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Nichtgleichgewichtsdynamik kondensierter Materie in der Zeitdomäne

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Ultrafast electronic response of graphene to the strong and localized electric field of a highly charged ion

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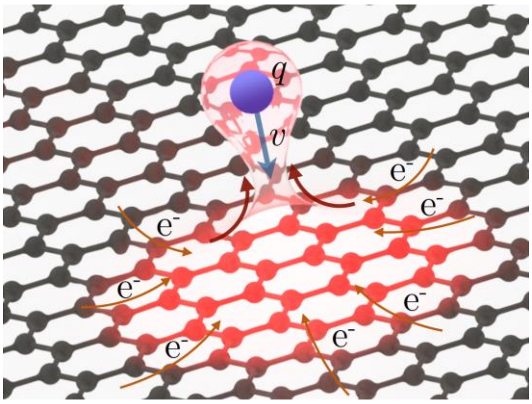

Highly charged ions (HCI) are a reliable tool to study the short-time response of 2D materials under extreme conditions. The wording extreme refers thereby to the large, local external electric field induced by an approaching HCI. A charge state of q = 35 implies a local field strength of 1.8×10^{11} Vm^{-1} at 5 Å distance from it. Achieving the same local field strength using laser fields would require power densities above 10^{17} Wcm^{-2}.

Previous HCI transmission measurements through thin carbon films and HCI scattering investigations from solid surfaces have reported unexpectedly large charge capture within 5-30 fs [1 and refs. therein].

We take the final step and transmit slow (< 1 a.u.) highly charged Xe ions with charge states (q > 30) far away from equilibrium through the ultimately thin 2D material, a freestanding single layer of graphene.

Measurements of the charge state and energy of the transmitted ions show that tens of electrons are extracted from a small surface area within a few femtoseconds, which implies high local surface current densities in the order of 10^{12} Acm^{-2}. The absence of any traces of large-scale lattice deformation, which would be expected due to the large amount of deposited energy, confirms the intrinsic ability of graphene to sustain exceptionally high current densities and to resupply the interaction region with electrons preventing Coulomb explosion [2].

Our findings indicate that the electronic excitation in graphene get rapidly screened on a sub-100 fs time scale. Our current understanding of HCI-solid interactions is not able to explain an almost complete de-excitation of the projectiles within the limited interaction time with a 2D target. This strongly points to a new mechanism for hollow atom decay. A possible candidate will be discussed.

References

[1] R. A. Wilhelm et al. *Phys. Rev. Lett.* **112**, 153201 (2014).

[2] E. Gruber et al. *Nat. Commun.* **7**, 13948 (2016).

Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

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