rists are not sure what initial conditions and evolutionary paths take a white dwarf from stable equilibrium to a supernova explosion.

Nonetheless, says Nelemans, "the companion stars in Henize 2-428 are so massive that something explosive is bound to happen. Their discovery is an important case to guide theory." The context of the discovery is likely to intrigue astronomers as well. As Noam Soker at the Technion–Israel Institute of Technology puts it, "Planetary nebulae are much more than just beautiful. They are the crossroads of many other astrophysical objects."

Mark Wilson

References

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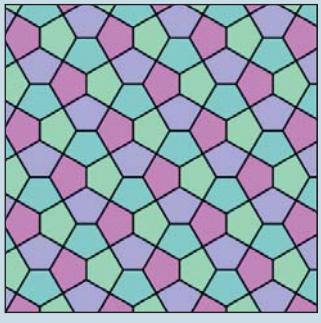
physics update

These items, with supplementary material, first appeared at http://www.physicstoday.org.

Modeling wind farms' influence on weather. The amount of electricity generated worldwide from wind has been increasing by roughly an order of magnitude per decade; in 2012 wind power generated 520 terawatt-hours, according to the US Energy Information Administration. The fast growth is prompting researchers to study not just how airflows affect the extraction of wind energy by wind farms (see, for example, the Quick Study by John Dabiri, PHYSICS TODAY, October 2014, page 66) but also how wind farms affect the atmosphere. That influence extends through the atmospheric boundary layer, a region of turbulent, well-mixed air that strongly couples to Earth's surface and whose height ranges from tens of meters to a few kilometers. Understanding the interactions between wind farms and the boundary layer is important for modeling weather and other large-scale atmospheric processes. Flows around individual wind turbines can't be spatially resolved in weather models, so they must instead be parameterized. One common approach is to treat wind farms as sinks of momentum and sources of turbulence at finite, realistic elevations. Mahdi Abkar and Fernando Porté-Agel of the École Polytechnique Fédérale de Lausanne now put that approach on an analytical footing that can take into account wind-farm densities, farm layouts, and wind direction. In particular, the researchers show the importance of various factors affecting the wind velocity inside wind farms. Incorporating those considerations into the parameterization produced good agreement with large-eddy simulations of the boundary layer for the vertical profiles of both the drag forces and the turbulent energy induced by wind farms in different configurations. (M. Abkar, F. Porté-Agel, *J. Renewable Sustainable Energy* **7**, 013121, 2015.) —RJF

Predicting pentagonal graphene. Symmetry precludes the use of regular pentagons to tile a surface. However, as the accompanying figure shows, you can tile with irregular pentagons in a pattern known as Cairo tiling, named after the paving on several streets in Egypt's capital. According to a new theoretical study by Qian Wang of Peking University and her collaborators, the same pattern can be realized on the atomic scale: in graphene-like sheets of carbon. Carbon structures that feature pentagons have already been synthesized. The archetypal fullerene, C_{60}, comprises 12 pentagons amid 20 hexagons; the smallest, C_{20}, comprises 12 pentagons. Despite those antecedents, the idea that carbon could be coaxed into forming pentagonal sheets arose not from fullerenes but from a new crystalline phase that was predicted three years ago. Known as T12, the phase has two repeating layers, one of which consists of a corrugated arrangement of Cairo-tiled pentagons. Working on the assumption that the buckled layer could be chemically exfoliated, Wang and her collaborators calculated its properties. Although the material, dubbed penta-graphene, turned out to be metastable, it withstands heating up to 1000 K. It is stronger and somewhat less stiff than graphene, and it can be rolled up to form nanotubes. Unusually, penta-graphene has a negative Poisson's ratio: If you stretch it longitudinally, it will also stretch laterally. And unlike pure graphene, pure penta-graphene is a semiconductor, whose nearly direct 3.25-eV bandgap might make it optically useful. (S. Zhang et al., *Proc. Natl. Acad. Sci. USA* **112**, 2372, 2015.) —CD



Evidence for primordial gravitational waves negated. On 17 March 2014, scientists working with the South Pole's BICEP2 telescope announced that they had seen characteristic twisted patterns, called *B* modes, in the polarization of microwave photons coming from a significant patch of sky. The team, after accounting for contributions from dust in our galaxy, interpreted its observations as arising from primordial gravitational waves, stretched by cosmic inflation and imprinted on the cosmic microwave background (CMB; see PHYSICS TODAY, May 2014, page 11). Several months later data from the *Planck* collaboration suggested that dust may have caused the BICEP2 result after all (see the Commentary by Mario Livio and Marc Kamionkowski, PHYSICS TODAY, December 2014, page 8). Now a joint paper by researchers from BICEP2, the South Pole's Keck Array collaboration, and *Planck* finds no solid evidence for primordial gravitational waves. At frequencies much above 200 GHz, the galactic-dust contribution to *B* modes dominates the gravitational-wave-induced CMB signal. The new joint work compared the *B*-mode distribution observed by *Planck* at 353 GHz, for which dust is surely the cause, with that observed by BICEP2, and later by Keck, at 150 GHz. The distributions were highly correlated, suggesting that dust is also responsible for the 150-GHz signal. The strength of gravitational-wave-induced CMB polarization is conventionally described by a dimensionless parameter, r. Last year's BICEP2 announcement cited $r = 0.2$, several standard deviations away from zero; the new work bounds r to be less than 0.12. Evidence for gravitational waves may yet be lurking in the original BICEP2 data; if so, it will take more work to tease it out. (P. A. R. Ade et al., BICEP2/Keck and *Planck* collaborations, *Phys. Rev. Lett.* **114**, 101301, 2015.) —SKB