Time dependent photonics in a plasmonic context

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Introduction

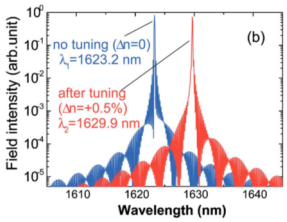
- Dynamic photonics: numerous remarkable phenomena such as frequency conversion, optical isolation, topological effects, frequency comb generation, …
- Plasmonics: use of strong field confinement

} Idea: Use of plasmonic effects to enhance dynamic effects

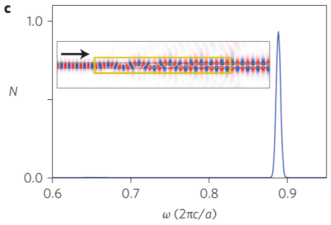
Dynamic photonics

Dynamic wavelength conversion :

Dynamic effects can change the wavelength of the light inside a cavity [1]



Dynamic effects proportional to confinement

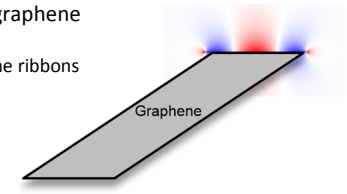


Many different phenomena are possible using dynamic photonics, such as indirect interband photonic transitions [2]

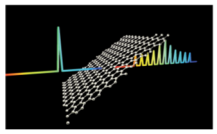
Graphene and plasmonics

Plasmonic modes are supported by graphene structures

For example: Graphene ribbons

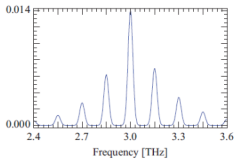


Frequency comb using a graphene sheet [3] :

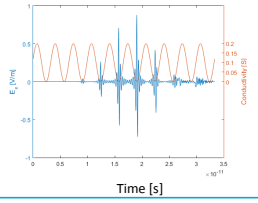


Dynamic modulation of graphene conductivity

Frequency domain



Time domain

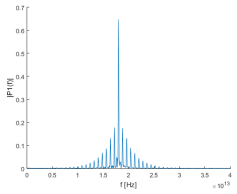


Frequency comb generation

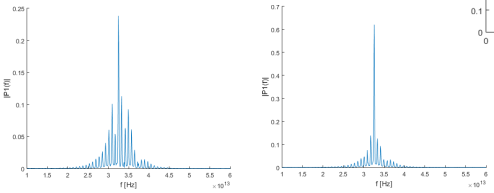
Idea: use a graphene grating properties to selectively enhance the comb peaks

Use of diffraction:

Below the diffraction limit:

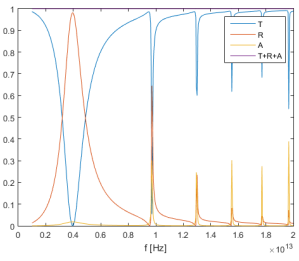


Above the diffraction limit:

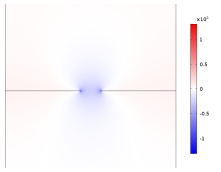


Creates and separates light in frequency and spatial domain!

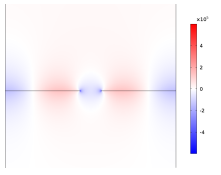
Use of plasmonic modes?



Possible modulation using E_F



High tunability of plasmonic modes in graphene gratings



Conclusion

Only using the absorption properties of graphene, we can create frequency combs that have a spatial dependence

Perspective: use of plasmonic resonances in graphene gratings

References

[1] M. Notomi and S. Mitsugi, Wavelength conversion via dynamic refractive index tuning of a cavity, *Phys. Rev. A,* ***73****, 051803(R)* (2006)

[2] Z. Yu and S. Fan, Complete optical isolation created by indirect interband photonic transitions, *Nature Photonics*, **3**, 91 (2009)

[3] V. Ginis, P. Tassin, T. Koschny and C.M. Soukoulis, Tunable terahertz frequency comb generation using time-dependent graphene sheets, *Phys. Rev. B,* **91**, 161403(R) (2015)