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On-chip microwave circulators using quantum Hall plasmonics

ALICE MAHONEY, JAMES COLLESS, SEBASTIAN PAUKA, JOHN HORNIBROOK, ANDREW DOHERTY, DAVID REILLY, ARC Centre of Excellence for Engineered Quantum Systems, School of Physics, The University of Sydney, NSW 2006, Australia., LUCAS PEETERS, ELI FOX, DAVID GOLDHABER-GORDON, Department of Physics, Stanford University, Stanford, California 94305, USA., XUEFENG KOU, LEI PAN, KANG WANG, Department of Electrical Engineering, University of California, Los Angeles, California 90095, USA., JOHN WATSON, GEOFFREY GARDNER, MICHAEL MANFRA, Department of Physics and Astronomy, Purdue University, West Lafayette, Indiana 47907, USA. — Circulators are directional circuit elements integral to technologies including radar systems, microwave communication transceivers and the readout of quantum information devices. Their non-reciprocity commonly arises from the interference of microwaves over the centimetre-scale of the signal wavelength in the presence of bulky magnetic media that breaks time-reversal symmetry. We present a completely passive on-chip microwave circulator with size 1/1000th the wavelength by exploiting the chiral, 'slow-light' response of a GaAs/AlGaAs 2-dimensional electron gas in the quantum Hall regime. Further, by implementing this circulator design on a thin film of a magnetic topological insulator ($Cr_{0.12}(Bi_{0.26}Sb_{0.62})_2Te_3$), we show that similar non-reciprocity can be achieved at zero magnetic field. This additional mode of operation serves as a non-invasive probe of edge states in the quantum anomalous Hall effect, while also extending the possibility for integration with superconducting devices.

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