Noise Characterization of Quantum Amplifiers

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• Superposition
• Classical bit
• Quantum bits (Qubits)
  – Very powerful computers
  – Quantum mechanics is real!
• Quantum -> small signal
• Use amplifier to increase signal
  – Is amp noise larger than signal?
Noise Measurement

• Noise is undesired signal from electronics.
• Difficult to precisely measure low noise values of amplifiers
• Current Methods
  – Y-factor method
  – Hot cold method \{Complicated\}
• New method
  – Shot Noise Tunnel Junction
Shot Noise Tunnel Junction

“The Source”

Bias Voltage

Bias Tee

LNA

Spectrum Analyzer

AFM image of SNTJ chip

SNTJ container
How to extract Amp Noise Temp

\[ P = k_b B T_n \]

\[ T_{\text{sys}} = G \left[ T_n + \frac{eV}{2k_b} \coth \left( \frac{eV}{2k_b T} \right) \right] \]

- \( T_{\text{sys}} \) is the system noise temp
- \( M \) is the ratio of values 1 and 2
- \( T \) is the Johnson noise of the SNT
- \( T_n \) is amplifier noise

\[ T_n = \frac{MT - \frac{eV}{2k_b} \coth \left( \frac{eV}{2k_b T} \right)}{1 - M} \]

Bias Voltage
Equipment

• Agilent Spectrum Analyzer
Source Output

Curve matches theory
Miteq Amplifier Noise

\[ P = k_b BT_n \]

\[ NF = 10 \log \left( 1 + \frac{T_n}{T_{\text{measurement}}} \right) \]
Conclusions

• An easy method for noise characterization
• Better understanding of noise from amplifiers
  – Easy way to test new amplifiers!
• Quantum Info in grad school!
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