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Hall coefficient sign reversal in metamaterials

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The Hall-effect remains broadly important nearly 140 years after its discovery. In science, the integral and fractional- quantum Hall effects have revolutionized condensed matter physics. Meanwhile, the classical Hall-effect remains a vital semiconductor characterization tool and proven contactless-sensing technology for essential applications. Recent work, see C. Kern *et al.*, Phys. Rev. Lett. 118, 016601 (2017), claims novel sign reversal of the Hall-coefficient in chain-mail-like 3D metamaterials, whereby an n-type semiconductor mimics the Hall-effect of a p-type semiconductor, see also Physics Today 70 (2), 21 (2017); Nature 544, 44 (2017). Measurement-geometry-related Hall-effect sign-inversion is known from studies of 2D or 3D- semiconductor plates including a hole with current and voltage contacts placed on the interior boundary of the hole (see R. G. Mani *et al.*, Appl. Phys. Lett. 64, 1262 (1994); Z. Phys. B 92, 335 (1993); Patents: DE 4308375C2; U.S. 5,646,527; EP 0689723B1). Studies of such “anti-hall bars” demonstrate a sign reversed Hall-effect with respect to the standard hole-less geometry. A Hall-bar including a single supplementary hole can be transformed into an “anti-hall-bar” by turning the sample inside out, which shifts the exterior boundary and contacts to the sample interior while moving the hole-boundary to the exterior. For a fixed direction of the magnetic field B , device-inversion leads to sign-reversal of the Hall-effect in “anti-hall bars” since the device-orientation becomes flipped with respect to B . Here, we discuss the relation between such sign inversion and the reported sign reversal of the Hall coefficient in metamaterials.

Biography

Ramesh G Mani obtained his PhD in Physics from the University of Maryland–College Park. He has worked at the Max-Planck-Institute for Solid State Physics in Stuttgart, Germany, University of California–Santa Barbara and Harvard University. He is presently a Faculty Member at Georgia State University in Atlanta, GA. He invented the “anti-hall bar” geometry and demonstrated dual/multiple simultaneous ordinary and quantized hall effects in a single specimen. The work served as the basis for many international patents relating to offset voltage reduction in hall sensors. He also discovered the microwave radiation-induced zero-resistance states in the two dimensional electron system.

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