PHYS261 Atomic Physics and Physical Optics

Lecture Thursday 21. August 2008

Topics:

In lecture: Hydrogen Atom and hydrogen-like Atoms
Here: history, matlab, spectra, elliptic trajectories (planet-like)

Comment:

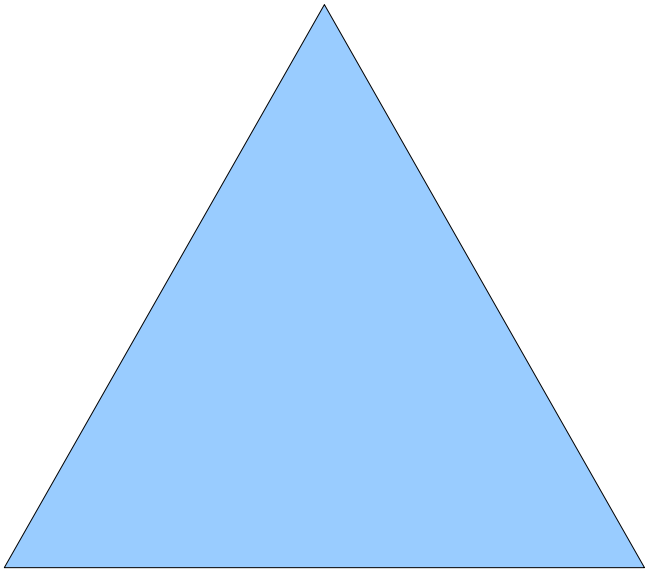
The matlab and links are added **at the web page**
Everybody at uib.no ''domane'' can use Matlab

This is an edited, probably final version

hydrogen Atom:
history

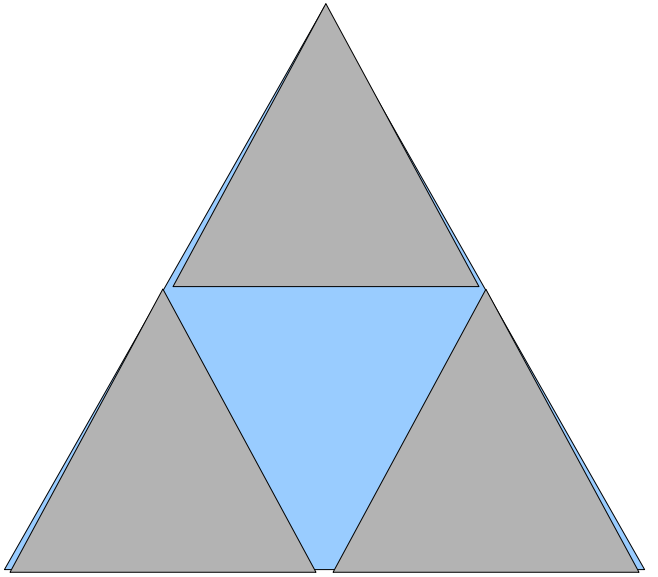
http://web.ift.uib.no/AMOS/PHYS261/spectra/
http://web.ift.uib.no/AMOS/PHYS261/molec-pict/

How to make a tetrahedron



Facts: n l m
Solution of Schrödinger equation

Hydrogen Physics –
defines atomic units New text on atomic units



1s 2s 2p 3s 3p 3d 4s 4p 4d 4f

L=0 L=1 L=2 L=3

Facts: n l m
Solution of Schrödinger equation
Hydrogen Physics –
defines atomic units (New text on atomic units from theses)

The atomic units are defined by

$e = 1$ a.u. of charge ,

$m_e = 1$ a.u. of mass ,

$\hbar = 1$ a.u. of energy $\times 1$ a.u. of time,

where m_e is the mass of electron, e is the elementary charge

$\hbar$ is the Planks constant divided by 2π.

1s 2s 2p 3s 3p 3d 4s 4p 4d 4f

L=0 L=1 L=2 L=3 L=4 L=5

S P D F g h i .....

Sharp Principal Diffuse Fundamental ... the rest is alphabet

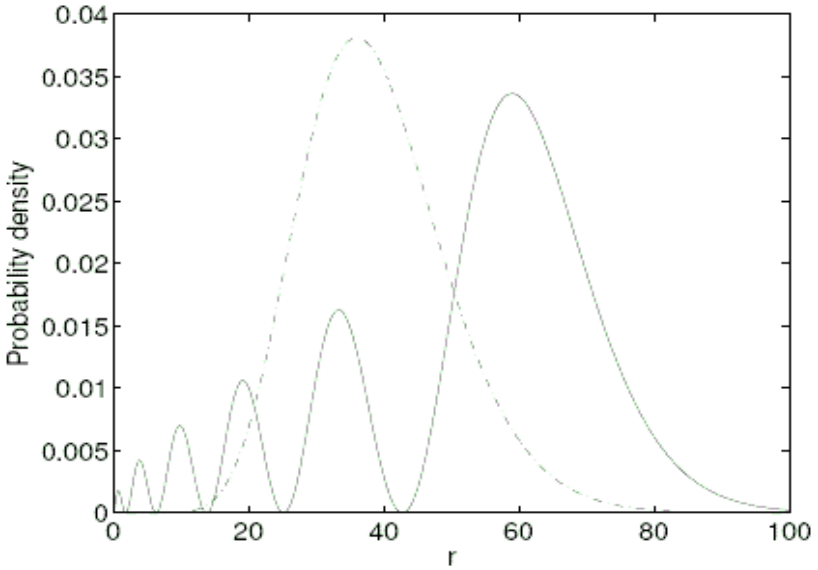
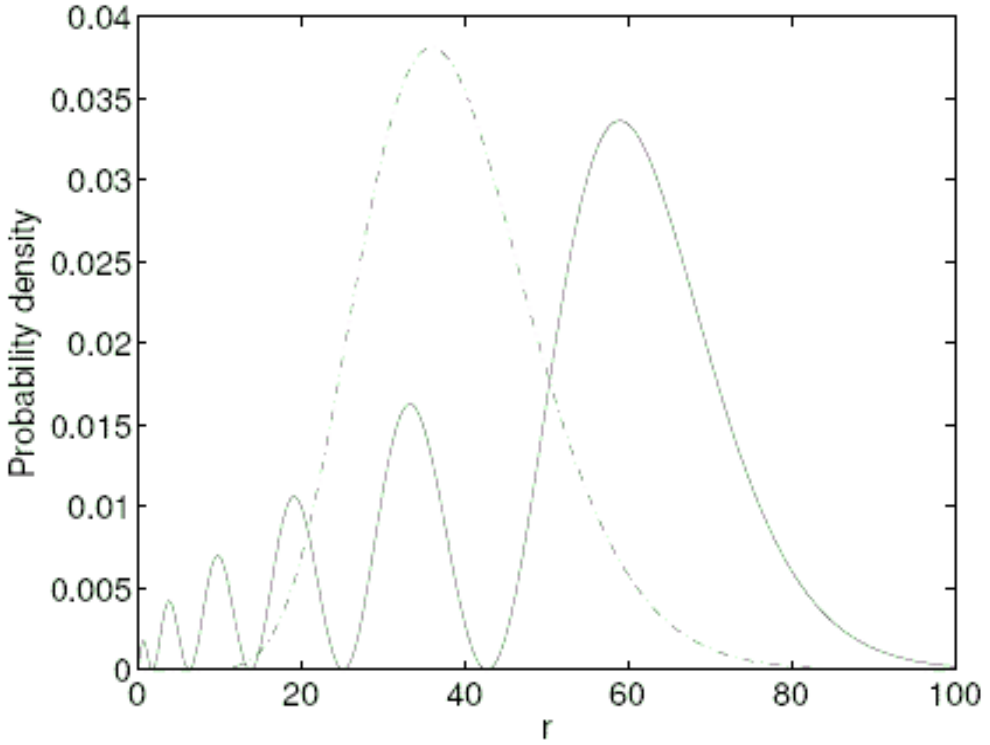


Figure 2.1: Comparison of radial probability densities for two hydrogenic states with principal quantum number $n = 6$. The dot-and-dash line shows the probability density $r^2|R_{nl}(r)|^2$ for the highest possible orbital quantum value, the function $r^2|R_{65}(r)|^2$, which is a circular state, while the solid line represents the lowest orbital quantum value 0, i.e. $r^2|R_{60}(r)|^2$ and contains the radial behaviour corresponding to elliptic orbits.



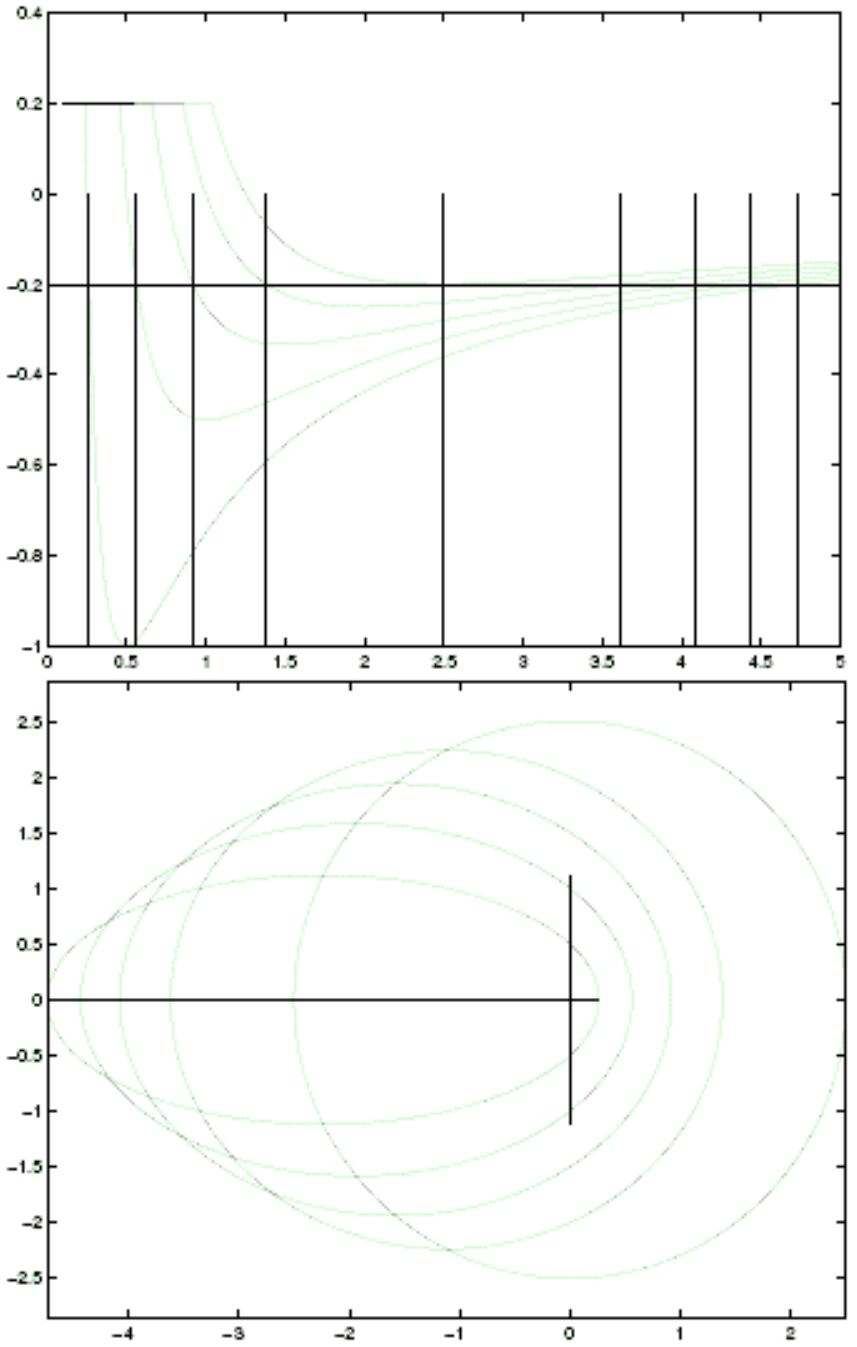
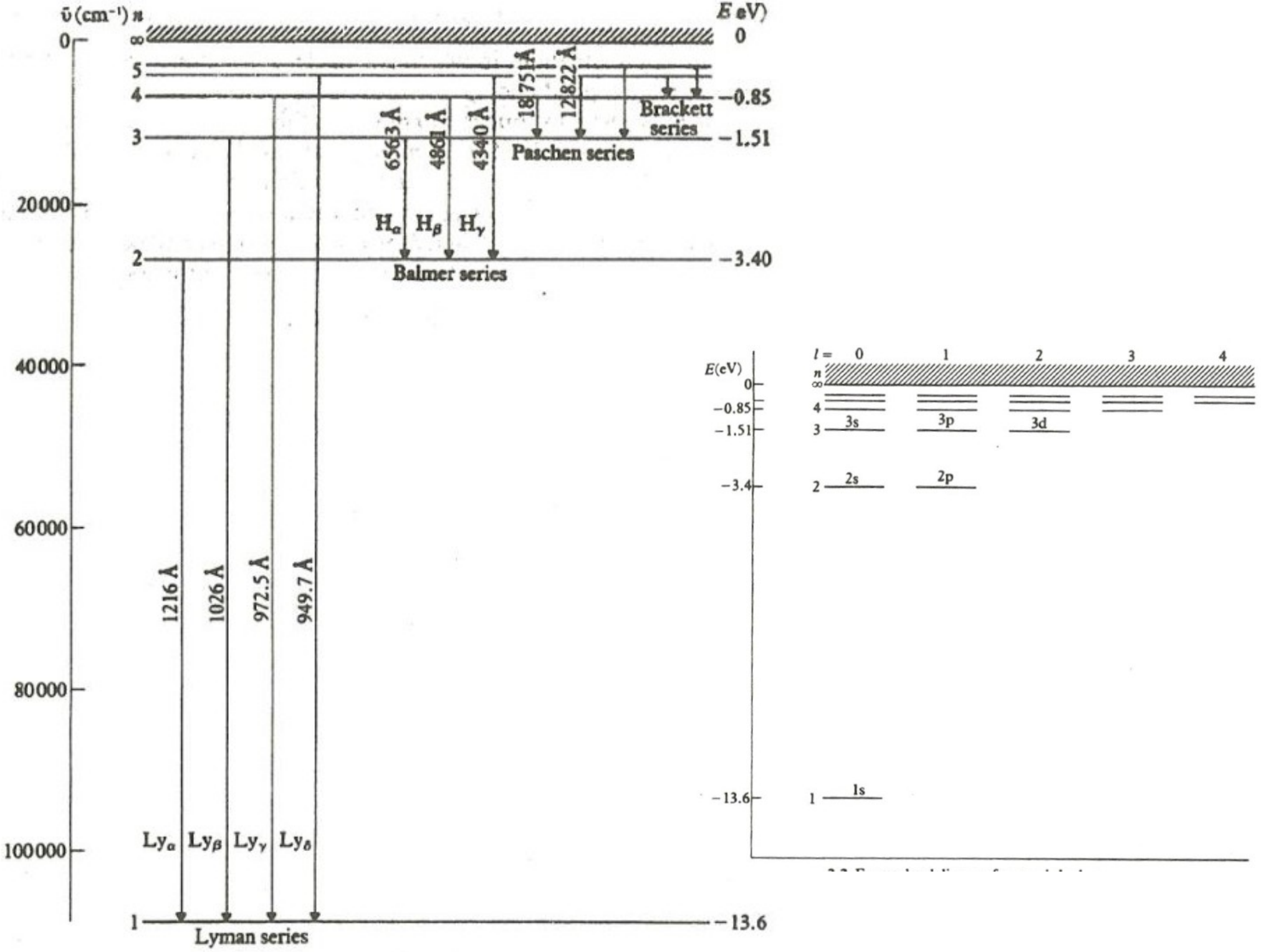
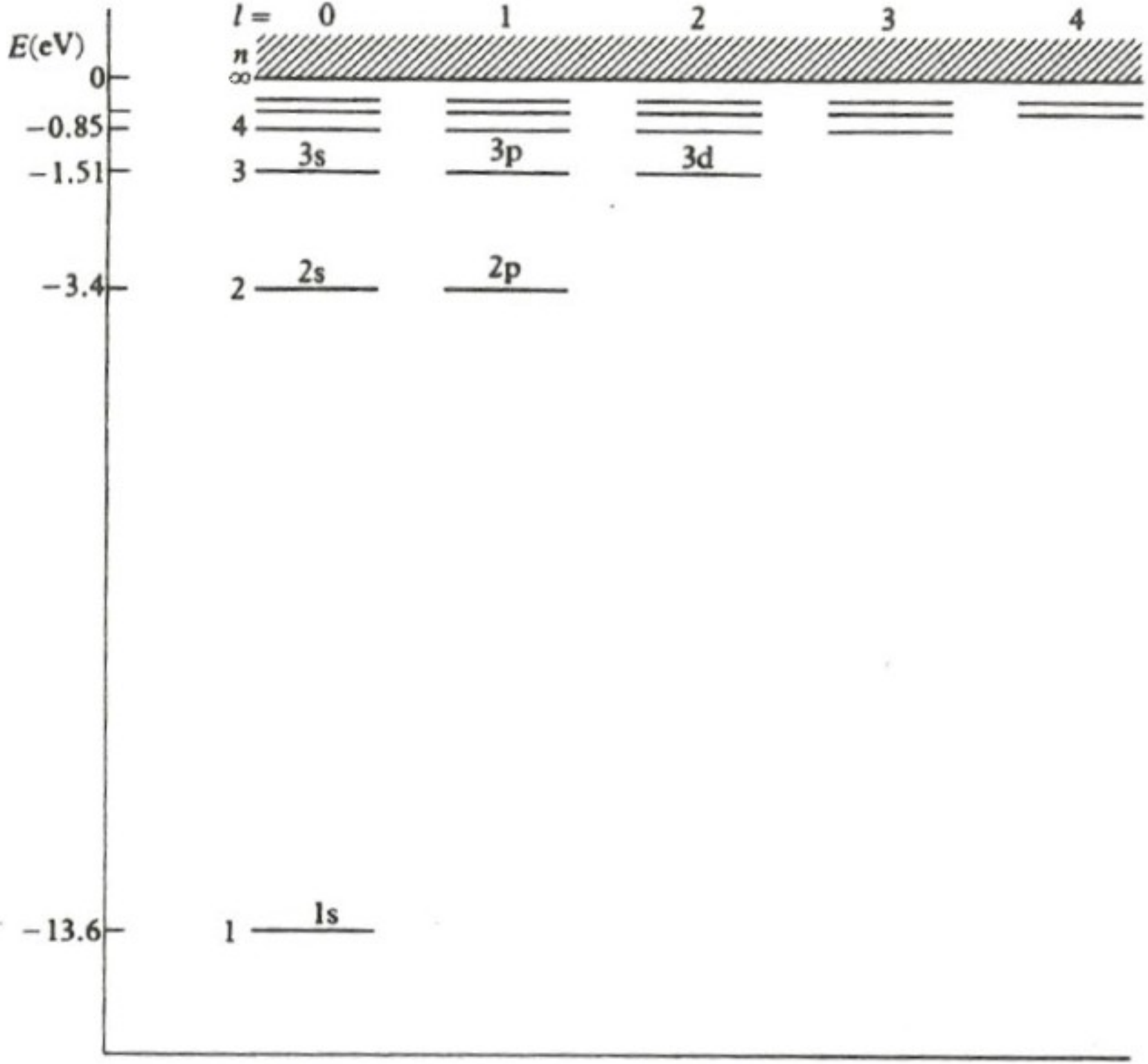
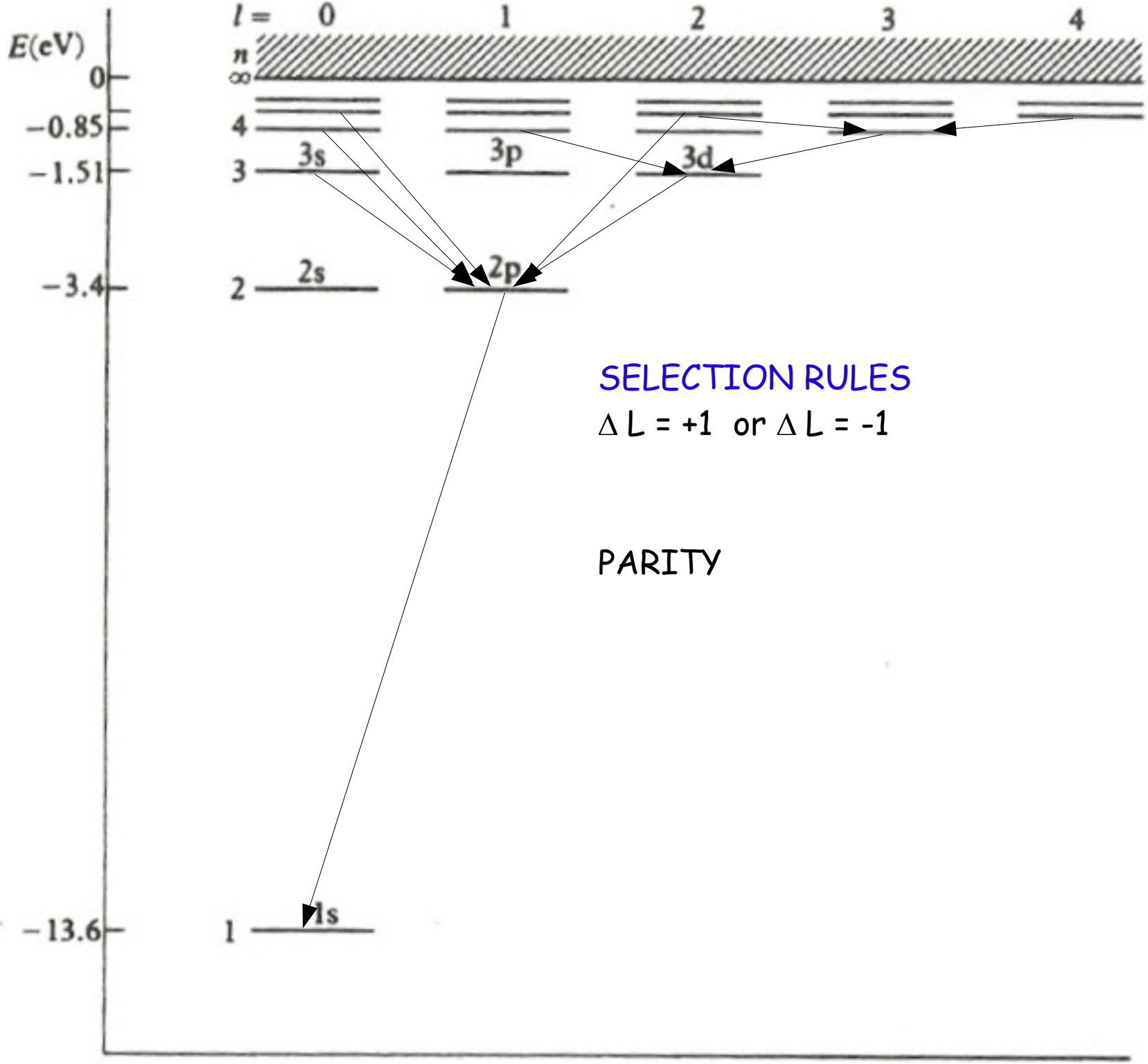


Figure 3.2: Upper part: Potential energy including centrifugal barier, defining the range of radial motion for elliptic and finally circular motion (single point).
Lower part: Corresponding trajectories, from elliptic trajectory to the circular one. All trajectories correspond to the same total energy.



1.16 The spectrum of atomic hydrogen.


E(eV)
l = 0
1
2
3
4
n
∞
0
−0.85
−1.51
−3.4
−13.6
4
3
2
1
3s
3p
3d
2s
2p
1s



SELECTION RULES

$\Delta L = +1$ or $\Delta L = -1$

PARITY

IONIZE an atom
remove 1 electron - how?
Oldest:
Photoeffect photon must have more energy than the binding energy

(Einstein : Nobel Price)

Negative energy -> bound system

Energy can only be positive ??

Mass M=2000 m
electro «absorbs» a photon

ORIGINAL PLAN TEXT

hydrogen Atom:
history
Facts: n l m
Solution of Schrödinger equation

Hydrogen Physics – defines atomic units

1s 2s 2p 3s 3p 3d 4s 4p 4d 4f

L=0 L=1 L=2 L=3

E_0 = 13.6 eV (1 Rydberg) 27.2 eV 1 Hartree (1 a.u. energy)

$E_n = E_0 /(n^2)$

What is 1 eV
Selection rules
Experiments (accelerators)

Spectroscopy (wavelengths)
Visible light (prisms)
Shorter wavelengths diffraction gratings

longer wavelengths ?