

Precise determination of heavy quark masses

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Talk contents

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- 2. Research goal & plan : top mass determination**
- 3. Current status**
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◆ Status of modern high energy physics

• Experiment ◆ **Energy frontier** (LHC) ◆ **High precision** (Belle-II)

• Theory **Increase precision of prediction**

◆ High precision QCD prediction : **important**

↳ masses $m_{t,\overline{\text{MS}}}$, $m_{b,\overline{\text{MS}}}$, CKM V_{xy} , coupling $\alpha_s, \dots \in \mathcal{L}_{\text{SM}}$

→ **profound understanding on fundamental physics at high energy**

My research: Develop new framework for precise QCD prediction

• LHC physics (for m_t)

...uncertainty from PDF

$$\delta m_t \sim 1 \text{ GeV}$$

• Belle-II physics (for m_b , V_{cb} & V_{ub})

...renormalon uncertainty

$$\delta m_b \sim 30 \text{ MeV}$$

→ **Reduce by Operator Product Expansion analysis!**

Final research goal in GPPU

Top mass determination using lepton energy distribution @LHC (&moments)

Difficulties

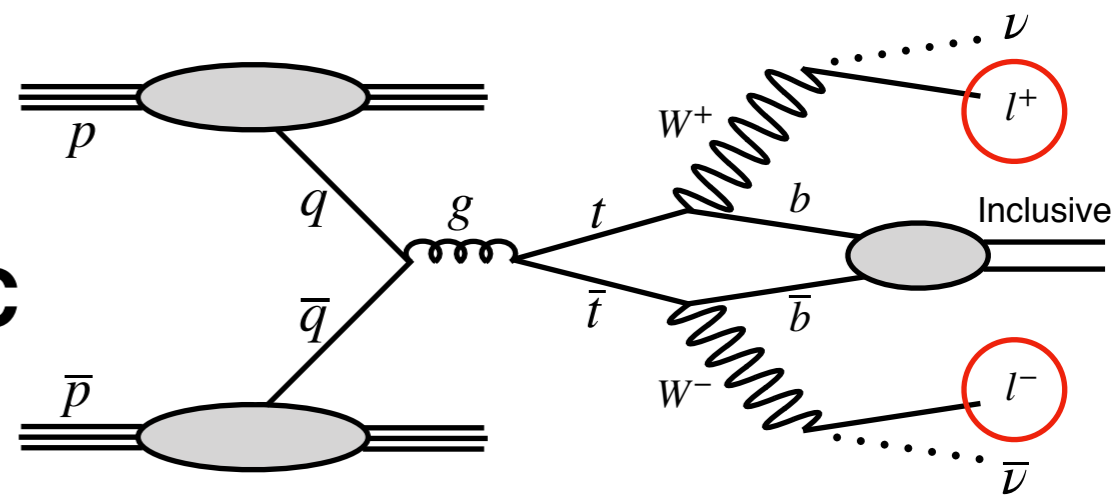
wide energy scale, renormalon subtraction, non-perturbative effects, ...

→ Understanding on **b-flavor physics** will help us !

What we plan

Bottomonium spectrum, B meson decay, ...

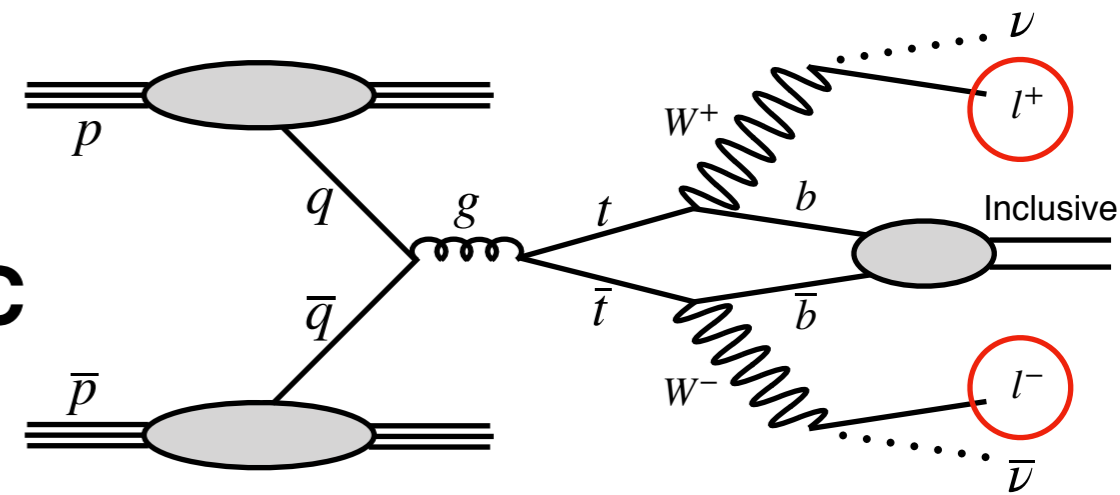
- ◆ Study on b-flavor physics
 - Operator Product Expansion (OPE) analysis of bottomonium
 - ... Good example for systematic renormalon subtraction
 - Study on hadron semileptonic decay & OPE analysis of decay rate
 - : **B-meson semileptonic inclusive decay** $B \rightarrow X_c l \bar{\nu}$
- ◆ Reduction of initial state uncertainties (PDF) from LHC data



Final research goal in GPPU

Top mass determination using lepton energy distribution @ LHC (& moments)

Current status



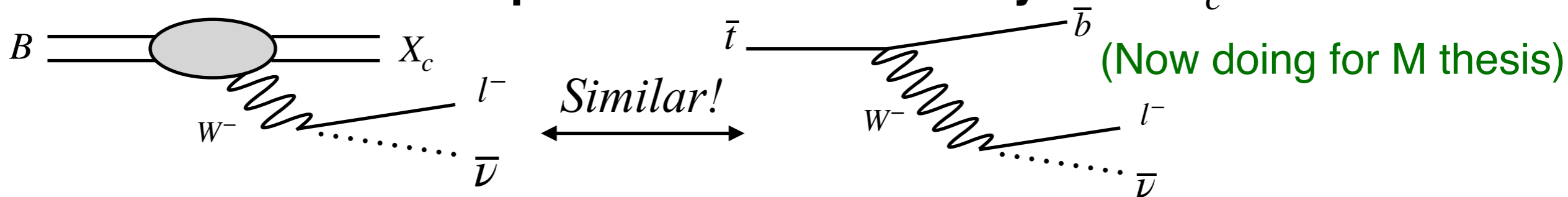
- OPE analysis of bottomonium

: basically analysis is done (PLB 795 (2019) 107 YH, Y. Sumino)

→ need to **improve LL approx.** for quark mass analysis (start soon)

- Study on hadron semileptonic decay & OPE analysis of decay rate

: B-meson semileptonic inclusive decay $B \rightarrow X_c l \bar{\nu}$



(Now doing for M thesis)

- Reduction of initial state uncertainties from LHC data (in Doctor course)

→ **Treatment of Parton Distribution Function in context of OPE**

- ◆ **So far** ...discussion with A.Vairo and N.Brambilla (@TU, June, 2019)
 - with K.Fujii and J.Tian (@KEK, Aug, 2019)
 - (about quark mass determination with B & D mesons)
- ◆ **From now on**
 - **International Workshop on Future Linear Colliders (LCWS 2019)**
 - @Sendai, Japan, Oct.28th~Nov.1st, 2019
 - **Precision calculations in quantum field theory** (15th DESY Workshop)
 - @Nurnberg-Furth, Germany, Apr.26th~May.1st, 2020
 - **Visiting Technische Universität München**
 - @Munich, Germany, Undefined, 2020
 - With A.Vairo and N.Brambilla
 - **Visiting Karlsruher Institut für Technologie**
 - @Karlsruher, Germany, Undefined, 2020

