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Engineering the Quantum Computer: A Case Study of the Circulator

The Faraday-effect circulator was invented in the 1950's, based on some fundamental theoretical insights about the role of nonreciprocity in transmission systems. These Faraday devices are used successfully at both optical and at microwave frequencies; the latter have a unique and essential role in making solid-state quantum computing work. Also in the 1950's, microwave circulators based on a very different phenomenon, the Hall effect, were also considered. It was "proved" then that a Hall bar cannot make a good gyrator (a close cousin to the circulator). This proof is flawed, and we have shown that good gyrators are possible for Hall angle -> 90 degrees (aka "quantum Hall") if the device is contacted capacitively. We predict that the resulting Hall circulator can be much more miniaturized than the Faraday kind, and I will show some preliminary experimental efforts in this direction. I will discuss the relation of this device functionality to the physics of chiral edge magnetoplasmons in the Hall conductor.