Search for *CP*-violating charge asymmetry in $B^{\pm} \to J/\psi K^{\pm}$ decays at Belle

K. Sakai

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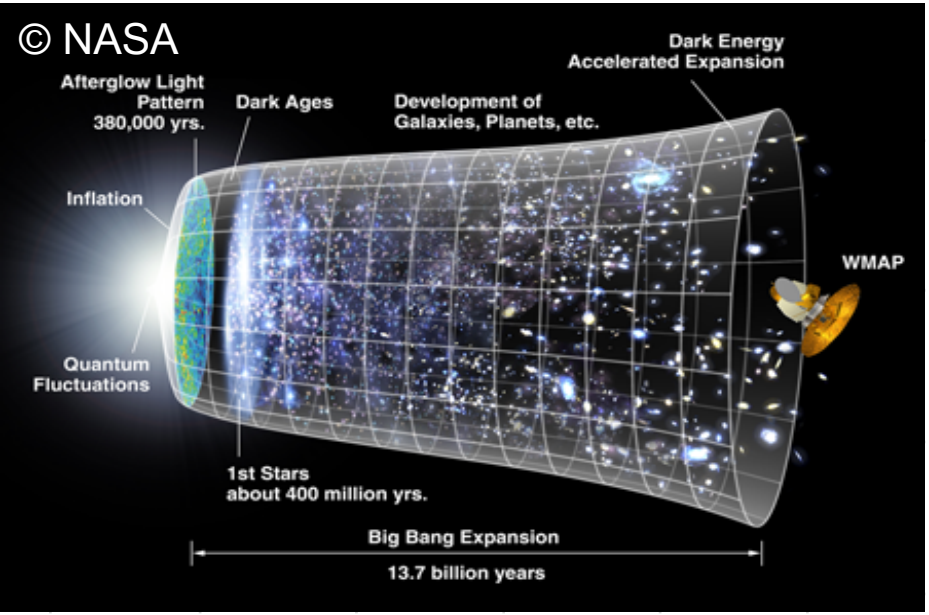
Introduction



Russia Physicist, Sakharov
suggested three conditions in 1967.

Anti-matter 0 %

Matter 4%

Dark matter 23%

Dark energy 73%

1. Baryon number violation
2. Out of thermal equilibrium
3. C- and CP-symmetry violation

(CP violation was found in 1964)

Theoretical motivation of $A_{CP}(B^+ \to J/\psi K^+)$

CP asymmetry is well explained by the SM.
However, this asymmetry looks too small,

to explain matter and anti-matter.

So, precise measurement of $A_{CP}(B^+ \to J/\psi K^+)$ is important.

$A_{CP}(B^+ \to J/\psi K^+) \sim 0.3\%$ (the Standard Model)
(W.-S. Hou, M. Nagashima, and A. Soddu, arXiv:hep-ph/0605080)

$A_{CP}(B^+ \to J/\psi K^+) \sim \mathcal{O}(1\%)$ (An extra U(1) gauge boson)
(V. Barger, C.-W. Chiang, P. Langacker, and H.-S. Lee, Phys. Lett. B **598**, 218 (2004))

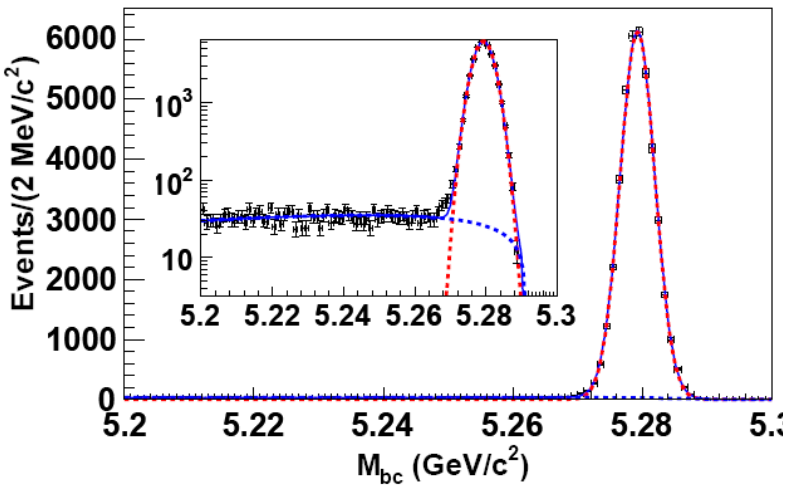
$A_{CP}(B^+ \to J/\psi K^+) \sim \mathcal{O}(10\%)$ (An extra coupling to the charged Higgs boson)
(G.-H. Wu and A. Soni, Phys. Rev. D **62**, 056005 (2000))

$A_{CP}(B^+ \to J/\psi K^+)$ measurement is good probe to search beyond the SM.

Experimental motivations of $A_{CP}(B^+ \to J/\psi K^+)$

1. Clean decay mode

2. One of decays which has large branching fraction



Charmonium modes

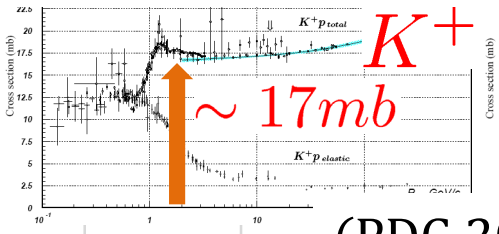
$\eta_c K^+$	(9.1 ±1.3) × 10^{-4}				1753
$\eta_c K^*(892)^+$	(1.2 $^{+0.7}_{-0.6}$) × 10^{-3}				1648
$\eta_c(2S) K^+$	(3.4 ±1.8) × 10^{-4}				1320
$J/\psi(1S) K^+$	(1.014±0.034) × 10^{-3}				1683
$J/\psi(1S) K^+ \pi^+ \pi^-$	(1.07 ±0.19) × 10^{-3}			S=1.9	1612
$h_c(1P) K^+ \times$ B($h_c(1P) \to J/\psi \pi^+ \pi^-$)	< 3.4		× 10^{-6}	CL=90%	1401
$X(3872) K^+$	< 3.2		× 10^{-4}	CL=90%	1141
$X(3872) K^+ \times$ B($X \to J/\psi \pi^+ \pi^-$)	(9.5 ±1.9) × 10^{-6}			S=1.3	1141
$X(3872) K^+ \times$ B($X \to J/\psi \gamma$)	(2.8 ±0.8) × 10^{-6}				1141
$X(3872) K^*(892)^+ \times$ B($X \to J/\psi \gamma$)	< 4.8		× 10^{-6}	CL=90%	939
$X(3872) K^+ \times$ B($X \to \psi(2S) \gamma$)	(9.5 ±2.8) × 10^{-6}				1141
$X(3872) K^*(892)^+ \times$ B($X \to \psi(2S) \gamma$)	< 2.8		× 10^{-5}	CL=90%	939
$X(3872) K^+ \times$ B($X \to D^0 \overline{D}^0$)	< 6.0		× 10^{-5}	CL=90%	1141
$X(3872) K^+ \times$ B($X \to D^+ D^-$)	< 4.0		× 10^{-5}	CL=90%	1141
$X(3872) K^+ \times$ B($X \to$	(1.0 ±0.4) × 10^{-4}				1141

However, there is a concern which must be solved.

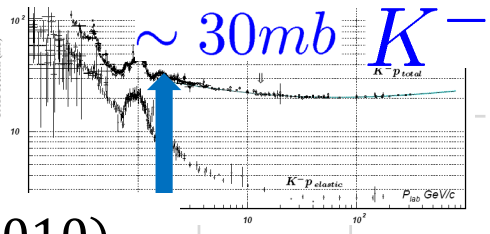
The efficiency difference between K^+ *and* K^-

(1) Material interaction.

Ex.) cross section with proton

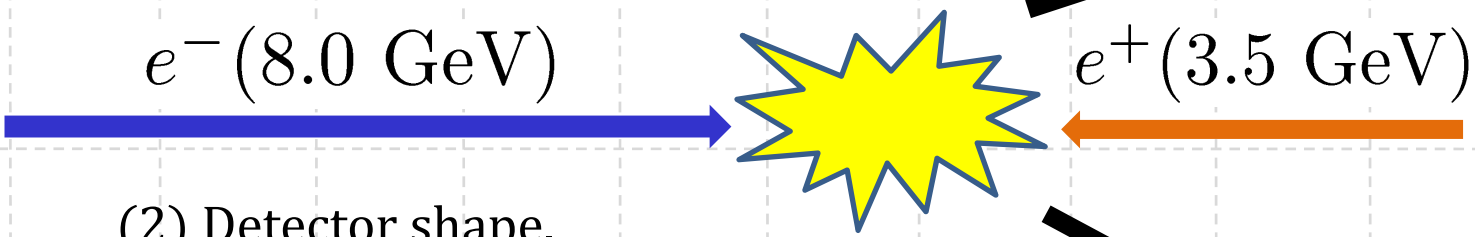


K^+ $\sim 17mb$



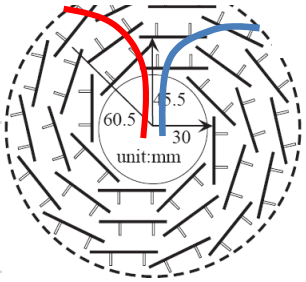
$\sim 30mb$ K^-

(PDG 2010)



(2) Detector shape.

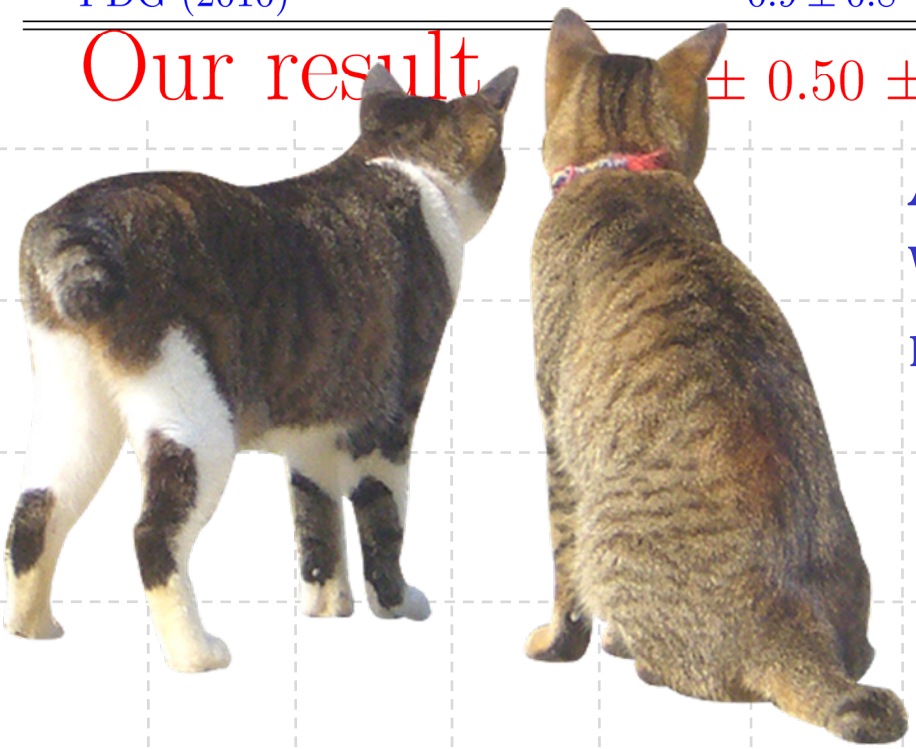
Ex.) Silicon vertex detector



This was solved by using $D_s^+ \to \phi\pi^+$ and $D^0 \to K^-\pi^+$ decays.

Comparing the precisions

	Charge asymmetry (%)	Signal yeild
CLEO (2000)	$1.8 \pm 4.3 \pm 0.4$	$\sim$ 500
Belle (2003)	$-2.6 \pm 2.2 \pm 1.7$	$\sim$ 2,000
BaBar (2005)	$3.0 \pm 1.4 \pm 1.0$	$\sim$ 7,000
Belle (2008)($p\bar{p}$)	$9 \pm 7 \pm 2$	$\sim$ 200
DØ (2008)	$0.75 \pm 0.61 \pm 0.30$	$\sim$ 40,000
PDG (2010)	0.9 ± 0.8	-
Our result	$\pm$ 0.50 $\pm$ 0.22	$\sim$ 41,000



As you can see,

We got most precise result to date.

Finally, I promise to drive cats away in front of my poster!

Thank you for your attention.