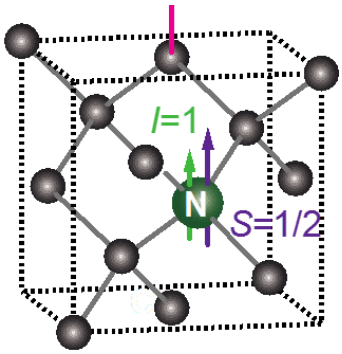
OIST OKINAWA INSTITUTE OF SCIENCE AND TECHNOLOGY GRADUATE UNIVERSITY
沖縄科学技術大学院大学

# Microwave Amplification by a Spin Maser

## Applications

- Quantum computer
- Ultra-sensitive spin resonance spectrometer
- Any cryogenic microwave quantum technologies

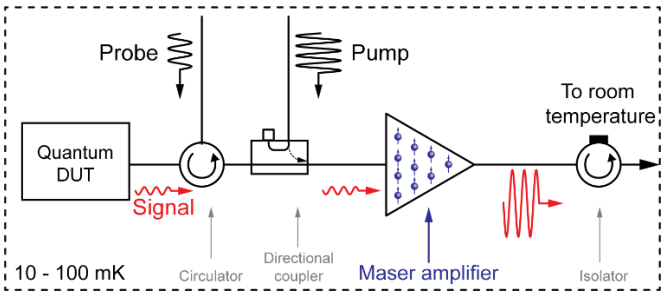



Schematic of a nitrogen doped diamond implemented as a maser amplifier

## Problem & Solution

One of the crucial technological issues in quantum computing or quantum information research is low-power microwave signal processing at cryogenic (millikelvin) temperatures, i.e., the amplification of tiny microwave signals with as little added noise as possible. This low noise cryogenic amplification has been realized by a device called Josephson parametric amplifiers (JPA). However, these JPAs suffer from limited dynamic range, i.e., their very low input saturation power, which limits how many qubits can be processed in a quantum computer.

This invention overcomes the above problems by providing a maser amplifier utilizing impurity spins in gem crystals. The inventors demonstrated the maser amplification by pumping nitrogen impurity spins in diamond and probed it by sending a weak microwave tone and monitoring the signal out of a microwave resonator. Noise temperature was measured to be about 0.5 K, which is near the quantum limit. The saturation power is at least about 100 picowatt, which is more than 3 orders of magnitude higher than the current state-of-the-art JPAs.




An example of maser amplifier implementation

## Benefits

- High amplification gain (30 dB)
- Large dynamic range (larger than -70 dBm, at least more than 1000 times better)
- Near-quantum-limited noise performance (Noise temperature of ~0.5 K)

## Patent Pending

## Keywords

Quantum computer, quantum technologies, quantum microwave, maser amplifier, quantum-limited amplification,

## For more information

Business Development/Technology Licensing Section
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