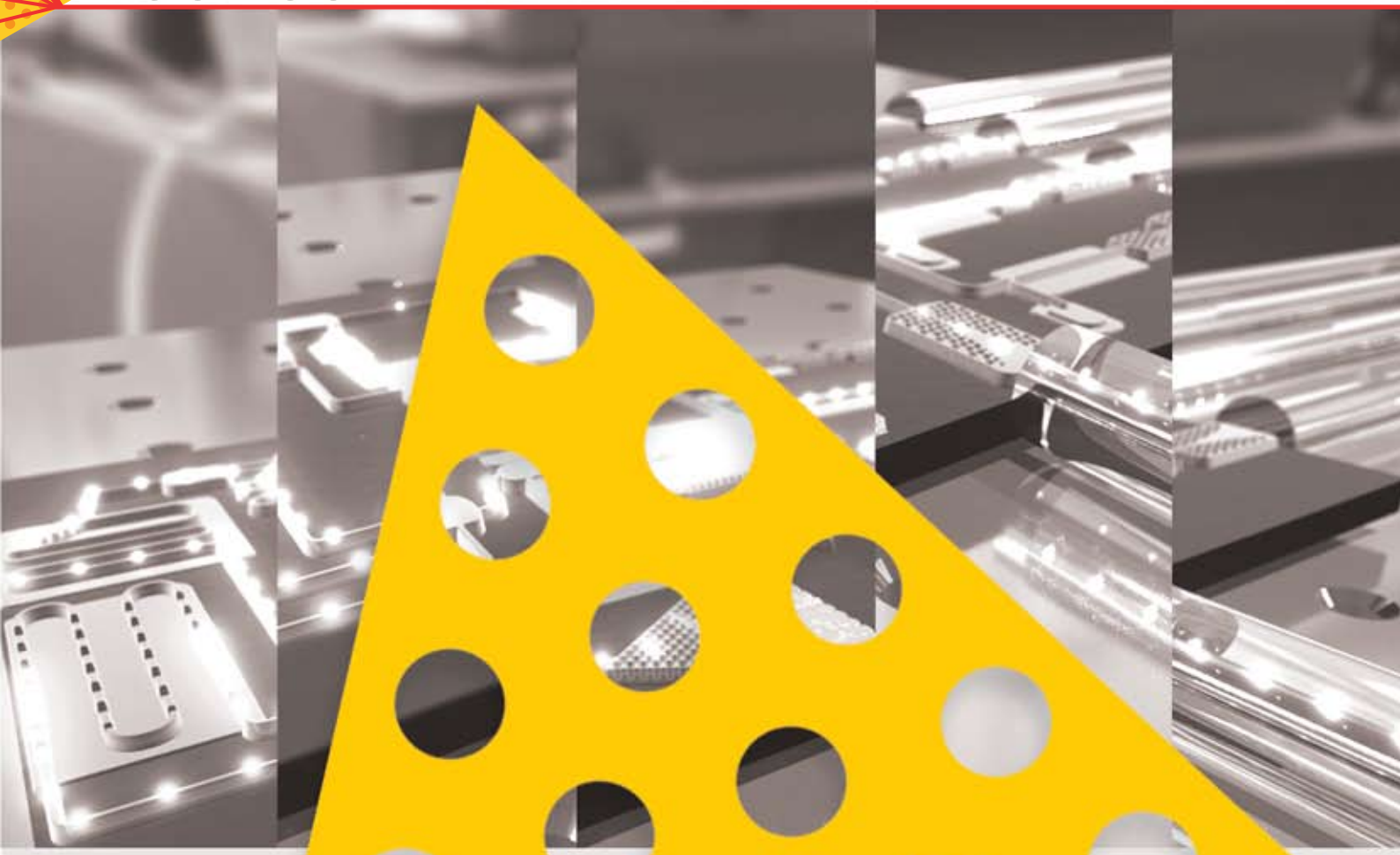
CUDOS

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

An Australian Research Council Centre of Excellence



Annual Report 2007

Chief Investigator

Prof Ross C McPhedran

Ross McPhedran completed his undergraduate studies and PhD at the University of Tasmania, before moving to Sydney in 1975 as a Queen Elizabeth II Fellow. He was appointed a Senior Lecturer in the School of Physics in 1984, and was promoted to a Personal Chair in 1994. His interests range over many aspects of wave theory, photonics, composite science, mathematical methods and numerical alogorithms.

Awards, honours, major international visits

In 2007, Professor McPhedran co-edited two special issues of journals: the Proceedings of ETOPIM7 in Physica B, Vol. 394, May, and Waves in Random and Complex Media, Vol. 17, December. He gave a plenary talk at the international conference Waves 2007, July, Reading University, and other invited talks at the Courant Institute, New York University, and the American Society of Mechanical Engineers, Texas A and M University, College Station. He also visited the University of Liverpool under a grant from the EPSRC (UK), where he worked on the properties of elastic waves in platonic crystals. He finished a term on the Board of Proceedings of the Royal Society A, and continues on the Boards of Journal of Optics A and Waves in Random and Complex Media. His work on optical cloaking was highlighted in the popular French science magazine, *Science et l'Avenir*, October 2007.

Key areas of research contribution within the Centre

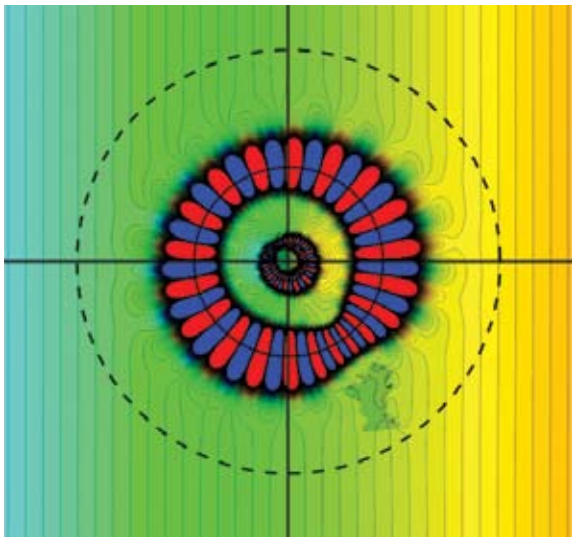
Professor McPhedran is engaged in the theory underlying the electromagnetic properties of photonic crystals, of and currently is particularly involved in the development of theories for the properties of defects in PC's. He is also involved in the development of methods for density of states calculations in photonic crystals and their applications in radiation dynamics effects, and the modelling and applications of microstructured fibres. He also works on the theory and applications of surface plasmons in structured materials, and is active in the study of the use of plasmonic resonances in optical cloaking.

Researchers and students

In 2007, Dr. Christian Karnutsch joined CUDOS, to work on microfluidics and plasmonics, in collaborations with Professors Eggleton and McPhedran. Sam Campbell is a PhD student working with Professors McPhedran, de Sterke and Botten on lamellar diffraction gratings and their applications, while Sahand Mahmoodian completed an Honours project in 2007 on defects in photonic crystals, and will commence his PhD on the same topic in 2008.

Research achievements during 2007

A study [1] of surface plasmon detectors for bio-molecules showed that the incorporation of an optimized sinusoidal grating in a frustrated-total reflection detector resulted in a six-fold enhancement of sensitivity. Pioneering work on cloaking or hiding of objects from electromagnetic probes has been reported in Optics Express [2]. The work showed that quite complicated systems of polarisable particles can be cloaked using a system composed of a hollow cylinder cloaked with a material exhibiting a plasmonic resonance. The first study of bending waves in thin perforated plates has been made [3]. This work has shown that such systems, termed platonic crystals, can provide excellent filtering characteristics, with broad band gaps possible even with perforations of very small radius. Continuing work has shown that such structures can also provide very flat bands, with possible applications in delay lines and other structures requiring ultra-slow sound.



Cloaking of a familiar French figure by plasmonic resonance. The silhouette is composed of polarisable dipoles, whose response to an external field is counteracted by a cloaking system made of an optically resonant material.

[1] Alleyne, C.J., Kirk, A.G., McPhedran. R.C., Nicorovici, N.A. and Maystre, D.: Enhanced SPR Sensitivity using Periodic Metallic Structures, Optics Express, 15, 8163-8169 (2007).

[2] Nicorovici, N.A., Milton, G.W. and McPhedran, R.C.: Cloaking of Polarizable Discrete Systems by Anomalous Resonance, Optics Express, 15, 6314-6323 (2007).

[3] Movchan, A.B., Movchan, N.V. and McPhedran, R.C.: Bloch-Floquet Bending Waves in Perforated Thin Plates, Proc. Roy. Soc. A, 463, 2505-2518 (2007).