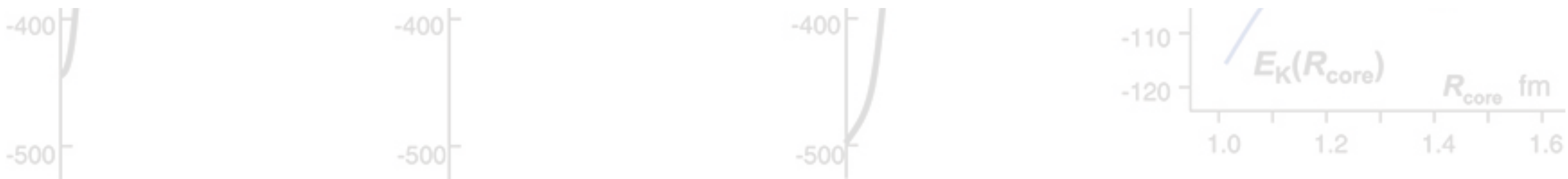


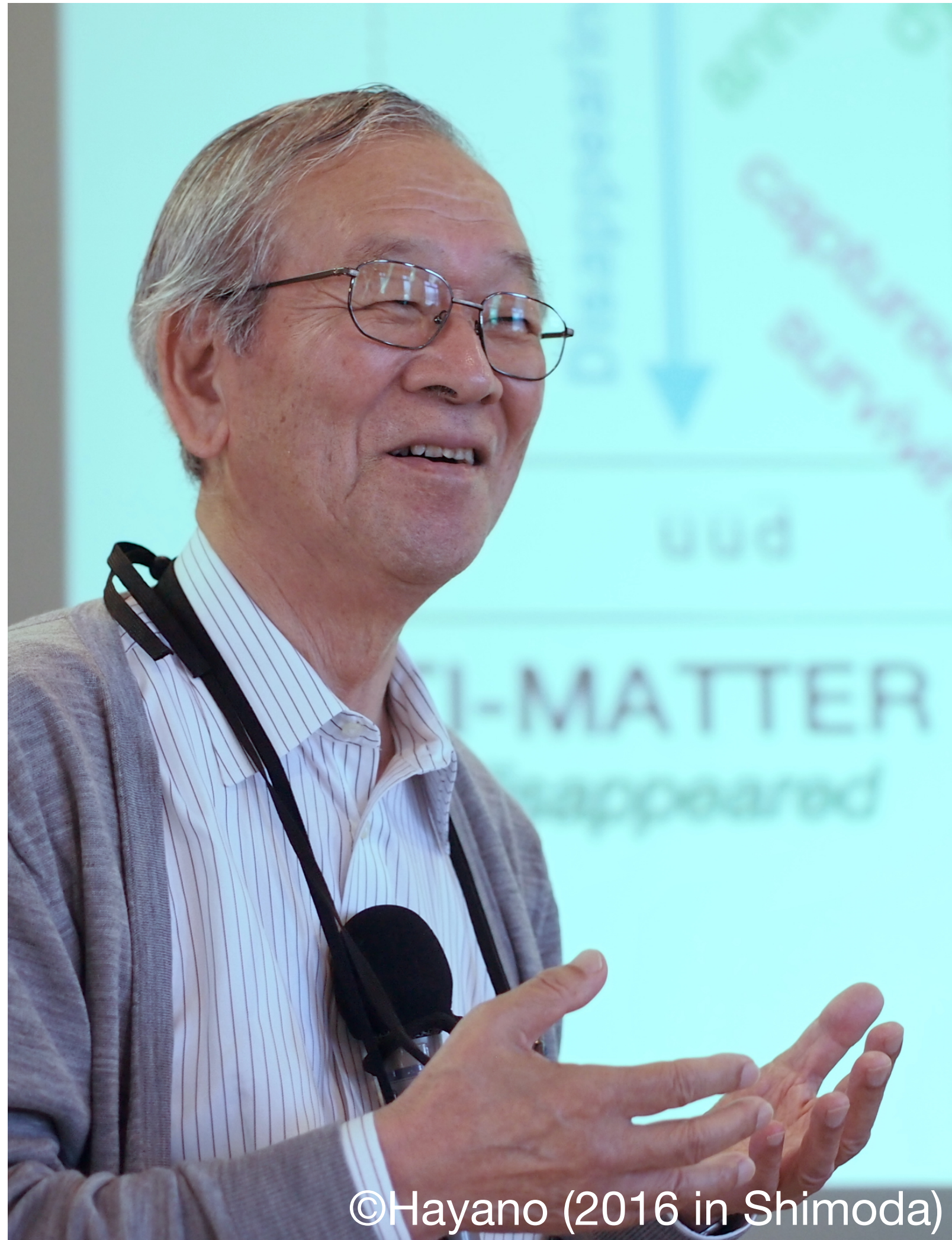
Toshi YAMAZAKI - A Legacy of Bold Ideas in Hypernuclear & Strange Particle Physics

1.6



Ryugo HAYANO, The University of Tokyo

In Memoriam

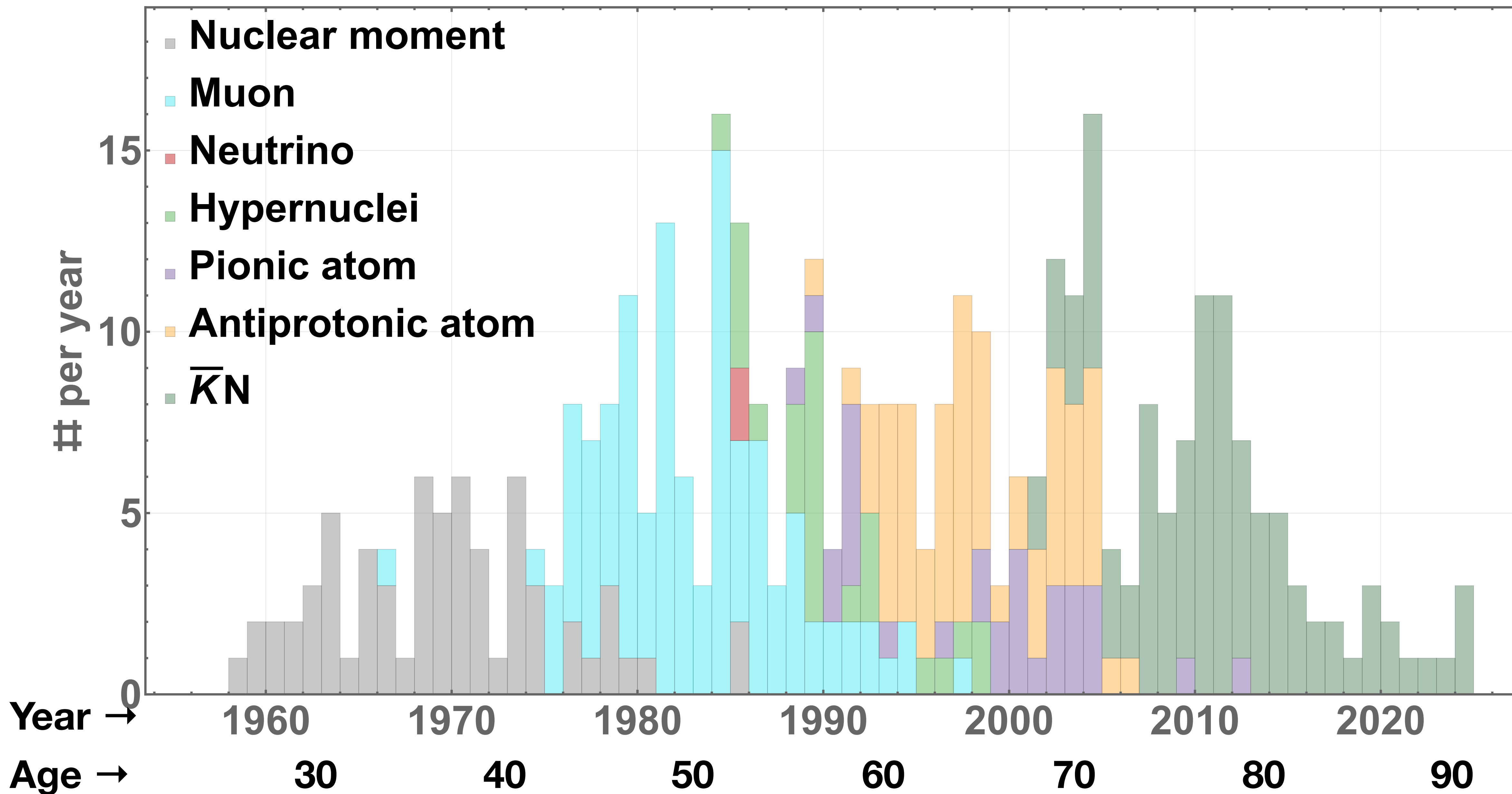


Toshi YAMAZAKI
Jan 31, 2025 (aged 90)



Yoshinori AKAISHI
Sep 3, 2025 (aged 85)

Toshi's 400+ papers across 7+ fields



Age →

30

40

50

60

70

80

90

$\bar{K}N$

Pionic nuclei

Antiprotonic atom

Hypernuclei

Muon

ν

Nuclear Moment

← INS Director →

Year →

1960

1970

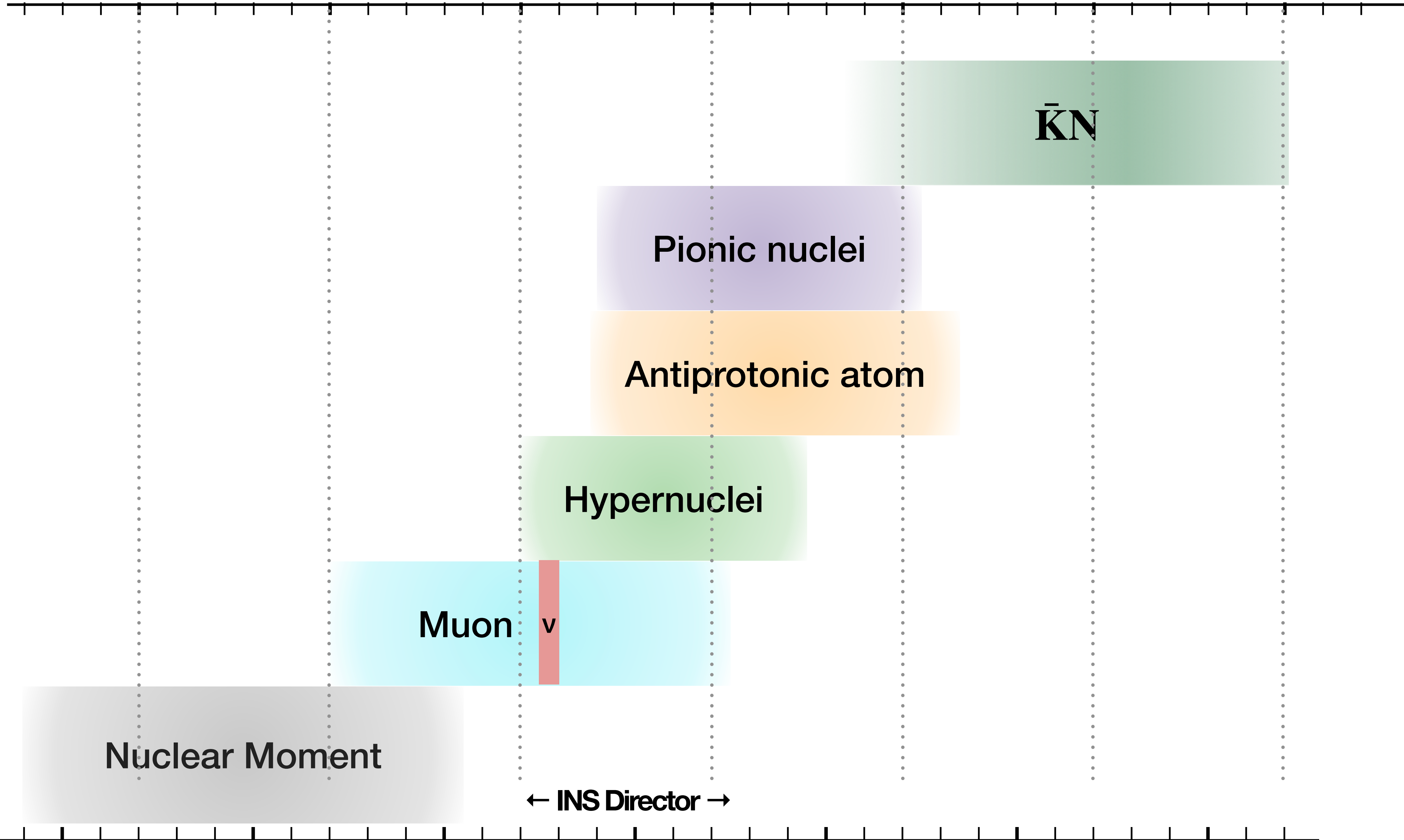
1980

1990

2000

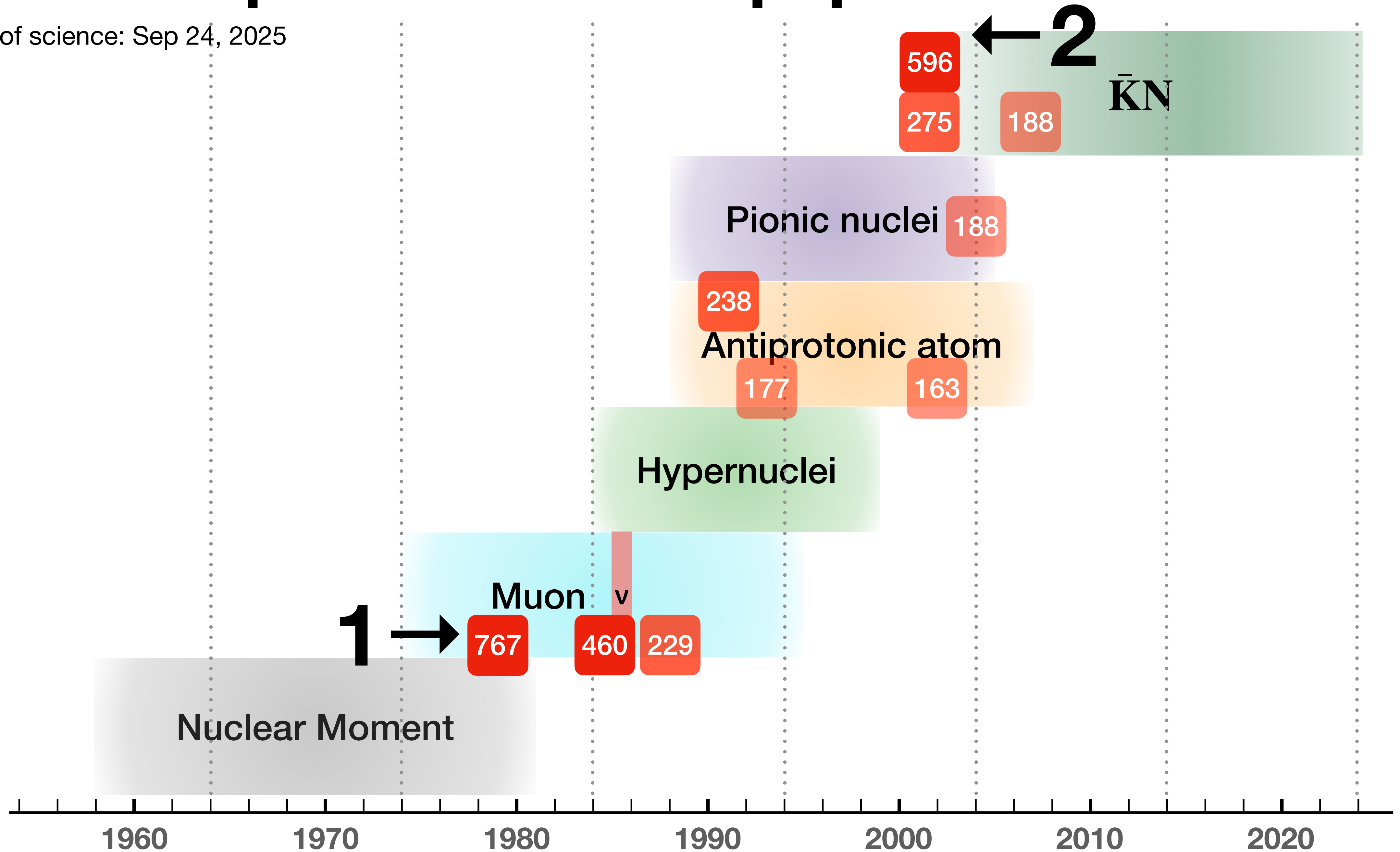
2010

2020

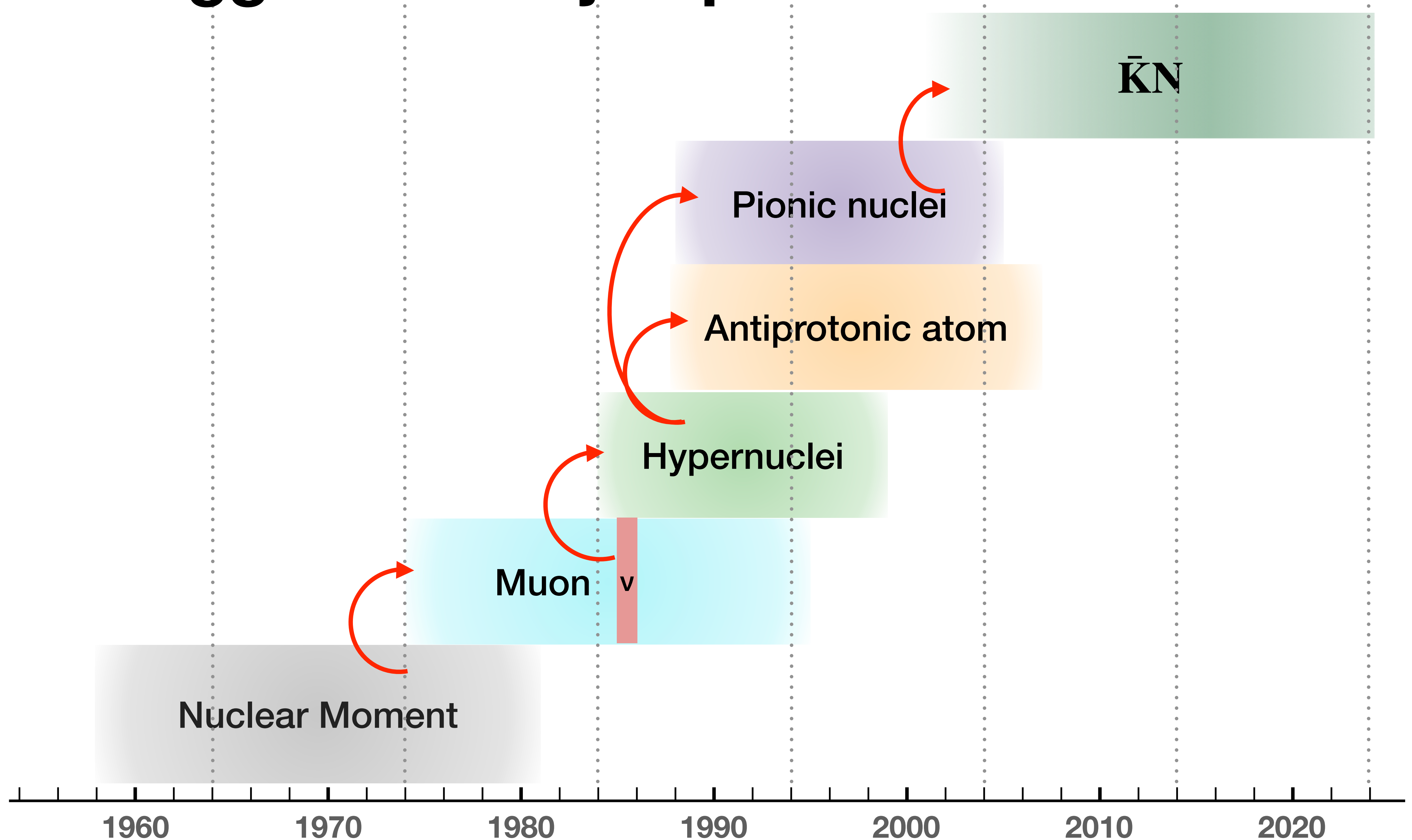


Toshi's Top 10 most cited papers

Web of science: Sep 24, 2025



What triggered the "jumps"?



Let me try to explain as best I can.

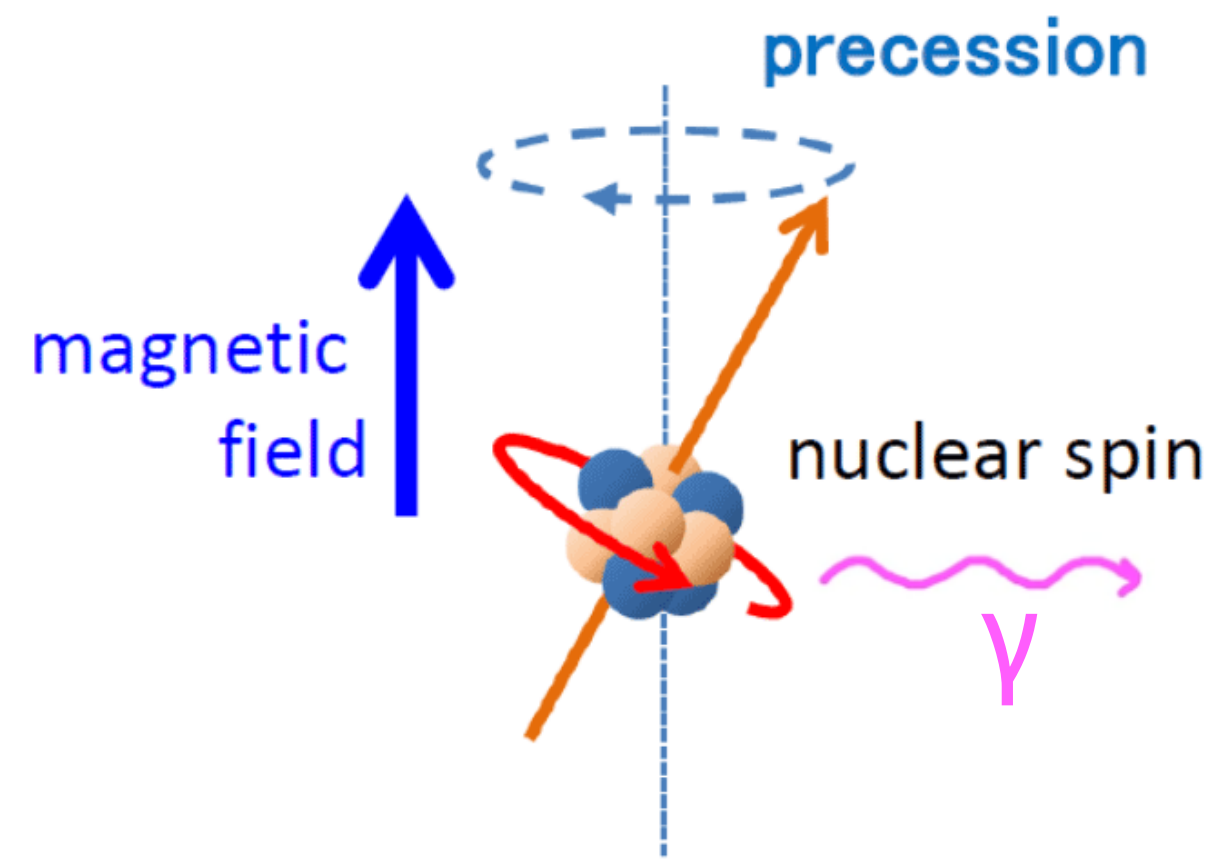
Nuclear Moment

@ RIKEN (~1970): Pioneering PAD Experiment

† Perturbed angular distribution

Discovery: proton orbital **g-factor**
 $g_{\ell}^{\text{eff}} = 1.09 \pm 0.02$ (pionic effect)

Miyazawa



1970

PHYSICAL REVIEW LETTERS

2

ANOMALOUS ORBITAL MAGNETISM OF PROTON DEDUCED FROM
THE MAGNETIC MOMENT OF THE 11^- STATE OF $^{210}\text{Po}^\dagger$

T. Yamazaki and T. Nomura

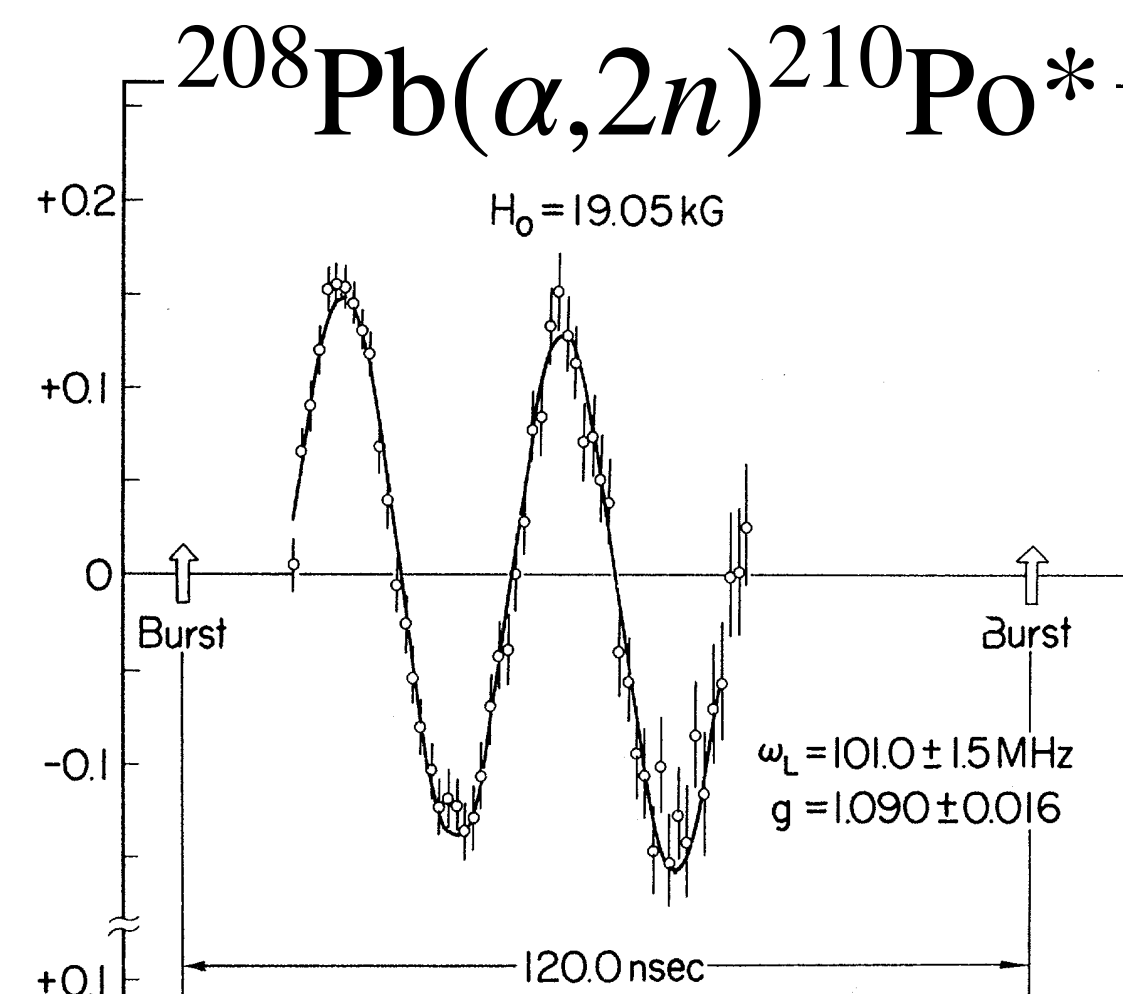
Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo, Japan,
The Institute of Physical and Chemical Research, Yamato-machi, Saitama-Ken, Japan

and

S. Nagamiya* and T. Katou

The Institute of Physical and Chemical Research, Yamato-machi, Saitama-Ken, Japan
(Received 1 June 1970)

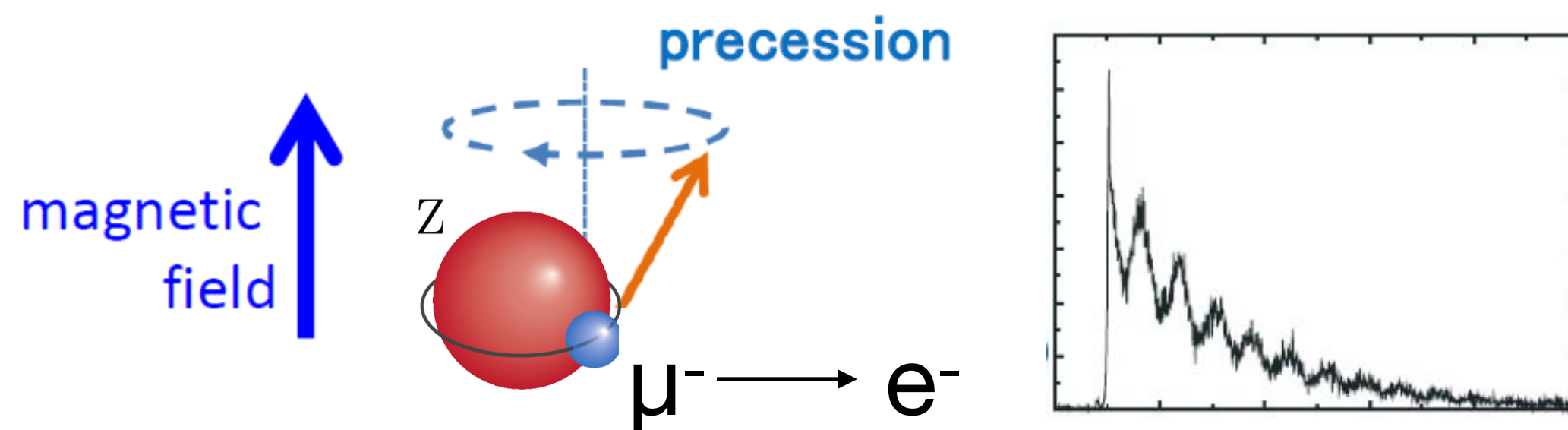
Nishina Memorial Prize



1. Nuclear Moment — Early 70s → Muon

💡 μ^- bound to a nucleus → $\mu\text{SR}^{\dagger\dagger}$
 †† muon spin rotation

- μ^- -A **g-factor** (relativistic effect)
 - Solid-state physics applications
- To **LBL** (184" cyclotron)



umber 1

1974 @ LBL: bound μ^- g-factor¹

RELATIVISTIC EFFECT ON MAGNETIC MOMENTS OF NEGATIVE MUONS BOUND TO HIGH-Z NUCLEI[☆]

T. YAMAZAKI, S. NAGAMIYA, O. HASHIMOTO, K. NAGAMINE and K. NAKAI
Department of Physics, Faculty of Science, University of Tokyo, Bunkyo-ku, Tokyo, 113, Japan

K. SUGIMOTO
Department of Physics, Faculty of Science, Osaka University, Toyonaka, Osaka 560, Japan

and

K.M. CROWE
Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720, USA

Received 5 September 1974

→ TRIUMF

My thesis 1979

Zero- and low-field spin relaxation studied by positive muons

R. S. Hayano, Y. J. Uemura, J. Imazato, N. Nishida, T. Yamazaki, and R. Kubo

Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo, Japan

and TRIUMF, Vancouver, Canada

(Received 27 February 1979)

- Zero-field μ^+ SR method invented
- Ideal for studying magnetic phase transitions
- Applied to spin glass, high-T_c superconductors, etc.
- Still widely cited today

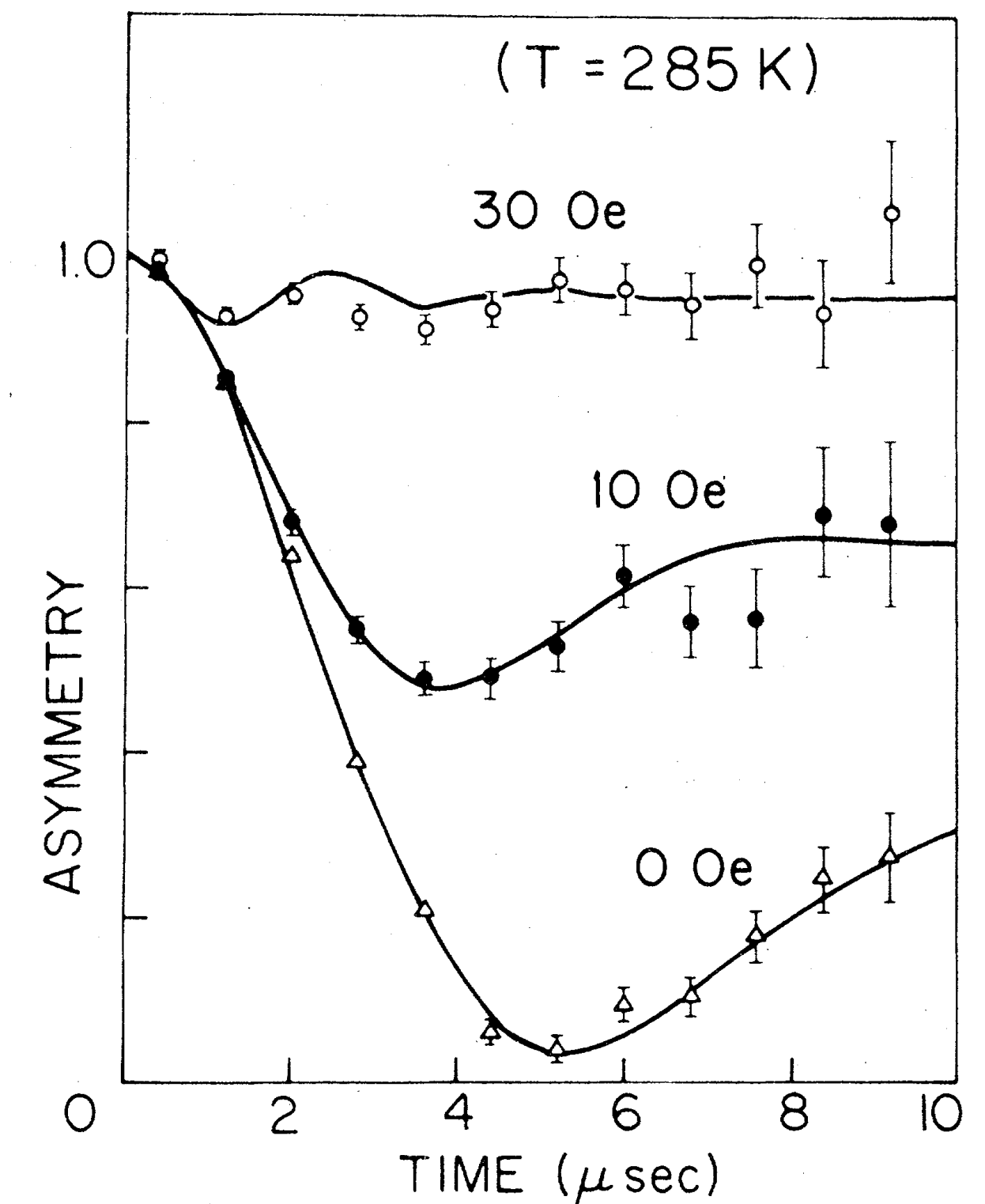


FIG. 2. Observed μ^+ longitudinal relaxation functions in MnSi at room temperature with 0, 10, and 30 Oe external fields. The solid curves are the best fits to Eq. (10).

2. Muon $\rightarrow$ ν mid 80s $\rightarrow$ Hypernuclei

- LBL: no μ -Pd spin precession
 $\rightarrow$ puzzling
- LAMPF: μ -Pd X-ray circular polarization

1977 @ LAMPF: μ -Pd X-ray circular polarization observed

5 DECEMBER 1977

Circular Polarization of Muonic X Rays and Origin of Strange μ^- Depolarization in Pd Metal

T. Yamazaki, R. S. Hayano, J. Imazato, and K. Negamine
Department of Physics, University of Tokyo, Bunkyo-ku, Tokyo, Japan

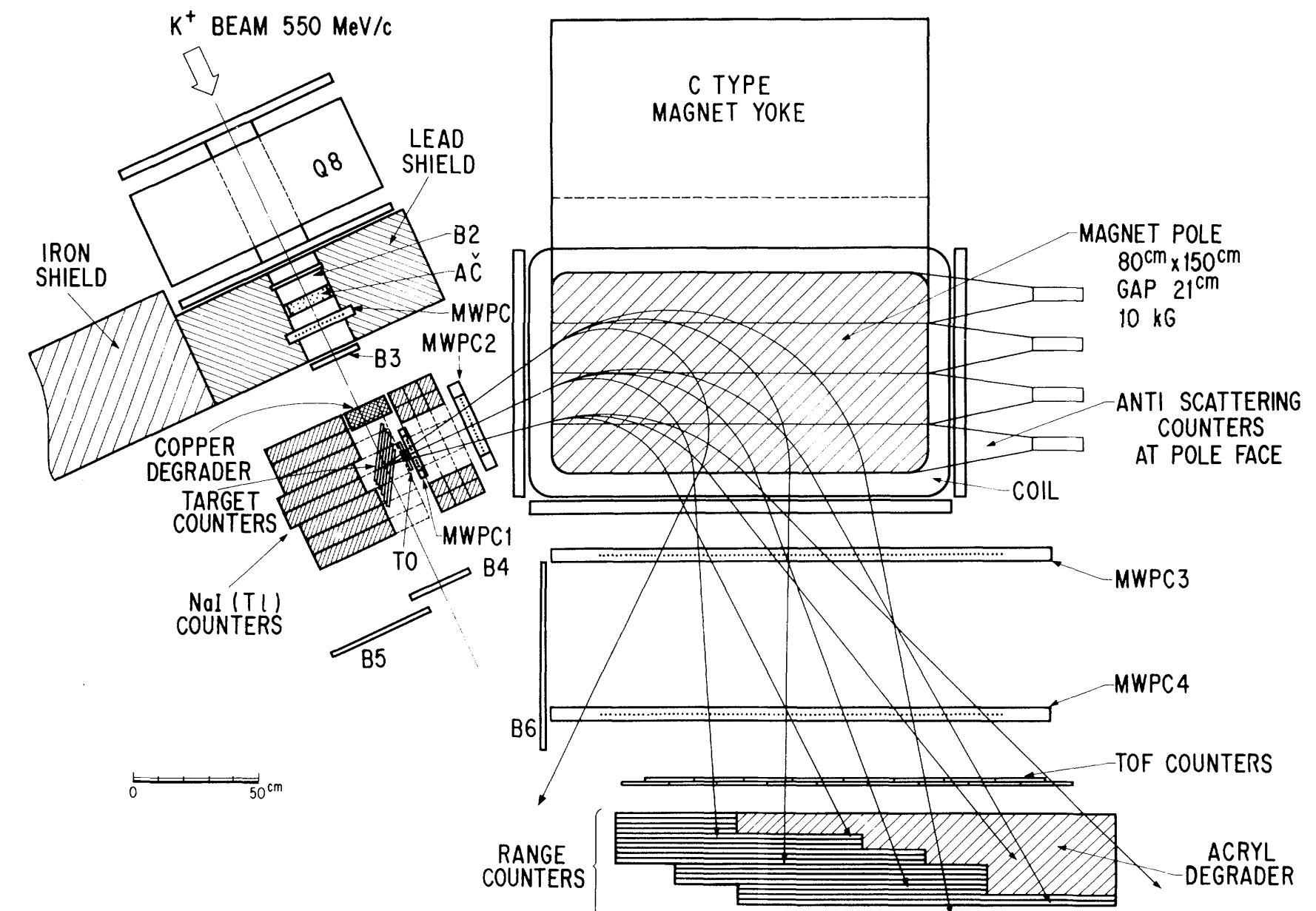
2. Muon ν mid 80s $\rightarrow$ Hypernuclei

- LBL: no μ -Pd spin precession
 $\rightarrow$ puzzling
- LAMPF: μ -Pd X-ray circular polarization $\rightarrow$ anomaly traced to 1s state
- SUNY: Schrock's questions $\rightarrow$ Toshi's first hears of the (then-hot) heavy- ν problem

$$\left| \nu_{\mu} \right\rangle = \sum_{i=1}^3 U_{\mu i} \left| \nu_i \right\rangle, \quad (m_{\nu_3} \gtrsim \sim 10 \text{MeV}/c^2??)$$

2. Muon $\rightarrow$ ν mid 80s $\rightarrow$ Hypernuclei

- KEK: $K^+ \rightarrow \mu^+ \nu$ (μ momentum measured); extra peak expected if heavy ν



1982 @ KEK: Heavy- ν search $\rightarrow$ no extra peak

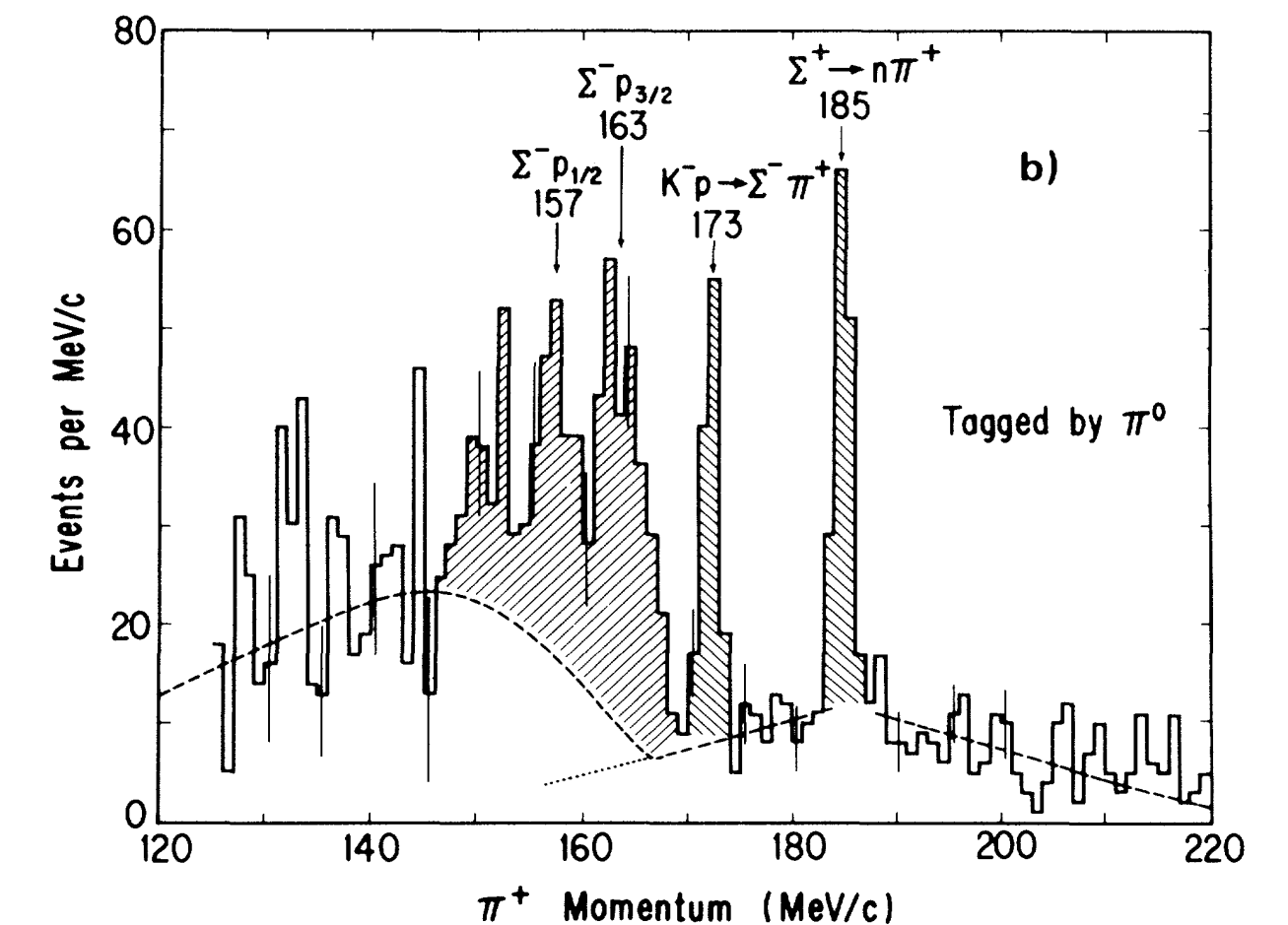
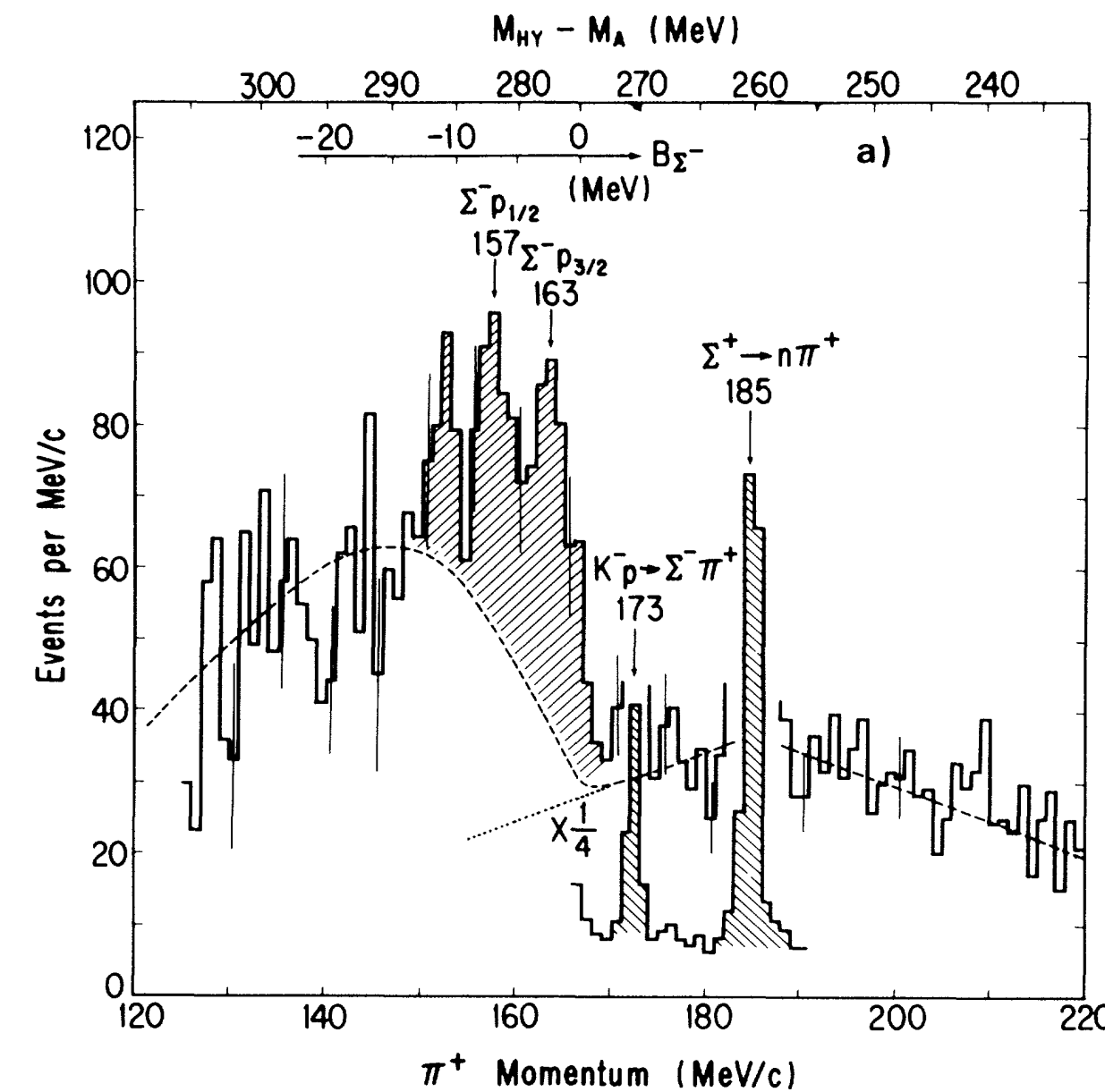
Heavy-Neutrino Search Using $K_{\mu 2}$ Decay

R. S. Hayano, T. Taniguchi, T. Yamanaka, T. Tanimori, R. Enomoto, A. Ishibashi,
T. Ishikawa, S. Sato, T. Fujii, and T. Yamazaki

*Department of Physics and Meson Science Laboratory, Faculty of Science, University of Tokyo, Bunkyo-ku,
Tojyo 113, Japan*

2. Muon $\rightarrow$ ν mid 80s $\rightarrow$ Hypernuclei

- Last day: try K^-
 - $\rightarrow$ excitement
 - $\rightarrow$ Povh's group invited



1985 @ KEK: doorway to hypernuclei but peaks were **illusory**

14 JANUARY 1985

Formation of $A = 12 \Sigma^-$ Hypernucleus from K^- Absorption at Rest; Observation of a Σ^- Spin-Orbit Doublet of Narrow Widths

T. Yamazaki, T. Ishikawa, K. H. Tanaka, Y. Akiba, M. Iwasaki, S. Ohtake,
H. Tamura, M. Nakajima, and T. Yamanaka

Department of Physics and Meson Science Laboratory, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113, Japan

Akaishi-sensei

HYP1988, Padua: Possible light Σ hypernuclei

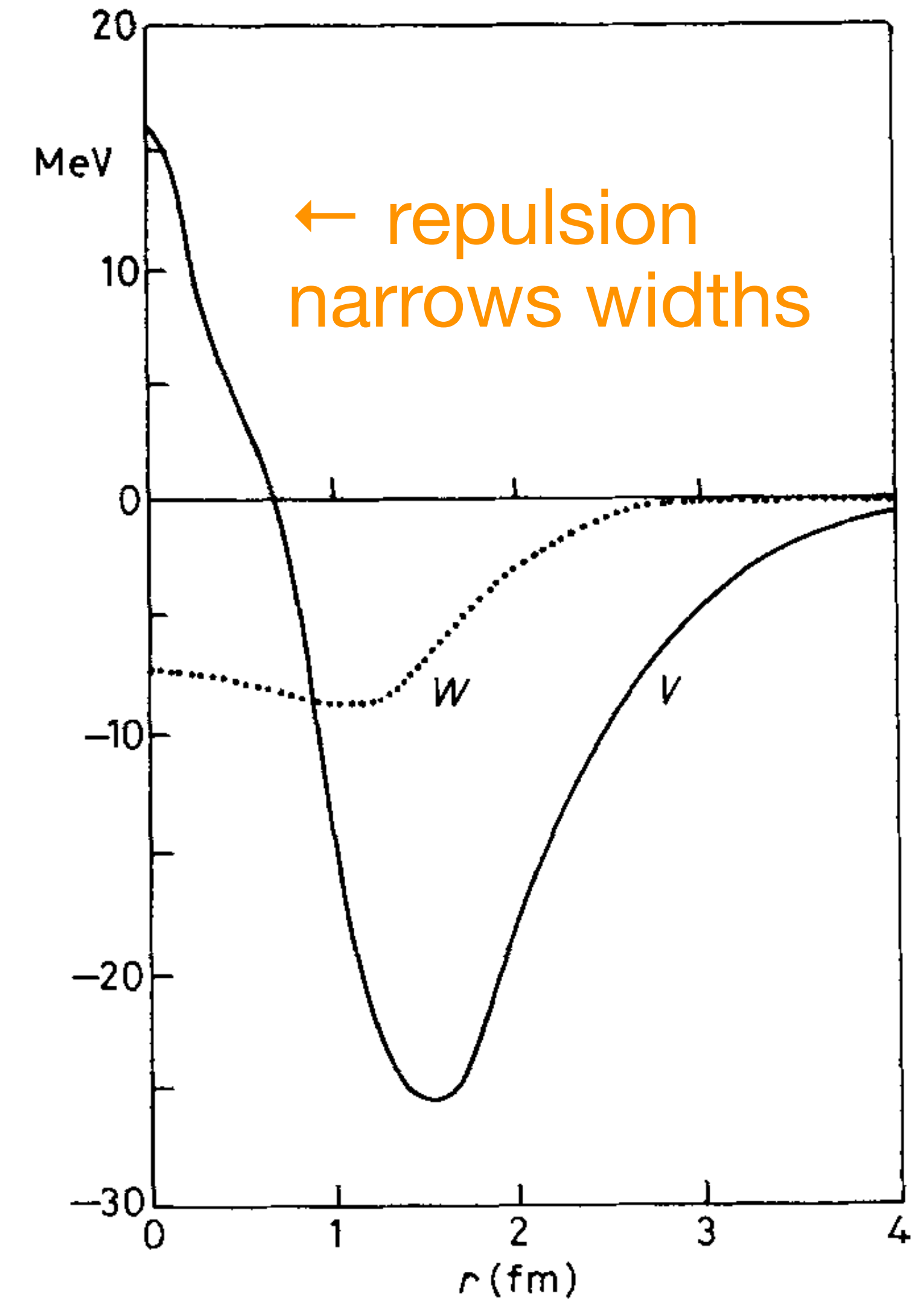
Possible Existence of Light Σ Hypernuclei (*)().**

Harada, **Akaishi** et al.

${}^4_{\Sigma}\text{He}$ (${}^4_{\Sigma}\text{H}$) with $I = 1/2$ and $S = 0$

* * *

The authors would like to thank Profs. T. Yamazaki and H. Bandō for valuable and helpful discussions.



KEK 1989: ${}^4\text{He}(\text{stopped } K^-, \pi^-) \rightarrow {}^4_\Sigma\text{He}$ bound state

EVIDENCE FOR A BOUND STATE OF THE ${}^4_\Sigma\text{He}$ HYPERNUCLEUS

R.S. HAYANO, T. ISHIKAWA, M. IWASAKI, H. OUTA, E. TAKADA, H. TAMURA

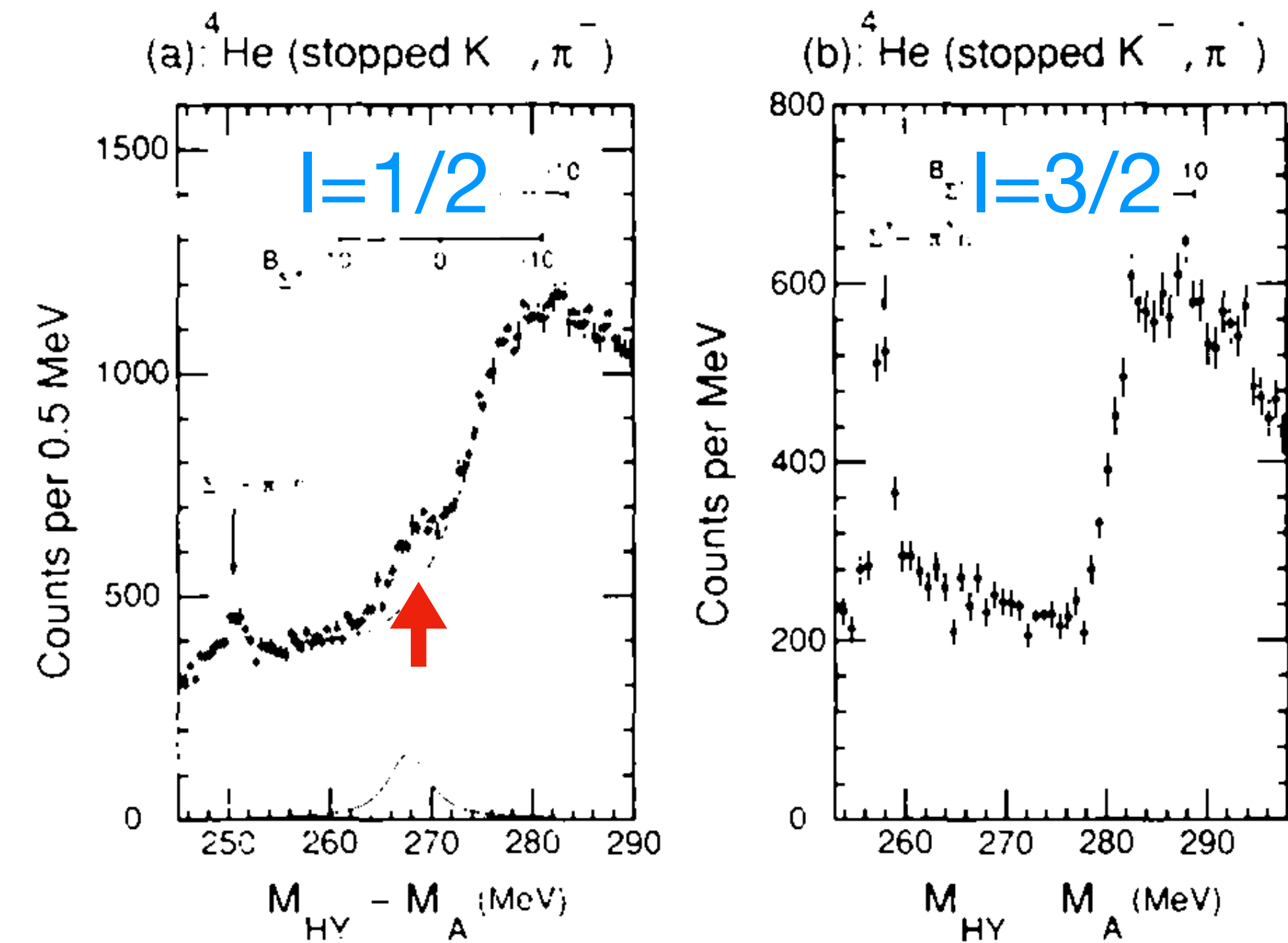
Department of Physics and Meson Science Laboratory, Faculty of Science, University of Tokyo, Tokyo 113, Japan

A. SAKAGUCHI

Department of Physics, Faculty of Science, Hiroshima University, Hiroshima 730, Japan

M. AOKI and T. YAMAZAKI

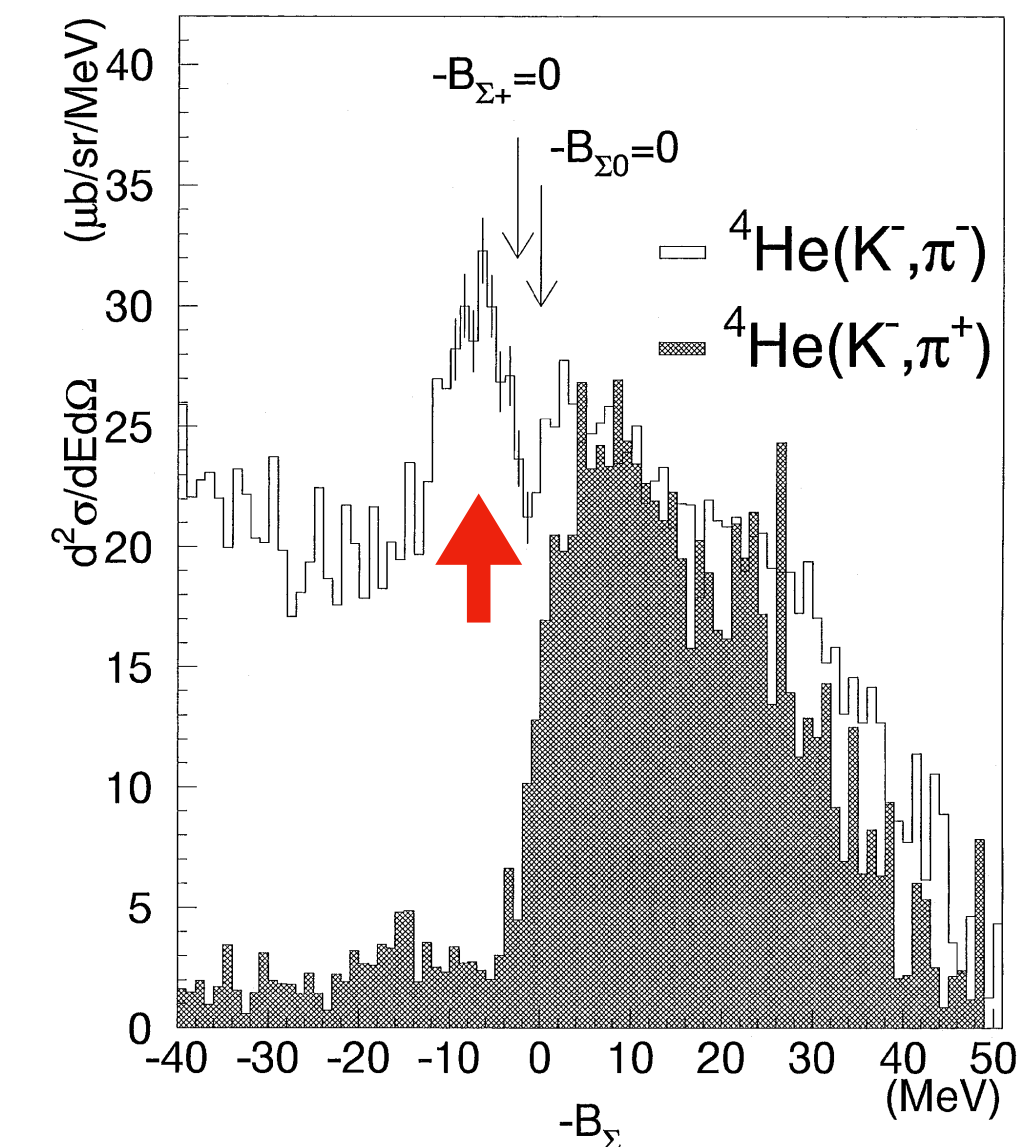
Institute for Nuclear Study, University of Tokyo, Tanashi, Tokyo 188, Japan



BNL 1998: ${}^4_\Sigma\text{He}$ confirmed (recoilless)

Nagae, Chrien, Hungerford et al.

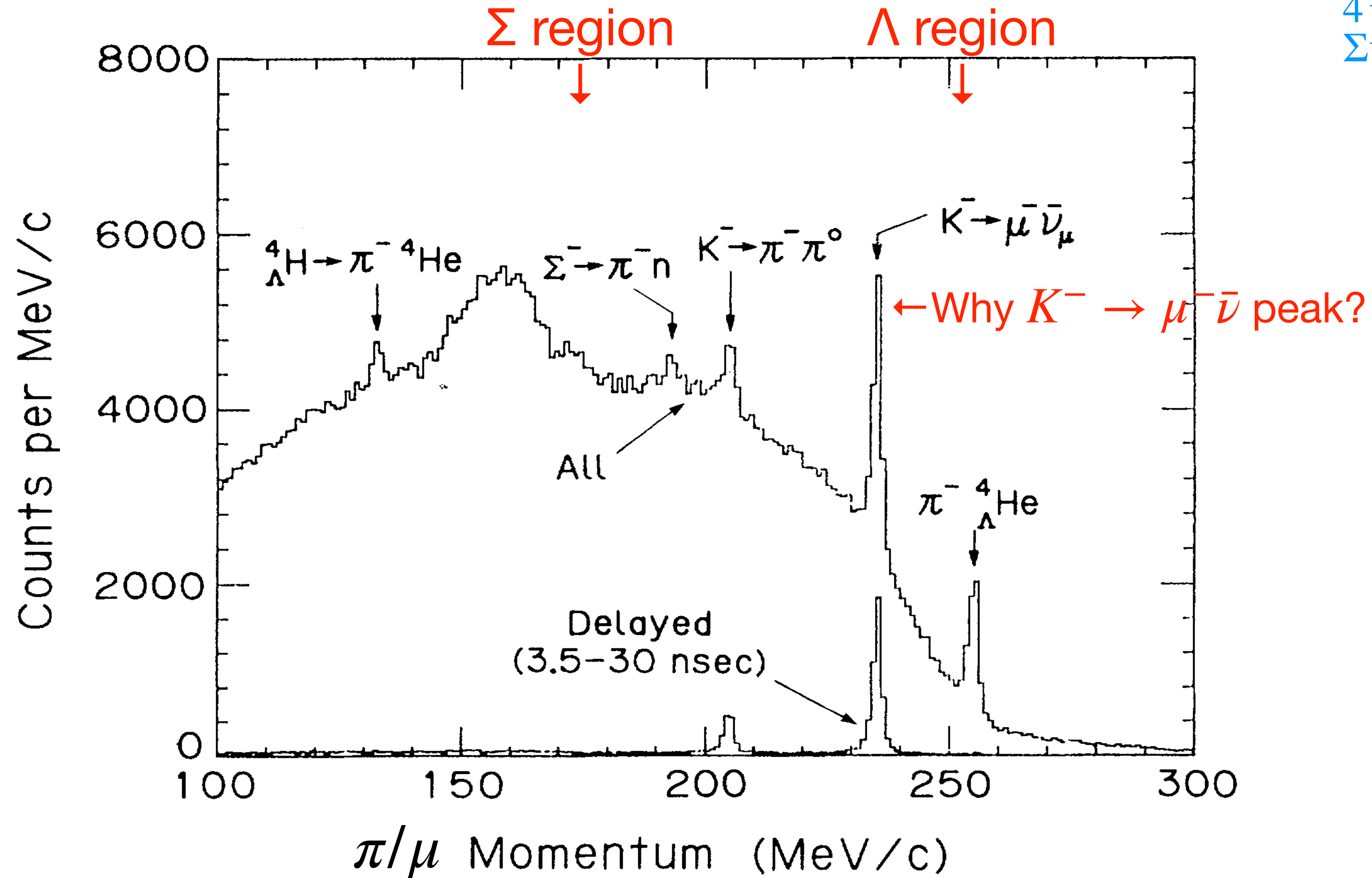
Observation of a ${}^4_\Sigma\text{He}$ Bound State in the ${}^4\text{He}(K^-, \pi^-)$ Reaction at 600 MeV/c



3.

Hypernuclei — Late 80s —> Antiprotonic atom

Byproduct of ${}^4_\Sigma\text{He}$ search



3. Hypernuclei — Late 80s → Antiprotonic atom

KEK 1989: serendipitous discovery of K^- "trapping"

Trapping of Negative Kaons by Metastable States during the Atomic Cascade in Liquid Helium

T. Yamazaki and M. Aoki

Institute for Nuclear Study, University of Tokyo, Tokyo 188, Japan

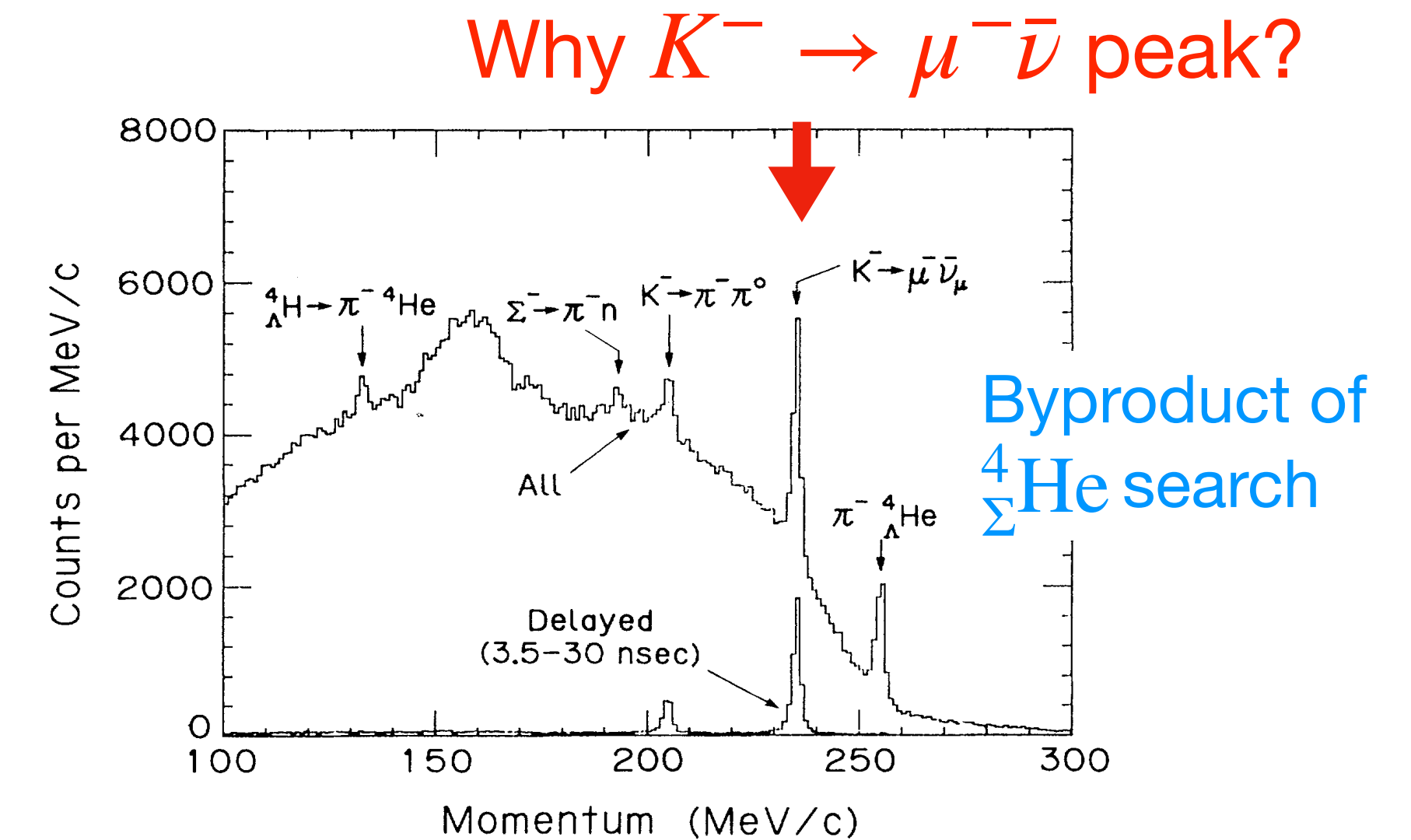
M. Iwasaki, R. S. Hayano, T. Ishikawa, H. Outa, E. Takada, and H. Tamura

Department of Physics and Meson Science Laboratory, Faculty of Science, University of Tokyo, Tokyo 113, Japan

A. Sakaguchi

Department of Physics, Faculty of Science, Hiroshima University, Hiroshima 730, Japan

(Received 5 July 1989)



KEK 1991: $\bar{p}\text{He}$ found REVIEW LETTERS 2 SEPTEMBER 1991

Discovery of Antiproton Trapping by Long-Lived Metastable States in Liquid Helium

M. Iwasaki, S. N. Nakamura, K. Shigaki, Y. Shimizu, H. Tamura, T. Ishikawa, and R. S. Hayano

Department of Physics and Meson Science Laboratory, Faculty of Science, University of Tokyo, Tokyo 113, Japan

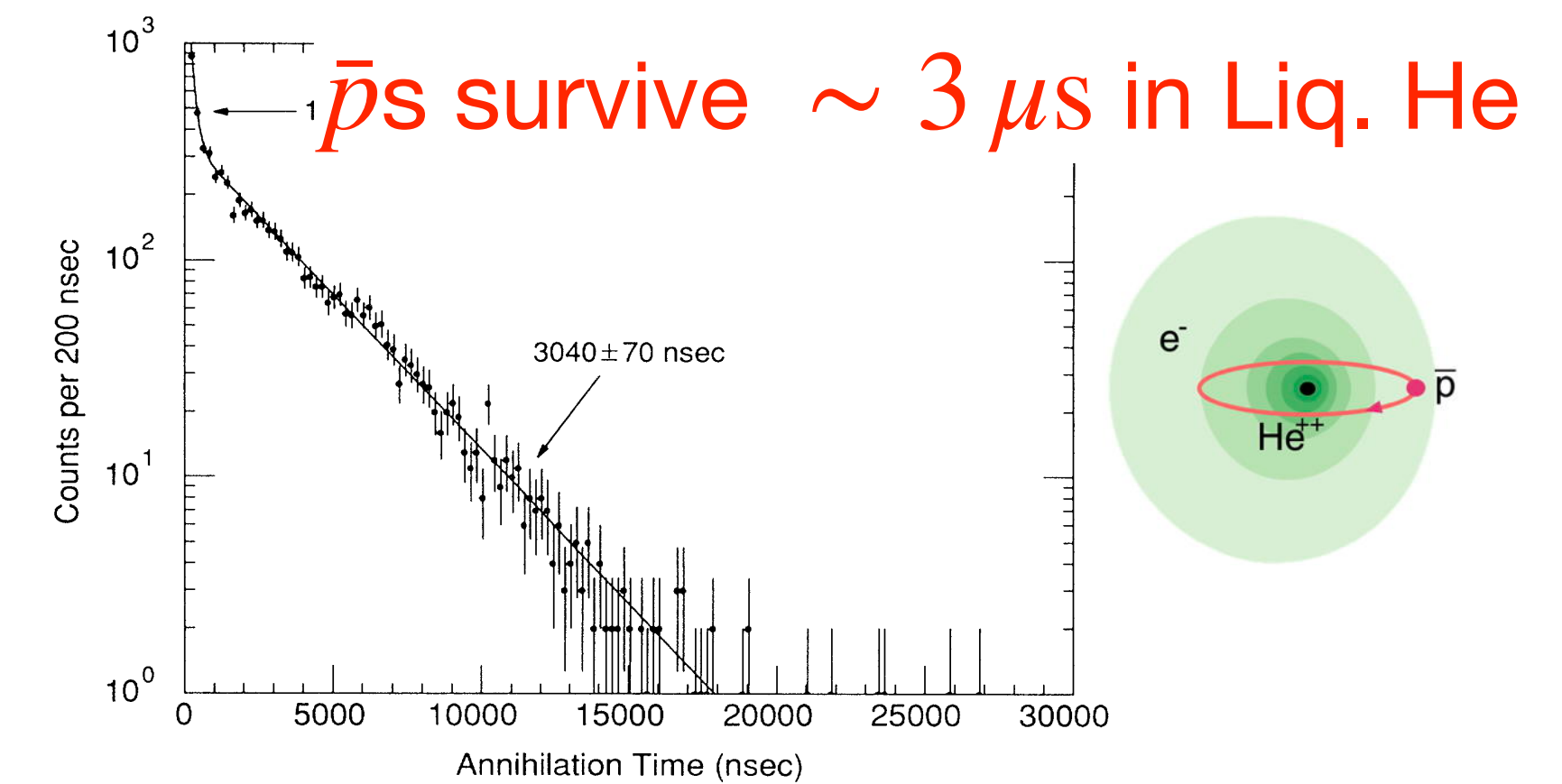
E. Takada

National Institute of Radiological Sciences, Chiba 260, Japan

E. Widmann, H. Outa, M. Aoki, P. Kitching,^(a) and T. Yamazaki

Institute for Nuclear Study, University of Tokyo, Tokyo 188, Japan

(Received 20 May 1991)



→ CERN

3. Hypernuclei — Late 80s → Antiprotonic atom

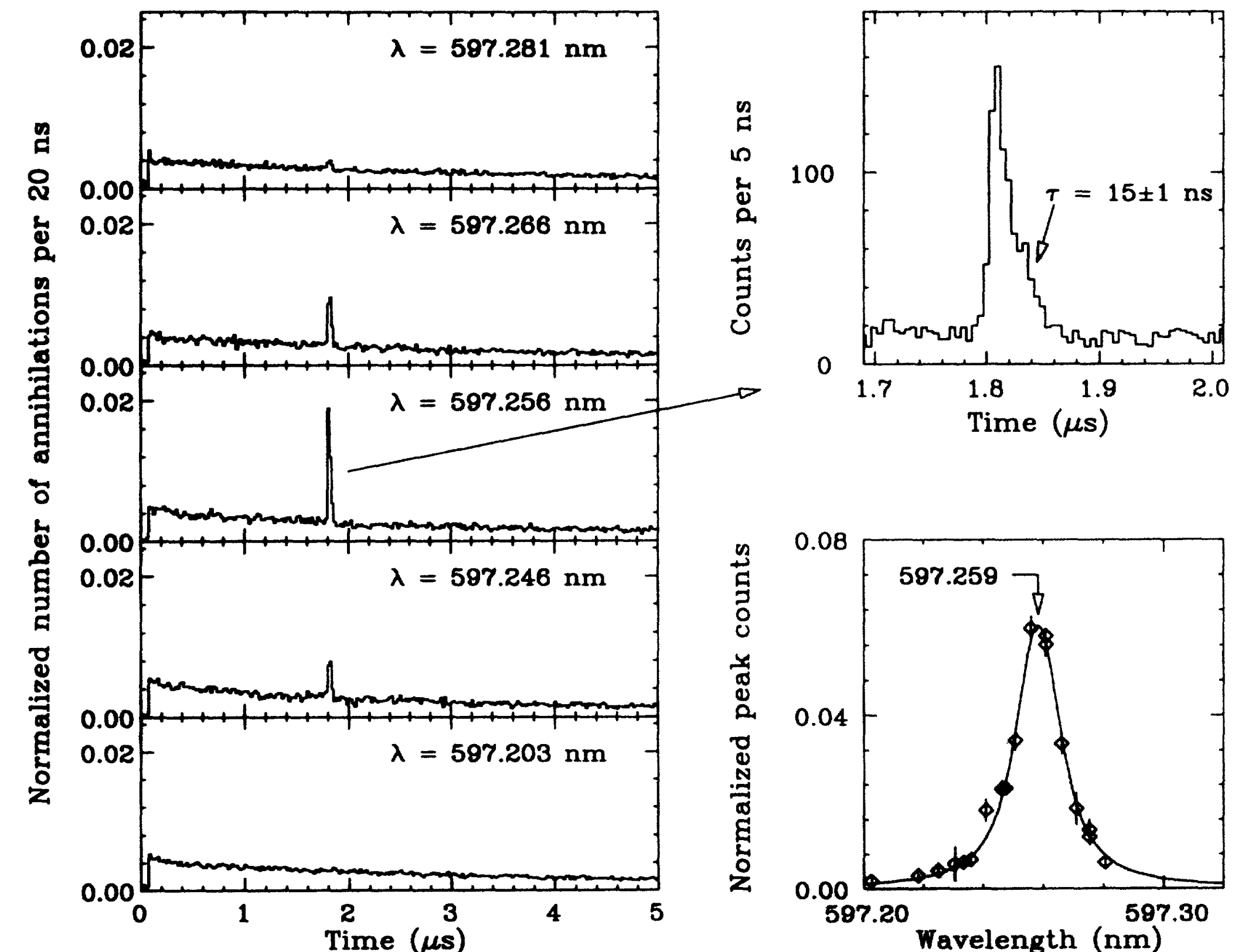
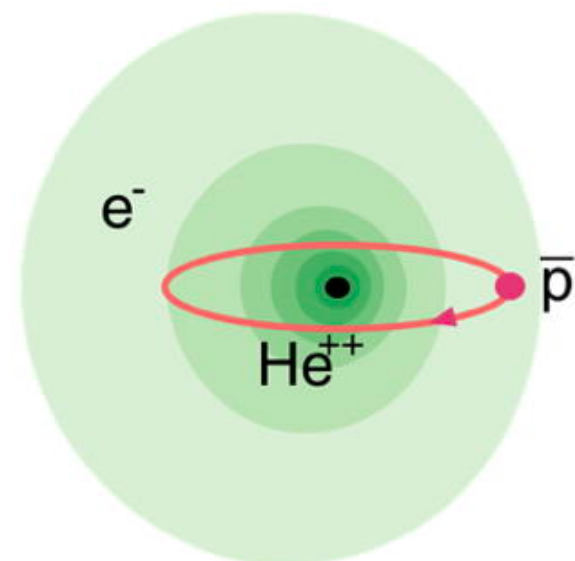
1994 @ CERN

REVIEW LETTERS

21 F

First Observation of Laser-Induced Resonant Annihilation in Metastable Antiprotonic Helium Atoms

- Laser spectroscopy of $\bar{p}\text{He}^+$ atom @ CERN
- CPT test etc. by ASACUSA group @ CERN AD / ELENA



4.

Hypernuclei — Late 80s → Pionic nuclei

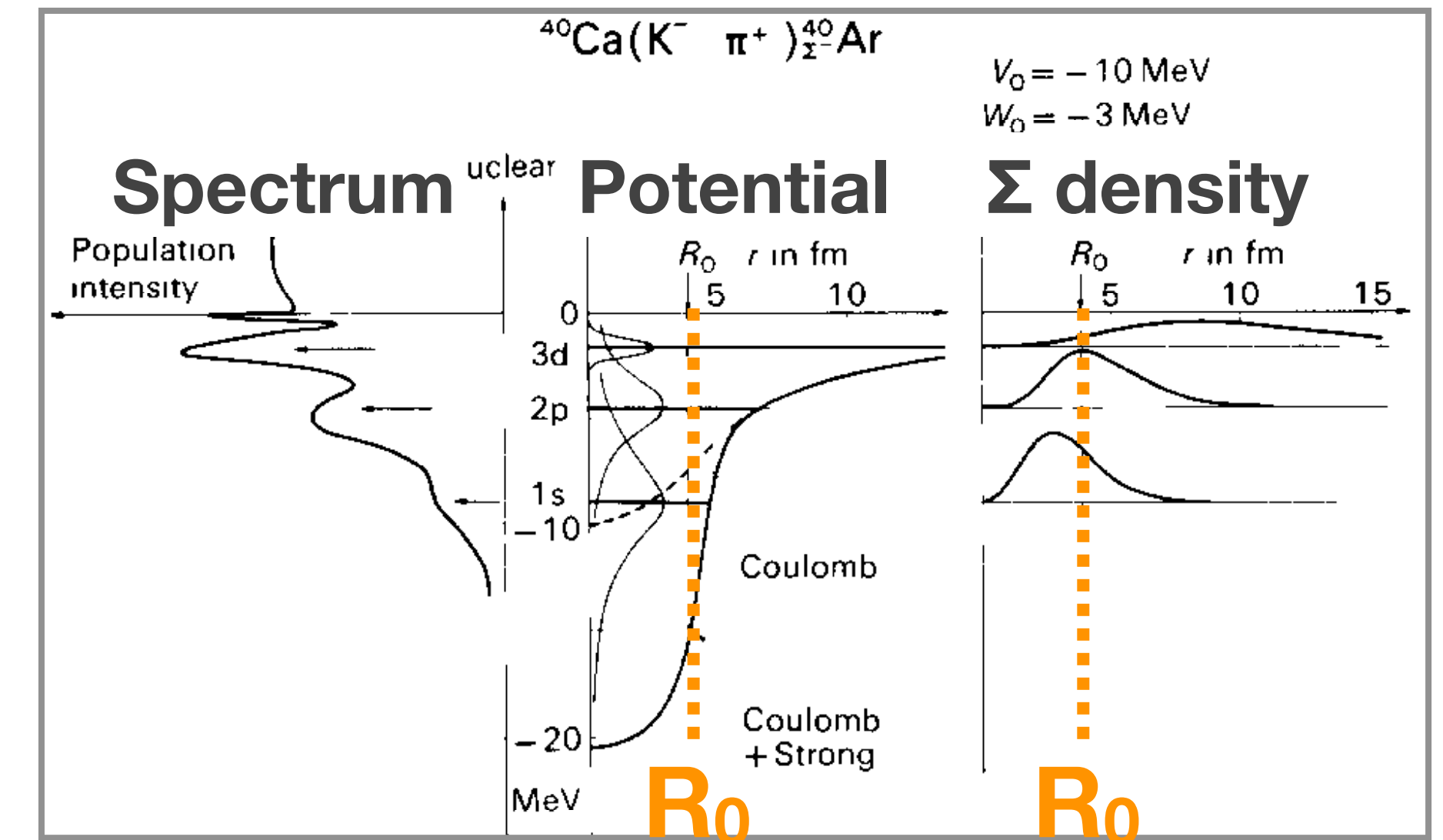
COULOMB-ASSISTED HYBRID BOUND STATES OF Σ^- IN MEDIUM NUCLEI POPULATED BY K^- ABSORPTION AT REST

T. YAMAZAKI

Institute for Nuclear Study, University of Tokyo, Tanashi Tokyo 188, Japan

R. S. HAYANO, O. MORIMATSU and K. YAZAKI

1988 Σ -A; Coulomb+Strong
→ narrow bound-states may be possible...



DEEPLY BOUND PIONIC STATES OF HEAVY NUCLEI

H. TOKI

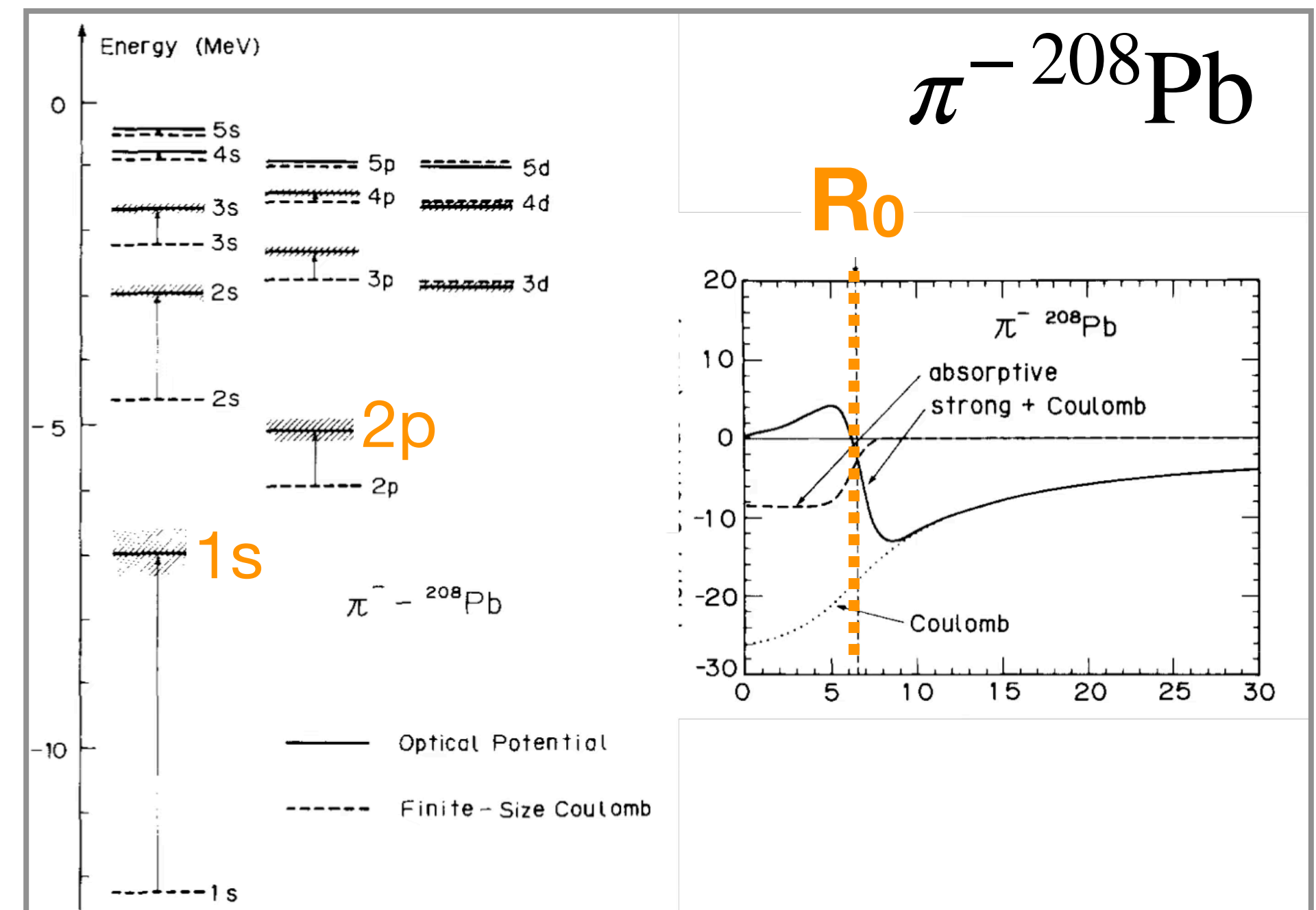
Department of Physics, Tokyo Metropolitan University, Setagaya, Tokyo 158, Japan

and

T. YAMAZAKI

Institute for Nuclear Study, University of Tokyo, Tanashi, Tokyo 188, Japan

1988 π^- -A; Coulomb+repulsive s-wave
→ narrow 1s state



4.

Hypernuclei — Late 80s → Pionic nuclei

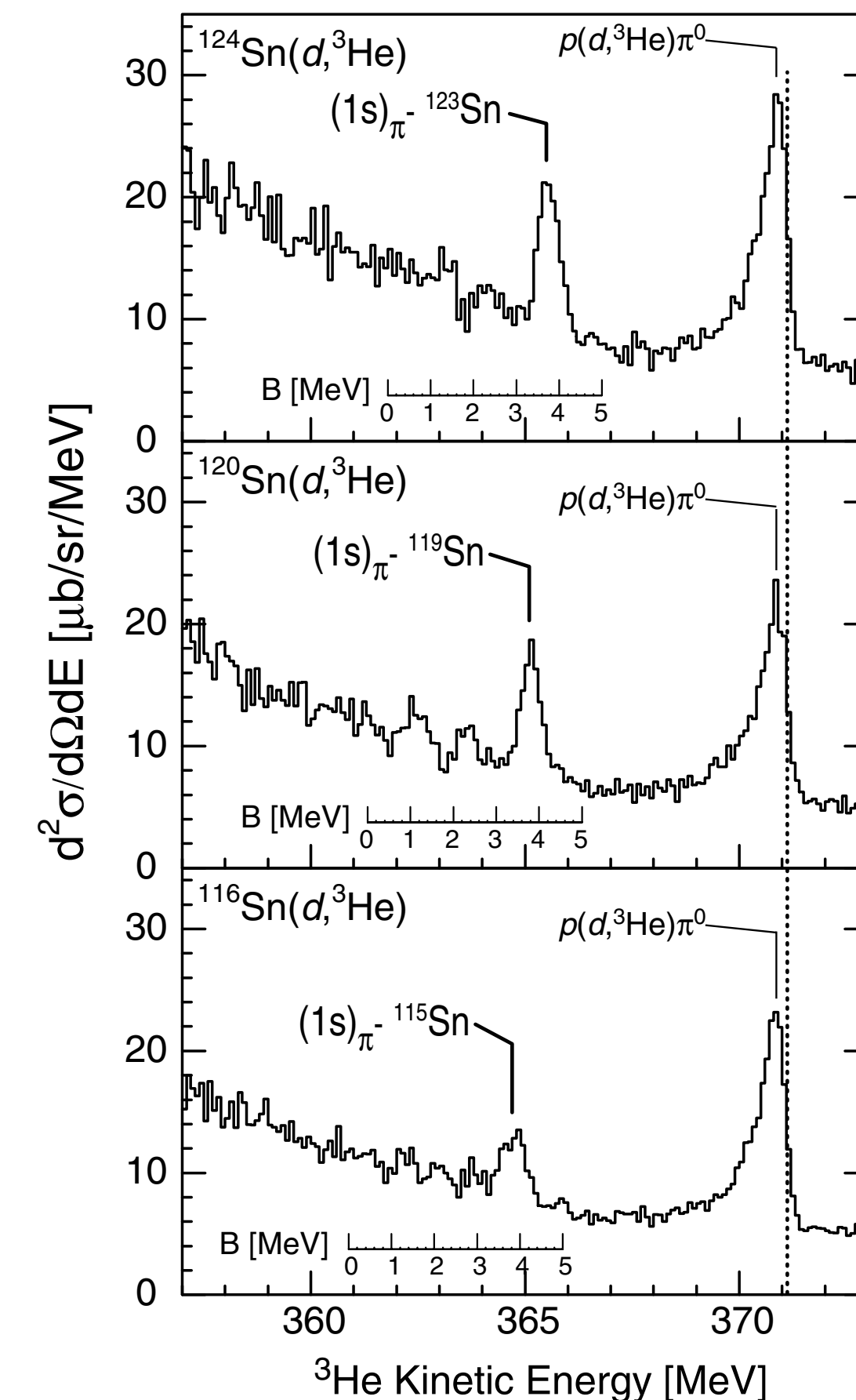
2004 @ GSI ER 7

PHYSICAL REVIEW LETTERS

week ending
20 FEBRUARY 2004

Precision Spectroscopy of Pionic 1s States of Sn Nuclei and Evidence for Partial Restoration of Chiral Symmetry in the Nuclear Medium

- $^{208}\text{Pb}(d, {}^3\text{He})$ succeeded in 1996
- $^{116,120,124}\text{Sn}(d, {}^3\text{He})$ in 2004 →
- In-medium pion decay constant
 $f_\pi^*(\rho)^2/f_\pi^2 \approx 0.64$



5. Pionic nuclei —~ HYP2000 (Torino) → $\bar{K}N$

Tullio Bressani

Strangeness nuclear physics toward the new millennium
- A personal summary of HYP2000

Toshimitsu Yamazaki^a

A vivid narrative of Toshi's journey

3. HADRON-NUCLEUS BOUND STATES

- 3.1. Struggling and straggling with Σ
- 3.2. Questions casted on "in-medium" invariant-mass spectroscopy
- 3.3. Bound hadron spectroscopy
- 3.4. Coulomb-assisted bound states
- 3.5. From Σ hypernuclei to pionic nuclei
- 3.6. Pionic nuclei and quark condensate in nuclear medium

4. KAONIC NUCLEI

- 4.1. From pionic nuclei to kaonic atoms
- 4.2. Narrow nuclear $\bar{K}$ states predicted
- 4.3. How to produce kaonic nuclei
- 4.4. $\Lambda(1405)$ as a door way to kaonic nuclei

2nd most cited

596

PHYSICAL REVIEW C, VOLUME 65, 044005

Nuclear $\bar{K}$ bound states in light nuclei

Yoshinori Akaishi¹ and Toshimitsu Yamazaki²

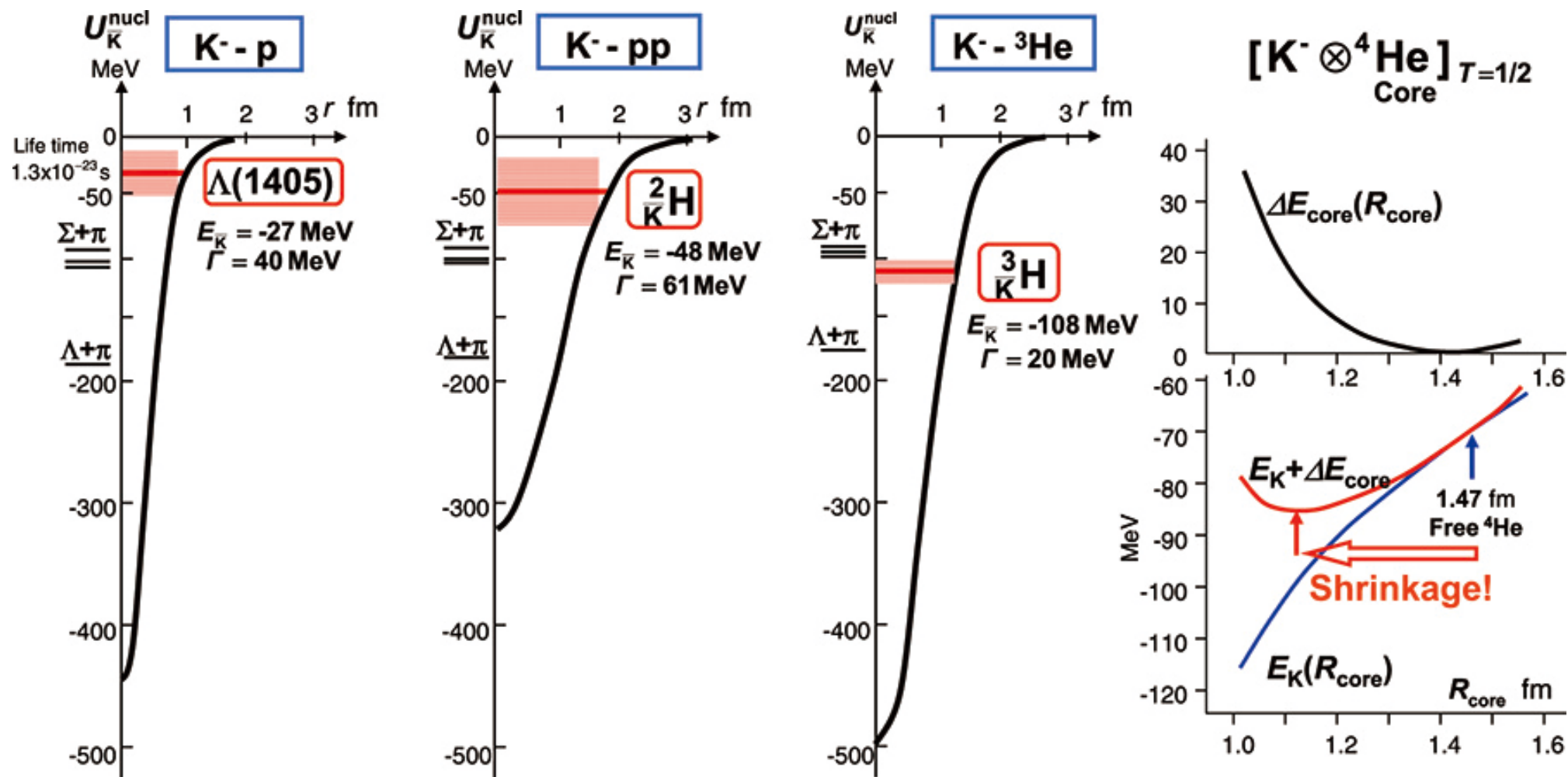
2002

Their latest (and last) paper
accepted Oct. 2, 2024

PROCEEDINGS
OF THE
JAPAN ACADEMY
SERIES B
PHYSICAL AND BIOLOGICAL SCIENCES
Proc. Jpn. Acad., Ser. B, Vol. 100, 607–614 (2024)

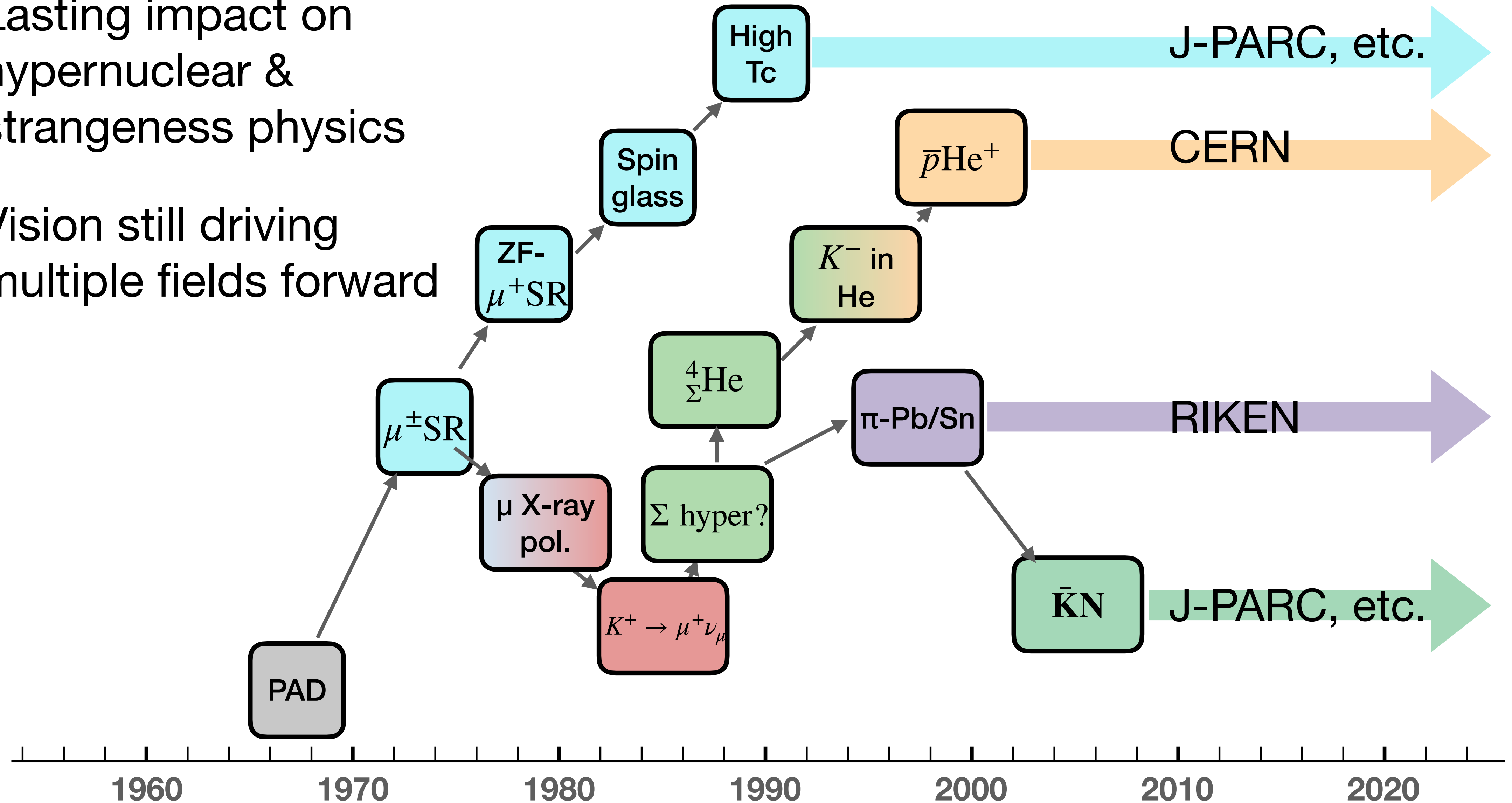
Kaonic nuclear clusters
— a new paradigm of particle and nuclear physics —

By Yoshinori AKAISHI^{*1,†} and Toshimitsu YAMAZAKI^{*2}



6. SUMMARY

- Lasting impact on hypernuclear & strangeness physics
- Vision still driving multiple fields forward





Toshi's motto: "Do what no one else does"