

## Curriculum Vitae

*Paolo Padovani*

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(Where one can find an up-to-date summary of my research activity, with links to the abstracts and texts of my papers)

## Curriculum Vitae

**Name:** Paolo Padovani

**Citizenship:** Italian

**Languages:** *Native:* Italian; *Others:* English (very good), German (fair), French and Spanish (basic)

**Education:** Laurea in Astronomia (Astronomy Degree)  
University of Padova, Italy  
29 March 1985  
Grade: 110/110 cum laude

Dottorato di Ricerca in Astronomia  
(PhD in Astronomy)  
University of Padova, Italy  
September 1989  
Grade: N/A

**Employment History:**

October 2011 - present Full Astronomer, European Extremely Large Telescope Science Office  
European Southern Observatory  
Garching bei München (Germany)

June 2008 - October 2011 Head, Virtual Observatory Project Office  
Full Astronomer  
European Southern Observatory  
Garching bei München (Germany)

November 2004 - June 2008 Head, Virtual Observatory Systems Department  
Full Astronomer  
European Southern Observatory  
Garching bei München (Germany)

December 2003 - October 2004 Astrophysical Virtual Observatory Scientist  
Work Area 1 (Science) Manager  
ST-ECF/European Southern Observatory  
Garching bei München (Germany)

September 1997 - November 2003 Archive Scientist, Associate Astronomer  
Space Telescope Division, European Space Agency  
Space Telescope Science Institute  
Baltimore, MD (USA)

November 1992 - December 2001 Assistant Professor (on leave from Sep. 1997)  
Physics Department, Second University of Rome  
Rome (Italy)

November 1990 - October 1992 ESO Fellow  
European Southern Observatory  
Garching bei München (Germany)

November 1989 - October 1990 NATO-CNR Advanced Fellow  
Space Telescope Science Institute  
Baltimore, MD (USA)

October 1987 - October 1989

Montedison Fellow  
Space Telescope Science Institute  
Baltimore, MD (USA)

**Research Interests:**

Active Galactic Nuclei (AGN) Evolution and  
Multifrequency Studies; Extragalactic Backgrounds;  
Radio Sources; Blazars; Unified Schemes;  
X-ray Spectra of AGN; Blazar Surveys;  
Deep radio surveys; Data Mining

**Technical Experience:**

Astronomical software: IRAF, MIDAS, SkyCat, ftools  
VO tools: Aladin, TOPCAT, VOSpec, VODEkstop, Splat, VOSED  
Unix, VMS, MacOS, Windows operating systems  
BASIC, FORTRAN, IDL, HTML  
L<sup>A</sup>T<sub>E</sub>X, Emacs, SuperMongo, Word, PowerPoint, Excel  
Database management (SQL, BROWSE)

**Observing Experience:**

Ground-based: ESO 2.2m, 3.6m, VLT 8m  
Space: ISO, HST, *BeppoSAX*, Chandra, XMM

**Referee for the Journals:**

Astronomical Journal, Astronomy and Astrophysics,  
Astrophysical Journal, Monthly Notices of the Royal Astronomical  
Society, New Astronomy, Publications of the Astronomical Society  
of the Pacific, Publications of the Astronomical Society of Japan,  
Science, Advances in Space Research, Astrophysics and Space Science,  
Baltic Astronomy, Revista Mexicana de Astronomia y Astrofisica,  
Journal of Physics G: Nuclear and Particle Physics

**Time Allocation Committees:**

Hubble Space Telescope, Cycle 6

**Assessor:**

Australian Research Council Large Grants  
and National Competitive Grants Program,  
Italian Space Agency,  
Padova University

**External Referee:**

James Clerk Maxwell Telescope,  
La Palma Telescope

**Memberships:**

International Astronomical Union 1994 - present  
American Astronomical Society 1997 - present  
European Astronomical Society 2004 - present

**Awards:**

STScI Group Achievement Award for the establishment  
of the Multi-mission Archive at STScI (MAST), 1998

**Training:**

Managing and Leading People in an International  
Environment, Management Centre Europe, Brussels  
October 13 - 17, 2008

Project Management  
TIBA, Ismaning, Germany  
November 10 - 12, 2008

Management Development Programme  
TIBA, Ismaning, Germany

Four Modules (5 days) in 2009

**Books:**

P. Padovani & C. M. Urry (eds.): Blazar Demographics and Physics, 2001, ASP, Vol. 227

P. Padovani with 49 other colleagues: Fifty Years of Quasars: Questions about Observations and Ideas, 2011, Springer-Verlag, in press

## Research Activity

My research is centered on the study of Active Galactic Nuclei (AGN) from a multifrequency point of view. I have in fact worked on radio, infrared, optical, ultraviolet, X-ray, and  $\gamma$ -ray data, mainly as part of international collaborations. A large fraction of my recent research activity is based on the analysis of large astronomical catalogs at different wavelengths, for which I have successfully used “data mining” techniques to select, for example, blazar candidates with very high efficiency.

From 1997 to 2003 I was an European Space Agency (ESA) Archive Scientist at the Multi-mission Archive at Space Telescope (MAST) in Baltimore, the NASA optical/UV archive center. As of December 2003 I was Work Science Manager for the Astrophysical Virtual Observatory (AVO) and as of November 1 2004 I was Head of the VO Systems Department at ESO. I have been Head of the VO Project Office in the Data Management and Operations Division at ESO since June 2008. I note that from 1997 onwards only 50% of my time could be devoted to research, the remaining fraction being occupied by functional duties, details of which can be found in the corresponding section.

My research interests can be divided into seven main areas:

### *Physical Evolution of AGN*

In this field I have worked on the constraints to different evolutionary scenarios of AGN [J2, J5, J6]<sup>†</sup> from observables like their central masses and Eddington ratios, which I have derived from optical spectroscopy plus X-ray to far infrared powers [J3, J4]. I have also investigated the relationship between active nucleus and host galaxy, in terms of mass-loss from stars as a way to fuel the central AGN [J19] and of the metallicity of the broad line regions (BLR) [J20]. The main results of this work are the following:

1. The AGN phenomenon cannot be long-lived (otherwise the central masses of AGN would be much larger than estimated) and most bright galaxies must have been quasars at least once in their lifetimes [J2, J4, J6];
2. Mass-loss from stars can explain the bolometric luminosity of local AGN with elliptical hosts (most probably the radio-loud ones) but its time dependence is too weak to explain the global evolution of the quasar luminosity function [J19];
3. Standard initial mass functions and current models of stellar evolution give metallicities for the gas lost by stars in the host galaxies of quasars which are consistent with those inferred in quasar BLRs [J20];
4. The chemical evolution of spiral bulges, with short formation timescales and high efficiency, combined with black hole accretion, can explain the main features of Seyfert galaxies [J63].

### *Extragalactic X-ray and $\gamma$ -ray Backgrounds*

In this field I have studied the contribution to the X-ray background of starburst galaxies [J8] and I have calculated from the first EGRET observations the contribution of radio-loud sources to the  $\gamma$ -ray background [J16]. The main results of these investigations are the following:

1. Starburst galaxies experiencing a mild evolution could give a 20 – 30% contribution to the X-ray background at 2 keV [J8];
2. BL Lacs and flat-spectrum radio quasars (which means, within the unified schemes, basically all radio sources) might be responsible for  $\sim 70\%$  of the  $\gamma$ -ray background at 100 MeV, leaving little room for a substantial contribution from radio-quiet AGN [J16].

### *Radio sources, Blazars: Unified Schemes*

I have also worked on radio sources and in particular on their unification with radio galaxies through relativistic beaming. The idea is that in some sources emission is dominated by collimated radiation from a relativistic jet closely aligned with the line of sight, with enormous effects on their apparent emitted power and their luminosity functions. These sources, known as blazars, include BL Lacs and flat-spectrum radio quasars and within the so-called “unified schemes” are the “beamed” counterparts of radio-galaxies.

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<sup>†</sup> These numbers refer to my papers as given in the publication list.

A large part of this work has been summarized in an Invited Review Paper which appeared in PASP in 1995 [J23].

I have studied the relationship between radio-loud and radio-quiet quasars [J18], and between X-ray and radio-selected BL Lacertae objects [J14, J21, J22] and assembled the largest BL Lac catalogue available at the time [J24]. I have worked on an ISO observational program aimed at the study of the infrared properties of the 1 Jy BL Lacs [J58], on an HST/NICMOS survey of the host galaxies of BL Lacs [J40], and I have studied the jet/accretion disk link in AGN [J28, J47]). Finally, I have assembled the largest multifrequency AGN database to date by collecting data at all frequencies available in digital form [C17] and used it, for example, to address the problem of the missing type 2 quasars [I9].

One outcome of this work has been the re-definition of the two BL Lac sub-classes (the old X-ray and radio-selected) on more physical grounds, namely the high-energy peak (HBL) and low-energy peak (LBL) BL Lacs, whose main difference is the peak frequency of the synchrotron emission (in a  $\nu - \nu f_\nu$  plot). LBL peak in the infrared/optical band while HBL peak in the UV/X-ray band. This definition has been readily accepted by the blazar community and is now the main one used in the literature. My main results in this area are the following:

1. I have tested the hypothesis that BL Lacs indeed are “beamed” low-power radio-galaxies. The observational data are consistent with the predictions of the beaming model and the comparison with observations has led to strong constraints on important parameters of the model like the Lorentz factors of the emission and the viewing angle [J7, J9, J10, J11, J12, J14]. Similarly, the data support the unification of flat-spectrum radio quasars (seen at small angles) with high-power radio galaxies (with their jets in the plane of the sky), with steep-spectrum radio quasars being at intermediate angles [J13].

2. The angles and Lorentz factors derived from this *statistical* approach are in good agreement with those obtained by the application of the Synchrotron Self-Compton (SSC) formalism to *individual* sources [J17].

3. The properties of X-ray selected BL Lacs (XBLs) can be derived from those of radio-selected BL Lacs (RBLs) under the hypothesis that the former objects represent the minority of the BL Lac population with energy breaks at X-ray (or higher) energies. This is at variance with the (once) common belief that XBLs represent the most numerous class [J21, J22].

4. I have studied the IR spectra of the 1 Jy BL Lacs using ISOCAM and ISOPHOT data, thereby filling a glaring gap in the spectral energy distribution of such sources [J58].

#### *X-ray Spectra of AGN*

I have studied the X-ray properties of AGN using *ROSAT* and *BeppoSAX* data. This work included a large fraction of the BL Lacs, flat-spectrum radio quasars, and quasars observed by *ROSAT* [J25, J27, J30, J31], a sample of X-ray- and radio-selected BL Lacs observed by *BeppoSAX* [J33, J43, J49], a sample of lobe-dominated radio quasars [J34], low-power radio galaxies [J35], and flat-spectrum radio quasars [J46] observed by *BeppoSAX*, plus two individual BL Lacs, notable for their X-ray variability [J37, J39]. The main results of this work are the following:

1. The well-known differences in X-ray spectra between BL Lacs selected in the radio and X-ray band have been interpreted as simply due to different emission mechanisms dominating in the two classes. Furthermore, a correlation has been found between X-ray spectral index and X-ray-to-radio flux ratio and synchrotron peak frequency, perfectly explained within this scenario [J25]. Detailed *BeppoSAX* observations of sub-samples of these sources confirm this picture and, combined with the broad-band spectral energy distributions, allow us to derive the physical parameters (intrinsic power, magnetic field, etc.) of the sources [J33, J43, J49].

2. The X-ray spectra of the majority of flat-spectrum radio quasars have been shown to be similar to those of radio-selected BL Lacs (LBL), contrary to what found by previous studies which were plagued by low spectral resolution and/or small-number statistics [J27]. This has implications for the connection between the two blazar classes.

3. Low-energy X-ray cutoffs (absorption at  $E \lesssim 1$  keV) are relatively common in quasars and almost exclusively associated with radio-loud quasars. These cutoffs are physically related to the quasars and not due to intervening systems and their fraction increases significantly with redshift [J30]. A detailed study of

some of the absorbed sources shows that  $\sim 70\%$  of the quasars with good optical spectra show associated optical absorption lines [J31].

4. A hard X-ray component ( $\alpha_x \sim 0.7$ ) has been discovered in the *BeppoSAX* spectra of lobe-dominated radio quasars, at variance with the situation at lower energies where these sources exhibit relatively steep ( $\alpha_x \sim 1.2$ ) spectra. The flat, high-energy slope is very similar to that displayed by flat-spectrum/core-dominated quasars, which suggests that the same emission mechanism produces the hard X-ray spectra in both classes [J34].

5. Synchrotron emission in the X-ray band of radio quasars has been detected for the first time by using *BeppoSAX* observation of four flat-spectrum radio quasars. Three of these sources belong to a newly discovered class of radio quasars with synchrotron peaks in the UV/X-ray band [J48]. This has important implications for our understanding of jet emission processes in radio sources [J46, J64].

#### *Blazar Surveys*

Our knowledge of blazars is based on samples which suffer from small number statistics and relatively high limiting fluxes. This means that our understanding of the blazar phenomenon is mostly based on relatively bright and intrinsically luminous sources, and we have only sampled the tip of the iceberg of the blazar population. I have been trying to change that by assembling deeper, larger samples, by using large catalogs and selecting blazar candidates with very high efficiency. The main focus of my work has been the Deep X-ray/Radio Blazar Survey (DXRBS) [J32, J42, J47, J48, J57, J59, I10, I13, I15], which correlates the *ROSAT* WGACAT X-ray database with several radio catalogs, restricting the candidate list to serendipitous flat spectrum radio sources ( $\alpha_r \leq 0.7$ ). After ten years of observing runs at northern and southern hemisphere observatories, including 8 nights at the ESO 3.6m, 6 nights at the ESO 2.2m, and 34 hours of VLT/FORS1, DXRBS now contains 259 radio-loud quasars, 44 BL Lacs, and 35 narrow-line radio galaxies for a total of 338 objects, 97% of which have a measured redshift. By reaching X-ray fluxes  $\sim$  a few  $10^{-14}$  erg  $\text{cm}^{-2}$   $\text{s}^{-1}$  and 5 GHz fluxes  $\sim$  50 mJy, DXRBS is the faintest and largest flat-spectrum radio sample with nearly complete ( $\sim 95\%$ ) identification. Hermine Landt has done her PhD work on the survey. I have also been involved with the “Sedentary” survey, which is aimed at reaching deeper fluxes but only for a subset of extreme BL Lacs, of the HBL type. Namely, we are looking for BL Lacs with large X-ray-to-radio flux ratios, and therefore with synchrotron peak frequency well in the X-ray band [J38, J55, C42].

Preliminary results on the DXRBS luminosity functions showed a remarkable agreement with the predictions of unified schemes [C54]. Together with Hermine, I have also used the DXRBS blazars, with other sources, to study the role of the Ca H&K break, a stellar absorption feature, in classifying BL Lacs [J45] and to propose a new physical classification scheme for blazars [J53]. Also, I have studied the relation between accretion disk (thermal emission) and jet (non-thermal emission) in DXRBS blazars. I found that, contrary to previous claims,  $\sim 25\%$  of our radio quasars have relatively small ( $< 3 \times 10^8 M_\odot$ ) black hole masses. Moreover, non-thermal emission dominates the optical/UV band of flat-spectrum radio quasars, making up  $\sim 85\%$  of the total and the total disk power is of the same order of the jet kinetic power [J47]. We have discovered a new class of flat-spectrum radio quasars with synchrotron peaks in the UV/X-ray band [J48]. Very Large Array (VLA) observations of 25 such sources show that their radio morphologies are similar to those of other radio quasars. However, their range of extended powers is more similar to that of BL Lac objects and extends down to the low values typical of low-power (Fanaroff-Riley type I) radio galaxies [J58]. Finally, we presented the number counts, evolution, and luminosity functions of DXRBS blazars, improving by more than one order of magnitude in flux and power over previous surveys and showing that the so-called “blazar sequence” goes against the observational evidence [J59, J62]. As regards the “Sedentary” survey, the mere fact that the shape of the radio number counts is the same as that of the counts for all BL Lacs (i.e., that the fraction of extreme HBL does not depend on radio flux) by itself poses strong constraints to detailed blazar physical models [J38, J55, J61]. I have also worked on the evolution of WMAP blazars [J71] and on the spectral energy distribution of *Fermi* blazars [J72].

#### *The Great Observatories Origins Deep Survey (GOODS)*

I have been part of the Great Observatories Origins Deep Survey (GOODS) project, which combines extremely deep observations from NASA’s Great Observatories, Spitzer, HST, and Chandra, ESA’s XMM-

Newton, and from the most powerful ground-based facilities, to survey the distant universe to the faintest flux limits across the broadest range of wavelengths. I have worked on GOODS AGN related projects at various wavelengths. The AGN subgroup has published a paper on the space density of high-redshift QSOs [J50]. By combining optical-IR color selection with X-ray detection we have selected a small but robust sample of quasar candidates at  $3 \lesssim z \lesssim 5.2$ . Another paper dealt with the optically faint X-ray population [J51]. I have worked with the CDFS team on some extremely deep VLA data of the CDFS area [J65, J66, J67, J68, J70]. We find that, while the well-known flattening of the radio number counts below 1 mJy is mostly due to star forming galaxies, these sources and AGN make up an approximately equal fraction of the sub-mJy sky, contrary to some previous results. The AGN include radio galaxies, mostly of the low-power, Fanaroff-Riley I type, and a significant radio-quiet component, which amounts to approximately one fifth of the total sample [J68].

#### *Virtual Observatory Science*

Given my functional roles in the AVO, Euro-VO, and at ESO, I have always been committed to the pursuit of science with Virtual Observatory (VO) tools and I have always thought that the ultimate goal of the VO is to facilitate astronomical research. One of the results of this has been the publication of the first refereed, fully VO-based paper, which has led to the discovery of  $\sim 30$  new obscured quasar candidates (as compared to 9 previously known) in the two GOODS fields [J54]. The acceptance of the paper was accompanied by a joint ESO/ESA press release in 2004. I have also given invited talks and colloquia at various conferences, institutes, schools, and many VO days on scientific applications of VO tools [e.g., I19, I20, I21, I22, I24].

#### *Miscellanea*

In the past few years I have been working on some non-AGN related issues. I have used my expertise in handling large catalogues at various wavelengths to co-author a paper on the Supernova rate in radio-loud and radio-quiet ellipticals. The former turned out to be 4 times more prolific producers of Type Ia Supernovae than the latter, a fact which we have interpreted as linked to enhanced star-formation [J56]. I have also worked on how the VO can help solving some open problems in A stars research [I19], high-energy astrophysics [I22], and post-AGB objects [C60]. Finally, I have worked out what type of sources the Square Kilometre Array (SKA) will see and what sort of multi-wavelength properties they will have, which are very important for source identification and for the synergy between the SKA and its various pathfinders with future missions in other bands, including SPICA, JWST, the E-ELT, PAN-STARRS, LSST, WFXT, and IXO [J73].

## Functional Activity

*June 2008 - October 2011*

In this period I was Head of the Virtual Observatory Project Office, an evolution of the Virtual Observatory Systems Department. I am also currently responsible for ESOS' participation to the Euro-VO International Co-operation Empowerment (ICE) project and had the same role for Euro-VO Astronomical Infrastructure for Data Access (AIDA). This entailed also collaborating to the writing of the proposals to the European Commission under various Framework Programmes (FP5, FP6, and FP7), managing the various projects and their budgets, supervising ESO's participation, and producing the technical and financial reports. I have also had various roles outside ESO in the Euro-VO and the International Virtual Observatory Alliance (IVOA), as detailed below, including being Secretary of the Euro-VO Science Advisory Committee, Project Scientist of Euro-VO AIDA, board member of many Euro-VO projects, and vice-chair and then chair of the IVOA Executive Committee.

*November 2004 - June 2008*

In this period I was Head of the VO Systems (VOS) Department in the Data Management and Operations Division at ESO. VOS' main mission was two-fold: 1. to make the ESO Science Archive Facility (SAF) into a powerful scientific resource for the ESO community by creating, ingesting, and publishing science grade Advanced Data Products (ADP), by providing a VO-compliant enhanced interface to all archive holdings, and by integrating VO tools into it; 2. to coordinate ESO's involvement in Virtual Observatory activities. The department was built from scratch and included the Virtual Observatory Technology (VOT), the ADP, and the Facility Centre (FC) groups, for a total of about 14 people [D19]. Since January 1, 2006 VOS was also in charge of all archive interfaces. VOS' main achievements include:

1. The ADP/MVM pipeline, a data reduction system for the production of ADP, specifically for WFI, SOFI and ISAAC and other VLT imaging instruments. This was built around the core functionalities provided by the EIS/MVM software. The software was used for the release to the astronomical community in September 2005 of the ISAAC/GOODS science ready data set (astrometrically calibrated stacked images and mosaics reduced from 11,600 science frames, 10,600 calibration frames, photometrically calibrated using pre-determined zero points from SOFI data). This release was received extremely well by the international astronomical community.
2. The building of the architecture for making ADP "VO Compliant" was also started, by defining the metadata structure to be used with ADP (both imaging and spectroscopy), in compliance with the IVOA Registry Requirements Document. This activity has also lead to guidelines to the ESO community for making available ADP through the ESO archive interface. This is very relevant for Large Programmes, whose Principal Investigators are requested to release reduced data starting from Period 75, and especially for Public Surveys (VST and VISTA) data products.
3. A new Science Archive web interface ([http://archive.eso.org/eso/eso\\_archive\\_main.html](http://archive.eso.org/eso/eso_archive_main.html)) was deployed on April 4, 2005 when the ESO archive opened to the world community. The aim of the new interface was to facilitate data queries and convey maximum information to archival users who might not be familiar with ESO instruments.

VOS activities were reviewed in 2008 by a mostly external panel, which "was very impressed by the achievements of VOS in its various tasks".

As part of my VOS duties I managed ESO's participation in the Euro-VO project (<http://www.euro-vo.org>) and the IVOA (<http://www.ivoa.net>). The Euro-VO [D17, D19, D20] was the logical next step from AVO as a Phase-B deployment of an operational VO in Europe. The Euro-VO includes ESO, the European Space Agency, and six national funding agencies, with their respective VO nodes: INAF (Italy), INSU (France), INTA (Spain), NOVA (The Netherlands), STFC (UK), and RDS (Germany). I am the Euro-VO Facility Centre [FC] Scientist. The FC is one of the three parts of the Euro-VO (the other ones being the Data Centre Alliance [DCA] and the Technology Centre [TC]) and is the "public face" of the Euro-VO, by providing a centralised registry for resources, standards and certification mechanisms but above all community support for VO technology take-up and dissemination and scientific program support using VO technologies and resources. The FC is jointly managed by ESO and ESA.

I was also in charge of ESO's participation to the Euro-VO Data Centre Alliance (DCA) and was heavily involved with the Euro-VO VO-Tech project.

*December 2003 - January 2005*

In this period I was Work Area 1 (Science) Manager for the Astrophysical Virtual Observatory (AVO: <http://www.euro-vo.org/twiki/bin/view/Avo/>). The AVO had been jointly funded by the European Commission (under FP5) with six European organisations (ESO, ESA, AstroGrid, the Centre de Données astronomique de Strasbourg [CDS], TERAPIX, and Jodrell Bank) participating in a three year, Phase-A work programme.

I was in charge of all scientific aspects of the project, including planning and carrying out the scientific demonstrations we held once a year, managing a team spread over four European countries, and chairing the AVO Science Working Group (SWG), a body of about 50 astronomers. My main achievements include:

1. Planning, coordinating, and carrying out two (out of three, as the first one was done before my move to ESO) AVO science demonstrations. These were held on an annual basis, in coordination with the IVOA, for the AVO SWG, established to provide scientific advice to the project. These two very successful demonstrations were held in January 2004 (ESO, Garching), and 2005 (ESAC, Madrid).
2. First VO paper. The second demonstration was so successful that it led to the discovery of 31 new optically faint, obscured quasar candidates (the so-called QSO 2) in the two GOODS fields. These results, in turn, led to the publication of the *first* refereed astronomical paper enabled via end-to-end use of VO tools and systems, of which I was first author [J54, D13, D14, D15, D16]. The paper was also publicised by an ESO/ESA press release in May 2004.
3. Science Reference Mission (SRM). The SRM was a definition of the key scientific results that the full-fledged VO in Europe should achieve when fully implemented. It consisted of a number of science cases, with related requirements, against which the success of the operational VO in Europe will be measured. It was written by the AVO SWG under my coordination and I carried out the final editing.
4. Science input on VO tools. I coordinated the AVO SWG work, collected their input, and gave my own on the development of VO tools. For the purpose of the demonstrations progressively more complex AVO demonstrators were constructed, including the so-called "AVO prototype", an evolution of Aladin, developed at CDS. I made sure that such tools were assessed and evaluated by astronomers, so that they would fulfill their needs, and that the input was fed back to the developers. This interaction worked extremely well and produced a set of tools which can be used for the day-to-day work of astronomers. Most of the functionalities developed for the AVO demonstrations were afterwards included in the public version of Aladin.

*1997 - 2003*

I was an Archive Scientist at the Multi-mission Archive at Space Telescope (MAST) from September 1997 to November 2003, that is since its inception, and was also the one who came up with its name. MAST is the NASA optical/UV archive center, which hosts, among other missions, HST, FUSE, and IUE.

I consistently provided assistance with the development of MAST, by supervising three developers of archive interfaces, revising the archive manual [D1], writing Archive articles for the STScI Newsletter [D11] and the AAS Newsletter, preparing contributions/posters to meetings about MAST, and supervising the two archive "hotseat" staff who provide assistance to archive users. Apart from performing my day-to-day job, I also led a number of initiatives to expand the utility of MAST, including:

1. the creation of tools to search the MAST holdings by class (<http://archive.stsci.edu/search/>);
2. a literature link project, to directly link MAST data to the resulting published papers at the Astrophysics Data System (ADS) and vice-versa (see <http://adsabs.harvard.edu/Groups/search/HST> at the ADS). This project, the first ever of this kind, stimulated other centers, including ESO, to start providing similar services, and has been hailed as a major step towards the VO;
3. a spectral/imaging scrapbook, that is a Web tool which permits the user to peruse representative spectra or sky images from *all* mission data stored in MAST at the same time (<http://archive.stsci.edu/-scrapbook.php>). Here I supervised the imaging part of the project;

4. a “pointing” tool to allow users to search for HST images in a powerful new way, i.e. by looking at regions of the sky observed more than N times, observed with 2 or more filters or more than twice within N day (<http://archive.stsci.edu/pointings/search.php>).

I was also the New Initiative Officer and then New Initiatives Panel (NIP) member for my division at STScI. The NIP’s charter was to support community initiated missions and STScI proposals responding to new opportunities, for example participation to Explorer missions. As a NIP member I provided a critical interface to my division, and had the authority to evaluate division input to proposal packages. I was also the MAST representative in the Astrophysical Databases Executive Council (ADEC), a body which coordinated the overall activities of NASA archive centers (<http://adccc.org/adec/>). As such, I contributed to a White Paper which the ADEC presented to NASA with a detailed plan for integration and interoperability of the NASA Data Centers in preparation for NASA participation to the VO.

*before 1997*

During my stay at ESO (Nov. 1990 - Oct. 1992), as part of my duties as fellow, I assisted visiting astronomers using the PDS microdensitometer to scan photographic plates, the OPTRONIX measuring machine for astrometric measurements, and the OPTOPUS package to prepare multi-slit spectroscopic observations for the ESO 3.6m telescope.

### **Teaching**

From 1992 to 1997 I was an Assistant Professor at the Physics Department of the II University of Rome. I taught “Laboratorio di Fisica” (Physics Lab) for 5 years. This entailed preparing the experiments, supervising the students during the conduction of the experiments, tutoring the students, reviewing and marking the lab reports as well as the final exams. The typical class included about 150 students.

### **Students Supervised**

PhD student Margherita Bonzini at ESO (2010 – present)

PhD student Hermine Landt at the Space Telescope Science Institute (1998 – 2002)

PhD student Luigi Costamante at the Space Telescope Science Institute (1998, 1999, and 2000) (with G. Ghisellini)

PhD student Valerio D’Elia at the Space Telescope Science Institute (2001) (with A. Cavaliere)

PhD thesis examiner of Giovanni Fossati (SISSA, Italy, Oct. 1998), Matthew Whiting (Melbourne, Australia, Apr. 2001), and Carolin Villforth (Turku, Finland, Apr. 2011)

### **Outreach Activities**

Lectures at the following schools:

Scuola Media “Leonardo da Vinci”, Bussolengo, Verona, Italy: November 2007, October 2008, November 2009, February 2012

Scuola Media “Annibale Maria di Francia”, Desenzano del Garda, Brescia, Italy: February 2010

Scuola Elementare di Colognola ai Colli, Verona, Italy: February 2010, February 2012

Scuola Elementare “Citella”, Bussolengo, Verona, Italy: March 2011

### Invited Talks/Colloquia/Reviews/Schools

*Relativistic Beaming and the Parent Population of BL Lacertae Objects*, ESO, Garching bei München, Germany, February 1991

*Relativistic Beaming and Unified Theories of AGN*, Observatoire de Meudon, Meudon, France, January 1992

*The Evolution and Fueling of AGN*, SISSA, Trieste, Italy, February 1993

*Relativistic Beaming and Unified Schemes of Radio Sources*, Osservatorio Astronomico di Padova, Italy, November 1993

*Beaming and Unification of AGN*, “First Italian Meeting on AGN”, Torino, Italy, February/March 1994 (invited review)

*The Unification of Radio-Loud AGN*, Royal Greenwich Observatory/Institute of Astronomy, Cambridge, UK, December 1994

*Unified Models of Radio-loud AGN*, “Unified Models of Radio-loud AGN”, Royal Astronomical Society Discussion Meeting, London, UK, January 1996 (invited review)

*Towards a Better Understanding of AGN*, “New Horizons from Multi-Wavelength Sky Surveys”, IAU Symposium 179, Baltimore, USA, August 1996 (invited talk)

*Unified Models of Radio-loud AGN: Recent Results*, “Second Italian Meeting on AGN”, Riccione, Italy, October 1996 (invited review)

*Gamma-ray Emitting AGN and Unified Schemes*, “Very High Energy Phenomena in the Universe”, XXXI-Ind Rencontres de Moriond, Les Arcs, France, January 1997 (invited review)

*The Past, Present, and Future of BL Lac Research*, Osservatorio Astronomico di Trieste, Italy, March 1997

*Unified Schemes of AGN*, XLI SAIT (Società Astronomica Italiana) Meeting, Bologna, Italy, April 1997 (invited review)

*The X-ray Spectra of BL Lacs*, “Second Annual Australian AGN Workshop”, Mount Stromlo Observatory, Australia, December 1997 (invited talk)

*A Deep X-ray/Radio Survey for Blazars*, “Looking Deep in the Southern Sky”, Sydney, Australia, December 1997 (invited talk)

*High Energy Emission from AGN and Unified Schemes*, “Frontier Objects in Astrophysics and Particle Physics”, Vulcano, Italy, May 1998 (invited review)

*The Two Classes of BL Lacs and Unified Schemes*, “BL Lac Phenomenon”, Turku, Finland, June 1998 (invited review)

*Relativistic Jets in the X-rays: BeppoSAX Spectra of BL Lacs*, “Relativistic Jets in Astrophysics”, Cambridge, UK, July 1998 (invited talk)

*BL Lacertae Objects: Recent Results and a Look at the Future*, Istituto di Radioastronomia, Bologna, Italy, October 1998

*Statistical Identification of Sources from Multiwavelength Surveys*, “X-ray Surveys and the History of Accretion in the Universe”, Rome, Italy, February 1999 (invited talk)

*Deep Blazar Surveys*, “Blazar Demographics and Physics”, Baltimore, USA, July 2000 (invited review)

*Summary Talk*, “Blazar Demographics and Physics”, Baltimore, USA, July 2000 (invited talk)

*Blazar Surveys*, “Blazar Astrophysics with BeppoSAX and other Observatories”, Frascati, Italy, December 2001 (invited review)

*A New Class of Radio Quasars*, SISSA, Trieste, Italy, April 2003

*A New Class of Radio Quasars*, “Multifrequency Behaviour of High Energy Cosmic Sources”, Vulcano, Italy, May 2003 (invited talk)

*A New Class of Radio Quasars*, “Baryons in Cosmic Structures”, Monteporzio Catone, Italy, October 2003 (invited talk)

*A-type Stars and the Virtual Observatory*, “The A-Star Puzzle”, IAU Symposium 224, Poprad, Slovakia, July 2004 (invited talk)

*Science with Multiwavelength Archives*, “NEON Archive Observing School”, ESO, Garching, Germany, July 2004

*Moving towards the Virtual Observatory*, “NEON Archive Observing School”, ESO, Garching, Germany, July 2004

*Science with Virtual Observatory Tools*, Astronomical Data Analysis Software & Systems XIV, Pasadena, USA, October 2004 (invited talk)

*Astronomy with the Astrophysical Virtual Observatory*, 205<sup>th</sup> American Astronomical Society Meeting, San Diego, USA, January 2005 (invited talk)

*Astronomy with the Virtual Observatory*, Astronomical Joint Colloquium, Heidelberg, Germany, May 2005

*High-energy Astrophysics and the Virtual Observatory*, “Multifrequency Behaviour of High Energy Cosmic Sources”, Vulcano, Italy, May 2005 (invited talk)

*Astrophysical Virtual Observatory and the Euro-VO*, Joint European and National Astronomy Meeting, Session on European Cooperation and Projects in Astronomy, Liege, Belgium, July 2005 (invited talk)

*The Blazar Sequence: Validity and its Predictions*, “The Multi-Messenger Approach to High-energy Gamma-ray Sources”, Barcelona, Spain, July 2006 (invited review)

*Science with Multiwavelength Archives*, “NEON Archive Observing School”, ESO, Garching, Germany, August 2006

*VO projects at the International and European level and the ESO VO experience*, Workshop “VObs.it – Osservatorio Virtuale Italiano”, Monteporzio, Italy, November 2006

*Gamma-ray emitting AGN and GLAST*, First GLAST Symposium, Stanford, USA, February 2007 (invited review)

*e-Astronomy: the Virtual Observatory and its implementation*, First Workshop for the e-Science structuring: “Paving a way for the development of e-Science in Chile”, Santiago de Chile, May 2007 (invited talk)

*The Virtual Observatory*, ESO Information Day for Czech Industry, Prague, June 2007

*Blazars: Extreme, Rare, and Interesting*, Munich Joint Astronomical Colloquium, ESO, June 2007

*Science with the Virtual Observatory*, Joint European and National Astronomy Meeting, “Science with Virtual Observatories” Symposium, Yerevan, Armenia, August 2007 (invited review)

*Blazars: Extreme, Rare, and Interesting*, Tata Institute of Fundamental Research, Mumbai, India, October 2007

*A Virtual Observatory Overview*, “Astronomy with Virtual Observatories” Workshop, Pune, India, October 2007 (invited review)

*Science with the Virtual Observatory*, “Astronomy with Virtual Observatories” Workshop, Pune, India, October 2007 (invited review)

*VO Science*, “Virtual Observatory Info Workshop”, Sofia, Bulgaria, January 2008 (invited review)

*Virtual Observatory Overview*, “The Finnish Graduate School in Astronomy and Space Physics: Summer School 2008”, Orilampi, Finland, June 2008

*Virtual Observatory Tools*, “The Finnish Graduate School in Astronomy and Space Physics: Summer School 2008”, Orilampi, Finland, June 2008

*Introduction to the Virtual Observatory*, “NEON Archive Observing School”, ESO, Garching, Germany, August 2008

*Virtual Observatory: Projects, Data Centres, and Science Capabilities*, “21st International CODATA Conference”, Kiev, Ukraine, October 2008 (invited talk)

*VO Science*, “Virtual Observatory Info Workshop”, Lisbon, Portugal, October 2008 (invited review)

*Concluding Remarks*, “Multi-wavelength Astronomy and the VO”, ESAC, Madrid, December 2008 (invited talk)

*The sub-mJy radio source population: star-forming galaxies or AGN?*, Stockholm Observatory, Department of Astronomy, Stockholm University, September 2009

*Wide Field X-ray Telescope synergies with next generation radio surveys*, “The Wide Field X-ray Telescope Workshop”, Bologna, Italy, November 2009 (invited talk)

*The micro- and nano-Jy sky*, “SKA 2010 Science and Engineering Meeting”, Manchester, UK, March 2010 (invited talk)

*AGN, star formation, and the nano-Jy sky*, Joint European and National Astronomy Meeting, “The Square Kilometre Array: Paving the way for the new 21st century radio astronomy paradigm”, Lisbon, Portugal, September 2010 (invited talk)

*Large Astronomical Data Sets and the Virtual Observatory*, Royal Astronomical Society Specialist Discussion Meeting “Novel methods for the exploitation of large astronomical and cosmological data sets”, London, UK, November 2010 (invited talk)

*Evolution and luminosity functions of sub-mJy radio sources: the solution to the long-standing problem of radio emission in radio-quiet AGN?*, Istituto di Radioastronomia, Bologna, Italy, March 2011

*Evolution and luminosity functions of sub-mJy radio sources: the solution to the long-standing problem of radio emission in radio-quiet AGN?*, Joint ASTRON - JIVE Colloquium, Dwingeloo, The Netherlands, April 2011

*A simplified view of blazars: why BL Lacertae is actually a quasar in disguise*, “Fermi & Jansky: Our Evolving Understanding of AGN”, St. Michaels, MD, USA, November 2011 (invited talk)

*The deep radio sky. And the solution to the long-standing problem of radio emission in radio-quiet AGN*, ASI Science Data Centre, Frascati, Italy, March 2012

### **Seminars/Contributed Talks**

*Masses and Eddington Ratios of AGN: Constraints on their Evolution*, Space Telescope Science Institute, Baltimore, USA, November 1987

*The Relationship between Seyfert 1 Galaxies and Quasars*, Space Telescope Science Institute, Baltimore, USA, January 1989

*Beaming and the Parent Population of BL Lacertae Objects*, Space Telescope Science Institute, Baltimore, USA, October 1989

*Luminosity Functions, Relativistic Beaming, and Unified Theories of AGN*, “Physics of AGN”, Heidelberg, Germany, June 1991 (contributed talk)

*A Connection between BL Lacertae Objects and Flat-Spectrum Radio Quasars?*, “The Nature of Compact Objects in AGN”, Cambridge, UK, July 1992 (contributed talk)

*BeppoSAX Observations of 2 Jy Lobe-dominated Broad-line AGN*, AAS Meeting, Washington D.C., USA, January 1998, (contributed talk)

*The Deep X-ray Radio Blazar Survey (DXRBS)*, “Third Italian Meeting on AGN”, Rome, Italy, May 1998 (contributed talk)

*The Deep X-ray Radio Blazar Survey (DXRBS)*, “Fourth Italian Meeting on AGN”, Trieste, Italy, May 2000 (contributed talk)

*Mining the Blazar Sky*, “Mining the Sky”, MPA/ESO/MPE, Garching bei München, Germany, August 2000 (contributed talk)

*Unification of Faint Radio-loud Sources: The DXRBS View*, “Issues in Unification of AGNs”, Marciana Marina, Elba, Italy, May 2001 (contributed talk)

*Synchrotron X-ray Emission from Flat-spectrum Radio Quasars*, “Fifth Italian Meeting on AGN”, Como, Italy, June 2002 (contributed talk)

*Synchrotron X-ray Emission from Flat-spectrum Radio Quasars*, “High Energy Blazar Astronomy”, Turku, Finland, June 2002 (contributed talk)

*The AVO to Euro-VO Transition*, Astronomical Data Analysis Software & Systems XV, San Lorenzo de El Escorial, Spain, October 2005 (contributed talk)

*Towards a VO-compliant ESO Science Archive*, “The Virtual Observatory in action: new science, new technology, and next generation facilities”, IAU XXVI General Assembly, Special Session 3, Prague, August 2006 (contributed talk)

*The Micro-Jy Radio Source Population: the VLA-CDFS View*, “At the Edge of the Universe”, Sintra, Portugal, October 2006 (contributed talk)

*The Micro-Jy Radio Source Population: the VLA-CDFS View*, “When the Universe formed stars”, Martinique, November 2008 (contributed talk)

*Constraints on the micro-Jy Radio Source Population from the VLA-CDFS Survey*, Joint European and National Astronomy Meeting, “Multi-wavelength High Redshift Surveys” Symposium, Hatfield, UK, April 2009 (contributed talk)

*The SKA and its pathfinders and their synergy with the ELTs*, “Feeding the Giants: Extremely Large Telescopes (ELTs) in the era of Surveys”, Ischia, Italy, August - September 2011 (contributed talk)

*Evolution and luminosity functions of microJy radio sources*, “Fourth International EMU (Evolutionary Map of the Universe) Workshop”, Bologna, Italy, September 2011 (contributed talk)

*The solution to the long-standing problem of radio emission in radio-quiet AGN: star formation*, “The Starburst-AGN Connection under the Multi-wavelength Limelight”, ESAC, Madrid, Spain, September 2011 (contributed talk)

### **Service on Committees, Panels, Boards**

Local Organizing Committee Workshop “Grand Unified Theories of AGN”, STScI, July 1990

Hubble Space Telescope Time Allocation Committee, Cycle 6, AGN Panel, 1995

Hubble Space Telescope Panel Support Scientist, Cycle 9, 1999

STScI Research and Science Advisory Committee (RSAC), Sept. 1999 - Sept. 2002

STScI New Initiative Panel (formerly NIO), June 2000 - June 2003

STScI Institute Fellow Selection Panel, 2000

Science and Local Organizing Committee Conference “Blazar Demographics and Physics”, STScI, July 2000

STScI Science Promotion Committee (SPC), 10/2000 - Nov. 2003

Study of Hubble Archive and Reprocessing Enhancements (SHARE), STScI, 2001 - 2002

Astrophysics Data Centers Executive Committee (formerly ADCCC), 1997 - 2003

NASA/IPAC Extragalactic Database (NED) Advisory Board, 2000 - 2004

Astrophysical Virtual Observatory Science Working Group, Chair, Dec. 2003 - Jan. 2005

ISO Active Archive Phase Mid-Term Review Board, June 2004

Centre de Donnés de Strasbourg (CDS) Council, Sept. 2004

Convenor Session “Real and Virtual Instruments”, Joint European and National Astronomical Meeting (JENAM) 2004, Granada, Spain, Sept. 2004

Euro-VO VO-TECH Technical Advisory Panel, May 2005 - June 2009

HyperLeda Review Panel, Apr. 2006

Euro-VO Science Advisory Committee, Apr. 2006 - Dec. 2011

ESO Director Discretionary Time Committee, May 2006 - Mar. 2008

Euro-VO Data Centre Alliance Board, Oct. 2006 - Dec. 2008

ASTRONET Roadmap Panel D “Theory, computing facilities and networks, Virtual Observatory”, co-Chair, Feb. 2007 - Nov. 2008

Scientific Organizing Committee “Science with Virtual Observatories” Symposium, JENAM 2007, Yerevan, Armenia, Aug. 2007

Scientific Organizing Committee “Astronomy with Virtual Observatories” Workshop, Pune, India, Oct. 2007

Euro-VO Astronomical Infrastructure for Data Access (AIDA) Project Scientist, Feb. 2008 - July 2010

Euro-VO Astronomical Infrastructure for Data Access (AIDA) Board, Feb. 2008 - July 2010

Scientific and Technical Organizing Committee, co-chair, “Multi-wavelength Astronomy and Virtual Observatory”, ESAC, Madrid, Spain, Dec. 2008

International Virtual Observatory Alliance Executive Committee, vice-chair, Dec. 2008 - May 2010

Scientific and Technical Organizing Committee, co-chair, “EuroVO School”, ESO, Germany, Mar. 2009

Organizing Committee “The Virtual Observatory and Distributed Computing”, JENAM 2009, University of Herfordshire, UK, Apr. 2009

Scientific and Technical Organizing Committee, chair, “EuroVO School”, CDS, Strasbourg, France, Jan. 2010

SKA Pathfinder Radio Continuum Survey Working Group, May 2010 - present

International Virtual Observatory Alliance Executive Committee, Chair, May 2010 - Oct. 2011

Organizing Committee “AstroInformatics 2010”, Caltech, USA, June 2010

Organizing Committee 3rd International School in Astronomy (AstroInformatics – Virtual Observatory), Belgrade, Serbia, June 2010

Euro-VO International Co-operation Empowerment (ICE) Board, Sept. 2010 - present

Scientific Organizing Committee “Probing the Radio Continuum Universe with SKA Pathfinders”, Leiden, The Netherlands, Feb. 2011

Scientific and Technical Organizing Committee, chair, “EuroVO School”, CDS, Strasbourg, France, Mar. 2011

Scientific Organizing Committee “Data intensive astronomy”, Special Session 15, 28th General Assembly of the IAU, Beijing, China, Aug. 2012

## Publication Summary

Journal papers . . . . .	78
Conference and technical papers . . . . .	121

### Journal papers

Mean number/year: 3.3  
First author papers: 29 (37%)  
First or second author papers: 49 (63%)  
Sole author papers: 7 (9%)

### Conference and technical papers

Mean number/year: 5.1  
First author papers: 56 (46%)  
Sole author papers: 22 (18%)  
Invited papers: 27 (28% of conference papers)

## Citations

The number of citations to my refereed papers taken from the Astrophysics Data System (ADS) is 6761 (Feb. 2012), which translates to an average number of 89 citations/paper. The citations to my first-author refereed papers total 1744, which translates to 62 citations/paper. For comparison, the mean number of citations to *all* refereed astronomical papers published since the publication date of my first paper (March 1988) is 17.8. My most quoted paper ranks number 46 out of these 479907 papers sorted by citations, while my four most quoted papers (5.3% of the total) are in the top 0.3%. My  $h$  index (Hirsch 2005, arXiv:physics/0508025v5) is 42.5 for all my papers and 22 for my first author papers. My  $m$  value (equal to  $h$  divided by the number of years elapsed since the first publication) is 1.8.