



Stefan Meyer Institute



OAW
Austrian Academy
of Sciences

Review of LEANNIS – a tribute to Paul Kienle

LEANNIS

Johann Marton
Stefan Meyer Institute
Vienna



Overview

- What is LEANNIS ?
- Short history of LEANNIS
- Kienle and LEANNIS

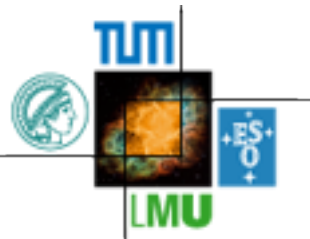


LEANNIS

9 participating institutions from 5 EU countries: Austria, Czech Republic, Germany, Italy, Poland



האוניברסיטה העברית בירושלים
The Hebrew University of Jerusalem



Technische Universität München



Laboratori Nazionali di Frascati



INSTYTUT PROBLEMÓW JĄDROWYCH im. Andrzeja Soltana
THE ANDRZEJ SOLTAN INSTITUTE FOR NUCLEAR STUDIES



Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

Objectives

LEANNIS

Central objectives of LEANNIS are the definition and coordination of studies on low-energy antikaon nucleon and nuclei interaction in theory and experiment centered at European scale, but with strong impact on the worldwide strategy in the field.

Main Tasks of LEANNIS

- **T1:** Theoretical investigations in in strangeness nuclear physics
- **T2:** New precision studies of the strong interaction in kaonic atoms
- **T3:** Nature of Lambda(1405)
- **T4:** Search for kaonic nuclear clusters in dedicated experiments
- **T5:** Towards in-medium modification studies of charmed hadronic systems
- **T6:** Expert Meetings, Workshops, Dissemination



Short Review

- Idea of LEANNIS network – going back to P. Kienle and W. Weise – around 2006
- Inventor of the name LEANNIS → Paul
- Covering important facets of low-energy strong interaction with strangeness

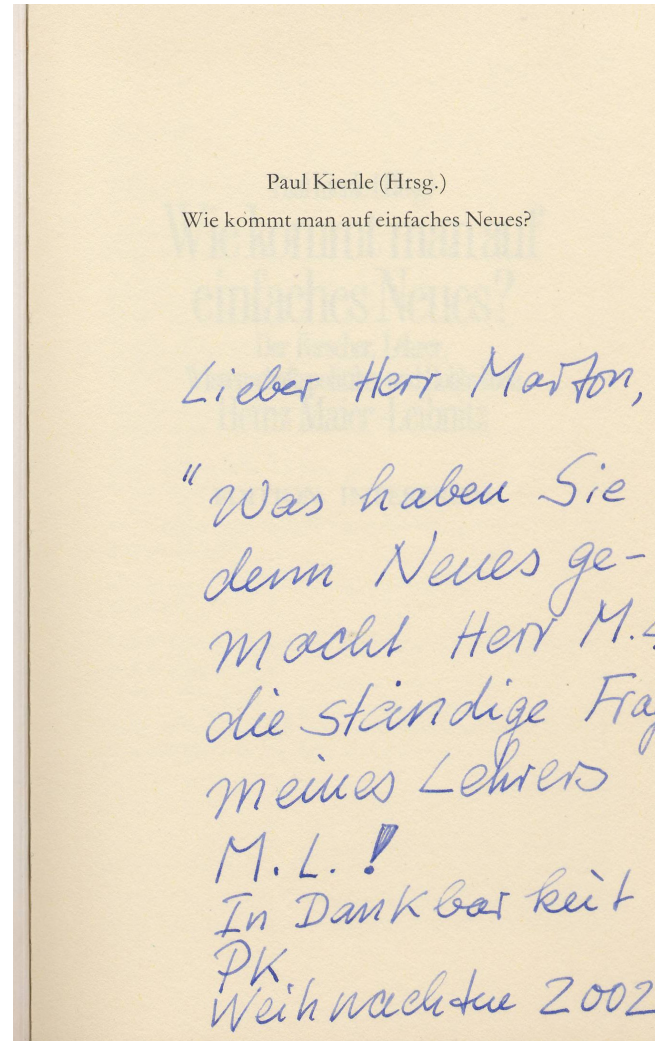
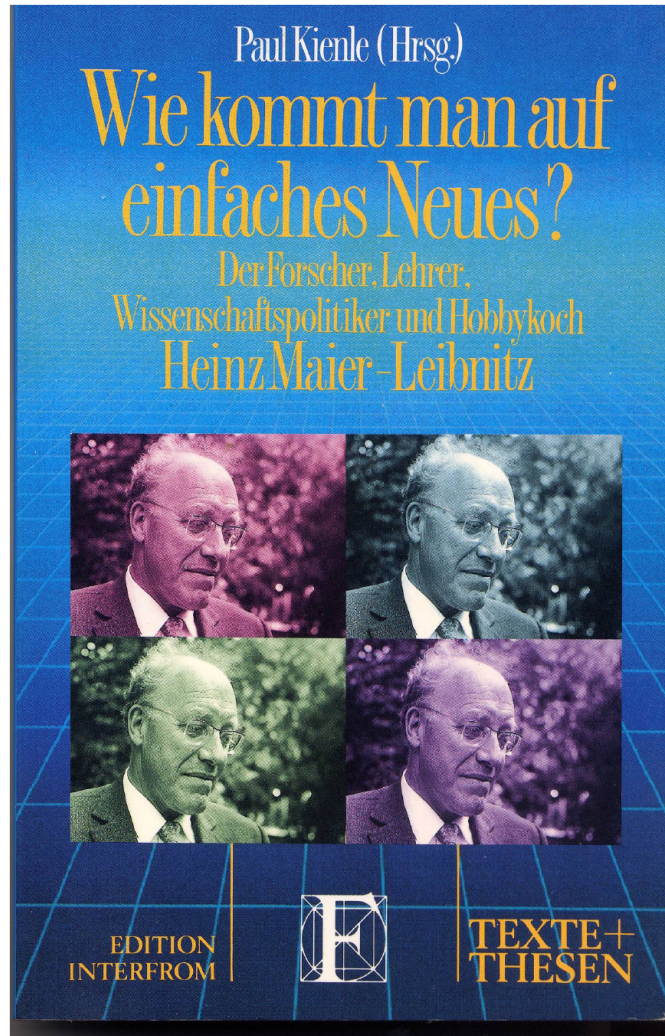
- LEANNIS in HadronPhysics2, 2009 – 2011
- LEANNIS in HadronPhysics3, 2012 - 2014

PK and LEANNIS

- Broad knowledge of (strangeness) nuclear physics – a unique sense for interesting questions
- Creativity – open to new ideas in physics
- Instrumentation-driven research – always interested in new technologies and techniques
- „Wie kommt man auf einfaches Neues?“
- Human sense – always supporting young scientists
- Together with Toshi Y. continuous efforts to clarify the kaonic bound state topic
 - DISTO analysis in respect to kaonic bound states
 - Idea of KLOE data analysis



Motto-central point



ALLES was man einmal verstanden hat, ist von da an einfach und kann Basis für Neues sein.

Everything you once have understood is then easy and can be basis for something new.

Paul's focus

- Deeply bound mesonic states
 - Pionic states – restoration of chiral symmetry
 - Kaonic nuclear clusters
 - FOPI pp reaction
 - DISTO pp reaction
 - Antiproton reactions – strangeness production, double K nuclei
- Properties of kaonic nuclear systems
 - Binding energy, width
 - Densities – connection to compact stars?

Paul's connection to Vienna



J. Marton, Meeting, 19 June 2013

Starting point

Exotische Atome: Rosen aus dem Blumengarten der subatomaren Physik

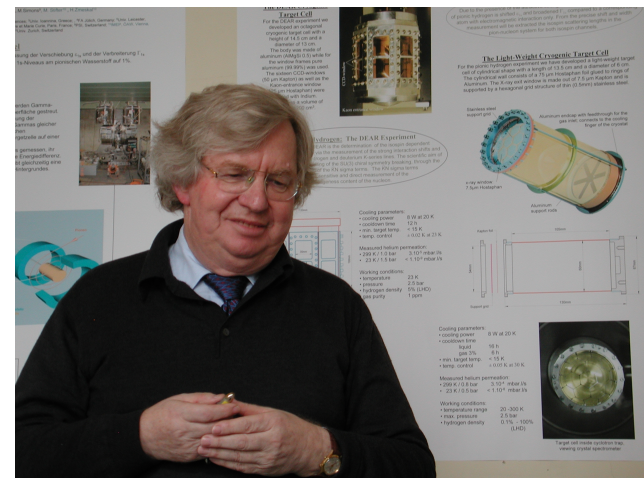
Paul Kienle^{a,b} und Johann Marton^a

^a Stefan Meyer Institut für subatomare Physik der ÖAW

^b Technische Universität München



Public Lecture by Paul
at the EXA08 Conference in Vienna,
Proceedings, Austrian Academy of Sciences





J. Marton, Meeting, 19 June 2013

Presentation of LEANNIS
at Frascati September 2007

LEANNIS

Low Energy Antikaon-Nucleon and –Nucleus Interaction Studies

Proposal for a Networking Activity in
I3-HadronPhysics (FP7)

2009

LEANNIS was started with January 1, 2009

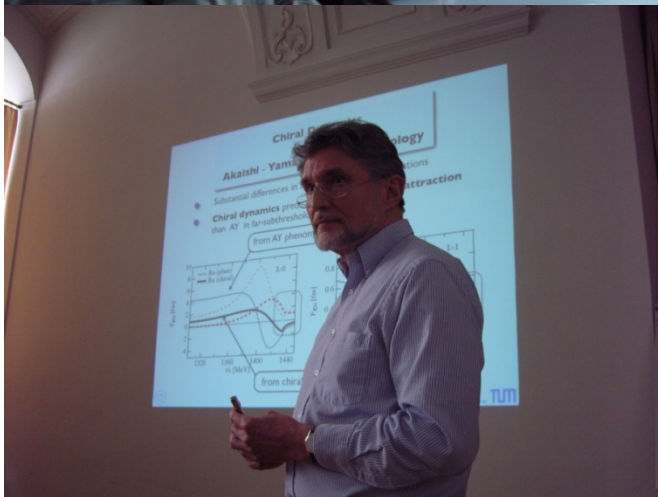
LEANNIS Kick-off Meeting



March 27, 2009 in Vienna

3 Overview Talks
10 Talks from LEANNIS Participants

Current Status
Plans for the 1st year and
distribution of Work



Other Research Projects

Finalized Projects

Talks & Events

EU Projects

FWF Projects

News

Thursday 25. April 2013

Guest scientist

Steven D Bass (Innsbruck)

[\[more\]](#)

Monday 22. April 2013

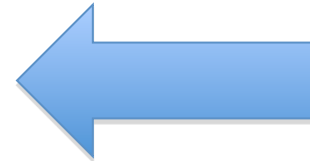
Kern- und Teilchenphysik in Österreich

Aus Anlass der



Aktualisierung der Europäischen Strategie der Teilchenphysik, die Ende Mai beschlossen worden

Kienle_Low_Energy_Antikaon_Interaction.pdf	1.8 M
Marton_Talk-Overview-26mar09.pdf	2.3 M
Weise_LEANNIS09.pdf	4.3 M



Informations from the LEANNIS Participants

Speaker	Title
V. Baru	The nucleon recoil effect in antikaon deuteron scattering at threshold
S. Wycech	Activities at SINS
C. Curceanu	SIDDHARTA and AMADEUS at LNF
E. Widmann	Kaonic He-3 and E15 at J-PARC
M. Faber	Activities at Atominstiute/TU Vienna
L. Fabbietti	Search for strange dibaryons with FOPI
O. Hartmann	π induced reactions
P. Buehler	Strangeness in heavy ion reactions with FOPI
J. Zmeskal	Search for Kaon-bound nuclei with antiprotons
R. Dzhygadlo	Study of the K-pp system below threshold with COSY-TOF

Baru_kd_recoil_LEANNIS2009.pdf	265 K
Buehler_LEANNIS09.pdf	487 K
Curceanu_siddharta-amadeus-vienna-27mar2009.pdf	9.9 M
Dzhygadlo_kmpp_leannis.pdf	414 K
Fabbietti_Part_One.pdf	13.5 M
Fabbietti_Part_Two.pdf	11.8 M
Faber.pdf	1.1 M

ECT* Workshop in connection with LEANNIS



ECT*
EUROPEAN CENTRE FOR THEORETICAL STUDIES
IN NUCLEAR PHYSICS AND RELATED AREAS
TRENTO, ITALY
Institutional Member of the ESF Expert Committee NuPECC

Castello di Trento ("Torre") restaurato, 18.8 x 27.1, painted by A. Eder on his way back from Vienna (1885). British Museum, London.

International Workshop on Hadronic Atoms and Kaonic Nuclei
solved puzzles, open problems and future challenges in theory and experiment
Trento, October 12 - 16, 2009

Main Topics

- Hadronic atoms – theory and phenomenology
- Consistent calculations for hadronic atoms transitions
- Meson-meson and meson-nucleon scattering status
- Lattice QCD calculations and low-energy effective theories
- Deeply bound meson-nucleon states, theoretical status

Speakers include

- Y. Akaishi, RIKEN, Japan
- S. Barshchikov, CERN
- T. Bressan, Univ. Torino, Italy
- I. Fialkowski, TU München, Germany
- E. Friedman, The Hebrew Univ., Jerusalem, Israel
- A. Gal, The Hebrew Univ., Jerusalem, Israel
- C. Guaraldo, INFN-INFN, Italy
- N. Harnemann, U. Heidelberg, Germany
- M. Iwasaki, RIKEN, Japan
- Z. Kalinowski, Mikasa Univ., Of Technology, Iran
- P. Kienle, TU München, Germany
- J. Marton, Prague, Czech Republic
- J. Marton, SMI Vienna, Austria
- T. Matulewicz, Soltan Inst. For Nuclear Studies, Poland
- S. Chada, INFN-INFN, Italy
- S. Piatek, Technische Universität Dresden, Germany
- O. Vazquez-Dorner, INFN-INFN, Italy
- W. Weise, TU München, Germany
- E. Widmann, SMI, Vienna, Austria
- S. Wycech, Soltan Inst. For Nuclear Studies, Poland
- T. Yamazaki, U. Tokyo, RIKEN, Japan
- J. Zmeskal, SMI, Vienna, Austria

Organizers

- Catalina Corceanu (Pittsburg) – INFN-INFN, Frascati (Italy)
- Carlo Guaraldo – INFN-INFN, Frascati (Italy)
- Paul Kienle – TU München (Germany)
- Johann Martin – SMI, Vienna (Austria)
- Wolfram Weise – TU München (Germany)

Director of the ECT*: Professor Achim Richter (ECT*)
Vice Director: Professor Marco Trini (Trento)

The ECT* is administered by the "Fondazione Bruno Kessler" and sponsored by the "Assessorato alla Ricerca" (Provincia Autonoma di Trento), funding agencies of EU Member and Associated States and has the support of the Department of Physics of the University of Trento.

For local organization please contact: Cristina Crista in this Campo - ECT* Secretariat - Villa Tombea - Strada della Tabarella 286 - 38123 Villaggio Trento - Italy; e-mail: cristina@ect.it; info@ect.it
Tel.: (+39-0461) 374-730 or -721 Fax: (+39-0461) 933007; E-mail: ect@ect.it or info@ect.it



HadronPhysics2
Next, it's through. Inspiring Matter.

International Workshop on
Hadronic Atoms and Kaonic
Nuclei
solved puzzles, open problems
and future challenges
in theory and experiment

Trento, 12 - 16 October, 2009

Organizers:

C. Curceanu, C. Guaraldo,

P. Kienle, J. Marton, W. Weise



J. Marton, Meeting, 19 June 2013

Search for Double Antikaon Production in Nuclei by Stopped Antiproton Annihilation

P. Kienle, Excellence Cluster Universe, TU München

- Introduction into the search for double kaonic nuclear cluster production by stopped antiproton annihilation
- Experimental approach @ J-PARC
- Experimental approach @ AD and FAIR

A Proposal for the CERN AD

DOUBLE-STRANGENESS PRODUCTION BY ANTIPROTONS

J. ZMESKAL¹, T. BRESSANI², C. CURCEANU³,
L. FABIETTI⁴, R. GOLSER⁵, C. GUARALDO³, P. KIENLE^{1,4},
N. KURODA⁶, J. MARTON¹, E. WIDMANN¹, Y. YAMAYZAKI⁶

¹SMI VIENNA, ²U. TORINO, ³LNF-INFN FRASCATI,
⁴TU-MUNICH, ⁵U VIENNA, ⁶U TOKYO

NEW OPPORTUNITIES IN THE PHYSICS LANDSCAPE OF CERN
CERN, MAY 12, 2009



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Austrian Academy
of Sciences



Stefan Meyer Institute
for Subatomic Physics

Letter of Intent for J-PARC

Letter of Intent for J-PARC

Double Anti-kaon Production in Nuclei by Stopped Anti-proton Annihilation

dated on 17 / 06 / 2009

M. Iwasaki¹, P. Kienle^{2,3}, H. Ohnishi¹, F. Sakuma^{1*}, and J. Zmeskal²

¹*RIKEN, Japan*

²*Stefan Meyer Institut für subatomare Physik, Austria*

³*Technische Universität München, Germany*

Abstract

We propose to search for double strangeness production by \bar{p} annihilation on helium nuclei at rest. The proposed experiment will provide significant information on double strangeness production and double strangeness cluster states.

Possibility of “Double-Kaonic Nuclear Cluster” Production by Stopped-pbar Annihilation

Prelude to „Double-Strange Nuclei“ @ LEAP

W. Weise, arXiv: 0507.058 (nucl-th) 2005
P. Kienle, J. Mod. Phys., **A22** (2007) 365
P. Kienle, J. Mod. Phys., **E16** (2007) 905
J. Zmeskal et al. EXA/LEAP 08, Hyper, Int
J. Zmeskal et al. „Double-Strangeness Production by Antiprotons, May 2009, CERN





J. Marton, Meeting, 19 June 2013



J. Marton, Meeting, 19 June 2013



J. Marton, Meeting, 19 June 2013

CERN Courier 2010

The fascinating world of strange exotic atoms - CERN Courier

<http://cerncourier.com/cws/article/cern/41461>

CERN Courier

CERN COURIER

Jan 20, 2010

The fascinating world of strange exotic atoms

Experts and young researchers from around the world participated in a recent international workshop that focused on puzzles past and present in the study of strange hadronic atoms and nuclei. Catalina Curceanu and Johann Marton report from Trento.

Résumé

Le monde fascinant des atomes exotiques

Le domaine des atomes exotiques connaît une renaissance, du point de vue expérimental et théorique. Du côté expérimental, de nouveaux faisceaux hadroniques peuvent être obtenus et bientôt être obtenus. De nouveaux détecteurs, ayant une performance améliorée, commencent également à fonctionner. Côté théorie, des avancées significatives ont eu lieu avec des développements récents dans les théories du champ effectif chirales et leur application aux systèmes noyau-hadron. L'atelier international sur le thème « atomes exotiques et noyaux hadroniques – énigmes résolues, problèmes en suspens et défis futurs pour la théorie et les expériences » a traité de ces questions du 12 au 16 octobre 2009, au Centre européen pour les études théoriques en physique nucléaire (ECT), à Trento.



Participants (http://images.iop.org/objects/ccr/cern/50/1/20/CCeds1_01_10.jpg)

The field of exotic atoms has a long history and it is currently experiencing a renaissance both the experimental and theoretical points of view. On the experimental side, new beams are either already available, with kaons at the DAΦNE facility at Frascati, or will become available with the start-up of the Japan Proton Accelerator Research Complex (J-PARC). New detectors, with improved performance in energy resolution, stability, efficiency, trigger capability etc, are also starting to operate. On the theoretical side there has advanced significantly through recent developments in chiral effective-field theories and their applications to hadron–nuclear systems. In light of these developments it was appropriate for the international workshop “Hadronic atoms and nuclei – solved puzzles and future challenges in theory and experiment” to address these topics on 12–16 October 2009, at the European Centre for Theoretical Studies in Nuclear Physics related areas, ECT*, Trento.

Under the title „The fascinating world of strange exotic atoms“ a report on the ECT* Meeting was published in the CERN Courier (authors C. Curceanu and J. Marton)



Mini-Proceedings

Thanks to the participants of the ECT* Workshop a (nearly) complete collection of summaries was compiled in Mini-Proceedings and is available at arXiv

arXiv:1003.2328v2 [nucl-ex] 12 Mar 2010

Eds. C. Curceanu and J. Marton



2010

LEANNIS meeting

LNF-INFN, 8-9 April 2010

The meeting will be held in aula Direzione (the first building on right once you enter inside LNF-INFN)

8 April

- 9.30 – 9.40 Welcome (Catalina Curceanu)
- 9.40 – 10.00 LEANNIS status (Johann Marton)
- 10.00 – 10.20 Next EU call: HP2 -> HP3 (Carlo Guaraldo)
- 10.20 – 10.50 KbarN and KbarNN interactions: theory status (Wolfram Weise)

10.50 – 11.15 Coffee break

- 11.15 – 11.45 An extraction of K-neutron amplitude from kaonic atoms (Slawomir Wycech)
- 11.45 – 12.15 Strangeness -1 Dibaryons (Avraham Gal)
- 12.15 – 12.45 Nuclear systems with antikaons (Jiri Mares)

12.45 – 14.30 Lunch break (*)

- 14.30 – 15.00 The Lambda1405 and even more strange resonances in pp collisions (Eliane Epple)
- 15.00 – 15.30 World first data of the $\Lambda(1405)$ in pp reactions for the charged decay channels (Johannes Siebenson)
- 15.30 – 16.00 Status of T8 Workpackage in LEANNIS (Olaf Hartmann)

16.00 – 16.30 Coffee break

- 16.30 – 17.00 Strange baryon production in HI collisions at SIS (Norbert Herrmann)
- 17.00 – 17.20 KLOE data analyses (Oton Vazquez Doce)
- 17.20 – 17.40 KHe analyses and future plans (Tomoichi Ishiwatari)
- 17.40 – 18.00 SIDDHARTA analyses status (Antonio Romero Vidal or Shinji Okada)

20.30 Dinner at the *Pezzafina* restaurant in Frascati (*)

9 April

- 9.30 – 9.50 DISTO latest results (Ken Suzuki)
- 9.50 – 10.20 Double Strangeness Production in Antiproton-Annihilation on ^3He at rest (Paul Kienle)
- 10.20 – 10.40 SIDDHARTA2 and AMADEUS future scientific programs (Catalina Curceanu)
- 10.40 – 11.00 SIDDHARTA2 and AMADEUS setup (Johann Zmeskal)

11.00 – 11.20 Coffee break

- 11.20 – 11.30 Report from Bonn group (from A. Rusetsky and U. Meissner, reported by Marton)
- 11.30 – 12.00 Perspectives of LEANNIS (Johann Marton)
- 12.00 – 13.15 Discussions and future plans, with special care about next EU HP call

13.15 End of meeting and Lunch (for those who wish having lunch at LNF) (*)



Strangeness in Nuclei, ECT*, October 4-8, 2010



arXiv:1104.1926v1 [nucl-ex] 11 Apr 2011



MINI-PROCEEDINGS
ECT* WORKSHOP

STRANGENESS IN NUCLEI

Eds. C. Curceanu (INFN-LNF/Frascati) and J. Zmeskal (SMI/Vienna)

Faces and Places (page 3) – CERN Courier

CERN Courier

CERN COURIER

Jan 25, 2011

Faces and Places (page 3)

Nuclear strangeness comes to Trento



The Strangeness in Nuclei workshop, which took place at the ECT* in Trento on 4–8 October, brought together some 50 international experts and young researchers to discuss recent results and exchange ideas about future studies in low-energy QCD and particle astrophysics. The workshop showed that the field continues to have a promising future, with an ideal mix of young and expert theoreticians and experimentalists, understood items and deep puzzles in a range of topics.

A session dedicated to the LEANNIS Network in HadronPhysics2 in EU Framework Programme 7 focused on low-energy antikaon–nucleon/nucleus interaction studies. The perspectives in the field were discussed in the context of future EU programmes.

2011

LEANNIS in HadrinPhysics2 ended in December 2011



EXA 2011
International Conference Anthydrogen and Fundamental Symmetries
on Exotic Atoms and Related Topics
Kaon Nucleus and Kaon Nucleon Interactions
Future Facilities and Instrumentation
Hadron Physics with Antiprotons
Low-energy QCD

SEPTEMBER 5th - 9th, 2011
Austrian Academy of Sciences / Theatersaal /
Sonnenfelsgasse 19 / 1010 Wien / AUSTRIA

INTERNATIONAL ADVISORY COMMITTEE
S. Bertolucci, T.O. Ericson, A. Gal, C. Guaraldo, R. Hayano, P. Indelicato, K. Jungmann, P. Kienle, H. Koch, J. Marton, K. Nagamine, S. Nagamiya, S. Paul, H. Rauch, D. Schwalm, B. Shirkov, H. Stöcker, E. Widmann, U. Wiedner, T. Yamazaki, J. Zmeskal

LOCAL ORGANIZING COMMITTEE
F. Bies, R. Gerll, D. Hartmann, J. Marton, E. Widmann, J. Zmeskal
Stefan Meyer Institute for Subatomic Physics
Austrian Academy of Sciences
1090 Vienna, Boltzmanngasse 3

exa2011@oaw.ac.at - MAIL
<http://www.oaw.ac.at/smi/EXA> - WEB



J. Marton, Meeting, 19 June 2013



LEANNIS Meeting Heidelberg, Germany July 1st, 2011

LEANNIS Meeting/FOPI Collaboration Meeting / Programme

Friday 01 July 2011

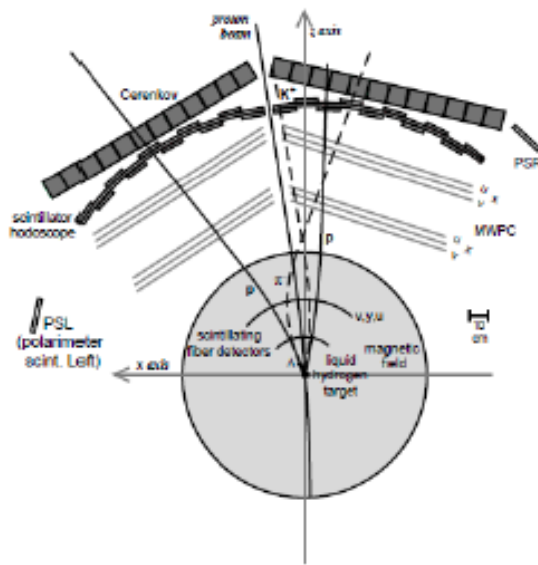
Friday 01 July 2011

FOPI Collaboration Meeting - Fakultätssaal, Villa Bergius (09:00-11:00)

time	title	presenter
09:00	Analysis meeting	
10:40	coffee break	

LEANNIS Meeting - Fakultätssaal, Villa Bergius (11:00-18:15)

time	title	presenter
11:00	Welcome and LEANNIS Status	MARTON, Johann
11:10	Production of Double- \square Antikaonic Dibaryon System, $K\bar{K}K\bar{K}N$, in p - p Collisions	TOSHI YAMAZAKI (RIKEN)
11:30	Status of the DISTO data analysis	PAUL KIENLE (EXCELLENCE CLUSTER UNIVERSE)
11:50	Status of the $pK\Lambda$ Analysis with HADES	EPPLÉ, Eliane
12:10	Status of COSY- \square TOF experiments - K - \square pp search	GILLITZER, Albrecht
12:30	lunch break	
14:00	KLOE data analysis and AMADEUS	OTON VAZQUEZ DOCE (LNF)
14:20	Low-energy $K\bar{K}N$ theory update with Siddharta constraints	WOLFRAM WEISE (TUM)
14:40	Heavy Ion Reactions	Prof. HERRMANN, Norbert
15:00	Status: Pion induced reactions with FOPI	HARTMANN, Olaf
15:15	$K0$ s in cold nuclear Matter	LAPIDUS, Kirill
15:35	break	
15:55	Λ -hypernuclear production: what we learned from the FINUDA results	CIEPLY, Ales
16:15	K^{\sim} - nuclear potentials in a coupled channel chiral model	MARÉŠ, Jiří
16:35	SIDDHARTA results on kaonic atom x - \square ray spectroscopy	TOMO ISHIWATARI (SMI)
16:55	Strong characteristics of kaonic deuterium	SHEVCHENKO, N.



Role of $\Lambda(1405)$ in the Formation of $X(K^-pp)$ revealed in $pp \rightarrow X+K^+$ at 2.50 GeV and 2.85 GeV

P. Kienle, M. Maggiora, K. Suzuki, T. Yamazaki
in behalf of the DISTO collaboration

Summary

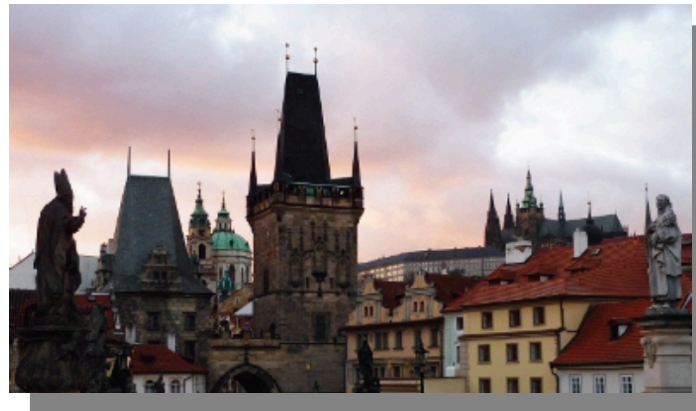
- In pp collisions the ratio of the production cross section for X(2265) $R_X^{\text{obs}} = \sigma_X(2.50)/\sigma_X(2.85) = 0.009 \pm 0.091$
- $R_X^{\text{expected}} = \sigma_X(2.50)/\sigma_X(2.85) \approx 0.33$
- $R_{\Lambda^*}^{\text{expected}} = \sigma_{\Lambda^*}(2.50)/\sigma_{\Lambda^*}(2.85) \approx 0.10 \Rightarrow \approx \text{exp. value}$
- High formation of X(2265) requires high Λ^* -p sticking probability which requires high Λ^* -p momentum available only at $T_p = 2.85$ GeV
- High momentum Λ^* in the entrance channel form the compact X(2265) in 2.85 GeV pp collisions
- This is additional evidence for the compactness of X(2265)

2012

With January 1st LEANNIS in HadronPhysics3 started

Kick-off Meeting - LEANNIS in HadronPhysics3

May 21 - 22, 2012, Prague





J. Marton, Meeting, 19 June 2013

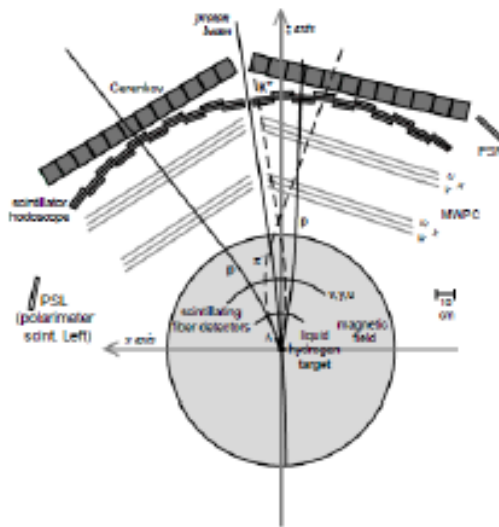
Monday, May 21		
9:00 - 9:15	Welcome local organizer, Curceanu, Marton	
9:15 - 9:45	J. Marton	The LEANNIS network in HADRONPHYSICS3
9:45 - 10:15	C. Curceanu	Low energy kaon-nucleon/nuclei experiments at DAFNE - SIDDHARTA and AMADEUS (an update)
10:15 - 10:45	coffee break	
10:45 - 11:15	J. Zmeskal	Measurement of kaonic deuterium with SIDDHARTA-2
11:15 - 11:45	T. Ishiwatari	Strong-interaction width of kaonic helium isotope
11:45 - 12:15	M. Cargnelli	Results and outlook of the kaonic hydrogen and deuterium experiments at DAFNE
12:15 - 14:00	lunch	
14:00 - 14:30	E. Friedman	Kaonic atoms update
14:30 - 15:00	N. Shevchenko	Near-threshold K^{Λ} -d scattering and properties of kaonic deuterium
15:00 - 15:30	S. Wycech	On the question of widths
15:30 - 16:00	coffee break	
16:00 - 16:30	A. Cieply	On the origin and movement of the poles in the coupled channels model for $K\bar{K}N$ interactions
16:30 - 17:00	Discussion	

Tuesday, May 22		
9:00 - 9:30	P. Kienle	Results from DISTO
9:30 - 10:00	A. Ivanov	Energy level displacement of excited np states of kaonic deuterium in Faddeev equation approach
10:00 - 10:30	N. Barnea	Theoretical studies of $K\bar{K}n$, $K\bar{K}N$, and $K\bar{K}NN$ systems
10:30 - 11:00	coffee break	
11:00 - 11:30	O. Hartmann	News from FOPI data
11:30 - 12:00	R. Muenzer	Status of the analysis of the p+p beamtime at FOPI
12:00 - 12:30	E. Epple	A way to a ppK^{Λ} - analysis for HADES
12:30 - 14:00	lunch	
14:00 - 14:30	K. Lapidus	Search for cold nuclear matter effects with neutral kaons
14:30 - 15:00	A. Gal	Superheavy hydrogen $6H\Lambda$
15:00 - 15:30	coffee break	
15:30 - 16:00	C. Guaraldo	Horizon 2020 and other EU opportunities
16:00 - 17:00	Discussion Closing	

Talks on experiments and theoretical studies
equally sharing the research field of LEANNIS



J. Marton, Meeting, 19 June 2013



DISTO Analyses of $X(2265)$; $S = -1$, $N^*(1710)$, and $\Sigma^0 p$ -Puzzle, Populated in $pp \rightarrow p \Lambda K^+$ Reactions

P. Kienle, M. Maggiora, K. Suzuki, T. Yamazaki
in behalf of the DISTO collaboration

Indication of a Deeply Bound and Compact $K^- pp$ State Formed
in the $pp \rightarrow p\Lambda K^+$ Reaction at 2.85 GeV

T. Yamazaki,^{1,2} M. Maggiora,³ P. Kienle,^{4,5} K. Suzuki,⁴ *et al.*

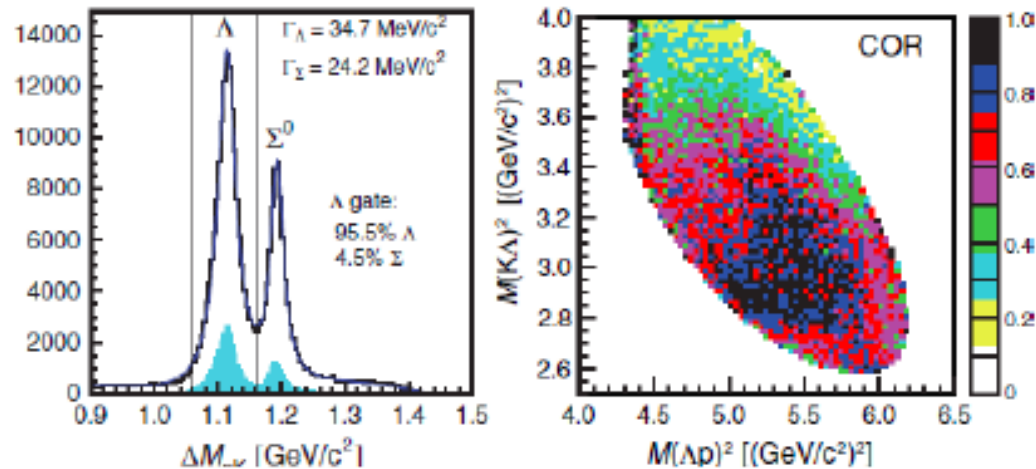
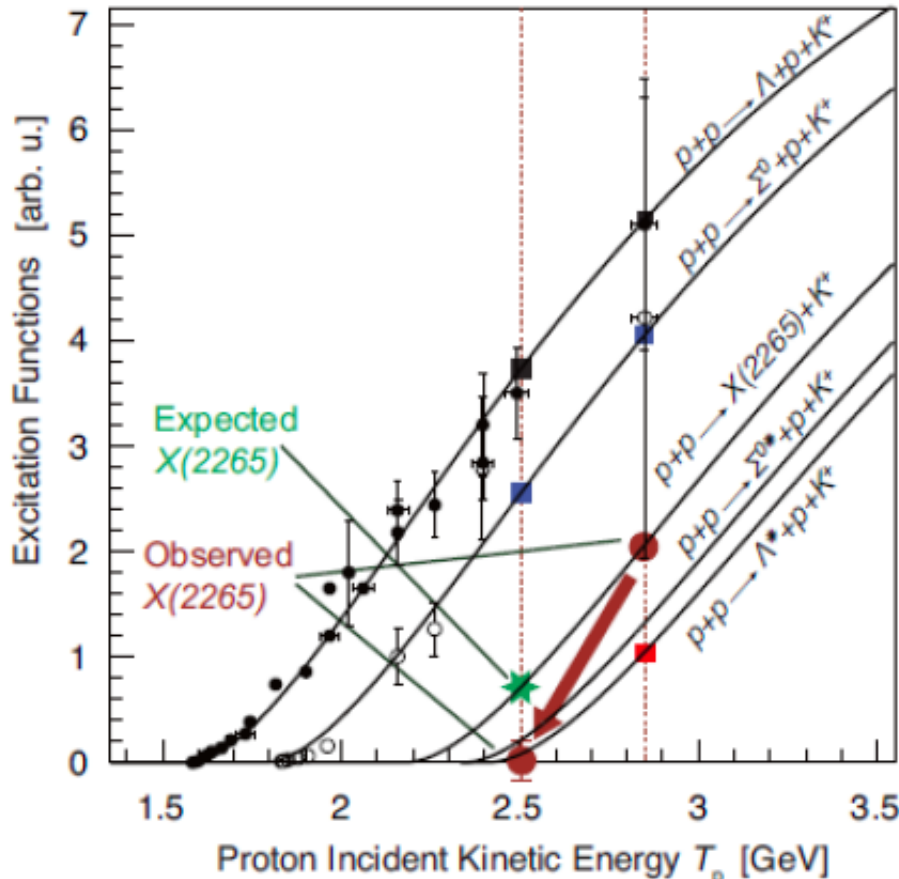


FIG. 1 (color). (Left) A $\Delta M(pK^+)$ spectrum of raw data after the kinematically constrained refit, acceptance uncorrected; the small shaded histogram includes events after p and K^+ cuts applied to obtain final spectra. (Right) An acceptance-corrected Dalitz plot of the exclusive $pp \rightarrow p\Lambda K^+$ reaction products at 2.85 GeV.

LEANNIS, 22.Mai 2012, Prag P.Kienle

Energy Dependence of Reaction Cross Sections



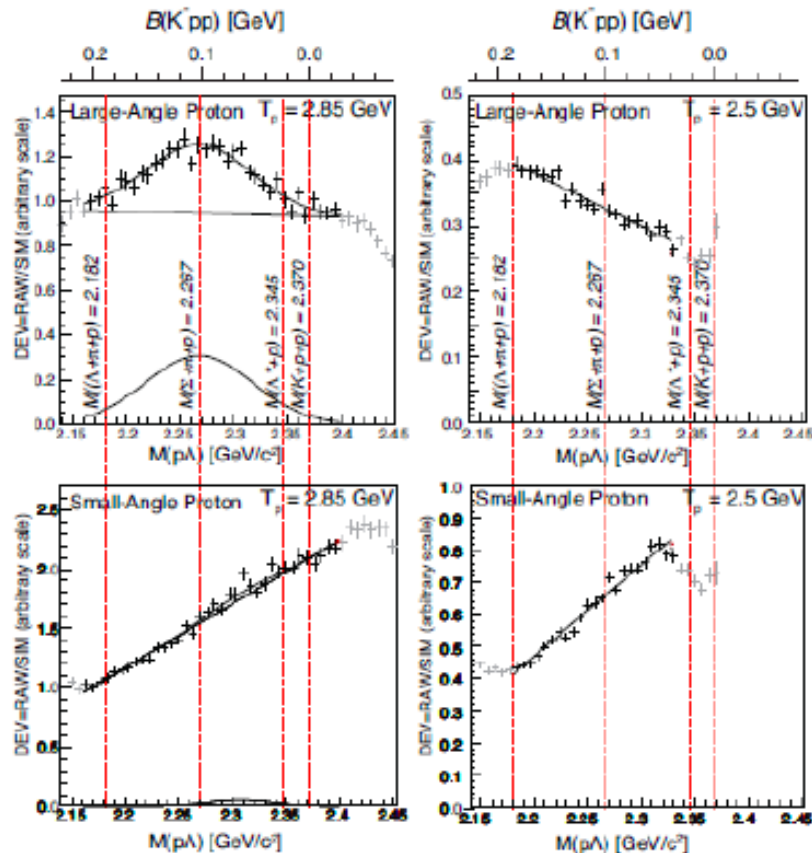
$$R_X^{\text{expected}} = \frac{\sigma_X(2.50)}{\sigma_X(2.85)} \approx 0.33,$$

$$R_X(\text{obs}) = 0.009 \pm 0.091$$

Note: The observed drop of the cross section for X(2265) from 2.85 GeV to 2.50 GeV is 3-times than expected for the other strangeness production reactions

$$\sigma(s) = C \sigma_0 \times \left(1 - \frac{s_0}{s}\right)^\alpha \times \left(\frac{s_0}{s}\right)^\beta$$

Invariant Mass $M(p\Lambda)$ Deviation Spectra at 2.85 GeV and 2.50 GeV Incident Energy



$$DEV^{(\alpha)} = RAW^{(\alpha)} / SIM^{(\alpha)}.$$

$$Y_X(T_p) = \frac{\text{Peak intensity in } DEV}{\text{BG intensity in } DEV},$$

$$Y_X(2.85) = 0.168 \pm 0.010, \quad Y_X(2.50) = 0.002 \pm 0.021.$$

$$\frac{Y_X(2.50)}{Y_X(2.85)} = 0.012 \pm 0.125.$$

$$R_X^{\text{obs}} = \frac{\sigma_X(2.50)}{\sigma_X(2.85)} = \frac{Y_X(2.50)}{Y_X(2.85)} \times \frac{\sigma_{p\Lambda K}(2.50)}{\sigma_{p\Lambda K}(2.85)} = 0.009 \pm 0.091,$$

$$R_X^{\text{expected}} = \frac{\sigma_X(2.50)}{\sigma_X(2.85)} \approx 0.33,$$

- Paul contributed in many respects to LEANNIS
- His activities in physics and his strong will to clarify mysteries in subatomic (hadron) physics was outstanding
- Some topics at frontier science were subject to controversial discussions
- In lively discussions (quite often) he was a bastion of calm
- Last but not least Paul was not only a brilliant physicist and expert in many fields – he had a distinct human sense which we miss badly.



9 EPILOG

Wenn es Rosen sind werden sie blühen.

P.K. from EXA05 Proceedings: **Se son' rose, fioriranno!**



Thank you Paul for all you have done for
LEANNIS and our community
in deep gratitude

Thank you for your attention