SIDDHARTA SDD detector for exotic atoms research

Physics case

***SI**licon **D**rift **D**etector for **H**adronic **A**tom **R**esearch by **T**iming **A**pplications*

The scientific aim

the determination of the ***isospin dependent*** $\bar{K}N$ ***scattering lengths*** through a

~ eV measurement of the shift
and *of the width*

of the K_α line of **kaonic hydrogen**

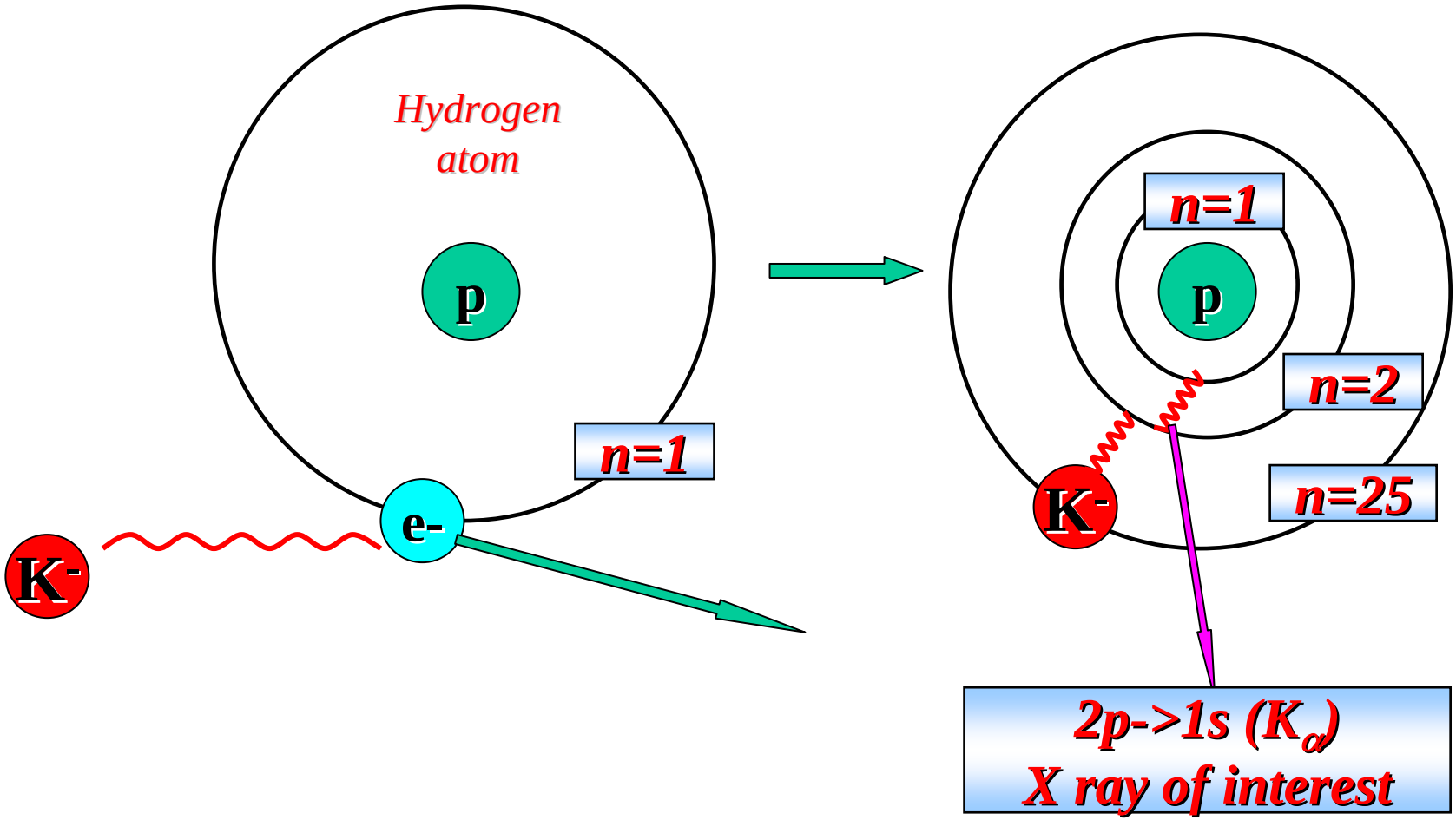
and

the *first (similar) measurement* of **kaonic deuterium**

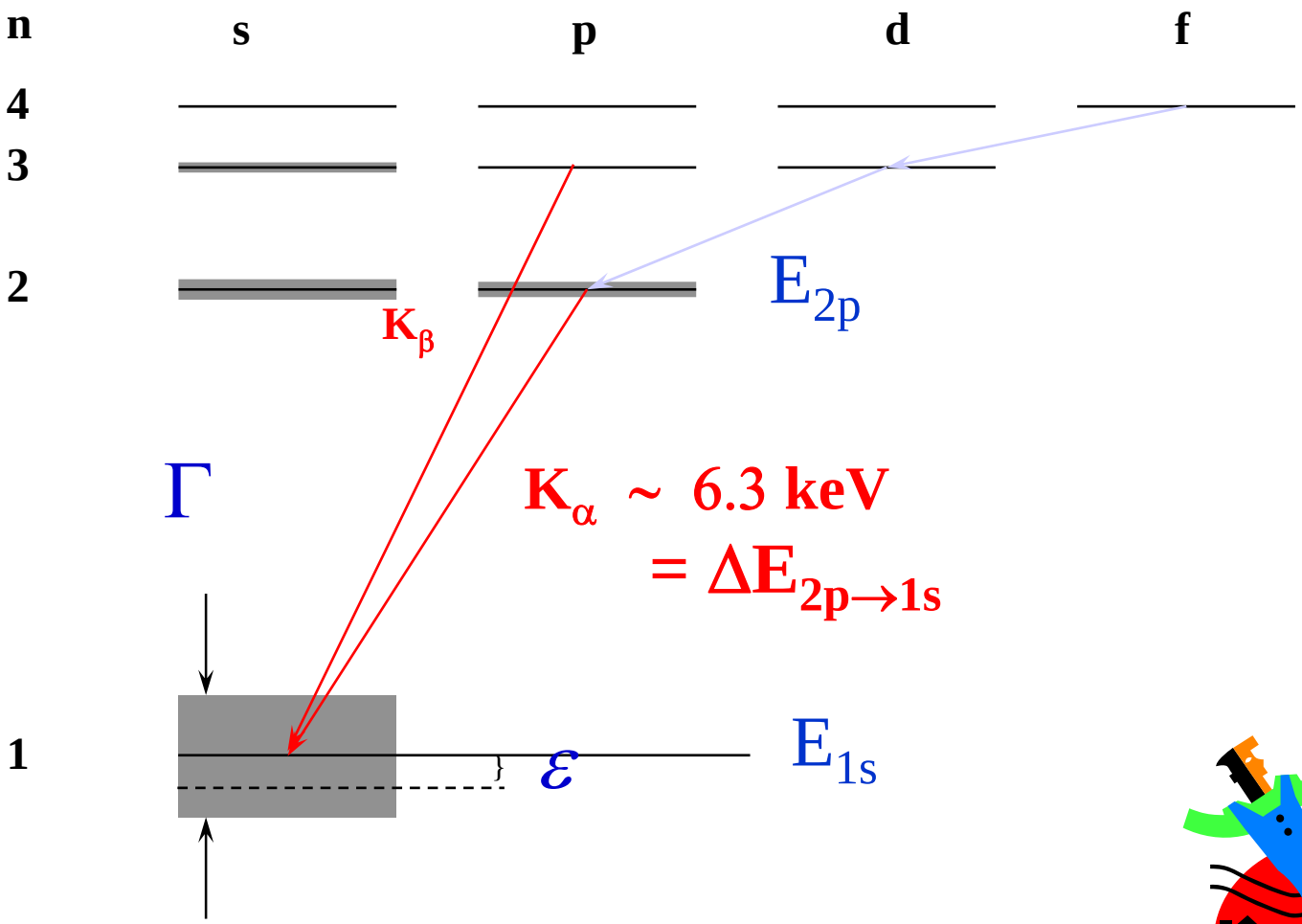
Kaonic Atom

Electronic hydrogen

Kaonic hydrogen



Kaonic cascade and the strong interaction



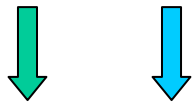
Antikaon-nucleon scattering lengths

Once the shift and width of the 1s level for kaonic hydrogen and deuterium are measured, with the Deser formulae *(neglecting isospin breaking corrections):*

$$\varepsilon + i\,\Gamma/2 = 412\; a_{K^-p}\; eV\; fm^{-1}$$

$$\varepsilon + i\,\Gamma/2 = 602\; a_{K^-d}\; eV\; fm^{-1}$$

one can obtain the isospin dependent antikaon-nucleon scattering lengths



$$a_{K^-p} = (a_0 + a_1)/2$$

$$a_{K^-n} = a_1$$

SIDSDHARTA Scientific program

Measuring the $\bar{K}N$ scattering lengths with the precision of a few percent will drastically change the present status of low-energy $\bar{K}N$ phenomenology and also provide a clear assessment of the SU(3) chiral effective Lagrangian approach to low energy hadron interactions.

1. **Breakthrough in the *low-energy $\bar{K}N$ phenomenology*;**
2. **Threshold amplitude in QCD**
3. **Determination of the *KN sigma terms*, which give the degree of chiral symmetry breaking;**
4. **Determination of the *strangeness content of the nucleon* from the KN sigma terms**
5. **Information on $\Lambda(1405)$**

Meson-nucleon sigma terms

- Sigma terms are directly connected with the symmetry breaking part of the strong interaction Hamiltonian

- Sigma terms measure the nucleon mass shift away from the chiral limit (m_q=0), therefore parameterizing the explicit breaking of chiral symmetry in QCD due to the non-zero quark masses.

The impact of the SIDDHARTA results

Presently only estimates exists of KN sigma terms.

A measurement of KN scattering lengths at the percent level would enable the determination of the KN sigma terms with a **precision of about 20%** or less.