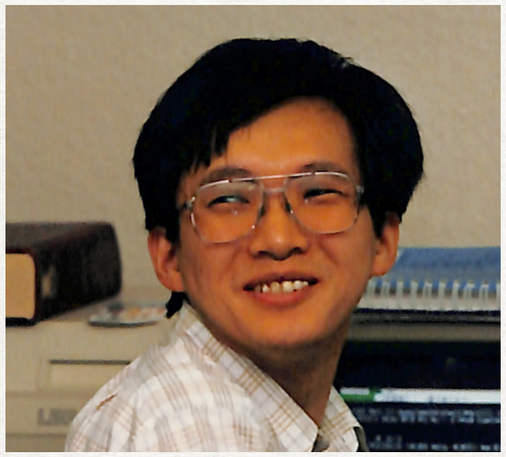
WELCOME TO THE CLUB

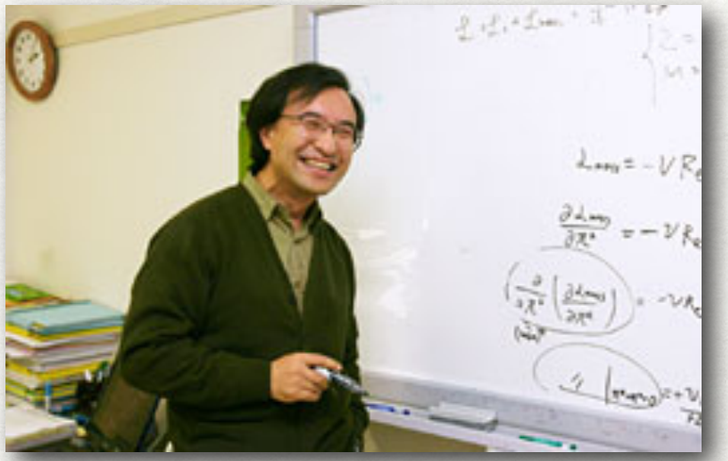
HOW DID I GET TO KNOW HITOSHI

HAGIWARA SCHOOL(萩原スクール）1990

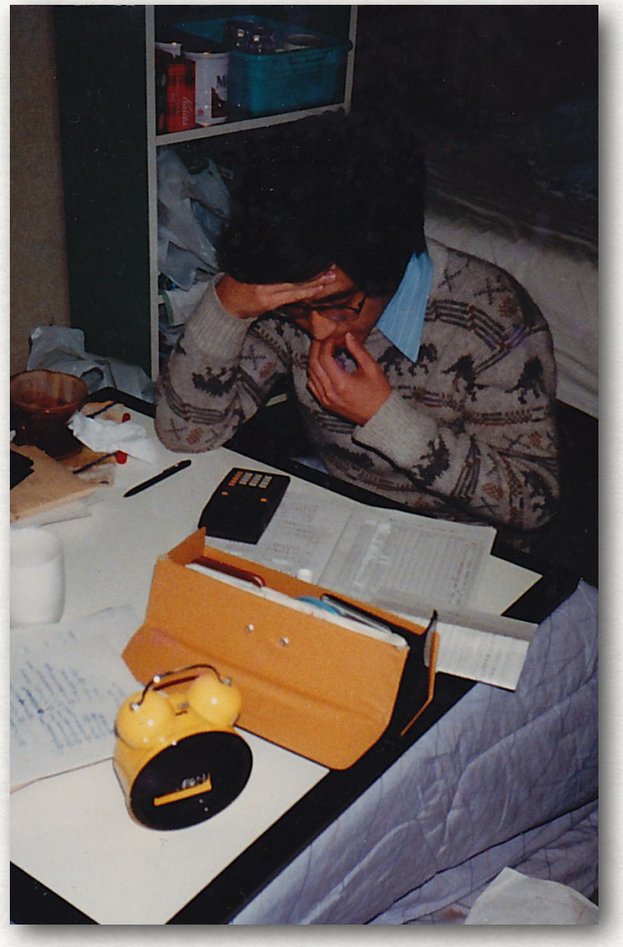
Hikasa



Hagiwara



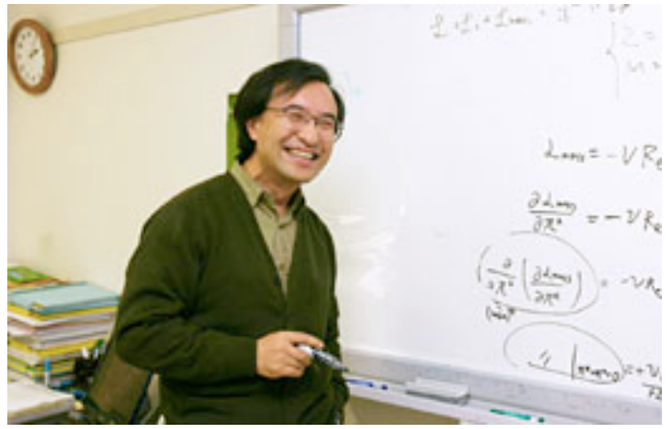
Hitoshi Murayama (early 90's)



- Lecture by Hikasa, and "虎の穴” (giving different project to each of them) by Hagiwara
- example:
  - "W or Z boson production at e+e- collider" , HELAS (helicitiy amplitude package) Murayama Watanabe Hagiwara
  - "top quark pair production near threshold" Yukinari Sumino and Hitoshi Murayama (1992)
  - "Three jet distribution from the one loop Zgg vertex at e+ e- colliders" (1990) "Grand unification threshold effects" with Yoichi Yamada

History

1991	HELAS
1994	MadGraph
2002	MadEvent
2006	MG/MEv4
2011	MadGraph5
2014	MadGraph5_aMC@NLO



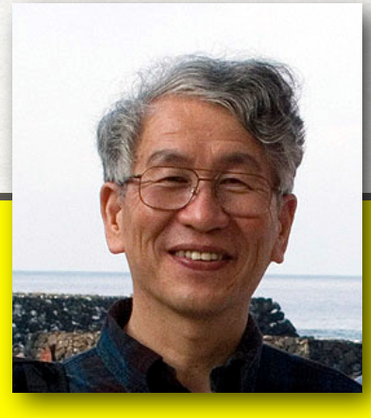
- Computing Matrix Element for a fixed Helicity and sum over the helicities.

- Suite of Routine, which allow to write the matrix element for any (SM) process

Madgraph is started in Japan

MY PHENO RESEARCH AT KEK(I)

- My husband (Shinichi) got PD position of KEK, and I spent the last year of my PhD course in KEK, “Sneak in Hagiwara-school”.
- then got JSPS fellowship on string theory and start to working on pheno under the supervision of Hikasa-san
- Easy to talk with Experimentalists



2nd floor of Kenkyu Honkan snapshot in 1990

Theory Group

salon

cat entrance
with human powered
autodoor

東島

Tsukuba
lattice

AKIRA
YAMAMOTO

Kamioka group
Atsuto Suzuki

Prof. Nyanko

BESS
experiment

Tanimori

THE 3RD FLOOR PS GROUP (YOSHITAKA KUNO)

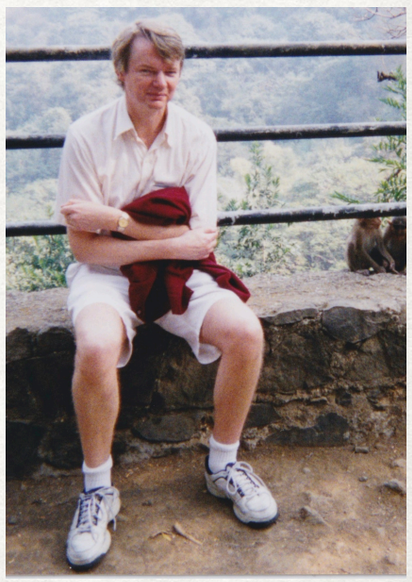
MY PHENO RESEARCH IN KEK

- project with Kamiokande group in KEK.　Limit of dark matter pair annihilation in the earth/sun with Masaki Mori.
- Started a project with Manuel Drees　(VAX phone collaboration)　→Nishina fellow (at SLAC) , Madison PD from Aug 1992.
- SUSY spectrum(239), Higgs sector(218), relic density(766), detection (380)　1603 citation for 4 papers　Less gender bias in US.
- 1993　AP position in KEK

Masaki Mori

from ICRR web site

Manuel Drees



M. N　(1991)

Physics Letters B 270 (1991) 89–96
North-Holland

PHYSICS LETTERS B

Search for neutralino dark matter in Kamiokande

M. Mori, M.M. Nojiri [1,2], Y. Oyama, A. Suzuki, K. Takahashi, M. Yamada
National Laboratory for High Energy Physics (KEK), Tsukuba, Ibaraki 305, Japan

H. Takei, K. Miyano, H. Miyata
Niigata University, Niigata, Niigata 950-21, Japan

K.S. Hirata, K. Inoue, T. Ishida, T. Kajita, K. Kihara, M. Nakahata, K. Nakamura, N. Sato [3]

WORKING WITH EXPERIMENTAL GROUPS

Linear Collider

Keisuke Fujii

- 1995 Okada, Murayama with JLC group "Precision study of supersymmetry" chargino and neutralino
- 1995 Nojiri and JLC group "slepton and coupling measurement ".
- Significant part of Snowmass 1996 and 2001 e+e- collider study are from Japan

Fight with Ian Hinchilife in Snowmass

Frank Paige

LHC(YITP, Kyoto U as associate Professor→KEK from 2006)

collaboration with Kawagoe-san accepted ATLAS SUSY group (Ian, and Frank Paige)
Preaching LHC physics and LHC toolkit chain in Japan
Did Les Houches workshop convener twice.
(met Gavin Salam, other event generator authors)
Start getting prenerly talks in Pascos, SUSY
(2004, 2006, 2008, and 2011)

Takeuchi

My SUSY 2008 talk, July 16-21

The Night before the LHC

The accelerator is aligned with care,
in hopes beams soon would be there

.

Mihoko M. Nojiri
(KEK & IPMU)

Affiliation is important

The stockings were hung by the chimney with care,
In hopes that St. Nicholas soon would be there;

by Clement Clarke Moore

Not quite "full scale" this year but

This talk is before LHC incident at Oct 16 2008

- I gave this talk in 2006, when it was scheduled in 2007.

- Though, it is not quite in 14TeV, LHC seems to be starting this year. 10 TeV by Oct? GLAST also launched on June 11, 2008, and working so far. Good year?

- We all hopes something new, "the gift",  and you must have your special plans for "the night before the LHC" (the item may vary from CMSSM minimum to unparticle, though.)

- Most likely the era of "freedom of model building" (SUSY, e-dim, black holes, branes....) will over. There will be more data, more constraints, more handle

- but when? and how?

START UP OF IPMU

- I was not related to IPMU at the WPI application stage.

- KEK was also applying to WPI and I knew it was not successful, then I got an e-mail from Hitoshi asking me to serve as PI, either externally or moving to Tokyo University, and I agreed to be an external PI.

- Many things were uncertain. ex: Yoshida-san found that moving in IPMU might reduce the total lifetime income(!)

- I still do not feel comfortable the WPI structure that a very few people do all administrative works.

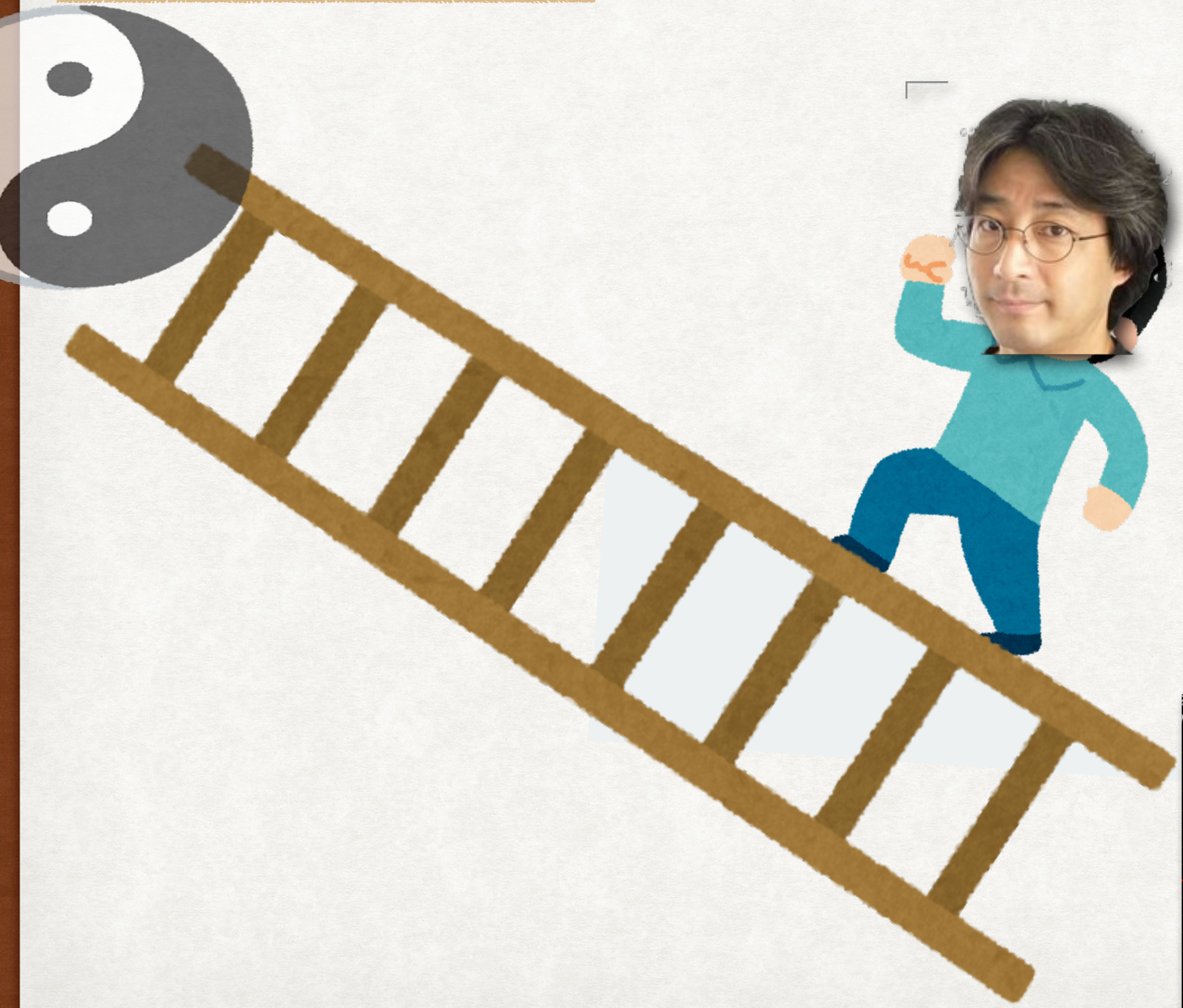
- Some people openly said that I should move IPMU because there were no women etc. and I was very embarrassed.

EARTHQUAKE(2011.3.11)→FUKUSHIMA ACCIDENT

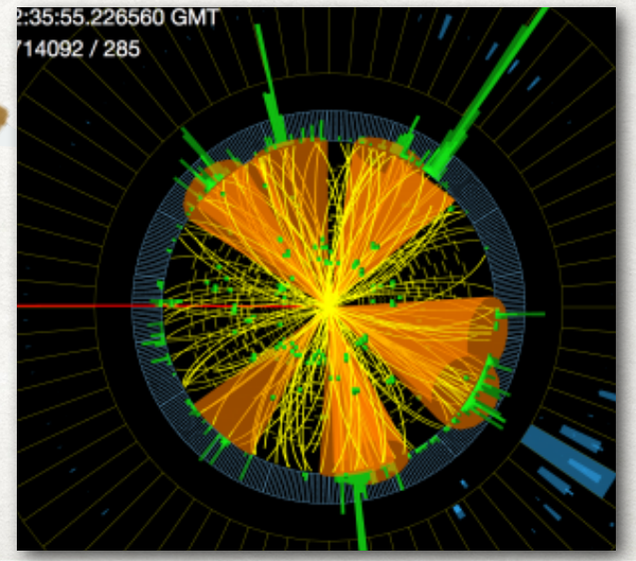
- PDs were flying back home temporaly and took some time to return.
- Radiation in Kashiwa was relatively higher among Tokyo-areas.
- I spent 1.5 years doing public outreaches (confirmation bias developed the non-scientific concerns.)
- radiation lectures on 2011.4.30, nakedloft in May, “geiger counter meeting” (2011.6.11) Kashiwa(UDCK) event with Tasaki-san 2012.3.10
- Hitoshi asked me to give a lecture in IPMU. I did it but I felt I was not trusted

at 611 geiger counter meeting

High scale physics



LHC experiment



High scale physics

Johan Alwall

Automatic Amplitude calculation

$\mathcal{L}_{SM} + \mathcal{L}_{BSM}$

2001 Matrix element and Parton shower
Matching (CKKW) → 2007Madgraph (Johan Alwall)

PRL with Johan Alwall in 2009

QCD correction

2006 QCD aware definition of jets(fastjet)

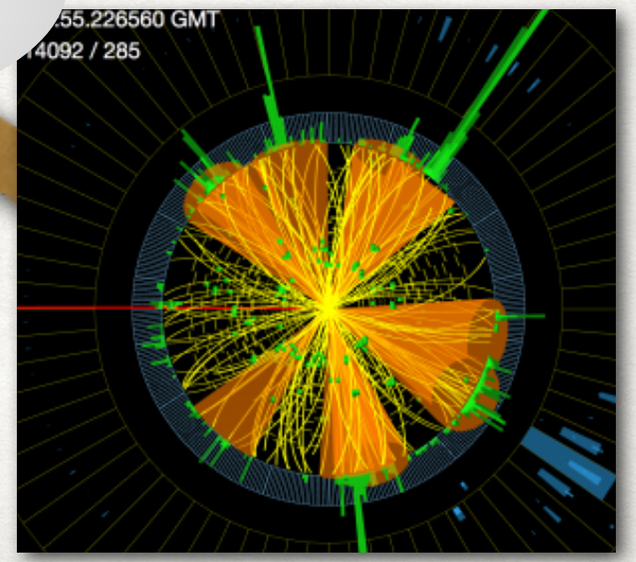
Parton shower

Pythia, Herwig, Sherpa →
Dipole shower → NNLL collection
(Panscale)

Hadronization

prediction LHC event

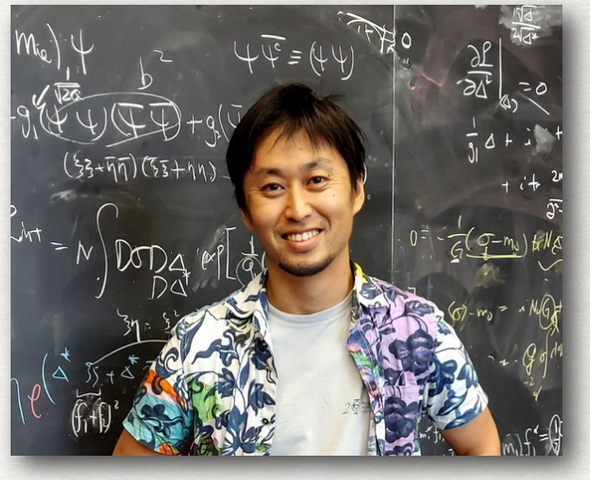
Bryan Webber (author of Herwig, Matching)
at his home (2024)



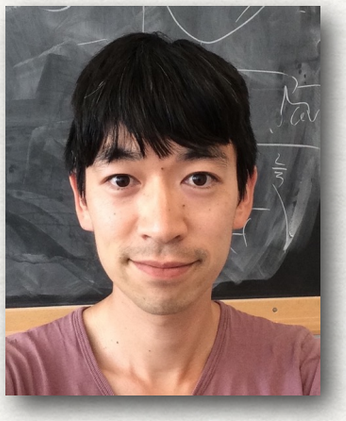
LHC AND IPMU

- First IPMU workshop is actually on LHC Physics.
- good students of Murayama-san and Yanagida-san (Tobioka, Harigaya, Fukuda)
- Helping them by installing Xcode, gfortran and various toolkits, and fix the computer problem. It is transition time from fortran to C++, and less transparent.
- We invited lots of key players of collider physics to IPMU. Like Bryan Webber, Johan Alwall, Jay Wacker, Gavin Salam…

Kosaku Tobioka



Harigaya



very first conference of
IPMU
1. Dec, 2007(Hitoshi, Seong Chan Park, Sumino, Takuchi, Hamaguchi)
2. Jun, 2008 (Jing Shu, Kazuki Sakurai, Tsutomu)
3. Mar 2009 (mass determination)
4. Nov 2009 (QCD)
5. Sep 2011 IPMU-YITP School
6. 2013 Collider School 7 Sep 2015 RunII

Focus week : Facing LHC data

Dates: Dec 17 to 21, 2007

Contact: Mihoko M. Nojiri (nojiri _at_ kek.jp)
(_a_ should be replaced by @)

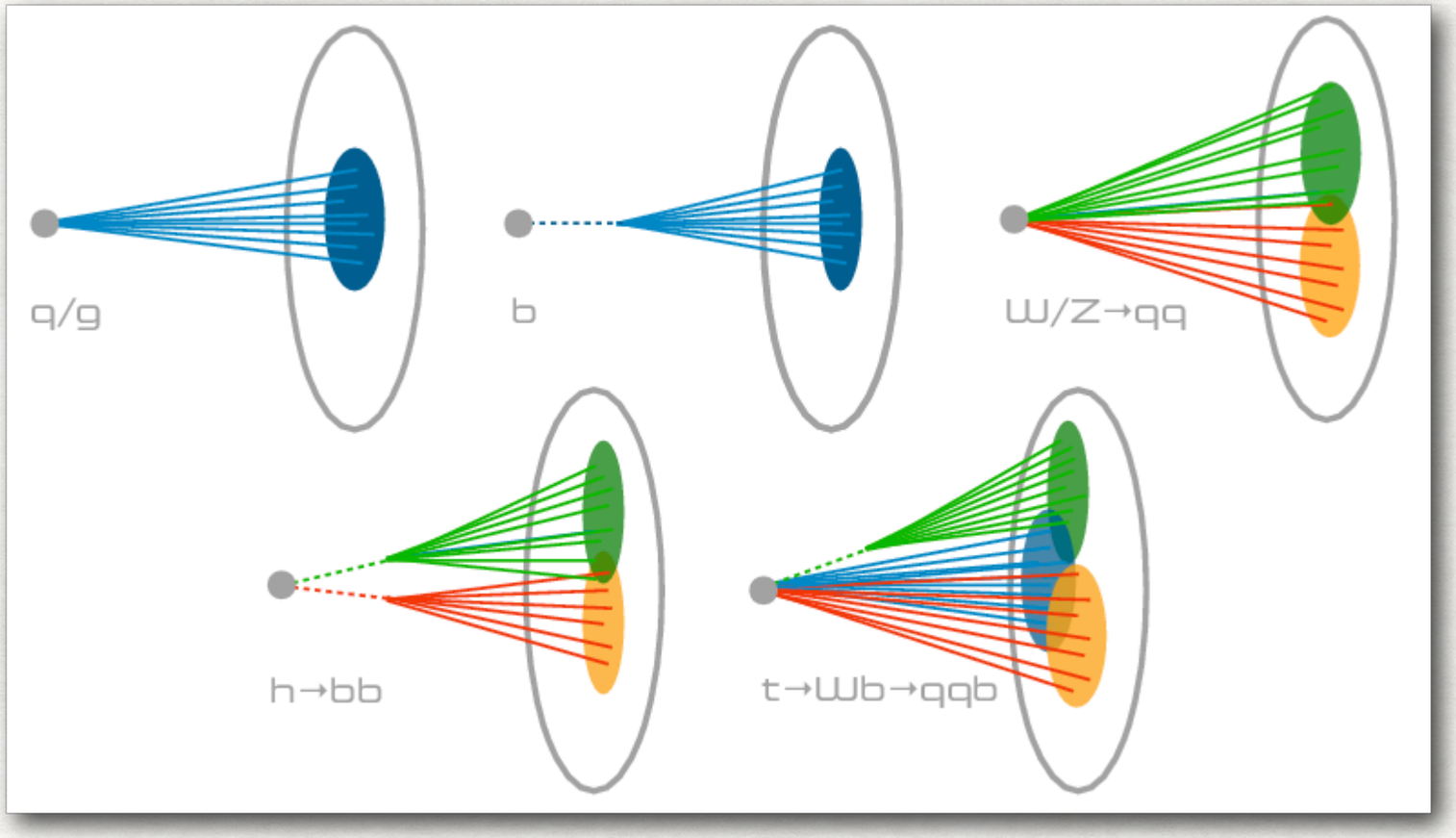
The meeting aims to discuss the issues related to the discovery of the new physics signature at LHC, ideas to measure the parameters, identify
experimental and theoretical reality that should be overcome by the start of the experiments. Following researchers are agreed to come.

Teruki Kamon (Texas A&M)
Tomasso Lari (Milan)
Patrick Meade (Harvard)
Tilman Plhen (Edinburgh)
Giacomo Polesello (Pavia)
Maxim Perelstein (Cornell)
Steffen Schumann (Edinburgh)
Jay Wacker (SLAC)
C.-P. Yuan (Michigan State)

STARTING MACHINE LEARNING→DEEP LEARNING.

- Jet Identification

+global QCD structure of the events



In IPMU, We applied ML to use the jet structure information to select interesting quark jet from heavy particle decay.

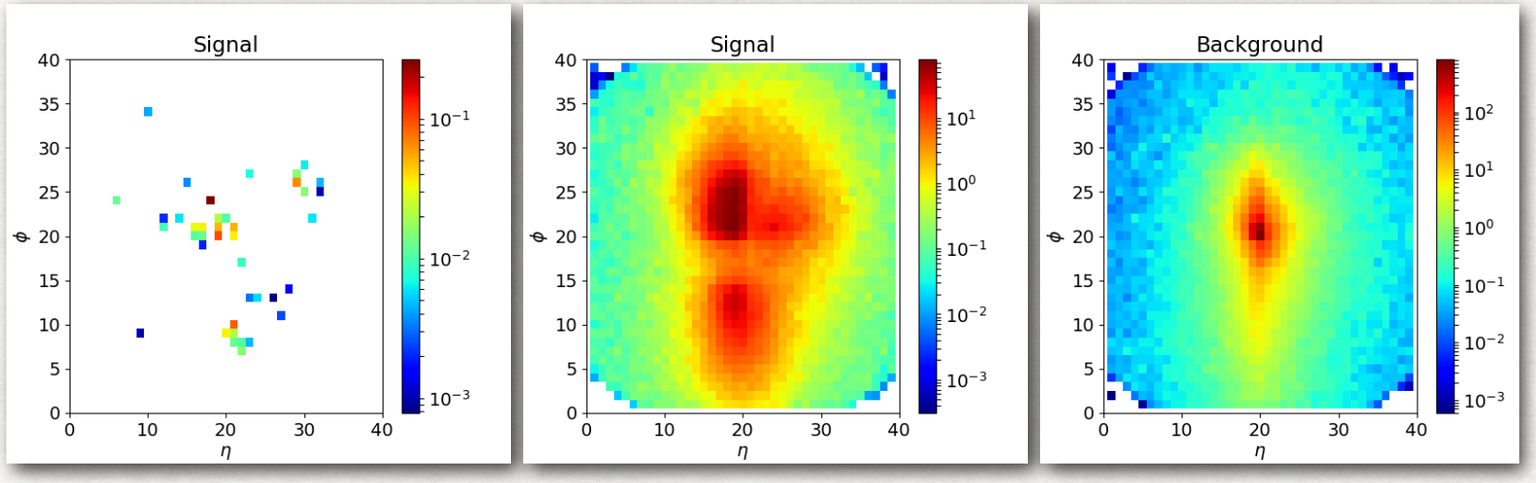
"Associated jet and subjet rates in light-quark and gluon jet discrimation" JHEP 04(2018) 131

"Quark -gluon discrimination in the search for gluino pair production at the LHC" *JHEP* 01 (2017) 044

Biplop

Satya

JET RECONSTRUCTION WITH DEEP LEARNING

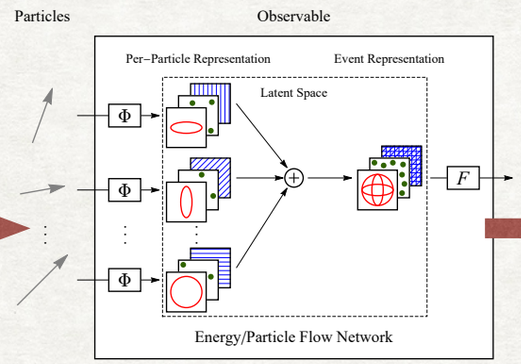


high energy top quark
is similar to light quark and gluons
but there is some difference

Jet as Image

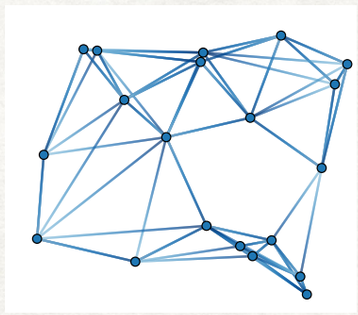
CNN(2014)

as sets



permutation invariance
(stable)
Easy to implement
QCD "values"

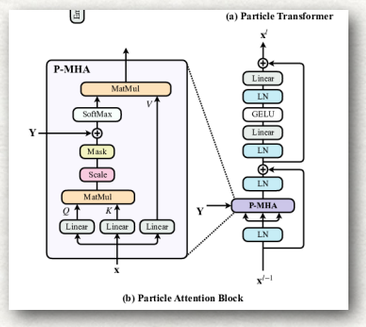
as graphs



sparse data
1902.08570
Particle Net

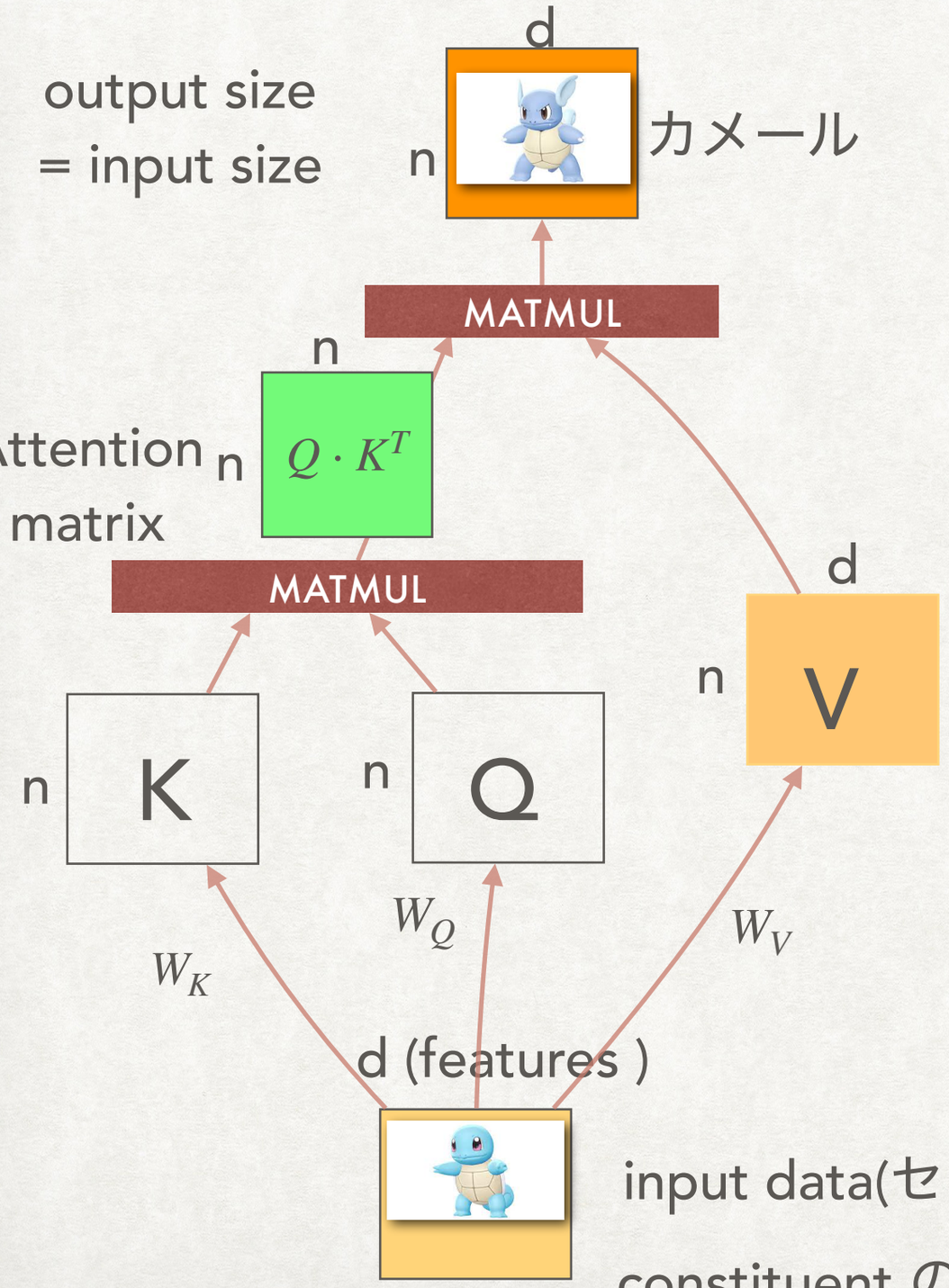
Lorentz net
(Graph respect special relativity)

transformer



building key
and query
2202.03772

“TRANSFORMER” :SELF ATTENTION LAYERS

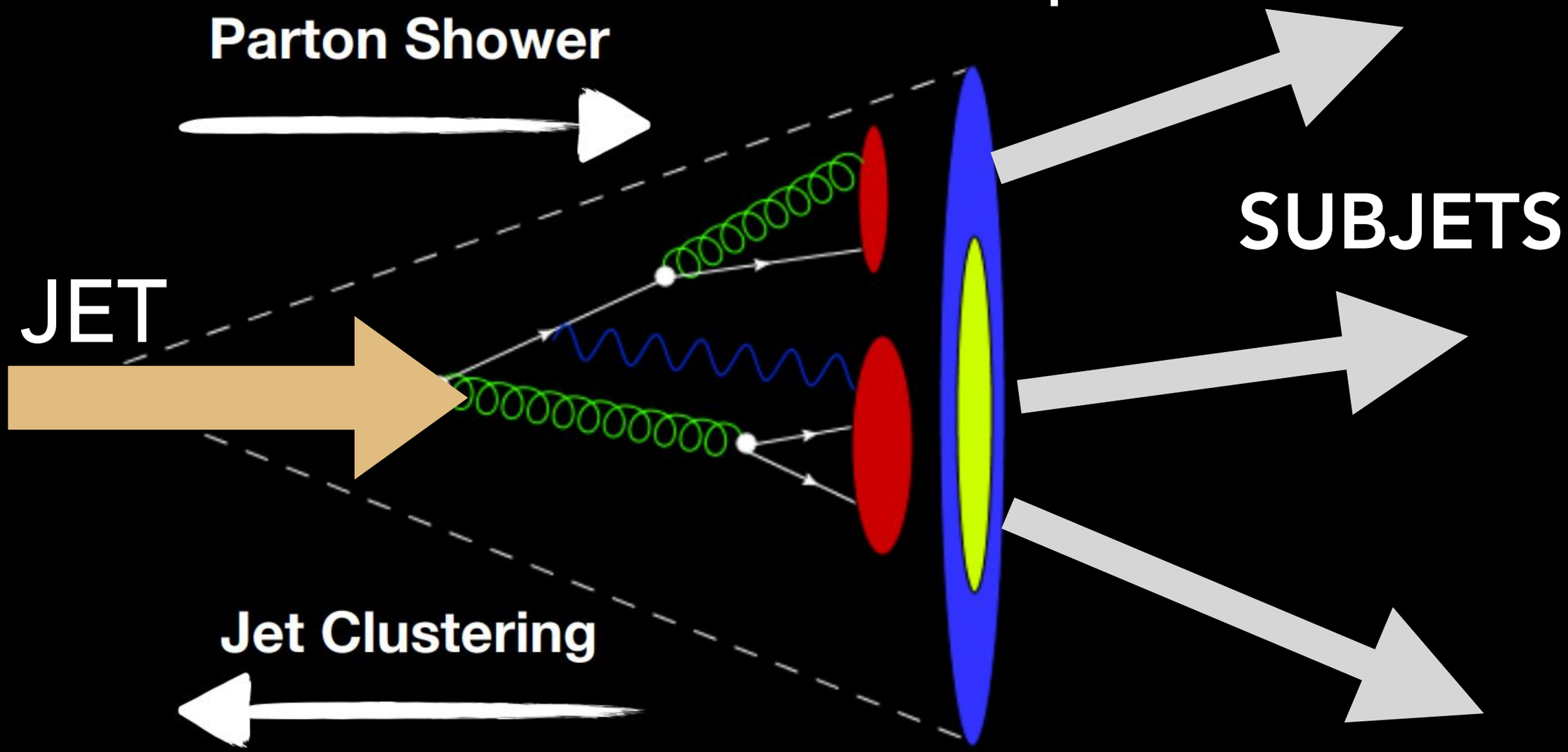


$$\text{Attention}(Q, K, V) = \text{softmax}(\frac{QK^T}{\sqrt{d_k}})V$$

- core of transformer is attention matix.
- calculate correlation of all inputs
- **input and output is same**
- **evollution X → X′→X″**

ATLAS and CMS will have jet trigger using transformer

what is the connection to this picture??



QCD community have developed sofisticated thoeretical treatment about this.

PHYSICS BEFORE NETWORK

- Ahmed Hammad Mihoko Nojiri *JHEP* 06 (2024) 176 2404.14677
- Ahmed Hammad, Stephano Moretti, Mihoko Nojiri *JHEP* 03 (2024) 144 2401.00452

- Hard Process = Partons(quarks and gluons) {y}
- a jet: P(hadrons in jets | parton ~ jet) = $P(\{x_i\}|\{y\})$
- jet with substructure $P(\{x_i\}|\{y_\alpha\})$

jet functions

pdf

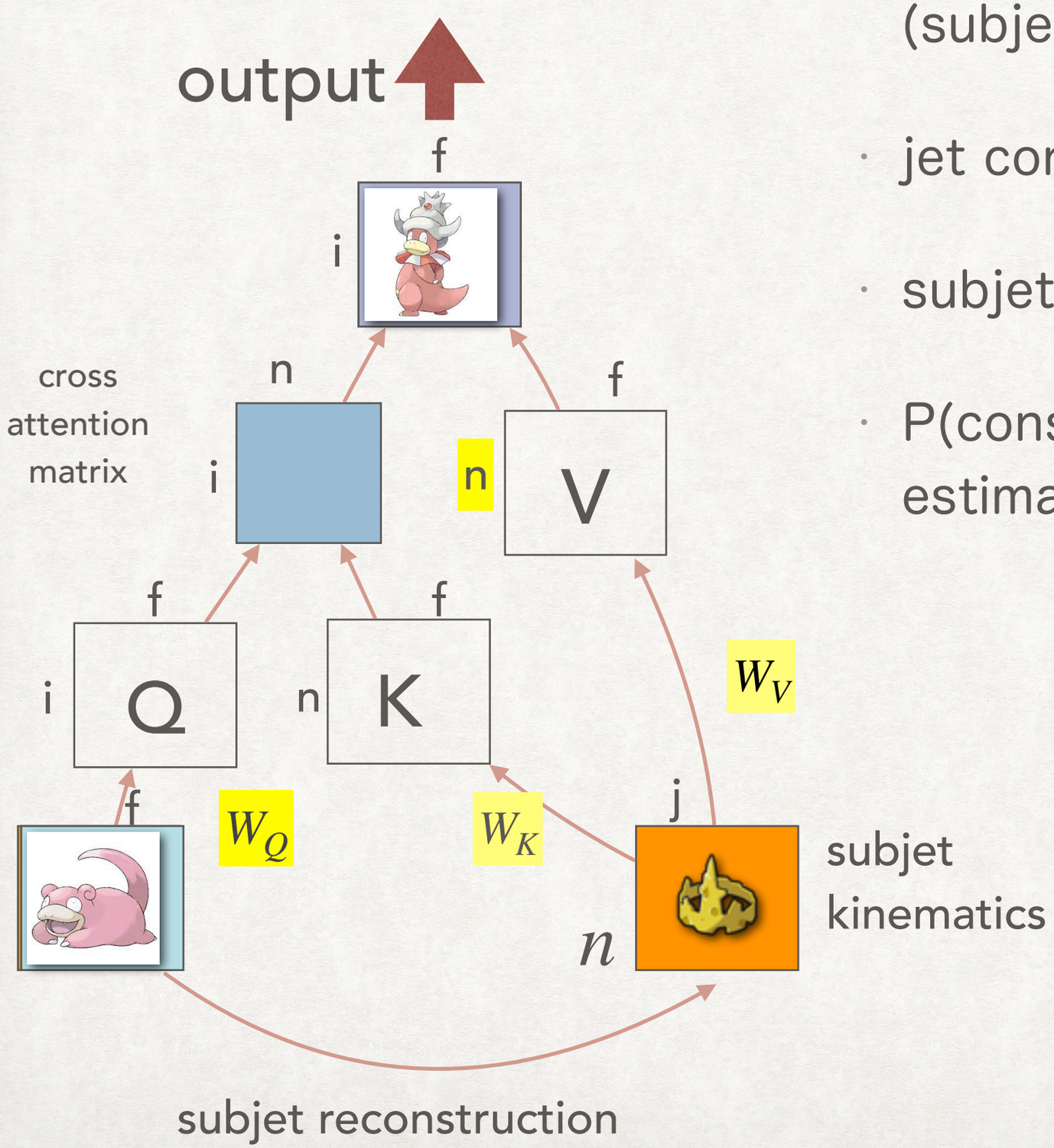
hard process

$$\sigma(pp \to a,b \to N\text{jets}) \sim H_N \left[B_a B_b \prod_{k=1}^{N} J_k \right] \otimes S_N \,,$$

Soft contribution

depends all subjets

CROSS ATTENTION LAYERS



- restrict network to cross attention (subjet) x (jet constituent)
- jet constituent Q
- subjet→ K, V : parton shower
- P(constituents | subjet~parton) is estimated efficiently

Performace comparable to Particle Transformer but much faster and lighter

Models	AUC	R50%	#Parameter	Time (GPU%)
ParT	0.9858	413+-16	2.14M	612
Mixer+subjet (CA)	0.9856	392+-5	86.03K	33
(AK)	0.9854	375+-5	86.03K	33
(HDBSCAN)	0.9859	416+-5	86.03K	33
LorentzNet	0.9868	498+-18	224K	
PELICAN (Lorents	0.9869	-	45K	-

*Subjet cone size R=0.3

*HDBSCAN is algorithm without distance measure

APPLICATION 2
TOWARD GLOBAL EVENT ANALYSIS

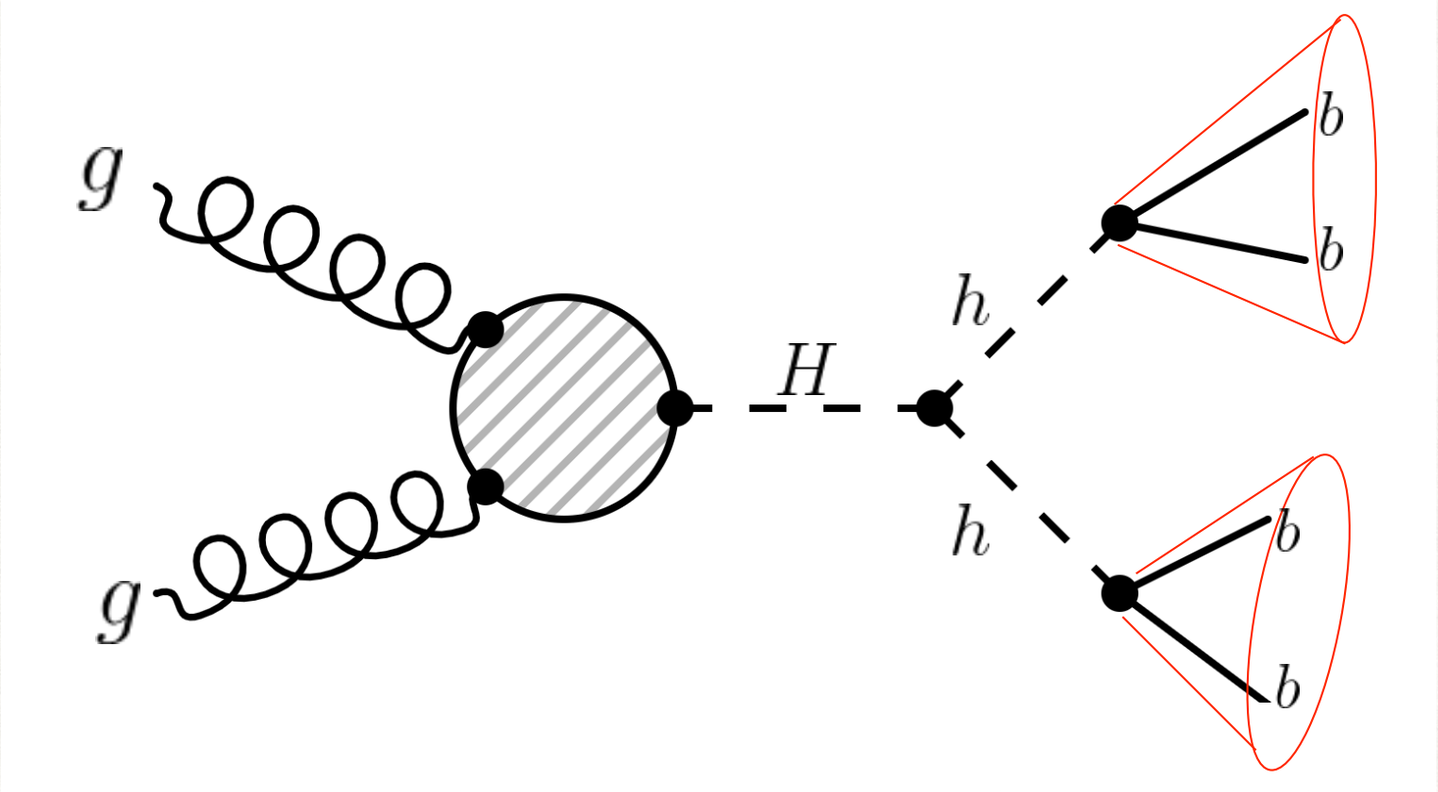
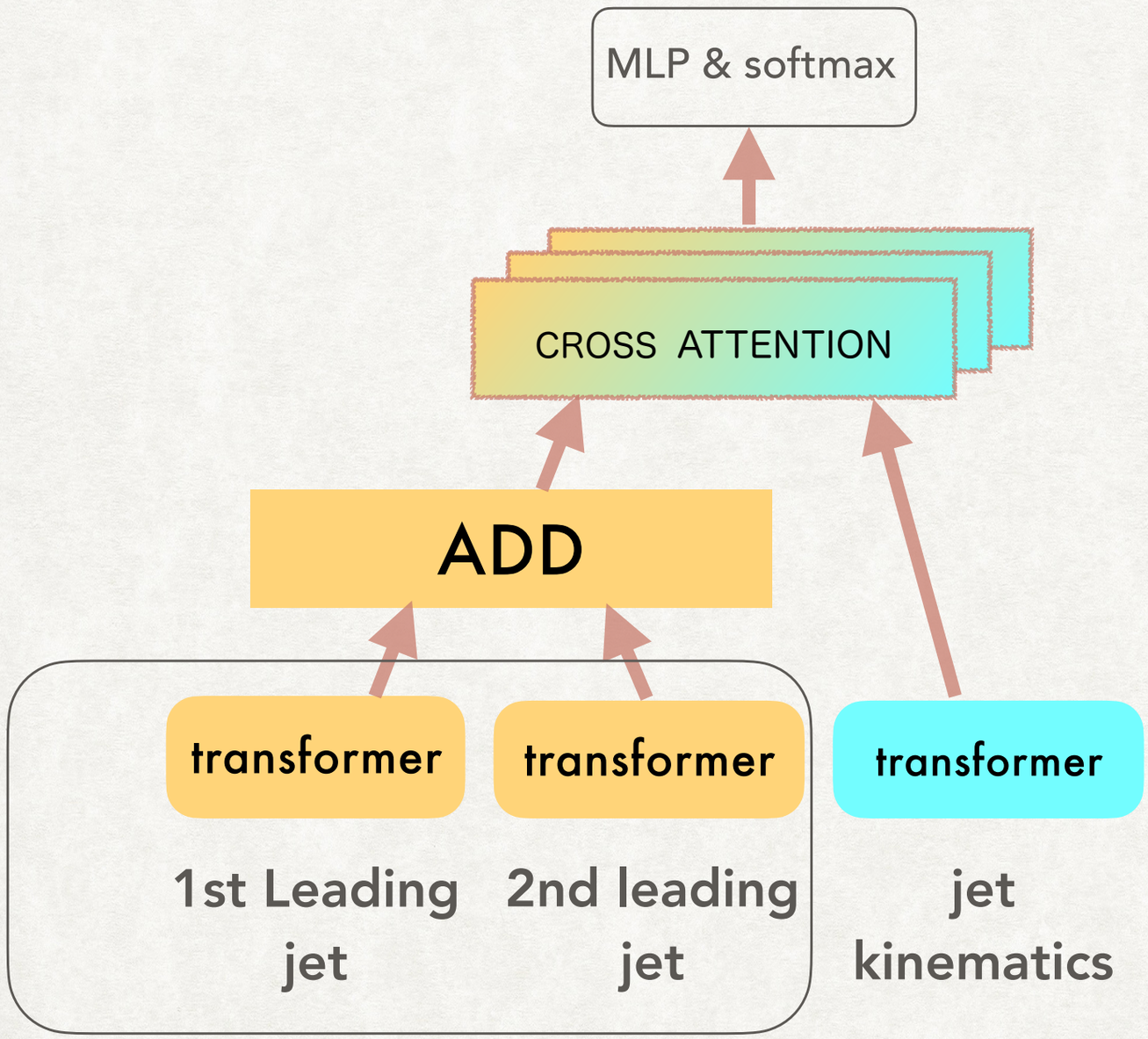


Figure 2: Feynman diagram for the signal process.

cross attention motention for 2 fatjet events



step 2 :multi-head cross attention
transform jet kin by
cross Att. [substracture]x [jet kin]

step 1 : multi-head self attention
[substructure]x[substructure]
[jet kin]x [jet kin]

Hitoshi,
Welcome to the Club,
Happy Birthday,
Happy Christmas