UNIVERSITÁ DEGLI STUDI DI TRIESTE
– Dipartimento di Fisica –
VERBALE N.35 del
DEL COLLEGIO DEI DOCENTI
DELLA SCUOLA DI DOTTORATO IN FISICA

Il giorno 07 dicembre 2012 alle ore 14:30, presso il Dipartimento di Fisica dell'Università, sede di via Valerio, 2, aula C, si è riunito, regolarmente convocato, il Collegio dei Docenti. Presiede il Prof. Paolo Camerini. Sono presenti:

	Università di Trieste Dipartimento di:		presente	assente	assente giustif.
– Componenti effettivi:					
1. ARFELLI Fulvia	RC	Fisica	X	…	…
2. BENATTI Fabio	RC	Fisica	X	…	…
3. BORGANI Stefano	PA	Fisica	…	…	X
4. BOSISIO Luciano	PA	Fisica	X	…	…
5. CAMERINI Paolo	PA	Fisica	X	…	…
6. CANTATORE Giovanni	PA	Fisica	…	…	X
7. DELLA RICCA Giuseppe	RC	Fisica	…	…	X
8. FRANCIOSI Alfonso	PO	Fisica	…	…	X
9. GIRARDI Marisa	RC	Fisica	X	…	…
10. GREGORIO Anna	RC	Fisica	X	…	…
11. LANCERI Livio	PO	Fisica	…	…	X
12. LONGO Renata	PA	Fisica	X	…	…
13. MARDIROSSIAN Fabio	PO	Fisica	…	…	…
14. MARTIN Anna	PA	Fisica	X	…	…
15. MATTEUCCI M. Francesca	PO	Fisica	X	…	…
16. MILOTTI Edoardo	PA	Fisica	…	…	X
17. MODESTI Silvio	PO	Fisica	X	…	…
18. PARMIGIANI Fulvio	PO	Fisica	…	…	X
19. PERESSI Maria	PA	Fisica	X	…	…
20. RUI Rinaldo	PO	Fisica	X	…	…
21. SENATORE Gaetano	PO	Fisica	X	…	…

Il Presidente, constatato il numero legale dei componenti effettivi del Collegio intervenuti, apre la riunione alle ore 14:45 per trattare il seguente ordine del giorno:

1. Approvazione OdG
2. Comunicazioni del Direttore.
3. Comunicazioni dei membri del Collegio.
4. Approvazione del Verbale n. 34.
5. Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti del XXVII ciclo ed approvazione seduta stante delle relazioni di fine anno.
6. Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti del XXVI ciclo ed approvazione seduta stante delle relazioni di fine anno.
7. Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti del XXV ciclo e predisposizione ed approvazione seduta stante dei medaglioni di presentazione

7.bis Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti prorogati del XXV ciclo ed approvazione seduta stante delle relazioni di fine anno.

8. Eventuale riassegnazione di posti/borse rimasti vacanti ed eventuale emissione di ulteriore bando. Delega al direttore.
9. Discussione ipotesi inserimento di membri non universitari nel Collegio.
10. Pratiche studenti.
11. Varie ed eventuali.

1. Approvazione OdG.

L'ordine del giorno è approvato all'unanimità (dopo l'aggiunta del punto 7bis come da comunicazione precedentemente circolata).

2. Comunicazioni del Direttore.

Si sono tenuti con successo i seminari fine anno e fine ciclo. Le presentazioni dei dottorandi del primo anno sono state in generale di buon livello, preparate con cura e con esposizioni efficaci. I seminari dei dottorandi del secondo anno hanno rivelato in tutti i casi un sostanziale progresso rispetto a quelle di un anno fa, sia in termini di approfondimento delle tematiche specifiche di ciascuna linea di ricerca che di lavoro effettivamente svolto: l'impressione ricavata è molto buona.

In contemporanea si è svolta la riunione del consiglio scientifico, che ha seguito le audizioni dei dottorandi del III anno, dando un commento generale molto positivo, soprattutto relativamente al fatto che le presentazioni sono risultate per la maggior parte accessibili anche a non esperti del settore.
A questo proposito la Prof.ssa Peressi fa notare che per ottimizzare ulteriormente questo lavoro è necessaria una forte collaborazione di tutto il collegio e sarà necessario aumentare l'attività seminariale.

Per quanto concerne il XXVIII ciclo le immatricolazioni sono in corso.
Il candidato che ha vinto la borsa extra-UE e' stato dichiarato decaduto. La borsa sarà resa disponibile per il concorso ordinario.

3. Comunicazioni dei membri del Collegio.

Non ci sono comunicazioni da parte dei membri del Collegio.

4. Approvazione del Verbale n. 34.

L'approvazione viene rimandata al prossimo collegio in quanto il verbale non e' stato circolato per tempo.

5. Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti del XXVII ciclo ed approvazione seduta stante delle relazioni di fine anno.

Il direttore ha inviato in anticipo le relazioni di fine anno del XXVII ciclo (vedi allegato 1). Si discute brevemente la situazione di ciascun dottorando tenendo anche conto dei seminari di fine anno.
Il lavoro di ogni candidato viene approvato singolarmente. Per i seguenti studenti viene deliberata la positiva conclusione dell'anno accademico e quindi l'ammissione all'anno successivo.

Area fisica Nucleare-subnucleare
SCHIZZI Andrea
LA LICATA Chiara
PANIZZO Giancarlo
CUMANI Paolo

Area fisica della materia
DI FRAIA Michele
FILIASI Mario

Area astrofisica
COSTANZI Alunno Cerbolini Matteo
POMANTE Emanuele

Area fisica medica
CAFARO Costantino
DOGO Federico

Area fisica teorica
TITIMBO CHAPARRO Kelvin Ruben (F.Teorica)

Questo punto dell'ordine del giorno viene redatto, letto ed approvato seduta stante.

6. Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti del XXVI ciclo ed approvazione seduta stante delle relazioni di fine anno.

Si discute brevemente la situazione di ciascun dottorando del XXVI ciclo in base alle relazioni (vedi allegato 2) di fine anno gia' precedentemente circolate al Collegio dal Direttore ed ai seminari svolti. Viene deliberata la positiva conclusione dell'anno accademico e quindi l'ammissione all'anno successivo dei seguenti studenti

Area fisica Nucleare-subnucleare
SALVINI Simona
CANDELISE Vieri
FORMATO Valerio

Area fisica della materia
ORLANDO Fabrizio
BIANCO Raffaello
BATTISTONI Andrea
GIANGRISOSTOMI Erika

Area astrofisica
GRIECO Valentina Luciana
MUNARI Emiliano
TAVAGNACCO Daniele

Area fisica teorica
DONADI Sandro

Questo punto dell'ordine del giorno viene redatto, letto ed approvato seduta stante.

7. Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti del XXV ciclo e predisposizione ed approvazione seduta stante dei medaglioni di presentazione

Il Collegio discute la situazione di ciascun dottorando e la qualità del seminario di fine ciclo. Vengono predisposti ed approvati i medaglioni (vedi allegato 3) di presentazione dei seguenti candidati all'esame finale:
CAPOGROSSO Valentina
LOPEZ Frances Caroline
DORIGO Mirco
OLIVIERI Giorgia
LEA Ramona
VATTAKUNNEL Shaji
NOVELLI Fabio
MOHAMMADI Sara
MONTANINO Damiana

Il direttore chiede delega a rivedere le presentazioni per apportare eventuali piccole correzioni e renderli omogenei.
Questo punto dell'ordine del giorno viene redatto, letto ed approvato seduta stante.

7.bis Relazione dei membri del Collegio a ciò delegati sulle audizioni degli studenti prorogati del XXV ciclo ed approvazione seduta stante delle relazioni di fine anno.

Si discute brevemente la situazione di ciascun dottorando del XXV ciclo a cui e' stata concessa una proroga. In base alle relazioni (vedi allegato 4) di fine anno già precedentemente circolate al Collegio dal Direttore ed ai seminari svolti viene deliberata la positiva conclusione dell'anno accademico dei seguenti dottorandi:

ARGENTIERI Giuseppe (Area fis.Teorica)

CONTINI Emanuele (Astrofisica)
GIACOBBE Paolo (Astrofisica)

Questo punto dell'ordine del giorno viene redatto, letto ed approvato seduta stante.

8. Eventuale riassegnazione di posti/borse rimasti vacanti ed eventuale emissione di ulteriore bando. Delega al direttore.

Le immatricolazioni per il XXVIII ciclo non si sono ancora chiuse per cui non si ha ancora la certezza di eventuali rinunce.

Si da' delega al direttore di disporre la riassegnazione dei posti e delle borse rimasti vacanti al termine delle immatricolazioni ed in caso all'eventuale emissione di un ulteriore bando.

Questo punto dell'ordine del giorno viene redatto, letto ed approvato seduta stante.

9. Discussione ipotesi inserimento di membri non universitari nel Collegio.

Si discute sull'ipotesi d'inserimento di membri non universitari all'interno del Collegio della

Scuola di Dottorato. Questa discussione, stimolata anche dal desiderio di alcuni enti finanziatori di una maggior presenza nella vita della Scuola, parte dalla constatazione della lunga collaborazione con i ricercatori degli enti finanziatori delle borse di dottorato, che hanno per lungo tempo contribuito alla didattica e alla supervisione della ricerca dei dottorandi della Scuola.
Il Prof. Senatore sottolinea l'opportunità di procedere in modo omogeneo con tutti gli enti che in vario modo partecipano o hanno partecipato all'attività del nostro dottorato. Propone l'inserimento di una persona per ente, perlomeno in una prima fase e chiede se si ha evidenza della presenza di esperti degli enti nei Collegi di altre Scuole di Dottorato in Italia e se sia possibile acquisire informazioni in tal senso.
Si apre una breve discussione, con il Prof. Rui che sostiene che gli enti dovrebbero esprimere il proprio interesse a partecipare al Collegio ed evidenzia che ci si trova d'accordo su quanto sia importante che le persone eventualmente coinvolte debbano essere realmente interessate a partecipare al Collegio e che dovranno essere proposte dal Collegio stesso con lo scopo di ampliare e rafforzare le competenze scientifiche dello stesso.
La Prof.ssa Martin interviene alla discussione su come proporre la collaborazione con gli enti.
Il Direttore commenta che l'inserimento di un singolo membro per ente può essere una soluzione ragionevole perlomeno in questa fase, in attesa di vagliare nuove possibili forme di collaborazione una volta uscito il nuovo regolamento ministeriale sui dottorati. Si decide di procedere in tale ipotesi e si delega il Direttore a preparare una lettera da proporre agli enti, rimandando alla prossima seduta la decisione su quali persone inserire nel Collegio.

10. Pratiche studenti.

La dottoranda Valentina GRIECO ha fatto richiesta per accedere al titolo di "Doctor Europaeus". Il Collegio approva.
Non ci sono altre pratiche studenti.

11. Varie ed eventuali.

Non ci sono varie ed eventuali.

La seduta si chiude alle ore 17:00.

IL PRESIDENTE	IL SEGRETARIO
Prof. P. Camerini	Dr. A. Gregorio

ALLEGATO 1

Università degli Studi di Trieste
Physics Doctoral School
XXVII cycle

2012 Year-end Report

Giancarlo Panizzo

November, 20th 2012

Contents

1 Brief Research Activity Report - 2012

The main research topics of 2012 has been two: Z polarisation asymmetry in bZ associate production at LHC (A_Z^{pol}) and $b\ g \to b\ H0$ associate production in MSSM at LHC.

$\mathbf{A_Z^{pol}}$ We have performed for the first time[1] a Leading Order complete study of the Polarisation Asymmetry of the Z boson in bZ associate production

$$A_Z^{pol} \equiv \frac{\sigma\left(Z_R\right) - \sigma\left(Z_L\right)}{\sigma\left(Z_R\right) + \sigma\left(Z_L\right)}.$$

In that we have shown its deep connection to another asymmetry parameter, A_{FB}^b, the only measured observable still in some contradiction with its SM prediction. With the calculation of A_Z^{pol} at LHC, we have proved the fundamental role this observable can take: it would provide the possibility of an independent verification of the possible SM discrepancy one should find imposing consistency with previous measurements of A_{FB}^b (that can reach the relative percent size). In this contest, we have shown that its definition endows it with strong stability under theoretical uncertainties (Parton Distribution Function set, scale variations), highly increased respect to simple cross section-like observables.

Study of MSSM $b\ g \to b\ H0$ at LHC After the discovery of a SM-like Higgs Boson at LHC (hereafter h), the subsequent fundamental question is connected with its nature. Besides the direct study of its physical properties, new light on the theoretical framework embedding it can be shed by the potential discovery of new particles. In the Minimal Supersymmetric SM there are other two neutral Higgs Bosons (H,$A0$), that can be light enough to be detected at LHC. The complete electroweak MSSM calculation at one loop of the cross section for $b\ g \to b\ H0$ (here $H0$ stands generically for a neutral Higgs Boson in MSSM) at LHC has already been performed previously[2] by our working group. But the hunt of new particles at colliders need theoretical results to be inserted in Monte Carlo simulation programs, and consequently to be higly simplified in term of computational costs. So we have studied the impact of the 1 loop contribution when a bottom quark is produced together with a Neutral Higgs Boson *other* than the one just discovered, assuming the latter to be identical to the SM one, in MSSM scenarios compatible with its measured mass. After a big number of simulations probing different parameter space points (both compatible with the recent discovery and accessible to LHC reach), whe have proved that, in the contest of production of a bottom quark in association with H, $A0$ at LHC, it is completely safe to simplify the entire 1 loop electroweak calculation retaining only the simple Born approximation, expecially in view of the experimental accuracy foreseen.

2 Approved plan of studies

Here the approved plan of studies. The courses already taken of course has been already

Professor	Title of the course	Period	Hours amount
L. Lanceri	Flavour e violazione di CP	17-21th december 2012	12 h
M. Bertolini	Supersymmetry	jan 30th - april 6th 2012	50 h
A. Romanino	Beyond the Standard Model	jan 30th - april 6th 2012	56 h

followed, per a total amount of 106 h. The exam of '*Supersymmetry*' has been taken on May 5th 2012. The exam of '*Beyond the Standard Model*' will be taken at the very beginning of 2013, simply for the natural time needed for its preparation, taking into account both the variety of its topics and the research activity commitments. The course on CP violation, though exceeding the 80 hours requested, has been added to fullfill the requirement of one in a different area from that being subject of research.

References

[1] M. Beccaria, N. Orlando, G. Panizzo , F.M. Renard , C. Verzegnassi, *The Relevance of polarized bZ production at LHC*. Phys.Lett. B713 (2012) 457-461

[2] M. Beccaria, G.O. Dovier, G. Macorini, E. Mirabella, L. Panizzi, F.M. Renard, C. Verzegnassi, *Semi-inclusive bottom-Higgs production at LHC: The complete one-loop electroweak effect in the MSSM*. Phys.Rev. D82 (2010) 093018

ACTIVITIES OF THE FIRST YEAR
PHD SCHOOL OF PHYSICS AT UNIVERSITY OF TRIESTE
PHD STUDENT: COSTANTINO CAFARO

PRIMARY TOPIC: ANALYSIS OF RADON PRONE AREAS IN FRIULI VENEZIA GIULIA AND CONTAMINATION IMPACT ON POPULATION

Internal Supervisor: Marco Budinich
External Supervisor: Concettina Giovani

Academic duties:

The candidate attended the following phd schools (certificates in attachment):

International School on Physics of Complex Systems (SISSA);
CIRGEO school on geostatistics (University of Padua).

The classes attended are:
Geophysical Fluid Dynamics (48 hours);
Bayesian Methods (16 hours);
Fit Methods and Kalman Filters (10 hours);
Geographic Information Systems (72 hours, reduced exam)
Geology I (no exam).

Research duties:

A selected studied bibliography can be found at the end of the report.

The candidate built up a complete GeoDataBase of the measurements gathered by ARPA in the time-span of 2 years.
He performed a merging study between the data gathered from high school students and the above-quoted ARPA DB. The measurements had been collected using CR-39 detector (passive nuclear track detectors) and read (the tracks were counted) by students visually, using microscopes. On the other hand, ARPA uses an electronic device (including a microscope) with internal tools able to discern tracks from impurities and count them.
The study consisted in a complete statistical analysis of data and a check of compatibility between the two procedures (few detectors have been re-read using ARPA instrumentation). Even though the two statistical distribution were consistent as a whole, the check yielded negative results. Each reading made by students was strongly biased and differed substantially with the result produced by ARPA.
It has been decided to re-read all detectors in order to improve the DB with these new data.

For the next spring it has been scheduled a new campaign of measurement. This time the main scientific purpose will be to study the variation of indoor radon

concentration at different floors of dwellings. Subsequently it will be possible to theoretically esteem the radiation dose absorbed by FVG inhabitants.
The candidate has contributed to the definition of the sampling, developing a criterion of interest based on radon (kriging-)average in each municipality, population density and floors distribution.

With respect CCDX project, after slightly changing the purposes of the experiment, it has been chosen to conduct two different trial: a diode-based detector and a low-cost camera-based detector. The project is on hold because some materials have to be purchased.

The candidate has reported in Naples, during the annual Envirad-Splash reunion, the studies on radiations performed by Trieste Dept. of Physics in the last year (Radon indoor, Caesium in countryside, Iodine on water bodies).

References

C. Giovani, M. Garavaglia, S. Pividore, R. Villalta, *Field Comparison of two different passive radon detector*, Radiation Protection Dosimetry, (2005) Vol 113, No 4, pp. 438-441

A.Bertolo, C.Bigliotto, C.Giovani, M.Garavaglia, M.Spinella, L.Verdi, S.Pegoretti, *Spatial Distribution of indoor radon in Triveneto (Northern Italy): a geostatistical approach*, Radiation Protection Dosimetry (2009) Vol 137, No 3-4, pp 318-323

M. Kanevsky, M. Maignan, *Analysis and Modelling of Spatial Environmental Data*, (2004) EPFL Press

I. Clark, *Practical Geostatistics,*(1987)

J.P. Chiles, P. Delfiner, *Geostatistics: Modeling Spatial Uncertainty,* (2001)

M. Budinich, M. Vascotto, *The 'Radon School Survey': measuring radioactivity at home*, Science in School 14 (April 2010), pp. 54-57

J. Kemsky, R. Klingel, A. Siehl, M. Valdivia-Manchego, *From radon hazard to risk prediction-based on geological maps, soil gas and indoor measurements in Germany,* (2008), Environmental Geology

R. Borgoni, V. Tritto, C. Bigliotto, D. De Bartolo, *A Geostatistical Approach to Assess the Spatial Association between Indoor Radon Concentration, Geological Features and Building Characteristics: The Case of Lombardy, Northern Italy,* (2011), International Journal of Environmental Research and Public Health

J.M. Barros-Dios, M.A. Barrero, A. Ruano-Ravina, A. Figueiras, *Exposure to Residential Radon and Lung Cancer in Spain: A Population-based Case-Control Study,* (2002), American Journal of Epidemiology

Dottorato in Fisica – Università di Trieste
XXVII ciclo
Matteo Costanzi Alunno Cerbolini

End year report - 2012

The study of the large-scale structure (LSS) of the Universe provides a powerful tool to constrain cosmological parameters.
In the decade, thanks to next generation LSS surveys (e.g. SDSS-III, PanSTARSS, EUCLID, LSST), the large amount and the high precision of available cosmological data will constrain these parameters with great accuracy.
In the first year of my PhD, I focused on the possibility of using future data on galaxy clusters (GCs) from a Euclid-like survey to constrain the neutrino properties, such as mass and number of species.
Euclid is an ESA medium class mission selected for launch in 2020 in the Cosmic Vision 2015-2025 programme. Estimates indicate that Euclid will find of order 60.000 clusters between redshift 0.2 and 2.0, using photometric data.
Galaxy clusters are the most massive bound objects in the Universe, and their population bears the imprints of the statistical distribution of initial fluctuations, their subsequent growth and the dynamics of the collapse if dark matter halos.
Since massive neutrinos affects the growth of structures the statistical properties of these objects, such as number counts and power spectrum of their distribution, are very sensitive to the neutrino masses and their mass spectra, as been proved in previous works (e.g. Mantz et al. 2010a).
With this aim, in collaboration with my supervisors (S. Borgani M. Viel), B. Sartoris and J.Q. Xia, I developed a code, implemented in the public Monte Carlo Markov Chains sampler software CosmoMC (Lewis & Bridle, 2002), to obtain forecast errors on many cosmological parameters and in particular on neutrino masses and effective number of neutrino species.
More specifically, using this code I estimated the constraints expected from a Euclid-like survey through the analysis of the cluster power spectrum and cluster number counts.
Because of parameters degeneracy the forecast errors depend on the assumptions made on the cosmological model. To assess this effects I performed a large number of tests varying cosmological model, and in particular treating both the neutrino mass and the effective number of neutrino species as free parameters.
Constraints on cosmological parameters are significantly tightened when Euclid measurements are combined with other survey. As soon as the data from the Planck satellite on cosmic microwave background anisotropies will be released, I will also perform an analysis combining a Euclid-like GC survey with a Plank-like survey.
These results have been recently presented at the Ringberg Workshop on galaxy clusters (Münich, 19-23 November 2012) and they will be presented in a paper to be submitted to an international refereed journal in early 2013.
For the next two years I am planning to extend the aforementioned analysis taking in to account more general cosmological model (e.g. dark energy model, non-flat Universe) and improving the code in order to use information from other observables (e.g. redshift space distortion) as well as from different survey (e.g. galaxy survey). Finally, the analysis tools that I developed will be applied to observational data to determine the tightness of constraints on neutrino properties from already available data.

Below I report the approved plan of studies with the indication of the followed courses and taken exams:

Prof.	Title of the course	hours	Followed courses	Taken exams
F. Longo	Gamma Ray Bursts	6	●	●
F. Matteucci	Nucleosynthesis and chemical evolution of galaxies	16	●	●
S. Borgani	Formation of Cosmic Structures	16	●	
P. Monaco	Galaxy Formation	10	●	●
M. Viel	Structure Formation	8	●	
S. Leach	Scientific computing in astronomy	12	●	●
G. De Zotti	Extragalactic Astrophysics	16	●	●

List of shools I have attended:

Summer School on Cosmology – 16 July 2012 - 27 July 2012, ICTP Trieste.

XI School of Cosmology: Gravitational Lenses, their impact in the study of galaxies and cosmology – 17 - 21 September 2012 at the Institut d'Études Scientifiques de Cargèse (Corsica).

Report of the first year of PhD School of Physics-XXVII Ciclo

Student: Paolo Cumani

Supervisors: Anna Gregorio
Francesco Longo

November 30, 2012

Research Activity

This first year of PhD was focused mainly on the development of track reconstruction and trigger algorithms.
The project for the GAMMA-400 mission foresees a tracker composed by multiple planes of tungsten and single-sided silicon, two layers with orthogonal strips per plane, in order to detect the incident gamma-rays. The impinging gamma-ray creates an electron/positron pair which is subsequently detected by the silicon layers. By reconstructing the tracks of the pair it is possible to know the direction of the incident gamma-ray. The reconstruction code is based on a Kalman filter, similar to the one used by the AGILE collaboration. After reading the hits simulated by mean of the Geant4 toolkit, the code finds out which are the best four tracks, one per every particle and every view, among all the possibility. It then estimates the energy of each particle using the information on the multiple scattering. This estimation is used to combine the tracks in the different views in order to deduce the direction of the incoming photon and an estimate of its energy.
Along the planned orbit for GAMMA-400, the expected number of incident protons is much higher than the number of gamma-rays, of the order of 1 gamma-ray every 10^5 proton. It is very important to define an efficient trigger in order to be able to discriminate between hits created by cosmic-rays and events related to the interaction of a gamma-ray. Moreover the trigger could help to reduce the amount of data that has to be transmitted to ground. A preliminary version of the trigger was implemented in the framework of the collaboration. The results from simulations of the predicted background rate, obtained by using the model CREME96, were analysed looking for different conditions in every detector. The incoming particle is identified as a gamma-ray if:

- there are no hit in the anticoincidence
- at least three subequent planes are hit in the tracker
- the information from the time-of-flight are compatible with particles coming from above

These past few weeks were dedicated to the implementation of a segmentation of the anticoincidence. The segmentation will help to discriminate between hits created by primary charged particle and hits created by backsplashed particles related to the interaction of a gamma-ray.

Plan of studies

- E. Milotti - Introduzione ai Metodi Bayesiani (16h - course attended and exam done)
- P. Schiavon - Metodi di Fit e Filtro di Kalman (10h - course attended)
- V. Bonvicini and R. Longo - Rivelatori al silicio ed elettronica di lettura (20h - course attended)
- M.Boezio and F. Longo - Fisica astroparticellare: raggi cosmici e raggi gamma (16h - course attended)
- F. Cossutti - Test sperimentali del Modello Standard (16h - course to be attended in December)
- A. Zanetti - Fisica adronica al Tevatron e a LHC (6h - course to be attended in January)

Attended School

- International School of Astroparticle Physics: Multi-Messenger Approach in High Energy Astrophysics (Paris, 2-13 July 2012)

UNIVERSITÀ DEGLI STUDI DI TRIESTE

SCUOLA DI DOTTORATO DI RICERCA IN FISICA

XXVII CICLO

Fellowship: "Experiments with synchrotron radiation "

Year-end report:

Time-Resolved and Imaging Techniques for Photoionization Studies of Atoms, Molecules and Clusters

Scientific sector Fis/03

DOCTORAL STUDENT
MICHELE DI FRAIA

SUPERVISOR , at Elettra-Sincrotrone Trieste
Dr. MARCELLO CORENO

THESIS SUPERVISOR, at University of Trieste
Prof. FULVIO PARMIGIANI

A.A. 2011/2012

Approved course of study:

- *Caratteristiche generali dei rivelatori* (60 hours)
- *Fisica Atomica e molecolare* (42 hours)

Courses attended:

- *Caratteristiche generali dei rivelatori*

Present attendance:

- *Fisica Atomica e Molecolare*

Examinations taken:

- *Caratteristiche generali dei rivelatori*, on Sep 9, 2012. Mark: BUONO.
  (A scan of my personal Transcript of Records is attached).

Examinations remaining:

- Fisica Atomica e Molecolare

Note: The course *Fisica Atomica e Molecolare* could not be attended earlier, since it is a first-semester course (started Sep 2012), whereas the doctoral school started only in January 2012. Examination will be taken in February 2013.

Attended International Schools:

- *School on Synchrotron and FEL Based Methods and their Multi-Disciplinary Applications* (ICTP, Trieste, 19-30 March 2012). Certificate achieved and deposited at the Secretariat of the Physics Department.

International School planned for 2013:

- *Excellence in Detector and Instrumentation Technologies EDIT 2013* (Japan, 12-22 March 2013) Status: Approved by Prof. L. Lanceri, Prof. P. Camerini, Prof. F. Parmigiani, Dr. M. Coreno. Awaiting selection of participants (due end of December 2012).

Attended conferences:

- *Synchrotron Radiation Instrumentation 2012* (Lyon, France, 9-13 July 2012). Presented a poster: *"X-Ray Beam Position Monitor Based on a Single Crystal Diamond Performing Bunch by Bunch Detection"*.

Year-end report 2012

The research project aims at studying the electronic structure of isolated species in the gas phase by means of photoionization spectroscopy. In particular the project is based on imaging and electron-ion coincidence techniques to investigate energetics and angular distributions of electrons and ions emitted upon VUV irradiation of atomic, molecular, and cluster targets. Photo-electrons are particular sensitive to the electronic structure of the outer orbitals responsible for chemical bonds; their Images are taken by 2D-detectors coupled to a Velocity Map Imaging (VMI) focusing system. Simultaneously time-of-flight (TOF) mass spectra of photo-ions can also be acquired. And by employing the PEPICo (PhotoElectron-PhotoIon-Coincidence) technique it is also possible to correlate kinetic energies of photoemitted electrons with the mass distribution of photo-ions, i.e. to a specific ionic state produced by primary irradiation of the target.

In the course of the PhD study, target of increasing complexity will be investigated: atomic, molecular and clusters samples with different light sources.

A thorough characterization of the experimental set-up (detectors; supersonic beams; light from synchrotron, Free Electron Laser (FEL), and laboratory sources) requires comparison with reference literature data. For this purpose, the study of simple atomic samples is fundamental. Additionally, when dealing with a novel and innovative light source such as the FEL FERMI@Elettra, studies of simpler systems such as rare gases and small molecules are prerequisite toward a proper description of radiation-matter interaction, especially of multiphoton dynamics of more complex targets.

Complementary studies, and the improvement of photon detector systems are also required in order to fully characterize the impinging radiation in terms of intensity, spot size, time structure, and spatial position.

In greater detail, during this first year of work, the PhD student:

i) Learned about assembling and installing two different 2D detector systems: one based on an imaging plate coupled to a CCD, the other on a crossed 2D delay-line detector. Several preliminary tests in the laboratory have been performed on both detectors before using them in dedicated beam-time at the Elettra Synchrotron Radiation Facility and at the Low Density Matter (LDM) endstation of the FERMI@Elettra FEL.

ii) Took part in beam-times on various subjects: Interatomic Coulombic Decay (Gasphase Beamline-April 2012), Helium droplets photoionization (Gasphase Beamline-May 2012), Dichroism in Methylcyclopentanone (CiPo Beamline-September 2012). During those Runs the student actively participated to the assembly of the whole experimental setup: in particular he mounted the detector system, the voltage floating supply chain, and the detector readout electronics. He also supported beamline users by developing Matlab scripts for *in situ* data analysis. The student also participated actively in preliminary experimental runs on the LDM beamline at Fermi@Elettra. During RUN 10 and RUN 11 (March/May 2012) he followed the activity on a prototype VMI; during RUN 12 and RUN 13 (July/October 2012) helped in the assembly of the final LDM endstation. At

FERMI@Elettra, together with Dr. Oksana Plekan (LDM beamline scientist) he developed a system for the characterization of the beam at the Low Density Matter (LDM) Fermi FEL endstation (March 2012). This system consisted of a multipurpose manipulator with a pinhole, a phosphor plate, and a YAG screen coupled to a CCD camera with telescope lenses.

iii) In parallel to all the above work, the PhD student, thanks to his consolidated experience in diamond detectors, continued the study of Beam Position and Intensity Monitors (BPM). In particular he proposed to perform tests in the VUV region and obtained beamtime first at the Gasphase Beamline, afterwards at the CiPo Beamline, in collaboration with the University of Firenze and with the *Detector and Instrumentation Laboratory Sincrotrone Trieste*. He independently designed and built the experimental setup, then performed several tests, demonstrating the possible use of diamond as a BPM, both in the X-ray band and in the VUV band (Results presented at *SRI 2012* Lyon and *SPIE 2012* San Diego).

iv) He also participated in a new project (XBPM) in collaboration with the *Detector and Instrumentation Laboratory Sincrotrone Trieste*, the University of Firenze and the Microfluorescence Beamline. The project consists in the design and construction of the first permanent X-ray BPM system based on diamond detectors, with the goal to provide it as a standard system to all the bending-magnets beamlines. Several tests have been performed (July-October 2012) in three 4-quadrant Chemical Vapour Deposition (CVD) diamond detectors using preliminary an X-ray tube of the Multilayer Laboratory at Elettra and then at the Microfluorescence Beamline.

v) During those test a problem arose in the homogeneity response of the detector, correlated to the particular growth technique of CVD diamond samples, and related to the lateral enlargement of the crystals. In collaboration with the CNRS group of the *Université Paris 13*, several other tests have been performed on different diamond sample grown on a different substrate (October 2012). A manuscript has been submitted to the journal *Diamond and Related Materials*, and is presently under review.

vi) For a possible use of diamond detectors as BPMs in FEL beamlines, a damage test on a diamond sample with the new High Harmonic Generation (HHG) laser of the project CITIUS has been performed under different power densities.; the results are still under analysis.

Supervisor (Dr. Marcello Coreno)

Doctoral Student (Michele Di Fraia)

REPORT 1st year

The student Federico Dogo, enrolled in the first year of the "XXVII Ciclo di Dottorato di Ricerca ovvero al VI Ciclo della Scuola di Dottorato in Fisica dell'Università di Trieste", initially decided to continue with the studies that he had undertaken as a MSc student. However his covert and as yet unexpressed passion for biophysics and for the mysteries of the origin of life has prompted him to leave astronomy and to embrace biophysics.

This shift meant that he had to quickly catch up and to learn the basics of a field that was quite new to him. Biophysics is actually an extremely varied field, where many different physical techniques – experimental, theoretical, and computational – are applied to biological problems. My research deals with the dynamics of populations of cells, especially tumour cells that are clustered together to form interacting populations, and this kind of study requires computational and analytical techniques that are akin to those used in the theory of dynamical systems and in molecular dynamics. Thus, it was not so difficult for Federico to adapt to the new research environment, and he started at once with a study of some basic, and well studied problems, reconstructing the solutions in a famous biomathematics book using the computational environment of *Mathematica*. Initially he dealt with the dynamics of biological populations, in particular, he studied single population growth and interacting populations, paying attention to prey-predator systems; using *Mathematica* he also improved his programming skills.

Afterwards, he turned to the main topic of his doctoral thesis, the construction of a repair-misrepair model of DNA. The motivation underlying this study is the development of a model that may be suitable for inclusion in the numerical simulation program that I have been developing for several years and that already includes many of the basic features of cells. One may wonder why not use one of the existing repair-misrepair models: the reason is simply that none of the existing models describes the dynamics of repair-misrepair in a satisfactory way. The final aim of the project is the development of a master equation for the populations of DNA strands with different grades of damage. Then, from the master equation, a stochastic equation follows that can be applied to each individual helix, and therefore to each single cell in the simulation program.

In this initial part of the study, Federico has reviewed the processes and the sources capable of damaging DNA, and has reviewed the existing literature. This is a preliminary step for any modelling attempt. A tentative model was developed by me some time ago, and Federico has already started working on it.

———

Papers

Edoardo Milotti, Vladislav Vyshemirsky, Michela Sega, Sabrina Stella, Federico Dogo, Roberto Chignola: *Computer-aided biophysical modeling* (in preparation)

———

Courses & Schools

Since the student Federico Dogo, enrolled in the first year of the "XXVII Ciclo di Dottorato di Ricerca ovvero al VI Ciclo della Scuola di Dottorato in Fisica dell'Università di Trieste", has changed his research topic, and since for this research field there are no predefined courses, the choice of courses is still in progress.

Schools and the possible other courses shall be selected shortly – some of them from the european network of excellence DoReMi (http://www.doremi-noe.net/index.html).

At the moment the list of courses is the following:

Gamma Ray Bursts	F.Longo	06 hours	(exam scheduled in December)
Laboratorio di Astrofisica Spaziale *	A.Gregorio	72 hours	(underway)
Dynamical Models in Biology **	C.Altafini	20 hours	(underway)
Total		*98 hours*	

* corso mutuato dalla Laurea Magistrale in Fisica dell'Università di Trieste
** corso mutuato dal PhD della SISSA

University of Trieste - Department of Physics
PhD Course (XXVII Cycle)

Candidate: Mario Filiasi

Supervisor: Dr. Erik Vesselli

Co-Supervisor: Prof. Maria Peressi

Project: Mathematical and Physical Models for Financial Risk Evaluation

First Year Report

My research project is financed by the European Social Fund and by LIST SpA, within the framework of the "SHARM project" (Supporting Human Assets in Research and Mobility). The purpose of the project is to promote and enhance the relationship between the academic and working sectors through the cooperation of universities with local enterprises. In accordance with this perspective, this PhD project establishes the collaboration between the **University of Trieste** and **LIST SpA**, a company that provides products and services in the informatic sector with specific application to the financial world. LIST collaborates to the research activities and contributes to the project's funding.
The people who are directly involved in this research project, are:

University of Trieste

- **Mario Filiasi** (PhD candidate)
- **Dr. Erik Vesselli** (supervisor)
- **Prof. Maria Peressi** (co-supervisor)

LIST SpA

- **Dr. Elia Zarinelli** (company supervisor)
- **Dr. Davide Davio** (director of LIST-Trieste)

In addition to the mentioned people, my research work is performed in close collaboration with **Prof. Matteo Marsili** from ICTP (International Centre for Theoretical Physics), who is offering his recognized experience on the research topics.

Usually, the coordination of the research activities between two separate organizations, namely the university and the company, is not a simple task. In order to achieve a full collaboration between the two parts, it has been necessary to organize some common reunions where all participants to the project could debate about its current state and its future developements. During the first year of the project, the research work was performed with the full agreement of all the people involved.

In the following, I report a brief description of the most important research activities I performed during the first year of the project.

Preliminary Work

The research topics of my PhD project require some knowledge in the fields of economics and quantitative finance that do not belong to the background of a common physics graduate. For this reason, I devoted the first part of my doctoral study to the acquisition of the fundamental concepts about the financial world. The main topics I examined are:

- General features of the derivatives markets
- Type of contracts (futures, forward, options, ...)
- Type of traders (speculators, arbitrageurs, hedgers, ...)
- Interest rates and theory of pricing
- Stochastic models for price fluctuations (Black & Scholes model, Heston model, ...)
- Type of risks (equity, currency, concentration, systemic, ...)
- Risk measures (Volatility, Value at Risk, ...)

Concentration Phenomena in Large Deviations

One of the most important subjects I have examined this year concerns the field of probability theory and, more specifically, the problem of **concentration phenomena in large deviations**. Such phenomena characterize the rare outcomes of a set of random variables and are very general because they occur each time the analyzed variables are described by fat-tailed distributions (i.e. probability distribution functions whose tails decay slower than an exponential). A concentration occurs when the rare outcomes of the whole set of variables are realized by extremely high values of only one variable and, unexpectedly, this is the typical way in which rare events of fat-tailed distributed variables are realized.

Due to its generality, the analysis of this topic has a very wide range of applications, especially in the field of quantitative finance. Many studies proved that the stock price's returns (which are believed to be the independent random variables of the price fluctuation process) are described by fat-tailed probability distribution functions, and this means that the rare events in the price dynamics can be realized through condensation phenomena. Obviously, the financial risk of market-exposed companies is strictly linked to the rare events in the dynamics of stock prices, so the analysis of concentration in large deviations is a fundamental step for the evaluation of the financial risk.

During the first year of my PhD course, I examined the problem of concentration in different ways:

Analytical study: in spite of the generality of this topic and its possible applications, the concentration phenomena still need further analytical investigations, especially in their relation to statistical physics. With regard to this:

1. I acquired the basic concepts about the relationship between "concentration phenomena in large deviations theory" and "condensation phenomena in classical statistical mechanics";
2. I tried to extend some existing analytical results to the most general case, with the specific aim of applying such results to the financial case;
3. I tried to provide a more exhaustive description of the phenomenon through the statistical characterization of the maximum of concentrated random variables.

Numerical study: the ultimate purpose of this study is the search of concentration phenomena in the observables related to the financial world, to provide a better explanation of rare events in market dynamics. Within this perspective, the numerical analysis of real data from financial markets becomes a necessary step in this work. Concerning this topic:

1. I developed a Monte-Carlo algorithm for the extraction of condensed random variables from a generic fat-tailed distribution, with the aim of testing analytical results and comparing real financial data with "clean" simulated data;

2. I searched for possible discontinuities in the time series of stock prices (that are responsible of great amounts of unexpected gains/losses) which can be explained as concentration phenomena in price returns;

3. I analyzed the correlation matrix of portfolios with the aim of describing the high correlation of the "market-mode" as a concentration phenomenon.

Special attention has been given to point 2, concerning the study of time series of stock prices. Trying to analyze the possibilities of unexpected large losses in assets investments, this point has the closest connection to the concept of risk. This work is still in progress, but the latest obtained results suggest that the correlation of price returns reduces the probability of concentrations (it means that discontinuities of prices are less frequent then what they are supposed to be on the base of the uncorrelated statistical properties of price returns).

Numerical Analysis on Market Micro-Structure

During 2012, I started to deal with another fundamental sector of quantitative finance with very strong relations to complex systems in statistical mechanics, namely, the **market micro-structure**. The market micro-structure denotes the dynamics of stock prices on the short time scale ($t < 1$ sec) and it describes how prices react to single buy or sell orders from market traders. Such sector of quantitative finance is one of the most interesting contact points between economics and statistical mechanics. On the short time scale, information, news and traders' decisions play a small role on price fluctuations, which are mainly driven by pure statistical processes.

The observation of price fluctuations and trade executions on short times allows to extract a huge amount of data from financial markets, and this facilitates the statistical analysis of market dynamics. During the first year of my PhD course I devoted a part of my study to the acquisition of the fundamental concepts of market micro-structure and I started to **analyze numerically a large set of public data** taken from the Italian stock market and provided by LIST.

First of all, I examined the structure of the order book (i.e. the the virtual place where buy and sell auctions take place) and learned the fundamental features of the double-auction mechanism, such as the presence of a bid-ask spread, the typology of orders (market orders, limit orders and cancellations), and the general regulation of the auctions. I also examined the principal observables of the market, such as liquidity, price volatility, frequency and correlations of the orders, and their general behavior with respect to the real time and the trading time. At the same time, I observed and measured such quantities on numerical data at my disposal, checking the compatibility between my own observations and those described in literature.

Because of the heterogeneity and the roughness of data, the numerical analysis I performed required the application of methods and algorithms for data processing. With regard to this, I developed and tested an **algorithm for the classification of trades executions** in "buy" or "sell" orders through the comparison of data from different sources. Such classification is fundamental for the statistical analysis of data and the modeling of the order book dynamics.

Market Impact Evaluation

Another important topic of study about the market micro-structure consists in the analysis of the **market impact**. Such phenomenon denotes the changes of stock prices caused by the action of traders' orders on the market, and so it describes the effects of supply-demand imbalance on very short time scales. The market impact is a fundamental subject in financial risk management since it is involved in any action of investors upon markets (for instance, market impact is the most important component of the liquidity risk, which occurs every time an investor is forced to sell a large amount of stocks in a very short time). Although it is a basic concept in market micro-structure, market impact is a complex phenomenon and is widely studied in literature. The research work I performed about this topic consisted in:

- Examining the most important scientific papers about market-impact and correlated subject, gaining knowledge of the most relevant analytical and numerical results about this topic.
- Studying the problem of market impact measurements, testing some techniques on data at my disposal.
- Comparing the numerical results reported in literature with the numerical analysis performed on my dataset.
- Analyzing the effect of market impact on time-spread orders (meta-orders) and its connection to the general problem of the "optimal execution" (i.e. the search of market strategies with minimum execution cost).
- Examining the existing statistical models that describe the order book dynamics (such as the so-called "zero-intelligence models") with the purpose of measuring the market impact of different type of orders through numeric simulations.

Among the mentioned topics, the problem of the **optimal execution of meta-orders** is a very wide and interesting issue and it will be the main topic of my next research work. The study of the optimal execution requires accurate measurements of the market impact, a deep statistical analysis of the order-flow on different time scales, and the knowledge of executed market strategies (which are non-public data). For this reasons, the numerical analysis of market data is not enough to find solutions to this problem and it should be combined with different analytical techniques. Concerning this, the research activities I plan to do in the next future consist in:

1. Setting up an "agent-based model" (a model describing the behaviour of individual traders reter than stock prices) that is capable to capture the most important features of market micro-structure.
2. Finding the right parameters of the model and testing its goodness through the comparison with real market data.
3. Using the model to simulate markets and perform direct measurements of the market impact (which cannot be performed on real markets).
4. Testing different market strategies on simulated markets to find their optimal execution.

List of attended courses and schools:

Lecture courses:

- **Introduction to Probability and Stochastic Processes**
  M. Marsili - ISAS (International School for Advanced Studies)
  20 hours - Final examination passed on Feb 10, 2012
- **Critical Phenomena**
  G. Pastore - University of Trieste (Department of Physics)
  48 hours - Currently ongoing.
  End of the course: Dec 2012 (final examination expected on Gen-Feb 2013)
- **Financial Risk Management**
  A. R. Bacinello - University of Trieste (Department of Economics)
  45 hours - Currently ongoing.
  End of the course: Dec 2012 (final examination expected on Gen-Feb 2013)

Schools/workshops:

- **School on Large Scale Problems in Machine Learning and Workshop on Common Concepts in Machine Learning and Statistical Physics**
  ICTP (International Centre for Theoretical Physics) - Aug 20-31, 2012
  Organizers: M. Marsili, H. J. Kappen, M. Opper, R. Zecchina.

Conferences

- **Instabilities in Financial Markets**
  Scuola Normale Superiore di Pisa - Oct 18-19, 2012
  Organizers: S. Marmi, F. Lillo.

Nov 26, 2012

PhD Candidate:
Mario Filiasi

Supervisor:
Erik Vesselli

Co-Supervisor:
Maria Peressi

Company Supervisor:
Elia Zarinelli

University of Trieste – Department of Physics

Doctoral School of Physics – Cycle XXVII – First Year (2011/2012)

Student: *Emanuele Pomante (INAF grant: Observational Astronomy)*

Year-end report:

The subject of the Ph.D. Work of E. Pomante is the study of the Intergalactic Medium (IGM) with high-resolution spectroscopy of quasars.

During this first year of activity E. Pomante got acquainted with the state-of-the-art basics of the instrumentation and the techniques of data reduction and analysis: how data are acquired at telescopes, what are the procedures of the measurements, what is needed in order to obtain a complete calibration and characterization of the data, how the instrument signature can be rigorously removed from the data.

Later on he focused on the Hi-Res instrument (Vogt et al 1994, SPIE, 2198, 362), an echelle spectrograph mounted at the Nasmyth focus of the Keck telescope. Pomante started by studying the technical properties of the instrument, later he became familiar with the data formats and their reduction.
The immediate goal of his work is twofold:

- enlarge (of about a factor two) the dataset used by our group to study the IGM (i.e. adding Keck data to the ESO UVES and XSHOOTER data)
- compare different instrument properties, environments and approaches to the data reduction and analysis in order to improve what is presently done with the ESO data and derive useful lessons for present and future instrumentation.

To achieve this result the student started to work on the tool developed by HiRes team for data reduction, which consists of an ensemble of procedures written in IDL language each one performing a specific step resumed as follows:

- Examine the set of data files to determine image type
- Organize the observations according to setups
- Process the flats and trace the orders
- Process the arcs and create 2D wavelength solutions
- Create a slit profile
- Process the object frames (flatten, CR reject)
- Identify and trace the object
- Sky subtract
- Extract

These procedures are contained in four different packages.
The first three are dervided from the tool developed for the Sloan Digital Sky Survey (SDSS) spectroscopic data reduction

- idlutils
- idlspec2d
- specflat

the last one is the one developed specifically for HiRes spectroscopic data

- xidl

These packages also contain a set of libraries (Goddard libraries) needed for the proper execution of the procedures.
To gain full control on the reduction process and be confident that the reduction carries out in a rigorous way the expected tasks the student had to delve deeply into the code.
The reduction procedure is applied to a sample of HiRes spectra extracted from the KOA (Keck Observatory Archive). In particular the initial work has been concentrated on the data from three night of observations of the object **J2123-0050** (quasar at redshift z ~ 2.3) for which data are available also from the ESO UVES archives and from the SDSS. In this way J2123-0050 is going to be the "Rosetta Stone" for the construction of the QSO spectra database.
E. Pomante analysed the characteristics and performance of each step of the pipeline and, in case, appropriately modified the code according to the specific needs.
Finally the student combined the basic building blocks (IDL procedures) to construct a new fully functional, reliable and "user friendly" pipeline that can be easily used to reduce HiRes spectra as well as generic high-resolution echelle data and from now on will be available to all the group's members.

Future perspective:

For the near future the main goal is to compare data taken with different instruments and reduced with different procedures. The noise properties have to be rigorously characterized in order to produce reduced data that can be reliably ingested into the data analysis packages with a fully automated procedure allowing an efficient comparison with simulations.
It is worth mentioning that the standard approaches available on the market at the moment are known not to be optimal in this respect. The comparison of different approaches on the same data and different telescopes/instruments observing the same objects will be crucial to assess the effects of the various operations (e.g. the rebinning and rectification introducing correlations in the data affecting the noise propagation, the optimal extraction, the background estimation...) in order to have them under full control.
This work is carried out in collaboration with the people developing the Data Analysis for the ESPRESSO instrument, the *Echelle spectrograph for rocky exoplanets and stable spectroscopic observations* (Pepe, Cristiani, Rebolo Lopez, et al. 2010, SPIE, 7735, 77350F-77350F-9), under construction for the ESO VLT.

In 2013 a dataset of high-resolution spectra of unprecedented quality and quantity will be produced as a first deliverable of the Ph.D. thesis work.
In the second half of the year the properties of IGM at high redshift will be addressed, starting from basic diagnostics such as the average opacity of the IGM as a function of redshift, the Probability Distribution Function of the flux transmission and the correlation function, aiming at a global comparison of the observed properties of the IGM with the corresponding quantities extracted from simulations in various flavors.

Approved plan of courses:

1. The Formation of Galaxies (P. Monaco) 10 ore
2. Nucleosynthesis and Chemical Evolution of Galaxies (F. Matteucci) 16 ore
3. Formation of Cosmic Structures (S. Borgani) 16 ore
4. Observational Astronomy - Modulo A (S. Cristiani) 24 ore
5. Observational Astronomy - Modulo B (S. Cristiani) 20 ore

Tot. 86 hours

All the courses have been followed, but only number 1. and 2. have been completed with the corresponding exams (see the attached personal Transcript of Records). The reason is that one of the courses ended in the last days of September and one in middle July.
The student plans to take the remaining exams between December 2012 and January 2013.

List of the attended Schools:

From 11 to 15 June 2012: *International School of Astrophysics "Francesco Lucchin" and the GREAT-ITN project (Teramo – Italy)*

From 10 to 22 September 2012: *NEON Observing School 2012 (Asiago Astrophysical Observatory)*

Report of the research activity performed in 2012

Supervisor: Prof. Giuseppe Della Ricca - PhD student: Chiara La Licata

November 24, 2012

During my first year of research activity as PhD student at the University of Trieste, I have been working on different topics, within the CMS experiment. I worked on the Z+jets analysis, developed by the group CMS of Trieste, and on the monitoring and calibration of the electromagnetic calorimeter ECAL of CMS. For the Z+jets analysis I have implemented the RIVET (Robust Independent Validation of Experiment and Theory) analysis that allows the comparison between theory and the experimental results obtained after the unfolding techinque to subtract the effect of the detector. It consists of an analysis at the generator level that matches the analysis done on the real data; it contains the selection of leptons (electrons and muons) and the jets using the same cut selection of the analysis on data.

At present my principal activity is related to the monitoring and calibration of the electromagnetic calorimeter. In particular I am working for the determination of the inter-calibration constants, using the phi-symmetry method and I am also involved in the validation of all the calibration constants, using the Z decay in two electrons. ECAL has been designed to have a high resolution, but that is possible only with a precise calibration, in order to achive and maintain the designed performance. Achieving the design goal calibration precision of 0.5% is particularly important for some physical channels as the decay of the Higgs boson in the two photons. The calorimeter is composed of 75848 lead tungstate crystals that have a different response due to their intrinsic differences and for this reason the inter-calibration constants have to be evaluated. Different methods for the calibration in situ of CMS have been realized, one of these is the phi-symmetry technique. It is based on the assumption that for a large number of minimum bias events

the total transverse energy has to be equal to the mean energy deposited on all the crystals of a ring at fixed pseudorapidity (η). This method is also a valid tool for the monitoring using the difference between constants in different periods. The inter-calibration constants evaluated with this and other tecniques have to be validated and for this pourpose the mass resolution of the Z decaying in e^+ and e^- is used. With a weekly frequency the performance of ECAL in reconstructing has to be evaluated comparing the peak shift and also the sigma of the Z of data and MonteCarlo.

During this year I have also covered some weeks as ECAL PFG shifter.

Plan of studies

Followed courses

- Introduzione ai metodi Bayesiani
- Rivelatori al Silicio ed elettronica di lettura
- Fisica astroparticellare: raggi cosmici e astrofisica gamma

Courses to follow:

- Test sperimentali del modello standard (December)
- Flavour e Violazione di CP (December)
- Fisica adronica al Tevatron (January)

Exams done

- Introduzione ai metodi Bayesiani

Exams to do

- Rivelatori al Silicio ed elettronica di lettura (January-February 2013)

- Fisica astroparticellare: raggi cosmici e astrofisica gamma (January-February 2013)
- Test sperimentali del modello standard (January-February 2013)
- Flavour e Violazione di CP (January-February 2013)
- Fisica adronica al Tevatron (January-February 2013)

Attended Schools

- PSI Summerschool on Particle Physics. "Closing in on the Standard Model"

Report of the Research Activity Performed in 2012

PhD student: Andrea Schizzi - andrea.schizzi@ts.infn.it
Supervisor: Prof. Giuseppe Della Ricca

Research activity

The main activity I have carried out during the first year of my phd has involved the study of the associated production of vector bosons and hadronic jets, as a continuation of the master thesis work. The focus of this analysis is to extend the previous CMS 2010 results on this topic using the higher statistics sample of proton-proton collisions collected by the CMS experiment during 2011. The main goal of this work is to measure the Z differential cross section in channels of the associated jet multiplicity. The analysis is documented in the CMS internal notes [1, 2, 3] and is aimed towards the publication of a paper [4]. My personal contribution to this work consists in the measurement of the global event selection efficiency by means of the Tag&Probe method. This method provides a data-driven efficiency measurement and in this context I have developed a stand-alone implementation of the Tag&Probe in order to measure both the online trigger efficiencies and the offline reconstruction and selection efficiencies as a function of the most interesting physical observables. Beside this contribution, I studied the major backgrounds to this channel and an effective strategy for their removal in the Z +Jets sample. Eventually, I was involved in the evaluation of the leading systematic uncertainties related to the Z+Jets cross sections measurement.
During this year I also worked on the calibration of the electromagnetic calorimeter (ECAL) using of π and η data samples. Their decay into a couple of photons allows the invariant mass to be fully reconstructed with the electromagnetic calorimeter and thus is a fundamental candle in order to test and optimize its energy resolution. In this context I developed a study of the π and η trigger selection thresholds with the aim of optimizing the signal to noise ratio for the calibration of the ECAL endcaps. Alongside this activity, I performed a monitoring of the π and η trigger rates over a periodic schedule.

Exams

- E. Milotti, *Introduction to Bayesian Statistics* - Lessons attended, exam passed.
- M. Boezio, F. Longo, Astroparticle Physics - Lessons attended, exam planned for January.
- W. Bonvicini, R. Longo, *Semiconductor Detectors* - Lessons attended, exam planned for January
- F. Cossutti, *Experimental Tests of the Standard Model* - Lessons to be attended in December.
- L. Lanceri, *B Physics and CP Violation* - Lessons to be attended in December.
- A. Zanetti, *Hadron Physics at Tevatron and LHC* - Lessons to be attended in January.

Conferences and Schools

- Talk at the IFAE conference, April 11-13 2012, Ferrara (Italy), with the title: “Jets produced in association with W and Z bosons in CMS”. The proceedings of the talk have been submitted for publication.
- Partecipation at the PSI Summerschool on Particle Physics - “Closing in on the Standard Model”, August 19-25 2012, Lyceum Alpinum in Zuoz (Switzerland).

Bibliography

[1] V. Candelise et al. *Study of the associated production of a Z boson and jets in pp collisions at s = sqrt(7) TeV*. CMS-AN-2011-451, 2011

[2] V. Candelise et al. *Comparison of GSF and Particle Flow electron reconstruction performances*. CMS-AN-2011-474, 2011

[3] V. Candelise et al. *Characterization of the final state radiation in Z boson decay to electrons*. CMS-AN-12-204, 2012

[4] V. Candelise et al. *Exclusive jet multiplicity and differential production cross sections of Z+jets events in proton-proton collisions at 7 TeV*. CMS-SMP-12-017, 2012

2012 Year-End Report

Kelvin Titimbo
Università degli Studi di Trieste
Doctoral School of Physics
XXVII Cycle

November 23, 2012

1 Research Activity Report

During 2012, the main research topics can be summarized in the following: Studies of the *quantum entanglement in identical particles, with emphasis in bosons* and *optical homodyne detection and quantum tomography in pulsed regime*

Quantum entanglement in identical particles

Nowadays, there is no doubt that the phenomenon of quantum entanglement lies at the heart of the foundation of quantum mechanics. Entanglement has been widely applied in many aspects of quantum information such as quantum teleportation, quantum cryptography, and quantum computation. Nevertheless, although the quantum entanglement is well studied in distinguishable-particle systems, entanglement in identical particles has hardly been investigated, and even a proper general definition is not given yet. It is obvious that we need a formal definition because there are certain system as Bose-Einstein condensates. Taking this into account, we have dealt with the definition for bipartite system in pure states in terms of the first quantization given by Ghirardi et al [1] where we consider the possibility of attribute a complete set of objective properties to each particle belonging to the composed system; and the second quantized approach by Benatti et al [2, 3] where the definition of separability is not related to the Hilbert space tensor product structure as the first one, but given in terms of commuting subalgebras of observables. We have been studying and comparing both approaches for bosons, and then we show the compatibility between them, noticing that the approach in terms of the subalgebra of observables gives the same information in terms of properties of each subsystems and it is easily extensible to most general states, mixed states and density matrices representation. Furthermore, the definition can be generalized into systems with more than two identical particles but keeping the idea of bipartition. The extension of the criteria for separability/entanglement to fermions involve the use of anticommutators and it is currently being studied.

Optical Homodyne Detection and Quantum Tomography

After recent experiments carried out in Elettra-Sincrotrone Trieste for balanced homodyne detection of quantum states of light working in the pulsed regime [4]. The research has been focused in the theoretical description of the system, i.e., local oscillator and signal in terms of multimode quantum states of light, which naturally appears in the mentioned regime. The main aim in this topic is describe each component in the homodyne tomography in a pulsed configuration in view of the possible applications to time-resolved spectroscopy experiments by measuring at different time the quantum state of the pulsed light after the interaction with the material [5, 6]

2 Plan of Studies

I have been attending the following courses

Professor	Title	Period	Number of Hours
Fabio Benatti	Statistical Mechanics	October 2012 - January 2013	48
Matteo Marsili	Probability Theory	October - November 2012	46
Stefano Olivares	Introduction to Quantum Optics	—	—

Currently, I have not taken any exam because I am still taking lectures. Nevertheless, the exam for Probability Theory has been scheduled for December 17th, 2012. The exam of Statistical Mechanics will be taken on February 2013. Course in Quantum optics will be held the next year due to availability of Prof. Olivares

3 Schools

Date	Venue	Organizers	Title
2 - 13 July 2012	ICTP, Trieste, Italy	ICTP	Summer School on Quantum Many-Body Physics of Ultra-Cold Atoms and Molecules
10 - 13 September 2012	Queen's University of Belfast, Belfast, Northern Ireland	Queen's University of Belfast	QuAMP Summer School

References

[1] GianCarlo Ghirardi, Luca Marinatto, and Tullio Weber. Entanglement and properties of composite quantum systems: A conceptual and mathematical analysis. *Journal of Statistical Physics*, 108:49–122, 2002. 10.1023/A:1015439502289.

[2] F. Benatti, R. Floreanini, and U. Marzolino. Bipartite entanglement in systems of identical particles: The partial transposition criterion. *Annals of Physics*, 327(5):1304 – 1319, 2012.

[3] F. Benatti, R. Floreanini, and U. Marzolino. Sub-shot-noise quantum metrology with entangled identical particles. *Annals of Physics*, 325(4):924 – 935, 2010.

[4] Martina Esposito. Design and experimental realization of a pulsed homodyne detector for optical quantum state characterization. Master's thesis, Università degli Studi di Trieste, 2012.

[5] O.V. Misochko, P. Gu, and K. Sakai. Coherent phonons in insb and their properties from femtosecond pump2̆013probe experiments. *Physica B: Condensed Matter*, 293(12̆0132):33 – 37, 2000.

[6] O.V Misochko. Implication of phase-dependent noise of coherent phonons in yba2cu3o72̆212̆03b4. *Physics Letters A*, 269(22̆0133):97 – 102, 2000.

ALLEGATO 2

PhD School of Physics XXVI Ciclo - 2012 report

Vieri Candelise

Universita' degli Studi di Trieste

November 2012

Research activity performed in 2012

During my second year as a PhD student, I focused my work on the study of the Z+jets analysis with 2011 data at 7 TeV in proton-proton collisions. For this analysis, I have dedicated my attention to the development of code needed to perform the unfolding procedure for the Z+jets observables measured with the CMS experiment. Unfolding is an essential tool when a measured distribution has to be compared with theoretical predictions. It is used to statistically deconvolve an experimental distribution for the smearing effects induced by the detector response, in order to have a consistent comparison between measured data and theoretical models. First of all, I performed a series of tests to validate the procedure by using Monte Carlo distributions, then I used the validated procedure to calculate the effect of the unfolding in the most relevant distribution of the analysis, such as the differential cross section of the inclusive Z+jets events as a function of the kinematic variables of the jet produced by the QCD radiation. The comparison between data and the pQCD predictions is made using a series of different Monte Carlo event generators. Also the calculation of the systematic effect induced by the different tuning of the generators is performed by varying the QCD parameter inside the different generators, like different models of parton density functions (PDFs) and the QCD renormalization scale. The measured and unfolded Z+jets differential cross sections are compared with the MadGraph and Sherpa predictions with different tuning. In late 2012 I started working on a possible evolution of the Z+jets analysis, studying the characteristics of the b-tagging tecnique, in order to have a preliminary plan for a Z + b quark analysis to start in the end of 2012. This work will lead to a

long term analysis, aimed to have as a final result the measure of the polarization asymmetry of the b quark, a crucial Standard Model parameter never measured in hadronic colliders.

Plan of studies and exams

- Flavour e violazione di CP (course attended and exam done)
- Fisica adronica al Tevatron (course attended and exam done)
- Rivelatori al silicio ed elettronica di lettura (course attended and exam done)
- Test Sperimentali del Modello Standard (course attended and exam done)

Schools and conferences

- Corfu' Summer Institute 2011 : "Unification at the LHC era"
- XCVII SIF Conference, L'Aquila, 26-30 September 2011. Presented talk title: "Study of the W/Z inclusive cross section in CMS"
- 2012 European School of High Energy Physics (ESHEP), Anjou, France
- 2012 MCnet - LPCC Summer School on Monte Carlo Event Generators for LHC

Teaching activity

- Teaching assistance position for the "Experimental Physics III" (Geometric and Phy- sics Optics Laboratory) lectures held by Dr. Giuseppe Della Ricca for Physicists, Universita' di Trieste, A.A. 2011/2012

Relevant pubblications

- V. Candelise et al., (9 authors); Measurement of the jet rate production in association to a Z boson, [CMS AN AN-11-451].
- V.Candelise et al., (9 authors); Comparison of GSF and Particle Flow electron reconstruction performance, [CMS AN AN-11-474].
- V. Candelise et al., (9 authors); Characterization of the final state radiation in Z boson decay to electrons, [CMS AN AN-12-204].

University of Trieste
PhD in Physics - XXVI cycle

Report on Daniele Tavagnacco′s activities during the second PhD year (2012)

Analysis and Characterization of Systematic Effects related to the Study of Cosmic Microwave Background anisotropies with the Planck LFI Instrument

Supervisor: Dr. Anna Gregorio

The PhD work of Dr. Daniele Tavagnacco is part of the data analysis of Planck LFI (Low Frequency Instrument). Planck is the third medium-sized mission (M3) of ESA (European Space Agency, www.esa.int/Planck) scientific program "Horizons 2000". With its telescope, 1.5 meters diameter and with the two on board instruments (LFI with Italian leadership and HFI with French leadership), Planck observes the sky simultaneously in nine frequency bands between 30 and 857 GHz with a sensitivity, angular resolution and frequency coverage never achieved before.

The satellite, launched on May 14th 2009, after an initial calibration phase, since August 2009 is positioned in a Lissajou orbit around the L2 point of the Earth-Sun system to observe the entire celestial sphere in about three years of continuous observations. Currently Planck is performing the seventh sky survey. The maps of the microwave sky that will be produced by LFI and by Planck in general represent a crucial scientific advancement in the determination of all the main non-degenerate, with respect to the CMBA (Cosmic Microwave Background Anisotropy), cosmological parameters,

The activity consists in the analysis of two of the steps that make up the scientific data reduction pipeline of the LFI instrument: the removal of electronic spikes signal and the photometric calibration. Electronic spikes represent a systematic effect for the instrument LFI given by the cross-talk between the housekeeping acquisition and the Scientific signal lines. This effect is manifested as a square wave signal, synchronous with the satellite on-board time, purely additive, which influences in a uniform way all acquisition lines of the LFI instrument. This signal must necessarily be characterized and removed by software prior to production of the sky maps. The work is aimed to check the temporal stability, during the entire mission, of the square wave template removed from the data. Both phase that signal amplitude variations have been controlled. In this way it is possible to verify the stability of instrument operation as a whole and estimate a possible residual spike signal in science data, after the removal of the template. The estimate of the residual signal in the scientific data gives an assessment of the systematic effect due to the electronic spikes on the final LFI data result.

The photometric calibration represents the data conversion from voltages to the observed temperature. The calibration for Planck follows a procedure similar to that used by WMAP: the observed dipole temperature modulation in CMB data given by the movement of the solar system with respect to the CMB reference system is compared with the signal modulation measured by the instrument. From the amplitude ratio, the "relative calibration" factor of the instrument is obtained for the specific pointing. Two limitations of this method are related to the uncertainty associated to the direction and intensity of the dipole and by the instrument pointings that involve areas in which the dipole is minimal. The absolute calibration of the instrument is then obtained by applying the same method to the annual

modulation of CMB data due to Earth orbit around the Sun and thus related only to fundamental constants. The goal is to achieve an absolute calibration better than 1%.

The cross-check of the calibration method is based on the iteration of the same procedure using quantities internal to the instrument. In particular, the calibration factor is calculated by comparing the voltage variations of the channel that is concerned with the measurement of the reference black body temperature with corresponding temperature fluctuations measured by the on board thermal sensors. From the comparison between the calibration curves obtained with these two methods, it is possible to study the instrument operation stability. Furthermore, it is possible to estimate the noise temperature of the in flight instrument that, compared with the noise temperature obtained during ground tests prior to the launch, provides another indication on the instrument operation stability.

Schools:

Second Sardinian Summer School in Astrophysics – Technology in radio astronomy and space science, 2012

Conferences:

Astrophysics from the radio to the sub-millimeter. Planck and other experiments in temperature and polarization, Bologna, 2012

PhD School of Physics XXVI Ciclo - 2012 report

Università degli studi di Trieste

November 21, 2012

Student:
Valerio Formato

Supervisors:
Mirko Boezio
Anna Gregorio

2012 Research activity

My second year as a Ph.D. student has been focused on the analysis of PAMELA data within the framework of three distinct topics, all related to the study of the propagation of cosmic rays in the galaxy and inside the solar system.

1. I have been continuing the work aimed to the evaluation of the absolute fluxes of different hydrogen and helium isotopes, ^{1}H, ^{2}H, ^{3}He, ^{4}He, which started in 2011. This information is a powerful tool in constraining cosmic ray propagation models within the galaxy, since ^{2}H and ^{3}He are secondary isotopes which are not present in cosmic rays sources and are created by the interaction of primary cosmic rays (mainly protons and ^{4}He) with the interstellar medium. The last phases of this work consisted in optimizing the event selections and the fit procedure developed in 2011, preparing an accurate procedure to account for the time-dependent conditions of PAMELA tracking system in the Montecarlo simulation, and studying all the systematic uncertainties of the measurement.

   This work has been approved by the PAMELA collaboration and a paper has been submitted to the *Astrophysical Journal*.

2. I also worked on the measurement of time-dependent electron and positron spectra which were the topic of Dr. Riccardo Munini's Master Thesis, for which I have been co-supervisor, focusing on all the details of the Montecarlo simulation given also the experience gathered from the hydrogen and helium isotopes analysis. This analysis led to a preliminary result for Dr. Munini's thesis and it's been re-examined in these last months to refine all the selections and to increase the statistics in order to lead to the most accurate determination possible of positron and electron fluxes at low energies.

3. Recently I moved to the measurement of cosmic-rays boron and carbon fluxes. This is probably one of the most useful measurement for cosmic-rays propagation in the galaxy. Performing this measurement with a satellite-borne experiment, such as PAMELA, reduces significantly the systematic uncertainties that come from the presence of the residual atmosphere above the instrument.

   I am currently working on the evaluation of the tracking system efficiency with Montecarlo simulations, given the experience gathered so far on this subject, on the optimization of some of the selections involving the spectrometer, on cross-checking the particle losses due to hadronic interactions taking place above the apparatus, and on the evaluation of the number of boron secondary events coming from carbon spallation in the detectors above the spectrometer. The current goal for this analysis is to have the first results on boron and carbon spectra by the end of the year.

Plan of studies

- E. Milotti - Introduzione ai Metodi Bayesiani (course attended and exam done)
- F. Longo - Gamma-ray Bursts (course attended and exam done)
- S. dalla Torre - Rivelatori a gas di particelle ionizzanti e rivelatori RICH (course attended and exam done)
- M. Boezio and F. Longo - Fisica astroparticellare: raggi cosmici e astrofisica gamma (course attended and exam done)
- F. Cossutti - Test sperimentali del model standard (course attended and exam done)
- V. Bonvicini - Rivelatori al silicio ed elettronica di lettura (course attended and exam done)
- A. Gregorio - Laboratorio di astrofisica spaziale (exam to be done as soon as possible)

Schools and conferences

- International School of Cosmic Ray Astrophysics, Erice, 4-10 July 2012
- SLAC Summer Institute 2012, Stanford, 23 July - 4 August 2012

Dottoranda (XXVI ciclo della Scuola di Dottorato in Fisica di Trieste): Erika Giangrisostomi

Supervisore (afferente all'ente finanziatore): Ph.D. Claudio Masciovecchio

Referente presso il collegio di dottorato: Prof. Fulvio Parmigiani

Tipologia di borsa: finalizzata al Progetto "Attività sperimentale con luce di Sincrotrone"

su fondi Sincrotrone Trieste S.C.p.A.

Titolo del progetto di ricerca: Studio della materia in condensata in condizioni termodinamiche estreme attraverso esperimenti di tipo pump-probe

CORSI FREQUENTATI

•"*Advanced Imaging and Spectromicroscopy methods for chemical and structural characterization of micro- and nano-materials*", tenuto dalla Ph.D. Maya Kiskinova;

esame sostenuto in data 24 giugno 2011

•"*Applicazioni della radiazione di sincrotrone*", tenuto dal Prof. Giorgio Paolucci;

esame sostenuto in data 7 dicembre 2011

SCUOLE FREQUENTATE

•"*HERCULES2012, Higher European research course for users of large experimental systems*"

tenutasi dal 4 marxo al 4 aprile 2012 a Grenoble, Francia

•"*XFEL2012, X-ray free electron laser school*"

tenutasi dal 4 all'8 giugno 2012 ad Annecy, Francia

BREVE RESOCONTO DELL'ATTIVITA' DI RICERCA SVOLTA NELL'ANNO 2012

Nel corso del suo secondo anno di dottorato, la dottoranda ha svolto attività di ricerca sui seguenti fronti.

i)

a)Ultimazione dell'allestimento, presso il laboratorio laser del gruppo IUVS-EIS ad Elettra, di un apparato pump-probe su tavolo ottico, da lei stessa progettato, per misure spettroscopiche di trasmissione e riflessione risolte in tempo al femtosecondo;

b)sua ottimizzazione in funzione del coniugare ampiezza e risoluzione spettrale, qualità del rapporto segnale-rumore e durata della misura;

c)messa a punto, in collaborazione con un team di informatici di Elettra, di un programma di acquisizione dati che, in quanto realizzato su piattaforma TANGO (il sistema di controllo distribuito sviluppato da un consorzio di facilities di sincrotrone ed adottato presso Fermi@Elettra) garantirà la piena integrabilità presso la beamline TIMEX che, con l'imminente installazione di un laser utenti e di una linea di ritardo, si appresterà ad effettuare analoghi esperimenti di tipo pump-probe.

i)

a)Partecipazione all'allestimento di TIMEX, la beamline di Fermi@Elettra dedicata a studi risolti in tempo della materia in condizioni estreme e/o metastabili, il cui layout è stato rivisto sostanzialmente a seguito della rinuncia, comunicata lo scorso gennaio dalla ditta da due anni assegnataria della commissione, alla realizzazione dello specchio ellissoidale di focalizzazione del fascio in camera sperimentale;

b)partecipazione allo sviluppo del software di acquisizione dati per la beamline

c)realizzazione di un software per l'analisi real-time dei dati acquisiti sulla beamline

d)partecipazione ai turni di commissing della beamline svoltisi durante i run 10 (marzo), 12 (luglio ed agosto) e 14 (novembre) della macchina Fermi@Elattra.

i)

Analisi dei dati raccolti durante le suddette campagne di misura, i cui principali risultati sono stati:

a)individuazione di condizioni critiche di operatività della macchina e degli strumenti di diagnostica delle caratteristiche del fascio FEL

b)individuazione delle tipologie di detector più idonee per la rilevazione dell'intensità del fascio FEL in camera sperimentale

c)determinazione della soglia $M_{4/5}$ del Ge, primo esempio assoluto di spettro di assorbimento da luce FEL (pubblicato in *New Journal of Physics* **14**, 113009 (2012));

d)determinazione della soglia $M_{2/3}$ del Ti che, differenziandosi per alcune caratteristiche dallo spettro di assorbimento collezionato presso la beamline di un normale sincrotrone di terza generazione (BEAR ad Elettra), apre la strada ad esperimenti XANES con una risoluzione temporale senza precedenti grazie alla quale è possibile monitorare modificazioni della struttura elettronica in materiali che l'intensissima luce FEL conduce in condizioni di eccitazione non altrimenti raggiungibili né sondabili.

Trieste, venerdì 23 novembre 2012

la Dottoranda

Erika Giangrisostomi

il Supervisore

Claudio Masciovecchio

Dottorato in Fisica – Università di Trieste
XXVI ciclo
Emiliano Munari

End year report - 2012

Galaxy clusters are complex systems, the study of which allows us to get information on the evolution and structure of the Universe. They are the subject of my research activity.

In this second year of my PhD activity, I have completed the study started in the first year. Through cosmological N-body and hydrodynamical simulations I have studied the statistical properties of galaxy clusters, such as density profile, radial distribution of substructures and galaxies, as well as dynamical properties such as velocity distributions of dark matter (DM) particles, DM substructures and galaxies, anisotropy of orbits and tidal disruption phenomena. The aim of this work is finding the link between the kinematics of objects in a galaxy cluster and the mass of the cluster itself. The mass is a fundamental property to put constraints on the cosmological models. The main problem is that the mass is not a directly observable quantity, so we need an observational "proxy" to infer it. The results of this work are presented in a paper submitted to the journal Monthly Notices of the Royal Astronomical Society (MNRAS).

Along with the aforementioned work on numerical simulations, I have also worked on real data coming from observations of galaxies in clusters. As explained above, mass is a fundamental quantity but is not directly observable. Therefore I have used different techniques to recover the mass profile of a real nearby cluster, A2142, from direct observables, namely the spatial and line of sight velocity distributions of the galaxies belonging to that cluster. The different techniques rely on some assumptions about the geometry of the system, usually considered spherically symmetric, and on the shape of the galaxy velocity distribution. Before these techniques are applied to the observational data, these must be treated in such a way as to get rid of observational biases, such as the removal of contaminant galaxies along the line of sight that appear in the cluster region only because of projection. The cluster mass profile determinations obtained via the different techniques are compared and found to be consistent. My own determinations are then compared with independent determinations from the literature, based on the hydrostatic equilibrium condition of the intra-cluster hot gas, and on the gravitational distortion of background galaxies induced by light path deformation by the cluster

potential ('weak lensing' technique). Combining the results from different methods is crucial to reduce the possible systematics as much as possible. I thus established the mass profile for A2142 in a very robust way. I have then used this mass profile to obtain information about the anisotropy of the orbits of galaxies, which is an important information to understand the formation process of this type of structures, and to derive constraints on the hierarchical model of structure formation (a direct consequence of the standard cosmological model). The results of this work will be presented in a paper to be submitted to Astronomy and Astrophysics in early 2013.

Along with the work I have just described, I have just started a new project that will presumably last for the third year. I am using a catalog of galaxies built from simulations, that can be adapted to mimic real observational survey, in particular, the planned ESA space survey 'Euclid'. The target of this project is to understand how observational effects (such as projection, limiting flux sensitivity, incorrect and incomplete identification of cluster members, etc.) can alter or even limit our determination of the mass of galaxy clusters. This work is meant to be a link between the other two works, as it makes use of simulated data, but treated as real observed data, and it is aimed to provide a helpful tool for observers in view of the scientific exploitation of Euclid data.

Below I report the list of the exams:

F. Longo	Gamma-ray bursts	6 ore
F. Matteucci	Nucleosynthesis and chemical evolution of galaxies	14 ore
S. Borgani	Formation of cosmic structures	16 ore
G. Granato – P. Monaco	Galaxy formation	10 ore
S. Leach	Scientifing computing in astronomy	10 ore
S. Leach	Statistics in astrophysics	6 ore
G. Ghirlanda	Data analysis and statistical methods	6 ore
G. De Zotti	Extragalactic astrophysics	16 ore

List of shools I have attended:

Scuola di Astrofisica “Francesco Lucchin”, XI ciclo, III corso, held in Bertinoro, 8-13 May 2011.

Summer School on Cosmology – ICTP 16-27 July 2012

Raffaello Bianco: Year-End Report 2012

Report

In the first year we started investigating an innovative and promising approach to topological order. In this first work we addressed the Chern number of a two-dimensional insulator and we showed that the corresponding topological order can be mapped by means of a topological marker, defined in coordinate space, and which may vary in different regions of the same sample. This work has been published by Phys.Rev. B as a Rapid Communication [1].

In this second year we have adopted the same local approach to study the magnetization effects in insulators at zero temperature. We found a local formula for the bulk magnetization. This formula, if applied to a crystal in thermodynamic limit, returns the well known results obtained working in the reciprocal space with Periodic Boundary Conditions. But thanks to its local nature our formula can be also used in a more general context (disordered materials and heterojunctions) irrispective of the Boundary Conditions used (either Open or Periodic Boundary Conditions). This work is currently under PRL's referees review [2].

In all our works, besides the analytical formulations, we have tested our findings providing many simulations over a model Hamiltonian.

[1] R. Bianco and R. Resta, *Mapping topological order in coordinate space*, Phys. Rev. B, 84,241106

[2] R. Bianco and R. Resta, *Are polarization and magnetization really bulk properties?*, Submitted to Phys. Rev. Letters

Schools and Workshops attended in 2012

- CECAM-HQ-EPFL, *Topological Insulators and Non-Perturbative Spin-Orbit Coupling*, Lausanne, January 9, 2012 - January 11, 2012

RELAZIONE SULL'ATTIVITA' DIDATTICA E DI RICERCA SVOLTA DURANTE IL SECONDO ANNO DI DOTTORATO

SUPERVISORE: ANGELO BASSI DOTTORANDO: DONADI SANDRO (CICLO XXVI)

Durante il secondo anno di dottorato ho svolto attività di tipo didattico e di ricerca, sotto la supervisione del Dr. Angelo Bassi. Le attività didattiche sono state:

- Una missione dal 15/02/2012 al 29/02/2012, finanziata dalla COST Action MP1006 (Fundamental Problems in Quantum Physics),al "Tata Institute of Fundamental Research", Mumbai (India), per una collaborazione di ricercacol Prof. Tejinder Singhed il Dott. Kinjalk Lochan. Quest'esperienza mi è stata utile per approfondire le mie conoscenze riguardo le implicazioni cosmologiche dei modelli di riduzione dinamica.

- Partecipazione, dal 24/04/2012 al 27/04/2012, alla conferenza "Quantum Malta 2012: Fundamental Problems in Quantum Physics" tenutasi a Malta e organizzata dal Dott. Angelo Bassi, il Prof. Detlef Dürr ed il Dott. Jackson Said in collaborazione con la COST Action "Fundamental Problems in Quantum Physics". In quest'occasione ho presentato un poster riguardante il mio lavoro di ricerca sull'emissione di radiazione nei modelli di riduzione dinamica.

- Partecipazione, dal 20/06/2012 al 22/06/2012, al workshop "Open Problems in Quantum Mechanics" tenutosi a Frascati (Roma) e organizzato dalla Prof.ssa Catalina Curceanu, dal Prof. Nino Zanghi, dal Dott. Angelo Bassi e dal Dott. Bassano Vacchini. In tale occasione ho potuto esporre i risultati ottenuti negli ultimi due anni a proposito dell'oscillazione delle particelle nei modelli di riduzione dinamica.

- Una missione dal 29/09/2012 al 24/12/2012, tramite fondi INFN, al Dipartimento di Matematica della University of California - Davis, per proseguire la mia attività di ricerca con la collaborazione del Dott. Dirk - André Deckert. Quest'esperienza si sta rivelando molto utile sia dal punto di vista della ricerca in sé sia perché è un'ottima occasione per migliorare il mio inglese. Inoltre il 29/11/2012 avrò l'occasione di fare un seminario all'università sui modelli di riduzione dinamica.

Riguardo eventuali corsi da seguire e relativi esami, quest'anno non ne ho seguito alcuno in quanto, già con i corsi dell'anno scorso, avevo svolto più delle 80 ore di lezione richieste dalla scuola.

L'attività di ricerca svolta quest'anno è stata il naturale proseguimento di quella svolta durante il primo anno di dottorato. Essa ha coinvolto principalmente due argomenti: lo studio di una formula consistente riguardo l'emissione di radiazione nei modelli di riduzione dinamica (noti anche col nome di modelli di collasso) e quello del fenomeno dell'oscillazione delle particelle in questi modelli.

Entrambe queste linee di ricerca hanno l'obiettivo di cercare fenomeni in cui sia possibile testare i modelli di riduzione dinamica. Infatti tali modelli, al fine di risolvere il problema della misura, ipotizzano una dinamica differente da quella della meccanica quantistica. Più precisamente essi assumono l'esistenza di un noise che interagisce con ogni sistema fisico e che tende a indurre il collasso della funzione d'onda per tale sistema. Questa differente evoluzione dei sistemi fisici si riflette in differenti predizioni rispetto a quelle date dalla meccanica quantistica e quindi i modelli di riduzione dinamica sono, almeno in linea di principio, verificabili sperimentalmente.

Tra i possibili fenomeni finora proposti per testare i modelli uno dei più promettenti è quello dello studio dell'emissione di radiazione elettromagnetica. L'idea fondamentale è che una conseguenza (indiretta) dell'azione del noise su sistemi fisici costituiti da particelle dotate di carica elettrica, è di far si che questi sistemi emettano radiazione. In particolare, dal momento che il noise agisce su qualunque sistema fisico, i modelli di collasso predicono emissione di radiazione anche per sistemi che, nella meccanica quantistica standard, non irradiano. In questi due anni ci siamo concentrati nello studio della particella libera e quello di una particella immersa in un potenziale armonico. Lo scopo è quello di trovare una formula per il rate di emissione per grandi tempi. Tale calcolo era già stato fatto in diversi lavori presenti nella letteratura, ma essi ottenevano risultati differenti. Il principale risultato del lavoro dell'anno scorso è stato quello di fare luce sull'origine di queste differenze: in particolare si è capito come mai, quando si calcola il rate per grandi tempi, il conto perturbativo dove si trattano il campo elettromagnetico (in seguito campo EM) ed il noise al prim'ordine dia un risultato differente da quanto si ottiene facendo un calcolo esatto e prendendo solo alla fine il risultato al prim'ordine. Chiarire questo è fondamentale perché il nostro obiettivo finale è calcolare il rate di emissione utilizzando il modello CSL (Continuous Spontaneous Localization), il quale permette solo di fare calcoli approssimati.

Osservando la formula esatta per il rate di emissione a tempi finiti è possibile individuare due termini: uno costante, che è presente anche nel limite per grandi tempi ed uno transiente, che va a zero per grandi tempi. Questo termine transiente contiene un esponenziale decrescente il cui esponente è diverso da zero solo quando il campo elettromagnetico viene calcolato al second'ordine o superiori. Quindi se ci si limita a fare un calcolo perturbativo in cui si considera il campo EM solo al prim'ordine, questo esponenziale diventa semplicemente 1 e, anche nel limite grandi tempi, il termine transiente sopravvive. Ciò significa che è necessario fare calcoli perturbativi trattando il campo EM ad ordini superiori al primo. Questo è stato il tema del mio lavoro di ricerca di quest'anno sull'emissione di radiazione. E' risultato fin da subito evidente che un calcolo perturbativo diretto di tutti i contributi fino al second'ordine è, da un punto di vista pratico, ingestibile: vanno considerati all'incirca una sessantina di diagrammi di Feynman differenti. Abbiamo allora provato a studiare il problema usando una doppia picture d'interazione, in modo da provare a trattare separatamente l'interazione EM dal noise, ma anche questo approccio comporta il calcolo di un numero notevole di contributi. Un tentativo differente è stato fatto, provando ad introdurre una massa crescente nel tempo nell'Hamiltoniana e facendo i calcoli al prim'ordine con tale Hamiltoniana. L'idea era quella di simulare lo smorzamento nel moto della particella dovuto alla reazione di radiazione (che è un effetto dell'interazione della particella col campo EM visibile solo ad ordini superiori al primo) introducendo questa massa crescente nel tempo. Comunque nemmeno questo tentativo è andato a buon fine. Infine abbiamo provato a fare calcoli perturbativi utilizzando la matrice densità. Questo approccio ha principalmente due vantaggi: da un lato si hanno equazioni col noise già mediato, dall'altro in queste equazioni compaiono molti commutatori, cosa che aiuta a semplificare il calcolo. In un primo momento abbiamo usato questa tecnica trattando sia il campo EM che il noise perturbativamente, ma in tal caso se si vuole andare almeno al second'ordine col campo EM il calcolo è ancora troppo complicato per essere portato a termine. Successivamenteabbiamo provato a usare questa tecnica trattando quasi esattamente il campo EM (infatti, utilizzando solo l'approssimazione di dipolo, è possibile, nella QED non relativistica, risolvere esattamente le equazioni di Heisenberg per gli operatori) e perturbativamente il noise. E, sorprendentemente, il calcolo è stato relativamente semplice ed è risultato consistente col risultato esatto (per grandi tempi i termini transienti vanno a zero). Quindi finalmente abbiamo trovato una tecnica che permetta di fare calcoli perturbativi in accordo coi risultati esatti. Il passo successivo sarà di applicare questa tecnica di calcolo al modello CSL.

L'altra linea di ricerca su cui mi sono concentrato riguarda l'oscillazione delle particelle nei modelli di riduzione dinamica. Avevamo già svolto questo calcolo l'anno scorso per i neutrini ed era risultato che,

rispetto alla formula prevista dalla meccanica quantistica, nei modelli di collasso il termine oscillante viene soppresso esponenzialmente. Si era anche trovato però che tale soppressione è così debole da non poter essere osservata sperimentalmente. Quest'anno abbiamo esteso il calcolo anche per i kaoni ed abbiamo generalizzato il nostro studio anche al caso di kaoni in stato entangled. In entrambi i casi abbiamo trovato che l'effetto dei modelli di collasso è di sopprimere il termine oscillante, in modo più forte di quanto non avvenga per i neutrini,ma ancora troppo piccolo per poter essere osservato in alcun esperimento.

Infine, dal momento che anche la decoerenza tende a sopprimere l'oscillazione delle particelle, abbiamo cercato di capire come quantificare tale effetto per confrontarlo con quello ottenuto dai modelli di collasso senza però, per ora, riuscirci. La principale difficoltà sta nel fatto che non vi sono, nella letteratura, molti lavori in cui viene data una stima della decoerenza: nella gran parte dei lavori si suppone solo che essa sia presente, che sia quantificata da uno o più parametri e se ne studiano gli effetti in funzione di tali parametri, che però non è chiaro come calcolare. In più, nei pochi lavori in cui questi parametri vengono effettivamente calcolati, questo viene fatto per mezzo di passaggi matematici che non ci risultano ancora chiari.

LISTA DEI LAVORI IN PUBBLICAZIONE

Il lavoro di ricerca svolto quest'anno sull'oscillazione dei neutrini e dei kaoni è stato esposto in tre differenti pubblicazioni. Tali pubblicazioni sono ancora al vaglio dei referee ma i preprint possono essere trovati sul sito http://arxiv.org/. Nel seguito riporto la lista di tali pubblicazioni:

1) Titolo: "The effect of spontaneous collapses on neutrino oscillations"
   Autori:"S. Donadi, A. Bassi, C. Curceanu, L. Ferialdi"
   Rivista dove è stato inviato il lavoro e riferimento su arxiv: Physical Review D, arXiv:1207.5997;

2) Titolo: "Are Collapse Models Testable via Flavor Oscillations?"
   Autori: "S. Donadi, A. Bassi, C. Curceanu, A. Di Domenico, B. C. Hiesmayr"
   Rivista dove è stato inviato il lavoro e riferimento su arxiv: Physical Review D, arXiv:1207.6000;

3) Titolo: "Testing Collapse Models with Neutrinos, Mesons and Chiral Molecules"
   Autori: "M. Bahrami,S. Donadi, L. Ferialdi, A. Bassi, C. Curceanu, A. Di Domenico, B. C. Hiesmayr"
   Rivista dove è stato inviato il lavoro: Physical Review Letters.

LISTA DEI TALK:

Nel seguito la lista dei talk che ho fatto quest'anno:

1) Titolo: "Particle oscillations in collapse models"
   Luogo e Data: Frascati (Roma) il 21/06/2012 durante il workshop "Open Problems in Quantum Mechanics";

2) Titolo: "Is Quantum Theory Exact? An introduction to Collapse Models and their new predictions which differ from standard Quantum Mechanics."
   Luogo e Data: Davis (California) il 29/11/2012.

Davis, California 23/11/2012 Sandro Donadi

Candidate: **Fabrizio ORLANDO**

Thesis title: *"Physical properties and functionalization of low-dimensional materials"*
Supervisor: Alessandro BARALDI
Co-supervisor: Silvano LIZZIT

Report on the research activity of the 2nd year

During this second year my research activity was focused on the characterization of the electronic and structural properties of epitaxial graphene (GR) grown on transition metal surfaces and, in particular, on the possibility of tailoring the electronic properties of GR through intercalation of atomic species.
The mass-production of GR-based electronic devices requires the synthesis of high-quality, i.e. with low defects concentration, and large-area carbon layers. This can be achieved by different routes, among which the epitaxial growth on transition metal surfaces is one of the most promising ones. However, this method has the disadvantage of a conductive substrate, rendering the conduction through GR irrelevant. The problem can be solved by transferring the GR layer on an insulating substrate, such as silicon oxide (SiO_2). However, the transfer process itself, although possible, introduces a large amount of defects in the GR lattice, inevitably leading to a strong decrease in carrier mobility. During the first part of this year I've been involved with the development of a novel method to electrically decouple epitaxial GR from its metal substrate. In particular, we demonstrated that is possible to insulate electrically GR from the metal, a Ru(0001) crystal surface in the specific case, without the need to transfer the GR layer [1]. This has been achieved by growing an insulating SiO_2 layer directly at the interface between GR and the metal. The procedure consists of three distinct phases. In the first step, epitaxial GR is grown on the clean Ru(0001) surface through adsorption and successive dissociation of ethylene (C_2H_4) at high temperature. The sample is then exposed to silicon, that intercalates below GR and forms a binary compound – a so-called silicide – with the metal substrate. In the last step, the system is exposed to molecular oxygen that also intercalates below GR leading to the progressive oxidation of the silicide, that converts into a SiO_2 layer. Each step of the reaction has been followed by high-energy-resolution X-ray photoelectron spectroscopy with synchrotron radiation. The electrical insulation was verified by performing lateral transport measurements at different locations of the GR layer. These measurements showed resistance values typical of a two-dimensional system, meaning that the transport is dominated by GR and not by the underlying metal. These results have been commented on the Research Highlights of Nature Nanotechnology in a paper titled *"Graphene: Silica in between"* (Nature Nanotech. **7**, 613 (2012)).
Epitaxial GR frequently exhibits a strong interaction with the substrate. In some cases, this interaction can be sufficiently strong to prevent the typical electronic properties of GR from being established. This issue, of obvious relevance for future GR-base electronic devices, was the second main object of investigation during this year. In particular, we concentrated on the decoupling of epitaxial GR grown on the Ir(111) surface, obtained through intercalation of molecular oxygen [2]. The choice fell on Ir (111) because on this surface large-scale GR layers with low defects concentration can be grown. Therefore, it follows that the decoupling of this system allows us to obtain a high structural quality GR layer that is weakly interacting with the metal substrate. The experimental results indicate that an efficient intercalation of oxygen takes place around 500 K, but only at a relatively high oxygen pressure (5×10^{-3} mbar). After complete intercalation, the narrow GR component of C 1s core level spectrum shifts towards lower binding energies, corresponding to a charge transfer from GR to oxygen. In addition, the valence band structure loses the characteristic features of the GR-Ir interaction while the linear dispersion with a single Dirac cone typical of quasi-freestanding GR is restored. The process is partly reversible: oxygen can be removed by heating the

system to a temperature of 600 K. The GR-metal interaction is then re-established but, in parallel, a small amount of carbon is lost suggesting the creation of defects in the GR layer. In conclusion, these results demonstrate that intercalation of oxygen is an effective method to decouple an extended GR layer from its metal substrate.

The realization of the above-mentioned experiments, conducted mainly at the SuperESCA beamline of the synchrotron light source Elettra, took advantage of the international collaboration with the research group headed by Prof. Ph. Hofmann (Aarhus, Denmark).

I'm also involved in the ongoing experimental investigation on other GR-related systems, e.g. intercalation of GR/Ir(111) and GR/Ru(0001) with Zr atoms, and study of epitaxial GR growth on the $Ni_3Al(111)$ surface.

Publications:

[1] S. Lizzit, R. Larciprete, P. Lacovig, M. Dalmiglio, **F. Orlando**, A. Baraldi, L. Gammelgaard, L. Barreto, M. Bianchi, E. Perkins, and P. Hofmann, *"Transfer-Free Electrical Insulation of Epitaxial Graphene from its Metal Substrate"*, Nano Letters **12**, 4503 (2012).

[2] R. Larciprete, S. Ulstrup, P. Lacovig, M. Dalmiglio, M. Bianchi, F. Mazzola, L. Hornekær, **F. Orlando**, A. Baraldi, P. Hofmann, and S. Lizzit, *"Oxygen Switching of the Epitaxial Graphene–Metal Interaction"*, ACS Nano **6**, 9551 (2012).

[3] **F. Orlando**, R. Larciprete, P. Lacovig, I. Boscarato, A. Baraldi, and S. Lizzit, *"Epitaxial Growth of Hexagonal Boron Nitride on Ir(111)"*, The Journal of Physical Chemistry C **116**, 157 (2012).

Plano of studies:

- "Critical Phenomena" (G. Pastore) 48 hours
- "Advanced Imaging and Spectromicroscopy methods for chemical and structural characterization of micro- and nano-materials" (M. Kiskinova) 12 hours
- "Molecular self-assembling and nanostructures" (A. Morgante) 20 hours

for a total of 80 hours of educational training. The results of the exams can be found in my personal Transcript of Record (in attachment). The exam of "Critical Phenomena" was held on the second academic year because at the end of the first year the course was still in progress.

Attended schools:

"Quantum phenomena in graphene, other low-dimensional materials and optical lattices" organized by CNR-DMD in Erice (TP), 26 July - 3 August 2011. Poster entitled: *"Epitaxial Growth of Hexagonal Boron Nitride on Ir(111)"*.

Trieste, 20/11/2012

Approved by: Alessandro Baraldi

End of the year report (2012)

PhD student: Valentina Luciana Grieco
Supervisor: Professor Francesca Matteucci
Co-Supervisor: Doctor Francesco Longo

Supernovae Ib/c are likely to be associated to long GRBs, therefore it is important to compare the SN rate in galaxies with the GRB rate.
Since the Type Ib/c SN rates study is based on the star formation rates we need to compute the star formation history of different morphological type of galaxies (ellipticals, spirals, irregulars).
In particular, ellipticals should have suffered an intense and short star formation episode whereas spirals and irregulars should have had milder star formation rates (SFR) and are still forming stars now.

While in the first year of PhD, we focused on computing the chemical evolution of irregular and spiral galaxies and on the calculation of the SNIb/c rate in relation to the GRB rate (the results of this work are now published on MNRAS), during the second year of PhD we worked on spheroidal galaxies and in particular on the Milky Way bulge taken as a typical spheroidal galaxy. Our final aim is to reproduce the caractheristics of the stellar populations observed in the bulge and to predict the Type Ib/c SN rate for a typical spheroidal in order to compare with the GRB rate at high redshift.
The recent although controversial discovery of two main stellar populations in the Galactic bulge, one metal-poor with a spheroid kinematics and the other metal-rich with a bar-like kinematics, suggests a revision of the classical model for bulge formation.
We computed in detail the chemical evolution of the Galactic bulge in order to explain the existence of the two main stellar populations. We also explored the possible existence of spatial abundance gradients inside the bulge.
To do that, we adopted a chemical evolution model that follows the evolution of several chemical species (from H to Ba) and took into account both infall and outflow of gas. We assumed that the metal-poor population formed first and on a short timescale, in agreement with previous models, while the metal-rich population formed later and out of the enriched gas either left from the formation of the previous one or originating from the inner disk. We predicted the stellar distribution functions for Fe and Mg, the mean ⟨[Fe/H]⟩ and ⟨[Mg/H]⟩ as well as the [Mg/Fe] vs. [Fe/H] relations in the two stellar populations. Then, we considered the case in which the metal-poor population could be the result of sub-populations formed with different chemical enrichment rates. In particular, the population close to the Galactic center could have evolved very fast, while the more external population could have evolved more slowly, in agreement with the dissipational gravitational collapse scenario.
When compared with observations, our results confirm that the old more metal-poor stellar population formed very fast (on a timescale of 0.1–0.3 Gyr) by means of an intense burst of star formation coupled with an initial mass function flatter than in

the solar vicinity, but not as flat as suggested in previous works. The metal-rich population, instead, should have formed on a longer timescale (~3 Gyr). We predicted differences in the mean abundances of the two populations that can be interpreted as a metallicity gradient. We also predicted possible gradients for Fe, O, Mg, Si, S, and Ba between sub-populations inside the metal-poor population itself.

In order to investigate the correlation between SNIb/c and GRB in a typical spheroid we computed the Type Ib/c SN rate in the Milky Way bulge starting from the star formation history predicted from our chemical evolution model. We adopted both single Wolf-Rayet stars (namely stars which have lost most of their H and He envelope) and massive binaries as SNIb/c progenitors and considered a dependence of the progenitors on the initial metallicity. In fact, the mass loss in massive stars ($M > 10\ M_{sun}$) increases with the initial metallicity in a way that the progenitors mass decreases with increasing metallicity.
We found that the SNI b/c rate has a maximum at 0.06 Gyr corresponding to z=7.

- PhD School:

National PhD School of Astrophysics “F.Lucchin”
XI Cyrcle 4th Course – E.Maiorana Centre, Erice (Italy)
Title: The transition from low-mass stars to planets galaxy bulges
September 4-9, 2011

PhD School:
I NAT Lectures On Astrophysics – San Paolo (Brazil)
Title: Collapsing or Collading Systems: solving the galactic puzzle

- Papers published:

Grieco, V. et al. 2012, A&A,548, A60
Title: Chemical evolution of the Galactic bulge: different stellar populations and possible gradients

Grieco, V. et al. 2012, MNRAS, 423, 3049
Title: Metallicity effects on cosmic Type Ib/c supernovae and gamma-ray burst rates

- Conferences 2012

- 07.05.2012 - 11.05.2012, Fermi/Swift GRB conference, poster session
Title: Metallicity effects on cosmic Type Ib/c SN and GRB rates
- 29.05.2012 - 31.05.2012, Bologna, GREAT ESF-sponsored WORKSHOP
Title: Chemical evolution of the Galactic bulge: different stellar populations and possible gradients

PIANO DI STUDI

F. Matteucci	Nucleosynthesis and chemical evolution of galaxies	14 ore	Fatto
G. Granato – P. Monaco	Galaxy formation	10 ore	Fatto
S. Leach	Scientifing computing in astronomy	10 ore	Fatto
S. Leach	Statistics in astrophysics	6 ore	Fatto
G. Ghirlanda	Data analysis, statistics	6 ore	Fatto
G. De Zotti	Extragalactic astrophysics	16 ore	Fatto
A. Bressan	First stars	4 ore	Fatto
A.Gregorio – M.Messerotti	Fisica delle Interazioni Spazio Geospazio	20 ore	Fissato per il 6 dic 2012

Note: libretto in allegato

Report 2012

Simona Salvini

Research activities

During the first part of the year I attended the courses listed below and I took the relative exams.
I have worked on my reasearch project under the supervision of Prof. Daniele Treleani. The topic of my project is in the framework of the phenomenology of the multipartonic interactions (MPI) in hadron-hadron collisions. In particular, I focused on new theoretical aspects of MPIs and related phenomenological issues, as for example the Genearalized Parton Distributions, which are off-diagonal partonic distributions, and the jets production at hadronic colliders. Moreover I have been working on a numerical implementation of our theoretical model for MPIs in order to be able to simulate it. For this reason I learnt how to use the MonteCarlo integration routine VEGAS and MADGRAPH.

VEGAS evaluates multidimensional integrals (in my case, 10-dimensional integrals). Since it is based on MonteCarlo methods, it generates a large number of configurations which might be used to obtain other distributions, related to different observables. My codes exploit VEGAS to estimate some integrated cross sections in regions of the phase space similar to that one defined by one of the calorimeters of the LHC.
MADGRAPH is a generator of partonic matrix elements.

After some preliminary tests on VEGAS, I wrote a code that evaluates the differential cross section in the transverse momentum for the dijet production in order to understand how to interface the output generated by MADGRAPH. What I obtained is in agreement with the experimental data from Tevatron. Then I wrote a code evaluating the integrated cross section for the production of 4 jets at the LHC. In this case the multiparton interactions are implemented. All these codes are written in C++ programming language.

Courses

Electroweak and Strong Interactions, Prof. S. Petcov, Prof. G. Martinelli (60h)
- grade: 27/30

Beyond the Standard Model, Prof. A. Romanino (60h)
- grade: "buono" (good)

Schools

I attended the XVIth LNF Spring School Bruno Touschek at the “Laboratori Nazionali INFN di Frascati” (7-11 May 2012). I gave a talk at the “Young Researchers Workshop” related to the School.
Next year I will partecipate in another summer school.

Cicle: XXVI

Dottorando: Battistoni Andrea

Supervisor: Dr. Bencivenga Filippo

Object: year-end report

During the first part of this second year Andrea has contributed to complete the data analysis concerning the characterization of a new high-resolution UV interferometer device (results published in Review of Scientific Instrument 83, 103102 (2012)). Andrea has also improved the methodology, based on the exploitation of special spatial filters conceived by himself, for acquiring inelastic (Brillouin) light scattering at any scattering angle without artefacts due to the finite numerical aperture of collection optics.

Andea also learned the time resolved (pump-probe) experimental technique usually referred to as “transient grating”. In particular, exploiting two different experimental configurations it has been possible to collect both low resolution (0.1 nanosecond) wide range (> microsecond) and high resolution (0.1 picosecond) short range (a few nanoseconds) measurements, in order to determine the time dependence of the spectrum in 7-8 decades in time. In summary, the combination of the transient grating method and inelastic (UV-Visible) Brillouin ligth scattering at variable scattering angle permitted to carry out an effective broadband acoustic spectroscopy in a wide wavevector and time/frequency range.

Andrea has also designed and tested a device, compatible with the severe geometrical constraints of the aforementioned experimental techniques, able to control the sample temperature in the 200-400 K range.

During the second part of the year Andrea has employed the acquired skills to start a set of measurements on two prototype liquids: glycerol and acetonytrile. The former is usually considered as an archetype of “simple liquid”, being virtually free from intramolecular degrees of freedom, while the latter shows molecular degrees of freedom of both vibrational and orientational nature. While the interplay between intramolecular vibrations and acoustic dynamics in acetonitryle has been already discussed in litterature, possible effects of molecular orientations on acoustic properties has not yet been studied. Andrea is currently using the broad acoustic spectroscopy to investigate on the effects of the molecular dipole (essentially related to orientational dynamics) on the structural relaxation process, which is instead associated to the translationa (intermolecular) degrees of freedom and drives the dynamic transitions between the liquid phase and the glassy or gaseous ones. Complementary inelastic scattering measurements on this sample have been carried out both at the IUVS beamline (Sincrotrone Trieste) and at the GHOST laboratory (Universita' di Perugia). If compliant with the schedule of the PhD course, such kind of study will be systematically extended to other samples characterized by different values on molecular dipole.

Additionally, Andrea actively participated at the first commissioning experiments of the EIS-TIMEX end station, recently installed at the FERMI@Elettra free electron laser facility (results published in New Journal of Physics 14, 113009 (2012)), while in the near future he will participate at the commissioning of the EIS-TIMER end station, which is the first experimental facility able to provide transient grating measurements at nanometer scale.

In this second year of the PhD course Andrea participated at the following international schools:

- Synchrotron radiation and FEL based methods and their multidisciplinary applications (ICTP, Trieste, Italy)
- X-FEL school 2012 (Annency, France)

Best regards,

Filippo Bencivenga

ALLEGATO 3

PRESENTAZIONI DEI CANDIDATI ALL'ESAME FINALE.

Valentina Capogrosso
PhD candidate
School of Doctorate in Physics – University of Trieste
(Supervisor: Prof. Fulvio Parmigiani)
Referees: Prof. Andrea Damascelli, Dr. Mario Cuoco

The candidate has positively accomplished the educational activity as approved by the "Collegio Docenti" comprehensive of lectures, schools and conferences.

The scope of Valentina Capogrosso's thesis is to study complex systems (half doped single layered manganites and layered strontium ruthenates $Sr_{n+1}Ru_nO_{3n+1}$) showing strong electronic correlations effects by x-ray spectroscopies.

In particular, the studies reported by Valentina Capogrosso consist in the investigation of the orbital physics and topology of layered strongly correlated electron systems by means of x-ray absorption spectroscopy, resonant x-ray emission spectroscopy and an ab-initio computational approach. In addition, part of the thesis of Valentina Capogrosso reports on a novel approach suitable for measuring x-ray absorption spectra of photoinduced transient states of matter.

For performing such experiments a new time resolved XAS setup capable of providing spectroscopic information in the time and energy domains has been designed and developed.

These experimental setups along with an ab-initio computational approach have brought interesting results that can be summarized in the following points:

1) Characterization of the orbital topology of the half-doped single layered Pr0.5Ca1.5MnO4
2) Characterization of the metastable hidden state of Pr0.5Ca1.5MnO4
3) Characterization of the orbital topology of the first three members of the Ruddlesden-Popper $Sr_{n+1}Ru_nO_{3n+1}$ family

The scientific achievements obtained by Valentina Capogrosso are quite important.

The judgment about the PhD research and education of Valentina Capogrosso is good, while in the meantime the target of forming a prepared young experimental physicist has been completed.

Publications 2012
Manuscripts submitted (Physical Review B):
"Effects of charge-orbital order-disorder phenomena on the unoccupied electronic states in the single layered half-doped Pr0.5Ca1.5MnO4"

Manuscripts in preparation:
"Resonant X-ray emission study of the $Sr_{n+1}Ru_nO_{3n+1}$ (n=1,2,3) family: role of the apical and planar oxygen sites"

Presentation of Frances Caroline Lopez
Supervisor: prof. Renata Longo
Referees: prof. Roberto Bellotti, prof. Roberto Cirio

The candidate has completed the educational activities approved by the Teachers Board, including international schools and courses on medical physics, digital detectors, synchrotron radiation (SR).
The research work has been done in the field of digital detectors for medical imaging with SR. The candidate was involved in the development of the final version of a detector named PICASSO (**P**hase **I**maging for **C**linical **A**pplication with **S**ilicon detector and **S**ynchrotron radiation) that is a system designed for the clinical facility of the SYRMEP beamline, where mammography and imaging research is currently being performed.

The candidate developed a new software architecture and firmware with the assistance and in collaboration with the SLS Detector Group of Paul Scherrer Institute in the frame of an upgrade of the detector controllers. Moreover she worked at front-end electronics, analog and digital component tests and at measurements of the overall performance of its electronics.

The detector was brought to Elettra for testing to evaluate its imaging capabilities. In particular, signal-to-noise ratio, contrast, and spatial resolution were evaluated concurrent with the dose given to the standard mammographic phantoms being imaged at both the experimental and the radiological stations of the SYRMEP beamline.

The last part of her program concludes with the testing of the recently assembled four layers of PICASSO, which constitute the detector's final configuration. This system is controlled by two separate controllers, and a preliminary evaluation on how images are reconstructed with the inherent time delay was done.

Phase contrast methods were applied using the prototype under development. Further, this version of the detector was also used in pioneering imaging experiments during the program, in collaboration with University College London.

The candidate has the MSc in Applied Physics at University of Santo Tomas in Manila, the Philippines and the BSc in Medical Physics at De La Salle University, Manila, the Philippines. She worked as Medical Physicist and Assistant Radiation Protection Officer in the field of radiation therapy in her country.

Her research project in development of a single photon counting system for mammography with synchrotron radiation was a completely new field for her. She is very brave in approaching new problems and works hard. She has done a lot of work in a very independent way and she built up a considerable experience in this research field. The challenge of a very fast and reliable read-

out system for such a large area photon counting detector in order to meet the severe constrain of in vivo, clinical, medical imaging is quite demanding. Moreover her contribution to both characterization of the detector and development of a new set-up for phase contrast imaging based on the properties of a linear array silicon pixel detector was essential for the success of the experiments (paper in press).
During the last year of the project she was ill for about one month and she spent some weeks at the hospital, in the following 2 months her recovering was good and progressive but she was not able of working with her usual energy, therefore we stopped the submission of the abstracts to both Pisa meeting on advanced detectors and IEEE NSS&MIC. For the same reasons the final results were obtained in the beamtime held in November at Elettra and an exhaustive paper is not ready yet. In the first months of the 2013 she will be supported by the TRIL program of the ICTP in order to complete some research work and write a full paper.

During her Ph.D. course she published 2 papers on international journals with referees and she presented 4 contributions (oral or posters) in international conferences and 2 contributions in Italian conferences. At the "Secondo Convegno Congiunto SILS-SISN, in Trieste, Italy 1-3 September 2011 Frances Lopez was one of the winners: Best poster, Young Researcher's Award.

Publications

Munro PRT*, Rigon L, Ignatyev K, Lopez FC, Dreossi D, Speller RD and Olivo A. A quantitative non-interferometric x-ray phase contrast imaging technique Optics Express (in press, 2012)

Lopez, FC*, Rigon L, Longo R, Arfelli F, Bergamaschi A, Chen RC, Dreossi D, Schmitt, B, Vallazza E, Castelli E 2011 *Development of a fast read-out system of a single photon counting detector for mammography with synchrotron JINST* ***6*** *C12031* doi:10.1088/1748-0221/6/12/C12031 *inserted in UGOV

Oral Presentation

Lopez, FC*, Rigon L, Longo R, Arfelli F, Bergamaschi A, Chen RC, Dreossi D, Schmitt, B, Vallaza E, Castelli E *Development of a fast read-out system of a single photon counting detector for mammography with synchrotron*
13th International Workshop of Radiation Imaging Detectors, 2011 Zurich, Swiss

Longo, R*, Arfelli F, Dreossi D, Lopez FC, Quai E, Quaia E, Tromba G, Castelli E *Misura in vivo del coefficiente di attenuazione lineare della mammella* VII Congresso Nazionale Associazione Fisica Medica 13-16 Settembre 2011 Catanzaro, Italy

Poster Presentation

Lopez FC*, Rigon L, Arfelli F, Bergamaschi A, Chen RC, Dreossi D, Longo M, Schmitt B, Vallazza E, Castelli E and Longo R
"The PICASSO detector at the clinical mammography facility of the SYRMEP beamline: preliminary results"
7th Medical Applications of Synchrotron Radiation Workshop 17-20 October 2012 Shanghai, China

Longo R*, Arfellli F, Dreossi D, Lopez FC, Quai E, Quaia E, and Tromba G
"In vivo measurements of the breast linear attenuation coefficient"
7th Medical Applications of Synchrotron Radiation Workshop 17-20 October 2012 Shanghai, China

Longo M*, Rigon L, Arfelli F, Chen RC, Lopez FC, Olivo A, Munro P, and Longo R
"A quantitative study of coded-aperture based X-ray phase contrast imaging with synchrotron radiation"
V Alpe-Adria Medical Physics Meeting 3-5 May 2012 Trieste Italy

Lopez,FC*, Rigon L, Longo R, Arfelli F, Bergamaschi A, Chen RC, Dreossi D, Schmitt, B, Vallaza E, Castelli E.
"*PICASSO: En route to digital detection for mammography with synchrotron radiation"*
Secondo Convegno Conguinto SILS-SISN, XIX Convegno Nazionale SILS, XXII Convegno Nazionale SISN Trieste, Italy 1-3 September 2011 (One of the winners: Best poster, Young Researcher's Award)

Presentation of the PhD thesis work of Giorgia Olivieri.
Supervisor: prof. Alberto Morgante
Referees: Prof. Maurizio Canepa, Prof. Gvido Bratina

The Candidate has positively accomplished the required educational activities as approved by the Teachers Board, including the Ph.D. courses and lectures and the attendance to schools and conferences.

The PhD course of Giorgia Olivieri started in May 2010, with some delay respect to the expected date due to late recruitment.
The research project focused on the study of organic materials for electronics and organic photovoltaics and the realization of some test photovoltaic cells. The organic materials and interfaces have been studied by applying spectroscopic experimental techniques mainly based on synchrotron radiation. Giorgia Olivieri has acquired during her PhD a good knowledge of X-ray photoemission and absorption spectroscopies and more in general of the experimental use of synchrotron radiation including the beamline instrumentation (monochromator and X-ray optic) and the detection apparatuses (photoelectron analyzers and X-ray detectors). She has also acquired experience in complex data analysis in particular for the interpretation of the resonant photoemission (RESPES) results, which requires to deal with very large data sets. Moreover this technique implies complex processes to be considered in the interpretation of the data when it's used as "core hole clock" (CHC) method to study charge transfer processes at interface to determine the charge transfer times in the femtosecond range.
Giorgia Olivieri studied systems based on a novel organic molecule (4-hydroxycyanobenzene) which displays highly anisotropic transport properties which are very promising for its use in molecular electronic. She studied the electronic properties of the single molecule in gas phase, single crystals and thin films and interfaces with metal substrates.
Giorgia Olivieri has also studied supermolecular assembly of interdigitated C60 and Hexabenzocoronene (HBC) molecules. These systems have been studied in collaboration with research groups at Columbia University in New York which have developed methods to modify the HBC molecular structure in such a way to obtaine contorted HBC which structurally better adapt to the quasi-spherical shape of C60 with the aim of obtaining a better electronic coupling. At Columbia they have demonstrated that photovoltaic cells based on contorted HBC and C60 have significantly higher efficiency than those containing flat HBC. Giorgia Olivieri objective was to determine which were the elementary processes in the cell operation that were causing the increased efficiency. To reach this objective she has studied the electronic and morphological properties of the assembly structures with HBC molecules of variable degree of contortion and applying complex models to analyze RESPES she has determined charge transfer times at the interface between C60 and HBC and its dependence from the degree of contortion. It has been demonstrated that for contorted HBC the charge transfer time (related to the electron-hole dissociation in the PV cell) is shorter than for flat HBC.
Giorgia Olivieri has also worked at the Columbia Laboratory for Unconventional Electronics (CLUE) for 4 months developing organic molecules and graphene based photovoltaic cells designed iusing the tandem configuration.
Giorgia Olivieri has acquired a good knowledge of the various complex experimental techniques that she has used for the experiments carried out during her thesis work. She is now able to run independently experiments at synchrotron radiation facility. Her contribution has been particularly appreciated by the colleagues at Columbia University during her stay there. She has carried out a good amount of scientific work that is surely

original and focused on fundamental physical processes very relevant for understanding and improving organic material based devices. Various publications on international refereed journals are expected as a result of her thesis work. One paper has been already submitted, a second has been written, more papers will follow.

"Donor-acceptor shape matching drives performance in photovoltaic", Schiros T., Kladnik G., Prezzi D., Ferretti A., Olivieri G., Cossaro A., Floreano L., Verdini A., Schenck C., Cox M., Gorodetsky A., Plunkett K., Delongchamp D., Nuckolls C., Morgante A., Cvetko D., Kymissis I. Submitted

"Investigation of 4HCB molecule by synchrotron based techniques" Olivieri G. et al. In preparation

Presentation of the Candidate Ramona Lea
Supervisor: prof. Paolo Camerini, co-supervisor: dott. Stefano Piano
Referees: prof. Josef Pochodzalla, prof. Laura Fabbietti

Ramona Lea has fruitfully accomplished the required educational activities as approved by the Teachers Board, including PhD courses, schools and conferences.

The scientific activity of Ramona Lea has developed within the Trieste group of the ALICE experiment where she performed an analysis to study the production of light hypernuclei in ultra-relativistic heavy-ion collisions at $\sqrt{s_{NN}}$ = 2.76 TeV. Specifically she focused her work on the study of the production of $^{3}_{\Lambda}H$ (anti-$^{3}_{\Lambda}H$) detected via its decay $^{3}_{\Lambda}H \rightarrow {}^{3}He + \pi^{-}$ (anti-$^{3}_{\Lambda}H \rightarrow$ anti-$^{3}He + \pi^{+}$). The study is relevant for the study of the formation and evolution of the Quark Gluon Plasma and to study the baryon-strangeness correlation on an event-by-event basis.

This type of analysis was new within the collaboration and required a relevant effort to develop the proper analysis approach, the algorithms and the simulations to accomplish a task that from the very beginning appeared rather hard because of the poor statistics and the relevant combinatorial background.

During the first year she worked on a highly selective identification of heavy charged particles which was not available in the ALICE official offline analysis software nor simulated in the official Monte-Carlo.

From the second year she focused on the determination of the proper topological cuts and analysis procedure to enhance the signal over background ratio; besides, she devoted a lot of effort to determine the proper acceptance and efficiency corrections. The latter, together with the determination of the systematic errors, needed the development of new and dedicated approaches. In her activity Ramona had in fact to face and autonomously solve several problems since no similar analysis had been performed before within the collaboration. To be able to carry out such a work she also had to implement the simulation of hypernuclei in the official Monte-Carlo.

She has presented her work to the collaboration (Physics Analysis group and Physics Working Group) on a regular basis, always showing a prompt understanding of the criticisms and a remarkable capability to quickly react , properly readjusting -whether necessary - her analysis.

The main results of her work can be briefly summarized as follows.

-Evidence of the formation of hypertriton and anti-hypertriton in Pb-Pb collisions in an energy regime never tested before.

-Determination of production yields as a function of the transverse momentum: $^{3}_{\Lambda}H$ and its antiparticle have similar production yields.

-Analisys of (anti-)^{3}He production and comparison with (anti-) $^{3}_{\Lambda}H$: determination of production ratios relevant to discriminate between different model predictions of QGP evolution.

-Determination of the temperature of the system by comparison with the production yield of deuterons.

-Determination of the Strangeness population factor, which is sensitive to the local correlation of strangeness and baryon number (the result calls for further theoretical developments).

-Determination of the hypertriton lifetime.

-The studies performed are also relevant as a feasibility study for the search of more exotic systems such as $\Lambda\Lambda$- or Ξ-hypernuclei which may become available with higher statistics.

Finally, Ramona always showed a prompt understanding of the relevant problems of the analysis and proved very capable in interpreting the obtained results and in finding new solutions. In carrying out this challenging job she showed very good skills and an increasing independence and maturity during the last two years of her activity.

She is aiming at obtaining a post-doc fellowship at the University of Trieste which will allow her to take advantage of an INFN simil-fellow at CERN for the year 2013.

She has signed 25 publications of the ALICE collaboration.

Talks.

Besides several internal presentations in the ALICE collaboration, the results have been reported in three international conferences:

- Strangeness in Quark Matter (SMQ2011) – Cracow, Poland, 18th -24th September 2011;
- 2nd European Nuclear Physics Conference (EunPC) - Bucharest, Romania , 17th -21th September 2012;
- XI International Conference on Hypernuclear Physics - Barcelona, Spain, 1st – 5th October, 2012 ;

and at the

- XCVII Congress of the Italian Society of Physics (SIF) - L'Aquila (26th – 29th September 2011).

Proceedings.

- Hypernuclei Production in Pb–Pb Collisions at $\sqrt{s_{NN}}$=2.76 TeV with ALICE at LHC.
  Ramona Lea for the ALICE Collaboration.
  Proceedings of the conference HYP2012, Barcelona Spain.

- Light Hypernuclei Production in Pb–Pb Collisions at $\sqrt{s_{NN}}$=2.76 TeV with ALICE at LHC.
  Ramona Lea for the ALICE Collaboration.
  Proceedings of the conference SQM2011, Cracow, Poland.
  Acta Physica Polonica B Proceedings Supplement vol. 5 (2012) page 599

Presentation of the candidate Shaji Vattakunnel

Supervisor: prof. Francesca Matteucci

Referees: prof. Marcella Brusa, prof. Massimo Persic

The Candidate has positively accomplished the required educational activities as approved by the Teachers Board, including the Ph.D. courses and lectures and the attendance to schools and conferences. The PhD thesis of Shaji Vattakunnel, "The cosmic star formation rate: Observational measures and modelization", is devoted to the study of the cosmic star formation history and star forming galaxies, both from an observational and from a theoretical point of view. Star formation is one of the key element for understanding galaxy formation and evolution. In general, instantaneous star formation in a given galaxy can be estimated through the measure of tracers related to the emission of young, massive, short-lived stars. However, most of the star formation tracers are affected by strong uncertainties. It must be stressed that it is possible to identify star forming regions only in local galaxies due to the limited angular resolution, whereas for distant galaxies we must rely on the total galaxy emission. The work of Vattakunnel is mainly focused on the study of star formation tracers in the X-ray and radio bands, which are not affected by absorption. The X-ray emission is mostly associated to the high-mass X-ray binaries, while the radio emission is due to the thermal bremsstrahlung emission from HII clouds associated to star forming regions and relativistic electrons in supernova remnants. However, these two observables have their own observational complexities: X-ray emission can be contributed also by low-mass X-ray binaries (whose emission is proportional to the integrated star formation history rather than the instantaneous one) by hot gas and, most importantly, by the presence of a central Active Galactic Nucleus (AGN); radio emission can also be contaminated by the presence of the AGN if relativistic jets are present. Despite these complexities these two signatures are often used also at high redshifts, where the limited angular resolution (which can be at best 1 arcsec) does not allow one to spatially identify the AGN contribution. In order to properly estimate the star formation rate in distant galaxies, a detailed diagnostic based on all the possible information from the X-ray and radio bands must be performed.

the first work of the thesis project of Shaji Vattakunnel, is to develop such a diagnostic and apply it to the deepest X-ray and radio data available to date in the Chandra Deep Field South (CDFS). His goal was to identify sources powered by star formation in the radio and X-ray bands. A full spectral analysis of the identified X-ray counterparts of the VLA sources, supported by optical measure of the redshift for the majority of them, allowed him to characterize in detail their X-ray properties, and to provide a robust classification in terms of AGN and star forming galaxies. He then derived the X-ray and radio correlation for SFR at high redshift, finding agreement with local measurements and no hints of evolution. However, the data also indicates that the complex physics behind the X-ray and radio emission associated to star formation introduces significant scatter between L_X and SFR. This issue is presently explored by Vattakunnel in a companion work which involves also IR data from the Spitzer and the Herschel

satellites. So far, the SF galaxy catalog defined by Vattakunnel represent the cleanest sample of high redshift SF galaxies obtained in the X-ray and radio band, and this work was actually the first published on the 4 Ms Chandra data of the 4 Ms, in the context of a wide and well recognized international collaboration. Vattakunnel also worked actively on several papers of the CDFS collaboration aiming at characterizing the entire population of radio sources identified in the field, thanks to a multiwavelength data set which included also IR and optical data from the ground and from satellites (including the Hubble Space Telescope). One paper is already published (Bonzini, M. et al. 2012, "The Sub-mJy Radio Population of the E-CDFS: Optical and Infrared Counterpart", ApJS, 203, 15), one is submitted (Millet et al. 2012, "The VLA 1.4 GHz Survey of the Extended Chandra Deep Field South: Second Data Release"), one is in preparation (Bonzini, M. et al. 2012, "The sub-μJy radio sky in the E-CDFS: source population", in preparation). Thanks to his work on the CDFS X-ray data, which include not only the X-ray analysis but also a careful and ad-hoc data reduction, he is involved as a second author in a paper on the residual X-ray Background by A. Moretti (2012, Spectrum of the unresolved cosmic X ray background: what is unresolved 50 years after its discovery"), which recently gained a lot of visibility also thanks to a INAF press release (http://www.media.inaf.it/2012/11/28/fondo-x-da-record/). To summarize, his work on the X-ray data of the CDFS is gaining momentum in the extragalactic community, and it is likely to produce several science papers in addition to those already realized during his PhD.

In the second part of the thesis he modelled starburst-like galaxies making use of galactic chemical evolution models. The model consists of a one-zone model where the galaxy is formed by infall of primordial gas (no metals). The gas forms stars, which in turn pollute the interstellar medium (ISM) with newly created elements the interstellar medium. Supernova feedback was taken into account and the development of galactic winds followed. The models were then constrained by observational data relative to chemical abundances. The results suggested that he high z starbursts are only massive galaxies and that low mass starbursts can be observed only in the local universe. Moreover he concluded that only bursting models with strong efficiency of star formation can reach the high star formation values that he derived in high-z galaxies.A paper on this subject is ready to be submitted (Vattakunnel & al. 2013, "Chemical Evolution of Starburst Galaxies ").

To summarize, Shaji Vattakunnel managed to accomplish a very ambitious task: to approach during his PhD a very broad and complex field like the cosmic star formation both with observational and theoretical tool. We remark that this double approach is rarely seen in PhD projects. His PhD lasted four years but the effective working time is much closer to three years, since a fourth year has been asked because of a health condition which severely slowed down his activity. The quality and the number of the scientific results obtained by Shaji Vattakunnel show that he already developed a strongly independent and professional attitude in carrying out his scientific research. He is a very accurate person and he always double-checks his work. He participated to two PhD Schools and to scientific conferences where he presented his work. His English

is very good both written and spoken.

Courses followed during the PhD:

1. Cosmic Structure Formation (16 hours) (passed)
   Prof. Stefano Borgani
2. X-ray Astronomy (8 hours) (passed)
   Prof. Paolo Tozzi
3. Stellar Nucleosynthesis and Chemical Evolution (10 hours) (passed)
   Prof.ssa Maria Francesca Matteucci
4. Stellar feedback and galaxy evolution (10 hours) (passed)
   Dott. Simone Recchi (Universita' Statale di Vienna)
5. Evoluzione chimica e fotometrica delle galassie (40 hours) (passed)
   Prof.ssa Maria Francesca Matteucci

Schools:
First year:

Summer School Novicosmo 2009: Highlights in Astrophysics.

Second year:

National PhD School of Astrophysics Francesco Lucchin 2010: *The Infrared Universe: the Herschel and Alma eras.*

Talks:
First year:

Student talk in the Summer School Novicosmo 2009: *Faint and Extragalactic Sources: Star Formation and Nuclear Activity.*

Report of Summer School Novicosmo 2009.

End of the first year seminar: *Star Formation and Nuclear Activity at high redshift.*

Second year:

Journal Club OATS: *Star Formation and Nuclear Activity of Faint and Extragalactic Sources.*

Talk in the National Congress AGN9 2010: *The VLA Survey of the Chandra Deep Field South: X-ray Properties of Radio Sources.*

Third year:

Journal Club OATS: *Report of PhD School "Francesco Lucchin" 2010: IR Surveys - from the dust to the galaxy populations.*

Fourth year:

Talk in the National Congress AGN10 2012: *Results from the VLA-E–CDFS Survey: X-ray Properties of Radio Sources.*

Publications:

Vattakunnel, S.; Tozzi, P.; Matteucci, F.; Padovani, P.; Miller, N.; Bonzini, M.; Mainieri, V.; Paolillo, M.; Vincoletto, L.; Brandt, W. N.; Luo, B.; Kellermann, K. I.; Xue, Y. Q. 2012: *The Radio - X–ray relation as a star formation indicator: Results from the VLA–E-CDFS Survey.*

Bonzini, M.; Mainieri, V.; Padovani, P.; Kellermann, K. I.; Miller, N.; Rosati, P.; Tozzi, P.; Vattakunnel, S.; Balestra, I.; Brandt, W. N.; Luo, B.; Xue, Y. Q. 2012: *The sub-mJy radio population of the E-CDFS: Optical and IR Counterpart Identification.*

Moretti, A.; Vattakunnel, S.; Tozzi, P.; Salvaterra, R.; Severgnini, P.; Fugazza, D.; Haardt, F.; Gilli, R. 2012: *Spectrum of the unresolved cosmic X ray background: what is unresolved 50 years after its discovery.*

Presentation of the Candidate Mirco Dorigo.

Supervisor: Annamaria Zanetti; Internal supervisor: Lorenzo Vitale

Referees: prof. Franco Simonetto, prof. Pierluigi Campana

The Candidate has fruitfully accomplished the required educational activities as approved by the Teachers Board, including PhD courses, schools and conferences.

Mirco Dorigo has worked for his PHD thesis on the CDF experiment at the Tevatron proton-antiproton Collider with a center of mass energy of 1.96 TeV and located at Fermilab (U.S.A). His activity has been mainly devoted to the study of the Bs -> Phi Phi and Bs -> J/Psi Phi decays.
In his first PHD year he worked on the Bs -> Phi Phi channel focusing on the measurement of the polarization amplitudes and on the search for CP violation, both world first measurements. An important achievement was the development of a novel technique to measure CP-violating asymmetries in the Bs -> Phi Phi decays in a low statistic sample. He was ollaborating and stimulating the discussion with some theoreticians on this issue which was not yet fully understood on the theoretical side. This work led to the publication by CDF of the first search for CP violation in the Bs -> Phi Phi decays.
In the second and third year he worked on the final CDF measurement of the CP-violating phase of the Bs mixing amplitude using the Bs-> J/Psi Phi decays and the full RunII dataset. The analysis has been recently published. This very complex analysis requires the decay time-dependent analysis with the Bs flavor identification at production and the angular analysis of the final decay particles. It has been performed by a small group of people in which Mirco Dorigo had the leading role in all the main areas of the analysis and he was the person in charge when the analysis more difficult issues were involved. Furthermore he demonstrated a great attitude to work within a group and he has been highly effective in the supervision of another PHD student and of a master student.

In conclusion, Mirco Dorigo is a brilliant physicist and the level of his work has always been excellent and scientifically rigorous. He has been able to deeply understand the problems he had to face in all the analysis projects, while maintaining always a realistic and pragmatic approach leading him to be very productive and able to find innovative methods and ideas.

Publications

As a member of the CDF Collaboration's default authors list Mirco Dorigo is co-author of about 90 papers (see http://inspirehep.net/search?p=author%3AM.Dorigo.1 for complete list). In the following, the list of publications for which he has actively participated giving a direct contribution – public papers have been inserted in the U-GOV catalogue.

Journals Paper

[1] T. Aaltonen *et al.* (CDF Collaboration), *Measurement of Polarization and Search for CP Violation in $B_s^0 \to \phi\phi$ Decays*, Phys. Rev. Lett. **107**, 261802 (2011) [arXiv:1107.4999 (hep-ex)].

[2] T. Aaltonen *et al.* (CDF Collaboration), *Measurement of the Bottom-Strange Meson Mixing Phase in the Full CDF Data Set*, Phys. Rev. Lett. **109**, 171802 (2012) [arXiv:1208.2967 (hep-ex)].

Conference Proceedings

[A1] M. Dorigo (for the CDF Collaboration), *CDF results on CP violation in hadronic B decays*, (2012), in preparation, for the 36th International Conference on High Energy Physics.

[A2] M. Dorigo (for the CDF and D0 Collaborations), *Recent heavy flavor results from the Tevatron*, (2012) [arXiv:1205.3899 (hep-ex)], for the 47th Rencontres de Moriond, QCD and High Energy Interactions.

[A3] M. Dorigo (for the CDF Collaboration), *Suppressed B_s^0 Decays at CDF*, (2011) [arXiv:1105.4437 (hep-ex)], for the 13th International Conference on B-Physics at Hadron Machines.

[A4] M. Dorigo (for the CDF Collaboration), *Charmless and Penguin Decays at CDF*, (2010) [arXiv:1012.4738 (hep-ex)], for the 6th International Workshop on the CKM Unitarity Triangle.

[A5] M. Dorigo (for the CDF and D0 Collaborations), *Measurements of the masses, lifetimes and decay modes of hadrons at Tevatron*, (2010) [arXiv:1005.2564 (hep-ex)], for the 45th Rencontres de Moriond, QCD and High Energy Interactions.

CDF Public Note

[B1] M. Dorigo *et al.*, *Measurement of B_s^0 Mixing Phase in $B_s^0 \to J/\psi\phi$ Decays Using the Full Run II Data Sample*, CDF Note 10778 (2012).

[B2] M. Dorigo *et al.*, *Measurement of Triple Products Asymmetries of the $B_s^0 \to \phi\phi$ Decay*, CDF Note 10424 (2011).

[B3] M. Dorigo *et al.*, *Measurement of the Polarization Amplitudes of the $B_s^0 \to \phi\phi$ Decay*, CDF Note 10120 (2010).

CDF Internal Note

[C1] M. Dorigo *et al.*, *An Updated Measurement of the CP-Violating Phase β_s in 9.6 fb^{-1} of Data*, CDF Internal Note 10722 (2012).

[C2] M. Dorigo *et al.*, *Study of Triple Products in the $B_s^0 \to \phi\phi$ Decay*, CDF Internal Note 10416 (2011).

[C3] M. Dorigo *et al.*, *Measurement of the Polarization Amplitudes of the $B_s^0 \to \phi\phi$ Decay*, CDF Internal Note 10073 (2010).

Conference talks

36th International Conference on High Energy Physics talk on *CDF results on CP violation in hadronic B decays*, Jul 4–11, 2012, Melbourne (Australia);

47th Rencontres de Moriond, QCD and High Energy Interactions talk on *Recent heavy flavor results from the Tevatron*, Mar 10–17, 2012, La Thuile (Italy);

13th International Conference on B-Physics at Hadron Machines talk on *Suppressed B_s^0 decays at CDF*, Apr 4–8, 2011, Amsterdam (The Netherlands);

6th International Workshop on the CKM Unitarity Triangle talk on *Charmless and Penguin Decays at CDF*, Sept 6–10, 2010, University of Warwick (United Kingdom);

45th Rencontres de Moriond, QCD and High Energy Interactions talk on *Measurements of the masses, lifetimes and decay modes of hadrons at Tevatron*, Mar 13–20, 2010, La Thuile (Italy).

Presentation of the candidate Damiana Montanino
(supervisor Dr. Fabio Cossutti, internal supervisor Dr. Giuseppe della Ricca)
Referees: prof. Attilio Andreazza, Dr. Maarten Boonekamp

Dr. Damiana Montanino has positively accomplished the required educational activities as approved by the "Collegio", including the Ph.D. courses and lectures and the attendance to schools and conferences.

The scientific activity of Dr. Damiana Montanino has taken place within the CMS Collaboration Trieste group. During her first year, she has continued to study the phenomenon of Multiple Parton Interactions in proton-proton collisions which had been the topic of her degree thesis. In particular she has developed a feasibility investigation of the characterization of this phenomenon through the measurement of very low transverse momentum jets made of charged particles, the so-called mini-jets.

During the remaining two years her activity has moved to the main topic of her Ph.D. thesis, the study of the associated production of Z bosons and hadronic jets in the proton-proton collisions at 7 TeV, collected by the CMS experiment in 2011. This phenomenon is interesting both in itself, as precision test of QCD corrections to the well known Drell-Yan production mechanism of lepton pairs, and as background to a broad variety of new physics scenarios, from Standard Model Higgs search to several others beyond the Standard Model.

Given the involvement of the CMS Trieste group in the ECAL electromagnetic calorimeter since its beginning, Dr. Montanino has naturally concentrated her attention on the Z decay channel into electron-positron pairs, contributing to a number of studies related to the ECAL response optimization and the electron reconstruction. She has taken part into calibration studies using selected samples of π^0 mesons, and she has performed a detailed comparison of electron reconstruction algorithms, with the purpose of assessing the performances of the electron reconstruction in a particle flow approach. This global event description paradigm has become the standard one adopted in the CMS collaboration, and for the specific study of the Z+jets production it has the advantage of allowing a clean treatment of lepton isolation from jets with no overlap or energy double counting. The results of this study have been documented in an internal note and presented in several CMS internal meetings and workshops.

The work of Dr. Montanino on this analysis is an integral part of the publication on the subject that the CMS Trieste group is currently finalizing for the approval by the Collaboration before submission to a journal. The thesis work has been presented by Dr. Montanino to the CMS Standard Model Physics group and it has been formally endorsed.

Dr. Montanino has spent one year at CERN as associate in the context of the program for INFN young researchers (August 2011 – July 2012).

Dr. Montanino has reached the formative and scientific targets established at the beginning of her Ph.D. path.

She has signed 195 publications of the CMS Collaboration; she is co-author of 3 internal notes:

- V. Candelise, M. Casarsa, F. Cossutti, G. Della Ricca, B. Gobbo, M. Marone, D. Montanino, D. Scaini, A. Schizzi, "*Comparison of GSF and Particle Flow electron reconstruction performance*", CMS Analysis Note AN-11-474
- V. Candelise, M. Casarsa, F. Cossutti, G. Della Ricca, C. La Licata, M. Marone, D. Montanino, A. Schizzi, "*Characterization of the final state radiation in Z boson decay to electrons*", CMS Analysis Note AN-12-204
- V. Candelise, M. Casarsa, F. Cossutti, G. Della Ricca, B. Gobbo, C. La Licata, M. Marone, D. Montanino, D. Scaini, A. Schizzi, T. Umer, "*Study of the associated production of a Z boson and jets in pp collisions at* $\sqrt{s} = 7$ *TeV*", CMS Analysis Note AN-12-376

and she has given the following presentations to conferences:

- "*Mini-jet carichi e coppie di mini-jet carichi per lo studio di Multiple Parton Interactions a LHC con il rivelatore CMS*" contribution to XCVI Congresso Nazionale SIF - Bologna, 20 - 24 September 2010
- "*CMS Electromagnetic Calorimeter performance during the 2011 LHC run*" contribution to IFAE 2012 - Ferrara, 11 - 13 April 2012 to appear in Nuovo Cimento C, Vol.36 N.1 (2013)

Fabio Novelli
PhD candidate
School of Doctorate in Physics – University of Trieste
(supervisor: Prof. Fulvio Parmigiani, CoSupervisor: Dr. Daniele Fausti)

Referees:
Dr. Ranan Tobey, University of Groningen
Dr. Adolfo Avella, University of Salerno

The candidate has positively accomplished the educational activity as approved by the "Collegio Docenti" comprehensive of lectures, schools and conferences.

The scope of Fabio Novelli's thesis is to study complex systems (transition metal oxides) showing strong electronic correlation effects by time resolved optical spectroscopies in the femtosecond time domain.

In particular, the studies reported by Novelli consist in novel experimental approaches and models suitable for measuring the time evolution of the dielectric function as a function wavelength in pump and probe configurations. By means of a new optical setup capable of providing spectroscopic information in the time and frequency domains Fabio Novelli studied photo-induced phenomena in YVO3, LaCuO4 and superconducting YBCO.

The very important results of his original work obtained with this approach can be summarized as follow:

-He revealed the existence of an excitonic resonance on the Hubbard transition in YVO3 (Phys. Rev. B, 86, 165135, 2012)

-He showed the possibility of selectively drive negative "pressure-like" effects on the charge transfer excitation on LaCuO4 (in prep.)

-He revealed a shift of the coherent vibrational response in photo-excited superconductors (in prep.).

In addition to this Novelli setup a novel spectroscopy capable of measuring the ultrafast changes in high energy optical properties driven by single cycle far infrared excitation with field amplitude as high as 100kV/cm. The measurements of the high energy effects as a function of phase an amplitude of the perturbing field allowed for:

- The identification of a novel regime of light matter interaction (the Franz Keldysh effect) where memory effects are of relevance at ambient temperature for negligible quantum confinement (Submitted).

The scientific achievements obtained by Fabio Novelli are quite important and they represent the outcome of a research activity of very high quality and to some extent exemplar.

The significant number of high quality publications and manuscripts presented by the candidate support this appraisal.

The judgment about the PhD research and education of Fabio Novelli is excellent, while in the meantime the target of forming a new and brilliant young experimental physicist has been completed.

Presentation of Sara Mohammadi

Supervisor: Giuliana Tromba, Internal supervisor: Fulvio Parmigiani,
Referees: Prof. Josef Kaiser, prof. Alessia Cedola

Previous Education:

- B. Sc. in Physics, Alzahra University, Tehran, IRAN.
- M. Sc. in Condense Matter Physics, Damghan University of Basic Sciences, Damghan, IRAN.

Doctoral Thesis on:
Bio-medical X-Ray Imaging with Synchrotron Radiation - Study and implementation of algorithms related to Phase Sensitive techniques.

Sara's thesis was dedicated to phase contrast imaging with Synchrotron Radiation and to the evaluation of algorithms for phase retrieval with their application to selected case studies in biomedical research. For her activity she worked at the Elettra SYRMEP beamline, where she participated to several experiments in collaboration with external users.
Sara developed a good knowledge in radiation transport in matter and in imaging techniques. She studied and compared different methods for phase retrieval, understanding their approximations and their applicability limits.
She gave an important contribution in the development of methods for quantifying the effectiveness of these algorithms. For this purpose she designed and realized adequate tests objects, containing low and high absorption details. She acquired microtomography scans and compared the results obtained with the two most commonly used phase retrieval methods with the standard reconstruction algorithm. This work enabled all of us to deeply understand the potential of these methods for improving the image quality, allowing for a better differentiation of details in the sample under study.
Sara showed that these methods can be used also as a pre-processing procedure, prior to quantitative analysis. If conditions for their application are satisfied, they contribute to increase the signal to noise ratio and facilitate the image segmentation, enhancing at the same time the edges visibility. As a result, the quantitative analysis aiming to extract morphological and textural information on the samples is considerably improved.

She successfully applied this technique to a variety of “real samples” in research projects carried out in collaboration with the beamline users.
The project carried out was completely new for her, particularly for the theoretical part, concerning the interaction radiation-matter and the related mathematical formalism.
During the thesis she gained experimental skills essential for a beamline scientist: she learned basics about the beamline optics and got trained in operating the micro-CT set-up at the SYRMEP beamline. She was also involved for planning and organizing the experiments, starting from the sample preparation, the choice of the imaging parameters, up to the images reconstructions and quantitative analysis. Particularly in the last year she reached a good maturity with a complete independence in managing an experiment.

Sara has a very good approach to experimental work and has always shown great interest of high level applications of her work. Good tempered, she is a loyal person with good communication skills. She also had good interaction with colleagues and beamline users. These qualities have been essential for her in the initial and more difficult phase of her PHD course. She successfully managed to cover her initial knowledge gap with respect to italian students and, with a strong determination, was able to integrate into an environment completely new for her, overcoming the brakes and the obstacles raised by her family and friends.

During her Ph.D. thesis Sara attended two courses on Synchrotron Radiation Sources and Applications, one School on Mathematical Models in Image Processing and one Workshop on Imaging techniques with Synchrotron Radiation.
As reported below, she presented a talk on “Application of phase-sensitive techniques to biological samples with different absorption levels”, at 4th Workshop on Imaging Techniques with Synchrotron Radiation, Bordeaux and contributed to six posters at International Conferences.
She has one paper submitted for publication on J. Radiation Physics and Chemistry and other four papers on int. Journals in preparation.

As a post-doc position she is aiming to get a TRIL fellowship by ICTP.

Talks/Posters/Papers.

S. Mohammadi, R. Chen, C. Dullin, M. Regvar, G. Tromba, "*Application of phase-sensitive techniques to Biological samples with different absorption levels*", 4th ITSR Workshop on Imaging Techniques with Synchrotron Radiation, Bordeaux, France, September 2011 (Oral Presentation).

S. Dal Monego, C. Garrovo, S. Biffi, E. Larsson, S. Mohammadi, G. Tromba, C. Dullin, "Functional phase contrast X-ray lung imaging in a preclinical asthma model: first feasibility study at Elettra", Secondo convegno congiunto SILS-SISN, Trieste 1-3 Settembre 2011. (Poster)

S. Dal Monego, S. Mohammadi, E. Larsson, C. Dullin, C. Garrovo, S. Biffi, G. Tromba, "Functional phase contrast X-ray lung imaging in a preclinical asthma model", Personalised Medicine: Better Healthcare for the Future - A Rational Approach Focusing on Bioinformatics, Medicinal Chemistry and Medicine, COST - European Cooperation inScience and Technology, Larnaca, Cyprus, 17-22nd of June, 2012 (Poster).

C. Dullin, S. dal Monego, E. Larsson, S. Mohammadi, C. Garrovo, S. Biffi, A. Lorenzon,, G. Tromba, "Combined high resolution and functional CT imaging in a preclinical asthma mouse model: first feasibility study at Elettra", Conference on Medical Applications of Synchrotron Radiation (MASR), Oct. 17-19 2012, Shangai. (Poster).

E. Larsson, C. Dullin, S. Mohammadi, F. Brun, S. Dal Monego, S. Biffi, C. Garrovo, A. Lorenzon, G. Tromba, Quantitative Analysis of Asthmatic Mice Model by means of Synchrotron X-ray Computed Microtomography, Molecular Imaging Conference 2012, Cluster in Biomedicine, Trieste, Italy, 10-11:th of December, 2012. (poster accepted, still to be presented).

S. Pesaro, K. Prince, G. Tromba, S. Mohammadi, R. Ceccherelli, G. Rossi, "*Study of dystrophic versus physiological wing feathers of the common swift using phase contrast imaging and histological evaluation*", 1st International Conference on Avian, Herpetological, Herpetological and Exotic Mammal Medicine, Wiesbaden, Germany, April 2013 (Abstract accepted).

C. Dullin, S. dal Monego, E. Larsson, S. Mohammadi, A. Lorenzon, C. Garrovo, S. Biffi, G. Tromba, "*Functional phase contrast CT imaging in an asthma mouse model, utilizing barium labeled alveolar macrophages*", Second International Symposium on Bio-Medical Applications of X-Ray Phase Contrast Imaging, Garmisch-Partenkirchen, Germany, Jan 2013 (poster accepted, still to be presented).

A. P. Almeida, L. P. Nogueira; R. C. Barroso; M. Colaço; A. Mantuano; D. Braz; S. Mohammadi; G. Tromba; S. C. Cardoso; E. S. Garcia; M. S. Gonzalez; P. Azambuja, *"Phase contrast Micro-computed tomography for comparison of reconstructed slices of Rhodnius prolixus with and without phase retrieval technique"*, J. Radiation Physics and Chemistry, September 2012 (Submitted).

"SR μ-tomography reconstructions of wheat (Triticum aestivum) seeds reveal X-ray translucent vacuoles within aleurone cells and specific reticulate networks of seed coats", M. Regvar et al. (in preparation)

"Evaluation of phase retrieval techniques to improve x-ray phase contrast imaging in pre-clinical lung disease models", J. Synchrotron Rad, S. Mohammadi et al. (in preparation).

"Three dimensional detection and staging of morphological alterations in different pre-clinical asthma mouse models utilizing phase contrast x-ray lung imaging", C. Dullin et al. (in preparation).

"A comparison of 3D poly (ε -caprolactone) tissue engineering scaffolds produced with conventional and addictive manufacturing techniques by means of quantitative analysis os synchrotron radiation μ–CT images", Journal of Instrumentation, Proceeding of Conference on Medical Applications of Synchrotron Radiation (MASR), Oct. 17- 19 2012, Shangai. F.Brun et al. (in preparation).

ALLEGATO 4

End of year report

Giuseppe Argentieri

RESEARCH ACTIVITY

The main object of my research has been the study of a particular type of open quantum system, taken from a recent PRL article: a minimal three-site circuit, inside of which three electrons can freely move producing a current as an external pumping is applied.

The specific setup of the system allows one degenerate doubly occupied ground state while its dynamics reduces to the evolution of a pseudospin (qubit) under the action of the periodic potential. Furthermore, the influence of a noisy environment has a dissipative effect which eventually produces the establishing of a steady DC current in a regime condition. The dependence of the steady current on the driving frequency is the key point of the original paper. Since this observable is proportional to the pseudospin polarization at large times, its final value is directly related to the asymptotic state of the system.

The determination of this stationary state must be carried through a careful derivation of the Master Equation: different kinds of Markovian approximations lead to different Master Equations and hence to different results. But this is not the only consequence. Any given Master Equation must ensure a positive dynamics in order to be physically consistent and the further requirement of the complete positivity is needed to keep the physical consistency also in couplings with generic ancillas.

An even more serious issue is whether a non-completely positive dynamics could give rise to possible violations of the Laws of Thermodynamics. In order to answer this question a slightly different approach to the problem has been taken, which eventually should allow to compute and study the evolution of some thermodynamic quantities and to check if their behaviour in regime conditions is in contrast or in agreement with Thermodynamics prescriptions.

PLAN OF STUDIES

- *Quantum Information with continuous variable systems* [S. Olivares] 21h
- *Introduction to Quantum Information* [F. Benatti] 30h
- *Topological Quantum Field Theories* [A. Tanzini] 20h
- *Formation of Cosmic Structures* [S. Borgani] 16h

ATTENDED SCHOOLS

- *Testing Quantum Foundations in Particle Physics*, December 17-19 2010
- *School on New Trends in Quantum Dynamics and Quantum Entanglement*, February 14-18 2011

Emanuele Contini

Report

November 26, 2012

1 Attività di Ricerca

Il mio progetto di ricerca, iniziato ad aprile 2010, è incentrato sullo studio della formazione ed evoluzione delle galassie di ammasso ed, in particolare, di regioni di *proto-ammassi* ad alto redshift ($z > 1.5 - 2$). Lo studio prevede in particolare:

1. L'analisi di simulazioni N-body ad alta risoluzione di ammassi, e lo studio delle proprietà e dell'evoluzione di sottostrutture di materia oscura;

2. Utilizzo di modelli *semi-analitici* per generare predizioni specifiche per galassie in ammassi e proto-ammassi.

Gli obiettivi da raggiungere nel breve periodo durante il primo anno del corso di dottorato, erano:

1. Acquisire familiarità con simulazioni N-body e algoritmi per l'identificazione di strutture e sottostrutture di materia oscura;

2. Analisi di un set di simulazioni ad alta risoluzione di ammassi e studio della distribuzione spaziale, distribuzione in massa, ed evoluzione delle sottostrutture di materia oscura;

Entrambi gli obiettivi sono stati portati a termine nell'arco del primo anno. I risultati raggiunti sono stati pubblicati in un articolo pubblicato sulla rivista scientifica MNRAS.

Gli obiettivi da raggiungere nell'arco del secondo anno erano:

1. Acquisire familiarità con un modello semi-analitico già sviluppato, da utilizzare nel medio-lungo termine per generare predizioni specifiche da confrontarsi con dati osservativi (es. luminosità in varie bande, sia ottiche che infrarosse ed altre proprietà osservabili delle galassie di ammassi e proto-ammassi);

2. Ampliamento del modello semi- analitico a disposizione con l'inclusione di processi fisici che attualmente non sono modellati (per es. spoliazione mareale di stelle da galassie satelliti e formazione della luce diffusa in gruppi ed ammassi di galassie). Tali estensioni del modello permetteranno di formulare previsioni specifiche che potranno essere poi verificate attraverso future campagne osservative.

Il primo obiettivo è stato raggiunto con successo nel corso del secondo anno, mentre il secondo ha impiegato anche buona parte del terzo. Negli ultimi mesi, sono riuscito ad includere diversi modelli per la formazione della componente diffusa e sto analizzandone i risultati, i quali saranno oggetto di un secondo articolo che è in preparazione.

Gli obiettivi da raggiungere nell'arco del terzo anno erano:

1. Accoppiamento del modello semi-analitico con un codice *Radiative Transfer Solver*. Questo permetterà di predire l'emissione nel lontano infrarosso che è dominata dalla polvere, di notevole importanza nello studio di proprietà fisiche della popolazione di galassie ad alto redshift.

2. Studio delle proprietà della popolazione di galassie in proto-clusters da confrontare con quelle osservate.

Il lavoro necessario per accoppiare il modello a disposizione con un codice di trasporto radiativo è iniziato ed a buon punto. Questi obiettivi però non sono ancora stati raggiunti e verranno portati a termine nel tempo a disposizione da qui alla fine del dottorato.

2 Piano di Studi

Il mio piano di studi è riassumibile nei cinque corsi che seguono:

- Chemical evolution of Galaxies (18h)
- Formation of Cosmic Structures (16h)
- Gamma-Ray-Bursts (6h)
- Galaxy Formation (10h)
- Astronomia Osservativa (48h)

per un totale di 98 ore di lezione. Per ciascun corso ho sostenuto un esame (discussione di un argomento di particolare interesse presentato durante il corso con estensione dello stesso a casi pratici, e.g. confronti con dati osservativi o applicazioni reali) con esito positivo.

3 Scuole di Astrofisica

Ad oggi ho seguito le seguenti due scuole di astrofisica,

- **School of Astrophysics Francesco Lucchin**, tenutasi a Madonna di Campiglio, 27 Giugno-2 Luglio 2010. La scuola era focalizzata su due argomenti: *Gravitational lenses and dark matter*, e *Black holes in astrophysics*.

- **Summer school on Cosmology**, tenutasi a Trieste (ICTP), 16-27 Luglio 2012. I principali argomenti erano: *Dark Matter and Large Scale Structure*, e *Galaxy Clusters and Galaxy Formation*.

4 Articoli

1. " Statistics of Substructures in Dark Matter Haloes"; Contini E., De Lucia G., Borgani S., 2011, MNRAS, in press (arXiv/1111.1911v1)

2. " Modeling the Intra-Cluster Light in a semi-analytic model of galaxy formation"; Contini E., De Lucia G., Borgani S., Villalobos A., in prep.

Photometric transit search for planets around cool stars from the Western Italian Alps: the APACHE survey

End of the year report (2012)

PhD student: Paolo Giacobbe
Supervisors: Professor Francesca Matteucci, Professor Mario G. Lattanzi (Osservatorio Astronomico di Torino – OATo)
P.I. of the project: Doctor Alessandro Sozzetti (Osservatorio Astronomico di Torino – OATo)

Note
This report summarizes the natural development of my PhD project during the first and second PhD years.
Furthermore, it shows the developments concerning my collaborations, firstly, into the GAPS project consortium; secondly, about astrometric planet detection around nearby M dwarfs in the GAIA mission contest.
The publications, conferences, PhD schools and workshops lists at the end of this report completes the overview of my three PhD years.

APACHE PROJECT

Abstract
Small-size ground-based telescopes can effectively be used to look for transiting rocky planets around nearby low-mass M stars using the photometric transit method, as recently demonstrated for example by the MEarth project. Since 2008 at the Astronomical Observatory of the Autonomous Region of Aosta Valley (OAVdA), we have been preparing for the long-term photometric survey APACHE, aimed at finding transiting small-size planets around thousands of nearby early and mid-M dwarfs. APACHE (A PAthway toward the Characterization of Habitable Earths) is designed to use an array of five dedicated and identical 40-cm Ritchey-Chrtien telescopes and its observations started at the beginning of summer 2012.

The preliminary step towards the APACHE survey: the pilot study
The 2012 was a transition year between the pilot study of the APACHE project and the whole survey.
It is useful to summarize here the results of the pilot study in order to better understand why it was a necessary preparatory step towards a long-term search for transiting, small-radius planets around thousands of dM stars.
The pilot study was a 1.5 year-long photometric monitoring campaign of a sample of 23 nearby (d < 60 pc), bright (J < 12) dM stars. This survey has been carried out with the pre-existing instrumentation at OAVdA (a 25-, 40- and 81-cm telescope).
In this study, we aimed at:
a) demonstrating the sensitivity to < 4 R_{Earth} transiting planets with periods up to 5 days;

b) improving our knowledge of some astrophysical properties of our targets (e.g., activity, rotation) by combining spectroscopic information and our differential photometric measurements.
The results showed are presented in detail in the paper Giacobbe et al. 2012 (MNRAS, 424, 3101)

Results summary and conclusions of the pilot study:

-Photometric precision
We achieve a typical nightly RMS photometric precision of ~5 mmag, with little or no dependence on the instrumentation adopted or on the details of the methodology utilized to perform differential photometry on the targets.
We also carried out an analysis of the impact of correlated (red) noise on time-scales of 30 min, which showed that it is typically ≈ 1.35 greater than pure white noise, with a weak dependence on the method used to perform differential photometry. This result reveals that our data are only mildly affected by short-term correlated systematics.
The estimated photometric precision degrades to ~9 mmag when the ensemble light curves are determined over the typical ~2 months duration of the observations for each target.
Such degradation is understood in terms of a combination of unmodeled medium-term systematics in our data and intrinsic variability of our target stars.

-Stellar variability analysis
We searched for periodic transit-like events in the photometric dataset for each target using the BLS algorithm.
No such signal was recovered for any target (an expected result given the sample size).
The light curves of our program stars were inspected for evidence of periodic signals of approximately sinusoidal shape, which could be interpreted as due to the presence of rotating spots on the stellar photosphere.
For two stars in our sample, LHS 3445 and GJ 1167A, we found clear evidence of a periodicity in the light curve ascribable to such effect.
Finally, we detected short-term, low-amplitude flaring events in the differential photometric measurements of LHS 3445 and LHS 2686 (the latter not known to be a flare star).

-Sensitivity to small-radius transiting planets
We carried out detailed, large-scale simulations of transit signals (of periods in the range 0.5-5 days and depths in the range 0.5%-2% in flux units) injected in the actual (nightly reduced) photometric data for our sample. A total of 400,000 light curves were analyzed for each target using a real-life transit events search algorithm (BLS). The study of the BLS transit recovery rates and overall performance for a sub-sample of stars with good, fair, and poor phase coverage highlighted the capability of BLS to identify the correct period (when multiple transits were observed) even for signals

with depth close to the typical photometric precision of the data (~5 mmag), albeit with low statistical confidence, as well as some of its performance limitations which are driven by the specific choice of its most relevant setup parameters.
We expressed our main findings in terms of two easy-to-use comparison metrics, i.e. transit detection probabilities and phase coverage. We found a quasi-linear relationship between the two quantities. Based on the BLS algorithm, there appears to be a limit of ~90% in the probability of detecting a transit even when the phase coverage approaches 100%. Around stars in our sample with good phase coverage (> 50%), we would have had > 80% chances of detecting companions with P < 1 day and transit depths ≈ 0.5% in flux units, or larger. Correspondingly, around these stars we would have been sensitive to companions with radii as small as ~1.0-2.2 R_{Earth}.

From the pilot study to the survey: defining the observing strategy and the input catalogue of red dwarfs

The results from the pilot study helped us to define an observing strategy for the targeted survey APACHE.
Taking into account the use of synthetic transits, as discussed in the previous section, by assuming different numbers of consecutive exposures (from 1 to 5) and different temporal samplings (from 20 to 50 minutes), we evaluated the transit detection probabilities for stars with different average phase coverages.
The temporal sampling is here defined as the time interval between two consecutive pointings of the telescope at the same target.
At the moment, we decided to adopt the "3 exposures every ~20 minutes" strategy, which will be eventually revisited after the first season of the survey.

We defined the APACHE Input Catalogue (AIC) of red dwarfs starting from the list of 8889 stars in Lepine & Gaidos 2011, AJ, 142, article id. 138.
The AIC is composed of ~3000 targets selected on the base of their visibility from our site and a suitable number of potentially good comparison stars in the f.o.v. Moreover, several catalogs have been cross-checked to get information about the targets, as a precise determination of spectral class, their projected rotational velocity v*sin*i, their level of chromospheric activity, and excluding known spectroscopic binary systems.
The number of the Gaia transits scheduled for each target has also been determined, and stars with >100 Gaia observations will be prioritized.
On the base of all the information collected, a final ranking has been determined to define the priority for observations.

The present status of the APACHE survey

The APACHE observations started in June 2012 using four identical 40-cm RC telescopes located on the renewed scientific platform of OAVdA. The movements of the telescopes and the data acquisition operations are fully autonomous and controlled by the open source software RTS2 (http://rts2.org), which we have been

adapted to the needs of the APACHE survey: the system, accessing to a customized database, takes images, ensures a good pointing (i.e. the target star is always placed at the centre of the CCD sensor), keeps track of what was done. Each telescope observes stars selected from one of the four sub-lists of the AIC, with no overlapping with the others.
The data reduction and analysis are performed by the upgraded pipeline TEEPEE developed by the authors and described in Damasso, Giacobbe et al. 2010 (PASP, 122, 895, 1077) and Giacobbe et al. 2012.
TEEPEE performs differential aperture photometry testing several apertures and choosing the best one together with the best set of comparison stars.
The last TEEPEE release has implemented new features in order to manage the whole data reduction according to the big amount of raw data and the observations strategy.
The main feature of this new stable release is the systematic databasization of the whole kind of result of the pipeline. Each result of every process (from raw to photometrized data) during the data reduction is stored in a customized database. Moreover we are developing a fully automatized analysis pipeline based on the DB system in order to automatize even the noise-analysis and the periodic signal search.

First results from the APACHE observations
After ~4 months of observations at regime, 93 red dwarfs and 10 known transiting exoplanets have been monitored for several nights. The results obtained, in terms of photometric precision and transits detection, reveals the good stability of the hardware systems and the encouraging quality of the data, accordingly with the results of the pilot study.
Moreover we have the first detection, by our standard photometric method and detection analysis, of a target with a transiting companion. Unfortunately this eclipsing binary was already known since early 2012!!!

Characterizing the Global Architectures of Planetary Systems (GAPS)

The GAPS project propose to use the surgical precision of HARPS-N@TNG in order to perform a long-term observational program that will allow us to characterize the global architectural properties of exoplanetary systems.
The main goals of the program are:

1) the determination of the frequency of potentially habitable low-mass companions to northern low-mass stars;
2) the test of planet formation and migration theories by searching for additional (low-mass) companions in known single- and multiple-planet systems;
3) the derivation of the first quantitative estimate of the frequency of Neptune-mass planets around northern low-metallicity stars;
4) the undertaking of a novel study to measure the occurrence rates of giant planets in dense stellar environments;
5) the investigation of the outcome of planet-disk and planet-planet interaction scenarios in exoplanet systems through innovative measurements of the Rossiter-McLaughlin effect.

6) the providing of novel measurements for the characterization of tidal dissipation effects due to the interaction between the planets and their host stars, for the understanding of the impact of star-planet interactions on stellar activity, and for the improvement of relevant physical parameters (masses, radii) of selected planet hosts.

My work is strictly correlated with point 1). In particular, the GAPS program has the potential of revealing a few transiting planets the average density of which will be estimated. Atmospheric characterization will be possible with instruments, such as EchO, presently in a study phase. For this reason the subsample of point 1) will be monitored photometrically by the APACHE transiting planet search survey.

Furthermore, the whole subsample has been built starting from the PMSU catalog (that contains the nearest low-mass stars) and the Lépine & Gaidos (2011) catalog. Thereafter, we have selected stars with spectral types from M0 to M2.5, with V <12 and > 0 deg, and with high resolution spectroscopy available in order to select slow rotators without measurable activity (Reiners et al. 2012). At the end we selected stars that will be observed with APACHE. The final list contains 120 stars evenly distributed in the sky.

About 30% of the subsample is also in the region frequently observed by Gaia (> 100 field transits). For these stars we will get detailed information on astrometric wobbling introduced by massive planets and therefore on the planetary systems. Our simulations show that we need 40 observations for each star in order to reach the required sensitivity in the HZ.

During the first step of the GAPS project, still ongoing at the moment ,(144.75 hrs of observing time have been executed, with 23 hrs lost due to bad weather conditions, and 15.5 hrs lost due to technical problems) I was involved in the data collection and reduction.

Astrometric Planet Detection Around Nearby M Dwarfs: The Gaia Potential

Context

Cool, nearby M dwarfs within a few tens of parsecs from the Sun are becoming the focus of dedicated experiments in the realm of exoplanets astrophysics. Gaia, in its all-sky survey, will deliver precision astrometry for a magnitude-limited (V = 20) sample of M dwarfs.

We want to investigate some aspects of the synergy between the Gaia astrometric data on nearby M dwarfs and other ground-based and space-borne programs for planet detection and characterization.

We carry out numerical simulations to gauge the Gaia potential for precision astrometry of exoplanets orbiting a sample of known dM stars within ∼ 30 pc from the Sun. We express Gaia sensitivity thresholds as a function of system parameters and in view of the latest mission profile, including the most up-to-date astrometric error model.

The first results show:

1) it will be possible to accurately determine orbits and masses for Jupiter-mass planets with orbital periods in the range $0.2<P<5.0$ yr (the nominal mission duration). Given that present-day planet fraction estimates around M dwarfs, ≈ 102 giant planets could be found by Gaia around the sample;
2) in the same period range, inclination angles will be determined with enough precision (a few percent) so that it will be possible to identify planets which are likely to transit in a regime of orbital separations which is inaccessible from the ground and only marginally probed from space by dedicated transit discovery missions such as CoRoT and Kepler;
3) 3) for well-sampled orbits, the uncertainties on planetary ephemerides, separation ϱ and position angle ϑ, will degrade at typical rates of $\Delta\varrho < 0.01$ AU/yr and $\Delta\vartheta < 2$ deg/yr, respectively. These are over an order of magnitude smaller than the degradation levels attained by present-day ephemerides predictions based on mas-level precision HST/FGS astrometry;
4) Planetary phases will be measured with typical uncertainties $\Delta\beta$ of several degrees, resulting (assuming a simple purely scattering atmosphere) in average errors on the phase function $\Delta\Phi(\beta) \approx 0.1$, and expected uncertainties in the determination of the emergent flux of wide-separation ($0.3 < a < 03.0$ AU) giant planets of ∼ 25%.

This results helps to quantify the actual relevance of the Gaia observations of the large sample of nearby M dwarfs for a synergetic effort to optimize the planning and interpretation of follow-up/characterization measurements of the discovered systems by means of transit survey programs, and upcoming and planned ground-based as well as space-borne observatories for direct imaging (e.g., SPHERE, EPICS, JWST) and simultaneous multi-wavelength spectroscopy (e.g., EchO).

In this context, the statistical and numerical analysis tools (e.g. orbital fitting) of the simulated data play a key role.

My contribution, now in the early phase, is focused on extending the orbital fits algorithm of the resulting Gaia observable (the one-dimensional coordinate ψ in the along-scan direction) that can be modeled as ψ (α, δ, $\mu\alpha$, $\mu\delta$, π, A, B, F,G, P, e, τ), where the five standard astrometric parameters correspond to the actual positions (α, δ), proper motion components ($\mu\alpha$, $\mu\delta$), and parallax (π) of each target M dwarf, while A, B, F, and G are the four Thiele-Innes elements (Green 1985).

The algorithm use a Markov Chain Monte Carlo (MCMC)-driven global search approach to the identification of good starting guesses for the orbit fitting procedure that combines a period search with a local minimization algorithm (Levenberg-Marquardt).

PhD school:

National PhD School of Astrophysics "F. Lucchin"
XI Cycle 4th Course -- E. Majorana Centre, Erice (Italy)
The transition from low-mass stars to planets Galaxy bulges
September 4-9, 2011

National PhD School of Astrophysics "Francesco Lucchin"
Second cycle 2010 Asiago (Italy)
GAIA: science with one billion stars
The Infrared Universe: the Herschel and Alma eras
October 24-30, 2010

Workshop:

GREAT-ESF Workshop
G*aia and Exoplanets:*
GREAT Synergies on the Horizon
TORINO, Nov 5-7, 2012

2010 Sagan Exoplanet Summer Workshop
Stars as Homes for Habitable Planetary Systems
NASA Exoplanet Science Institute, California Institute of Technology, Pasadena, CA
July 26-30, 2010

P. Giacobbe "**A PAthway towards the Characterization of Habitable Earths: the APACHE project**", poster and popup presentation at "***Stars as Homes for Habitable Planetary Systems***" Pasadena (CA), 26-30 July 2010.

3rd ***Workshop Italian Astrobiology Society***
26-28 May 2010
Trieste-Italy

P. Giacobbe, M. Damasso, P. Calcidese, A. Bernagozzi, E. Bertolini, M. G. Lattanzi, R. Smart, A. Sozzetti "**A pilot study for a transiting planet search around M dwarfs: Progress Report**", poster presented at "When Darwin meets Copernicus. 3rd Workshop of the Italian Astrobiology Society" Duino-Aurisina (TS), 26-28 Maggio 2010.

Conferences:

European Planetary Science Congress 2012
IFEMA-Feria de Madrid
23 – 28 September 2012, Madrid, Spain

P. Giacobbe "**Photometric transit search for planets around cool stars from the Western Italian Alps: the APACHE survey**", poster presentation.

IAU Symposium 276
The Astrophysics of Planetary Systems: Formation, Structure, and Dynamical

Evolution
Torino - Italy, 11-15 October 2010

M. Damasso, A. Bernagozzi, E. Bertolini, P. Calcidese, P. Giacobbe M.G. Lattanzi, M. Perdoncin, A. Sozzetti, L.R. Smart, G. Toso "**A microvariability study of nearby M dwarfs from the Western Italian Alps: status update**", poster presented at International Astronomical Union Symposium 276, Torino, 11-15 Ottobre 2010.

Publications:

Sozzetti, A., Giacobbe, P., Lattanzi, M. G., Micela, G., Morbidelli, R. ans Tinetti, G., **"Astrometric Planet Detection Around Nearby M Dwarfs: The Gaia Potential",** *A&A, (in prep)*

Giacobbe, P., Damasso, M., Sozzetti, A., Toso, G., Perdoncin, M., Calcidese, P., Bernagozzi, A., Bertolini, E., Lattanzi, M.G. and Smart, R.L., "**Photometric transit search for planets around cool stars from the western Italian Alps: A pilot study**", *Monthly Notices of the Royal Astronomical Society, Volume 424, Issue 4, pp. 3101-3122*

Damasso M., Giacobbe P., Toso G., Calcidese P., Bernagozzi A., Bertolini E., Sozzetti A., Lattanzi M.G., Perdoncin M., Smart R.L., "**New variable stars discovered from the Western Italian Alps I. Observations from fields 12hr < RA < 24hr**", *Open European Journal on Variable Stars, paper #0138, 45 pages (2011).*

http://var.astro.cz/oejv/issues/oejv0138.pdf

M. Damasso, A. Carbognani, P. Calcidese, P. Giacobbe, A. Bernagozzi, E. Bertolini , M.G. Lattanzi, R. Smart, A. Sozzetti, "**Two new variable stars observed in the field of the extrasolar planet host star WASP-3"**, *Open European Journal on Variable Stars paper #0122, (2010).*

http://astro.sci.muni.cz/variables/oejv/issues/oejv0122.pdf

M. Damasso, P. Giacobbe, P. Calcidese , A. Sozzetti, M.G. Lattanzi, A. Bernagozzi, E. Bertolini , R. Smart, *"***Photometric transit search for planets around cool stars from the Western Italian Alps: a site characterization study"***, Publications of the Astronomical Society of the Pacific, Volume 122, issue 895, pp.1077-1091, (2010)*

http://arxiv.org/abs/1007.0252

Contributions to scientific conference:

Smart R., Bernagozzi A., Bertolini E., Calcidese P., Carbognani A., Cenadelli D., Christille J.M., Damasso M., Giacobbe P., Lanteri L., Lattanzi M.G., Sozzetti A. "**Photometric transit search for planets around cool stars from the Western**

Italian Alps: the APACHE project", scientific poster accepted for the International Astronomical Union Symposium 293 (IAUS293) – Formation, detection, and characterization of extrasolar habitable planets as part of the *International Astronomical Union XXVIII General Assembly*, Bejing, China (August 20-31, 2012).

Sozzetti, A., Giacobbe, P., Lattanzi, M. G., Micela, G., Morbidelli, R. ans Tinetti, G., **"The Gaia Astrometric Survey of Nearby M Dwarfs",** *in GREAT Workshop 'Orbital Couples: "Pas de Deux" in the Solar System and the Milky Way', Proc. IMCCE, Observatoire de Paris, (in press)*

Damasso, M., Bernagozzi, A., Bertolini, E., Calcidese, P., Giacobbe, P., Lattanzi, Mario G.; Perdoncin, M., Sozzetti, A., Smart, R., Toso, G., **"A microvariability study of nearby M dwarfs from the Western Italian Alps: Status update**", *The Astrophysics of Planetary Systems: Formation, Structure, and Dynamical Evolution, Proceedings of the International Astronomical Union, IAU Symposium, Volume 276, p. 525-526 (2011)*

Bernagozzi A., Bertolini E., Calcidese P., Damasso M., Giacobbe P., Lattanzi M.G., Smart L.R., Sozzetti A., "**A photometric transit search for planets around cool stars from the italian alps: results from a feasibility study"**, *in Coudé du Foresto V., Gelino D.M., Ribas I. Eds. Pathways Towards Habitable Planets, Astronomical Society of the Pacific Conference Series, vol. 430, pp. 420-421 (2010).*