

bloomed to feast on the unnatural bounty. Most of the gas was gone within four months.⁶

A growing body of evidence from ice-core data also fails to support spikes in atmospheric methane from ancient hydrate blowouts. Methane is formed by both biological and thermogenic processes, each having a distinct fingerprint of carbon isotopes. Although studies have not yet placed quantitative constraints on the emissions of hydrate methane, carbon-14 analyses suggest that the release of geologically young

methane from wetlands around 12000 years ago was the main cause of an increase in atmospheric methane at the time. The contribution from hydrates was small by comparison.⁷

Nonetheless, massive amounts of hydrocarbons released into the oceans may still affect their carbon cycle and have ecological consequences. Because of the size of the newly discovered craters and the global magnitude of the climate-sensitive reservoirs they tap, any potential effects remain a topic of active research.

Mark Wilson

References

1. C. Ruppel, J. D. Kessler, *Rev. Geophys.* **55**, 126 (2017).
2. A. Solheim, A. Elverhøi, *Geo-Mar. Lett.* **13**, 235 (1993).
3. K. Andreassen et al., *Science* **356**, 948 (2017).
4. P. Serov et al., *Proc. Natl. Acad. Sci. USA* **114**, 6215 (2017).
5. S. A. Yvon-Lewis, L. Hu, J. D. Kessler, *Geophys. Res. Lett.* **38**, L01602 (2011).
6. J. D. Kessler et al., *Science* **331** 312 (2011); M. Du, J. D. Kessler, *Environ. Sci. Technol.* **46**, 10499 (2012).
7. See, for example, V. V. Petrenko et al., *Science* **324**, 506 (2009).

PHYSICS UPDATE

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

SPIDER DRAGLINE SILK'S SURPRISING TWIST

Among its many remarkable mechanical properties, spider silk is most often touted for tensile strength that rivals steel but at a fraction of the density. Its torsional strength—as evidenced by how spiders like the golden orb-weaver in the photo manage to hang from draglines without spinning out of control—has more recently caught researchers' atten-

tion. To test how spider silk responds to torsional strain, Yuming He of Huazhong University of Science and Technology in Wuhan, China, and his collaborators mounted threads drawn from golden orb-weavers in a torsion pendulum. When Kevlar thread, metal wires, and other conventional fibers are given a twist and released, they undergo damped oscillations around the initial resting point. In contrast, the spider-silk threads oscillated around an angular position that's displaced from the original resting point. That indicates that some type of plastic deformation dissipates much of the energy of the twist and reduces the subsequent oscillation

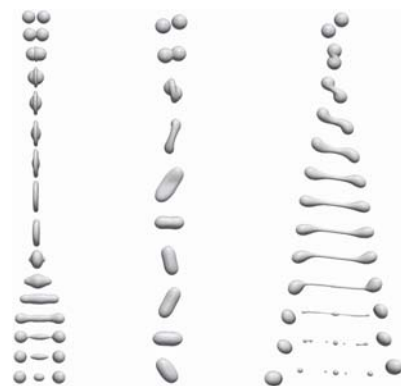


amplitude. A spider-silk thread is composed of a bundle of fibrils, and each fibril contains proteins strung in a combination of amorphous chains and crystalline sheets. The researchers speculate that the amorphous chains, which are loosely linked by hydrogen bonds, can easily separate and deform. That deformation, together with friction between fibrils, can quickly dissipate applied energy. Meanwhile, the crystalline sheets act to maintain the shape of the silk. (D. Liu et al., *Appl. Phys. Lett.* **111**, 013701, 2017; photo by C. Frank Starmer.)

—SC

COLLISIONS OF VISCOUS DROPLETS

From industrial food and drug processing to car and jet engines, the interactions between small liquid droplets have a surprisingly large effect on our lives. Wherever they occur, the interactions are complex—involving multiple phases and multiple time and length scales. And as shown in the figure, collisions can have different outcomes, including reflexive separation (left), stretching separation (right), and coalescence (center). Although numerical, theoretical, and experimental efforts over the past few decades have explored the underlying fluid dynamics, a detailed understanding, especially concerning the role of viscous forces, has yet to emerge. For water



droplets, viscous forces are usually much less relevant than surface tension, but in spray drying and other industrial applications they can be substantial and lead to

significant energy loss as the droplets merge and deform. To better understand the effect of droplet viscosity, a team of Dutch researchers led by Hans Kuipers (Eindhoven University of Technology) has analyzed the influence of viscous energy dissipation on the outcomes of 116 simulated droplet collisions. Based on their results, the researchers derive a phenomenological model that captures the dependence of the collision outcome on the droplets' viscosity, impact parameter, and ratio of kinetic energy to surface tension. The model may help improve the production of milk powder, infant formula, and many other goods. (G. Finotello et al., *Phys. Fluids* **29**, 067102, 2017.)

—RJF