ROBERTO MAOLI
Curriculum Vitae

Rome
October, 25th 2022

Part I – General Information

Full Name	Roberto Maoli
Citizenship	Italian
Spoken Languages	Italian, English, French

Part II – Education

Type	Year	Institution	Notes (Degree, Experience,…)
University graduation	1990	University of Rome La Sapienza	Master degree in Physics (Laurea in Fisica) – 110/110 *cum laude*
PhD	1994	Université de Paris VI	PhD in Physics – grade: *Très honorable avec les félicitations du jury*

Part III – Appointments and other activities

IIIA – Academic Appointments

Start	End	Institution	Position
09/2021	now	University of Rome La Sapienza	Associate Professor (Professore Associato)
05/2000	09/2021	University of Rome La Sapienza	Researcher (Ricercatore Tempo Indeterminato)
05/1998	04/2000	Institut d'Astrophysique de Paris	Postdoc (CEE fellowship – TMR Lensing)
01/1995	04/1998	Observatoire de Paris	Postdoc (ESA fellowship, CNR-NATO fellowships)
10/1991	12/1994	Observatoire de Paris-Meudon - École Normale Supérieure	PhD student

IIIB – Other Appointments

Start	End	Institution	Position
10/2004	02/2005	Institut d'Astrophysique de Paris	Bourse Ville de Paris
03/2005	03/2005	Space Telescope Science Institute - Baltimore	Visitor
04/2005	04/2005	Institut d'Astrophysique de Paris	Bourse Ville de Paris

IIIB – Other Activities

11/2017	Knight, Jones, Field – Fondamenti di Fisica (Piccin ed.)	Editor of the italian edition

Part IV – Teaching experience and other Academic duties

IIIA – Teaching experience

Year	Institution	Lecture/Course
From 2005-06 to now	University of Rome La Sapienza	Theoretical Cosmology / Master Degree in Astronomy and Astrophysics
From 2010-11 to now	University of Rome La Sapienza	Physics / Bachelor in Biology
From 2000-01 to 2009-10	University of Rome La Sapienza	Assistant in Mechanics, Thermodinamics or Electromagnetism courses

IIIB – Academic duties

Year	Institution	Activity
From 2016 to now	University of Rome La Sapienza	Member of *Commissione di Gestione dell'Assicurazione Qualità* at Department of Physics
From 2016 to now	University of Rome La Sapienza	Member of *Commissione per la verifica dei requisiti per l'ammissione alla Laurea Magistrale* at Department of Physics
From 2016 to now	University of Rome La Sapienza	Member of *Commissione per la pianificazione della didattica della Fisica* at Department of Physics
2013-14	University of Rome La Sapienza	Member of *Giunta di Dipartimento* at Department of Physics
2013-14	University of Rome La Sapienza	Member of *Giunta di Facoltà* at Faculty of Science
From 2000 to now	University of Rome La Sapienza	Member of the Qualification Committees for the selection of several postdoc positions
From 2010 to now	INAF – Rome observatory	Member of the Qualification Committees for the selection of several postdoc positions
From 2015 to now	University of Rome La Sapienza	Tutor of the Master in Astronomy & Astrophysics (Laurea magistrale in Astronomia e Astrofisica)

Part V - Society memberberships, Awards and Honors

Year	Title
03/2017	Award for excellent university teaching for 2015-16 from the Faculty of Science of Sapienza
02/2020	Award for excellent university teaching for 2018-19 from the Faculty of Science of Sapienza

Part VI – Research Activities

Keywords

Cosmology
Clusters
CMB
Gravitational lensing

Brief Description

EUCLID

Euclid is an ESA medium class space mission that will be launched in 2024. It will use a 1.2 meter telescope to observe 14000 square degrees of the sky. Euclid primary goal is to map the geometry and evolution of the dark universe with unprecedented precision. The aim is to place high accuracy constraints on Dark Energy, Dark Matter and Gravity using two independent cosmological probes: cosmic shear and baryonic acoustic oscillations. For this purpose, Euclid will measure the shape and spectra of galaxies in the visible and NIR, out to redshift 2, thus covering the period over which dark energy accelerated the universe expansion. Cosmic shear is the gravitational distortion of the shape of background galaxies by the large scale structure of the universe. It is considered one of the most promising probes to determine the distribution of the dark matter in the universe and the equation of state and its time evolution of the dark energy. For cosmic shear measurements is mandatory to have very deep high quality images. Euclid will measure the shape of 2 billions galaxies with the image quality of a space telescope.
I am member of the Euclid collaboration and I am particularly involved in the lensing part being responsible of the Italian weak lensing working package in the frame of the ASI contract for this mission.

High order statistic of lensing fields

The unprecedented high quality and large quantity of Euclid data will allow to have access to information which is typically buried into noise in present day data. On the contrary, Euclid will make it possible to probe the non Gaussianity of the lensing convergence field thus opening the way to higher than second order statistics.
With the lensing group of Rome observatory, we explore the use of higher order moments (HOM) of the convergence field as a way to increase the lensing Figure of Merit (FoM). The main problem we have addressed has been how to match theoretical predictions (based on idealistic noiseless conditions) and actual measurements (with realistic noise and map reconstruction issues). Calibration strategies have been worked out and tested against MICE simulations. This has also allowed to make Fisher matrix forecasts showing how much the Figure of Merit is increased when high order statistics is added to the standard shear power spectrum analysis. This general project have been carried on for different estimators. In particular, we have considered high order moments and Minkowski functionals, while the analysis of other probes (both topological as Betti numbers and local as three – points correlation function) is in progress. As a side project, moreover, we have also investigated higher order moments of the shear field in order to improve the estimate of clusters mass from weak lensing data.

Systematics of cosmic shear measurements

The goal of Euclid mission to discriminate among different cosmological scenarios and determine the cosmological parameters with unprecedented precision will be reached only if we will be able to keep under control al the systematics associated with galaxy clustering and cosmic shear measurements.
The wavelength dependence of the compact diffraction limited point spread function (PSF) of space–based observations introduce a subtle effect in shear measurements related to the wide filter adopted in Euclid observations. Since the galaxy has not a constant spectral energy distribution, the effective PSF is no more constant over the galaxy image contrary to what one assumes when performing shape measurements. This introduces a bias referred to as colour gradient (CG) bias. With Rome lensing group, we used HST images to evaluate CG bias and to develop a calibration strategy for Euclid mission. We determined the CG bias using HST observations in the F606W and F814W filters and observe a correlation with the colour, in line with expectations, whereas the dependence with redshift is weak. The biases for individual galaxies are generally well below 1%, which may be reduced further using morphological information from the Euclid data. Our results demonstrate that CG bias should not be ignored, but it is possible to determine its amplitude with sufficient precision, so that it will not significantly bias the weak lensing measurements using Euclid data.

Constraints on DHOST theories from clusters of galaxies
Degenerate higher-order scalar-tensor (DHOST) theories are considered the most general class of scalar-tensor theories so that any constraints on them apply to the full set of scalar-tensor models. DHOST theories modify the laws of gravity even at galaxy clusters scale hence affecting the weak lensing (WL), X-ray and Sunyaev-Zel'dovich observables. We derived the theoretical expression for the lensing convergence and the pressure profile of clusters in the framework of DHOST theories, and quantified how much they deviate from their General Relativity (GR) counterparts.

Cluster detection using weak lensing observations:
For its own property, weak lensing can be used to perform a blind search of unknown mass concentrations on wide-field surveys, by searching significant signal peaks in the shear maps. In the last decades weak lensing was shown to be an useful tool for detecting and counting massive halos, particularly galaxy clusters. Their comoving number density as a function of mass and redshift is a powerful cosmological probe and mainly depends on three fundamental parameters: the total matter density of the Universe, Ω_M, the normalization of the power spectrum, σ_8, and the evolution of DE equation of state w. I used the mass aperture Map-statistics, to predict the detectability and the number density of cluster-sized halos expected from a wide survey optimized for weak lensing. In this way I investigated the capability of peak statistic to discriminate among rival gravity theories, considering both dark energy models and extended theories of gravity.

Cluster Mass and density profile with lensing data:

The only direct method to estimate cluster masses without any assumption about its dynamical state is via measurement of the distortion (shear) of the shapes of background galaxies that are weakly lensed by the gravitational potential of the cluster. I performed a weak lensing analysis of Abell 611 on LBT (Large Binocular Telescope) data in order to estimate the cluster mass and to compare different methods to reconstruct the cluster shear field. With my collaborators we also analyzed the possibility to use strong and weak lensing data to optimize the cluster mass reconstruction.

CFHT Legacy Survey:
CFHTLS is a french-canadian project that used the largest field of view CCC camera available at that moment to carry on a sky survey in five optical bands with a very good seeing and high image quality. The large area of 170 square degrees of the WIDE survey made possible for the first time the computation of the cosmic shear spectrum at degree scales, while the high magnitude limit reached in the DEEP survey allowed for the first attempt of lensing tomography. CFHTLS has been for many years the best available measurements of cosmic shear with the best precision in the determination of cosmological parameters (mainly σ_8 and Ω_m).

MITO-Pol polarimeter (2001-2006):
MITO-Pol was a millimeter polarimeter for the 2.6 meter telescope of MITO observatory (Testa Grigia-Cervino). The polarimeter used spider-web bolometers cooled at 0.3 K. The goal of this experiment was the search of calibration sources for the study of the Cosmic Microwave Background (CMB) polarization.

OLIMPO (2001-2006):
OLIMPO is a balloon-borne telescope devoted to the measurement of CMB anisotropies at small angular scale (3-5 arcmin) and the detection of Sunyaev-Zel'dovich effect in a sample of low redshift clusters. In particular I was in charge of the observational planning of cluster detected in lensing survey, either with an optical and –ray counterpart or without it (dark clouds).

Cosmic shear (1998-2000):
I participated to the **first detection of cosmic shear** with the research group of the *Institut d'Astrophysique de Paris*.
We used deep optical images obtained with the NTT and VLT ESO telescopes and with the Canada France Hawaii Telescope to study the shape distortion of the background galaxies produced by weak gravitational effect by the foreground galaxies.
The furthest galaxies are deformed due to the curvature that their light rays undergo when passing near large mass structures, placed between the observer and these galaxies. Their shape becomes elliptical with the major axis perpendicular to the gravitational field. This distortion therefore allows us to trace the properties of the large scale structure responsible for the phenomenon with the enormous advantage of being sensitive to the gravitationally active mass and not only to the luminous mass of sources.

By observing a large number of galaxies (over 200,000) to counteract the statistical noise given by their intrinsic ellipticity, it is possible to establish the value of some cosmological parameters related to the formation and evolution of structures, such as Ω_0 and σ_8.

IF emission by high-z sources (1998-2000):
I used the bolometer array of the IRAM radiotelescope to search for thermal IR emission produced by dust in radio-quiet quasars and more generally in high redshift sources characterized by an high star formation rate.

Primordial molecules (1992-1997):
The presence of a primordial molecular medium at high redshift (z=5-400) can produce an effect on the CMB spectrum and its anisotropies. In particular I highlighted the role of LiH molecule that can produce via resonant scattering process the dumping of CMB primary anisotropies and the generation of secondary anisotropies associated with primordial clouds with a peculiar velocity in respect to the Hubble flux.

PRONAOS-SMH (1992-1997):
PRONAOS was a balloon borne telescope using an heterodyne radiometer to detect molecular oxygen and water lines in the interstellar medium. I was in charge to develop and characterize the Nb/AlOx/Nb superconductive junctions used in the mixer. The double band noise temperature obtained for the radiometer was 230 K, one of the best sensibility at that time for this kind of detectors.

Part VII – Summary of Scientific Achievements

Product type	Number	Data Base	Start	End
Papers [peer review]	32	Web of Science	1992	2022
Papers [proceeding]	16	Web of Science	1992	2022

Total Citations	1661
Average Citations per Product	34,6
Hirsch (H) index	16
Normalized H index*	0.53

***H** index divided by the academic seniority.