Heavy Flavour Suppression
- round table -

Antonio Vairo

Technische Universität München

What do we know about the finite temperature potential?

The potential is the interaction describing the quarkonium time evolution in an EFT that follows from QCD by integrating out all modes of energy larger than the binding energy:

$$i\frac{\partial}{\partial t}\phi = \left[\frac{\mathbf{p}^2}{m} + V(\mathbf{r},\mathbf{p},T,\ldots) + \text{low-energy interactions}\right]\phi$$

We distinguish two regimes:

- Weak coupling: all scales are perturbative, i.e. larger than $\Lambda_{\rm QCD}$.
- Strong coupling: some scales are of order $\Lambda_{\rm QCD}$.

Weak coupling

Temperature	Potential (LO)	Thermal Width	Dissociation Mechanism
$T \gtrsim mg$	screened	$\Gamma \sim \alpha_s T \times (m_D a_0)^2 > E_{\rm bin}$	screening
$mg \gg T \gtrsim mg^{4/3}$	Coulomb	$\Gamma \sim \alpha_s T \times (m_D a_0)^2 > E_{\rm bin}$	inelatic parton scattering
$mg^{4/3} \gg T \gtrsim mg^3$	Coulomb	$\Gamma \sim \alpha_s T \times (m_D a_0)^2 < E_{\rm bin}$	inelastic parton scattering
$mg^3 \gg T$	Coulomb	$\Gamma \sim \alpha_s T \times (E_{\rm bin} a_0)^2 < E_{\rm bin}$	gluodissociation

$a_0 \sim 1/(mg^2)$ = Bohr radius
$E_{\rm bin} \sim mg^4$ = binding energy
$m_D \sim gT$ = Debye mass

Strong coupling

- Analysis based on lattice calculations at different Euclidean times. See talk by A. Rothkopf.

- Such an analysis is important because we know from weak-coupling studies that the real part of the potential cannot be extracted from the Wilson loop free energy or from the correlator of Polykov loops. Moreover, it is crucial to obtain also the imaginary part of the potental.

- Ideally one would like to be able to express the real and imaginary part of the potential and its relativistic corrections in terms of expecation values of non-perturbative operators. A program that has been realized for quarkonium at zero temperature.

What is the experimental impact of the imaginary part of the potential?

- A specific weak-coupling case that could be tested at LHC could be the $\Upsilon(1S)$:

$$m_b \approx 5 \text{ GeV} > m_b\alpha_{\rm s} \approx 1.5 \text{ GeV} > \pi T \approx 1 \text{ GeV} > m_b\alpha_{\rm s}^2 \approx 0.5 \text{ GeV} \sim m_D \gtrsim \Lambda_{\rm QCD}$$

- Can we have measures of the thermal width ($\sim$ number) of the $\Upsilon(1S)$ at different temperature? In this case:

$\Gamma \sim T$ (for gluodissociation) and $\Gamma \sim T^3/m^2$(for inelastic parton scattering dissociation).