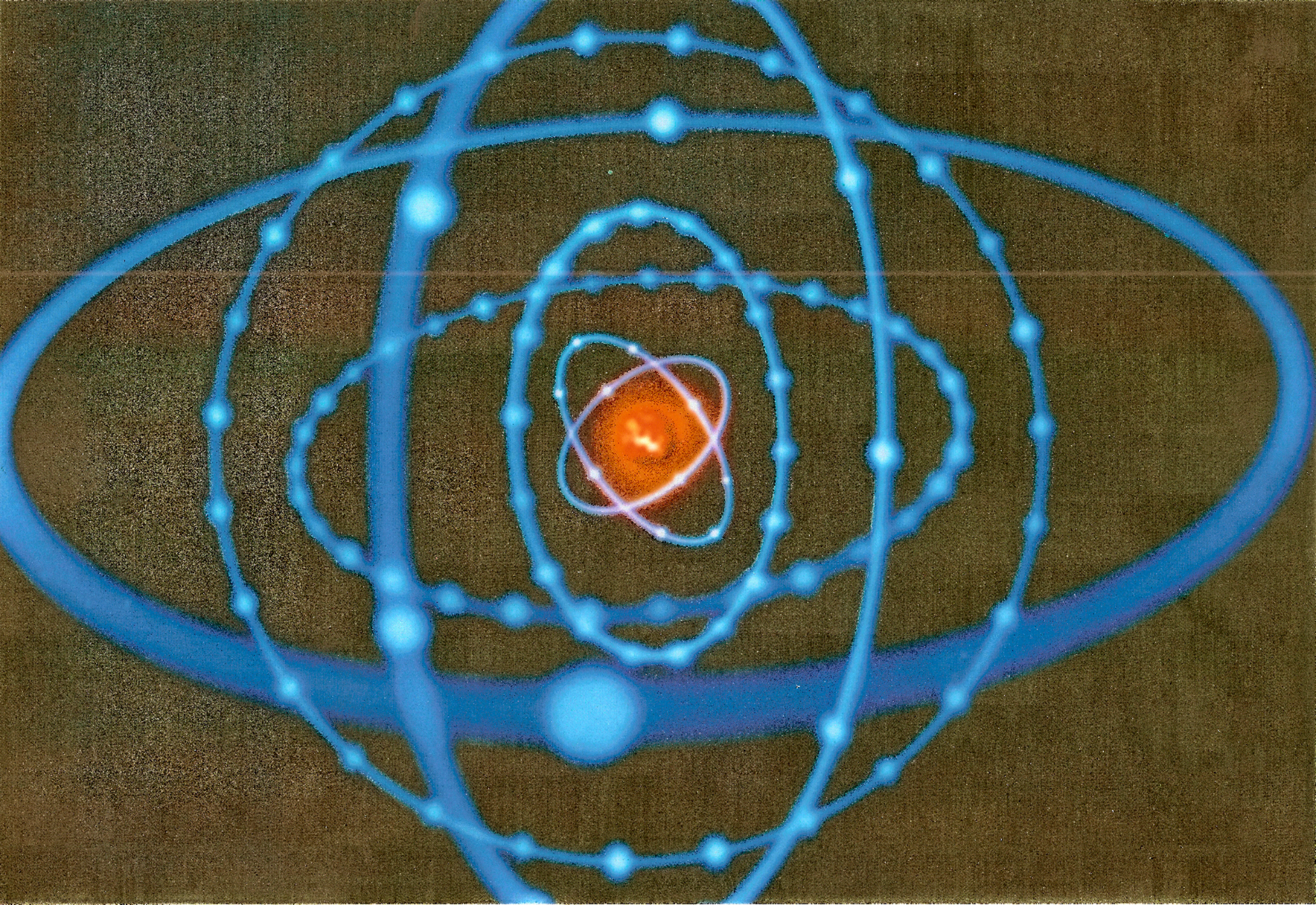
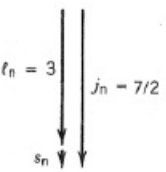
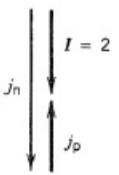
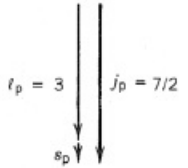
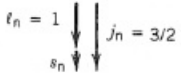
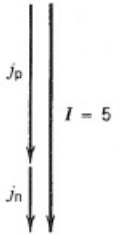
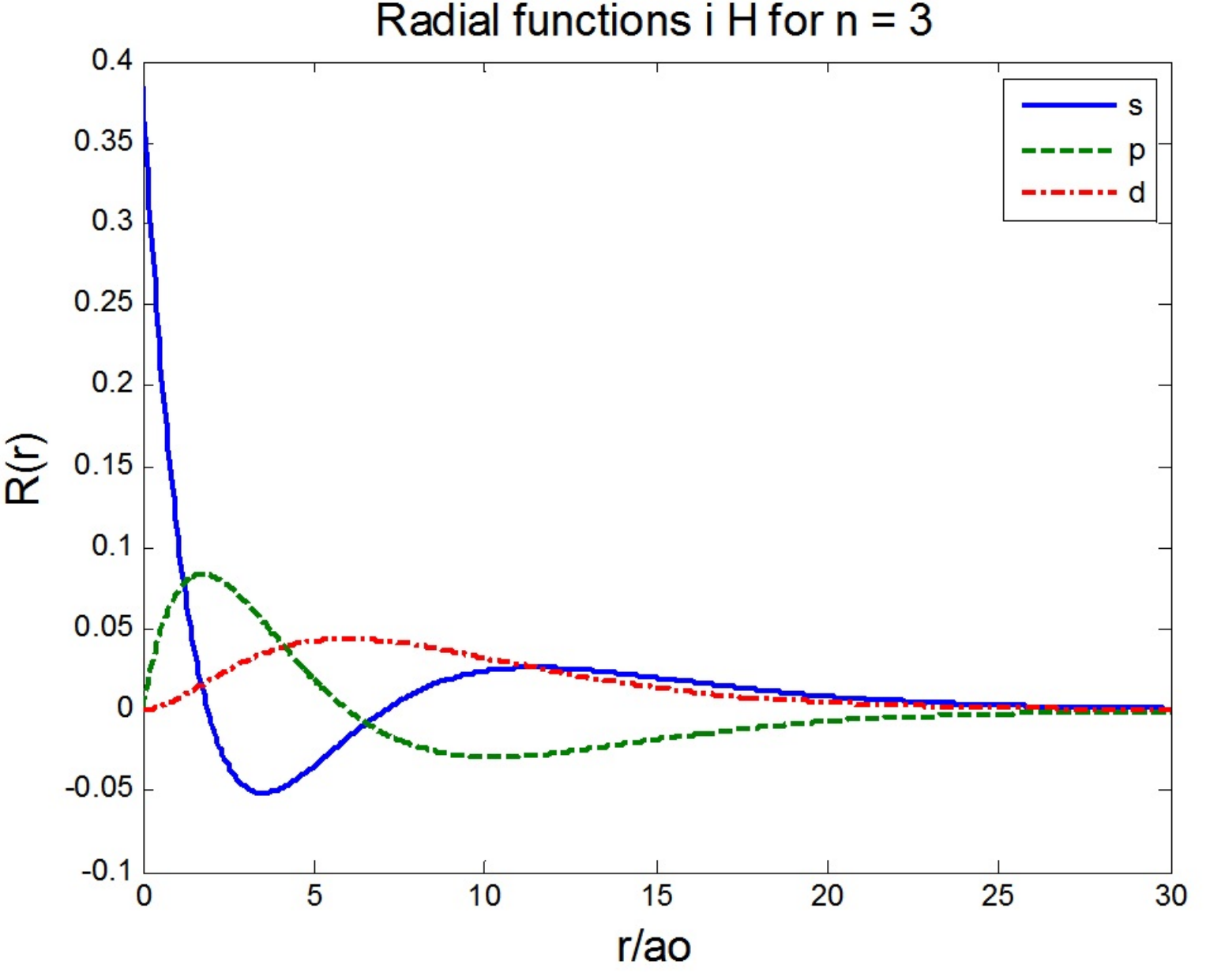


Krane Chapter 16.

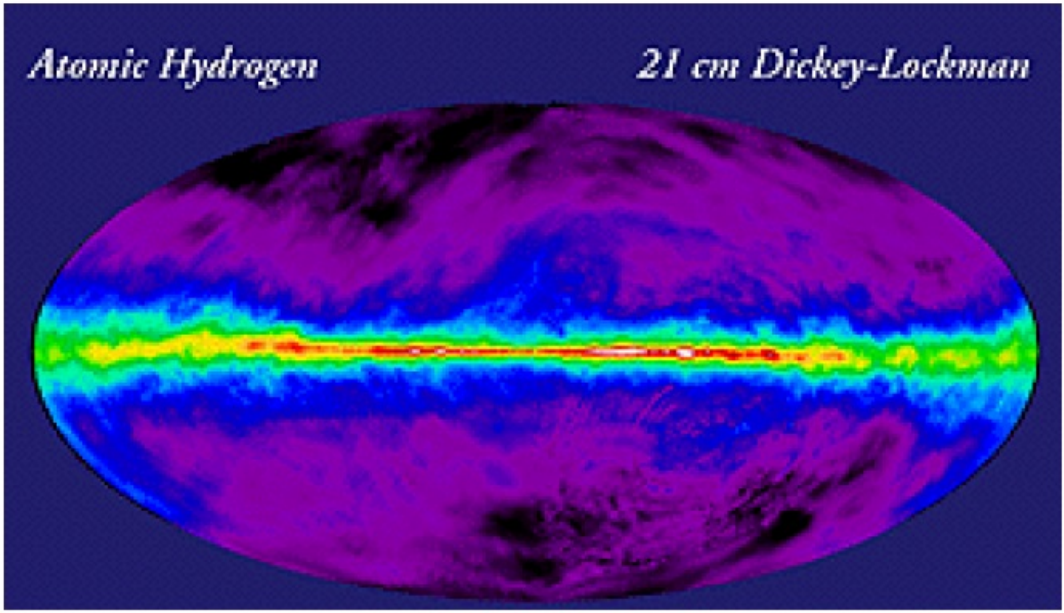
	Proton	Neutron	Total
^{38}Cl	$d_{3/2}$	$f_{7/2}$ 	$I = 2$ 
^{50}Sc	$f_{7/2}$ 	$p_{3/2}$ 	$I = 5$ 

Generally:

- A odd => I half-integer
- A even => I integer
- A and Z even => $I = 0$

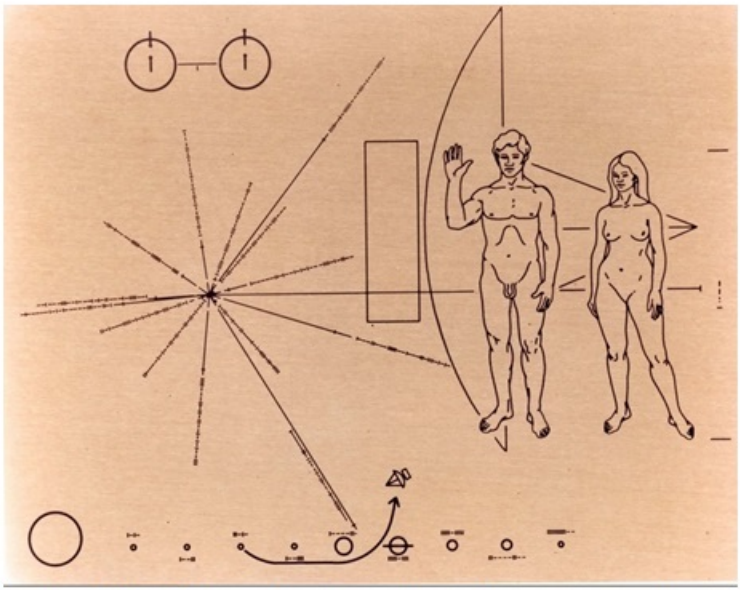

Radial functions i H for n = 3
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
R(r)
0
5
10
15
20
25
30
r/ao
s
p
d

21 cm radiation map, showing the distribution of neutral Hydrogen gas in the galactic disk.



The Pioneer Space Mission 1972

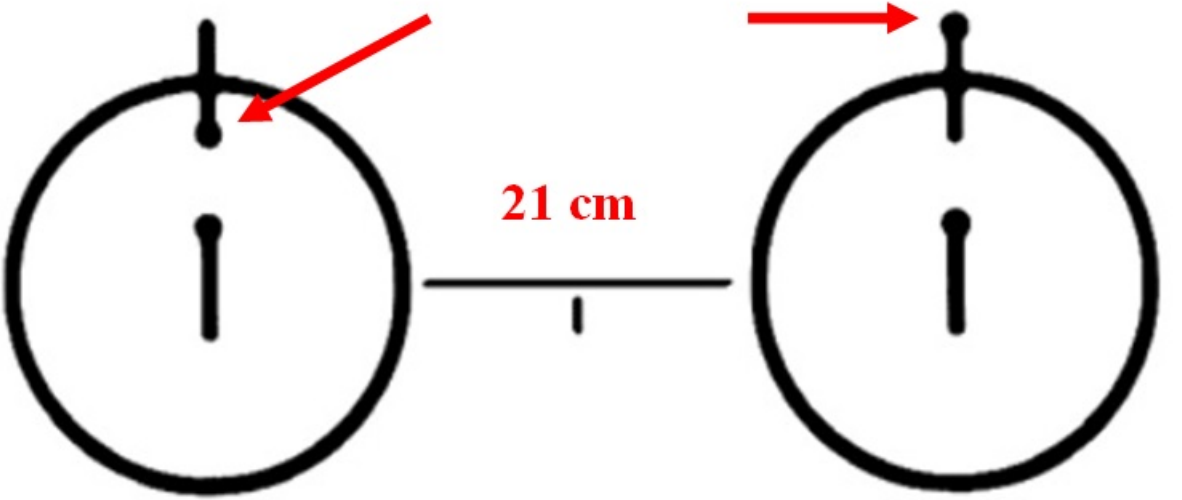
The Pioneer plaques are a pair of gold-anodized aluminium plaques which were placed on board the 1972 *Pioneer 10* and 1973 *Pioneer 11* spacecraft, featuring a pictorial message, in case either Pioneer 10 or 11 is intercepted by extraterrestrial life. The plaques show the nude figures of a human male and female along with several symbols that are designed to provide information about the origin of the spacecraft.



At the top left of the plate is a schematic representation of the hyperfine transition of hydrogen, which is the most abundant element in the universe. Below this symbol is a small vertical line to represent the binary digit 1. This spin-flip transition of a hydrogen atom from electron state *spin up* to electron state *spin down* can specify a unit of length (wavelength, 21 cm) as well as a unit of time (frequency, 1420 MHz). Both units are used as measurements in the other symbols.

From Wikipedia

Spin-flip in H. 21 cm radiation



Definition of the fundamental units in the SI system

http://physics.nist.gov/cuu/Units/current.html

Definitions of the SI base units

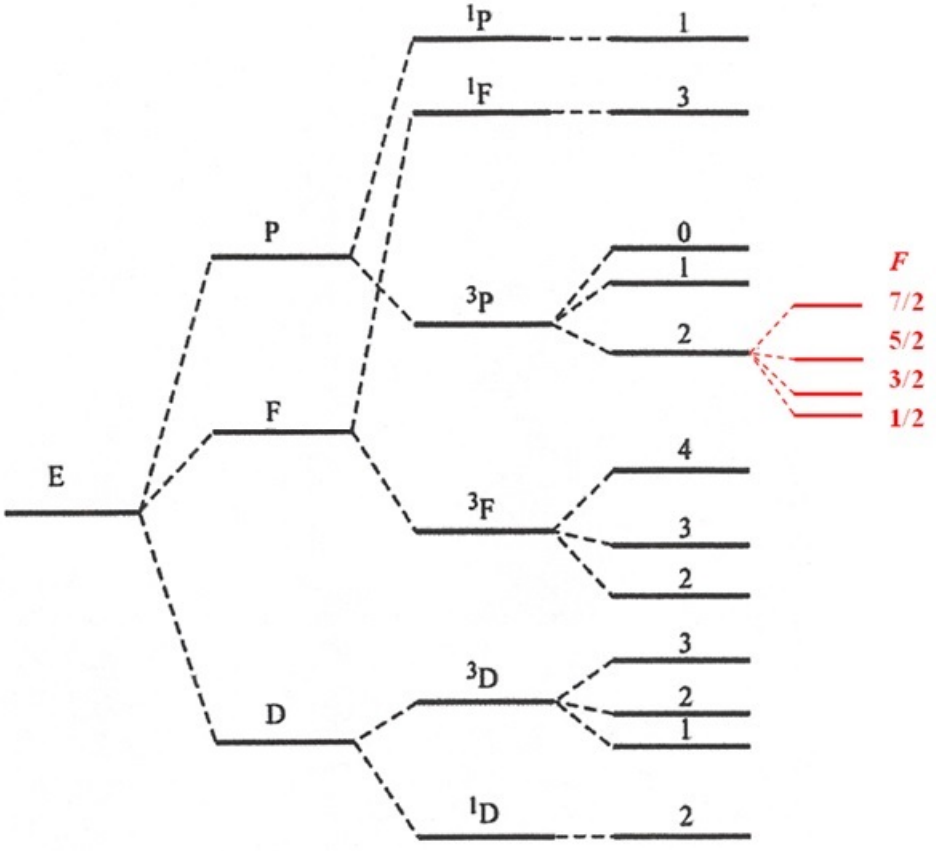
Unit of length	**meter**	The meter is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second.	Go to historical context
Unit of mass	**kilogram**	The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram.	Go to historical context
Unit of time	**second**	The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.	Go to historical context

....

^{133}Cs. 6s $^{2}S_{½}$, $I = ½ \Rightarrow F = 0,1.$

$\Delta E = 38$ μeV och $\lambda = 3,26$ cm

pd-configuration LSJ-coupling and a nuclear spin of 3/2



Configuration	Term	Level	Sublevel
Central field	Repulsion	Spin-orbit	Hfs

Selection rules E1 transitions with hfs

$\Delta F = 0, \pm 1$ not $0 \rightarrow 0$

$\Delta J = 0, \pm 1$ not $0 \rightarrow 0$

Only one electron may change orbital, $n\ell \rightarrow n'\ell'$

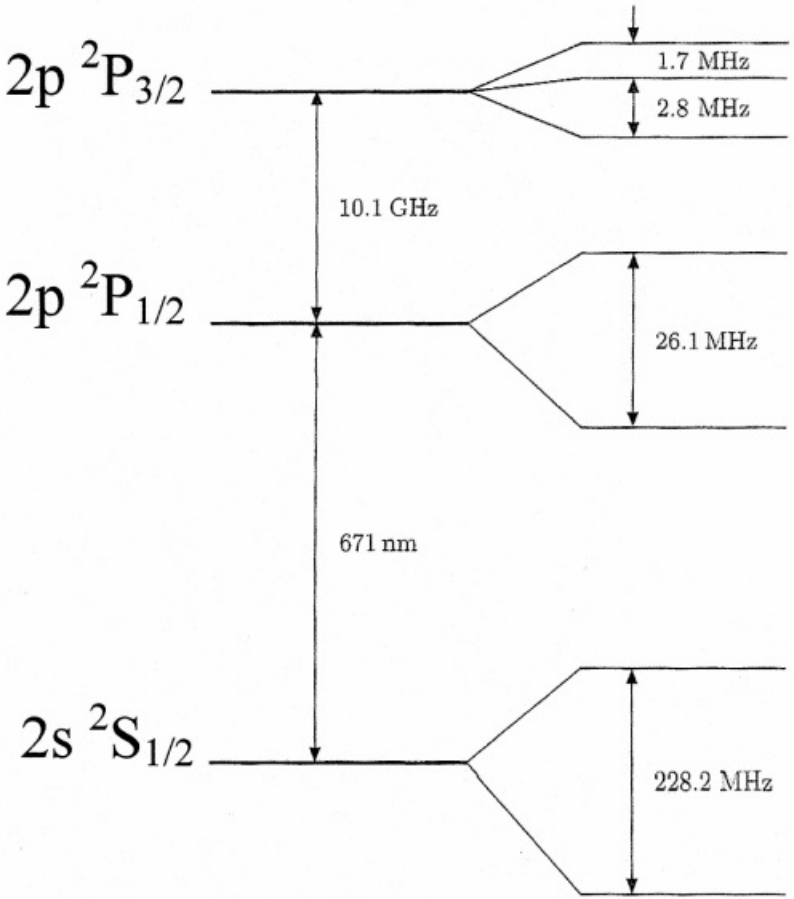
$\Delta \ell = \pm 1$

In perfect LS-coupling

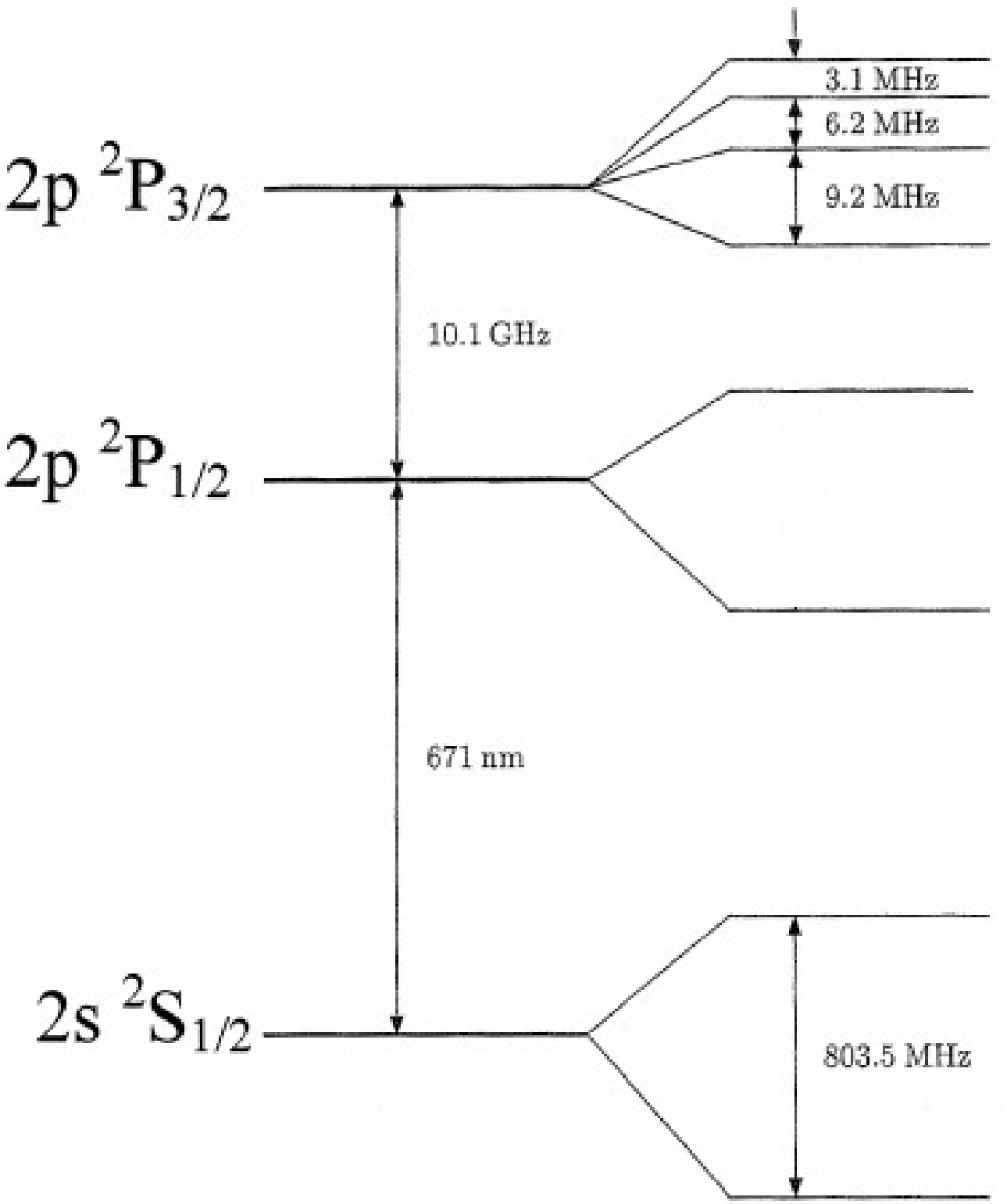
$\Delta S = 0$

$\Delta L = 0, \pm 1$ ej $0 \rightarrow 0$

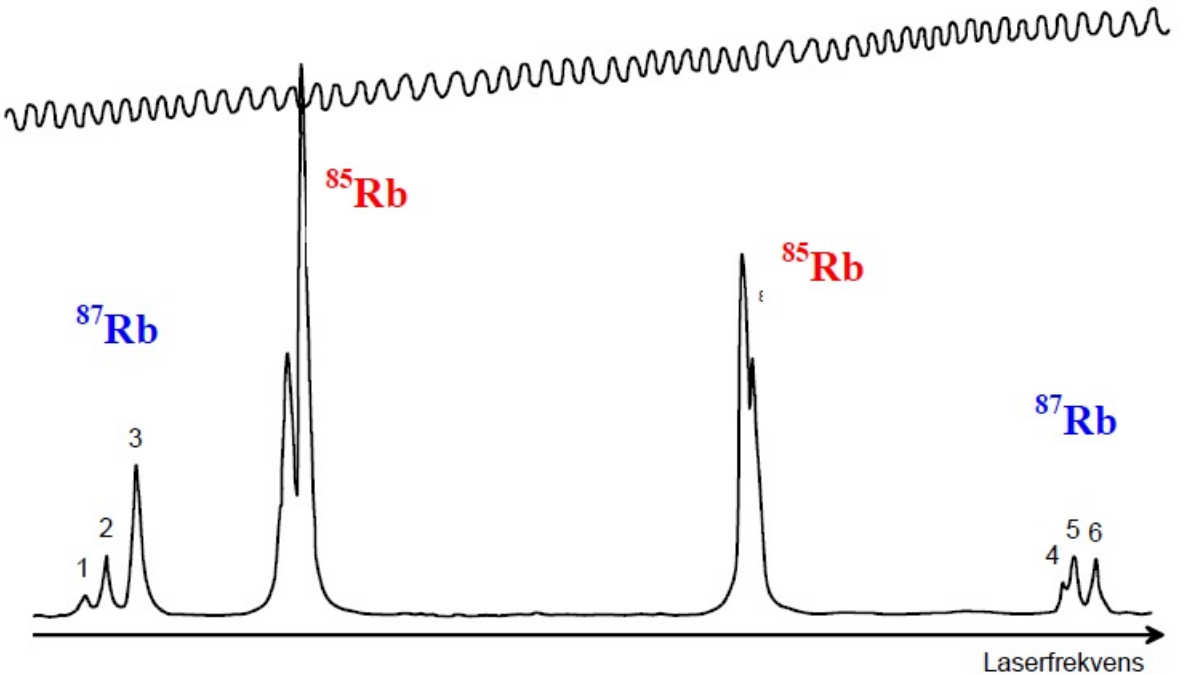
Determine the nuclear spin of ^{6}Li



Determine the nuclear spin of ^{7}Li



Hyperfin structure and isotope shift



Hfs and isotope shift in the 5s $^2S_{1/2}$ – 5p $^2P_{3/2}$ transition in Rb