Curriculum Vitae

by Rodolfo Canestrari

Personal info

Name	Rodolfo
Surname	Canestrari
Place and date of birth	ITALY, Fano, 24-09-1980
Addresses	Home: via San Carlo, 20 20885 Ronco Briantino (MB) ITALY Business: via Emilio Bianchi, 46 23807 Merate (LC) ITALY
Telephones	Office: +39 039 5971044 Mobile: +39 3427931089 Mobile: +39 3487749610
e-mails	Business: rodolfo.canestrari@brera.inaf.it Personal: rodolfo.canestrari@gmail.com

Studies

Date (from – to)	October 2006 – July 2010
Institute	Università dell'Insubria (Varese-Como) Math and Physics Department
Main subjects of the study	PhD dissertation: "Thin glass sheets for innovative mirrors in astronomical applications" (for details see "Scientific work experiences" section)
Qualification awarded	PhD in Astronomy and Astrophysics

Date (from – to)	October 1999 – March 2006
Institute	Alma Mater Studiorum - Università degli Studi di Bologna Astronomy Department
Main subjects of the study	Mathematics and Geometry, Physics and Experimental Physics, Chemistry, Introduction to Theoretical Physics, Condensed Matter, Astronomy and Laboratory of Astronomy, Astrophysics, Nuclear and sub-nuclear Astrophysics, Cosmology, Physics of Galaxies. Laurea dissertation: "Telescopes for Hard X-ray Astronomy: technological development of multilayer mirrors" (for details see "Scientific work experiences" section)
Qualification awarded	Laurea Degree in Astronomy. Mark: 104/110

Date (from – to)	September 1994 – July 1999
Institute	Technical Secondary High School “Enrico Mattei” - Urbino Electronics and Telecommunications
Main subjects of the study	Analog and Digital Electronics, Electrical engineering, Automatics, Technology-Design-Engineering, Laboratory of Electronics-Electrical-Automatics-Mechanics, Mechanical drawing with AutoCAD Release 11
Qualification awarded	Chief technician expert in Electronics and Telecommunications. Mark: 96/100

Scientific work experiences

Date (from – to)	November 2012 – till now
Institute	INAF – Osservatorio Astronomico di Brera Via E. Bianchi, 46 – 23807 Merate (LC)
Institute type	Public Research Institute
Employment type	Staff position – Researcher
Main research activities and responsibilities	This position is funded in the context of the ASTRI flagship project funded by the Italian Ministry for University, Education and Research I am the coordinator of the work package "WP 3100 - Telescope structure and mirrors" for the flagship project A.S.T.R.I. (Astronomy with Mirrors with Italian Replication Technology). The work package includes the study, design and implementation of an end-to-end SST double reflection Cherenkov telescope prototype for the project CTA.

Date (from – to)	November 2010 – October 2011
Institute	INAF – Osservatorio Astronomico di Brera Via E. Bianchi, 46 – 23807 Merate (LC)
Institute type	Public Research Institute
Employment type	Staff position – Researcher
Main research activities and responsibilities	This position is funded in the context of the ASI / INAF “High Energy Astronomy” contract to carry out the following activities: - development of innovative optical processing techniques such as Ion Beam Figuring, Jet / Bonnet polishing and glass slumping, with particular reference to the mirrors for the WFXT mission and future Cherenkov telescopes; - development of mirrors and telescopes for astronomy in the high-energy band, also including ground-based

telescopes such as Cherenkov telescopes;
- characterization of innovative optical materials;
- design of mirrors for future X-ray missions and Cherenkov telescopes;
- X-ray metrology of mirrors through innovative methods;
- participation to meetings with other groups involved in technical and scientific ground- and space-based projects for High Energy Astronomy.

The research activity is the follow-up of the work started in the second part of the PhD on the development of innovative mirrors and mechanical structures for next-generation Cherenkov telescopes.

From January 2011, I am the coordinator of the work package "WP 3100 - Telescope structure and mirrors" for the flagship project A.S.T.R.I. (Astronomy with Mirrors with Italian Replication Technology). The work package includes the study, design and implementation of an end-to-end SST double reflection Cherenkov telescope prototype for the project CTA.

Date (from – to) January 2007 – October 2010
Institute INAF – Osservatorio Astronomico di Brera
Via E. Bianchi, 46 – 23807 Merate (LC) ITALY
Institute type Public Research Institute
Employment type INAF scholarship – PhD student (till July 9th, 2010)
Main research activities and responsibilities 3-year INAF scholarship (extended for additionally 10 months), on: "Innovative optical technologies for future large ground-based telescopes". This grant has funded the PhD (paper34).

The work included and includes among other things:

- study and development of the so called "hot slumping" technology for the manufacturing of large deformable segments for adaptive optics. This study has been conducted in the framework of the "ELT Design Study" (WP9300) funded by FP6. Main activities were:
  - market-search, characterization, comparison and trade-off of materials to be used within the process;
  - study and development of a technological process suitable for the purpose of the project (adaptive optical segments);
  - development and testing of an innovative astatic support for the measurement (using interferometric setup) of thin optical segments having long radius of curvature (5-10 meters);
  - related publications: paper31, paper20, paper14

- preliminary study aimed to evaluate to "hot slumping"

process previously developed for the realization of optical segments for grazing incidence X-ray mirrors, with particular reference to the ESA / NASA / JAXA mission IXO (formerly XEUS) (paper29, paper24, paper19);

- study and development of the so called “cold slumping” technology for the manufacturing of large (> 1 m), stiff, lightweight and low-cost optical segments for the new generation of Cherenkov telescopes. Main activities were:
    - market-search, characterization, comparison and trade-off of materials to be used within the process, such as foam glass and epoxy adhesives;
    - study and development of a suitable technological process in order to achieve, on industrial scale, the production of mirrors for Cherenkov telescopes;
    - optical, thermal and fast-ageing (UV, salt-fog) tests on mirrors and prototypes having long radii of curvature (> 30 meters);
    - related publications: paper35, paper32, paper30, paper26, paper18

- study and initial tests aimed on improving the optical performances of mirrors made from the “cold slumping” approach by using “hot slumped” glass shells (paper36, paper33, paper32, paper25, paper23, paper21);

- study and development of the “Ion Beam Figuring” technology for the correction of shape’s errors of high precision optical components (including aspheric) and made by a variety of materials such as Zerodur, BK7, Quartz, Silicon Carbide. Main activities were:
    - correcting the flatness of a demonstrator mirror for the NIRSpec instrument, onboard the JWST;
    - development and testing of an innovative system for the concentration of ion beams for the correction of errors at high spatial frequencies and/or small optical surfaces;
    - correcting the flatness of 3 small mirrors for the LLTs (Laser Launching Telescopes) for the virtual star generation (adaptive optics) for the Subaru Telescope;
    - correcting the surface of a small optical window by inserting a predetermined pattern described by Zernike polynomials;
    - related publications: paper28, paper17, paper13

- metrological characterizations (LTP, WYKO, ZYGO, AFM,

Nomarski, CMM), optical tests, thermal and fast-aging tests (UV and salt-fog) on moulds, optical deformable mirrors, large (> 1 m) mirrors and high-precision optical components (including aspheric);

- development of IDL and Visual Basic codes with GUI (Graphic User Interface) for data reduction and interpretation;

- development of Visual Basic codes with GUI for managing scientific instruments. With particular reference to:
  - control and active management of the furnace used in the "hot slumping" process;
  - control of thermocouples system used in the "hot slumping" process;
  - control and management of the astatic support system for the interferometric measurements of deformable mirrors made by "hot slumping" process: high sensitivity load-cell and high-precision Picomotor;

- co-supervisor of Gianpaolo Motta for his Laurea Magistrale degree in Astrophysics and Space Physics at the University of Milano-Bicocca (2010, supervisor Prof. Mario Zannoni). Thesis title: "Development of lightweight mirror segments for Cherenkov telescopes";

- co-supervisor of Gaetano Marino and Stefano Sangalli for their Degree in Aerospace Engineering at the Polytechnic of Milano (2011, supervisor Prof. Sala). Both theses concern the study and characterization of new materials and adhesives for the production of Cherenkov mirrors for future projects;

- since June 2009, member of the INAF working group for the CTA project (Cherenkov Telescope Array). In particular, I am the responsible for the development of the mirrors for the small-telescope to be implemented within CTA.

Date (from – to)	July 2006 – December 2006
Institute	INAF – Osservatorio Astronomico di Brera Via E. Bianchi, 46 – 23807 Merate (LC)
Institute type	Public Research Institute
Employment type	Project Collaboration Contract (Co. Co. Pro.)
Main research activities and responsibilities	In the context of contract No 011863 concluded between INAF and the European Commission for the "ELT Design Study"

project (WP9300). The work included among other things:

- study and development of the "hot slumping" technology for the manufacturing of deformable optical segments for adaptive optics. (for details see above);
- study and development of the "Ion Beam Figuring" technology (for details see above);
- Metrological characterizations (LTP, WYKO, ZYGO, AFM, Nomarski, CMM) of deformable optics and high-precision optical components (including aspheric)

Date (from – to)	March 2006 – June 2006
Institute	INAF – Osservatorio Astronomico di Brera Via E. Bianchi, 46 – 23807 Merate (LC)
Institute type	Public Research Institute
Employment type	Scientific collaboration
Main research activities and responsibilities	Follow up of the work begun during the Thesis in the form of a scientific collaboration (free of charge) at INAF-Osservatorio Astronomico di Brera. Main activities were: - metrology of Silicon strips samples for a feasibility study (conducted by ESA) on the micro-pore optics for the XEUS telescope: microroughness (spectrally resolved in terms of PSD, Power Spectral Density) characterization of the samples by AFM metrology, WYKO, LTP, XRS (paper15); - metrology of samples with Silicon Carbide reflective coatings deposited with an innovative PE-CVD process in collaboration with the company Galileo Avionica, within the project MEF/ITU-INAF "PRISMA" (paper10, paper4); - metrological characterization of an antenna prototype for RFID systems (paper5)

Date (from – to)	December 2005
Institute	INAF – Osservatorio Astronomico di Brera Via E. Bianchi, 46 – 23807 Merate (LC)
Institute type	Public Research Institute
Employment type	Scientific collaboration
Main research activities and responsibilities	Repair, upgrade, testing and verification of the scientific instrumentations WYKO TOPO 2D and AFM Digital Instrument. The WYKO TOPO 2D is a profilometer for measuring with high accuracy (2 nm) surface profiles (on a scale of 5.2mm - 10 microns) using the optical interferometry technique. The AFM is an instrument for measuring with very high accuracy (<0.1 nm) the surface microroughness (on a scale of 100 microns - 1 micron).

Date (from – to)	January 2005 – March 2006

Institute	INAF – Osservatorio Astronomico di Brera Via E. Bianchi, 46 – 23807 Merate (LC)
Institute type	Public Research Institute
Employment type	Laurea student
Main research activities and responsibilities	The Laurea Thesis (paper3) was aimed mainly to the extension of X-ray focusing mirrors to the hard X-ray band (10-100 keV) by means of interferential multilayer coatings. During the Thesis I have performed the characterization of mirrors samples and substrates made in various materials (such as Fused Silica, Nickel, Zerodur): - surface microtopography (Atomic Force Microscope, WYKO profilometer, Nomarski microscope); - X-ray diffraction (X-ray reflectivity and scattering measurements performed with a three-axis diffractometer in monochromatic setup). I have performed a study of the internal structure of multilayer coatings (periodic and graded multilayer) through a detailed analysis of the microroughness growth. In particular, I have worked on measuring and interpreting data obtained from metrology. Then applying an existing model to describe the microroughness growth. This model allows us to compare the performance, in terms of surface roughness, of different deposition techniques. I have produced a code in IDL (also having a graphical user interface) for the computation of that analysis. I also have verified the correctness of the model through an independent check using X-ray scattering measurements (paper8). This work was within the study for the development of multilayer coatings for the SYMBOL-X mission. I have collaborated in the analysis of the internal structure of multilayer coatings (periodic and graded) by the interpretation of the reflectivity diagrams through the PPM code. The results have been verified with the analysis of such samples produced by transmission electron microscopy (TEM) with excellent agreement (paper12, paper7). During the Thesis, I have collaborated with the Harvard-Smithsonian Center for Astrophysics (Boston, USA) for the manufacturing of hard X-ray mirror shells with multilayer coating deposited by magnetron sputtering, and with the Max Planck Institut für extraterrestrische Physik (MPE Garching) for the characterization of those X-ray optics at the PANTER facility (Neuried, Germany). Measures, reduction and interpretation of X-ray reflectivity and scattering data. The measurements were among the first ever conducted on mirrors up to 50 keV.

Support to the mirrors calibration activities at the PANTER facility is still ongoing (paper22, paper11, paper9, paper2, paper1).

Other info and stuff

Languages English and German (basic)

Driving license European driving license B-type

Military service Free

Technical, computer and scientific instrumentation skills Analyses of scientific data with accurate surface metrology instrumentations such as Atomic Force Microscope, Wyko TOPO 2D optical interferometer, Nomarsky microscope, Long Trace Profilometer, Zygo Fizeau interferometer, different types of optical and contact probes (Rodenstock, Heidenhain)

Measurements, calibration and analysis of X-ray (0.5-50 keV) reflectivity and scattering data performed either in pencil-beam or full-illumination setup both in monochromatic or energy-dispersive configuration. Facilities: Bede D1 diffractometer system and PANTER (MPE).

Microsoft Office suite, in particular Word, Excel, PowerPoint, Publisher and Office Project (for Gantt charts), Chartist (for WBS and work flow diagrams).

Programming languages: Basic and Visual Basic, Pascal, Fortran, IDL, HTML, assembler Z80 and Intel 8080, Latex.

More stuff 2013: Member of the evaluation committee for a Post-doc position for the ASTRI project
2012: Member of the evaluation committee for a software development position for the ASTRI project
2011: Member of the evaluation committee of a "call for bids" for the design of the double-reflection Cherenkov telescope for the ASTRI project
2011: Member of the evaluation committee for a Post-doc position for the ASTRI project
2010: Course on “fire fighting in a medium-risk company” held by Confindustria of Lecco
2010: Course on “first aid training for designated employees” held by the Italian Red Cross of Lecco
2006-till now: collaboration in the public outreach activities of the Observatory of Brera as speaker and telescope technician.
2006: collaboration in the public outreach activities at the

Planetarium of Lecco.
2001-2002: Scholarship for the third year of university.
1999-2000: Scholarship for the first year of university.

Attachments Attachment 1: publications
Attachment 2: oral contributions
Attachment 3: schools, workshops and congresses