

Franck-Condon principle for heavy-quark hadron decays

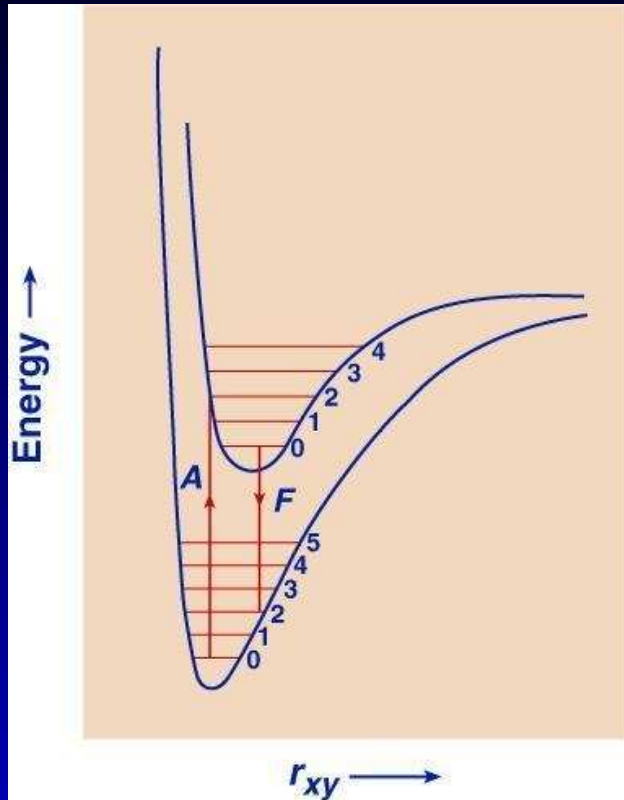


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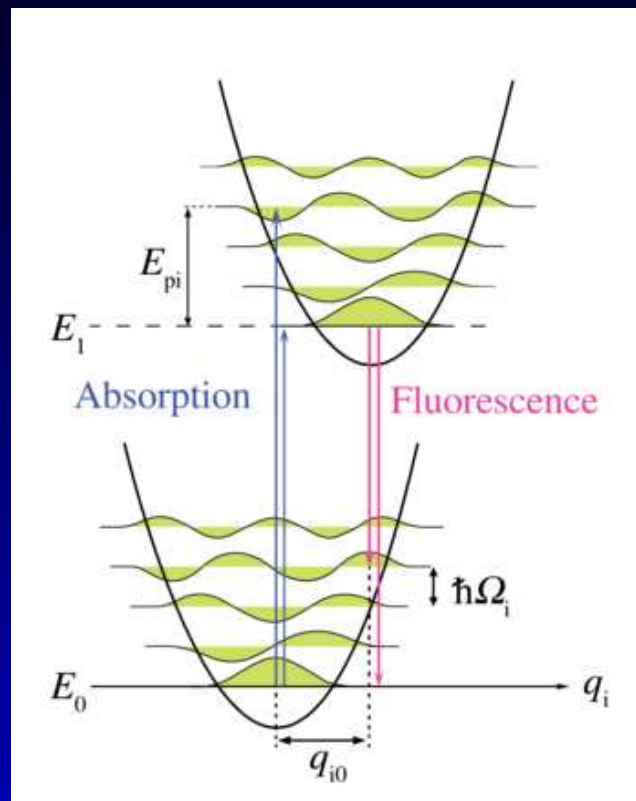
Molecular electronic transitions



adiabatic potentials
for nuclear motion

Born-Oppenheimer approx.

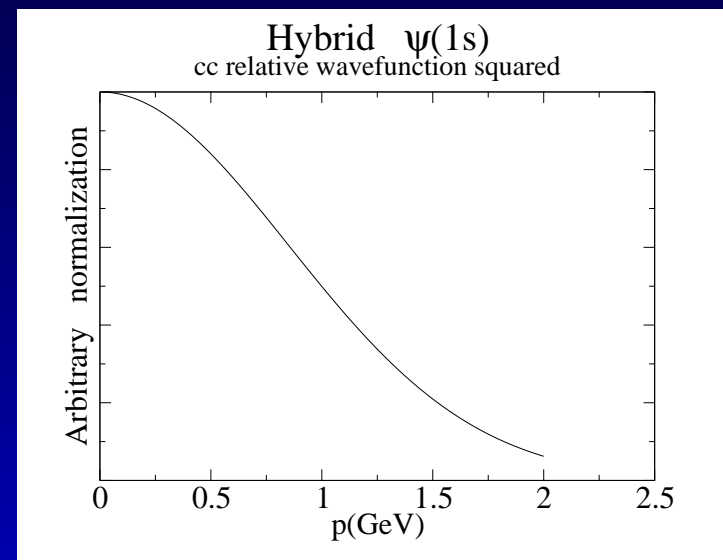
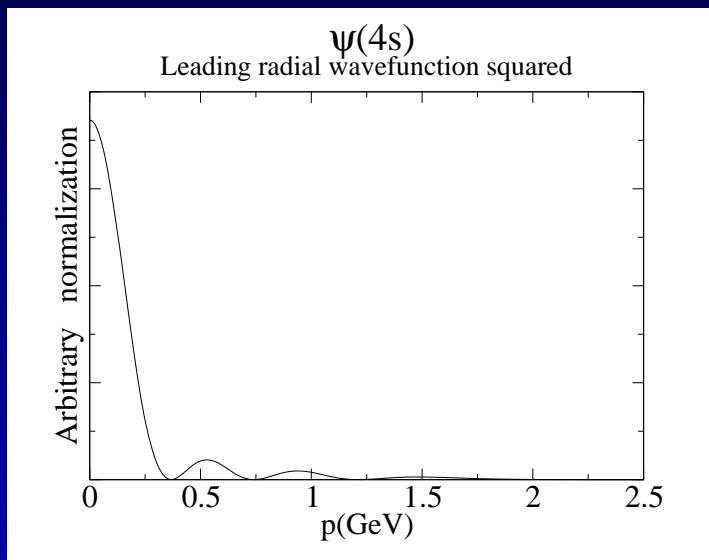
Molecular electronic transitions



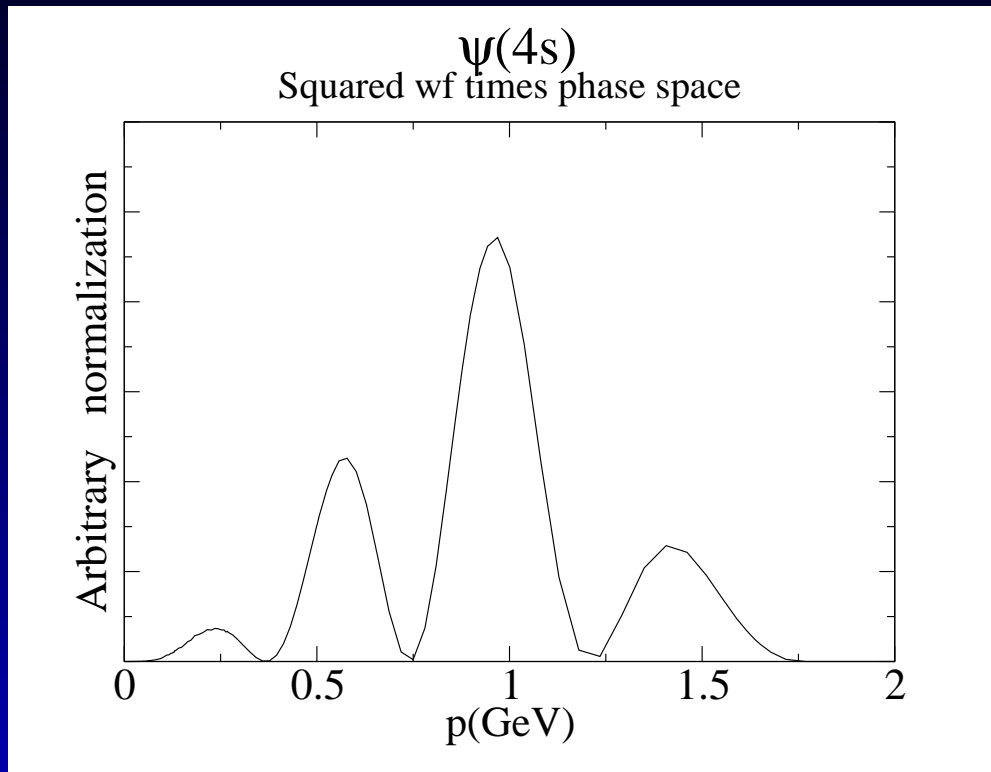
Conjecture

The heavy-quark momentum distribution in the decaying hadron coincides with the momentum distribution of the decay-product hadrons each carrying a heavy quark

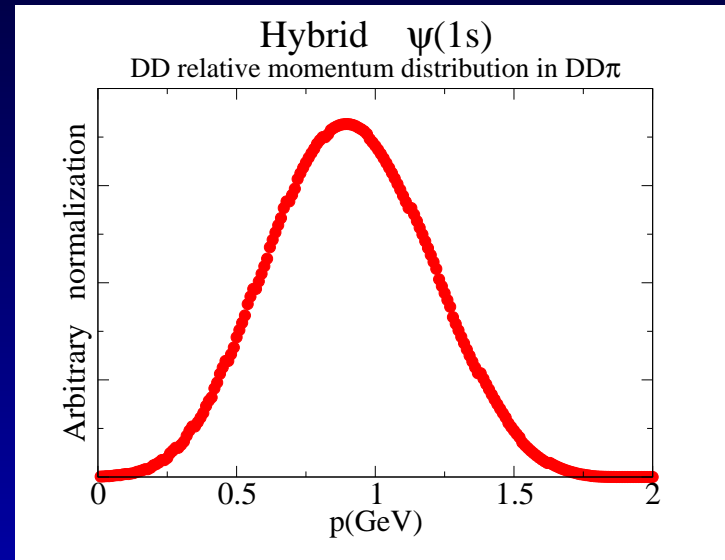
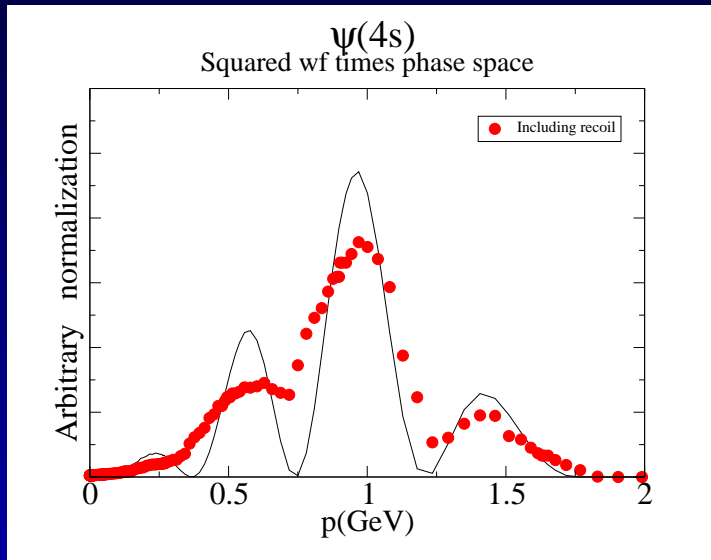
Sturm-Liouville nodes



$$\psi(4260) \rightarrow \bar{D}D\pi$$

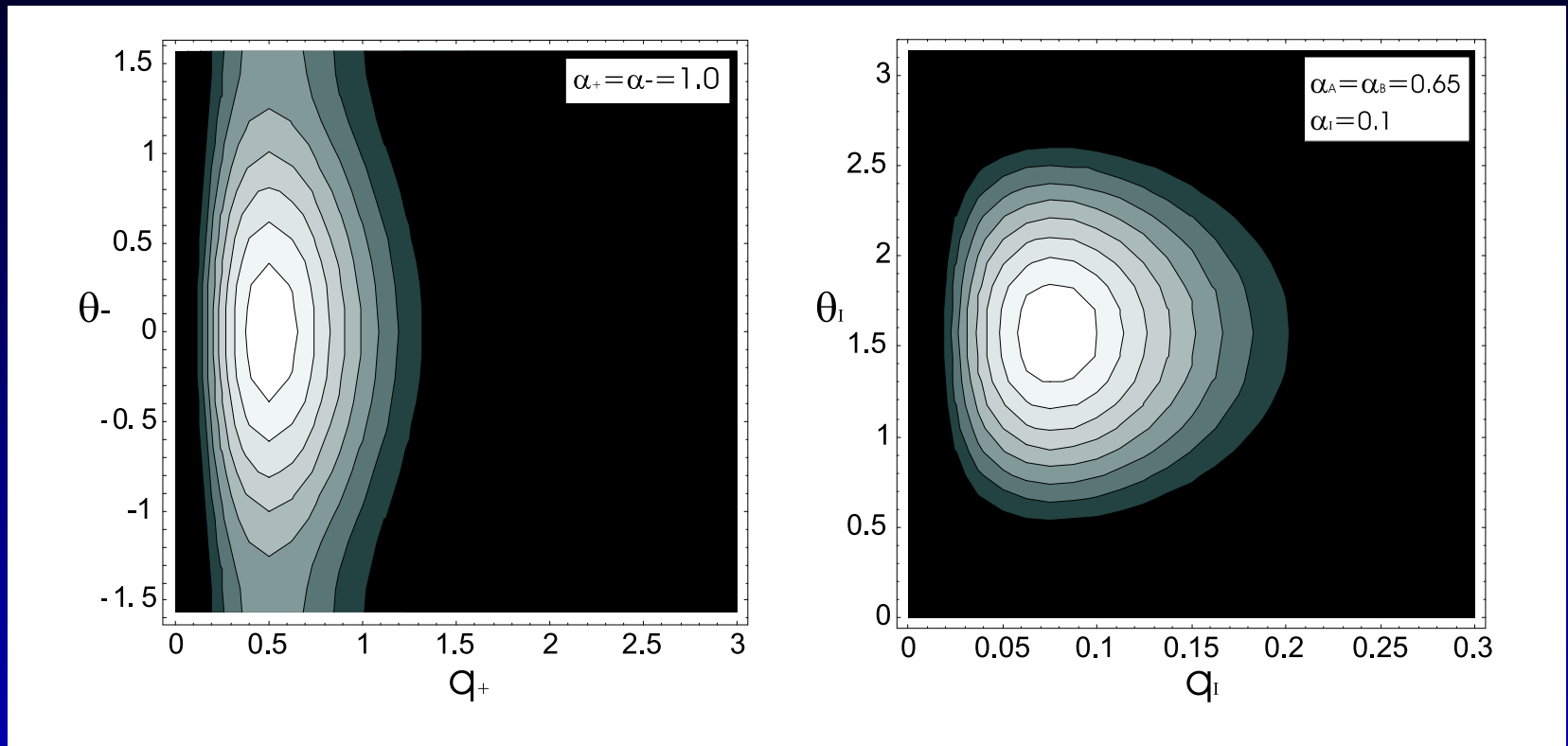


$$\psi(4260) \rightarrow \bar{D}D\pi$$



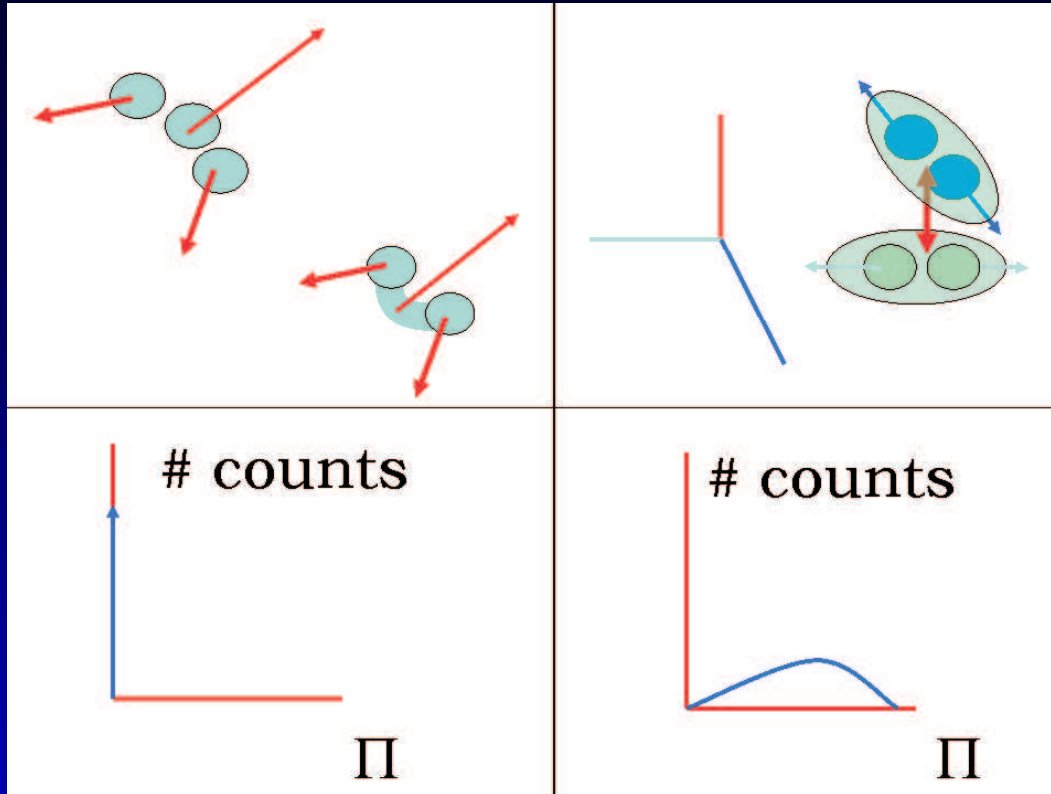
Obvious test: $\Upsilon(5S) \rightarrow \bar{B}B\pi$

Hybrids vs tetraquarks



Wang, General, Cotanch and LL-E PLB07

Exploit off-plane motion in 4q



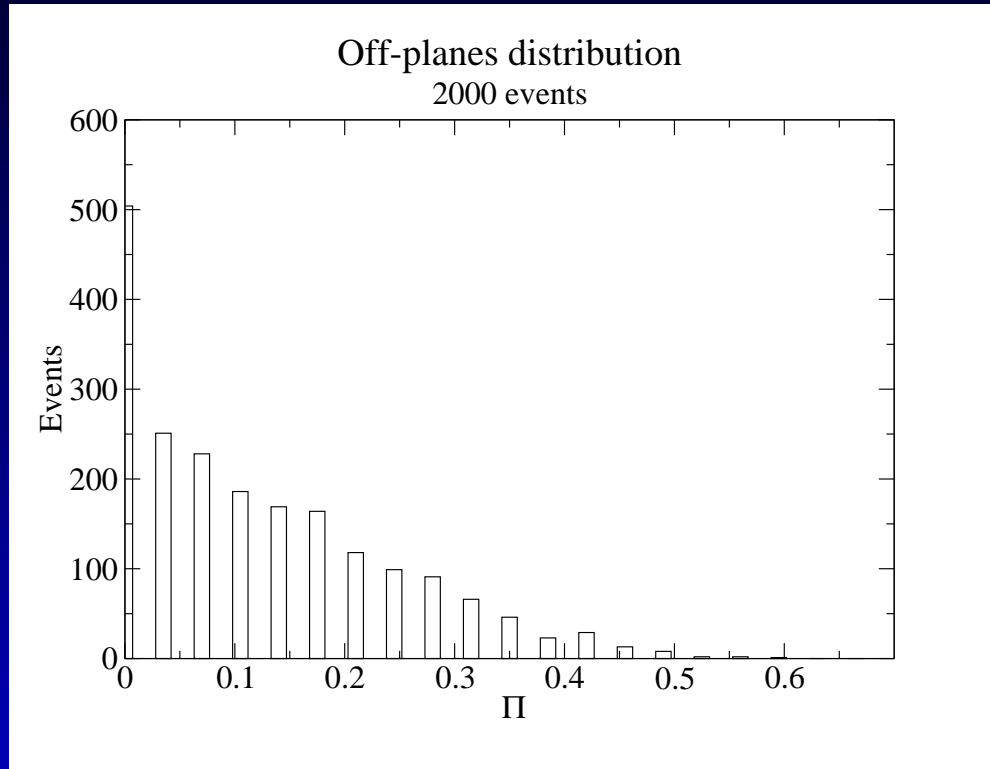
Off-planes correlator

In a four-meson decay

$$\Pi(\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3, \mathbf{p}_4) = \frac{((\mathbf{p}_1 \times \mathbf{p}_2) \cdot \mathbf{p}_3)^2}{\sqrt{|\mathbf{p}_1 \times \mathbf{p}_2| |\mathbf{p}_2 \times \mathbf{p}_3| |\mathbf{p}_1 \times \mathbf{p}_3| |\mathbf{p}_1 \times \mathbf{p}_4| |\mathbf{p}_2 \times \mathbf{p}_4| |\mathbf{p}_3 \times \mathbf{p}_4|}}$$

Wang, General, Cotanch and LL-E PLB07

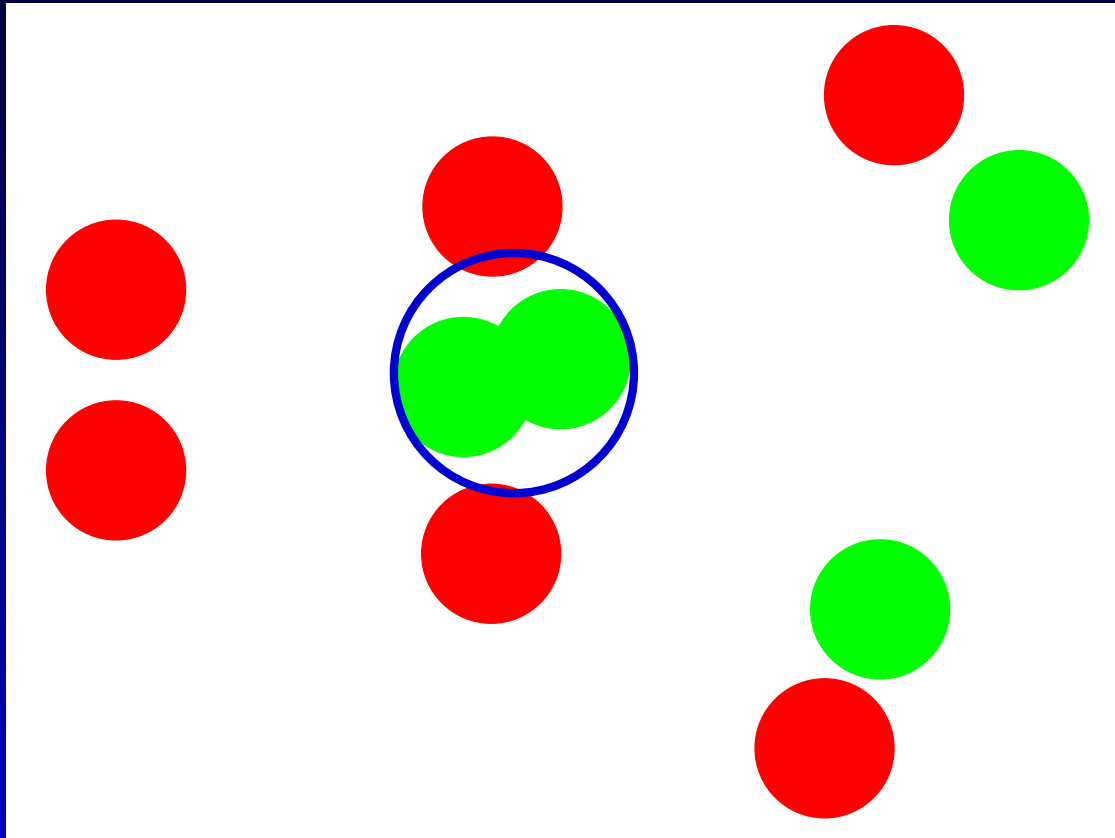
Distribution of off-planes



Random variable $\Pi \in (0, 0.707)$
Double-charm region not explored
This plot for $Z(4430) \rightarrow D\bar{D}\pi\pi$

Hadron decay mechanism

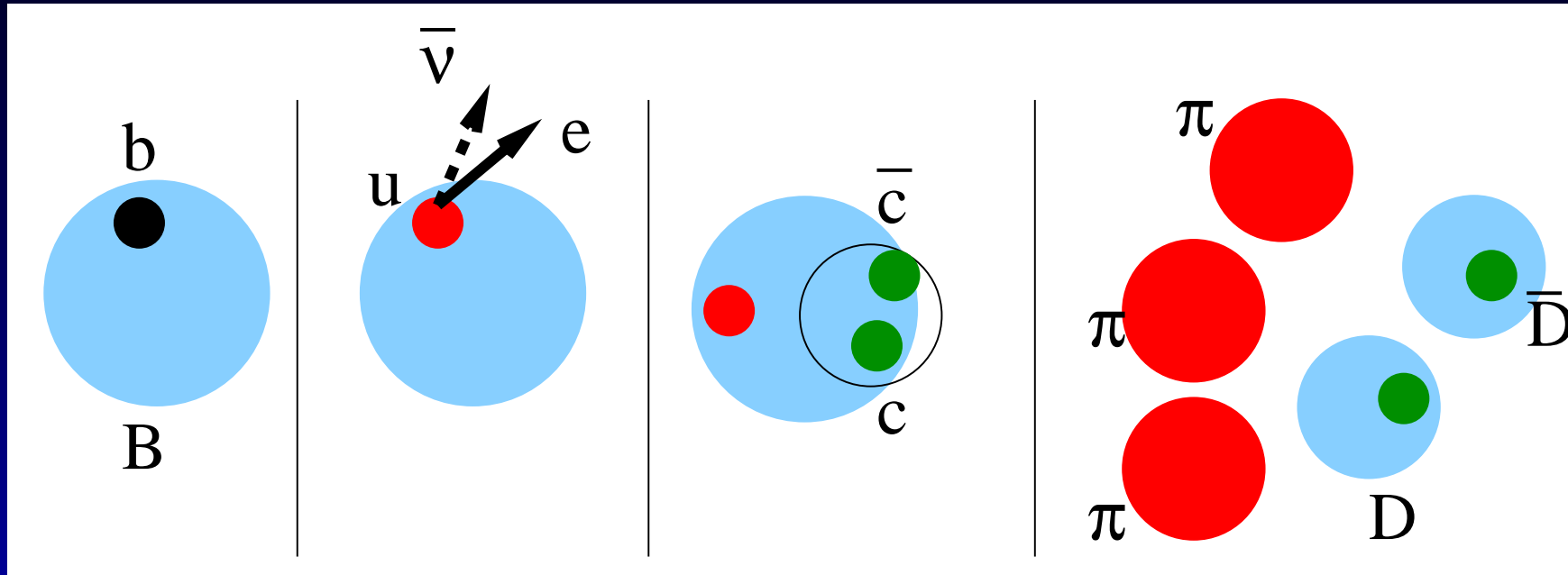
Quark model dilemma:



QCD vector theory suggests 3S_1 pair creation
but phenomenology prefers 3P_0

$\bar{q}q$ spin correlations unmeasured in DIS

Use B decays



The $\bar{D}D$ distribution reveals the $\bar{c}c$ wf
LL-E *et al* SCADRON70 Lisbon meeting

Conclusions

- Franck-Condon principle a powerful tool for hadrons
- $q\bar{q}$ nodes distinguish from $qq\bar{q}$
- Off-planes correlator $qq\bar{q}\bar{q}$
- Sea $q\bar{q}$ wavefunction