UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Exploring Jet Substructure in Semi-visible jets

Deepak Kar and Sukanya Sinha
(with lots of useful advice from Tim Cohen and Joel Doss)

Snowmass 2021, joint meeting of EF9/10 on dark showers

Based on arxiv: 2007.11597
(partial results were shown at DM@LHC 2020)

The questions we tried to answer:

- Do the semi-visible jets have different substructure than “qcd” jets?

- If so, how? How much of that is model-dependent?

- If there are model-independent discriminating features, can they be useful in a LHC search?

Setup

- Looked at extreme scenarios, where R_{inv}=0 should correspond to “normal” jets, and R_{inv}=1 should correspond to pure “dark jets”.

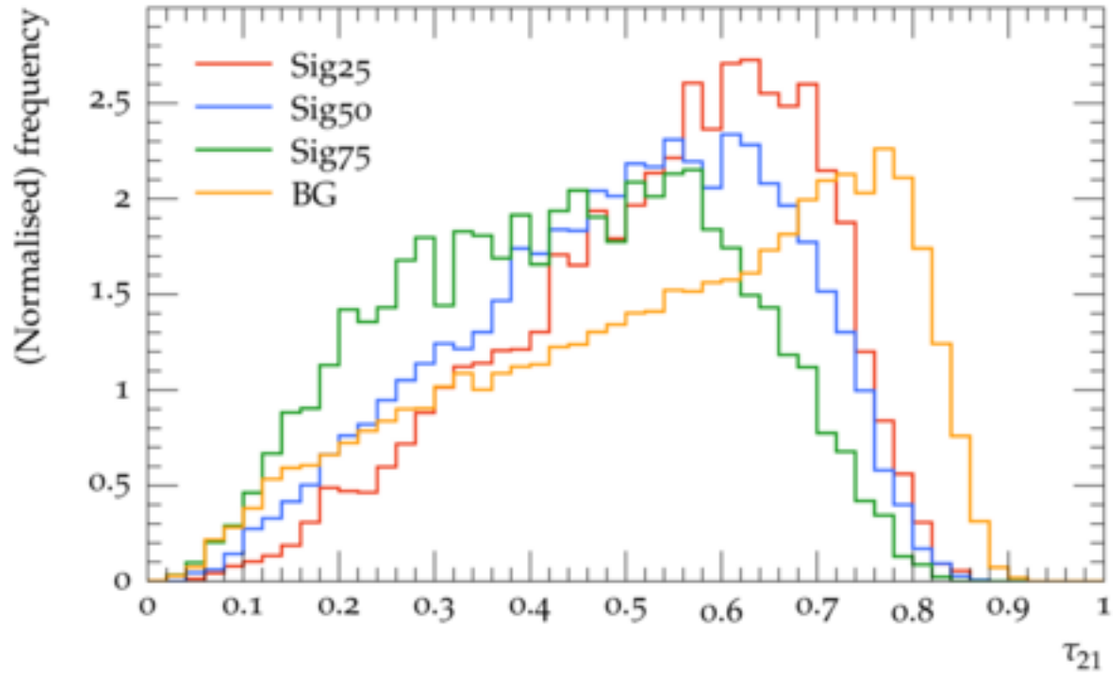
- Forced intermediate and dark hadrons to cluster in jets to check effect on substructure observables in these extreme scenarios.

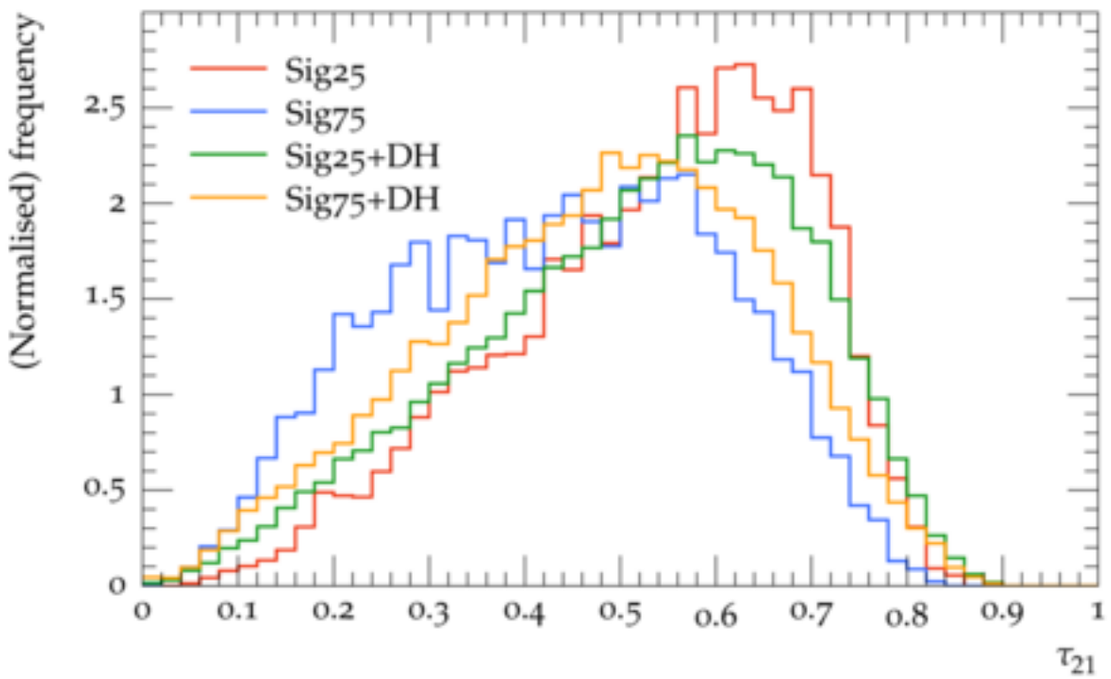
1. Difference in substructure

- Certain variables like C_2, τ_{21}, τ_{32} seem to have some discriminating power.

- Caused by interspersing of dark and visible hadrons.

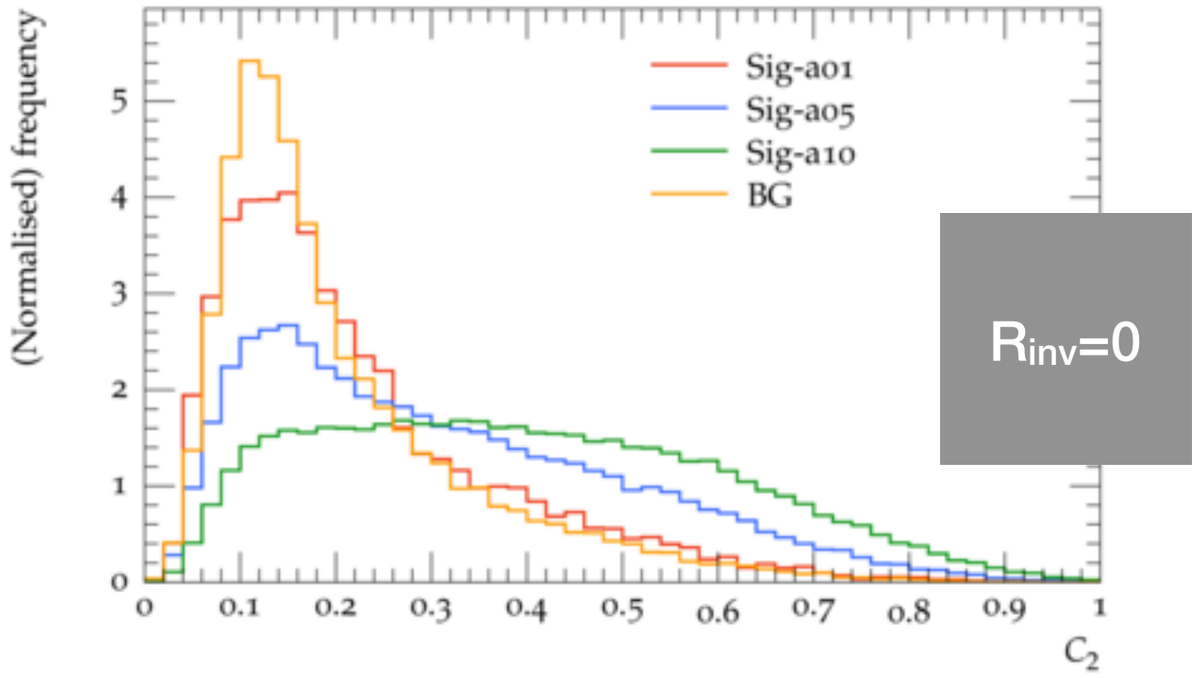
- Even with a conservative 30-40% uncertainty as proposed by Cohen et al, differences would remain.



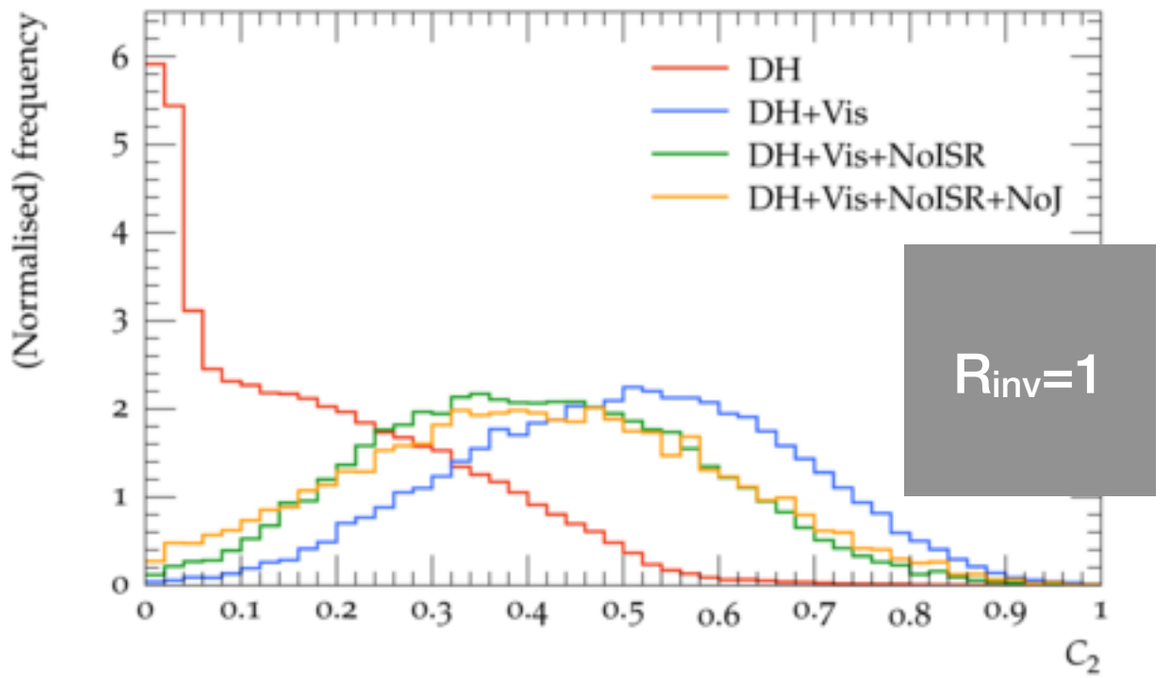


2. Model dependance

- For HV FSR α=0.1, certain obervables look similar.
- Not affected by grooming, intermediate to final dark hadron decay.
- Visible hadrons from ME/ISR make the jets more multi-prong, but not the same effect everywhere.



R_{inv}=0



R_{inv}=1

3. Usefulness in searches?

- In the current implementation of the model, the substructure observables do not buy additional sensitivity in this specific search, the most signal to background separation comes from missing transverse momentum or H_T requirements.

- We can easily envisage a scenario where the cross-section of semi-visible jets signal will be comparable to Standard Model background, and discriminating power of the substructure observables will prove critical.