

Terahertz Quantum Sensing

“Terahertz quantum sensing” — M. Kutas et al., Sci. Adv. 2020

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Outline

1 Motivation

2 Key concepts

3 Theory

4 Experiment

5 Results

6 Conclusions

Why terahertz quantum sensing?

- Terahertz (THz) carries material-specific contrast but detectors are inefficient.
- Use correlated photons: idler (THz) interacts with sample; signal (visible) is detected.
- Infer THz properties without direct THz detection.

Induced coherence without induced emission

- SPDC produces signal (visible) + idler (THz) photon pairs.
- Two indistinguishable generation pathways interfere at the signal, dependent on idler path.
- Object transmissivity and idler phase modulate interference visibility.

Operator picture (intuition)

$$\hat{a}'_s = u \hat{a}_s + v \hat{a}_i^\dagger, \quad \hat{a}'_i = u \hat{a}_i + v \hat{a}_s^\dagger,$$

with $|u|^2 - |v|^2 = 1$. Low-gain: $|v| \ll 1$.

Signal rate (schematic)

$$R(\theta_s) = N \int d\omega_i d\theta_i [1 + t(\theta_i) \cos(\phi_0 + \frac{\omega_i}{c} \Delta l_i)] \quad (1)$$

Setup (Fig.1)



Schematic (paper Fig.1).

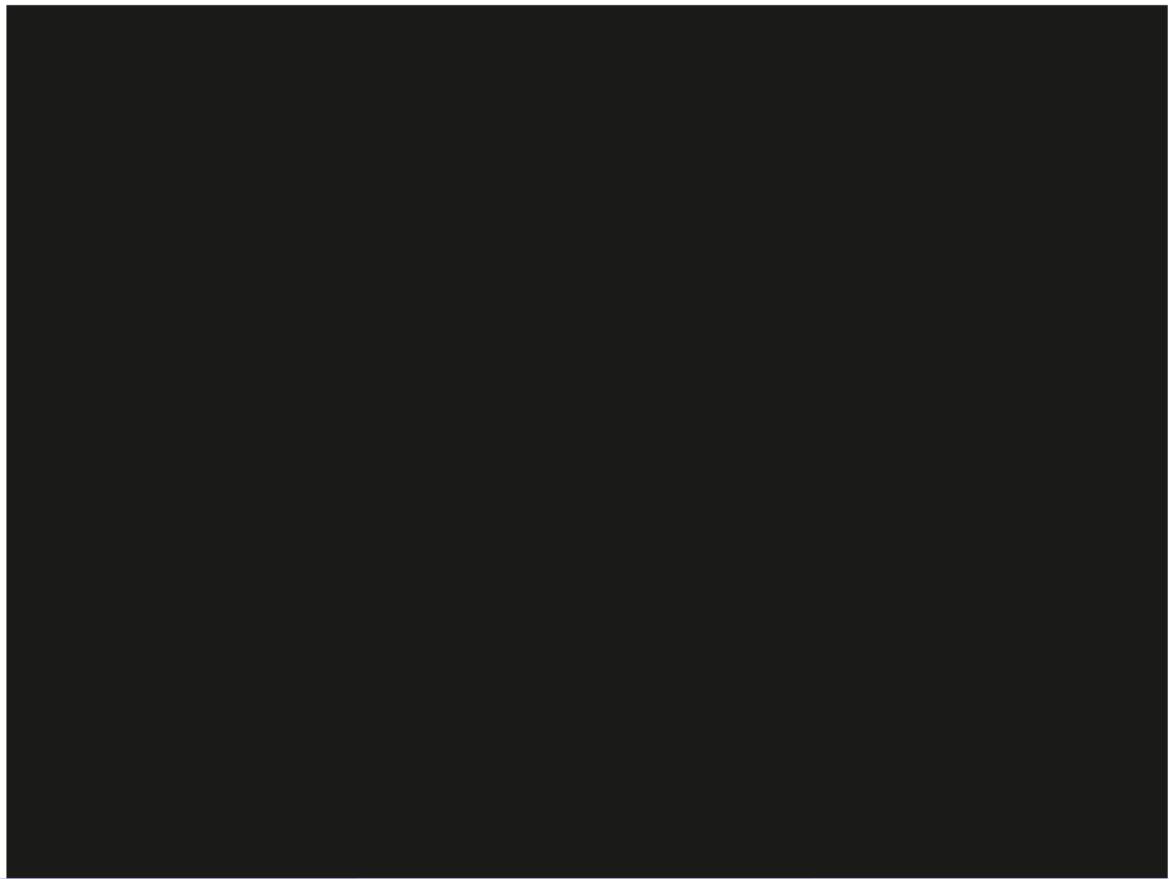
Layout (Fig.2)



Interference and FFT (Fig.3)



Thickness sensing (Fig.4)



Checks (Fig.5 Fig.6)



Pump-power linearity and idler angular distribution.

Conclusions

- Induced coherence enables THz sensing using visible detectors.
- Demonstrated thickness extraction and FFT signatures around 1.26 THz.
- Improvements: better idler collection, reduced loss, spectral control.

References

M. Kutas et al., "Terahertz quantum sensing," Sci. Adv. 6, eaaz8065 (2020).