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Bismuth in strong magnetic fields: unconventional Zeeman coupling and correlation effects JASON ALICEA, Caltech, LEON BALENTS, KITP — Recent experiments on bismuth have uncovered remarkably rich magnetization structure at fields well beyond the regime in which all carriers are expected to reside in the lowest Landau level. Motivated by these findings, we start from a microscopic tight-binding model and derive a low-energy Hamiltonian for the holes and three Dirac electrons pockets in bismuth. We find that an unconventional electron Zeeman effect, overlooked previously, suppresses the quantum limit for the electrons dramatically, giving rise to the observed anomalous magnetization structure. We further study interaction effects near fields at which the 2nd Landau level for one electron pocket empties, where magnetization hysteresis was observed. Here we find instabilities towards both charge density wave and Wigner crystal phases, and propose that hysteresis arises from a first-order transition out of the latter.

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