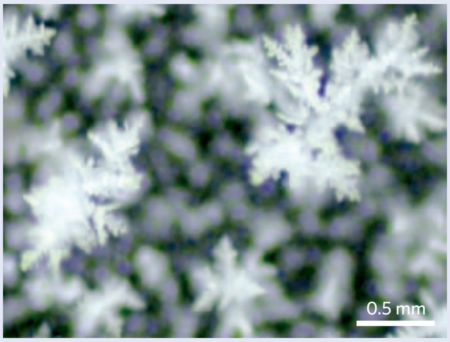
ATMOSPHERIC OPTICS

Snow on demand

The ability to trigger precipitation on demand would present huge socio-economical benefits for many arid countries around the world. Ju *et al.* at the Shanghai Institute of Optics and Fine Mechanics in China and Laval University in Canada have now reported an optical approach that can be used to induce the formation of rain and snow (*Opt. Lett.* Doc. ID 157795; 2012).

'Cloud-seeding' using silver salt particles as condensation nuclei is the most common way of artificially inducing rain, although its effectiveness is questionable. In 2010, Jérôme Kasparian and co-workers demonstrated a more environmentally friendly approach that uses self-guided ionized filaments generated from ultrashort 220 mJ pulses at a repetition rate of 10 Hz (*Nature Photon.* **4,** 451–456; 2010).

In contrast, Ju *et al.* used a relatively low-energy femtosecond Ti:sapphire laser to deliver 9 mJ pulses at a repetition rate of 1 kHz. They say that such high-repetition laser pulses could provide a more efficient way of inducing macroscopic water condensation and snow formation.



The laser pulses were focused by an *f*/70 concave mirror into a 50 cm × 50 cm × 20 cm diffusion cloud chamber filled with ambient air, where they generated filaments of around 10 cm in length. A 532 nm probe beam from a semiconductor laser was co-propagated with the femtosecond laser beam to allow observation of the filamentation-induced event via Mie scattering. A vertical temperature gradient was maintained in the chamber; the bottom base plate was held at −46 °C while the top of the chamber was kept at room temperature.

Continuous heating of the filaments in the chamber generated an intense updraft of warm, moist air. This air cooled as it travelled upwards, resulting in further water condensation via convection and cyclone-like action to form particles with diameters of 40–300 µm. The researchers say that this process can be seen with the naked eye.

After 30 minutes of irradiation, approximately 13 mg of snow was scattered below the laser filament centre across an area measuring 2.0 cm × 1.5 cm. This snow had an HNO_3 concentration of 0.032 mol L^{-1}, which confirms efficient H_2O–HNO_3 ice nucleation due to the photo-oxidative chemistry of nitrogen triggered by filamentation.

NORIAKI HORIUCHI

SURFACE-EMITTING FIBRE LASERS

Perfect ring-like beam

Fibre lasers capable of producing stable, axially symmetric ring-like radiation from an extended surface may prove to be an important new light source for applications in medical imaging, sensing, bio-sensing and security systems.

Andrei A. Fotiadi and Patrice Mégret

Fibre lasers have found a plethora of unique functions throughout both fundamental science and practical applications[1]. The wide variety of fibre cavity configurations currently available, including continuous-wave, mode-locked, *Q*-switched and single-frequency designs, offers an impressive range of performance characteristics. In such lasers, including the recently demonstrated exotic cases of ultralong and random fibre lasers[2,3], the waveguiding properties of the fibre are exploited to accumulate gain and thus produce a high-quality, low-divergence beam along the fibre axis. Aside from the use of fibres as gain media in conventional long-scale configurations, the unique and rather special properties of fibres, such as their perfect cylindrical symmetry, freedom in precise profile engineering, and reliable and universal fabrication processes, have yet to be fully exploited in novel fibre laser configurations.

In 2006, Shapira *et al.*[4] proposed a new type of fibre laser in which the fibre emits radiation radially from its circumferential surface. The wall of the fibre comprises a high-quality annular mirror lining an active fibre core, thus providing strong lasing in the plane perpendicular to the fibre axis. In principle, the emission from such a laser must be cylindrically symmetric, given the symmetry of the fibre walls. In practice, however, today's surface-emitting fibre lasers generate azimuthally anisotropic optical wavefronts because of the interplay between the cylindrical fibre resonator and the gain medium when pumped by a polarized axial pump. This behaviour is thought to result from polarization effects in the gain medium caused by the polarized pump wave, which leads to residual axial asymmetry.

Writing in *Nature Photonics*[5], Stolyarov *et al.* now report an important development in this area: radially isotropic lasing using a hollow-core Bragg fibre in combination with organic dye (rhodamine 590)-doped water plugs placed inside the fibre core, which act as azimuthally isotropic gain media. In this set-up, the gain media are insensitive to the pump polarization, owing to the fast molecular reorientation of the dye. Unlike cylindrical devices based on whispering gallery modes, this laser generates a purely cylindrical wavefront with a precise polarization fixed