# Ultra-confined acoustic THz graphene plasmons

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The interaction of terahertz (THz) radiation with graphene has a vast application potential in many technologies, including imaging, communications, sensing, or photo-detection, among others. Recently, it has been shown that the excitation of localized THz plasmons in graphene can strongly enhance light-matter interactions, opening the door to more efficient optoelectronic devices. Here, we will present on the first visualization of propagating graphene plasmons (GPs) at THz frequencies, which can also be controlled by metallic (split) gates. More importantly, due to the coupling of the GPs with the metal gate underneath we observe a linearization of the plasmon dispersion (thus revealing acoustic plasmons), which comes along with an extreme confinement of the plasmon fields [1]. These extraordinary GPs properties are very promising for sensing and communication technologies. To map the THz GPs, we introduce nanoscale-resolved THz photocurrent nanoscopy as a novel tool for studying fundamental and applied aspects of local THz photocurrent generation with a resolution of 50 nm, 3 orders of magnitude below the diffraction limit (**Fig. 1**).

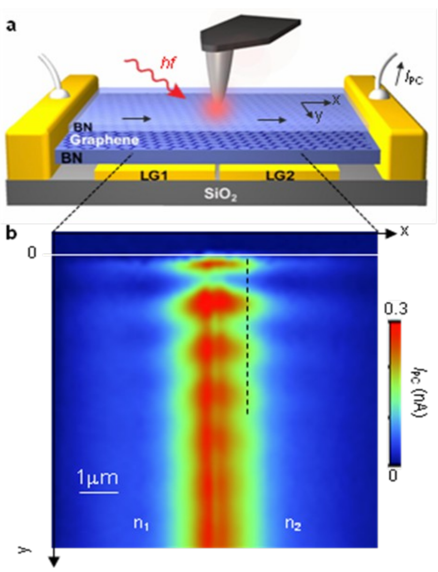


Fig. 1: (a) Schematics of the experimental setup. The laser-illuminated metal tip of an AFM serves as a nanoscale near-field light source. The near-field induced photocurrent in the graphene (encapsulated by h-BN layers) is measured through the two metal contacts to the left and right. LG1 and LG2 represent the split gate (gold) used for controlling the carrier concentration in the graphene to the left and the right of the gap between them. (b) Experimental near-field photocurrent image, $I_{PC}$, recorded at f = 2.52 THz.

[1] P. Alonso-González, A. Y. Nikitin, Y. Gao, A. Woessner, M. B. Lundeberg, A. Principi, N. Forcellini, W. Yan, S. Vélez, A. J. Huber, K. Watanabe, T. Taniguchi, L. E. Hueso, M. Polini, J. Hone, F. H. L. Koppens, and R. Hillenbrand, *arXiv:1601.05753 [cond-mat.mes-hall]*, (2016).