

Survey of Observables: Medium-Induced Asymmetries

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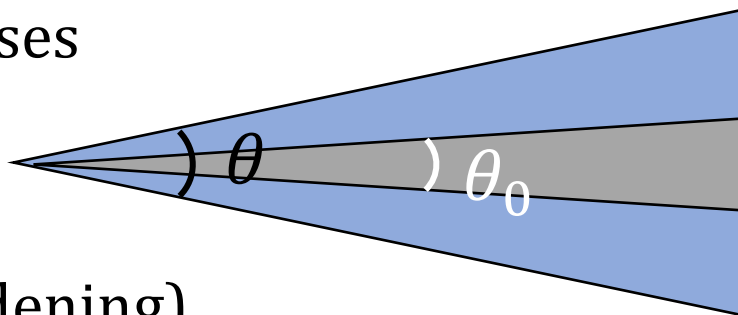
ECT: New Jet
Quenching Tools in HIC*

2/12/2024

Symmetry and Antisymmetry

- Bread & butter jet quenching observables are driven by **isotropic** processes

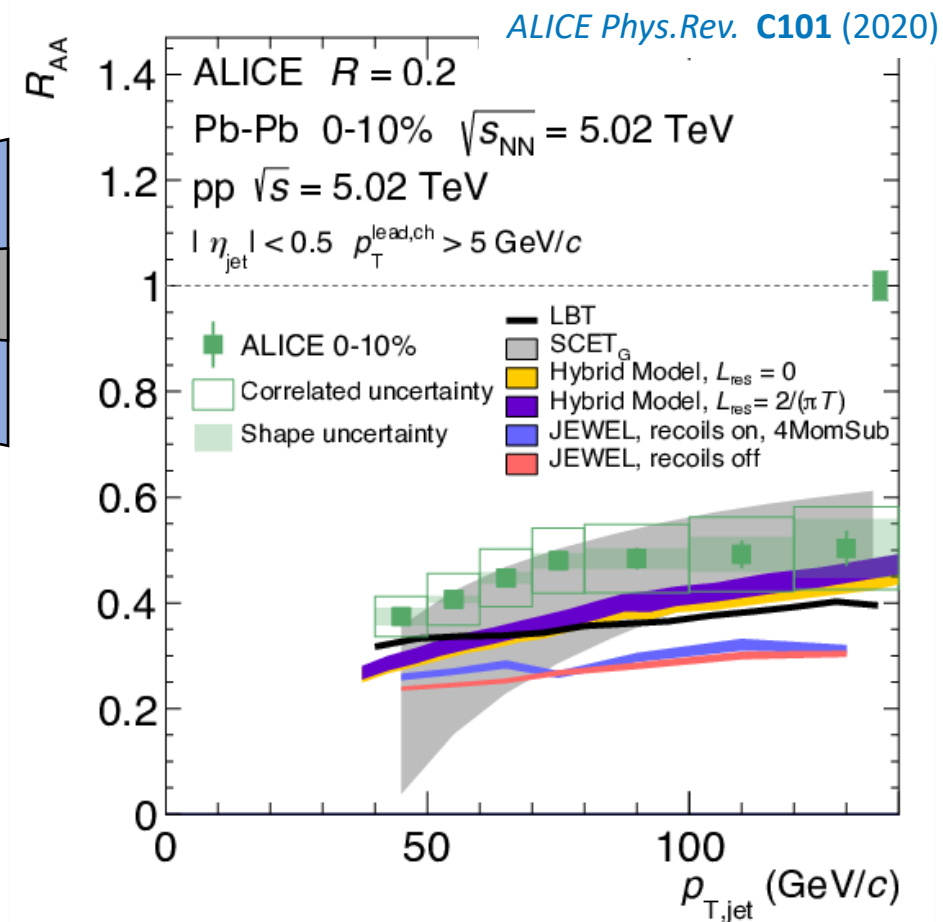
- R_{AA} (Energy loss)
- Acoplanarities (p_T broadening)



- There are **many competing “backgrounds”**:

- Vacuum Sudakov shower
- Gluon saturation

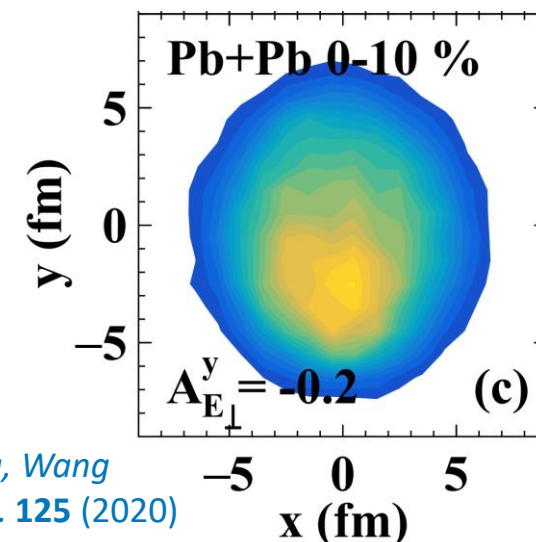
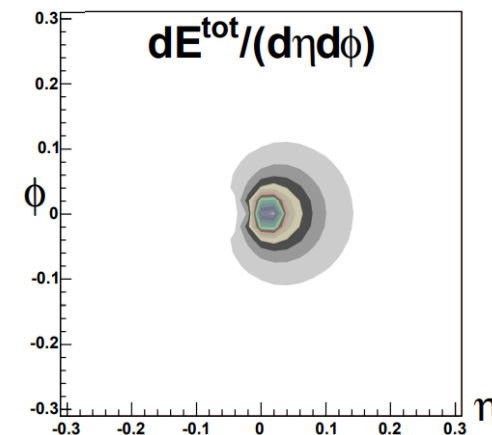
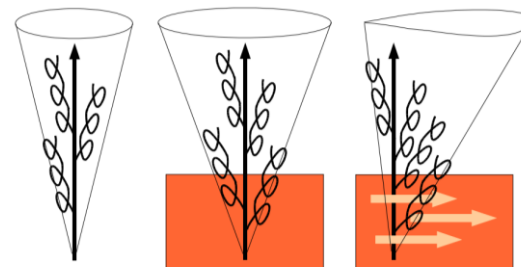
- ❖ **Antisymmetric** observables can select on **different microscopic channels** which have **fewer backgrounds** than the symmetric ones



Beyond Symmetric Jet/Medium Interactions

- Armesto / Salgado / Wiedemann (2004):
 - “Boosted” potential $v(\vec{q}) \rightarrow v(\vec{q} - \vec{q}_0)$
 - **Asymmetric jet shapes**
 - He / Pang / Wang (2020):
 - Spatially inhomogenous $\hat{q}(\vec{x}) = \hat{q}_0 + \vec{x} \cdot \vec{\nabla} \hat{q} + \dots$
 - Proposed **gradient tomography** using asymmetries
 - Sadofyev / Sievert / Vitev (2021):
 - Sub-eikonal deflection with **velocity** $\sim \left(\frac{\mu}{E}\right) \frac{\vec{u}_\perp}{1-u_\parallel}$
 - Eikonal deflection with **gradients** $\sim \vec{\nabla}_\perp T$
- ❖ Formalisms further developed in several recent works.

Armesto, Salgado, Wiedemann, *Phys.Rev.Lett.* **93** (2004)



He, Pang, Wang
Phys.Rev.Lett. **125** (2020)

Designer Observables

- Direct **left/right asymmetry** (“ v_1 type”)

$$A_N^{\vec{n}} = \frac{\int d^3k \frac{dN}{d^3k} \text{sgn}(\vec{k} \cdot \vec{n})}{\int d^3k \frac{dN}{d^3k}}$$

- **Coupling to medium geometry** (“ v_2 type”)

$$v_n e^{in\Psi_n} = \frac{\int dp_T d\phi R_{AA}(p_T, \phi) e^{in\phi}}{\int dp_T d\phi R_{AA}(p_T, \phi)}$$

- Event plane correlations: hard/soft v_n
- Generalized symmetric cumulants

$$\langle A_n B_m^* \rangle$$

- ❖ Similar harmonics for **jet substructure**: jet shape, hadron-in-jet distributions, etc.

- ❖ Centrality dependence, double ratios, event shape engineering, deformed nuclei, ...

