

Theoretical Astroparticle Physics

PRIN 2012 Project
Midterm Review Workshop

Torino, 9-10 July 2015

The Project

Title: **Theoretical Astroparticle Physics**

Funded by: MIUR

ERC Panels: PE2_2 Particle Physics
PE9_12 Dark matter, dark energy
PE9_14 Cosmology

Duration: 3 years

MIUR Approval: 18 October 2013

Official start: 8 March 2014

Web page: prin-astroparticle.to.infn.it

Goals and topics

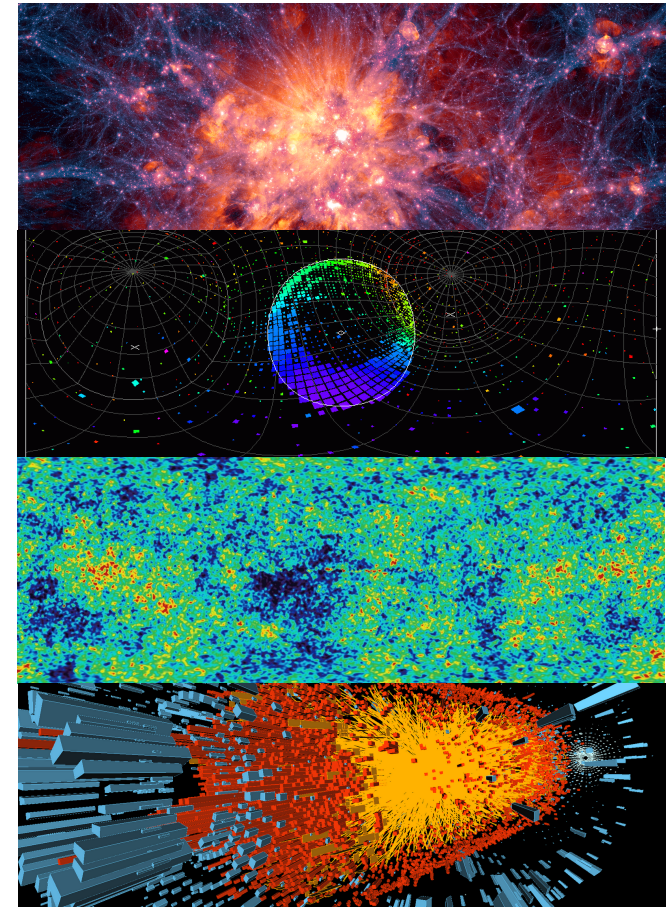
Goal of the project: to contribute to the theoretical understanding of the main open problems in astroparticle physics, also profiting of the decisive experimental results expected from observational astrophysics, precision cosmology and particle accelerators

WP1 – Dark Matter

WP2 – Neutrino Physics

WP3 – Cosmological Aspects

WP4 – Particle Physics Aspects



8 Research Units



Currently 82 members from 19 Institutions

Organization

Principal Investigator: Fornengo (TO)

Steering Committee: formed by the 8 research units coordinators

TO:	Fornengo
PD:	Masiero
SISSA:	Petcov
BA:	Gasperini
NA/SA:	Miele
FE:	Masina
AQ/LNGS:	Berezhiani
LNF/RM:	Nardi

Board of WP Coordinators:

WP1 – Dark Matter	Donato (TO) + Ullio (SISSA)
WP2 – Neutrino Physics	Lisi (BA) + Mangano (NA/SA)
WP3 – Cosmological Aspects	Melchiorri (LNF/RM) + Pietroni (PD)
WP4 – Particle Physics Aspects	Berezhiani (AQ/LNGS) + Masina (FE)

External International Referees: C. Munoz (UAM/IFT/CSIC, Madrid – Spain)
G. Raffelt (MPP, Munich – Germany)

UNIVERSITY OF TORINO

N. Fornengo	Staff	University of Torino	
A. Diaferio	Staff	University of Torino	
F. Donato	Staff	University of Torino	
C. Giunti	Staff	INFN/Torino	
L. Ostorero	Staff	University of Torino	
A. Del Popolo	Staff	University of Catania	
M. Regis	Staff	University of Torino	
A. Bottino	Associate	Accademia delle Scienze di Torino	
E.M. Zavanin	Associate	INFN/Torino	(until 29.02.2016)
A. Cuoco	Postdoc	University of Torino	(until 28.02.2015)
C. De Boni	Postdoc	University of Torino	(until 30.09.2015)
M. Di Mauro	Postdoc	University of Torino	(until 30.10.2015)
M. Falco	Postdoc	University of Torino	contract co-funded by the project
A. Vittino	Postdoc	University of Torino	contract co-funded by the project (until 31.10.2015)
H. Yu	Postdoc	University of Torino	(until 31.03.2015)
H. Zechlin	Postdoc	University of Torino	contract co-funded by the project
M. Campigotto	PhD Student	University of Torino	
S. Gariazzo	PhD Student	University of Torino	



TORINO

- Multi-wavelength/multi-messenger signals of DM
- Radio and gamma-rays: astrophysical sources and DM
- Cross-correlations of gamma-rays DM signal and DM gravitational tracers (cosmic shear, galaxy clusters, CMB lensing)
- Cosmic-rays and diffusion models
- DM direct searches: theoretical aspects
- DM and LHC synergy
- Cosmic structures in standard/alternative gravity
- Weak lensing
- Galaxies and galaxy clusters astrophysics
- Neutrino oscillations, phenomenology and theoretical modeling
- Neutrino bounds from cosmology
- Sterile neutrinos

UNIVERSITY OF PADOVA

A. Masiero	Staff	University of Padova
C. Brogгинi	Staff	INFN/Padova
M. Laveder	Staff	University of Padova
P. Paradisi	Staff	University of Padova
M. Pietroni	Staff	INFN/Padova + University of Parma



- Lepton Flavor Violation
- LHC SUSY searches
- Sterile Neutrinos
- SUSY searches at LHC
- Neutrino masses from Large Scale Structure of the Universe
- Cosmological perturbations for the LSS
- Sterile neutrinos in cosmology
- Constraints on time dependence of fundamental parameters from nuclear decay rates measurements

SCUOLA SUPERIORE DI STUDI AVANZATI (SISSA, Trieste)

S. Petcov	Staff	SISSA	Group coordinator
P. Ullio	Staff	SISSA	
A. Stuart	Postdoc	SISSA	contract co-funded by the project
D. Gaggero	Postdoc	SISSA	
J. Lopez Pavon	Postdoc	SISSA	
I. Girardi	PhD student	SISSA	
A. Titov	PhD student	SISSA	
M. Valli	PhD student	SISSA	

- Neutrino oscillations
- Neutrino masses and nature (Dirac/Majorana)
- Neutrino mass models: phenomenology and tests at LHC
- LFV as a signature of New Physics
- Leptogenesis and leptonic CP violation
- Nature of DM
- Dark matter signals

UNIVERSITY OF BARI

M. Gasperini	Staff	University of Bari	Group coordinator
E. Lisi	Staff	INFN/Bari	
A. Marrone	Staff	University of Bari	
A. Mirizzi	Staff	University of Bari	(since 01.03.2015)
D. Montanino	Staff	University of Lecce	
L. Tedesco	Staff	University of Bari	
G. Fogli	Associate	INFN/Bari	
F. Capozzi	PhD student	University of Bari	
G. Fanizza	PhD student	University of Bari	



- Global analysis of neutrino oscillation data, with focus on hints of CP violation
- Sensitivity to ν mass hierarchy in atmospheric and reactor neutrino experiments
- Turbulence and collective effects in Supernova neutrino flavor transitions
- Degeneracy of particle and nuclear physics uncertainties in $0\nu 2\beta$ decay
- Reference Earth model and uncertainties for geoneutrino studies
- Axion-like-Photon conversion in Galaxy Clusters
- Primordial ALPs from moduli decay and direct and indirect detection prospects
- Cosmic acceleration in inhomogeneous and anisotropic models
- New approach to perturbative evaluation of cosmological lensing effect based on the Jacobi map and on the Geodesic Light-cone Gauge

UNIVERSITY OF NAPOLI "Federico II" + UNIVERSITY OF SALERNO

G. Miele	Staff	University of Napoli	Group coordinator
M. Blasone	Staff	University of Salerno	
V. Bozza	Staff	University of Salerno	
G. Lambiase	Staff	University of Salerno	
G. Mangano	Staff	INFN/Napoli	
O. Pisanti	Staff	University of Napoli	
L. Rosa	Staff	University of Napoli	
G. Vitiello	Staff	University of Salerno	
S. Morisi	Postdoc	University of Napoli	
M. Chianese	PhD student	University of Napoli	



- Collective effects in neutrino oscillations
- Sterile neutrinos
- BBN and nuclear rates
- Models Beyond the SM
- HE neutrinos in IceCube
- Low reheating mechanism in the early universe

UNIVERSITY OF FERRARA

I. Masina	Staff	University of Ferrara
G. Fiorentini	Staff	University of Ferrara
F. Mantovani	Staff	University of Ferrara
B. Ricci	Staff	University of Ferrara
A. Dolgov	Associate	University of Ferrara
M. Montuschi	Postdoc	University of Ferrara
M. Baldoncini	PhD Student	University of Ferrara
G. Iacobellis	PhD Student	University of Ferrara
V. Strati	PhD Student	University of Ferrara



contract co-funded by the project
(since 01.03.2015)

- Higgs boson and primordial inflation
- Solar models, including effect of exotic physics (e.g. chameleon fields)
- Analysis of worldwide reactor antineutrinos signals

UNIVERSITY OF L'AQUILA + LABORATORI NAZIONALI DEL GRAN SASSO

Z. Berejiani	Staff	University of L'Aquila	Group coordinator
R. Aloisio	Staff	INAF/Arcetri + Gran Sasso Science Institute	
M. Mannarelli	Staff	INFN/Laboratori Nazionali del Gran Sasso	
L. Pilo	Staff	University of L'Aquila	
F. Villante	Staff	University of L'Aquila	
F. Vissani	Staff	INFN/Laboratori Nazionali del Gran Sasso	
V. Berezhinsky	Associate	INFN/Laboratori Nazionali del Gran Sasso	
G. Pagilaroli	Researcher	INFN/Laboratori Nazionali del Gran Sasso	
A. Addazi	PhD Student	University of L'Aquila	
R. Biondi	PhD Student	University of L'Aquila	
A. Parisi	PhD Student	University of L'Aquila	



- Supersymmetry and grand unification
- Baryon and lepton number violation
- Baryogenesis
- Dark matter, BBN, CMB and BAO tests for LCDM and other
- Cosmological scenarios
- Neutrino oscillations, high energy neutrinos
- Ultra high energy cosmic rays
- Axion physics and other light exotics
- Massive gravity

ISTITUTO NAZIONALE DI FISICA NUCLEARE (Laboratori Nazionali di Frascati) + UNIVERSITY OF ROMA "Sapienza"

E. Nardi	Staff	INFN/Laboratori Nazionali di Frascati	Group coordinator
A. Melchiorri	Staff	University of Roma "Sapienza"	
G. Anamiati	Postdoc	University of Cagliari	
S. Boucenna	Postdoc	INFN/Laboratori Nazionali di Frascati	contract co-funded by the project
E. Giusarma	Postdoc	University of Roma "Sapienza"	
M. Krauss	Postdoc	INFN/Laboratori Nazionali di Frascati	
A. Meroni	Postdoc	INFN/Laboratori Nazionali di Frascati	(until 30.09.2014)
L. Pagano	Postdoc	University of Roma "Sapienza"	contract co-funded by the project
E. Peinado	Postdoc	INFN/Laboratori Nazionali di Frascati	(until 30.09.2014)
G. Cabass	PhD student	University of Roma "Sapienza"	
M. Gerbino	PhD student	University of Roma "Sapienza"	
L. Salvati	PhD student	University of Roma "Sapienza"	

(...)



FRASCATI - ROMA

- Leptogenesis in GUTs, alternative models to standard leptogenesis
- Neutrino Masses and mixings
- Charged lepton flavor violation
- Majorana neutrinos and neutrinoless double-beta decay
- Spontaneous breaking of Flavour Symmetries
- Discrete symmetry groups and neutrino phenomenology
- Asymmetric Dark Matter (DM); Flavoured DM; DM effective interaction
- Data Analysis of Cosmic Microwave Anisotropies data from the Planck Experiment
- Dark Energy and possible interactions with DM
- Inflation and primordial GW Background
- Constraints on neutrino physics from Cosmology

Some analytics

- Publications: **242** (including 1 book for Cambridge University Press)
- Citations: **4000+**
- Presentations at International Conferences:
 - **90+ invited**
 - **50+ contributed**
- Organizations of International Conferences and Schools:
 - **20+**, including **NOW 2014, ISAPP 2014, TAUP 2015**
- Participation to International Boards and EU Committees (organization, refereeing)
- Participation as members in: **Planck, Fermi, HESS, Borexino** projects
- Role in the “What Next” INFN Program:
 - **7 members** of the project are Conveners (Dark Matter, Neutrinos, Cosmic Rays, Cosmology working groups)
 - **10+ workshops** organized
- Outreach: **15+** activities
- **19 PhD** students involved, **50+ master degree** students involved
- **Hiring on the project: 7 postdocs hired + 2 selections under way**

Workshop organization

- Reports from each Work Package
 - “Neutrino” and “Cosmology” today
 - “Dark Matter” and “New Physics” tomorrow morning
- 15 talks which cover a partial selection of the topics and work done by all Research Units
- Meeting with the Referees