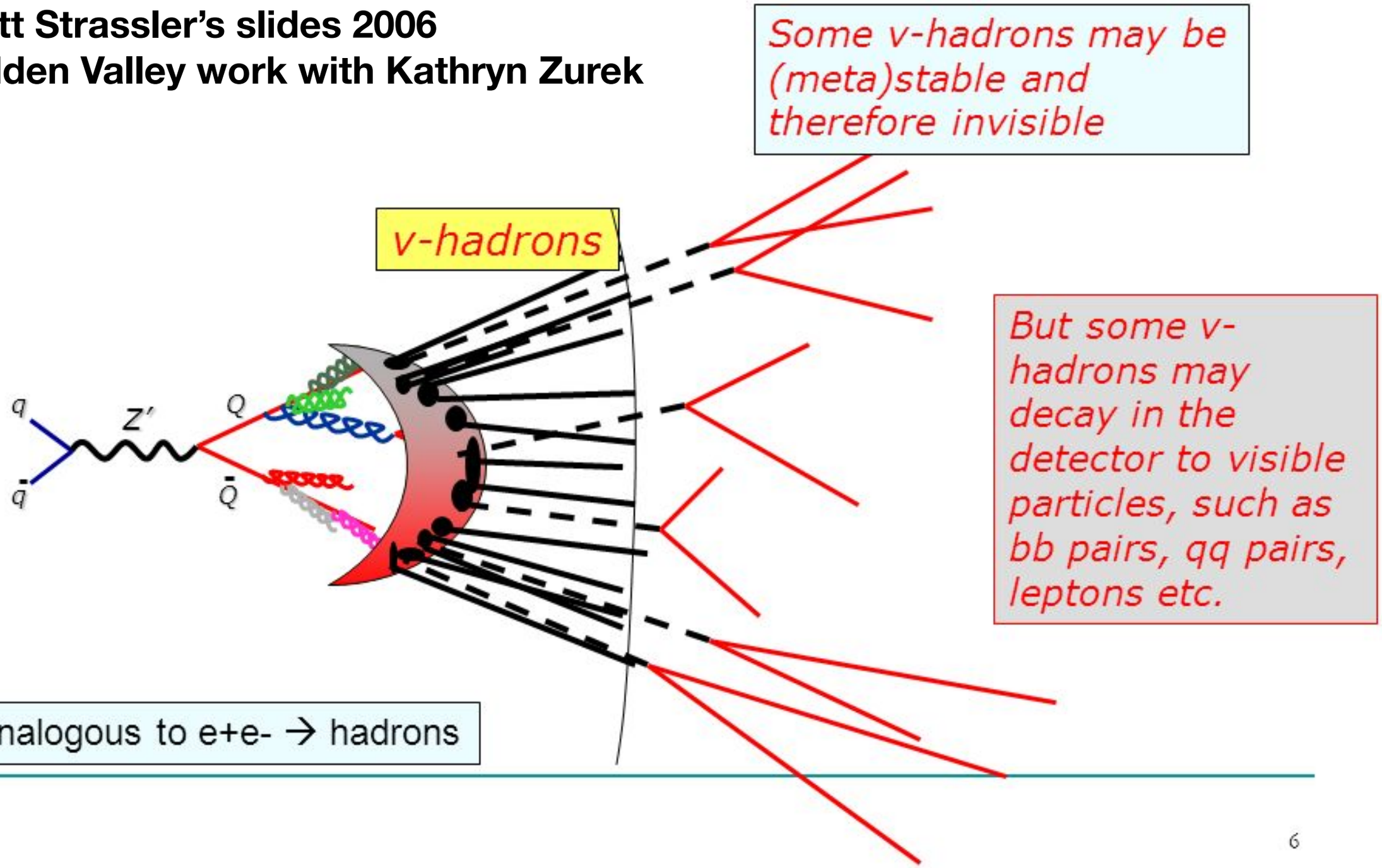
Dark Showers
WG report

Jakub Scholtz
on behalf of the Dark Showers working group:
Michael Adersberger, James Beacham, Malte Buschmann, Cari Cesarotti, Jared Evans, Marat Freytsis, Simon Knapen, Dylan Linthorne, Matt Reece, Sophie Renner, Jakub Scholtz, Pedro Schwaller, Jessie Shelton, Daniel Stolarski, Yuhsin Tsai, Devin Walker and more …

$q\bar{q} \rightarrow Q\bar{Q}$: An illustrative example

Matt Strassler's slides 2006
Hidden Valley work with Kathryn Zurek



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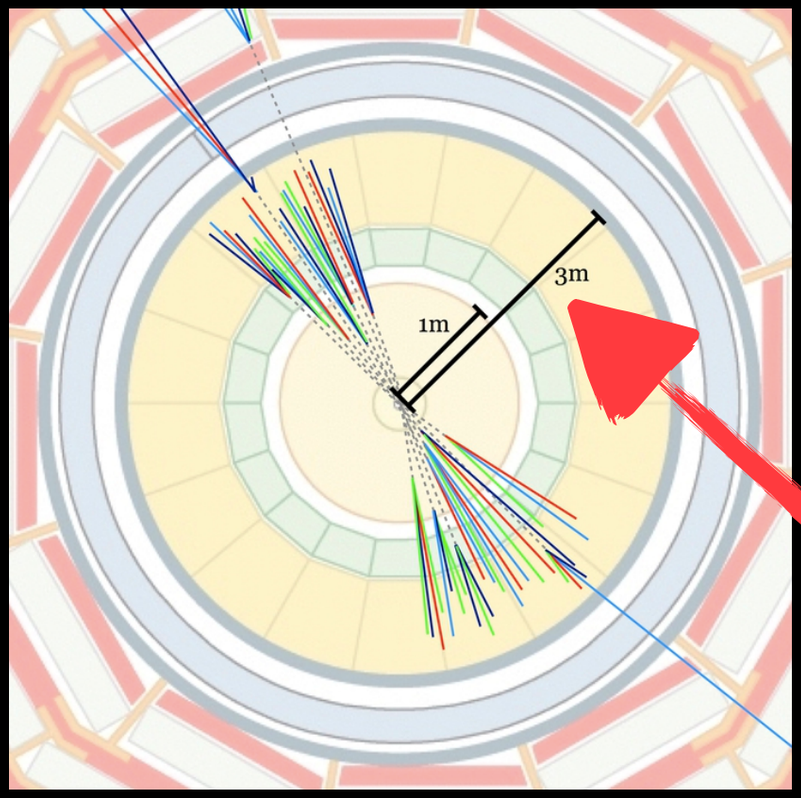
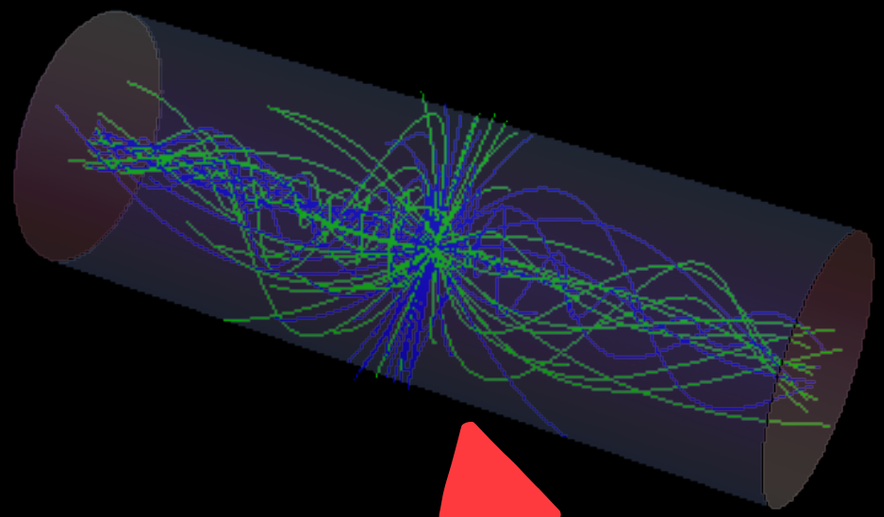
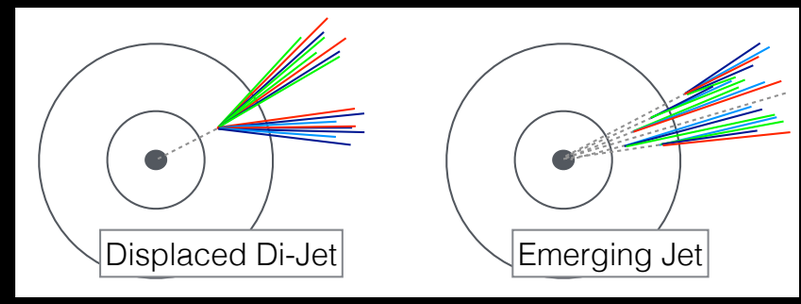
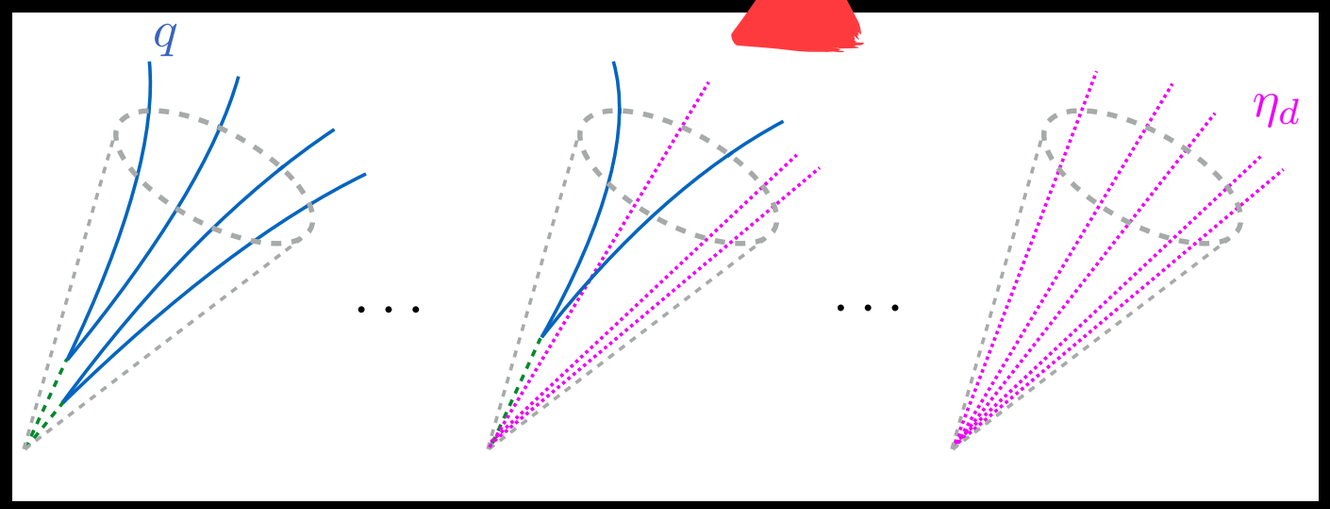
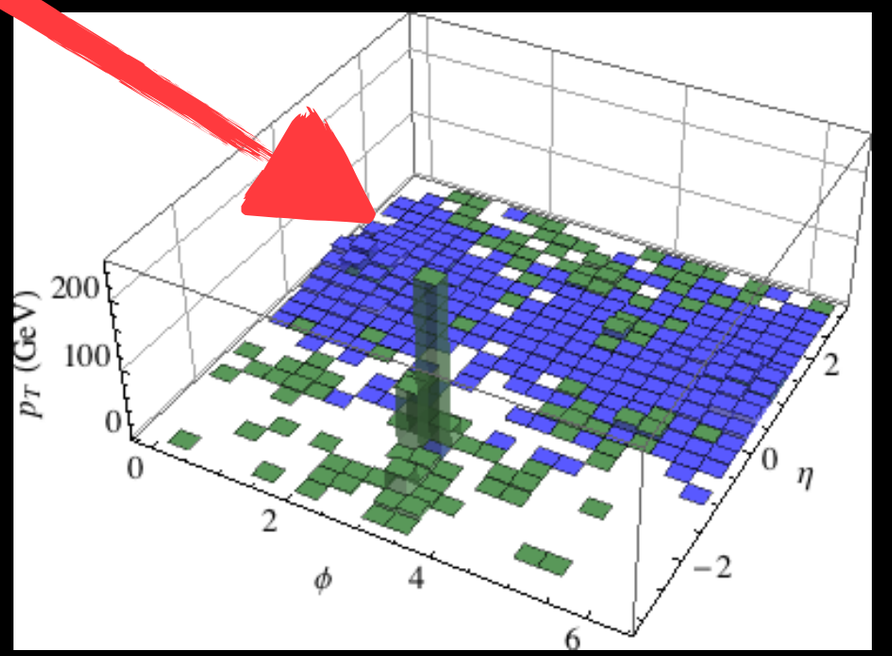






Dark Showers





Work so far …

Slide from my summary in April

Classifiers: Theory

1. How can we design benchmarks such that we cover the range of behaviors in these categories:

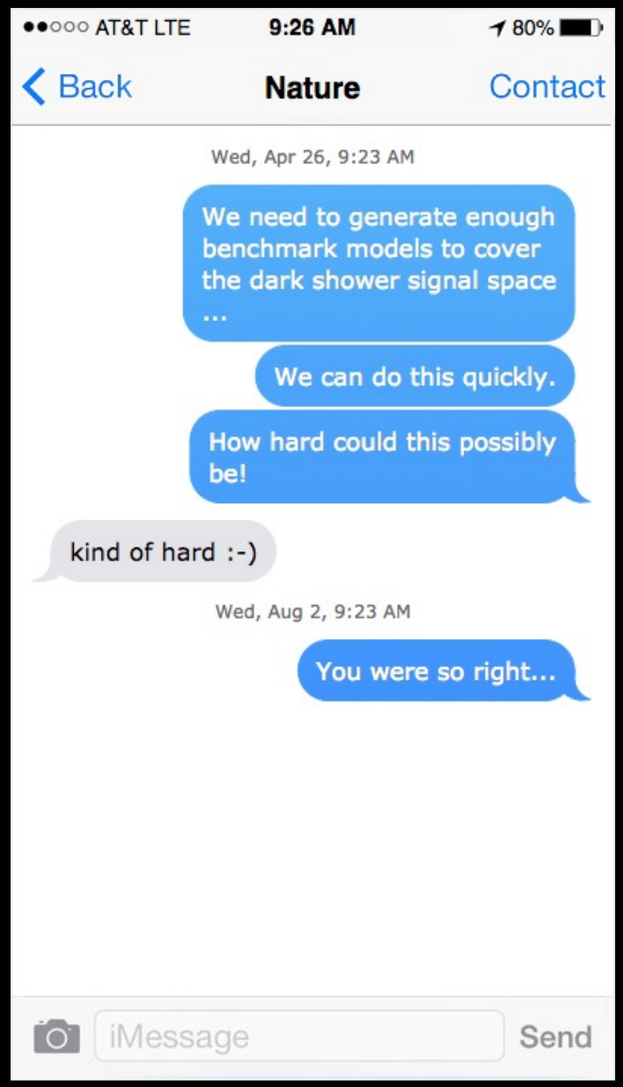
   I. Typical width of the jet (cone size)

   II. Number of “emerging jets” (depending on jet definition)

   III. SM composition within the jet: Fraction of the energy of the jet carried by some SM particle at a given Lxy (light hadrons, heavy hadrons, electrons, muons…)

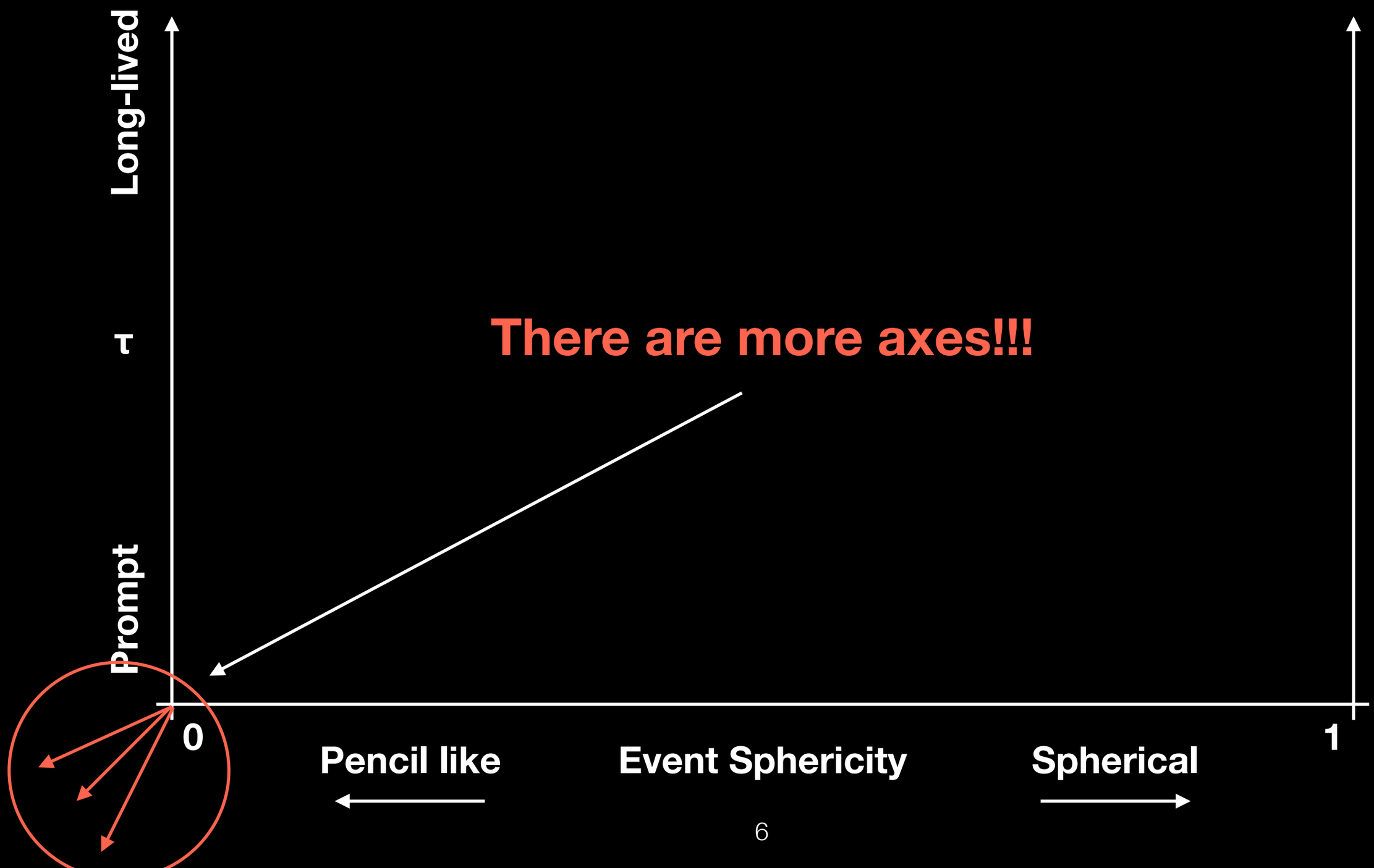
   IV. Typical number of particles per jet (as a function of Lxy)

Private conversation with Nature



The lay of the theory land

Di-DarkJet Plane



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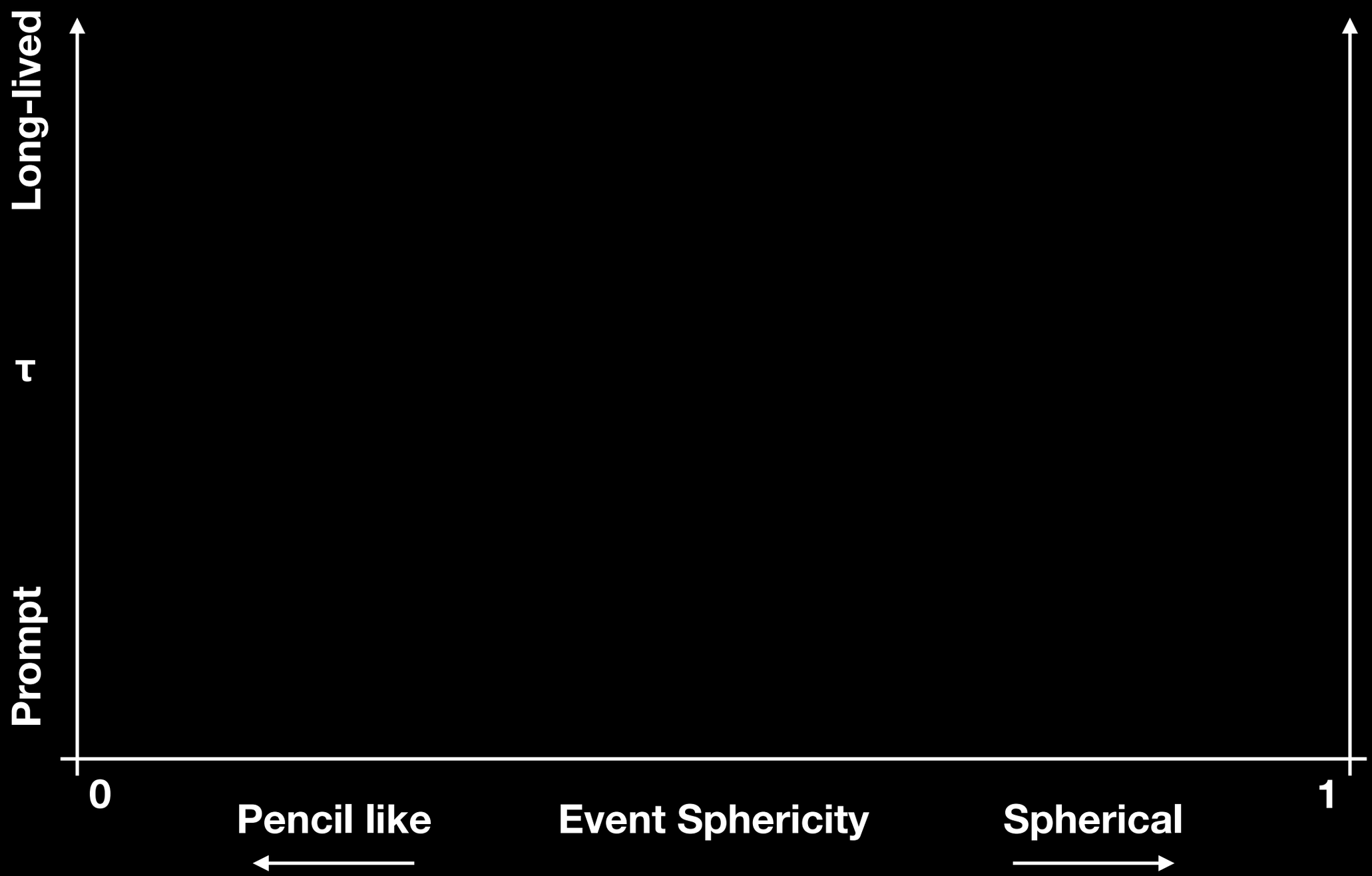

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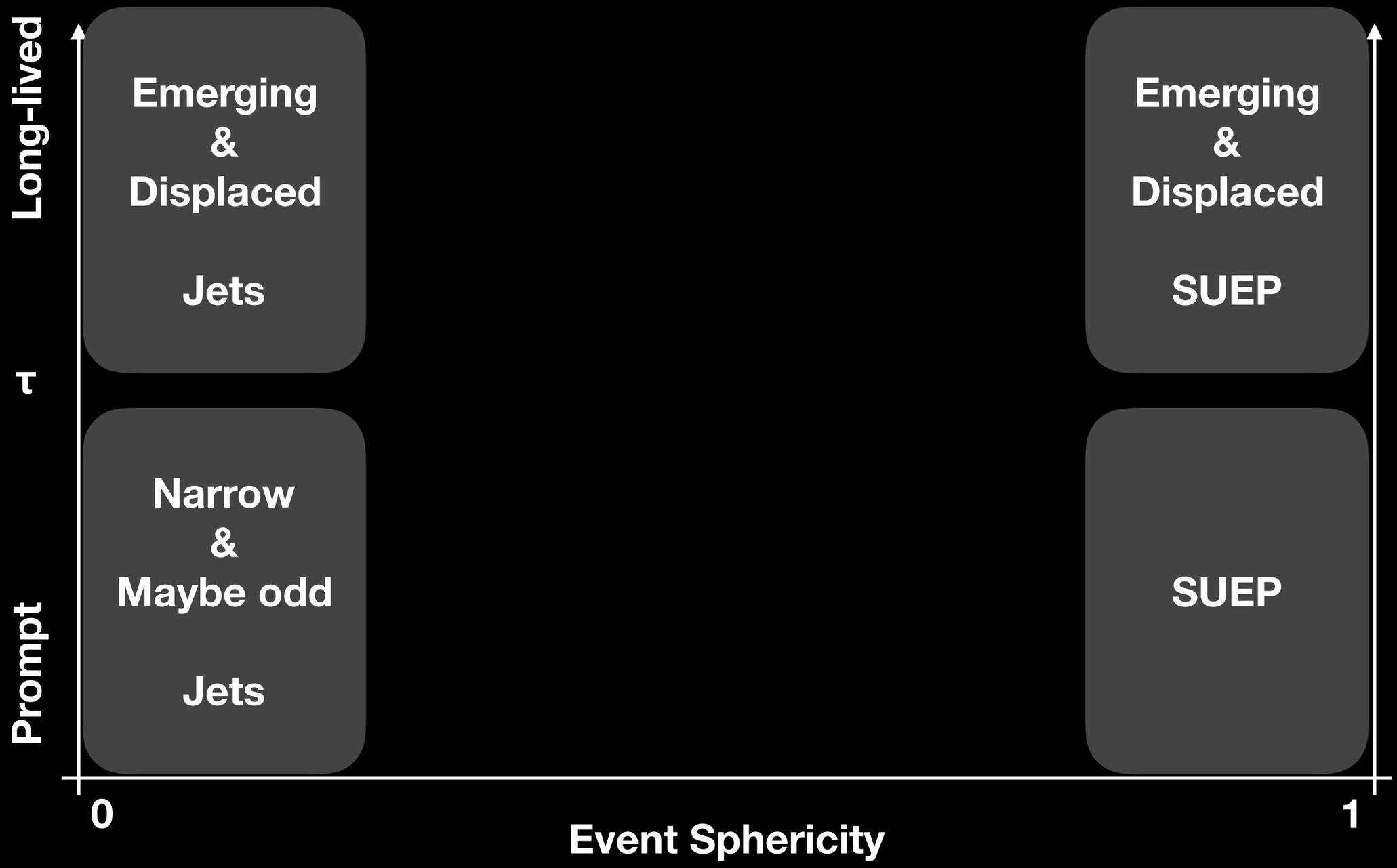

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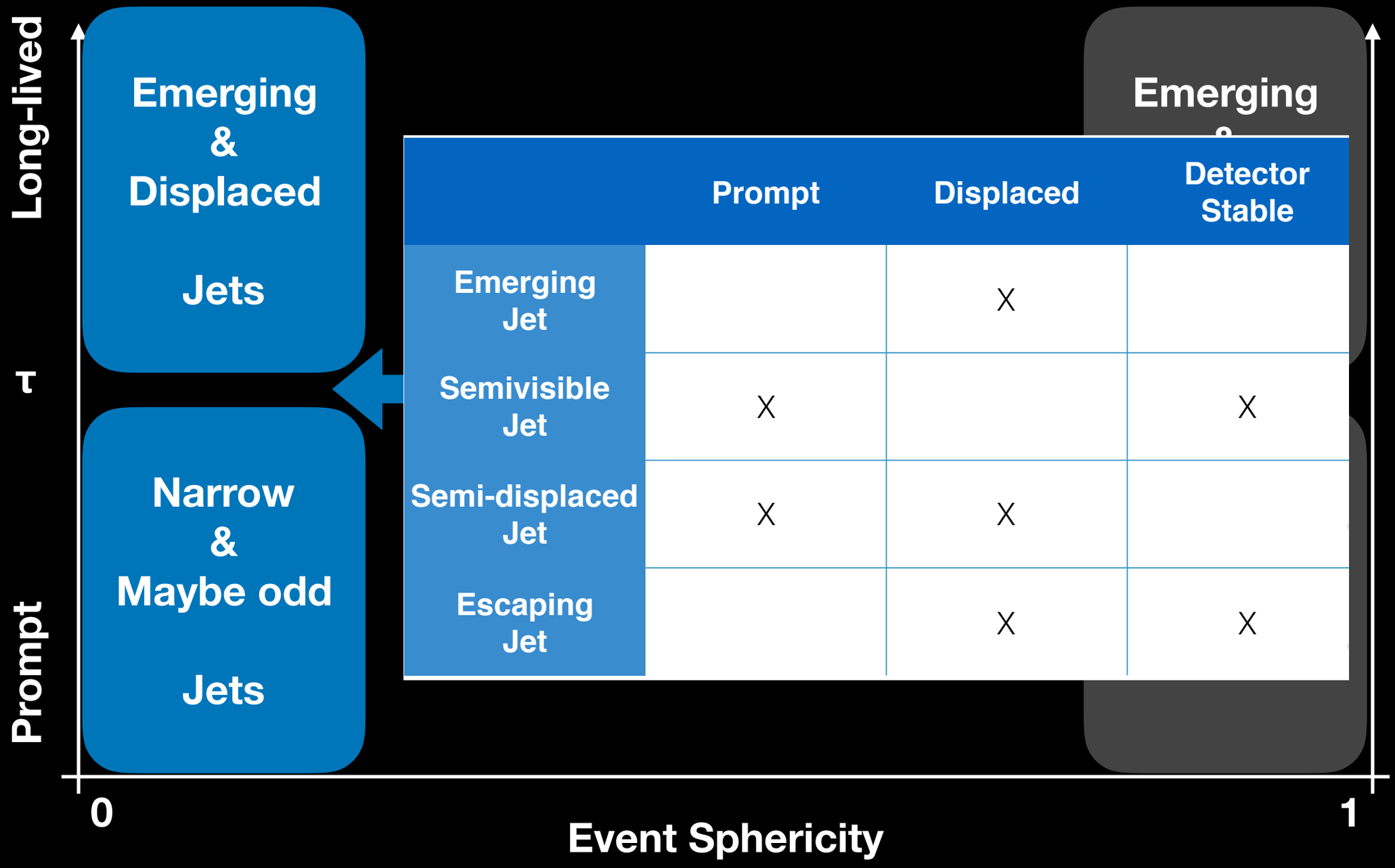

	Prompt	Displaced	Detector Stable
Emerging Jet		X	
Semivisible Jet	X		X
Semi-displaced Jet	X	X	
Escaping Jet		X	X

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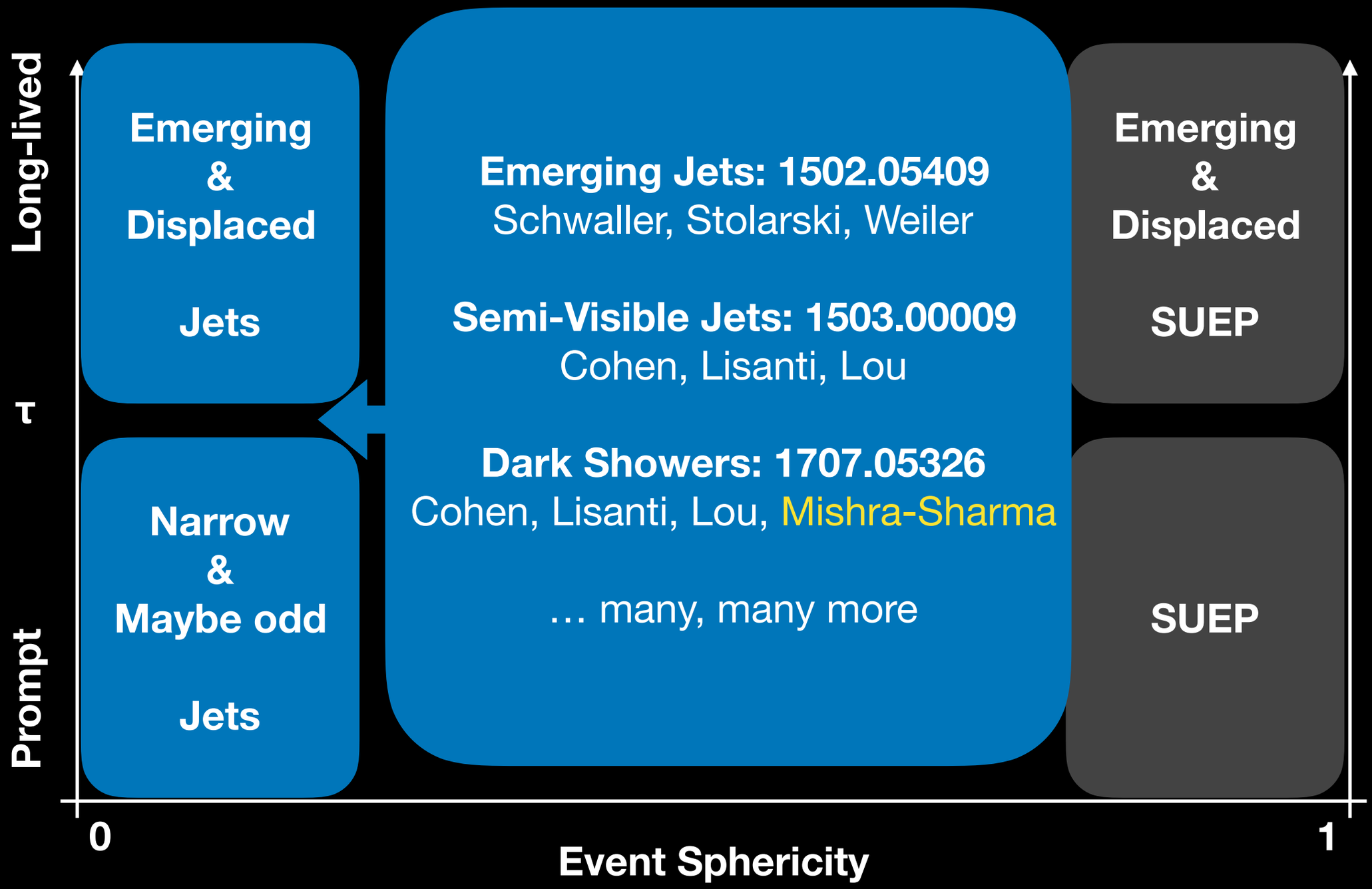

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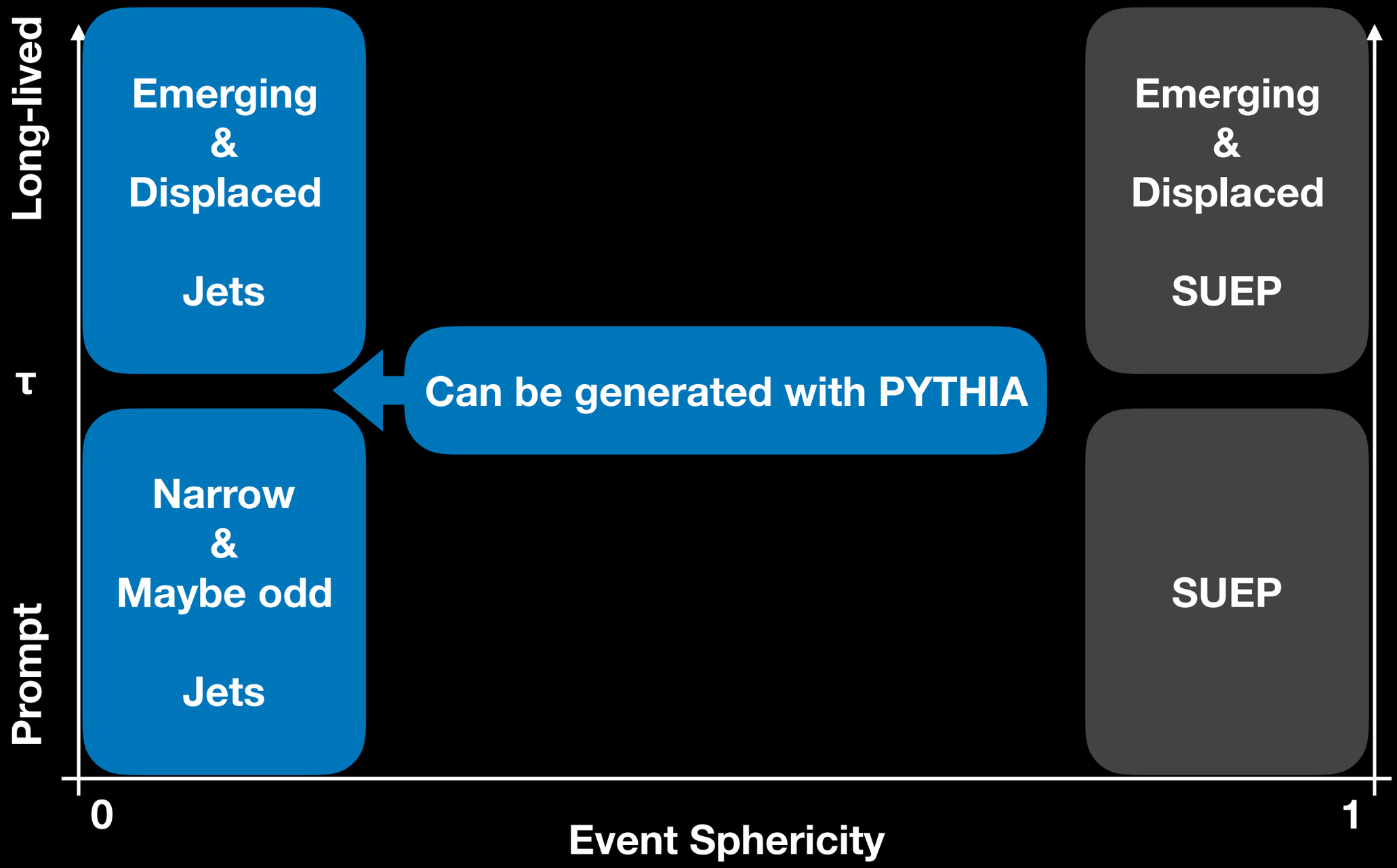

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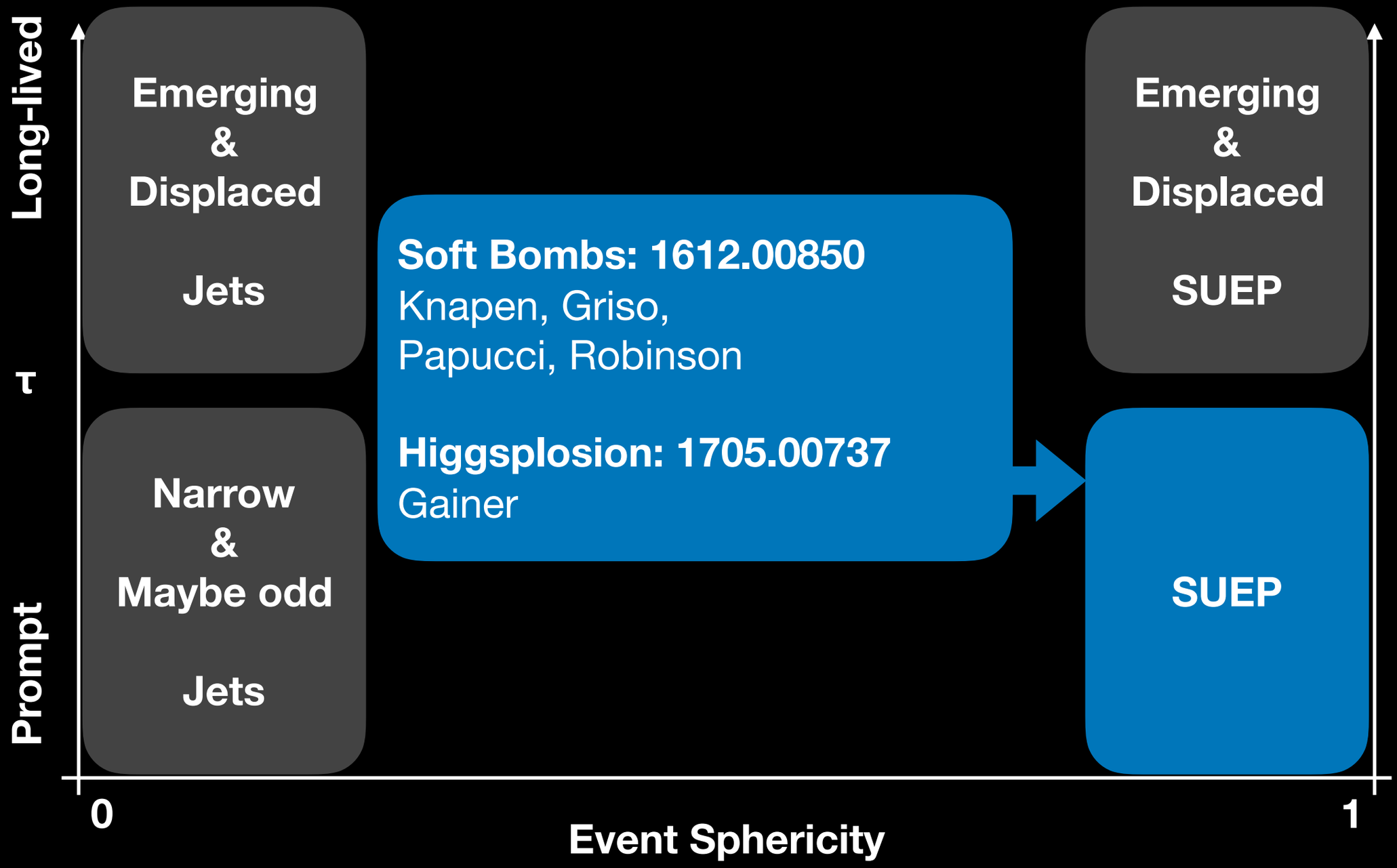

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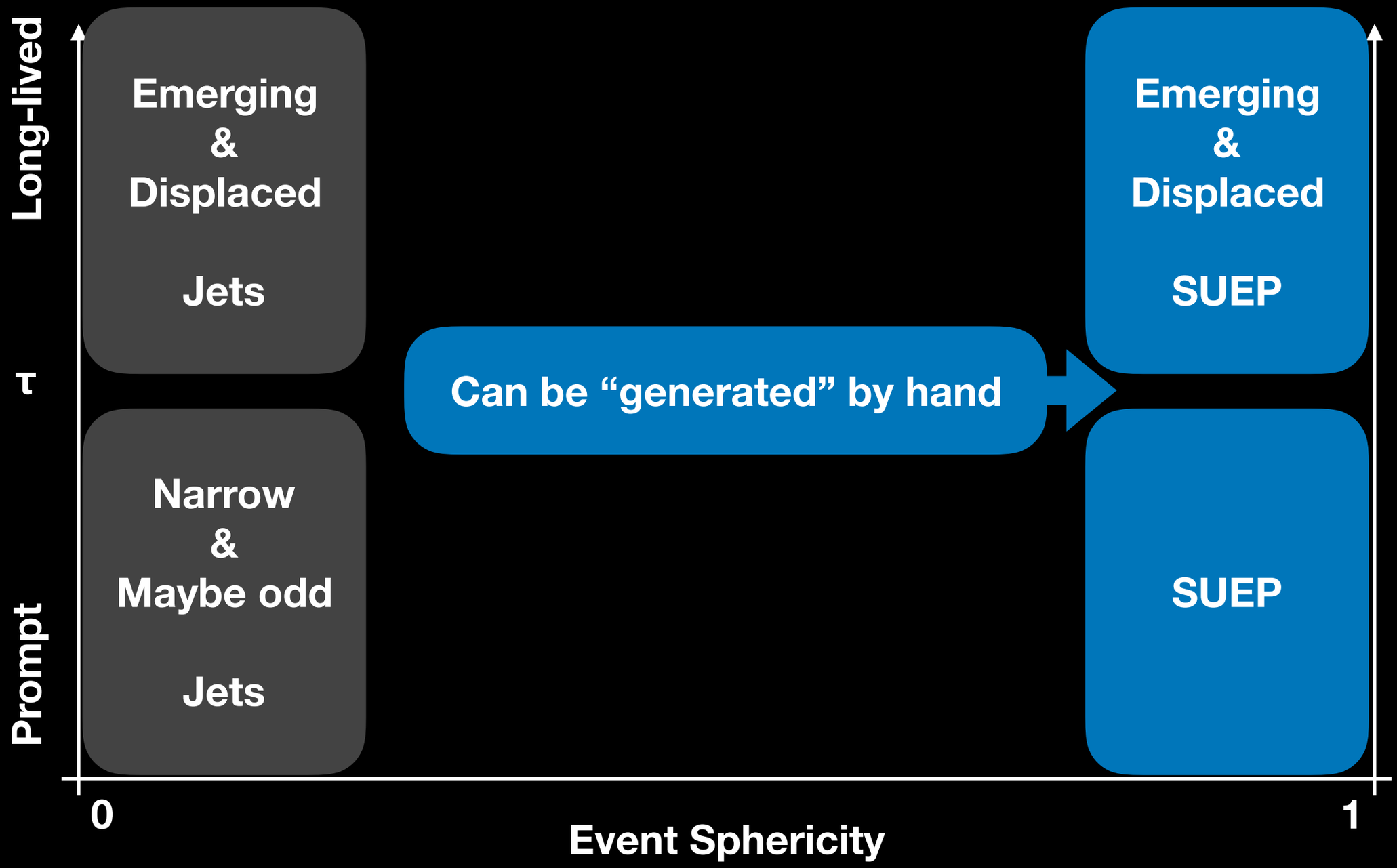

The lay of the theory land

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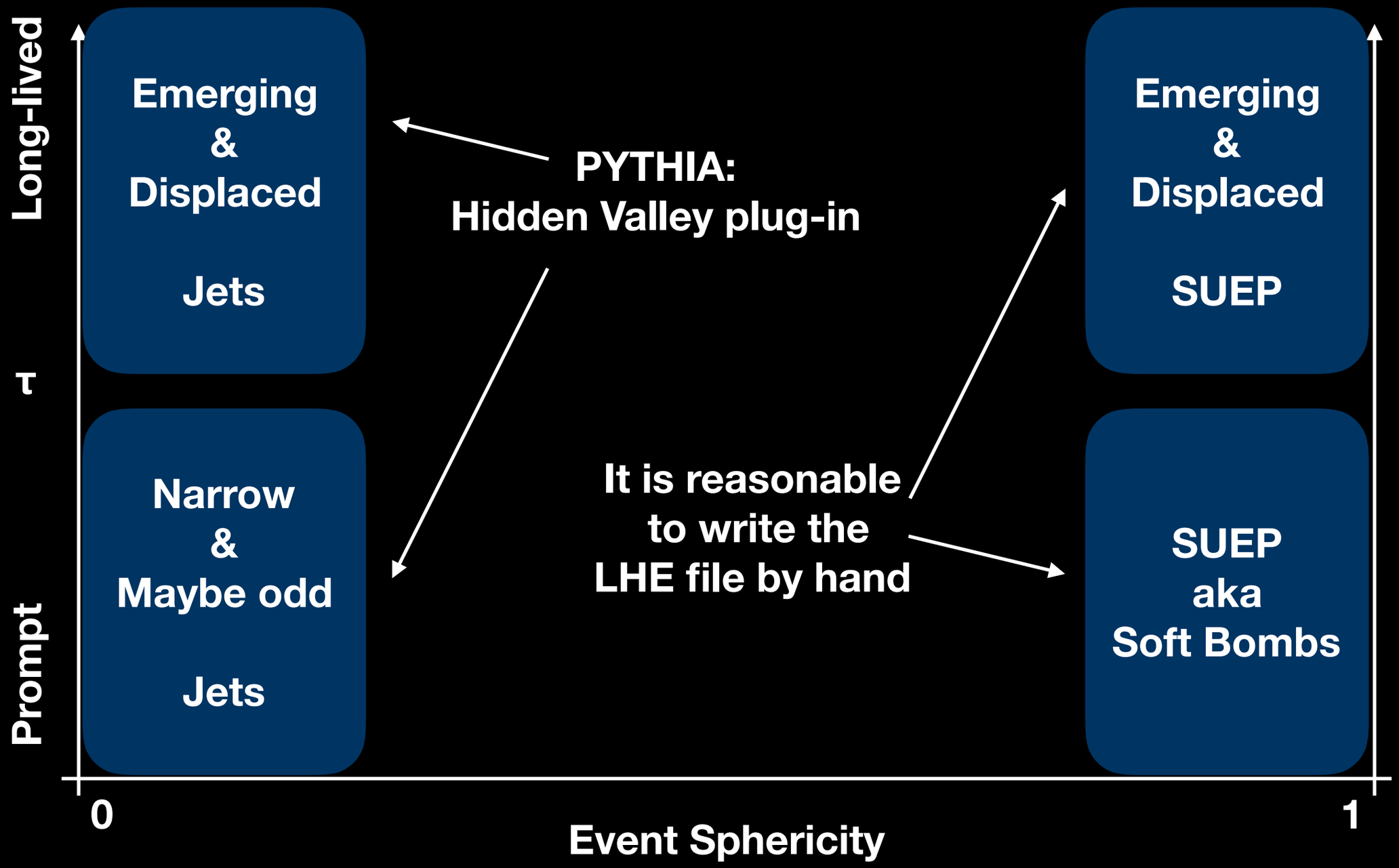

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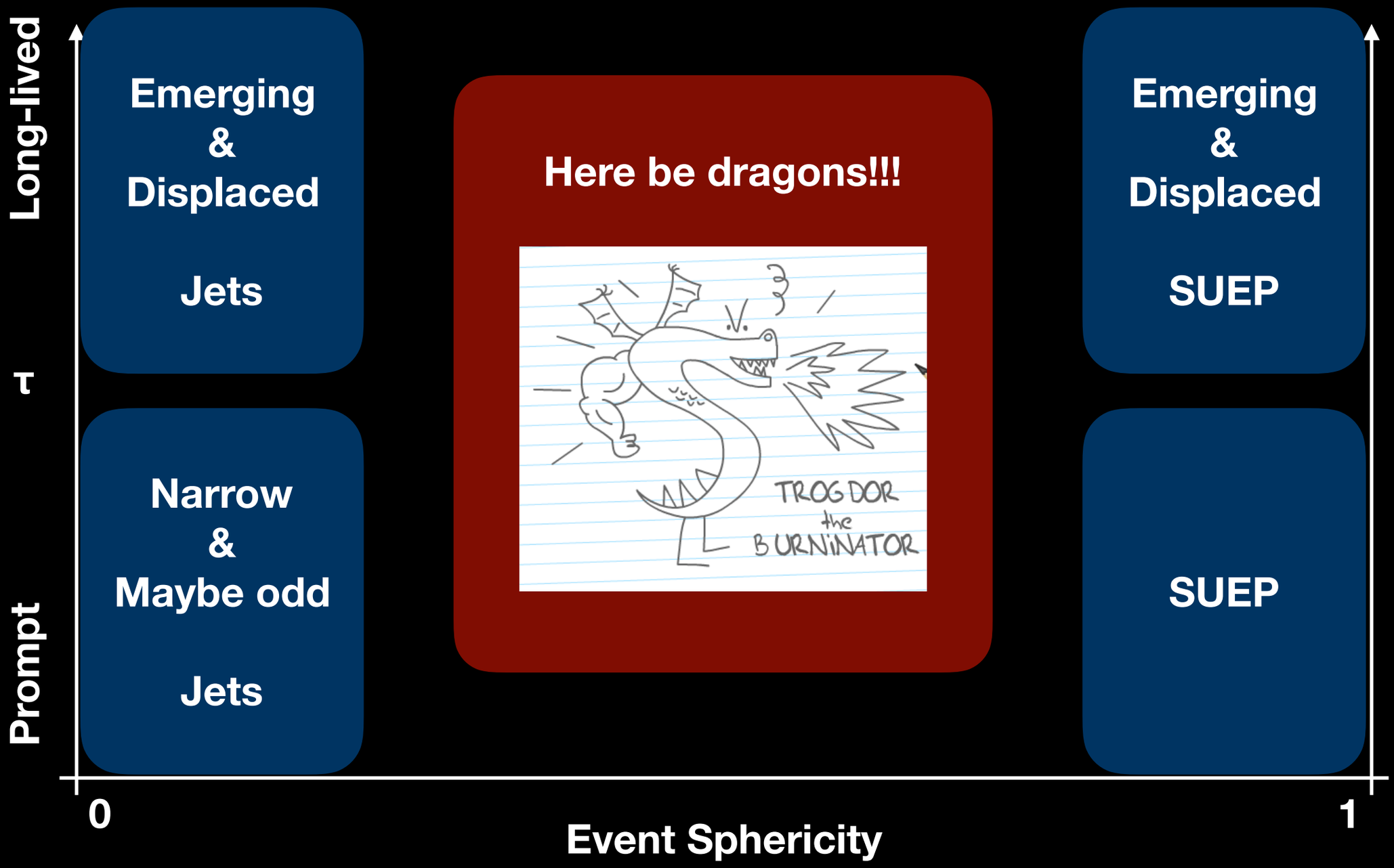
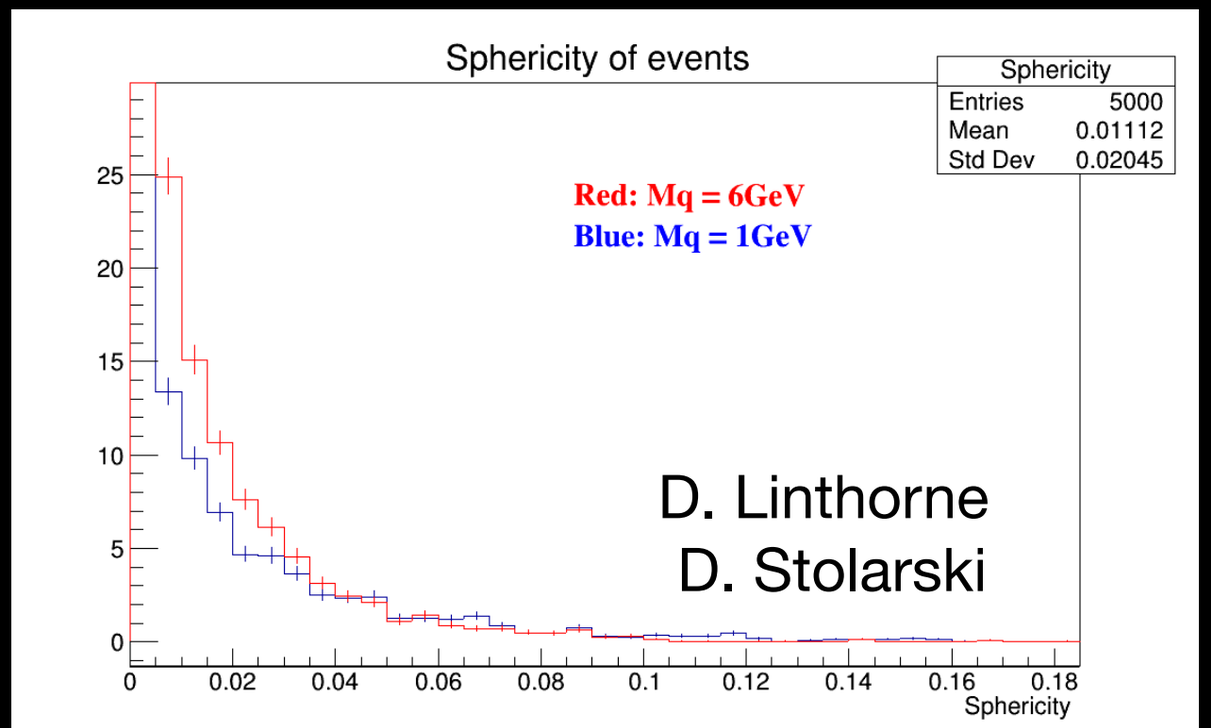
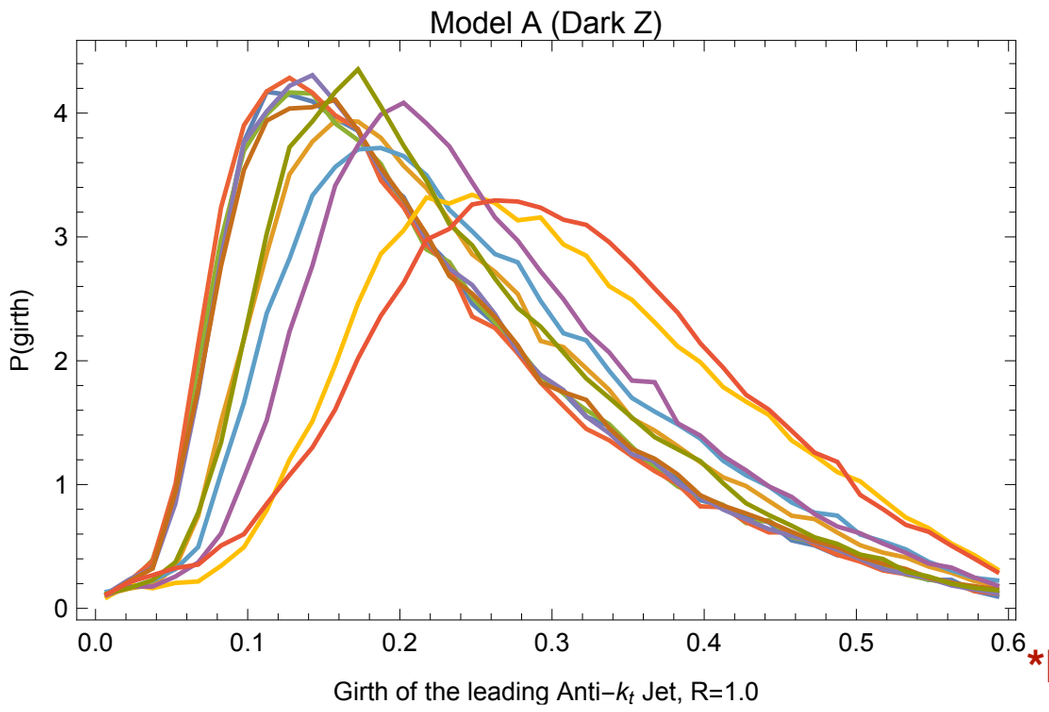


Running PYTHIA with Hidden Valley





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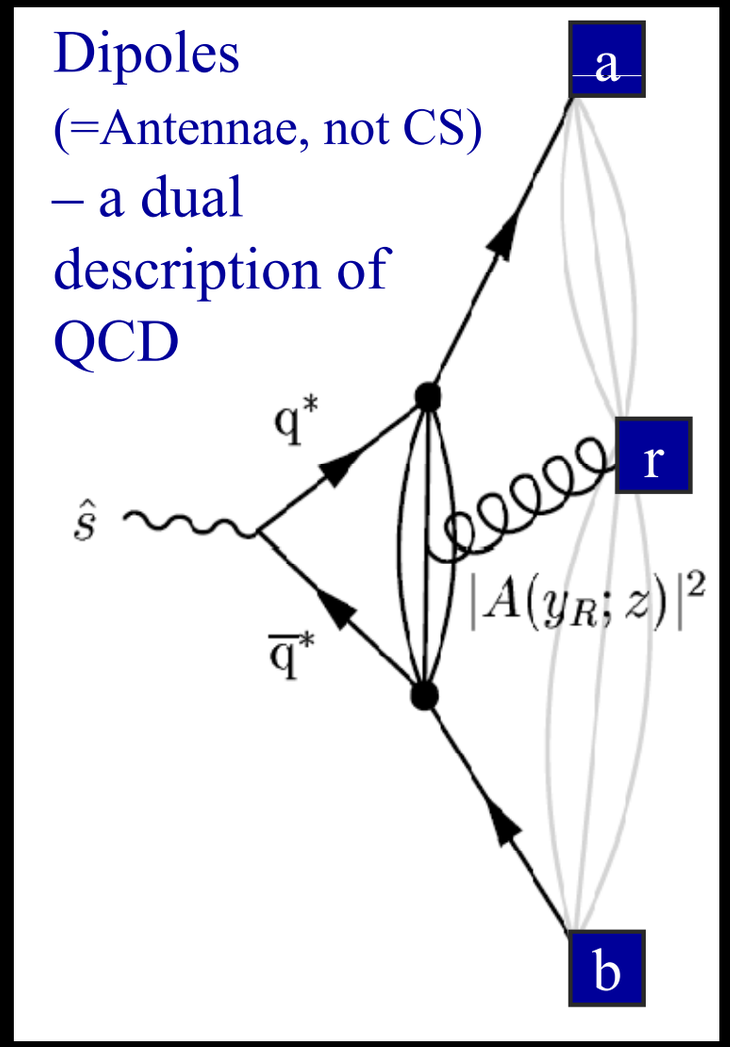
(3,8),Λ=10,m_Q=10,m_π=5,m_ρ=20
(8,8),Λ=10,m_Q=10,m_π=5,m_ρ=20
(50,8),Λ=10,m_Q=10,m_π=5,m_ρ=20 *
(3,2),Λ=10,m_Q=10,m_π=10,m_ρ=40
(3,2),Λ=10,m_Q=10,m_π=2.5,m_ρ=10
(3,2),Λ=20,m_Q=20,m_π=10,m_ρ=40
(3,2),Λ=40,m_Q=40,m_π=20,m_ρ=80
(3,2),Λ=10,m_Q=40,m_π=5,m_ρ=20
(3,2),Λ=10,m_Q=20,m_π=5,m_ρ=20
(3,2),Λ=10,m_Q=80,m_π=5,m_ρ=20

***Not Real, there is an internal cap on both Nc & Nf**

JS

Running PYTHIA with Hidden Valley

- **PYTHIA uses a dipole shower**: it requires a hierarchy in radiation angles: the aren't many splittings with similar angles: prongy (non-spherical) results
- **Using an Antenna shower** may ameliorate this issue
- We probably still need the **fixed order calculation and matching**.



taken from P. Skands

How to deal with this theory blind spot?

a. Utter rubbish but quick: write an LHE file by hand: rescale SUEP into a cone. We can do this today.

b. Longer-time scale: Abandon the SU(N) scheme, use a model for dark shower with more control. C. Cesarotti and M. Reece.

c. Longer-time scale: Use a different showering method: VINCIA (uses a antenna shower), M. Freytsis is working on this. Still not clear if we can implement close to the conformal window (comments?).

d. Longer-time scale: HEJ (by J. Andersen) is software that can probe the high sphericity events for QCD. Maybe we work together to make predictions for our wide dark showers.

e. Super-long-time scale: Work with showering and hadronization community.

Further Questions

Classifiers: Theory

1. How can we design benchmarks such that we cover the range of behaviors in these categories:

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Further Questions

Tasks for the experimentalists

- Secondary vertex efficiency in ATLAS and CMS
- How Jet cleaning cuts (or a MET cut, if we were to do one) affect emerging jet efficiencies cuts
- Get SUEP lhe files from Simon Knapen, et al., and simulate, estimate efficiencies
- Investigate dedicated triggers (ATLAS: FTK, photon-jets, inner tracker hit multiplicity, etc.)

Conclusions

- We have found several paths around the biggest theory obstacle: we are implementing them.

- We still have a lot of work to do: Secret strategy to piggyback on the other groups?

- This is a pretty untouched topic (a whole new region to think about):
  a. If you can do something with R=0.4,0.5 jets, can you do it with R=1.0,1.5 jets?
  b. How about pile-up sensitivity?

- We are fun and looking for more people.