A-DEPENDENCE OF HEAVY FLAVOUR PRODUCTION IN QCD

N. Armesto, C. Pajares,
C. A. Salgado, Yu. M. Shabelski

We calculate the A-dependences of charm and beauty production cross sections on nuclear targets taking into account the difference of quark and gluon distributions in free nucleons and in nucleus. At comparatively low energies, if $\sigma \propto A^{\alpha}$, the value of α is slightly higher than unity. With the growth of the initial energy the value of α decreases and becomes smaller than unity. We also calculate the values of α for different Feynman-x of the produced $Q\overline{Q}$ pair and obtain that they decrease significantly in the beam fragmentation region.

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NEW CORRECTIONS TO THE ENERGY LEVELS OF TWO-BODY SYSTEMS

M. I. Eides

We have calculated radiative correction to the Lamb shift of order $\alpha^2(Z\alpha)^5 m$ induced by the light by light scattering insertion in external photons. New contribution turns out to be equal to $-0.122(2)\alpha^2(Z\alpha)^5/(\pi n^3)(m_r/m)^3 m$, or, numerically, -0.66 kHz for $2S$-state and -5.28 kHz for $1S$-state in hydrogen, respectively. These results complete our calculation of all corrections of order $\alpha^2(Z\alpha)^5 m$ to the Lamb shift induced by the diagrams with closed electron loops.

We have obtained contributions of order $\alpha^2(Z\alpha)^5$ to the hyperfine splitting and Lamb shift, induced by the gauge invariant set of nineteen diagrams with two radiative photon insertions in the electron line. Our new contribution to the hyperfine splitting in the ground state of muonium is equal to $-0.3701(4)$ kHz, while the corrections to the 1S and 2S Lamb shifts in hydrogen are equal to $-334.2(1)$ kHz and $-41.78(2)$ kHz, respectively.

Calculation of these corrections completes the program of calculation of all corrections of order $\alpha^2(Z\alpha)^5$ to the hyperfine splitting and Lamb shift, thus reducing by an order of magnitude theoretical uncertainty of respective theoretical expressions. The agreement between the theory and the experimental value of the hyperfine splitting in the ground state of muonium is excellent. Comparison of the theoretical expression with the experimental value leads in this case to determination of the electron-muon mass ratio with accuracy three times higher than the accuracy of the best direct experimental measurement of this quantity.

Uncertainty of the theoretical expression for the Lamb shift is reduced to 28 kHz for the 1S state and to 4 kHz for the 2S state of hydrogen. Hence, on the basis of the accurate theory, we are able to reject one of two discrepant experimental values of the proton charge root mean square radius.

New level of the theoretical precision achieved for the Lamb shift is crucial for the determination of a precise value of the Rydberg constant on the basis of the high precision spectroscopic measurements.

The problem of $m\alpha^6$ corrections to the P-levels of positronium and helium was also considered during our work on this project. We have demonstrated accurately that the only source of the true radiative corrections of the order $m\alpha^6$ to P-states is the anomalous magnetic moment.

A series of corrections of order α^6 to the S-levels in positronium and a new radiative-recoil correction of order $\alpha(Z\alpha)^5(m/M)$ to the Lamb shift in hydrogen were obtained.

We have also obtained new corrections of order $\alpha^3(Z\alpha)^4$ and $\alpha^2(Z\alpha)^6$ to the Lamb shift.

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