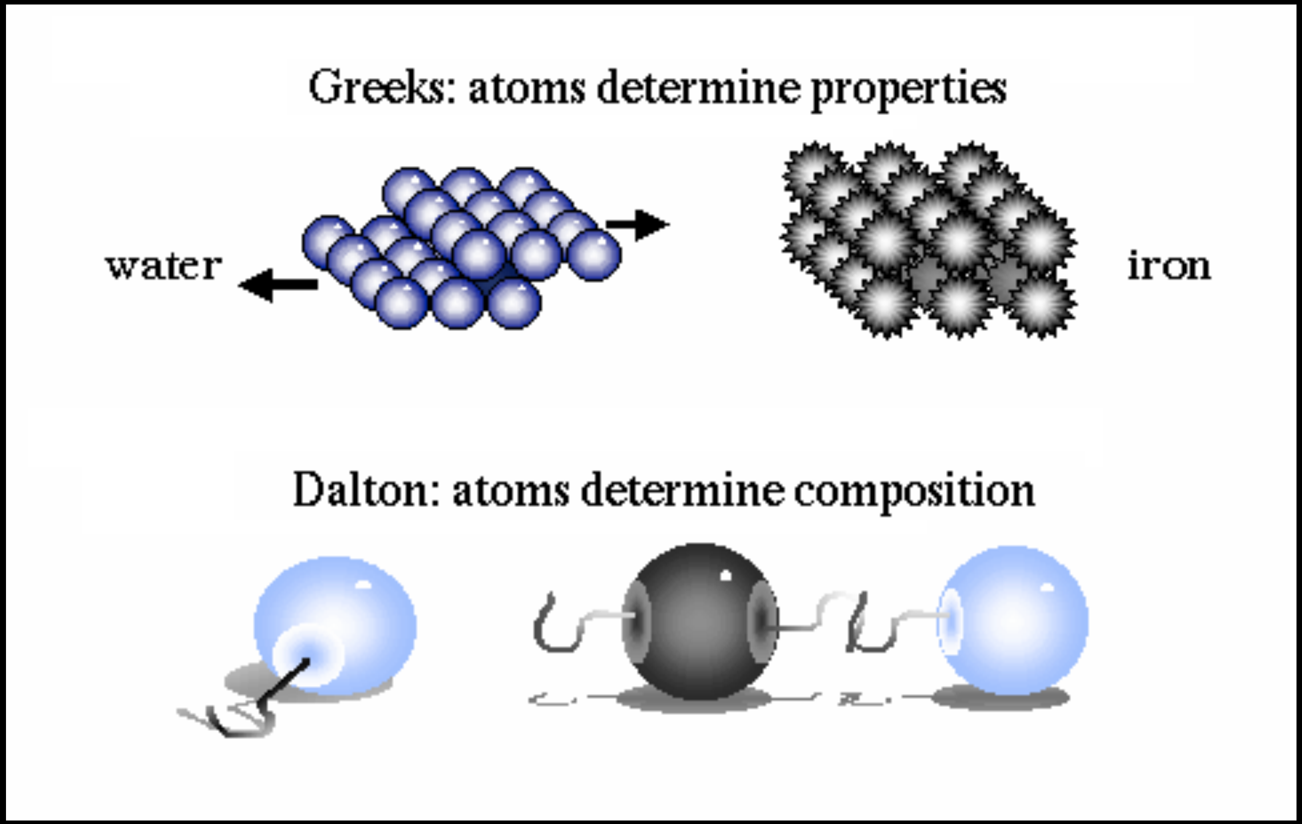
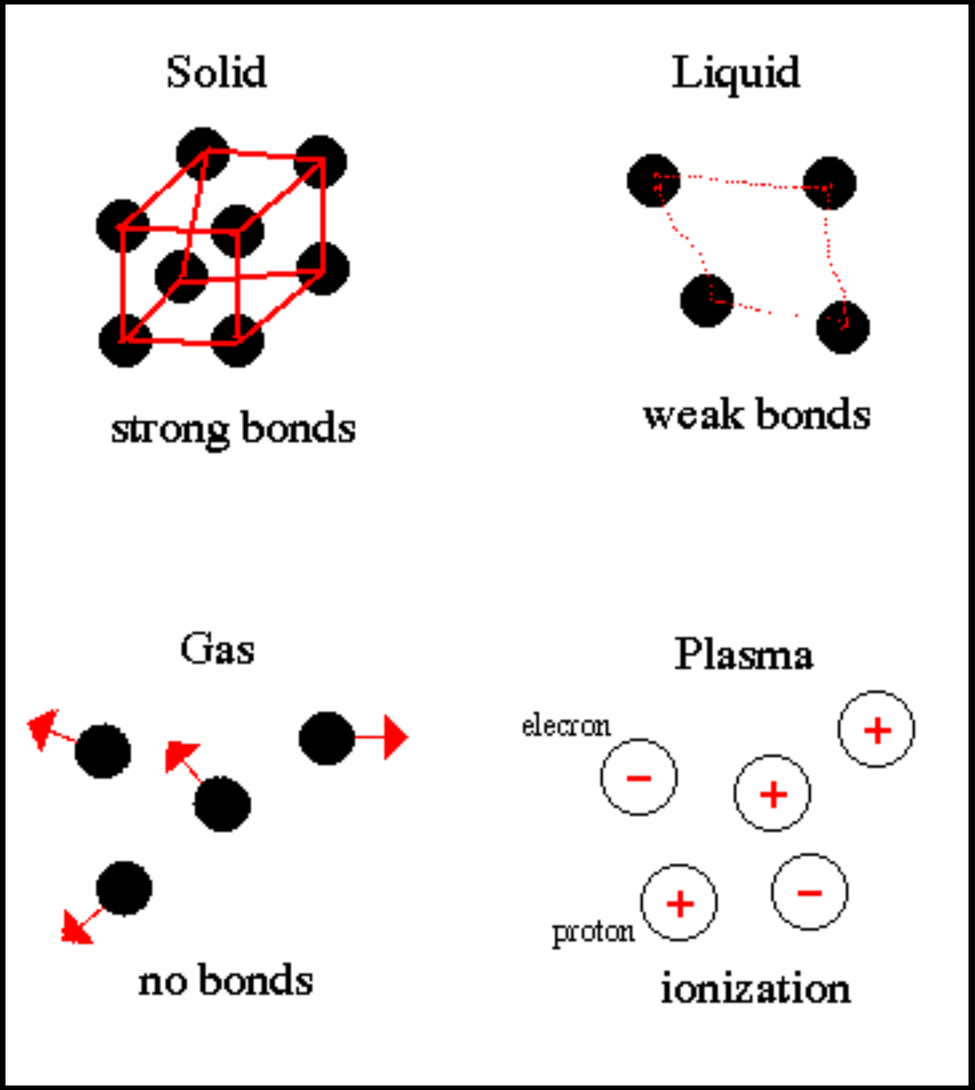


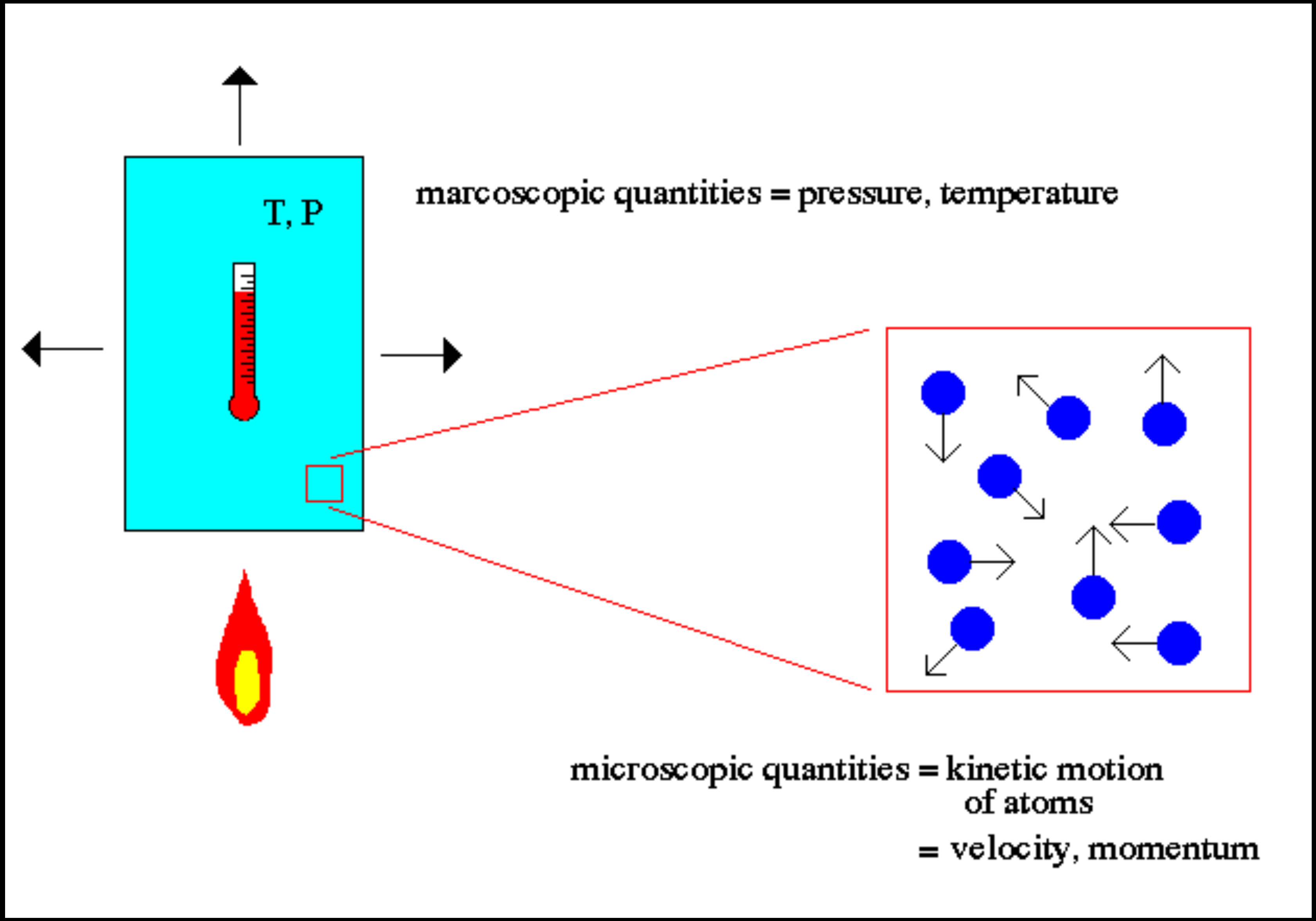
The ancient philosopher, Heraclitus, maintained that everything is in a state of flux. Nothing escapes change of some sort (it is impossible to step into the same river).

On the other hand, Parmenides argued that everything is what it is, so that it cannot become what is not (change is impossible because a substance would have to transition through nothing to become something else, which is a logical contradiction). Thus, change is incompatible with being so that only the permanent aspects of the Universe could be considered real.

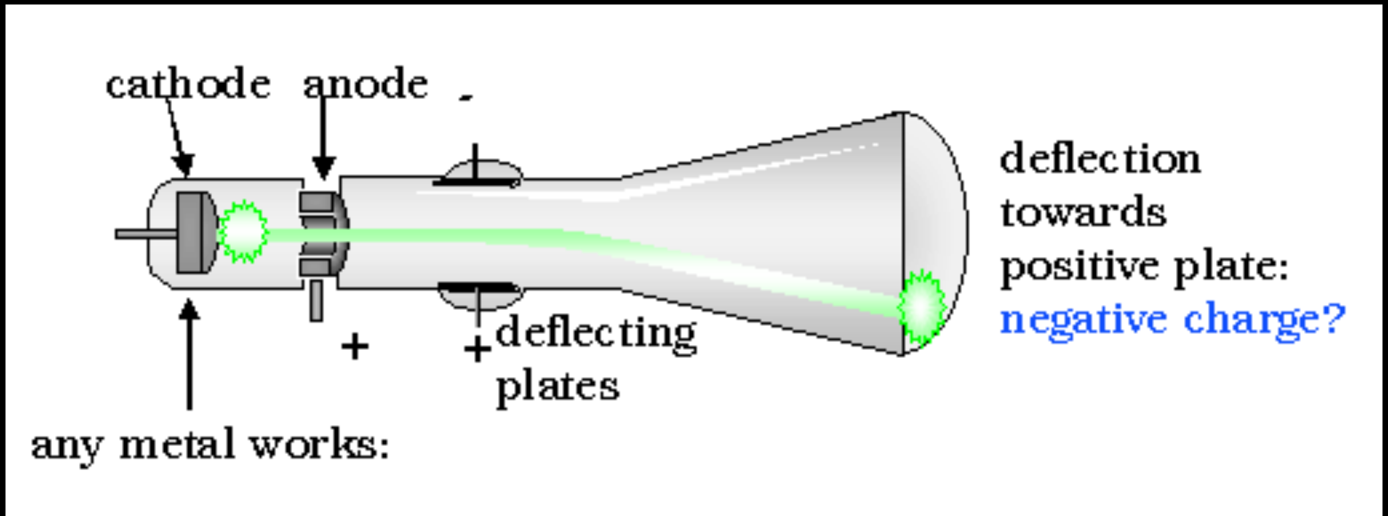
An ingenious escape was proposed in the fifth century B.C. by Democritus. He hypothesized that all matter is composed of tiny indestructible units, called atoms.



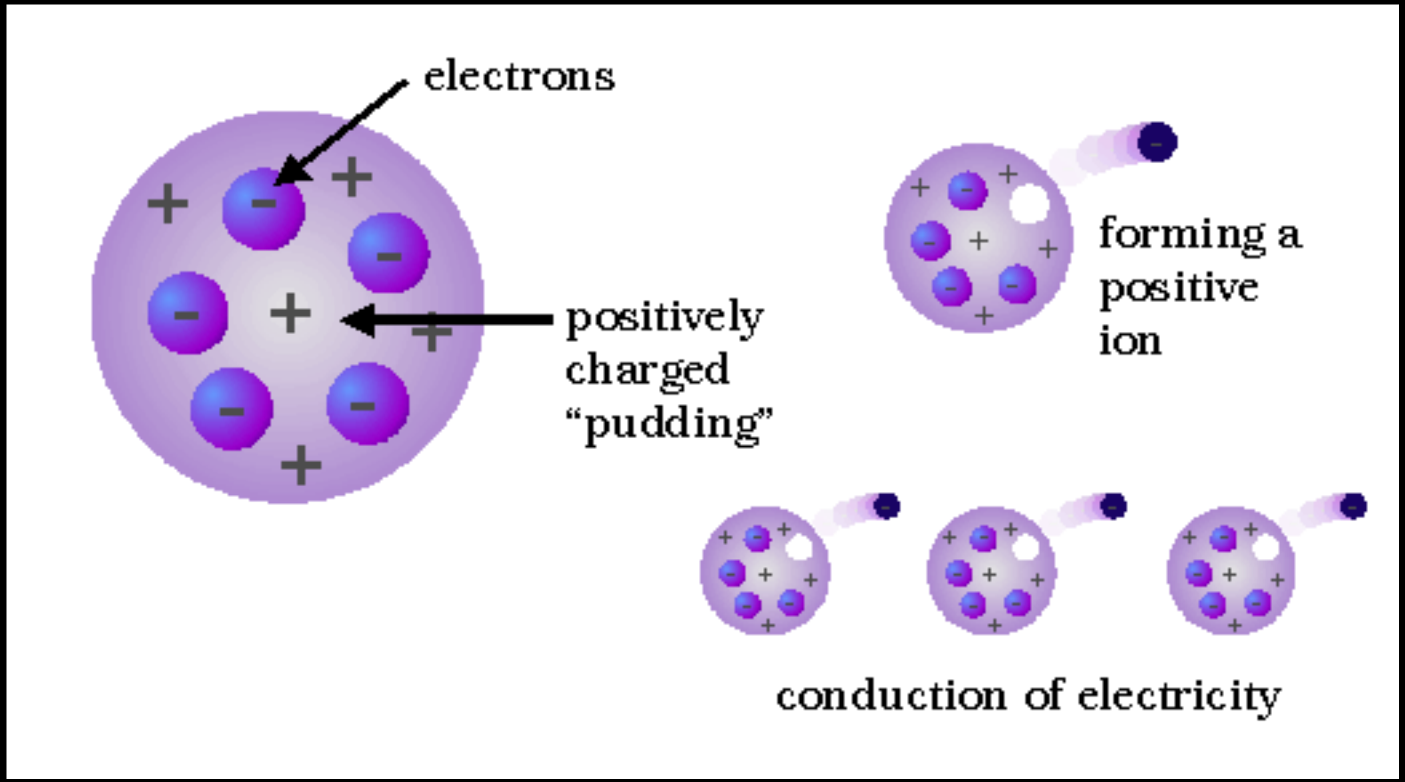
Matter exists in four states: solid, liquid, gas and plasma. Plasmas are only found in the coronae and cores of stars. The state of matter is determined by the strength of the bonds between the atoms that makes up matter. Thus, is proportional to the temperature or the amount of energy contained by the matter.

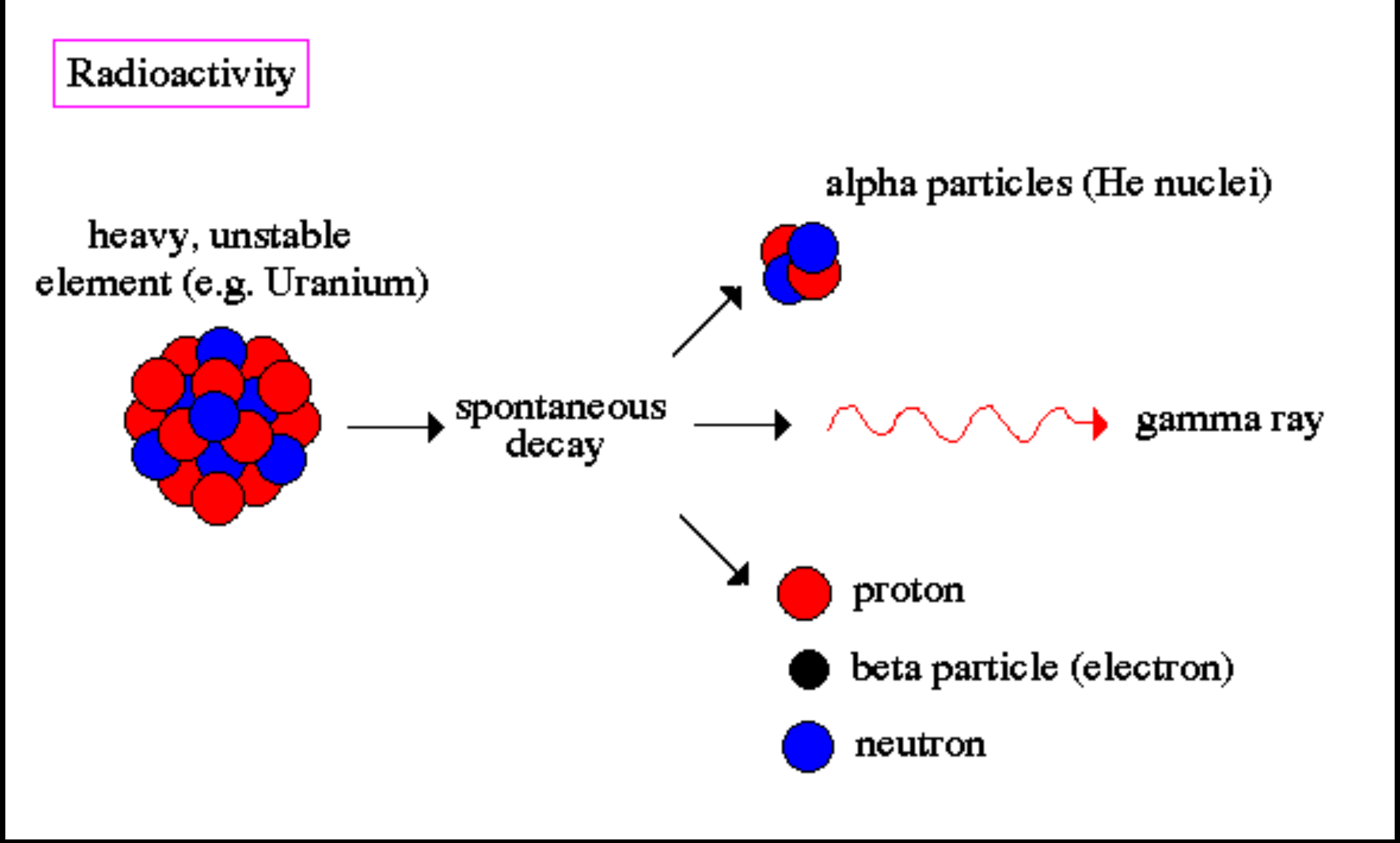


Atomic theory is the field of physics that describes the characteristics and properties of atoms that make up matter. The key point to note about atomic theory is the relationship between the macroscopic world (us) and the microscopic world of atoms. For example, the macroscopic world deals with concepts such as temperature and pressure to describe matter. The microscopic world of atoms theory deals with the kinetic motion of atoms to explain macroscopic quantities.

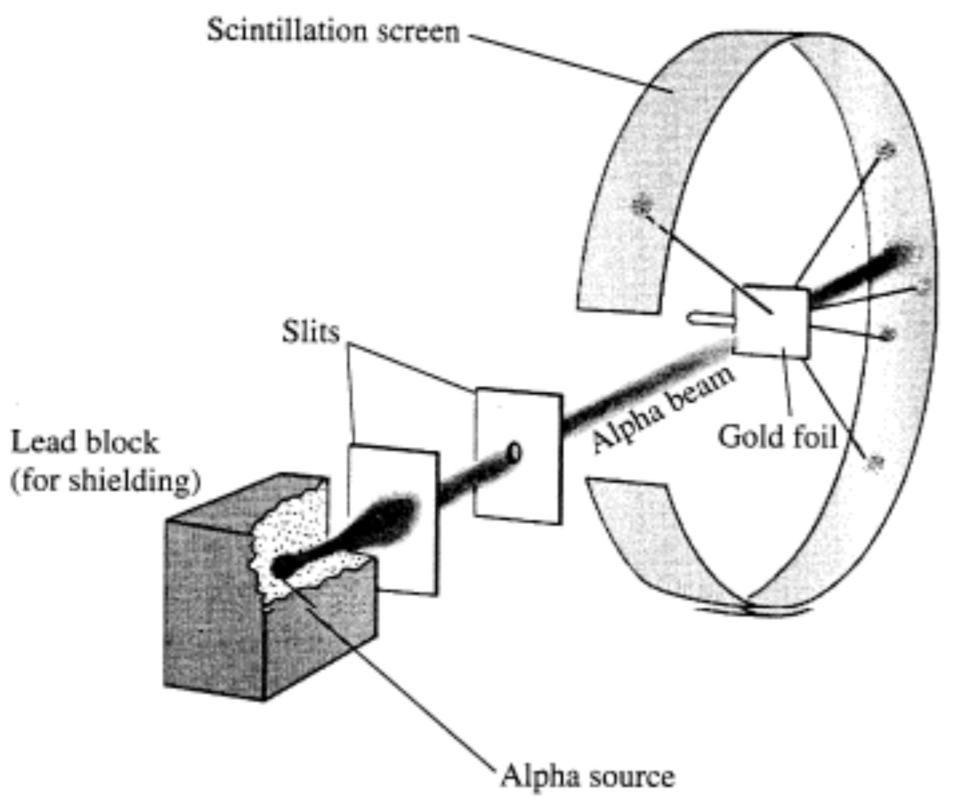


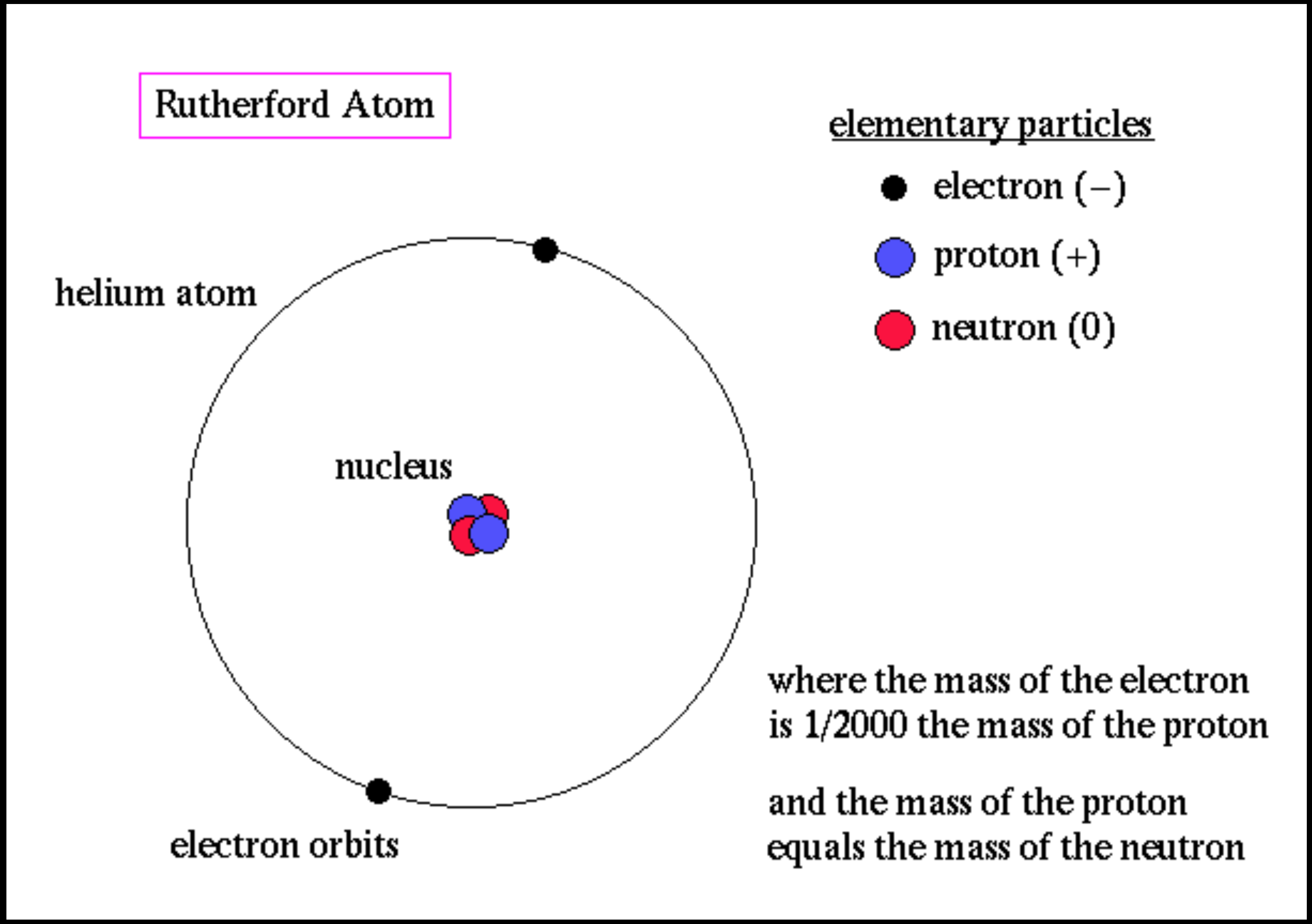
Using a cathode ray scope, Thomson determined that all matter, whatever its source, contains particles of the same kind that are much less massive than the atoms of which they form a part. They are now called electrons, although he originally called them corpuscles.





Rutherford overturned Thomson's atom model in 1911 with his well-known gold foil experiment in which he demonstrated that the atom has a tiny, massive nucleus.





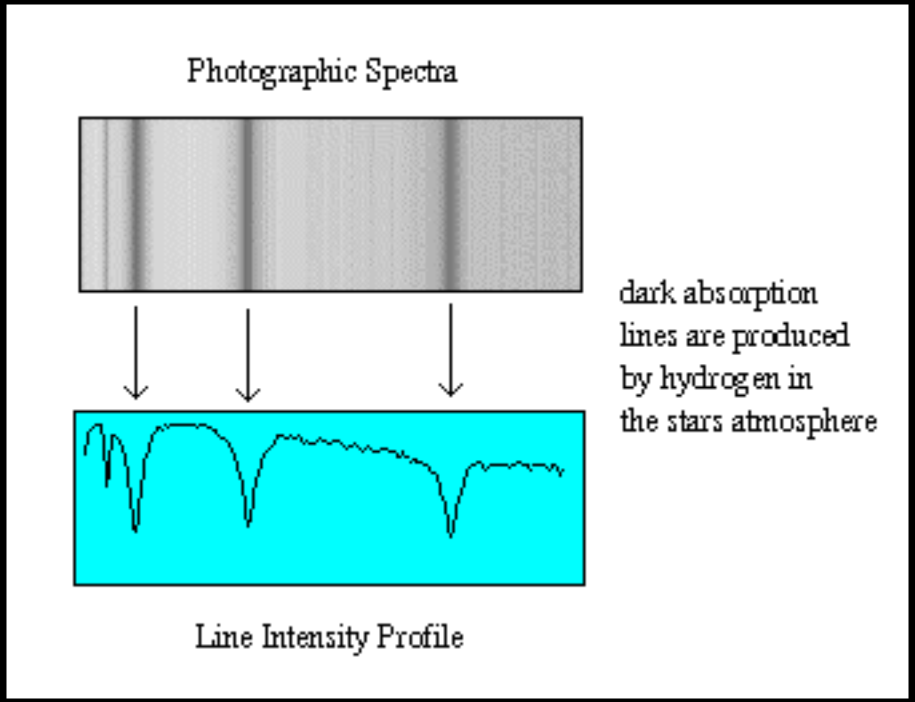
The Rutherford atomic model has been alternatively called the nuclear atom, or the planetary model of the atom.

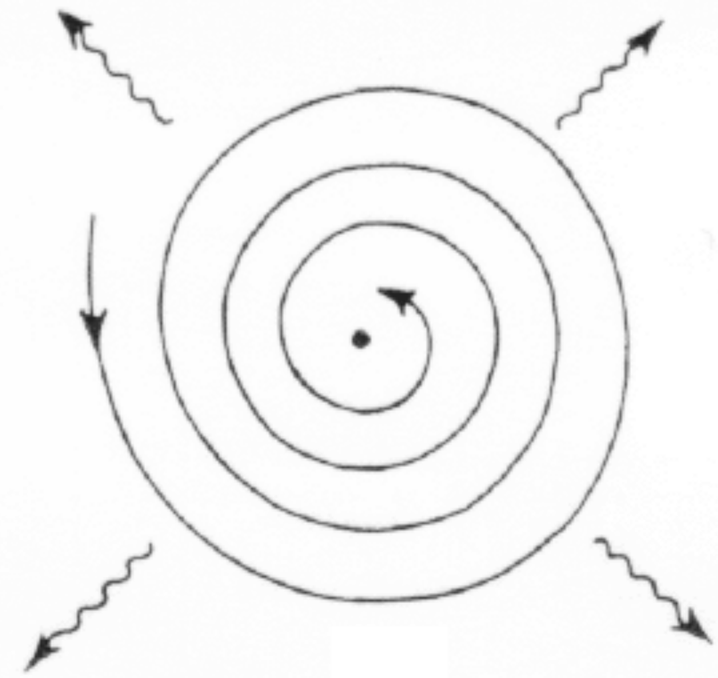
Spectroscopy:

The fact that the temperature and energy generation of an object can be determined by its Planck curve made the study of spectrum the key component to stellar astronomy. The amount of energy emitted from stars is determined by measuring their brightness or the amount of light they emit. This is called photometry. However, two major developments expanded our understanding of the chemical make-up of stars. They were:

The invention of the spectroscope, a device that separates white light into component colors called a spectrum.

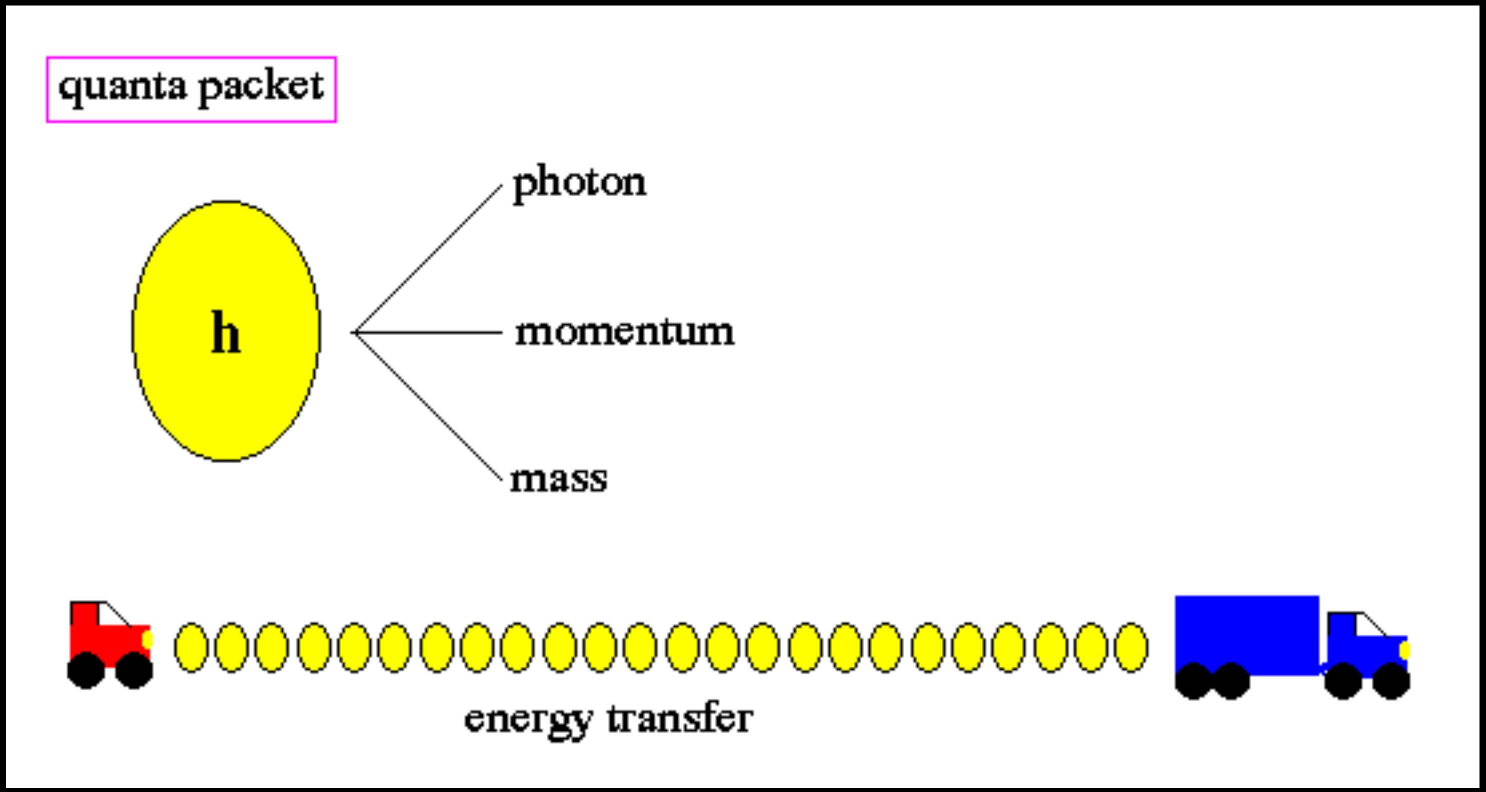
And the discovery that elements emit a unique spectrum, i.e. produce a unique chemical fingerprint in the spectrum.



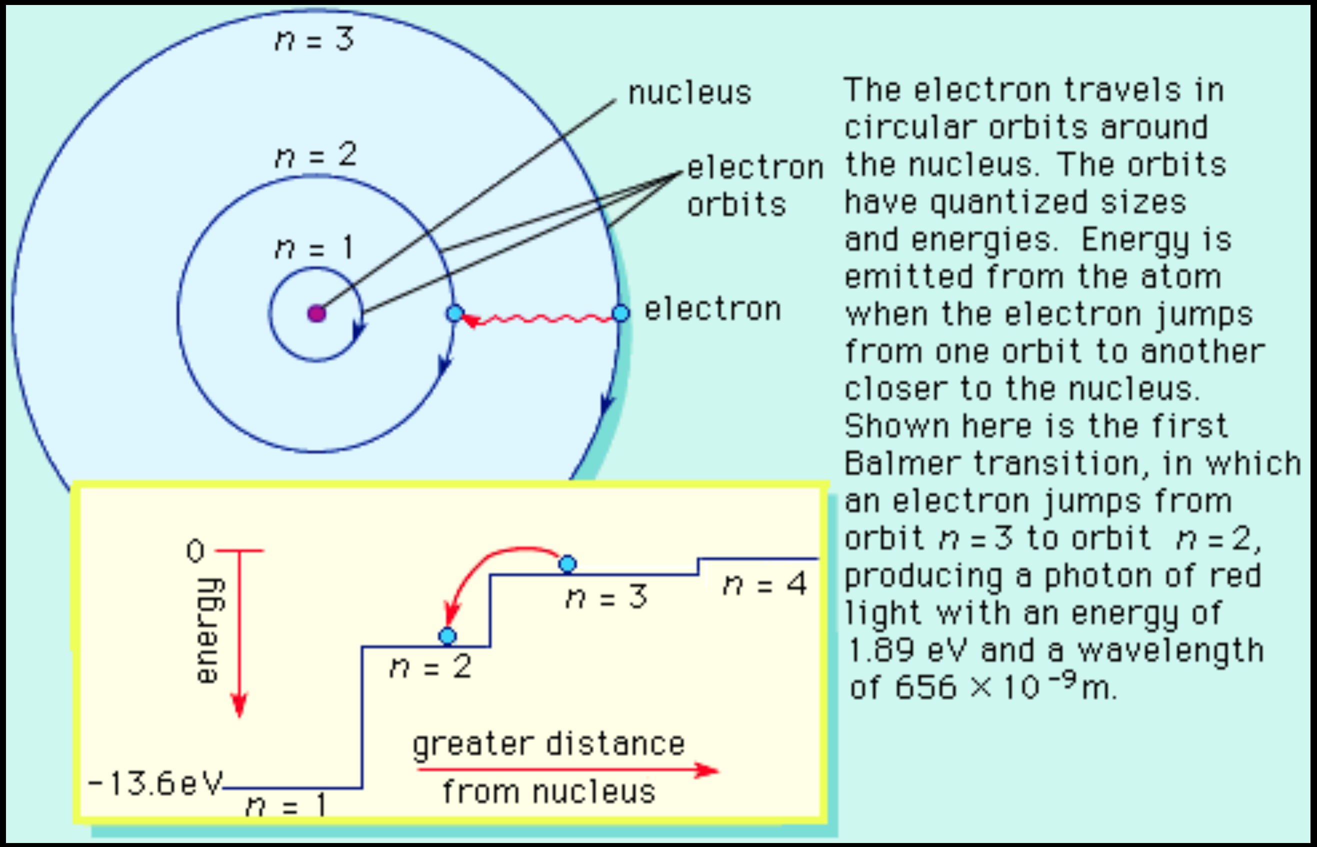


According to classical physics, an electron in orbit around an atomic nucleus should emit electronmagnetic radiation (photons) continuously, because it is continually accelerating in a curved path. The resulting loss of energy implies that the electron should spiral into the nucleus in a very short time (i.e. atoms can not exist).

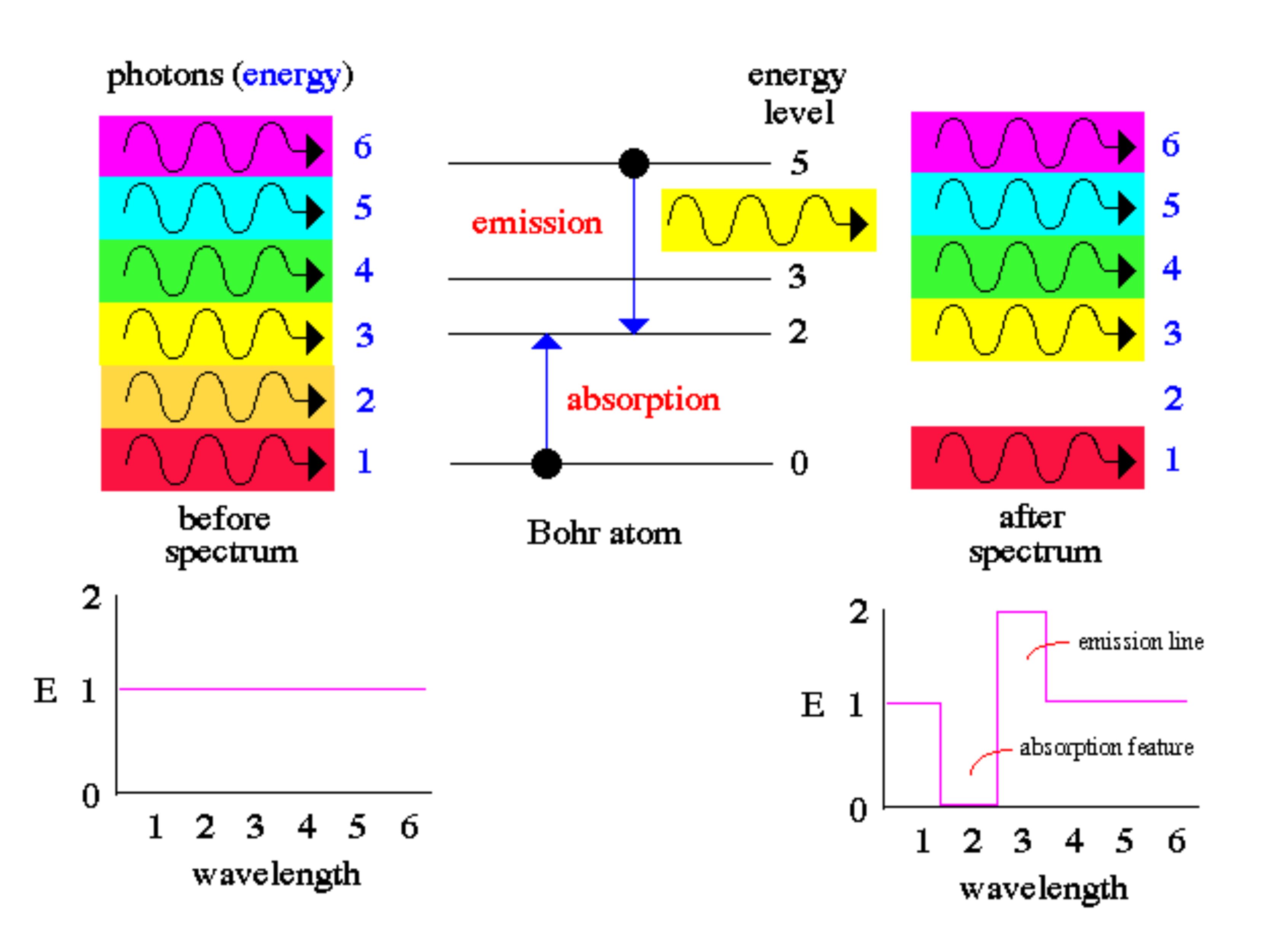
To resolve this problem, Planck made a wild assumption that energy, at the sub-atomic level, can only be transferred in small units, called quanta.



Changes of energy, such as the transition of an electron from one orbit to another around the nucleus of an atom, is done in discrete quanta. Quanta are not divisible. The term quantum leap refers to the abrupt movement from one discrete energy level to another, with no smooth transition. There is no ``inbetween''.



The Bohr model basically assigned discrete orbits for the electron, multiples of Planck's constant, rather than allowing a continuum of energies as allowed by classical physics.



photons (energy)
6
5
4
3
2
1
before
spectrum
energy
level
5
emission
3
2
absorption
0
Bohr atom
6
5
4
3
2
1
after
spectrum
2
E 1
0
1 2 3 4 5 6
wavelength
2
emission line
E 1
absorption feature
0
1 2 3 4 5 6
wavelength