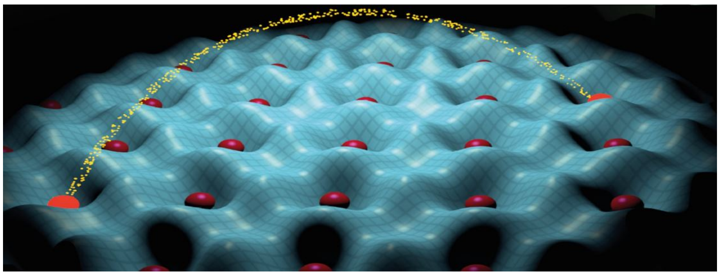

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”Engineering interactions in the Quantum Hall effect through vacuum field in metamaterial cavities”

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In a microcavity, the strength of the electric field caused by the vacuum fluctuations, to which the strength of the
light-matter coupling WR is proportional, scales inversely with the cavity volume. One very interesting feature of the
circuit-based metamaterials is the fact that this volume can be scaled down to deep subwavelength values in all three
dimension of space.1 We have used transport to probe the ultra-strong light-matter coupling2 and shown that the
latter can induce a breakdown of the integer quantum Hall effect3. The phenomenon is explained in terms of cavityassisted
hopping, an anti-resonant process where a an electron can scatter from one edge of the sample to the other
by “borrowing”a cavity photon from the vacuum4. Recently a proposal suggested that the value of the quantized
Hall voltage can be renormalized by the cavity5, but later work demonstrated that such renormalization corresponds
to a singular point in the parameter space. We have investigated this effect experimentally using a Wheatstone bridge
geometry6 and found the quantization to be held7.
We have also investigated a new experimental geometry where a hovering resonator is positioned with
nanoactuators above the Hall bar, providing a way to continuously vary the light-matter coupling up to a value of
WR/w=0.33 while the sample is maintained at millikelvin temperatures. Using this approach, we observe the effect of
light-matter coupling on the effective electron g-factor as well as its effect on the gap of the Laughlin states. In
particular, we observe a enhancement of the 5/3,4/3 and 5/7 fractional state gaps by up to a factor of two8.

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