A Unified Formalism toward Polarization, Magnetization and the θ-term in a Periodic Insulator KUANG-TING CHEN, PATRICK LEE, MIT — The traditional perturbative calculation expands in powers of the gauge potential. This procedure proves problematic when a uniform electric or magnetic field is present. Here we provide a perturbative expansion of the electronic Green's functions directly in powers of the fields. On the other hand, the first order correction to the free energy to an insulator with periodic boundary conditions in the presence of the electric field is actually a Berry's phase. To express the Berry's phase in terms of the Green's functions, one is required to extend the Green's function to one extra dimension. With the trick, one can then calculate the effective action to arbitrary order of the electric and magnetic field. One new result we have obtained is that the θ-term is given by the combination of the Green's functions in the extended momentum space, similar to the Wess-Zumino-Witten term, even without time reversal symmetry.

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