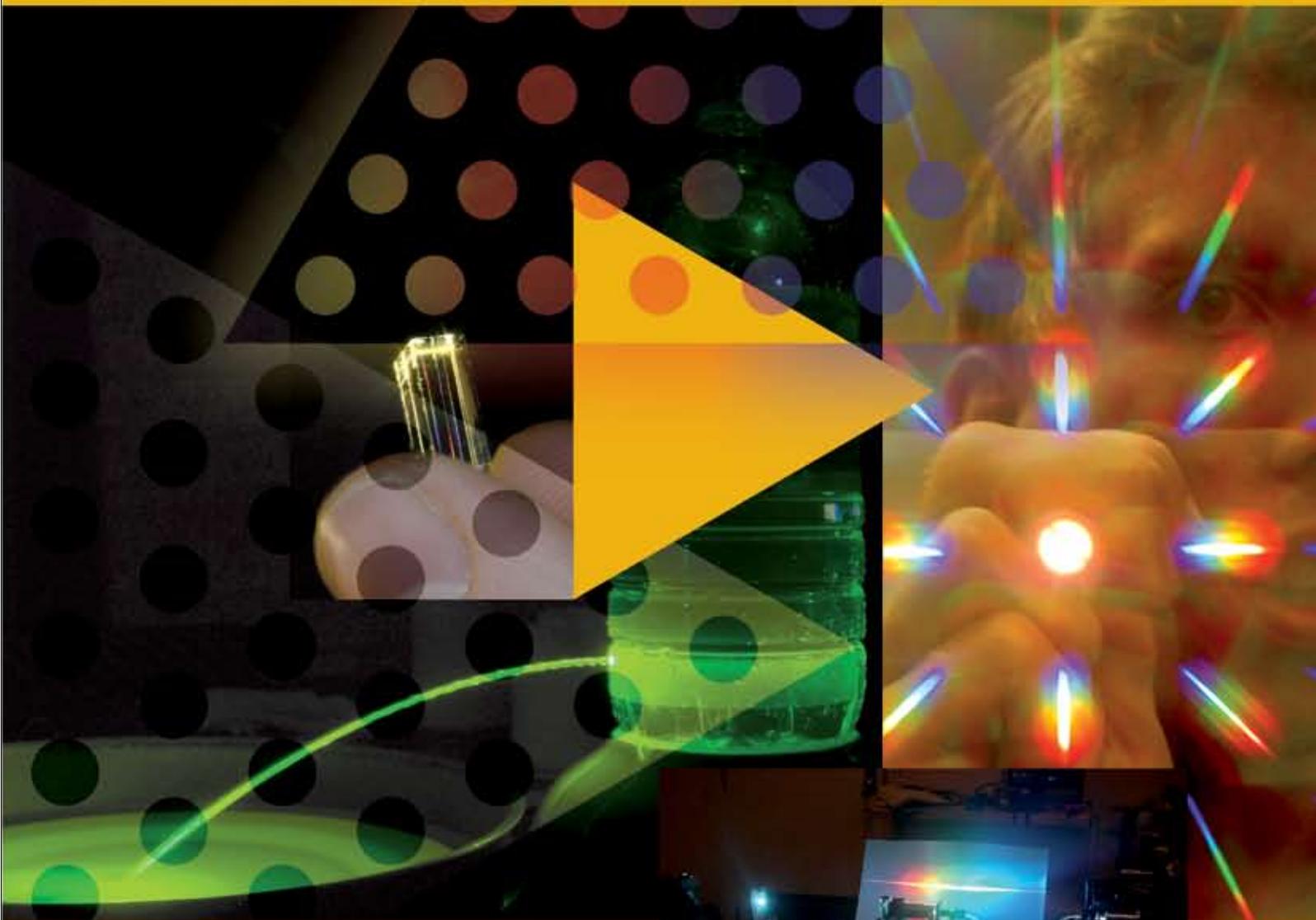


# CUDOS

The Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS)



A N N U A L R E P O R T

2006



Judith Dawes is Associate Professor in Physics at Macquarie University, working on the radiation dynamics of photonic crystal structures, and the development and applications of solid-state lasers. She teaches Physics and Optoelectronics, and is currently Postgraduate Director for Physics and Director of the BTech (Optoelectronics) degree. She received her PhD from the University of Sydney with a 1-year fellowship at the University of Rochester, and subsequent postdoctoral work at the University of Toronto, before taking up her position at Macquarie.

### Research contributions in CUDOS

Research in radiation dynamics contributes to 3D Photonic Crystal Flagship and the Waveguide Amplifier and Oscillator Flagship Projects.

### Roles in CUDOS

Chief Investigator, Associate node director (Macquarie University) and outreach coordinator for Macquarie University.

### Research activity

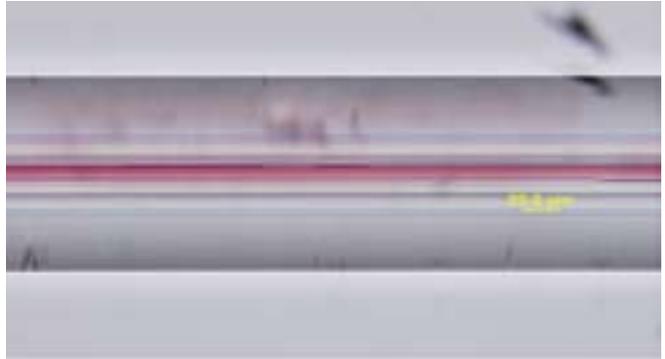
Our research concerns the influence on light emission of the environment in which emitters are embedded. When light emitters are incorporated into the periodic structure of a photonic crystal, the emission of certain frequencies of light can be enhanced or suppressed. The phenomenon has been predicted theoretically but experimental demonstrations in various materials or geometries are relatively rare. A highlight of the past year has been the close collaboration of theorists and experimentalists from CUDOS to work on this problem. Controlling the light emission in photonic crystals offers the potential for developing efficient light sources, for example by lowering the threshold of a laser. Radiation dynamics is an important fundamental in the overall CUDOS research program because efficient light sources are required to drive nonlinear optical devices.

### Research achievements during 2006

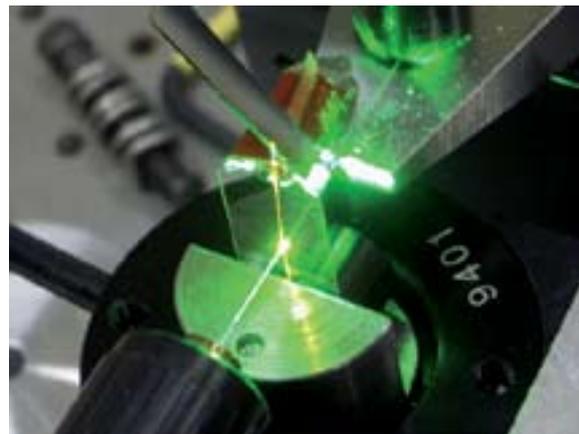
During 2006, our research included observations of radiation dynamics in emission from 2-dimensional (2D) photonic crystal fibres and 3-dimensional (3D) opals. Sam Myers, working with Judith Dawes, and collaborating with research staff and students from Macquarie University and the University of Sydney, submitted his MSc thesis on the topic of Radiation Dynamics in Tapered Photonic Crystal Fibres. Sam tapered hollow-core photonic crystal fibre by up to a factor of four in diameter. Although the system has a relatively low refractive index contrast (glass to air), it has proved to be an excellent 2D model system for studying photonic crystals, as it allows for a continuous variation of the photonic crystal pitch along the taper.

## A/Professor Judith Dawes

▼ **Figure 1. Tapered photonic crystal fibre with dye solution in the central hole.**



Sam demonstrated enhancement and suppression of light emitted from dye molecules infiltrated into the core of a tapered photonic crystal fibre, (see Figure 1) and the complex spectral features that he observed (see Figure 2) were explained using detailed modelling of local density of states effects and radiation patterns (see Figure 3) by Dr David Fussell, formerly at CUDOS at University of Sydney, now at Queen's University in Canada. This work and associated movies of the modelled local density of states radiation patterns was published in Optics Express [Myers SJ, Fussell DP, Dawes JM, Mägi E, McPhedran RC, Eggleton BJ, de Sterke CM, Manipulation of spontaneous emission in a tapered photonic crystal fibre, OPTICS EXPRESS 14, 12439-12444 (2006)]. Intriguingly, for this 2D system, light emission within the photonic bandgap is enhanced over a range of frequencies. This behaviour cannot be explained simply as if the photonic crystal was "filtering the light" but is attributed to the direct influence of the environment on the emitters.



▲ **Figure 2. Transverse characterization of emission from the tapered photonic bandgap fibre.**

