estimate that the magnitude of the gain and loss should range from 100 to 1,000 cm^{-1} ,” said Takata.

A non-contact optical scheme for measuring the temperature of a gas was discussed by Yukiko Shimizu from the National Institute of Advanced Industrial Science and Technology. She described the development of an optical-frequency-comb thermometer, whereby temperature is determined by the rotational constant of a molecule. As a proof-of-principle experiment, she measured the absorption spectrum of acetylene gas under a pressure of 60 Pa at room temperature by dual-comb spectroscopy. The temperature of

the acetylene gas was calculated by the fitting of the obtained 50 absorption lines to the theoretical equations of the vibration–rotational transition. Given that the pressure linewidth (4.5 MHz) was smaller than the Doppler linewidth (240 MHz), the obtained absorption lines were fitted to Gaussian functions. By using this fitting method, the temperature was experimentally determined as $23.3 \pm 0.87^\circ\text{C}$; a value in good agreement with that obtained by putting a resistance thermometer on the outer wall of the gas cell (23.4°C). “Going forward, I would like to further expand the ability of the optical-frequency-comb thermometer.

Given that dual-comb spectroscopy has a short measurement time and covers a broad spectrum, possible future applications can be transient temperature measurement of firing in a motorcar engine, or the simultaneous temperature measurement of each component gas in a non-equilibrium mixed state,” concluded Shimizu.

The next JSAP meeting will be held in Fukuoka on 5–8 September 2017. □

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LIQUID CRYSTALS

Realizing 3D topological solitons

Topological solitons are knots in continuous physical fields classified by non-zero Hopf index values. When mapped to 3D physical fields, 3D topological solitons, called hopfions, are true pearls of mathematics and topology, and physics. They are physical realizations of the celebrated mathematical Hopf fibration. However, although they are predicted to exist in different physical systems, up until now there haven't been many reliable experimental demonstrations.

Now, Paul Ackerman and Ivan Smalyukh from the University of Colorado at Boulder, USA, introduce a method to experimentally generate and numerically analyse such localized structures in chiral nematic liquid crystals (*Phys. Rev. X* **7**, 011006; 2017). They show that knotted field configurations can be embedded in a uniform background of a physical field as stable configurations in real physical systems. The findings will pave the way for many applications ranging from new modes of liquid-crystal displays to data storage and spintronics.

“Our research group has long-standing research interests in soft condensed-matter physics, photonics and topology, so the experimental, numerical and theoretical search for such structures was perhaps the most exciting thing we could

do at the nexus of these fields,” Smalyukh told *Nature Photonics*.

Ackerman and Smalyukh used holographic laser tweezers to reliably generate 3D topological solitons and then explored them in detail with 3D nonlinear optical imaging. An ytterbium-doped fibre laser operating at 1,064 nm and a phase-only spatial light modulator are integrated into the holographic laser tweezers set-up. The set-up is capable of producing arbitrary 3D patterns of laser light intensity within the liquid crystals. The laser tweezers are also integrated with a 3D imaging set-up based on three-photon excitation fluorescence polarizing microscopy to enable fully optical generation, control and non-destructive imaging of the solitons.

In a similar fashion to the mathematical Hopf maps, the method demonstrated by Ackerman and Smalyukh relates all points of the medium's order parameter space to their closed-loop pre-images within the 3D solitons. The authors showed a large diversity of naturally occurring and laser-generated topologically non-trivial solitons with differently knotted nematic fields, which previously have not been realized in theories and experiments. Their numerical modelling further provides insight into the role of the medium's chirality, confinement and elastic constant anisotropy in enabling the stability of these 3D solitons. The authors' findings demonstrate that chiral nematic liquid crystals will serve as model systems for experimental studies of such solitons, enabling deeper understanding.

“The ability of realizing topologically non-trivial, stable static field configurations in the optical axis orientation patterns of a liquid crystal is of great interest for many applications ranging from racetrack memories to various electro-optic and photonic devices, where optical generation of such solitons could allow for engineering new means of light–matter interactions and optical circuitry,” Smalyukh affirmed.

RACHEL WON

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