

CURRICULUM VITAE STUDIORUM- PIA ASTONE

Position and Main Responsibilities: summary

March 2001–today: **INFN “First Researcher”**, Rome section.

2003–today: **Member of the Virgo collaboration**. And of the LIGO / Virgo (LVC) collaboration since 2007, when the first agreement between the two collaborations was signed. **Virgo scientific and computation coordinator from 2012 to 2014, and LIGO / Virgo scientific co-coordinator** in the same period. Experience in advanced data analysis techniques to extract low Signal Noise Ratio (SNR) signals from noise. Experience in noise recognition and data cleaning techniques. Experience in advanced calculation techniques (code optimization, hierarchy of analysis procedures, use of GPUs, parallelization for GRID use).

Nov. 2005–today: **Professor (through contract and convention with INFN)**, for the teaching of Physics, at "La Sapienza" ("Faculty of Medicine and Pharmacy"). Member of the **commission for didactics** of the same faculty, starting from the actual academic year (2020/2021). 75 hours, 8 CFU. See: <https://corsidilaurea.uniroma1.it/it/users/piaastoneuniroma1it>

2018- today: member of the **Steering Committee of the "Amaldi Center"**, Department of Excellence project (chair: Prof. ██████████), and **responsible** for one of the 5 research lines (L2: data analysis for gravitational wave detectors) of the project. Information at the site: <http://www.roma1.infn.it/amaldicenter/home.html>

October 2018-January 2019: member of the **INFN commission** for the recruitment of 3 permanent researchers, III level (research theme: experimental gravitational wave searches), call 20010/18.

June 2019–today: **national INFN coordinator** (and local chair in the INFN section of Rome) for the outreach project **Lab2GO**, aimed at enhancing the organization and use of laboratories, in secondary Italian schools. And, from the same period, **local coordinator of the outreach activities** in the Rome INFN section (<https://web.infn.it/CC3M/index.php/it/chi-siamo/persona>).

April 2020–today: **chair of the Virgo group of the INFN section of Rome** and member of the restricted higher decisional committee in Virgo, the “Virgo Steering Committee”, **VSC**.

From the academic year 2020/2021: responsible, with ██████████ and ██████████, for one **PhD course at the Physics Department of La Sapienza** on “Advanced Data analysis techniques. Theory and applications”. 20 hours, 3 CFU.

ASN habilitation for Full Professor, first level, for the scientific disciplinary sector **FIS02 / C1**, validity: 16/05 / 2019-16 / 05/2025

ASN habilitation for Full Professor, first level, for the scientific disciplinary sector **FIS02 / A1**, validity: 20/12 / 2019-20 / 12/2028

Personal web pages: <http://www.roma1.infn.it/rog/astone/>

RESEARCH FIELDS

Physics of gravitational waves (GW); GW Data Analysis, with particular expertise in stochastic background research and transient signals (at the beginning) and in the research of continuous and long transient gravitational waves (CW), in more recent years; Observational relativity and cosmology. Computational issues.

Outreach activities, for dissemination of results related to GW searches and activities for physics laboratories in second degree secondary Italian schools.

PREVIOUS POSITIONS IN THE INFN

1988-1990: INFN researcher, with a 2-year position. Work on data analysis (filtering procedures, data acquisition system) within the group of GW resonant detectors (ROG: Gravitational Wave Research), to search for transient GW signals (such as those from Supernova explosion)

1990-2000: since December 1990, INFN researcher with a permanent position. Work in GW data analysis, with emphasis on noise mitigation, search for transient signals, stochastic background and CW signals.

HIGHER EDUCATION AND PREVIOUS WORK EXPERIENCES AND TRAINING

1979: Classical high school diploma "Classical high school", with full marks (60/60)

1984: Degree with honors in Physics, at the University of Rome "La Sapienza" Supervisors:

Prof. ██████████, Prof. ██████████. Experimental thesis: `` Analysis

through spontaneous noise and stimulation of capacitor characteristics. "1984, June 28

1984-1986: Work as a volunteer "research assistant" at the Faculty of Electronic Engineering, with

Prof. ██████████, Prof. ██████████.

1984-1986: High school teacher at the "Maxwell" Technical Institute and teacher

at the Military School of Aeronautics in Pratica di Mare.

1986-1988: qualification as a physicist designer of radar systems at the company "Contraves", I worked on the design of delay lines and low noise amplifiers for the X-SAR mission. Training courses and professional experience on the use of Computer Aided Engineering systems. I have in this period attended courses, produced results and reports of a level and quality comparable to a PhD experience (studies that in Italy at that time were only at the beginning, so that an experience in external company was to be preferred).

MAIN SCIENTIFIC CHARGES and RESPONSIBILITIES

1998-2003: Responsible for data analysis for the scientific activities of the ROG group and co-chair for the "International Gravitational Event Collaboration" (IGEC), for the search for transient signals in a network of resonant GW detectors, spread all over the world (Italy, CERN, Louisiana, Western Australia). Responsible for the two agreements between the ROG group and the Polish Academy of Sciences, first, and the AEI Institute of Potsdam, later, for the analysis of the Nautilus detector data, in research activities of continuous gravitational signals and of gravitational stochastic background. Agreements signed with Prof. ██████████ (Poland) and Prof. ██████████ (AEI), with whom a fruitful collaboration has continued since then.

2010-2012: Virgo chair of the "CW working group" (Continuous wave searches) and co-chair of the same LIGO / Virgo group.

2012-2014: Chair of Virgo data analysis and co-chair in the LIGO / Virgo collaboration ("DAC chair", data analysis activities). We were preparing LIGO / Virgo science for the era of advanced detectors, along with future collaboration with electromagnetic (EM) partners. In particular, the proposal to prepare very detailed "Research plans", conceived and coordinated by me together with my LIGO co-chair, as you can see at the following link <https://dcc.ligo.org/LIGO-T1400054/public>, proved to be the right strategy in the years immediately following, when the gravitational wave detection became a reality. During the same period, I was a member of the "Virgo Steering Committee" (VSC), the highest decision-making body of Virgo.

2012-2014: coordinator of the computation in preparation of "Advanced Virgo", with the particular mandate to develop the "Advanced Virgo Computing Model", which I did, producing the computation model. See the document at the public link at <https://tds.virgo-gw.eu/ql/?c=9474>

2012-2015: chair of the ROG group of the INFN in Rome. The resonant detectors were still in operation, pending the entry into measurement of Advanced LIGO and Advanced Virgo, in "Astrowatch" mode (observation, in case of detectable events even at low sensitivity).

2013: member of the restricted LIGO / Virgo task force for the renewal of the agreement between the two collaborations. This agreement was very important for successful joint activities in the era of advanced detectors, which began with the first detection of a binary black hole merger in September 2015 (signal GW150914).

2015: member of the "LIGO Red Team" for the revision of the LIGO "Computing Model" (assignment given to me by Prof. [REDACTED], for my experience as coordinator of Virgo computation). The mandate was to thoroughly examine LIGO's computing environment and compute requests prior to submission to the National Science Foundation (NSF). This was extremely important, following an initial almost negative NSF report in May 2014, and led to the full approval of the calculation model and subsequent claims.

September 2015-February 2016: for my previous work and role in the LIGO / Virgo collaboration, in September 2015 I was commissioned to be one of the six editors of the first article on the discovery of gravitational waves (Phys. Rev. Lett. 116, 061102). The following link contains information on this subject <https://www.ligo.org/magazine/LIGO-magazine-issue-8-extended.pdf#page=34>. This assignment was of great responsibility and an important recognition of my commitment to collaboration. We had to decide not only the structure of the document, but also the details of the content, the citations and we had full responsibility and the last word on any proposal that came from other collaboration members (we worked managing more than 3000 "tickets", i.e., different comments from collaboration members). We had the responsibility to answer to the reviewers of the journal and to present our work to the collaboration, through regular meetings and discussions.

2018-> today: member of the Steering Committee of the "Amaldi Center", Department of Excellence project (head of Prof. [REDACTED]) and responsible for one of the five scientific lines of the project. Information at: <http://www.roma1.infn.it/amaldicenter/home.html>

October 2018-January 2019: member of the INFN commission for the recruitment of 3 permanent researchers, III level (research theme: experimental gravitational wave searches), call 20010/18.

Since June 2019 I am national INFN chair (and local chair in the INFN section of Rome) for the outreach project "Lab2GO", for the re-evaluation of school laboratories in secondary schools. Information on the site: <https://web.infn.it/lab2go/>. In this project we follow about 80 schools and, only in the INFN section of Rome and the Department of Physics, we have more than 20 researchers who join by tutoring in schools. We typically reach each year more than 300 students. During the Covid pandemia and to face the restrictions, we have reorganized the project, without changing the original idea "science passes through your hands", and the Lab2go@home variant has been successfully implemented. Through guided lectures and experiences we have and are now improving the student's ability to observe, make and document experiments. See: https://lab2go.roma1.infn.it/doku.php?id=fisica:lab2go_at_home_fisica:start

Since October 2019 I am also the contact person in the INFN section of Rome for all the outreach activities (third mission, under the CC3m commission, chaired by Dr. [REDACTED]) on behalf of the Director Dr. [REDACTED].

Since April 2020, I am the chair of the Virgo group of the INFN section of Rome and again member of the restricted higher level decisional committee in Virgo, the VSC. Funding and personnel requests are done under my responsibility. Our group is presently composed by 25 researchers, including PhDs and post-docs, amounting to 14.4 FTE. We cover experimental and data analysis aspects of GW searches.

OTHER RESPONSIBILITIES

2008-2011: as part of the INFN activities in the Rome section, I had the mandate of the director Dr. [REDACTED], to coordinate education and training courses for INFN colleagues (in some cases the lectures were open to University Physics students).

2013-2015: Chair in Virgo of the "LVC Diversity Committee", with the mission of promoting awareness on issues related to gender, race, religion etc., addressing issues of equity and protecting the rights of minorities of any kind in a scientific context. I wrote the document that defines the difficult role of the "Ombudsperson", confidant and contact person for problems of this type, in relation to LIGO / Virgo collaborations.

November 2017 - November 2019: Chair of the INFN task force for scientific dissemination related to

gravitational waves in schools. Under my mandate, on behalf of Prof. [REDACTED], head of the CC3M - commission for the third mission - INFN, and therefore under my scientific coordination, we have produced a popular comic, distributed in various locations and attached to the issue of "Àsimmetrie" the official magazine of INFN) of April 2019. The comic can be downloaded from the website:

https://www.asimmetrie.it/images/26/pdf/fumetto_allegato_AS26.pdf

In the same period, I also coordinated the production of three posters, respectively, on the history, science and discovery of gravitational waves (already translated and also available in English). The posters are public, and the Italian versions can be downloaded from the Virgo documentation site: <https://tds.virgo-gw.eu/?content=3&r=16247>, <https://tds.virgo-gw.eu/?content=3&r=16246>, <https://tds.virgo-gw.eu/?content=3&r=16245>

2019: I also built, for demonstration use in secondary schools, a low-cost Michelson interferometer (~ 150 euros), together to Ettore Majorana, and prepared detailed written instructions (with images) for the INFN Asimmetrie magazine, autumn 2018 issue, in order to disseminate this experience among students and encourage schools to add this activity in their laboratories (in the end, the school will have a new tool, which can be used for teaching experiences). The article and the instructions can be downloaded from the website: <https://www.asimmetrie.it/interferometro-fai-da-te>

In recent years, especially following the discovery of September 2015, I have held many educational seminars in schools or other institutions, some of which are listed below (details can be found on my personal web pages).

TEACHING ACTIVITY

1990-today: activity as an assistant teacher in numerous university courses (physics for mathematics and chemistry courses, experimental physics for chemistry courses, electronics and physics laboratories in physics courses). Since 2005, as written above, I have been teaching Physics, with a "Contract professor position", thanks to a contract before and to an agreement with INFN after, to the first year students of "La Sapienza" in the specialist degree in Pharmacy. Here I also recently supervised 4 master's degree theses (and I am currently following one), on topics related to the applications of physics to medical therapy and diagnostics.

1995-today: Supervisor of numerous degree theses in physics (4 master's in the last 2 years, 1 master's in progress). Co-supervisor of many Bachelor's and Master's degree theses in physics. External supervisor of doctoral theses (1 for the University of Barcelona, 2 for the AEI in Golm, Germany, 1 University of Trento).

2011-today: mentor in a "summer students" project, IREU project. In recent years I have supervised the work of 10 students (also in the Covid period, working via the web) who work, in the 2 summer months, on various aspects of data analysis with interferometric detectors. Website: <http://www.phys.ufl.edu/ireu/> and site listing the projects, including mine: <http://www.phys.ufl.edu/ireu/projects/sapienza.html>

2016: support for the thesis of 2 high school students for their final exam ("Maturita'classica" and "Maturita scientifica").

2017-today: tutor of the Lab2GO project for the Nomentano scientific high school in Rome, 3 yrs, De Sanctis, 1 yr, and Trafelli (Nettuno) in the last year, 2021/2021. And, as already described in this CV, I am the national responsible for this project. And I have, and am presently, organizing the online activities, as needed to face Covid-issues.

November 2016 - November 25, 2019: supervisor of a PhD student in Physics, [REDACTED] (in collaboration with a professor at the University of Florida, Prof. [REDACTED]). Thesis title: "Using machine learning and the Hough Transform to search for gravitational waves due to r-mode emission by isolated neutron stars".

2018/2019, 2019/2020, 2020/2021: Tutor "Phys Lab II" (officially assigned by "Giunta CAD of the Department of Physics", "La Sapienza", Rome). The projects I propose are related to data analysis with LIGO/Virgo data or with simulations (in this case: injections of signals, codes optimizations, parameter estimations). See for example the last report produced

Master Thesis: I have supervised many master thesis. In most recent years, from 2016:

--in Physics (all experimental, on advanced data analysis techniques): [REDACTED], [REDACTED], [REDACTED], [REDACTED]. Presently: two new thesis.

(see <https://web.infn.it/VirgoRoma/index.php/en/thesis-and-projects>)

--in Pharmacy (compilation thesis on applications of physics to medicine): [REDACTED], [REDACTED], [REDACTED]. Presently: [REDACTED].

2019: contract with EDISES for the revision of the Serway textbook "Principi di Fisica", Italian version. This is a multi-author project. I edited 2 chapters of the book (Fluids, First Principle of Thermodynamics). Print scheduled for 2021 (due to Covid delay).

October 2020-today: member of the teaching commission of the Faculty of Pharmacy and Medicine. I was already member of this commission from November 2016 for 2 academic years.

INTERNATIONAL CONFERENCES and ORGANIZATION OF SCHOOLS

I have been in the Scientific Organizing Committee (SOC) and in the Local Organizing Committee (LOC) of international conferences and schools. Very recently:

2016: member of the Scientific Organizing Committee for the doctoral school "5th GraWIToN School - 2nd School DAS", 24-28 October 2016, "La Sapienza" University of Rome. Also speaker of lectures and practical exercises for students.

2018: in the SOC of the "GEMMA" conference on GW, Multimessenger Astronomy, Dark Matter. Link: <http://www.roma1.infn.it/conference/GEMMA/> 2019: LOC of the "First European Physical Society Conference on Gravitation", held in Rome. Agenda here: <https://agenda.infn.it/event/15395/>

A detailed list is attached at the end of this CV, in the section "List of invited reports and organization of conferences and schools"

REVIEW and EDITORIAL ACTIVITIES

2011-today: I have been and am presently a reviewer for the National Agency for the Evaluation of Universities and Research Institute (ANVUR): "Reviewer of research products for VQR on behalf of ANVUR".

VQR stands for "Research Product Quality Assessment" and I have reviewed 3 articles.

I have also been reviewer of the Italian Ministry of Research (MIUR) of the "Programs for Young Researchers Rita Levi Montalcini" and I have evaluated two proposals in the last 2 years.

In the years 2012-2013 I was a reviewer of two FIRB proposals ("Future in Research" program).

In 2017 I evaluated, as an expert of MIUR (as indicated in the REPRIZE database), a project for the Department of Mathematics, Computer Science and Physics of the University of Udine (in charge of the Research Services Area of the University of Udine).

1995-present: referent for numerous journals, including "Physical Review D", "Physical Review Letters", "Classical and Quantum Gravity" (O (10) in two years).

2007-today: Internal contact person for numerous documents and presentations written by colleagues of the LIGO / Virgo collaboration. Internal reviewer also of various analysis procedures and scientific results on GW searches (recently, General Relativity Test, CW analysis with E @ H, Equivalence Principle Test).

2019: contract with EDISES for the revision of the Serway textbook "Principi di Fisica", Italian version. This is a multi-author project. I'm editing 2 chapters of the book (Fluids, First Law of Thermodynamics)

2020: reviewer of national proposals for Poland (grant call: Preludium-19, ST9: Astronomy and Space Science. 1 report) and Great Britain (grant call: STFC 2020 gravitational waves grants round. 2 reports).

PUBLICATIONS

Author of over 300 papers in international refereed journals (333 according to Scopus, Dec. 2020)

Index H (Scopus, December 2020): 70

<https://www.scopus.com/authid/detail.uri?authorId=8728100700>

INVITED TALKS

In addition to numerous specific contributions to scientific conferences and seminars (as well as collaboration meetings) I have been invited as a speaker in the plenary sessions of numerous international scientific conferences. Among others, in 2001 I was invited to Perth for the "4th E. Amaldi Conference" to summarize the results and status of the resonant GW detectors and was also interviewed for the Western Australia Newspaper. Coming to the last few years, in 2015 I was invited to the Marcel Grossman meeting, to talk about the state of CW signal searches, in LIGO / Virgo. I have been invited twice, by the organizers of the Spanish General Relativity Meeting (ERE). The last time was in September 2015 (immediately before GW's discovery). In December 2017 I was invited to present the recent discoveries of LIGO / Virgo at the workshop of the Italian Space Agency (ASI).

From January to March 2018, I was invited to 3 other international conferences, on different topics, all related to my research activity on GW. In May 2018 I was invited to the workshop "Light, Imaging, Microscopy, Spectra" (LIMS), <http://www.frascati.enea.it/LIMS2018/>, on the role of optical technologies in the discovery of GW. In January 2020, I gave an invited talk at TMEX2020 (16 Rencontres du Vietnam, on Particle Astrophysics and Cosmology) , see: <http://vietnam.in2p3.fr/2020/tmex/>, to talk about the recent results obtained with the Earth's gravitational detector network.

A detailed list is attached at the end of this CV, in the section `` List of invited reports and organization of conferences and schools''

SCIENTIFIC outreach activities

From February 2016 to today:

- **Invited (February 2016)** to the Cascina press release (at the European Gravitational Observatory (EGO)) of 12 February to announce the first discovery of GW. In particular, I was commissioned to comment on the discovery, from the EGO site, for the general public in Italy on Rai News 24, immediately after the announcement in Cascina and Washington. The official INFN announcement for GW's first revelation contains my interview. I then gave several interviews on the first direct detection of gravitational waves and on GW in general, on TV stations (Rai News 23, Rai 2 in "Rai 2 Storie, with an interview in November 2016, TV 2000 for the news), radio (RadioPadania, Rai 2), and also newspapers such as La Stampa, Il Giornale, Repubblica and many others. In addition to these, an interview with the edited monthly "La Freccia" (Trenitalia) in April 2016.
- **Numerous seminars** held in Italian middle and high schools. A seminar also for an elementary school.
- Seminar on gravitational waves organized by the Physics Department of "La Sapienza" in January 2018 for high schools, open by appointment (~ 200 students).
- **Dissemination seminars** for adults (in particular three for the "Astronoamiamo" association), on GW and general relativity tests. In this context I am presently taking a data analysis mini-course started in

January 2021: <https://www.astronomiamo.it/DivulgazioneAstronomica/Informazioni-Corso-Astronomia/Analisi%20del%20segnale%20per%20la%20rivelazione%20delle%20onde%20gravitazionali%20con%20rivelatori%20LIGO%20e%20Virgo>

- **Testimonial** of an event held during the "International Brain Week", in March 2017, organized by the Regina Elena Cancer Institute.
- Lectio Magistralis at the 57 National Congress of the SNO Applied Neurological Sciences. Naples, May 2017.

May 2017: As part of the INFN event "Particles in the library", I held a conference at the Villino Corsini Library, 4 May 2017. See: <https://www.bibliotechediroma.it/opac/news/a-spasso-per-spacetime-what-gravitational-waves-and-how-we-discovered-them/18295>

- **May 2018:** invited conferences (together with Prof. S. Frasca) at the annual "Matlab Expo" events, in Rome and Milan. The reason for this invitation is related to the award we received from Matworks, mentioned in the AWARDS section.
- **On June 15th 2018**, I gave an 18 minute speech at **TEDxMonopoli** on "Innovative waves, seas and currents". See: <https://tedxmonopoli.com/> (the interviews are uploaded on the official TEDx pages) or on the YouTube channel (where my other interventions are also uploaded)
- **October 2018:** RAI Scuola and RAI 3: Galileo Memex TV Program: interview on the subject of the signals still missing from the GW revelation, with presentation of a representative object of the experiment. It was broadcast on October 19, 2018, however available online: <http://www.raiscuola.rai.it/programma-unita/memex-galileo/301/-1/default.aspx#Puntate>
- **In July 2018:** I was a member of the technical panel for the Photowalk 2018 event, <http://edu.lnf.infn.it/photowalk-2018/>.
- **2019:** as already mentioned, responsible for the creation of informative comics, posters and instructions for the construction of educational interferometer. National and local Lab2GO manager. Local contact person for the CC3m INFN, Rome section
- **12 April 2019:** Festival Scienza e Filosofia, Foligno. With Marco Pallavicini. Interview by [REDACTED].
- **18 October 2019:** Focus Live Festival, Trento "Ultimissime dalla SpazioTempo", with G. Prodi.
- **30 October 2019:** Festival Scienza. Genova. With Dario Menasce.
- **October 2020:** Focus Live Festival, Milano (interview online, for Covid reasons). With Eugenio Coccia. Interview by [REDACTED].
- **November 2020:** organizer (with Paolo Pani) of the European Research Night Activities, for the INFN and Physics Department of La Sapienza, in particular within the Amaldi Research Center activities. See <https://www.phys.uniroma1.it/fisica/en/node/13164>. Within this context, I have also organized an event, November 23th, to observe the International Space Station (a sort of FlashMob on web), for the particularly good observing conditions at the passage. See <https://www.phys.uniroma1.it/fisica/en/node/13164>. We have reached ~ 300 people, mainly students and teachers, connected with us on Zoom to attend a lecture of Prof. Giulio D' Agostini, observe, comment, share pictures, videos and emotions.

NATIONAL AND INTERNATIONAL AWARDS

- 11 December 2017. Physics World 2017 Breakthrough of the Year Award for direct detection of gravitational waves (GW) LIGO / Virgo collaboration <https://www.ligo.caltech.edu/news/ligo20171212>
- May 2016. Breakthrough special Prize for the direct detection of GW, shared with all the signatories of the article on the discovery of gravitational waves (but awarded individually).
- 12 July 2016. Gruber Cosmology Prize for the first GW survey, <http://gruber.yale.edu/ligo-team-members>.
- Einstein Medal 2017. See <http://ligoawards.blogspot.com/2017/08/einstein-medal-for-ligo-and-virgo.html>

- I had the honor, in December 2017, of being invited by the LIGO collaboration organization team ([REDACTED]) to participate in the Nobel Prize celebrations in Stockholm (the three lessons, in an area reserved for LIGO / Virgo and two official banquets offered by colleagues who have received the Nobel Prize.

FINANCING SUPPORTS BASED ON SELECTIVE COMPETITIONS

2016: Under the direction of Prof. [REDACTED], the data analysis group of Virgo Rome was awarded a grant from MathWorks, including 20kuro, ~ 60 free licenses and support (as detailed in an agreement under the responsibility of Prof. [REDACTED]). The two lessons (one in Rome and one in Milan) that I held, together with Prof. S. Frasca, at Matlab EXPO (May 2018) are related to the project funded by this grant.

January 2018-today: Member of the Steering Committee, for the "Department of Excellence" project, assigned to the Physics Department of the Sapienza University of Rome by ANVUR: [www.anvur.org/attachments/article/1205/All6DElenco180 .pdf](http://www.anvur.org/attachments/article/1205/All6DElenco180.pdf). The steering committee is currently playing a key role in the success of the project and I am also in charge of coordinating its investments related to the IT needs of the data analysis activities.

2020: PI PRIN proposal 2020. Submitted in January 2021. Units are INFN (I am also the local PI) , Sapienza (local PI [REDACTED]) and INAF (local PI Prof. [REDACTED]).

Title: Cutting-edge strategies to identify new GEMS (Gravitational- and ElectroMagnetic-wave Sources) in the Universe with current and next-generation detectors. It included 3 letters of intent by the Nobel Laureate Prof. [REDACTED], the CNAF Director, Prof. [REDACTED] and by the Director of the National Galileo Telescope, Dr. [REDACTED]

LIST OF RELATIONS ON THE INVITATION AND ORGANIZATION OF CONFERENCES OR SCHOOLS

- Organizing Committee of the First Edoardo Amaldi Conference on Gravitational Waves. Villa Tuscolana Frascati 14-17 June 1994;
- Advisory Committee of the 4th Gravitational Waves Data Analysis Workshop, Rome, 2-4 Dec 1999
- Scientific Committee of the 4th Amaldi Conference, 8-13 July 2001
- Invited speaker (plenary) at the 27th Spanish Relativity Meeting, Alicante Spain 2003
- Scientific Committee of the 10th Gravitational Waves Data Analysis Workshop,
- Brownsville Texas (US), 2005. LOC of the 14th Gravitational waves data analysis workshop GWDAW14. Rome, 2010
- Invited speaker (plenary) at the 9th Amaldi Conference, Cardiff (2011). "Recent results for the search of Continuous waves with the LIGO and Virgo detectors" (contribution published on CQG 27 (19) 2012)
- Session organizer, with Prof. Alan Weinstein, at the 2 conferences (held together) Amaldi 10 and General Relativity and Gravitation (GR20). Session title: "Gravitational Waves: Search Results, Data analysis and Parameter Estimation". Co-author (first name) of the summary published in General Relativity and Gravitation, available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4579869/>
- Invited speaker (plenary) at "New perspectives in time domain astronomy: electromagnetic follow-up of gravitational wave candidates" INAF (National Institute of Astrophysics) Monte Mario, Rome, 5 December 2013. "GW searches with the LIGO and Virgo detectors: recent results and perspectives for the Advanced Detectors Era ". Preparatory to the organization of the joint work "Gravitational Waves and EM follow up" in the era of advanced detectors.
- Invited speaker (plenary) at the 14th Marcel Grossman Meeting, July 2015 Rome. "Searched for
- Continuous Wave Sources: recent results and plans for the Advanced Detector Era"
- Invited speaker (plenary) at the Spanish Relativity Meeting, ERE2015, Palmas de Mallorca. 7-11

September 2015. <http://grg.uib.es/ERE2015/>. "GW searches with the LIGO and Virgo detectors: recent results and perspectives for the upcoming Advanced Detectors Era".

- Scientific and organizational committee of the school for PhD students "5th GraWIToN School - 2nd DAS School", October 2016, 24-28, Rome "La Sapienza" University. He is speaker of the theoretical session and practical exercise session on the theme "Continuous Wave searches".
- Lectio Magistralis at the 57 National Congress of the SNO Applied Neurological Sciences. Naples, 24 May 2017. Title: "The discovery of gravitational waves"
https://www.avenuemedia.eu/wp-content/uploads/2017/05/SNO_prog_finale.pdf
- Invited speaker (plenary) at the Italian Space Agency (ASI) workshop,
<https://www.asi.it/it/eventi/workshop/workshop-onda-gravitazionali-asi-4-December>.
"Observation of gravitational waves from a binary neutron star inspiral with the LIGO and Virgo detectors". 4 December 2017.
- 2018: SOC of the "GEMMA" conference on the theme GW, Multimessenger Astronomy, Dark Matter (Lecce. June 2018).
- Invited speaker (plenary) at the conference: "Clues on GRB origin from chemical evolution models", Sexten 28 January-2 February 2018. "Observation of gravitational waves from a binary neutron star merger with LIGO and Virgo detectors"
- LOC member of the "First European Physicist Society Conference on Gravitation", Rome, February 2019.
- GRASS: Gravitational Waves Science and Technology Symposium, Padua, March 2018. Invited speaker (plenary). "Recent results and future challenges for Continuous waves and Stochastic background searches with a network of gravitational wave detectors" Web:
<https://agenda.infn.it/conferenceDisplay.py?confId=14869> (talk also on YouTube)
- Current problems in Theoretical Physics, "Gravitational Waves". Invited speaker (plenary): "Present results and future challenges with the network of gravitational wave detectors". 26-03-2018
- Invited speaker (plenary) (opening lecture) at the LIMS (Light, Imaging, Microscopy, Application Spectra) organized by the ENEA research center in Frascati for the International Day of light. See:
<http://www.lightday.org/> And: <http://www.frascati.enea.it/LIMS2018/>. 17/05/2018. Talk title: "The discovery of gravitational waves and the contribution of optical technologies".
- TMEX2020: invited speaker. Title: "The search of gravitational waves with ground-based detectors" (January 6, 2020). See: <http://vietnam.in2p3.fr/2020/tmex/index.html>

Short description SCIENTIFIC ACTIVITY (in Bold selected papers articles)

- **1988-2003:** Analisi dei dati nell'esperimento "Ricerca di onde gravitazionali" (ROG) (membro della collaborazione dall'anno 1988). I rivelatori GW erano Explorer (CERN) e Nautilus (Laboratori Nazionali di Frascati). Sono stata molto coinvolta in tutte le attività di analisi dei dati (DA) della collaborazione ROG e per questo sono stata nel 1998 chiamata dallo spokesperson (Prof. ██████████) a coordinare le attività di DA. Poi, quando è stata istituita la "International Gravitational Event Collaboration" (IGEC), sono stata co-responsabile, responsabile del coordinamento dei lavori e dei risultati, con il Prof. ██████████ (Università di Trento). Vedi l'articolo (non allegato) PRD 68: 0556 (2003). IGEC era una rete mondiale di rivelatori di GW. È stata eseguita l'analisi di mesi, fino ad anni di dati. L'analisi è stata fatta per cercare segnali molto corti di GW, come quelli previsti dalle esplosioni di Supernova. Nell'ambito della collaborazione ROG ho lavorato attivamente per anni per migliorare la sensibilità delle procedure per segnali transienti, sulla base di filtri adattati e di uno studio dettagliato delle caratteristiche del rumore e dell'applicazione di adeguate procedure di eliminazione del rumore. Poi ho iniziato a lavorare anche alla ricerca di segnali GW continui (CW). L'articolo (non allegato, ma lo cito per evidenziare la continuità nel tempo della mia attività scientifica) PRD 65: 02201 (2002) riporta la prima analisi fatta per cercare CW con i dati di un rivelatore risonante. È stato fatto sotto la mia responsabilità. La base del metodo è ancora oggi parte delle procedure che utilizziamo per analizzare i dati LIGO e Virgo per le ricerche All-Sky CW. PRD 65: 042003 (2002) è infatti un documento metodologico, fatto con i colleghi dell'Accademia polacca delle scienze, in virtù di un accordo tra l'Accademia polacca delle scienze e il gruppo ROG, di cui ero responsabile. L'obiettivo era un'analisi dei dati Nautilus (rivelatore risonante GW), ma il metodo è ancora alla base di molti altri algoritmi che LVC utilizza oggi. Nel 2010, sempre con il gruppo polacco, ho scritto un altro documento metodologico, estendendo il metodo ai rivelatori interferometrici, pubblicato su PRD 82.022005. Ho anche lavorato attivamente alla ricerca dello sfondo stocastico (anche durante un'esperienza di 4 mesi all'università di Cardiff con il prof. ██████████) e coincidenze di dati GW con raggi gamma, raggi cosmici e neutrini. Ciò è documentato negli articoli della collaborazione ROG in quel momento. In generale, l'esperienza che ho acquisito lavorando in ROG è stata molto importante quando mi sono associata alla collaborazione con la Virgo.
- **From the year 2003 to today:** Virgo collaboration. My main scientific interest within the Virgo collaboration is the science of neutron stars (NS) and data analysis (DA) for the detection of continuous gravitational waves (CW) from rapidly rotating neutron stars (NS), in isolated or binary systems. CWs are quasi-monochromatic signals with frequency proportional to the rotation frequency of the star. The typical deformation amplitude should be much weaker than that of coalescing binary systems (already detected) and with a duration greater than the observation time (of the order of months or years). For this reason, the CW signals have not yet been detected, but important efforts come both from the experimental side and from the use of more sophisticated and robust data analysis tools, and this is my field of expertise. Algorithms must be hierarchical since a compromise must be found between computational limitations and the inevitable lack of sensitivity. Some of these aspects, the work done to design solid procedures and some recent results obtained with my specific involvement, are documented in the attached articles. Recently, more attention has been paid to signals due to emissions such as high-amplitude r-mode excitation, the birth of a rapidly rotating magnetar (an NS with a strong magnetic field) following a supernova explosion. or to the merger of two NS. In these cases, the CW emission can be very intense and only last for hours / days in the LIGO-Virgo band. The data analysis activity is different from the previous one and, from some points of view, it is even more difficult as the signal duration is unknown and the parameter space is larger. I am particularly involved in these studies and analyzes (here I was the supervisor of a doctoral student, ██████████, whose PhD work ended on November 25, 2019).
- I worked and directly followed the analysis for the search for a signal following the merger of the two neutron stars, which produced, in August 2017, the GW170817 signal. Here we have applied a procedure that is the result of a modification of those applied to search for continuous signals ("Modified Frequency Hough", based on the idea of ██████████). We have also started comparison studies to carry out the same search with Machine Learning, in particular using Convolutional Neural Network. These works were done in collaboration with the Virgo group of Rome Sapienza and with Prof. ██████████, University of Florida. The theme is very current and on this my commitment in next years it will be high Attached articles cited below.

- My main interest and goal remain, however, the detection of signals from neutron stars, both of known parameters (such as the pulsar of the Vela la Crab) and unknown (and therefore the "All-Sky searches" aimed at the whole sky, the whole frequency band [10-2048] Hz and wide spin-down range). Attached articles on which I have worked directly related to these issues (search for continuous or quasi-continuous signals) are therefore:
- **PRD 100, 062005 (2019)**. "How effective is machine learning to detect long transient gravitational waves from neutron stars in a real search?"
- **PRD 98, 102004 (2018)**. A. Miller, P. Astone, et al "Method to search for long duration gravitational wave transients from isolated neutron stars using the generalized frequency-Hough transform".
Our method has also been used to search for a possible long transient following the coalescence GW170817 and published in **The Astrophysical Journal 875, 2, 2019** ("Search for Gravitational Waves from a Long-lived Remnant of the Binary Neutron Star Merger GW170817 ")
- **PRD 94: 122006 (2016)**. Description of an improved version of the Einstein @ Home procedure, carried out under the responsibility of LIGO colleagues in the Hannover Max Planck group (first signatory [REDACTED]). I contributed, as I was one of the two procedure reviewers, with the task of verifying changes to existing procedures and part of the software.
- **PRD 90: 042002 (2014)**. Description of the research method used in the All-Sky CW research performed in the DA Virgo group, Rome. All-Sky searches in the Virgo group in Rome are carried out under my responsibility. Used in many published analyzes (for example: "All-sky Search for Periodic Gravitational Waves in the LIGO Data", PRD 96, 062002 (2017) and more recently in **PRD 100, 024004 (2019)** results of All-Sky searches on data of the detectors in the scientific runs O1 and O2. Analysis on the latest scientific run, O3, is in progress.
- **LVC. PRD, 88: 102002 (2013)**. Search for CW signals from the galactic center. I was directly involved as an internal auditor of the method and the results. And external referee of Berit Behnke's related PhD thesis (20 June 2013, University of Hannover), title: "A direct search of continuous GWs from isolated unknown neutron stars at the Galactic Center"
- In addition to the activities mentioned above, I followed the "Testing General Relativity" procedures as an internal auditor. My interest in this work started when I was data analysis coordinator, in September 2012. For this reason, I contributed to the document "Testing GR with GW150914", **PRL 116, 221101 (2016)**, where we verified up to what point the properties, we were able to measure with the binary black hole system GW150914, were compatible with GR. In relation to this experience, I worked, mainly as an internal reviewer on the results, on the results of **The Astrophysical Journal Letter 848: L13** "Gravitational Waves and Gamma-Rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A". The first GW signal detected in triple coincidence on 14 August 2017 was very important to the additional science achieved (excellent source localization, new GR tests, which may also include tests on signal polarizations) and was clearly a wonderful result for collaboration, as it demonstrated that the detector was working as intended. My work as a former scientific coordinator, described above, was almost entirely aimed at preparing these results. In addition, I contributed to **PRL 119, 141101 (2017)**, with discussions and comments.
- The coalescence detection of the binary system of NS GW170817, see article **PRL 119.161101 (2017)**, really marked the beginning of a new era, in which multi-messenger astronomy will play a pivotal role. I actively contributed to this achievement, with the work done to prepare this science and promote and coordinate early interactions with possible EM partners. As mentioned above, I was the scientific referent of LIGO and Virgo in the years 2012-2014 and as such chosen among the 6 LIGO / Virgo scientists in charge of writing the discovery document on GW150914 (**PRL 116, 061102 (2016)**). See the article in LIGO magazine: <https://www.ligo.org/magazine/LIGO-magazine-issue-8-extended.pdf#page=34>. I also contributed, especially following one of my undergraduate experts in Machine Learning techniques, to a methodological article to identify a procedure for detecting short transients from supernova explosions, **PRD 98, 122002 (2018)**. The results are very promising and further work is important.

STATEMENT on research activity

My work has been focused on data analysis procedures for the search for gravitational signals. For several years my primary interest has been in the search for continuous sources but also long transients (duration hours / days / months). Despite the great success of recent years, the sector is still very early in the measurements and my main interest is to contribute to the discovery of signals in a category not yet revealed, such as persistent emissions from neutron stars.

The detection of gravitational waves of this type is also based on a synergy between observations of gravitational waves, electromagnetic waves (EM) and theoretical studies and therefore the construction of a solid group that can cover the different skills is part of my project of research. The information that this revelation can bring about the physics at the base of neutron stars is different and complementary to that which can be obtained from the study of the collision between neutron stars in a binary system. Having a nuclear physics laboratory in the sky that can be monitored over a long period will lead to priceless physics results. My interest also moves towards third generation gravitational detectors, such as ET and also LISA. Where the signals are too weak to be detected by the current network, the developed algorithms (increasingly sensitive and well organized from the point of view of the management of computing resources) will also be used on these. I am currently working on different ideas to try to improve sensitivity, noise rejection and above all the robustness of the analyzes (to meet situations in which the waveforms are not exactly as we expect them and / or to apply them to signals that are not moldable / unexpected). These are algorithms based on hierarchical procedures, with alternations of different methods (2-dimensional FFT, Machine Learning, recognition of spectral characteristics in the data). The use of distributed computing, such as for example CNAF or Nikhef machines, is very important, as it is typically a very large parameter space and a complex problem. On this, I have acquired a lot of experience over the years. Furthermore, I have always had a passion and interest in university teaching and scientific dissemination at various levels.



Pia Astone



