SPC Summary

BSM - Energy Frontier
USQCD proposals, 2017

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BSM within USQCD

Almost all HEP-USQCD effort is related to BSM physics

What falls in the **BSM - Intensity Frontier** category?
- Strongly coupled models that are BSM candidates
  - Dilaton-like Higgs ✓
  - pNGB-like Higgs ✓
  - models where walking is tunable ✓
  - models with partial compositeness ✓
  - models with 4-fermion interactions
    - ...
- Dark matter from strongly coupled models ✓
- Nuclear physics of strongly coupled systems ✓
- Investigations of general conformal systems
  - boundary of conformal window ✓
  - anomalous dimensions ✓
    - ...
- SUSY & AdS/CFT correspondance ✓
- ...

✓ by USQCD

These topics are intertwined
BSM within USQCD

Relatively small effort: 6.5% of all requests,

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Total: (J-psi hrs)
- IF: 21%
- EF: 6.5%
- NP: 56%
- Th: 16.5%
BSM within USQCD

Goal:
understand the (general) properties of models that could describe BSM physics

Synergies:
• Pheno community:
predictions for non-perturbative quantities like
  - hadron spectrum in near-conformal or walking theories
  - anomalous dimensions relevant for mass generation
• Lattice community:
  BSM models are QCD - variants. BSM projects contribute
  - HMC code testing/development (SUSY, Grid code for MDW, staggered w/FUEL)
  - Measurement techniques (disconnected spectrum, spectrum with gradient flow - mixed action studies, step scaling / \beta\ function calculations)
  - Most collaborations will share codes & configurations
2017 USQCD BSM proposals:

**Higgs is dilaton-like state**
- J. Kuti /LHColl : 2 flavor sextet model  
  80.4M Jpsi

**Higgs is pNGB**
- E. Neil : pNGB with fermions in 2 different representations  
  6.1M Jpsi
- O. Witzel /LSD coll : 4+6 flavors  
  24.4M Jpsi

**Conformal FP**
- C. Rebbi : Step scaling function and universality with MDW  
  14.8M Jpsi

**Lattice SUSY**
- S. Catterall/ Syracuse & RSI group: ongoing investigations  
  that even string theorists care about  
  18M Jpsi

**Incite projects:**
- LHColl : sextet
- LSD : 8 flavors, 4+4 flavors (staggered), 4+6  MDW
- SUSY (see J. Giedt’s talk)
• 2-flavor SU(3) sextet model is candidate BSM with
  - only 3 Goldstone pions
  - light Higgs as 0^{++} sigma state

• On-going project; Configurations are generated with Incite &
  other time; Request is for capacity computing on GPU for
  measurements
  - RG β function
  - η-prime through topology - gradient flow
  - mass anomalous dimension (close to 1)
  - spectrum both in ε and p-regime; many on gradient-flowed
    configurations (mixed action)
Gradient flow mixed action spectrum

Spectral density from Chebyshev expansion
E.Neil: Composite Higgs on the Lattice

- First lattice efforts pursuing “composite PNGB Higgs” by Tel Aviv/Colorado

- Higgs boson appears as an exact Goldstone of chiral symmetry breaking; interactions w/EW, top quark generate usual Higgs potential.

- UV completions of such models (mostly) classified by Ferretti and Karateev\(^1\); simplest model is SU(4) w/ fermions in 4 and 6 irreps

- Initial lattice studies underway (right): meson spectroscopy tests chPT with two irreps. Future results: finite-T, Higgs potential, top partner decay…

1) [https://arxiv.org/abs/1312.5330](https://arxiv.org/abs/1312.5330)

- 6.1M Jpsi, clusters
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• This model is not near an IRFP. It is not expected to show walking or even large anomalous dimensions - those properties should come form a UV completion


6.1M Jpsi, clusters
Most BSM systems require large scale separation between IR & UV ("need walking")
Mass split systems with $m_\ell$ light and $m_h$ heavy flavors achieve this
  • the scale separation is tunable by $m_h$
  • UV spectrum is governed by a conformal fixed point of $m_\ell+m_h$
    flavors
    - hyperscaling and high level predictability
  • IR is chirally broken with $m_\ell$ light flavors
Previous study of 4 light + 8 heavy flavors verified these principles

New proposal: study 4 light + 6 heavy flavors with DWF
  • closer to the conformal window
  • correct chiral symmetry is important at the conformal FP that governs the UV behavior
  • use the GRID code for configuration generation

O. Witzel/LSD : 4+6 flavors with DWF

• 24.4M Jpsi, KNL
Goal:

- Investigate the parameter range of 10 flavors in preparation for the 4+6 study
- Study universality of fermion actions at conformal FP with 12 flavors

C. Rebbi: Step scaling study of 10 and 12 flavors with DWF

- 14.8M Jpsi cluster or KNL

New

Step scaling function with $N_f=10$
suggesting the existence of an IRFP
in agreement with Chiu’16
BSM within USQCD

- Small but active community
- There are several new/developing projects, methods
  Waiting for more participants and projects!