

**EXERCISE FOR LECTURE ON  
DETERMINATION OF THE FUNDAMENTAL  
PARAMETERS OF QCD:**

Determine the QCD strong coupling constant from the  
tau-decay rate

Download the review paper by A. Pich: arXiv: 1310.7922. Use Eq.(70) to determine the QCD strong coupling. Consider only the perturbative QCD (PQCD) expression  $\delta_P$ , given in Eq.(72) and take only the leading term  $n = 1$ . Determine the function  $A^{(1)}(\alpha_s)$ , Eq. (73), by integrating in the complex square energy  $s$ -plane. The integral can be easily evaluated by a change of variable:  $s = s_0 e^{i\phi}$ , with  $s_0 = M_\tau^2$ , and integrating in  $\phi$  in the interval  $(0, 2\pi)$ . You should end up with an equation relating the  $R$ -ratio on the left-hand side, a number which you need to input, and an expression containing  $\alpha_s(M_\tau^2)$  on the right hand side. Finally solve for  $\alpha_s(M_\tau^2)$ . Your result should roughly agree with the value quoted in the paper using the full PQCD expansion.