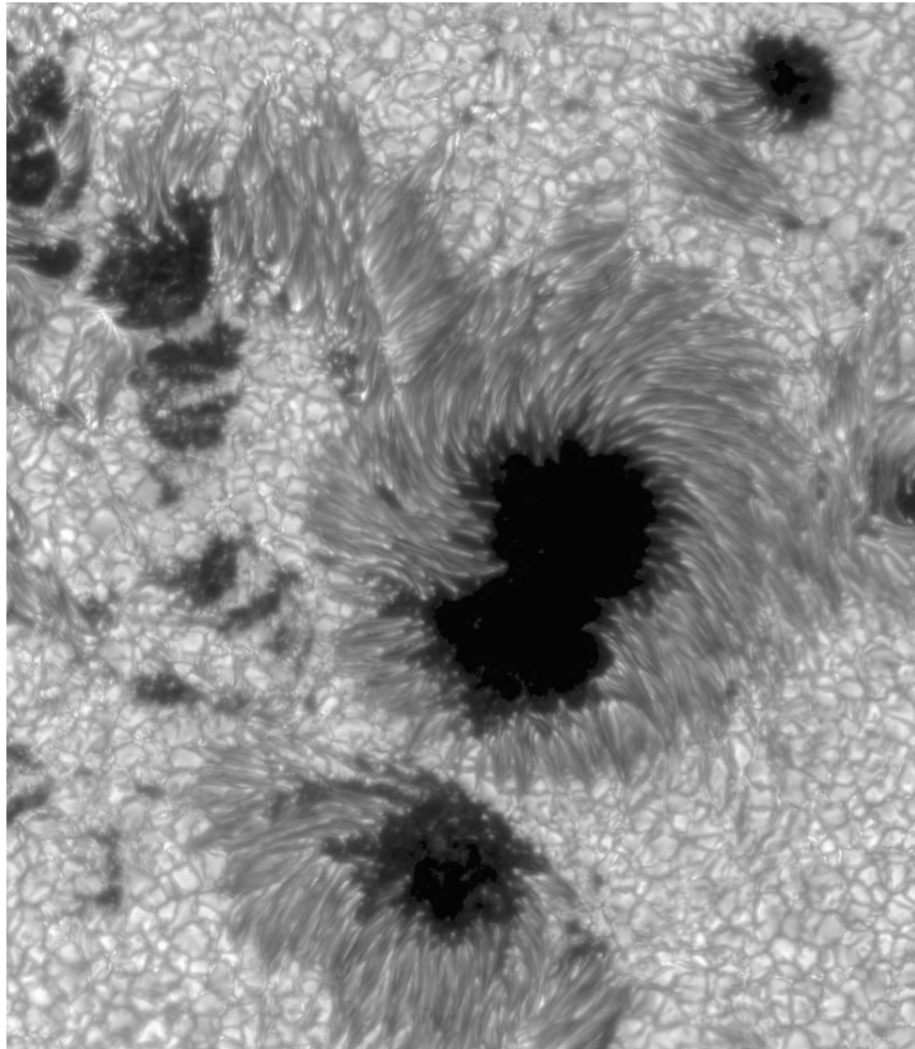


Chapter 9

The Sun



Units of Chapter 9

The Sun in Bulk

The Solar Interior

The Solar Atmosphere

The Active Sun

The Heart of the Sun

9.1 The Sun in Bulk

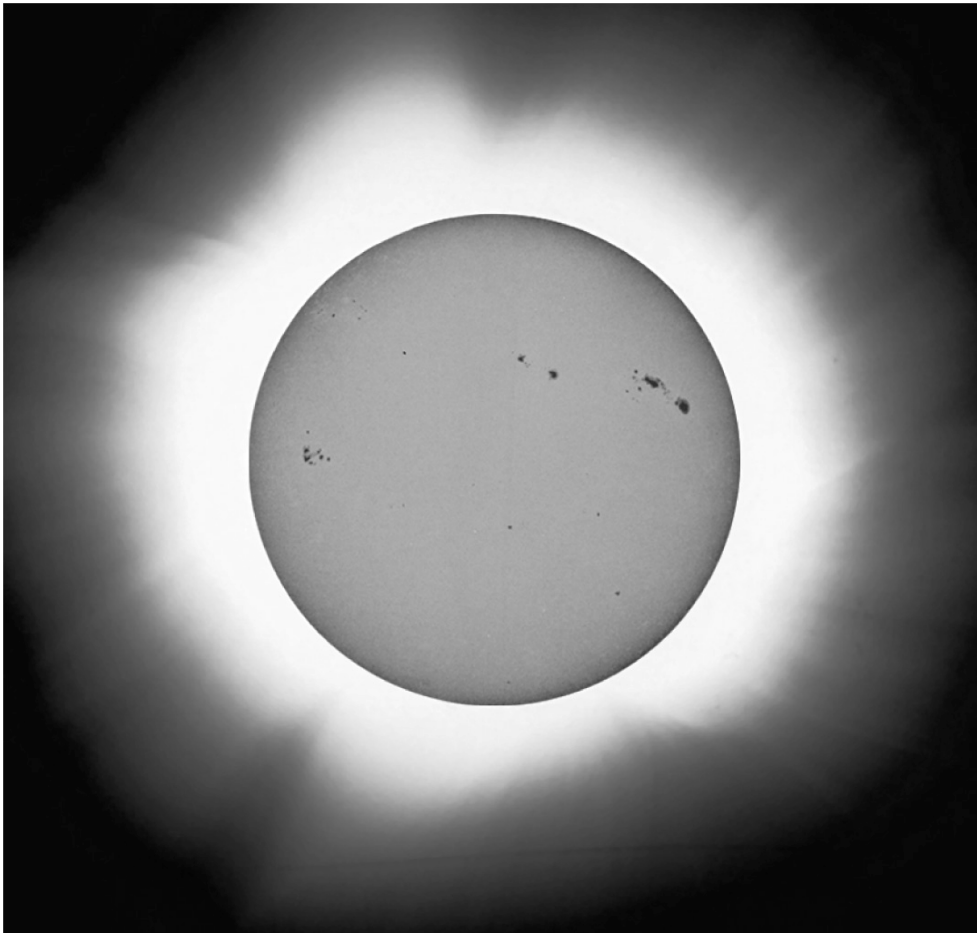
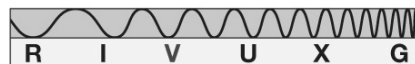


TABLE 9.1 Some Solar Properties

Radius	696,000 km
Mass	1.99×10^{30} kg
Average density	1410 kg/m^3
Rotation period	25.1 days (equator); 30.8 days (60° latitude) 36 days (poles) 26.9 days (interior)
Surface temperature	5780 K
Luminosity	3.86×10^{26} W

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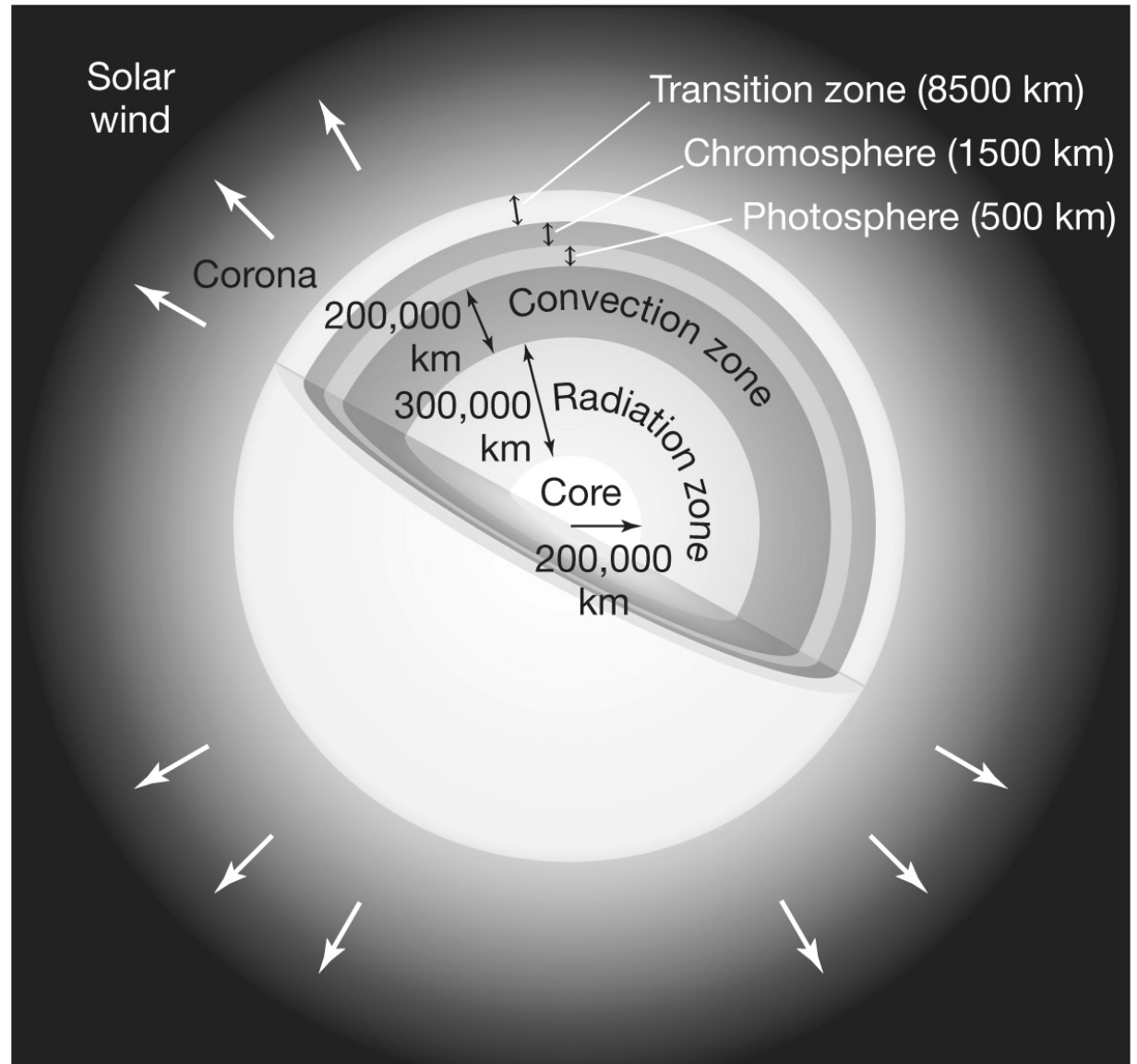
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9.1 The Sun in Bulk

Interior structure of the Sun:

Outer layers are not to scale.

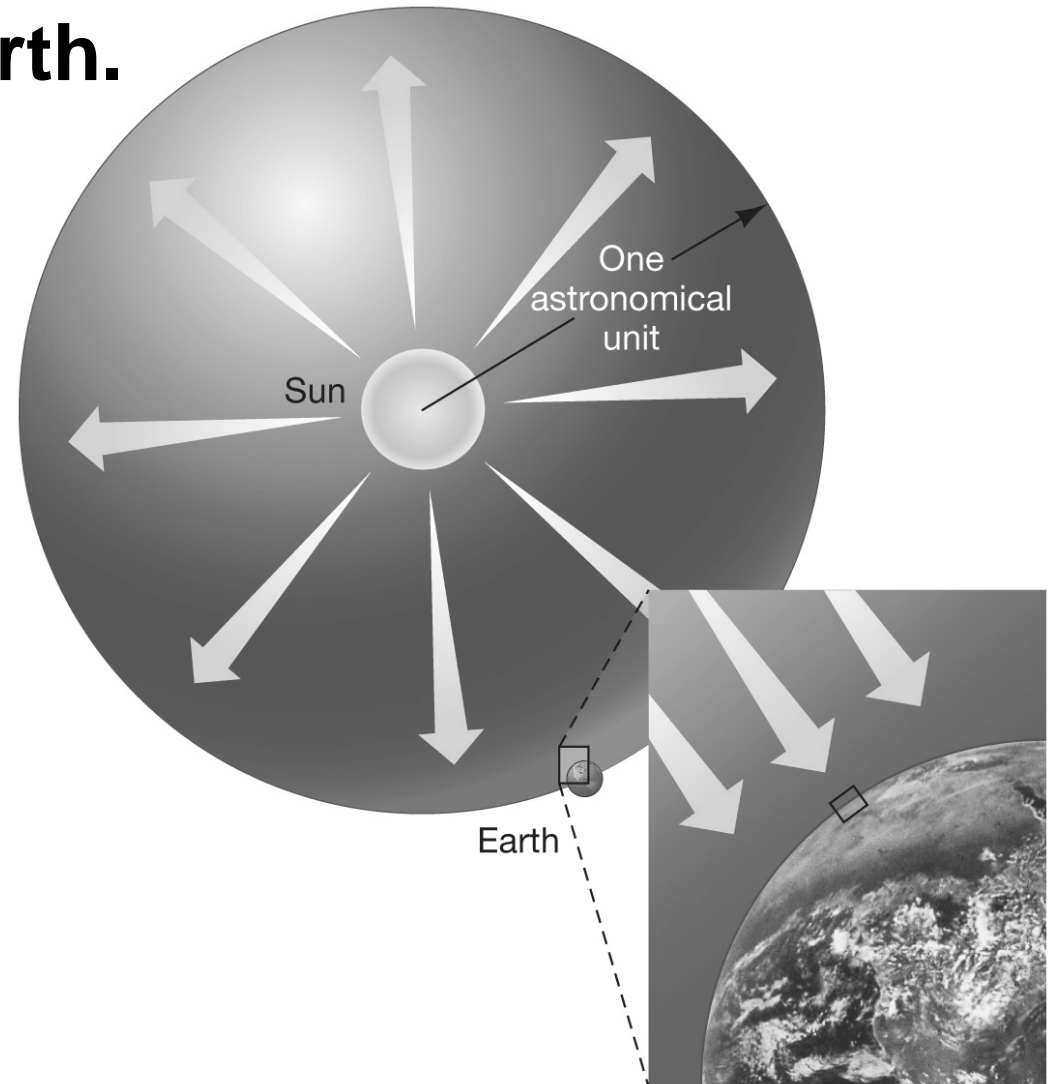
The core is where nuclear fusion takes place.



9.1 The Sun in Bulk

Luminosity – total energy radiated by the Sun – can be calculated from the fraction of that energy that reaches Earth.

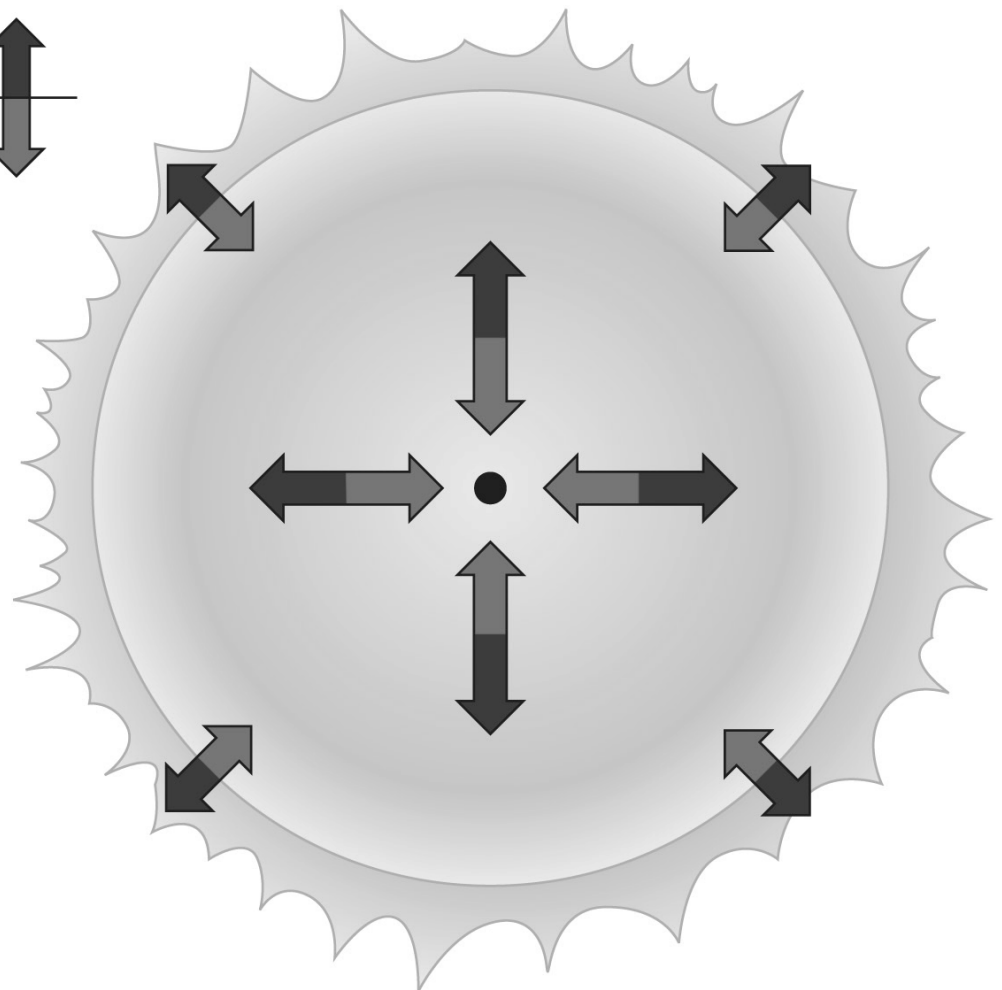
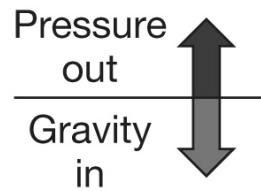
Total luminosity is about 4×10^{26} W – the equivalent of 10 billion 1-megaton nuclear bombs per second.



9.2 The Solar Interior

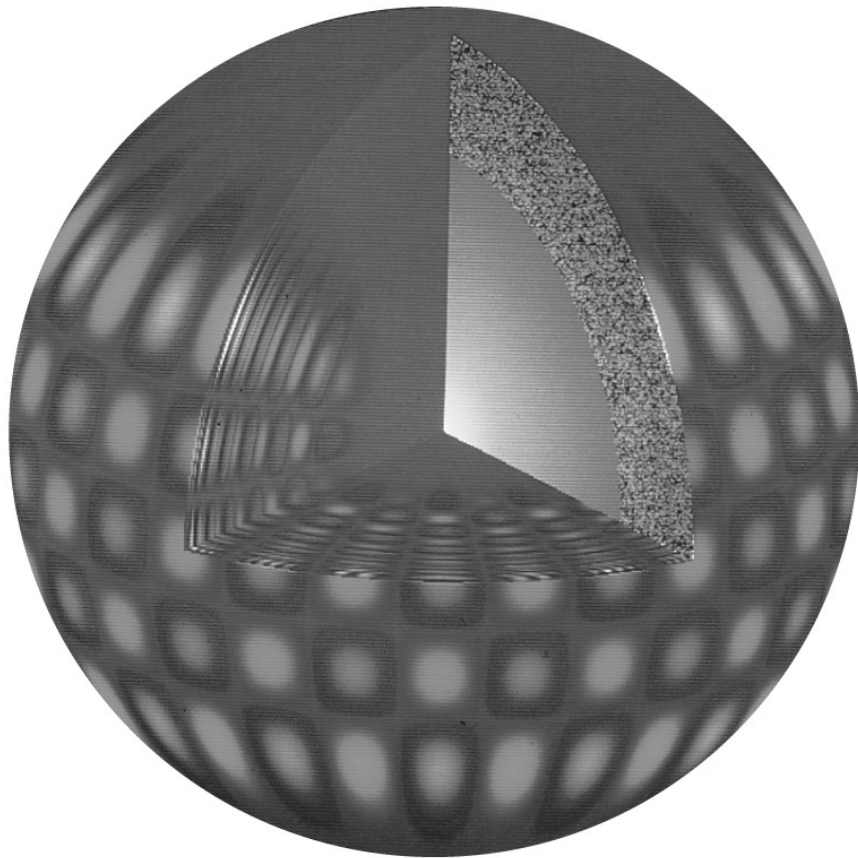
Mathematical models, consistent with observation and physical principles, provide information about the Sun's interior.

In equilibrium, inward gravitational force must be balanced by outward pressure:

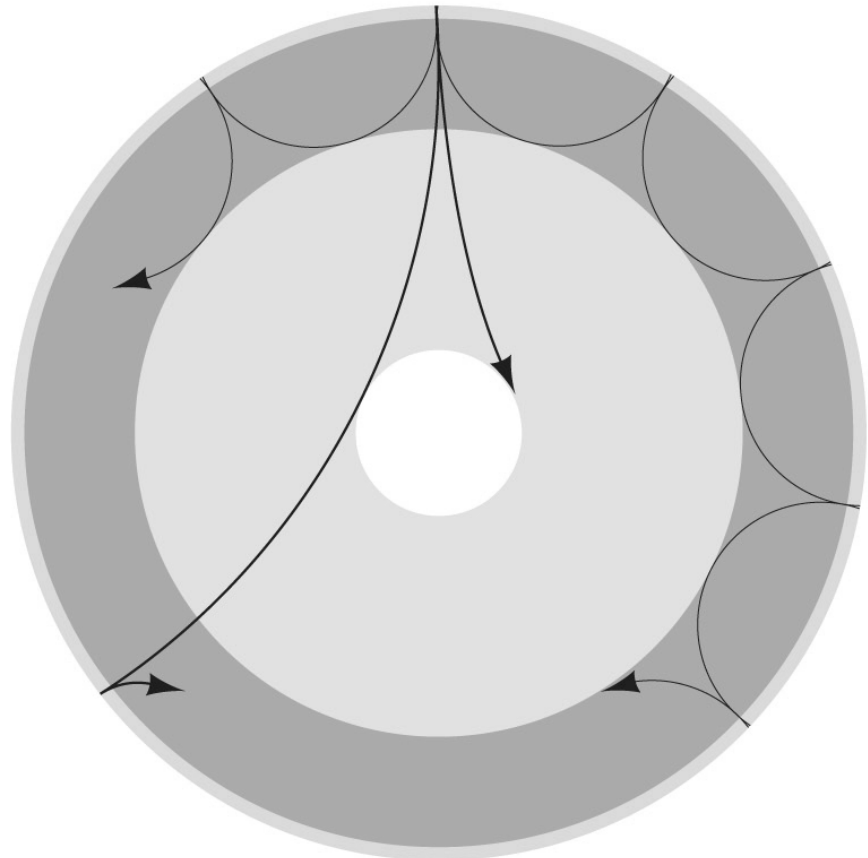


9.2 The Solar Interior

Doppler shifts of solar spectral lines indicate a complex pattern of vibrations:



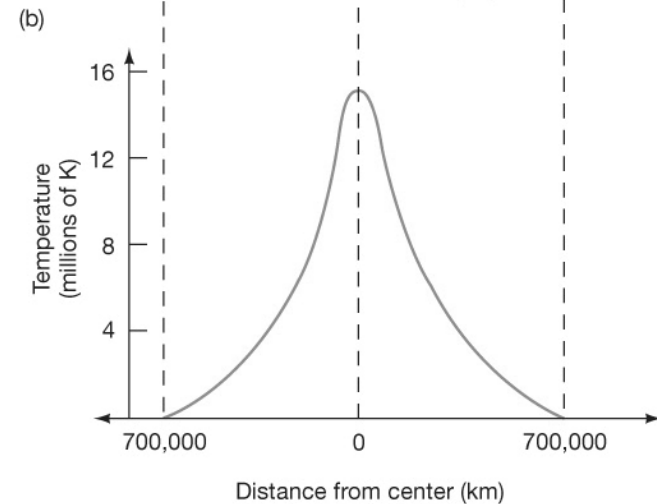
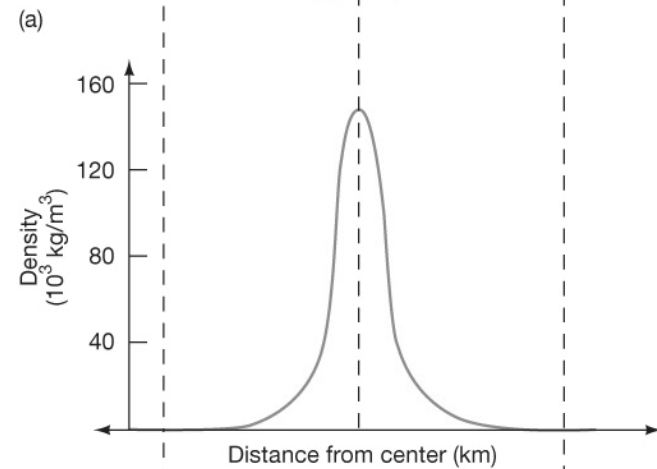
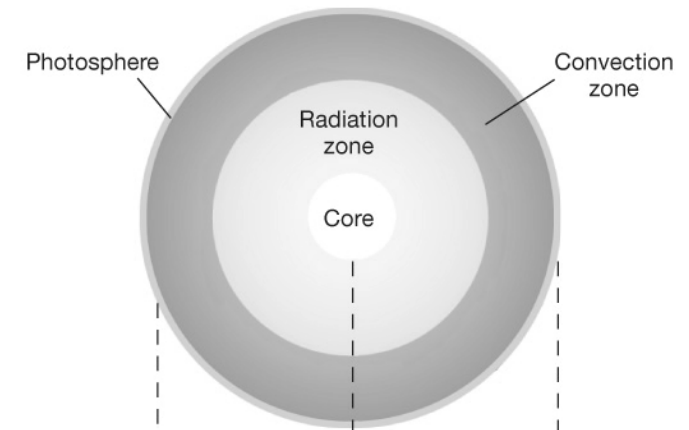
(a)



(b)

9.2 The Solar Interior

Solar density and temperature, according to the standard solar model:

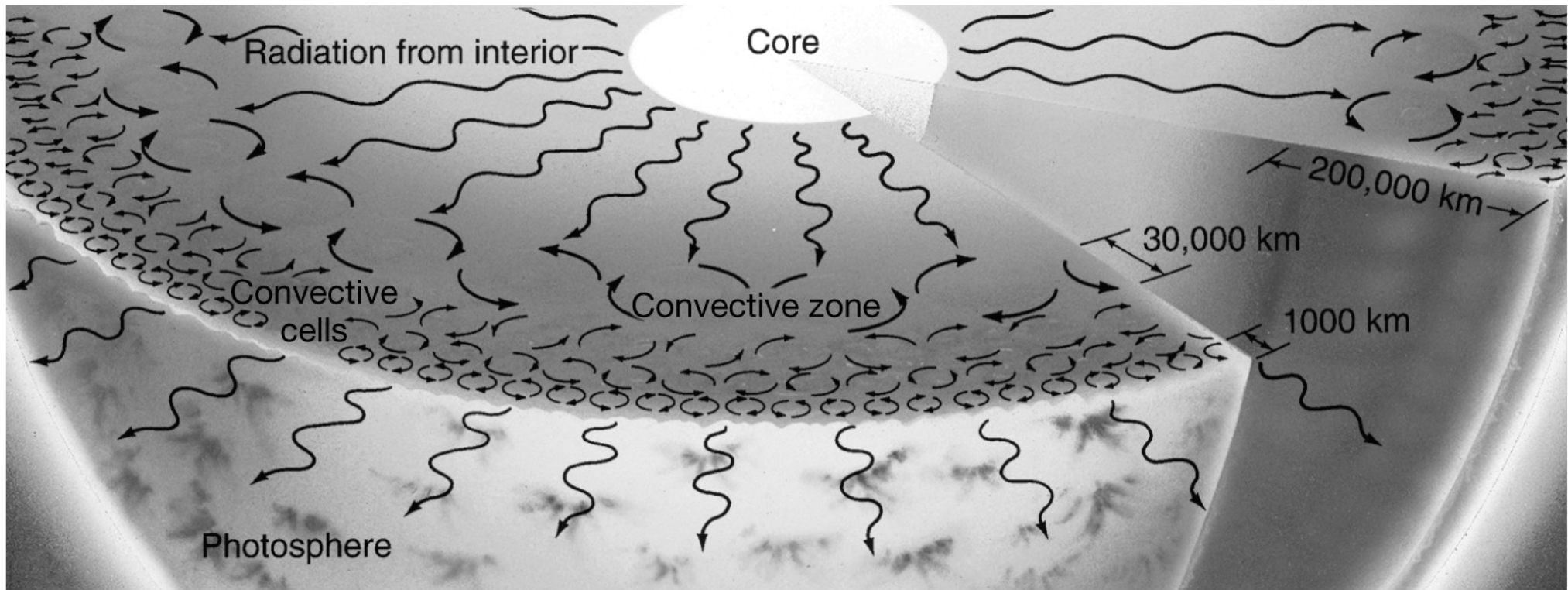


(c)

9.2 The Solar Interior

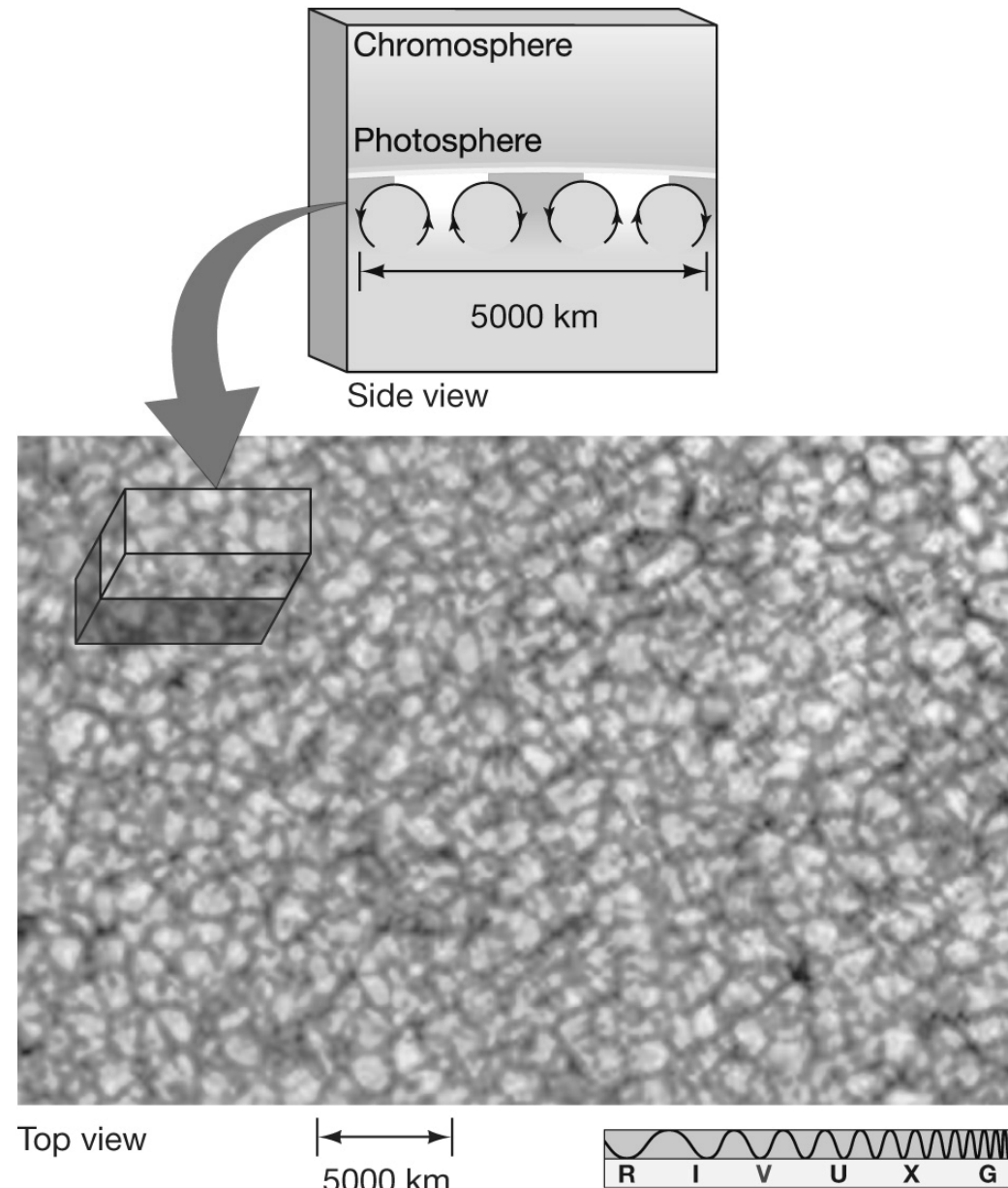
Energy transport

The radiation zone is relatively transparent; the cooler convection zone is opaque:



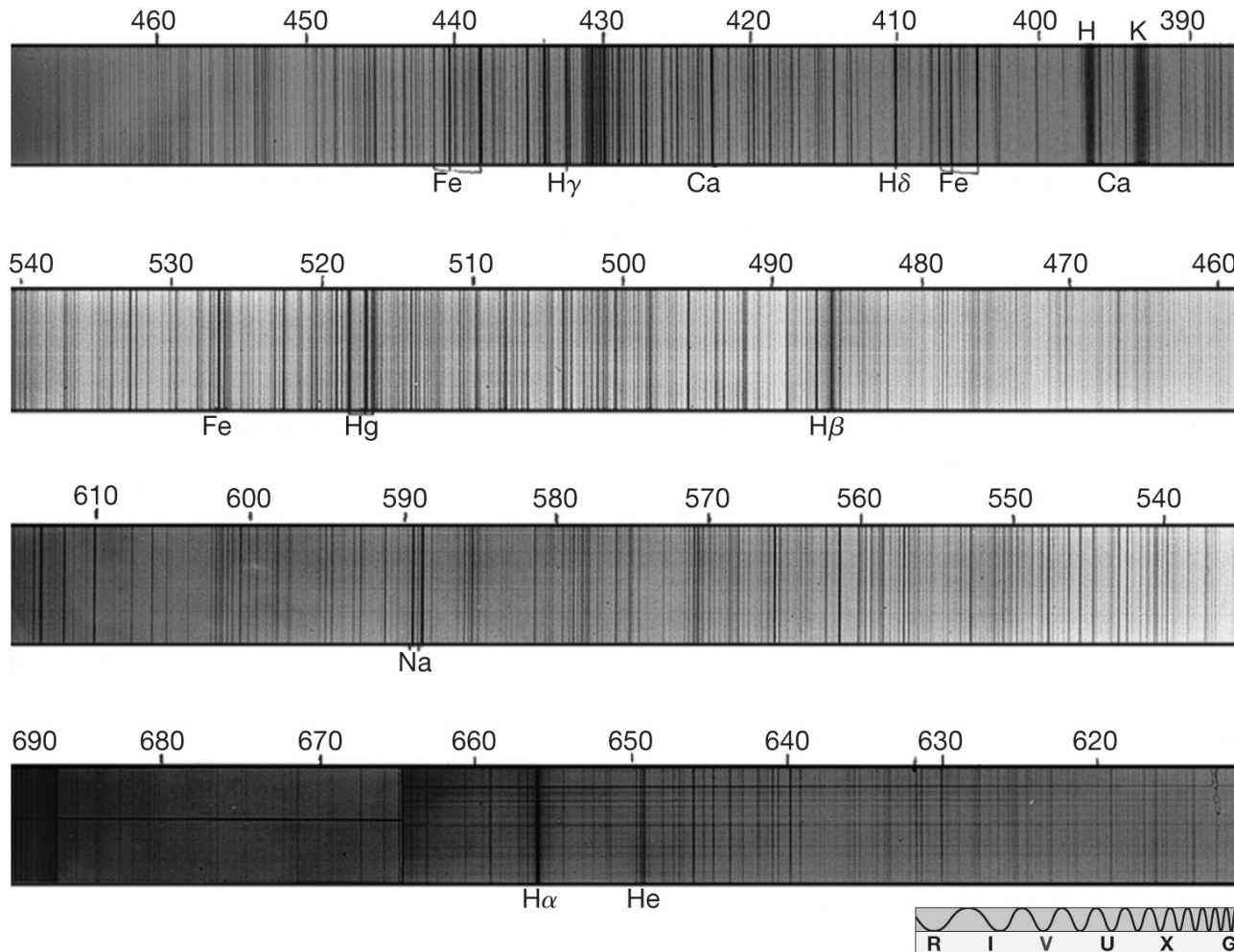
9.2 The Solar Interior

The visible top layer of the convection zone is granulated, with areas of upwelling material surrounded by areas of sinking material:



9.3 The Solar Atmosphere

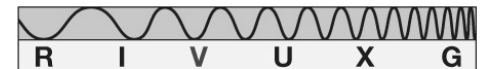
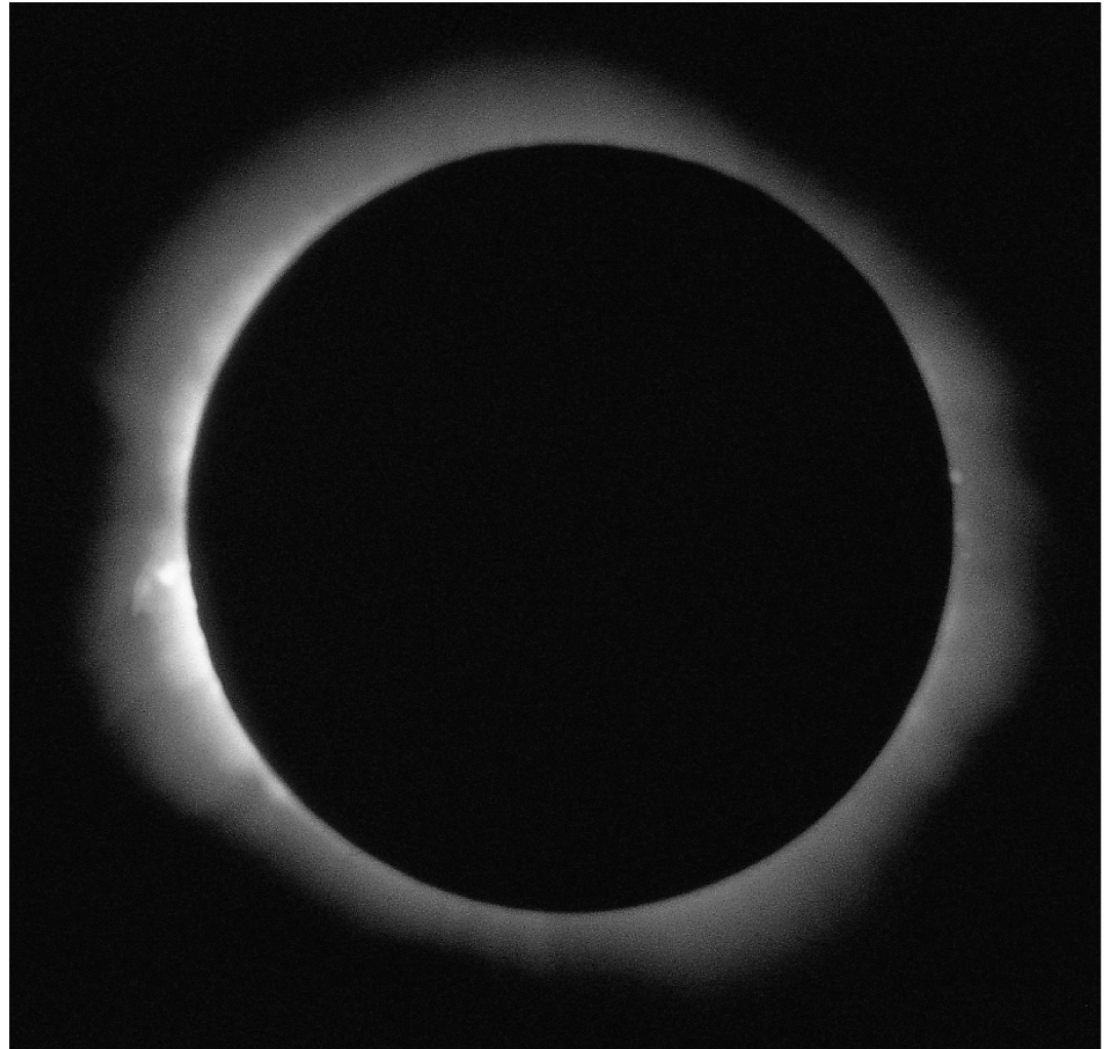
Spectral analysis can tell us what elements are present, but only in the chromosphere and photosphere:



9.3 The Solar Atmosphere

The cooler chromosphere is above the photosphere

Difficult to see directly, as photosphere is too bright, unless Moon covers photosphere and not chromosphere during eclipse:



9.3 The Solar Atmosphere

Small solar storms in chromosphere emit spicules:

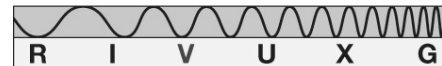
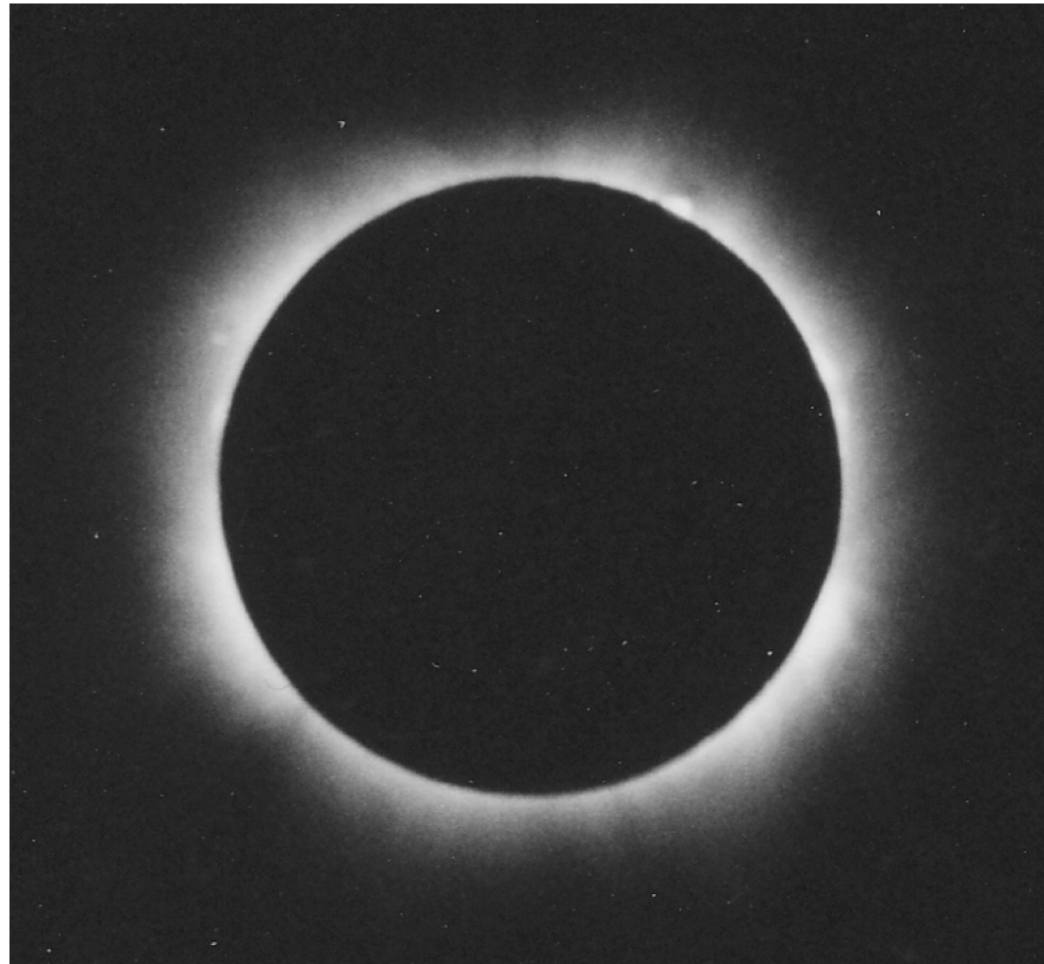


3000 km



9.3 The Solar Atmosphere

Solar corona can be seen during eclipse if both photosphere and chromosphere are blocked:



9.3 The Solar Atmosphere

Corona is much hotter than layers below it – must have a heat source, probably electromagnetic interactions.

