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# On the spin correlations of muons and tau leptons produced in the high-energy annihilation processes $e^+e^- \to \mu^+\mu^-, \tau^+\tau^-$

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The electromagnetic processes of annihilation of $(e^+e^-)$ pairs –
which may be generated, in particular, in relativistic nucleus-nucleus and hadron-nucleus collisions – into heavy flavor lepton pairs are
theoretically studied in the one-photon approximation, using the
technique of helicity amplitudes . For the process $e^+e^- \to \mu^+\mu^-$, it is shown that – in the case of the unpolarized
electron and positron – the final muons are also unpolarized but their spins prove to be strongly correlated. For the final $(\mu^+\mu^-)$ system, the structure of triplet states is analyzed and explicit expressions for the components of the spin density
matrix and correlation tensor are derived; besides, the formula for
the angular correlation at the decays of the final $\mu^+$ and $\mu^-$ is obtained .

It is demonstrated that the spin correlations of muons in the
process $e^+e^- \to \mu^+\mu^-$, have the purely quantum character, since one of the Bell-type incoherence inequalities for
the diagonal components of correlation tensor is always violated
( i.e., there is always one case when the modulus of sum of two
diagonal components exceeds unity ) . In doing so, it is also established that, when involving the additional contribution of
the weak interaction of lepton neutral currents through the virtual $Z^0$ boson, the qualitative character of the muon spin correlations does not change.

Analogous consideration can be wholly applied as well to the annihilation process $e^+e^- \to \tau^+\tau^-$,
which becomes possible at much higher energies.

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