

SUMMER SCHOOL
on
LOW-DIMENSIONAL QUANTUM SYSTEMS:
Theory and Experiment
(16 - 27 JULY 2001)

PLUS

PRE-TUTORIAL SESSIONS
(11 - 13 JULY 2001)

EVIDENCE FOR LUTTINGER LIQUID BEHAVIOR
AT THE EDGE OF THE
FRACTIONAL QUANTUM HALL EFFECT

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These are preliminary lecture notes, intended only for distribution to participants

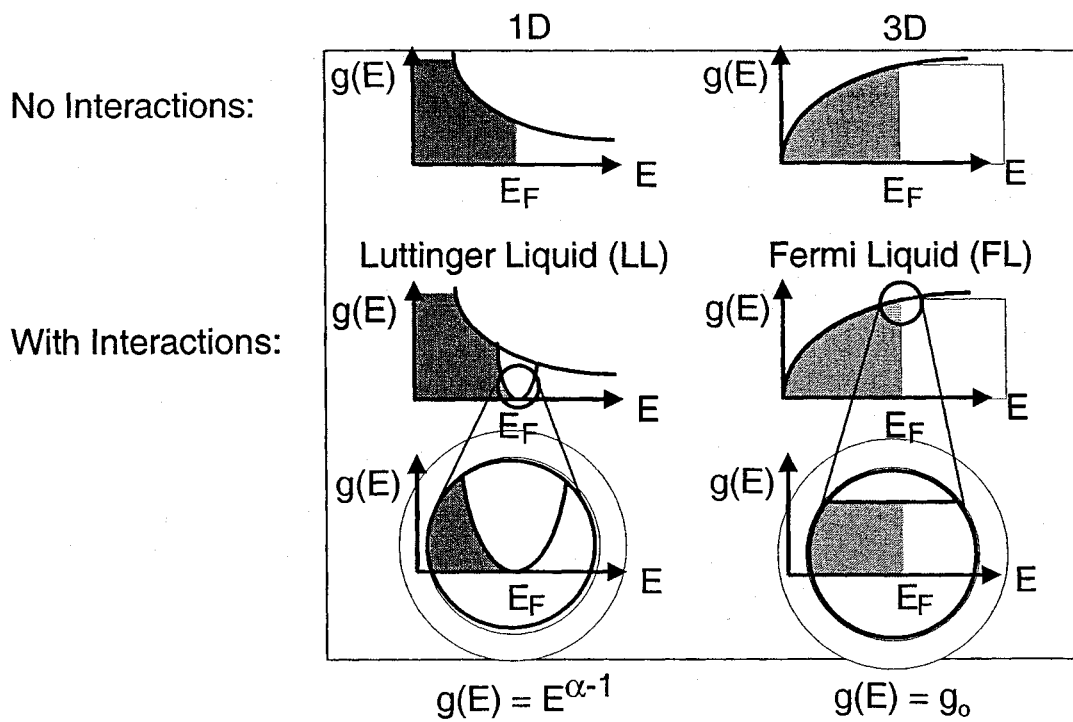
Evidence for Luttinger Liquid Behavior at the Edge of the Fractional Quantum Hall Effect

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Luttinger & Fermi Liquids



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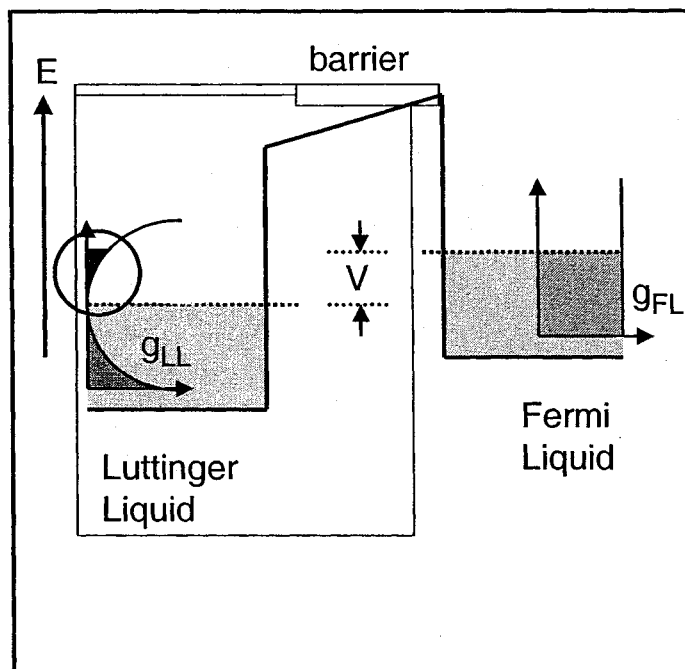
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Tunneling Experiment

$$I = \int_0^V g_{LL}(E) dE$$

$$I = \int_0^V E^{\alpha-1} dE$$

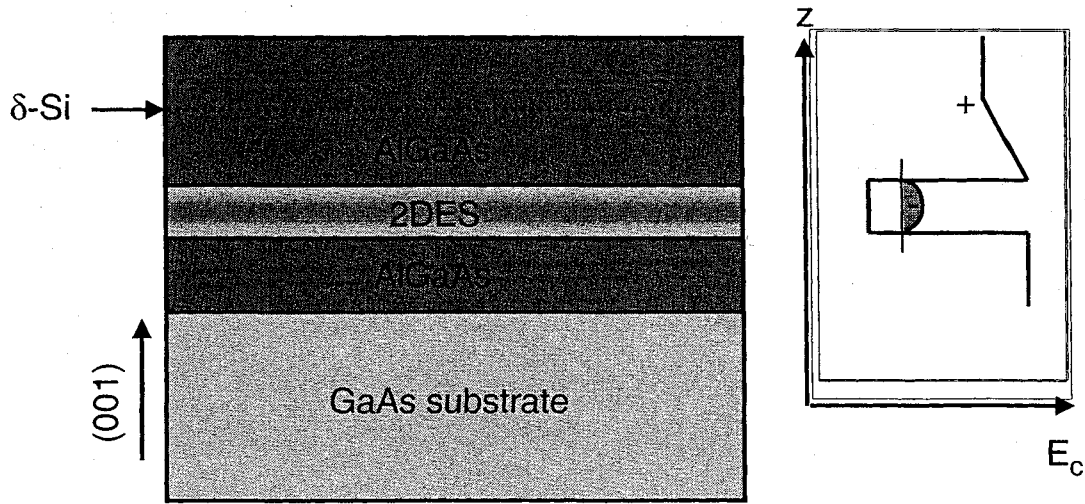
$$I = V^\alpha$$



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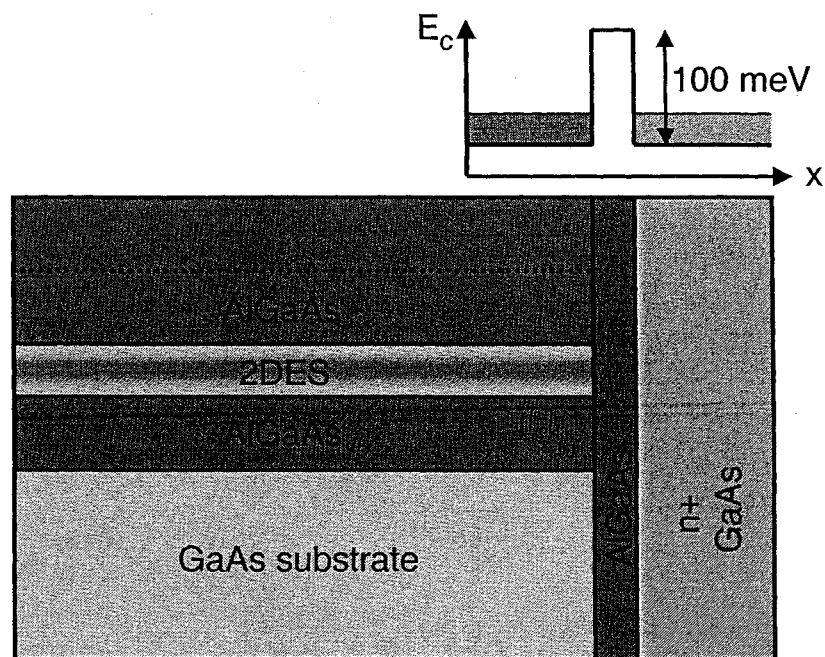
Device Fabrication: 2-Dimensional Electron System



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Device Fabrication: Cleaved-Edge Overgrowth

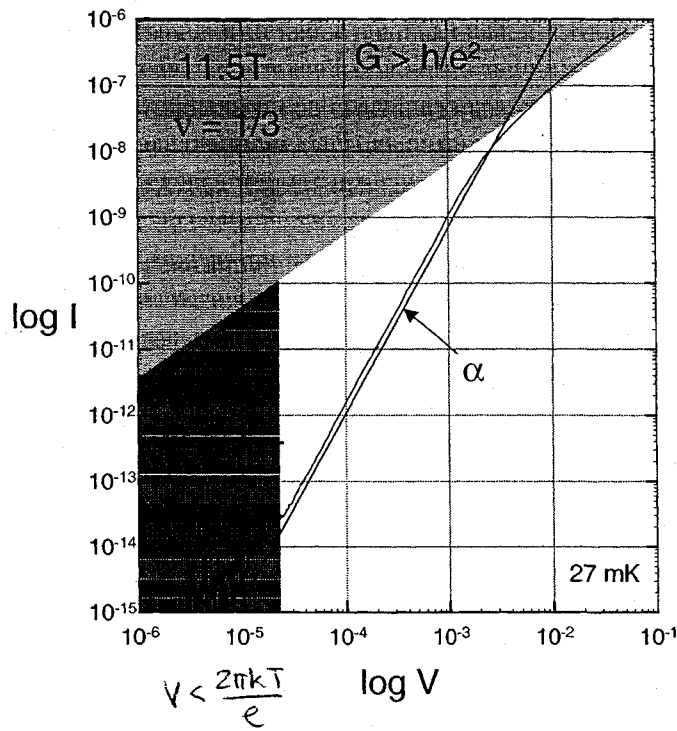


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Tunneling log(I)-log(V)

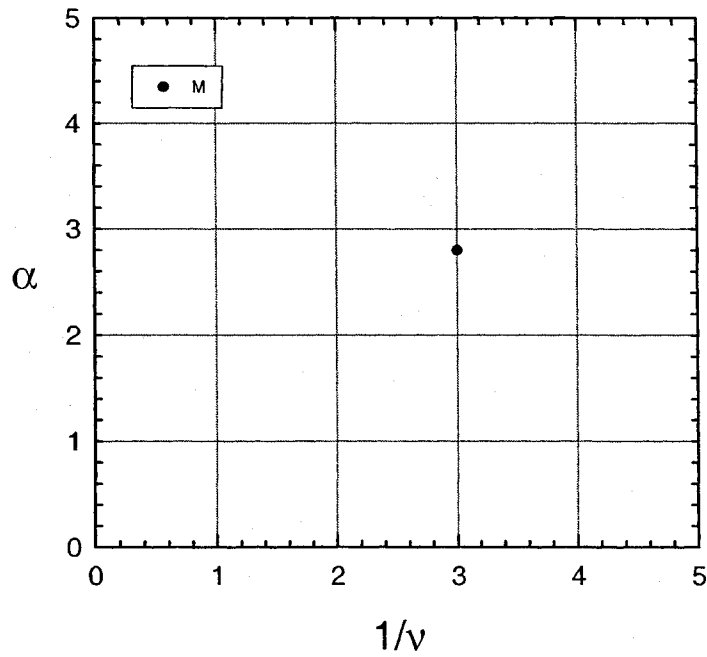
Sample M



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α vs. $1/\nu$



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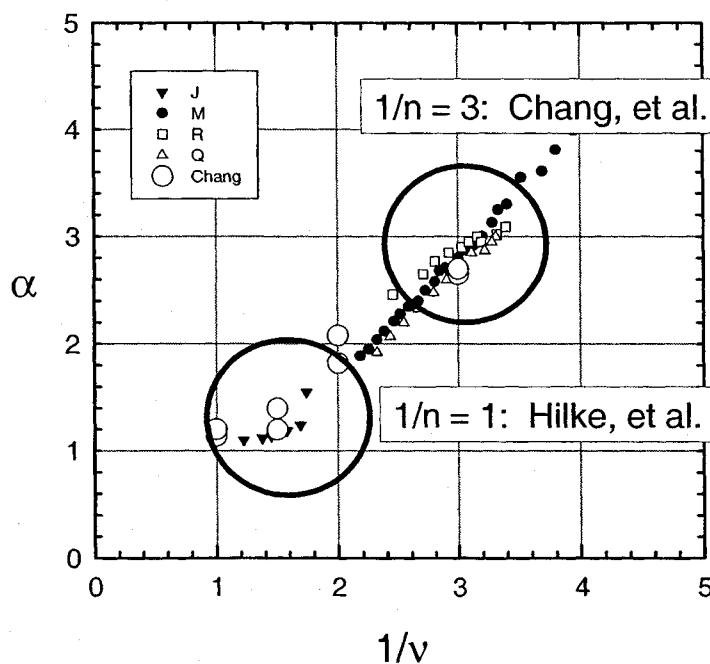
Subsequent Theoretical work

- Lee & Wen - cond-mat (98)
- Zuelicke, McDonald, & Johnson - PRB (98)
- Yang, and Han - PRB (98)
- D'Amico & Vignale - PRB (99)
- Lopez & Fradkin - PRB (99)
- Milovanovic & Shimshoni - PRB (99)
- Pruiskin, Skoric, & Baranov - PRB (99)
- Pryadko, Shimshoni, & Auerbach - PRB (00)
- Moore, Sharma, & Chamon - PRB (00)

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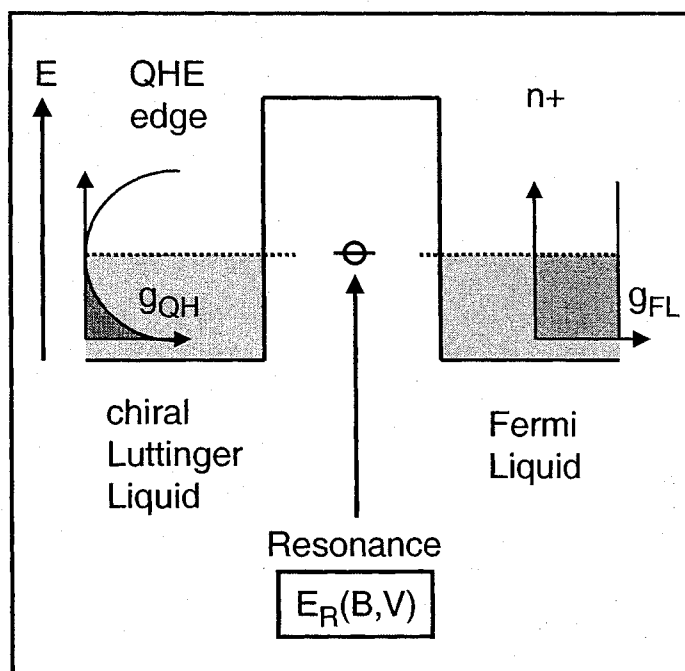
Subsequent Experimental work



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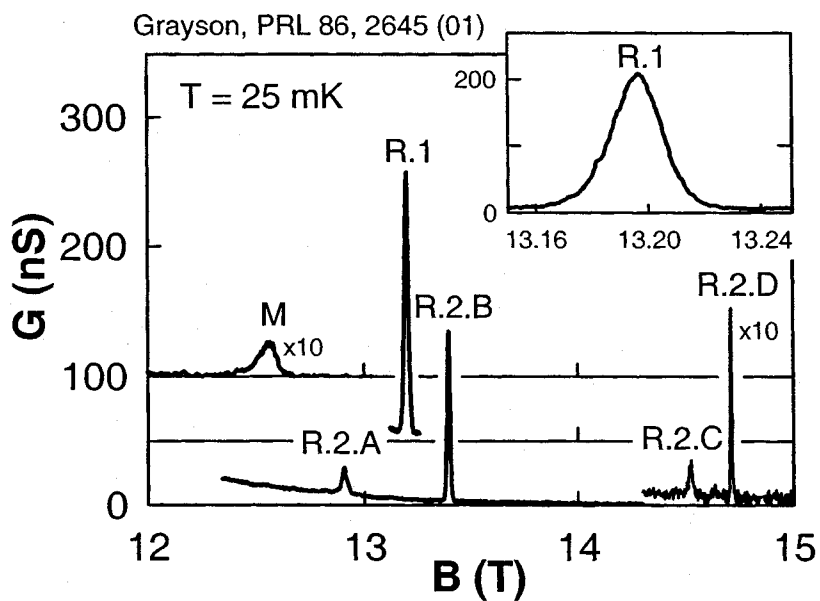
Band Model for Resonance



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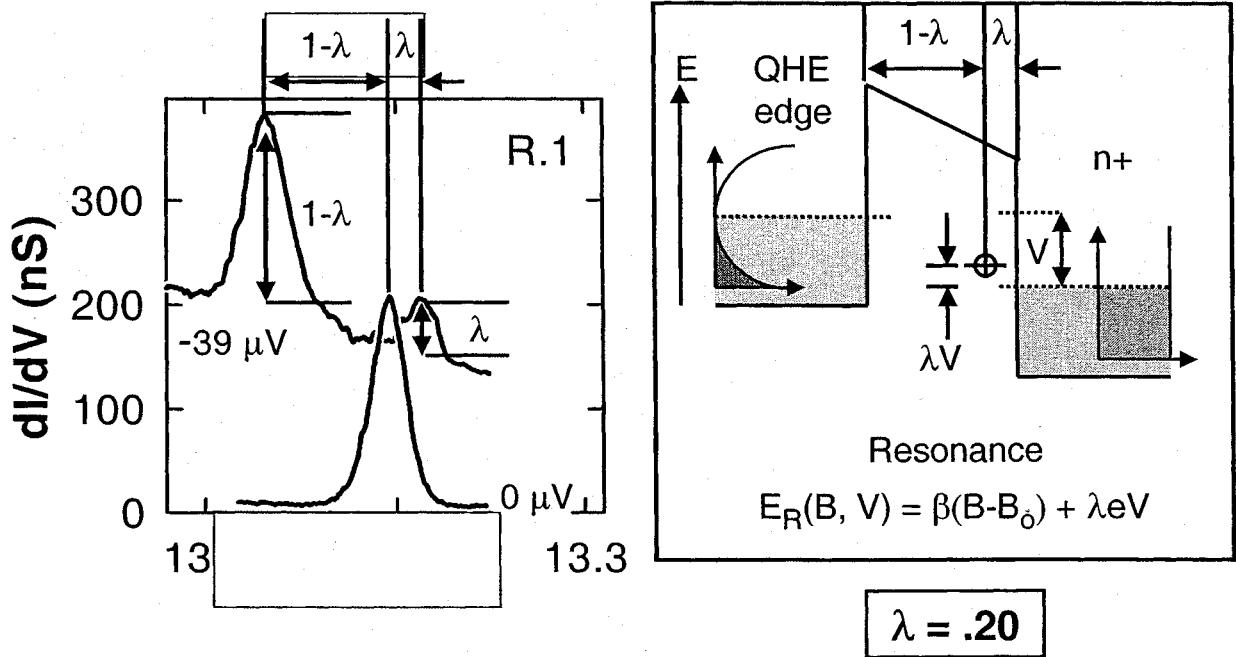
Resonances



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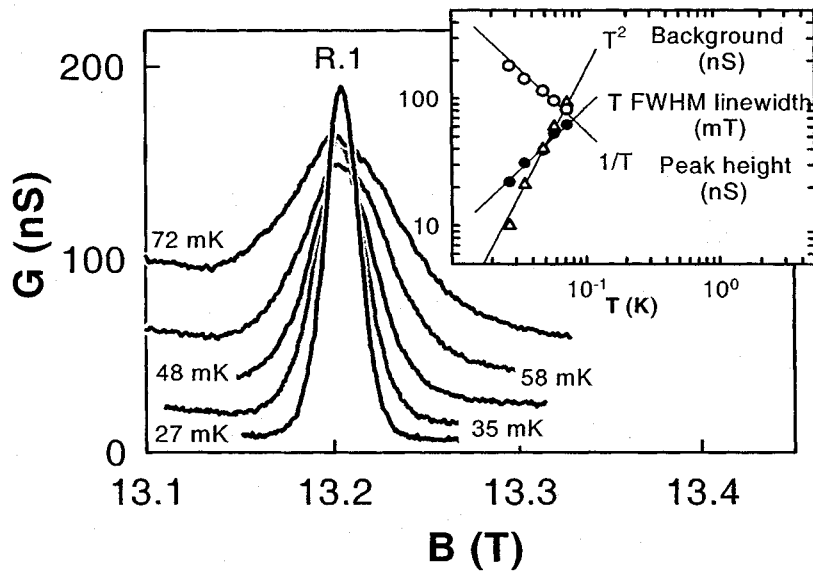
Lever Arm: λ



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Temperature Dependence

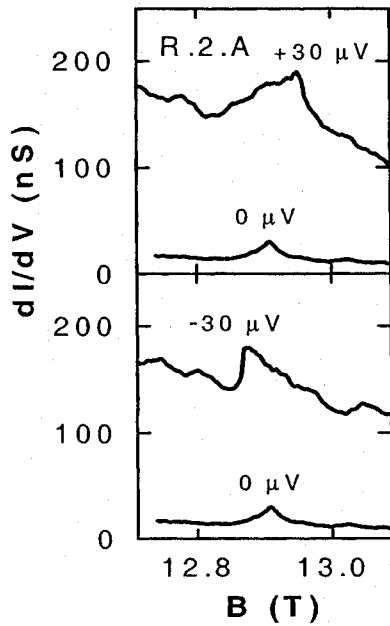


"FL" resonance
on
LL background
(?)

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QHC Resonance



Single lopsided peak under bias

Non-conservation of area

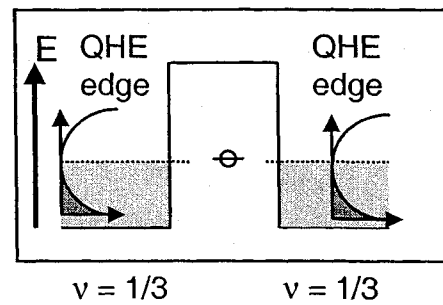
=> *NON-FL RESONANCE!*

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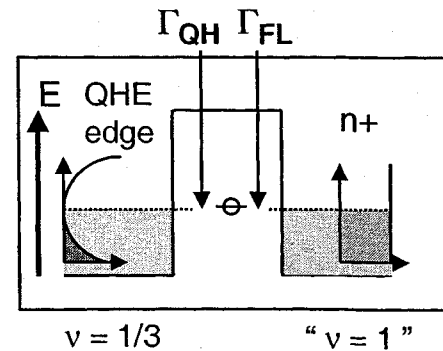
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Theory for Biased Chiral LL Resonance

C. Chamon & X.-G. Wen
PRL 70 2605 (93)



Replace one $\nu = 1/3$ edge with $\nu = 1$
to represent a Fermi liquid



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Conclusions

RESONANT TUNNELING at a FQHE EDGE

- First observation of non-Fermi liquid resonance lineshape under bias
- Observe *weak & strong* coupling limits

TUNNELING into a FQHE EDGE

- Chiral Luttinger liquid description: RIGHT or WRONG?
 - original formalism correctly describes single edge modes ($\nu=1/3$)
 - but new formalism required to explain the observed behavior away from $\nu=1/3$
 - recent results show device dependence, presumably in edge density
 - problem requires further ~~funding~~ [✓] study

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Far-Infrared Hall effect in YBCO

Resolving the anomalous Hall effect in normal-state Hi Tc's



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