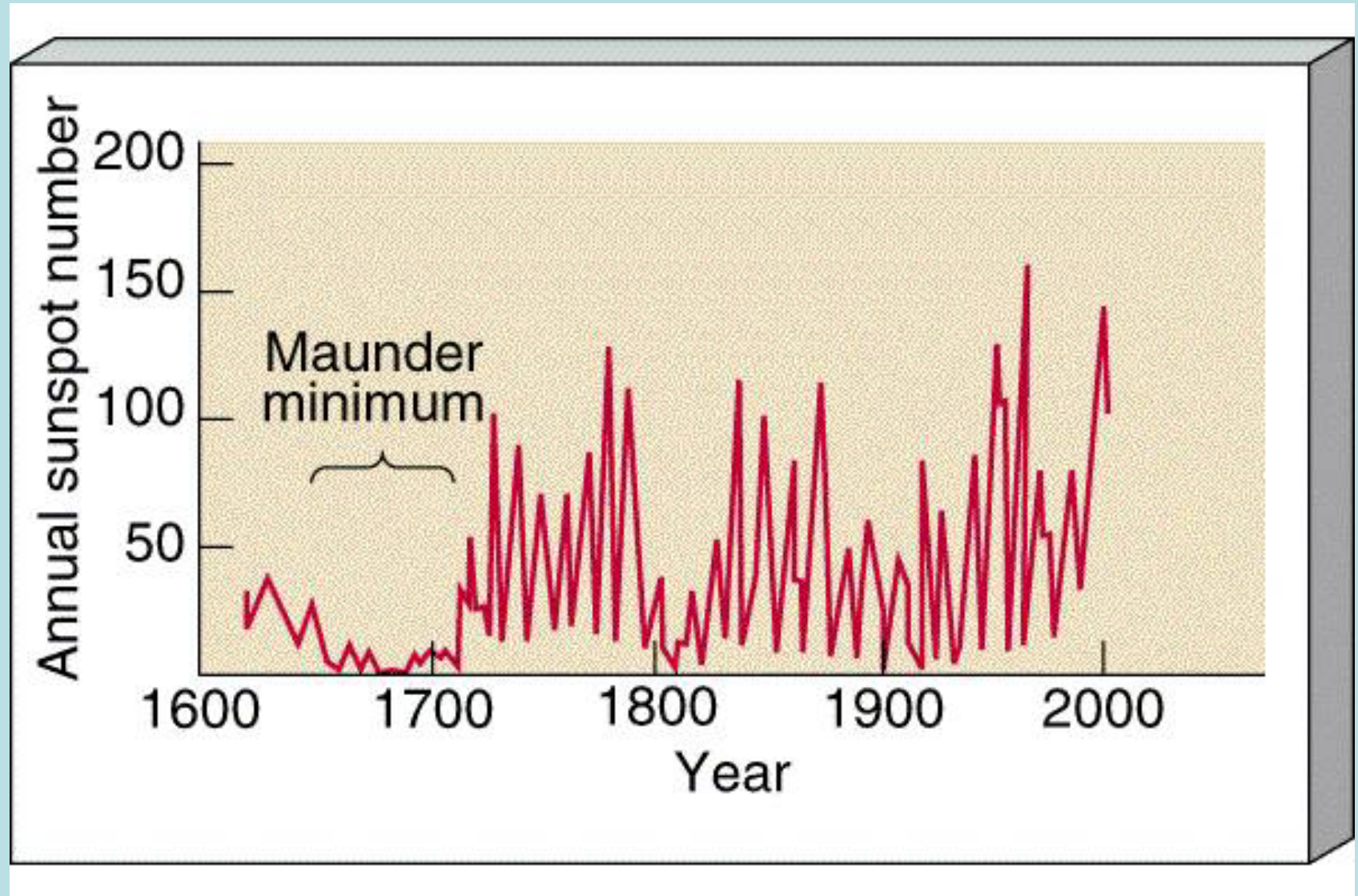


Huge blasts from the corona, known as coronal mass ejections (CMEs), are the most violent space weather events.

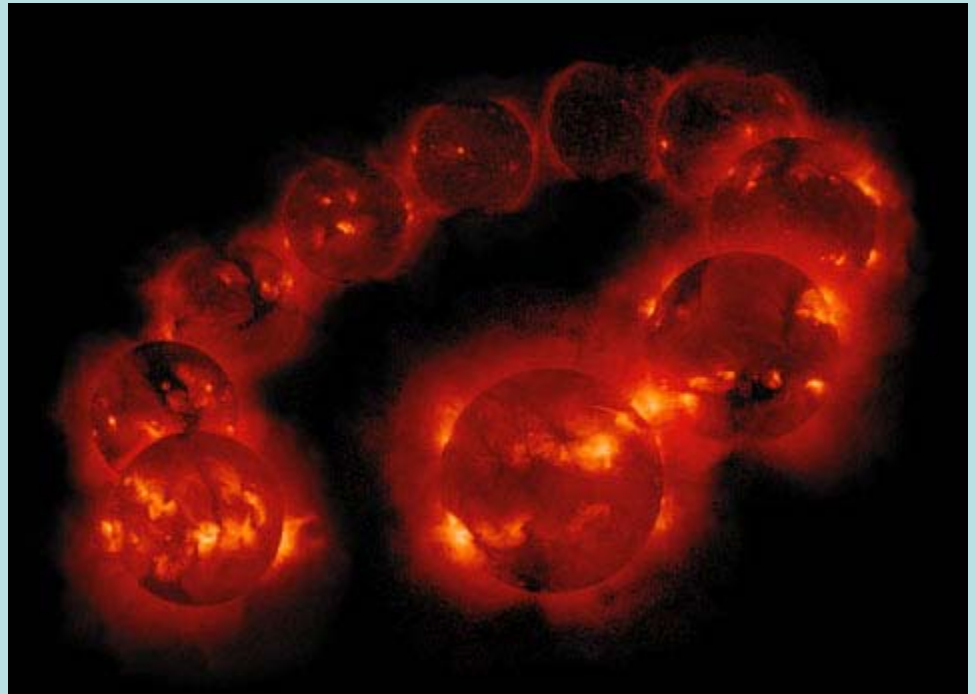
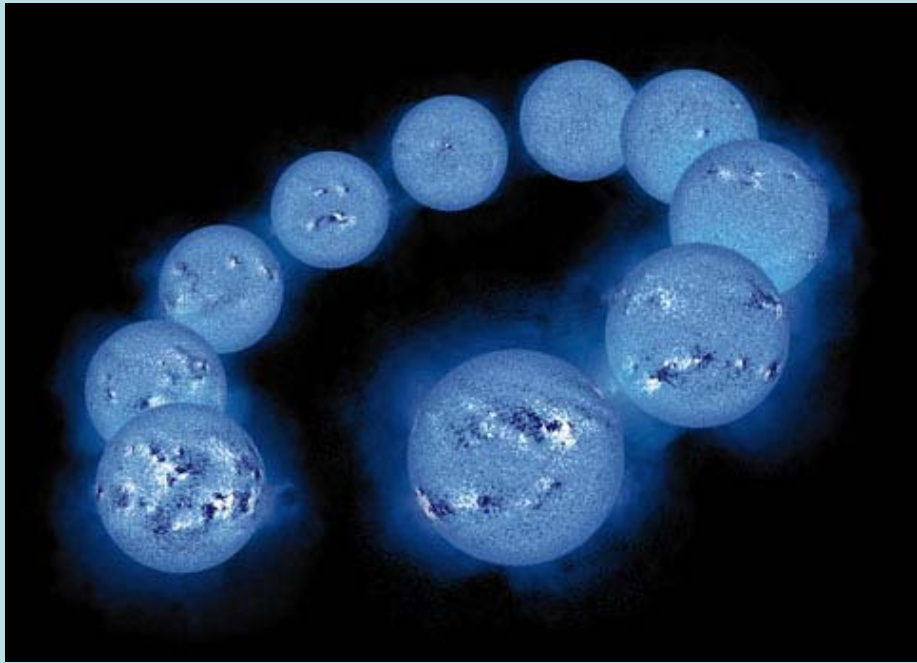




# Sunspot Changes



# The Solar Cycle



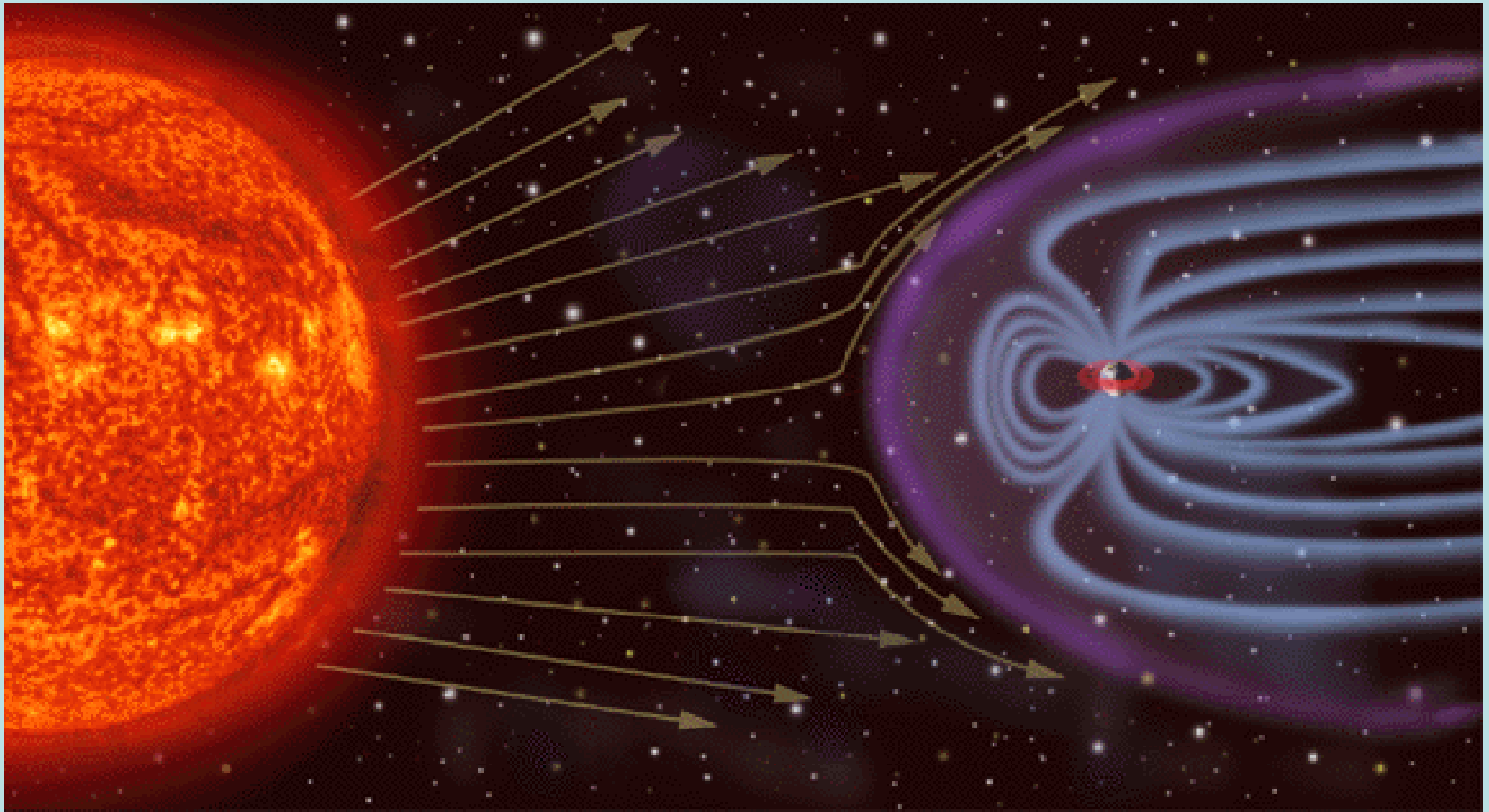
# Cold in North America & Europe

## 1650-1720

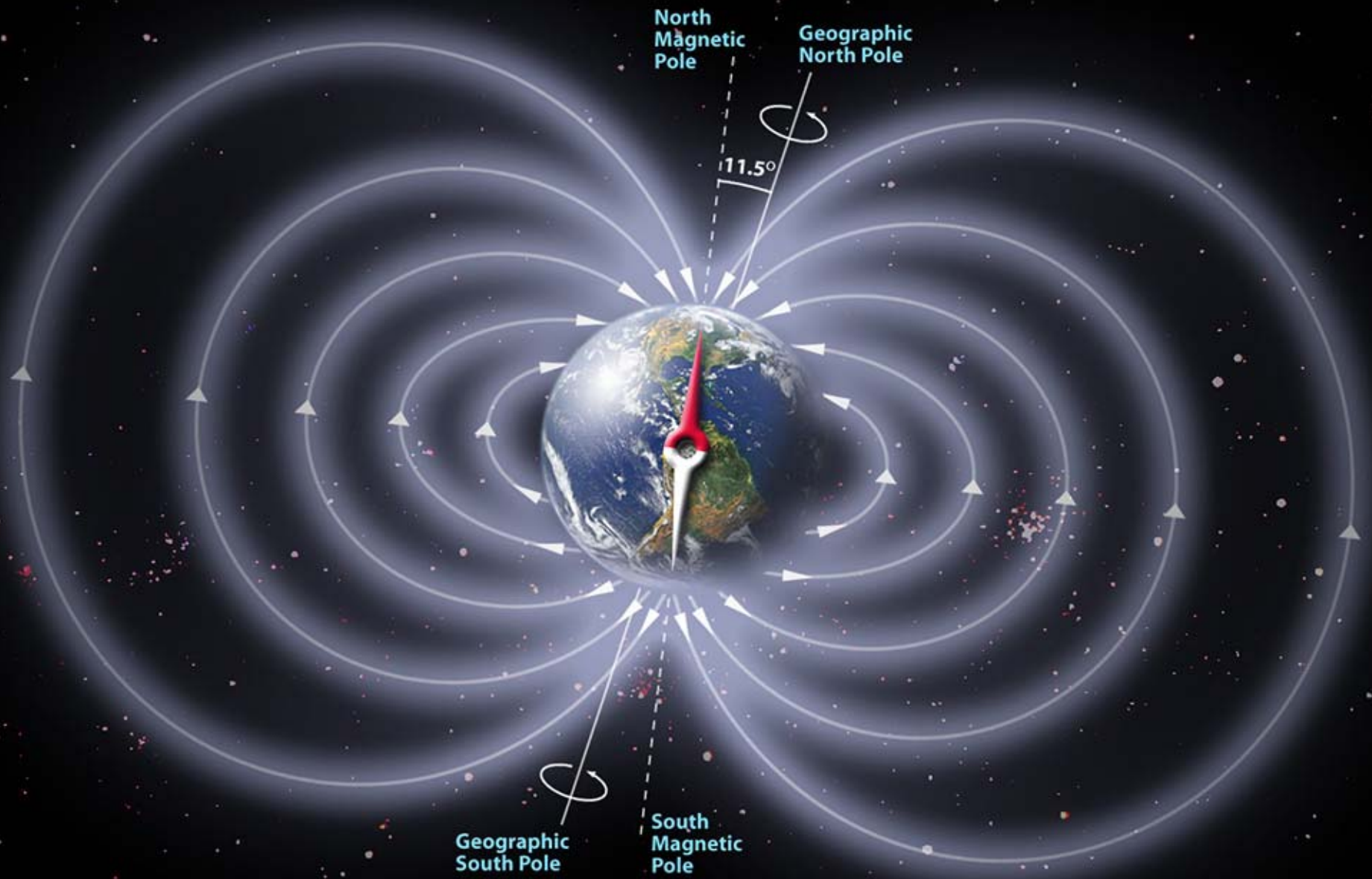




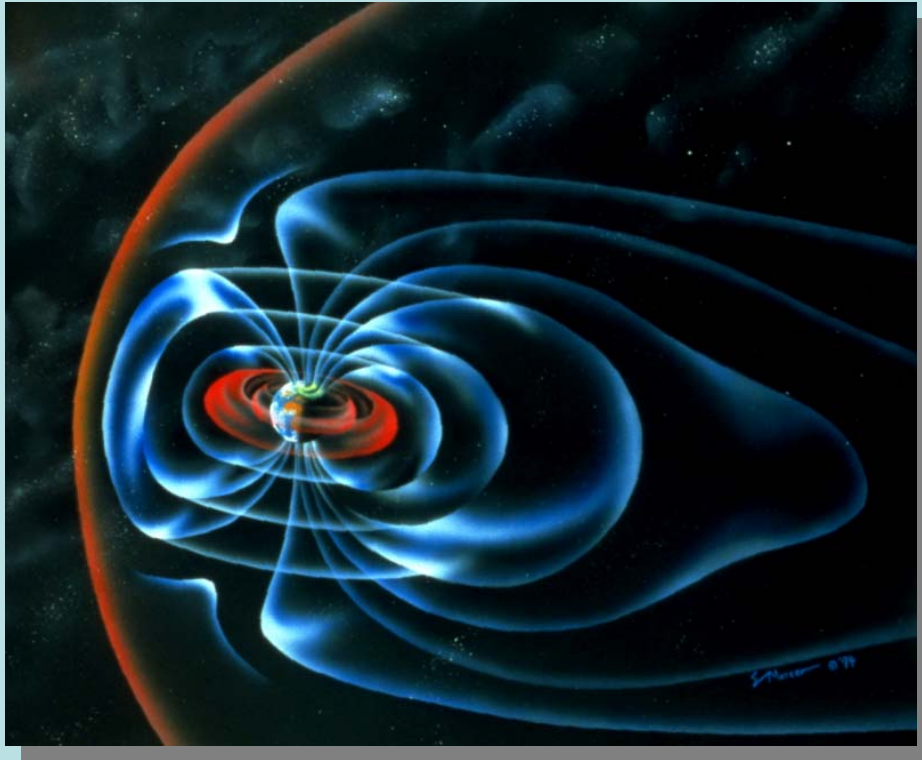
# Gale Force Winds



# The Earth's Magnetic Field



# Radiation Belts Surround Earth

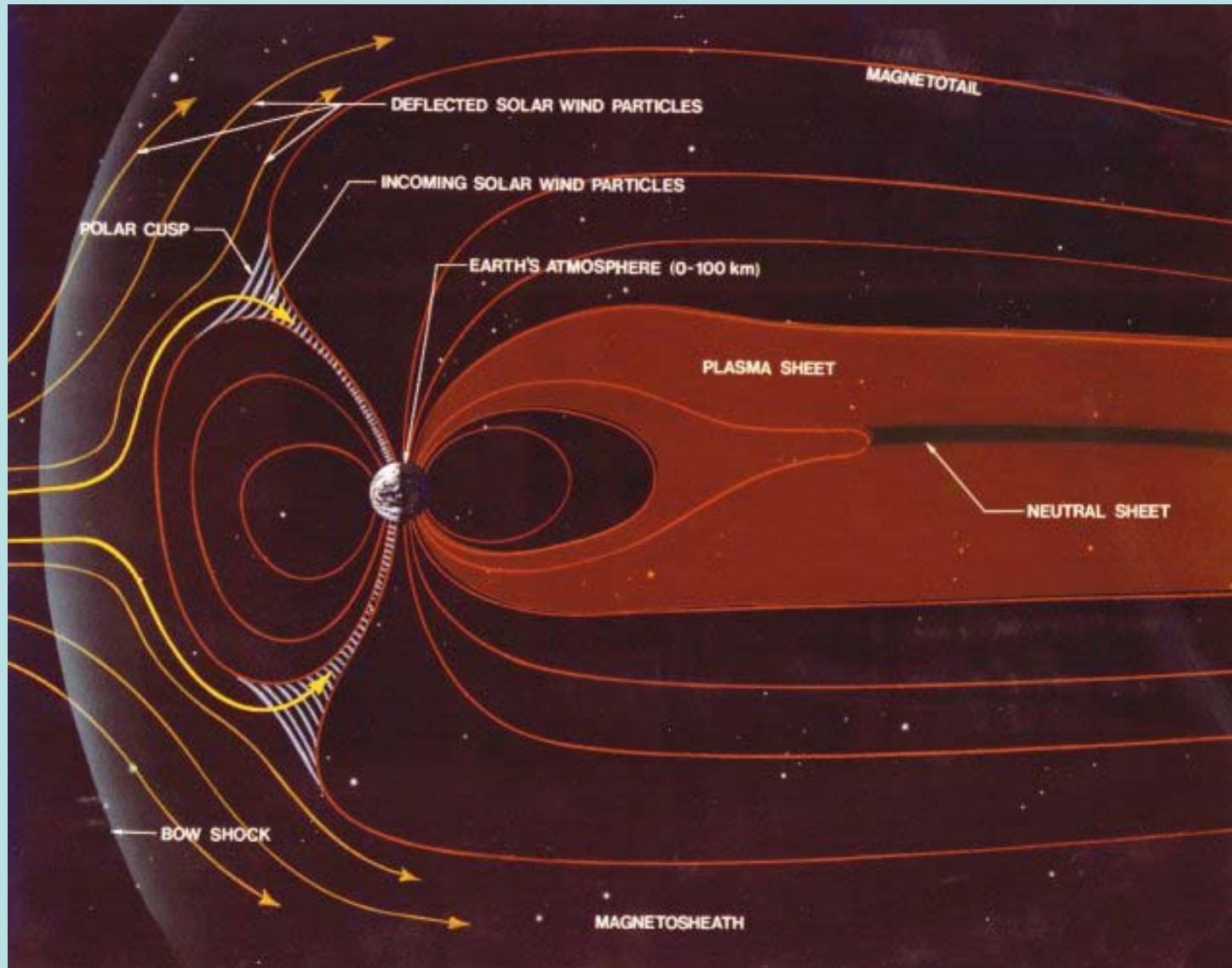


First Major Discovery of the  
Space Age





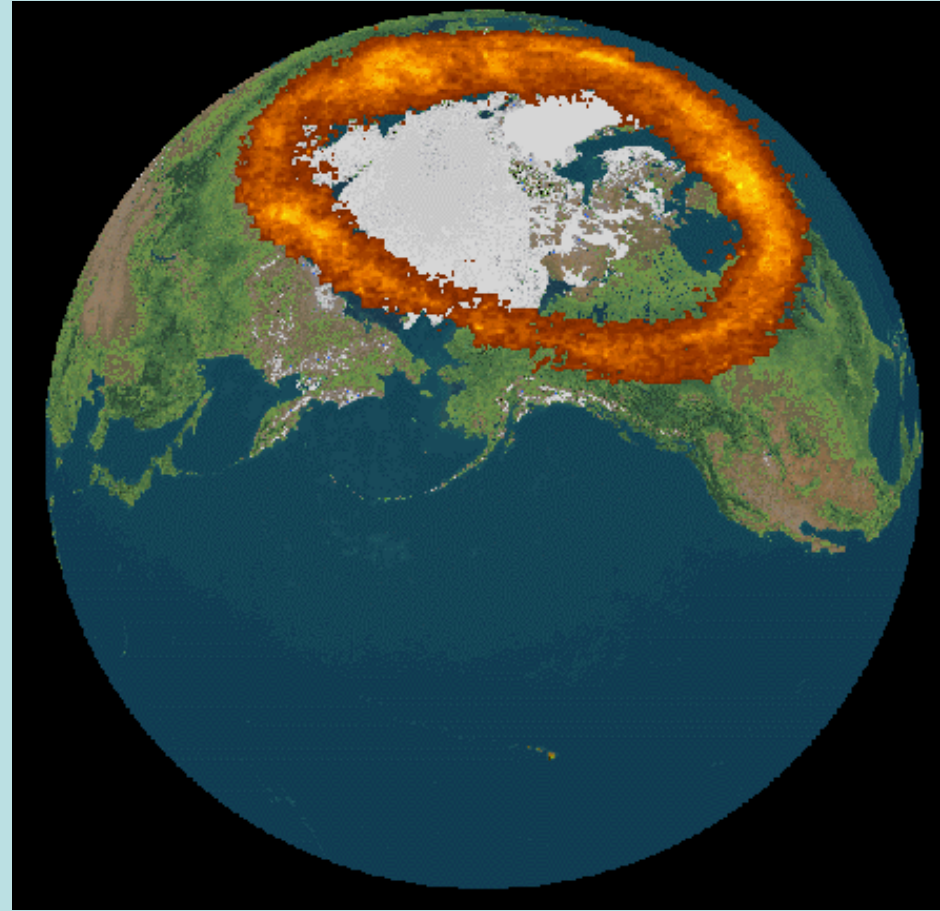
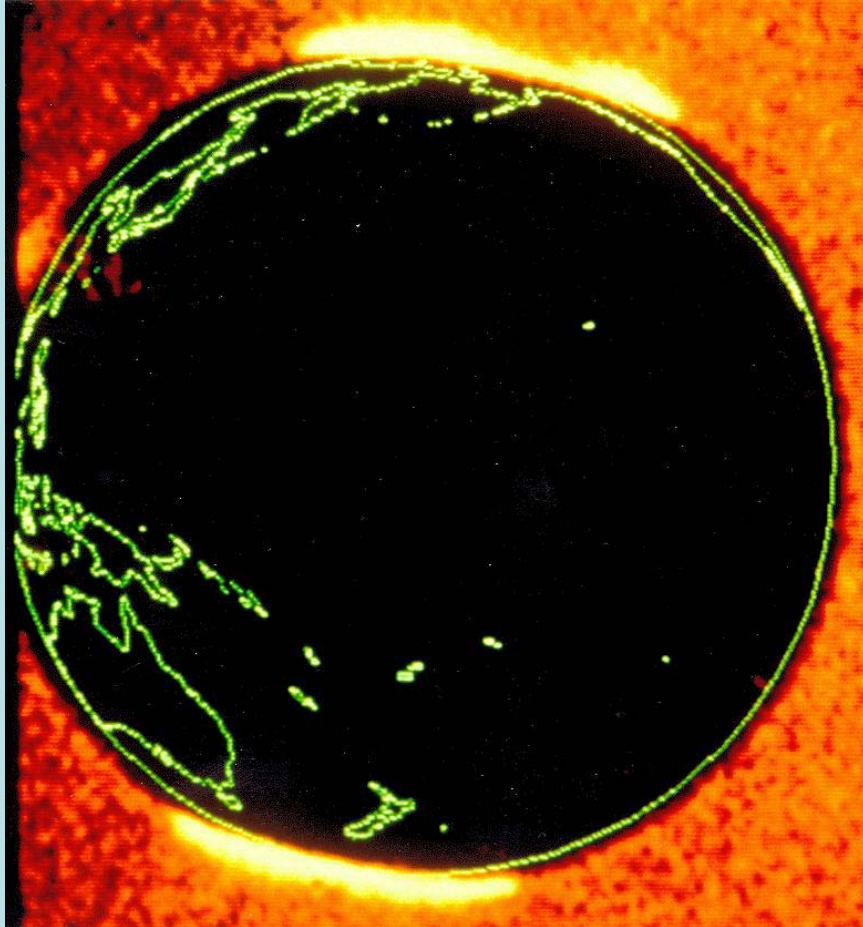
# Earth's Magnetosphere



# Space Weather: from the Sun to Earth



# Auroras – both north & south





# Auroras – many shapes & colors



# Auroras - from space

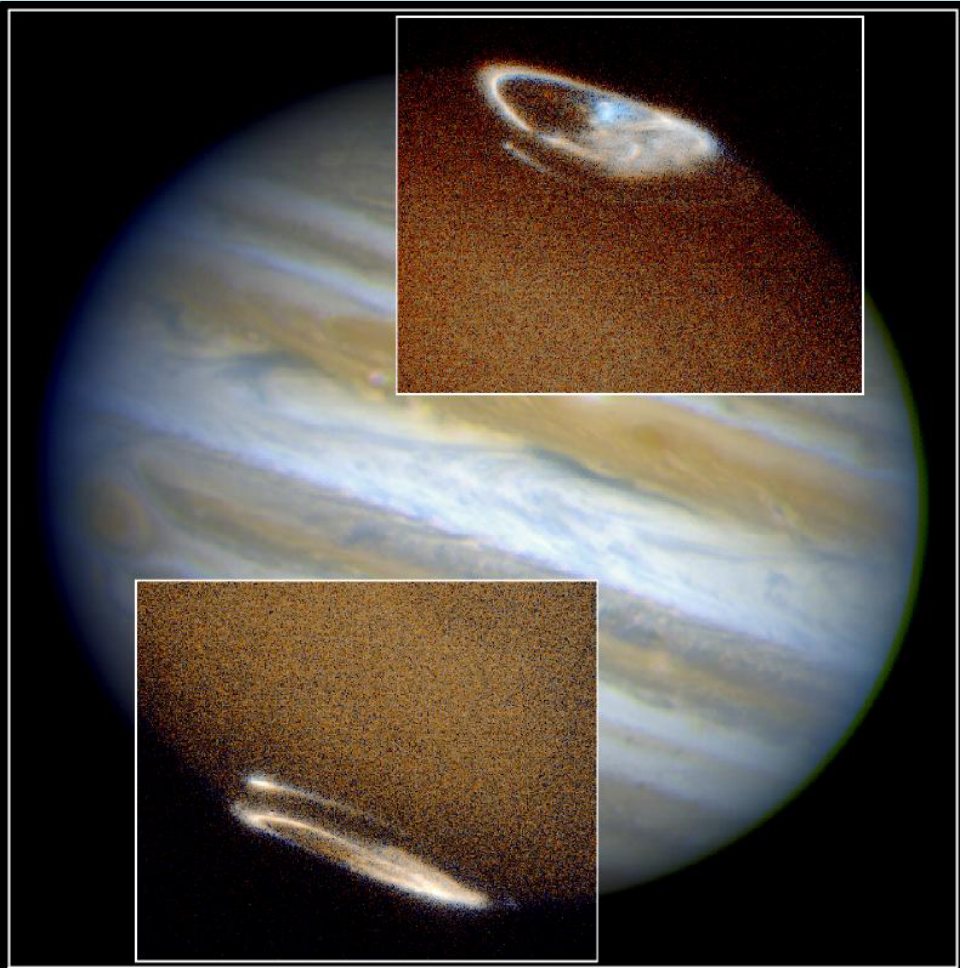


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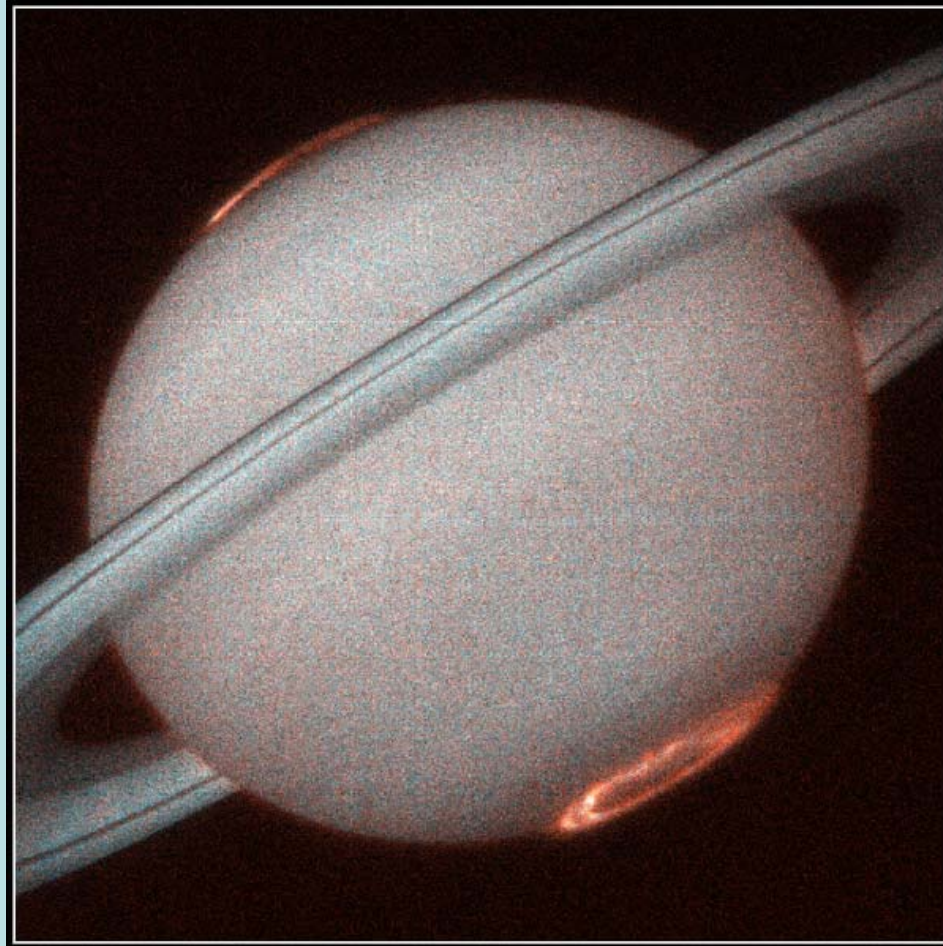
# Auroras – on other worlds



**Jupiter Aurora**

HST • STIS • WFPC2

PRC98-04 • ST Sci OPO • January 7, 1998  
J. Clarke (University of Michigan) and NASA



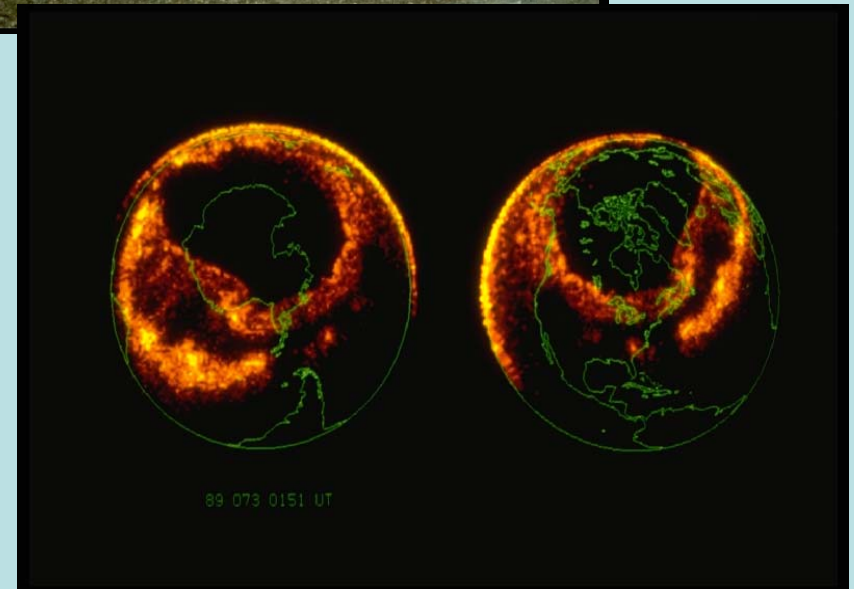
**Saturn Aurora**

HST • STIS

PRC98-05 • ST Sci OPO • January 7, 1998 • J. Trauger (JPL) and NASA



# Magnetic Storm Effects



# Bubbles in Bubbles







[www.spaceweathercenter.org](http://www.spaceweathercenter.org)