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Towards the quantum anomalous Hall effect in HgMnTe

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Although there are plenty of theoretical and experimental studies of the anomalous Hall effect in the ferromagnetic materials, the quantum version, namely "quantum anomalous Hall effect", has never been observed in the realistic materials. In this work, we report the experimental evidence of the quantum anomalous Hall effect in the Mn doped HgTe quantum wells. We observe a long quantized Hall plateau from 0.2 T to $>$ 25 T with the Hall conductance e^2/h in the p-doped regime. By carefully analyzing the gate voltage and temperature dependence of the experimental data, we find the long plateau origins from the fact that the two zero Landau levels in HgMnTe doped system have the same slope, which is exactly the required condition for the quantum anomalous Hall effect. Theoretical $\mathbf{k}\cdot\mathbf{p}$ calculation is carefully compared with the experimental data to identify the influence from the magnetic impurities. A HgMnTe-ferromagnet hybrid structure is proposed for the possible future device applications.