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O. Pulci *et al* 2012 *EPL* **98** 37004 [doi:10.1209/0295-5075/98/37004](http://dx.doi.org/10.1209/0295-5075/98/37004)

**Strong excitons in novel two-dimensional crystals: Silicane and germanane**

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We show by first-principles calculations that, due to depressed screening and enhanced two-dimensional confinement, excitonic resonances with giant oscillator strength appear in hydrogenated Si and Ge layers, which qualitatively and quantitatively differ from those of graphane. Their large exciton binding energies and oscillator strengths make them promising for observation of novel physical effects and application in optoelectronic devices on the nanoscale.

[New Journal of Physics](http://iopscience.iop.org/1367-2630/) [Volume 16](http://iopscience.iop.org/1367-2630/16) [October 2014](http://iopscience.iop.org/1367-2630/16/10)

L Matthes *et al* 2014 *New J. Phys.* **16** 105007 [doi:10.1088/1367-2630/16/10/105007](http://dx.doi.org/10.1088/1367-2630/16/10/105007)

**Optical properties of two-dimensional honeycomb crystals graphene, silicene, germanene, and tinene from first principles**

OPEN ACCESS [Focus on Silicene and Other 2D Materials](http://iopscience.iop.org/1367-2630/focus/Focus%20on%20Silicene%20and%20Other%202D%20Materials)

L Matthes1, O Pulci2 and F Bechstedt1

Part of [Focus on Silicene and Other 2D Materials](http://iopscience.iop.org/1367-2630/focus/Focus%20on%20Silicene%20and%20Other%202D%20Materials)

We compute the optical conductivity of 2D honeycomb crystals beyond the usual Dirac-cone approximation. The calculations are mainly based on the independent-quasiparticle approximation of the complex dielectric function for optical interband transitions. The full band structures are taken into account. In the case of silicene, the influence of excitonic effects is also studied. Special care is taken to derive converged spectra with respect to the number of **k** points in the Brillouin zone and the number of bands. In this way both the real and imaginary parts of the optical conductivity are correctly described for small and large frequencies. The results are applied to predict the optical properties reflection, transmission and absorption in a wide range of photon energies. They are discussed in the light of the available experimental data.

**Side-dependent electron escape from graphene- and graphane-like SiC layers**

Inizio modulo

Fine modulo

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Appl. Phys. Lett. 100, 043110 (2012); <http://dx.doi.org/10.1063/1.3679175>

The structural and electronic properties of SiC-based two-dimensional (2D) crystals are studied by means of density functional theory and many-body perturbation theory. Such properties cannot simply be interpolated between graphene and silicene. The replacement of half of the C atoms by Si atoms opens a large direct electronic gap and destroys the Dirac cones. Hydrogenation further opens the gap and significantly reduces the electron affinity to 0.1 or 1.8 eV in dependence on the carbon or silicon termination of the 2D crystal surface, thus showing a unique direction dependent ionization potential. This suggests the use of 2D-SiC:H as electron or hole filter.

**Infrared absorbance of silicene and germanene**

Inizio modulo

Fine modulo

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Appl. Phys. Lett. 100, 261906 (2012); <http://dx.doi.org/10.1063/1.4731626>

Calculating the complex dielectric function for optical interband transitions we show that the two-dimensional crystals silicene and germanene possess the same low-frequency absorbance as graphene. It is determined by the Sommerfeld finestructure constant. Deviations occur for higher frequencies when the first interband transitions outside *K* or *K*′ contribute. The low-frequency results are a consequence of the honeycomb geometry but do not depend on the group-IV atom, the sheet buckling, and the orbital hybridization. The two-dimensional crystals may be useful as absorption normals in silicon technology.

# Rayleigh instability of confined vortex droplets in critical superconductors

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Depending on the Ginzburg–Landau parameter *κ*, superconductors can either be fully diamagnetic if http://www.nature.com/nphys/journal/v11/n1/images/nphys3146-m1.gif(type I superconductors) or allow magnetic flux to penetrate through Abrikosov vortices if http://www.nature.com/nphys/journal/v11/n1/images/nphys3146-m2.gif(type II superconductors; refs [1](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref1), [2](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref2)). At the Bogomolny critical point, http://www.nature.com/nphys/journal/v11/n1/images/nphys3146-m3.gif, a state that is infinitely degenerate with respect to vortex spatial configurations arises[3](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref3), [4](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref4). Despite in-depth investigations of conventional type I and type II superconductors, a thorough understanding of the magnetic behaviour in the near-Bogomolny critical regime at *κ* ∼ *κ*c remains lacking. Here we report that in confined systems the critical regime expands over a finite interval of *κ* forming a critical superconducting state. We show that in this state, in a sample with dimensions comparable to the vortex core size, vortices merge into a multi-quanta droplet, which undergoes Rayleigh instability[5](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref5) on increasing *κ* and decays by emitting single vortices. Superconducting vortices realize Nielsen–Olesen singular solutions of the Abelian Higgs model, which is pervasive in phenomena ranging from quantum electrodynamics to cosmology[6](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref6), [7](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref7), [8](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref8), [9](http://www.nature.com/nphys/journal/v11/n1/full/nphys3146.html#ref9). Our study of the transient dynamics of Abrikosov–Nielsen–Olesen vortices in systems with boundaries promises access to non-trivial effects in quantum field theory by means of bench-top laboratory experiments.