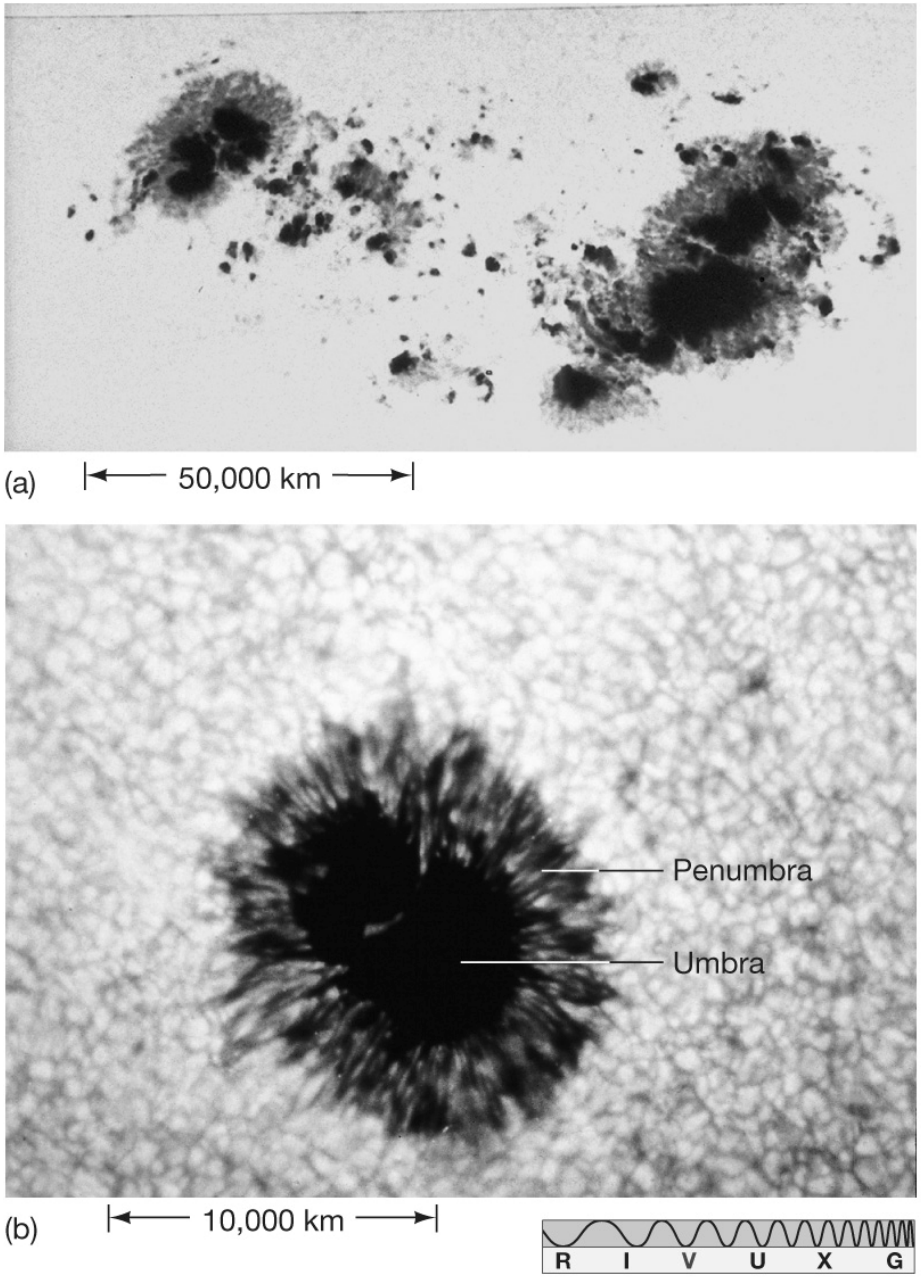
9.4 The Active Sun

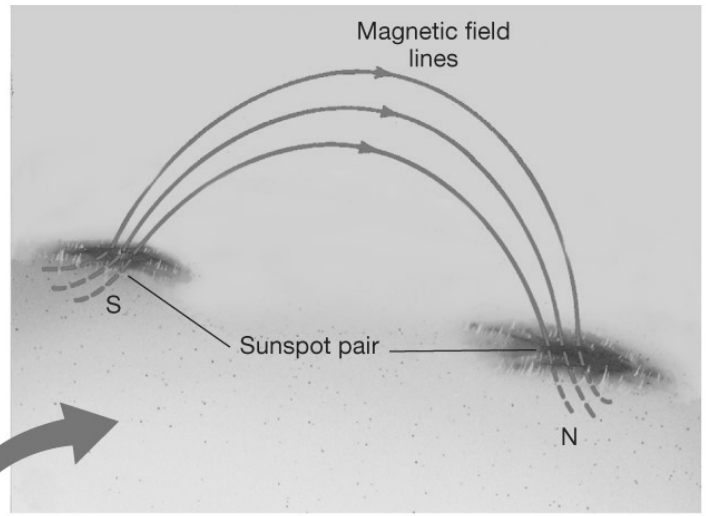
Sunspots: appear dark because slightly cooler than surroundings:

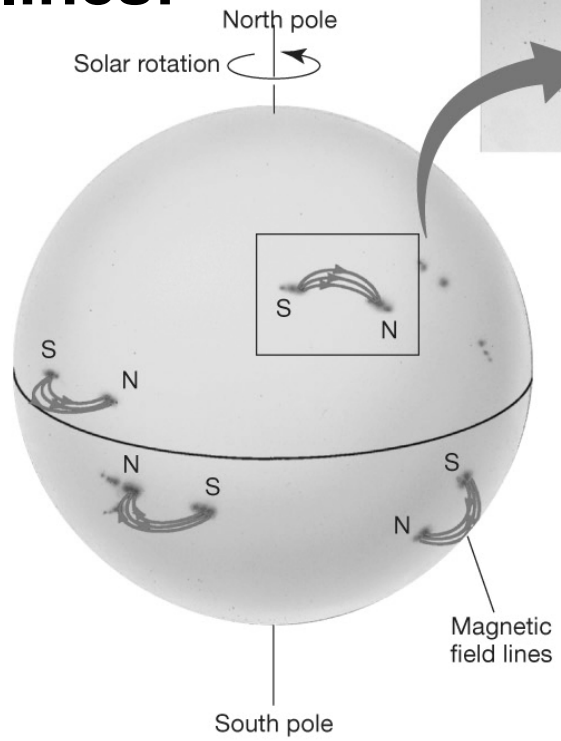


9.4 The Active Sun

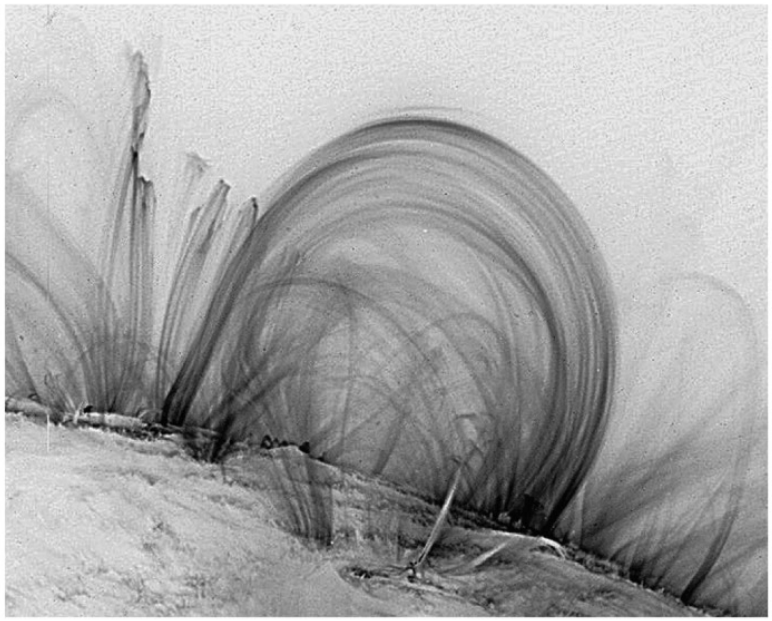
Sunspots come and go, typically in a few days.

Sunspots are linked by pairs of magnetic field lines:





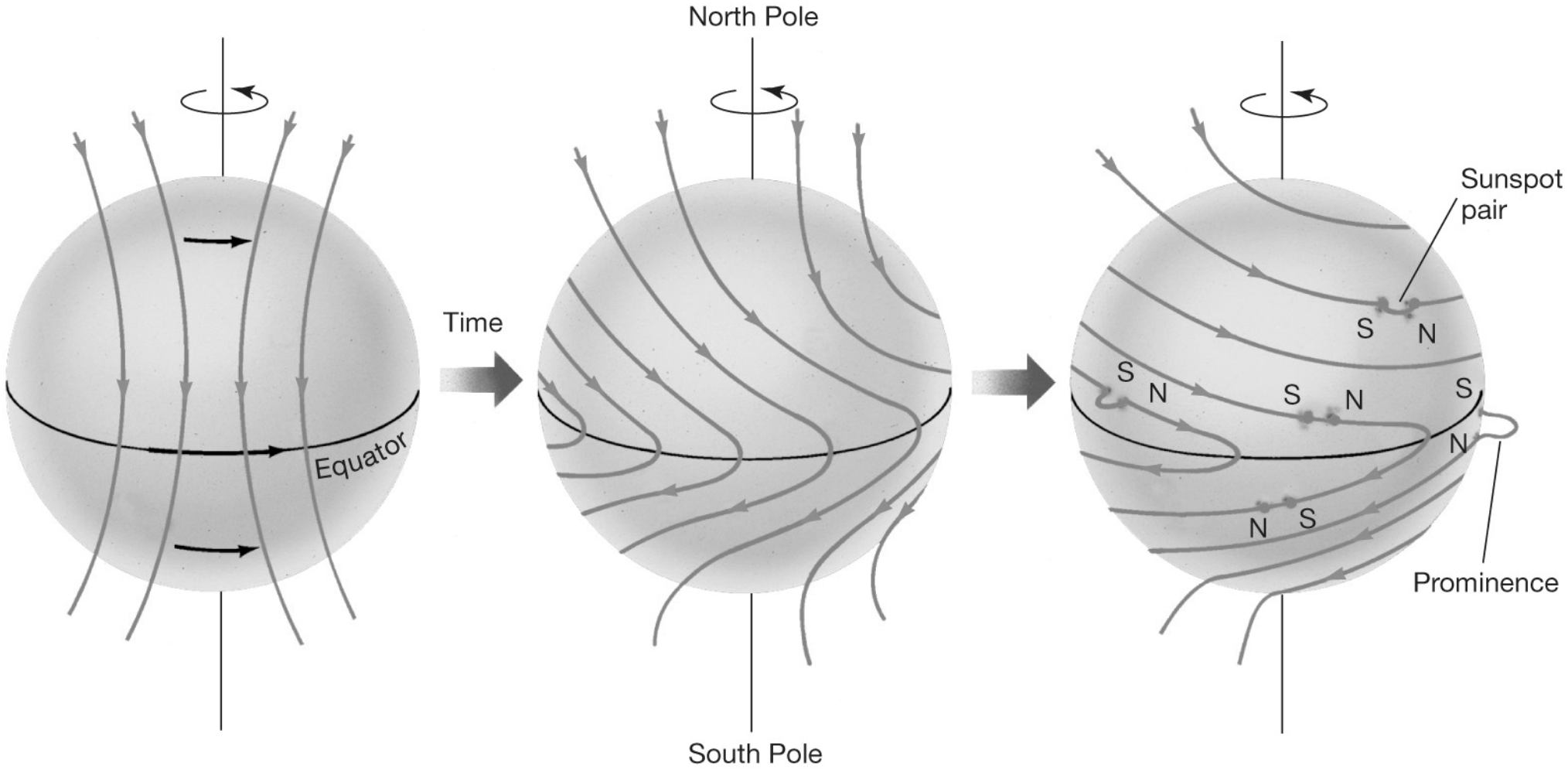
(a)



(b)

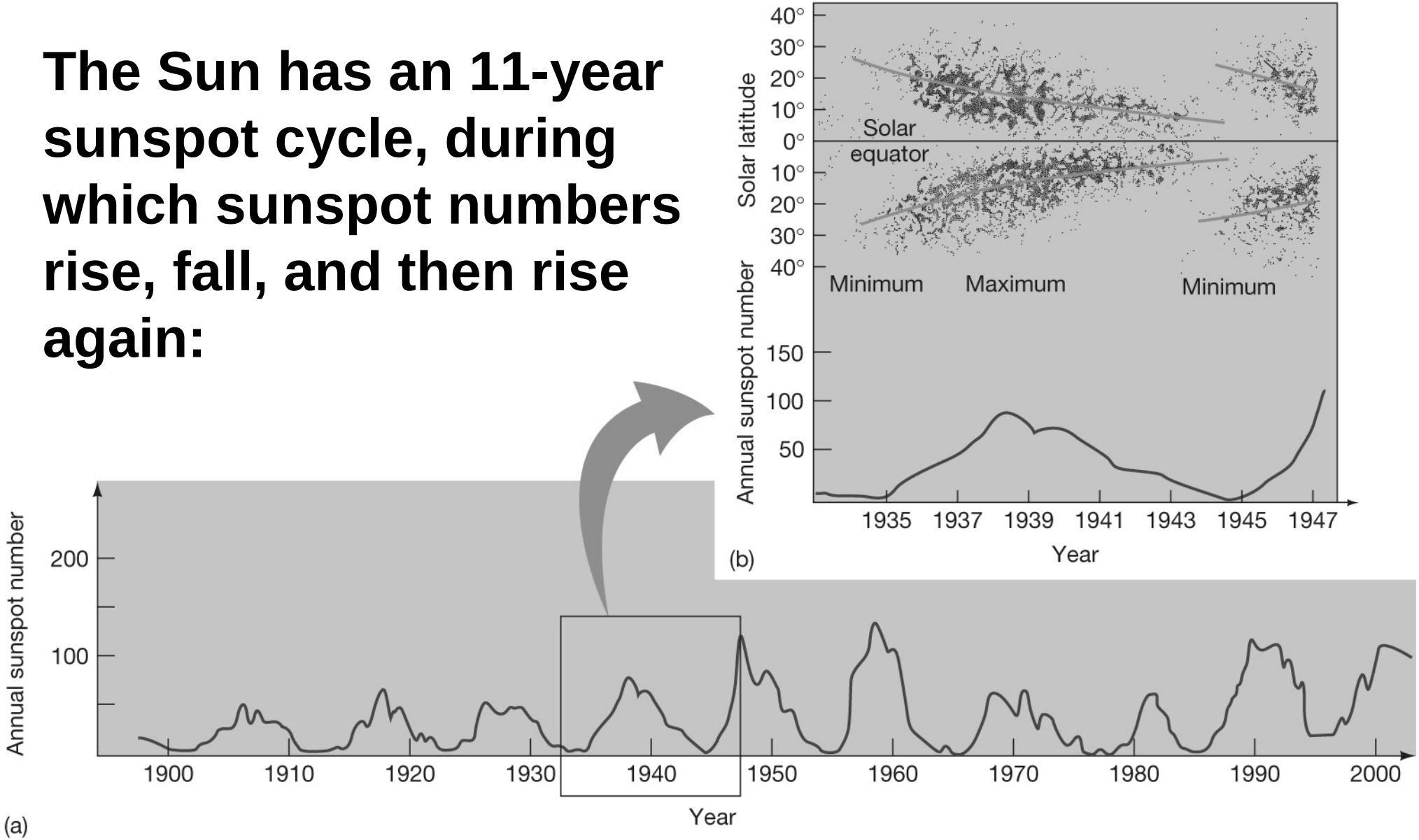
9.4 The Active Sun

The rotation of the Sun drags magnetic field lines around with it, causing kinks



9.4 The Active Sun

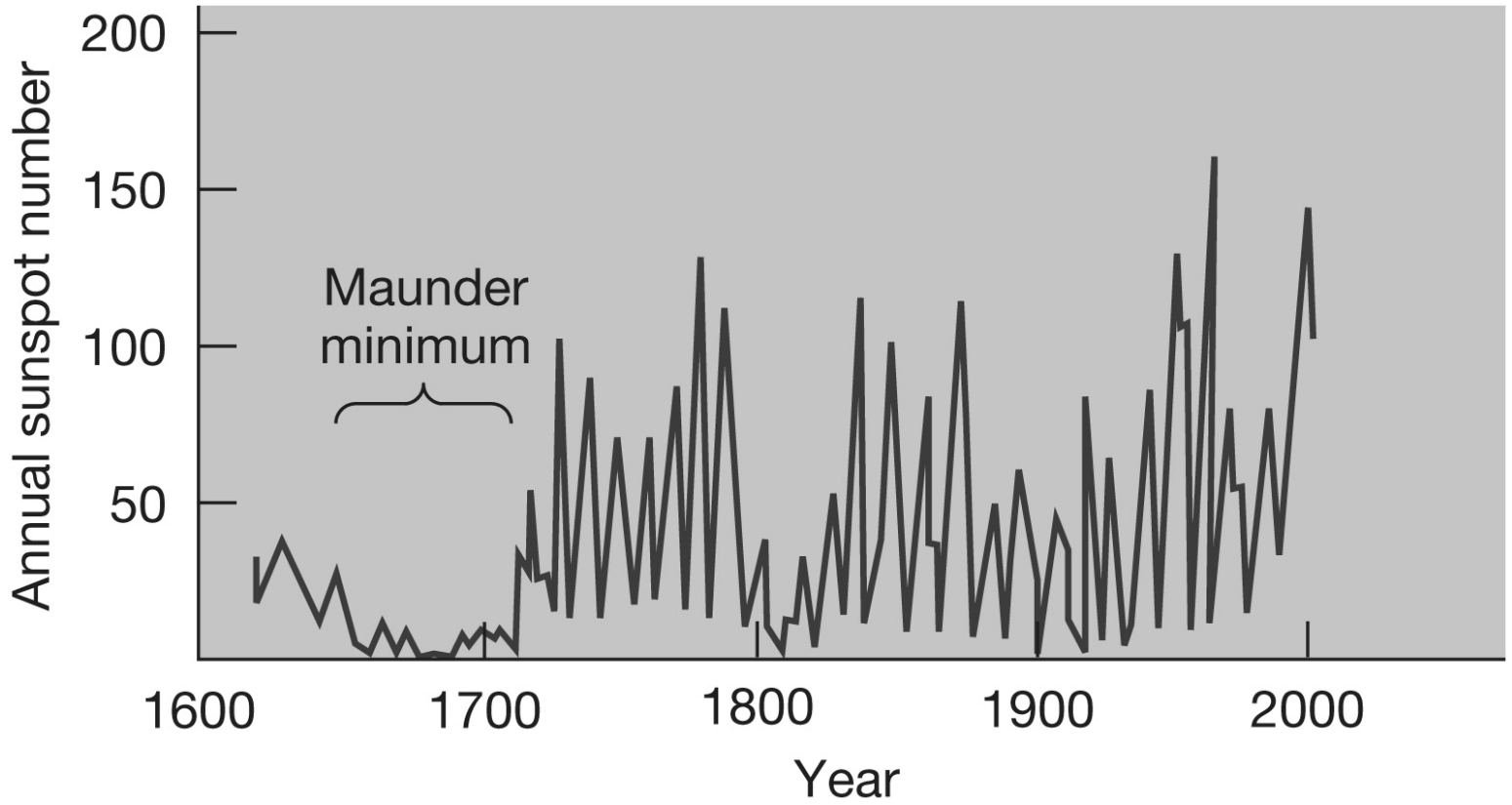
The Sun has an 11-year sunspot cycle, during which sunspot numbers rise, fall, and then rise again:



9.4 The Active Sun

This is really a 22-year cycle, because the spots switch polarities between the northern and southern hemispheres every 11 years.

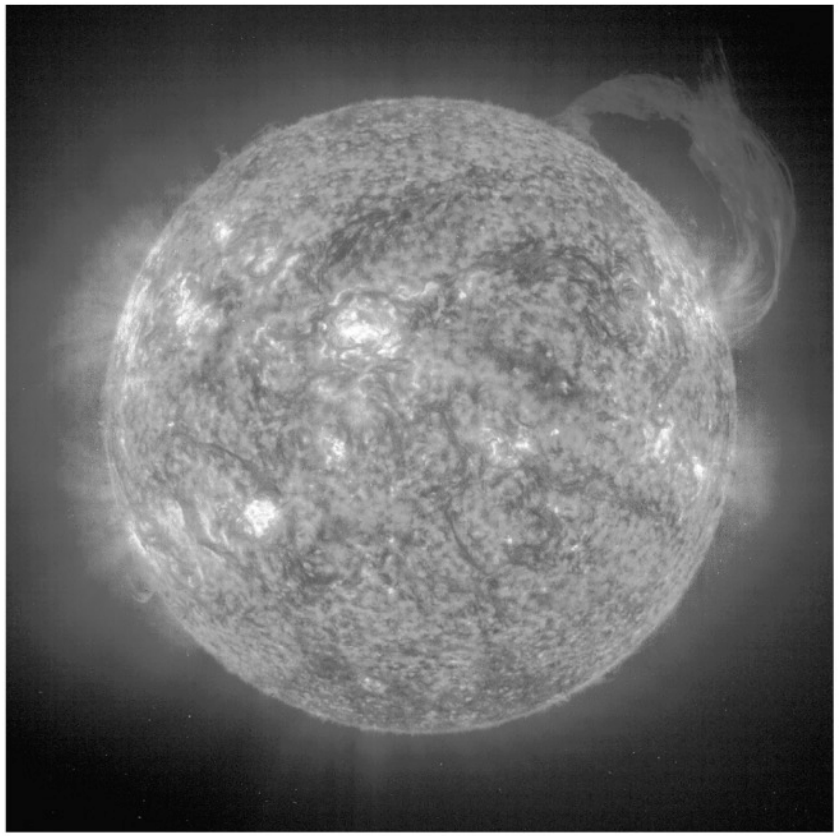
Maunder minimum: few, if any, sunspots:



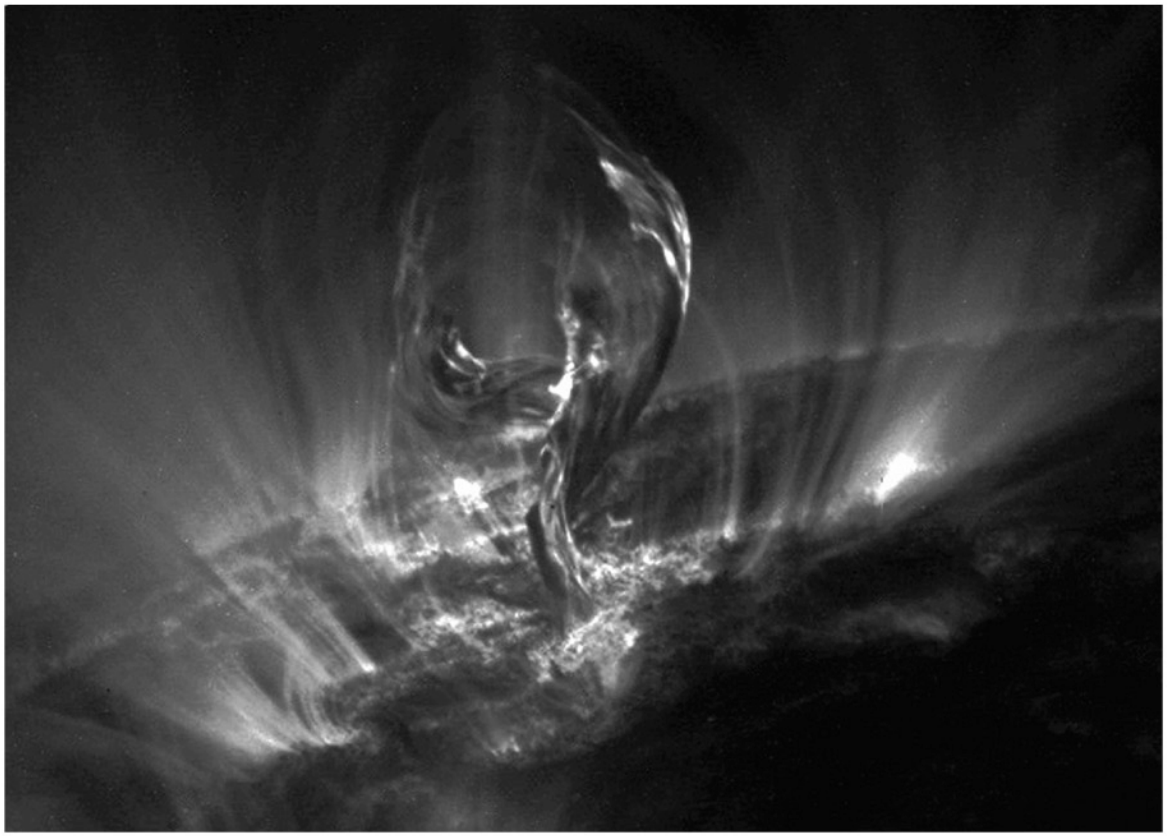
9.4 The Active Sun

Areas around sunspots are active; large eruptions may occur in photosphere.

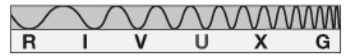
Solar prominence is large sheet of ejected gas:



(a)

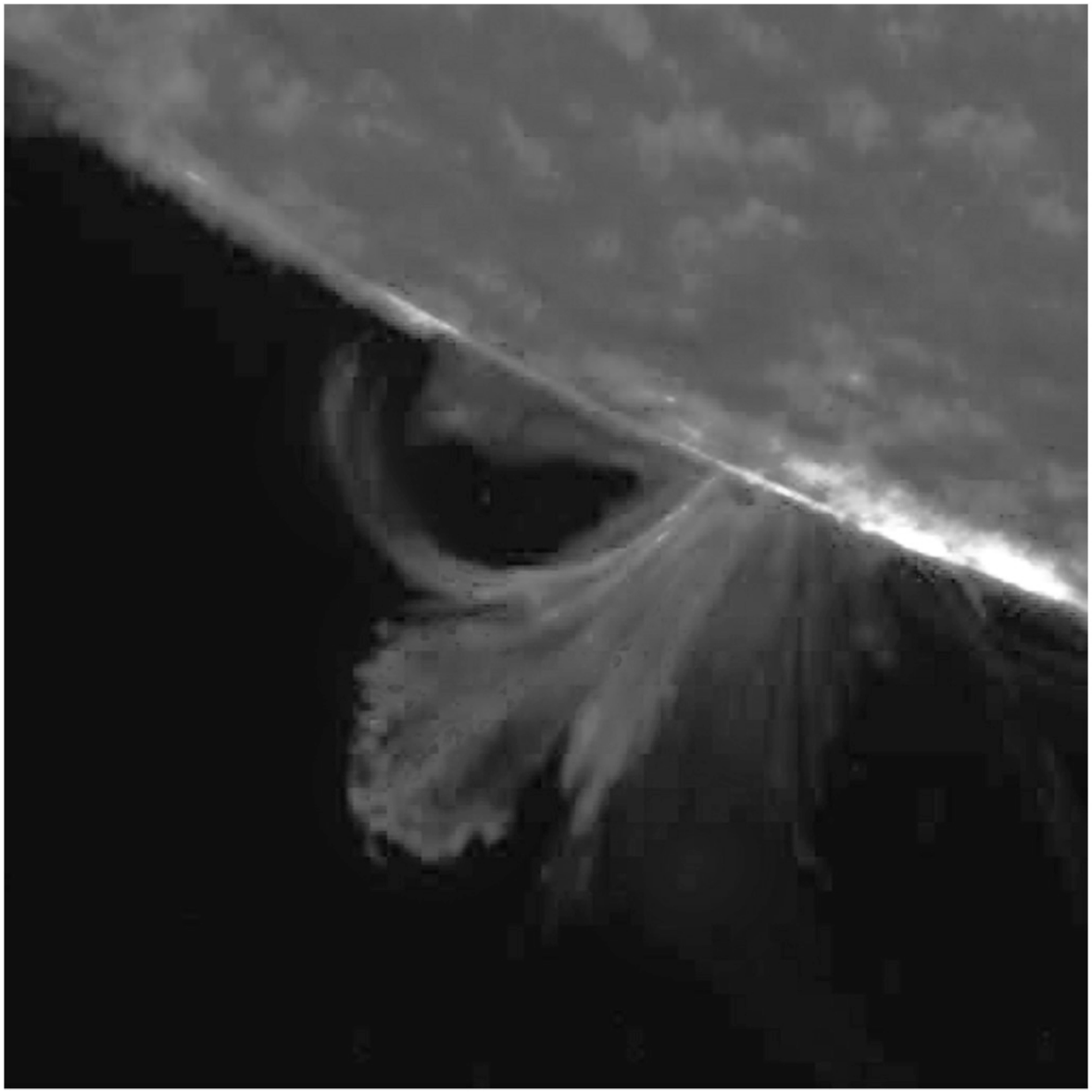


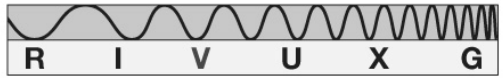
(b)



9.4 The Active Sun

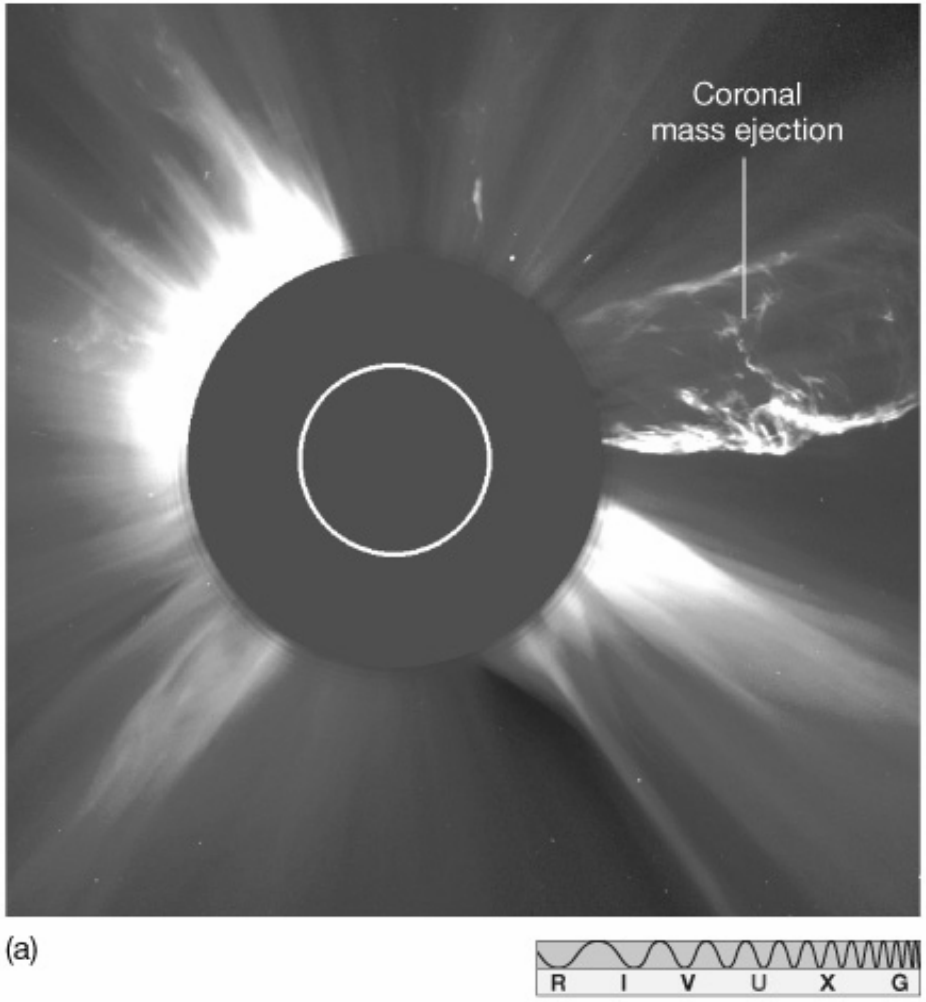
Solar flare is a large explosion on Sun's surface, emitting a similar amount of energy to a prominence, but in seconds or minutes rather than days or weeks:

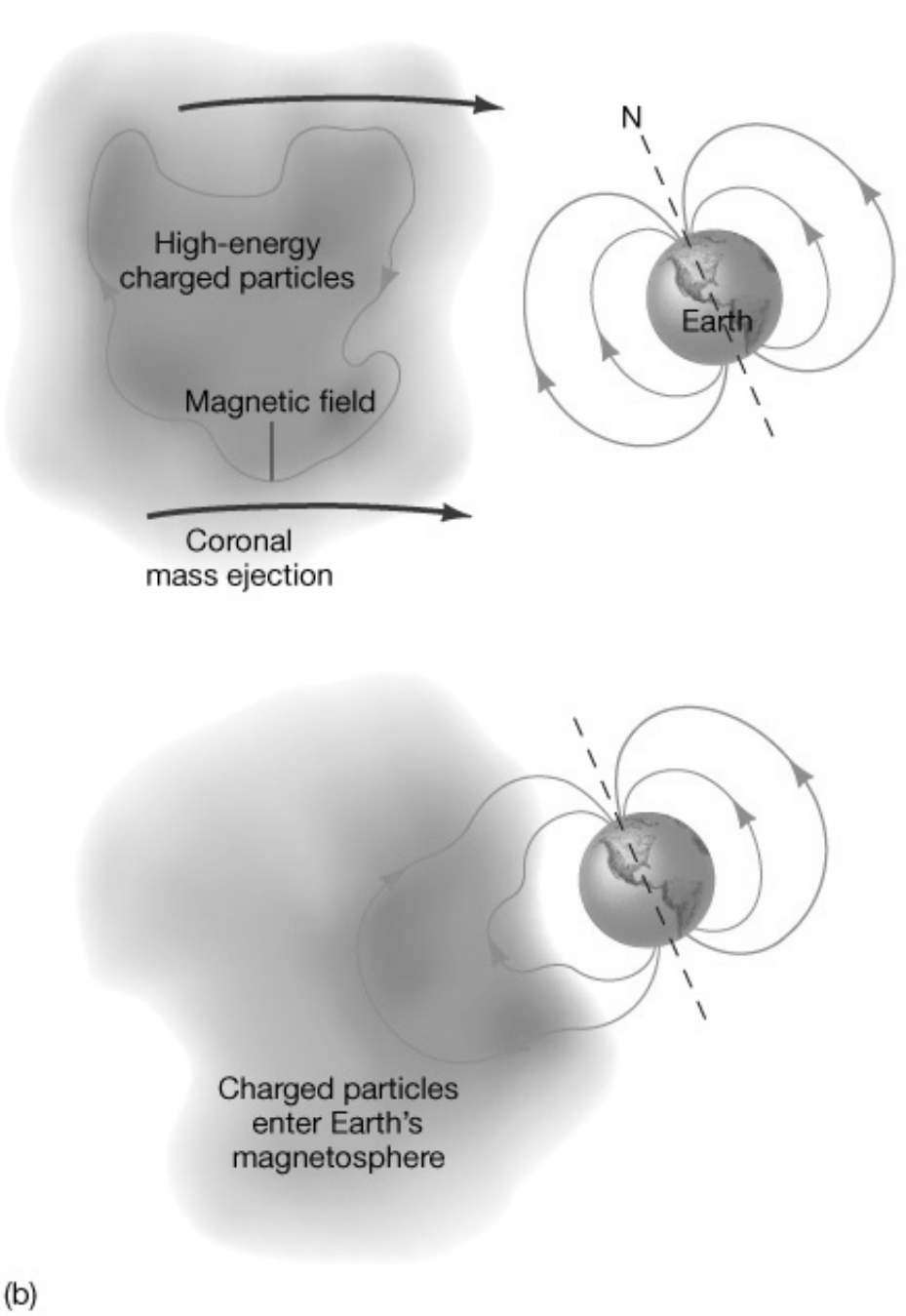




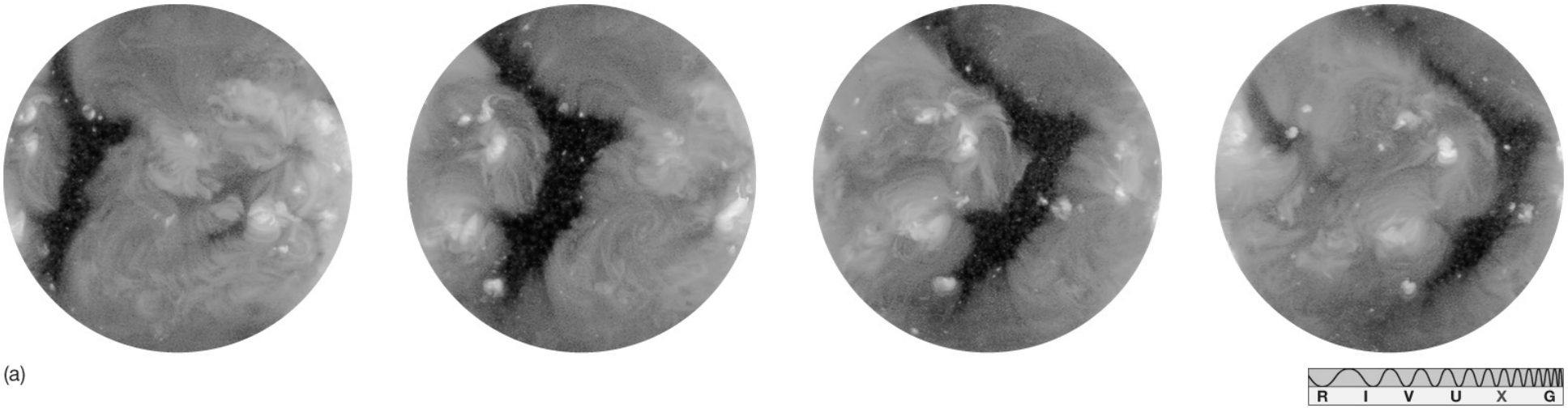
9.4 The Active Sun

A coronal mass ejection emits charged particles that can affect the Earth:

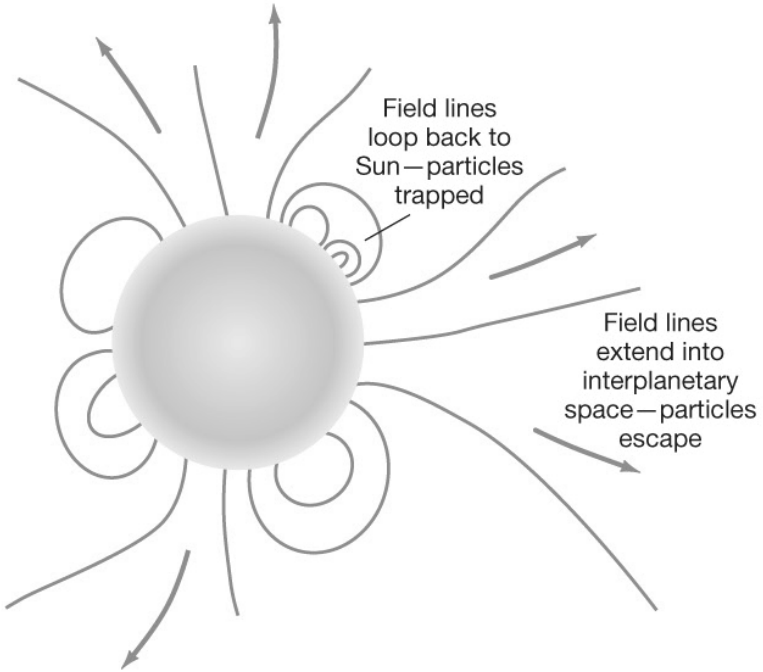




9.4 The Active Sun



(a)

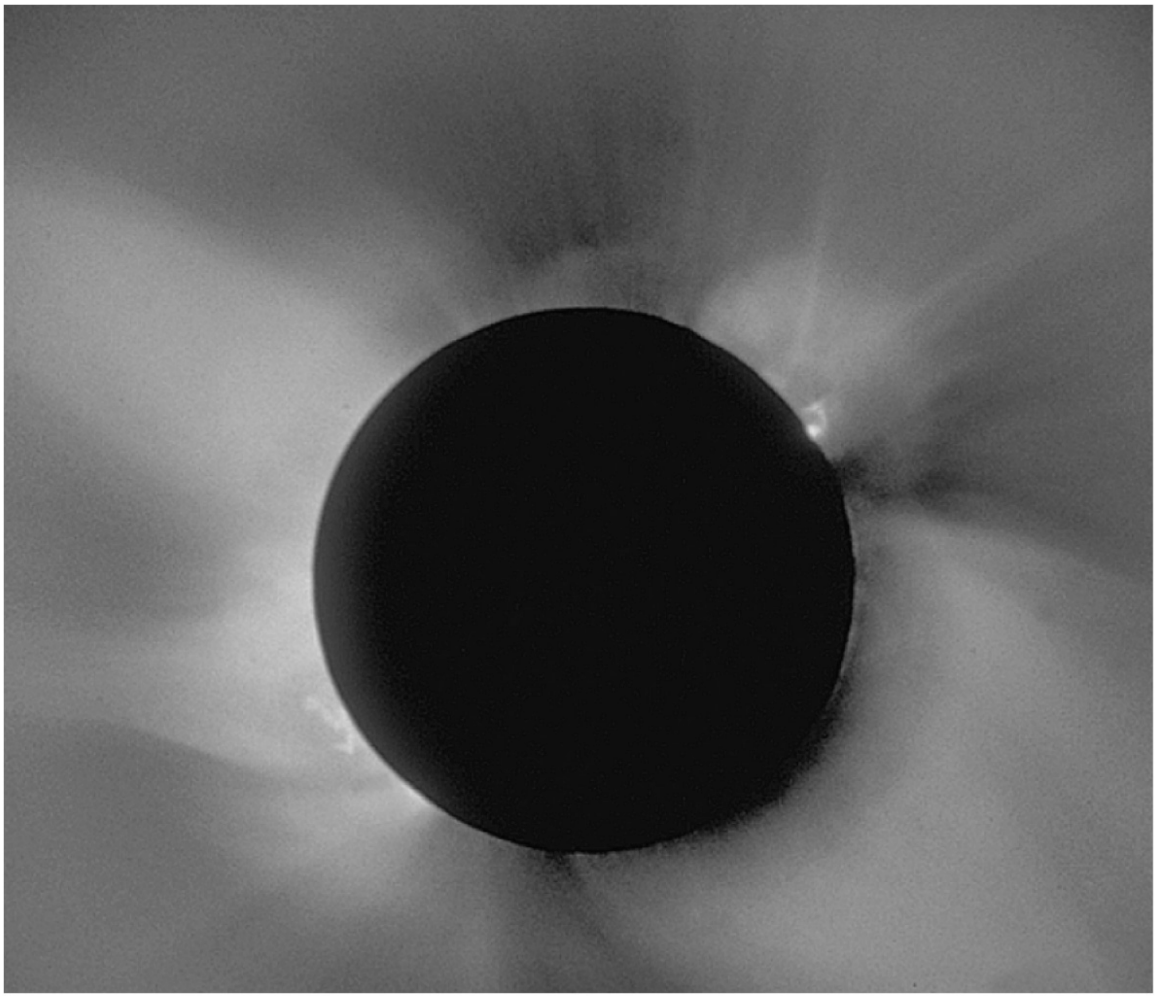


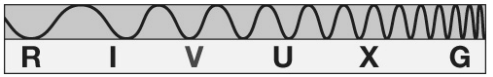
(b)

Solar wind escapes Sun mostly through coronal holes, which can be seen in X-ray images

9.4 The Active Sun

Solar corona changes along with sunspot cycle; is much larger and more irregular at sunspot peak:

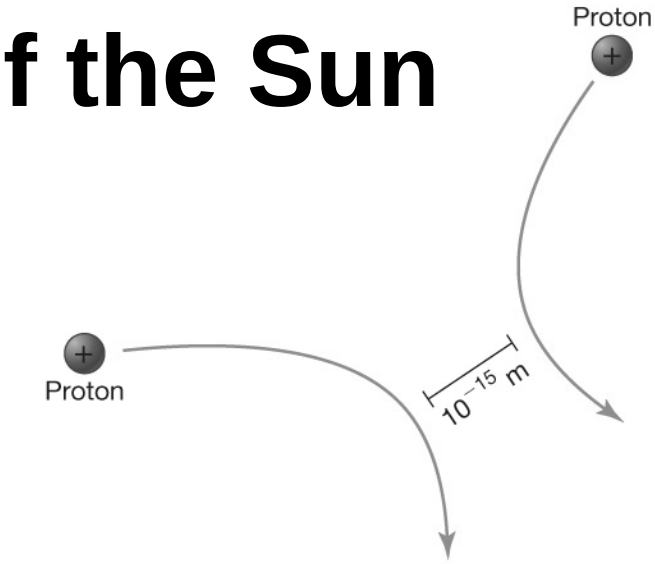




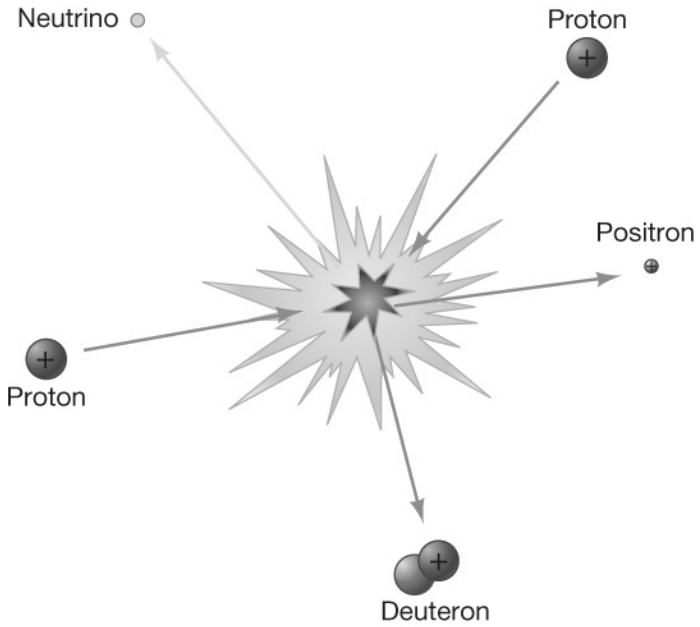
9.5 The Heart of the Sun

Nuclear fusion requires that like-charged nuclei get close enough to each other to fuse.

This can happen only if the temperature is extremely high – over 10 million K.



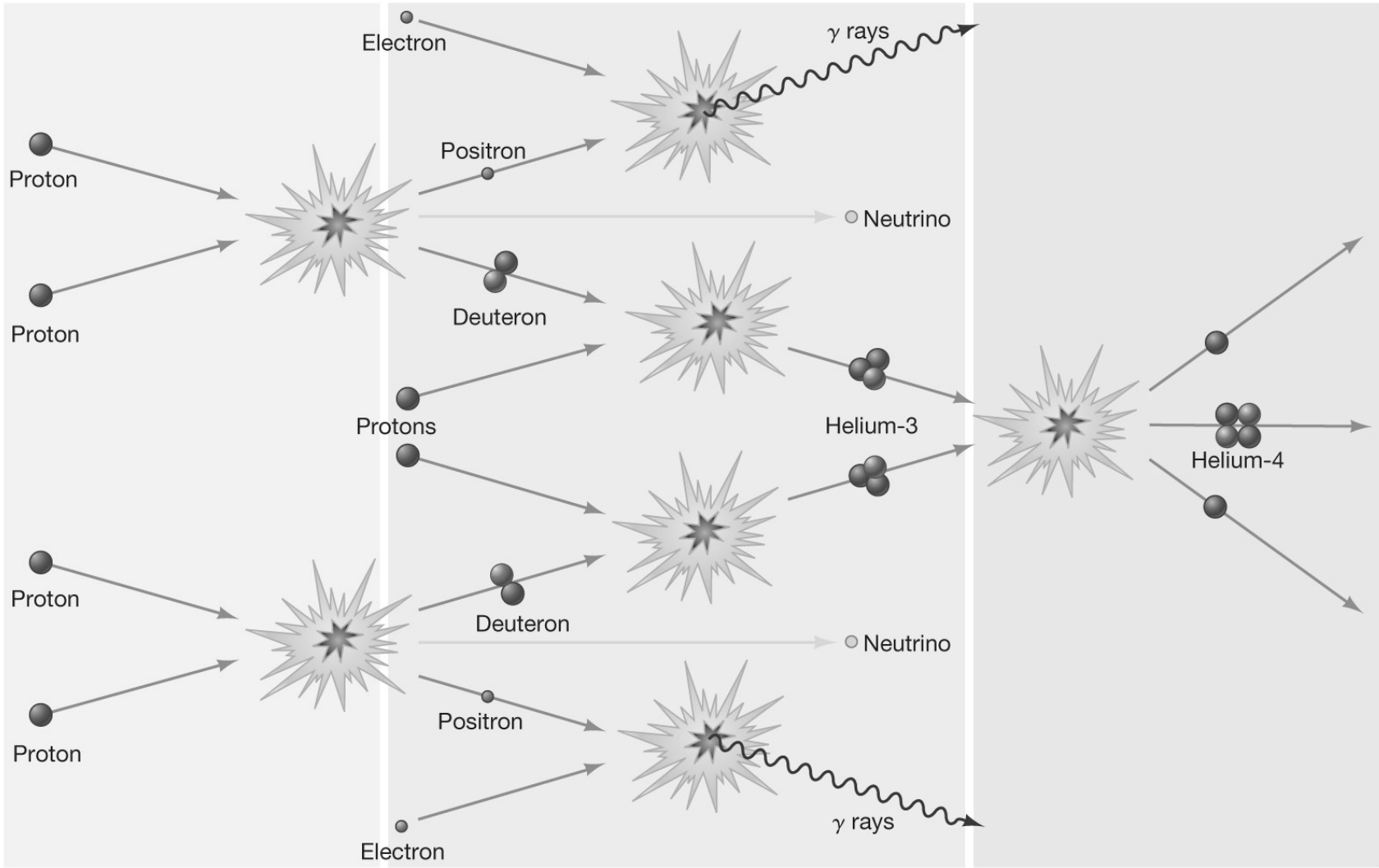
(a)



(b)

9.5 The Heart of the Sun

The process that powers most stars is a three-step fusion process:



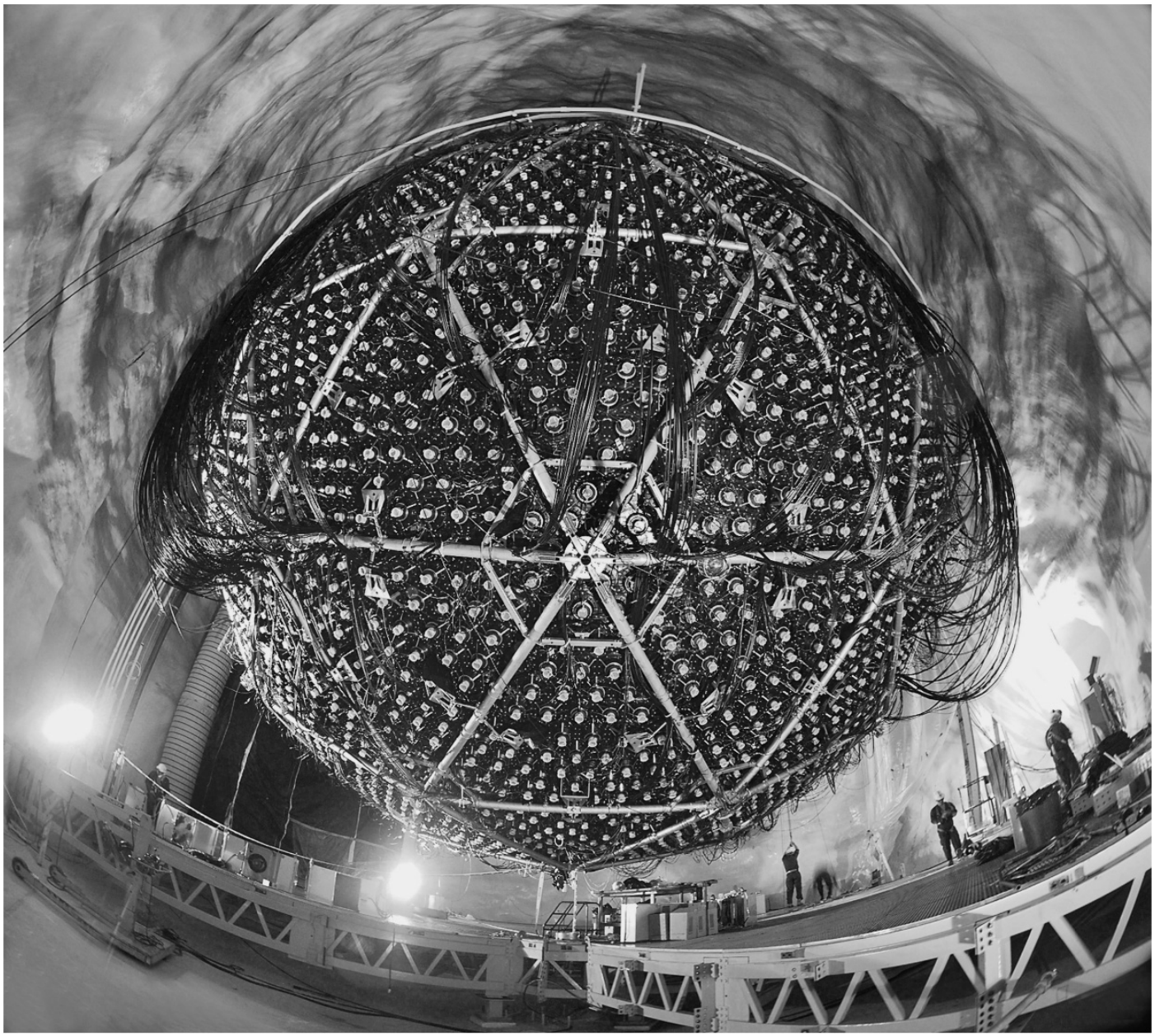
9.5 The Heart of the Sun

Neutrinos are emitted directly from the core of the Sun, and escape, interacting with virtually nothing. Being able to observe these neutrinos would give us a direct picture of what is happening in the core.

Unfortunately, they are no more likely to interact with Earth-based detectors than they are with the Sun; the only way to spot them is to have a huge detector volume and to be able to observe single interaction events.

9.5 The Heart of the Sun

The Sudbury neutrino observatory:



Summary of Chapter 9

- **Sun is held together by its own gravity and powered by nuclear fusion**
- **Outer layers of Sun: photosphere, chromosphere, corona. The corona is very hot.**
- **Mathematical models and helioseismology give us a picture of the interior of the Sun**
- **Sunspots occur in regions of high magnetic fields; darker spots are cooler**

Summary of Chapter 9

- **Nuclear fusion converts hydrogen to helium, releasing energy**
- **Solar neutrinos come directly from the solar core, although observations have told us more about neutrinos than about the Sun**