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Amplification of THz Radiation by Strong Interaction of Drifting Electrons with Plasmons in Graphene and GaN

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More than 40 years ago, a new direction in physics opened up with the arrival of plasma-wave electronics. The possibility that the plasma waves could propagate faster than electrons fascinated all. Therefore, it was initially expected that plasmonic devices, including detectors and generators of electromagnetic radiation, would be able to work effectively in the very high frequencies - terahertz (THz) range, inaccessible to standard electronic devices. However, numerous experimental attempts to realize the amplifiers or emitters failed: the intensity of radiation turned out to be too small, plasma resonances too broad, or devices operated only at cryogenic temperatures.

We demonstrate – for the first time- experimentally strong interaction of resonant plasmons in Graphene with drifting electrons leading to THz radiation amplification with a gain going up to 9%. The results are interpreted using a dissipative plasmonics crystal model, which captures some trends and basic physics of the amplification phenomena but is far from being completed [1] .

We will present challenges of both experimental and theoretical research on the strong plasmons-drifting electrons- THz light interaction in Dirac matter - that were recently (2022) recognized as an important research direction by EU commission - awarding ERC -Advanced grant –"TERAPLASM" that will be realized by CENTERA laboratory – UNIPRESS-PAN in consortium with CEZAMAT – Technical University of Warsaw and in collaboration with teams from Japan France Germany

[1] Boubanga-Tombet S, Knap W, Yadav D, Satou A, But DB, Popov VV, Gorbenko IV, Kachorovskii V, Otsuji T: Room-Temperature Amplification of THz Radiation by Grating-Gate Graphene Structures. Phys Rev X 2020; 10((3): 031004. [DOI: 10.1103/PhysRevX.10.031004]

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