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Femtoscopic correlations and the strangeness baryon-baryon interactions

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We study the baryon-baryon interactions with strangeness $S = -2$ and corresponding momentum correlation functions in leading order covariant chiral effective field theory. The relevant low energy constants are determined by fitting to the latest HAL QCD simulations, taking into account all the coupled channels. Extrapolating the so-obtained strong interactions to the physical point and considering both quantum statistical effects and the Coulomb interaction, we calculate the $\Lambda\Lambda$ and $\Xi^- p$ correlation functions with a spherical Gaussian source and compare them with the recent experimental data. We find remarkable agreement between our predictions and the experimental measurements by using the source radius determined in proton-proton correlations, which demonstrates the consistency between theory, experiment, and lattice QCD simulations. Moreover, we predict the $\Sigma^+\Sigma^+$, $\Sigma^+\Lambda$, and $\Sigma^+\Sigma^-$ interactions and corresponding momentum correlation functions. We further investigate the influence of the source shape and size of the hadron pair on the correlation functions studied and show that the current data are not very sensitive to the source shape. Future experimental measurement of the predicted momentum correlation functions will provide a non-trivial test of not only SU(3) flavor symmetry and its breaking but also the baryon-baryon interactions derived in covariant chiral effective field theory.

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