Search for Deeply Bound Kaonic Nuclear States in AMADEUS experiment

Laboratori Nazionali di Frascati

Magdalena Skurzok[(a)] for AMADEUS Collaboration

(a) M. Smoluchowski Institute of Physics, Jagiellonian University, 30-059 Cracow, Poland

1. Intoduction

The existence of **Deeply Bound Kaonic Nuclear States** (DBKNS) of K^-, also called kaonic nuclear clusters, was firstly predicted by professor Wycech in 1986 [1]. Since then the DBKNS has been intensively debated by the scientific community, both by experimentalists and by the theoreticians. According to some theories the existence of very deeply bound states is possible (about 100 MeV of binding energy for the K^-pp nuclei decaying to Λp) while other theories are predicting much less bound states [2-4]. Therefore, in order to clarify this issue, experimental data are needed. **AMADEUS** goal is to do the first complete investigation of the Λp, $\Sigma^0 p$, Λd, $\Sigma^0 d$ and Λt channels, searching for signals coming from the bound states and, in the same time, exploring intensively the rich physics of these channels [5,6].

2. Motivation

- **nuclear and particle physics**:

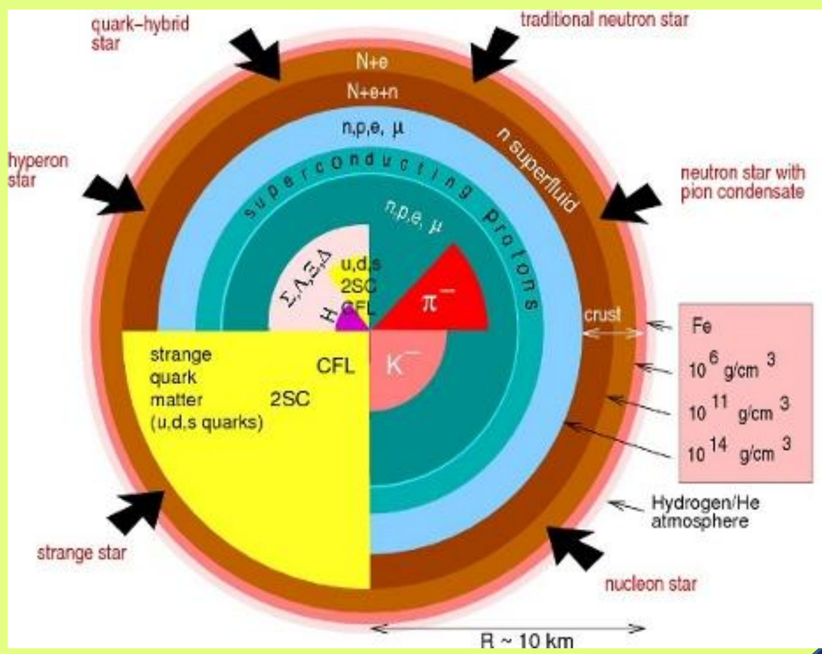
better understanding of elementary kaon - nucleon interaction for low energies in the non-perturbative QCD

↓

solving one of the crucial problems in hadron physics: **hadron masses** (related to the chiral symmetry brea-king), hadron interac-tions in nuclear medium and the structure of the dense nuclear matter [2-4].

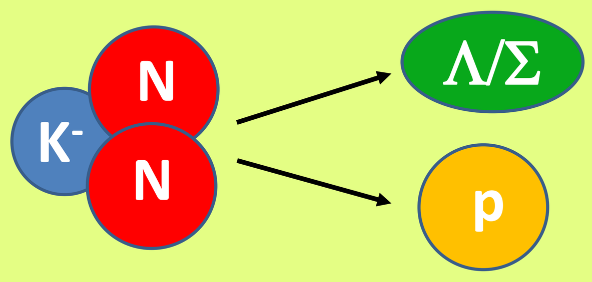
- **astrophysics**:

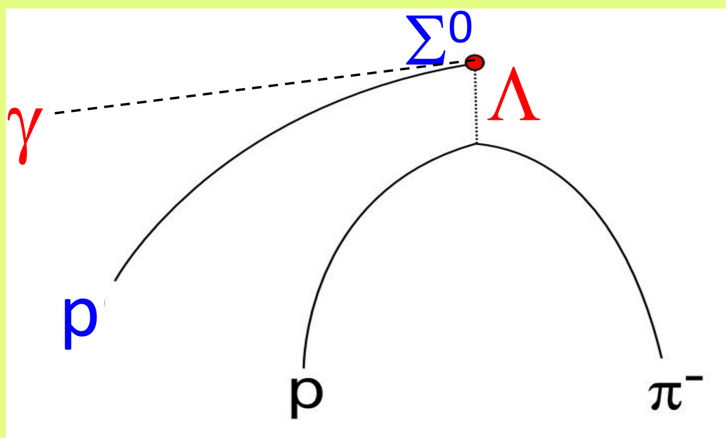
the binding of the kaon in nuclear medium may impact on models describing the structure of **neutron stars** (Equation of State of neutron stars) [7-9] including binaries which are expected to be sources of the gravitational waves.



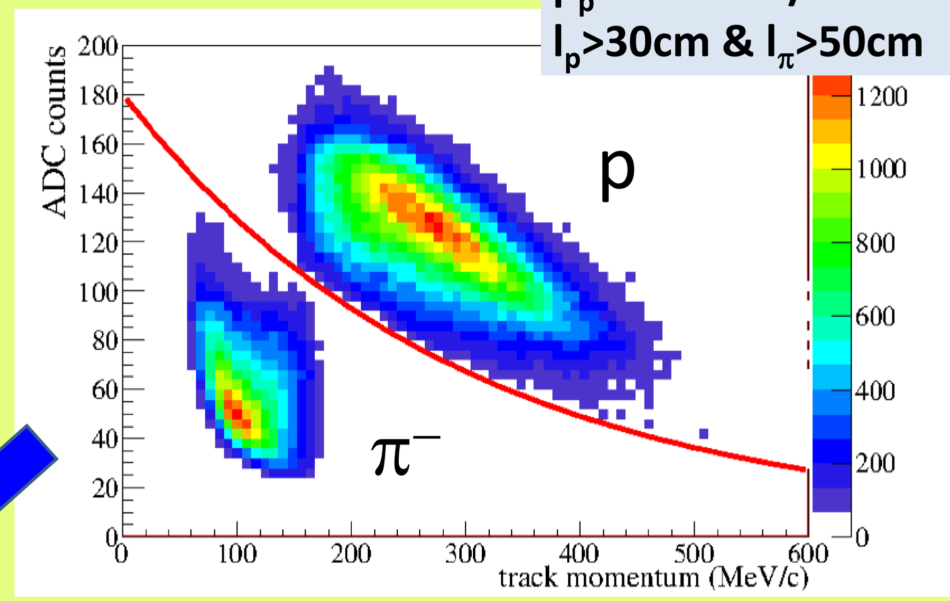
4. Data analysis

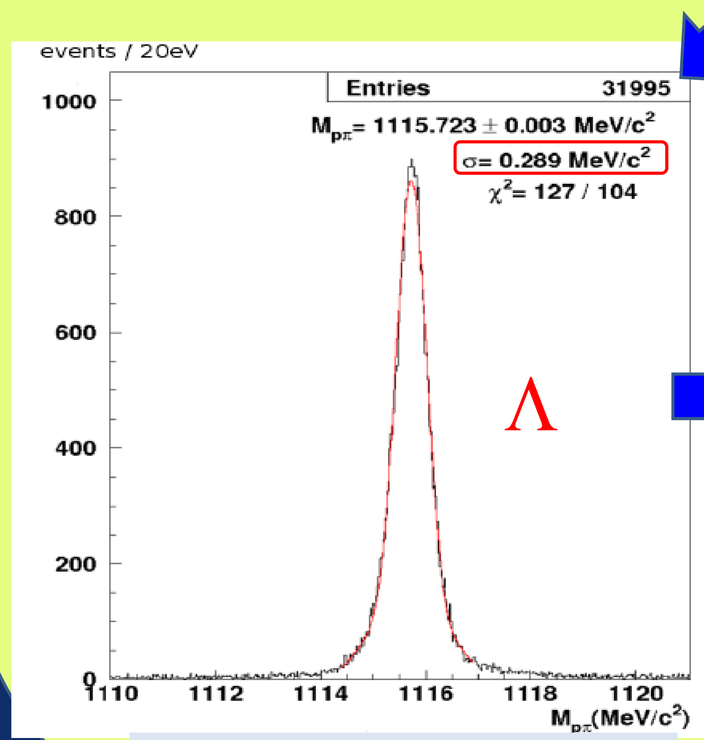
$K^-pp \rightarrow \Sigma^0 p$
$\quad\hookrightarrow \Lambda\gamma$
$\quad\quad\hookrightarrow p\pi^-$ (BR~64%)



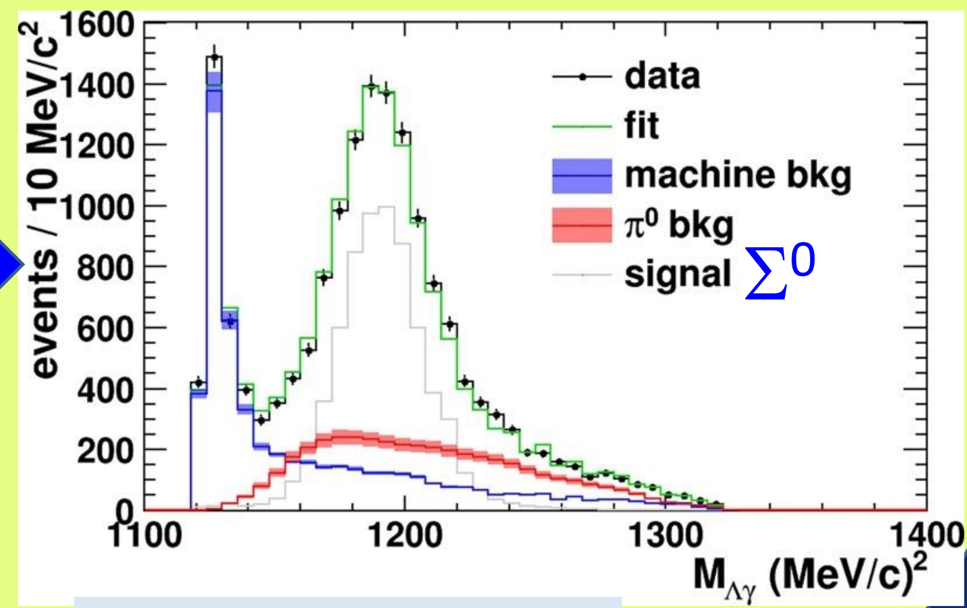


$p_p > 170$ MeV/c
$l_p > 30$cm & $l_\pi > 50$cm



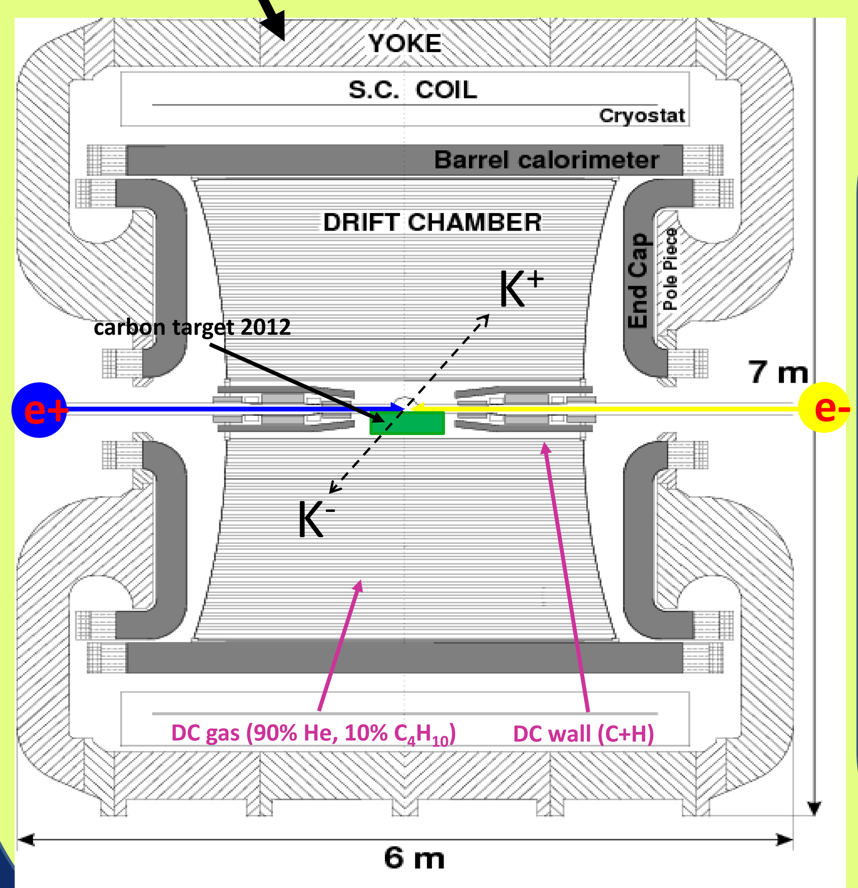


$1112 < M_{p\pi} < 1118$ MeV/c^2



$1150 < M_{\Lambda\gamma} < 1235$ MeV/c^2

3. AMADEUS experiment



DAΦNE

- $\phi \rightarrow K^- K^+$ (49.2%), ≈1000 ϕ/s
- monochromatic **low momentum** Kaons ≈127 Mev/c
- **back to back** $K^- K^+$ topology
- **small hadronic background** due to the beam

KLOE

- Cilindrical DC with **4π geometry** & electromagnetic calormeter
- **96% acceptance**
- **high efficiency and resolution** for charged and neutral particles

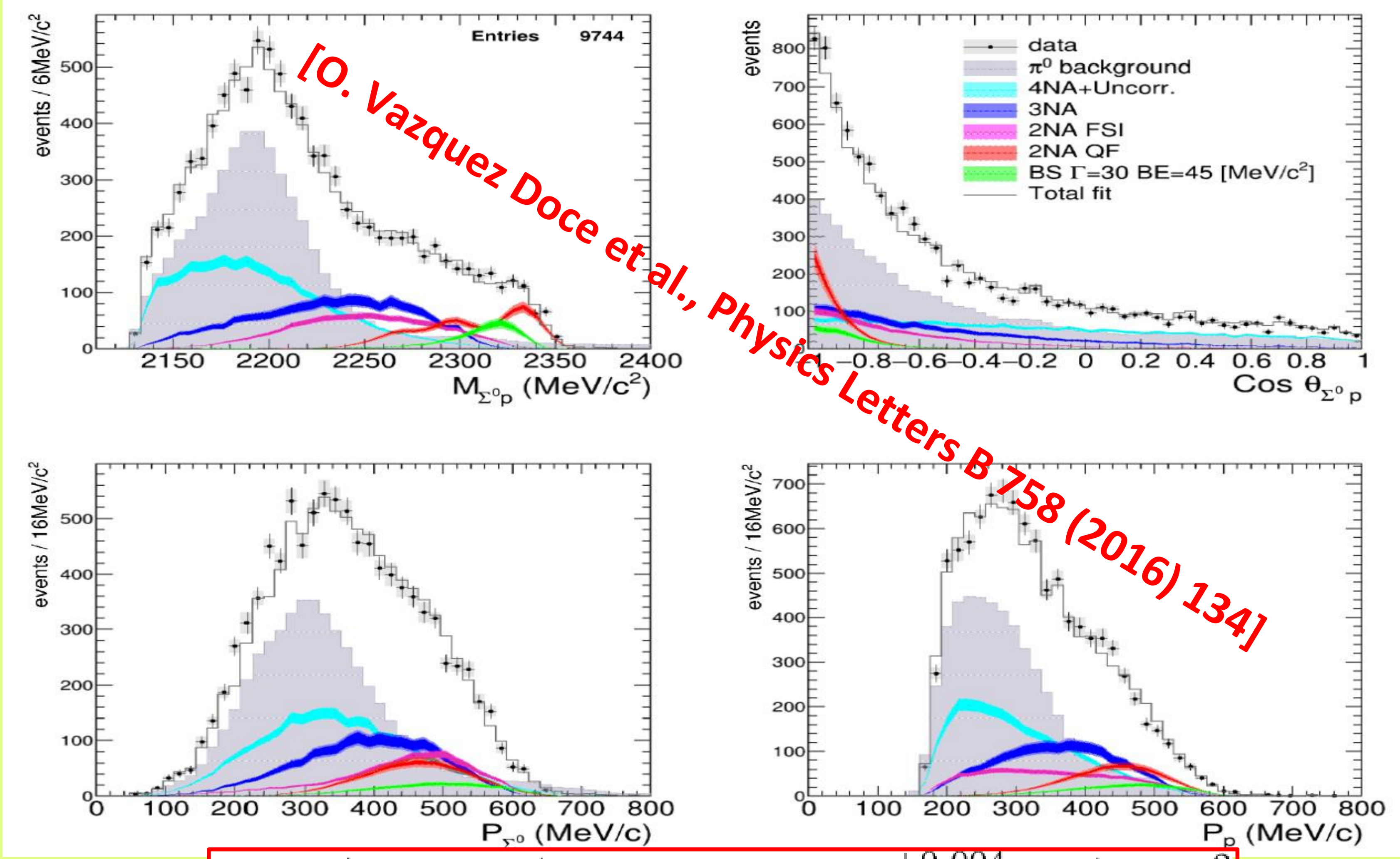
↓

- exclusive measurement of the considered processes

K^- absorption on light nuclei AT REST & IN FLIGHT

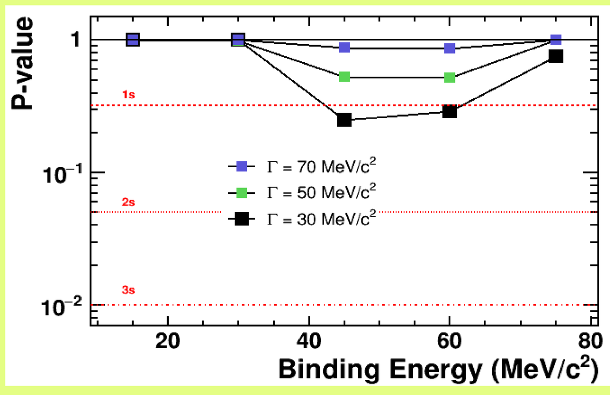
5. Results

Fit to data



$$Yield/K^-_{stop} = (0.044 \pm 0.009 stat^{+0.004}_{-0.005} syst) \cdot 10^{-2}$$

Best sollution:
$\chi^2 = 0.807$
$B_s = 45$ MeV
$\Gamma = 30$ MeV



Analyses
$K^-pp \rightarrow \Lambda p$
$K^-ppn \rightarrow \Lambda d$
$K^-ppnn \rightarrow \Lambda t$
in progress

6. References

[1] S. Wycech, Nucl. Phys. A 450, 399c (1986).
[2] Y. Akaishi, T. Yamazaki, Phys. Lett. B535, 70 (2002).
[3] A. Dote, T. Hyodo, W. Weise, Phys. Rev. C79, 014003 (2009).
[4] S. Wycech, A. M. Green, Phys. Rev. C79, 014001 (2009).
[5] C. Curceanu et al., Acta Phys. Polon. B46, 203 (2015).
[6] K. Piscicchia et al., Hyperfine Interact. 234, 9 (2015).
[7] J. M Lattimer, M. Prakash, Science 304, 538 (2004)
[8] A. E. Nelson and D. B. Kaplan, Phys. Lett B192 (1987).
[9] A. Scordo, et al., AIP Conf. Proc. 1735 080015 (2016).

Project financed by Polish National Science Center, grant No.UMO-2016/21/D/ST2/01155