Departamento de Física de Materiales

Average density of Bloch electrons in a magnetic field: a second-order response

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MIÉRCOLES 10 DE DICIEMBRE A LAS 12:00

SALA DE SEMINARIOS
DEPARTAMENTO DE FÍSICA DE MATERIALES, UCM

Electronic systems in magnetic fields give rise to many novel phenomena. Strong-field responses have long inspired new ideas -particularly in connection with quantum Hall effects - but the weak-field regime has received comparatively less attention. Here, we study how the average electronic density is modified by the presence of a weak static homogeneous magnetic field in a clean three-dimensional (3D) crystal of arbitrary symmetry, whether metal or insulator. We focus on the regime in which the field is strong enough to trigger interesting nonlinear responses but weak enough that Bloch wave functions remain a valid description of the electronic states.

To linear order and for insulators, the density follows the well-known Streda formula, but for metals there is an extra contribution from the orbital magnetic moments at the Fermi surface. To second order, we find that the average density depends on several microscopic processes. Among these, the quantum metric tensor plays an important role by generating a pseudo-magnetic moment resulting from the rotation of the Bloch wave functions in the complex projective plane. We also discuss the implications of our results for the volume and pressure. The method we develop is explicitly gauge invariant, considers intraband and interband processes on equal footing, accommodates relaxation processes, and can be readily extended to other observables.

Biography of presenting author：
He did his PhD. in Physics at the University of Illinois Urbana-Champaign, under the advice of Eduardo Fradkin. Then, he did a Postdoc stage at UC Berkeley, under Joel Moore. At present he is a physics professor at Kent State University (OH, USA) since 2017.