

against those produced experimentally and found good agreement.

The two theorists also looked at intruders of different shapes. They tested a cylinder, a rectangular prism, and a V-shaped object. The match between RFT predictions and their continuum model was so good, Askari says, “it was getting a little scary.”

All that raises the question, Why does

RFT work so well? Because of the simplicity of a square plate’s geometry, Kamrin and Askari could gain insight from dimensional analysis. From the equations built into their model, the analysis implied that the granular resistive force on a square plate of width L , illustrated in figure 2, must scale as L^3 .

Kamrin and Askari further reasoned that if RFT works, they could shrink the

plate width from L to a much smaller value λ , and then calculate the resistive force on the L -sized plate by summing the forces on a collection of λ -sized plates. And indeed, for granular media, RFT produces the correct scaling. In fact, for a square plate, it predicts the force exactly.

However, if one does the same analysis for a plate moving through a viscous fluid, RFT doesn’t scale correctly. The

PHYSICS UPDATE

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

SUPERNOVA IMPOSTOR PEGGED AS REPEAT OFFENDER

For a short spell in the mid 1800s, η Carinae, a hypergiant star in the Southern Hemisphere’s Carina constellation, had the look of what astronomers now call a supernova: It ejected some 15 solar masses of gas and dust, released 10^{43} joules of energy, and briefly became the second-brightest star in the sky. But unlike a star undergoing a supernova,

η Carinae survived the flare-up. The event, known as the Great Eruption, has long puzzled astronomers, and now a study by Megan Kiminki, Nathan Smith (both at the University of Arizona), and Megan Reiter (University of Michigan) suggests there’s more to η Carinae’s story.

By analyzing 20 years of *Hubble* images, Kiminki and her coworkers were able to estimate the velocities of hundreds of objects in the expanding cloud of ejecta that surrounds the star. Extrapolating the trajectories back in time, they could infer the moment, give or take a few decades, when each object was hurled from the star. The results indicate that the ejecta couldn’t have originated from a single eruption; there had to be two others—one in the 1500s and another in the 1200s. In the image, the colors of the velocity arrows indicate the time of an object’s ejection (red, 1800s; yellow–green, 1500s; blue–violet, 1200s). The star itself is obscured by an oblong cloud known as the Homunculus Nebula. The apparent 300-year cycle of outbursts rules out at least one popular explanation for the Great Eruption—that it was a one-time event triggered when η Carinae swallowed a smaller companion star—and places new constraints on others. (M. M. Kiminki, M. Reiter, N. Smith, *Mon. Not. R. Astron. Soc.* **463**, 845, 2016.)

—AGS

GRAPHENE MEMBRANES’ ANOMALOUS DYNAMICS

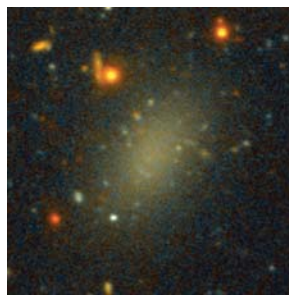
The burgeoning exploration and development of the nanoworld is forcing scientists to reexamine and reframe many established aspects of our familiar macroscopic world. Among the tenets experiencing renewed interest is the nature of the thermal fluctuations that underlie the random walks of Brownian motion (see, for example, the Quick Study by Mark Raizen and Tongcang

Li, *PHYSICS TODAY*, January 2015, page 56). The University of Arkansas’s Paul Thibado and colleagues now report ultraprecise dynamical measurements on a freestanding, atomically thin sheet of graphene that show clear deviations from classical Brownian behavior. With its regular hexagonal lattice, monolayer graphene offers an exceptionally clean two-dimensional system for studying membrane behavior. Using a custom scanning tunneling microscope (STM), the researchers tracked the out-of-plane dynamics of an atom-sized region of the membrane with subnanometer, millisecond resolution for more than two and a half hours. Over that time, the region’s height exhibited Brownian excursions that spanned 10 nm, but they were punctuated with rare, large jumps—so-called Lévy walks (see the article by Joseph Klafter, Michael Shlesinger, and Gert Zumofen, *PHYSICS TODAY*, February 1996, page 33). Molecular dynamics simulations revealed that the jumps arose from spontaneous mechanical buckling, which changed the region’s local curvature and height. The graphene studies may yield insights into the contributions thermal fluctuations make to the proper functioning of biomembranes. Moreover, the STM could be used to tune the graphene’s stochastic fluctuations, offering the tantalizing prospect of artificial nanoscale motors and engines. (M. L. Ackerman et al., *Phys. Rev. Lett.* **117**, 126801, 2016.)

—RJF

A LARGE GALAXY MADE ALMOST ENTIRELY OF DARK MATTER

Scattered among the galaxies of the Coma cluster are dozens of objects that are as large as the Milky Way but shine only 1/100 as bright. The stability of those ultradiffuse galaxies (UDGs) in the tidally disruptive Coma environment suggests that they may be



held together by an unusually large component of dark matter. Now a research team led by Pieter van Dokkum of Yale University has measured the mass of one UDG, Dragonfly 44, and found a value similar to that of our Milky Way. Combining mass and luminosity determinations, the group concluded that Dragonfly 44 is 99.99% dark matter.

The group’s key measurement was of the UDG’s spectrum near the hydrogen-alpha absorption line at 656 nm. Because different stars in the galaxy move with different speeds, the nominal absorption line is broadened to a peak whose width can be related to the mass of the central, star-containing portion of the galaxy. In essence, greater mass yields stronger centripetal forces, a wider range of speeds, and a broader peak. The spectral measurements plus modeling yielded an estimate for mass in the dark-matter halo of Dragonfly 44 and thus for the galaxy’s total mass.