

Measuring 4th Generation CKM Parameters at the LHC

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Introduction

With 2011-2012 LHC data, t' and b' quarks could be discovered below the *Unitarity Bound* around 500--550 GeV.

Measurements of $B_s \rightarrow J/\Psi\phi$ and $B_s \rightarrow \mu^+\mu^-$ may give us $V_{t's}^* V_{t'b}$ that touches upon the *Baryon Asymmetry of the Universe (BAU)*.

Measuring $V_{t's}^* V_{t'b}$ gives $b \rightarrow s$ Quadrangle

$V_{t's}^* V_{t'b}$ could be determined by simultaneously measurements of

the CPV phase in time-dept. $B_s \rightarrow J/\Psi\phi$,

and the branching fraction of $B_s \rightarrow \mu^+\mu^-$.

$\sin 2\Phi_{B_s}$ from t-dept. $B_s \rightarrow J/\Psi\phi$

t' and t interfere in $b\bar{s} \rightarrow s\bar{b}$ box.

$$M_{12}^s \propto \Delta_{12}^s \equiv \left[(\lambda_t^{\text{SM}})^2 S_0(t, t) + 2\lambda_t^{\text{SM}} \lambda_{t'} \Delta S_0^{(1)} + \lambda_{t'}^2 \Delta S_0^{(2)} \right],$$

$$2\Phi_{B_s} \equiv \arg M_{12}^s \equiv \arg \Delta_{12}^s$$

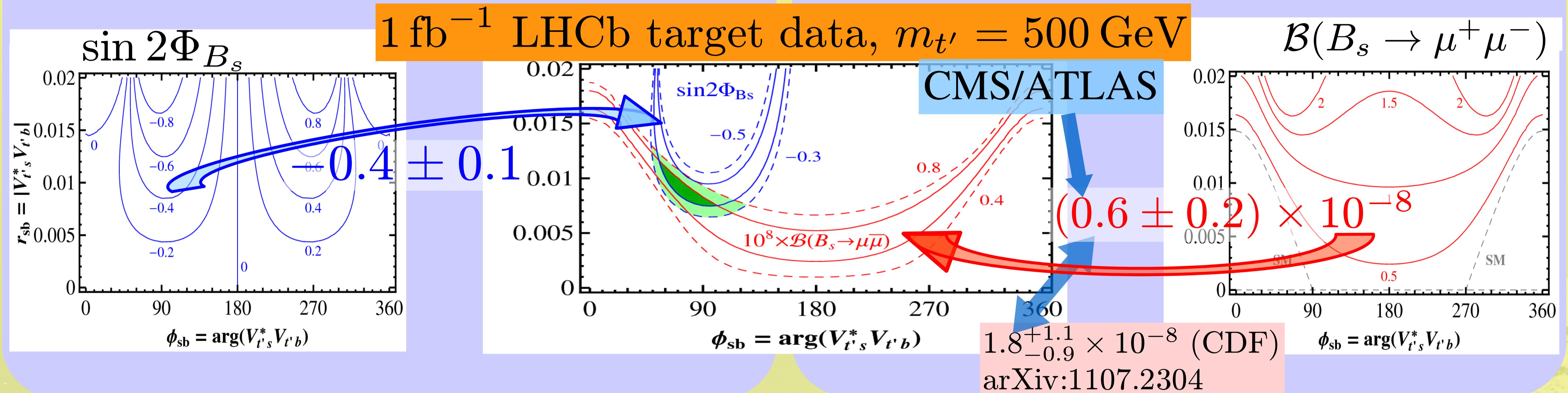
$$* - \sin 2\beta_s = \sin \phi_s \equiv \sin 2\Phi_{B_s}, \lambda_q \equiv V_{qs}^* V_{qb}.$$

Rate of $B_s \rightarrow \mu^+\mu^-$

$$\mathcal{B}(B_s \rightarrow \bar{\mu}\mu) = C \frac{\tau_{B_s} \eta_Y^2}{\hat{B}_{B_s} \eta_B} \frac{|\lambda_t^{\text{SM}} Y_0(x_t) + \lambda_{t'} \Delta Y_0|^2}{|\Delta_{12}^s| / |\Delta m_{B_s}|^{\text{exp}}},$$

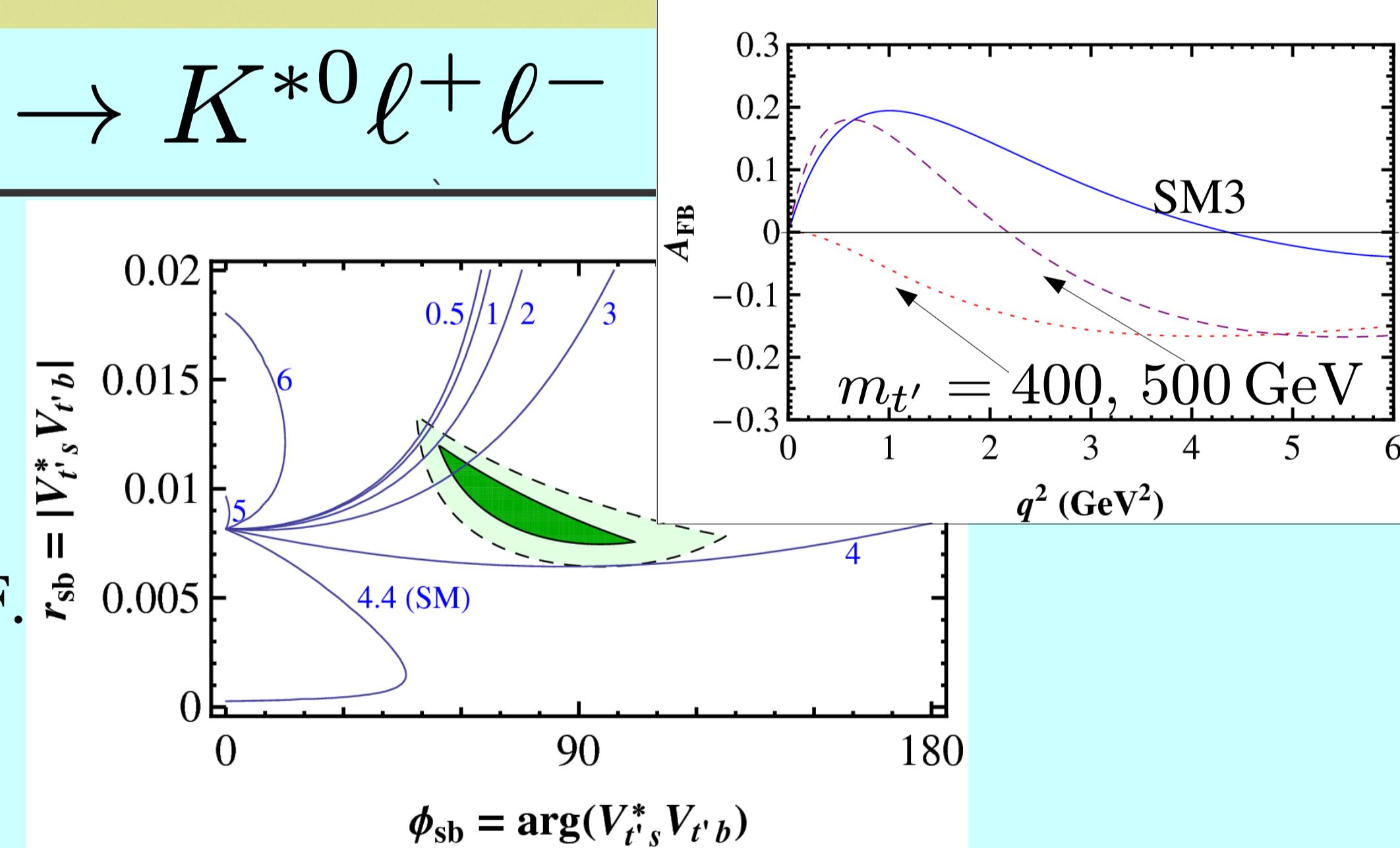
* Hadronic uncertainty reduced by taking ratio with $|\Delta m_{B_s}| / |\Delta m_{B_s}|^{\text{exp}}$
 \longrightarrow Bag Parameter only

* Δ_{12}^s (SD part of M_{12}^s) modifies $m_{t'}$ dependence.

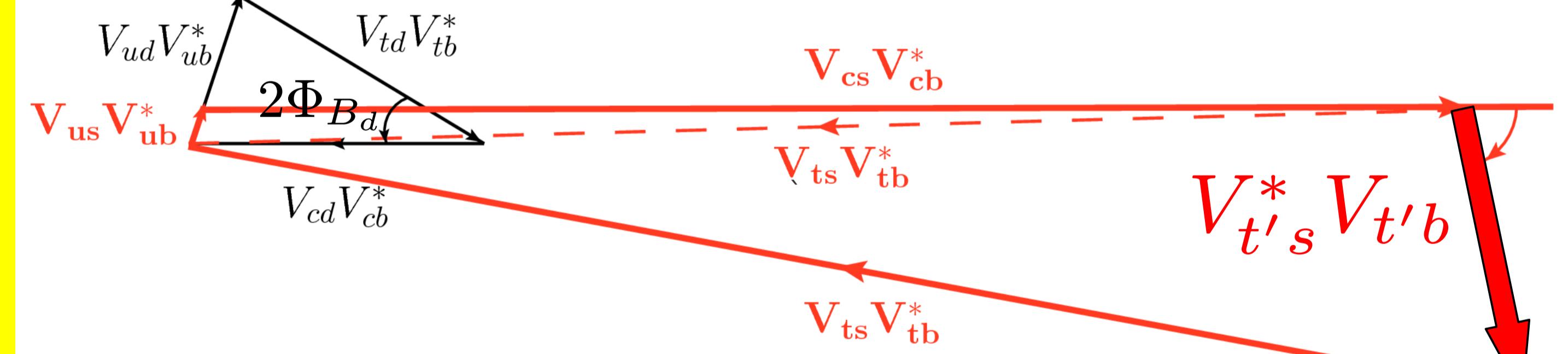


A_{FB} in $B^0 \rightarrow K^{*0} \ell^+ \ell^-$

Larger $|V_{t's}^* V_{t'b}|$ agrees more with hint of no zero crossing from Belle/BaBar/CDF.



Drawing $b \rightarrow s$ Quadrangle

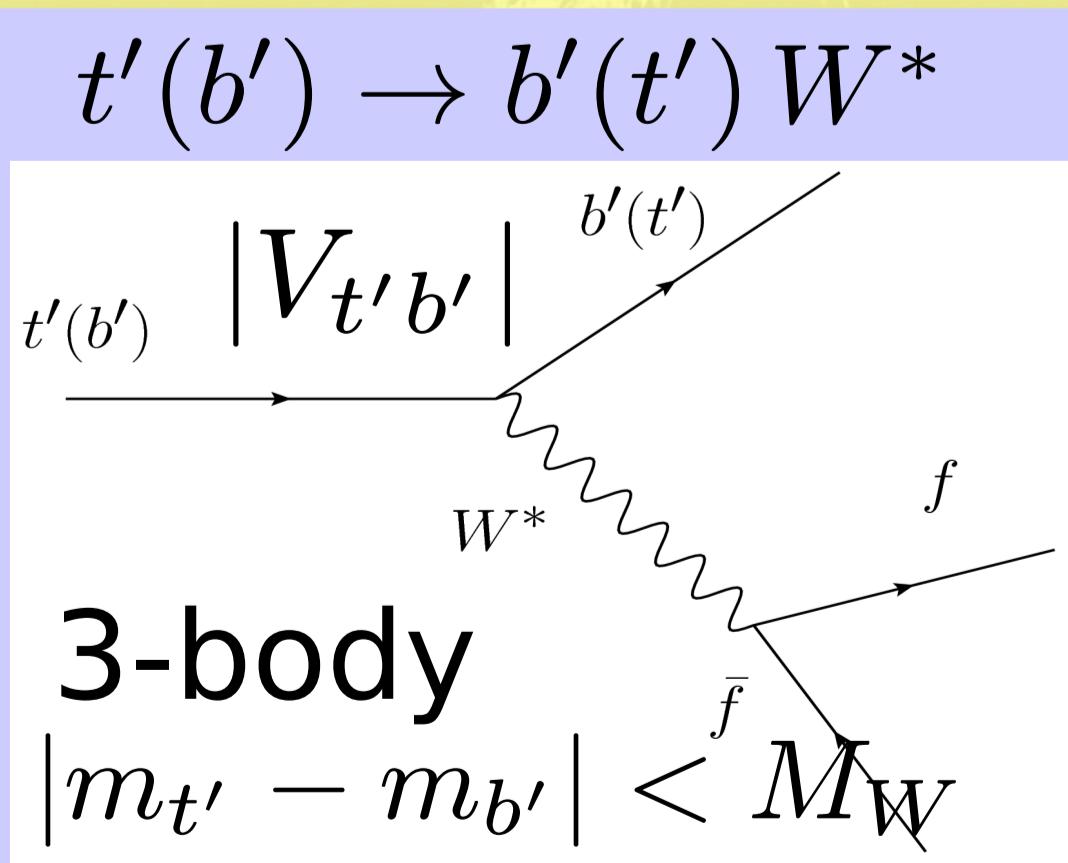


Enough CPV for BAU!?

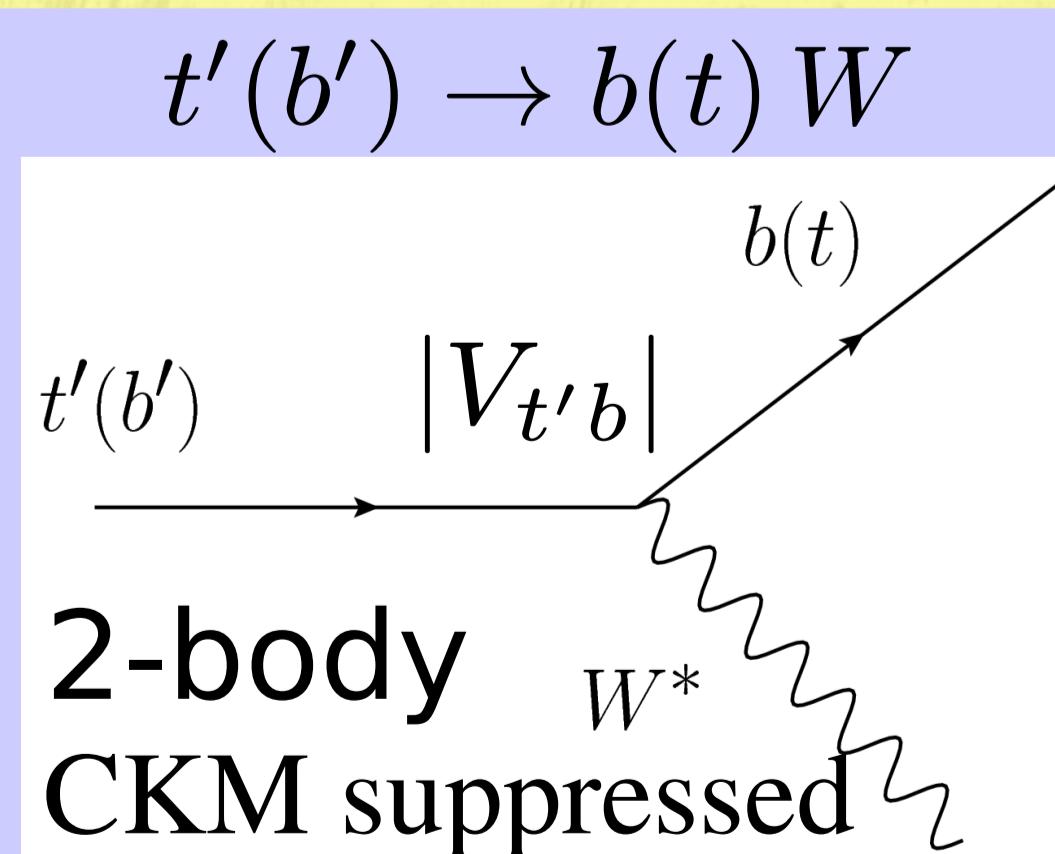
[WSH, Chin. J. Phys. 2009]

Measuring $|V_{t'b}|$ by Threshold Effect

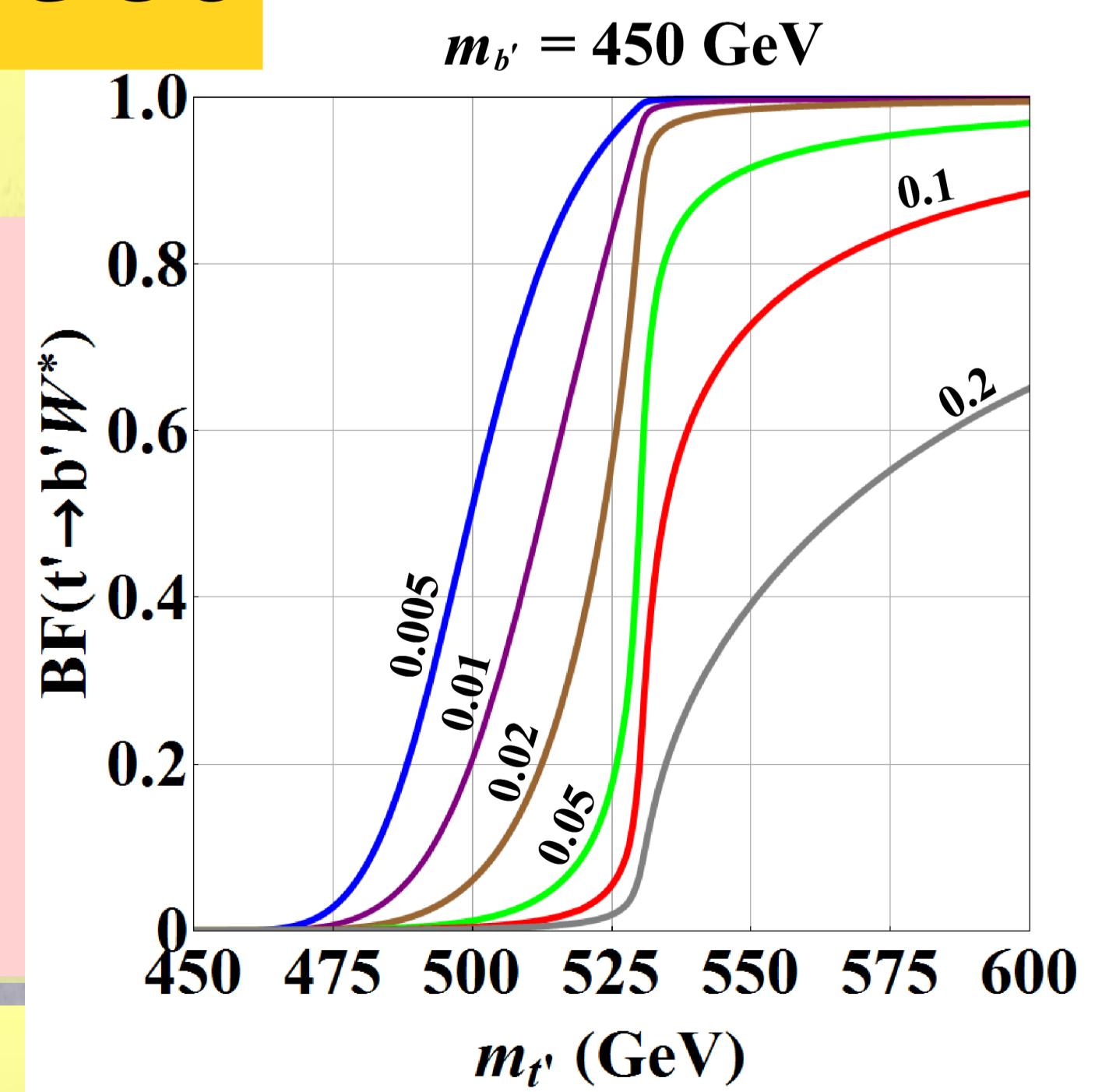
Two Main Channels



Compete



Measuring $|V_{t'b}|$ by
 $\mathcal{B}(t' \rightarrow b' W^*)$
 esp. for small $|V_{t'b}|$!
 [complement Bs Program]



Conclusion

Along with t', b' Direct Search, the LHC could measure 4th generation CKM parameters in near future.

It could carry enough CPV for Matter Dominance of the Universe.

Reference: WSH, Kohda, and Xu, arXiv: 1107.2343; Chao et al., arXiv:1101.0592, to appear in PRD