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# Spintronic emitters in the Terahertz Regime

**Applied optical spectroscopy**

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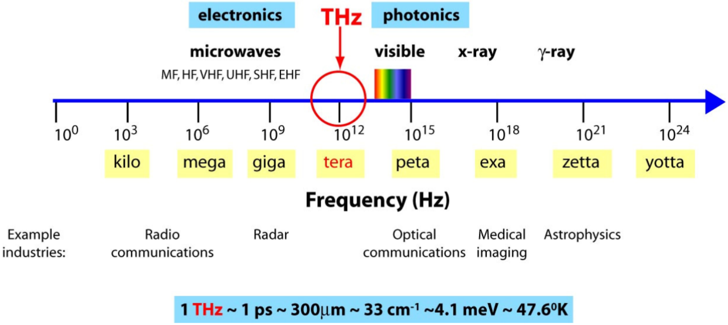
## Outline

## The THz Gap



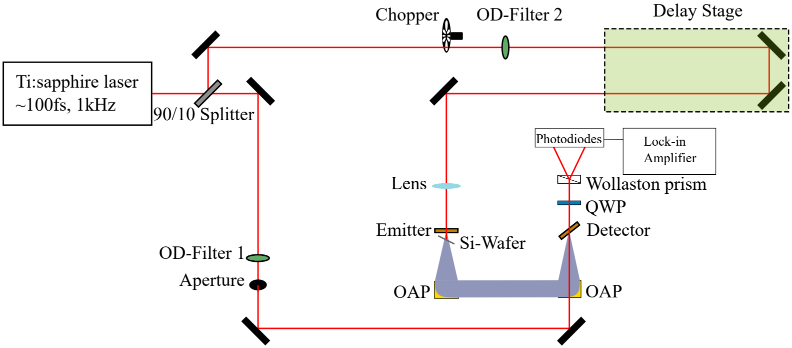

The electromagntic spectrum from G. P. Williams, Rep. Prog. Phys, **69** (2005).

## Terahertz

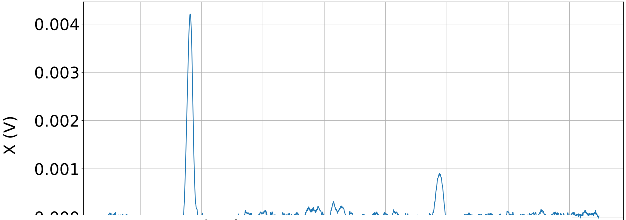
So why do we need terahertz radiation?

- medicine
- security
- data transmission & saving
- physics

## Introduction




- PCA




- Non linear crystals

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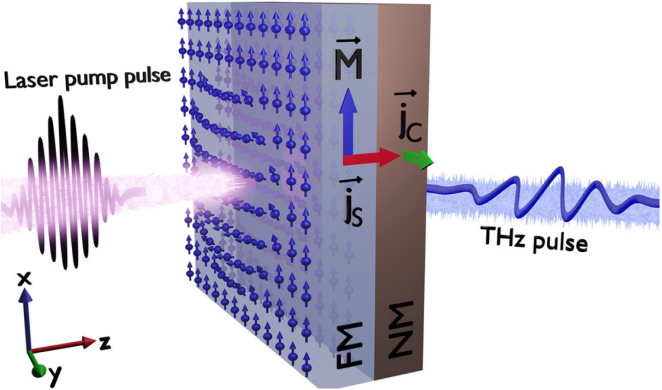
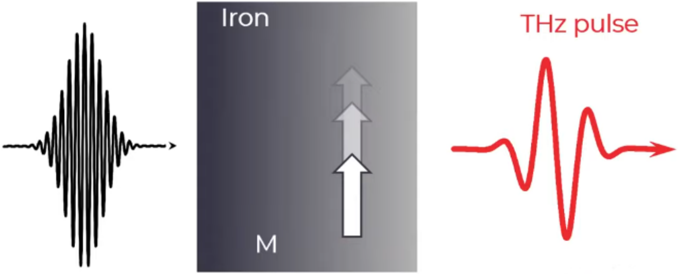
## What are Spintronic emitters?

- Ferromagnetic Material (FM)
- Non Magnetic (NM)
- Magnetic field

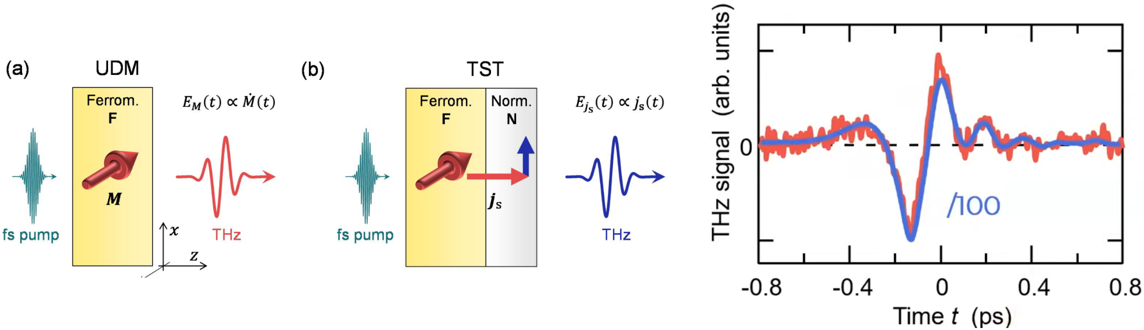


## How does it work?




$$E_{\mathrm{DM}} \propto \dot{M}(t) \tag{1}$$

## Stronger if we attach NM



## Where does the current come frome?

## Conclusion

**ZnTe reached**

electric field strengths **9.59** kV/cm

**GaP reached**

## Conclusion

**ZnTe reached**
electric field strengths **9.59** kV/cm

**GaP reached**
electric field strengths **3.38** kV/cm

## Conclusion

**ZnTe reached**

electric field strengths 9.59 kV/cm

conversion effiencies $2.08 \times 10^{-5}$

**GaP reached**

electric field strengths 3.38 kV/cm

## Conclusion

**ZnTe reached**

electric field strengths 9.59 kV/cm

conversion effiencies $2.08 \times 10^{-5}$

**GaP reached**

electric field strengths 3.38 kV/cm

conversion effiencies of $2.71 \times 10^{-6}$

**Thank you all for your attention!**

[1] Gwyn P Williams. “Filling the THz gap—high power sources and applications.” In: Reports on Progress in Physics 69.2 (2005), p. 301.

[2] Y. P. Ashish et al. “Terahertz technology and its applications.” In: Drug Invention Today 5.2 (2013), pp. 157–163. ISSN: 0975-7619. DOI: https://doi.org/10.1016/j.dit.2013.03.009.

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[4] K. Rikkinen et al. “THz radio communication: Link budget analysis toward 6G.” In: IEEE Communications Magazine 58.11 (2020), pp. 22–27.

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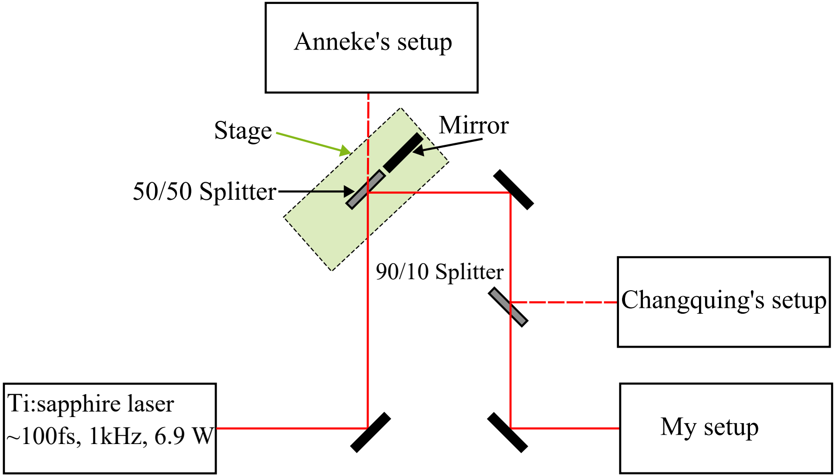
[6] I. Wilke and S. Sengupta. Nonlinear Optical Techniques for Terahertz Pulse Generation and Detection—Optical Rectication and Electrooptic Sampling. CRC press, 2017, pp. 59–90.

[7] R. Rouzegar et al. Laser-induced terahertz spin transport in magnetic nanostructures arises from the same force as ultrafast demagnetization. 2021. DOI: 10.48550/ARXIV.2103.11710. URL: https://arxiv.org/abs/2103.11710.

[8] A. Nahata, A. S. Weling, and T. F. Heinz. “A wideband coherent terahertz spectroscopy system using optical rectification and electro-optic sampling.” In: Applied Physics Letters 69.16 (1996), pp. 2321–2323. DOI: 10.1063/1.117511.

[9] L. Jiang et al. “Efficient terahertz wave generation from GaP crystals pumped by chirp-controlled pulses from femtosecond photonic crystal fiber amplifier.” In: Applied Physics Letters 104.3 (2014), p. 031117. DOI: 10.1063/1.4862270.

## Lower/Higher initial Power




The beam path before it reaches the shown setup.

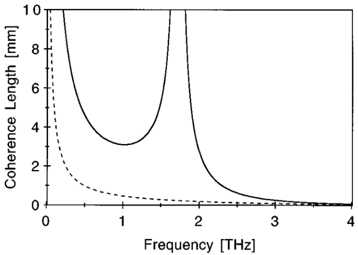
## Coherence-length

Defined as

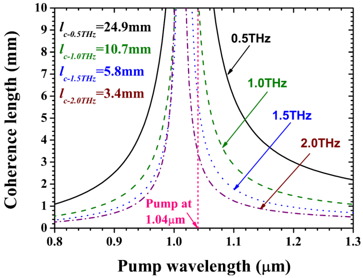
$$l(\omega_{THz}) = \frac{\pi c}{\omega_{THz}\left|n_{opt\ eff}(\omega_0) - n_{THz}(\omega_{THz})\right|} \tag{2}$$

with

$$n_{opt\ eff} = n_{opt}(\omega) - \lambda_{opt}\left.\frac{\partial n_{opt}}{\partial \lambda}\right|_{\lambda_{opt}} \tag{3}$$

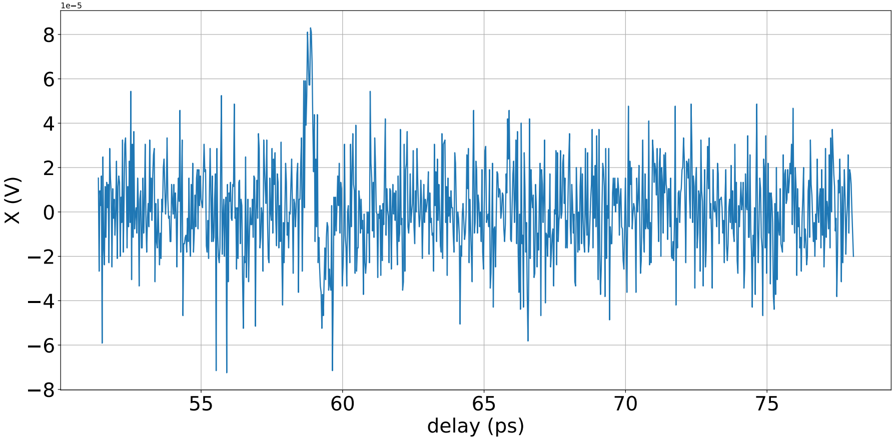



(ZnTe) With 800 nm pump laser from A. Nahata and A. S. Weling, A wideband coherent terahertz spectroscopy system using optical rectification and electro-optic sampling, Appl. Phys. Lett., **69**, (2014).




(GaP) With various pump laser wavelengths from L. Jiang and L. Chai, Efficient terahertz wave generation from GaP crystals pumped by chirp-controlled pulses from femtosecond photonic crystal fiber amplifier, Appl. Phys. Lett. **104**, (2014).

## Other GaP measurments




EOS of GaP with 24.2 mW pump power.