

High Energy Theory Group Activities

BNL-Symposium

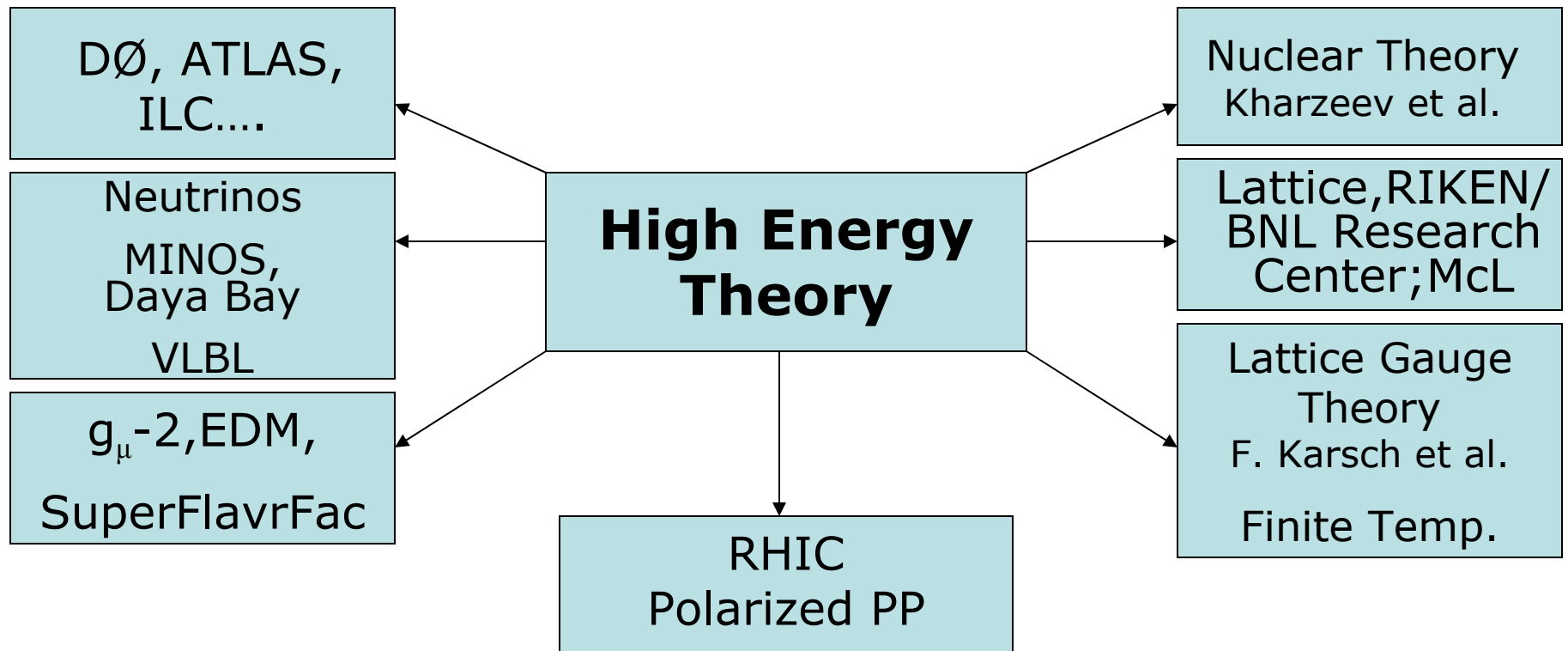
10/2/07

OVERVIEW

- **VERY BROAD in SCOPE**
- **VERY INTIMATELY LINKED to EXPERIMENTS**

Breadth of Scope

HET is playing an important role in many physics dept. activities



Unique Environment

Extremely Diverse Research Program

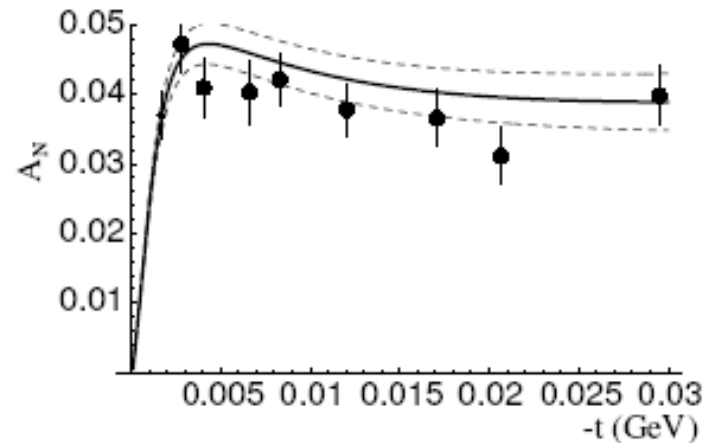
- LHC Collider Physics: **Paige, Kilgore**; Davoudiasl, Dawson, Soni, **S. Gopalakrishina, C. Jackson (J.Kile)**
- Perturbative QCD: Kilgore, Dawson, **C.Jackson (C.Sturm)**
- Electroweak Physics (Precision, Rare, Low Energy, Neutrinos): Marciano, **(J.Kile)**
- Rare K, B : Soni
- Polarized Protons (QCD at RHIC): Trueman
- **Astroparticle-Cosmology: Davoudiasl**
- Lattice Gauge Theories: Formalism and Phenomenology (RB(R)C): Creutz, Soni, **E.Scholz**

Glimpses of some recent research

Made P , ω , f , ρ , a_2 Regge fit to low $-t$ data

Compare with new pp polarization data at 24 GeV from RHIC.

Data and fit agree to $\sim 10\%$.



Agreement close to 5% goal for RHIC SPIN program: measure polarized parton distributions, study W, Z production etc.

Tale of Two Numbers: Combined data on $\sin^2 \theta_W$, M_W , M_Z , and M_t consistent with Standard Model. Imply light Higgs, $M_H = 85_{-28}^{+39}$ GeV and $S = -0.13 \pm 0.10$, severely constraining new physics.

But two best measurements of $\sin^2 \theta_w$, A_{LR} from SLC and A_{FB}^b from LEP, are inconsistent by $\sim 3\sigma$:

$$\begin{aligned}\sin^2 \theta_W &= 0.2307(3) & A_{LR} \\ \sin^2 \theta_W &= 0.2320(3) & A_{FB}^b\end{aligned}$$

A_{LR} is quite consistent with supersymmetry.

A_{FB}^b value implies $M_H \sim 500$ GeV, $S \sim 0.45$, and $T \sim 0.65$. About what is expected in Technicolor models!

Existing data cannot resolve this. LHC?

Differential DY @ NNLO (kilgore)

- **$pp(\bar{p}) \rightarrow l^+ l^- (\gamma)$ of crucial importance**
- **Need for ever greater precision**
- **Potential impact on many measurements**

at the Tevatron and LC such as W-mass measurement, forward-backward asymmetry, LHC luminosity monitoring via W/Z production rates

SUSY QCD Corrections to Higgs+b Production @ Tevatron

S. Dawson and C.B. Jackson, arXiv:0709.4519

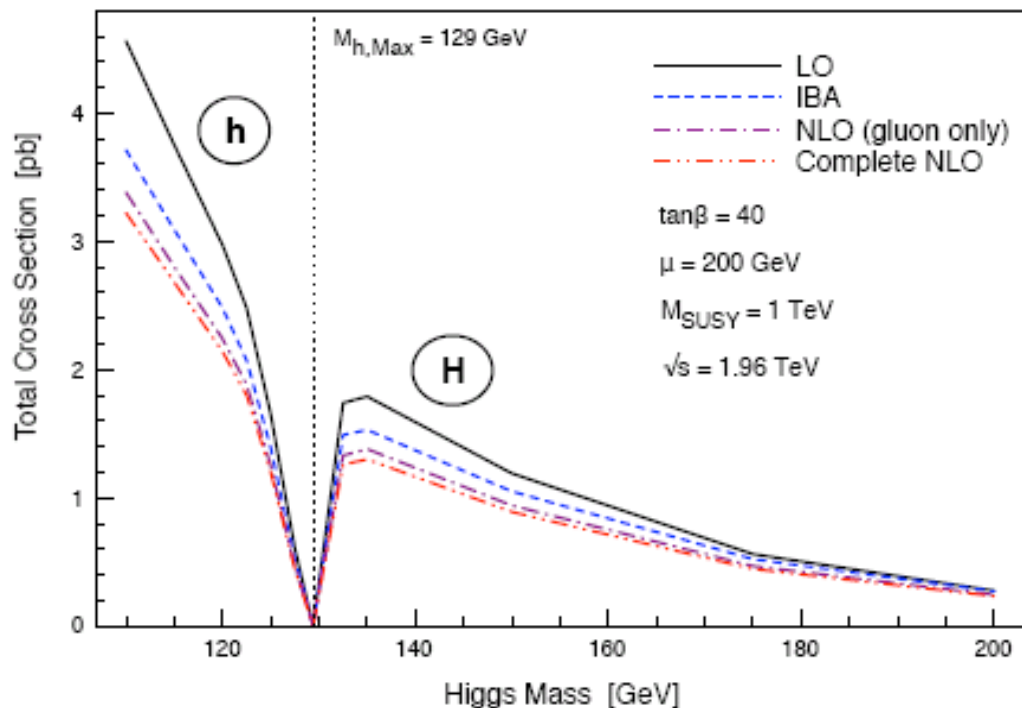
Higgs + bottom production is a **discovery mode** for MSSM Higgs bosons (@ Tevatron and LHC)

QCD corrections to H + b production are **complete** and **fully understood**

We have calculated the **full SQCD corrections** and combined with QCD corrections to obtain **most reliable prediction available**.

Traditionally: SQCD corrections approximated via **effective bbH vertex**

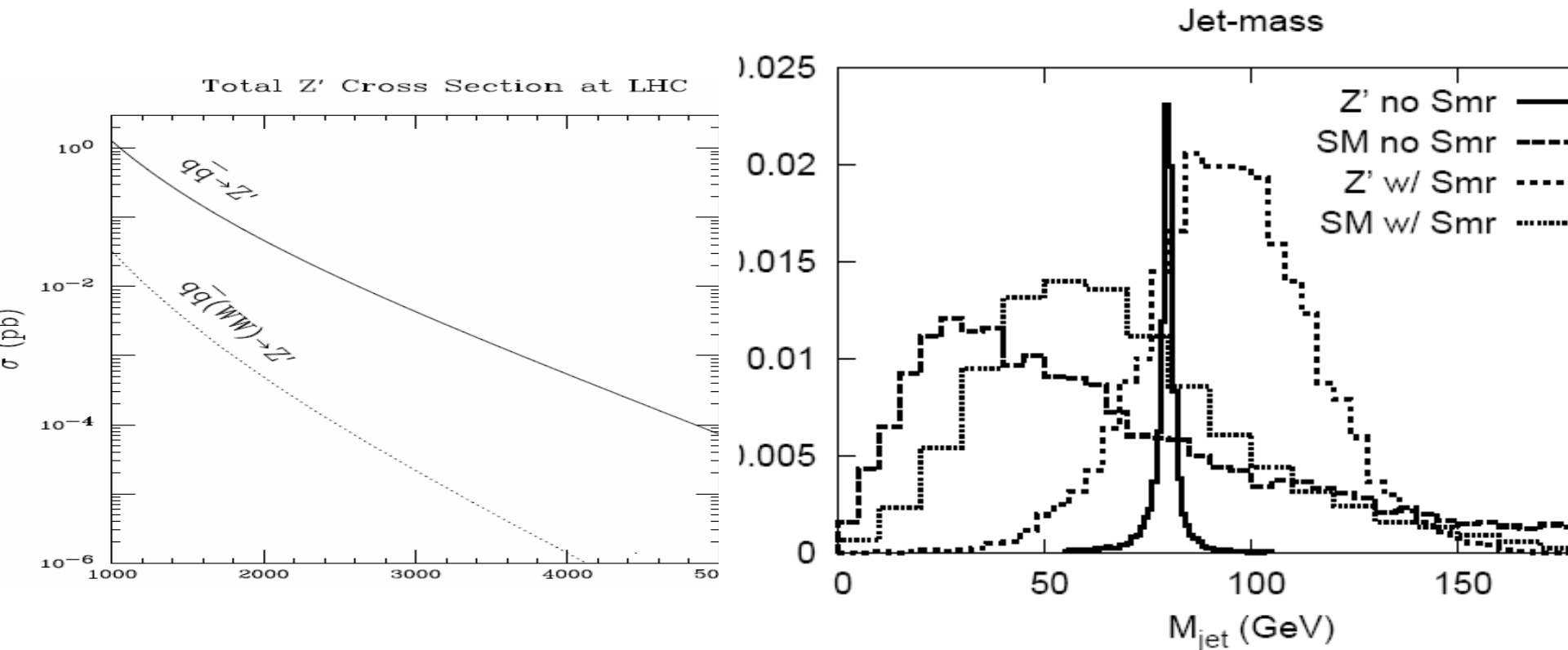
Observe **fairly good agreement** between effective vertex approach, “**NLO (gluon only)**”, and the complete fixed-order calculation (“**Complete NLO**” = QCD + SQCD)



S. Gopalakrishina et.al (arXiv:0709.0007)

Z-Bosons from Warped Extra-Dimension @ the LHC

Z's from RS models of hierarchy & flavor have unique features: couple mostly to pairs of W_L and t_R and not much to light quarks or to leptons



A Tale of 3 numbers

- I) Expt [ϵ_K , B-mixing, $b \rightarrow u\bar{c}v\dots$] + Lattice **WME**
→ $\sin 2\beta_{SM} = 0.78 \pm 0.04$
- II) BF measurements [$B \rightarrow \psi K_S$] = 0.674 ± 0.026
- III) BF measurements [$B \rightarrow (\varphi, \eta' \dots) K_S$] = 0.52 ± 0.05
- → *Deviations 2.8(II-III) - 3.5(I-III) sigmas*
- → *new particle(s) with masses*
~0.3 to 3 TeV with at least 1 new
BSM CP-odd phase

***Constraining unparticle physics with
cosmology and astrophysics
(Davoudiasl) hep-ph/07053636***

- **Unconventional matter (due Georgi), interacts thru higher dimensional operators with SM particles. Nevertheless, Hooman demonstrates that it has significant impact on big bang nucleosynthesis & supernova data which is used to stringently constrain model parameters.**
- **(PRL to appear soon; already has >40 citations)**

Ideas for near future

LHC (huge gorilla) on our minds

Through day to day research and otherwise it is imperative that we position ourselves so that we can speedily respond to discoveries

- **Periodic Joint HET/ATLAS Lunch Seminars**
 - **Joint (HET/RIKEN/YITP) Seminars with YITP@SB heavily weighted towards LHC**
 - **Brookhaven Forum 2007: New Horizons @ Colliders (May30-June 1, 2007) New Wkshp series initiated.**
- BF'08 is also being planned**
- **Hooman D is playing the central role in all of these**

Note also Loopfest Workshops (Dawson et al) series & Loopfest'09 will focus on LHC radiative corrections

Particle Physics & Cosmology Center(P2C2) ***(SB+BNL)*** ***LDRD Proposal (HD+AS)***

- **Mindful of:**
- **Importance & timeliness of this interdisciplinary field**
- **“vacuum” at BNL**
- **Local available expertise in Particle & Nuclear Physics**
- **Onset of LHC & also era of precision cosmology**
- **Relevance of RHIC to early universe**
- **BNL/SB BlueGene/L can be usefully exploited for relevant numerical simulations which can flourish rapidly alongside existing lattice simulations**
- **post-doc + few visitors/yr +wkshp ...modest start**

RBC plans

- From the outset RBRC & HET via RBC has had an important overlap through lattice.
- Numerous RIKEN Fellows (e.g. Blum, Dawson, Izubuchi...), post-docs and dozens of Columbia students work very closely with A.S & moved on to successful careers....
- RIKEN-BNL-Columbia collaboration very likely to acquire much more powerful hardware in the next few years
- QCDSP (~1 Tf)'98; QCDOC (~10 Tf)'04
- -> ~20 X computing power than QCDOC
- **MUST POSITION OURSELF TO MAKE THE BEST USE OF THIS PRECIOUS RESOURCE FOR PRECISION CALCULATIONS.**

EXPECT LATTICE QCD to stay relevant to the LHC era... (more in Creutz's talk)

Summary of near future plans/ideas

- **Anxiously look forward to LHC data:**
- **HET has been enhancing existing expertise in this important area to speedily exploit emerging opportunities.**
- **Strive also to remain active in other areas:**
- **Low-energy precision physics**
- **Neutrino physics**
- **Lattice gauge theory**
- **Will like to build a cosmology-astroparticle connection esp. with numerical simulations, given existing links to lattice ; P2C2 proposal**