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# SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



## COURS D'ETE ET TABLES RONDES DE L'OTAN

ADVANCED STUDY INSTITUTES (ASIs) are tutorial courses of two weeks' duration on new, important topics for up to 100 scientists and research students. They aim at the dissemination of advanced scientific knowledge and promotion of international contacts among scientists. No tuition fees are requested from participants; some may obtain small grants to assist with travel and living expenses.

Each meeting is held under the responsibility of its Director, to whom all requests for attendance or support should be addressed. Attendance at meetings marked ● is, however, by invitation only. A number of the meetings are being held under the sponsorship of the Special Programmes on Air-Sea Interaction (A-S), Eco-Sciences (ES), Human Factors (HF), Marine Sciences (Mar.S), Materials Science (Mat.S) and Systems Science (SS).

Locations and dates may change. Titles and addresses have been abridged. Many meetings are of an interdisciplinary nature : please check all subject areas.

ADVANCED RESEARCH WORKSHOPS (ARWs) are working meetings which enable leading researchers, scientists and engineers to review the state-of-the-art in specific topics in fast moving fields and to formulate recommendations for the future. They are of about five days' duration and attendance is usually by invitation only.

**PUBLICATIONS :** Proceedings of meetings are published in the NATO ASI and Conference Series by : Plenum – Reidel – Nijhoff – Springer Verlag.

## I LIFE SCIENCES

## ASIs

## BIOMASS UTILIZATION

Prof. W. COTÉ, College of Env. Sciences, State Univ. Syracuse, New York 13210, USA  
September 20-30, 1982 : Berkeley Springs, W. Virginia, USA

## STRUCTURE AND FUNCTION OF PLANT GENOME

Prof. O. CIFERRI, Istituto di Microbiologia, via Sant'Epifanio 14, 27100 Pavia, Italy  
September 1-11, 1982 : Erice, Italy

## ORGANIZING PRINCIPLES FOR NEURAL DEVELOPMENT

Prof. S.C. SHARMA, New York Medical College, Dept. of Ophthalmology, Valhalla, N.Y. 10595, USA  
June 1-12, 1982 : Povoá do Varzim, Portugal

## REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES

Prof. M. GRUNBERG-MANAGO, Institut de Biologie, 13, rue P. et M. Curie, 75005 Paris, France  
August 3-September 11, 1982 : Spetsai, Greece

## GENETIC ENGINEERING IN EUKARYOTES

Dr. P.F. LURQUIN, Biology Dept., Washington State Univ., Pullman, Wa. 99164, USA  
July 26-August 6, 1982 : Pullman, USA

## NUMERICAL TAXONOMY

Prof. R.R. SOKAL, Dept. of Ecology, State University of New York, Stony Brook, NY 11794, USA  
July 4-16, 1982 : Bad Windsheim, Germany

## GENE EXPRESSION IN NORMAL AND TRANSFORMED CELLS

Dr. J.E. CEUS, Institute of Chemistry, University of Aarhus, 8000 Aarhus C, Denmark  
May 25-June 4, 1982 : Sintra Estoril, Portugal

## NEW DEVELOP. AND METHODS IN MEMBRANE RESEARCH AND BIOL. ENERGY TRANSDUCTION

Prof. K. WIRTZ, Biochemistry, University, Trans 3, Padualaan 8, 3508 TB Utrecht, The Netherlands  
August 16-29, 1982 : Spetsai, Greece

## THE IMMUNE SYSTEM : GENES, RECEPTORS AND REGULATION

Prof. M. PAPAMICHAIL, Anti-Cancer Institute, 171 Alexandras Ave., Athens 603, Greece  
August 25-September 5, 1982 : Spetsai, Greece

## PINEAL GLAND AND ITS ENDOCRINE ROLE

Prof. F. FRASCHINI, Dept. of Chemotherapy, University, via Vanvitelli 32, 20120 Milan, Italy  
June 21-July 2, 1982 : Erice, Italy

## RELATED SOCIO-TECHNICAL APPROACHES TO THE MANAGEMENT OF UNCERTAINTY

Dr. L. WILKIN, U.L.B., Centre E. Bernheim, 28 av. F.D. Roosevelt, 1050 Brussels, Belgium  
July 4-17, 1982 : Maratea, Italy

## MOLECULAR MODELS OF PHOTORESPONSIVENESS

Prof. G. MONTAGNOLI, CNR, Institute of Biophysics, via S. Lorenzo 26, 56100 Pisa, Italy  
August 29-September 10, 1982 : San Miniato, Italy

## MICROVASC. RHEOLOGICAL, METABOLIC &amp; HEAT TRANSFER ASPECTS OF THE HEART ●

Dr. L. DINTENFASS, Haemurheol. & Bior. Dept., Med. Research Kanematsu Mem. Inst. Hosp., Sydney 2000, Austr.  
July 4-11, 1982 : Bonas, France

## UNDERSTANDING AND AIDING HUMAN DECISION MAKING (HF/SS) ●

Prof. J. MCKENNEY, Harvard Univ., Grad. Sch. Business Admin., Soldiers Field, Boston, MA 02163, USA  
Prof. C. STABELL, Norwegian Sch. Economics & Business Admin., Helleveien 30, 5000 Bergen, Norway  
March 28-April 2, 1982 : Williamsburg, Virginia, USA

## II PHYSICS

## ASIs

## NEW DIRECTIONS IN GUIDED WAVE AND COHERENT OPTICS

Prof. D.B. OSTROWSKY, Lab. d'Electrooptique, Université, Parc Valrose, 06034 Nice, France  
July 5-16, 1982 : Cargèse, France

## TECHNIQUES AND CONCEPTS OF HIGH ENERGY PHYSICS

Prof. T. FERBEL, Dept. of Physics, University, Rochester, N.Y. 14627, USA  
July 1-12, 1982 : Adirondacks, USA

## PROGRESS IN NUCLEAR DYNAMICS

Prof. D. BOAL, Dept. of Physics, Simon Fraser University, Burnaby, BC, Canada V5A 1S6  
August 23-September 3, 1982 : Vancouver, B.C., Canada

## COHESIVE PROPERTIES OF SEMICONDUCTORS UNDER LASER IRRADIATION

Prof. L.D. LAUDE, Université de l'Etat, 23, Av. Maistriau, 7000 Mons, Belgium  
July 19-31, 1982 : Cargèse, France

## METHODS IN COMPUTATIONAL MOLECULAR PHYSICS

Prof. G.H.F. DIERCKSEN, Institut für Astrophysik, Karl Schwarzschild Str. 1, 8046 Garching, FRG  
August 9-22, 1982 : Bad Windsheim, Germany

## FUNDAMENTAL PROCESSES IN ENERGETIC ATOMIC COLLISIONS

Prof. H.O. LUTZ, Physics Dept., University of Bielefeld, 4800 Bielefeld 1, Germany  
September 20-October 1, 1982 : Maratea, Italy

## LASER PHYSICS, SYSTEMS AND TECHNIQUES

Prof. S.D. SMITH, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, Scotland  
August 8-28, 1982 : Edinburgh, Scotland

## GRAVITATIONAL RADIATION

Dr. M.T. BÉAL-MONOD, Physique des Solides, Université de Paris Sud, 91405 Orsay, France  
June 2-21, 1982 : Les Houches, France

## ATOMIC &amp; MOLECULAR PROCESSES IN CONTROLLED THERMONUCLEAR FUSION

Prof. C.J. JOACHAIN, U.L.B., Campus Plaine CP 227, Bd. du Triomphe, 1050 Bruxelles, Belgium  
July 19-30, 1982 : Palermo, Italy

## COMPOSITION AND ORIGIN OF COSMIC RAYS

Prof. M.M. SHAPIRO, Code 4020, Naval Research, 4555 Overlook Ave S.W., Washington DC 20375, USA  
June 20-30, 1982 : Erice, Italy

## III CHEMISTRY, EARTH SC., MATHEMATICS

## ASIs

## POLYMER COLLOIDS III

Dr. G.W. POEHLEIN, School of Chemical Engineering, Inst. of Technology, Atlanta, Ga. 30332, USA  
June 29-July 8, 1982 : Bristol, UK

## AIR-SEA EXCHANGE OF GASES AND PARTICLES

Dr. P.S. USS, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK  
July 19-30, 1982 : Durham, N.H., USA

## THE MULTINUCLEAR APPROACH TO MAGNETIC RESONANCE

Prof. J.B. LAMBERT, Dept. of Chemistry, Northwestern University, Evanston, Illinois 60201, USA  
August 23-September 3, 1982 : Stirling, Scotland

## SYSTEMS OF NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS

Prof. J.M. BALL, Dept. of Mathematics, Heriot-Watt University, Edinburgh EH14 4AS, Scotland  
July 25-August 7, 1982 : Oxford, UK

## NONLINEAR STOCHASTIC PROBLEMS

Prof. J.M.F. MOURA, Caps Complexo, Instituto Superior Tecnico, Av. R. Pais, 1000 Lisbon, Portugal  
May 16-28, 1982 : Algarve Portugal

## COMPUTATIONAL ASPECTS OF COMPLEX ANALYSIS

Prof. H. WERNER, Institut für Angewandte Mathematik, Wegelerstr. 6, 5300 Bonn 1, Germany  
July 26-August 6, 1982 : Braunlage, Germany

## SYSTEMATICS AND THE PROPERTIES OF THE LANTHANIDES

Prof. S.F. SINHA, Hann Meitner Institute, Glienicke Str. 100, 1000 Berlin 39, Germany  
July 11-25, 1982 : Braunlage, Germany

## MESOSCALE METEOROLOGY OBSERVATIONS, THEORIES AND MODELS

Dr. D.K. LILLY, National Center for Atmospheric Research, PO Box 3000, Boulder, Col 80307, USA  
July 13-31, 1982 : Bonas, France

## SURFACE PROPERTIES &amp; CATALYSIS BY NON METALS

Prof. J.P. BONNELLE, Univ. Sciences et Techn., Lab. de Catalyse, Bât. C-3, F-59655 Villeneuve d'Ascq Cedex, France  
June 28-July 9, 1982 : Namur, Belgium

## REMOTE SENSING APPLICATIONS IN MARINE SCIENCE AND TECHNOLOGY

Prof. A.P. CRACKNELL, Carnegie Laboratory of Physics, University, Dundee DD1 4HN, Scotland  
August 1-21, 1982 : Dundee, Scotland

## THERMOCHEMISTRY OF MOLECULES, IONIC SPECIES AND FREE RADICALS

Prof. M. RIBEIRO DA SILVA, Chemistry Department, University of Oporto, 4000 Porto, Portugal  
July 4-17, 1982 : Vimeiro, Portugal

## SIMULATION &amp; MODEL BASED METHODOLOGIES: AN INTEGRATIVE VIEW

Dr. T.I. OREN, Dept. of Computer Science, Ottawa University, 375 Nicholas, Ottawa, Canada K1N 9B4  
July 26-August 6, 1982 : University of Ottawa Campus, Canada

## CHEMISTRY OF IONS IN THE GAS PHASE

Prof. M.A. FERREIRA, Chemistry Dept., Univ. of Lisbon, R. Escola Politécnica, 1294 Lisbon Codex, Portugal  
September 6-17, 1982 : Vimeiro, Portugal

#### PHYSICAL METHODS IN BIOLOGICAL MEMBRANES AND THEIR MODEL SYSTEMS

Prof. F. CONTI, Istituto di Chimica Fisica, Piazzale A. Moro 5, 00185 Rome, Italy  
September 20 - October 2, 1982 : Altavilla Milicia, Italy

#### PHOTORECEPTION & VISION IN INVERTEBRATES

Prof. M.A. ALL, Biology Dept., University of Montreal, C.P. 6128, Succ. A, Montreal, Que H3C 3J7, Canada  
July 11-24, 1982 : Lennoxville, Canada

#### BIOMAGNETISM: AN INTERDISCIPLINARY APPROACH

Prof. S.J. WILLIAMSON, Dept. of Physics, New York University, 4 Washington Pl., New York, NY 10003, USA  
September 1-12, 1982 : Frascati, Italy

#### DYSLEXIA - A GLOBAL ISSUE

Prof. R.N. MALATESHA, School of Education, Oregon State University, Corvallis, Oregon 97331, USA  
August 15-27, 1982 : Algarve, Portugal

#### THE APPLICATION OF LASER LIGHT SCATTERING TO THE STUDY OF BIOLOGICAL MOTION

Prof. J.C. EARNSHAW, Dept. of Pure & Applied Physics, Queen's University, Belfast BT7 1NN, N. Ireland  
June 20 - July 3, 1982 : Maratea, Italy

#### PRINCIPLES AND METHODS IN RECEPTOR BINDING

Prof. F. CATTABENI, Inst. of Pharmacology, University of Urbino, Urbino, Italy  
September 8-18, 1982 : Urbino, Italy

#### IMMUNOTOXICOLOGY

Dr. P.W. MULLEN, Kenic Bioresearch Labs. Ltd., P.O. Box 878, Kentville, NS, Canada B4N 4H8  
July 14-24, 1982 : Wolfville, N.S. Canada

#### CHILD ABUSE AND NEGLECT

Dr. J.E. LEAVITT, School of Education, California State University, Fresno, Calif. 93740, USA  
June 1-12, 1982 : Europe

#### TECHNICAL ADVANCES IN BIOMEDICAL PHYSICS

Dr. P.P. DENDY, Biomedical Physics Dept. Aberdeen University, Foresterhill, Aberdeen AB9 2ZD, Scotland  
September 14-28, 1982 : Istanbul, Turkey

#### BIOLOGICAL BASES OF ANTISOCIAL BEHAVIOUR (HF)

Dr. S.A. MEDNICK, Ctrf. Longitudinal Res., Social Sc. Res. Inst., Univ. of Sthn. Calif., Los Ang., CA 90007, USA  
August 25-30, 1982 : Skiathos, Greece

#### ARWS

##### GENETICAL AND ENVIRONMENTAL FACTORS DURING THE GROWTH PERIOD ●

Prof. Ch. SUSANNE, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium  
August 1982

##### WORLD PRIORITIES FOR SEABIRD CONSERVATION ●

Dr. J. TEMPLE LANG, Av. P. Hymans, 113, Bte 19, 1200 Bruxelles  
August 3-5, 1982 : Cambridge, UK

## IV ENGINEERING AND APPLIED SCIENCES

### ASIS

#### MATHEMATICAL MODELS & DESIGN METHODS IN SOLID-LIQUID SEPARATION

Dr. A. RUSHTON, UMIST, P.O. Box 88, Manchester M60 1QD, UK  
January 4-15, 1982 : Lagos, Portugal

#### ELECTRONIC SYSTEM EFFECTIVENESS AND LIFE CYCLE COSTING

Mr. J.K. SKWIRZYNSKI, Marconi Res. Lab., W. Hanningfield Rd., Gt. Baddow, Chelmsford CM2 8HN, UK  
July 12-24, 1982 : Norwich, UK

#### PROCESS AND DEVICE SIMULATION FOR MOS-VLSI CIRCUITS

Prof. P. ANTognETTI, Istituto di Elettrotecnica, Viale Cause 13, 16145 Genova, Italy  
June 28 - July 9, 1982 : Urbino, Italy

#### MECHANICS OF FLUIDS THROUGH POROUS MEDIA

Prof. M.Y. CORAPCIOGLU, Civil Engineering, University of Delaware, Newark, DE 19711, USA  
July 18-27, 1982 : Newark, USA

#### IMPACT OF CLUSTER PHYSICS IN MATERIAL SCIENCE AND TECHNOLOGY

Dr. J. DAVENAS, Physique des Matériaux, Univ. C. Bernard Lyon 1, 69622 Villeurbanne Cedex, France  
June 13-27, 1982 : France

#### THE SCIENTIFIC BASIS OF FLOTATION

Prof. K.H. IVES, Dept. of Civil Engineering, University College, Gower St., London WC1E 6BT, UK  
July 5-16, 1982 : Cambridge, UK

#### HEAVY CRUDE OIL RECOVERY

Prof. E. OKANDAN, Mining & Petroleum Engineering Dept., METU, Ankara, Turkey  
June 21 - July 4, 1982 : METU, Ankara, Turkey

#### RELIABILITY THEORY AND ITS APPLICATION IN STRUCTURAL AND SOIL MECHANICS

Prof. P. THOFT-CHRISTENSEN, Aalborg University Centre, Danmarksvej 19, 9000 Aalborg, Denmark  
August 29 - September 10, 1982 : Bornholm, Denmark

#### ANALYTICAL LASER SPECTROSCOPY

Prof. S. MARTELLUCCI, Institute of Physics, Piazza V. Tecchio 80, 80125 Naples, Italy  
September 23 - October 3, 1982 : Erice, Italy

#### ATOMIC PHYSICS OF HIGHLY IONIZED ATOMS

Prof. R. MARRUS, Physics Dept., University of California, Berkeley, CA 94720, USA  
June 7-18, 1982 : Cargèse, France

#### NEW TRENDS IN ATOMIC PHYSICS

Prof. R. STORA, Division Théorique, CERN, CH 1211, Genève 23, Suisse  
June 28 - July 29, 1982 : Les Houches, France

#### DIFFUSE MATTER IN GALAXIES

Prof. M. LEVY, Lab. de Physique Théorique, Université P. & M. Curie, 4 Place Jussieu, 75230 Paris, France  
July 19-31, 1982 : Cargèse, France

#### LASER APPLICATIONS TO CHEMISTRY

Prof. F.T. ARECCHI, Istituto Nazionale di Ottica, Largo E. Fermi 6, 50125 Firenze, Italy  
June 27 - July 9, 1982 : San Miniato, Italy

#### NUCLEAR STRUCTURE - SYMMETRIES AND BROKEN SYMMETRIES

Prof. P.J. BRUSSAARD, Physics Dept., Utrecht Univ., P.O. Box 80,000, 3508 TA Utrecht, Netherlands  
August 16-28, 1982 : Dronen, The Netherlands

#### PHOTOCHEMISTRY AND PHOTOPHYSICS IN THE VACUUM ULTRAVIOLET

Prof. S.P. MCGLYNN, Dept. of Chemistry, Louisiana State University, Baton Rouge, LA 70803, USA  
August 15-29, 1982 : Wisconsin, USA

#### ADVANCES IN SUPERCONDUCTIVITY

Prof. J. RUVALDS, Physics Dept., University of Virginia, Charlottesville, VA 22901, USA  
July 3-15, 1982 : Erice, Italy

#### THE ELECTRONIC STRUCTURE OF COMPLEX SYSTEMS

Prof. P. PHARISEAU, Theoretische Vaste Stof en Lage Energie Kernfysica, Krijgslaan 271, S9, 9000 Gent, Belgium  
July 12-23, 1982 : Gent, Belgium

#### NON-LINEAR RAMAN SPECTROSCOPY & ITS CHEMICAL APPLICATION

Prof. W. KIEFER, Physikalisches Inst., Postfach 3008, 8580 Bayreuth, Germany  
August 22 - September 3, 1982 : Bad Windsheim, Germany

#### PHYSICS OF POLARONS: RECENT PROGRESS

Prof. J.T. DEVREESE, Dept. Natuurkunde, Univ. Instelling Antwerpen, Universiteitsplein 1, B-2610 Wilrijk, Belgium  
July 19-31, 1982 : Antwerp, Belgium

#### ARW

##### STATISTICAL MECHANICS OF IONIC MATTER ●

Dr. M.T. BÉAL-MONOD, Physique des Solides, Université de Paris-Sud, 91405 Orsay, France  
March 29 - April 10, 1982 : Les Houches, France

#### MASS TRANSFER AND KINETICS IN ION EXCHANGE

Prof. L. LIBERTI, Istituto di Ricerca sulle Acque, CNR, 5 Via de Blasio, 70123, Bari, Italy  
May 30 - June 12, 1982 : Maratea, Italy

#### ANALYSIS AND DESIGN OF BRIDGES

Dr. C. YILMAZ, Faculty of Engineering, Middle East Technical University, Ankara, Turkey  
June 28 - July 9, 1982 : Izmir, Turkey

#### IMAGE SEQUENCE PROCESSING & DYNAMIC SCENE ANALYSIS

Prof. T.S. HUANG, Coordinated Science Lab., 1101 W. Springfield Ave., Urbana, Illinois 61801, USA  
June 21 - July 2, 1982 : Goslar-Hahnenklee, Germany

#### EVOLVING GEOGRAPHICAL STRUCTURES

Dr. D.A. GRIFFITH, Dept. of Geography, State Univ. of New York, Buffalo, N.Y. 14260, USA  
July 18-30, 1982 : San Miniato, Italy

#### PICTORIAL DATA ANALYSIS

Dr. R.M. HARALICK, Dept. of Electrical Engineering, Virginia Polytechnic Inst., Blacksburg, VA 24061, USA  
August 1-14, 1982 : Bonas, France

#### MAGNETIC RESONANCE TECHNIQUES IN FOSSIL ENERGY PROBLEMS

Dr. L. PETRAKIS, Gulf Science & Technology Co., P.O. Drawer 2038, Pittsburgh, PA 15230, USA  
June 21 - July 2, 1982 : Patras or Corfu, Greece

#### LAND & ITS USES - ACTUAL & POTENTIAL : ENVIRON. APPRAISAL FOR PLANNERS (ES)

Prof. F.T. LAST, Inst. of Terrest. Ecol., Bush Estate, Penicuik, Midlothian EH26 0QB, UK  
March, 1982 : Edinburgh, Scotland, UK

#### ARWS

##### TWO PHASE FLOW AND HEAT TRANSFER ●

Prof. S. KAKAC, Dept. of Mechanical Engineering, Univ. of Miami, Coral Gables, FL 33124, USA  
August 30 - September 3, 1982 : Munich, Germany

#### GEOLOGIC. SYNTH. OF THE APPALACHIAN-CALEDONIAN-HERCYNIAN MAURITANIDE OROGEN

Prof. P.E. SCHENK, Geology Dept., Dalhousie University, Halifax, Nova Scotia, B3H 3J5, Canada  
August 8-21, 1982 : Fredericton, Canada

#### ANALYSE DE DONNEES

Prof. P. BERTHAUME, Dept. Mathématique, Univ. Montreal, C.P. 6128, Succ. A, Montreal, Que H3C 3J7, Canada  
July 26 - August 13, 1982 : Montreal, Canada

#### CO-ORDIN. CHEM. OF METALLOENZYMES IN HYDROLISIS & OXYG. INSERTION MECHANISMS

Prof. I. BERTINI, Ist. Chimica Generale, Università di Firenze, Via Gino Capponi 7, 50121 Firenze, Italy  
May 28 - June 8, 1982 : San Miniato, Italy

#### ARWS

##### TRANSPORT IN NON-STOICHIOMETRIC COMPOUNDS ●

Dr. G. PETOT-ERVAS, C.N.R.S., Laboratoire P.M.T.M., Av. J.B. Clément, 93430 Villetaneuse, France  
June 29 - July 3, 1982 : Perpignan, France

##### THE LAST DEGLACIATION-TIMING AND MECHANISM ●

Prof. J.C. DUPLESSY, Centre des Faibles Radioactivités, C.N.R.S., 91190 Gif-sur-Yvette, France  
June 1982 (4 days) : Maine, USA

##### GEOLOGICAL EVOLUTION OF THE MEDITERRANEAN BASIN (Mar.S) ●

Prof. R. SELLU, Inst. di Geologica, Univ. Via Zamboni 63-67, 40127 Bologna, Italy  
Prof. D.J. STANLEY, Div. Sediment, E-109 NMH, Smithsonian Inst., Washington DC 20580, USA  
March 1-9, 1982 : Erice, Italy

##### FLOWS OF ENERGY AND MATERIALS IN MARINE ECOSYST.: THEORY AND PRACTICE (Mar.S) ●

Dr. M.J.R. FASHAM, Inst. of Oceanog. Sc., Brook Rd., Wormley, Godalming, Surrey GU8 5UB, UK  
May 20-26, 1982 : Bombannes, Bordeaux, France

##### HYDROTHERMAL PROCESSES OF SEAFLOOR SPREADING CENTERS (Mar.S) ●

Dr. P.A. RONA, Atlantic Oceanog. & Meteorolog. Labs., 15 Rickenbacker Causeway, Miami, FL 33149, USA  
March, 1982 : to be announced

##### MECHANISMS OF MIGRATION IN FISHES (Mar.S) ●

Dr. J.D. McCLEAVE, Migratory Fish Res. Inst., Univ. of Maine, Orono, ME 04469, USA  
December 12-13, 1982 : to be announced

##### COASTAL OCEANOGRAPHY (Mar.S) ●

Prof. H.G. GADE, Dept. of Oceanog., Geophys. Inst., Univ. Bergen, 5014 Bergen, Norway  
June 6-10, 1982 : Os (Bergen)-Norway

##### MARSEN (Marine Remote Sensing Experiment) (A-S) ●

Prof. K. HASSELMANN, Max-Planck-Inst. f. Meteorolog. Bundesstr. 55, 2000 Hamburg 13, Germany  
Summer 1982 : Hamburg, Germany

##### ISSUES IN ACOUSTIC SIGNAL/IMAGE PROCESSING AND RECOGNITION ●

Prof. C.H. CHEN, Coll. of Engineering, Southeast. Mass. Univ., North Dartmouth, MA 02747, USA  
June 2-6, 1982 : Sintra Estoril, Portugal

##### ELECTRONIC STRUCTURE AND PROPERTIES OF HYDROGEN IN METALS (Mat.S)

Prof. P. JENA, Virginia Commonwealth Univ., 901 W. Franklin Str., Richmond VA 23284, USA  
March 4-6, 1982 : Richmond, Virginia, USA

##### EDUCATIONAL MODULES - 3rd NATO/EMMSE-WECC WORKSHOP (Mat.S)

Dr. J.H.W. DE WIT, Dpt. of Chem., Rijksunivers., 771 Croesestraat, Utrecht, Netherlands  
September, 1982 : to be announced

##### HYDROMETALLURGICAL PROCESS FUNDAMENTALS (Mat.S)

Prof. R. BAUTISTA, Dept. of Chemical Eng., Iowa State Univ., Ames, Iowa 50011, USA  
July 25 - August 1, 1982 : Cambridge, UK

##### MICROELECTRONICS - STRUCTURES & COMPLEXITIES (Mat.S)

Dr. R. DINGLE, Bell Labs., Murray Hill, NJ 07974, USA  
March 14-20, 1982 : France

##### COHERENCE AND ENERGY TRANSFER IN GLASSES (Mat.S)

Dr. P.A. FLEURY, Bell Labs., Murray Hill, NJ 07974, USA  
September, 1982 : Cambridge, UK or Grenoble, France

##### EFFICIENCY OF MANUFACTURING SYSTEMS (SS) ●

Prof. B. WILSON, Dept. of Systems, Univ. of Lancaster, Bailrigg, Lancaster LA1 4YR, UK  
September, 1982 : Amsterdam, Netherlands

##### HEALTH SERVICE SYSTEMS (SS) ●

Dr. A. VAN DER WERFF, Minist. of Health Service, PB 439, 2260 AK Leidschendam, Netherlands  
August 29 - September 3, 1982 : The Hague, Netherlands

Further information on the NATO International Scientific Exchange Programmes may be obtained from : NATO Scientific Affairs Division, B 1110 Brussels



<b>LETTERS</b>	Small Business R & D: <i>J. J. LaFalce; W. B. Rudman; P. Speser;</i> Radiation Effects: <i>T. A. Louis; H. E. Holden; W. J. Schull and</i> <i>J. V. Neel</i> .....	456
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# AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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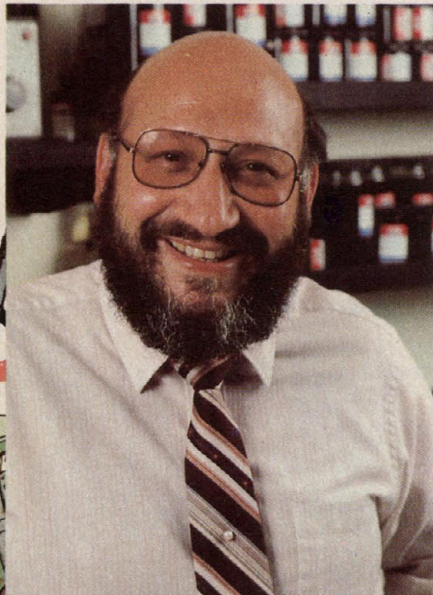
Montage of Voyager photographs constructs a view over the limb of Enceladus (foreground, Voyager 2) which looks back toward the sun to observe Rhea (lower right, Voyager 1), Saturn (Voyager 1), Mimas (near Saturn, Voyager 2), and Titan (upper right, Voyager 2). Voyager 2 is currently proceeding toward flybys of Uranus (January 1986) and Neptune (August 1989). See page 499. [Montage prepared by R. W. Post, Photolab, Jet Propulsion Laboratory, Pasadena, California 91103]

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# A curiously tenacious that's saving millions

**Hal Shaub discovered the molecule's properties at Exxon Research and Engineering Company.**



Hal Shaub (Ph.D. Chemistry), Senior Research Associate in Exxon Research and Engineering Company, discovered some curious properties of a molecule in his work to develop fuel-saving motor oils. "It's a very tenacious molecule," Hal says, "sporting a pair of highly polar 'feet' that attach to positive and negative sites on metal surfaces."

## Two Kinds of Friction

In a typical internal combustion engine, a considerable amount of fuel is consumed in overcoming friction. It has two sources: *rubbing* where lubricant film fails and metal-to-metal contact occurs, and *drag* caused by the viscosity of the lubricant itself. Friction can be reduced by lowering oil viscosity, but there is a point at which friction begins to increase due to failure of the lubricant film and

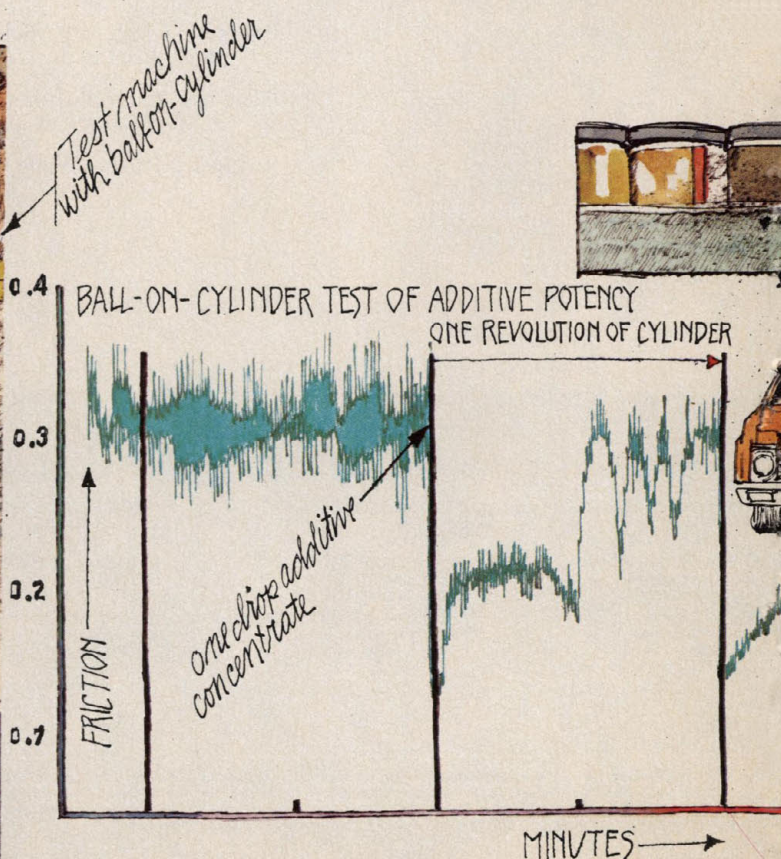
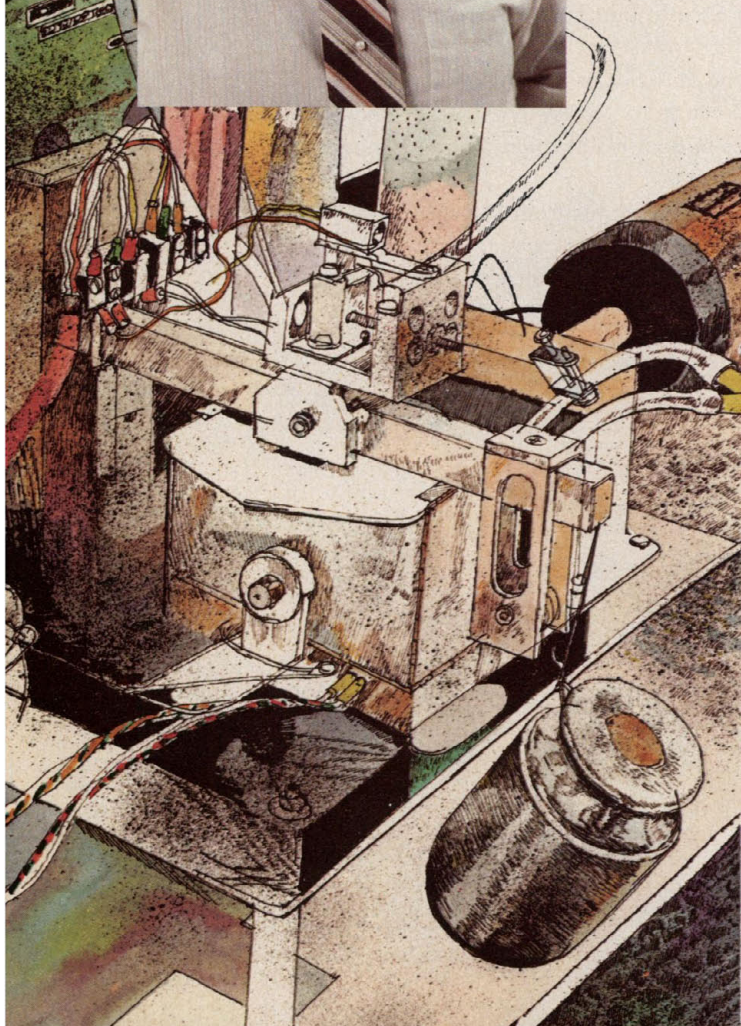
resulting metallic contact. To Hal, this suggested developing sturdier lubricant films.

Hal uses a unique laboratory device to assess additives—Exxon's "ball on cylinder" test that simulates conditions in parts of the engine where lubricant films commonly give way. The test gives positive laboratory confirmation that the curious two-footed molecule reduces friction. But it has also raised puzzling questions about how and why.

## Two Theories on How the Molecule Works

The additive that Hal discovered actually seems to chemisorb on steel surfaces, reducing metallic contact under thin lubricant film conditions.

One theory is that this chemisorption reduces adhesive wear, and low friction prevents sub-surface fatigue wear. So stresses exerted by the load cause plastic deformation of rubbing steel surfaces—resulting in smoother surfaces and less friction.





# molecule from Exxon of gallons of fuel.

But Hal believes that when metallic parts contact and heat in the presence of the molecule, changes in the metal's chemistry occur. Specifically, the melting point may be lowered, causing surface irregularities to deform in a more uniform way—resulting in lower friction.

Hal adds that various additive chemicals can compete with the molecule for polar sites on the metal, can prevent it from getting to the surface, or both. So for the molecule to work its magic, special chemical techniques must be used to incorporate it into the motor oil.

## Mileage Improvements Averaged over 4%

The complete additive technology, in a super premium motor oil, was assessed for overall engine performance in dynamometer and

road tests, including a grueling taxi fleet test. Other special road fleet tests demonstrated improvements in fuel economy averaging over 4%, compared to conventional 10W-40 motor oils of the time.

The additive technology has been incorporated in Exxon's *Uniflo*® automotive motor oil since 1977, in heavy-duty oils for diesel engines since 1980, and is now in *Exxon Extra Motor Oil*®. The fuel savings resulting from consumer use of these fuel-efficient oils are estimated at millions of gallons per year.

Meanwhile, Hal Shaub is continuing his work. "We think we can *double* the fuel economy improvements achieved to date," says Hal.

For more information on Hal Shaub's molecule and ER & E, write Ed David, President, Exxon Research & Engineering Company, Room 603, P.O. Box 101, Florham Park, New Jersey 07932.

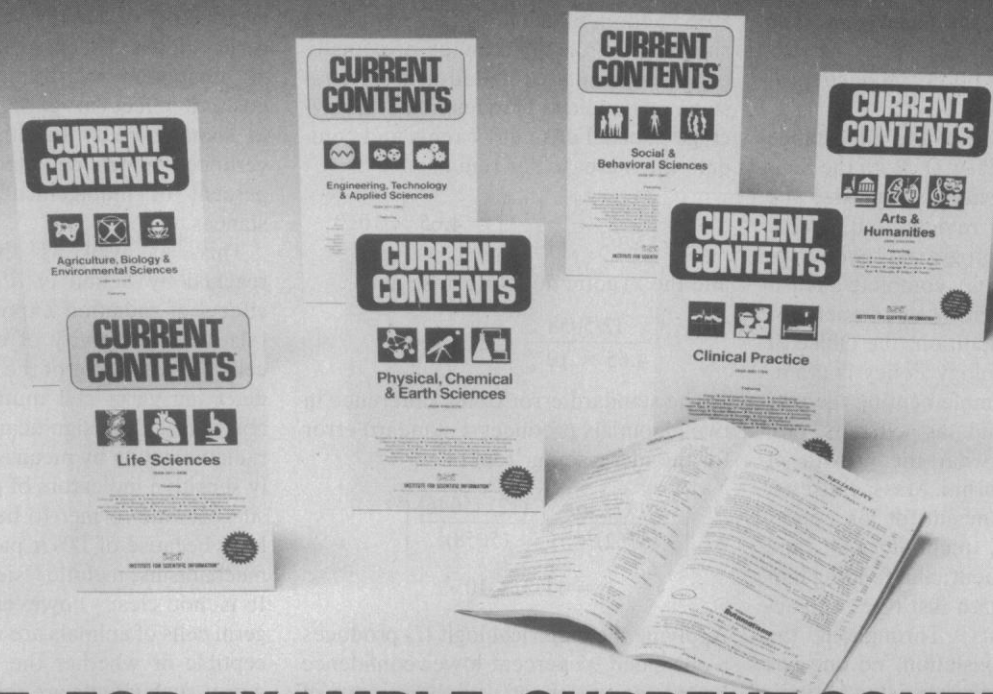
## Exxon Research and Engineering Company

Fuel-saving engine lubricants are just one example of technological innovation going forward on many fronts at Exxon Research and Engineering Company. A wholly owned subsidiary of Exxon Corporation, ER&E employs over 2,000 scientists and engineers working on petroleum products and processing, synthetic fuels, pioneering science, and the engineering required to develop and apply new technology in the manufacture of fuels and other products.





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## The End of the Beginning

Voyager 2 journeyed 4 years from the warm sands of Florida to the icy environs of Saturn. Scientific specialists have been awed by the intricate and unexpected natural phenomena which characterize the Saturnian system, just as they were earlier bedazzled by Jupiter. Millions of others around the world have been carried along via instant global communications on this fantastic journey of the mind.

But a funny thing happened on the way to the outer planets. While the Voyagers functioned relatively smoothly in space, circumstances in their terrestrial birthplace were not so harmonious. Double-digit inflation combined with unprecedented interest rates painfully exacerbated the growing disparity between expectations and reality for middle-class Americans. NASA plans for a smooth transition to the reusable space shuttle were dashed by schedule delays and burgeoning costs. All planetary launches following the Pioneer/Venus Mission in 1978 became dependent upon timely development of the shuttle and upper stages.

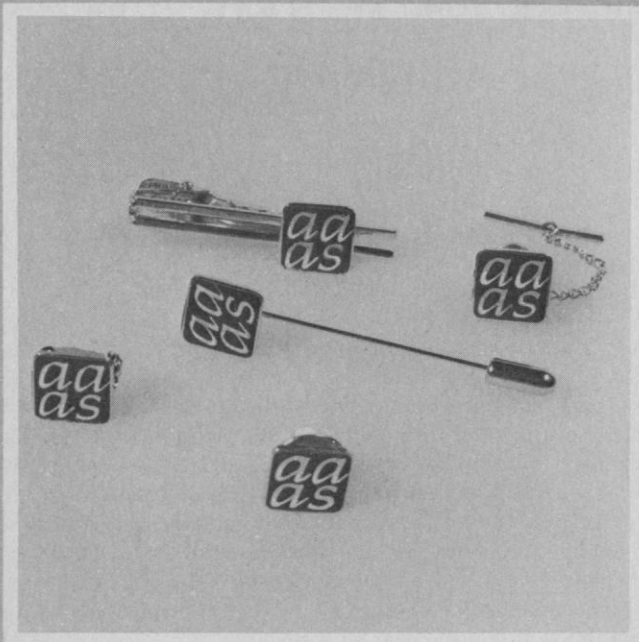
Voyager 2 began its ambitious four-planet journey in August 1977. At that time Galileo, a long-duration Jupiter orbiter also carrying a sophisticated entry probe for direct atmospheric sampling, was firmly scheduled for launch this very month aboard shuttle flight 16. Two International Solar Polar Mission (ISPM) spacecraft, one American and one European, were planned to depart by shuttle in February 1983 on exploratory passages over opposite poles of the sun. By 1984, the Venus Orbiting Imaging Radar (VOIR) spacecraft was expected to map by radar the permanently cloud-shrouded surface of Earth's closest planetary relative. And even a daring rendezvous with the nucleus of Halley's comet in 1986 was contemplated.

What is the situation now? Galileo is the only remaining U.S. planetary project under development, its launch delayed until 1985. The U.S. ISPM spacecraft has been canceled outright and the launch of its European counterpart delayed until 1986. VOIR, deferred again last year until at least 1988, has come to resemble more the fading grin of a Cheshire cat than a serious national objective. Halley's comet will be investigated by spacecraft of the Soviet Union, Western Europe, and Japan—but not the United States. By these actions the United States unilaterally abandoned world leadership in planetary exploration, one of the 20th century's most uplifting and challenging technological and scientific enterprises. A brilliant burst of American imagination and energy, catalyzed by the Apollo decision, carried our senses and intellect inward to Mercury as well as outward beyond Saturn—but now has nearly run its course.

Our new challenge is to maximize the scientific and exploratory significance of the much more modest U.S. deep space activities projected for the 1980's. The Deep Space Net, which so skillfully captured Voyager's faint video signals from a distance of over 1 billion miles, steadily improves. New deep space missions still can materialize as long as they do not require increased launch-vehicle capability or strain the NASA budget. Opportunities for truly collaborative international deep space efforts may arise to replace symbolic and sometimes paternalistic arrangements of the past.

On a longer time scale, ambitious new missions to the moon and Mars can and should come about in response to the expanding capabilities and aspirations of many more peoples than just those of the United States and the Soviet Union.

During the next century, humankind's growing comprehension and utilization of our solar neighborhood are likely to make the events of the last two decades seem tiny in magnitude but large in historical import. While forgoing dominance, the United States can still make crucial contributions in a more internationalized era of space exploration. The readership of *Science*, especially, can help this uncertain nation once again look outward in space and forward in time. Perhaps our national expectations will again be rising 4 years hence when Voyager 2 reaches Uranus.—BRUCE MURRAY, Jet Propulsion Laboratory, Pasadena, California 91109



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behind-the-scenes interpreter of the academy's mission and activities.

Also, in the 10 days of speechmaking, there was a key sentence buried in the report by Fang Yi, lamenting the "over-concentration of power in the academy" (17). Such a statement is not made casually and, despite the lavish praise he heaped on the scientists, it may be assumed that the academy lost something in the course of the reorganization. It would appear that by stressing the academy's long-range tasks, primarily "in pure science and other fields of technical science," and contrasting these with the immediate and short-term scientific research in industrial departments and local scientific research institutions, Fang Yi seemed to circumscribe the academy's control over scientific activities outside its own institutes.

Given the extreme policy fluctuations, we are inclined to forget that most Chinese are realistic most of the time. Scientists may be elitist and they may have (to their own detriment) oversold their case in 1977 and 1978; at the same time it is only fair to assume that in most instances their motives were good and they sincerely believed that strong and internationally competitive science was synony-

mous with a strong China. While China's national interests dictate that emphasis in science be redirected toward the economy, China also is chauvinistic—she has many world-level scientists and will not deny them the opportunity to do basic research in those areas of science where there is real promise of achievement. The leaders may even adjust to the inevitability of elitism among the scientists. After all, what an individual is is not determined either by "class nature," as the Communists would have us believe, or by "human nature," as we are apt to assume, but by a combination of both. Although they may not admit it, the policy-makers must know that conversion of an elitist scientist to a proletarian scientist runs counter to both "natures." The Chinese say that "You don't cut off the feet to make the shoes fit." At this stage, Beijing is only binding the scientists' feet to force them into the tight shoes of economic readjustment.

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1. Hongqi [Red Flag], No. 2 (16 January 1980), translated in *U.S. Joint Publ. Res. Serv. Publ. 75,317* (17 March 1980). The fact that he was specifically referring to the exclusion of younger scientists from positions of authority does not detract from the general significance of the statement.
2. H. W. Bode, in "Basic research and national goals," National Academy of Sciences report to the Committee on Science and Astronautics, U.S. House of Representatives (March 1965), p. 76.
3. The complete texts of the major speeches at the National Science Conference are contained in appendix A of *Science in Contemporary China*, L. A. Orleans, Ed. (Stanford Univ. Press, Stanford, Calif., 1980), pp. 535-563.
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5. Renmin Ribao [People's Daily] (27 March 1981), in *Foreign Broadcast Inf. Serv.* (14 April 1981).
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9. An excellent review and evaluation of the U.S.-P.R.C. science protocols is given by R. P. Suttmeier, "U.S.-P.R.C. scientific cooperation: An assessment of the first two years," report prepared for the Department of State (June 1981).
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11. Jingji Yanjiu [Economic Research], No. 11 (20 November 1981), in *U.S. Joint Publ. Res. Serv. Publ. 77,285* (30 January 1981).
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13. For a detailed account of this meeting, see H. S. Klein, *China Exchange News* (September 1981), pp. 1-5.
14. *China Daily* (28 June 1981).
15. *Beijing Review*, No. 22 (1 June 1981).
16. Kuangming Ribao [Kuangming Daily] (14 July 1981).
17. *Ibid.* (27 May 1981).
18. I thank L. Bruno, A. DeAngelis, T. Fingar, H. Klein, P. Perrolle, and Chi Wang for reading and commenting on this article.

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