

Heavy flavors in medium WG

Preparatory meeting, 05-Dec-18. Giuseppe Bruno, Christian Weiss (Conveners)

Purpose: Collect physics topics for WG agenda and document, start discussion

Background on Workshop

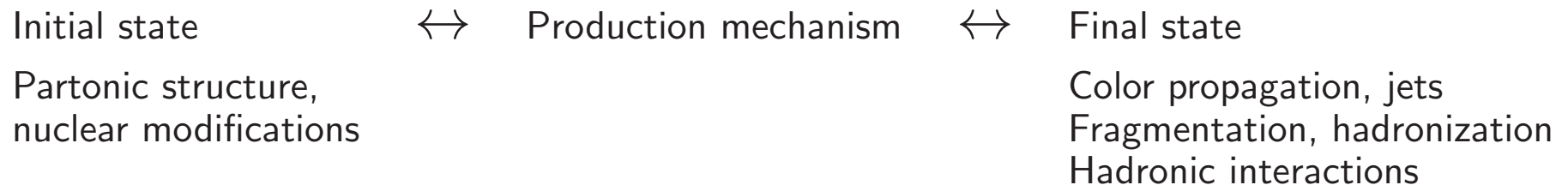
- Four Working Groups: (1) (Multi)quark spectroscopy, incl. ordinary and exotic quarkonia, tetraquarks; pentaquark-like and doubly heavy baryons; (2) Gluonic spectroscopy, incl. small- x and saturation; (3) Diffractive production; (4) Heavy flavors in medium
- Aim: Perform assessment and produce working document for heavy-flavor program with EIC
- Schedule: Compressed, 2 1/2 days total, 1/2 day per WG
- Format: Concise summary talks; discussions essential, also outside the sessions

Heavy flavor interactions with matter

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$$\text{HF} \begin{cases} \text{open } D, B, \Lambda_{c,b}, \dots \\ \text{quarkonia } J/\psi, \eta_c, \Upsilon, \dots \end{cases} \quad \text{matter} \begin{cases} \text{cold} \\ \text{hot} \end{cases} \quad \text{interaction} \begin{cases} \text{low-energy } \lesssim 1 \text{ GeV} \\ \text{high-energy } \gg 1 \text{ GeV} \end{cases}$$

Schematic



Experiments and facilities

$pp/pA/AA$	LHC, RHIC, Tevatron
ep/eA	EIC \leftarrow
ep	HERA, EMC
e^+e^-	VEPP, BEPC, CESR, LEP, SLC, KEKB, PEP-II

Our agenda

- Physics topics and questions?
- Status and prospects of pA/AA experiments?
- Opportunities with ep/eA at EIC?

- Interaction of energetic heavy quarks with matter

Effects: p_T broadening, energy loss, jet structure and evolution, . . .

Mechanisms: Induced radiation, collisions, time/distance scales

ep/eA at EIC: Variable energy $\nu = \text{few } 10 - 100 \text{ GeV}$

Controlled initial-state kinematics through electron detection

HF reconstruction using next-gen PID (π/K), vertex detection, momentum resolution

Possibility of correlation measurements

ep/eA theory: HF production mechanism in ep well studied, higher orders, uncertainties

- Hadronization of heavy quarks in vacuum and in matter

HF fragmentation: Mechanism, first-principles theory calculations?

HF hadronization: Color neutralization \leftrightarrow hadronization, time/distance scales

ep/eA at EIC: [Same as above]

ep/eA theory: [Same as above]

Topics: Open heavy flavors II

- Hadronic interactions of heavy mesons/baryons

Cross sections of $D, B, \Lambda_{c,b}$ with nucleons: Heavy \leftrightarrow light comparison

Scattering amplitudes: Re/Im, intermediate states?

ep/eA at EIC: Light nuclei deuteron, ^3He , ^4He

Detection of nuclear breakup state, spectator tagging

Input to theory calculations of structure & FSI in spectroscopy

Input to transport models for heavy-ion final states

- Open HF production as probe of partonic initial state

Nuclear modification of gluons: EMC effect $x > 0.3$, antishadowing $x \sim 0.1$, shadowing $x \ll 0.1$

HF production as initial-state probe if final-state effects can be corrected/eliminated

ep/eA at EIC: Combined nuclear ratio measurements of $F_2(\text{light})$ and $F_2(\text{charm})$ for relative luminosity control

ep/eA theory: Nuclear gluons from either $F_{2,L}(\text{light}) + \text{DGLAP}$ or from $F_2(\text{charm})$, test universality and production mechanism

- High-energy interaction of heavy quarkonia with matter

Color transparency: Fundamental prediction of QCD, necessary for factorization theorems

Coherent phenomena in heavy quarkonium production on nuclei

ep/eA at EIC: Wide range of x and $Q^2 \leftrightarrow$ coherence length and dipole size
Forward detection of coherent nuclear scattering, diffractive breakup

ep/eA theory: Collinear factorization, dipole model, NRQCD, phenomenology
Sensitivity to heavy quarkonium wave function, incl. excited states
Connection with nuclear GPDs, nuclear shadowing

- Low-energy interaction of heavy quarkonia with matter

Multipole expansion, Van-der-Waals force of QCD

Nuclear bound states \leftrightarrow Pentaquarks

Quantum numbers and excited states ψ, ψ' . Polarization phenomena?

- Heavy quarkonium production mechanism on nucleon

Puzzles and uncertainties in pp : Can ep help understand pp ?

Proposed schedule

Wednesday, 19 Dec, 14:30–18:00

Heavy flavors in medium WG

Conveners	(5')	14:30-14:35	Introduction
Ivan Vitev	(30')	14:35-15:05	Heavy flavors as probe of nuclear medium
Rongrong Ma	(30')	15:05-15:35	HF meson production at RHIC and LHC
Pietro Antonioli	(30')	15:35-16:05	HF baryon production from e^+e^- to Pb-Pb
Coffee break	(30')	16:05-16:35	
Christian Weiss	(25')	16:35-17:00	Open heavy flavor production and reconstruction at EIC
Peter Schweitzer	(30')	17:00-17:30	Low-energy interactions of heavy quarkonium with matter
Enrico Scomparin	(30')	17:30-18:00	Heavy quarkonium production at RHIC and LHC