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Higher Order Nonlocal Effects of Relativistic Ponderomotive Force in High Power Lasers NATSUMI IWATA, YASUAKI KISHIMOTO, KENJI IMADERA, Kyoto University — Recently, the intensity of high power lasers has reached $10^{21} W/cm^2$. Since such intensity is realized by tight focusing, the ponderomotive force becomes strong and plays an essential role in laser-matter interaction. The ponderomotive force has been derived by the averaging method, and explained as a force proportional to the field gradient under the first-order approximation with respect to ϵ, the ratio between particle excursion length and scale length of field amplitude gradient. However, under strong focusing, the higher order terms neglected in the above method becomes important. Here, we introduce the noncanonical Lie perturbation theory based on the variational principle in phase space [1] and present an extended theory of relativistic ponderomotive force that includes nonlocal effects expressed by the higher order terms. By successfully finding suitable coordinates, we obtained a new formula of the relativistic ponderomotive force that involves second and third spatial derivatives of the field amplitude. We applied the formula to study particle confinement in a hollow-shaped laser field. The higher order terms are found to play a leading role regulating the betatron motion.

[1] N. Iwata, Y. Kishimoto and K. Imadera, Plasma Fusion Res. 6, 2404105 (2011)

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