Quarkonium equilibrium limits and properties in hot matter "Saclay" approach

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18th of December, 2019

Equilibrium limit

Our model (of Blaizot and Escobedo (2018)) is constructed in such a way that in the steady state the probability of a given state i is $p_i = e^{-\frac{E_i}{T}}/Z$.

$$Z = \sum_n e^{-\frac{E_n}{T}} + \frac{(N_c^2 - 1)V(MT)^{3/2}}{(4\pi)^{3/2}},$$

where the sum is over all singlet bound states and the second term represents the contribution of the octet.

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Key inputs

- Whether the binding energy is much bigger than the decay width or not. Tells us if we can use our model or not.
- We need to know the binding energy of each bound state and its decay width. The real part of the potential informs about this.
- Our decay rate in the static limit can be compared with the lattice imaginary part of the potential.
- What is the energy gap between singlet and octets?

Real part of the potential

At the moment we are using a Yukawa potential with a leading order HTL Debye mass.

Preliminary observations

- It seems that leading order HTL overestimates the value of the Debye mass $\rightarrow$ overestimate of the importance of screening.
- A theoretical question that must be answered to use a non-perturbative real part of the potential in our approach is what is the value of the energy gap between singlets and octets.

Imaginary part of the potential

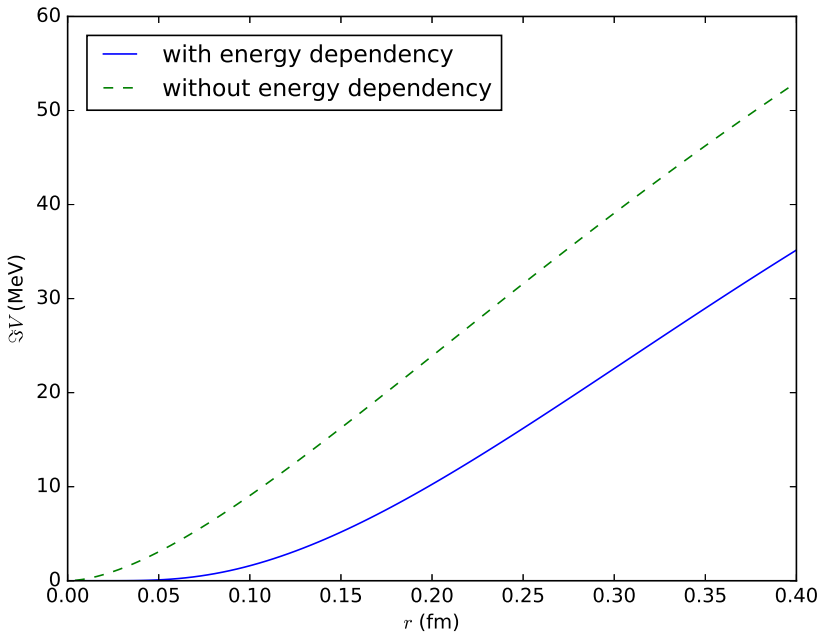
Related with the decay width, $\Gamma_s(r) = 2\Im V_s(r)$.

$$\Gamma_s(r) = 2g^2 C_F \mathrm{e}^{-\frac{V_o(r)-V_s(r)}{T}} \int_{\mathbf{q}} \Delta^{>}(V_o(r) - V_s(r), \mathbf{q})| \sin\left(\frac{\mathbf{qr}}{2}\right)|^2 ,$$

interesting to compare this with the approximation that corresponds to the Laine potential

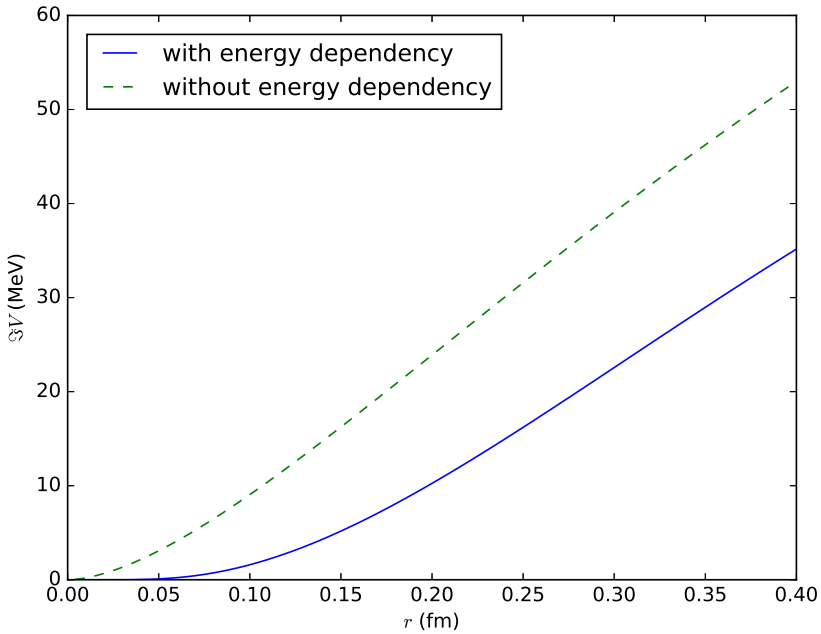
$$\Gamma_s^0(r) = 2g^2 C_F \int_{\mathbf{q}} \Delta^{>}(0, \mathbf{q})| \sin\left(\frac{\mathbf{qr}}{2}\right)|^2 ,$$

Imaginary part of the potential



Theoretically well motivated effect that should be seen on the lattice if $V_s(r) - V_o(r) \sim T$. Is it possible?

Imaginary part of the potential



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Physical consequences

- Suppression of the singlet decay width at small temperatures.
- Transitions to high energy octet states is more unlikely than to lower energy ones.