

## What did Dickens know about Phaseonium?

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In the Pickwick Papers, Charles Dickens has his character Sam exclaim that he needed "a pair o' patent double million magnifyin' gas microscopes of hextra power"<sup>1</sup> Now the general wisdom is that improvements to microscopy are bounded by the laws of optics which tell us that resolution is a function of the wavelength of the radiation used for imaging and inversely proportional to the refractive index of the medium and lens. We have discussed in this space various ways which can and have been used to "circumvent" mother nature, by such tricks as not using lenses and employing scanning techniques instead in order to obtain images.

It turns out that there may yet be other useful "loopholes" in natural laws. Let's for example consider the fact that the refractive index of a material is a measure of the interaction of photons with the matter they traverse. In that sense refraction is related to absorption, which occurs when materials interact so strongly with photons that the latter never emerge. The energy of the photon is used up in raising some of the electrons of the material from one level to a higher one. In a seminal experiment more than 10 years ago, Ugo Fano at the Univ. of Chicago showed that this absorption can be prevented (see reference<sup>2</sup>). Using a laser beam of precisely the right energy he found that it is possible to "link" two high energy levels together. An incoming beam, which would normally be absorbed by raising some of the material's electrons to one of these levels now does not suffer this fate, because the linked levels interfere with each other's ability to absorb the photon. As a result the erstwhile absorbing material is now transparent. In recent years such quantum optical considerations have open further possibilities. Marlan Scully of the Univ. of New Mexico and his collaborators<sup>3</sup> have proposed that materials of very high refractive index could be obtained which would be transparent by linking appropriate energy levels as just described, to produce a phase coherent atomic ensemble, dubbed "phaseonium". In collaboration with Ed Fry at the Houston Advanced Research Center, Scully is working on phaseonium and is banking on the fact that it will be the stuff from which microscope lenses will be made in the next century. Lets see, if N were doubled, with lambda remaining constant, the resolution would be doubled. The estimates<sup>4</sup> are that N could reach values of 10 or even 20, i.e. at least an order of magnitude better than what can be achieved today (N=1.5). If there were a concomitant increase in resolution, light microscopes built with phaseonium lenses might therefore be capable of resolving 10 nm, everything else remaining unchanged.

Phaseonium lenses, of course, are still a dream. Right now it is expected that they would consist of gas at a density of about one Torr. Assuming that the phaseonium gas is compatible with life it is possible to fantasize about carrying out studies of molecular processes at electron microscope resolution, in live cells. No more fixation, no vacuum, no damage by electron bombardment. Wait a minute say the skeptics, there are problems! Even if phaseonium lenses can be built, cells are 90% water and need to be bathed in an aqueous medium to survive. As a result researchers will be limited by the refractive index of water just as it is in the case of live cells with light microscopes today. To take advantage of the high refractive index one would have to use immersion in a homogeneous medium, in this case replacing the water with phaseonium. That probably means to fix the cells so one can remove the water with "minimal" damage. Maybe so. Of course the optimists might argue historically, recalling that early electron microscopists had to overcome the then commonly held view that exposure to an electron beam would turn specimens to useless cinders. Should phaseonium keep its promise in spite of potential difficulties, Charles Dickens's dream of a "gas microscope" would indeed have come true. How the dickens did he know? ■

1. Dickens, C. (1836) Pickwick Papers, Ch34: The memorable trial of Bardell against against Pickwick.
2. N. Singer (1992) Coupled states clear darkness and quiet the light. Science 258, 32-33.
3. M. Fleischhauer et al. (1992) Resonantly enhanced refractive index without absorption via atomic coherence Phys. Rev. A 46, 1468-1487
4. M.O. Scully. From lasers and masers to phaseonium and phasersd (1992) Physics Reports 219, 191-201

## REGIONAL MSA/MAS EVENTS

- ★ March/April '93: Chesapeake EMS Spring Workshops. Theme is CONFOCAL MICROSCOPY and ASSOCIATED TECHNIQUES. Baltimore/Washington. John P. Petrali: (410)671-2334 or Blair Bowers: (301)496-3611.
- ★ April 21/23 '93: Florida EMS Annual Meeting. To be held in conjunction with SCANNING '93. Orlando, FL. Evelyn Llausnitzer: (904)392-3451.
- ★ May 12/14 '93: SEEMS and Alabama SEM Joint Meeting. Birmingham, AL. Charles Humphrey: (404)639-3306.
- ★ May 14 '93: Spring Mountain States EMS and Colorado MAS Spring Symposia. USGS, Denver CO. Cathy Johnson: (303)744-5372
- ★ May 20 '93: Joint Meeting of the Central States EMS and the Missouri, Illinois and Kansas MAS. Invited speakers and presentations in both biological field and materials sciences. Nada Chang: (217)787-7338.

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(\*\*\*): Contact Microscopy Today for further information.

✓ April 27/28 '93: **Material Characterization & Testing Spring Symposium.** GE R&D Ctr. Schenectady, NY. John Sutliff: (518)387-7732.

May 3/5 '93: **MAJOR ANALYTICAL INSTRUMENTATION CENTER** (Univ of Florida).

✓ **Transmission Electron Microscopy**  
 ✓ **Practical Surface & Thin Film Analysis**  
 ✓ **Scanning Delectron Microscopy**  
 Gainesville, FL. (904)392-6985.

✓ May 5/7 '93: **1st International Symposium on Computerized Data Standards: Databases, Data Interchange, and Information Systems.** Atlanta, GA. Dorothy Savini: (215)299-5413.

✓ May 8/13 '93: **Food Structure Annual Meeting.** Chicago, IL. Dr. Ohm Johari: (708) 529-6677.

✓ May 9/13 '93: **EMAS '93.** Rimini, Italy (\*\*\*)

✓ May 17/19 '93: **Computer Assisted Image Analysis and Measurement** (NC State Univ. Short Course) Raleigh, NC: (919)515-2261.

✓ May 17/19 '93: **TEM Specimen Preparation School** (Gatan R&D). Pleasanton, CA. Reza Alani: (510)463-0200.

✓ June 2/4 '93: **Trends in Cell and Molecular Biology - 18th Annual Meeting.** George Washington Univ., Washington, DC. Fred Lightfoot: (202)994-2881.

✓ June 3/5 '93: **20th Annual Meeting of the Microscopical Society of Canada.** Univ. of Toronto. Nan Anderson: (416)483-3712

✓ June 4/5 '93: **Microscopy, Microanalysis & Molecular Biology in the Enviromental Sciences: S. Calif. Academy of Science Meeting.** CALSTATE, Long Beach, CA. Zed Mason: (310) 985-5266.

✓ June 6/10 '93: **Molecular Microspectroscopy** (9th Annual short course & workshop). Miami Univ., Oxford, OH. (513)529-2873.

✓ June 9/11 '93: **15th Symposium on Applied Surface Analysis.** Case Western Reserve Univ, Cleveland OH. Jeffrey I Eldridge (216)433-6074.

### LEHIGH UNIV COURSES:

✓ June 14/18 '93: **Basic Course.**  
 ✓ June 21/25 '93: **Advanced Courses.**  
 ✓ June 21/24 '93: **Analytical EM..**  
 ✓ June 24/25 '93: **Thin Specimen Prep.**

Info: Prof. Joe Goldstein: Tel.: (215)758-5133

✓ July 11/16 '93: **Microbeam Analysis Annual Meeting.** L.A., CA. Jack Worrall, MAS '93, PO Box 1014, Monrovia, CA 91017-1014.

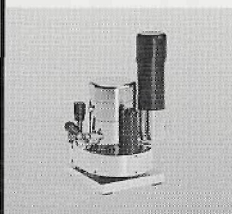
✓ July 17/23 '93: **Immunocytochemistry and Cryosections '93.** A practical course. Yale School of Med. Paul Webster: (203)785-5072

✓ July 19/23 '93: **Freeze Fracture Course.** Colorado State Univ., Ft. Collins, CO. Eileen Diepenbrock: (303)491-5847.

✓ July 31/Aug 1 '93: **A Practical Experience In Cryofixation and Freeze-Substitution.** (MSA Pre-Meeting Workshop) Miami Univ, Oxford, OH. A. Allenspach: (513)529-3100.

✓ August 1/6 '93: **51st Annual Microscopy Society of America (MSA/EMSA) Meeting.** Cincinnati, OH. MSA Business Office: Tel.: (800)538-3672; Fax: (508)548-9053.

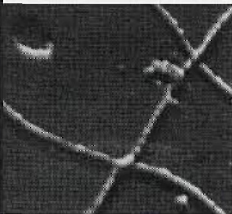
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