$^{(2S+1)}L_J$ $^1S_0$ $^3S_1$ $^3P_2$ $^3P_1$ $^3P_0$ $^1P_1$ $^3D_3$ $^3D_2$ $^3D_1$ $^1D_2$ $^??_?$

Mass (MeV/c²)

■ measured states

☐ model predictions (mass, width)

$V \propto a/r + b\,r$

Y(4660)

ψ(4415)
Y(4350)
Y(4260)
X(4160)

ψ(4040)
X(3940)
χ$_{c2}$(2P)
Y(3915)
X(3872)

Open charm threshold

η$_c$(2S) ψ(2S)
χ$_{c2}$
χ$_{c1}$
χ$_{c0}$
h$_c$

ψ(4160)
ψ(3770)

Z⁺(4430)
X(4350)
Z⁺₂
Y(4140)
Z⁺₁ Z⁺(4020)
Z⁺(3900)

J/ψ

η$_c$(1S)

kinematic threshold for decays into two D mesons

■ Established

■ New States

☐ Theory

5000
4750
4500
4250
4000
3750
3500
3250
3000
2750
2500

0^{-+} 1^{--} 2^{++} 1^{++} 0^{++} 1^{+-} 3^{--} 2^{--} 1^{--} 2^{-+} $?^?$ J^{PC}
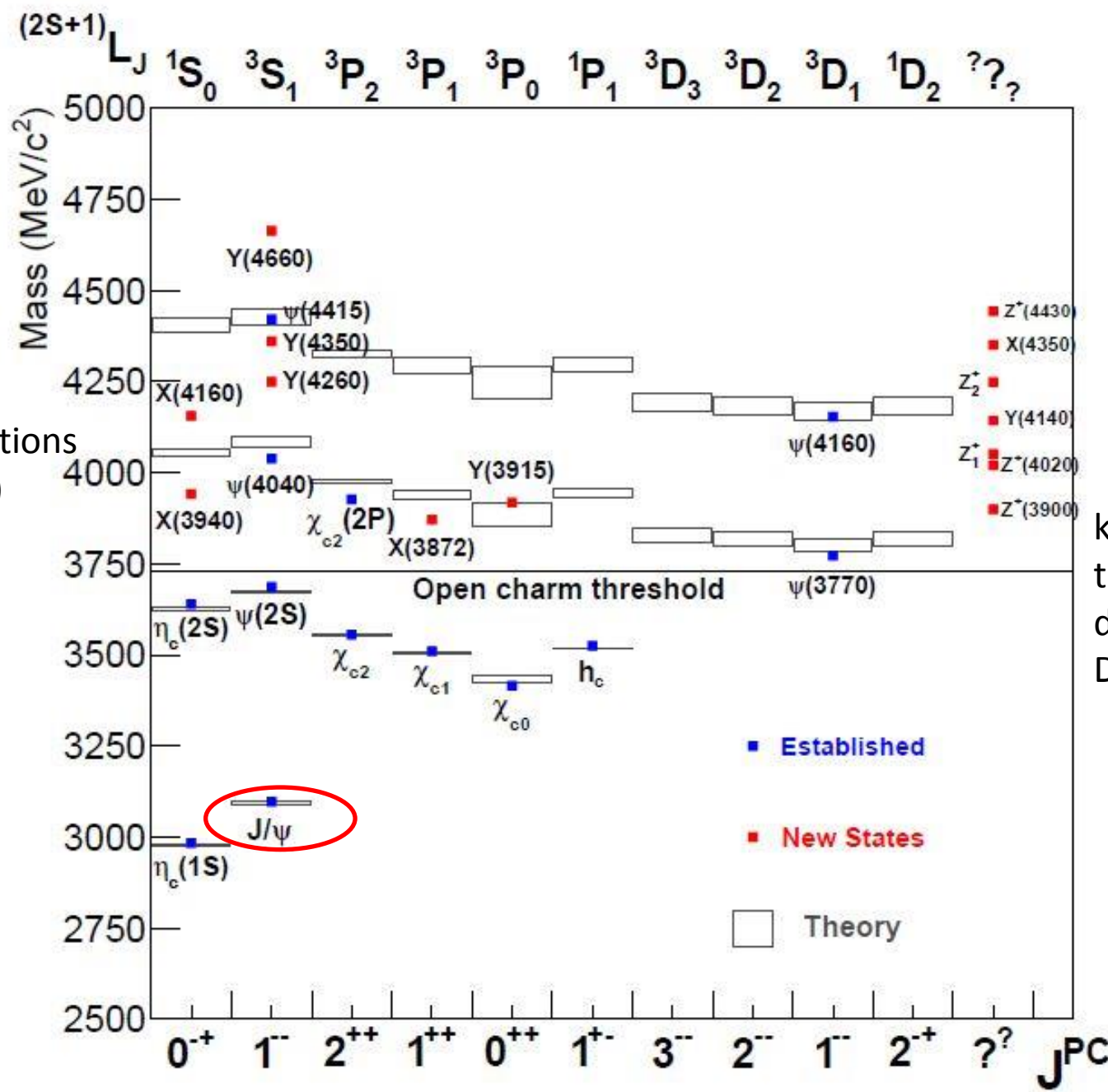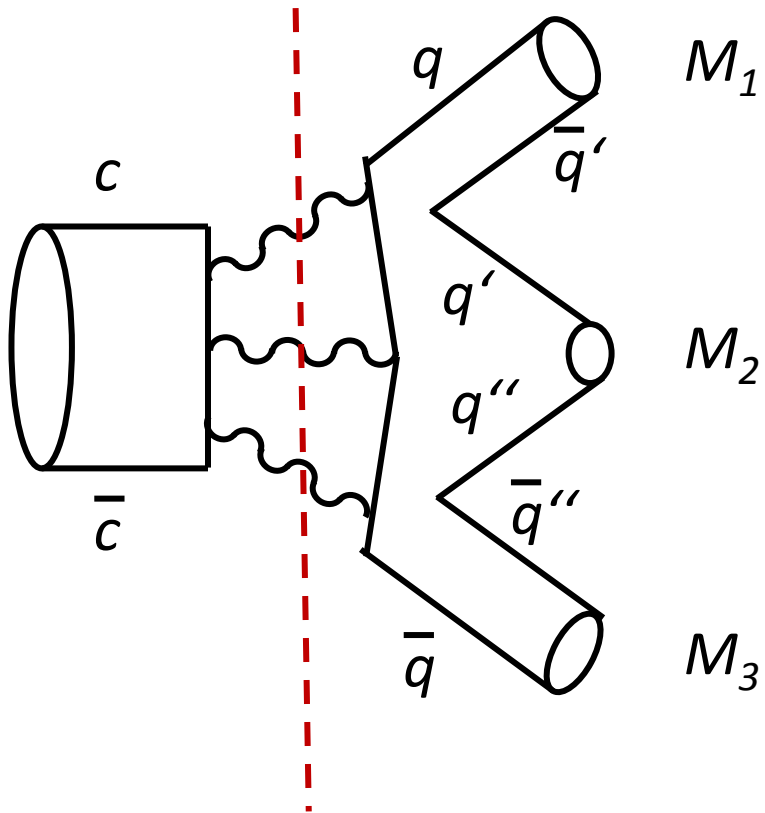
diagram can be cut in a way to cross only gluon lines
$\Rightarrow$ OZI rule, small probability (due to α_s^3)

as opposed to