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dortmund

Spintronic emitters in the Terahertz Regime

Applied optical spectroscopy

Max Koch

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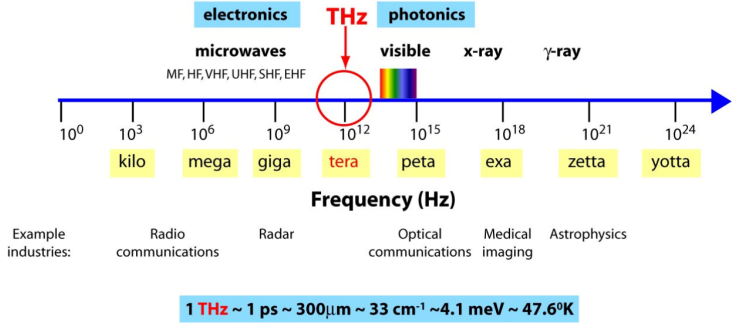
TU Dortmund
Fakultät Physik

Outline

The THz Gap



1 THz ~ 1 ps ~ 300μm ~ 33 cm^{-1} ~4.1 meV ~ 47.6°K

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

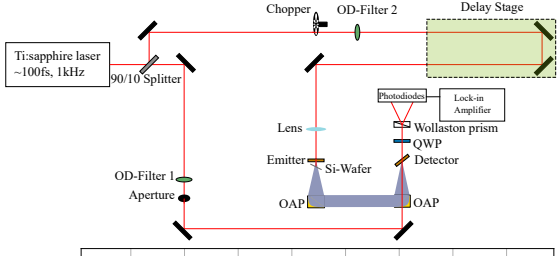
Terahertz

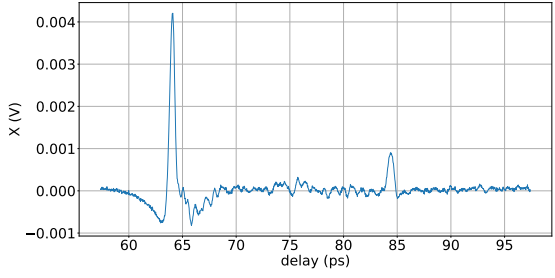
So why do we need terahertz radiation?

- medicine
- security
- data transmission & saving
- physics

Introduction

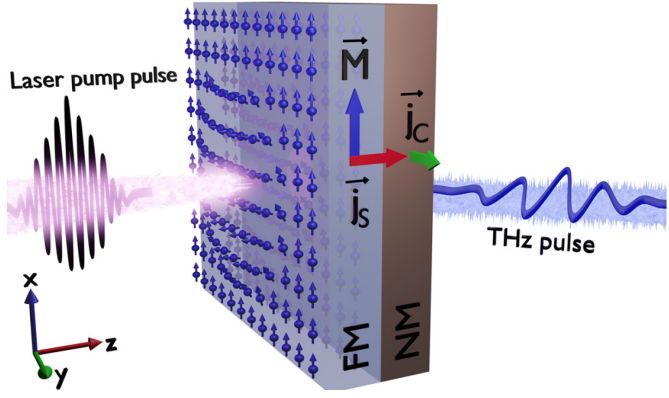
- PCA
- Non linear crystals



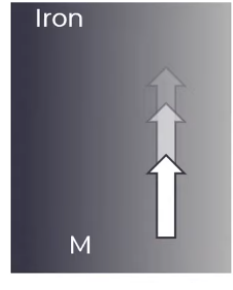


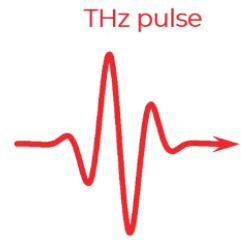
What are Spintronic emitters?

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



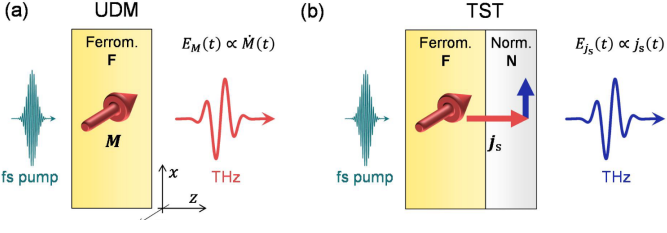
How does it work?

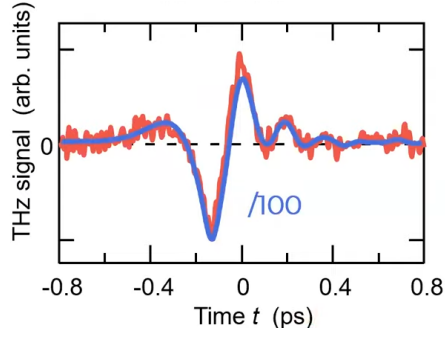




$$E_{\mathrm{DM}} \propto \dot{M}(t) \tag{1}$$

Stronger if we attach NM

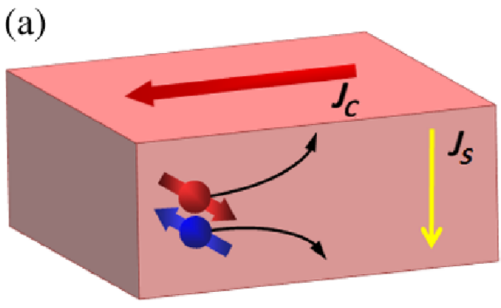




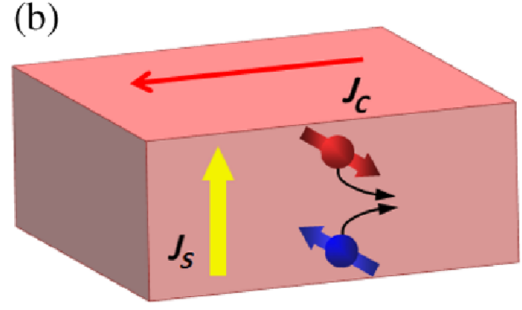
Where does the current come frome?

Inverse Spin Hall effect!

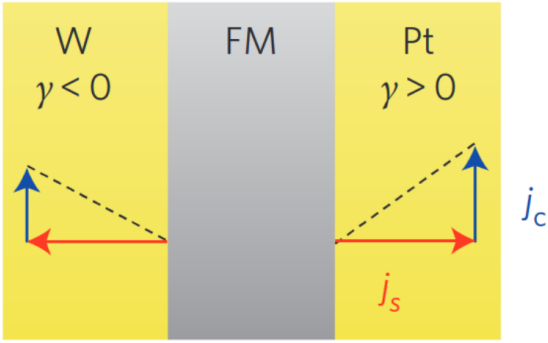
Spin Hall effect

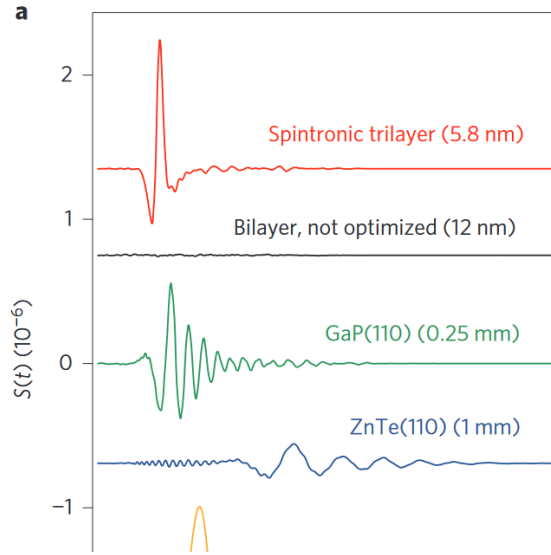


Inverse Spin Hall effect

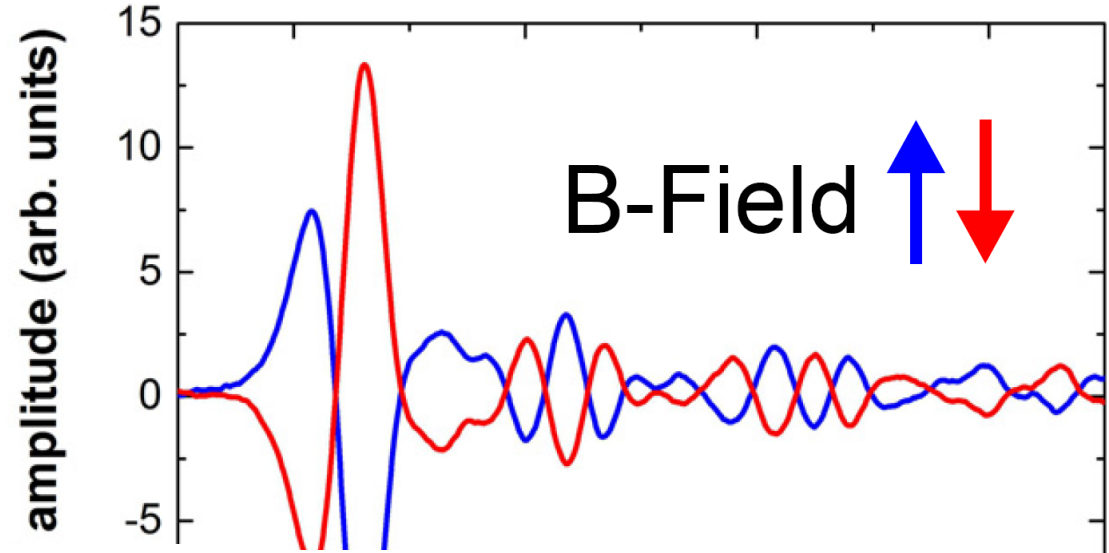


2 Layers are not the end

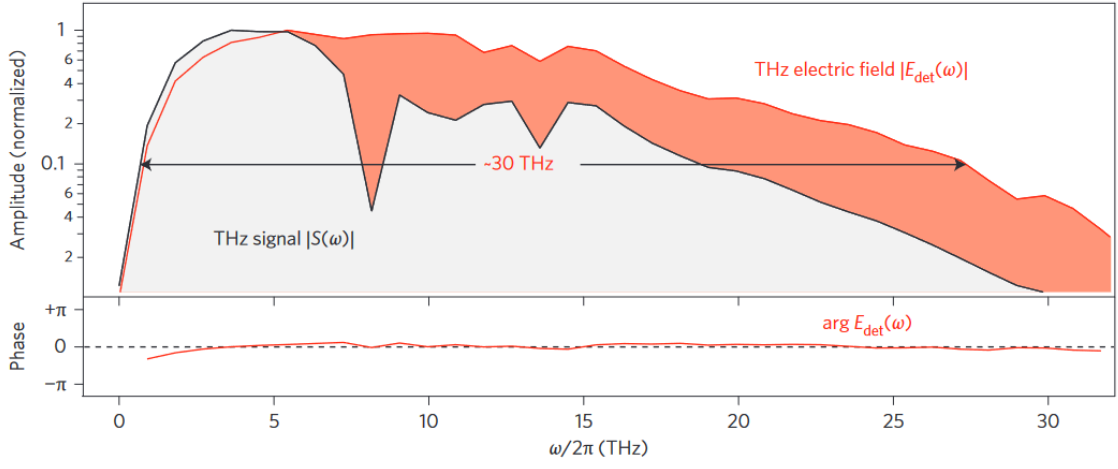




Polarization



Broadband


Amplitude (normalized)
1
6
4
2
0.1
6
4
2
THz electric field $|E_{det}(\omega)|$
~30 THz
THz signal $|S(\omega)|$
Phase
+π
0
−π
arg $E_{det}(\omega)$
0
5
10
15
20
25
30
$\omega/2\pi$ (THz)

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.

[3] L. Hai-Bo et al. “Detection and identification of explosive RDX by THz diffuse reflection spectroscopy.” In: Opt. Express 14.1 (2006), pp. 415–423. DOI: 10.1364/OPEX.14.000415.

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

[5] K. Olejník et al. “Terahertz electrical writing speed in an antiferromagnetic memory.” In: Science advances 4.3 (2018), eaar3566.

[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.” In: (2021). DOI: 10.48550/ARXIV.2103.11710. URL: https://arxiv.org/abs/2103.11710.