UNIVERSITÀ DELLA CALABRIA
Dipartimento di FISICA

ANNUAL REPORT 2005

ACADEMIC YEAR 2004-2005

Scientific publications in 2005

Indice

Introduzione

Sono ormai quasi venti anni che il Dipartimento di Fisica dell'Università della Calabria, prepara e distribuisce il suo rapporto di attività annuale. La prima edizione risale all'anno accademico 1986/87 ed era stata prodotta con una stampante ad aghi e successivamente fotocopiata e spillata nella segreteria del dipartimento. Dall'anno scorso il rapporto di attività nella parte scientifica è stato redatto in inglese, per facilitarne la diffusione anche tra i centri di ricerca internazionali.

Riguardando i rapporti anno per anno è possibile farsi un'idea di quanto e come il dipartimento di fisica sia cambiato in questo periodo. A parte alcune fluttuazioni c'è un chiaro trend di crescita, del dipartimento sia in termini di personale che di pubblicazioni: il personale di ruolo è passato dalle 25 unità del 1987 alle 49 unità del 2005, ma accanto al personale di ruolo sono progressivamente comparsi, prima un consistente numero di dottorandi (dalle poche unità del 1997, fino alle 26 unità del 2005) poi un altrettanto consistente numero di assegnisti e borsisti post-doc (dalle poche unità degli anni tra il 1990 ed il 1999, fino alle 16 unità del 2005).

Oggi il dipartimento di fisica rappresenta una consistente realtà nel panorama della ricerca nazionale ed internazionale, con settori che, anche dal punto di vista della massa critica di ricercatori, hanno ormai raggiunto una notevole visibilità. All'interno del dipartimento gruppi di ricerca di assoluto rilievo internazionale sia dal punto di vista quantitativo che qualitativo, sono presenti nei campi della fisica molecolare ed in particolare dei cristalli liquidi, della fisica dei plasmi con particolare riguardo allo studio della corona solare e del mezzo interplanetario, della fisica delle alte energie, della fisica delle superfici. Ognuno di questi gruppi ha al suo attivo progetti che hanno ottenuto chiari riconoscimenti, sia nazionali che internazionali. In entrambe le tornate del bando ministeriale COFINLAB, destinato al finanziamento di centri di ricerca di eccellenza, il dipartimento di fisica è stato presente con successo: nella prima tornata è, infatti, stato finanziato il *Centro di Eccellenza per il Calcolo ad Alte Prestazioni*, cui ha contribuito in maniera determinante il gruppo di plasmi astrofisici, nella seconda tornata è invece stato finanziato il *Centro di eccellenza per la Preparazione ed il Trattamento di Materiali a struttura organizzata su scala nanometrica per applicazioni in fotonica, optoelettronica, trasformazioni e separazioni* nella realizzazione del quale ha un ruolo primario il gruppo di cristalli liquidi. Il gruppo di fisica delle Alte Energie è direttamente coinvolto nel progetto internazionale ATLAS, destinato a realizzare uno strumento da installare all'interno del *Large Hadron Collider* per rivelare il bosone di Higgs. Nell'ambito di questo progetto, nei laboratori del dipartimento di fisica sono stati realizzati i 35.000 tubi a deriva necessari alla costruzione delle camere di precisione di uno spettrometro a muoni.

Del resto il numero di pubblicazioni su riviste internazionali, dedotte dai precedenti rapporti di attività, non ha cessato di crescere dalle poche decine degli anni '80, fino alle circa 100 negli ultimi anni, mostrando che la crescita del dipartimento in termini di personale è stata accompagnata da una crescita ancora più accentuata in termini di produttività scientifica.

Gli anni che ci si prospettano debbono essere quelli del consolidamento dei risultati raggiunti e della capacità di utilizzare le competenze sviluppate nella prospettiva di applicarle a tematiche direttamente legate allo sviluppo del territorio calabrese. Questo obiettivo richiederà da un lato una collaborazione sempre più stretta con

le istituzioni territoriali, dall'altro lo sforzo concorde e convinto di tutto il personale del dipartimento, sforzo che, ne sono certo, sarà consapevolmente realizzato, superando in un'ottica di sviluppo e di crescita comune i problemi legati alla definizione di criteri equi ed efficaci di distribuzione delle risorse.

Tabella: evoluzione del personale e delle pubblicazioni del dipartimento dal 1987 al 2005

Anno	Ordinari	Associati	Ricercatori	Assegnisti Post-Doc	Dottorandi	Pubblicazioni su Riviste Internazionali
1987	5	14	6		3	20
1988	5	16	6		3	26
1989	5	15	6	3	6	21
1990	5	15	6	3	9	76
1991	5	14	10	2	10	53
1992	5	12	11	2	11	46
1993	4	17	10	2	12	52
1994	4	17	10	2	15	41
1995	5	16	12	2	11	57
1996	6	14	12		19	62
1997	6	14	12		19	63
1998	6	14	13		18	53
1999	6	14	13		19	66
2000	8	18	9	11	24	80
2001	11	19	5	12	19	92
2002						83
2003	12	20	11	11	35	103
2004	12	19	13	17	30	89
2005	12	23	14	16	26	104

Arcavacata di Rende, 25 ottobre 2006

Il direttore del dipartimento
(prof. Pierluigi VELTRI)

DEPARTMENTAL ADMINISTRATION

Head of Department:
Pierluigi VELTRI

Executive Board:
Elio COLAVITA, Giancarlo SUSINNO, Alessandro PAPA, Cesare UMETON, Luigi PAPAGNO, Ignazio GUERRA, Assunta BONANNO, Nicola SCARAMUZZA

Department Council:
12 Full Professors
23 Associate Professors
14 Senior Researchers
8 Representatives of PhD students
9 Representatives of the Technical and Administrative Staff

Administative Secretary:
Giocondo PERRI

RESEARCH PERMANENT STAFF

Full Professors

1. Roberto BARTOLINO *FIS07*

2. Lev BLINOV *FIS03*
3. Gaetano CANNELLI *FIS01*
4. Elio COLAVITA *FIS07*
5. Giovanni FALCONE *FIS01*

6. Ignazio GUERRA *GEO10*
7. Antonino OLIVA *FIS01*
8. Luigi PAPAGNO *FIS01*
9. Luigi SPORTELLI *FIS07*
10. Giancarlo SUSINNO *FIS01*
11. Cesare UMETON *FIS01*
12. Pierluigi VELTRI *FIS03*

Associate Professors

1. Raffaele AGOSTINO *FIS01*
2. Renzo ALZETTA *FIS02*
3. Riccardo BARBERI *FIS07*
4. Orazio BARRA *FIS01*
5. Rosina BARTUCCI
6. Assunta BONANNO *FIS01*
7. Lorenzo CAPUTI *FIS01*
8. Vincenzo CARBONE *FIS03*
9. Enzo CAZZANELLI *FIS03*
10. Gabriella CIPPARRONE *FIS03*
11. Gennaro CHIARELLO *FIS07*
12. Giovanni CROSETTI *FIS01*
13. Roberto FIORE *FIS02*
14. Laura LA ROTONDA *FIS01*
15. Francesco MALARA *FIS01*
16. Alessandro PAPA
17. Francesco PIPERNO *FIS03*
18. Nicola SCARAMUZZA *FIS07*
19. Marco SCHIOPPA *FIS01*
20. Carlo VERSACE *FIS01*
21. Galileo VIOLINI *FIS02*
22. Fang XU *FIS01*
23. Gaetano ZIMBARDO *FIS06*

Senior Researchers

1. Michele CAMARCA *FIS01*
2. Marcella CAPUA *FIS01*
3. Anna CUPOLILLO
4. Maria DE SANTO *FIS07*
5. Vincenzo FORMOSO *FIS01*
6. Domenico GIULIANO *FIS02*
7. Antonella GRECO
8. Rita GUZZI *FIS07*
9. Pasquale PAGLIUSI
10. Francesco PLASTINA
11. Leonardo PRIMAVERA *FIS05*
12. Pierfrancesco RICCARDI
13. Antonello SINDONA
14. Giuseppe STRANGI *FIS07*

Post-Doctoral Research Fellows

1. Pasquale BARONE
2. Vincenzo BRUNO
3. Tommaso CARUSO
4. Marco CASTRIOTA
5. Francesca CASTROVILLARI
6. Federica CIUCHI
7. Antonio DE LUCA
8. Domenico DI GIACOMO
9. Fabio LEPRETI
10. Giuseppe LIBERTI
11. Donatella MARMOTTINI
12. Anna MASTROBERARDINO
13. Evelin MEONI
14. Daniela PACILE'
15. Pasquale PAGLIUSI
16. Manuela PANTUSA

Phd Students

(XVII Cycle)

1. Cristina ADORISIO
2. Giuseppe AVOLIO
3. Rosita DE BARTOLO
4. Guido GUERINI
5. Antonio VECCHIO
6. Alessandro VELTRI
7. Paolo VETRÒ
8. Federico Pasquale ZEMA

(XVIII Cycle)

1. Pietro GIUDICE
2. Giuseppina NIGRO
3. Francesco CAPORALE
4. Rosa ZAFFINO
5. Marco PAPAGNO
6. Adalisa TALLARICO
7. Maria Francesca DE FRANCESCHIS
8. Giuseppe AUDDINO
9. Gianluigi FILIPPELLI

(XIX Cycle)

1. Mario COMMISSO
2. Tony APOLLARO
3. Sergio SERVIDIO
4. Claudia GIALLOMBARDO
5. Antonio POLICICCHIO

(*XX Cycle*)

1. Rossella DE MARCO
2. Salvatore FAZIO

3. Alfonso POLICICCHIO
4. Daniela SALVATORE

TECHNICAL AND ADMINISTRATIVE STAFF

Administration

1. Giocondo PERRI (*Administrative Secretary*)
2. Gaspare PECORA (*Vice-Administrative Secretary*)
3. Lidia MAIDA
4. Anna Eduardina PASTORE

Secretary

5. Luigina DE ROSE
6. Luigi PARISE

Teaching Laboratories

7. Mario LOMBARDI
8. Giovanni VIAPIANA (*Person in charge*)

Computer Staff

9. Nicola GUARRACINO (*Person in charge*)
10. Fedele STABILE

Research Laboratories

Molecular Physics and Biophysics
11. Bruno DE NARDO (*Person in charge*)
12. Carmine PRETE

Ion-Matter Interaction and Surface Electronic Spectroscopy

13. Eugenio LI PRETI (*Person in charge*)
14. Vito FABIO

Elementary Particles

15. Francesco SCIOMMARELLA
16. Francesco PELLEGRINO

Geophysics

17.Gerolamo LATORRE

The Physics Department hosts a INFM Section with the following staff:
Sonia VIVONA (*Administrative Official - INFM*)
Antonio BOZZARELLO (*Administrative Collaborator*)

Department phonebook
(for calls from outside the Department, dial first (+39)-0984-49)

INTERNET: @FIS.UNICAL.IT
HTTP: WWW.FIS.UNICAL.IT
FAX: 4401

ALZETTA Renzo	6028
AGOSTINO Raffaele	6162
BARBERI Riccardo	6118-6150
BARRA Orazio	6171
BARTOLINO Roberto	6122
BARTUCCI Rosina	6074-6073
BLINOV Lev	6124
BONANNO Assunta	6170-6178
RICCARDI Pierfrancesco	6171
BOZZARELLO Antonio	6008
CAMARCA Michele	6172-6178
CANNELLI Gaetano	6155
CAPUA Marcella	6022
CAPUTI Lorenzo	6154-6173
CARBONE Vincenzo	6131-6033
CAZZANELLI Enzo	6114-6142
CHIARELLO Gennaro	6157-6174
CIPPARRONE Gabriella	6115-6148
COLAVITA Elio	6156-6174
CROSETTI Giovanni	6021
DE NARDO Bruno	6111-6106
DE ROSE Luigina	6001
DE SANTO Maria Penelope	6150
FABIO Vito	6076-6166
FALCONE Giovanni	6057
FIORE Roberto	6018
FORMOSO Vincenzo	6161
GIULIANO Domenico	6025
GRECO Antonella	6132
GUARRACINO Nicola	6030
GUERRA Ignazio	3166
GUZZI Rita	6077-6073
LA ROTONDA Laura	6014-6102
LAMANNA Ernesto	6020-6103
LATORRE Gerolamo	3664
LI PRETI Eugenio	6179-6165
LOMBARDI Mario	6083
MAIDA Lidia	6006
MALARA Francesco	6135-6033
OLIVA Antonino	6167-6178
PAPA Alessandro	6015
PAPAGNO Luigi	6158-6174
PARISE Luigi	6002
PECORA Gaspare	6005
PELLEGRINO Francesco	6102-6098
PERRI Giocondo	6004
PIPERNO Franco	6058
PLASTINA Francesco	6046
PRETE Carmine	6142
PRIMAVERA Leonardo	6138
SCARAMUZZA Nicola	6113-6151
SCHIOPPA Marco	6017-6104
SCIOMMARELLA Francesco	6011
SPORTELLI Luigi	6076-6073
STABILE Fedele	6027
STRANGI Giuseppe	6120
SUSINNO Giancarlo	6016-6104
UMETON Cesare	6117-6152
VELTRI Pierluigi	6136-6033
VERSACE Carlo	6116-6147
VIAPIANA Giovanni	6053
VIOLINI Galileo	6024
VIVONA Sonia	6007
XU Fang	6168-6178
ZIMBARDO Gaetano	6134-6033

Network and Computer Service	*6035*
Medical Physics Lab.	*6068*
Astrophysical Plasmas Computer Lab.	*6033*
Ion-Matter Interaction Lab.	*6178*
Electronic Spectroscopy Lab.	*6174*
Biophysics Lab.	*6073*
Molecular Physics Lab.	*6151*
Particle Physics Lab.	*6104*
Optics Lab.	*6152*
Mechanical Workshop	*6006*

SEMINARS (2005)

18 gennaio 2005
Prof. Galileo Violini, Dipartimento di Fisica, Università della Calabria, *Kaon-Nucleon physics at intermediate, low and unphysical energies revisited*

1 giugno 2005
Prof. Derek Marsh, MPI, Gottingen, *Comparing and contrasting high field and time-resolved EPR of spin-labels in lipid membranes.*

14 giugno 2005
Dott. Roberto Cimino, INFN-LNF, *Potenzialita' dei Laboratori Nazionali INFN di Frascati per studi di R&D*

8 luglio 2005
Prof. B. Alles, INFN-Pisa, *Limiti sulla (non) rottura di parita`in QCD tramite l'operatore di carica topologica*

13 luglio 2005
Prof. Gaetano Zimbardo, Dipartimento di Fisica, Università della Calabria*, Plasma stellare e interazione vento solare-terra*

20 luglio 2005
Prof. Piotr Pieranski, Poznan University of Technology, Poland, *La fisica dei nodi*

20 Luglio 2005
Prof. Janos B. Nagy, Università di Namur, Belgio, *Nanotubi di Carbonio: sensori e materiali nanocompositi*

21 luglio 2005
prof. Piotr Pieranski, Poznan University of Technology, Poland, *La fisica del colpo di frusta - La fisica dei* nodi

5 settembre 2005
Prof. A. Flachi,Yukawa Inst., Kyoto, *Escape of black holes from the brane*

20 settembre 2005
Dr. Pietro Giudice, Dipartimento di Fisica, Università della Calabria, *Teorie di gauge su reticolo a temperatura e densità fin*ite

20 settembre 2005
Dr. Francesco Caporale, Dipartimento di Fisica, Università della Calabria, *Studio di processi di collisione ad alta energia*

22 settembre 2005
Dr. Antonio Vecchio, Dipartimento di Fisica, Università della Calabria*, The Proper Orthogonal Decomposition as a technique for the analysis and modelling of complex systems:....*

22 settembre 2005
Dott.ssa Giuseppina Nigro, Dipartimento di Fisica, Università della Calabria, *Turbulent Models for Solar Flares and Astrophysical Dynamos*

27 settembre 2005
Dott.ssa Maria Francesca De Franceschis, Dipartimento di Fisica, Università della Calabria, *Dissipazione di Onde di Alfvén nelle Strutture Coronali*

27 settembre 2005
Dr. Alessandro Veltri, Dipartimento di Fisica, Università della Calabria, *Models for photo-induced formation of permanent diffraction gratings*

28 settembre 2005
Prof. G. Volkov, Serpukhov, IHEP, Mosca, *Hunting for new symmetries in Kalabi-Yau jungles*

29 settembre 2005
Dott.ssa Rosa Letizia Zaffino, Dipartimento di Fisica, Università della Calabria, *Critical properties of two-level atom systems interacting with a radiation field*

29 settembre 2005
Dr. Giuseppe Avolio, Dipartimento di Fisica, Università della Calabria, *Test dello spettrometro a muoni dell'esperimento ATLAS nella zona sperimentale H8 presso il CERN di Ginevra*

4 ottobre 2005
Dott.ssa Cristina Adorisio, Dipartimento di Fisica, Università della Calabria , *Ageing studies of Atlas Muon Spectrometer drift tubes @ CERN Gamma Irradiation Facility and Observability of MSSM Neutral Higgs Bosons via Sparticle Decay Modes in ATLAS*

4 ottobre 2005
Dr. Pasquale Federico Zema, Dipartimento di Fisica, Università della Calabria, *GNAM: un sistema di monitoring a basso livello per l'esperimento ATLAS.*

5 ottobre 2005
Dr. Paolo Vetrò, Dipartimento di Fisica, Università della Calabria, *Caratterizzazione di difetti nei solidi attraverso spettroscopie di luminescenza: problematiche e possibili applicazioniapplicazioniMercoledì*

5 ottobre 2005
Dott.ssa Adalisa Talarico, Dipartimento di Fisica, Università della Calabria, *Studio della variabilita' spaziale della concentrazione di Radon nei gas del suolo utilizzando il Kriging multigaussiano*

5 ottobre 2005
Dr. Marco Papagno, Dipartimento di Fisica, Università della Calabria, *Electronic structure study of low-dimensional systems with Angle-Resolved Photoemission Spectroscopy"*

11 ottobre 2005
Prof. Angelo Vulpiani, Università La sapienza, Roma, *Il moto browniano: origine di un problema*

12 ottobre 2005
Prof. Angelo Vulpiani, Università La sapienza, Roma, *Il moto browniano: caos deterministico e rumore*

Prof.ssa Margherita Hack, Università di Trieste, *Scoperta di pianeti extrasolari e probabilità di vita*

13 ottobre 2005
Dr. G. Paolucci, Sincrotrone ELETTRA, Trieste, *La luce di sincrotrone per l'indagine della materia: il laboratorio ELETTRA di Trieste*

13 Ottobre 2005
Prof. V. Shibaev, Chemistry Department of Moscow State University Lenin Hills, *Liquid Crystalline Photocromic Polymer as a novel type of Photooptical Active Media*

18 ottobre 2005
Dr. Alain Noullez, Observatoire de la Cote d'Azur, Nice, *Turbulent velocity measurements using nonintrusive optical techniques*

19 ottobre 2005
Prof. Mario Calvetti, *I Laboratori Nazionali di Frascati oggi e il possibile futuro*

7 Novembre 2005
Prof. Maurizio Prato, Università di Trieste, *Nanostrutture del Carbonio: Sintesi e applicazioni*

8 novembre 2005
Dr. Andrea Goldoni, Sincrotrone Elettra-Trieste, *Proprietà fisiche delle nanostrutture di carbonio*

22 novembre 2005
Dr. Enrico Maccallini, Department of physics- Groningen , *Intercalation compounds of Smectite Clays*

1 Dicembre 2005
Prof. G. Cannelli, Dipartimento di Fisica, Università della Calabria, *Dinamica dell'idrogeno nei solidi mediante la Spettroscopia anelastica*

15 dicembre 2005
Prof. Ugo Zammit, Dipartimento di Ingegneria Meccanica, Università di Roma 2, *Metastabilità e comportamento vetroso nei Cristalli Liquidi con disordine random statico*

19 dicembre 2005
Prof. F. Buccella, Università di Napoli - *Distribuzioni dei partoni ispirate alle statistiche quantiche*

19 dicembre 2005
Prof.ssa G. Pancheri, INFN - Lab. Naz. Frascati, *Bruno Touschek e la nascita delle collisioni e+e-*

LAUREA THESIS' IN 2005

may 5

Erminia INFUSINO
Proprietà vibrazionali di ossigeno-ossido di carbonio e idrogeno-ossido di carbonio coadsorbiti sulla superficie di Ni(100).
Relatore: Prof. Elio COLAVITA

Domenico IMPIOMBATO
Nanotubi di carbonio:produzione,caratterizzazioni ed effetti indotti da bombardamento ionico.

Relatore*:* prof. Luigi PAPAGNO

Mario GRAVINA
Studio numerico di propriet‡ critiche del modello di Potts a tre stati in tre dimensioni.
Relatore: Prof. Alessandro PAPA

Antonio Raimondo MARINO
Studio vibrazionale del sistema CO/Ni(100) mediante spettroscopia ad alta risoluzione in perdita di energia di elettroni (HREELS).
Relatore: Prof.: Gennaro CHIARELLO

Gaetano NICASTRO
Differenti trattamenti di superfici e ricostruzione d'ordine in cristalli liquidi nematici.
Relatore: Prof.: Nicola SCARAMUZZA

Tania RUGIERO
Fotoluminescenza di molecole anisotrope: il controllo elettro-ottico.
Relatore: Prof. Riccardo BARBERI

Ivan SINOPOLI
Stime radioprotezionistiche nella radioterapia tiroidea attraverso la simulazione di un fantoccio antropomorfo.
Prof.: Ernesto LAMANNA

Marianna STUMPO
Utilizzo di modelli Meteo-Marini per l'analisi del moto ondoso lungo le coste calabresi.
Prof.: Carlo BELLECCI

July 26

Andrea BORRELLI
Utilizzo dei modelli meteo-marini per la previsione del moto ondoso lungo le coste calabresi.
Relatore: Prof. Carlo BELLECCI

July 28

Antonio MAZZUCA
Analisi dei fenomeni discreti della luce in strutture periodiche.
Relatore: Prof. Cesare UMETON

October 5

Francesca MASTROPIETRO
Tests on Resistive Plate Chambers for the OPERA experiment.
Relatore: Prof. Giancarlo SUSINNO
1st LEVEL DEGREE THESIS' IN 2004

July 28

Roberta VASTA
Conduttanza in contatti puntiformi come misura della carica localizzata in un doppio punto quantico.
Relatore: Dr. Domenico GIULIANO

Alessandra APICELLA
Fase geometrica in un doppio punto quantico.
Relatore: Dr. Domenico GIULIANO

Massimo MASCIARI
Contributo alla carta magnetica della Calabria: rilievi nell'area del bordo centro-meridionale della Sila
Relatore: Prof. Ignazio GUERRA

October 10

Gianfranco MORELLO
Misura della variazione del fattore di moltiplicazione dei tubi a deriva delle camere di precisione dello spettrometro per muoni dell'esperimento ATLAS in un test di invecchiamento con neutroni epitermici della facility TAPIRO dell'ENEA-Casaccia.
Relatore: Prof. Marco SCHIOPPA

Melissa INFUSINO
Effetti della radiazione di neutroni epitermici sull'efficienza di rivelazione di una camera di precisione dello spettrometro per muoni dell'esperimento ATLAS al CERN di Ginevra.
Relatore: Prof. Marco SCHIOPPA

Sandro DONATO
La natura non lineare dell'attrito.
Relatore: Prof. Vincenzo CARBONE

Serena DALENA
Simulazioni cinetiche dello strato di Harris.
Relatore: Prof. Pierluigi VELTRI

October 25

Luciano NICCOLI
Fenomeni fito-climatici ed erosione costiera in provincia di Cosenza: studio con tecniche di telerilevamento
Relatore: Prof. Ignazio GUERRA

Federico SALATINO
Il telerilevamento come strumento per il monitoraggio di un'area protetta: un'applicazione al Parco della Sila
Relatore: Prof. Ignazio GUERRA

Giuseppe SALLORENZO
Applicazione del telerilevamento per studi territoriali: evoluzione dell'abitato di Cosenza dal 1954 al 2000
Relatore: Prof. Ignazio GUERRA

December 15

Dario STELITANO
Generazione di una griglia adattiva per la descrizione e la modellizzazione spazio-temporale delle precipitazioni in Calabria
Relatore: Prof. Vincenzo CARBONE

Stefania SACCO
Formazione di immagini medicali con apparecchiature Tc.
Relatore: Prof. Antonino OLIVA

Marco ROMEO
Evoluzione cosmologica delle probabilit‡ di cluster delle nubi Ly-alpha negli spettri d'assorbimento dei Quasars.
Relatore: Prof. Vincenzo CARBONE

Iva NURCIA
Intermittenza della turbolenza del vento solare: analisi delle leggi di scala anomale dei parametri magnetici di plasma misurati dal satellite ISEE3.
Relatore: Prof. Vincenzo CARBONE

Lucantonio MUSTICA
Analisi dati di serie temporali da misure meteorologiche.
Relatore: Prof. Vincenzo CARBONE

Ersilia LEONARDIS

Elaborzione dati in frequenze dei moti convettivi sulla superfice solare.
Relatore: Prof. Pierluigi VELTRI

Teresa GRANATA
Formazione stellare e turbolenza comprimibile.
Relatore: Prof. Vincenzo CARBONE

Francesca DI MARE
Frequenze di risonanza negli archi coronali.
Relatore: Prof. Pierluigi VELTRI

Francesco CARBONE
Azione laser random in cristalli liquidi nematici.
Relatore: Dr. Giuseppe STRANGI

2nd LEVEL DEGREE THESIS' IN 2005

July 27

Marina MINNITI
Ruolo della promozione elettronica nell'emissione cinetica di elettroni da superfici di alluminio bombardate con ioni Kripton.
Relatore: Dr. Pierfrancesco RICCARDI

Antonio POLITANO
Stati elettronici confinati sulla superficie di Cu (111) e di Na/Cu (111): Misure di spettroscopia ad alta risoluzione di perdita di energia degli elettroni.
Relatore: Prof. Gennaro CHIARELLO

Rossella FALCONE
La teoria di Gauge su (3) a temperatura finita sul reticolo.
Relatore: Prof. Alessandro PAPA

Silvia PERRI
Problemi diffusivi in campi elettromagnetici stocastici.
Relatore: Prof. Vincenzo CARBONE

PhD THESIS' in 2005 (XVII Cycle)

Dr. Pietro GIUDICE
Teorie di gauge su reticolo a temperatura e densita' finite
SUPERVISORE: Prof. Alessandro PAPA

Dr. Francesco CAPORALE
Studio di processi di collisione ad alta energia
SUPERVISORE: Prof. Alessandro PAPA

Dr. Antonio VECCHIO
The Proper Orthogonal Decomposition as a technique for the analysis and modelling of complex systems:....
SUPERVISORE: Prof. Vincenzo CARBONE

Dott.ssa Giuseppina NIGRO
Turbulent Models for Solar Flares and Astrophysical Dynamos
SUPERVISORE: Prof. Pierluigi VELTRI

Dott.ssa Maria Francesca DE FRANCESCHIS
Dissipazione di Onde di Alfvén nelle Strutture Coronali
SUPERVISORE: Prof. Francesco MALARA

Dr. Alessandro VELTRI
Models for photo-induced formation of permanent diffraction gratings
SUPERVISORE: Prof. Cesare UMETON

Dott.ssa Rosa Letizia ZAFFINO
Critical properties of two-level atom systems interacting with a radiation field
SUPERVISORE: Prof. Renzo ALZETTA

Dr. Giuseppe AVOLIO
Test dello spettrometro a muoni dell'esperimento ATLAS nella zona sperimentale H8 presso il CERN di Ginevra
SUPERVISORE: Prof. Giancarlo SUSINNO

Dott.ssa Cristina ADORISIO
Ageing studies of Atlas Muon Spectrometer drift tubes @ CERN Gamma Irradiation Facility and Observability of MSSM Neutral Higgs Bosons via Sparticle Decay Modes in ATLAS
SUPERVISORE: Prof. Giancarlo SUSINNO

Dr. Pasquale Federico ZEMA
GNAM: un sistema di monitoring a basso livello per l'esperimento ATLAS.
SUPERVISORE: Prof. Marco SCHIOPPA

Dr. Paolo VETRÒ
Caratterizzazione di difetti nei solidi attraverso spettroscopie di luminescenza: problematiche e possibili applicazioniapplicazioniMercoledi'
SUPERVISORE: Prof. Antonino OLIVA

Dott.ssa Adalisa TALARICO
Studio della variabilita' spaziale della concentrazione di Radon nei gas del suolo utilizzando il Kriging multigaussiano
SUPERVISORE: Prof. Giovanni FALCONE

Dr. Marco PAPAGNO
Electronic structure study of low-dimensional systems with Angle-Resolved Photoemission Spectroscopy"
SUPERVISORE: Prof. Gennaro CHIARELLO

1. ASTROPHYSICS

Professors and Researchers: Pierluigi Veltri
Vincenzo Carbone
Francesco Malara
Gaetano Zimbardo
Leonardo Primavera
Antonella Greco
Luca Sorriso-Valvo (*LICRYL, INFM/CNR Cosenza*)

Postdoc fellows Pierre Pommois
Fabio Lepreti
Nicolas Décamp

PhD students Rosita De Bartolo
Antonio Vecchio
Maria Francesca De Franceschis
Giuseppina Nigro
Sergio Servidio
Rossana De Marco

Collaborators Francesco Valentini *(University of California, San Diego, USA)*
Marco Onofri *(Aristotle University, Thessaloniki, Greece)*
Loukas Vlahos *(Aristotle University, Thessaloniki, Greece)*
Thomas O'Neil *(University of California, San Diego, USA)*
Dan Dubin *(University of California, San Diego, USA)*
André Mangeney (*Observatoire de Paris-Meudon, Paris, France*)
Roberto Bruno *(IFSI - CNR, Frascati, Italy)*
Bruno Bavassano *(IFSI - CNR, Frascati, Italy)*
Giancarlo Alfonsi *(Università della Calabria,Cosenza, Italy)*
Thomas Straus *(INAF, Osservatorio Astronomico di Capodimonte,Italy)*
Ignazio Guerra *(Università della Calabria,Cosenza, Italy)*
Paolo Harabaglia *(Università della Basilicata, Potenza, Italy)*
Alexandre Taktakishvili *(Abastumani Observatory, Tbilisi, Georgia, and University of Texas at El Paso, USA)*
Alexander Milovanov *(Space Research Institute, Mosca, Russia)*
Lev Zelenyi *(Space Research Institute, Mosca, Russia)*
Sergei Savin *(Space Research Institute, Mosca, Russia)*
Ermanno Amata *(IFSI - CNR, Frascati, Italy)*
Giuseppe Consolini *(IFSI - CNR, Frascati, Italy)*
Wieslaw M. Macek, *(Space Research Centre, Polish Academy of Sciences, Warsaw, Poland)*
Fabio Reale *(Università di Palermo, Palermo, Italy)*
Giovanni Peres *(Università di Palermo, Palermo, Italy)*
Vanni Antoni *(Consorzio RFX - CNR, Padova, Italy)*
Alessandro Ippolito *(Università della Calabria,Cosenza, Italy)*
Alain Noullez *(Observatoire de la Cote d'Azur, Nice, France)*
Angelo Vulpiani, *(Università "La Sapienza", Rome, Italy)*

Introduction

The research in Astrophysics in the Physics Department of University of Calabria is mainly devoted to study plasmas. Most of interplanetary matter and of the solar atmosphere is actually formed by plasma. For that reason, most of data obtained in space missions, or by solar observatories, can be interpreted within the framework of plasma physics. Such data have allowed for the construction of models describing astrophysical phenomena, and they have represented a powerful tool of investigation which has often given new perspectives for the comprehension of phenomena in fundamental physics. This has allowed to use the space as a huge laboratory where measurements not accessible in a terrestrial laboratory can be performed. On the other hand, using analogue techniques both on space and on laboratory measures allows for a comparison of the basic physical phenomena that take place on completely different

scales, and for a comprehension of such phenomena, which are relevant both in the domain of controlled thermonuclear fusion and in the perspective of industrial applications.

The group of Astrophysical Plasmas of Calabria University has been involved in such kind of problems, in collaboration with other groups of Italian universities (Palermo, Basilicata) and with Italian Institutions (IFSI - CNR of Frascati, RFX - CNR of Padova, Osservatorio di Capodimonte) and foreign Institutions (Observatoire de Paris-Meudon, Space Research Institute, Moscow, University of California, Aristotle University of Thessaloniki, Abastumani Astrophysical Observatory, Tbilisi, Georgia). The specific research themes under study during the year 2005 are indicated in the following.

1.1 PLASMA ASTROPHYSICS

1.1.1 Magnetohydrodynamic waves and turbulence in the solar atmosphere and in the solar wind

Convective turbulence, global oscillations and solar activity

The interior of the Sun behaves like a resonant cavity, which supports the excitation of global oscillations at peculiar discrete frequencies. In presence of a gravitational field and density stratification, two modes can be excited, namely acoustic p-modes and gravitational g-modes. Since g-modes are concentrated near the centre of the Sun, they represents privileged probes to access the physics of the deep interior. Their observations, so far not unambiguously established, should furnish a fundamental improvement for heliosismology. Solar oscillations compete with a different process, namely the turbulent convection within the photosphere observed as a stochastic spatio-temporal behaviour of granulae that cover the whole surface of the Sun (except in sunspots). We investigated the spatio-temporal dynamics of the solar photosphere by performing a Proper Orthogonal Decomposition (POD) of line of sight velocity fields computed from high resolution data coming from the MDI instrument onboard the SOHO satellite. Using this technique, we are able to identify and characterize the different dynamical regimes acting on the system. Low-frequency oscillations, with frequencies in the range 20-130 micro-Hz, dominate the most energetic modes (excluding solar rotation), and are characterized by spatial patterns with typical scales of about 3000 km (the scale of the solar granulation). Patterns with larger typical scales, of the order of 10000 km, are associated to p-modes oscillations at frequencies of about 3000 micro-Hz.

The POD have been used also to investigate the spatio-temporal features of the solar activity. Rather than the usual sunspots, daily observations of the green coronal emission in the period 1949-1996 are used as indicator of the 11-years solar cycle. We show that few POD modes suffice in describing both the space and time main periodicities. In particular two POD modes are enough to describe both the 11-years time periodicity and the "butterfly" diagram of the migration of active regions. Moreover, apart for the basic periodicity, we found evidences for further intercycle temporal periodicities.

Alfvén wave dissipation in 3D coronal structures

The dissipation of Alfvén waves is one of the physical mechanisms proposed to explain the heating of the solar corona. Because of the very high values of the effective Reynolds/Lundquist number, the problem is how to move the wave energy on sufficiently small scales to be dissipated. In three-dimensional structures dissipative mechanisms are particularly efficient, since small scales can be generated exponentially ("fast dissipation" regime). Such a regime has been studied using WKB models for compressible plasmas. A quantitative evaluation has been obtained by using a realistic model of the coronal magnetic field above a quiet-Sun region. The effects of energy leakage through the coronal base, as well as the effect of open magnetic lines and conversion into magnetosonic waves have been included, thus obtaining a detailed energy balance between dissipation and losses.

Turbulent models of nanoflares

In coronal closed magnetic structures photospheric motions inject energy in form of Alfvénic fluctuations propagating along the magnetic field in both directions. Nonlinear interactions give rise to an energy cascade to small scales, which finally leads to events of energy dissipation, which have been related to nanoflares. Using a hybrid shell model, based on RMHD equations, we have reproduced several statistical properties of nanoflares: distributions of energy, peak power, durations and waiting time. The model indicates large-scale velocity fluctations work as a trigger for the energy cascade. Thus, increses of such fluctuations, due to resonance phenomena, are directly related to the generation of a nanoflare event, in accordance with observations. The results of this model have been used as input for a hydrodynamic loop model, in which both thermodynamic and radiative phenomena are described. The resulting temporal behaviour of the loop, as well as the corresponding formation of some spectral lines, compares favorably with observations.

Particle acceleration by Fermi mechanism

In 1949 E. Fermi introduced a model that describes the acceleration of charged particles to very high energies, thus explaining the observed spectral properties of cosmic rays. The Fermi's model is based on the estimation of the probability of the occurrence of stochastic encounters of a charged particle with magnetized interstellar clouds. We

investigated the dynamics of a realization of Fermi's relativistic acceleration mechanism that is a charged test particle oscillating between two reflecting plates that moves stochatiscally. By allowing the charge to radiate energy during each collision, we find that two main features of the system: 1) due to the radiation drag the energy gained by the particle is bounded, 2) the radiated energy represents a typical realization of an on-off intermittent process, due to numerous encounters with a very small emission, interrupted by short and intense bursts of radiation. This intermittent radiative process exhibits non-gaussian statistical features.

Turbulence and particle acceleration in microflares

A relevant fraction of the energy of a flare is released in form of relativistic particles; a similar phenomenon is also observed in microflares, but at lower energies. There are indication that particle acceleration could be related to the turbulent state of the coronal plasma. We set up a model of particle acceleration in a developed MHD turbulence. The effect of the parallel resistive electric field is considered, which is mostly relevant at the smallest dissipative scales. The electric field is represented by a synthetic turbulence technique which is able to describe the effects of spatial intermittency. Particle distribution and their time evolution is reconstructed by a test particle method. The model shows that a tail of nonthermal high energy particles can be generated, in form of a power-law. Acceleration takes place within few tenths of seconds and the efficiency is related to the spectral energy flow in the turbulence, through the amplitude of large-scale velocity fluctuations. These feature compare well with observations. Moreover, the model clarifies the importance of intermittency in determining the high energy part of particle distributions.

Turbulence and scale laws in the solar wind

The scale laws of turbulent low-frequency fluctuations in the solar wind have been studied in the past, mainly for the velocity field, and it has been shown that they are not different from those measured in ordinary fluids. The magnetic field presents characteristic scale laws which are similar to those of passive scalars measured in laboratory experiments. Such scale laws are also different from those of magnetic field observed in fusion plasmas. We have used spacecraft data to study problems related to the active or passive role that magnetic field plays in the solar wind. We have performed a series of statistical data analyses, using wavelet transform and based on: a) identification of intermittent events at all the scales; b) statistical properties as quiet times, Poissonian statistics, etc.; c) the possible interconnection between intermittent events in the velocity and magnetic field. We have studied the scale laws of fluctuations of the angle between magnetic and velocity field, at different scales and at different distances from the Sun. Hence, from MHD equations we have phenomenologically obtained the scale laws of the defined quantities. These comparisons can be used as a further test to verify to which extent MHD describes solar wind turbulence.

Turbulence generated by magnetic tearing instabilities

In the Earth magnetotail current sheet, as well as in the current sheet of a plasma device as the RFX, a higher turbulence level has been identified, whose origin is probably the tearing instability which develops in the presence of a polarity inversion of the magnetic field. The nonlinear evolution of such instability generates a turbulence through energy transfer from large to small scales. It is also responsible for the formation of large scale structures in consequence of magnetic island coalescence. A 3D MHD simulation code has been built up to study a configuration where unstable modes develop at different resonance surfaces. The results show that in the presence of a guide field the nonlinear evolution is characterized not only by mode coalescence on a single resonant surface but also by a direct energy cascade to resonant surfaces increasingly distant from the current sheet center, with the consequent formation of small scale structures on the sides. We have studied the spectral properties of the resulting turbulence, as spectral index and anisotropy, at different locations within the current sheet. Such properties can be compared with measures in the magnetotail current sheet.

1.2 NORMAL AND ANOMALOUS TRANSPORT PROCESSES IN THE HELIOSPERE

High energy charged particle diffusion in the solar wind

Particle transport in the solar wind strongly depends both on the magnetic structure and on the turbulence of the solar wind. The presence of magnetic turbulence in the heliosphere has the effect of a non-collisional charged particle diffusion; such a mechanism has a crucial importance for the cosmic ray transport and for the propagation to the Earth of energetic particles generated by solar events through the solar wind. We have shown by numerical simulation that different transport regimes can be obtained, i.e. Non Gaussian transport regimes which include superdiffusion and subdiffusion. We have assessed how these anomalous transport regimes depend on the turbulence level, on the turbulence anisotropy, and on the ratio of the Larmor radius over the correlation length.

Anomalous diffusion in the Earth magnetopause and magnetotail

The plasma transport across the magnetopause has been studied by a test particle simulation in which a sheared background magnetic field is included, as well as a model turbulence similar to that observed in the Earth

magnetopause. This model has allowed us to calculate the plasma flux across the magnetopause. We are now considering the transport of ionospheric oxygen across the magnetopause. Moreover, we have developed a hybrid numerical model of the far magnetotail. Studying the test particle behaviour in this model we have shown that the current can break in two separate sheets, in accordance with some observations of the CLUSTER spacecraft. This study have been carried out in collaboration with researchers of the Space Research Institute of Moscow and of the Abastumani Astrophysical Observatory of Tbilisi.

Anomalous transport processes in the solar transition region and in coronal loops

The solar transition region represents the border between a region dominated by a collisional transport (photosphere) and a non-collisional region (the corona). In order to study the transport processes in these conditions we have developed a new Montecarlo numerical code which iteratively solves the Boltzmann equations. It allows us to calculate the evolution of electron distribution function and to evaluate the departures from a Maxwellian. The code has allowed us to build a new model of the solar transition region.

The solar corona plasma is structured by the magnetic field which often assumes a loop-like structure. Inside these structures a non negligible level of magnetic turbulence can be generated. In collaboration with collegues from the Aristotle University of Thessaloniki, we have developed a numerical model to study the transport of particles accelerated by a flare inside the loop. It is found that some particles can be mirror trapped by the magnetic fluctuations, while others can free stream toward the loop foopoints, corresponding to anomalous transport regimes. In general, a non Gaussian transport behaviour is found.

1.3 LABORATORY PLASMAS

1.3.1 Simulations of nonlinear kinetic waves by Vlasov codes

In kinetic theory, the time evolution of the distribution function obeys a continuity equation (Vlasov equation), when collisions between particles are absent. The Vlasov equation is a nonlinear partial differential equation, whose analytical solution is avalaible only in a few simplified linear cases, but the nonlinear regime, including the most interesting physical phenomensa, must be investigated numerically. Using newly developed numerical codes and thanks to the development of high performance computing systems, we numerically investigated the nonlinear evolution of the plasma system in a high dimension phase space (1D in physical space and 3D in velocity space). We analyzed the propagation of waves in kinetic plasmas, in both magnetized and unmagnetized case, focusing on the nonlinear energy exchange between waves and particles trapped in the wave potential well. Trapped particle populations appear as vortex structures in the distribution function, whose stability and tendency to merge is studied using higly refined numerical grids. For this purpose, the parallelizzation of the numerical algorithms is crucial in exploting the computing power of the modern massive parallel computers.

1.3.2 Self-organization in dynamical models of laboratory plasmas

We investigated the inviscid nonlinear dynamics of a low-beta plasma, through a dynamical system obtained by a Galerkin projection of MHD equations. We show that a single Fourier mode dominates over the whole energy spectrum, a self-organization mechanism within turbulence being responsible for this effect. Our results are in agreement with observations of an analogous phenomenon, say the emergence of a quasi single-helicity stato in reversed field pinch laboratory plasmas.

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. F. Valentini , V. Carbone, P. Veltri, A. Mangeney,
Self-consistent Lagrangian study of nonlinear Landau damping,
Physical Review **E71** (2005) 017402/1-4.

2. F. Valentini, P. Veltri, A. Mangeney,
Magnetic-field effects on nonlinear electrostatic-wave Landau damping,
Physical Review **E71** (2005) 016402/1-8.

3. R. Bruno, V. Carbone, B. Bavassano, L. Sorriso-Valvo,
Observations of magnetohydrodynamic turbulence in the 3D heliosphere,
Advances in Space Research **35** (2005) 939-959.

4. A. Vecchio, V. Carbone, F. Lepreti, L. Primavera, L. Sorriso-Valvo, P. Veltri, G. Alfonsi, Th. Straus,
Proper Orthogonal Decomposition of Solar Photospheric Motions,
Physical Review Letters **95** (2005) 061102/1-4.

5. V. Carbone, L. Sorriso-Valvo, P. Harabaglia, I. Guerra,
Unified scaling law for waiting times between seismic events,
Europhysics Letters **71** (2005) 1036-1042.

6. S. Servidio, V. Carbone,
Nonlinear Dynamics of Inviscid Reduced MHD Plasmas: The Appearance of Quasi-Single-Helicity States,
Physical Review Letters **95** (2005) 045001/1-4.

7. F. Valentini,
Nonlinear Landau damping in nonextensive statistics,
Physics of Plasmas **12** (2005) 072106/1-7.

8. F. Valentini, P. Veltri, A. Mangeney,
A numerical scheme for the integration of the Vlasov-Poisson system of equations, in the magnetized case,
Journal of Computational Physics **210** (2005) 730-751.

9. F. Valentini, V. Carbone, P. Veltri, A. Mangeney,
Wave-particle interaction and nonlinear Landau damping in collisionless electron plasmas,
Transport Theory and Statistical Physics **34** (2005) 89-101.

10. A. Greco, A. Taktakishvili, G. Zimbardo, P. Veltri, L. M. Zelenyi,
Ion transport through the turbulent magnetopause: calculations of the distribution function moments,
Planetary and Space Science **53** (2005) 141-147.

11. S. Savin, L. Zelenyi, E. Amata, A. Greco, S. Klimov, R. E. Lopez, A. Taktakishvili, P. Veltri, G. Zimbardo, et al.,
Magnetosheath interaction with high latitude magnetopause: Dynamic flow chaotization,
Planetary and Space Science **53** (2005) 133-140.

12. G. Consolini, M. Kretzschmar, A. T. Y. Lui, G. Zimbardo, W. M. Macek,
On the magnetic field fluctuations during magnetospheric tail current disruptions: a statistical approach,
Journal of Geophysical Research - Space Physics **110** (2005) A07202- A07214.

13. P. Pommois, G. Zimbardo, P. Veltri,
Energetic particle transport in anisotropic magnetic turbulence,
Adv. Space Res. **35** (2005) 647-652.

14. A. Ippolito, P. Pommois, G. Zimbardo, P. Veltri,
Magnetic connection from the Earth to the solar corona, flare positions, and solar energetic particle observations,
Astronomy and Astrophysics **438** (2005) 705-711.

15. G. Zimbardo,
Anomalous particle diffusion and Levy random walk of magnetic field lines in three-dimensional solar wind turbulence,
Plasma Phys. Control. Fusion **47** (2005) B755- B767.

16. A. Vecchio, L. Primavera, V. Carbone, L. Sorriso-Valvo,
Periodic behavior and stochastic fluctuations of solar activity: Proper Orthogonal Decomposition analysis,
Solar Physics **229** (2005) 359.

17. P. Veltri, G. Nigro, F. Malara, V. Carbone, A. Mangeney,
Intermittency in MHD Turbulence and Coronal Nanoflares Modelling,
Nonlinear Processes in Geophysics **12** (2005) 245-255.

18. F. Reale, G. Nigro, F. Malara, G. Peres, P. Veltri,
Modeling a coronal loop heated by MHD-turbulence nanoflares,
Astrophysical Journal **633** (2005) 489-498.

19. G. Nigro, F. Malara, P. Veltri,
Large Amplitude Velocity Fluctuations in Coronal Loops: Flare Drivers?,
Astrophysical Journal **629** (2005) L133-L136.

20. F. Malara, M. F. De Franceschis, P. Veltri,
Dissipation of Alfvén waves in complex 3D coronal force-free structures,
Astronomy and Astrophysics **443** (2005) 1033-1046.

21. G. Alfonsi, L. Primavera,
A Parallel Computational Code for the Eduction of Coherent Structures of Turbulence in Fluid Dynamics,
Springer Lecture Notes in Computer Science **3606** (2005) 381-392.

22. G. Alfonsi, L. Primavera,
Description of Turbulent Events Through the Analysis of POD Modes in Numerically Simulated Turbulent Channel Flow,
Springer Lecture Notes in Computer Science **3514** (2005) 623-630.

23. R. Bruno, and V. Carbone,
The Solar Wind as a Turbulence Laboratory,
Living Review in Solar Physics **2** (2005) 4-186.

24. V. Carbone, F. Lepreti, L. Sorriso-Valvo, P. Veltri, V. Antoni, R. Bruno,
Scaling laws in plasma turbulence,
La Rivista del Nuovo Cimento **27** (2005) 1-108.

A.1.2 Publications on international journals accepted in 2005

1. S. G. De Bartolo, M. Veltri, L. Primavera,
Estimated Generalized Dimensions of River Networks,
to appear on Journal of Hydrology.

2. R. Gaudio, S. G. De Bartolo, L. Primavera, S. Gabriele, M. Veltri,
Lithologic control on the multifractal spectrum of river networks,
to appear on Journal of Hydrology.

B PUBLICATIONS ON CONFERENCE PROCEEDINGS

B.1 Publications on international conference proceedings in 2005

1. R. Bruno, V. Carbone, L. Sorriso-Valvo, E. Pietropaolo, B. Bavassano,
Intermittency in Space Plasma Turbulence,
in Multiscale Coupling of Sun-Earth Processes, edited by A. T. Y. Lui, Y. Kamide and G. Consolini, Elsevier, pp. 9-28 (2005).

2. A. Vecchio, V. Carbone, F. Lepreti, P. Veltri, Th. Straus., L. Sorriso-Valvo,
POD analysis of photospheric velocity field: solar oscillations and granulation,
in Proceedings of the 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, edited by D. Danesy, S. Poedts, A. DeGroof, J. Andries, ESA Publications Division, The Netherlands (2005).

3. F. Lepreti, H. Isliker, L. Vlahos, K. Petraki,
A model of quiet time particle acceleration in interplanetary space,
in Proceedings of the 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, edited by D. Danesy, S. Poedts, A. DeGroof, J. Andries, ESA Publications Division, The Netherlands (2005).

4. G. Nigro, F. Malara, P. Veltri,
Velocity fluctuations in coronal loops as flare drivers,
in Proceedings of the 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, edited by D. Danesy, S. Poedts, A. DeGroof, J. Andries, ESA Publications Division, The Netherlands (2005).

5. N. Décamp, F. Malara,
Particle acceleration in an intermittent RMHD turbulence,
in Proceedings of the 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, edited by D. Danesy, S. Poedts, A. DeGroof, J. Andries, ESA Publications Division, The Netherlands (2005).

C INVITED PRESENTATIONS

C.1 Invited presentations at international conferences in 2005

1. L. Sorriso-Valvo,
Small scale anisotropy of intermittency in solar wind magnetic turbulence,
in Second WISER Workshop on Computing in Space and Astrophysical Plasmas (HPC 2005), Leuven (Belgium), April 18-22, 2005.

2. F. Valentini, P. Veltri, T. O'Neil, D. Dubin,
Eulerian and Particle-in-Cell simulations of waves in plasmas: Bernstein modes and Electron Acoustic Waves,
in International Conference on Transport Theory, Budapest (Hungary), July 24-30, 2005

3. G. Zimbardo,
Anomalous particle diffusion and Levy random walk of magnetic field lines in three dimensional solar wind turbulence,
in 32nd European Physical Society Conference on Plasma Physics, Tarragona (Spain), June 27 - July 1, 2005

4. V. Carbone,
Turbulence and chaotic dynamics in anisotropic fluids,
VII Mediterranean Workshop and Topical Meeting on "Novel Optical Materials and Applications",
Cetraro (CS, Italy), May 29 - June 4 (2005).

5. V. Carbone,
Statistical analysis of turbulent data from solar wind and fusion plasmas,
8-th International Workshop on the Interrelationship between Plasma Experiments in Laboratory and Space (IPELS), Tromso, Norway, July 4-8 (2005).

C.2 Invited presentations at national conferences in 2005

1. G. Zimbardo,
La nascita della fisica moderna,
in X Scuola Estiva di Stilo, "Astronomia e Astrofisica nella progettazione di percorsi formativi", Stilo (RC), July 25-30, 2005.

2. V. Carbone
The spatio--temporal dynamics of the solar photosphere,

IV Convegno della Ricerca Italiana in Fisica Solare e Relazioni Sole-Terra, Trieste, October 18-20, 2005.

D PRESENTATIONS AT CONFERENCES

D.1 Presentations at international conferences in 2005

1. F. Valentini, D. Dubin, T. O'Neil,
   Numerical simulations of driven electron acoustic waves,
   in APS meeting, 47th Annual Meeting of the Division of Plasma Physics, Denver (USA), October 24-28, 2005.

2. A.V. Milovanov, L.M. Zelenyi, G. Zimbardo,
   Scale-free statistics and long-range dependence in magnetotail fluctuations,
   in IPELS 2005, Tromso (Norway), July 5-8, 2005.

3. R. De Bartolo, A. Greco, P. Veltri, G. Zimbardo,
   3D hybrid code for Earth's magnetotail analysis,
   in Conference on 'Turbulence and Fine Scale Structure in Solar and Astrophysical Plasmas', Montegufoni, Florence (Italy), October 3-7, 2005.

4. A. Vecchio, V. Carbone, F. Lepreti, P. Veltri, Th. Straus., L. Sorriso-Valvo,
   POD analysis of photospheric velocity field: solar oscillations and granulation,
   in 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, Leuven (Belgium), September 11-16, 2005.

5. F. Lepreti, H. Isliker, L. Vlahos, K. Petraki,
   A model of quiet time particle acceleration in interplanetary space,
   in 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, Leuven (Belgium), September 11-16, 2005.

6. A. Vecchio, V. Carbone, F. Lepreti, L. Primavera, L. Sorriso-Valvo, P. Veltri, Th. Straus,
   Proper Orthogonal Decomposition analysis of photospheric velocity fields,
   in Conference on 'Turbulence and Fine Scale Structure in Solar and Astrophysical Plasmas', Montegufoni, Florence (Italy), October 3-7, 2005.

7. F. Lepreti, H. Isliker, L. Vlahos, K. Petraki,
   Quiet time particle acceleration in the interplanetary space,
   in Conference on 'Turbulence and Fine Scale Structure in Solar and Astrophysical Plasmas', Montegufoni, Florence (Italy), October 3-7, 2005.

8. N. Décamp, F. Malara,
   Particle acceleration in an intermittent RMHD turbulence,
   in 11th European Solar Physics Meeting. The Dynamic Sun: Challenges for Theory and Observations, Leuven (Belgium), September 11-16, 2005.

9. N. Décamp, F. Malara,
   A synthetic turbulence model for particle acceleration,
   in Conference on 'Turbulence and Fine Scale Structure in Solar and Astrophysical Plasmas', Montegufoni, Florence (Italy), October 3-7, 2005.

D.2 Presentations at national conferences in 2005

1. A. Greco, V. Carbone, L. Sorriso-Valvo,
   Statistical analysis of the numerical time evolution of a financial market by a spin model,
   in XCI Congresso Nazionale della Società Italiana di Fisica, Catania, September 26 - October 1, 2005.

2. G. Zimbardo, P. Pommois, A. Ippolito, P. Veltri
   Estimate of the angular size of coronal mass ejections from energetic particle observations,
   in XLIX Congresso della Società Astronomica Italiana, Catania, May 2-7, 2005.

3. G. Zimbardo, P. Pommois, P. Veltri,
   Non Gaussian transport of energetic particles in solar wind anisotropic magnetic turbulence,

in IV Convegno della Ricerca Italiana in Fisica Solare e Relazioni Sole-Terra, Trieste, October 18-20, 2005.

4. L. Sorriso-Valvo, V. Carbone, I. Guerra, C. De Rose, P. Harabaglia,
   Non-poisson statistics of quiet times in seismic time series: a local test,
   in GNGTS, Rome, December 15-17, 2005.

ORGANIZATION OF CONFERENCES

1. Workshop on High Performance and Grid Computing, Università della Calabria, Rende, March 7-24, 2005.

2. FIELD THEORY IN PARTICLE PHYSICS AND IN CORRELATED SYSTEMS. MODELS AND MATHEMATICAL METHODS.

Professors and Researchers: Roberto Fiore, Domenico Giuliano, Alessandro Papa, Galileo Violini

Postdoc fellows Igor Ivanov (*INFN*), Donatella Marmottini

PhD students Francesco Caporale (*XVIII cycle*), Gianluigi Filippelli (*XVIII cycle*), Pietro Giudice (*XVIII cycle*)

Collaborators M. Caligiuri (*Università della Calabria, Cosenza, Italy*)
R. Capozza (*Università di Modena, Italy*)
V.S. Fadin (*Budker Institute for Nuclear Physics, Novosibirsk, Russia*)
P. Gensini (*Università di Perugia & INFN-Perugia, Italy)*
I.F. Ginzburg (*Budker Institute for Nuclear Physics, Novosibirsk, Russia*)
R. Hurtado (*Universidad Nacional de Bogotà, Colombia*)
D.Yu. Ivanov (*Sobolev Isntitute of Mathematics, Novosibirsk, Russia)*
L.L. Jenkovszky (*Bogolyubov Institute for Theoretical Physics, Kiev, Ucraine*)
P. Lucignano (*SISSA, Trieste, Italy*)
A. Merlani (*Istituto del Restauro, Roma, Italy*)
N.N. Nikolaev (*Forschungzentrum Jülich, Germany*)
F. Paccanoni (*Università di Padova & INFN-Padova, Italy*)
E. Salusti (*Università di Roma – La Sapienza, Italy*)
A.A. Savin (*DESY, Hamburg, Germany*)
P. Sodano (*Università di Perugia & INFN-Perugia, Italy*)
Y. Srivastava (*Università di Perugia & INFN-Perugia, Italy)*
A. Tagliacozzo (*Università di Napoli, Italy*)
V.R. Zoller (*ITEP, Moscow, Russia*)

Introduction

The research activity during 2004 included the following subjects:

- phenomenology of hadron collisions and Quantum Chromodynamics (QCD) in the high-energy limit;
- electroweak theory beyond the standard model;
- non-perturbative properties of gauge theories discretized on a space-time lattice;
- field theory of correlated devices;
- kaon-nucleon interaction at low energy;
- non-linear wave-equations for fluids in porous material.

A major part of this activity has been carried on in collaboration with other research groups in Italy and abroad. For the part concerning the non-perturbative study of gauge theories on a space-time lattice, a large use has been done of the computational facilities of the Physics Department and of the Istituto Nazionale di Fisica Nucleare (INFN) – Gruppo Collegato di Cosenza.

2.1 QCD IN THE REGGE LIMIT AND HADRON PHENOMENOLOGY

2.1.1 QCD in the Regge limit

The calculation of the two-gluon production contribution to the next-to-leading non-forward BFKL kernel has been completed. This contribution was the last missing part of the kernel. Together with the next-to-leading (NLO) gluon Regge trajectory, the NLO contribution of one-gluon production and the contribution of quark-antiquark production which were found before, it defines the kernel completely for any colour state in the t-channel, in particular the Pomeron kernel presented recently.

The kernel of the BFKL equation for non-zero momentum transfer has been found at the NLO. It is presented in various forms depending on the regularization of the infrared singularities in "virtual" and "real" parts of the kernel. The infrared safety of the total kernel is demonstrated and a form free from the singularities is suggested.

The amplitude for the forward electroproduction of two light vector mesons in next-to-leading order BFKL has been calculated. This amplitude is written as a convolution of two impact factors for the virtual photon to light vector meson

transition with the BFKL Green's function. It represents the first next-to-leading order amplitude ever calculated for a collision process between strongly interacting colorless particles.

2.1.2 Hadron Phenomenology

The evolution in the photon virtuality Q^2 of the structure functions for the neutrino-nucleon interaction has been studied analytically at twist-2 in the region of small values of the Bjorken x-variable and for soft non-perturbative input.

In the special case of flat initial conditions, the calculation included also the contribution of the twist-4 gluon recombination corrections, whose effect in the evolution is explicitly determined. The resulting charged-current

neutrino-nucleon total cross section has been determined and its behavior at ultra-high energies has been discussed.

In the same context, a simple analytic expression has been found for the for the (spin-averaged) neutrino-nucleon cross section for ultra-high energies at twist-2, obtained as the asymptotic limit of the previous findings. This expression gives values for the cross section in remarkable numerical agreement with the previous numerical evaluation in the energy region relevant for forthcoming neutrino experiments. The role and the relevance of saturation and recombination effects has been discussed in this approach, in comparison with other recent suggestions.

Diffractive production of excited vector mesons and meson with spin 3 in deep inelastic scattering were studied. In the case of spin-3 mesons a new regime of hadronic diffraction has been discovered: the regime of domination of the helicity violation. Numerical calculations performed indicate a rich set of experimental possibilities in the family of excited rho mesons, yet to be explored.

In addition, two previous papers were accepted for publication: the review article on diffractive production of vector mesons and a suggestion of a new measurement of the Pomeron phase in diffractive dipion production.

It has been developed the light-cone color dipole description of highly asymmetric diffractive interactions of left-handed and right-handed electroweak bosons. The origin and the strength of the left-right asymmetry effect are estimated in terms of the light-cone wave functions. An evaluation of the small-x neutrino-nucleon DIS structure functions xF_3 and 2xF_1 is reported and is compared with experimental data.

The shadowing effect has been studied in highly asymmetric diffractive interactions of left-handed and right-handed W-bosons with atomic nuclei. The target nucleus is found to be quite transparent for the charmed-strange Fock component of the light-cone W^+ in the helicity state $\lambda=+1$ and rather opaque for the c – anti-s dipole with $\lambda=-1$. The shadowing correction to the structure function $\Delta xF_3 = xF_3^{(\nu N)} - xF_3^{(\text{anti-}\nu\ N)}$ extracted from ν Fe and anti-ν Fe data is shown to make up about 20% in the kinematical range of CCFR/NuTeV.

2.2 ELECTROWEAK THEORY BEYOND THE STANDARD MODEL

A new point of view based on the group theory was suggested on the general structure of the electroweak model with two doublets of Higgs fields. Within this approach several phenomena known to take place in this theory (CP-violation, Z_2 symmetry, Peccei-Quinn symmetry) were shown to acquire a clear and simple linear algebraic interpretation. In the same two-Higgs-doublet model, within its most general case, conditions for perturbative unitarity have been established.

2.3 LATTICE GAUGE THEORIES

The (2+1)-dimensional QED gauge theory with dynamic matter has been studied by Monte Carlo numerical simulations. This theory is a candidate to the description of the pseudo-gap phase in high-T_c superconductors. The aim of the study has been the understanding of the nature of the transition from the superconductive to the anti-ferromagnetic phase. On the other side, the investigation of (2+1)-QED can help to understand mechanisms of confinement in presence of fermionic fields and, in particular, the role played by monopoles. A comparison has been done between numerical determinations obtained with the compact and with the non-compact formulation of the gauge sector of the theory, in order to verify if the conjecture of equivalence of the two formulations is valid in the continuum limit. The results are not incompatible with this conjecture. As a by-product, it has been found that the monopole density is weakly dependent on the volume and on the fermionic mass. This suggests that the mechanism of confinement à la Polyakov formulated in the compact theory should hold also in presence of massless fermions.

2.4 FIELD THEORY OF CORRELATED DEVICES

2.4.1 Two-boundary field theory of a Josephson junction chain

By using conformal field theory and integrable model techniques, we have studied a Josephson junction chain, with a "weaker" link, connected to two bulk superconductors at fixed phase difference. We have found that the pertinent field theory for such a system corresponds to a particular limit of the two-boundary Sine-Gordon model. By means of a careful renormalization group analysis, we have derived the phase diagram of the system and have calculated the Josephson current flowing through the chain. We are presently applying the same techniques to study the phase diagram of a Superconducting Quantum Interference Device (SQUID), composed of three Josephson junction (Mooij's SQUID).

2.4.2 Conduction across interferometric rings with the Path Integral formalism

We have derived the conductance across an Aharonov-Bohm interferometric ring, in the presence of a Rashba interaction, which gives rise to a Berry phase, in the wavefunctions of electrons propagating across the interferometer. We have studied the combined effects of such a phase, and of the Bohm-Aharonov phase, on the conductance across the ring, and have considered in detail the decoherence effects, due to disorder.

2.5 PHYSICS OF KAON-NUCLEON INTERACTIONS

We started to revise the programs of analysis of low-energy Kaon-Nucleon (KN) reactions in order to include the first results from Dafne, that have solved the kaonic atoms puzzle. The medium-term interest of this program comes both from the perspective of a new machine in Japan (J-Parc), which should start its operation by 2008, and from its connection with the discussions on the future of Dafne. The field of KN Physics has been object of recent developments by Spanish (Oller) and German (Borasoy) groups which further justify our interest to reanalyze the data.

A number of talks on these topics and on the activity of the collaboration have been presented by GV. They include: a seminar in January at TRIUMF, Vancouver, two seminars in Italy (one in March at LNF, Frascati, and another in June at the University of Perugia), two seminars in August at the Institute of Theoretical Physics and Mathematics, Tehran, one seminar in August at the Institute of Advanced Studies, Zanjan, and an invited talk at the Congress of the Colombian Physical Society, held in October in Barranquilla. Other talks have been presented by the other members of the collaboration. The collaboration in the previous activity is limited to PG, RH and MC. Moreover, together with YS, we have proposed a collaboration with the LNF experimental groups active at Dafne (in particular DEAR/SIDDHARTA and KLOE), in order to improve the old low-energy Kbar-N analyses through the inclusion of the conditions that DEAR already imposes for what concerns the s-wave and that will come from SIDDHARTA for the p-wave, and the utilization of new scattering data.

2.6 NON-LINEAR WAVE EQUATIONS FOR FLUIDS IN POROUS MATERIALS

This research is a follow-up of a series of seminars given by Salusti at our University. We started a collaboration in order to study a system of two fluids in porous rocks. The purpose of this research, which develops a previous one by Salusti and Merlani, and is in an advanced stage, is to write and determine the numerical solutions of the non-linear wave equations for the pressure and the concentration of solutes in porous materials that are saturates with a fluid. The techniques used are typical of Mathematical Physics.

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. V.S. Fadin, R. Fiore,
   Non-forward BFKL Pomeron at next-to-leading order,
   Phys. Lett. **B610** (2005) 61, Erratum-ibid. **B621** (2005) 61.

2. V.S. Fadin, R. Fiore,
   Non-forward NLO BFKL kernel,
   Phys. Rev. **D72** (2005) 014018.

3. D.Yu. Ivanov, A. Papa,
   Electroproduction of two light vector mesons in the next-to-leading approximation",
   Nucl. Phys. **B732** (2006) 183.

4. R. Fiore, L.L. Jenkovszky, A.V. Kotikov, F. Paccanoni, A. Papa, E. Predazzi,
   Analytical evolution of nucleon structure functions with power corrections at twist-4 and predictions for ultra-high energy neutrino-nucleon cross section,
   Phys. Rev. **D71** (2005) 033002.

5. F. Caporale, I.P. Ivanov,
   Production of orbitally excited vector mesons in diffractive DIS",
   Phys. Lett. **B622** (2005) 55.

6. F. Caporale, I.P. Ivanov,
   Production of spin-3 mesons in diffractive DIS,
   Eur. Phys. J. **C44** (2005) 505.

7. I.F. Ginzburg, I.P. Ivanov,
   How *to measure the Pomeron phase in diffractive dipion photoproduction*,
   Eur. Phys. J. **C45** (2006) 193.

8. R. Fiore, V.R. Zoller,
   Charged currents, color dipoles and xF_3 at small x,
   JETP Lett. 82 (2005) 385; Pisma Zh. Eksp. Teor. Fiz. 82 (2005) 440.

9. R. Fiore, V.R. Zoller,
   Left-right asymmetry of nuclear shadowing in charged current DIS,
   Phys. Lett. **B632** (2006) 87.

10. I.F. Ginzburg, I.P. Ivanov,
    Tree-level unitarity constraints in the most general 2HDM,
    Phys. Rev. **D72** (2005) 115010.

11. I.P. Ivanov,
    Two-Higgs-doublet model from the group-theoretic perspective,
    Phys. Lett. **B632** (2006) 360.

12. R. Fiore, P. Giudice, D. Giuliano, D. Marmottini, A. Papa, P. Sodano,
    QED_3 on a space-time lattice: compact versus noncompact formulation,
    Phys. Rev. **D72** (2005) 094508; Erratum-ibid**. D72** (2005) 119902.

13. D. Giuliano, P. Sodano,
    Effective Boundary Field Theory for a Josephson Junction chain with a weak link,
    Nucl. Phys. **B 711** (2005) 480.

14. R. Capozza, D. Giuliano, P. Lucignano, A. Tagliacozzo,
    Quantum interference of electrons in a ring: tuning of the geometrical phase,
    Phys. Rev. Lett. **95** (2005) 226803.

A.1.2 Publications on international journals accepted in 2005

1. I.P. Ivanov, N.N. Nikolaev and A.A. Savin,
   Diffractive *vector meson production at HERA: From soft to hard QCD*,
   to appear on Phys. Atom. Nucl., hep-ph/0501034.

B PUBLICATIONS ON CONFERENCE PROCEEDINGS

B.1 Publications on international conference proceedings in 2005

1. P. Giudice and A. Papa,
   Finite temperature 2-color QCD for real and imaginary chemical potential.
   Nucl. Phys. Proc. Suppl. **140** (2005) 529.

2. R. Fiore, P. Giudice and A. Papa,
   Numerical test of Polyakov loop models in high temperature SU(2),
   Nucl. Phys. Proc. Suppl. **140** (2005) 583.

3. D.Yu. Ivanov and A. Papa,
   The virtual photon to light vector meson impact factor in the next-to-leading order,
   Nucl. Phys. Proc .Suppl. **146** (2005) 117.

C PRESENTATIONS AT CONFERENCES

C.1 Presentations at international conferences in 2005

1. D.Yu. Ivanov, A. Papa,
   Electroproduction of two light vector mesons in the next-to-leading BFKL,
   talk given by A. Papa at "New Trend in High Energy Physics", Yalta, Crimea, Ukraine, 10-17 Sept. 2005.

2. D.Yu. Ivanov, A. Papa,
   Electroproduction of two light vector mesons in the next-to-leading BFKL,
   talk given by A. Papa at "Hadron Structure and QCD 2005", S. Petersburg, Russia, 20-24 Sept. 2005.

3. R. Fiore, P. Giudice, D. Giuliano, D. Marmottini, A. Papa, P. Sodano,
   QED_3 on a space-time lattice: compact versus non-compact formulation,
   poster presented to "Lattice 2005", Dublin, Ireland, July 25-30, 2005.

4. D. Giuliano,
   Boundary Field Theory formulation of Mesoscopic Devices,
   lectures given at the school on "Field Theories for Quantum Coherent Devices", Capri, June 2005.

EDITION OF CONFERENCE PROCEEDINGS

1. **Diffraction in high-energy physics**.
   Proceedings of the 3rd International Workshop, *Diffraction 2004*,
   Cala Gonone, Italy, September 18-23, 2004.
   Edited by B. Löhr, R. Fiore, I.P. Ivanov, A. Papa, Nucl. Phys. B, Proc. Suppl. **146** (2005) 250 pages.

3. EXPERIMENTAL PARTICLE PHYSICS

Physicists: Giuseppe Avorio (ATLAS)
Cristina Adorisio (ATLAS)
Marcella Capua (ZEUS)
Giovanni Crosetti (ATLAS)
Salvatore Fazio (ZEUS)
Ernesto Lamanna (ATLAS)
Laura La Rotonda (ATLAS)
Anna Mastroberardino (ZEUS)
Evelin Meoni (ATLAS)
Antonio Policicchio (ATLAS)
Daniela Salvatore (ATLAS)
Marco Schioppa (ATLAS, ZEUS)
Giancarlo Susino (ATLAS, ZEUS)
Enrico Tassi (ZEUS)
Pasquale F. Zema (ATLAS)
Technicians: Francesco Pellegrino (ATLAS, ZEUS)
Vittorio Romano (ATLAS)
Paola Turco (ATLAS)

The experimental particle physics studies the most fundamental constituents of matter and the forces that cause their mutual interactions. The researches are made by means of particle accelerators and particle detectors. The first ones rise the energy of beam particles (in the most powerful accelerators the energy can reach some TeV) and allow them to collide against a target that can be fixed or a second beam. The detectors are designed to reconstruct the particles produced as a consequence of the beam-target particle interactions.

The researches on high energies physics to which the physicists of this University take part are:

1. Study of the proton structure by means of deep inelastic scattering at electron-proton accelerator HERA of DESY laboratory (Hamburg, Germany) with the experiment ZEUS.
2. Study of proton-proton interactions at LHC accelerator of CERN laboratory (Geneva, Switzerland) with the experiment ATLAS.

3.1 ZEUS EXPERIMENT AT HERA E-P COLLIDER (HAMBURG-GERMANY)

International collaboration

Scattering experiments have been a huge success in revealing the complex world of structure of matter. The basic concept is quite simple: a point-like and energetic test particle (i.e. electron) is scattered on a target (i.e. proton) and its angular and energy distribution are measured. The first time that this technique was employed (1911) revealed that the atom has a positively charged core with a radius of less than 30 fm (Rutherford-Geiger-Marsden). Since 1911 many scattering experiments have been performed to explore the structure of nucleus on scale smaller and smaller. The "object" size □ that can be resolved in the scattering process is determined by the four momentum Q transferred from the test particle to the target one. From the uncertainty relation it follows that □≈1/Q, therefore to increase the resolution it is required larger momentum transfer and hence higher beam energies. This is best achieved in the storage rings where the test and the target particle collide head-on. In the HERA collider two separate magnet systems guide the e and p beams around the 6,3 km long ring and two independent superconducting RF systems accelerate the e and p bunches up to 30GeV and 820GeV energy respectively. The electrons meet protons in a head-on collision in four points along the ring where are located as many detectors always ready to record any interesting event coming from the interaction point. The four experiments are known as H1, ZEUS, HERMES and HERA-B.

At the maximum beam energies the centre of mass energy is $(4 \cdot E_e \cdot E_p)^{1/2} \cong 314\text{GeV}$, much larger than previously achieved in such collisions, and the exploring distance scale 10^{-18}m of the proton structure can be reached. At large momentum transfers (the kinematical limit at HERA is 10^5 GeV^2/c^2) there is a direct interaction of the electron with one of the proton quarks, while the "remnants" of the proton are only slightly involved. For this reason HERA is often addressed as the world's only electron-quark collider.

The Cosenza HEP group has been involved, since 1988, in the design, construction, testing, calibration, alignment, running and maintenance of three sub-detectors of ZEUS experiment: Forward Muon Spectrometer, Leading Proton Spectrometer and Vertex Detector. Furthermore the Cosenza researchers participate, since 1991 when the detector start to operate, the data taking as well as the physics analysis. During this last year there are new ZEUS results on forward jet production in deep inelastic electron proton scattering and low-x parton dynamics. Analysis of the hadronic final states have produced several precision measurements of inelastic J/psi production in deep inelastic scattering and exclusive electroproduction of phi mesons. Zeus data show a clear signal of the pentaquark decaying to Xi-pi in deep inelastic scattering.

3.2 ATLAS EXPERIMENT AT LHC P-P COLLIDER (GENEVA-SWITZERLAND)

Nature has given us more than one elementary particle (6 fermions, 6 quarks and the carriers of the four fundamental interactions), whose masses ranges in a wide interval of values from the mass-less gauge bosons to the top quark M_t=100 GeV/c^2. With this variety of particles and masses we should have an answer about the mechanism that determines the particle masses. Many experiments with particle accelerators are looking into the mechanism that gives rise to mass.

In 1964 Peter Higgs first proposed a very clever and very elegant solution to this problem: the whole of space is permeated by an undetectable field, similar in some ways to the electromagnetic field. As particles move through space they travel through this field, and if they interact with it they acquire what appears to be mass. This is similar to the action of viscous forces felt by particles moving through any thick liquid: the larger the interaction of the particles with the field, the more mass they appear to have. Thus the existence of this field is essential in Higg's hypothesis for the production of the mass of particles. Moreover from quantum theory follows that fields have particles associated with them (i.e. the photon is associated with the electromagnetic field). So the Higg's field should has a particle associated with, the Higgs boson. Finding the Higgs boson is thus the key to discovering whether the Higgs field does exist and whether our best hypothesis for the origin of mass is indeed correct.

The Standard Model of particle physics predicts that the Higgs boson is a hypothetical, massive subatomic neutral particle whose existence would explain the masses of the elementary particles. Up to now, no experiment definitively detected the existence of the Higgs bosons. The Higgs field is perceived the same from every direction (scalar field) and is mostly indistinguishable from empty space. The Higgs boson, sometimes called the **God particle,** itself has a characteristic rest-mass. The best estimate value for this mass is 117GeV, with a theoretical upper limit of 251 GeV. Particle accelerators have probed energies up to about 115 GeV, and have recorded a small number of events that could be interpreted as resulting from Higgs bosons, but the evidence is as yet inconclusive. It is expected that LHC, the multi-TeV p-p collider currently under construction at CERN, will be able to confirm or disprove the existence of the God particle. LHC will provide 10 times higher centre of mass energy and 100 times higher p-p collision rates than previous colliders. This opens up a new frontier of physics and ATLAS detector will explore this great potential.

ATLAS is a general purpose detector designed to detect clean signal and perform accurate measurements of: charged leptons, photons, non-interactive particles such as neutrinos through missing energy measurements, hadronic jets, bottom quarks. The basic design concept to achieve these goals includes three detector systems:

1. a **tracker** with semi-conductor pixel and strip detectors for very high accuracy measurements of the charged particle trajectories, followed by straw tubes detector giving a bubble chamber like image of the event and independent electron identification. The tracker is confined to a cylinder 6,8m long and 1,1m radius in a 2T magnetic field provided by a superconductive solenoid.
2. a **calorimeter** with an inner cylinder in highly granular liquid argon technology with Pb absorber, followed at large radius by an iron-scintillator calorimeter providing good resolution in a very cost-effective manner.
3. a high precision stand-alone **muon spectrometer**. Its conceptual layout is based on the magnetic deflection of muon track in a system of three large superconducting air-core toroid magnets instrumented with separate-function trigger and high-precision tracking chambers.

The Cosenza HEP group are actively involved in various aspects of the design, construction and installation of the muon spectrometer detector system since 1994. During this period the hardware projects in which the group participated have employed and trained many undergraduates and doctorates student in the process.

During this year the Cosenza group has participated to many ATLAS activities:

1. rewiring of damaged MDT chambers using a no-invasive technique;
2. commissioning and test of the BIL chambers at CERN;
3. ATLAS MDT aging studies at the Gamma Irradiation Facility of CERN;
4. ATLAS MDT aging studies at the neutron and gamma facility of ENEA Research Centre at Rome;
5. realization of a low level, real time data acquisition software for the ATLAS sub-detector to monitoring the data during test beam and the first period of ATLAS data taking.
6. Monte Carlo simulation of muon spectrometer performances with GEANT 4.
7. study of Higgs and bottom signals using the muon spectrometer.

A PUBLICATIONS ON REVIEW

A.1 Publications on international review

A.1.1 Publications on international review published on 2005

1. ZEUS Collaboration; M. Capua, S. Fazio, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Measurement of charm fragmentation ratios and fractions in photoproduction at HERA,
European Physical Journal **C44** (2005) 351-366.

2. ZEUS Collaboration; M. Capua, S. Fazio, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Inclusive jet cross sections and dijet correlations in D+- photoproduction at HERA,*
Nuclear Physics **B729** (2005) 492-525.

3. ZEUS Collaboration; M. Capua, S. Fazio, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Measurement of inelastic J/psi production in deep inelastic scattering at HERA,
European Physical Journal **C44** (2005) 13-25.

4. ZEUS Collaboration; M. Capua, S. Fazio, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Exclusive electroproduction of phi mesons at HERA,
Nuclear Physics **B718** (2005) 3-31.

5. ZEUS Collaboration; M. Capua, S. Fazio, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
An NLO QCD analysis of inclusive cross-section and jet-production data from the zeus experiment,
European Physical Journal **C42** (2005) 1-16.

6. ZEUS Collaboration; M. Capua, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Forward jet production in deep inelastic ep scattering and low-x parton dynamics at HERA,
Physics Letters **B632** (2005) 13-26.

7. ZEUS Collaboration; M. Capua, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Multijet production in neutral current deep inelastic scattering at HERA and determination of alpha(s),
European Physical Journal **C44** (2005) 183-193.

8. ZEUS Collaboration; M. Capua, A. Mastroberardino, M. Schioppa, G. Susinno, et al.,
Search for lepton-flavor violation at HERA,
European Physical Journal **C44** (2005) 463-479.

9. ZEUS Collaboration; M. Capua, A. Mastroberardino, M. Schioppa, G. Susinno, et al.**,**
Search for pentaquarks decaying to Xi-pi in deep inelastic scattering at HERA,
Physics Letters **B610** (2005) 212-224.

10. ZEUS Collaboration; M. Capua, A. Mastroberardino, M. Schioppa, G. Susinno, et al.**,**
Study of deep inelastic inclusive and diffractive scattering with the ZEUS forward plug calorimeter,
Nuclear Physics **B713** (2005) 3-80.

11. C. Adorisio, et al.**,**
Aging studies on Atlas muon spectrometer drift tube,
IEEE Trans. Nuclear Science **52** (2005) 2971-2976.

B PUBLICATIONS ON CONFERENCE PROCEEDINGS

B.1 Publications on international conference proceedings in 2005

1. G. Avolio et al.,
ATLAS MDT chamber ageing test at ENEA Casaccia neutron and gamma facilities,
Proceeding of the 9th conference on Astroparticle, Particle, Space Physics, Detectors and Medical Physics

Applications ICATTP 2005.

C PRESENTATIONS AT CONFERENCES

C.1 Presentations at international conferences in 2005

1. P.F. Zema et al.
The GNAM monitoring system and the OHP histogram presenter for ATLAS
Proceeding of the 14th IEEE Real Time Conference 2005 – ATL-DAQ-CONF-2005-029.

2. A. Policicchio et al.
Precision Chambers Performance,
Contribution to ATLAS Physics Workshop, Rome, June 6-11, 2005.

3. G. Avolio et al.
Test Beam MDT and Calorimetry,
Contribution to ATLAS Physics Workshop, Rome, June 6-11, 2005.

4. SURFACE ELECTRON SPECTROSCOPY (SPES)

Professors and Researchers:	Elio Colavita *(Group Leader)*
	Gaetano Cannelli
	Raffaele Agostino
	Gennaro Chiarello
	Vincenzo Formoso
Postdoc fellows	Tommaso Caruso
	Enrico Maccallini
PhD students	Alfonso Policicchio
	Antonio Politano
Technicians	Salvatore Abate
	Giovanni Desiderio
	Vito Fabio
	Eugenio Li Preti
Collaborators	P. Milani *(University of Milano, Italy)*
	P. Rudolf *(Material Science Center, University of Groningen, The Netherlands)*
	A. Goldoni *(Elettra, Trieste, Italy)*

Research subjects:
1) Chemisorption on metal surfaces, their electronic properties
2) Carbon nanostrucures spectroscopic studies

Introduction

The scientific research of the group has been carried out essentially along two lines:
1) Chemisorption on metal surfaces and their electronic properties;
2) Carbon nanostrucures spectroscopic studies.

The former line deals with the study of the interaction of simple metals with surfaces of metal single crystals and, moreover, with the investigation of the electronic properties of metal and alloy surfaces. The study is experimental and HREEL and Synchrotron photoemission spectroscopies are used.

The latter research line deals with a characterization of nanostructured carbon thin films containing well ordered grapheme multilayers, onion and nanotubes. The study is performed in collaboration with the Group of prof. Milani at CIMAINA, University of Milano. The films are prepared by supersonic cluster beam deposition. The strategic importance of nanostructured CN_x in several technological fields is acknowledged.

During the past year the Group spent part of its time to implement an Electron Microscopy Laboratory equipped with a Transmission Electron and Secondary Electron Microscopies.

4.1 CHEMISORPTION ON METAL SURFACES AND THEIR ELECTRONIC PROPERTIES

The $Fe_{62}Ni20Cr_{18}$ valence band was studied by scanning the photon energy across the $2p_{3/2}$ core-level threshold of each element of the alloy and a resonant enhancement of the weak 3d-like features was observed. In pure transition metals, similar valence band resonances are explained by a radiation-less Raman de-excitation emission, which is active at threshold and degenerate with the two-hole satellite of direct photoemission. Present structures are associated to satellite features occurring in $Fe_{62}Ni20Cr_{18}$ and their intensities and binding energies are compared to those of the pure metal components. The alloy satellite resonant behaviour reveals some peculiar modifications of: a) the crossover between the radiation-less Raman scattering and the Auger emission regimes; b) the ratio of the relative intensities of the main and satellite peaks. We mainly assign these differences to the hetero-nuclear bonds occurring in the alloy (ref.1).

4.2 CARBON NANOSTRUCURES SPECTROSCOPIC STUDIES

4.2.1 Nanostructured CN_x thin films were prepared by supersonic cluster beam deposition and systematically characterized by transmission electron microscopy, electron energy loss spectroscopy, X-ray photoelectron spectroscopy and scanning electron microscopy. The incorporation of nitrogen in the films and the nanostructure were controlled by using different synthesis routes. Films containing bundles of well ordered graphene multilayers, onions and nanotubes embedded in an amorphous matrix were grown alongside purely amorphous films by changing the deposition parameters. Graphitic nanostructures were synthesized without using metallic catalysts. The structures and

electronic properties of the films have been studied by EELS. The role played by N in the carbon nanostructures has been deducted from XPS line shape analysis (ref.2).

4.2.1 Supersonic cluster beam deposition is a viable method for the synthesis of nanocrystalline metal/ carbon composites. By assembling carbon and metallic clusters seeded in a supersonic beam, we have grown films consisting of metal nanoparticles embedded in a nanostructures carbon matrix. Samples containing 3d transition metals (Ti, Ni) and Au, Pd, Pt with different metal abundances, particle size and dilution have been characterized by transmission electron microscopy. The influence of different metals on the structure of the carbon matrix has been investigated. Spatially resolved ultraviolet photoemission electron spectroscopy showed substantial surface oxidation of 3d transition metal clusters. On a micrometric scale, the spatial distribution of the metallic nanoparticles appeared to be homogeneous (ref.3).

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. V. Formoso, G. Chiarello, R. Agostino, L. Papagno, E. Colavita, L. Floreano, R. Gotter, A. Morgante, A. Santaniello, A. Verdini,
Resonant valence-band photoemission spectroscopy on $Fe_{62}Ni20Cr_{18}$ alloy,
The European Physical Journal **B43** (2005) 463-470.

2. G. Bongiorno, M. Blomqvist, P. Piseri, P. Milani, C. Lenardi, C. Ducati, T. Caruso, P. Rudolf, S. Wachtmeister, S. Csillag, E. Coronel,
Nanostructured CNx (0 < x < 0.2) films grown by supersonic cluster beam deposition,
Carbon **43** (2005) 1460-1469.

3. G. Bongiorno, C. Lenardi, R. Agostino, T. Caruso, M. Amati, C. Ducati, M. Blomqvist, E. Barborini, P. Piseri, S. La Rosa, E. Colavita, P. Milani,
Nanocrystalline metal/carbon composites produced by supersonic cluster beam deposition,
Journal of Nanoscience and Nanotechnology **5** (2005) 1072-1080.

4. M. Castriota, T. Caruso, R.G. Agostino, E. Cazzanelli, W. Henderson, S. Passerini,
Raman Investigation of the Ionic Liquid N-Methyl-N-propylpyrrolidinium Bis(trifluoromethanesulfonyl)imide and Its Mixture with $LiN(SO_2CF3)_2$,
Journal of Physical Chemistry **A109** (2005) 92-96.

D PRESENTATIONS AT CONFERENCES

D.1 Presentations at international conferences in 2005

1. T. Caruso, R.G. Agostino, V. Formoso, G. Chiarello, E. Colavita, C. Lenardi, G. Bongiorno, P. Piseri, P. Milani, S. La Rosa, M. Bertolo,
Spatially resolved photoemission spectroscopy of cluster-assembled carbon and nanocomposite carbon/metal films,
MMD Meeting, Matter Materials and Devices", June 22-25, 2005, Genova, Italy.

D.2 Presentations at national conferences in 2005

1. T. Caruso, R.G. Agostino, V. Formoso, G. Chiarello, E. Colavita,
Electronic properties of carbon in nanotubes and nanocrystalline metal/ carbon composite,
"CARBON Meeting", Catania, Italy, November 28, 2005.

5. SOLID STATE PHYSICS: SURFACES AND NANOMATERIALS

Professors and Researchers: Giovanni Falcone
Antonino Oliva
Luigi Papagno
Renzo Alzetta
Assunta Bonanno
Lorenzo Caputi
Franco Piperno
Fang Xu
Michele Camarca
Anna Cupolillo
Daniela Pacilè
Francesco Plastina
Piero Riccardi
Antonio Sindona

Postdoc fellows Pasquale Barone
Giuseppe Liberti
Marco Papagno

PhD students Tony J. G. Apollaro
Marianna Barberio
Mario Commisso
Claudia Giallombardo
Stefano Maletta
Angela Milazzo
Marina Minniti
Sarah Rudi
Giuseppe Sapia
Rosa Letizia Zaffino

Collaborators: Alessandra Lanzara *(Dept. of Physics, University of California, Berkeley, USA)*
Marco Grioni *(École Polytechnique Fédérale de Lausanne, Switzerland)*
Davor Pavuna *(École Polytechnique Fédérale de Lausanne, Switzerland)*
Raul Baragiola *(Lab. for Atomic and Surface Physics, University of Virginia, Charlottesville, USA)*
Zdenek Sroubek *(Acad. Science Czech Republic, URE, Prague)*
Valerio Pirronello *(Dip. di Fisica, Facoltà di Ingegneria, Università di Catania, Italy)*
Giuseppe Giuliani *(Istituto di Fisica "Volta", Università di Pavia, Italy)*
Marisa Nichelini *(Dipartimento di Fisica, Università di Udine, Italy)*
G. M. Palma, A. Lozinski *(Università di Milano, Italy)*
W. Mao, D.V. Averin *(Stony Brook University, USA)*
R. Fazio *(Scuola Normale Superiore, Pisa, Italy)*

Introduction

Carbon nanotubes (CNT's) discovery has generated new challenging perspectives for what concerns fundamental and applicative research in the nanoscale materials as nanoelectronics and nanosensors. We plan to address our research in understanding, from a fundamental point of view, the electronic properties of these new nanoscaled materials which are considered as promising building blocks for molecular electronics. Both home-made and commercially produced single and multiwall carbon nanotubes will be investigated. It is thought that most of future applications of CNT's in nanoelectronics will depend on our ability in modifying their electronic properties by appropriate doping: one method to modify the electronic properties of CNT's is the addition of electron acceptors or donors. On the other hand for nanosensors technology is of paramount importance the knowledge of the elementary steps involved in the gas-CNTs interaction during adsorption. The characterization of the samples regarding their morphology, electronic properties and geometrical structure will be done with various techniques present at the University of Calabria.

We work also on the description of coherent quantum oscillations of two (in general interacting) superconducting quantum bits, measured continuously by a generic mesoscopic and non-linear detector. As an example, we discussed a SQUID magneto-meter with the calculation of detector-spectra which can show how the

intrinsic non linearity can lead to a mixing of the Rabi oscillations of the two qubits.

Finally we develop and test new media tools for the learning and teaching of physics at high school and university level. Rigorous educational research into student understanding is performed and used, either to inform the development of tools or to assess their effectiveness for the in-class work.

5.1 SCIENCE IN CARBON NANOTUBES AND NANOSTRUCTURES

Carbon nanotubes are an interesting class of nanostructured materials. A number of techniques including laser vaporization, chemical vapor deposition (CVD) and discharges between two carbon electrodes have been used to prepare single-walled and multi-walled carbon nanotubes. A single-walled carbon nanotube (SWCNT) can be viewed as a single layer of graphite folded up into a cylinder having a diameter of as little as 1 nm and a length up to many micrometers. Multi-walled nanotubes (MWCNTs) are several cylinders arranged in coaxial alignment. Depending on the width of the graphite sheet and the way it is folded a variety of nanotubes with different structure and electronic properties can be obtained.

Since their discovery, carbon nanotubes have attracted great attention because of their unique physical and chemical properties which are of practical importance in a variety of fields such as catalysis, hydrogen storage, electrical and thermal conductivity, field emission and high Young's modulus.

Recent studies showed that the electronic properties of SWCNTs are sensitive to gas exposure. Alkali atoms chemisorption, for instance, induces dramatic changes in the electronic and atomic structure, depending on the C/A (A: alkali metal) ratio. We study the effect induced by chemical doping on the above properties as a function of temperature and kind of dopant. The sample can be doped by termal diffusion of alkali metal deposited on the surface or directly by ion implantation using several impact energies 0.1 - 10KeV. Radiation damage induced by ion bombardment on the CNTs is another aspect of our experimental investigation.

In recent years we studied the electronic and vibrational properties of SWCNTs by electron energy loss (EELS) and photoelectron spectroscopies (PES). The high resolution electron energy loss spectroscopy (HREELS) technique was also used to study the electronic and vibrational properties of molecules and atoms adsorbed on SWCNTs. These studies indicate that the above techniques are particularly suited to investigate with the same apparatus the electronic and vibrational properties of carbon nanotube samples and their interaction with metal and gases.

5.2 NON ADIABATIC RESPONSE OF A MANY ELECTRON SYSTEM TO A SLOWLY VARYING, SEMICLASSICAL PERTURBATION

The research activity focussed on non adiabatic excitations of a many electron system interacting with a semiclassical probe, i.e., an external potential whose typical time is large on the femtosecond-scale of non radiative, electron-hole recombination processes. Applications were proposed in the field of atomic collision in solids, with the main motivation that slow ions reflecting from (or within) a solid target provide a unique source for electronic excitations confined just to the surface region, making the related spectroscopies very surface sensitive tools to study solids; Besides, several questions of both fundamental and practical interest are involved, concerning the ionization/neutralization of projectiles, the mechanisms of electron and photon emission, and the characteristics of sputtered particles from the solid. More importantly, the project has opened the way to study the effect of atomic intercalation into nanomaterials, specifically examining the electronic properties of litihum intercalated, single walled carbon nanotubes.

In general, the interaction of an ion impinging on a target material presents a highly dynamic many-body problem that should take into account the trajectory followed by the projectile, the geometric structure of the target material, the (multi-)electron exchange between target and projectile as well as the accompanying excitation of both collision partners.

At present, most models handle the trajectories followed by the projectile classically while they combine both classical and quantum mechanical concepts in the treatment of the electronic ion-target system. The classical treatments of ion trajectories make extensive use of Monte Carlo based simulation codes in which the paths followed by the projectiles are in principle made up of sequences of trajectory-changing binary projectile-target collisions. The electronic ion-target system is mostly treated in terms of a model Hamiltonian formalizing the interaction between the discrete electronic projectile levels and the valence bands of the material. Electron transfer occurs usually either by one electron processes, such as in resonant electron tunnelling, or by two electron Auger-type processes, such as Auger neutralization or Resonant neutralization followed by Auger De-excitations.

5.3 ION FORMATION IN SPUTTERING

In recent years, considerable progress has been achieved in the theoretical description of resonant electron exchanges for which non-perturbation methods have been developed and applied to the description of many-electron atoms on simple metallic surfaces, generally using a jellium model. A vary cumbersome problem is positive/negative ionization of secondary atoms sputtered from solid surfaces, because of the complicated physical and chemical

reactions occurring during ejection. We have proposed a generalized time dependent Anderson-Newns Hamiltonian, obtained from first principles, to describe the interaction of secondary $Cu^{\pm}$ atoms ejected from clean Cu(100) surfaces. Surface effects were explained in terms of quasi-molecular interactions between secondary emitted and their nearest-neighbor substrate atoms that, in the collision cascade generated by the primary ion beam, provide the initial impulse to emitted particles. We used a Jellium surface and modelled the motion of ejected atoms with simple analytical trajectories. We developed a parameter-free theory whose numerical solution produced excellent agreement with the studied experiments, especially at very low emission energy of the order of some electronvolts. Progress have been made that let us extend a more sophisticated version of the theory to the $Ag^{\pm}$-Ag(100) and $Au^{\pm}$-Au(100) systems.

5.4 ION INDUCED COLLECTIVE EXCITATIONS IN SOLIDS AND SHAKE-UP ELECTRONS

Another active and alive field is secondary electron emission from positive atomic ion impacts, because of the huge number of applications to solid, clusters and biomolecules and water. From a theoretical point of view, the ejection of an electron from a solid can be described by the following three mechanisms: excitation of the electron, transport of the excited electron to the surface, and finally, emission from the surface. The minimum energy which a bound electron must gain in order to be emitted from a conductor equals the excitation energy to the conduction band of the solid, plus the energy which is needed to overcome the work function of the target-vacuum interface. However, if the electron is excited at some depth below the surface, it may lose energy during the transport to the surface. This means that an initial energy even higher than the minimum energy is required to transport electrons from the depth of the solid to outside the surface. Particle-induced secondary electron emission is normally divided into two different mechanisms, in which either the translational kinetic energy or the internal potential energy of the incident projectile is transferred to a target electron. The requirement for potential electron emission from a conductor is that energy which is released when an incident ion is either neutralized, or else relaxes to a lower excited state, is larger than twice the work function of the surface. Potential emission occurs for most multiply-charged atomic ions, but only for a few singly-charged atomic ions such as ions of hydrogen and noble gases. Kinetic electron emission can occur when kinetic energy from the incident particle is transferred to target electrons. The detailed mechanism for kinetic emission is not well understood, which is reflected in poor predictions of the threshold velocity below which kinetic emission should not be observed. On the other hand, potential electron emission has been long discussed in terms of two-electron, Auger type processes, such as Auger neutralization and resonant neutralization followed by interatomic Auger de-excitation. In Auger Neutralization, the electrostatic repulsion between two target electrons leads to one of the electrons tunnelling to neutralize the incoming ion, and the other being excited. Recent experimental studies have shown that the energy released by ion neutralization at metal targets can also produce collective excitations in the conduction band, such as surface plasmons (P. Riccardi et al., Phys. Rev. Lett. 84, 378 (2000)), whose decay occurs predominantly by excitation of a single conduction electron. Although some models have been proposed to describe the creation of plasmon excitations, a theory of this processes is still lacking as well as with theoretical results to be compared with experimental data. We have found another collective excitation due to the sudden change of charge of the projectile, which leads to a rearrangement of the ground state of conduction electrons on a long time-scale; this final-state effect parallels the sudden creation of a core hole by absorption of a soft x-ray photon (G.D. Mahan, Phys. Rev. 163, 612 (1967); P. Nozieres and C.T. De Dominicis, Phys. Rev. 178, 1097 (1969)), known as Fermi edge singularity, and reflects in the broadening of the kinetic energy distributions of ejected electrons, for a given incident ion velocity. A more interesting application, concerning the broadening of the C1s-line in lithium intercalated, single walled carbon nanotubes, as function of the concentration of dopants, is in progress.

5.5 ION INTERACTION WITH NANOSTRUCTURES

The energy distributions of electrons emitted in the interaction of Na^+ ions with Al surfaces as a function of incident ion energy in the range 300-2000 eV have been measured. We discuss the Auger spectra of Sodium, which show several lines due to decay in vacuum of projectiles, singly and doubly excited in the 2p shell by electron promotion in close encounters with target atoms. Our results indicate that the double vacancy production is in close relation with the Al-2p electron excitation via an *autoexcitation* mechanism.

In subsequent work we performed preliminary studies on luminescence emission from bundles of multiwalled carbon nanotube (MWCNT) induced either by heating (thermo-luminescence, TL) or by ion bombardment of (iono-luminescence, IL) the sample. For N_2 exposure we do not observe any evidence of N_2 absorption on the sample. For 2 keV N_2^+ ion bombardment or Na vapour deposition or Na^+ ion implantation, IL spectra show a continuous decrease of luminescence intensity. These results are interpreted as due to an increasing sample doping.

We also measured the resistivity of Na- and N2-doped single-wall carbon nanotube (SWNT) mats as a function of doping and temperature. For an isolated SWNT the current theory predicts a Luttinger Liquid (LL) electrical behaviour caused by a quasi one-dimensionality of the system. Our results show that for clean SWNT mats the electrical behaviour can be explained within the framework of the weak localization theory, that upon increasing sodium or nitrogen doping, the mat resistance changes as the sample undergoes a progressive metallization, and that

the resistivity displays a pronounced temperature dependence described by a power law (R□T-□) with exponent □varying with dopants. We interpret such results in terms of system disorder change.

5.6 ION INTERACTION WITH SOLIDS

Electron emission by 130-430-eV Ar+ ion impact on polycrystalline Al surfaces has been studied extending the theory of Auger neutralization to include the singular response of the metal conduction band to the sudden change of charge in the incoming hole state, following its neutralization. The results show an effect manifested in the high-energy tail of the electron energy distributions, where the theory accounts very well with experiments.

The energy distributions of electrons emitted in the interaction of slow Na+ ions with polycrystalline Al surfaces has also been investigated. To study sub-threshold plasmon excitation we performed measurements as a function of emission angle which showed the excitation of bulk plasmons, confirming the kinetic nature of the excitation process.

We studied also experimental energy distributions and yields of electrons emitted from MgO surfaces under the impact of slow noble gas and sodium singly charged ions at varying incident energies. At impact energies below similar to 1 keV, electron spectra are nearly independent of ion type and energy. A tail of high-energy electrons is observed to grow at higher impact energies. The results are explained in terms of promotion of oxygen-2p electrons during binary projectile-oxygen collisions populating continuum and excitonic states. Excitons can significantly contribute to electron emission due to the negative electron affinity of the surface.

5.7 MULTIMEDIAL EDUCATION

In this research section we develop and test new media tools for the learning and teaching of physics at high school and university level. Rigorous educational research into student understanding is performed and used, either to inform the development of tools or to assess their effectiveness for the in-class work.

An interactive Java Applet has been outlined, aimed at helping students in understanding the classical relative motions. The applets simulates the fall of a body from a plane either freely or under the air friction force. The learner is allowed to choose either the ground-fixed system of reference or the plane-fixed one. Preliminary assessment results and future directions of the project will be discussed.

Numerical methods for integrating motion equations of simple systems are a well established part of the high school physics and mathematics syllabus. Teaching them by means of traditional methods, often results barely stimulating, and meanwhile students aren't allowed to grasp the different speed of convergence of various methods, mainly on account of tedious calculations needed. Regarding the solution of general problems not analytically solvable, moreover, computational difficulties, hide the didactic purpose of this argument from students. The Java applet presented here permits to overcome such difficulties, allowing the learners to pay attention directly on the different efficiency of various numerical integration methods, by means of interactivity and real-time graphical feedback.

5.8 QUANTUM COHERENCE AND CORRELATION

5.81. Superconducting nanocircuits for quantum information processing

We developed a description of coherent quantum oscillations of two (in general interacting) superconducting quantum bits, measured continuously by a generic mesoscopic and non-linear detector. As an example, we discussed a SQUID magneto-meter. The calculated detector-spectra show how the intrinsic non linearity can lead to a mixing of the Rabi oscillations of the two qubits. If they are not interacting and have different oscillation frequencies, the mixing manifests itself via the comparison of new spectral peaks corresponding to the sum and difference frequencies. In the presence of interaction, the additional non-linearity produces a shifts and a coherent splitting of the single qubit peaks. Finally, we discuss how the peak heights in the signal to noise ratio are limited by some relationship imposed by quantum mechanics among the various correlation functions involved (including charge and current correlations).

5.82. Quantum correlations in many-body systems

We have analyzed the thermodynamic properties of a N two-level systems interacting with a single radiation mode in the strong-coupling regime. In this limit, developing a perturbative expansion of the partition function in the high-temperature limit, we have explored the connections between the Dicke and the collective one-dimensional Ising model (XY model).

For the case of a single two level system (or qubit), we have also described the ground state entanglement of the bipartite system composed by a qubit strongly interacting with a single mode oscillator. The amount of entanglement present in the fundamental level has been evaluated as a function of the coupling strength, of the transition frequency and of the tunnelling amplitude (or level asymmetry)of the qubit. This has been done in the adiabatic regime, assuming that the evolution of the two level system is much faster than that of the oscillator. Within

the adiabatic approximation, we obtained a complete characterization of the ground state properties of the coupled system and, in particular, we found that both the spin magnetization and the amount of entanglement show a critical behavior in the case of symmetric qubit for the case of very strong interaction.

5.8.3 Coherence in nuclei and nuclear matter

The structure of 11Li, the first halo nucleus found, has been analyzed in the framework of the Preparata model of nuclear structure. By applying Coherent Nucleus Theory, a new interaction potential has been derived for the halo-neutrons that rightly reproduces the fundamental state of the system.

5.8.4 Quantum communication in spin systems

Using the Holstein-Primakoff transformation, that establishes a direct relationship between the magnetic properties of a spin lattice and those of an ensamble of bosons, we obtained an approximate description for the dynamics of a spin system for the case of a hyper-cubic lattice in arbitrary spatial dimensions. For an Ising-like interaction between nearest neighbors, the system can be described in terms of spin wave, allowing for the evaluation of the fidelity for the transmission of quantum information from one site to another of the lattice. Furthermore, we studied the properties of entanglement sharing among the various spins and in particular near the ferromagnetic phase transition.

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. M. Papagno, D. Pacilé, C. Giallombardo, A. Cupolillo, L. Papagno,
   HREEL study of c(5 x sqrt (3) x 9)rect-N structure on Ni(111) surface,
   Journal of electron spectroscopy and related phenomena **148** n. 3 (2005) 164-169.

2. V. Formoso, G. Chiarello, R. Agostino, L. Papagno, E. Colavita, L. Floreano, R. Gotter, A. Morgante, A. Santaniello, A. Verdini,
   Resonant valence-band photoemission spectroscopy on Fe62Ni20Cr18 alloy,
   The European Physical Journal **B43** (2005) 463-470.

3. D. Pacilé, A. Cupolillo, C. Giallombardo, M. Papagno, L. Papagno,
   Chemical reactions of CO molecules catalysed by alkali-metal atoms on the Ni(111) surface,
   Chemical Physics Letters **413** n. 4-6 (2005) 420-428.

4. M. Grioni, Ch.R. Ast, D. Pacilé, M. Papagno, H. Berger, L. Perfetti,
   Photoemission as a probe of coexisting and conflicting periodicities in low- dimensional solids,
   New Journal of Physics **7** (2005) 106.

5. A. Sindona, P. Riccardi and G. Falcone
Resonant mechanisms for negative ionization of secondary emitted atoms from sputtered metals,
Nucl. Instrum and Meth. **B230** (2005) 449.

6. A. Sindona, R. A. Baragiola, S. Maletta, G. Falcone, A. Oliva and P. Riccardi,
Broadening effects in Auger Neutralization of 130 -430 eV Ar^+ ions at Al surfaces,
Nucl. Instrum and Meth. **B230** (2005) 298.

7. A. Sindona, R. A. Baragiola, G. Falcone, A. Oliva and P. Riccardi,
Many-body shake-up in Auger neutralization of slow Ar^+ ions at Al surfaces,
Phys. Rev. **A71** (2005) 052903.

8. M. Commisso, M. Minniti, A. Sindona, A. Bonanno, A. Oliva, R. A. Baragiola and P. Riccardi,
Kinetic electron excitation in the interaction of slow Kr^+ ions with Al surfaces,
Phys. Rev. **B72** (2005) 165419.

9. P. Riccardi, P. Barone, A. Bonanno, A. Oliva, P. Vetrò, M. Isimoto, R.A. Baragiola,
Kinetic Electron Emission in he Interacions of Slow ions with MgO Surfaces,
Nucl. Instr. and Meth. **B230** (2005) 455-459.

10. M. Commisso, A. Bonanno, A. Oliva, M. Camarca, F. Xu and P. Riccardi,
Plasmon Excitation and Electron Promotion in the Interaction of Slow Na+ Ions with Al Surfaces,
Nucl. Instr. and Meth. **B230** (2005) 438-442.

11. W. Mao, D.V. Averin, F. Plastina, R. Fazio,
Continuous measurements of two qubits,
Phys. Rev. **B71** (2005) 085320.

12. R. Alzetta, G. Liberti and R. L. Zaffino,
Nuclear halo and the coherent nuclear interaction,
International Journal of Modern Physics **E14** (2005) 645.

13. G. Liberti and R.L. Zaffino,
Thermodynamic properties of the Dicke model in the strong-coupling regime,
Eur. Phys. J. **B44** (2005) 535.

A.1.2 Publications on international journals accepted in 2005

1. M. Papagno, D. Pacilé, G. Caimi, H. Berger, L. Degiorgi and M. Grioni,
Electronic structure of one-dimensional copper-oxide chains in $LiCu_2O_2$ from angle-resolved photoemission and optical spectroscopy,
to appear on Phys. Rev.

2. Ch. R. Ast, D. Pacilé, M. Papagno, T. Gloor, F. Mila, G. Wittich, K. Kern, H. Brune and M. Grioni,
Symmetry dependent overlayer-substrate hybridization in a surfactant: Pb on Ag(111),
to appear on Phys. Rev. B.

3. D. Pacilé, Ch. R. Ast, M. Papagno, M. A. Schneider and M. Grioni,
The electronic structure of an ordered Pb/Ag(111) surface alloy: theory and experiment,
to appear on Phys. Rev. B.

4. R. Sanjinés, M. Benkahoul, M. Papagno, F. Lévy, and D. Music,
Electronic structure of Nb_2N and NbN thin films,
to appear on J. Appl. Phys.

5. P. Barone, A. Bonanno, M. Commisso, M. Minniti, A. Oliva, P. Riccardi,
Auger electron emission in the interaction of slow Na^+ ions with Al surfaces,
to appear on Rad. Phys. and Chem.

6. M. Barberio, P. Barone, A. Bonanno, M. Camarca, F. Xu,
Thermo- and iono- luminescence on MWCNT bundles,
to appear on Rad. Phys. and Chem.

7. G. Liberti, R. L. Zaffino, F. Piperno and F. Plastina,
Entanglement of a qubit coupled to a resonator in the adiabatic regime,
to appear on Phys. Rev. A.

A.2 Publications on national journals

A.1.1 Publications on national journals printed in 2005

1. P. Sapia, A. Milazzo, A. Bonanno,
Approccio Visuale all'Integrazione Numerica delle Equazioni del Moto: un'Applet Java sul Moto Parabolico con Attrito Viscoso,
Didattica e Didattiche Disciplinari **1** (2005)135-150.

2. A.Milazzo, A. Bonanno,
Un Laboratorio Virtuale di Cinematica per visualizzare e rendere interattivo il moto del proiettile,
Scienzaonline n.11-12, Anno 2, 17 Gennaio 2005.

A.1.2 Publications on national journals accepted in 2005

1. P. Sapia, A. Oliva, A. Bonanno,
Un'applet Java per lo studio dei moti relativi,
to appear on La Fisica nella Scuola.

2. P. Sapia, G. Falcone, A. Bonanno,
Un learning object multimediale per l'insegnamento/apprendimento dell'effetto fotoelettrico,
to appear on Didattica e Didattiche Disciplinari.

B PUBLICATIONS ON CONFERENCE PROCEEDINGS

B.1 Publications on international conference proceedings in 2005

1. A. Milazzo, A. Bonanno,
On-line Virtual Kinematics Laboratory Visualizing Interactively Projectile Motion ,
in Proceedings of MPTL 9 (9th Meeting on Multimedia in Physics Teaching and Learning)
Graz, 9-11 September 2004.
Published on-line only: http://physik.uni-graz.at/MPTL9/proceedings/ProcMilazzo.pdf

C INVITED PRESENTATIONS

C.1 Invited presentations at international conferences in 2005

1. F. Plastina, T. J. G. Apollaro, G. M. Palma, A. Lozinski,
Entanglement and communication in spin systems,
invited talk at "Meccanica Quantistica e Computazione Quantistica", March 18, 2005, Vietri sul mare, Italy.

2. A. Bonanno
Multimedial learning object for special relativity,
Semana de la ensenanza della Fisica, Bogotà, September 12-16, 2005.

C.2 Invited presentations at national conferences in 2005

1. A. Bonanno,
Dalla relatività di Galileo alla relatività di Einstein,
Workshop su nuove tecnologie nella didattica delle scienze, Università della Calabria, May 2005.

D PRESENTATIONS AT CONFERENCES

D.1 Presentations at international conferences in 2005

1. P. Sapia, A. Bonanno
A Java applet for spectrograms,
10th Meeting on Multimedia in Physics Teaching and Learning (MPTL10), Berlin, Oct 5-7, 2005.

2. A. Milazzo, A. Bonanno
A new applet Java about frictional force,
10th Meeting on Multimedia in Physics Teaching and Learning (MPTL10), Berlin, Oct 5-7, 2005.

D.2 Presentations at national conferences in 2005

1. P. Sapia, A. Bonanno
Un *percorso visuale per l'insegnamento/apprendimento dell'effetto fotoelettrico*,
VII Congresso Nazionale dell' **A**ssociazione per la **D**idattica con le nuove **T**ecnologie (ADT), Rimini, Sept 30 – Oct 2, 2005.

2. M. Barberio, A. Bonanno, G. Falcone, P. Sapia,
Tecnologie didattiche ed educazione alla salute: un'applet Java per l'esame audiometrico,
in "DIDAMATICA 2006", Cagliari, May 11-13, 2005

3. A. Bonanno, M. Camarca, P. Sapia, M Serpe,
La realtà fisica e la sua rappresentazione: un percorso integrato tra fisica, matematica ed informatica attraverso una cardioide,
in "DIDAMATICA 2006", Cagliari, May 11-13, 2005.

4. E. Cazzanelli, M. Castriota, A. Cupolillo, L. Caputi, L. Papagno,
Raman investigation on linear carbon chains inside nanotubes,
GNSR2005, Casa delle Culture - Cosenza, Novembre 9-11, 2005.

6. MOLECULAR BIOPHYSICS

Professors and Researchers: Luigi Sportelli
Rosa Bartucci
Rita Guzzi

Postdoc fellows: Manuela Pantusa
Andrea Stirpe

Undergraduate Students: Francesco De Simone
Cristina Vecchio

Technical staff: Bruno De Nardo
Carmine Prete

Collaborators: D. Marsh (*Max Planck Institut for Biophysical Chemistry, Goettingen, Germany*)
S.A. Dzuba, D.A. Erilov (*Institute for Chemical Kinetics and Combustion, Novosibirsk, Russian Academy of Science and Dept. of Physics, Novosibirsk, Russian Federation*)
D. Grasso, C. La Rosa, D. Miliardi (*Dipartimento di Chimica, Università di Catania, Italy*)
G. W. Canters, M. Ph. Verbeet (*Gorlaeus Laboratory, University of Leiden, Netherland*)
S. Cannistraro, L. Andolfi (*Dept. of Environmental Science, University of Tuscia, Viterbo, Italy*)
B. Rizzuti, (*Licryl, CNR-INFM, Dept. of Physics, University of Calabria, Italy*)
V. Lippolis, A. Garau (*Dip. to di Chimica Organica and Analitica, University of Cagliari, Italy*)

Introduction

In the year 2005 the research activity has essentially concerned with two main topics in the field of Molecular Biophysics. In particular, the first has concerned self assembled supramolecular lipid structures, their dynamic properties and interaction with active biomolecules, while the second topic has regarded the thermal and spectroscopic properties of Metal-Proteins with oxidase activity. Molecular Dynamics Simulation of a Metal-Protein, Azurin, has also been considered. In the following the main results obtained in each field are reported.

6.1 DYNAMICS PROPERTIES and INTERACTIONS in SELF ASSEMBLED SUPRAMOLECULAR LIPID STRUCTURES

6.1.1 Bipolar Tetraether Lipids: Chain Flexibility and Membrane Polarity Gradients from Spin-Label ESR

Membranes of thermophilic archaea are composed of unique tetraether lipids in which C40, saturated, methyl-branched biphytanyl chains are linked at both ends to polar groups. In this paper membranes composed of bipolar lipids P2 extracted from the acidothermophile archaeon Sulfolobus solfataricus are studied. The biophysical basis for the membrane formation and thermal stability is investigated by using electron spin resonance (ESR) of spin-labelled lipids. Spectral anisotropy and isotropic hyperfine couplings are used to determine the chain flexibility and polarity gradients, respectively. For comparison, similar measurements have been carried out on aqueous dispersions of diacyl reference lipid dipalmitoyl phosphatidylcholine and also of diphytanoyl phosphatidylcholine, which has methyl-branched chains. At a given temperature, the bolaform lipid chains are more ordered and less flexible than in normal bilayer membranes. Only at elevated temperatures (80 °C) does the flexibility of the chain environment in tetraether lipid assemblies approach that of fluid bilayer membranes. The height of the hydrophobic barrier formed by a monolayer of archaebacterial lipids is similar to that in conventional fluid bilayer membranes, and the permeability barrier width is comparable to that formed by a bilayer of C16 lipid chains. At a mole ratio of 1:2, the tetraether P2 lipids mix well with dipalmitoyl phosphatidylcholine lipids and stabilize conventional bilayer membranes. The biological as well as the biotechnological relevance of the results is discussed.

6.1.2 Calorimetric and spin-label ESR studies of PEG:2000-DPPE containing DPPC/lyso-PPC mixtures

The thermotropic behaviour of multibilayers of dipalmitoylphosphatidylcholine (DPPC) containing up to 10 mol% of lyso-palmitoylphosphatidylcholine (lyso-PPC) in the presence and in the absence of low content of the polymer-lipid PEG:2000-DPPE has been studied by differential scanning calorimetry (DSC) and electron spin resonance (ESR) spectroscopy, using the spin probe di-tert-butyl-nitroxide (DTBN). In the absence of polymer-lipids, the main phase transition temperature, T_m, of DPPC is down shifted as function of content of lyso-PPC and the shifts are in the range of $\Delta T = T - T_m = -0.5 \div -1.5$ °C. Correspondingly, the cooperative unit, CU, of the transition first

decreases and then levels off with the amount of lyso-PPC mixed with DPPC. In the mixed lipid dispersions the membrane fluidity increases at any temperature. The addition of increasing amount of PEG:2000-DPPE at submicellar concentration, i.e., from the low density mushroom regime to the brash conformational one of PEG:2000 chains, in the lipid matrix composed of DPPC and 10 mol% lyso-PPC do not affect neither the thermotropic phase transition behaviour nor the membrane fluidity and the transition cooperativity of the mixed lipid dispersions.

6.1.3 Time-Resolved Electron Spin Resonance Studies of Spin-Labelled Lipids in Membranes

Pulsed electron spin resonance methods have been applied to study the dynamics and the penetration of water (D_2O) in spin-labelled phospholipid membranes. Dipalmitoylphosphatidylcholine membranes, with and without an equimolar amount of cholesterol, have been used, with phosphatidylcholine site-specifically spin-labelled throughout the sn-2 chain.

The librational lipid chain motion in the low-temperature phase of phospholipid bilayers has been revealed by means of primary and stimulated electron spin echo-detected ESR spectra in the sub-nanosecond and microsecond timescale, respectively. The influence of temperature and chain position of labelling on the lipid chain dynamics have been investigated. Three-pulse electron spin echo envelope modulation (ESEEM) spectroscopy is used to determine the transmembrane profiles of the water permeation in the membranes. They display a sigmoidal dependence on position of labelling that is characteristic of polarity profiles. Moreover, a narrow spectral component and a broad one are resolved in the D_2O ESEEM spectra of lipid chains spin labelled across the width of bilayer membranes. The two components are assigned by spectral simulations to free and H-bonded intramembrane water molecules, respectively.

6.2 MOLECULAR DYNAMIC SIMULATION and THERMAL STABILITY of METAL-PROTEIN with OXIDASE ACTIVITY

6.2.1 Thermal unfolding of pseudoazurin: calorimetric and spectroscopic studies

The thermal unfolding of pseudoazurin has been investigated by means of differential scanning calorimetry (DSC), optical density, fluorescence and electron paramagnetic resonance spectroscopy. The combination of these experimental techniques has allowed us to gain insight into the modifications of the copper site environment and of the whole protein structure, during the denaturation process.

The thermal transition from the native to the denaturated state results to be irreversible, on the whole, and occurs in the temperature range between 333.0 and 340.5 K, depending on the scan rate and the technique used.

The denaturation pathway of the pseudoazurin can be described in terms of the Lumry-Eyring model: $N \Leftrightarrow U \Rightarrow F$. The protein reversibly passes from the native (N) state to the unfolded (U) one, whereas the step towards the final (F) state is irreversible and kinetically controlled. This model has been checked by numerical simulation of the calorimetric thermograms. The thermodynamic parameters related to the reversible step (ΔH_U = 498 kJ·mol^{-1} and $T_{1/2}$ = 340.8 K) have been obtained by extrapolation of the DSC profile at infinite scan rate. These data together to the ΔCp value of 8.3 $\pm$ 0.9 kJ K^{-1} mol^{-1}, calculated by means two different theoretical methods, lead to a ΔG value of 39.2 kJ mol^{-1} at 298 K.

From the comparison of the data obtained by the different techniques used, it emerges that the thermal denaturation process of holo-pseudoazurin starts with the disruption of the copper active site and the destabilization of the hydrophobic core, and proceeds with the collapse of the whole protein. In addition, according to the EPR findings, the native type-1 copper ion, which is in a distorted tetrahedral configuration in the native state of the protein, shows type-2 copper features after the denaturation.

Finally the role of the copper on the thermal stability of pseudoazurin is also discussed. The unfolding of the apo-form of protein is a reversible process and occurs at 315 K.

6.2.2 Sampling of protein inner motions in molecular dynamics simulations

Molecular dynamics simulation is a powerful technique to investigate the dynamic behavior of a protein in solution. Simulations on the nanosecond time scale are generally considered sufficient to obtain consistent information for physical properties that depend on the motion of protein residues, such as fluctuations, deviations and cross correlated displacements. This concept has been tested on azurin, a protein that represents a good model to study coordinated inner movements because of its small size and inherent stiffness. Dynamical cross-correlation and principal component analysis have been used to assess the convergence of sampling of the protein motions in simulation.

The results show a good correlation between the crystallographic and simulated atomic fluctuations, indicating that the dynamics of azurin, at equilibrium, is similar in the crystal and in solution. Nevertheless, even in this rigid protein the different structural elements (such as beta-strands, hydrophobic patches, alpha-helix) take a relatively long time to coordinate their movements after the simulated annealing. As a consequence, simulations in the range of a few nanoseconds are proven to be insufficient to assess global collective motions of residues.

The information achieved on the nanosecond time scale, though primarily associated to chaotic diffusion, can be used to identify the protein collective degrees of freedom that are more restricted. This has been used to isolate a small, poorly structured region of azurin with high mobility. By filtering out in the data analysis the motions of this region, convergence of sampling for coordinate displacements of residues is obtained for the protein scaffold. Selective filtering of the motions of uninteresting protein regions with high conformational freedom is indicated as a suitable method to investigate the protein inner motions in the time scale commonly sampled in molecular dynamics simulations.

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. M. Pantusa, L. Sportelli, R. Bartucci,
Transfer of stearic acids from Albumin to polymer-grafted lipid containing membranes probed by spin-label Electron Spin Resonance,
Biophys. Chemistry **114** (2005) 121-127.

2. S. Belsito, R. Bartucci, L. Sportelli**,**
Paclitaxel interaction with phospholipids bilayers: High-sensitivity differential scanning calorimetry investigation,
hermochimica Acta **427** (2005) 175-180.

3. D.A. Erilov, R. Bartucci, R. Guzzi, A. Shubin, A.G. Maryasov, D. Marsh, A.A. Dzuba, L. Sportelli,
Water concentration profiles in membranes measured by ESEEM of spin-labeled lipids,
J. Phys. Chem **B109** (2005) 12003-12013.

4. A. Stirpe, R. Guzzi, H. Wijma, M.Ph. Verbeet, G.W. Canters, and L. Sportelli,
Calorimetric and spectroscopic investigations of the thermal denaturation of wild type Nitrite Reductase,
Biochim. Biophys. Acta **1752** (2005) 47-55.

5. R. Bartucci, A. Gliozzi, A. Gambacorta, D. Marsh, L. Sportelli,
Bipolar Tetraether Lipids: Chain Flexibility and Membrane Polarity Gradients from Spin-Label Electron Spin Resonance,
Biochemistry **44** (2005) 15017-15023.

6. C. Caltagirone, F. Demartin, F.A. Devillanova, L. Escriche, A. Garau, F. Isaia, V. Lippolis, R. Kivekas, F. Jalali, V. Muns, M. Shamsipur, L. Sportelli, A. Yari, G. Verani,
Modelling blu copper-proteins: Interaction of Cu(II) with mixed-donor phenanthroline-containing macrocycles,
Inorg. Chem. Acta **358** (2005) 2403-2412.

A.1.2 Publications on international journals accepted in 2005

1. R. Bartucci, D.A. Erilov, R. Guzzi, L. Sportelli, S.A. Dzuba, D. Marsh,
Time-Resolved Electron Spin Resonance Studies of Spin-Labelled Lipids in Membranes,
to appear on Chem. Physics of Lipids.

A.2 Publications on national journals

A.2.2 Publications on national journals accepted in 2005

1. A. Stirpe, R. Guzzi,
Thermal unfolding of holo and apo pseudoazurin,
to appear on Il Nuovo Cimento C.

C INVITED PRESENTATIONS

C.1 Invited presentations at international conferences in 2005

1. R. Bartucci,
Spin-labelled lipids in membranes: pulsed ESR studies,
4th Workshop on "Protein-Lipid Interactions", Dubrovnik, Croatia, October 6-9, 2005.

C.2 Invited presentations at national conferences in 2005

1. R. Bartucci
Time-Resolved Electron Spin Resonance Studies of Spin-Labelled Lipids in Membranes,

VII Convegno GIRSE, Padova, September 25-27, 2005.

3. R. Guzzi
A comparative investigation of the thermal unfolding of pseudoazurin in the holo and apo form,
XCI Congresso Nazionale SIF, Catania, September 26 – October 1, 2005. Award for the best Oral Communication of the Section IVb – Biophysics and Medical Physics.

D PRESENTATIONS AT CONFERENCES

D.1 Presentations at international conferences in 2005

1. R. Bartucci, R. Guzzi, L. Sportelli,
Time-resolved FT-ESR studies of spin-labelled biosistems,
5th Workshop on "Molecular Interactions of the Lipid-Protein Interactions", University of Calabria, September 10-12-2005.

2. R. Bartucci, R. Guzzi, L. Sportelli,
Spin-labelled lipids in membranes: pulsed ESR studies,
4th Workshop on Protein-Lipid Interactions, Dubrovnik, Croatia, October 6-9, 2005.

D.2 Presentations at national conferences in 2005

1. A. Stirpe, R. Guzzi, G.W. Canters and L. Sportelli,
Thermal unfolding of pseudoazurin: calorimetric and spectroscopic studies
MMD-Meeting, Italian conference on matter, materials and devices, Genova, June 22-25, 2005 – Italy

2. M. Pantusa, L. Sportelli, R. Bartucci,
Transfer of stearic acids from Albumin to polymer-grafted lipid containing membranes probed by spin-label Electron Spin Resonance,
MMD– Meeting, Italian conference on matter, materials and devices, Genova, June 22-25, 2005 - Italy

3. B. Rizzuti, L. Sportelli and R. Guzzi,
Sampling of protein inner motions in molecular dynamics simulations
MMD– Meeting, Italian conference on matter, materials and devices, Genova, June 22-25, 2005 - Italy

4. R. Guzzi, A. Stirpe, G. W. Canters and L. Sportelli,
A comparative investigation of the thermal unfolding of pseudoazurin in the holo and apo form,
SIF-Società Italiana di Fisica, Catania, September 26 – October 1, 2005 - Italy.

5. R. Bartucci, R. Guzzi, L. Sportelli,
Time-Resolved Electron Spin Resonance studies of spin-labelled lipids in membranes
VII Convegno GIRSE, Padova, September 25-27, 2005 – Italy.

6. D.A. Erilov, R. Bartucci, R. Guzzi, A.A. Shubin, A.G. Maryasov, D. Marsh, S.A. Dzuba , L. Sportelli,
Water concentration profiles in membranes measured by ESEEM of spin-labeled lipids,
MMD– Meeting, Italian conference on matter, materials and devices, Genova, June 22-25, 2005 - Italy

ORGANIZATION OF CONFERENCES

1. Workshop on "*Molecular Interaction at the Lipid/Protein Interface*",
Department of Physics, University of Calabria, September 10-12, 2005.

7. PHYSICS AND APPLICATIONS OF THE SOFT MATTER

Professors and Researchers:	Roberto Bartolino
	Lev M. Blinov
	Cesare Umeton
	Riccardo C. Barberi
	Enzo Cazzanelli
	Gabriella Cipparrone
	Nicola Scaramuzza
	Carlo Consolato Versace
	Maria Penelope De Santo
	Pasquale Pagliusi
	Giuseppe Strangi
Postdoc fellows	Marco Castriota
	Antonio De Luca
	Alessandro Veltri
	Carlo Vena
	Bruno Zappone
PhD students	Habib Ayeb
	Valentin Barna
	Stefano D'Elia
	Luciano De Sio
	Samah Ferjani
	Salvatore Marino
	Mario Ariosto Matranga
	Gaetano Nicastro
	Luigia Pezzi
	Clementina Provenzano
	Tania Rugiero
Collaborators	Federica Ciuchi *(CNR, Cosenza, Italy)*
	Michele Giocondo *(CNR, Cosenza, Italy)*
	Giuseppe Lombardo *(CNR, Cosenza, Italy)*
	Alfredo Mazzulla *(CNR, Cosenza, Italy)*
	Alfredo Pane *(CNR, Cosenza, Italy)*
	Tiziana Barone (*Università della Calabria, Cosenza, Italy)*
	Bruno A. De Nardo (*Università della Calabria, Cosenza, Italy)*
	Giuseppe De Santo (*Università della Calabria, Cosenza, Italy)*

International collaborations	University of Bucharest (*Romania*)
	Centre Paul Pascal - Bordeaux (*France*)
	University of Colorado - Boulder (*USA*)
	University of Tunis (*Tunisia*)
	College de France - Paris (*France*)
	University of Marseille (*France*)
	University of Exeter (*UK*)
	Chalmers University - Goteborg (*Sweden*)
	University of Kent (*USA*)
	Polytechnic of Madrid (*Spain*)
	Polytechnic of Bucharest (*Romania*)
	University of Gent (*Belgium*)
	University of Ljublijana (*Slovenj*)
	Russian Academy of Sciences (*Russia*)
	University of Tblisi (*Georgia*)
	Philips Research Center (*The Netherlands*)
	Hewlett Packard Research Center (*UK*)
	University of Nizhny - Novgorod (*Russia*)

Introduction

The research activity in 2005 has been concerned with the following subjects: PDLC e POLICRYPS, liquid crystals, nonlinear optics, electrooptics, electrodynamical instabilities, oxide thin films, polymer, nonlinear dynamics, nanoscience of soft matter, vibrational spectroscopy

7.1 VIBRATIONAL SPECTROSCOPY

In the year 2005 the Laboratory of vibrational spectroscopy carried out an extensive scientific and technological work of synthesis and characterization of thin solid film, mostly tungsten , vanadium and rhenium oxides, to be used for electrochromic devices and for asymmetric nematic liquid crystal cells. Beside the materials research, development and testing of electrochromic devices, based on both organic and inorganic films, were performed, pointing out to possible new technological applications, interesting some industrial firm.

Moreover, some research of Raman spectroscopy on particular materials has been made in collaboration with other group of this Department, of others Department of this University, and of other Italian and foreign universities and research centers. To be pointed out, the first Raman investigation on ionic liquids, made in collaboration with ENEA (Casaccia), the works on disordered magnetic system based on NiO-MgO solid solution and the one about mixed films of Re-Ta, both in collaboration with Trento and Riga (Latvia) University, and the paper on polymeric blend, made in collaboration with a group of the Chemistry Department.

During the year 2005 the group cared for the organization work of the 19 ° National Meeting of GNSR, about the Raman spectroscopy, held in Cosenza, 9-11 november 2005. In this conference the first results of the Raman investigation of the linear carbon chains inside multiwalled nanotubes were presented.

Finally, the preliminary tests for applications of the micro-Raman Spectroscopy to the study of archaeological manufacts have been performed, and spectral database and proper literature have been collected.

7.2 REALIZATION OF MICROCAVITY LASERS USING DISTRIBUTED FEEDBACK

Distributed feedback microstructures have been as an innovative array of organic, color-tunable microlasers. Dye-doped helixed liquid crystals were embedded within periodic, polymeric microchannels sculptured by light through a single-step process. The helical superstructure was oriented along the microchannels; the lasing was observed along the same direction at the red edge of the stop band. Several physical and technological advantages arise from this engineered heterostructure: a high quality factor of the cavity, ultralow lasing threshold, and thermal and electric control of the lasing wavelength and emission intensity. This level of integration of guest-host systems, embedded in artificially patterned small sized structures, might lead to new photonic chip architectures.

7.3 INVESTIGATION OF POLICRYPS GRATINGS

a) Implementation of a Kogelnik-like model for the diffraction efficiency of POLICRYPS gratings.

POLICRYPS are diffraction gratings consisting of continuous and well-aligned nematic films separated by polymer slices, which are originated in nematic-containing polymer composites when cured by a UV interference pattern. The diffraction efficiency of these gratings has been experimentally investigated in detail; its temperature dependence reveals a rather complex, nonmonotonic shape. When the influence of an external electric field has been investigated, the dependence of the diffraction efficiency on the applied voltage appeared to be nonmonotonic too, the particular shape depending on the actual value of the sample temperature; in general, both switch-on and switch-off of the diffraction mechanism could be observed as an effect of the external field. For this kind of grating, a Kogelnik-like model has been implemented that makes use of only real values of some physical quantities, without the necessity of any fitting parameter. Numerical solutions account for the temperature dependence of the diffraction efficiency with good accuracy.

b) Observation and modellization of two-wave coupling during the formation of POLICRYPS diffraction gratings.

We have performed an experimental characterization of two-wave mixing that occurs inside a sample between the beams used for the fabrication of POLICRYPS diffraction gratings. The effect depends on the phase shift between the curing interference pattern and the grating being cured. Since this shift can be mechanically induced by accidental vibrations of the experimental setup, a high setup stability is needed and we have devised a mechanism that enables to control setup vibrations in situ and used it to monitor the experiment. When the mechanically induced shift was significantly small, wave mixing was observed only if the initial intensities of the two curing beams were different from each other. Furthermore, we have also implemented a simple model which accounts very well for the main features of the observed effect.

7.4 GENERATION OF SPATIAL SOLITONS IN LIQUID CRYSTALS.

We have demonstrated that, in suitably designed cells with undoped nematic liquid crystals, extraordinary-wave spatial solitons can be excited at every applied voltage without adjustments in the input polarization. Their walk-off, hence direction of propagation, is externally controlled over angles as large as 7°. The results pave the way not only to polarization-forgiving generation but also to voltage readdressing of these extraordinary wave nematicons.

7.5 NEMATIC ORDER RECONSTRUCTION AND NANOSCOPIC LIQUID CRYSTAL SURFACE INTERACTIONS.

Nematics constitute ideal systems for the study of structural forces exchanged by solid bodies. These forces have a two-fold nature: when the distance separating the submerged bodies is larger than the nematic coherence length, the force between them essentially results from the elastic distortion of the nematic director in the intervening region; when the separating distance is comparable with the nematic (nanoscopic) coherence length, the interaction force is also affected by the local molecular order, which can be revealed at a macroscopic scale. Upon exploring a whole range of distances close to the coherence length, it is likely to induce bifurcations from and transitions among different equilibrium configurations.

Recently, we presented the first time resolved experimental characterization of the biaxial switching between two topologically distinct textures of a nematic liquid crystal cell submitted to a strong electric field. This fast electro-optical effect is governed by the electric induced order reconstruction in the nematic bulk, which continues to be an actual challenge for a complete theoretical description of the nematodynamics. Now, the average molecular orientation change is obtained without any local director rotation, but with a suitable deformation of the ellipsoid which represents the nematic order.

A parallel research has been conducted for the experimental analysis of structural forces at nanoscale. Using a temperature controlled Atomic Force Microscope (AFM), we studied surface induced pre-smectic order in the nematic and isotropic phases of 4-cyano-48-n-octylbiphenyl. A home-modified AFM head has been used to measure the structural force between a flat glass plate and a 10 μm glass sphere, both being treated to induce homeotropic alignment of the confined liquid crystal layer in between. We observed surface-induced pre-smectic force not only in the isotropic, but also in the nematic phase. We measured the temperature dependencies of the pre-smectic force, the smectic correlation length and the smectic order parameter at the surface. In this work, we extended the AFM force experiments to optically anisotropic and disordered fluids by introducing a force-detecting system, based on piezoresistive AFM cantilevers.

7.6 MEDICAL APPLICATIONS OF SCANNING PROBE MICROSCOPIES

Refractive errors are some of the most common ophthalmic abnormalities. The introduction of excimer laser technology in refractive corneal surgery aims to eliminate all or the major part of the first corneal surface optical aberrations through the modelling of the corneal surface. Among the main causes of post-operative aberrations are the new corneal profile created by laser and the roughness of the treated surface. It is mandatory for an optimal surgical outcome that the treated surface be as similar as possible to the natural architecture of the cornea. The aim of our study is to evaluate the corneal topography before and after the laser treatment by means of Atomic Force Microscopy.

Recently new investigations are performed for the development of a “Colloidal Probe Microscope” in order to study the surfaces forces of biological bodies immersed in aqueous solutions.

7.7 OPTICALLY INDUCED NONLINEAR DYNAMICS AND CONTROL IN LIQUID CRYSTAL FILM

The nonlinear response of LC to an intense optical field represents an example of radiation-matter interaction in which nonlinear phenomena can be easily investigated. Recently, we observe that the cascade of successive homoclinic gluing bifurcations is responsible for the transition towards stochastic regime. Even if our is not an ad hoc system to reproduce the homoclinic chaos, the route to chaos through gluing bifurcation happens in a natural way, due to the NLC symmetry.

The obtained results shown that LC are systems in which complex dynamics can be studied with very simple experiments, and suggest to use them for the control of the chaos. The activity has been focused on the development of a technique to control nonlinear dynamics: different methods has been tested, but particular attention has been devoted to achieve an all optical control. A large investigation of the dynamical regimes reached by the system through the control has been realised starting from different initial regimes.

7.8 SURFACE INDUCED PHOTOREFRACTIVITY IN PURE LIQUID CRYSTAL CELLS

Highly sensitive photo-electrical reorientation effects have been observed in pure LC cell, under the combined application of DC electrical field and low power illumination (μW). The phenomenon is characterized by very large nonlinear coefficients (>10 cm^2/W). Wave mixing experiments suggest a PR-like effect induced by photoelectric modulation of the surface charge density at the polymer-LC interface, which produces refractive index grating via

nematic director reorientation in the bulk. The spatially modulated electric field within the LC layer has been exploited to control the grating spatial phase and, then, the energy transfer in two beams coupling experiments (TBC gain). Both the photo-electric surface activation and the surface photorefractive gratings have been investigate from experimental and theoretical point of view.

7.9 POLARIZATION HOLOGRAPHY IN MOLECULAR MATERIALS

Polarization gratings in LC, LC-polymers composite materials have attracted great interest because of peculiar diffraction properties which open the way to promising application in displays and photonic technologies. Several materials and configurations have been investigated. Near 100% efficiency orientational gratings have been obtained in a nematic cell by modulating the in-plane anchoring axis on polarization-sensitive aligning substrates. External voltage allows adjusting the efficiency over the whole range.

The manipulation of the topography in thin films of azo-benzene based dyes and polymers has been achieved and formation of the surface relief gratings has been reported for the first time with polarization holography in systems without azo-compounds.

7.10 TUNABLE LASING IN CHOLESTERIC LIQUID CRYSTALS

The study of dye doped cholesteric liquid crystal devices with the purpose of developing low threshold and widely tunable laser has been performed . Several strategies have been investigated obtaining lasing from a cascade of CLC laser systems and tunability of the same laser device in the wavelength range 350nm-700nm.

7.11 LASER ACTION IN LIQUID CRYSTALS

This research field involves the creation and the study of novel photonic band-gap microstructures which give rise to color tunable, DFB micro-cavity lasers with a high ratio between the quality factor Q of the cavity and its volume V, usually referred to as the Purcell-number. The optical micro-cavities were obtained by embedding dye-doped helixed liquid crystals in holographically patterned polymeric micro-channels. The orientation of the LC helix axis along the micro-channels offers several physical advantages: increase of the cavity length and thus the number of periods, small modal volume, directional control, improvement of the liquid crystal orientational order parameter and wavelength tunability. The distributed feedback needed to obtain laser oscillations in the case of a small refractive index modulation requires thousands of periods in order to behave as an optical cavity with a quite high quality factor, The presented geometry allows obtaining a number of periods which is about two orders of magnitude larger than conventional systems because it exploits the entire length of the micro-channel in a waveguide regime instead of the sample thickness. In this way, each micro-channel becomes an optical mirror-less microcavity with a very small volume V of only a few cubic micrometers. This results in a remarkable Purcell-number which is very desirable since it enhances the factor of spontaneous emission and severely reduces the threshold of laser emission.

The laser emissions were found to be circularly polarized, indicating that distributed feedback mechanisms take place through circular Bragg reflection. The LC micro-channel behaves like a miniaturized mirror-less cavity laser, where the emitted laser light propagates in the waveguide defined by the chiro-selective liquid-crystalline medium. The micro-lasers of the array are intrinsically phase locked because they are simultaneously stimulated by the same laser pump. Furthermore, tailoring a proper array of electrodes which enables the application of a local electric field would give rise to electrically programmable phase holograms with interesting light polarization properties.

More recently investigations have been carried out about the confinement of dye doped helixed liquid crystal in cylindrical microcavities which gives rise to a 3D periodical superstructure where the two naturally preferred helical directions (axial and radial) create spontaneously. Low-threshold highly directional laser action was demonstrated both radially and axially. Along with the expected band-edge modes has been observed the existence of long-lived spectrally narrow laser defect modes within the central region of the stop band. Fine temperature tuning of the stimulated emission wavelength was achieved for both lasing situations. Experimental evidence has confirmed the existence of the two distinct DFB microresonator structural configurations (axial and radial) which are behind the demonstrated temperature tunable multidirectional (3D) lasing system. This level of integration might lead to new photonic chip architectures and devices, such as zero-threshold micro-lasers, phased array, discrete cavity solitons, filters and routers.

7.12 CHANGES OF THE ELECTRO-OPTIC RESPONSE OF NEMATIC LIQUID CRYSTAL CELLS

A polarity-sensitive electro-optical response observed in nematic liquid crystal cells characterized by asymmetric insertion of thin films of titania-vanadia oxide with a Ti/V atomic ratio of 1/1, prepared by sol-gel synthesis on transparent indium tin oxide. The electro-optical effect is opposite to previously reported ones but is obtained using the same materials with a slightly different sol-gel route. The structural properties of titania-vanadia films are extensively studied with particular attention paid to the thermal history of the films. The measurements made of the films and on the nematic liquid crystal cell demonstrate that the crystalline structure of the film is responsible of the observed effect. Thermal annealing of the films results in formation of structures that dramatically change the electric properties of the

films. A qualitative model is proposed to explain the surface charge distribution inside the nematic liquid crystal cell that results in the observed electro-optical effect.

7.13 ELECTROHYDRODINAMIC INSTABILITIES

We have studied the electrohydrodinamic behaviour of the doped nematic liquid crystal mixture M5. The nematic liquid crystal mixture M5 has been prepared in our laboratory by its components (SYNTHON Chemicals GmbH & Co KG) in the following ratios:

4-hexyloxyphenyl-4'-methoxybenzoate **22,0 wt%;**
4-octyloxyphenyl-4'-pentyloxybenzoate **30,3 wt%;**
4-heptyloxyphenyl-4'-hexyloxybenzoate **13,3 wt%;**
4-butyloxyphenyl-4'-hexylbenzoate **34,4 wt%.**

The mixture, which does not shows a low frequency electroconvection regime, has been characterized by micro DSC, polarized microscopy and impedance analysis.

To obtain the low frequency electrohydrodinamic instabilities we doped at several percentages the M5 by its reaction precursors ***4-(n-Octyloxy)phenol and 4-Heptylbenzoic acid***, in the following we will refer to these two compounds as salt and acid respectively.

The conductivities, the dielectric constants, the birefringence of the doped materials have been determined and we measured the phase diagrams to estimates the influence of the dopants on the cut-off frequency of low frequency regime. We obtained that the clearing point temperature TC decreases when the salt concentration increases. On the contrary TC is almost independent from the acid concentration.

Increasing the acid concentration we observed an increasing of both the perpendicular resistivity and the cutoff frequency.

The perpendicular dielectric constant doesn't change significantly in any case.

In conclusion the mixtures (SALT=10wt% ACID=6wt%) and (SALT=12wt% ACID=5wt%) are good candidates to replace MBBA for electroconvenction experiments.

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. S. Marino, M. Castriota, V. Bruno, E. Cazzanelli, G. Strangi, C. Versace, N. Scaramazza,
   Changes of the electro-optic response of nematic liquid crystal cells due to inserted titania-vanadia films,
   J. Applied Physics **97** (2005) 013523-1/8.

2. E. Cazzanelli, A. Kuzmin, G. Mariotto, N. Mironova-Ulmane,
   One-magnon Raman scattering in $Ni_cMg_{1-c}O$ solid solutions,
   Physica status solidi (c) **2**, n. 1 (2005) 708–711.

3. M. Castriota, T. Caruso, R. G. Agostino, E. Cazzanelli, W. Henderson, S. Passerini,
   Raman Investigation of the Ionic Liquid $PYR_{13}TFSI$ and its Mixture with LiTFSI,
   Journal of Physical Chemistry **A109** (2005) 92-96.

4. E. Cazzanelli, A. Kuzmin, G. Mariotto, N. Mironova-Ulmane,
   Behaviour of one-magnon frequency in antiferromagnetic $Ni_cMg_{1-c}O$ solid solutions,
   Physical Review **B71** (2005) 134415.

5. M. Castriota, S. Marino, C. Versace, G. Strangi, N. Scaramuzza, E. Cazzanelli,
   Characterization of Tungsten Trioxide Thin Film Deposited by Spin Coating and the Effect on Their Insertion in Liquid Crystal Cells,
   Molecular Crystals & Liquid Crystals **429** (2005) 237-253.

6. N. Mironova-Ulmane, V. Skvortsova, A. Kuzmin, U. Ulmanis, I. Silos, E. Cazzanelli, G. Mariotto,
   Magnetic ion exchange interactions in NiO-MgO solid solutions,
   Physics of the Solid State **47,** n. 8 (2005) 1516-1522.

7. V. Bruno, M. Castriota, S. Marino, C. Versace, G. Strangi, E. Cazzanelli, N. Scaramazza,
   Asymmetric Response to Electric Field in Nematic Liquid Crystal Cells Containing Vanadium Oxide Thin Films Prepared by Sol-Gel Synthesis,
   Molecular Crystals & Liquid Crystals **441** (2005) 27-43.

8. M. Castriota and D. Teeters,
   Impedance spectroscopy of PEO-lithium triflate confined in nanopores of alumina membranes,
   Ionics **11** (2005) 220.

9. I. Nicotera, L. Coppola, C. Oliviero, M. Castriota, E. Cazzanelli,
   Investigation of ionic conduction and mechanical properties of PMMA-PVdF blend based polymer electrolytes,
   Solid State Ionics **177** (2005) 581-588.

10. G. Strangi, V. Barna, R. Caputo, A. De Luca, C. Versace, N. Scaramuzza, C. Umeton and R. Bartolino, G. Price,
    Color-Tunable Organic Microcavity Laser Array Using Distributed Feedback,
    Phys. Rev. Lett. **94** (2005) 63903.

11. G. Strangi, V. Barna, R. Caputo, A. De Luca, C. Versace, N. Scaramuzza, C. Umeton and R. Bartolino, G. Price,
    Color-Tunable Organic Microcavity Laser Array Using Distributed Feedback,
    Virtual Journal of Nanoscale, Science and Technology **11,** n. 8 (2005)

12. R. Caputo, A.V. Sukhov, C. Umeton, A, Veltri,
    A Kogelnik-like Model for the diffraction efficiency of POLICRYPS gratings,
    Journal of Optical Society of America **B22** (2005) 735.

13. A. Alberucci, M. Peccianti, and G. Assanto, G. Coschignano, A. De Luca, and C. Umeton,
    Self-healing generation of spatial solitons in liquid crystals,
    Opt. Lett, **30** (2005) 1381.

14. R. Caputo, L. De Sio, A. Veltri, C. Umeton, A. V. Sukhov,
Observation of two-wave coupling during the formation of POLICRYPS diffraction gratings,
Opt. Lett. **30** (2005) 1840.

15. R. Caputo, L. De Sio, A. Veltri, C. Umeton,
Model for two beam coupling during the formation of holographic gratings with a nematic film–polymer-slice sequence structure,
Appl. Phys. Lett. **87** (2005) 141108.

15. R. Caputo, L. De Sio, A. V. Sukhov, A. Veltri, C. Umeton,
Realization of POLICRYPS Gratings. Optical and Electro-Optical Properties,
Mol. Cryst. Liq. Cryst. **441** (2005) 111.

16. A. Chanishvili, G. Chilaya, G. Petriashvili, R.C. Barberi, R. Bartolino, G. Cipparrone, A. Mazzulla, R. Gimenez, L. Oriol, M. Pinol,
Widely tunable ultraviolet-visible liquid crystal laser,
Applied physics letters **86** (2005) 051107-1/3.

17. M. Lombardo, M.P. De Santo, G. Lombardo, R.C. Barberi, S. Serrao,
Roughness of Excimer Laser Ablated Corneas With and Without Smoothing Measured With Atomic Force Microscopy,
Journal of Refractive Surgery **21** (2005) 469-475.

18. B. Zappone, P. Richetti, R.C. Barberi, R. Bartolino, H. Nguyen,
Forces in nematic liquid crystals constrained to the nanometer scale under hybrid anchoring conditions,
Physical Review **E71** (2005) 041703-1/10.

19. G. Carbone, R.C. Barberi, I. Musevic, U. Krzic,
Atomic force microscope study of presmectic modulation in the nematic and isotropic phases,
Physical Review **E71** (2005) 051704-1/5.

20. A. Chanishvili, G. Chilaya, G. Petriashvili, R.C. Barberi, R. Bartolino,
Cholesteric liquid crystal mixtures sensitive to different ranges of solar UV irradiation,
Molecular crystals and liquid crystals **434** (2005) 353-366.

21. A. Chanishvili, G. Chilaya, G. Petriashvili, R. Barberi, R. Bartolino, G. Cipparrone, A. Mazzulla, R. Gimenez, L. Oriol, M. Pinol,
Widely tunable ultraviolet-visible liquid crystal laser,
Applied Physics Letters **86** (2005) 051107.

22. J.A. Reyes, C. Provenzano, G. Cipparrone, G. Barbero,
Optical properties of a nematic sample in the low-frequency regime of an external electric field,
Journal of Applied Physics **97** (2005) 123108.

23. L.M. Blinov, G. Cipparrone, A. Mazzulla, C. Provenzano, S.P. Palto, M.I. Barnik, A.V. Arbuzov, B.A. Umanskii,
Electric field controlled polarization grating based on a hybrid structure "photosensitive polymer-liquid crystal,
Applied Physics Letters **87** (2005) 061105.

24. S. Marino, M. Castriota, V. Bruno, E. Cazzanelli, G. Strangi, C. Versace and N. Scaramuzza,
Changes of the Electro-optic Response of Nematic Liquid Crystal Cells Due to inserted Titania-Vanadia Films,
Journal of Applied Physics **97** (2005) 013523-1/8.

25. M. Castriota, S. Marino, C. Versace, G. Strangi, N. Scaramuzza, E. Cazzanelli,
Characterization of Tungsten Trioxide Thin Film Deposited by Spin Coating and the Effect on Their Insertion in Liquid Crystal Cells,
Molecular Crystals and Liquid Crystals **429** (2005) 237 -253.

26. C. Vena, C. Versace, G. Strangi, V. Bruno, N. Scaramuzza, R. Bartolino,
Light Depolarization Effect by Electrohydrodynamic Turbulence in Nematc Liquid Crystals,
Mol. Crystals and Liquid Crystals **441** (2005) 1.

27. V. Bruno, M. Castriota, S. Marino, C. Versace, G. Strangi, E. Cazzanelli, N. Scaramuzza,
Asymmetric Response to Electric Field in Nematic Liquid Crystal Cells Containing Vanadium Oxide Thin Films Prepared by Sol-Gel Synthesis,
Mol. Crystals and Liquid Crystals **441** (2005) 27.

28. V. Barna, S. Ferjani, A. De Luca, R. Caputo, N. Scaramuzza, C. Versace, and G. Strangi,
Multidirectional Laser Action Due to Confinement Induced Self-Organization of Helixed Liquid Crystals in Cylindrical Microcavities,
Applied Physics Letters **87** (2005) 221108.

29. S. Marino, M. Castriota, V. Bruno, E. Cazzanelli, G. Strangi, C. Versace and N. Scaramuzza,
Changes of the Electro-optic Response of Nematic Liquid Crystal Cells Due to inserted Titania-Vanadia Films,
Journal of Applied Physics **97** (2005) 013523-1/8.

30. G. Strangi, V. Barna, R. Caputo, A. de Luca, C. Versace, N. Scaramuzza, C. Umeton, R. Bartolino, G. Price, Color
Tunable Distributed Feedback Organic Micro-Cavity Laser,
Physical Review Letters **94** (2005) 063903-1/4.

31. M. Castriota, S. Marino, C. Versace, G. Strangi, N. Scaramuzza, E. Cazzanelli,
Characterization of Tungsten Trioxide Thin Film Deposited by Spin Coating and the Effect on Their Insertion in Liquid Crystal Cells,
Molecular Crystals and Liquid Crystals **429** (2005) 237 – 253.

32. C. Vena, C. Versace, G. Strangi, V. Bruno, N. Scaramuzza, R. Bartolino,
Light Depolarization Effect by Electrohydrodynamic Turbulence in Nematc Liquid Crystals,
Molecular Crystals and Liquid Crystals **441** (2005) 1-11.

33. V. Bruno, M. Castriota, S. Marino, C. Versace, G. Strangi, E. Cazzanelli, N. Scaramuzza,
Asymmetric Response to Electric Field in Nematic Liquid Crystal Cells Containing Vanadium Oxide Thin Films Prepared by Sol-Gel Synthesis,
Molecular Crystals and Liquid Crystals **441** (2005) 27-43.

34. V. Barna, S. Ferjani, A. De Luca, R. Caputo, N. Scaramuzza, C. Versace, G. Strangi,
Band-Edge and Defect Modes Lasing Due to Confinement of Helixed Liquid Crystals in Cylindrical Microcavities,
Applied Physics Letters **87** (2005) 221108.

A.1.2 Publications on international journals accepted in 2005

1. J. Purans, A. Kuzmin, R. Kalendarev, E. Cazzanelli and M. Castriota,
Structural Characterization of Mixed Ta-Re Oxide Films,
to appear on Solid State Ionics.

2. A. Chanishvili, G. Petriashvili, G. Chilaya, R.C. Barberi, M.P. De Santo, M.A. Matranga, F. Ciuchi,
Lasing in an intermediate twisted phase between cholesteric and smectic A,
to appear on Applied Physics Letters.

3. M. Lombardo, M.P. De Santo, G. Lombardo, R. Barberi, S. Serrao,
Atomic Force Microscopy analysis of normal and photoablated porcine corneas,
to appear on Journal of Biomechanics.

4. C. Provenzano, G. Cipparrone and A. Mazzulla,
Photopolarimeter based on two gratings recorded in thin organic films,
to appear on Applied Optics.

5. L.M. Blinov, G. Cipparrone, A. Mazzulla, C. Provenzano, S.P. Palto, M.I. Barnik, A.V. Arbuzov, B.A. Umanskii,
A nematic liquid crystal as an amplifying replica of a holographic polarization grating,
to appear on Mol. Cryst. & Liq. Cryst.

B PUBLICATIONS ON CONFERENCE PROCEEDINGS

B.1 Publications on international conference proceedings in 2005

1. E. Cazzanelli, J. Purans, R. Kalendarev, M. Castriota,
   Structural characterization of mixed Ta-Re oxide films,
   Proceedings of "SSI-15", Baden-Baden, Germany, July 18-22, 2005.

2. C.C. Versace, V. Bruno, M. Castriota, S. Marino, G. Strangi, E. Cazzanelli, N. Scaramuzza,
   Asymmetric Response To Electric Field In Nematic Liquid Crystal Cells Containing Vanadium Oxide Thin Films Prepared By Sol-Gel Synthesis,
   Proceedings of "8th European Conference on Liquid Crystals", Sesto (BZ), Italy, February 27 – March 4, 2005.

3. S. Marino, M. Castriota, V. Bruno, C.C. Versace, G. Strangi, N. Scaramuzza, E. Cazzanelli,
   Characterization of Tungsten Trioxide Thin Film Deposited by Spin Coating And The Effect On Their Insertion In Liquid Crystal Cells,
   Proceedings of "8th European Conference on Liquid Crystals", Sesto (BZ), Italy, February 27 – March 4, 2005.

4. M. Castriota, E. Cazzanelli, N. Epervrier, G. De Santo, T. Barone, N. Scaramuzza, C.C. Versace, G. Strangi, R. Bartolino R. ,
   Synthesis and Raman spectroscopic characterization of vanadium pentoxide, gel and thin films, for applications in asymmetric nematic liquid crystal cell,
   Proceedings of "XIX National Congress GNSR", Cosenza (Italy), November 09-11, 2005.

5. E. Cazzanelli, M. Castriota, A. Cupolillo, L. Caputi, L. Papagno,
   Raman investigation on linear carbon chains inside nanotubes,
   Proceedings of "XIX National Congress GNSR", Cosenza (Italy), novembre 09-11, 2005.

C INVITED PRESENTATIONS

C.1 Invited presentations at international conferences in 2005

1. G. Strangi, V. Barna, R. Caputo, A. De Luca, C. Versace, N. Scaramuzza, C. Umeton, R. Bartolino, G.N. Price,
   DFB Micro-Laser Array: Helixed Liquid Crystals Embedded in Holographically Sculptured Polymeric Microcavities,
   8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

2. G. Strangi, V. Barna, S. Ferjani, R. Caputo, A. De Luca, C. Versace, N. Scaramuzza, C. Umeton and R. Bartolino
   Tunable Laser Action in Helixed Liquid Crystal Confined to Microcavities,
   7th Mediterranean Workshop "Novel Optical Materials and Applications" NOMA '05, May 29- June 4, 2005, Cetraro (Italy).

3. G. Strangi, V. Barna, S. Ferjani, R. Caputo, A. De Luca, C. Versace, N. Scaramuzza, C. Umeton and R. Bartolino
   Lasing in dye doped helixed liquid crystals embedded in hetero-structured microcavities,
   6th International Balkan Workshop on Applied Physics, July 5-7, 2005 Constanta (Romania).

D PRESENTATIONS AT CONFERENCES

D.1 Presentations at international conferences in 2005

1. A. De Luca, A. Veltri, L. Pezzi, C.P. Umeton,
   Experimental and Theoretical Characterization of Reorientation Effects in Saturable Kerr like Media,
   XI international Topic Meeting Optics of Liquid Crystal, Sand Key, Florida, October 2-7, 2005.

2. L. De Sio, A. Veltri, R. Caputo, A. De Luca, A. Sukhov, C.P. Umeton,
   In-situ optical control e stabilization of the curing process of POLICRYPS gratings,
   NOMA 7th International Conference on Novel Materials and Application, Cetraro (CS), May 30 – June 4, 2005.

3. A. Veltri, R. Caputo, A. Sukhov, C.P. Umeton,

Model for photo-induced formation of permanent diffraction gratings in liquid crystalline composite materials, XI international Topic Meeting Optics of Liquid Crystal, Sand Key, Florida, October 2-7, 2005.

4. A. Veltri, L. Pezzi, A. De Luca, C.P. Umeton,
Different Reorientational Regimes in LC Materials Undergoing Multiple Irradiation,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

5. A. De Luca, G. Coschignano, C.P. Umeton,
Particular Thin Cells for Spatial Solitons Characterization,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

6. L. De Sio, R. Caputo, A. Veltri, A. De Luca, A. Sukhov, C.P. Umeton,
Optical feedback for vibration control in a holographic setup,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

7. A. De Luca, A. Veltri, L. Pezzi, C.P. Umeton,
Reorientational effects in saturable Kerr-like media undergoing multiple irradiation,
7th Mediterranean Workshop and Topical Meeting – "NOMA 2005", Cetraro (CS), Italy, May 29 – June 4, 2005.

8. M. Lombardo, M.P. De Santo, G. Lombardo, R.C. Barberi, S. Serrao,
Smoothness of excimer laser ablated corneas as observed at Atomic Force Microscope,
The 9th Winter Refractive Surgery Meeting", Cavalieri Hilton Hotel, Roma, February 4-6, 2005.

9. H. Ayeb, F. Ciuchi, G. Lombardo, R.C. Barberi,
Effect of surface treatment on the electric field induced biaxial order reconstruction in nematic,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

10. R.C. Barberi, F. Ciuchi, H. Ayeb, G. Lombardo,
Nematic order reconstruction: a novel fast textural switching mechanism,
11th International Topical Meeting on Optics of Liquid Crystals, Marriott Suites Clearwater Beach on Sand Key, Florida, USA, October 2 – 7, 2005.

11. G. Chilaya, A. Chanishvili, G. Petriashvili,R. Barberi, R. Bartolino, M.P. De Santo, M.A. Matranga, P. Collings,
Light Control of Cholesteric Liquid Crystals Using Azoxy-based Host Materials,
11th International Topical Meeting on Optics of Liquid Crystals, Marriott Suites Clearwater Beach on Sand Key, Florida, USA, October 2 - 7, 2005.

12. P. Pagliusi, C.Y. Chen and Y.R. Shen,
Sum-frequency Vibrational Spectroscopy on Rubbed Poly(vinyl cinnamate) Films for Liquid Crystal Alignment,
American Physical Society Meeting, Baltimore, USA, March 13-17, 2006.

13. P. Pagliusi and G. Cipparrone,
Surface Photorefractivity in Layer-Structured Liquid Crystal Device,
7th Topical Meeting on Novel Optical Materials and Applications, Cetraro (CS), May 29-June 04, 2005.

14. P. Pagliusi and G. Cipparrone,
Surface-charge Photoelectric Modulation Phenomena in Layer-Structured Liquid Crystal Device,
11th International Topical Meeting on Optics of Liquid Crystals, Tampa (FL), October 2-7, 2005.

15. V. Bruno, M. Castriota, S. Marino, C. Versace, G. Strangi, E. Cazzanelli, N. Scaramuzza,
Asymmetric Response to Electric Field in Nematic Liquid Crystal Cells Containing Vanadium Oxide Thin Films Prepared by Sol-Gel Synthesis,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

16. S. Marino, M. Castriota, V. Bruno, C. Versace, G. Strangi, N. Scaramuzza, E. Cazzanelli,
Characterization of Tungsten Trioxide Thin Film Deposited by Spin Coating and the Effect on Their Insertion in Liquid Crystal Cells,

8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

17. G. Strangi, V. Barna, S. Ferjani, A. De Luca, R. Caputo, N. Scaramuzza, C. Versace,
Fluorescence and Laser Action in Cylindrical Micro-Resonators,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

18. L. Tortora, C. Vena, S. Manfredi, C. Versace, G. Strangi, G. Chidichimo,
Electroconvective instabilities in doped nematic liquid crystals,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

19. C. Vena, C. Versace, G. Strangi, and R. Bartolino,
Optical Study of Electrohydrodynamic Turbulence in Nematic Liquid Crystal Films,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

20. A.G. Petrov, C. Versace, N. Scaramuzza, S. D'Elia, Y. Marinov, L. Tedorova,
Orientation Effects of PTFE Nanolayers Upon the Nematic PCB,
8th European Conference On Liquid Crystals, Sesto (BZ), Febuary 27 – March 4, 2005.

21. S. Ferjani, V. Barna, A. De Luca, C. Versace, N. Scaramuzza, G. Strangi,
Thermal Behavior of Diffusive Lasing in Partially Ordered Nematic Liquid Crystals,
11th International Topical Meeting on Optics of Liquid Crystals (OLC 2005), Marriot Suites Clearwater Beach on Sand Key, Florida (USA), October 2-7, 2005.

22. V. Barna, S. Ferjani, A. De Luca, R. Caputo, N. Scaramuzza. C. Versace, G. Strangi,
Band-Edge and Defect Modes Laser Action in Dye Doped Chiral LC Confined in Cylindrical Microcavities,
11th International Topical Meeting on Optics of Liquid Crystals (OLC 2005), Marriot Suites Clearwater Beach on Sand Key, Florida (USA), October 2-7, 2005.

23. G. Strangi, S. Ferjani, V. Barna, A. De Luca, C. Versace, N. Scaramuzza, R. Bartolino,
Random Lasing and weak Localization of Light in Nematic Liquid crystals,
11th International Topical Meeting on Optics of Liquid Crystals (OLC 2005), Marriot Suites Clearwater Beach on Sand Key, Florida (USA), October 2-7, 2005.

24. V. Barna, N. Scaramuzza, G. Strangi, A.Th. Ionescu, E.S. Barna, A.L. Alexe-Ionescu,
Fast Electro-Optic Switching in Nematic Liquid crystals. Role of Delocalized Electrons in Polyaniline-Nematogen Cyanobiphenyls Interaction,
11th International Topical Meeting on Optics of Liquid Crystals (OLC 2005), Marriot Suites Clearwater Beach on Sand Key, Florida (USA), October 2-7, 2005.

ORGANIZATION OF CONFERENCES

1. *Progress in Science*, Cetraro, Italy, August 15-20, 2005.

8 GEOPHYSICS

Professors and Researchers:	Ignazio Guerra
Postdoc fellows	Anna Gervasi (*from National Institute of Geophysics and Volcanology (INGV), Center for Seismology and Seismic Engineering)*
Collaborators	P. Harabaglia and M. Mucciarelli (*Basilicata University, Potenza, Italy*) M.R. Gallipoli (CNR – Tito Scalo (*PZ), Italy*) A. Moretti (*Univ. of L'Aquila, L'Aquila, Italy*) G. Neri, B. Orecchio and D. Presti (*Univ. of Messina, Messina, Italy*) M. Maistrello and G. Musacchio (*INGv, Milano, Italy*) G. Gaudiosi and D. Lo Bascio (*INGV – Napoli, Italy*) J. Armbruster, W.J. Kim, A. Lerner-Lam, L. Seeber e M. Steckler (*Lamont Doherty Observatorv, Columbia Univ., New York, USA*)

RESEARCH LINES

8.1 Introduction

The research group is engaged in many lines of activity, in spite of its lean composition. In most cases this is due to the nature of its activities, based on the elaboration of experimental data collected by means of observations that have to be carried on over long span of time. The group indeed was established about thirty years ago in a department different from Physics with the explicit finality of answering the requirement of seismological observations in Calabria, a region characterized by a seismic risk among the highest in the Mediterranean Basin. This origin is still conditioning its programs, mainly of observational nature.

Due to the relatively great distance from the nearest centres of geophysical research and the relevance of the geodynamical problems arising from the features of the territory, the group at the Department of Physics is a reference point for both researchers, from abroad too, as well as some public administrations.

8.2 Seismotectonics

Seismotectonics is the branch of seismology that deals with the complex relations between earthquakes and geological structures. It is based on the accurate location of the seismic sources, that in turn requires a model as more realistic as possible for the elastic waves propagation in the studied area. Generally an iterative process is performed: new seismographic data help to better constrain the velocity model that in turn leads to better locations. The map of seismicity that results from the above mentioned activity is then correlated to the tectonic features observed in the area. In particular the space distribution of the seismic foci can trace the position of the slip surfaces at depths not accessible to direct observation, while the propagation model includes the mechanical discontinuities met with by seismic waves along their path to the seismic stations. Seismograms contain further information that allows for determining the dynamics of the phenomena at the seismic sources. The reconstruction of the geometry of the geological bodies and then present kinematics is the result of these research activities.

Accurate seismotectonic investigations are essential in Calabria because of the peculiarity of seismic activity in the region. The area hosted in fact most of the largest earthquakes reported in Italy in historical times. However it had been practically quiescent since 1908. Moreover the adjacent Tyrrhenian Sea is the scat of deep earthquakes attributable to the interaction of the Eurasian and African plates. that represents one of the more interesting geodynamical problems in the Mediterranean area. Therefore the monitoring of the local seismicity and its relation to the tectonic features is an important task for the scientific investigation devoted to the seismic risk assessment.

In this frame, most of the daily effort of the research group is dedicated to the management of the Calabrian Regional Seismic Network. This network has the dual role of providing an almost meal time monitoring of the area and of incrementing the available waveform data bank. The first is useful in civil protection tasks, the collected information being sent to National Institute of Geophysics and Volcanology, Rom (INGV); the second is the basic instrument to conduct seismotectonic investigations.

In 2005, the CAT/SCAN project designed by a research group in the Lamont-Doherty Earth Observatory (Columbia University. New York) was concluded. Detailed seismographic observations started Winter 2003 however continued in Northern Calabria during the whole 2004, by means of about 20 portable seismic acquisition systems.

8.3 Statistical Seismology

This line of research is mainly based on a joint effort between Geophysics and the Astrophysics Groups of the Physics Department.

The main goal has been the modeling the pattern of seismic occurrence The main result is the retrieval of a relation that describes the pattern of both of main events and seismic sequences. A fall-out of this investigation is the observation that world wide distributed main events have a pattern of occurrence that shows a weak correlation of every event with those preceding it.

Some statistical techniques can be applied to different geophysical phenomena, like the inversion of the Earth magnetic field.

8.4 Site effects

One of the problems in seismic risk assessment arises from the frequent empirical observation that different sites at very short distances one from the other can behave very differently under the effects of an earthquake. This is due to differential amplifications and polarizations of the elastic waves due to very local conditions. Identification. characteritation and detailed mapping of small-sized homogeneous are the phases of the so-called "seismic microzonation''. This know ledge will then be transferred in the construction of the seismic risk maps.

In 2005 the research group has been continued the collaboration to the ''Urban Project" of the municipality of Crotone. Specific task pursued by the geophysical group was to provide for the seismotectonic framework of the city by analyzing the seismicity. both historical and instrumental, and the necessary information for the microzonation.

8.5 Applied Geophysics

Among the surveying techniques that can be used to map buried geological bodies, the magnetic survey is one of the most interesting. It consists in measuring the intensity of the magnetic field within a closely spaced grid (about 1 km step). Then the main component of the signal due to source in earth core is subtracted from the observed data. In a similar manner also the periodical variation are subtracted. The remaining portion of the signal, termed *magnetic anomaly*, can be attributed to variations in the magnetic susceptibility of the rocks that compose the Earth crust. The interpretation of this residual field consists in creating a geometrical model of the buried structures that causes a synthetic field as similar as possible to the observed one.

The research group is currently working on the construction of a detailed magnetic map of Calabria, involving students too, when possible. The effort will obviously take several years.

8.6 Environmental geophysics

This branch of geophysics deals with the investigation of very shallow phenomena that most directly affects human activities and the environment where they happen.

Among the many possible techniques, the research group concentrates on the analysis of the content of ^{222}Rn of gases flowing from soils. It is in fact well known that excessive Rn concentrations can be extremely dangerous to human health, this gas is naturally discharged in particular geodynamic areas. Since it is rather heavy, it has the tendency not to be dispersed in the atmosphere, particularly in closed and badly ventilated buildings.

Continuous recording of the CO_2, H_2 and H_2S flowing from soil continued during 2005 by means of the prototype of the gas monitoring station built in the frame of the CIPE Project completed in 2004.

A PUBLICATIONS ON SCIENTIFIC JOURNALS

A.1 Publications on international journals

A.1.1 Publications on international journals printed in 2005

1. Guerra I., Cosentino M.T., Gervasi A., Harabaglia P. e Rosa A. B., *The 1998-99 Pollino (Southern Apennines, Italy) seismic crisis: tomography of a sequence*
   Ann. Geophys., 48, 6, 107-119, 2005

2 Carbone V., Sorriso-Valvo L., Harabaglia P. and I. Guerra, *Unified scaling law for waiting times between seismic events*
Europhys. Let. 71, 6, 1036-1042, 2005

D PRESENTATIONS AT CONFERENCES

D.1 Presentations at international conferences in 2005

1. Armbruster J., Wilson C.K., Steckler M. S., Seeber L., Lerner-Lam A., *Crust and Upper Mantle Structure Above a Retreating Subduction Zone: Receiver Function Images From the CAT/SCAN Project in Southern Italy*,
   Am. Geophy. Un. Fall Meeting, S. Francisco, 2005.

2. Kim W., Guerra I., Armbruster J.G., Gervasi A., Seeber L., Harabaglia P.: *Seismicity in the Calabrian Forearc: Is it Consistent with Ongoing Subduction?*
   Am. Geophy. Un. Fall meeting, S. Francisco, 2005.

D.2 Presentations at national conferences in 2005

1. Sorriso-Valvo L., Carbone V., Guerra I., De Rose C., Harabaglia P., 2005: *Statistica non Poissoniana dei tempi di attesa fra eventi sismici: un test locale*
   24° Conv. Ann. Gr. Naz. Geofis. Terra Solida, 2005.

3. Moretti A,. De Rose C., Gervasi A., Guerra I., Harabaglia P. , 2005, *La sismicità attuale come strumento di interpretazione della sismicità storica: la possibile sorgente del terremoto calabro del 1832*
   24° Conv. Ann. Gr. Naz. Geofis. Terra Solida, 2005.

4. Gervasi A., Guerra I., Moretti A., Neri G., Orecchio B., Presti D. e G. Valensise, *Identificazione di strutture sismogenetiche in Calabria attraverso il confronto fra sismicità crostale e dati geologici*
   24° Conv. Ann. Gr. Naz. Geofis. Terra Solida, 2005.

5. INGV, LDEO e UniCal (A. Amato, P. Baccheschi, A. Gervasi, L. Margheriti, J. Armbruster, A. Lerner Lam, M. Steckler, L. Seeber, C. De Rose, I. Guerra and P. Harabaglia): *Il Progetto CAT/SCAN*
   24° Conv. Ann. Gr. Naz. Geofis. Terra Solida, 2005.

6. Gaudiosi G., Lo Bascio D., Maistrello M., Musacchio G. e Guerra I., *La struttura crostale del Tirreno sub-orientale e dello Ionio occidentale*
   24° Conv. Ann. Gr. Naz. Geofis. Terra Solida, 2005.