Wave and diffusion phenomena are fascinating and interesting subjects being present in our daily life.

The study of these "classical" phenomena have interested generations of physicists because their description is one of the unifying threads connecting diverse areas of physics.

Usually the two kinds of phenomena are treated distinctly from each other, over all from mathematical view point because the governing (differential) equations are mostly of different type.

There are several cases, however, where they are interrelated like in the so called intermediate processes governed by more general equations where derivatives of non-integer order are present.

The study of these phenomena requires the application of some "classical" methods of mathematical physics, like special functions, integral transforms and fractional calculus, that nowadays have been improved in this respect.

Usually to represent a relevant wave phenomenon one discusses the existence of solitons, special solitary waves exhibiting particle-like behaviour under mutual interaction. This solitary wave was formerly observed in water wave propagation by J. Scott Russell on the Edinburgh-Glasgow canal in 1834; he called it the "great wave of translation". But the most famous and attractive "great wave" is that one, much more complex, depicted by the Japanese artist Katsushika Hokusay (1760-1849), see Fig.1.

P.G. Drazin and R.S. Johnson:
"Solitons; an Introduction", Cambridge Univ. Press, 1989.

K. Hokusay:
"In the Hollow of a Great Wave off the Coast of Kanagava", 1830-31. Xilography cm 38 x 25.5, Metropolitan Museum, New York.

G.B. Whitham:
"Linear and Nonlinear Waves", Wiley, 1974.

Fig. 1

To represent diffusion phenomena one often considers their stochastic formulation through random walk processes, namely, in a broad sense, diffusion may be considered the macroscopic average of a random walk. The Brownian motion is known to be the stochastic foundation of the so-called normal diffusion, where the prob ability density is a Gaussian evolving in time with a variance proportional to the first power of time.

In Brownian motion a particle makes random jumps and each jump is usually small. The resulting normal diffusion is described by a Gaussian distribution with a finite variance which characterizes the width of the distribution, see plate *a* of Fig. 2. To explain deviations from normal diffusion occurring in several transport processes, diffusion equations of fractional order (in space and/or in time) have been
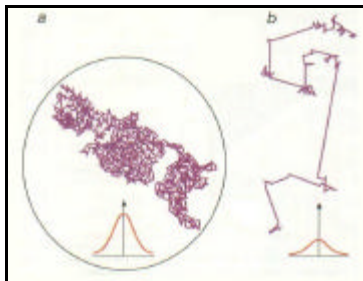

Fig. 2

proposed in recent times. For example, a space fractional diffusion equation governs the Lévy-like diffusion where long flights are interspersed with shorter jumps, so a much larger region is covered by the particle. The variance of a Lévy distribution diverges. This is depicted in plate *b* of Fig. 2. Nowadays stochastic processes are widely used to treat fluctuations of financial markets, extending the pioneering work by the French mathematician L. Bachelier in his 1900 thesis, who anticipated the 1905 paper by Einstein on the Brownian motion.

J. Klafter, M. F. Shlesinger and G. Zumofen: "Beyond Brownian motion", Physics Today, Vol. 49 No 2 (1996), pp. 33--39.

R. Metzler and J. Klafter, "The random walk's guide to anomalous diffusion: a fractional dynamics approach", Physics Reports, Vol. 339 (2000), pp. 1-77.

C. Tsallis: "Lévy Distributions", Physics World, Vol. 10 No 7 (1997), pp. 42-45.

Some related WEB sites:

http://www.fracalmo.org	for Fractional Calculus Modelling
http://www.diogenes.bg/fcaa	for the Journal "Fractional Calculus and Applied Analysis"
http://www.physycom.unibo.it	for Physics of Complex Systems at the University of Bologna
http://www.econophysics.org	for Econophysics

Department of Physics
University of Bologna
Via Irnerio 46, 40126
BOLOGNA

Phone: +39-051-209-1098
Fax: +39-051-247244

Interdisciplinary Workshop

FROM WAVES TO DIFFUSION AND BEYOND

20 December 2002

Department of Physics
University of Bologna
Via Irnerio 46, 40126
**BOLOGNA**

Official language: ITALIAN

An INTERDISCIPLINARY WORKSHOP on the subject "**FROM WAVES TO DIFFUSION AND BEYOND**" will be held on Friday, December 20, 2002 at the Department of Physics, University of Bologna, Via Irnerio 46, 40126 BOLOGNA.

Official language: ITALIAN

On the occasion of the 60th birthday of Prof. Francesco Mainardi (Teacher and Researcher in Mathematical Physics at the University of Bologna) his former students and Italian collaborators have agreed to meet and discuss together their scientific and professional interests.

The title of the workshop somehow reflects the various topics treated by Mainardi and his co-workers, from problems of wave propagation and diffusion to special functions, fractional calculus and random walk models applied to finance (econophysics).

Anyone wishing to attend is kindly requested to send an e-mail by Saturday, December 14 to: info@fracalmo.org specifying his/her affiliation, date of arrival/departure.
This will help the organizers with catering arrangements (coffee breaks) and lecture room availability.
For arrangements of the last minute, please call 051-209.1098
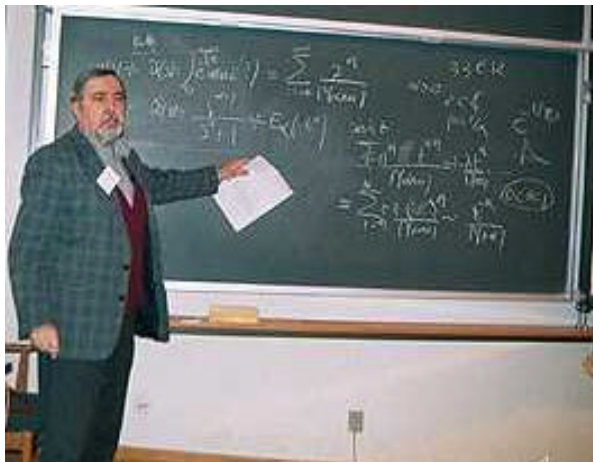
F. Mainardi lecturing on Fractional Calculus at MaPhySto Center, Univ. Aarhus, January 2000.
Credit: MaPhySto News No. 4, February 2000, Fig. 12, p. 9, http://www.maphysto.dk/

ORGANIZING COMMITTEE:
Enrico SCALAS (Chairman),
Claudia DAFFARA, Ombretta PINAZZA, Giuliano VITALI

Program

20.12.02 Morning   AULA B

1. Morning Session on Mathematical Physics and Modelling
Chair: **Piero OLLA** (ISAC-CNR, Lecce)

09:15 - 09:20 OPENING by Enrico SCALAS (DISTA, Università del Piemonte Orientale, Alessandria)

09:20 - 09:40 Gianni PAGNINI (Istituto ISAC-CNR, Bologna): Special Functions via Mellin-Barnes Integrals

09:40 - 10:00 Paolo PARADISI (Istituto ISAC-CNR, Lecce): Dynamics of Solid Particles in Turbulent Flows

10:00 - 10:20 Silvana DI SABATINO (Dip. Scienze Materiali, Università, Lecce): Modelling Pollution Dispersion in Urban Areas

10:20 - 10:40 Dino ZARDI (Dip. Ing. Civile Ambientale, Università, Povo-Trento): Dynamics of Mountain and Valley Winds

10:40 - 11:00 Fabio CAVALLINI (Istituto Nazionale Oceanografia e Geofisica Sperimentale - OGS, Sgonico, Trieste): Causal Generalized Functions in Geophysical and Environmental Modelling

11:00 - 11.20 COFFEE BREAK

2. Morning Session on Mathematical Physics and Modelling
Chair: **Maria Carla TESI** (Dip. Matematica, Università, Bologna)

11:20 - 11:40 Daniele MORETTI - Alessandro VIVOLI (Dip. Fisica, Università, Bologna): Random Walks and Fractional Diffusion

11:40 - 12:00 Claudia MANZONI - Ombretta PINAZZA (Dip. Fisica, Università - INFN, Bologna): Self-Similar Stochastic Processes

12:00 - 12:20 Michele BALDINI (Dept. Physics, New York University, New York, USA): Recent Developments on the Stochastic Burgers Equation

12:20 - 12:40 Giuliano VITALI - Dip. Scienze e Tecnologie Agro Ambientali, Università, Bologna): Mathematical Physics in Surface Hydrology

12:40 - 13:00 Massimo TOMIROTTI (Dip. Ing. Civile, Università, Brescia): Hyperbolic Conservation Laws and Applications to the Dam-Break Problem

13:00 - 14:30 LIGHT LUNCH

20.12.02 Afternoon AULA A

1. Afternoon Session on Finance/Econophysics and Management
Chair: **Maria I. LOFFREDO**   (Dip. Scienze Matematiche e Informatiche, Università, Siena)

14:30 - 15:00 Domenico CAVALIERE (LEK Consulting, Milano): From Physics to Management and Consulting

15:00 - 15:30 Gian-Italo BISCHI (Istituto Scienze Economiche, Università, Urbino):
Dynamic Modelling and Complexity in Economics

15:30 - 16:00 Donatella TOCCI (Banca FINECO, Reggio Emilia): The Talent

16:00 - 16:20 COFFEE BREAK

2. Afternoon Session on Finance/Econophysics and Management
Chair: **Eduardo ROMAN** (Dip. Fisica - INFN, Milano)

16:20 - 16:40 Enrico GRASSI (Liceo Scientifico, San Marino):
Stock Market Trends: the Behaviour of a Chartist

16:40 - 17:00 Gianni DE FABRITIIS (ATALab, Firenze):
On Size and Growth of Business Firms

17:00 - 17:30 Enrico SCALAS (Dip. Scienze e Tecnologie Avanzate, Università del Piemonte Orientale, Alessandria):
On the Role of Phenomenological Models in Finance

17:30 - 18:00 Marco RABERTO (Dip. Ing. Biofisica ed Elettronica, Università, Genova): Agent-Based Computational Economics: A New Mainstream in Econophysics

18:00 - 18:20 Claudia DAFFARA (Dip. Fisica, Università - ENEA, Bologna): The WEB site www.fracalmo.org

18:20 - 18:30 CONCLUSIONS by F. Mainardi (Dip. Fisica, Università - INFN, Bologna)

SOCIAL DINNER
20:00 at Restaurant Donatello, Via A. Righi 8, 40126 Bologna
Tel 051.23.54.38 (Menu - Cucina Bolognese)