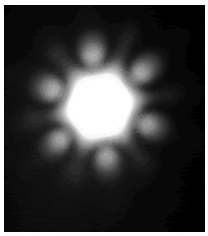
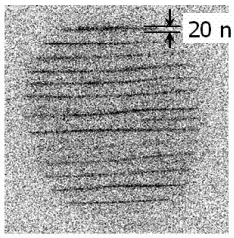




POWAG'04 Summer-school evaluation-test

4 weeks (from 19th Oct 2004) are given to answer these questions and returning them to the POWAG 2004 Organising Committee (return by 16th Nov 2004). Answers can be provided from either a group of students or by the individual student.

Lecture 1 (Kashyap): *100 years of photosensitivity in optical glasses*

Lecture 2 (Poumellec): *Fundamentals of photosensitivity*

Lecture 3 (Limberger): *Are stresses and stress changes in optical fibres the key to understanding phenomenon of photosensitivity?*

Lecture 4 (Ibsen): *UV-written Bragg gratings*

Q: **Can a Bragg grating be used as an optical matched filter? If yes, describe the requirements to the transfer-function (amplitude and phase profiles) of the grating, and discuss which advantages, if any, can be expected. If it exists, design a Bragg grating optical matched filter to an input field of your choice.**

Lecture 5 (Webb): *Bragg gratings in sensing applications*

Lecture 6 (Margulis): *Poling of glass*

Q: **Is it possible to generate second harmonic in glass? Prove that second-order nonlinear processes are possible only in media without inversion symmetry. Give examples of isotropic media without inversion symmetry.**

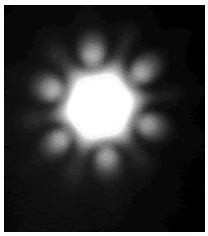
Lecture 7 (Douay): *New directions and the future of UV-written technologies*

Lecture 8 (Kryukov): *Advances in ultra-short pulse lasers*

Lecture 9 (Kazansky): *Breaking the limits in glass: From quantum interference to fs nano-structuring*

Q1: **Can light waves of different frequencies interfere?**

Q2: **How is it possible to create dc field and second-order nonlinearity in glass by light? If so estimate the strength of dc electric field given second-order susceptibility 0.001 pm/V in silica glass.**



Q3: **What is intensity and strength of the electric field inside a femtosecond laser beam of 800 nm wavelength, 100 fs pulse duration and 1 μJ pulse energy focused in 1 μm spot?**

Q4: **Give examples of the smallest periodic structures that can be created by light inside transparent materials? Suggest an application of such structures.**

Q5: **Can light and plasma interfere?**

Lecture 10 (Seifert): *Laser engineering in nano-structured materials*

Q: **What can be responsible for the extinction of light (UV/VIS/NIR) by interaction with metallic nano-particles, and what is the specific feature of Ag (as compared with Au or Cu)?**

Lecture 11 (Russell): *Photonic crystal fibres: Fundamentals & applications*

Lecture 12 (Dianov): *Raman fibre lasers: Breakthrough in laser physics*

Lecture 13 (Grudinin): *High-power ultra-fast fibre lasers: New horizons and applications*

Q: **Why does passive mode locking of fibre-lasers require anomalous group velocity dispersion of the laser cavity?**

Lecture 14 (Murnane): *Multiphoton EUV photonics*

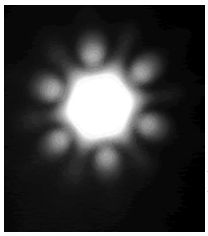
Q: **What is the large impediment to phase matching at very short wavelengths using the process of high harmonic generation driven by a femtosecond laser?**

Lecture 15 (Knight): *Non-linear optics in PCF*

Q: **Describe the most significant differences between hollow-core and solid-core fibers, which relate to the propagation of fibre-optical solitons.**

Lecture 16 (Rarity): *Quantum optics in wavelength-scale structures*

Q: **What happens when you pump a microstructured fibre with nanosecond Q-switched pulses slightly blue detuned into the normal dispersion regime? What is the origin of this phenomenon and how can we turn it into a convenient pair photon source.**



Lecture 17 (Keller): *Near-field optics in a quantum physical perspective*

Lecture 18 (Yablonovitch): *Quantum computing*

Q: **For 100 electron spins, how many distinct coefficients are there in the wave function?**

Lecture 19 (Folman): *The atom chip*

Q: **How are atoms being trapped and guided above the atom chip?**

Lecture 20 (Zayats): *Experimental nano-optics*

Q: **To achieve sub-wavelength resolution, the probe tip of a scanning near-field microscope should be scanned very close to the surface at the distance much smaller than the wavelength of light. Describe (with diagram's) three distance regulation modes used in scanning near-field microscopy. Discuss advantages and disadvantages of various modes. How can constant-distance mode be implemented in the experiment?**

Lecture 21 (Dholakia): *Optical trapping/tweezing of microscopic objects and atoms*

Q1: **Explain with the aid of a diagram how optical tweezers work for a transparent object that is much larger than the size of the light wavelength.**

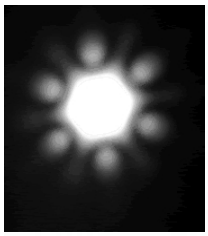
Q2: **Why might an annular shaped beam be better for axial trapping?**

Q3: **How might we have to modify this picture is we consider a particle is a lot smaller than the wavelength?**

Lecture 22 (Dudley): *Supercontinuum generation in PCF*

Q: **This is an open question concerning the basic properties of solitons in fibres.**

Using Taylor series expansions for the non-linear and dispersive phase shifts experienced by a hyperbolic secant pulse in an optical fibre, one can demonstrate that the condition corresponding to the cancellation of these phase shifts for a hyperbolic secant pulse leads to the launch condition for a fundamental soliton. See Dudley et al. "The cancellation of non-linear and dispersive



phase components on the fundamental optical fibre soliton: a pedagogical note", Optics Communications 193, 253-259, (2001).

Your task here is to develop the same analysis for any non-solitonic field of your choice, and attempt (as far as possible) to simplify and obtain closed form expressions for the accumulated phase. For example, you may wish to explore in this way why a Gaussian pulse is not a soliton, or what the effect of initial chirp on a soliton would be.

Full marks will be given for any rigorous and intelligent approach to the problem irrespective of any particular final answer obtained.

Lecture 23 (Pendry): *Negative refraction opens new doors in optics*

Q: **There is no specific question in relation to this Lecture, but please familiarise your self with the content of the Authors web-side.**

http://www.cmth.ph.ic.ac.uk/photonics/references.html