Pino Torinese, Sep 30 2020

Dr. Mario G. Lattanzi
INAF-OATo

Curriculum Vitae et Studiorum

Summary of Research Leadership Profile

Lattanzi has practiced space science since the beginning of his carrier as a research astronomer in 1987, and he has had the rare opportunity to take part, as a key collaborator or at the leadership level, in three different space missions dedicated primarily to astrophysics but also to the Solar System and that are making, and will continue to make, a difference in the Planetology of new systems!

With the Hipparcos mission, he shared the prime responsibility of reconstructing the astrometric parameters of the 40,000 primary stars with which the Hipparcos reference frame was established and, through collaborations, exploited the mission data for important results on the age of globular clusters, the kinematics of the Milky Way warp, and the energetics of isolated neutron stars (like Geminga) and Seyfert 2 galaxies.

As Instrument Scientist for the Hubble Space Telescope, he developed the scientific capabilities of the first optical interferometer operating in space to measure fundamental quantities like the mass of pre-main sequence stars or the changing photospheric diameter of Mira-type variables, to investigate on the nature of the super-massive stars in the LMC cluster R136a, and to derive sizes and shapes of a sample of suspected "double" asteroids to improve on their densities and therefore on their classification.

Finally, he was one of the ESA science team members that imagined and developed the Gaia mission that finished its nominal 5-year mission in July, 2019; the first scientific results (two major deliveries in 2016 and 2020 to the Astronomical Community worldwide) have impacted the research in Astrophysics so profoundly (more than 250 articles that are appear every month in the major refereed journals) so and it has been extended through the end of 2020.

Since 2006, he is responsible for the Italian participation in this program and led the effort for the realization of the Italian Data Processing Center (DPCT), in full operation since Gaia's launch (Dec 19, 2013). The DPCT is today, and it will continue to be for many years to come, the largest (it will reach 1.5 PB at mission's end) and most advanced Data Base ever in Italy dedicated to Astronomy and Space Research, a long-lasting space instrument in itself, to be exploited over the decades to come (see the reference to the TLS project below). The expectation is to continue and further develop the science projects that he has fostered and/or led throughout the many preparation years: confront the predictions of the Cosmology Concordance Model with the details of the Milky Way phase space of its thick disk and inner halo, test General Relativity to unthinkable levels and scales, and realize the largest unbiased census for extrasolar planets ever attempted.

He has also participated in important ESA science and technology study teams for developing new far-reaching missions, like building a kilometric-size interferometer on the Moon or in a free-flying configuration in orbit (the MOFFIT study). And for his recognized experience, he has been asked to participate in the preparations of new missions like Euclid and Plato.

More recently, as a Co-PI, Lattanzi has formulated and developed concepts for space instrumentation aimed at overcoming the limitations of Hipparcos/Gaia-like mission designs to achieve astrometric measurements up to fractions of μas's: these are the mission concepts GAME (2012) and AGP (2016) that were presented as proposals to ESA for the medium-size mission opportunities M3 (ESA call 2010) and M4 (ESA call 2014). These studies led to the project ASTRA (*Astrometric Science and Technology Roadmap for Astrophysics*), a key-technology demonstrator project to further develop and enable these sub-μas missions: ASTRA was approved for the three-year period 2019-2021 (the only one in Astrophysics!) by our MAECI and the Chinese Ministry of Science and Technology (MOST). It is with these kind of new-generation astrometry missions that rocky planets (including nearby habitable Earths) can be discovered and accurately measured or the detections and precise measurements (of both amplitude and direction) of Gravitational Waves can be brought in space.

Of particular importance in this context, his solid background in ground-based astronomy as testified by the projects led and accomplished (like the GSC2 Project) and by his participation in study groups or science committees established by ESO for the exploitation of the VLTI and for developing its next generation instrumentation. This kind of experience is what gives him the perspective of where are the borders and where the complementarities of space-borne and ground-based programs.

Over the years he has held important roles or led the design of space missions (science case, requirements, and instrumentation); has modeled and calibrated instruments operating in space; reduced, analyzed and, finally, exploited data for the progress of astrophysics and other fields of space science. For this, he has matured the diverse, interdisciplinary expertise necessary to receive and understand the technical complexities and the breath-taking scientific amplitude of the future challenges in astronomy and astrophysics.
Of particular importance in this context are the potential industrial applications of some of his activities. In particular, as one of the latest developments, the expertize in Catalog Astronomy (i.e., in the materialization of the Reference Frame: HIPPARCOS, GSC2 and Gaia in the near future) has gained him the opportunity to join Thales-Alenia Space – Italy (TAS-I) and Selex-Galileo (now Leonardo-Firenze), as sub-contractors, for delivering the first deep guidance catalog (to R=19!) that will be used by the Selex-Galileo Fine Guidance Sensor (FGS, to first ever to operate as a Star-Tracker at such faint magnitudes) for the absolute pointing and guiding of the Euclid telescope gaining back more than 30% of the mission time to the science case! The guiding catalog was formally delivered last June following the acceptance tests by TAS-I and ESA.
This last Summer (2020), we were contracted out by TAS-I for a similar, although initial, study for the mission SPICA (being studied by ESA): investigate the possibility to implement a deep guiding catalog for a potential SPICA FGS in the bands from the optical to the near (2.5 μm) and mid (5-10 μm) IR.

As done in the past (see for example the case of the APACHE Project), the proceeds of these activities, to complement the meager budgets we receive for Basic Research, will be reinvested in those more fundamental/forward looking research activities less likely to receive adequate funding: a good example of "managing research".

Lattanzi is Head of Research ("Dirigente di Ricerca") at INAF-Osservatorio Astrofisico di Torino. He started his 33-year-long career in astronomy as one of the three astronomers of the FAST Consortium in charge of the astrometric sphere reconstruction for the HIPPARCOS mission (1989-1997); was ESA Instrument Scientist for the Fine Guidance Sensor Interferometer on board HST (1989-1997), and Co-PI of the HST Guide Star Catalog-II project (1995-2002).
Thanks to his activity within the VLTI project, he was responsible for the scientific utilization of the INAF-OATo share of the VLTI Guaranteed Time (to 2013).

He was member of the ESA Science Advisory Group for the study of the "Astrometry Cornerstone Mission" Gaia (1997-2005), which accomplished the approval of the Gaia mission by ESA (2000 and 2002).

Lattanzi leads the AGRET *(Astrometry, Galaxy, Relativity, Exo-planets and related Technology*) Group at INAF-OATo, a 23-staff team of astronomers and scientists heavily involved in the Gaia mission. He is deputy head of the Coordination Unit 3 (core astrometry) in DPAC, the pan-European consortium formed for the data reduction of the Gaia data, and PI of its Astrometric Verification Unit (AVU). Finally, he is Principal Investigator for ASI and INAF, under a specific contract by ASI, of the Italian participation in Gaia since 2006.

Members of the AGRET team are or have been involved, as Co-I's at participating nodes, in a number of EU programs. Euro-Interferometry/OPTICON, ELSA in FP6, GREAT in EU-FP7, and "Gaia Selection Function" in EU H2020 (kick-off in 2020); they also lead the FP7 programs IPERCOOL "Interpretation and Parameterization of Extremely Red COOL dwarfs" (Start Exchange Program, PI R.L. Smart, coordinating nodes in UK, Brasil, and China), PARSEC "Parallaxes of Southern Extremely Cool Objects, Incoming International Fellowship" (PI R.L. Smart), and the "SPACE – 2012" program called "Measuring Eta_Earth: Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N, and Gaia" (EtaEarth in short, PI A. Sozzetti) with coordinating nodes in USA (CfA) and Europe (Observatory of Geneve, and London University College).

Sozzetti and Lattanzi led, respectively, the spectroscopic Work Package and the APACHE transit photometry activities of the photometry WP of the project *Ways-to-Other-Worlds* (WoW) funded by the Italian Ministry for Research (PI G. Micela, INAF-OAPa) through a special funding program ("Fondi Premiali") for supporting the continuation of the APACHE program and the study of a new transit photometric system to study planetary atmospheres optimized on the widest wavelength range possible, from VIS (including the bleu part of the spectrum) **through** NIR (up to 2.4 microns). Finally, Lattanzi is responsible for the Operational Unit 4 ("The Living Sky (TLS)") for the realization of the TLS prototype part of the special research program "MIning The Cosmos Big Data and Innovative Italian Technology for Frontier Astrophysics and Cosmology " (MITIC) selected and funded by the Italian Ministry of Research (PI Garilli, INAF-Milano, 2017).

He has a 27-year experience in the scientific and technical management of small to mid-size national and international projects (from a few people up to 60 researchers), on budgets ranging from a few tens of K-Euros to multi-million Euros, as is the case of the Italian participation in Gaia. Also, several of these projects were/are conducted in partnership with national and international Institutions like ASI, ESA, ESO, ST ScI, JPL, Chinese Academy of Sciences (CAS), and space industries (ALTEC, BOOSTEC, Thales-Alenia Space, Selex-Galileo/Leonardo-Firenze).

Personal Data

Name: Mario G. Lattanzi

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Born: April 30, 1959 in Nereto (TE), Italy

Higher Education

- Doctor in Astronomy cum Laude from the University of Bologna, Italy, 1983. Thesis: *Great Circle Reconstruction for the Hipparcos mission* (in Italian);
- Specialization in Numerical Analysis, Dep. of Mathematics, Univ. of Bologna, 1984. Thesis: *A Model for the Reconstruction of the Celestial Sphere in Hipparcos* (in Italian).

Current Position

- Head of Research ("Dirigente di Ricerca"), INAF-Astrophysical Observatory of Torino (INAF-OATo), Aug 4, 2017 -

Past Positions

- INAF-OATo, Senior Associate Astronomer, May 2006 – Aug 2017
- Research Professor at Shanghai Astronomical Observatory, Chinese Academy of Sciences, Feb 2015-Jan 2016
- INAF-OATo, Associate Astronomer, May 6 2003- April 2006
- INAF-OATo, Senior Research Astronomer, 1990-2003
- Contract Professor in "Fundamental Astronomy for the Milky Way", Dpt. of Physics, University of Torino (UniTo), since 2003 (changed to "Methods of Astrometry for Astrophysics" from a.y. 2012-2013), 2003 –
- Contract Professor for the course "Gravitational Astronomy and Metrology for astrophysics", Second Level Master Degree in "Mathematical and Physical Methods for Space Sciences", Dpt. of Mathematics, UniTo 2019 -
- Space Telescope Science Institute, ESA Associate Astronomer (Instrument Scientist for the scientific exploitation of the Fine Guidance Sensor Interferometer on board HST), 1989-1995
- ESA Fellow (Post-Doc) at the Space Telescope Science Institute, 1988 – 1989
- INAF-OATo, Research Astronomer, April 2, 1987-1990

Relevant Appointments

- ST ScI consultant for the scientific exploitation of the interferometric mode of the astrometer Fine Guidance Sensor on HST, 1995-1997
- Project Scientist , for the Italian participation in the "Guide Star Catalog 2", 1995 - 2001
- Member of the HIPPARCOS FAST Committee, for the early evaluation of the results of the Hipparcos mission for the FAST Consortium, 1989-1996
- Member of the ESA Science Working Team for the study of a Moon/Free Flyer Interferometer (MOFFIT), 1994 -1995
- Member of the ESA Science Advisory Group for the study of the "Astrometry Cornerstone Mission" (the Gaia mission), 1997-2005
- Member of the ESO Implementation Committee for the Very Large Telescope Interferometer (VLTI), 2000-2005
- Responsible for the scientific utilization of the INAF-OATo share of the VLTI Guaranteed Time acquired for the realization of FINITO, the very first fringe tracker ever to operate on Paranal (to 2013).

- Member of the SDT ("Science Demonstration Time") group at ESO for the development and implementation of scientifically interesting and technically challenging observing programs for the demonstration of the scientific potential of the VLTI, 2001-2005
- Responsible for the ESA subcontract (from Alenia Spazio, LMO-OATo-04-02-Gaia) devoted to the analysis of the opto-mechanical couplings of the Gaia astrometric payload. Acting as ESA subcontractor for the ESA contract to the prime Alenia Spazio named "Laser Metrology & Optics Active Control" (2003-2006);
- Member of the INAF Technical Support Committee (named "Comitato Antartide INAF") to the Joined Committee ("Comitato Paritetico") for the study of Astrophysics from Antarctica and the utilization of Dome C (formed by INAF and the *National Scientific Committee for Antarctica – "Comitato Scientifico Nazionale per l'Antartide"*) (Ortolani -Chair, Gregorini, Lattanzi, Testi) (2004-2005);
- PI of the national research program (call INAF 2002) entitled: "Stellar and extragalactic astrophysics with optical interferometry" (2005-2007);
- Deputy head of the Coordination Unit 3 (core astrometry) in DPAC, the pan-European consortium formed for the data reduction of the Gaia data, and PI of its Astrometric Verification Unit (AVU) (since 2007);
- Program Manager of the project APACHE, a photometric survey hunting for transiting low-mass planets orbiting a well-defined sample of M dwarfs stars in the solar neighborhood (in collaboration with the Regional Observatory of the Aosta Valley);
- Principal Investigator, for ASI and INAF, of the Italian participation in the ESA space astrometry mission Gaia, since 2005; this includes the overall supervision, for ASI, of the industrial partner (ALTEC SpA, Torino) for the realization of the Italian Gaia Data Processing Center (DPCT), one of the six involved in the Gaia mission operations across Europe (ASI contracts I/037/08/0, I/058/10/0, 2014-025-R.0, 2014-025-R.1.2015 and 2018-24-HH.0 to October 2021).
- Member of the Time Allocation Committee for the Italian TNG telescope on La Palma (2006-2008).
- Responsible for the contract from Thales Alenia (Purchase Order 1520037410 of Thales Alenia Space Italia, Torino) "Euclid Phase B2: Reference Star Catalogue of the Euclid FGS" (Aug 19, 2013).
- Member elected of the "Consiglio di Struttura" of the Torino Astrophysical Observatory in support of the Observatory Director (Oct 2013-2016).
- Appointed by the Chinese Academy of Sciences (CAS) member, for the sector astro-geodynamics/fundamental astronomy, of the International Expert Panel that conducted the first ever on–site International Expert Diagnosis Assessment exercise, for the evaluation of the Shanghai Astronomical Observatory of CAS (2014).
- Co-I and responsible for the Operational Unit 4 ("The Living Sky (TLS)") for the realization of the TLS prototype, of the special research program MITIC ("MIning The Cosmos Big Data and Innovative Italian Technology for Frontier Astrophysics and Cosmology ") selected and funded by the Italian Ministry of Research (PI Garilli, INAF-Milano, 2017).
- Co-I of the program ASTRA, funded for the three-year period 2019-2021 by our MAECI and the Chinese Ministry of Science and Technology (MOST) (PI Gai).

Main research activities

Lattanzi is or has been actively involved in the following research areas:

- The search and characterization of extra-solar planets and low mass (from extreme red dwarfs to brown dwarfs);
- fundamental properties (distance, mass, diameter) of pre-main sequence binaries; structure and evolution of open clusters and star-formation regions;
- the structure, kinematics, and age of the Milky Way; the MW as fossils searching ground (i.e. its local halo and thick disk) for testing the Concordance Cosmology Model at zero redshift (Local Cosmology);
- astronomical reference frames;
- space and ground-based astrometric and interferometric techniques with application to: Mira-type stars, super-massive stars, pulsar timing, energy mechanisms in active galaxies;
- formulation and implementation of general relativistic models and reference frames for micro-arc-second astrometry; astrometric tests of theories of gravitation; astrometric detection of Gravitational Waves;

- analysis of optical systems for very high precision astrometry and for very high resolution interferometry;
- prospects for nano-arcsecond astrometry in space (Astrometric Cosmology);
- methods and strategies for the realization of large data bases for astronomy.

The list above suggests that main traits of Lattanzi's activity are scientific curiosity and interdisciplinarity, i.e., attacking a fairly wide range of open astronomical problems and pursuing their solution through the development of innovative techniques, hardware and/or software, specifically designed for that purpose. However, a closer look at these themes reveals a very coherent approach to science (see Figure 1 below) to the point that Lattanzi's most recent research activity can in reality be summarized in just two words *Astrometric Cosmology*, as he has detailed in a recent invited review article with the same title (Mem. S.A.It., 2012, Vol. 83, 1033, see also Crosta, *La Rivista del Nuovo Cimento*, 2019, V. 42, Issue 10, p.443-510 and references therein).

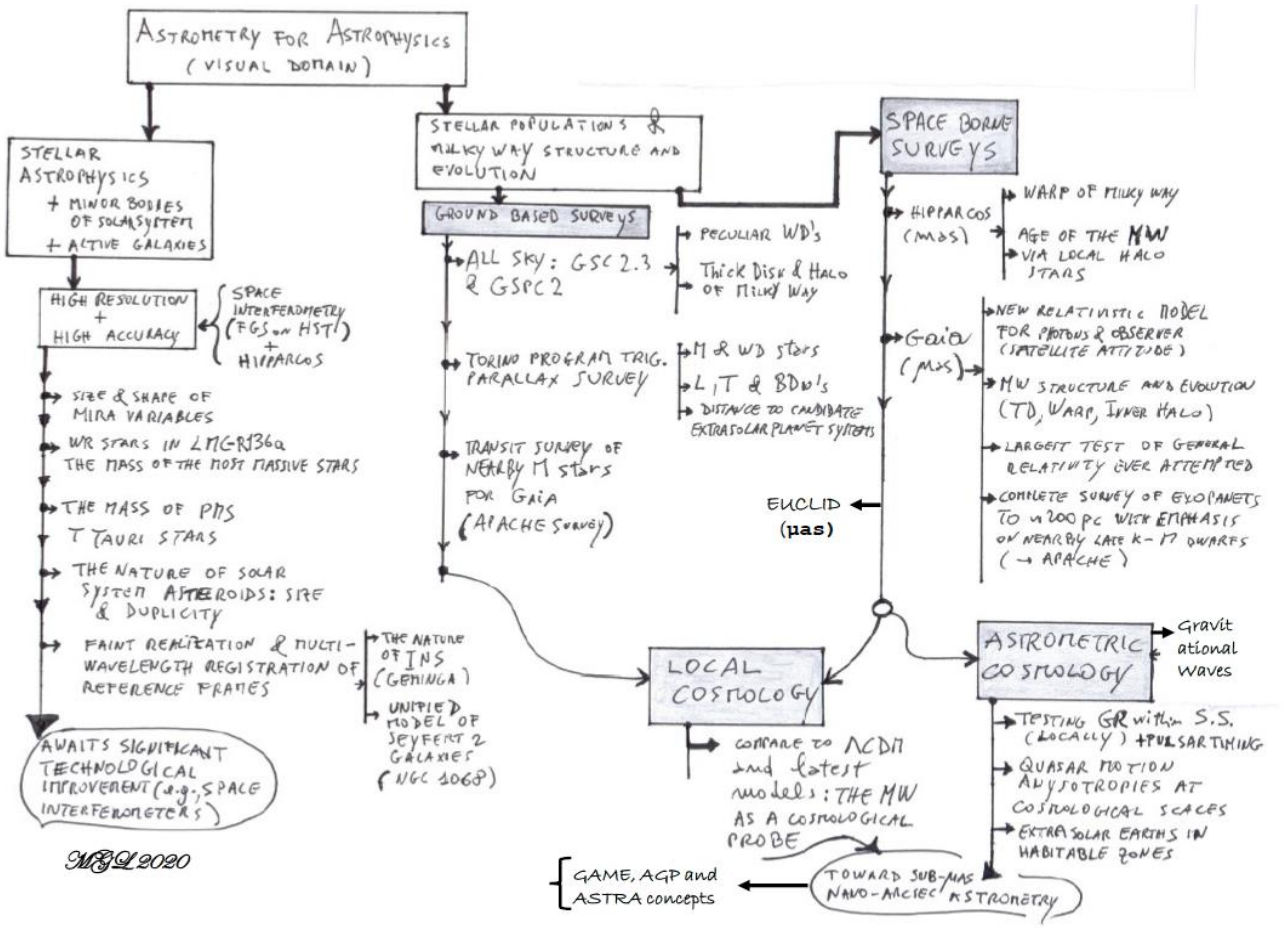

Figure 1. *Logic of Mario G. Lattanzi's scientific career: "Astrometry for Astrophysics and Cosmology". The items listed following the framed main entries explicitly refer to Lattanzi's publications on those topics (see Lattanzi's complete publication list, provided at the end of this Attachment).*

Lattanzi realized that theory had undergone extraordinary progress in stellar astrophysics and, more recently, in fundamental physics and cosmology, to the point that today extremely accurate predictions are possible at all scales demanding equally accurate observational, i.e. astronomical, proofs. In this context, of particular interest are the cosmological signatures predicted at zero redshift, i.e., at the scale of the Milky Way and of the realm of its small satellites and the other main galaxies comprising the Local Group, considered as a fundamental cosmological test case. The revolution in testing these predictions begins with the direct, i.e. independently from models, and accurate measurements of the individual fundamental quantities (mass, magnitude, color, size, distance and velocity) for complete, limited to faint magnitudes, samples of stars everywhere across the Milky Way.

And if the milli-mag quality required for magnitudes and colors or the meter, or sub-meter, per second needed for the velocity component along the line-of-sight are still possible from the ground, the ten or so

micro-arc-seconds (μas) in parallax and annual proper motions errors required for a first accurate mapping of the Galaxy phase space remains unique to space-borne measurements. This is the paradigm of the Gaia mission to whose design, development, and approval by ESA Lattanzi participated since the very beginning: the astrometric and spectro-photometric characterization of 1.5 billions objects down to R=20, the largest inventory ever attempted where the size of the survey is no compromise to the accuracy of the individual measurements: this is 21-st century astrometry, the synthesis of catalog (survey) astronomy with the realization of the tenets of advanced astrometry, something that only the access to space has made a reality.

Gaia is the first astronomical project able to confront the predictions of local cosmology, marking the beginning of "astrometric cosmology": a new science in its own right, already looking into future space astrometry missions designed to push accuracy below the one micro-arc-second and possibly beyond (Mem. S.A.It., 2012, Vol. 83, 1033). Thanks to Gaia the solar neighborhood, the first few hundred parsecs from the Sun, will also regain central stage becoming the transition zone where cosmology and the frontiers of stellar astrophysics finally joins together. As, within such borders distances and space velocities are measured to much better than 0.1% allowing super accurate calibrations of stellar parameters for practically the entire HR diagram, covering the most intriguing evolutionary stages and down in mass to the star-planet transition. It is within the solar neighborhood that Gaia's astrometry will allow final characterization of hundreds of the known planets discovered by the most advanced radial velocity and photometric transit ground-based surveys (including our own APACHE project, see below), and will characterize many of the several thousands new discoveries it will make including rocky planets orbiting low-mass dwarfs within their habitable zone!

The after Gaia will then witness another beginning: the cosmogony of the planetary systems accompanying our own in its journey around the Galaxy. This, while waiting for the 0.1 micro-arc-second space astrometry mission that will: i) "spot" the tiny gravitational pull of an Earth-like planet on a Sun analogue, for the first definitive confirmation of its existence humanity is waiting for; or ii) provide astrometric detections of Gravitational Waves (see also the monograph by Crosta 2019 mentioned above and references therein) for an almost ideal synergy with Earth-based or future space-born "traditional" gravitational antennas.

Finally, reaching the micro-arc-second level requires a tremendous improvement in the characterization of the space-borne 'observer': a) technology must allow for the stabilization of payload spatial configurations, or at least make provisions for on-board monitoring, to sub-atomic, i.e. pico-meter, levels for the several years usually needed to the astrometric measurements to reach the targeted accuracies; b) even in the weak gravitational fields of our Solar System theoretical astrometry has to provide a fully relativistic descriptions of everything: satellite state of motion and attitude, and the trajectories of the photons received from all directions. This has been a challenge even for Gaia, with a completely new model developed that guarantees already a 0.1 micro-arc-second modeling accuracy and it is built on a schema capable of pushing accuracy to whatever limits the future might require. In this respect Gaia, with 100 millions (as many as the primary stars specifically selected for this purpose) of relativistic trajectories (directions) to reconstruct at the same time, is by far the largest astronomical experiment in gravitational physics ever attempted. And future astrometry missions bear the promise to be the ultimate test of Einstein's GR itself.

This approach to science, i.e. mass production of astrometric (and spectro-photometric) data for billions of objects and at the same time quality measurements of such fundamental parameters for the individual objects, came of age during his years in Baltimore as Fine Guidance Sensor (FGS) Instrument Scientist at STScI where he was in charge of developing the scientific use of the Astrometer FGS, i.e., the best performing of the three available for the HST fine pointing and guiding. In particular, Lattanzi succeeded in developing the interferometric, high resolution, mode on the Astrometer for measuring diameters and masses by designing and implementing (through a number of specific HST proposals) an ad-hoc calibration program for the interferometric signature and science demonstration observations for proving feasibility and scientific potential (Lattanzi et al. 1994); Lattanzi et al. 1997; Tanga, Hestroffer, Lattanzi et al. 2003; Steffen, Mathieu, Lattanzi et al. 2001, see below).

As for the Catalog Astronomy part, Lattanzi was Co-PI of the GSCII Project for the production of the GSCII database (Lasker, Lattanzi et al. 2008) an astrometric and photometric 1-billion entries archive complete to R=20 (for a total of 10-billion observations, i.e., on average 10 observations per object) whose specifications are such that, besides its use as guide and bright object alert catalog for the HST operations, it represents the

most accurate and dense (to faint magnitudes) materialization, in visible light, of the 'non-rotating' Reference Frame until Gaia's results become available.
As such, it has been further developed with the addition of the APOP catalog (Qi, Yu, Bucciarelli, Lattanzi et al. 2015) and successfully employed to develop the Gaia mission and its science case and, in conjunction with the HIPPARCOS and TYCHO catalogs, to study the nature of high energy galactic and extragalactic objects via absolute registration of multi-wavelength images (Caraveo, Lattanzi et al. 1998; Lattanzi, Capetti, Macchetto 1997 and Capetti, Macchetto, Lattanzi 1997). It has also been instrumental for addressing hot issues in Galactic structure and Local Cosmology and the role of General Relativity (GR) in it (Spagna, Lattanzi et al. 2010; Curir, Lattanzi, et al. 2012, Lattanzi 2012, Curir et al. 2014, Re Fiorentin, Lattanzi et al. 2015, Crosta 2019). The first results from the Gaia mission (2016 and 2018) have proven the paradigm of Lattanzi's approach. Indeed, our group has been extremely successful in publishing important results on Galactic Structure (Poggio et al. 2017 and 2020), Stanghellini et al. 2017 and 2020) and Local Cosmology and GR (Casertano et al 2017; Riess et al. 2018; Crosta, Giammaria, Lattanzi, Poggio 2020 and references therein).

As recalled above, one trait the new astrometry still shares with the classical practice is the long time (decades!) required before actually seeing the final results of years of patience and hard work. Sometimes, this time is comparable of even longer than the scientific lifetime of a single astronomer or scientist, to the point that no time is left for the direct scientific exploitation on the scientific cases that had originally motivated the individual participation in the project. Also, its practice at an internationally recognized level requires interdisciplinary research skills (photometry, spectroscopy, engineering, ITC), and an unselfish approach to science: both needed to be formed first and then maintained.

This is why, upon his return to Italy, Lattanzi worked hard toward the creation of the AGRET group at OATo. Today this team brings together 23 staffers (70% of which are permanent after the addition between 2019 and 2020 of 2 more Research Scientists and 2 more Associate Scientists) including astronomers, experts in applied General Relativity, instrument designers and builders, and experts in advanced software systems. Lattanzi's leadership, coordination and constant mentoring led this team to the achievements below. His specific contribution to or participation in the individual programs can be in different forms and can take different roles: that of PI (including Program Management) or CO-I (including program scientific or technical leadership), or as a specialized collaborator.

The AGRET team at INAF-OATo is involved in many research areas, ranging from theoretical astrophysics and data processing to observational astronomy and instrumentation development. Several past and current activities are carried out in collaboration with national and international astronomical institutions, including the European Southern Observatory, the European Space Agency, the Space Telescope Science Institute, and the Shanghai Astronomical Observatory (SHAO) of the Chinese Academy of Sciences (CAS). The studies, experiments and observations (real or simulated) are based on both ground based instruments (VLBI, TNG, VLT/VLTI), and on satellites (Hipparcos, HST, IUE, ROSAT, IRAS, Gaia, NGST, GAME, AGP, Euclid).

The AGRET team was involved in the development and use of astronomical instrumentation in the visible, near- and mid-infrared bands (including the integration of three near- and mid-IR cameras), for conventional telescopes and interferometers, as well as in data processing programs. In particular, OATo had a significant participation in the Hipparcos Mission data processing and reduction, operation and calibration of the Hubble Space Telescope Fine Guidance Sensors, and the production of the Guide Star Catalog II for STScI and ESO. OATo contributed to the design study for the interferometric option of the ESA mission Gaia (1996-1998), under ESTEC contract, and to the initial proposal for the NIRVANA interferometric camera for LBT (1998-1999). OATo developed FINITO (1999-2003), the first Fringe Sensor Unit (FSU) for VLTI, in collaboration with ESO, and contributed as sub-contractor to the development of the two units of the PRIMA FSU. OATo participates to the JRA 4 of the EU FP6, under OPTICON, with activity focused on Co-phasing and Fringe Tracking, and fostered the development of astronomical interferometry in Italy on both scientific and technological aspects.

More recently, The AGRET team @OATo coordinates, for ASI and INAF, the Italian participation in the data reduction for the Gaia mission. For DPAC, the pan-European consortium entrusted by ESA with the mission science data reduction, the AGRET team is responsible for the validation of the core astrometry (via an independent reduction of the astrometry of the 100 million primaries) and for monitoring, and modeling, the performance of the astrometric instrumentation aboard, expected at the micro-arc-second level,

throughout the mission. OATo was one of the leading institutes in the European Leadership in Space Astrometry (ELSA) initiative, a RTN program supported within the EU-FP6, and is one of the four Italian leading Institutes representing INAF in GREAT, ELSA's continuation (but with more emphasis on scientific exploitation and outreach) as an EU-FP7 supported program. Finally, it is the only Italian participant among the six leading Institutes recently awarded the H2020 program "The Gaia Selection Function" (kick off in 2020).

Members of AGRET are leading (OATo leading node) the EU FP7 Programs: IPERCOOL "Interpretation and Parameterization of Extremely Red COOL dwarfs" (PI Smart; Start Exchange Program, coordinating nodes in UK, Brasil, and China), PARSEC "Parallaxes of Southern Extremely Cool Objects", (PI Smart; Incoming International Fellowship, and the "SPACE – 2012" program called "Measuring Eta_Earth: Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N, and Gaia" (EtaEarth in short, PI Sozzetti) coordinating nodes in USA (CfA) and Europe (Observatory of Geneve, and London University College).

Dr. Crosta leads the GAREQ experiment, designed to use the Gaia and Hubble (a specific proposal was approved in 2016 and will be completed in 2017) measurements to discriminate, for the first time, the effects of light deflection caused by Jupiter's quadrupolar mass distribution. The 2018 observations were also successful and the, quite complex, raw data reduction is still underway at the ST ScI in Baltimore.

Sozzetti and Lattanzi led, respectively, the spectroscopic Work Package and the APACHE transit photometry activities of the photometry WP of the recently approved project Ways-to-Other-Worlds (WoW) funded by the Italian Ministry for Research (PI G. Micela, INAF-OAPa) through a special funding program ("Fondi Premiali") for supporting the continuation of the APACHE program and the study of a new photometric transit system optimized on the widest wavelength range possible, from VIS (including the bleu part of the spectrum) **through** NIR (up to 2.4 microns).
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As mentioned above, in his recent review Lattanzi explains the wealth of the science case, in cosmology, fundamental physics and the science of exoplanets, left open by the fact that Gaia's accuracy, at its best, is limited to the few micro-arc-second level (Lattanzi 2012). And pushing astrometric accuracy to the micro-arc-second and beyond, in purse of the nano-arc-second, his a challenge for the mission strategies adopted as the astrometric stability of astronomical sources might not be able to support self-calibration instrumentation any longer and more, specifically designed, technology (active or passive or both) will have to be brought on board. That is why in recent years Lattanzi has fostered the search for ways to build payload designs and develop technology solutions for sub-micro-arc-second astrometry. An outstanding example of this activity is the GAME proposal (Lead Proposer Dr. Gai) that was first presented to ESA in 2010 in response to their call for M3 class missions of the Cosmic Vision program (Gai et al. 2012), and later, with the name AGP, in response of ESA's analogue 2014 call for M4 missions in fundamental physics (Riva et al 2016).
These studies have led to the project ASTRA (*Astrometric Science and Technology Roadmap for Astrophysics*), a key-technology demonstrator project to further develop and enable these sub-μas missions: ASTRA was approved for the three-year period 2019-2021 (the only one in Astrophysics!) by our MAECI and the Chinese Ministry of Science and Technology (MOST). It is with these kind of new-generation astrometry missions that rocky planets (including nearby habitable Earths) can be discovered and accurately measured or the detections and precise measurements (of both amplitude and direction) of Gravitational Waves can be brought in space.

Finally, by reinvesting proceeds from previous activities (contracts from space industries or national and international Institutions like ESO and JPL or overheads from managing EU programs) we where able to fund and develop, with the Regional Observatory of the Aosta Valley (OAVdA), the APACHE project, a seven-year precision photometric monitoring program (2-3 mmag), unique in Europe and implemented through an innovative battery of 5 automatic telescopes of the 0.4 m class, of a sample of about 2000 early-intermediate M dwarfs for the discovery of planetary transits. A program independent and at the same time

complementary to the Gaia mission of which will significantly increase the impact on the physics of planetary systems for this particular sample of stars (Damasso et al. 2010; Giacobbe et al. 2012). The program concluded recently with the publication of a catalog of photometric rotation periods for 107 rotating M dwarfs from the APACHE sample; these are stars that are primary targets of the NASA TESS mission as candidates for the identification of small transiting planets and particularly suitable for high precision mass measurements (Giacobbe, Benedetto, Damasso, ..., Lattanzi et al. 2020).

Utilization of/Experience with ground-based and space-borne facilities

- Paranal VLT's in VLTI configurations
- JKT, TNG, WHT at La Palma
- 2P2, 3P6 and NTT @ La Silla
- HST (science and calibration observations)

In the APPENDIX below, the list of the HST observing proposals (both for science and calibration, i.e. those serving all users of the science FGS I was responsible for as Instrument Scientist) I successfully entered as PI until my definitive departure from Baltimore in 1997 (as derived from a query to the NASA ADS Data Base).

Main realizations for the astronomical community

- HIPPARCOS. Catalog (with about 100 European Colleagues), "The Hipparcos and Tycho catalogues", 1997, ESA P-1200, Vol.1;
- GSC2. Catalog and Data Base (Lasker, Lattanzi, McLean et al. 2008, AJ);
- GSPC2. Catalog (Bucciarelli et al 2001, A&A);
- APOP (Qi, Yong, Bucciarelli, Lattanzi et al. 2015, AJ);
- Gaia DR1 Catalog (see the 2016 "Gaia Collaboration" papers);
- Gaia DR2 Catalog (see the 2018 "Gaia Collaboration" papers).

Most Important accomplishments and discoveries

- The development of a new, statistically important, generalization of the moving mean concept useful in high precision (and accuracy) comparisons of data (Bucciarelli, Taff, Lattanzi 1993).
- The break-up of the 1000-solar-masses WR stars in R136a cluster, at the core of 30Dor, in more 'normal' 60-100 M_{Sun} main sequence progenitors. A contribution to an observational problem theory cannot yet solve: the mass of the most massive stars than can be formed through the physics we know (Lattanzi et al. 1994);
- Size and Shape of Mira-type stars, firmly demonstrating that these stars are not round and that size and shape likely change during their pulsation cycles (Lattanzi et al. 1997)
- The discovery of the correlation between the circular velocity component of the motion of the MW thick disk stars and [Fe/H] and its mapping across the Milky Way plane: observational milestones for Local Cosmology (Spagna, Lattanzi, et al. 2010; Re Fiorentin, Lattanzi, Spagna 2019)
- The development of a new model for the relativistic description of photon trajectories and observer. The model is not only capable of describing Gaia's data with the necessary accuracy, it can also be applied to develop observation equations for future, sub-micro-arcsecond astrometry missions. In particular, for satellites we have introduced, and fully modelled, the concept of relativistic attitude (Crosta, Vecchiato, de Felice, Lattanzi 2015 and references therein; Bertone, Vecchiato, Bucciarelli, Crosta, Lattanzi et al. 2017; Crosta, Geralico, Lattanzi, Vecchiato, 2017; Vecchiato, Bucciarelli, Lattanzi et al. 2018).
- The first demonstration, utilizing kinematics of a sample of bona-fide thin disk stars extracted from the second Gaia data delivery (DR2), that a General-Relativity barionic-mass-only model of the disk kinematics fits the experimental data as well as state-of-the-art (Δ)CDM models (Crosta, Giammaria, Lattanzi, Poggio 2020).

Tutoring and mentoring

Lattanzi realized early on that teaching/tutoring and mentoring had to become an essential part of his scientific career. Key to his approach in tutoring and mentoring was the involvement of the thesis students or the young collaborators in the forefront activities of his research work or that of his team, always offering them a chance to express their personalities and foster new ideas, challenge their passion for research and push them to express their best potential, and finally put their talents into use. Over the 25 years from 1991 to date, Lattanzi tutored 19 students for their Laurea or Master degree in physics (specialization in astrophysics). The majority of them successfully entered PHD programs in Italy (Universities of Bologna, Padova, Siena, Torino and Trieste), Europe (DLR-Germany, Univ. of Munich, Univ. of Amsterdam, Univ. of Hertfordshire, UK) and in USA (Univ. of Pittsburgh), while others went on to pursue their science teaching careers in high schools, or work for IT companies. During the same years, Lattanzi acted as main advisor for nine PHD candidates and was mentor of nine Post-Docs and research trainees from China, UK, USA, and Italy coming to work with him on EU-FP-, National-, or Italian-funded programs.
Today, apart from the youngest elements awaiting to complete their PHD's, seven of the above collaborators are key members of his research team as accomplished astronomers and scientists on tenured (six) or long term (one) positions. Others are pursuing their careers as tenured astronomers and scientists abroad (France, Germany, Italy, and China).

In the following I attach the table providing the actual list of the students I have tutored toward their different achievements.

3-yr university diploma					
University	***A.Y.***	***University diploma in***	***Candidate***	***Title***	***Tutor/ Advisor***
TO	2018-19	Fisica	**Federica SANTUCCI**	**Scenario di rivelazione di onde gravitazionali per l'Astrometria Relativistica**	Lattanzi
TO	2017-18	Fisica	**Hervè HAUDEMAND**	**Le caratteristiche fisiche dell'ammasso aperto Stock 2 attraverso i nuovi dati della missione Gaia**	Lattanzi
TO	2014-15	Fisica	**Herta ARNAUD**	**Analisi e valutazione delle prestazioni astrometriche dei CCD a bordo del satellite Gaia forniti da differenti algoritmi di stima e confronto con il criterio di Cramér-Rao**	Lattanzi
TO	2013-14	Fisica	**Marco GIAMMARIA**	**Dalle segnature fossili dell'alone galattico al futuro della cosmologia locale nell'era di Gaia**	Lattanzi
Laurea magistrale in, ovvero Laurea specialistica in (Master)					
University	***A.Y.***	***Degree in***	***Candidate***	***Title***	***Tutor/ Advisor***
TO	2016-17	Fisica	**Gloria GUILLUY**	**L'atmosfera del Giove caldo transitante HD 189733b ad alta risoluzione spettrale**	Lattanzi
TO	2015-16	Fisica	**Marco GIAMMARIA**	**Galassie a disco da simulazioni cosmologiche avanzate: confronto delle proprietà strutturali e chemo-dinamiche con la Via Lattea**	Lattanzi
TO	2015-16	Fisica	**Giovanna RANOTTO**	**Studio di periodi di rotazione fotometrici di stelle nane rosse**	Lattanzi
TO	2013-14	Astrofisica e Fisica Teorica	**Lorenzo GIOANNINI**	**Ricerca di transiti planetari in serie temporali fotometriche di alta precisione nei campi della survey APACHE**	Lattanzi

University	*A.Y.*	*Degree in*	*Candidate*	*Title*	*Tutor/ Advisor*
TO	2009-10	Astrofisica e Fisica Cosmica	**Luca BIANCHI**	**Rappresentazione e ricostruzione relativistiche dell'assetto di satelliti applicate alla missione Gaia**	Lattanzi
TO	2009-10	Astrofisica e Fisica Cosmica	**Mario DAPRÀ'**	**Moti propri delle nane brune di campo nell'emisfero sud**	Lattanzi
TO	2009-10	Astrofisica e Fisica Cosmica	**Matteo PERDONCIN**	**Ricerca di pianeti extrasolari attorno a stelle nane M: caratterizzazione della micro-variabilità indotta da attività cromosferica**	Lattanzi
TO	2008-09	Astrofisica e Fisica Cosmica	**Paolo DONATI**	**Test astrometrici di Relatività Generale col Progetto GAME**	Lattanzi
TO	2008-09	Astrofisica e Fisica Cosmica	**Paolo GIACOBBE**	**Studio di fattibilità per la ricerca di pianeti extrasolari orbitanti intorno a stelle nane di tipo M con il metodo dei transiti**	Lattanzi
TO	2008-09	Astrofisica e Fisica Cosmica	**Federico MAROCCO**	**Proprietà fisiche delle nane brune super fredde**	Lattanzi
TO	2007-08	Astrofisica e Fisica Cosmica	**Federico COSSU**	**Fisica dell'ammasso aperto Stock 2 per mezzo di dati astrometrici e fotometrici**	Lattanzi

Laurea vecchio ordinamento (Old Master)

University	*A.Y.*	*Old Master in*	*Candidate*	*Title*	*Tutor/ Advisor*
Pisa	2000-01	Fisica	**Deborah BUSONERO**	**MISSIONE GAIA. Ottimizzazione dello strumento per misure di Astrometria Globale ad alta precisione**	Paolicchi (UniPI), Lattanzi
TO	1997-98	Fisica	**Fabrizia GUGLIELMETTI**	**Diametri angolari di variabili Mira con l'interferometro "FGS" sul telescopio spaziale Hubble**	Ferrari (UniTO), Lattanzi
Genova	1996-97	Fisica	**Marco DELBO'**	**Sistema di guida automatica per il telescopio astrometrico dell'Osservatorio Astronomico di Torino**	Ottonello (UniGE), Lattanzi
TO	1996-97	Fisica	**Mariateresa CROSTA**	**Misure astrometriche di onde gravitazionali**	Ferrari (UniTO), Lattanzi
TO	1996-97	Fisica	**Davide LOREGGIA**	**Modello teorico per l'interferometro FGS a bordo del telescopio spaziale Hubble**	Ferrari (UniTO), Lattanzi
TO	1995-96	Fisica	**Alessandro SOZZETTI**	**Astrometria globale ad altissima precisione per la ricerca di pianeti extrasolari**	Ferrari (UniTO), Lattanzi
Padova	1995-96	Fisica	**Alberto VECCHIATO**	**Astrometria Relativistica. Applicazioni al Progetto Gaia**	De Felice (UniPD), Lattanzi, Bernacca
TO	1990-91	Fisica	**Luca PIVIDORI**	**Algoritmi bidimensionali di centraggio di immagini stellari su lastre fotografiche digitalizzate per la derivazione di posizioni e moti propri**	Ferrari (UniTO), Lattanzi, Lasker

Ph.D. Thesis						
University, Research Center	**A.Y.**	***Ph.D. Thesis in***	***Cicle***	***Author***	***Title***	***Advisor(s)***
Torino	2021	Scienze della Natura e Tecnologie Innovative	XXXIII	**Marco GIAMMARIA**	**Gravitational Astrometry and Relativistic Galactic Models**	Crosta, Lattanzi
Torino	2020		XXXII	**Domenico BARBATO**	**Ricerca e Caratterizzazione di Pianeti Extrasolari con la missione Gaia**	Lattanzi, Sozzetti
Shanghai, Astronomical Observatory, CAS	2016	Astrometry and Celestial Mechanics	n.a.	**Shilong LIAO**	**Short term solution of the GAIA Celestial Sphere**	Qi, Tang (SHAO), Crosta, Vecchiato, Lattanzi (INAF-OATo)
Trieste	2014	Fisica	XXV	**Paolo GIACOBBE**	**Photometric transit search for planets around cool stars from the Western Italian Alps: the APACHE survey**	Matteucci (UniTS), Lattanzi
Torino	2010	Scienza e Alta Tecnologia	XXII	**Juan Carlos TERRAZAS VARGAS**	**Effects and consequences of the Radiation Damage on the Gaia CCD**	Bertaina (UniTO), Lattanzi
Torino	2005	Fisica e Astrofisica	XVII	**Paola RE FIORENTIN**	**Detection of fossil structures in the galactic halo by means of spectro-photometric and proper motion surveys**	Ferrari (UniTO), Lattanzi
Padova	2003	Scienze e Tecnologie Spaziali	XV	**Mariateresa CROSTA**	**Metodi di astrometria relativistica per l'analisi di dati astrometrici nei campi gravitazionali del Sistema Solare**	De Felice (UniPD), Lattanzi
Padova	2000	Scienze e Tecnologie Spaziali	XIII	**Alberto VECCHIATO**	**Astrometria relativistica dallo spazio: modelli teorici e implementazione di software per la riduzione dati**	De Felice (UniPD), Lattanzi
Torino	1993-94	Fisica	VII	**Alessandro SPAGNA**	**Survey di moti propri e colori con lastre Schmidt per lo studio della cinematica e struttura della Galassia**	Ferrari (UniTO), Lattanzi

Memberships

- Member, Società Astronomica Italiana
- Full member, American Astronomical Society
- Member, International Astronomical Union (Division A: Fundamental Astronomy, C.8 Astrometry;
- Division G: Stars and Stellar Physics, C.26 Double and Multiple Sstars)

Citation Indices

(as calculated with Google Scholar)

- h-index 44
- i10-index 109
- Citations 15395

Awards

- Outstanding Service Award, from the Space Telescope Science Institute, Oct 27, 1994;
- Certificate presented by ESA in recognition of the scientific contribution to ESA's Hipparcos Astrometry Project, ESA, Dec 9 1997;
- Certificate presented by ESA in recognition of the outstanding contribution made to the GAIA mission Project, ESA, Dec 19 2013;
- Awarded a Professorship under the 2015 International Fellowship Initiative (PIFI) for Visiting Scientist by the President of the Chinese Academy of Sciences.

Organization of international conferences / schools

- Course Director, International School of Space Science "*High Resolution Observations in Astronomy"*, L'Aquila, August – September 1999

- Chair and Convenor of the meeting "*GAIA: origin and evolution of the Milky Way"*, presentation of the ESA Cornerstone Mission Gaia to the Italian community, Roma, June 2000

- Chair and Convenor of the "*6th Gaia Planetary Systems Working Group Meeting"*, Geneve, April 2005

- Chair, European Science Foundation Conf. "*Putting our solar system in context: origin, and physical evolution of multiple planet systems*", Obergurgl (A), April 2010

- LOC Chair and Editor, IAU Symp. 276, "*The Astrophysics of Planetary Systems: Formation, Structure, and Dynamical Evolution*", Torino, October 2010

- Course Director, Lucchin School, "*Gaia: Science with One Billion Stars*", Asiago, October 2010

- SOC Member, GREAT ESF Conf., "*The Fundamental Cosmic Distance Scale: State of the Art and the Gaia Perspective*", Napoli, May 2011

- SOC Member and Editor GREAT ESF Workshop, "*QSO Astrophysics, Fundamental physics, and Astrometric Cosmology in the Gaia Era*", Porto (P), June 2011

- SOC Member of the GREAT ESF Workshop, "*Gaia and Exoplanets: GREAT Synergies on the Horizon*", Torino, November 2012

- SOC Member of the GREAT ESF Workshop, "*Gaia and the Unseen. The Brown Dwarf Question*", Torino, March 2014

- SOC Member of the Conferences , "*The Time Machine Factory*", Torino, October 2015 and September 2019

Service (including administrative duties)

- Referee for some among the main astronomical journals (AA, AJ, PASP, MNRAS);
- Served as Referee for the G2 class (Physics) of the ANVUR system for the evaluation of the quality of the Italian research system (VQR 2004-2010);
- Served as peer reviewer for the assignment of tenured positions of scientists and astronomers for institutions and universities in Europe (Observatoire de la Cote d'Azur, France) and USA (ST ScI, University of Missouri).
- Member and chair of several panels for the evaluation of candidates to fill permanent (tenured) and temporary positions of research astronomer and scientist at Italian Observatories (to feb 2020);

- Responsible for the automation project of the OATo main telescope (REOSC 1.05m) for utilization in parallax astrometry (the TOPP program), optical monitoring of extragalactic transients (like, e.g., Blazars) and monitoring of space debris (in collaboration with the Observatory of Shanghai, China);
- Responsible for direct contracts, from few thousands Euros to ~0.6 M€, to or from high tech companies in support of the research activities of the AGRET team: development of a new generation of multi-aperture light telescopes for testing fundamental physics through very high accuracy space astrometry (BOOSTEC, France; ADS, Italy); automatic telescopes for the APACHE Project (Officina Stellare, Italy); the development of the Italian Data Processing Center for the Gaia mission (ALTEC, SpA, Italy; Eurix, Italy; Oracle, USA); the production of the first deep star catalog for the Fine Guidance Sensor (FGS) aboard the Euclid satellite: the Euclid FGS will use the GSC II database for improving the absolute pointing performances of the telescope thus gaining more time/fields to the science of the Euclid mission (Thales Alenia Space Italia, France-Italy).
- Serving as Technical and Legal Responsible Officer for several contracts to external contractors for the activities of different on-going programs (in Italian "Responsabile Unico del Procedimento", in short RUP). Hereafter, the list (in Italian) of the RUP activities for the years 2011-2020 as taken from the site of the ANAC, the authority that oversees all contracts issued by the Italian public administrations..

Codice Identificativo di Gara (CIG)	***Descrizione***	***Importo***	***Data di acquisizione***
221182795F	Fornitura di due sistemi di acquisizione di immagini astronomiche necessari per la realizzazione del programma di ricerca "*Rivelazione di pianeti extrasolari con il metodo dei transiti fotometrici*"	€ 53.000,00	29/04/2011
2701857AEB	Fornitura di un sistema di controllo e movimentazione professionale a bordo del telescopio equatoriale REOSC	€ 70.754,59	09/06/2011
3865408B94	Servizio di realizzazione di software Java ad altissima specializzazione da consegnare ed integrare presso il Data Processing Center Italiano (DPCT), parte della sezione di Science Data Reduction del Segmento di Terra per la riduzione dei dati dal satellite Gaia dell'ESA	€ 53.500,00	25/01/2012
4294039115	Rinnovo per un anno dei Servizi Software Update License & Support (Supporto Tecnico). Licenze Oracle in modalità Campus Wide	€ 50.651,30	30/05/2012
4908052CA0	Servizio di realizzazione di sviluppo, ingegnerizzazione e implementazione codice Java ad altissima specializzazione per la fase pre-lancio del satellite Gaia dell'ESA	€ 69.500,00	01/02/2013
5126099EB3	Fornitura licenze ORACLE Campus Wide Perpetue per la missione spaziale Gaia	€ 309.979,17	16/05/2013
543514685C	Fornitura del cortometraggio di videoanimazione ad altissima specializzazione *The meaning of light: the photon that fell Gaia* per il programma di divulgazione nazionale inerente l'inizio delle operazioni della missione Gaia	€ 43.442,62	14/11/2013
5582895EAF	Utilizzo delle risorse informatiche nel progetto Gaia per calcolo parallelo	€ 65.000,00	30/01/2014
5821391BD0	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia – Fase di *Early Science Operations*	€ 50.100,00	23/06/2014
602979583D	Servizio di software update & support connesso al contratto licenze Oracle Campus Wide Perpetue per la missione spaziale Gaia – 2015	€ 65.200,00	27/11/2014
612489466B	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia – Fase di *Science Operations – Cycle 00*	€ 40.100,00	09/02/2015

Codice Identificativo di Gara (CIG)	***Descrizione***	***Importo***	***Data di acquisizione***
632667053E	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia – Fase di *Science Operations – Cycle 01*	€ 50.200,00	08/07/2015
6480347783	Servizio di software update e support connesso al contratto licenze Oracle Campus Wide Perpetue per la missione spaziale Gaia – 2016	€ 67.062,00	19/11/2015
657736012E	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia – Fase di *Science Operations – Cycle 02*	€ 50.100,00	02/02/2016
69244859C8	Servizio di software update e supporto connesso al contratto licenze Oracle Campus Wide Perpetue per la missione spaziale Gaia – 2017	€ 69.075,00	22/12/2016
6966116CC4	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia - Fase di *Science Operations – Cycle 03 – Final Development Phase*	€ 60.100,00	02/02/2017
7036900993	Utilizzo delle risorse informatiche nel progetto Gaia per calcolo parallelo – Annesso tecnico n. 2 al MOU CINECA-INAF	€ 75.000,00	04/04/2017
7223068845	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia – Fase di *'Science Operations – Data Segment 4 – Manutenzione Evolutiva dei sistemi AVU presso il DPCT*	€ 50.100,00	02/10/2017
733544263B	Servizio di software update e supporto connesso al contratto licenze Oracle Campus Wide Perpetue per la missione spaziale Gaia – 2018	€ 71.840,00	27/12/2017
7747650B07	Servizio di software update e supporto connesso al contratto licenze Oracle Campus Wide Perpetue per la missione spaziale Gaia – 2019	€ 74.000,00	21/12/2018
8155414C86	Servizio di software update e supporto connesso al contratto licenze Oracle Campus Wide Perpetue per la missione spaziale Gaia – 2020	€ 77.000,00	23/12/2019
8184850FE0	Utilizzo delle risorse informatiche nel progetto Gaia per calcolo parallelo – Annesso tecnico n. 3 al MOU CINECA-INAF	€ 50.000,00	24/01/2020
8294783F75	Servizio per la realizzazione di software Java ad altissima specializzazione per il Data Processing Center Italiano (DPCT) della missione Gaia - Fase di *Science Operations – Cycle 3 Data Segment 7 – Manutenzione del sistema AVU-GSR presso il DPCT per la missione Gaia e produzione della documentazione.*	€ 15.100,00	07/05/2020

Publications

Lattanzi has authored/co-authored 157 articles in several of the most important refereed journals on astrophysics and astronomical techniques. He has also published over 200 contributions to national and international meetings (including invited participations) and literally hundreds of technical reports for programs like Hipparcos, GSCII, HST-FGS, MOFFIT, Gaia, Euclid, etc.
A listing of his works is provided below.

Publications in International Refereed Journals

1. LIU J., ZHENG Z., SORIA R., ….., **LATTANZI M.G.** et al., 2020, **Phase-dependent Study of Near-infrared Disk Emission Lines in LB-1**, *Astrophys. J.*, **900**(1), article id. 42, 10 pp.

2. CROSTA M., GIAMMARIA M., **LATTANZI M.G.** et al., 2020, **On testing CDM and geometry-driven Milky Way rotation curve models with Gaia DR2**, *Mon. Not. R. Astron. Soc.*, **496**(2), 2107-2122

3. POGGIO E., DRIMMEL R., ANDRAE R., ….., **LATTANZI M.G.** et al., 2020, **Evidence of a dynamically evolving Galactic warp**, *Nature Astron.*, **4**, 590-596

4. GIACOBBE P., BENEDETTO M., DAMASSO M., …..**, LATTANZI M.G.** et al., 2020, **Photometric rotation periods for 107 M dwarfs from the APACHE survey**, *Mon. Not. R. Astron. Soc.*, **491**(4), 5216-5237

5. STANGHELLINI L., BUCCIARELLI B., **LATTANZI M.G.** et al., 2020, **The Population of Galactic Planetary Nebulae: a Study of Distance Scales and Central Stars Based on the Second Gaia Release**, *Astrophys. J.*, **889**(1), article id. 21, 10 pp.

6. LIU J., ZHANG H., HOWARD A.W., ….., **LATTANZI M.G.** et al., 2019, **A wide star-black-hole binary system from radial-velocity measurements**, *Nature*, **575**, 618-621

7. ABBAS U., BUCCIARELLI B., **LATTANZI M.G.**, 2019, **Differential astrometric framework for the Jupiter relativistic experiment with Gaia**, *Mon. Not. R. Astron. Soc.*, **485**(1), 1147-1156

8. RE FIORENTIN P., **LATTANZI M.G.** et al., 2019, **Evidence of a large-scale positive rotation-metallicity correlation in the Galactic thick disc**, *Mon. Not. R. Astron. Soc.*, **484**(1), L69-L74

9. Gaia Collaboration: EYER L., RIMOLDINI L. et al. (453 more), 2019 **Gaia Data Release 2: Variable stars in the colour-absolute magnitude diagram**, *Astron. Astrophys. Sp. Issue, Gaia Data Release 2*, **623**, article id. A110, 20 pp

10. SMART R.L., BUCCIARELLI B., JONES H.R.A., ….., **LATTANZI M.G.** et al., 2018, **Parallaxes of Southern Extremely Cool objects III: 118 L and T dwarfs**, *Mon. Not. R. Astron. Soc.*, **481**(3), 3548-3562

11. POGGIO E., DRIMMEL R., **LATTANZI M.G.** et al., 2018, **The Galactic warp revealed by Gaia DR2 kinematics**, *Mon. Not. R. Astron. Soc.*, **481**(1), L21-L25

12. VECCHIATO A., BUCCIARELLI B., **LATTANZI M.G.** et al., 2018, **The global sphere reconstruction (GSR). Demonstrating an independent implementation of the astrometric core solution for Gaia**, *Astron. Astrophys.*, **620**, article id. A40, 19 pp

13. BROWN A.G.A., **LATTANZI M.G.** et al., 2018, **Gaia and the Galactic Center Origin of Hypervelocity Stars**, *Astrophys. J.*, **866**(1), article id. 39, 9 pp

14. GUO S., QI Z., LIAO S., ….., **LATTANZI M.G.** et al., 2018, **Identifying quasars with astrometric and mid-infrared methods from APOP and ALLWISE**, *Astron. Astrophys.*, **618**, article id. A144, 7 pp

15. Gaia Collaboration: MIGNARD F., KLIONER S. et al. (449 more), 2018, **Gaia Data Release 2: The celestial reference frame (Gaia-CRF2)**, *Astron. Astrophys. Sp. Issue, Gaia Data Release 2*, **616**, article id. A14, 15 pp

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Date 30 Sep 2020…..

Signature

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APPENDIX

(Query from NASA ADS)

Title: Intermediate Plate Scale Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6921
Publication Date: 07/1996
Origin: HST
Keywords: HST Proposal ID #6921
Bibliographic Code: 1996hst..prop.6921L

Abstract

The problem of calibrating the FGSs for astrometric work involves two complementary aspects: the plate scale and the optical distortions. The scale-length desired in these calibration efforts differs. The essential point of this calibration is to refine our knowledge of the plate scale in the central region of the astrometer FGS for this is where all annual parallax work will be executed by the GOs and GTOs. It rests on a set of stars included in the ESA Astrometry satellite HIPPARCOS's observing list.

Title: Monitor the Long-Term Stability of FGS 3 Still
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6325
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6325
Bibliographic Code: 1995hst..prop.6325L

Abstract

The goal of these measurements is to monitor the internal positional stability of the FGSs by measuring many stars in the M35 check field repeatedly over a one year period. The results of these measurements are the stability characteristics of the FGS to allow an estimate of differential corrections to OFAD and Plate Scale. This is an ecliptic field. During each of two primary orientations, we will secure observations over a 130 day span, roughly every 30 days. THIS IS AN FGS 3 TEST.

Title: Red/blue and TF Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6181
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6181
Bibliographic Code: 1995hst..prop.6181L

Abstract

The purpose of this proposal is to obtain reference Transfer Functions through the NEUTRAL DENSITY at the center of the fov of FGS #3 (the astrometer). These Transfer Functions will be used to deduce the presence of secondary stars in multiple systems, and to calibrate the non-zero angular diameter of extended sources. This calibration is essential for many GO and GTO programs.

Title: Red/blue TF Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6180
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6180

Bibliographic Code: 1995hst..prop.6180L

Abstract

The purpose of this proposal is to obtain reference Transfer Functions through the PUPIL and CLEAR filters at the center of the fov of FGS #3 (the astrometer). These Transfer Functions will be used to deduce the presence of secondary stars in multiple systems, and to calibrate the non-zero angular diameter of extended sources. This program is essential for many GO and GTO programs.

Title: Intermediate Plate Scale Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6177
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6177
Bibliographic Code: 1995hst..prop.6177L

Abstract

The problem of calibrating the FGSs for astrometric work involves two complementary aspects: the plate scale and the optical distortions. The scale-length desired in these calibration efforts differs. The essential point of this calibration is to refine our knowledge of the plate scale in the central region of the astrometer FGS for this is where all annual parallax work will be executed by the GOs and GTOs. It rests on a set of stars included in the ESA Astrometry satellite HIPPARCOS's observing list.

Title: Binary Plate Scale Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6176
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6176
Bibliographic Code: 1995hst..prop.6176L

Abstract

The primary goal of this proposal is to calibrate the plate scale, for binary star observations, in the central region of the astrometer FGS. Five targets will be observed at 3 different positions. This is essential for supporting GO and GTO observations of double stars.

Title: Red/blue TF Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6175
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6175
Bibliographic Code: 1995hst..prop.6175L

Abstract

The purpose of this proposal is to obtain reference Transfer Functions through three filters (PUPIL, CLEAR and NEUTRAL DENSITY) at each of 3 points in FGS #3 (the astrometer). These Transfer Functions will be used to deduce the presence of secondary stars in multiple systems, and to calibrate the non-zero angular diameter of extended sources. The 3 points are distributed azimuthally along the midline of the field of view. The standard FGS calibration target, Upgren 69, will be observed through the F583W, PUPIL and F5ND filters at each of the 3 points.

Title: Delta Mini-Ofad
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6174
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6174
Bibliographic Code: 1995hst..prop.6174L

Abstract
The goal of these activities is to calibrate the changes to the optical field angle distortions (OFAD) of FGS unit #3. This calibration will return the knowledge of the OFAD, to within an arbitrary scale factor, to a level of accuracy sufficient to support an overall astrometry error budget of 0.0027 arcseconds rms. The actual solutions will provide the Project Data Base with the significant terms, their values, and their covariances including errors, which may then be applied to general FGS observations to reduce them for field angle distortions, except scale, alignment, and color corrections.

Title: Monitoring the Size and Shape of Mira-Type Stars Throughout Their Pulsation Cycles
Authors: Lattanzi, Mario
Publication: HST Proposal ID #6049
Publication Date: 07/1995
Origin: HST
Keywords: HST Proposal ID #6049 COOL STARS
Bibliographic Code: 1995hst..prop.6049L

Abstract
We propose to utilize the unmatched angular resolution in the visual of the astrometer FGS, in an attempt to measure SIZES and SHAPES of Miras variables and their variations with the pulsation phase. In particular, it would be possible, for the first time, to cover the full 4div6 (average) magnitude range of a pulsation cycle with the same instrument and with a fairly high signal-to-noise throughout. The scientific return is potentially very rewarding. Mapping the variations of Mira diameters is of key importance for the detailed understanding of their pulsation mechanism, and ultimately, for the use of Miras as galactic and extragalactic distance indicators. Also, confirmation of elliptical projected disks would set constraints on the existence and relevance of non-radial pulsations. The programme is particularly suited for the FGS, the only orbiting interferometer. It requires, together, all of those outstanding characteristics, high angular resolution, large dynamical range, and faint (for an interferometer) magnitude limit, which make this wide-band visual interferometer unique compared to ground based facilities.

Title: Intermediate Plate Scale Cycle 4 Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #5557
Publication Date: 07/1994
Origin: HST
Keywords: HST Proposal ID #5557
Bibliographic Code: 1994hst..prop.5557L

Abstract
The problem of calibrating the FGSs for astrometric work involves two complementary aspects; the plate scale and the optical distortions. The scale-length desired in these calibration efforts differs. The essential point of this calibration is to refine our knowledge of the plate scale in the central region of the astrometer FGS for this is where all annual parallax work will be executed by the GO's and GTO's. It rests on a set of stars included in the ESA Astrometry satellite HIPPARCOS's observing list.

Title: Intermediate Plate Scale Cycle 2 CALIBRATION-PART2
Authors: Lattanzi, Mario
Publication: HST Proposal ID #5250
Publication Date: 07/1992
Origin: HST
Keywords: HST Proposal ID #5250
Bibliographic Code: 1992hst..prop.5250L

Abstract

FGS CHARACTERIZATION The primary goal of this proposal is to calibrate the plate scale in the central region of the astrometer FGS. This is a modification of STAT SV proposal AST-SV-04 and uses and asterism observed by the ESA astrometry satellite HIPPARCOS especially for this purpose.

Title: Exposure Time Calibration in High Background Fields-Fixed
Authors: Lattanzi, Mario
Publication: HST Proposal ID #5066
Publication Date: 07/1992
Origin: HST
Keywords: HST Proposal ID #5066
Bibliographic Code: 1992hst..prop.5066L

Abstract

FGS CHARACTERIZATION. This proposal aims at the determination of the minimum observing time for TRANSfer Mode observing when point-like targets are projected against high background fields. Coupling of the OTA spherical aberration with FGS internal misalignments induces spurious correlation even in a beam of incoherent light as that from a perfectly flat background. This is further complicated when, as is the case for much cluster work, the backgrounds are strong and have steep luminosity gradients or are themselves variable. Observations will be performed in the center of the astrometer FGS. This proposal incorporates parts of STAT SV proposal AST-SV-01.

Title: Intermediate Plate Scale Cycle 2 Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #5065
Publication Date: 07/1992
Origin: HST
Keywords: HST Proposal ID #5065
Bibliographic Code: 1992hst..prop.5065L

Abstract

FGS CHARACTERIZATION The primary goal of this proposal is to calibrate the plate scale in the central region of the astrometer FGS. This is a modification of STAT SV proposal AST-SV-04 and uses and asterism observed by the ESA astrometry satellite HIPPARCOS especially for this purpose.

Title: Exposure Time Calibration in High Background Fields
Authors: Lattanzi, Mario
Publication: HST Proposal ID #4775
Publication Date: 07/1992
Origin: HST
Keywords: HST Proposal ID #4775
Bibliographic Code: 1992hst..prop.4775L

Abstract

FGS CHARACTERIZATION. This proposal aims at the determination of the minimum observing time for TRANSfer Mode observing when point-like targets are projected against high background fields. Coupling of the OTA spherical aberration with

FGS internal misalignments induces spurious correlation even in a beam of incoherent light as that from a perfectly flat background. This is further complicated when, as is the case for much cluster work, the backgrounds are strong and have steep luminosity gradients or are themselves variable. Observations will be performed in the center of the astrometer FGS. This proposal incorporates parts of STAT SV proposal AST-SV-01.

Title: Intermediate Plate Scale Cycle 2 Calibration
Authors: Lattanzi, Mario
Publication: HST Proposal ID #4727
Publication Date: 07/1992
Origin: HST
Keywords: HST Proposal ID #4727
Bibliographic Code: 1992hst..prop.4727L

Abstract

FGS CHARACTERIZATION The primary goal of this proposal is to calibrate the plate scale in the central region of the astrometer FGS. This is a modification of STAT SV proposal AST-SV-04 and uses and asterism observed by the ESA astrometry satellite HIPPARCOS especially for this purpose.

Title: Dark Count Statistics for GHRS Detectors
Authors: Lattanzi, Mario
Publication: HST Proposal ID #4012
Publication Date: 07/1992
Origin: HST
Keywords: HST Proposal ID #4012
Bibliographic Code: 1992hst..prop.4012L

Abstract

The proposed observations will obtain the statistical data needed to plan an operational strategy for observing faint targets with the GHRS.
The proposed test involves only the use of Side 2, since only this side of the GHRS can benefit from the results of this test at the present time. Because of the loss of the GHRS low-resolution mode (G140L), many observing programs that had originally specified G140L have been changed to use G160M. Hence, the problem of reducing the GHRS dark-count becomes even more acute. The proposed tests should give us the information needed to evaluate by how much the dark-count can be reduced by the appropriate operational strategy (see Question 3).