the muscle fibers of the spine's joint, and that response makes the living sea urchins move.

Inspired by the biological mechanoelectrical mechanism, the researchers 3D printed spines with a geometric structure that resembles that of sea urchins. Initial exposures to flowing water yielded similar voltages and potentials in the 3D-printed spines as they did in the biological ones. The researchers also built a three-by-three array of printed spines and demonstrated that they could map the spatial distribution of water passing through. Such a sensor, the researchers say, could be useful for marine monitoring, measurements of water flow, and other applications. **PT**

Reference

1. A. Chen et al., "Echinoderm stereom gradient structures enable mechanoelectrical perception," *Nature* **651**, 371 (2026).

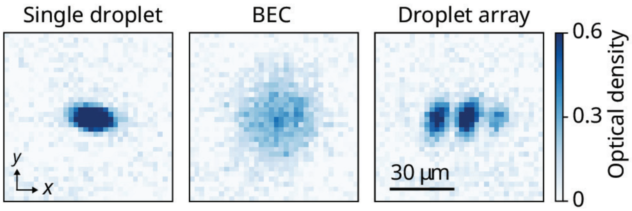
Quantum drops are spotted in ultracold gas of molecules

Strong and tunable long-range dipolar interactions could help probe the behavior of supersolids and other quantum phases of matter.

By Alex Lopatka

Two years ago, Sebastian Will of Columbia University and colleagues cooled a gas of sodium cesium molecules to nanokelvin temperatures inside an optical trap and formed the first Bose–Einstein condensate of dipolar molecules.[1] A key motivation of the research was exploiting dipole–dipole interactions—at such cold temperatures, they're more energetic than the molecules' kinetic energies—to form ordered structures such as supersolids, which flow with no viscosity. (For more on the 2024 findings, see the *PT* story "A Bose–Einstein condensate of dipolar molecules," by Daniel Garisto.) But the dipolar interactions in that initial demonstration were too weak to realize such phenomena.

Now, using a pair of linearly and elliptically polarized microwave



Absorption images show a droplet and a droplet array in a Bose–Einstein condensate (BEC) of ultracold dipolar sodium cesium molecules. Each picture is a three-image average taken along the *z*-direction. The strength of the molecular dipole–dipole interactions is controlled by an elliptically polarized microwave field. A large negative value of the ellipticity leads to the formation of a single self-bound droplet; a large positive value, to a droplet array. (Figure adapted from ref. 2.)

fields, Siwei Zhang (also at Columbia), Will, and colleagues have tuned the strength of the interactions between NaCs molecules to be much stronger than that in previous experiments.[2] As in the group's 2024 work, the resulting enhancements to the repulsive van der Waals forces stabilize the condensates by keeping the molecules from getting too close to one another and colliding.

As a consequence of the strengthened dipole–dipole interactions, the NaCs condensate transitions to the droplet phase. Dense single droplets and droplet arrays, shown in the figure, appear for various strengths and orientations of the applied fields. The most dense, strongly interactive molecular clouds persist for about 100 ms, long enough for the researchers to observe the effects of the molecular interactions.

Will and colleagues are investigating whether the droplets could be a superfluid, which flows without a loss of kinetic energy. If the droplet arrays have crystalline order, they could be supersolids. The new results may have broader applications. Ultracold dipolar molecules could be a test platform for researchers to study many-body systems with long-range interactions, novel self-organization processes, and other condensed-matter phenomena. **PT**

References

1. N. Bigagli et al., "Observation of Bose–Einstein condensation of dipolar molecules," *Nature* **631**, 289 (2024).
2. S. Zhang et al., "Observation of self-bound droplets of ultracold dipolar molecules," *Nature* **651**, 601 (2026).