



X-ray spectroscopy of Kaonic Atoms at the DAΦNE collider

Silicon Drift Detector for Hadronic Atom Research by Timing Application

The SIDDHARTA-2 experiment aims at a precise measurement of the kaonic deuterium x-ray transitions to determine the strong-interaction energy-level shifts and widths of the lowest lying atomic states.

The combined measurement of kaonic hydrogen (measured by the SIDDHARTA experiment) and kaonic deuterium allow the extraction of the isospin-dependent antikaon-nucleon scattering lengths, fundamental quantities for understanding aspects of low-energy QCD in the strangeness sector, which in turn is important for studies in particle and nuclear physics, as well as in astrophysics, including the emergent sector of gravitational waves emitted by binary (neutron) stars and the dark matter.

More than 20 years of hard work and successes for **KAONIC ATOMS**

1996 – first ideas to propose a new experiment (**DaΦne Exotic Atom Research**) at DAΦNE (**DEAR**)

2008 – 2009 - **Silicon Drift Detector for Hadronic Atom Research by Timing Application**

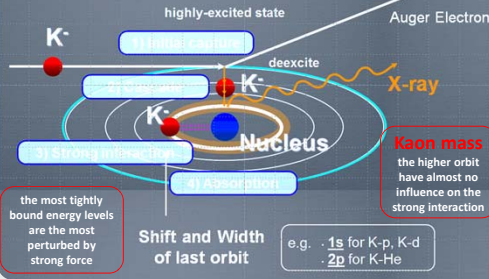
2018 start of **SIDDHARTA-2** experiment at DAΦNE

Kaonic atom formation

A powerful tool for studying strong interaction

$$n \sim \sqrt{\mu^2/m^2} n' \sim 25 \text{ (for K-p)} \\ (\mu^* : \text{K-p reduced mass})$$

highly-excited state



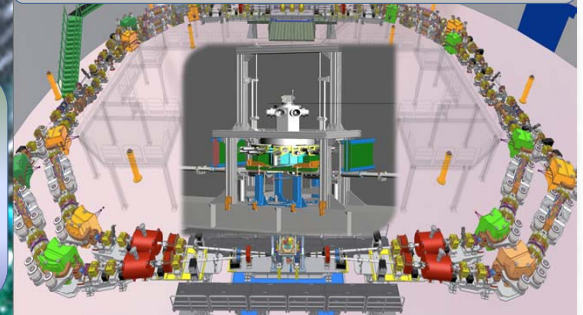
Important TRAINING for young researchers

the perfect time to participate !

Master thesis or Ph. D. thesis

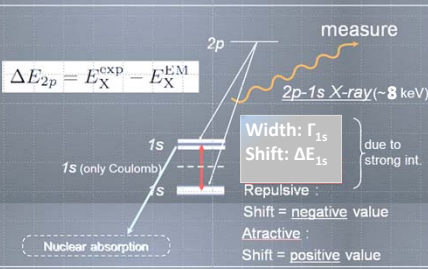
- preparation for **new installation** (autumn 2018)
- work with **various new detectors and complex nuclear instruments**
- participate to the **next period of data taking and analysis**

DAΦNE collider the best beam of low energy kaons ($p \sim 127 \text{ MeV}/c$)

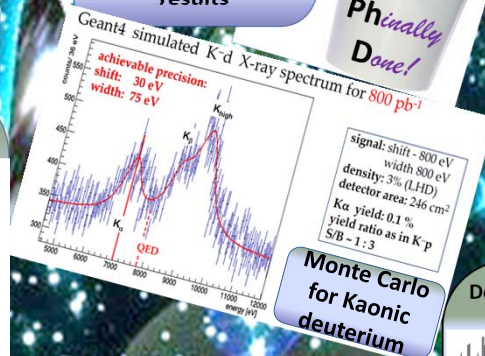


Installation in autumn 2018

Kaonic Deuterium



being involved in the analysis of the data from Monte Carlo simulation to final experimental results



S-wave scattering length

Deser-Trueman Formula

$$\Delta E_n^s - \frac{1}{2} \Gamma_n = -2\alpha^3 \mu_c^2 a_{K^-p}$$

Kaonic hydrogen SHIFT & WIDTH

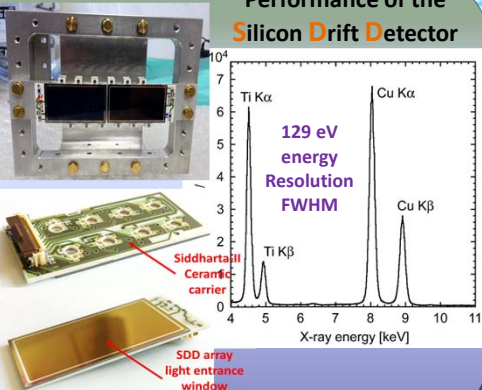
S-wave scattering length "a_{K-p}" expressed with isospin dependent scattering lengths a₀ (I=0), a₁ (I=1)

Isospin-breaking correction

$$\Delta E_n^s - \frac{1}{2} \Gamma_n = -\frac{\alpha^3 \mu_c^2}{2\pi M_{K^+} n^3} \times T_{KN} \left\{ 1 - \frac{\alpha \mu_c^2}{4\pi M_{K^+}} T_{KN}(s_n(\alpha) + 2\pi) + \delta_{KN}^n \right\}$$

U.-G. Meißner et al, Eur Phys J C35 (2004) 349

Performance of the Silicon Drift Detector

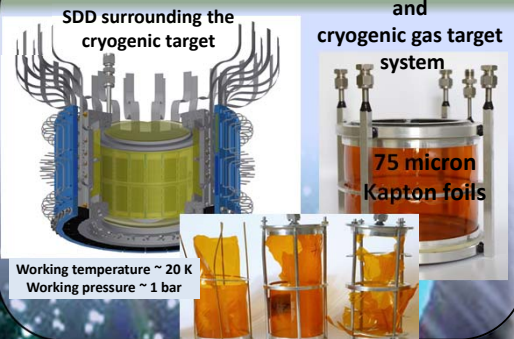


Futures perspective

... NOT ONLY Kaonic deuterium measurement



Development of advanced experimental methods and cryogenic gas target system

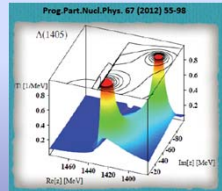


Kaonic Helium transitions to the 1s level

Light and heavier kaonic atoms Kaonic Oxygen, Kaonic Carbon, Si, Pb, ... with new HPGe detectors

Kaon radiative capture $\Lambda(1405)$ study (double pole structures?)

Charged Kaon mass precision measurement at the level of $< 7 \text{ keV}$ the "kaon mass puzzle" new proposals like TES, VOXES



Investigate the possibility of the measurement of other types of hadronic exotic atoms (sigmonic hydrogen ?)

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