Physical Spectra and the Limits of Perturbative Estimates in a Theory with a Higgs

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28th of July 2016
Southampton
England

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$$L = -\frac{1}{4} W^{a}_{\mu\nu} W_{a}^{\mu\nu}$$

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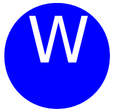
- Ws W^{a}_{μ} 

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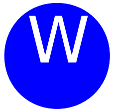
- Ws W_{μ}^{a} 

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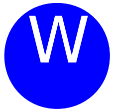
- Ws W^a_μ 

- Higgs h_i 

- No QED: Ws and Zs are degenerate
- Couplings g, v, γ and some numbers f^{abc} and t_a^{ij}

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- Global SU(2) Higgs custodial (flavor) symmetry
  - Acts as right-transformation on the Higgs field only

$$W_{\mu}^{a}\rightarrow W_{\mu}^{a} \qquad h_{i}\rightarrow h_{i}+a^{ij}h_{j}+b^{ij}h_{j}^{*}$$

Physical states

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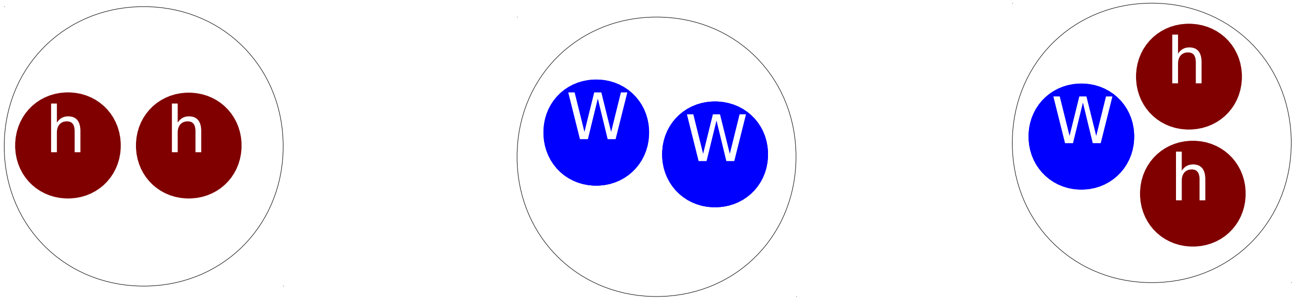

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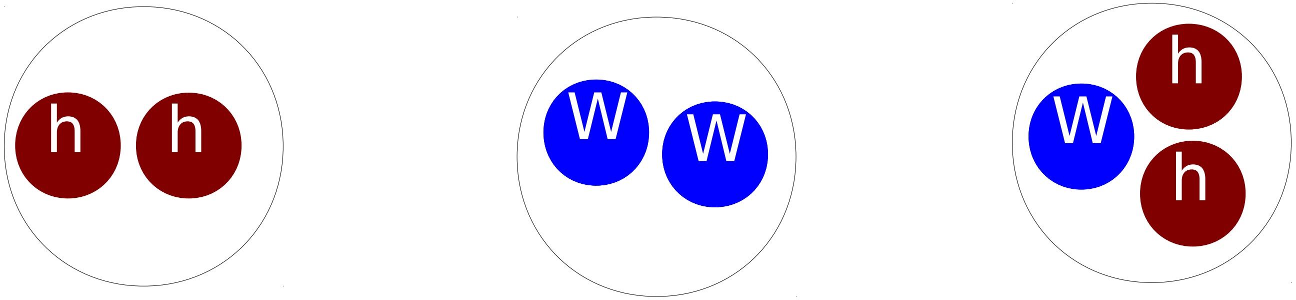

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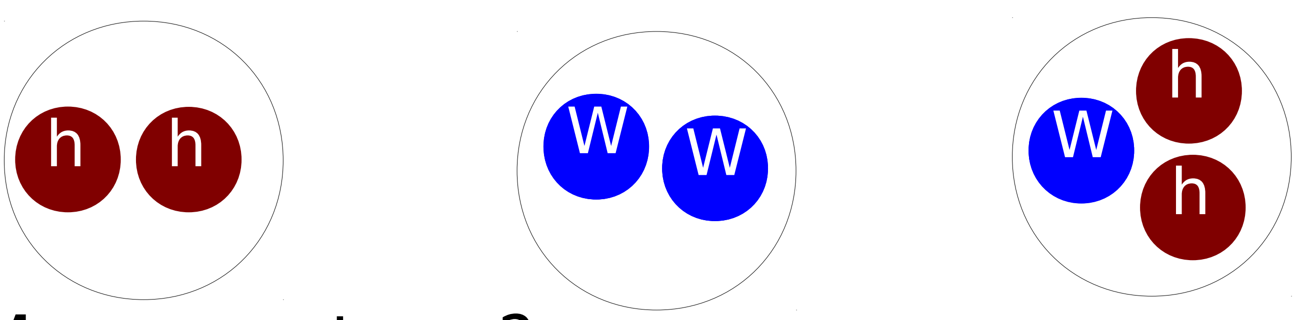

  - Mass spectrum?
  - Why does perturbation theory work?

Mass relation - Higgs

[Fröhlich et al. PLB 80
Maas MPLA 12, Maas & Mufti JHEP 14]

- Lattice result: Lightest 0^+ composite state has the same mass as Higgs at tree-level [Maas MPLA 12, Maas & Mufti JHEP 14]

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  - Perturbative tool to calculate bound state masses
- Deeply-bound relativistic state
  - Mass defect~constituent mass
  - Cannot be described with quantum mechanics

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  - Degeneracy patterns: Local vs. global symmetries
  - Works for 1HDM and 2HDM models [Maas & Pedro PRD 16]
  - May not hold for other theories [Maas MPLA 15, Maas & Törek'15]
    - Talk by Pascal Törek directly afterwards
  - Implications for Technicolor-type theories [Maas MPLA 15]

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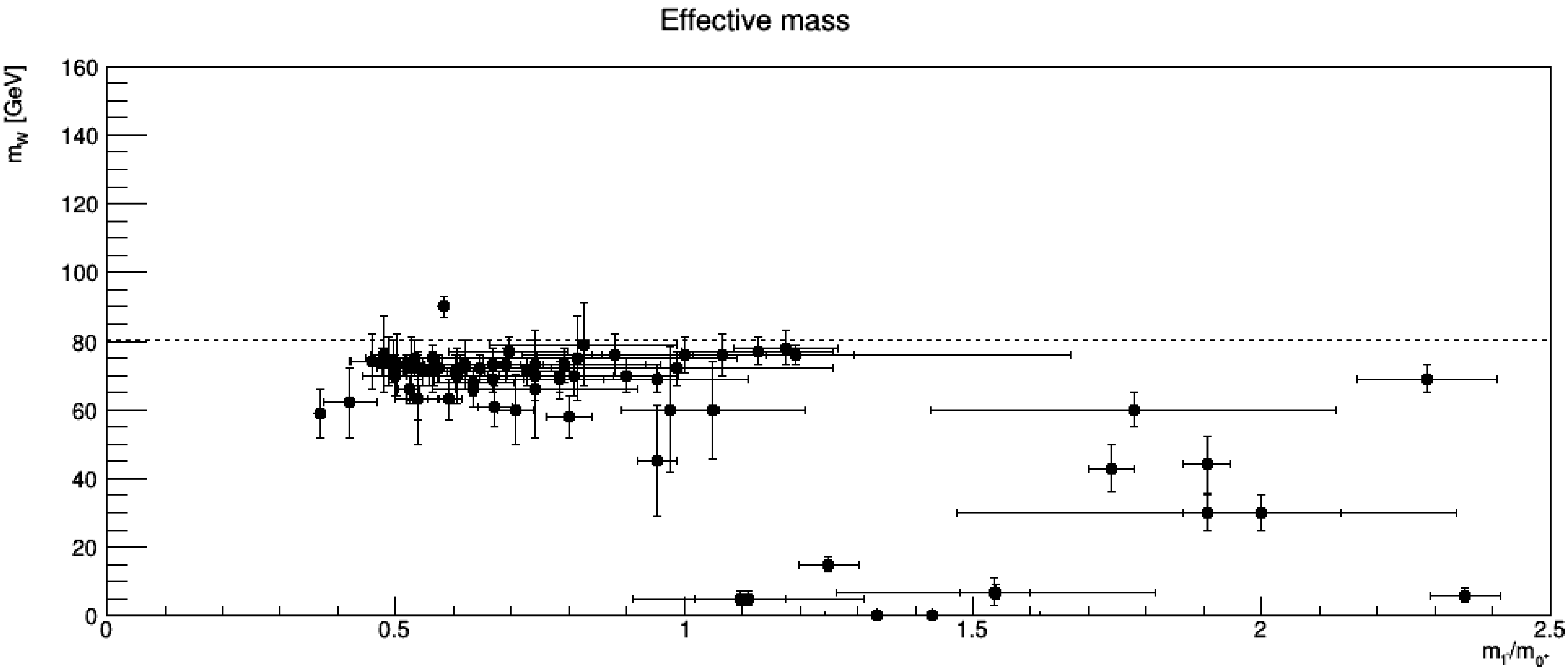
  - Implications for Technicolor-type theories [Maas MPLA 15]
- Dynamical [Maas & Mufti PRD 15]
  - When is this identification possible?
  - When is perturbation theory predictive?

FMS validity

[Maas & Mufti JHEP 14]



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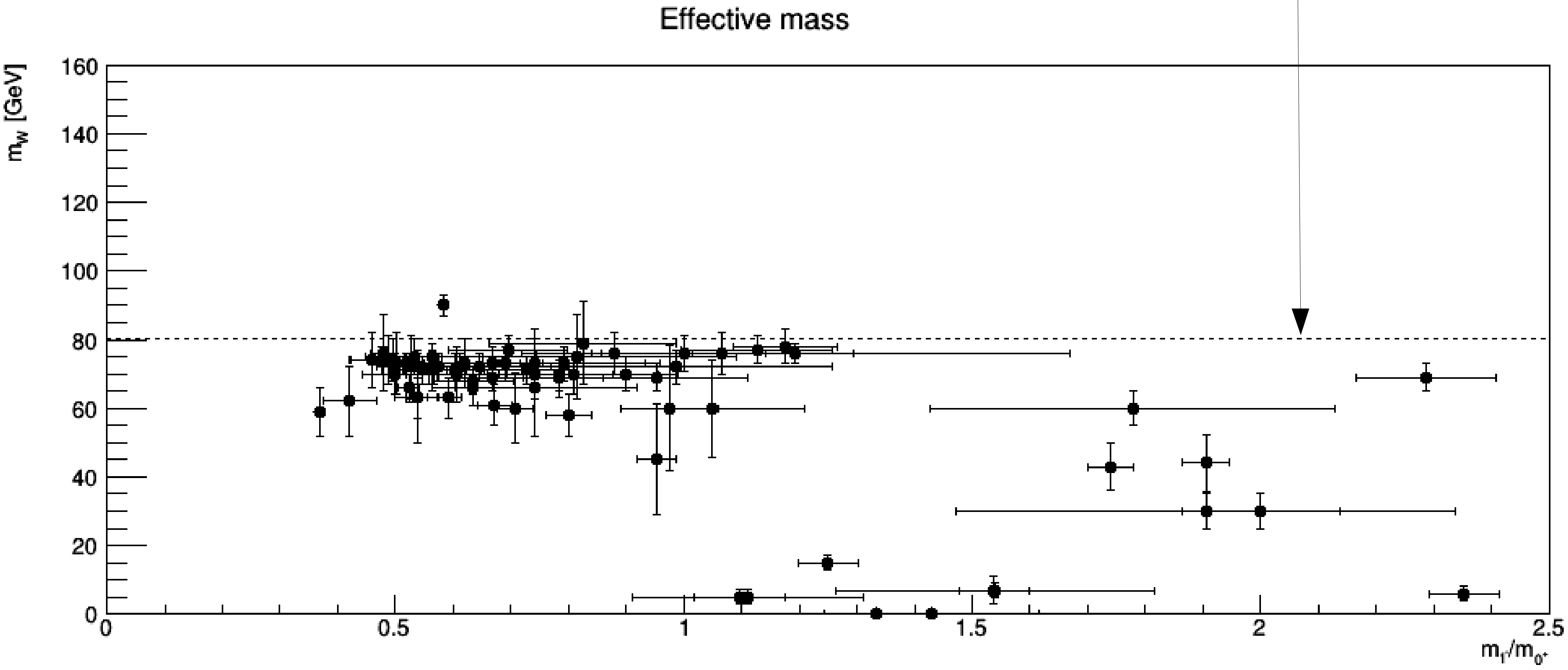

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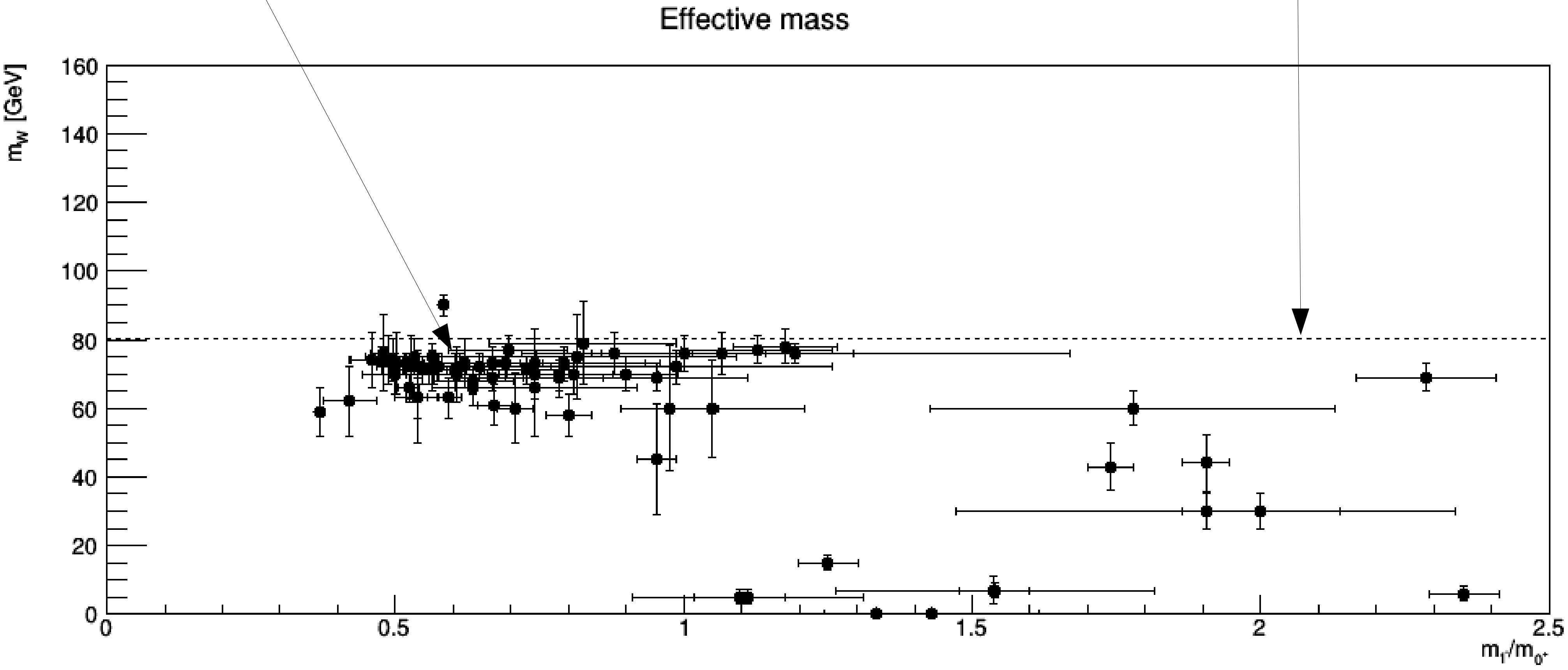

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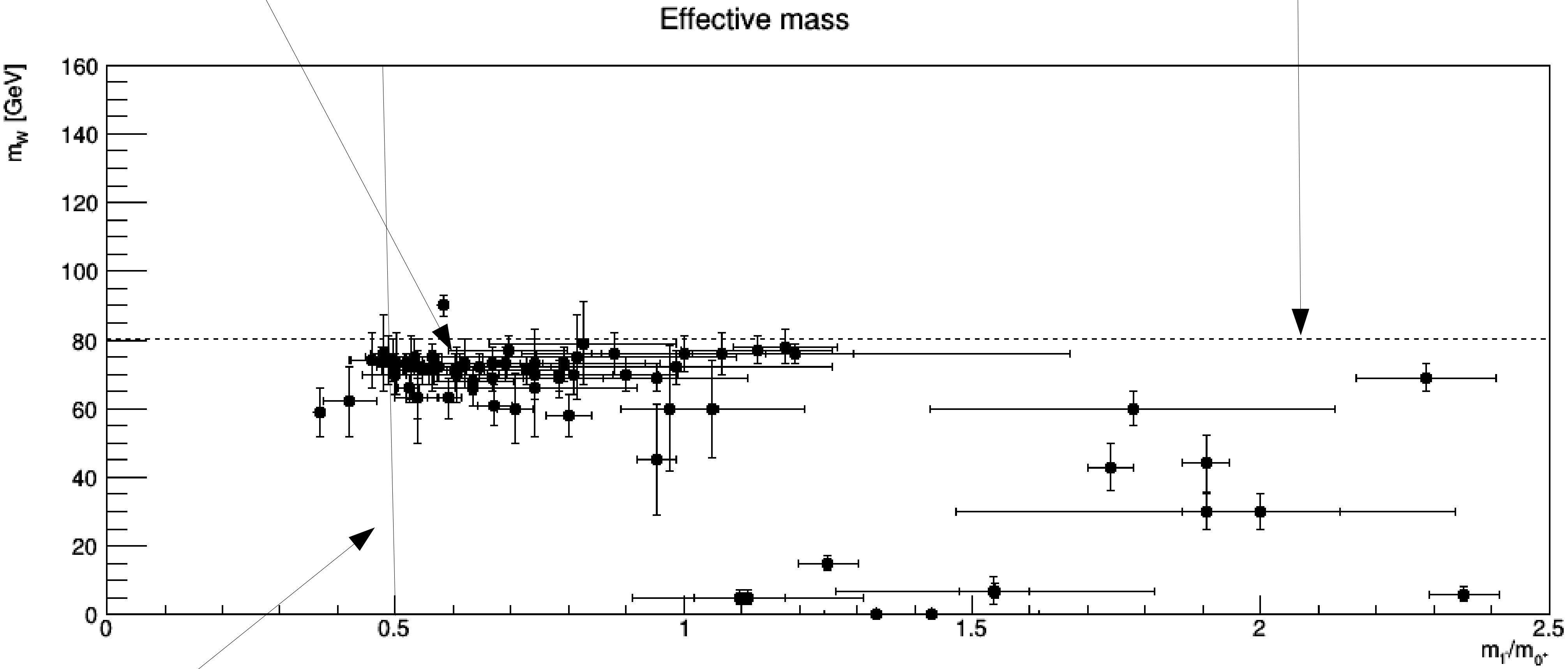

Elastic decay threshold
Higgs as resonance
Expensive, signal very bad

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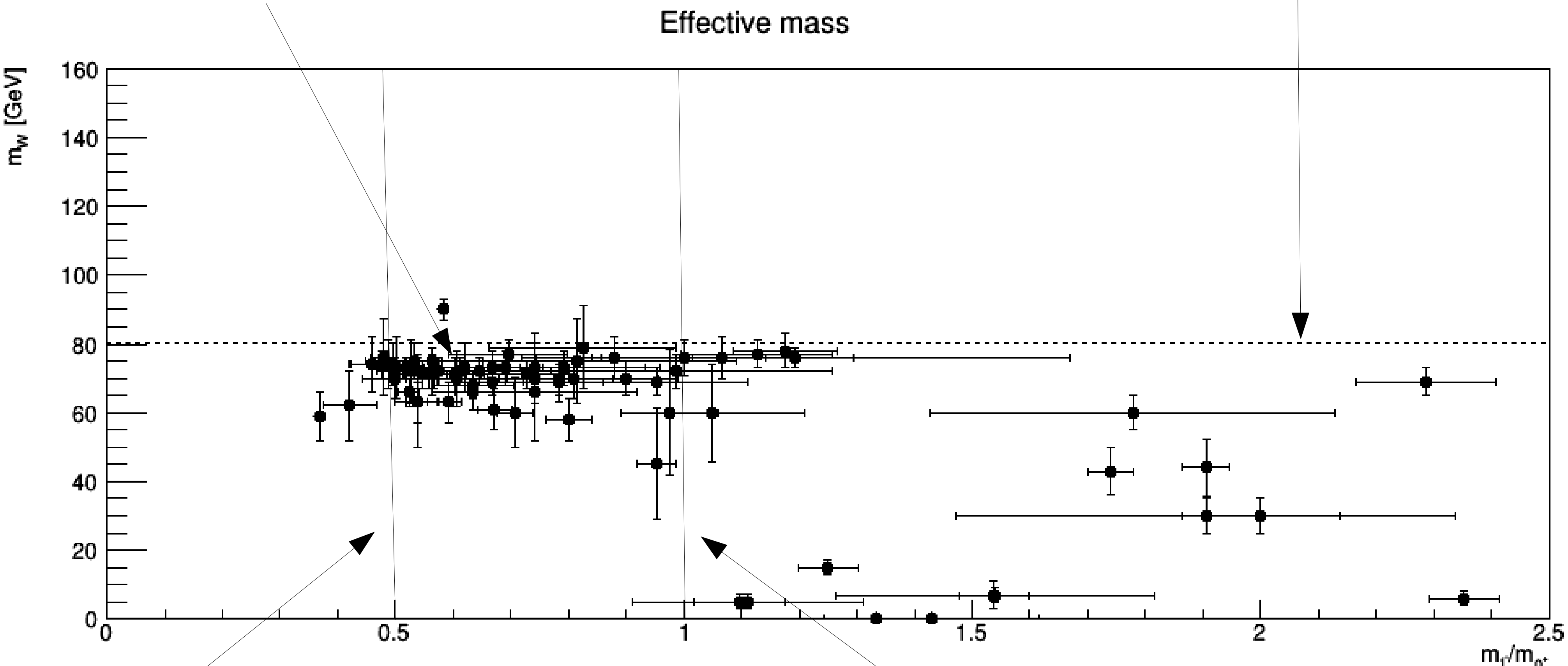

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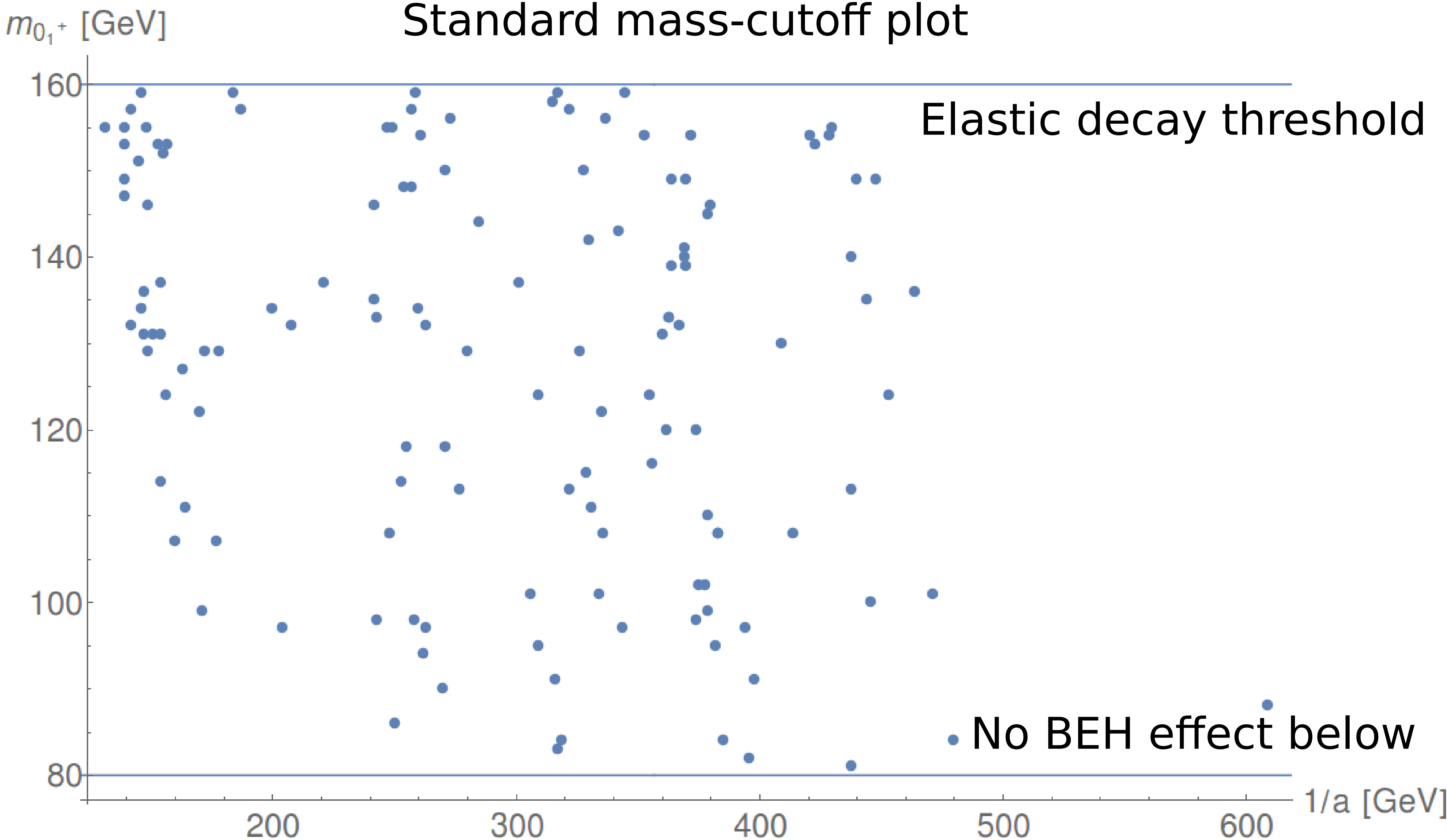
Higgs and W mass agrees
FMS stops working
So does Brout-Englert-Higgs!

Higgs mass

[Maas & Mufti PRD 15]

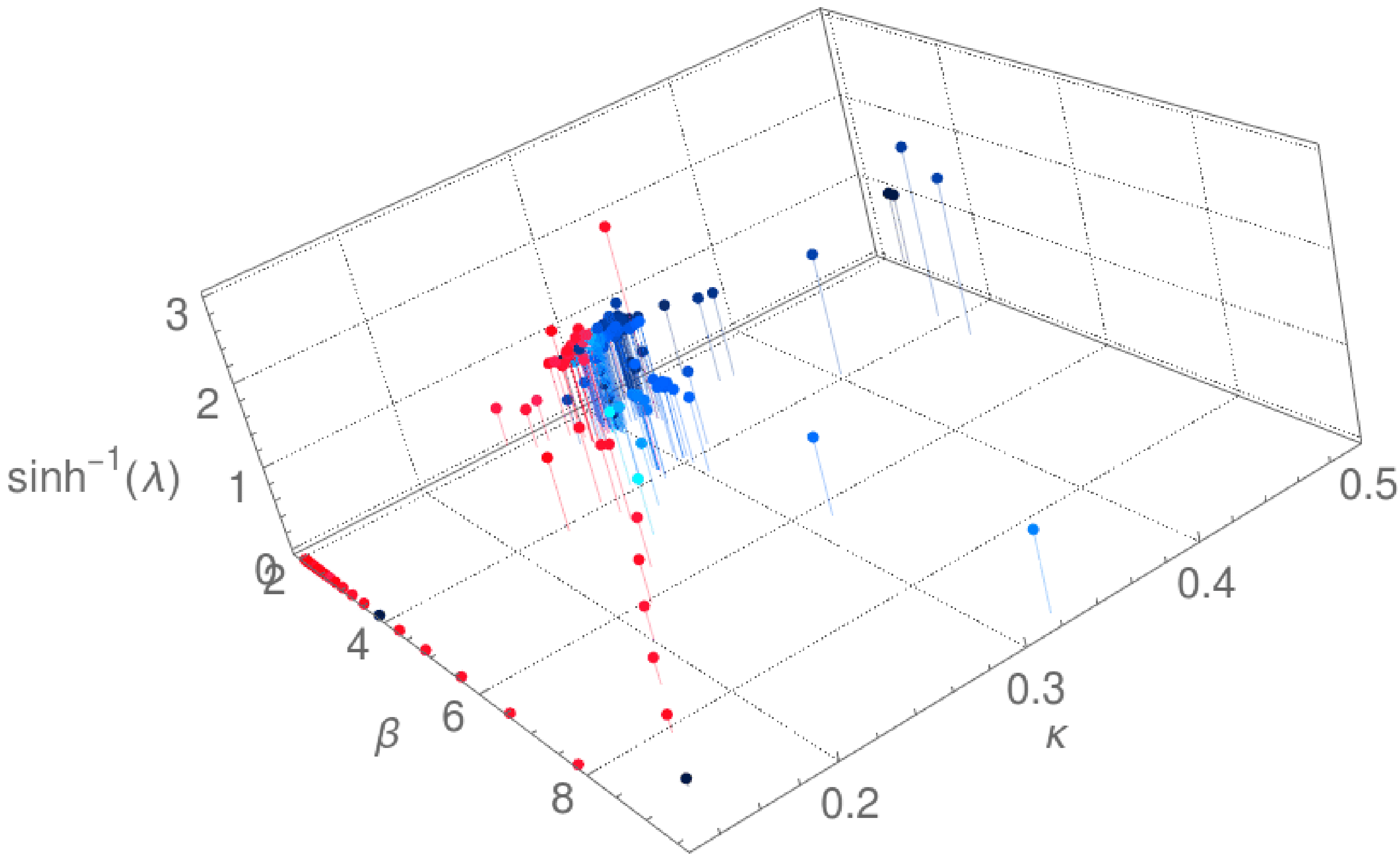
Standard mass-cutoff plot



No strong dependence of mass range on cutoff - expected

Phase diagram

[Maas & Mufti PRD 15]



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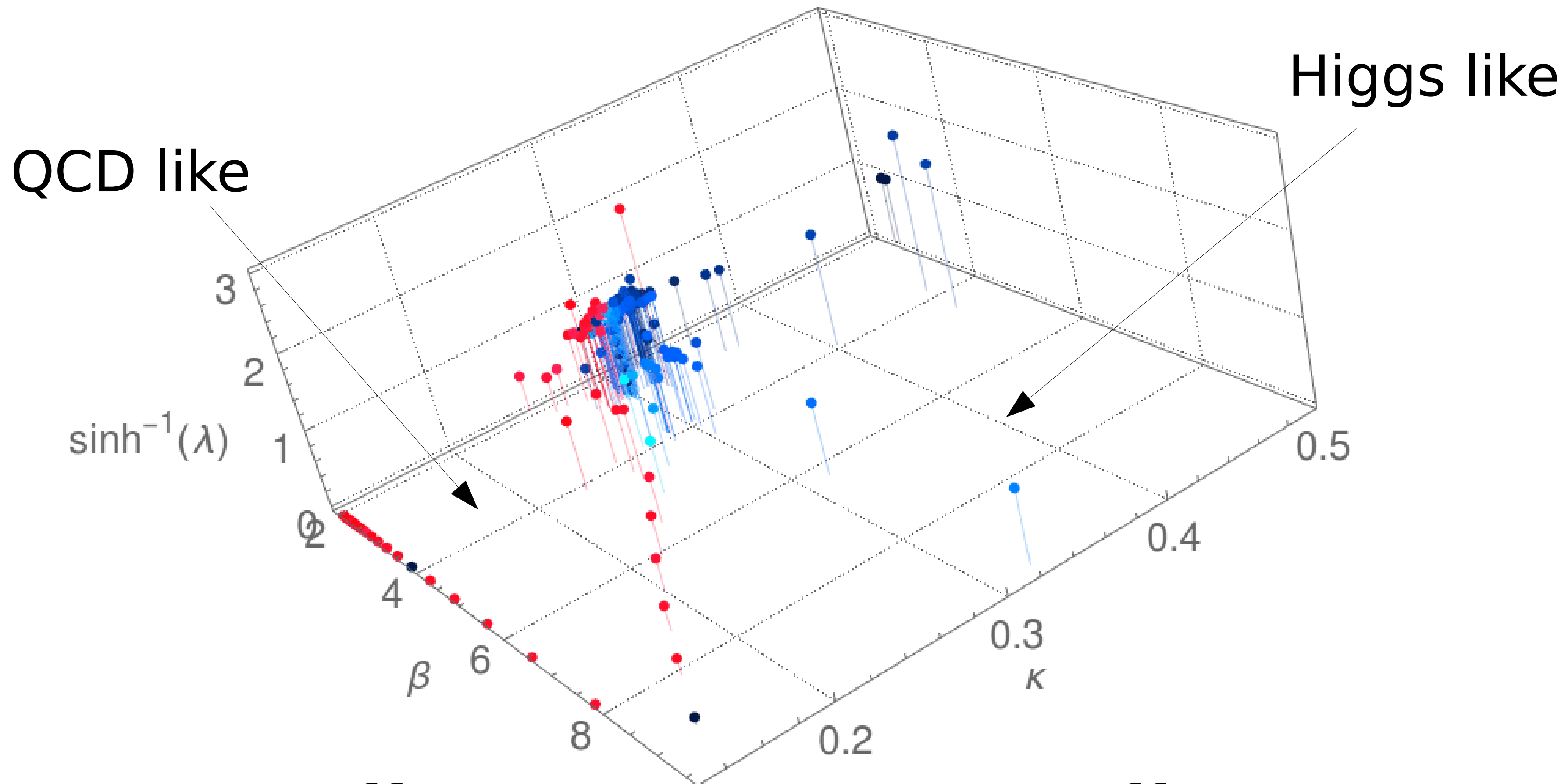

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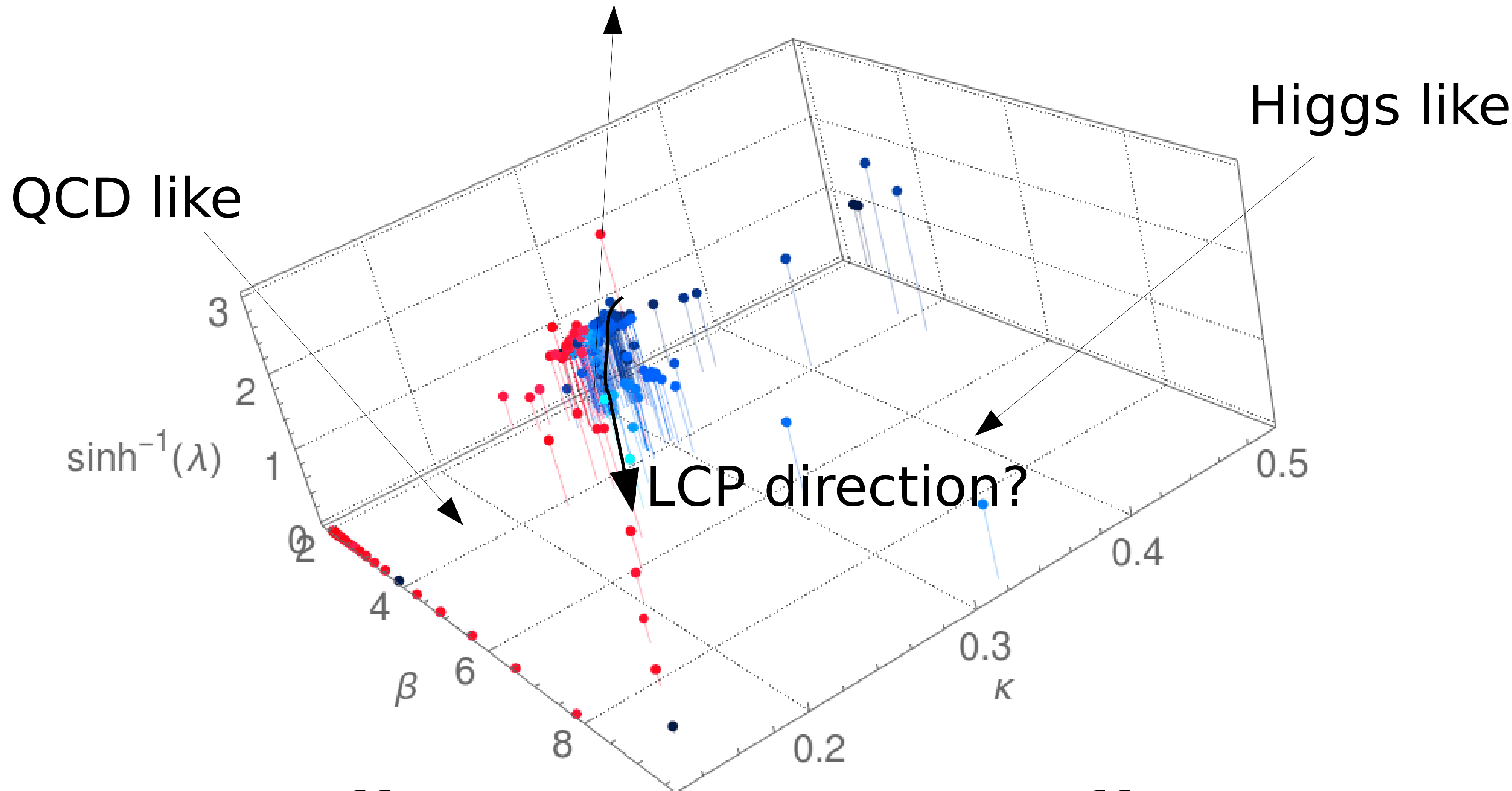

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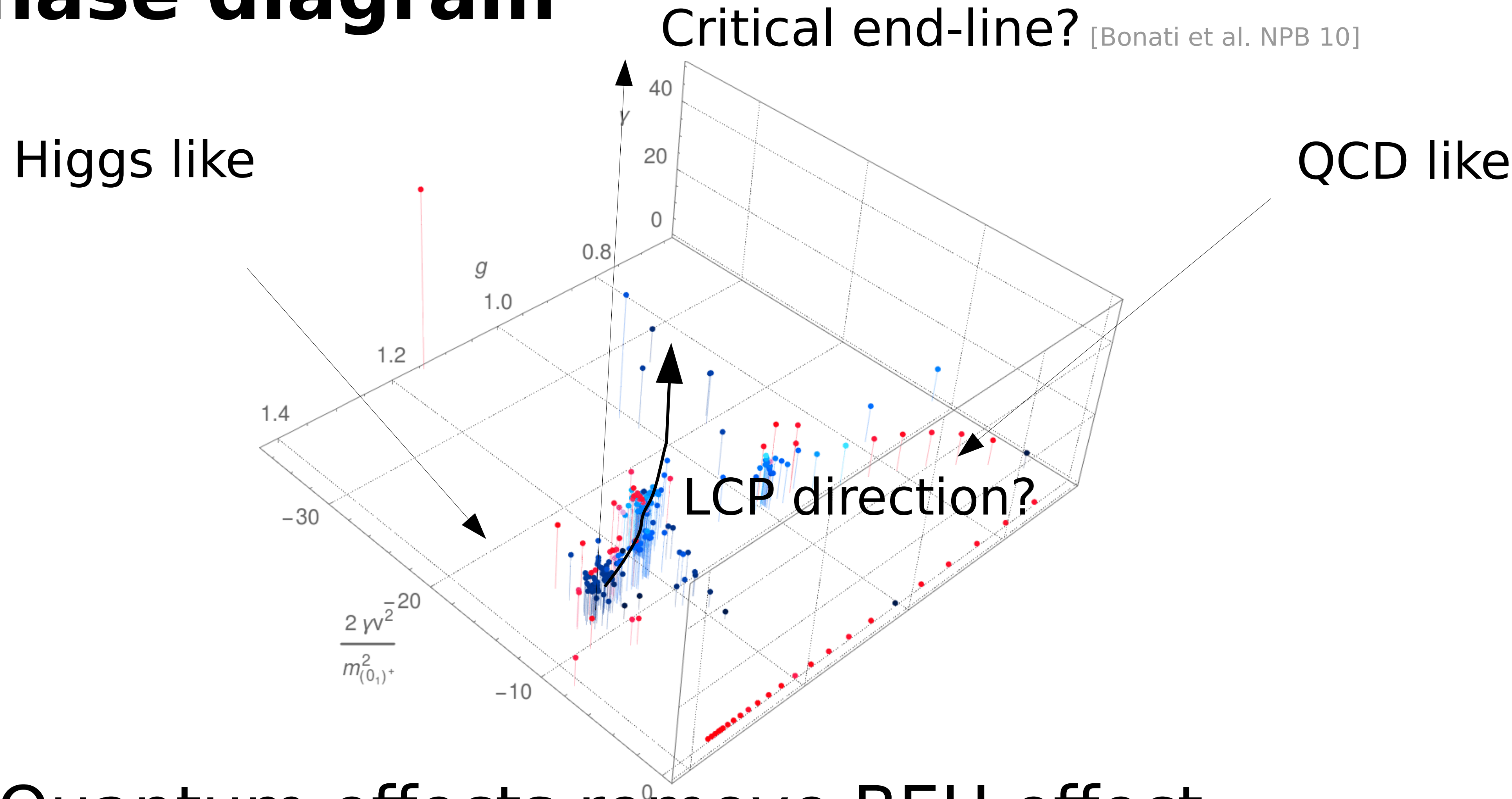

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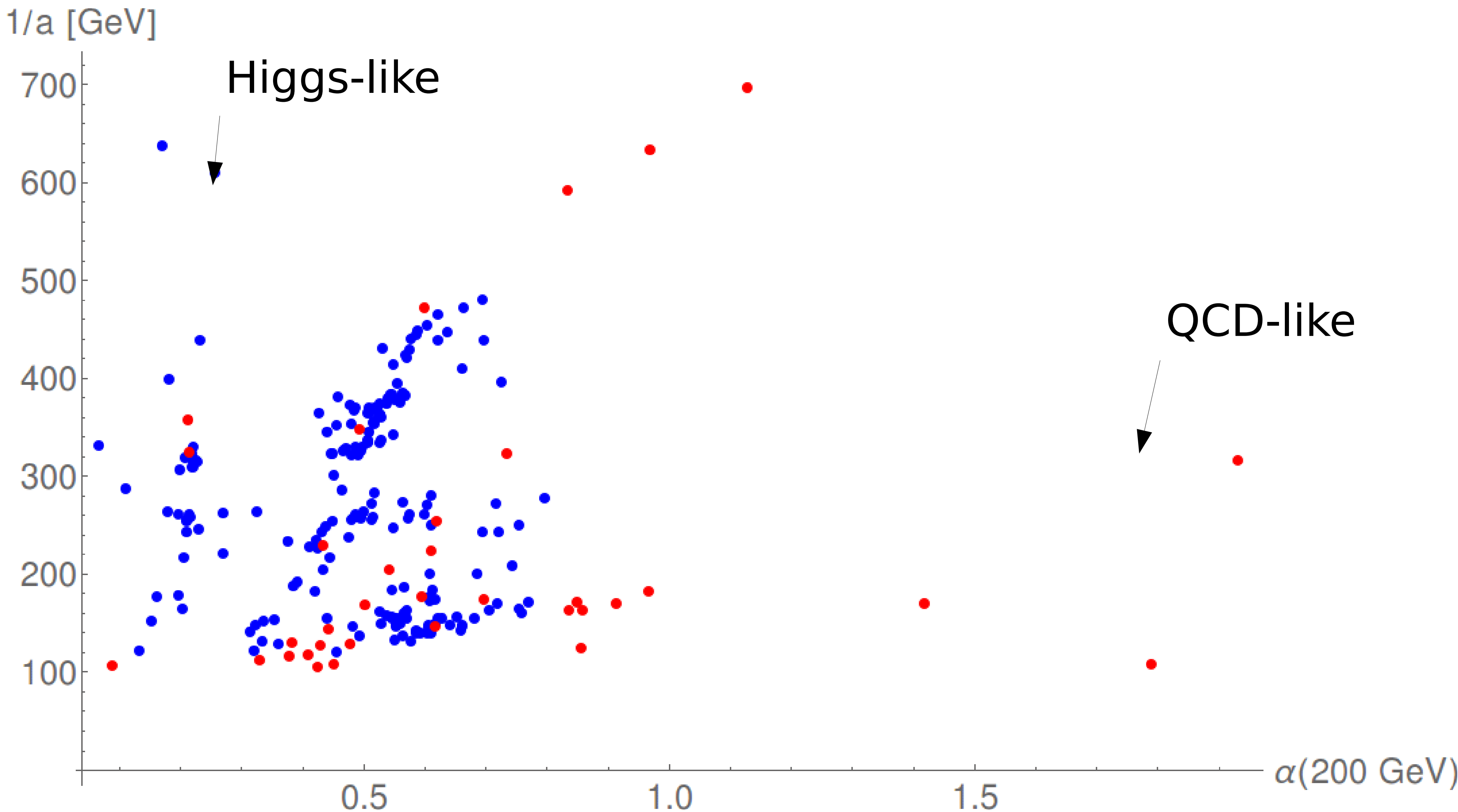

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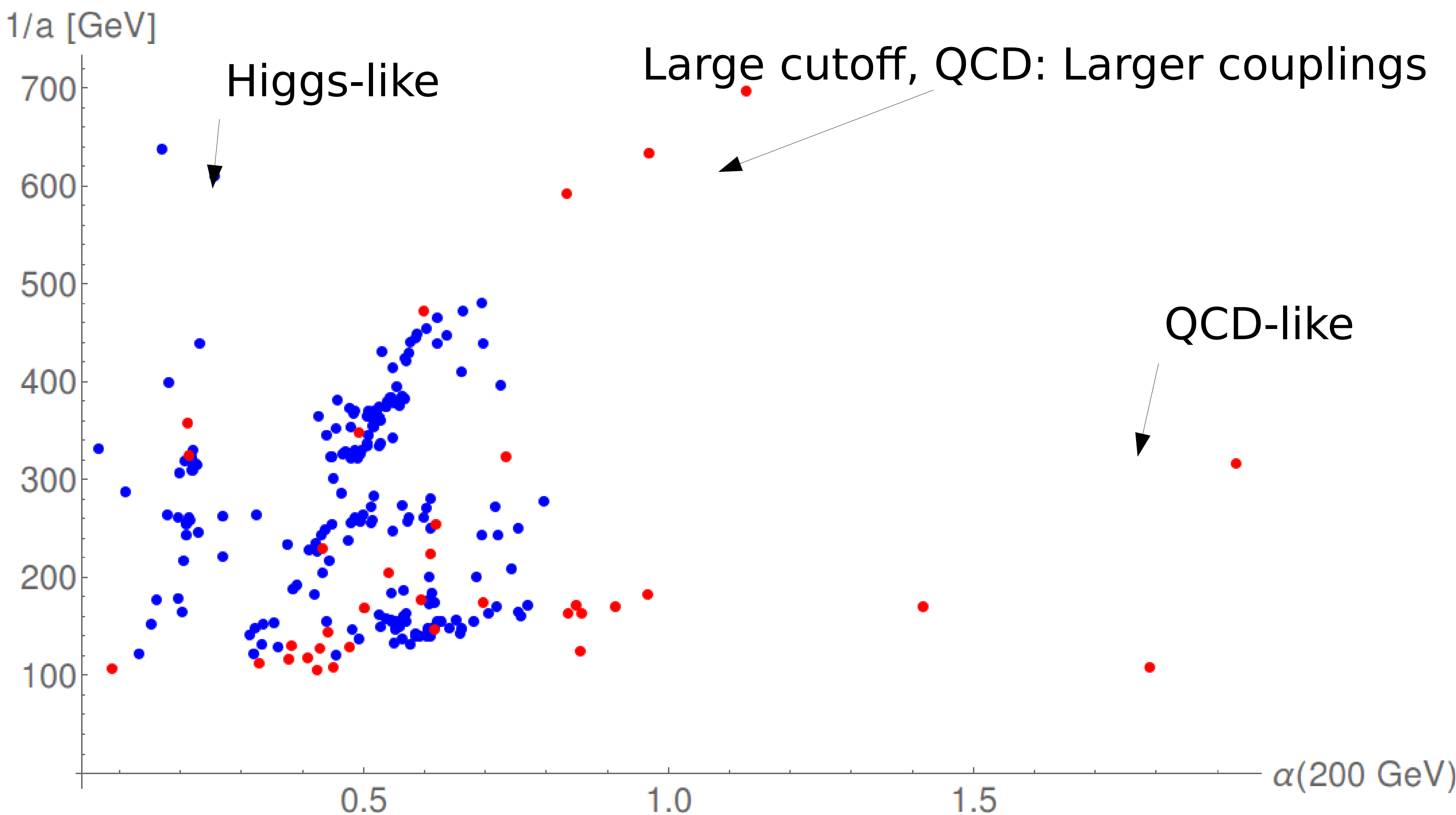

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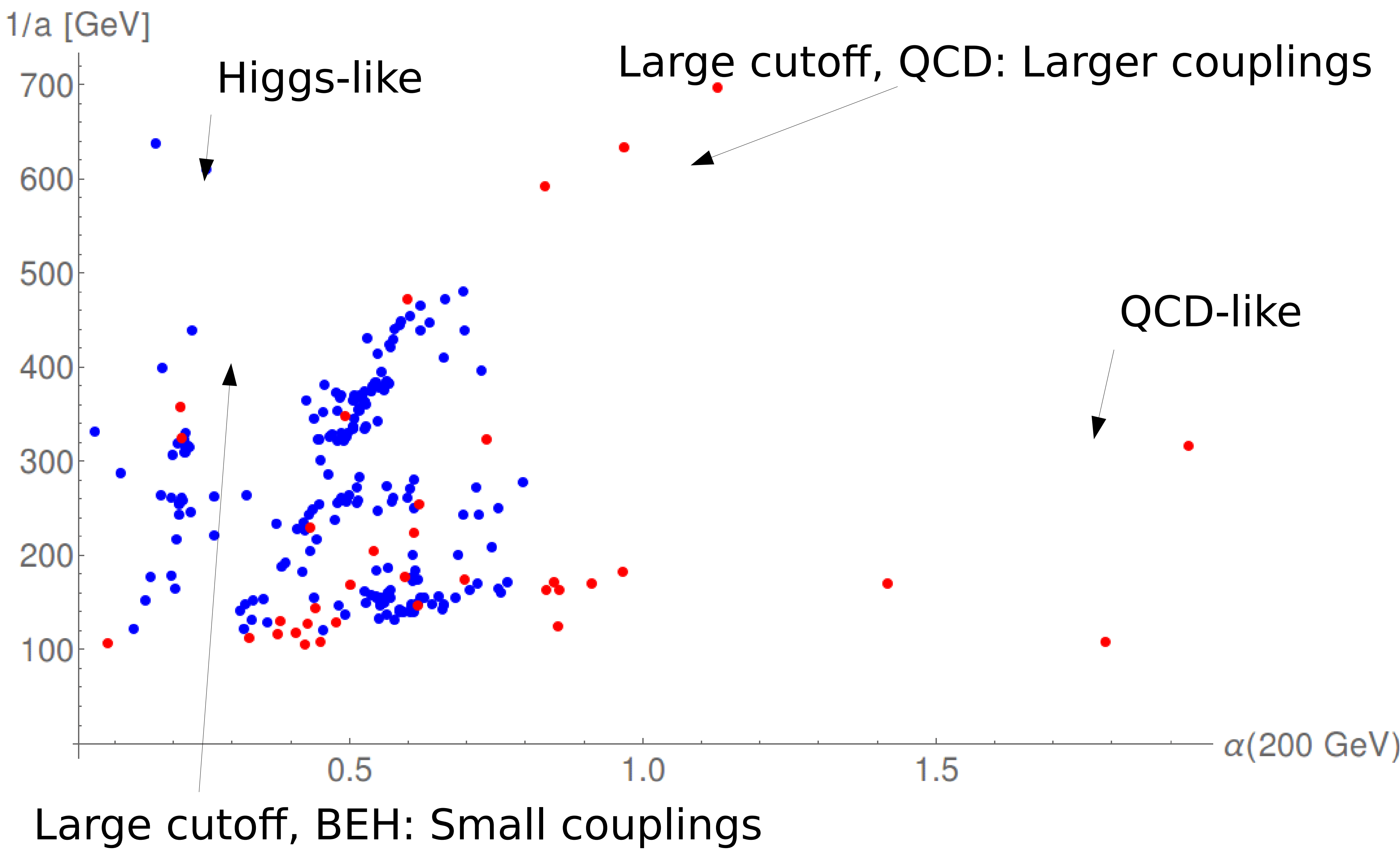

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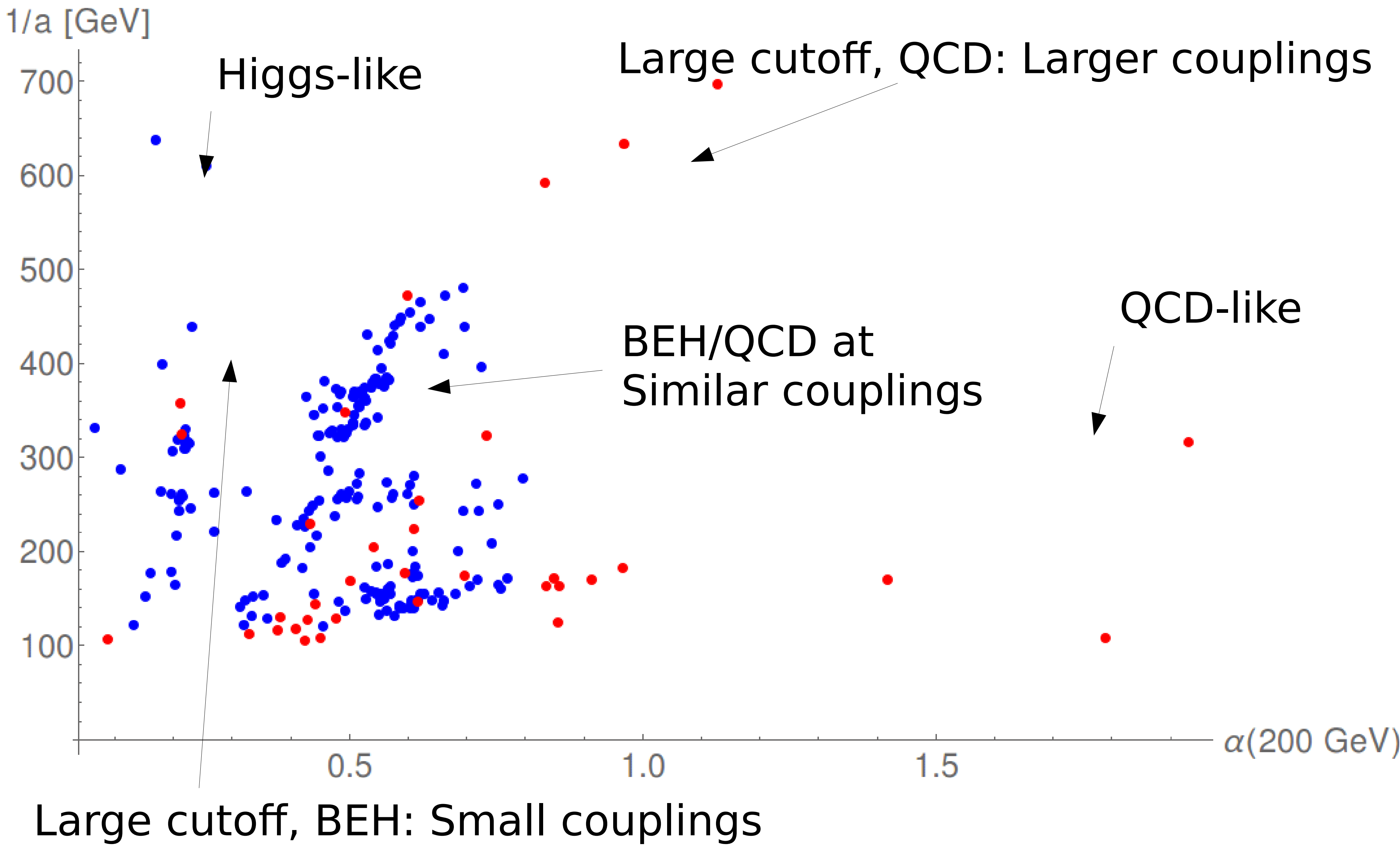

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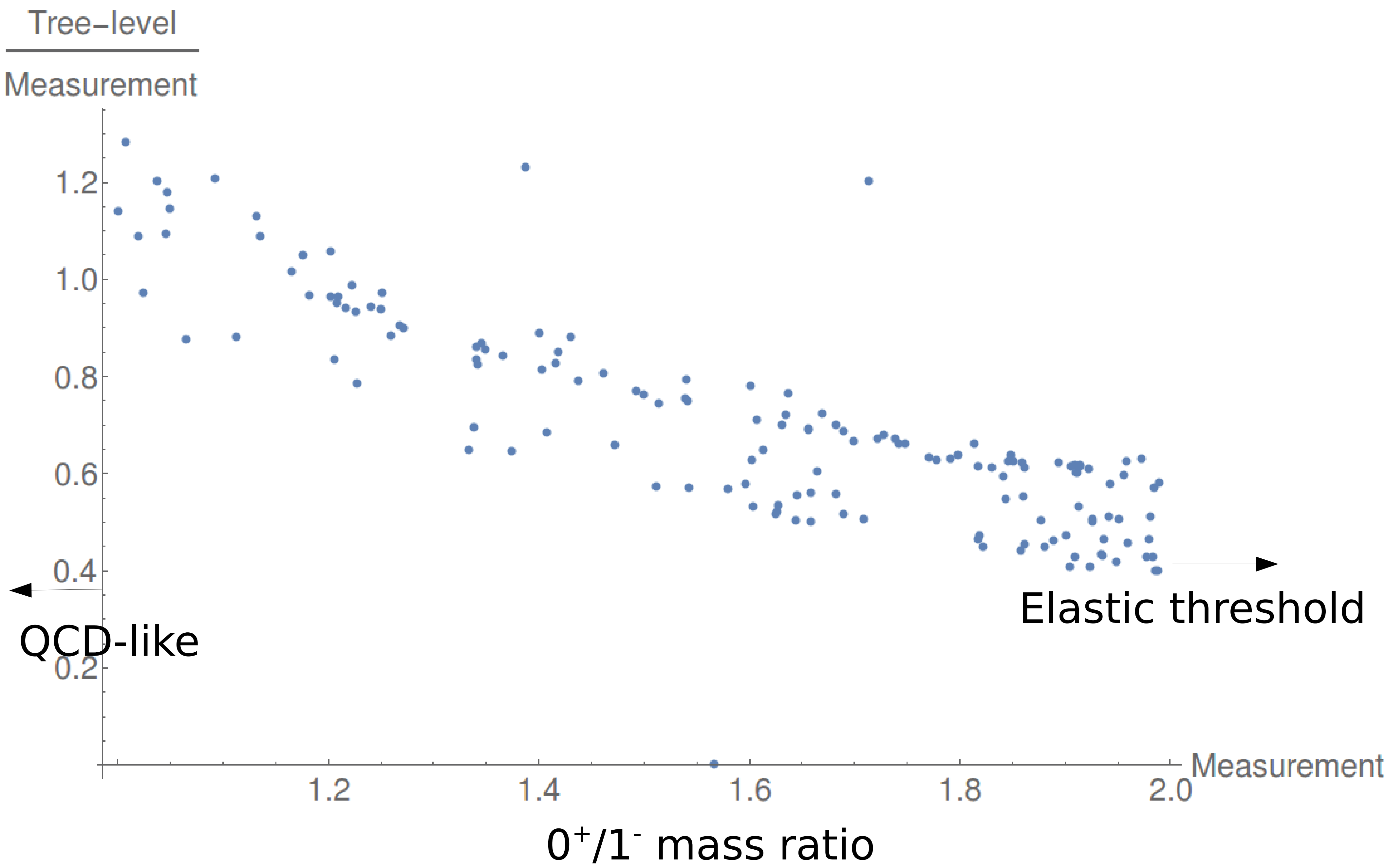

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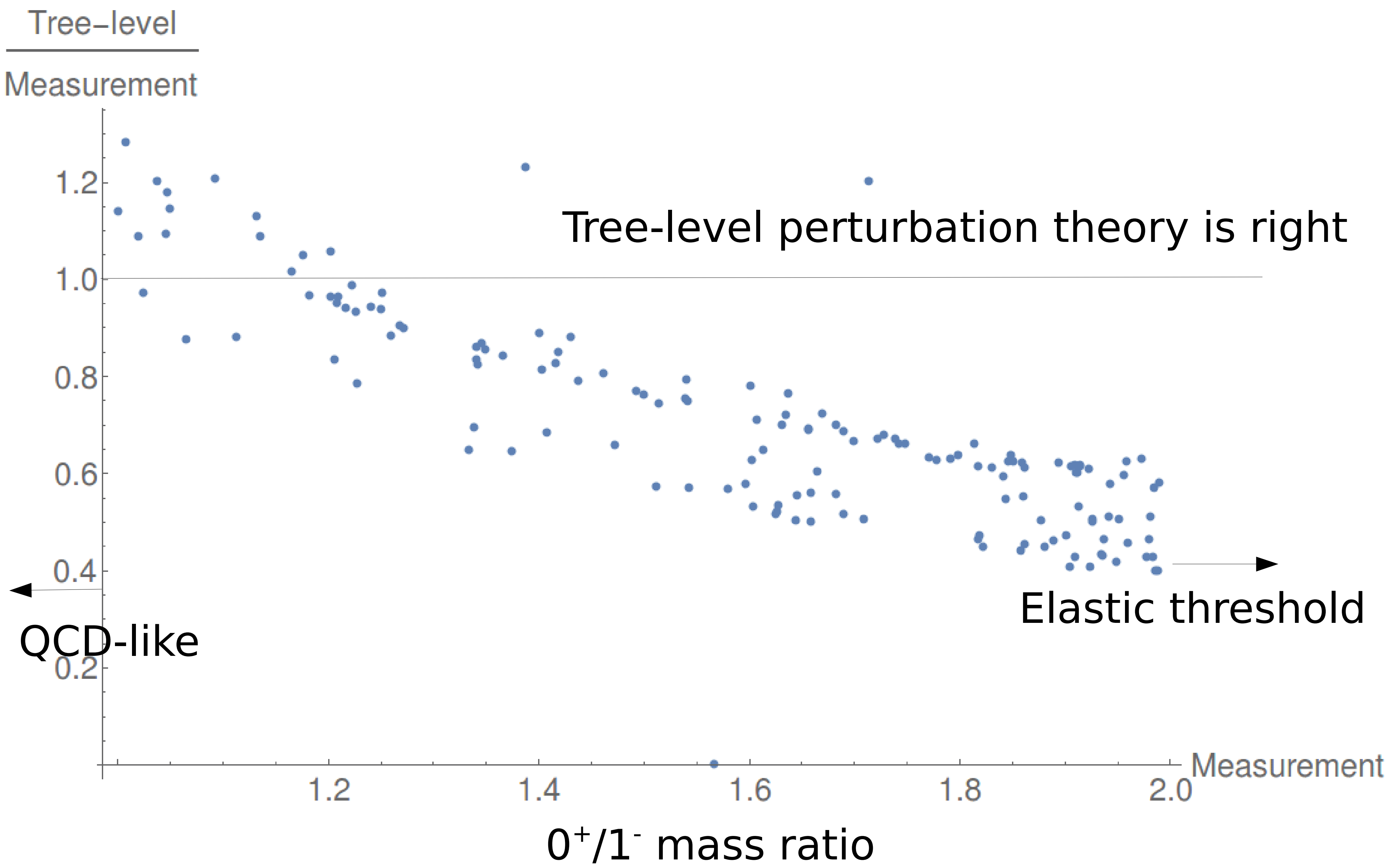

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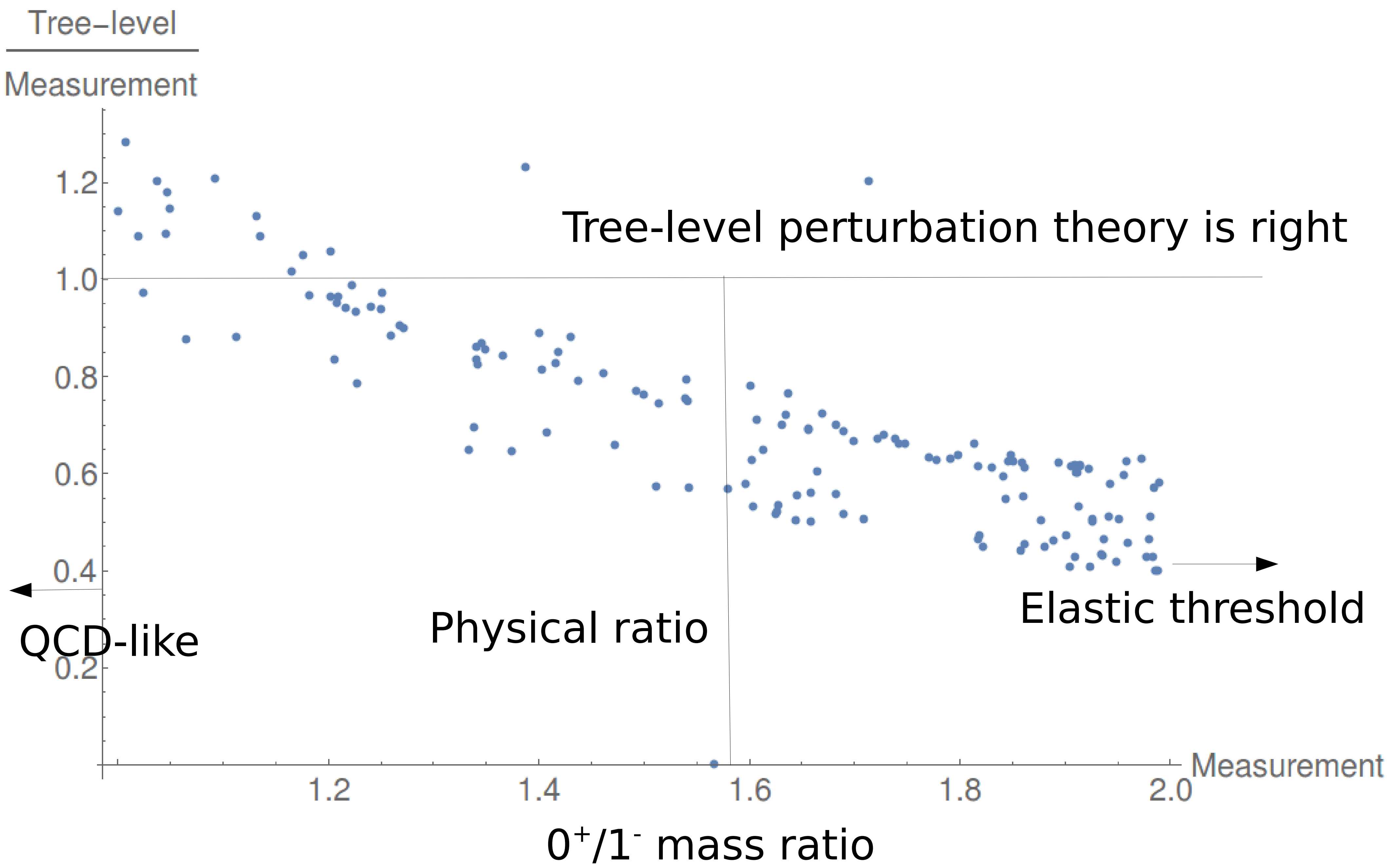

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- What happens beyond the SM case?

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55th International Winter School on Theoretical Physics

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