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Prof. D F Parker

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University of Edinburgh
The Kings Building
Mayfield Road
Edinburgh EH9 3JZ
United Kingdom

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ESF Study Centre Nonlinear Optics and Guided Waves

Names and Addresses of Participants

Prof. Fatkhulla Kh. Abdullaev, Theoretical Division, Physical-Technical Institute, Uzbek Academy of Sciences, 700084, Tashkent-84, G. Mavlyanova str. 2-b, Uzbekistan.
Tel: +7 3712 444769; *Fax:* +7 3712 35 43 11; *email:* fatkh@pti.silk.glas.apc.org

Prof. Alejandro B. Aceves, Dept. of Mathematics and Statistics, University of New Mexico, Albuquerque, New Mexico 87131, USA.
Tel: +1 501 277 3332; *Fax:* +1 505 277 5505; *email:* aceves@snell.unm.edu

Dr. J. Stewart Aitchison, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 339 8855; *Fax:* +44 (0)41 330 4709; *email:* s.aitchison@elec.gla.ac.uk

Dr. Nail Akhmediev, Optical Sciences Centre, Australian National University, Canberra, ACT 0200, Australia.
Tel: +61 (0)6 249 0191; *Fax:* +61 (0)6 249 5184; *email:* NNA124@RSPHY1.ANU.EDU.AU

Dr. Mark S. Alber, Department of Mathematics, University of Notre Dame, Mail Distribution Centre, Notre Dame, I.N. 46556, USA.
Tel: +1 219 239 8371; *email:* alber@cartan.math.nd.edu

Katie M. Allen, Photonics Research Group, EE & AP, Aston University, Aston Triangle, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4972; *Fax:* +44 (0)21 359 0156; *email:* allenkm@sun.aston.ac.uk

Dr. Dan Anderson, Institute for Electromagnetic Field Theory and Plasma Physics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.
Tel: +46 3172 1000; *Fax:* +46 317721573

Prof. John M. Arnold, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 330 4901; *Fax:* +44 (0)41 330 4907; *email:* jma@elec.gla.ac.uk

David Artigas, Department of Signal Theory and Communications, Universitat Politècnica de Catalunya, PO Box 30 002, 08080 Barcelona, Spain.
Tel: +34 9 3 4017361; *Fax:* +34 9 3 4017232; *email:* david@gaig.upc.es

Prof. Jagadish C. Bhakta, Department of Mathematics, University of Chittagong, Chittagong, Bangladesh.

Dr. Biswanath Bhattacharyya, Mathematics Department, University of North Bengal, Darjeeling 734 430, India.
Tel: +91 (0) 3556 434; *Fax:* +91 (0) 353 30812

Dr. Brigitte Bidégaray, Centre de Mathématiques et Leurs Applications, E.N.S. de Cachan, 61, avenue du Président Wilson, 94235 Cachan CEDEX, France.
Tel: +33 1 47402409; *Fax:* +33 1 47402169; *email:* brigitte@cmla.ens-cachan.fr

Svend Bischoff, Institute of Mathematical Modelling/AMF, The Technical University of Denmark, Bld. 306, Dk-2800, Lyngby, Copenhagen, Denmark.
Tel: +45 4288 2222; *Fax:* +45 45 93 7235; *email:* sb@lamf.dth.dk

Prof. Allan D. Boardman, Joule Laboratory, Department of Physics, University of Salford, Salford, M5 4WT, England.
Tel: +44 (0)61 745 5253; *Fax:* +44 (0)61 745 5903

Arnaud Boulnois, LSH, Bât P5, UST Lille, 59650 Villeneuve d'Ascq, France.
Tel: +33 20 43 68 27; *email:* arnaud@lsh.univ-lille1.fr

Massimo Brambilla, Sezione di Ottica, Dip. di Fisica, Università of Milano, Via Celoria 20, 20133 Milano, Italy.
Tel: +39 2 2392334; *Fax:* +39 2 2392712; *email:* mbrambilla@milano.infn.it

Dr. Harry Braden, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5072; *Fax:* +44 (0)31 650 6553; *email:* hwb@maths.ed.ac.uk

Patrick A. Buah, Department of EEIE, City University, Northampton Square, London, EC1V 0HB, England.
Tel: +44 (0)71 477 8000/3892; *Fax:* +44 (0)71 477 8568; *email:* af513@City.ac.uk

Ralph Burton, Applied Mathematics Section, Department of Mathematics & Statistics, University of Sheffield, Sheffield S10 2UN, England.
Tel: +44 (0)742 768555

Dr. John Byatt-Smith, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5036; *Fax:* +44 (0)31 650 6553; *email:* byatt@maths.ed.ac.uk

Jean-Christophe Celet, Laboratoire de Spectroscopie Hertzienne, Bâtiment P5, Université des Sciences et Technologies de Lille, 59650 Villeneuve d'Ascq, France.
Tel: +33 2043 6809; *Fax:* +33 2033 7020; *email:* celet@lsh.univ-lille1.fr

Sabino Chavez[†], Laser Optics Group, Blackett Laboratory - Optics Section, Imperial College, London SW7 2BZ, U.K.
Tel: +44 (0)71 594 7642; *Fax:* +44 (0)71 594 7777; *email:* sabino.chavez@ic.ac.uk
([†]Permanent address: I.N.A.O.E., Grupo de Fotonica, Apdo. Postal 51/216, Puebla, Pue., Mexico.) *Tel:* +52 22 472281 ; *Fax:* +52 22 472940; *email:* hmmc@tonali.inaoep.mx

Prof. Sergei A. Darmanyan, Institute of Spectroscopy RAS, 142092 Troitsk, Moscow reg. Russia.
Tel: +7 095 334 02 24; *Fax:* +7 095 334 02 24; *email:* darman@theor.isan.msk.su

Richard G. Docksey, Department of Mathematics, Imperial College, London, SW7 2BZ, England.
email: rgd@ic.ac.uk

Prof. Nick J. Doran, Dept. Electronic Engineering & Applied Physics, Aston University, Aston Triangle, Birmingham, B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4973; *Fax:* +44 (0)21 359 0156

Prof. Chris Eilbeck, Heriot Watt University, Department of Mathematics, Riccarton, Edinburgh EH14 4AS, Scotland.
Tel: +44 (0)31 451 3220; *Fax:* +44 (0)31 451 3249; *email:* chris@cara.ma.hw.ac.uk

Dr. John N. Elgin, Department of Mathematics, Imperial College, London, SW7 2BZ, England.
Tel: +44 (0)71 589 5111 Ext 5726; *Fax:* +44 (0)71 225 8361; *email:* j.elgin@ic.ac.uk

Prof. William J. Firth, Department of Physics and Applied Physics, University of Strathclyde, John Anderson Building, 107 Rotten Row, Glasgow G4 0NG, Scotland.
Tel: +44 (0)41 552 5018; *Fax:* +44 (0)41 552 2891; *email:* willie@phys.strath.ac.uk

Dr. Miroslaw Florjańczyk, Département de Physique, Centre d'Optique Photonique et Laser, Université Laval, Cité Universitaire, Québec, G1K 7P4, Canada.
Tel: +1 418 656 2454; *Fax:* +1 418 656 2623; *email:* 1150124@saphir.ulaval.ca

Wladek Forysiak, Photonics Research Group, EEAP, Aston University, Aston Street, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 5280; *Fax:* +44 (0)21 359 0156; *email:* forysiaw@aston.ac.uk

Anastasios Fragos, Department of Electronics and Electrical Engineering, University of Glasgow. Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 337 2100

Dr. Ildar Gabitov, Until June 1995; FTZ Telekom, FZ241l Am Kavalleriesand 3, D-64295 Darmstadt, Germany. *Tel:* +49 6151 833583; *email:* gabitov@sun.rhrk.uni-kl.de
Permanent; Landau Institute for Theoretical Physics, Kosygin Street 2, V-334 Moscow, Russia. *Tel:* +7 095 137 3244; *Fax:* +7 095 9382 270; *email:* ildar@cpd.landau.free.net

Thomas Gabler, Institute of Applied Physics, Friedrich-Schiller-Universität, 07745 Jena, Germany.
Tel: +49 03641 657 657; *Fax:* +49 03641 657 80

Stuart Galloway, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5047; *Fax:* +44 (0)31 650 6553; *email:* stuart@matns.ed.ac.uk

Jorge Garcia-Mateos, Departamento de Teoria de la Senyal y Comunicaciones, Universitat Politècnica de Catalunya, P.O. BOX 30002, 08080 Barcelona, Spain.
Tel: +34 34017361; *Fax:* +34 3401 7232; *email:* mateos@gaig.upc.es

Dr. James P. Gordon, Rm 4E-410, A.T.&T. Bell Laboratories, Holmdel, New Jersey 07733-3030, USA.
Tel: +1 908 949 2227; *Fax:* +1 908 949 8988; *email:* jim@spin.att.com

John Gray, Photonics Research Group, EE & AP, Aston University, Aston Triangle, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4972; *Fax:* +44 (0)21 359 0156; *email:* grayjw@cs.aston.ac.uk

Craig Hamilton, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 339 8855 Ext 6666; *Fax:* +44 (0)41 330 4907; *email:* ham@elec.gla.ac.uk

Prof. Robert G. Harrison, Heriot Watt University, Department of Mathematics, Riccarton, Edinburgh, Scotland.
Tel: +44 (0)31 451 3003; *Fax:* +44 (0)31 451 3249

Prof. Hermann A. Haus, Department of Electrical Engineering and Computer Science, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, MA 02139, USA.
Tel: +1 617 253 2585; *Fax:* +1 617 253 9611; *email:* haus@athena.mit.edu

Margarita Homar, Dpt. de Fisica, Universitat de les Illes Balears, E-07071 Palma de Mallorca, Spain.
Tel: +34 71 172537; *Fax:* +34 71 173224; *email:* dfsmhp4@ps.uib.es

Dr. David C. Hutchings, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 339 8855; *Fax:* +44 (0)41 330 4907; *email:* D.Hutchings@elec.gla.ac.uk

Prof. Robert Indik, Department of Mathematics, University of Arizona, Tucson, Arizona 85721, USA.
Tel: +1 602 621 1510; *Fax:* +1 602 621 1510; *email:* indik@math.arizona.edu

Christopher Jones, Division of Applied Mathematics, Brown University, Providence, R.I. 02912, U.S.A.
Tel: +1 401 863 3696; *Fax:* +1 401 863 1355; *email:* ckrtj@cfm.brown.edu

Magnus Karlsson, Institute for Electromagnetic Field Theory and Plasma Physics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.
Fax: +46 317721573
email: elfmk@elf.chalmers.se

Prof. William L. Kath, Engineering Sciences and Applied Mathematics, McCormick School of Engineering, Northwestern University, 2145 Sheridan Road, Evanston, Illinois, USA 60208
Tel: +1 708 491 5585; *Fax:* +1 708 491 2178; *email:* kath@nwu.edu

Prof. David J. Kaup, Clarkson University, Potsdam, New York 13699-5815, USA.
Tel: +1 315 268 2360; *Fax:* +1 315 268 2360; *email:* kaup@sun.mcs,clarkson.edu

Dr. Yuri S. Kivshar, Optical Science Centre, Australian National University, Canberra, ACT 0200, Australia.
Tel: +61 (0)6 249 3081 (office); *Fax:* +61 (0)6 249 5184; *email:* ysk124@rsphysse.anu.edu.au

Finlay M. Knox, Photonics Research Group, Dept. EE & AP, Aston University, Aston Street, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4972; *Fax:* +44 (0)21 359 0156; *email:* knoxfm@sun.aston.ac.uk

Prof. Stephan Koch, Fackbereich Physik, Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany.
Tel: +49 (0) 6421 284209; *Fax:* +49 (0) 6421 287076;
email: kochsw@mv13a.physik.uni-marburg.de

Dr. Wieslaw Krolikowski, Laser Physics Centre, Australian National University, Canberra ACT 0200, Australia.
Tel: +61 (0)6 2493752; *Fax:* +61 (0)6 249 0029; *email:* WZK11@RSPHY1.ANU.EDU.AU

Prof. Tassilo Küpper, Universität Köln, Mathematisches Institut, Weyertal 88, D50931 Köln, Germany.
Tel: +49 221 4702697; *Fax:* +49 470 5114; *email:* kuepper@mi.uni-koeln.de

Vincent Lecoeuche, UFR de Physique, Bâtinent P5, Laboratoire de Spectroscopie Hertzienne, 59650 Villeneuve d'Ascq, France.
Tel: +33 2043 4763; *Fax:* +33 2043 4084; *email:* LECOEUCH@LSH.UNIV-LILLE1.FR

Prof. Falk Lederer, University of Jena, Faculty of Physics, Max-Wien-Platz 1, Jena, D-07743, Germany.
Tel: +49 3641635938; *Fax:* +49 3641635182; *email:* pfl@physik.uni-jena.de

Dr. Joceline Lega, Institut Non Linéaire de Nice, UMR CNRS 129, 1361 Route des Lucioles, 06560 Valbonne, France.
Tel: +33 92 96 73 16; *Fax:* +33 93 65 2517; *email:* lega@ecu.unice.fr

Dr. Jin Liang, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 6483; *Fax:* +44 (0)31 650 6553; *email:* liang@maths.ed.ac.uk

Dr. Mietek Lisak, Institute for Electromagnetic Field Theory and Plasma Physics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.
Tel: +46 31 7721565; *Fax:* +46 31 7721573

Dr. Gregory G. Luther, Department of Mathematics and Statistics, University of New Mexico, Albuquerque, New Mexico 87131, USA.
Tel: +1 505 277 2114; *Fax:* +1 505 277 5505; *email:* luther@math.unm.edu

Prof. Barry Luther-Davies, Laser Physics Centre, Research School of Physical Sciences and Engineering, Australian National University, Canberra, ACT 0200, Australia.
Tel: +61 (0)6 249 4244; *Fax:* +61 (0)6 249 0029; *email:* BLD111@rsphy1.anu.edu.au

Stephen Lynch, Manchester Metropolitan University, Department of Mathematics and Physics, John Dalton Building, Manchester M1 SGD, England.
Tel: +44 (0)61 247 3587

Boris A. Malomed, Department of Applied Mathematics, Tel Aviv University, Ramat Aviv 69978, Israel.
Tel: +972 3 640 9623; *Fax:* +972 3 640 9357; *email:* malomed@leo.math.tau.ac.il

Abdellatif Mamhoud, Laboratoire de Physique de la Matière Condensée, Université de Nice Sophia - Antipolis, Parc Valrose, F-06108 Nice Cedex 02, France.
Tel: +33 9352 9892; *Fax:* +33 9352 9808; *email:* Mamhoud@naxos.unice.fr

Dr. Natale Manganaro, Department of Mathematics, University of Messina, Contrada Papardo, Salita Serpone 31, 98166 Messina, Italy.
Tel: +39 90 6763064; *Fax:* +39 90 393502; *email:* edu@imeuniv.bitnet

Dr. Ian Marshall, Department of Mathematics, Leeds University, Leeds LS7 9JT, England.
Tel: +44 (0) 532 335 130; *email:* amt6im@amsta.leeds.ac.uk

Jennifer Marshall, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5048; *Fax:* +44 (0)31 650 6553; *email:* jennifer@maths.ed.ac.uk

Dr. Paolo Masciulli, Department of Energetics, University "La Sapienza", Via Scarpa 14-16, 00161 Roma, Italy.
Tel: +39 (0)6 49916541; *Fax:* +39 (0)6 44240183; *email:* BERTOL88@itcaspur.caspur.it

Dr. Graham S. McDonald, Blackett Lab. - Optics, Imperial College, London SW7 2BZ, England.
Tel: +44 (0)71 594 7728; *Fax:* +44 (0)71 589 9463; *email:* g.mcdonald@ic.ac.uk

Prof. John G. McInerney, Department of Physics, National University of Ireland, University College Cork, Cork, Ireland.
Tel: (+353 21) 276 871; *Fax:* (+353 21) 276 949; *email:* step8036@vax1.ucc.ie

Ross McIntyre, Heriot Watt University, Department of Physics, Riccarton, Edinburgh, Scotland.
Fax: +44 (0)31 451 3249; *email:* e-phyrm@uk.ac.hw.phy

Stuart MacIntosh, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5047; *Fax:* +44 (0)31 650 6553; *email:* jsm@maths.ed.ac.uk

Dr. Linn F. Mollenauer, Rm 4C-306, AT&T Bell Laboratories, Crawfords Corner Road, Holmdel, NJ 07733, USA.
Tel: +1 908 949 5766; *Fax:* +1 908 949 5784; *email:* linn@spin.att.com

Dr. Jerry V. Moloney, Department of Mathematics, University of Arizona, Tucson, Arizona 85721, USA.
Tel: +1 602 621 6755; *Fax:* +1 602 621 1510; *email:* jml@math.arizona.edu

Dr. Carlos Montes, Laboratoire de Physique de la Matière Condensée, C.N.R.S., Université de Nice - Sophia Antipolis, Parc Valrose, F-06108 Nice Cedex 2, France.
Tel: +33 9352 9978; *Fax:* +33 9352 9808; *email:* montes@naxos.unice.fr

Prof. Alexander A. Nepomnyashchy, Department of Mathematics, Technion-Israel Institute of Technology, Haifa 32000, Israel.
Tel: +972 4 294170; *Fax:* +972 4 324654; *email:* nepom@leeor.technion.ac.il

Prof. Alan C. Newell, Department of Mathematics, University of Arizona, Tucson, Arizona 85721, USA.
Tel: +1 602 621 6893; *Fax:* +1 602 621 83122; *email:* anewell@math.arizona.edu

Dr. Gian-Luca Oppo, Department of Physics and Applied Physics, University of Strathclyde, 107 Rottenrow, Glasgow, G4 0NG, Scotland.
Tel: +44 (0)41 552 4400 Ext 3761; *Fax:* +44 (0)41 552 2891; *email:* gianluca@phys.strath.ac.uk

Prof. Lev A. Ostrovsky, Institute of Applied Physics, Russian Academy of Sciences, 46 Uljanov Street, 603600 Nizhny Novgorod, Russia.
Fax: +7 8312 367291; *email:* ostrov@appl.nnov.su

Prof. David Parker, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5049; *Fax:* +44 (0)31 650 6553; *email:* david@maths.ed.ac.uk

Dr. John Parkes, University of Strathclyde, Department of Mathematics, Livingstone Tower, Glasgow G1 1XH, Scotland.
Tel: +44 (0)41 552 4400 Ext 3720; *Fax:* +44 (0)41 552 8657; *email:* E.J.PARKES@strath.ac.uk

Rafat Pawlikowski, Institute of Physics, Polish Academy of Sciences, 02-668 Warsaw, Poland.
email: pawli@ifpan.edu.pl

Víctor M. Pérez-García, Departamento de Física Teórica I, Universidad Complutense, Madrid 28040, Spain.
Tel: +37 1 3944508; *Fax:* +34 1 3944683; *email:* PEREZ-GARCIA@SIM.UCM.ES

Dr. Andrew Pickering, Heriot Watt University, Department of Physics, Riccarton, Edinburgh, Scotland.
Tel: +44 (0)31 451 3203; *Fax:* +44 (0)31 451 3249; *email:* andrewp@cara.ma.hw.ac.uk

Prof. Len M. Pismen, Department of Chemical Engineering and Center for Research in Nonlinear Phenomena, Technion – Israel Institute of Technology, 32000 Haifa, Israel.
Fax: +972 4 293 086; *email:* cerlplp@techunix.technion.ac.il

Richard Putman, Joule Laboratory, Department of Physics, University of Salford, Salford M5 4WT, England.
Tel: +44 (0)61 745 5000 Ext 4805; *Fax:* +44 (0)61 745 5903;
email r.c.j.putman@physics.salford.ac.uk

Dr. Andrea Re, Department of Energetics, Università "La Sapienza", Via Scarpa 14-16, 00161 Roma, Italy.
Tel: +39 (0)6 49916541; *Fax:* +39 (0)6 44240183; *email:* BERTOL88@itcaspur.caspur.it

Prof. Nikolay N. Rosanov, Research Institute of Laser Physics, Scientific Center "S.I.Vavilov State Optical Institute", St.Petersburg, 199 034, 12 Birzhevaya line, Russia.
Tel: +7 812 5601834; *Fax:* +7 812 2181093; *email:* rosanov@ilph.spb.su

Jonathan Rubin, Division of Applied Mathematics, Brown University, Box F, Providence, R.I. 02912, USA.
Tel: +1 401 861 4019; *email:* jer@cfm.brown.edu

Dr. Boris A. Samson, Institute of Physics, Belarus Academy of Sciences, 70, F. Skaryna Ave., Minsk, 220072, Belarus.
Tel: +7 0172 395958; *Fax:* +7 0172 393131; *email:* ifanbel@bas03.basnet.minsk.by

Dr. Marco Santagiustina, Dipartimento di Elettronica ed Informatica, Università di Padova, Padova 35131, Italy.
Tel: +39 49 8287760; *Fax:* +39 49 8287699; *email:* ElETT19@IPDUNIVX.UNIPD.IT

Concepcion Santos, Department of Signal Theory and Communications, Universitat Politècnica de Catalunya, P.O. Box 30002, 08080 Barcelona, Spain.
Tel: +34 9 3 4016527; *Fax:* +34 9 3 4017232; *email:* santos@gaig.upc.es

Christoph Schulte, Arnold Sommerfeld Institut, TU Clausthal, Leibnizstr. 10, 38678 Clausthal, Germany.

Dr. Alexander Sergeev, Institute of Applied Physics, 46 Uljanov Street, 603600 Nizhny Novgorod, Russia.
Tel: +7 8312 363773; *Fax:* +7 8312 369717; *email:* FLX@APPL.NNOV.SU

Dr. Nicholas J Smith, Dept. Electronic Engineering & Applied Physics, Aston University, Aston Triangle, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 5280; *Fax:* +44 (0)21 359 0516; *email:* smithnj@sun.aston.ac.uk

Dr. Noel Smyth, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5080; *Fax:* +44 (0)31 650 6553; *email:* noel@maths.ed.ac.uk

Prof. Yuri A. Stepanyants, Institute of Applied Physics, Russian Academy of Science, 46 Uljanov St., 603600 Nizhny Novgorod, Russia.
Tel: +7 8312 384505; *Fax:* +7 8312 367291; *email:* yuas@appl.nnov.su

Prof. Charles A. Stuart, Département de Mathématiques, Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne, Switzerland.
Tel: +41 (0)21 693 2591; *Fax:* +41 (0)21 693 4303; *email:* stuart@masg3.epfl.ch

Juan P. Torres, Department of Signal Theory and Communications, Universitat Politècnica de Catalunya, P.O. Box 30002, 08080 Barcelona, Spain.
Tel: +34 3 401 7216; *Fax:* +34 3 401 7232; *email:* JPEREZ@VOLTOR.UPC.ES

Dr. Hai-Tan Tran, Department of Mathematics, University College, Australian Defence Force Academy, Canberra, ACT, Australia 2601.
Tel: +61 (0)6 2688485; *Fax:* +61 (0)6 2688886; *email:* htt@groucho.ma.adfa.oz.au

Dr. Stefano Trillo, Fondazione Ugo Bordoni, Via Baldassarre Castiglione 59, 00142 Rome, Italy.
Tel: +39 6 5480 3204; *Fax:* +39 6 5480 4402; *email:* truglo@fub.it; strillo@fub.it

Reidun Twarock, Arnold Sommerfeld Institut, TU Clausthal, Leibnizstr. 10, 38678 Clausthal, Germany.

Dr. Ivan M. Uzunov, Faculty of Physics and Astronomy, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany.
Tel: +49 3641 633955; *Fax:* +49 3641 63 5182

Dr. Theo P. Valkering, Center for Theoretical Physics, Department of Applied Physics, PO Box 217, University of Twente, 7500 AE Enschede, The Netherlands.
Tel: +31 53 893168; *Fax:* +31 53 332371; *email:* T.P.Valkering@TN.UTWENTE.NL

Dr. Stefan Wabnitz, Fondazione Ugo Bordoni, Via Baldassarre Castiglione 59, 00142 Roma, Italy.
Tel: +39 6 5480 3206; *Fax:* +39 6 5480 4405; *email:* SWAB@FUB.IT

Dr. Jonathan Wattis, Heriot Watt University, Department of Mathematics, Riccarton, Edinburgh, Scotland.
Tel: +44 (0)31 451 3252; *Fax:* +44 (0)31 451 3249; *email:* jonathan@cara.ma.hw.ac.uk

Kenton White, University of Arizona, Arizona Centre for Mathematical Sciences, Department of Mathematics , Tucson, Arizona 85721, USA.
Tel: +1 602 621 8129; *email:* jwhite@math.arizona.edu

William S. Wong, Rm 36-315, Department of Electrical Engineering and Computer Science, MIT, Cambridge, MA 02139 USA.
Tel: +1 617 253 8524; *Fax:* +1 617 253 9611; *email:* williamw@mit.edu

Richard W. Ziolkowski, Electromagnetics Laboratory, Department of Electrical and Computer Engineering, The University of Arizona, Tucson, AZ 85721, USA.
Tel: +1 602 621 6173; *Fax:* +1 602 621 8076; *email:* ziolkowski@ece.arizona.edu

EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

Reports from Investigation Groups

The topics on which investigation groups met during the Study Centre were:

Aug. 10
- Fibre laser issues.
- Transverse patterns and waveguiding in nonlinear optics.

Aug. 11
- 4-dimensional (space-time) structures - paraxial and non-paraxial optics.
- Characterisation of chaos in an N-dimensional N-DST equation.
- Dark solitons - are they any use?

Aug. 15
- Dynamics of coupled NLS equations.
- Future problems in optical communications.

Aug. 16
- Exact solutions for coupled NLS equations.
- All-optical switching - progress and possibilities.

Aug. 18
- Planar waveguides and spatial solitons.
- Spatial structures.

Oral Reports delivered were:

Aug. 18
- Optical Communications (Mollenauer, Kath, Smith, Gabitov).
- All-optical switching (Arnold, Hutchings, Aitchison, Tran).
- Dynamics and chaos in NLS and N-DST (Wabnitz, Akhmediev, Jones).
- Coupled NLS (Akhmediev, Aceves).
- Exact solutions for coupled NLS (Florjanczyk, Arnold, Boardman, Jones).

Aug. 19
- Dark solitons - theory and use (Kivshar, Allen).
- Spatial solitons, planar waveguides and stability (Jones, Chavez, Tran).
- Numerical issues in nonlinear optics (Perez-Garcia).
- Optical collapse in cavities (McDonald).
- Suppression of Gordon-Haus jitter without filters (McDonald, Wabnitz).
- 4-D space-time structures (McDonald, Chavez, Samson).

Written reports for distribution to all participants and sponsors (available upon request from I.C.M.S., 14 India Street, Edinburgh, EH3-6EZ, Tel: +44 131 220-1777, FAX: +44 131 220-2053, e-mail: icms@maths.ed.ac.uk) are:

Dark solitons - Various Aspects of Practical Applications	6pp
Future Problems in Optical Communications	8pp
An Alternative Scheme for a Soliton Transmission System	5pp
Exact Solutions of Coupled Nonlinear Schrödinger Equations	4pp
Ultra-Fast Switching in Semiconductor Waveguides	28pp
3-D and 4-D Structures in Paraxial and Nonparaxial Nonlinear Optics	12pp
Numerical Schemes in Nonlinear Optics	6p

Any further reports which come to hand will be notified and distributed to participants by electronic mail. Those requiring hard copy should notify I.C.M.S. at the address above.

EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

This Study Centre was held as a three-week workshop, with lectures, investigation sessions, library, computing facilties, lunch and refreshment facilities in the James Clerk Maxwell Building, University of Edinburgh. The majority of participants were accommodated in the nearby Suffolk Halls (Heriot Watt University) and adjacent hotels and guest houses. The Study Centre was adopted as an HCM Euroconference, so significantly helping many research students to participate throughout. The meeting formed part of the 1993-94 programme of the International Centre for Mathematical Sciences, whose premises (the birthplace of James Clerk Maxwell) were used in the final week for a reception hosted by the Edinburgh Mathematical Society. Other receptions were hosted by the Faculty of Science and Engineering, The University of Edinburgh and The City of Edinburgh District Council. Grants towards travel and subsistence costs were obtained from the International Centre for Mathematical Sciences (London Mathematical Society grant), The Royal Society, London, the International Science Foundation, the Office of Naval Research (London), the European Office of Aerospace Research and Development (U.S.A.F.), the European Research Office (U.S. Army) and from BNR (Europe) Ltd. Among the 105 participants from 20 countries, the majority of whom gave lectures or presented posters, were 32 research students and 14 post-doctoral workers.

The main aims of the Study Centre were: to advance the theory, computation and exploitation of nonlinearity in optical waveguides; to further the modelling of physical processes such as laser dynamics and active materials and to analyse the related evolution equations; to further develop techniques for large-scale computation of optical phenomena. Surveys of the various fields, providing a basis for investiation topics, were given by:

- Professor W.L. Kath (3 lectures on soliton dynamics in birefringent fibres and on long-distance propagation with phase-sensitive amplifiers).
- Dr. J.N. Elgin (3 lectures on 'The nonlinear optics of erbium-doped fibre amplifier systems').
- Dr. J. Lega (3 lectures on 'Phase and amplitude equations for lasers').
- Professor R. Indik (3 lectures on 'Numerical methods for nonlinear optics').
- Professor A.B. Aceves (3 lectures on 'Modulational instabilities in optical systems').
- Professor J.V. Moloney (2 lectures on 'Nonlinear optical interactions in large aspect ratio systems and on femtosecond timescales').
- Professor A.C. Newell (3 lectures on Maxwell-Bloch equations, pattern formation and on the inverse-scattering transform in nonlinear optics).
- Dr. L.F. Mollenauer (2 lectures on 'Ultra long distance transmission using solitons in optical fibres').

Additionally, single one-hour invited lectures were delivered by:

- Professor N.J. Doran, Solitons in optical communications.
- Dr. G.-L. Oppo, Controlling spatio-temporal chaos in nonlinear optics.
- Professor R.G. Harrison, Dynamics and chaos in nonlinear optical fibre: Theory and experiment.
- Dr. J.S. Aitchison, Spatial solitons in planar waveguides.
- Professor D.J. Kaup, Effects of inhomogeneities on the propagation of optical solitons.
- Dr. Yu.S. Kivshar, Dark solitons in nonlinear optics.

Dr. M. Brambilla, The formation and dynamics of spatio-temporal structures in nonlinear optical systems.
Professor W.J. Firth, Spontaneous optical patterns in a nonlinear cavity.
Professor H.A. Haus, Pulse propagation and pulse generation in fibres.
Dr. S. Wabnitz, Soliton interaction and switching in optical fibres.
Dr. B.A. Malomed, Soliton dynamics in nonuniform and birefringent fibres.
Dr. J.P. Gordon, Theoretical aspects of long distance soliton transmission in fibres.
Professor C.K.R.T. Jones, Dynamical systems techniques in optical wave propagation.
Professor S.W. Koch, Microscopic modelling of the nonlinear response of semiconductors.
Dr. D. Anderson, Pulse propagation determined by the NLS equation: A variational approach.
Professor J.M. Arnold, Quasi-particle approximations in the theory of optical fibre solitons.
Professor R.W. Ziolkowski, Finite-difference time-domain modelling of ultrashort optical pulse interactions with linear and nonlinear corrugated waveguides.
Dr. S. Trillo, Homoclinic instabilities in parametric three-wave mixing.
Professor A.D. Boardman, Bright/dark spatial soliton interactions.

There were, also, 21 half-hour lectures and three poster sessions, at which 32 posters were presented. No investigation sessions were timetabled until the second week, but much discussion was initiated during the first week, continuing through coffee breaks, meals, social events and during the Highland Excursion (7-9 August) in which 55 participants took part. The investigation sessions generated sufficient interest that it was rarely practical to schedule more than two simultaneously. It was clear that instigators of the investigation topics invested considerable effort in presenting topics to generate interactions between scientists from different disciplines. In some cases, significant computation was undertaken during the Study Centre, using existing code and involving the high-performance computing available in the Edinburgh Parallel Computation Centre.

Topics which generated particularly strong interactions are the subjects of the investigation group reports (see attached list). The presence simultaneously of Drs Mollenauer and Gordon (A.T.&T.) and Professor Haus (M.I.T.) provided great expertise on practical issues of long-distance optical transmission systems and on concepts and theory which might further improve system performance. Many useful ideas were generated from other groups working in the U.K., Germany, Italy, Russia and the U.S.A. (see report 'Future Problems in Optical Communications'). The presumption in favour of using existing (recently) installed fibre shows both the penalty imposed by large financial investment in technology which can rapidly be superseded and the mathematical difficulty of designing repeater systems when the attenuation is comparable with the repeater spacing. Lectures from Dr. Gabitov (Moscow/Darmstadt) and Dr. Sergeev might advance these difficult problems. Another strategy, described in 'An Alternative Scheme for a Soliton Transmission System', uses phase sensitive modulators. Theoretical, numerical and experimental work shows promise of operating long distance transmission systems at the 1.3μm window of existing (low dispersion) fibres, chosen inappropriately for the balance between nonlinearity and dispersion essential to soliton operation.

Dark solitons (i.e. localized gaps in continuous wavetrains) are a subject of much active research. Dr. Kivshar and colleagues at A.N.U., Canberra, reported many theoretical advances, while Professor Doran's group at Aston University are seeking ways of overcoming the major difficulty in generating dark solitons - the need for a πphase shift across the soliton. It seems that spatial dark solitons (self-guiding planar beams) have potential in planar switching and logic devices. There was much discussion about planar waveguides. Fabrication technology is now well advanced while, mathematically, many of the problems are closely analogous to those of fibre optics. The planar geometry generates nonlinear eigenvalue problems of significant interest to mathematical analysts (Jones, Stuart, Küpper), while the modulation theory for spatial beams generates coupled nonlinear Schrödinger (CNLS) equations. Discussion built upon the interesting amplitude-dependent switching effects described by Dr. Tran (Canberra), practical Lagrangian-variational methods outlined by Professor Boardman (Salford), and the interaction of a planar beam with a corrugated interface currently being investigated by Professor Abdullaev (Tashkent) (report to follow). Discussions on 'Exact Solutions for CNLS Equations', showed that semi-inverse, similarity and Lie-group methods are still capable of revealing new explicit solutions. While it is recognized that 'exact' solutions are extremely special, their importance in suggesting structures of lasting duration is important. A leading open question concerns the 'dissipative solitons' of Anderson, Lisak and Sergeev. Ultra-fast Switching is a major interest in Glasgow, which generated considerable interest as a complement to strictly optical topics in the Study Centre. It offers ready integration into optical networks, with topic of 3-D and 4-D Optical Structures presents profound theoretical difficulties. Current approaches are necessarily largely numerical, although justification (asymptotic) for the paraxial approximation is a significant issue. Stability of the resulting entities (light bullets, etc.) is a major concern, currently being addressed largely through numerical computation. 'Numerical Schemes in Nonlinear Optics' were largely discussed in informal sessions, following Professor Indik's three survey lectures. Some participants discussed extensively with members of the Edinburgh Parallel Computation Centre, whose director Professor Kenway was present to discuss future use of the facilities (Cray T3D), for which there is considerable scope.

Copies of notes for most of the invited speakers were freely available before the lectures, while a photocopying service was available for other notes and offprints. Visits to Professor Harrison's laboratory at Heriot-Watt University and to the optics laboratories at Edinburgh University's Physics Department were arranged. It was the general consensus that a good community spirit was fostered early, both by accommodating the majority of participants in Suffolk Halls and adjacent hotels and guest houses and through the social events. These provided excellent opportunities for the mathematicians, physicists, telecommunications and electronics engineers to exchange ideas and learn of novel viewpoints. Participants were very appreciative of the substantial scope provided for following up the many ideas raised by the lectures and posters. (Indeed, even on a walk over three of the 3,000+ ft peaks in the Monadh Liath mountains, there was considerable cross-disciplinary discussion). The Study Centre was blessed with predominantly warm and clement weather, but despite this and the attractions of the Edinburgh Festival during the third week, attendance at the working sessions was gratifyingly large and constant. The Study Centre had its problems but readily adapted to circumstances one principal speaker was on jury service and was allowed just two days in Edinburgh while delivering his three lectures, one Russian participant (mistakenly) feared his bag and passport has been stolen - so causing police to be called to the University reception, another Russian for

whom Royal Society support had been granted could not obtain a passport). The local organisers (Prof. D.F. Parker, Dr. J.G.B. Byatt-Smith and Dr. N.F. Smyth) thank all participants for their enthusiasm. They are particularly indebted to Miss Jennifer Marshall for abundant secretarial support before, during and after the Study Centre. They are also extremely grateful to the other secretaries, to Dr. Jin Liang and to many research students who helped with numerous practical arrangements.

The national and age distribution of participants was as follows:

Country	Res. Student	Young Scientists (⩽35)	36 years or over.	
Australia	–	3	2	
Bangladesh	–	–	1	
Belarus	–	1	–	
Canada	–	1	–	
Denmark	1	–	–	
France	4	1	1	
Germany	3	1	4	
India	–	–	1	
Ireland	–	1	–	
Israel	–	1	2	
Italy	3	4	–	
Netherlands	–	–	1	
Poland	–	1	–	
Russia	–	–	4	
Spain	6	–	–	
Sweden	1	–	2	
Switzerland	–	–	1	
U.K.	11	11	11	
U.S.A.	2	4	10	
Uzbekistan	–	–	1	
Ghana/U.K.	1	–	–	
Greece/U.K.	1	–	–	
Mexico/U.K.	1	–	–	
Morroco/France	1	–	–	
	35	29	41	= 105

ESF Study Centre Nonlinear Optics and Guided Waves

Names and Addresses of Participants

Prof. Fatkhulla Kh. Abdullaev, Theoretical Division, Physical-Technical Institute, Uzbek Academy of Sciences, 700084, Tashkent-84, G. Mavlyanova str. 2-b, Uzbekistan.
Tel: +7 3712 444769; *Fax:* +7 3712 35 43 11; *email:* fatkh@pti.silk.glas.apc.org

Prof. Alejandro B. Aceves, Dept. of Mathematics and Statistics, University of New Mexico, Albuquerque, New Mexico 87131, USA.
Tel: +1 501 277 3332; *Fax:* +1 505 277 5505; *email:* aceves@snell.unm.edu

Dr. J. Stewart Aitchison, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 339 8855; *Fax:* +44 (0)41 330 4709; *email:* s.aitchison@elec.gla.ac.uk

Dr. Nail Akhmediev, Optical Sciences Centre, Australian National University, Canberra, ACT 0200, Australia.
Tel: +61 (0)6 249 0191; *Fax:* +61 (0)6 249 5184; *email:* NNA124@RSPHY1.ANU.EDU.AU

Dr. Mark S. Alber, Department of Mathematics, University of Notre Dame, Mail Distribution Centre, Notre Dame, I.N. 46556, USA.
Tel: +1 219 239 8371; *email:* alber@cartan.math.nd.edu

Katie M. Allen, Photonics Research Group, EE & AP, Aston University, Aston Triangle, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4972; *Fax:* +44 (0)21 359 0156; *email:* allenkm@sun.aston.ac.uk

Dr. Dan Anderson, Institute for Electromagnetic Field Theory and Plasma Physics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.
Tel: +46 3172 1000; *Fax:* +46 317721573

Prof. John M. Arnold, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 330 4901; *Fax:* +44 (0)41 330 4907; *email:* jma@elec.gla.ac.uk

David Artigas, Department of Signal Theory and Communications, Universitat Politècnica de Catalunya, PO Box 30 002, 08080 Barcelona, Spain.
Tel: +34 9 3 4017361; *Fax:* +34 9 3 4017232; *email:* david@gaig.upc.es

Prof. Jagadish C. Bhakta, Department of Mathematics, University of Chittagong, Chittagong, Bangladesh.

Dr. Biswanath Bhattacharyya, Mathematics Department, University of North Bengal, Darjeeling 734 430, India.
Tel: +91 (0) 3556 434; *Fax:* +91 (0) 353 30812

Dr. Brigitte Bidégaray, Centre de Mathématiques et Leurs Applications, E.N.S. de Cachan, 61, avenue du Président Wilson, 94235 Cachan CEDEX, France.
Tel: +33 1 47402409; *Fax:* +33 1 47402169; *email:* brigitte@cmla.ens-cachan.fr

Svend Bischoff, Institute of Mathematical Modelling/AMF, The Technical University of Denmark, Bld. 306, Dk-2800, Lyngby, Copenhagen, Denmark.
Tel: +45 4288 2222; *Fax:* +45 45 93 7235; *email:* sb@lamf.dth.dk

Prof. Allan D. Boardman, Joule Laboratory, Department of Physics, University of Salford, Salford, M5 4WT, England.
Tel: +44 (0)61 745 5253; *Fax:* +44 (0)61 745 5903

Arnaud Boulnois, LSH, Bât P5, UST Lille, 59650 Villeneuve d'Ascq, France.
Tel: +33 20 43 68 27; *email:* arnaud@lsh.univ-lille1.fr

Massimo Brambilla, Sezione di Ottica, Dip. di Fisica, Università of Milano, Via Celoria 20, 20133 Milano, Italy.
Tel: +39 2 2392334; *Fax:* +39 2 2392712; *email:* mbrambilla@milano.infn.it

Dr. Harry Braden, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5072; *Fax:* +44 (0)31 650 6553; *email:* hwb@maths.ed.ac.uk

Patrick A. Buah, Department of EEIE, City University, Northampton Square, London, EC1V 0HB, England.
Tel: +44 (0)71 477 8000/3892; *Fax:* +44 (0)71 477 8568; *email:* af513@City.ac.uk

Ralph Burton, Applied Mathematics Section, Department of Mathematics & Statistics, University of Sheffield, Sheffield S10 2UN, England.
Tel: +44 (0)742 768555

Dr. John Byatt-Smith, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5036; *Fax:* +44 (0)31 650 6553; *email:* byatt@maths.ed.ac.uk

Jean-Christophe Celet, Laboratoire de Spectroscopie Hertzienne, Bâtiment P5, Université des Sciences et Technologies de Lille, 59650 Villeneuve d'Ascq, France.
Tel: +33 2043 6809; *Fax:* +33 2033 7020; *email:* celet@lsh.univ-lille1.fr

Sabino Chavez[†], Laser Optics Group, Blackett Laboratory - Optics Section, Imperial College, London SW7 2BZ, U.K.
Tel: +44 (0)71 594 7642; *Fax:* +44 (0)71 594 7777; *email:* sabino.chavez@ic.ac.uk
([†]Permanent address: I.N.A.O.E., Grupo de Fotonica, Apdo. Postal 51/216, Puebla, Pue., Mexico.) *Tel:* +52 22 472281 ; *Fax:* +52 22 472940; *email:* hmmc@tonali.inaoep.mx

Prof. Sergei A. Darmanyan, Institute of Spectroscopy RAS, 142092 Troitsk, Moscow reg. Russia.
Tel: +7 095 334 02 24; *Fax:* +7 095 334 02 24; *email:* darman@theor.isan.msk.su

Richard G. Docksey, Department of Mathematics, Imperial College, London, SW7 2BZ, England.
email: rgd@ic.ac.uk

Prof. Nick J. Doran, Dept. Electronic Engineering & Applied Physics, Aston University, Aston Triangle, Birmingham, B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4973; *Fax:* +44 (0)21 359 0156

Prof. Chris Eilbeck, Heriot Watt University, Department of Mathematics, Riccarton, Edinburgh EH14 4AS, Scotland.
Tel: +44 (0)31 451 3220; *Fax:* +44 (0)31 451 3249; *email:* chris@cara.ma.hw.ac.uk

Dr. John N. Elgin, Department of Mathematics, Imperial College, London, SW7 2BZ, England.
Tel: +44 (0)71 589 5111 Ext 5726; *Fax:* +44 (0)71 225 8361; *email:* j.elgin@ic.ac.uk

Prof. William J. Firth, Department of Physics and Applied Physics, University of Strathclyde, John Anderson Building, 107 Rotten Row, Glasgow G4 0NG, Scotland.
Tel: +44 (0)41 552 5018; *Fax:* +44 (0)41 552 2891; *email:* willie@phys.strath.ac.uk

Dr. Miroslaw Florjańczyk, Département de Physique, Centre d'Optique Photonique et Laser, Université Laval, Cité Universitaire, Québec, G1K 7P4, Canada.
Tel: +1 418 656 2454; *Fax:* +1 418 656 2623; *email:* 1150124@saphir.ulaval.ca

Wladek Forysiak, Photonics Research Group, EEAP, Aston University, Aston Street, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 5280; *Fax:* +44 (0)21 359 0156; *email:* forysiaw@aston.ac.uk

Anastasios Fragos, Department of Electronics and Electrical Engineering, University of Glasgow. Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 337 2100

Dr. Ildar Gabitov, Until June 1995; FTZ Telekom, FZ241l Am Kavalleriesand 3, D-64295 Darmstadt, Germany. *Tel:* +49 6151 833583; *email:* gabitov@sun.rhrk.uni-kl.de
Permanent; Landau Institute for Theoretical Physics, Kosygin Street 2, V-334 Moscow, Russia. *Tel:* +7 095 137 3244; *Fax:* +7 095 9382 270; *email:* ildar@cpd.landau.free.net

Thomas Gabler, Institute of Applied Physics, Friedrich-Schiller-Universität, 07745 Jena, Germany.
Tel: +49 03641 657 657; *Fax:* +49 03641 657 80

Stuart Galloway, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5047; *Fax:* +44 (0)31 650 6553; *email:* stuart@maths.ed.ac.uk

Jorge Garcia-Mateos, Departamento de Teoria de la Senyal y Comunicaciones, Universitat Politècnica de Catalunya, P.O. BOX 30002, 08080 Barcelona, Spain.
Tel: +34 34017361; *Fax:* +34 3401 7232; *email:* mateos@gaig.upc.es

Dr. James P. Gordon, Rm 4E-410, A.T.&T. Bell Laboratories, Holmdel, New Jersey 07733-3030, USA.
Tel: +1 908 949 2227; *Fax:* +1 908 949 8988; *email:* jim@spin.att.com

John Gray, Photonics Research Group, EE & AP, Aston University, Aston Triangle, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4972; *Fax:* +44 (0)21 359 0156; *email:* grayjw@cs.aston.ac.uk

Craig Hamilton, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 339 8855 Ext 6666; *Fax:* +44 (0)41 330 4907; *email:* ham@elec.gla.ac.uk

Prof. Robert G. Harrison, Heriot Watt University, Department of Mathematics, Riccarton, Edinburgh, Scotland.
Tel: +44 (0)31 451 3003; *Fax:* +44 (0)31 451 3249

Prof. Hermann A. Haus, Department of Electrical Engineering and Computer Science, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, MA 02139, USA.
Tel: +1 617 253 2585; *Fax:* +1 617 253 9611; *email:* haus@athena.mit.edu

Margarita Homar, Dpt. de Fisica, Universitat de les Illes Balears, E-07071 Palma de Mallorca, Spain.
Tel: +34 71 172537; *Fax:* +34 71 173224; *email:* dfsmhp4@ps.uib.es

Dr. David C. Hutchings, Department of Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland.
Tel: +44 (0)41 339 8855; *Fax:* +44 (0)41 330 4907; *email:* D.Hutchings@elec.gla.ac.uk

Prof. Robert Indik, Department of Mathematics, University of Arizona, Tucson, Arizona 85721, USA.
Tel: +1 602 621 1510; *Fax:* +1 602 621 1510; *email:* indik@math.arizona.edu

Christopher Jones, Division of Applied Mathematics, Brown University, Providence, R.I. 02912, U.S.A.
Tel: +1 401 863 3696; *Fax:* +1 401 863 1355; *email:* ckrtj@cfm.brown.edu

Magnus Karlsson, Institute for Electromagnetic Field Theory and Plasma Physics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.
Fax: +46 317721573
email: elfmk@elf.chalmers.se

Prof. William L. Kath, Engineering Sciences and Applied Mathematics, McCormick School of Engineering, Northwestern University, 2145 Sheridan Road, Evanston, Illinois, USA 60208
Tel: +1 708 491 5585; *Fax:* +1 708 491 2178; *email:* kath@nwu.edu

Prof. David J. Kaup, Clarkson University, Potsdam, New York 13699-5815, USA.
Tel: +1 315 268 2360; *Fax:* +1 315 268 2360; *email:* kaup@sun.mcs,clarkson.edu

Dr. Yuri S. Kivshar, Optical Science Centre, Australian National University, Canberra, ACT 0200, Australia.
Tel: +61 (0)6 249 3081 (office); *Fax:* +61 (0)6 249 5184; *email:* ysk124@rsphysse.anu.edu.au

Finlay M. Knox, Photonics Research Group, Dept. EE & AP, Aston University, Aston Street, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 4972; *Fax:* +44 (0)21 359 0156; *email:* knoxfm@sun.aston.ac.uk

Prof. Stephan Koch, Fackbereich Physik, Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany.
Tel: +49 (0) 6421 284209; *Fax:* +49 (0) 6421 287076;
email: kochsw@mv13a.physik.uni-marburg.de

Dr. Wieslaw Krolikowski, Laser Physics Centre, Australian National University, Canberra ACT 0200, Australia.
Tel: +61 (0)6 2493752; *Fax:* +61 (0)6 249 0029; *email:* WZK11@RSPHY1.ANU.EDU.AU

Prof. Tassilo Küpper, Universität Köln, Mathematisches Institut, Weyertal 88, D50931 Köln, Germany.
Tel: +49 221 4702697; *Fax:* +49 470 5114; *email:* kuepper@mi.uni-koeln.de

Vincent Lecoeuche, UFR de Physique, Bâtinent P5, Laboratoire de Spectroscopie Hertzienne, 59650 Villeneuve d'Ascq, France.
Tel: +33 2043 4763; *Fax:* +33 2043 4084; *email:* LECOEUCH@LSH.UNIV-LILLE1.FR

Prof. Falk Lederer, University of Jena, Faculty of Physics, Max-Wien-Platz 1, Jena, D-07743, Germány.
Tel: +49 3641635938; *Fax:* +49 3641635182; *email:* pfl@physik.uni-jena.de

Dr. Joceline Lega, Institut Non Linéaire de Nice, UMR CNRS 129, 1361 Route des Lucioles, 06560 Valbonne, France.
Tel: +33 92 96 73 16; *Fax:* +33 93 65 2517; *email:* lega@ecu.unice.fr

Dr. Jin Liang, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 6483; *Fax:* +44 (0)31 650 6553; *email:* liang@maths.ed.ac.uk

Dr. Mietek Lisak, Institute for Electromagnetic Field Theory and Plasma Physics, Chalmers University of Technology, S-412 96 Göteborg, Sweden.
Tel: +46 31 7721565; *Fax:* +46 31 7721573

Dr. Gregory G. Luther, Department of Mathematics and Statistics, University of New Mexico, Albuquerque, New Mexico 87131, USA.
Tel: +1 505 277 2114; *Fax:* +1 505 277 5505; *email:* luther@math.unm.edu

Prof. Barry Luther-Davies, Laser Physics Centre, Research School of Physical Sciences and Engineering, Australian National University, Canberra, ACT 0200, Australia.
Tel: +61 (0)6 249 4244; *Fax:* +61 (0)6 249 0029; *email:* BLD111@rsphy1.anu.edu.au

Stephen Lynch, Manchester Metropolitan University, Department of Mathematics and Physics, John Dalton Building, Manchester M1 SGD, England.
Tel: +44 (0)61 247 3587

Boris A. Malomed, Department of Applied Mathematics, Tel Aviv University, Ramat Aviv 69978, Israel.
Tel: +972 3 640 9623; *Fax:* +972 3 640 9357; *email:* malomed@leo.math.tau.ac.il

Abdellatif Mamhoud, Laboratoire de Physique de la Matière Condensée, Université de Nice Sophia - Antipolis, Parc Valrose, F-06108 Nice Cedex 02, France.
Tel: +33 9352 9892; *Fax:* +33 9352 9808; *email:* Mamhoud@naxos.unice.fr

Dr. Natale Manganaro, Department of Mathematics, University of Messina, Contrada Papardo, Salita Serpone 31, 98166 Messina, Italy.
Tel: +39 90 6763064; *Fax:* +39 90 393502; *email:* edu@imeuniv.bitnet

Dr. Ian Marshall, Department of Mathematics, Leeds University, Leeds LS7 9JT, England.
Tel: +44 (0) 532 335 130; *email:* amt6im@amsta.leeds.ac.uk

Jennifer Marshall, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5048; *Fax:* +44 (0)31 650 6553; *email:* jennifer@maths.ed.ac.uk

Dr. Paolo Masciulli, Department of Energetics, University "La Sapienza", Via Scarpa 14-16, 00161 Roma, Italy.
Tel: +39 (0)6 49916541; *Fax:* +39 (0)6 44240183; *email:* BERTOL88@itcaspur.caspur.it

Dr. Graham S. McDonald, Blackett Lab. - Optics, Imperial College, London SW7 2BZ, England.
Tel: +44 (0)71 594 7728; *Fax:* +44 (0)71 589 9463; *email:* g.mcdonald@ic.ac.uk

Prof. John G. McInerney, Department of Physics, National University of Ireland, University College Cork, Cork, Ireland.
Tel: (+353 21) 276 871; *Fax:* (+353 21) 276 949; *email:* step8036@vax1.ucc.ie

Ross McIntyre, Heriot Watt University, Department of Physics, Riccarton, Edinburgh, Scotland.
Fax: +44 (0)31 451 3249; *email:* e-phyrm@uk.ac.hw.phy

Stuart MacIntosh, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5047; *Fax:* +44 (0)31 650 6553; *email:* jsm@maths.ed.ac.uk

Dr. Linn F. Mollenauer, Rm 4C-306, AT&T Bell Laboratories, Crawfords Corner Road, Holmdel, NJ 07733, USA.
Tel: +1 908 949 5766; *Fax:* +1 908 949 5784; *email:* linn@spin.att.com

Dr. Jerry V. Moloney, Department of Mathematics, University of Arizona, Tucson, Arizona 85721, USA.
Tel: +1 602 621 6755; *Fax:* +1 602 621 1510; *email:* jml@math.arizona.edu

Dr. Carlos Montes, Laboratoire de Physique de la Matière Condensée, C.N.R.S., Université de Nice - Sophia Antipolis, Parc Valrose, F-06108 Nice Cedex 2, France.
Tel: +33 9352 9978; *Fax:* +33 9352 9808; *email:* montes@naxos.unice.fr

Prof. Alexander A. Nepomnyashchy, Department of Mathematics, Technion-Israel Institute of Technology, Haifa 32000, Israel.
Tel: +972 4 294170; *Fax:* +972 4 324654; *email:* nepom@leeor.technion.ac.il

Prof. Alan C. Newell, Department of Mathematics, University of Arizona, Tucson, Arizona 85721, USA.
Tel: +1 602 621 6893; *Fax:* +1 602 621 83122; *email:* anewell@math.arizona.edu

Dr. Gian-Luca Oppo, Department of Physics and Applied Physics, University of Strathclyde, 107 Rottenrow, Glasgow, G4 0NG, Scotland.
Tel: +44 (0)41 552 4400 Ext 3761; *Fax:* +44 (0)41 552 2891; *email:* gianluca@phys.strath.ac.uk

Prof. Lev A. Ostrovsky, Institute of Applied Physics, Russian Academy of Sciences, 46 Uljanov Street, 603600 Nizhny Novgorod, Russia.
Fax: +7 8312 367291; *email:* ostrov@appl.nnov.su

Prof. David Parker, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5049; *Fax:* +44 (0)31 650 6553; *email:* david@maths.ed.ac.uk

Dr. John Parkes, University of Strathclyde, Department of Mathematics, Livingstone Tower, Glasgow G1 1XH, Scotland.
Tel: +44 (0)41 552 4400 Ext 3720; *Fax:* +44 (0)41 552 8657; *email:* E.J.PARKES@strath.ac.uk

Rafat Pawlikowski, Institute of Physics, Polish Academy of Sciences, 02-668 Warsaw, Poland.
email: pawli@ifpan.edu.pl

Víctor M. Pérez-García, Departamento de Física Teórica I, Universidad Complutense, Madrid 28040, Spain.
Tel: +37 1 3944508; *Fax:* +34 1 3944683; *email:* PEREZ-GARCIA@SIM.UCM.ES

Dr. Andrew Pickering, Heriot Watt University, Department of Physics, Riccarton, Edinburgh, Scotland.
Tel: +44 (0)31 451 3203; *Fax:* +44 (0)31 451 3249; *email:* andrewp@cara.ma.hw.ac.uk

Prof. Len M. Pismen, Department of Chemical Engineering and Center for Research in Nonlinear Phenomena, Technion – Israel Institute of Technology, 32000 Haifa, Israel.
Fax: +972 4 293 086; *email:* cerlplp@techunix.technion.ac.il

Richard Putman, Joule Laboratory, Department of Physics, University of Salford, Salford M5 4WT, England.
Tel: +44 (0)61 745 5000 Ext 4805; *Fax:* +44 (0)61 745 5903;
email r.c.j.putman@physics.salford.ac.uk

Dr. Andrea Re, Department of Energetics, Università "La Sapienza", Via Scarpa 14-16, 00161 Roma, Italy.
Tel: +39 (0)6 49916541; *Fax:* +39 (0)6 44240183; *email:* BERTOL88@itcaspur.caspur.it

Prof. Nikolay N. Rosanov, Research Institute of Laser Physics, Scientific Center "S.I.Vavilov State Optical Institute", St.Petersburg, 199 034, 12 Birzhevaya line, Russia.
Tel: +7 812 5601834; *Fax:* +7 812 2181093; *email:* rosanov@ilph.spb.su

Jonathan Rubin, Division of Applied Mathematics, Brown University, Box F, Providence, R.I. 02912, USA.
Tel: +1 401 861 4019; *email:* jer@cfm.brown.edu

Dr. Boris A. Samson, Institute of Physics, Belarus Academy of Sciences, 70, F. Skaryna Ave., Minsk, 220072, Belarus.
Tel: +7 0172 395958; *Fax:* +7 0172 393131; *email:* ifanbel@bas03.basnet.minsk.by

Dr. Marco Santagiustina, Dipartimento di Elettronica ed Informatica, Università di Padova, Padova 35131, Italy.
Tel: +39 49 8287760; *Fax:* +39 49 8287699; *email:* ElETT19@IPDUNIVX.UNIPD.IT

Concepcion Santos, Department of Signal Theory and Communications, Universitat Politècnica de Catalunya, P.O. Box 30002, 08080 Barcelona, Spain.
Tel: +34 9 3 4016527; *Fax:* +34 9 3 4017232; *email:* santos@gaig.upc.es

Christoph Schulte, Arnold Sommerfeld Institut, TU Clausthal, Leibnizstr. 10, 38678 Clausthal, Germany.

Dr. Alexander Sergeev, Institute of Applied Physics, 46 Uljanov Street, 603600 Nizhny Novgorod, Russia.
Tel: +7 8312 363773; *Fax:* +7 8312 369717; *email:* FLX@APPL.NNOV.SU

Dr. Nicholas J Smith, Dept. Electronic Engineering & Applied Physics, Aston University, Aston Triangle, Birmingham B4 7ET, England.
Tel: +44 (0)21 359 3611 Ext 5280; *Fax:* +44 (0)21 359 0516; *email:* smithnj@sun.aston.ac.uk

Dr. Noel Smyth, Department of Mathematics and Statistics, University of Edinburgh, Kings Buildings, Edinburgh, Scotland.
Tel: +44 (0)31 650 5080; *Fax:* +44 (0)31 650 6553; *email:* noel@maths.ed.ac.uk

Prof. Yuri A. Stepanyants, Institute of Applied Physics, Russian Academy of Science, 46 Uljanov St., 603600 Nizhny Novgorod, Russia.
Tel: +7 8312 384505; *Fax:* +7 8312 367291; *email:* yuas@appl.nnov.su

Prof. Charles A. Stuart, Département de Mathématiques, Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne, Switzerland.
Tel: +41 (0)21 693 2591; *Fax:* +41 (0)21 693 4303; *email:* stuart@masg3.epfl.ch

Juan P. Torres, Department of Signal Theory and Communications, Universitat Politècnica de Catalunya, P.O. Box 30002, 08080 Barcelona, Spain.
Tel: +34 3 401 7216; *Fax:* +34 3 401 7232; *email:* JPEREZ@VOLTOR.UPC.ES

Dr. Hai-Tan Tran, Department of Mathematics, University College, Australian Defence Force Academy, Canberra, ACT, Australia 2601.
Tel: +61 (0)6 2688485; *Fax:* +61 (0)6 2688886; *email:* htt@groucho.ma.adfa.oz.au

Dr. Stefano Trillo, Fondazione Ugo Bordoni, Via Baldassarre Castiglione 59, 00142 Rome, Italy.
Tel: +39 6 5480 3204; *Fax:* +39 6 5480 4402; *email:* truglo@fub.it; strillo@fub.it

Reidun Twarock, Arnold Sommerfeld Institut, TU Clausthal, Leibnizstr. 10, 38678 Clausthal, Germany.

Dr. Ivan M. Uzunov, Faculty of Physics and Astronomy, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany.
Tel: +49 3641 633955; *Fax:* +49 3641 63 5182

Dr. Theo P. Valkering, Center for Theoretical Physics, Department of Applied Physics, PO Box 217, University of Twente, 7500 AE Enschede, The Netherlands.
Tel: +31 53 893168; *Fax:* +31 53 332371; *email:* T.P.Valkering@TN.UTWENTE.NL

Dr. Stefan Wabnitz, Fondazione Ugo Bordoni, Via Baldassarre Castiglione 59, 00142 Roma, Italy.
Tel: +39 6 5480 3206; *Fax:* +39 6 5480 4405; *email:* SWAB@FUB.IT

Dr. Jonathan Wattis, Heriot Watt University, Department of Mathematics, Riccarton, Edinburgh, Scotland.
Tel: +44 (0)31 451 3252; *Fax:* +44 (0)31 451 3249; *email:* jonathan@cara.ma.hw.ac.uk

Kenton White, University of Arizona, Arizona Centre for Mathematical Sciences, Department of Mathematics , Tucson, Arizona 85721, USA.
Tel: +1 602 621 8129; *email:* jwhite@math.arizona.edu

William S. Wong, Rm 36-315, Department of Electrical Engineering and Computer Science, MIT, Cambridge, MA 02139 USA.
Tel: +1 617 253 8524; *Fax:* +1 617 253 9611; *email:* williamw@mit.edu

Richard W. Ziolkowski, Electromagnetics Laboratory, Department of Electrical and Computer Engineering, The University of Arizona, Tucson, AZ 85721, USA.
Tel: +1 602 621 6173; *Fax:* +1 602 621 8076; *email:* ziolkowski@ece.arizona.edu

EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

Reports from Investigation Groups

The topics on which investigation groups met during the Study Centre were:

Aug. 10
- Fibre laser issues.
- Transverse patterns and waveguiding in nonlinear optics.

Aug. 11
- 4-dimensional (space-time) structures - paraxial and non-paraxial optics.
- Characterisation of chaos in an N-dimensional N-DST equation.
- Dark solitons - are they any use?

Aug. 15
- Dynamics of coupled NLS equations.
- Future problems in optical communications.

Aug. 16
- Exact solutions for coupled NLS equations.
- All-optical switching - progress and possibilities.

Aug. 18
- Planar waveguides and spatial solitons.
- Spatial structures.

Oral Reports delivered were:

Aug. 18
- Optical Communications (Mollenauer, Kath, Smith, Gabitov).
- All-optical switching (Arnold, Hutchings, Aitchison, Tran).
- Dynamics and chaos in NLS and N-DST (Wabnitz, Akhmediev, Jones).
- Coupled NLS (Akhmediev, Aceves).
- Exact solutions for coupled NLS (Florjanczyk, Arnold, Boardman, Jones).

Aug. 19
- Dark solitons - theory and use (Kivshar, Allen).
- Spatial solitons, planar waveguides and stability (Jones, Chavez, Tran).
- Numerical issues in nonlinear optics (Perez-Garcia).
- Optical collapse in cavities (McDonald).
- Suppression of Gordon-Haus jitter without filters (McDonald, Wabnitz).
- 4-D space-time structures (McDonald, Chavez, Samson).

Written reports for distribution to all participants and sponsors (available upon request from I.C.M.S., 14 India Street, Edinburgh, EH3-6EZ, Tel: +44 131 220-1777, FAX: +44 131 220-2053, e-mail: icms@maths.ed.ac.uk) are:

Dark solitons - Various Aspects of Practical Applications	6pp
Future Problems in Optical Communications	8pp
An Alternative Scheme for a Soliton Transmission System	5pp
Exact Solutions of Coupled Nonlinear Schrödinger Equations	4pp
Ultra-Fast Switching in Semiconductor Waveguides	28pp
3-D and 4-D Structures in Paraxial and Nonparaxial Nonlinear Optics	12pp
Numerical Schemes in Nonlinear Optics	6p

Any further reports which come to hand will be notified and distributed to participants by electronic mail. Those requiring hard copy should notify I.C.M.S. at the address above.

EUROPEAN SCIENCE FOUNDATION STUDY CENTRE

Nonlinear Optics and Guided Waves, 1-20 August 1994

This Study Centre was held as a three-week workshop, with lectures, investigation sessions, library, computing facilties, lunch and refreshment facilities in the James Clerk Maxwell Building, University of Edinburgh. The majority of participants were accommodated in the nearby Suffolk Halls (Heriot Watt University) and adjacent hotels and guest houses. The Study Centre was adopted as an HCM Euroconference, so significantly helping many research students to participate throughout. The meeting formed part of the 1993-94 programme of the International Centre for Mathematical Sciences, whose premises (the birthplace of James Clerk Maxwell) were used in the final week for a reception hosted by the Edinburgh Mathematical Society. Other receptions were hosted by the Faculty of Science and Engineering, The University of Edinburgh and The City of Edinburgh District Council. Grants towards travel and subsistence costs were obtained from the International Centre for Mathematical Sciences (London Mathematical Society grant), The Royal Society, London, the International Science Foundation, the Office of Naval Research (London), the European Office of Aerospace Research and Development (U.S.A.F.), the European Research Office (U.S. Army) and from BNR (Europe) Ltd. Among the 105 participants from 20 countries, the majority of whom gave lectures or presented posters, were 32 research students and 14 post-doctoral workers.

The main aims of the Study Centre were: to advance the theory, computation and exploitation of nonlinearity in optical waveguides; to further the modelling of physical processes such as laser dynamics and active materials and to analyse the related evolution equations; to further develop techniques for large-scale computation of optical phenomena. Surveys of the various fields, providing a basis for investiation topics, were given by:

- Professor W.L. Kath (3 lectures on soliton dynamics in birefringent fibres and on long-distance propagation with phase-sensitive amplifiers).
- Dr. J.N. Elgin (3 lectures on 'The nonlinear optics of erbium-doped fibre amplifier systems').
- Dr. J. Lega (3 lectures on 'Phase and amplitude equations for lasers').
- Professor R. Indik (3 lectures on 'Numerical methods for nonlinear optics').
- Professor A.B. Aceves (3 lectures on 'Modulational instabilities in optical systems').
- Professor J.V. Moloney (2 lectures on 'Nonlinear optical interactions in large aspect ratio systems and on femtosecond timescales').
- Professor A.C. Newell (3 lectures on Maxwell-Bloch equations, pattern formation and on the inverse-scattering transform in nonlinear optics).
- Dr. L.F. Mollenauer (2 lectures on 'Ultra long distance transmission using solitons in optical fibres').

Additionally, single one-hour invited lectures were delivered by:

- Professor N.J. Doran, Solitons in optical communications.
- Dr. G.-L. Oppo, Controlling spatio-temporal chaos in nonlinear optics.
- Professor R.G. Harrison, Dynamics and chaos in nonlinear optical fibre: Theory and experiment.
- Dr. J.S. Aitchison, Spatial solitons in planar waveguides.
- Professor D.J. Kaup, Effects of inhomogeneities on the propagation of optical solitons.
- Dr. Yu.S. Kivshar, Dark solitons in nonlinear optics.

Dr. M. Brambilla, The formation and dynamics of spatio-temporal structures in nonlinear optical systems.
Professor W.J. Firth, Spontaneous optical patterns in a nonlinear cavity.
Professor H.A. Haus, Pulse propagation and pulse generation in fibres.
Dr. S. Wabnitz, Soliton interaction and switching in optical fibres.
Dr. B.A. Malomed, Soliton dynamics in nonuniform and birefringent fibres.
Dr. J.P. Gordon, Theoretical aspects of long distance soliton transmission in fibres.
Professor C.K.R.T. Jones, Dynamical systems techniques in optical wave propagation.
Professor S.W. Koch, Microscopic modelling of the nonlinear response of semiconductors.
Dr. D. Anderson, Pulse propagation determined by the NLS equation: A variational approach.
Professor J.M. Arnold, Quasi-particle approximations in the theory of optical fibre solitons.
Professor R.W. Ziolkowski, Finite-difference time-domain modelling of ultrashort optical pulse interactions with linear and nonlinear corrugated waveguides.
Dr. S. Trillo, Homoclinic instabilities in parametric three-wave mixing.
Professor A.D. Boardman, Bright/dark spatial soliton interactions.

There were, also, 21 half-hour lectures and three poster sessions, at which 32 posters were presented. No investigation sessions were timetabled until the second week, but much discussion was initiated during the first week, continuing through coffee breaks, meals, social events and during the Highland Excursion (7-9 August) in which 55 participants took part. The investigation sessions generated sufficient interest that it was rarely practical to schedule more than two simultaneously. It was clear that instigators of the investigation topics invested considerable effort in presenting topics to generate interactions between scientists from different disciplines. In some cases, significant computation was undertaken during the Study Centre, using existing code and involving the high-performance computing available in the Edinburgh Parallel Computation Centre.

Topics which generated particularly strong interactions are the subjects of the investigation group reports (see attached list). The presence simultaneously of Drs Mollenauer and Gordon (A.T.&T.) and Professor Haus (M.I.T.) provided great expertise on practical issues of long-distance optical transmission systems and on concepts and theory which might further improve system performance. Many useful ideas were generated from other groups working in the U.K., Germany, Italy, Russia and the U.S.A. (see report 'Future Problems in Optical Communications'). The presumption in favour of using existing (recently) installed fibre shows both the penalty imposed by large financial investment in technology which can rapidly be superseded and the mathematical difficulty of designing repeater systems when the attenuation is comparable with the repeater spacing. Lectures from Dr. Gabitov (Moscow/Darmstadt) and Dr. Sergeev might advance these difficult problems. Another strategy, described in 'An Alternative Scheme for a Soliton Transmission System', uses phase sensitive modulators. Theoretical, numerical and experimental work shows promise of operating long distance transmission systems at the 1.3μm window of existing (low dispersion) fibres, chosen inappropriately for the balance between nonlinearity and dispersion essential to soliton operation.

Dark solitons (i.e. localized gaps in continuous wavetrains) are a subject of much active research. Dr. Kivshar and colleagues at A.N.U., Canberra, reported many theoretical advances, while Professor Doran's group at Aston University are seeking ways of overcoming the major difficulty in generating dark solitons - the need for a πphase shift across the soliton. It seems that spatial dark solitons (self-guiding planar beams) have potential in planar switching and logic devices. There was much discussion about planar waveguides. Fabrication technology is now well advanced while, mathematically, many of the problems are closely analogous to those of fibre optics. The planar geometry generates nonlinear eigenvalue problems of significant interest to mathematical analysts (Jones, Stuart, Küpper), while the modulation theory for spatial beams generates coupled nonlinear Schrödinger (CNLS) equations. Discussion built upon the interesting amplitude-dependent switching effects described by Dr. Tran (Canberra), practical Lagrangian-variational methods outlined by Professor Boardman (Salford), and the interaction of a planar beam with a corrugated interface currently being investigated by Professor Abdullaev (Tashkent) (report to follow). Discussions on 'Exact Solutions for CNLS Equations', showed that semi-inverse, similarity and Lie-group methods are still capable of revealing new explicit solutions. While it is recognized that 'exact' solutions are extremely special, their importance in suggesting structures of lasting duration is important. A leading open question concerns the 'dissipative solitons' of Anderson, Lisak and Sergeev. Ultra-fast Switching is a major interest in Glasgow, which generated considerable interest as a complement to strictly optical topics in the Study Centre. It offers ready integration into optical networks, with topic of 3-D and 4-D Optical Structures presents profound theoretical difficulties. Current approaches are necessarily largely numerical, although justification (asymptotic) for the paraxial approximation is a significant issue. Stability of the resulting entities (light bullets, etc.) is a major concern, currently being addressed largely through numerical computation. 'Numerical Schemes in Nonlinear Optics' were largely discussed in informal sessions, following Professor Indik's three survey lectures. Some participants discussed extensively with members of the Edinburgh Parallel Computation Centre, whose director Professor Kenway was present to discuss future use of the facilities (Cray T3D), for which there is considerable scope.

Copies of notes for most of the invited speakers were freely available before the lectures, while a photocopying service was available for other notes and offprints. Visits to Professor Harrison's laboratory at Heriot-Watt University and to the optics laboratories at Edinburgh University's Physics Department were arranged. It was the general consensus that a good community spirit was fostered early, both by accommodating the majority of participants in Suffolk Halls and adjacent hotels and guest houses and through the social events. These provided excellent opportunities for the mathematicians, physicists, telecommunications and electronics engineers to exchange ideas and learn of novel viewpoints. Participants were very appreciative of the substantial scope provided for following up the many ideas raised by the lectures and posters. (Indeed, even on a walk over three of the 3,000+ ft peaks in the Monadh Liath mountains, there was considerable cross-disciplinary discussion). The Study Centre was blessed with predominantly warm and clement weather, but despite this and the attractions of the Edinburgh Festival during the third week, attendance at the working sessions was gratifyingly large and constant. The Study Centre had its problems but readily adapted to circumstances one principal speaker was on jury service and was allowed just two days in Edinburgh while delivering his three lectures, one Russian participant (mistakenly) feared his bag and passport has been stolen - so causing police to be called to the University reception, another Russian for

whom Royal Society support had been granted could not obtain a passport). The local organisers (Prof. D.F. Parker, Dr. J.G.B. Byatt-Smith and Dr. N.F. Smyth) thank all participants for their enthusiasm. They are particularly indebted to Miss Jennifer Marshall for abundant secretarial support before, during and after the Study Centre. They are also extremely grateful to the other secretaries, to Dr. Jin Liang and to many research students who helped with numerous practical arrangements.

The national and age distribution of participants was as follows:

Country	Res. Student	Young Scientists (≤35)	36 years or over.	
Australia	–	3	2	
Bangladesh	–	–	1	
Belarus	–	1	–	
Canada	–	1	–	
Denmark	1	–	–	
France	4	1	1	
Germany	3	1	4	
India	–	–	1	
Ireland	–	1	–	
Israel	–	1	2	
Italy	3	4	–	
Netherlands	–	–	1	
Poland	–	1	–	
Russia	–	–	4	
Spain	6	–	–	
Sweden	1	–	2	
Switzerland	–	–	1	
U.K.	11	11	11	
U.S.A.	2	4	10	
Uzbekistan	–	–	1	
Ghana/U.K.	1	–	–	
Greece/U.K.	1	–	–	
Mexico/U.K.	1	–	–	
Morroco/France	1	–	–	
	35	29	41	= 105