

Room-temperature Masers

Masers operable at room temperature and in ambient conditions

Background

- Masers can be operated either as oscillators or amplifiers operating at microwave frequencies with a noise performance limited only by the laws of quantum mechanics.
- Conventional masers require cryogenic temperatures or ultrahigh vacuums, but the Imperial College Maser Group has developed masers capable of operating in ambient conditions.
- Room-temperature masers offer a noise performance orders of magnitude better than that of semiconductor microwave amplifiers.

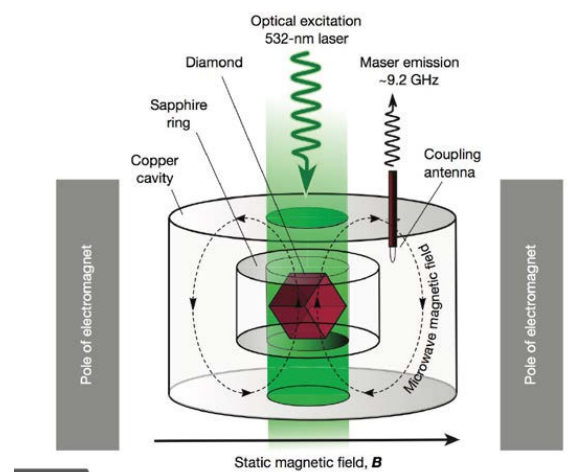
Applications

- Ultrasensitive microwave receivers for use in telecommunications, radar, radio astronomy, magnetic resonance imaging and any other application that benefits from low noise.
- Frequency standards locked to local oscillators for improved timing resolution.
- Anti-jamming receivers exploiting the high resistance of masers to intermodulation distortion from jamming signals.
- Microwave qubit readout for superconducting and ionic qubits, where the high dynamic range of masers will allow for high-throughput quantum computing.

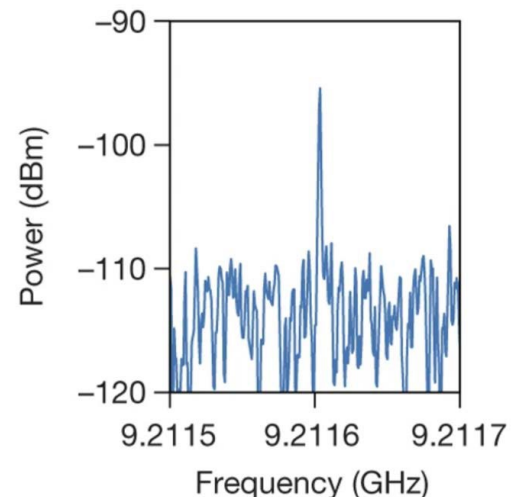
Intellectual Property

Three granted patents covering organic room-temperature masers, spin-defect room-temperature masers, using masers to establish quantum oscillations.

One application for use of technology to reduce noise in electron paramagnetic resonance applications.



Schematic of room-temperature maser based on spin defects in diamond



Ultranarrow linewidth of ~50Hz for a diamond room-temperature maser operating as an oscillator at 9.2 GHz

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Technology reference: **6199, 7861, 8016**

Pentacene Maser Preliminary Specifications

The pentacene maser is capable of pulsed operation at 1.45GHz and does not require external magnetic fields. Quantities marked with * based on theoretical considerations.

Table 1: Pentacene Maser Preliminary Specifications

Parameter	Value	Unit	Notes
Oscillator Linewidth	6	kHz	For oscillation frequency of 1.45 GHz
Oscillator Output Power	-30	dBm	
Noise Temperature*	<1	K	
Weak Signal Gain*	>20	dB	
Amplifier Bandwidth	5	MHz	

Diamond Maser Preliminary Specifications

The diamond maser is capable of continuous-wave operation with the centre frequency tunable using an external magnetic field. Quantities marked with * based on theoretical considerations.

Table 2: Diamond Maser Preliminary Specifications

Parameter	Value	Unit	Notes
Oscillator Linewidth	50	kHz	For oscillation frequency of 9.2 GHz
Oscillator Output Power	-60	dBm	
Allan Deviation*	<10 ⁻¹²	dBm	For 1s average time operating as an oscillator
Noise Temperature*	<1	K	
Phase Noise*	-150	dBc/Hz	For 1 kHz offset from carrier
Weak Signal Gain*	>20	dB	
Amplifier Bandwidth	5	MHz	
Input Saturation Power*	-80	dBm	

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