Seed Phase

Microwave masers and frequency combs for communications and sensing

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What is the problem?

Modern technology relies on precise timing and sensing for many applications ranging from satellite based communications and GPS, through to ultra-precise sensors for geophysical mapping, GPS-less navigation, remote sensing and mapping of gasses, chemical analysis and medical imaging. Lasers, a source of coherent monochromatic light of a single frequency, has proved essential for such technologies, while optical frequency combs, which lase at many frequencies, have permitted many new types of technologies. The development of sensing and communication technologies at microwave frequencies has not developed as quickly as the equivalent to the laser: MASER, and microwave frequency comb: Multi-Maser, are either extremely expensive or non-existent. Developing a small compact source of coherent microwave radiation at multiple frequencies would transform many microwave sensing/communication/imaging technologies. Drawbacks of traditional coherent low-noise microwave sources of radiation:

- Extremely costly and very large
- No commercial source of a Multi-MASER is available
- Requires complicated methods of generation

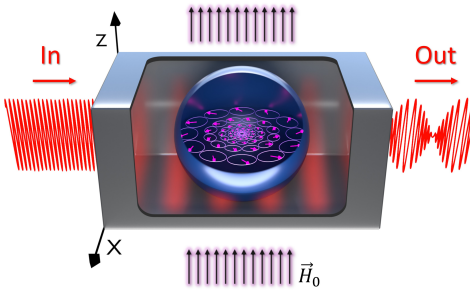

Figure 1: Microwave cavity setup containing a ferromagnet (YIG) turns an input microwave into multitone microwave laser.

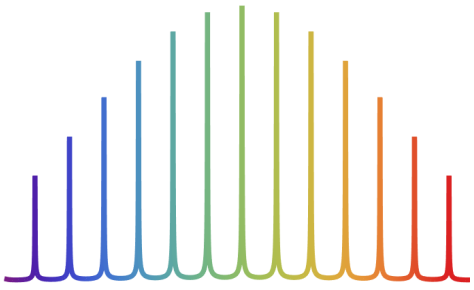

Figure 2: Frequency comb of microwave radiation. Schematic of the multiple frequencies of microwave radiation which are emitted by the Multi-MASER.

What is your solution?

We have invented a method to generate a microwave frequency comb using magnons. Magnons are a coherent spin waves made from crystalline soft ferrites – with Yttrium Iron Garnett (YIG). By coupling the magnons in a small sphere of YIG in a microwave cavity – we show that one is able to demonstrate both a single MASER tone and, with larger driving, the generation of a Multi-MASER microwave frequency comb. Our Technology Advantages:

- Separation between microwave tones easily tuned
- Small and cheap and operates at room temperature
- Different from all other designs in the literature our Multi-MASER radiation exhibits quantum squeezing – permitting even more precision in metrology applications.

Keywords: Microwave frequency comb, Magnons, Multi-MASER

Other resources

- Unit website

Contribution to SDGs

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