

PERSONAL INFORMATION

Luciano Burderi



📍 Physics Department, University of Cagliari, SP Monserrato-Sestu, KM 0.7, 09042

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EDUCATION AND ACADEMIC TITLES

2018 National Scientific Qualification for the professorships of the I band

Concession Sector 02 / C1 Astronomy, Astrophysics, Physics of the Earth and the Planets, 2016
Call – D.D. 1532/2016

2013 National Scientific Qualification for the professorships of the I band

Concession Sector 02 / C1 Astronomy, Astrophysics, Physics of the Earth and the Planets, 2016
Call – D.D. 222/2012

1994 PhD degree

Title of PhD thesis: Temporal variability in neutron star systems
University of Palermo

1989 Degree in Physics with a score of 110/110 cum laude

Title of Degree thesis: A timing method for a millisecond pulsar in a binary system
University of Palermo

PERSONAL SKILLS

Mother tongue Italian

Other languages

	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken interaction	Spoken production	
English	C1	C1	C1	C1	C1
French	B1	B1	B1	A2	A2

Levels: A1 and A2: Basic user – B1 and B2: Independent user – C1 and C2: Proficient user
[Common European Framework of Reference for Languages](#)

WORK EXPERIENCE

- 2020 – Present **Full Professor**
Astronomy and Astrophysics
Department of Physics – University of Cagliari
- 2006 – 2009 **Coordinator of the PhD School in Nuclear Physics and Astrophysics**
Department of Physics – University of Cagliari
- 2005 – 2020 **Associate Professor**
Astronomy and Astrophysics
Department of Physics – University of Cagliari
- 1999 – 2005 **Researcher Astronomer**
INAF – Astronomical Observatory of Rome
Astronomy and Astrophysics
- 1996 – 1999 **Post-doc**
Italian Space Agency (ASI) – Rome
Astronomy and Astrophysics
- 1994 – 1996 **Research Associate (rolling grant)**
Astronomy Group – University of Leicester
Astronomy and Astrophysics

TEACHING EXPERIENCE

University of Cagliari

- 2006 – Present **Foundations of Astronomy and Astrophysics**
Bachelor's Degree, Department of Physics – University of Cagliari
- 2006 – Present **High Energy Astrophysics**
Master's Degree, Department of Physics – University of Cagliari
- 2016 – 2018 **Introduction to Special and General Relativity (Progetto Lauree Scientifiche, for high-school teachers)**
Department of Physics – University of Cagliari
- 2006 – 2009 **Astrophysics**
Master's Degree, Department of Physics – University of Cagliari
- 2006 – 2009 **Radio Astronomy**
Master's Degree, Department of Physics – University of Cagliari
- 2006 – 2009 **Experimental Astronomy**
Master's Degree, Department of Physics – University of Cagliari

University of Palermo

- 2000 – 2002 **Teaching Laboratory in Astrophysics and Cosmology**
Scuola Interuniversitaria Siciliana - S.I.S.S.I.S., Department of Physics – University of Palermo
- 1999 – 2000 **Astronomy Teaching and History of Astronomy**

Scuola Interuniversitaria Siciliana - S.I.S.S.I.S., Department of Physics – University of Palermo

1997 – 1999 General Physics

Faculty of Agriculture – University of Palermo

NUMBER OF PUBLICATIONS AND H-INDEX

SAO/NASA Astrophysics Data System (<https://ui.adsabs.harvard.edu>)

Publications: 387

Publications in international refereed ISI journals: 202

Publications non-refereed: 185

Number of total citations: 6535

Hirsch Index (H-index): 43

Google Scholar (<https://scholar.google.com>)

Publications: 445

Number of total citations: 8470

Hirsch Index (H-index): 48

Scopus (<https://www.scopus.com>)

Publications: 254

Number of total citations: 5583

Hirsch Index (H-index): 39

Web of Science (<https://www.webofscience.com>)

Publications: 264

Number of total citations: 5451

Hirsch Index (H-index): 40

PARTICIPATION IN INTERNATIONAL ACADEMIES WITH PRESTIGE IN THE SCIENTIFIC SECTOR

2006 – Present

Member of the International Astronomical Union

IAU - Member Reference # 11727

REVIEWER OF QUALIFIED SCIENTIFIC INTERNATIONAL JOURNALS AND INSTITUTIONS

2017 – Present

Referee of international scientific journal Heliyon

Elsevier Publishing Company

2016

Reviewer the program Consolidate the Foundations to support fundamental research

University of Rome *Tor Vergata*

2015 – Present

Reviewer for the for the program *Programma per Giovani Ricercatori "Rita Levi Montalcini"*

Italian Ministry of Education

2015 – Present

Referee for the international scientific journal Advances in Astronomy

2013 – Present

Reviewer for *Albo MIUR dei Revisori*

Italian Ministry of Education

2013 **Reviewer for the Marie Curie COFUND Programme PISCOPIA**

European Union 7th Framework Programme

2010 – Present **Referee for the funding of research proposals in the Netherlands**

Netherlands Organisation for Scientific Research (NWO)

2002 – Present **Referee of international scientific journal Astronomy & Astrophysics**

2002 – Present **Referee of international scientific journal Monthly Notices of the Royal Astronomical Society**

1997 – Present **Referee of international scientific journal The Astrophysical Journal**

REVIEWING AND EDITORIAL EXPERIENCE

2007 **Editor of the book: Interacting binaries: accretion, evolution, and outcomes, AIP Conference Proceedings, Vol. 797**

<http://dx.doi.org/10.1063/v797>

2005 **Editor of the book: The multicolored landscape of compact objects and their explosive origins, AIP Conf. Proc. 924**

<http://dx.doi.org/10.1063/v924>

ORGANIZATION OF WORKSHOPS AND CONFERENCES(MOST RELEVANT SINCE 1999)

2019 **International Conference (SOC and LOC) "L'Uomo e il Cosmo nella storia. Paradigmi, miti, simboli"**

Palermo, September 18 – 20, 2019

2017 **International Conference (SOC and LOC) The amazing life of stars: from the Main Sequence to the Gravitational Waves**

Cefalù, September 4 – 8, 2017

2016 **International Conference (chair SOC and chair LOC) XXII SIGRAV Conference - A century of general relativity**

webpage: <http://www.oa-roma.inaf.it/sigrav2016>

Cefalù, September 12 – 18, 2016

2016 **International Conference (chair SOC) EWASS 2016 - Symposium S15- "Exploring pulsar formation, evolution and magnetic field: from low mass X-ray binaries to magnetars"**

webpage: <http://eas.unige.ch/EWASS2016/session.jsp?id=S15>

Athens, July 4 – 8, 2016

2015 **International Conference Congresso Nazionale Oggetti Compatti (CNOC)**

web: <http://www.brera.inaf.it/~campana/cnoc9/CNOC9/Welcome.html>

Roma, September 22 – 25, 2015

- 2015 **International Conference Science with MOS: towards the E-ELT era**
Cefalù, September 7 – 11, 2015
- 2014 **International Conference EVN Symposium 2014: 12th European VLBI Network Symposium and Users Meeting**
webpage: <http://evn2014.oa-cagliari.inaf.it/EVN2014/>
Cagliari, October 7 – 10, 2014
- 2014 **International Conference (chair SOC) The Unquiet Universe: Week One: The Distant Universe, Week Two: The Local Universe**
web: <http://www.oa-roma.inaf.it/meetings/cefalu/2014/>
Cefalù, June 2 – 14, 2014
- 2013 **National Conference Scuola Lucchin - PhD School of Astrophysics Francesco Lucchin**
webpage: <http://www.oa-roma.inaf.it/ScuolaLucchin2013/>
Gaeta, September 15 – 20, 2013
- 2013 **International Conference Seeking the Leading Actor on the Cosmic Stage: Galaxies versus Black Holes**
webpage: http://www.oa-roma.inaf.it/GVBH/Galaxies_vs_SMBH.2013.html
Castellammare del Golfo (Sicily, Italy), June 24 – 28, 2013
- 2013 **International Conference Vesf School - School on Gravitational Waves, Neutrinos and Multiwavelength electromagnetic Observations: the new frontier of Astronomy**
webpage: http://www.roma1.infn.it/teongrav/VESF/SCHOOL2013_WEBSITE/Vesf_School.html
INAF - Osservatorio Astronomico di Monte Porzio Catone a Roma, April 15 – 18, 2013
- 2012 **International Conference Reading the Book of Globular Clusters with the Lens of Stellar Evolution**
webpage: <http://www.oa-roma.inaf.it/meetings/gc-meeting/web/Home.html>
Roma, INAF - Osservatorio Astronomico di Monte Porzio Catone, November 26 – 28, 2012
- 2012 **International Conference Sardinian Summer School in Astrophysics - 2nd cycle, Astrochemistry: The Astronomer's survival kit**
webpage: <http://astrochem2012.oa-cagliari.inaf.it>
Parco Tecnologico della Sardegna (Cagliari), September 30 – October 6, 2012
- 2012 **International Conference Sardinian Summer School in Astrophysics - 2nd cycle - Technology in Radio Astronomy and Space Science**
webpage: <http://techno2012.oa-cagliari.inaf.it/school/index.php>
Parco Tecnologico della Sardegna (Cagliari), June 11 – 16, 2012
- 2011 **International Conference Sardinian Summer School in Astrophysics Single-Dish Radio Astronomy and Radio Science**
webpage: <http://summerschool2011.oa-cagliari.inaf.it/SSS2011>
Pula (Cagliari), September 12 – 17, 2011
- 2011 **International Conference Advances in Computational Astrophysics: methods, tools and outcomes**

webpage: <http://www.oa-roma.inaf.it/meetings/cefalu/2011/Home.html>
Cefalù (Italy), June 13 – 17, 2011

- 2010 **International Conference Radio pulsars: An astrophysical key to unlock the secrets of the Universe: A conference celebrating the 45th anniversary of Jocelyn Bell's scientific career**

webpage: <http://pulsar.ca.astro.it/pulsar/Pulsar-Conference-2010>
Chia Laguna, Sardinia (Italy), October 10 –15, 2010

- 2010 **International Conference Binary Star Evolution: Mass Loss, Accretion, and Merges: in Celebration of Ron Webbink's 65th Birthday**

webpage: <http://ciera.northwestern.edu/Ron-fest2010>
Mykonos (Greece), June 22 – 25, 2010

- 2010 **National Conference Dall'eV al TeV tutti i Colori dei GRB: Secondo Congresso Nazionale sui Gamma Ray Burst,**

webpage: <http://www.mediterraneanastronomy.org/grb2010>
Cefalù, June 15 – 18, 2010

- 2008 **International Conference Probing Stellar Populations out to the Distant Universe**

webpage: <http://www.mporzio.astro.it/cefalu2008>
Cefalù (Italy), September 7 – 19, 2008

- 2007 **International Conference XXI Century Challenges for Stellar Evolution**

webpage: <http://www.oa-teramo.inaf.it/cafalu07>
Cefalù (Italy), August 29 – September 2, 2007

- 2007 **National Astrophysics School Oggetti Compatti e Pulsar – Scienza con Alma**

webpage: <http://pulsar.ca.astro.it/pulsar/Scuola2007>
Maracalagonis (Cagliari), May 20 – 26, 2007

- 2006 **National Conference (chair SOC) The Multicoloured Landscape of Compact Objects and their Explosive Origins: Theory vs. Observations**

webpage: <http://www.mporzio.astro.it/cefalu2006>
Cefalù (Italy), June 11 – 24, 2006

SCIENTIFIC RESPONSIBILITY FOR INTERNATIONAL PROPOSAL FOR EUROPEAN SPACE AGENCY CALLS

- 2022 **Lead Proposer of the space mission ALBATROS (Astonishingly Long Baseline Array Transient Reconnaissance Observatory from Space)**

ESA call for a Medium-size and a Fast mission opportunity in ESA's Science Programme
Final technical evaluation of ESA board: not feasible as F – fast small mission, but could be an M – medium-size mission

- 2022 **Proposer of the space mission THESEUS (Transient High-Energy Sky and Early Universe Surveyor)**

ESA call for a Medium-size and a Fast mission opportunity in ESA's Science Programme
Selected for phase-A study

2019 Lead Proposer of the project GrailQuest (Gamma Ray Astronomy International Laboratory for Quantum Exploration of Space-Time)

ESA call for the scientific long term plan Voyage 2050

Selected for publication in the voyage 2050 Special Issue (Science theme for ESA's long-term plan for the scientific programme: the nearby and distant Universe) of the journal Experimental Astronomy

SCIENTIFIC RESPONSIBILITY
FOR INTERNATIONAL AND
NATIONAL RESEARCH
PROJECTS, ELIGIBLE FOR
FUNDING ON THE BASIS OF
COMPETITIVE CALLS FOR PEER
REVIEW (MOST RELEVANT
SINCE 1999):

2019 PRIN 2017: Scientific Responsible of the research unit of the University of Cagliari for the PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE - Bando 2017

Project title: The new frontier of Multi-Messenger Astrophysics: follow-up of electromagnetic transient counterparts of gravitational wave sources (Prot. 20179ZF5KS)

Admitted to funding and funded with € 896,100.00

2019 Scientific Responsible of the HERMES Project

funded by internal Italian Space Agency proposal with € 1,900,000.00

2019 Member of Project Manager Board in the EU Horizon 2020 project – HERMES:

High Energy Rapid Modular Ensemble of Satellites, Scientific Pathfinder

funded with € 3,318,450

2019 Scientific Responsible and Scientific Coordinator of the HERMES Project

Funded by the Ministry of Education with € 1,650,000.00

2018 Scientific Responsible and Scientific Coordinator of the Research Project

Project title: "H.E.R.M.E.S. High Energy Rapid Modular Experiment Scintillator"

Funded by Italian Space Agency with € 500,000.00.

2017 Scientific Responsible and Scientific Coordinator of the Research Project of Fundamental Science 2012 annuality of the Autonomous Region of Sardinia

Project title: "Neutrons Stars as a laboratory of Physics of the Ultra-dense matter: a Multifrequency study"

Code: CRP-60529

2012 Scientific Coordinator of European Community Funds: FP7-PEOPLE-2007-1-1-ITN

Project title: "Multiwavelength Studies of Galactic Black Holes"

ITN 215212 (<http://www.black-hole.eu>).

2012 PRIN 2005

Project title: "Osservazioni e ricerca di pulsar e pulsar al millisecondo"

- 2007 **PRIN 2007**
Project title: "Ambienti estremi nella nostra Galassia: campi gravitazionali forti, getti relativistici e campi magnetici critici in stelle di neutroni in accrescimento"
- 2005 **PRIN 2005**
"Un nuovo impulso allo studio teorico delle pulsar al millisecondo"
- 2004 **PRIN 2004**
Project title: "Collaudo Scientifico del Telescopio REM: Gamma-Ray Bursts, Oggetti Compatti Galattici e Stelle Variabili"
- 2003 **PRIN 2003**
Project title: "Evoluzione delle pulsar al millisecondo nella Galassia e negli Ammassi Globulari"
- 2002 **PRIN 2002**
Project title: "Progettazione e realizzazione dell'Ottica del telescopio e della camera infrarossa del progetto REM. Sviluppo del software di processo, telemetria ed analisi dei risultati"
- 2001 **PRIN 1999**
Project title: "Osservazioni multifrequenze di radio pulsar e di associazioni pulsar/SNR e studio dei processi non termici connessi"

SCIENTIFIC RESPONSIBILITY
FOR INTERNATIONAL AND
NATIONAL RESEARCH
PROJECTS, ELIGIBLE (BUT NOT
ADMITTED) FOR FUNDING ON
THE BASIS OF COMPETITIVE
CALLS FOR PEER REVIEW
(MOST RELEVANT SINCE 2010)

- 2015 **Scientific Responsible of the research unit of the University of Cagliari for the PRIN-COFIN 2015, considered suitable but not admitted to funding**
Project title: 'A comprehensive multi-role study of neutron stars in Low Mass X-ray Binaries and their evolutionary outcomes'
Protocol: 2015WTAHCA, National Scientific. Responsible: Prof. Tiziana Di Salvo
- 2012 **National Scientific Responsible and of the research unit of the University of Cagliari for the PRIN-COFIN 2012, considered suitable but not admitted to funding**
The restless sky of neutron stars: the road to a deeper understanding of fundamental physics
Protocol: 2012EMYERA
- 2011 **Scientific Responsible of the research unit of the University of Cagliari for the PRIN-COFIN 2010/11, considered suitable but not admitted to funding: Low and High Energy Photons, Cosmic Rays, Gravitational Waves**
Project title: 'Observational Windows for the Study of the Physics of Compound Stars'
Protocol: 2010L4T9YT, National Scientific Responsible: Prof. Mario Vietri

PARTICIPATION IN
INTERNATIONAL RESEARCH
GROUPS:

- 2019 – Present **Science Working Group coordinator of the ScientificSpace Mission The-
seus**

Working Group 6: Additional and GO Science

- 2018 – Present **Principal Investigator of the Scientific Space Mission HERMES Scientific Pathfinder funded by Italian Ministry of Education**
Italian Space Agency, European Community (HORIZON2020) with a total budget of € 8,184,45
- 2015 – Present **Member of the International Research Group: X-ray Imaging Polarimetry Explorer - XIPE**
Project title: "Science Study Magnetic Fields working group in compact objects, WG.1-2.4"
- 2014 – Present **Member of an international research group funded by the International Space Science Institute in Bern**
Project title: "The disk-magnetosphere interaction around transitional millisecond pulsars"
- 2013 – Present **Member of the International Research Groups: Strong Gravity and Observatory Science for the Athena + X-ray observatory mission**
Project title: "a Large Class science mission selected by ESA for the ESA's Cosmic Vision 2015-25 program"
- 2013 – Present **Member for Research Group on Low Mass X-ray Binaries (WG1) within NewCompStar Collaboration, MPNS COST Action MP1304**
Project title: "Exploring fundamental physics with compact stars (NewCompStar)"
- 2011 – Present **Member of the International Research Groups: Science Observatory and Dense Matter for the evaluation phase of the LOFT (Large Observatory For X-ray Timing) satellite**

CREATION OF NEW
ENTERPRISES (SPIN OFF),
DEVELOPMENT, USE AND
MARKETING OF PATENTS

- 2015 **Development of software for data analysis and in particular for pulsar timing analysis**
On February 10, 2015, as Sole Director L. Burderi signed an agreement for the Permission to use Copyrighted Material through which he granted the use of the intellectual property of this software to Timelab Technologies Ltd., a company registered under the number 9010209 in England and Wales.

ORAL AND/OR INVITED
CONTRIBUTIONS IN NATIONAL
AND INTERNATIONAL
CONFERENCES AND SEMINARS
(SELECTIONS OF THE MOST
RELEVANT FROM 2008

- 2023 **TIMESCALES in ASTROPHYSICS CONFERENCE**, invited review talk Time Variability of Accreting Neutron Stars and Pulsar, New York University Abu Dhabi, January 15-21, 2023
- 2023 **High redshift GRBs in the JWST era**, invited talk, From the HERMES fleet to the flight of the ALBATROS: surfing the waves of quantum space-time, Sexten, January 09 – 13 2023
- 2022 **Congresso Nazionale GRB V**, invited talk, From the HERMES fleet to the flight of the ALBATROS: surfing the waves of quantum space-time, Trieste, september 12-15, 2022
- 2022 **INAF – IASF Palermo**, invited seminar, From the HERMES fleet to the flight of the ALBATROS: surfing the waves of quantum space-time, Palermo, march 10, 2022

- 2021 43rd COSPAR Scientific Assembly, invited talk, GrailQuest Gamma-ray Astronomy International Laboratory for Quantum Exploration of Space-Time & HERMES High Energy Rapid Modular Ensemble of Satellites, January 28 – February 4 2021, Sydney
- 2020 University of Leicester, Department of Astronomy, invited seminar, GrailQuest Gamma-ray Astronomy International Laboratory for Quantum Exploration of Space-Time & HERMES High Energy Rapid Modular Ensemble of Satellites Hunting for Gravitational Wave Electromagnetic Counterparts, invited talk, Leicester, February 12, 2020
- 2019 Future of astronomy with small satellites, talk GrailQuest Gamma-ray Astronomy International Laboratory for Quantum Exploration of Space-Time & HERMES High Energy Rapid Modular Ensemble of Satellites Hunting for Gravitational Wave Electromagnetic Counterparts, Springer Nature Campus – London, 11 November 2019
- 2019 X-ray Astronomy 2019 - Current Challenges and New Frontiers in the Next Decade, HERMES (High Energy Rapid Modular Ensemble of Satellites) & GrailQuest (Gamma-ray Astronomy International Laboratory for Quantum Exploration of Space-Time) Hunting for Gravitational Wave Electromagnetic Counterparts Probing Space-Time Quantum Foam, Bologna, Italy, September, 8-13, 2019
- 2019 Dipartimento di Fisica Ettore Pancini – Università Federico II, The HERMES project High Energy Rapid Modular Ensemble of Satellites Probing Space-Time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterparts, Naples, Italy, May, 17, 2019
- 2019 LXII Congresso SAI Roma, Accademia dei Lincei, High Energy Rapid Modular Ensemble of Satellites Probing Space-Time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterparts, Rome, Italy, May, 14-17, 2019
- 2019 Département d'Astronomie Université de Genève Ecogia, The HERMES project High Energy Rapid Modular Ensemble of Satellites Probing Space-Time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterparts, Geneva, Switzerland, April, 8, 2019
- 2019 Dipartimento di Fisica e Scienze della Terra, Università di Ferrara, The HERMES project High Energy Rapid Modular Ensemble of Satellites Probing Space-Time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterparts, Ferrara, Italy, March, 26, 2019
- 2019 New York University Abu Dhabi, The HERMES project High Energy Rapid Modular Ensemble of Satellites Probing Space-Time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterparts, Abu Dhabi, United Arab Emirates, March, 13, 2019
- 2019 12th INTEGRAL Conference 1st AHEAD Gamma-ray Workshop, The HERMES project (High Energy Rapid Modular Ensemble of Satellites): space-time quantum foam and hunting for gravitational wave electromagnetic counterparts, Geneva, Switzerland, February, 11-15, 2019
- 2018 42nd COSPAR Scientific Assembly, The HERMES project (High Energy Rapid Modular Ensemble of Satellites) Hunting for Gravitational Wave Electromagnetic Counterparts and Probing Space-Time Quantum Foam, Pasadena, California, July 14-22 July, 2018
- 2018 ECOST meeting PHAROS: The multi-messenger physics and astrophysics of neutron stars, Monteporzio Catone, Roma, March 20-23, 2018
- 2017 The HERMES project (High Energy Rapid Modular Ensemble of Satellites): Probing Space-time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterpart, 29th Texas Symposium on Relativistic Astrophysics, Cape Town, South Africa, December 3 – 8, 2017
- 2017 The HERMES project (High Energy Rapid Modular Ensemble of Satellites): Probing Space-time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterpart, invited seminar, INAF-IASF, Palermo, Italy, November 13, 2017
- 2017 The HERMES project (High Energy Rapid Modular Ensemble of Satellites): Probing Space-time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterpart, 15th INTEGRAL Symposium: Energetic Time Domain Astrophysics, Venezia, Italy, October 15 – 20, 2017

- 2017 The HERMES project (High Energy Rapid Modular Ensemble of Satellites): Probing Space-time Quantum Foam and Hunting for Gravitational Wave Electromagnetic Counterpart, 3rd COSPAR Symposium (COSPAR Symposium 2017): Small Satellites for Space Research, Jeju, South Korea, September 18 – 22, 2017
- 2017 Invited Reviewer and discussion leader of the session: Accretion on pulsating stars – La Gomera Accretion Week 2017, San Sebastián de La Gomera, La Gomera Island, Canary Islands, Spain, September 11 – 15, 2017
- 2017 Was Zeno Right? Quantum Clocks and the Discreteness in Quantum Gravity, invited talk, Gran Sasso Science Institute, Via Melchiorre Delfico, 67100 L'Aquila, Italia, June 28, 2017.
- 2017 Orbital evolution of AMXP in the context of non-conservative mass transfer, invited talk, INAF Osservatorio Astronomico di Roma, Monte Porzio Catone, Roma, Italia, May 16, 2017.
- 2017 Orbital evolution of AMXP in the context of non-conservative mass transfer, 2nd ISSI meeting on Transitional Neutron Stars Bern (Switzerland), January 23 – 27, 2017
- 2016 The Quantum Clock: a critical discussion on (space-)time, XXII SIGRAV Conference Cefalù, September 12 – 18, 2016
- 2016 The HERMES project High Energy Rapid Modular Ensemble of Satellites, Workshop Nazionale di Macroarea 4 su Astrofisica Relativistica e Particellare, Bologna, June 6 – 7, 2016
- 2016 The Quantum Clock: a critical discussion on (space-)time, invited talk, INAF Osservatorio Astronomico di Trieste, February the 3rd, 2016.
- 2015 Is Radio-Ejection ubiquitous among Accreting Millisecond Pulsar?, EWASS 2015, Tenerife (Spain), June 26, 2015
- 2015 The Quantum Clock: a critical discussion on (space-)time, invited talk, University of Tübingen (Germany), Institute for Astronomy and Astrophysics, June the 8th, 2015
- 2015 Is Radio-Ejection ubiquitous among Accreting Millisecond Pulsar (including Transitional Neutron Stars), ISSI meeting on Transitional Neutron Stars Bern (Switzerland), March 2 – 6, 2015
- 2014 Timing of Accreting Millisecond Pulsars: open issues, 1st meeting: WORKING GROUP 1 "Astrophysics" Barcelona, September 23, 2014 16) The Quantum Clock: a critical discussion on (space-)time, Problemi Attuali di Fisica Teorica (XX Edizione), Vietri sul Mare, April 11 – 16, 2014
- 2013 The Quantum Clock: a critical discussion on (space-)time, invited talk, Dipartimento di Fisica, Università di Ferrara, September 25, 2013
- 2013 The Quantum Clock: a critical discussion on (space-)time, 2° Mediterranean Conference on Classical and Quantum Gravity, Veli Losinj (Croatia), June 9 – 15, 2013
- 2013 Coherent Timing Analysis of Accreting Millisecond Pulsars, Physical Applications of Millisecond Pulsars, Aspen (USA), January 19 – 24, 2013
- 2012 On Low Mass X-ray Binaries and Millisecond Pulsar, Reading the book of Globular Clusters with the lens of stellar evolution, Osservatorio Astronomico di Roma, November 26 – 28, 2012
- 2012 The Quantum Clock: a critical discussion on (space-)time & Test it with GRBs, invited talk, Osservatorio Astronomico di Roma, Monteporzio Catone (Roma), November the 6th, 2012
- 2012 The Quantum Clock: a critical discussion on (space-)time & Test it with GRBs, SIGRAV XX-Conference, Napoli, October 22 – 26, 2012
- 2012 The Quantum Clock: a critical discussion on (space-)time & Test it with GRBs, XIII Marcel Grossmann Meeting, Stockholm (Sweden), July 1 – 7, 2012

- 2012 On Low Mass X-ray Binaries and Millisecond Pulsar, VOSS 2012 (Vatican Observatory School) The Formation and Evolution of Stellar Clusters, Castel Gandolfo (Roma), June 3 – 29, 2012
- 2012 The GRAAL experiment (Gamma Ray Astronomy Antarctica Laboratory): probing the ultimate structure of the space-time with a tethered balloon borne platform, Quantum Gravity Workshop, Università La Sapienza, Roma, March 28 – 29, 2012
- 2011 Heretic Transients Accreting Millisecond X-ray Pulsar: the bridge between Radio Pulsar and X-ray Binaries, Autumn Workshop: Principles of Multi-wavelength High Time Resolution Astrophysics, Santa Margherita di Pula (Cagliari), October 9 – 16, 2011
- 2011 Non standard orbital evolution in LMXBs, X-ray Astrophysics up to 511 keV, Università di Ferrara, September the 16th, 2011
- 2011 Finding order in the chaos: coherent timing and spectral analysis of accreting millisecond pulsars, invited talk, Università di Ferrara, July the 7th, 2011
- 2011 Timing and spectral analysis of Accreting millisecond pulsars in LMXBs: Looking at the inner accretion flow with *Loft*, invited talk, Osservatorio Astronomico di Roma, June the 8th, 2011
- 2010 Orbital Evolution in Close X-ray Binary Systems: the Role of Mass Outflows, invited talk, Osservatorio Astronomico di Roma, January 26, 2010
- 2009 Timing of the ADC source and X-ray pulsar 2A 1822-371: A Stable Orbital Period Derivative over 30 Years, Congresso Nazionale Oggetti Compatti 2009, Santa Margherita di Pula (Cagliari), September 22 – 25, 2009
- 2008 Timing of the 2008 Outburst of SAX J1808.4-3658 with XMM-Newton: A Stable Orbital Period Derivative over Ten Years, IAU XXVIIth General Assembly, Rio de Janeiro (Brazil), August 3 – 14, 2009
- 2008 SAX J1808-3658: Witnessing the Banquet of a Hidden Black Widow?, Cool Discs, Hot Flows-Funasdalen (Sweden), March 25 – 30, 2008
- 2008 SAX J1808-3658: Witnessing the Banquet of a Hidden Black Widow?, invited talk, Astronomical Institute of Amsterdam (UvA), January the 8th, 2008

PARTICIPATION IN INTERNATIONAL ACADEMIES WITH PRESTIGE IN THE SCIENTIFIC SECTOR

- 2018 – Present From 2018 to present Luciano Burderi has participated as a speaker in various scientific dissemination events at the Unione Sarda Planetarium in Cagliari. He has also been a guest, as a speaker or participant in debates on the dissemination of science to the general public in various television programs (*Videolina*, Cagliari), radio broadcasts and streaming (*Passione Astronomia*). Recordings of this activity can be found on the YouTube channel.
- 2017 Le onde gravitazionali e le controparti elettromagnetiche, Convitto Maria Luigia, Parma, November 24, 2017
- 2017 Dove sono tutti quanti? – L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi, Convitto Maria Luigia, Parma, November 23, 2017
- 2017 Ecologia Scientifica e Modelli di Sviluppo: un progetto per la Sardegna, Invited Lecture for Corso di aggiornamento dell'Ordine dei Giornalisti della Sardegna. Tema: I problemi energetici della Sardegna, SulciScienza, Carbonia, November 16, 2017
- 2017 Presente! Le tre dimensioni del tempo alla luce della ricerca scientifica contemporanea, Invited Roundtable with Professor Silvano Tagliagambe, SulciScienza, SOTACARBO Grande Miniera di Sebariu, Carbonia, November 15, 2017

- 2017 La vita in mondi alieni, Invited Roundtable during a Public Outreach event, Planetario di Cagliari, piazza Unione Sarda, Cagliari, July 27, 2017
- 2017 Einstein: 100 anni di relatività e la scoperta delle Onde Gravitazionali, Istituto di Istruzione Superiore "G. Pischedda, Viale Alghero, 08013 Bosa (Oristano), May 27, 2017
- 2017 Einstein 100 anni di relatività, invited Public Outreach Lecture, University of Cagliari, Aula Magna della Facoltà di medicina – Cittadella Universitaria di Monserrato – Cagliari, May 26, 2017
- 2017 Lecture iv): Relatività Ristretta e Relatività Generale, invited course of lectures for high school professors of the Progetto Lauree Scientifiche, University of Cagliari, Aula A del Dipartimento di Fisica - Cittadella Universitaria di Monserrato – Cagliari, March 26, 2017
- 2017 Lecture iii): esercizi di Relatività: la natura particellare del fotone, invited course of lectures for high school professors of the Progetto Lauree Scientifiche, University of Cagliari, Aula A del Dipartimento di Fisica - Cittadella Universitaria di Monserrato – Cagliari, March 22, 2017
- 2017 Lecture ii): orologio a luce e Principio di Relatività, invited course of lectures for high school professors of the Progetto Lauree Scientifiche, University of Cagliari, Aula A del Dipartimento di Fisica - Cittadella Universitaria di Monserrato – Cagliari, March 8, 2017
- 2017 Lecture i): equazioni di Maxwell ed introduzione alla Relatività, invited course of lectures for high school professors of the Progetto Lauree Scientifiche, University of Cagliari, Aula A del Dipartimento di Fisica - Cittadella Universitaria di Monserrato – Cagliari, March the 1st, 2017
- 2017 La natura del cosmo oltre lo spazio ed il tempo, invited lecture for Public Outreach on Quantum Gravity, University of Cagliari, Aula A del dipartimento di Fisica - Cittadella Universitaria di Monserrato – Cagliari, February 23, 2017
- 2017 Il cosmo dopo la Relatività Generale: Struttura, Nascita, ed Evoluzione dell'Universo, breve viaggio nella cosmologia, invited talk at the National Conference Relatività e fisica quantistica: un matrimonio lungo un secolo, Fondazione Banco di Sardegna, Via S.Salvatore da Horta, 2 – Cagliari, February 22, 2017
- 2017 La natura del cosmo oltre lo spazio ed il tempo, Dipartimento di Fisica dell'Università di Cagliari, February 23, 2017
- 2017 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), San Giovanni in Persiceto, Bologna, December 16, 2016
- 2016 Dibattito con Silvano Tagliagambe: "I linguaggi della scienza, della letteratura e dell'arte: punti di convergenza e differenze.", Biblioteca Provinciale Cagliari, May 26, 2016
- 2016 Einstein: 100 anni di relatività" (e la rivelazione delle Onde Gravitazionali), Liceo Convitto, Cagliari, March 22, 2016
- 2016 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), Liceo Scientifico Pacinotti, Cagliari, March 16, 2016
- 2016 Tavola rotonda per PLEXSUS arte e scienza: con Silvano Tagliagambe, Cagliari, March 15, 2016
- 2016 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), Caffè Internazionale, Palermo, January 18, 2016
- 2015 Einstein 100 anni di relatività, Planetario Unione Sarda, Cagliari, December 28, 2015
- 2015 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), Auditorium dell'Osservatorio Astronomico di Cagliari, November 11, 2015

- 2015 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), Fondazione Mandralisca, Cefalù, September 8, 2015
- 2015 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), Osservatorio Astronomico di Roma, May 8, 2015
- 2014 Ecologia Scientifica e Modelli di Sviluppo, presso Liceo Paritario Pirandello, Carbonia (Sardegna), November 16, 2014
- 2014 L'esistenza degli Dei: come il Paradosso dei Gemelli ed il Principio Copernicano forniscono una "soluzione relativistica" al Paradosso di Fermi ("Dove sono tutti quanti?"), Istituto di Fisica dell'Università di Palermo, May 20, 2014
- 2014 Dalle nubi di Polvere ai Buchi Neri: nascita, vita, morte delle stelle, Istituto Minerario Asproni, Iglesias (Sardegna), May 13, 2014
- 2014 Ecologia Scientifica e Modelli di Sviluppo, Centro Studi ed Iniziative di Politica Economica in Sicilia, Palermo, May 10, 2014
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- 2014 Problemi Attuali di Fisica Teorica, Vietri sul Mare, Salerno, April 16, 2014
- 2014 Conferenza divulgativa Astronomia, Liceo Scientifico Amaldi, Carbonia, February 19, 2014
- 2013 Dalle nubi di Polvere ai Buchi Neri: nascita, vita, morte delle stelle, Castello Aragonese, Gaeta, September 16, 2013
- 2013 Dalle nubi di Polvere ai Buchi Neri: nascita, vita, morte delle stelle, Castello di Castellammare, June 25, 2013
- 2013 Dalle nubi di Polvere ai Buchi Neri: nascita, vita, morte delle stelle, Liceo Classico De Castro, Oristano (Sardegna), March 26, 2013
- 2013 Quantum Clock: una discussione critica sullo spazio tempo, Facoltà di Scienze della Formazione dell'Università di Palermo, February 27, 2013
- 2012 Curve chiuse di tipo tempo: causalità, casualità e libero arbitrio, Facoltà di Scienze della Formazione dell'Università di Palermo, November 21st, 2012

SUMMARY OF RESEARCH ACTIVITY

Luciano Burderi carries out his research activity in the field of High Energy Astrophysics. His studies are focused on binary systems that harbour a compact object (neutron star, NS, or black hole, BH) accreting matter from a companion star (secondary). In these sources, matter accretes on the compact (primary) object and releases the potential gravitational energy mostly in the X-ray band. For NS and BH the efficiency of the accretion process is about 10% of the rest mass. The analysis of the emission in the X-ray band allows to study the geometry of the accretion flow, the physical parameters of the primary and the behavior of matter in extreme conditions: strong gravitational fields and intense magnetic fields. The research activity is based on both a theoretical and an observational approach, mainly through the analysis of data from satellites for X-ray astronomy. In particular, the scientific activity of Burderi has focused on the so-called Low Mass X-ray Binaries (LMXBs), in which the secondary has a mass smaller than that of the Sun.

Most of these systems are transients with time-scales ranging from days to years. The transience is difficult to explain with variations in the contact conditions between the surface of the secondary and its Roche Lobe (RL), since these occur on much longer time-scales. Indeed, the nuclear evolution of the secondary goes on at least for tens or hundreds of millions of years, and comparable or longer time-scales are associated with other processes that maintain the contact with the RL thanks to losses of angular momentum: Magnetic braking or emission of gravitational waves. One possible solution is that instabilities in the accretion flow determines the transience. In particular, the thermal instabilities of the accretion disk occurring where its surface temperature falls below the plasma ionization temperature, are a promising mechanism. Indeed, unstable disks are emptied on viscous time-scales, which are on the desired range (from days to years, depending on the viscosity and the extension of the disk). In this case it is important to take into account the irradiation of the disk by the X-rays from the accreting source. This has stabilizing effects for compact binary systems that accommodate less extended disks (the extent of the disk depends on the size of the RL of the primary, which increases with the orbital period). The proposed scenario is in broad agreement with the observations (van Paradijs 1996, King, Kolb, and Burderi 1996), although it needs ad hoc values for the dimensionless viscosity parameter of Shakura & Sunyaev (1973) to be reconciled with experimental data. In particular it is necessary to assume significant variations of this parameter between the Hot and Cold states of the disk. It is believed that these more complex models, known as Disk Instability Models (DIMs), operate in most systems. Encouraged by this success, Burderi, King and Szuszkiewicz (1998) studied the disks that feed the super-massive BHs of the Active Galactic Nuclei (AGN), examining all the possible models of optically thick and geometrically thin stationary discs relevant to AGNs, identifying the schemes in which they are stable compared to the DIMs. The result of this study shows that most AGN disks are unstable.

Burderi, King and Szuszkiewicz (1998) have therefore hypothesized that each galaxy hosts a super-BH at its center and that the AGNs are only the fraction of supermassive BH currently subject to an unstable growth episode (outburst). In this context only some, if not all, Quasars could contain a population of stable discs, having growth rates much higher than the other AGNs. The scale times of the DIM, suitably rescaled, range from several tens to several hundred years depending on the viscosity parameter adopted. In this context we should mention the editorial News and Views of the prestigious Nature magazine signed by Siemiginovska & Elvis (1999) which discusses the implications of the results of Burderi, King and Szuszkiewicz (1998). The same work was cited by Virginia Trimble in its review *Astrophysics in 1999* (Trimble and Aschwanden 2000), where the most significant results in astrophysics of the year are illustrated. In the same review, another work of Burderi (Burderi, King, and Wynn 1998) is quoted on the discrepancy between the cooling timescale and the spin-down timescale of a Millisecond Radio Pulsar (MSP, a class of about 200 radio pulsars with spin periods below ten milliseconds).

In recent years the research of Burderi and his group have focused on theoretical and observational studies of a new class of X-ray sources, the so-called Accreting Millisecond Pulsars (AMPs): binary systems that host a rapidly rotating NS (which emits pulsations in the X-ray band), with a weak magnetic field undergoing transient accretion episodes from a very low mass secondary. To date, 18 AMPs are known (the first SAX J1808.4-3658, was discovered in 1998, Wijnands and van der Klis 1998), and it is believed that these systems are closely related to MSPs. The theoretical framework that link these two classes, revealed in two very different bands of the electromagnetic spectrum, is the so-called Recycling Scenario. According to this evolutionary scheme, the spin of an NS is firstly slowed down - below the threshold required to trigger the non-thermal emission of the radio pulsar - from the conversion of rotational energy into electromagnetic radiation according to the Larmor's formula. Subsequently, the NS is reactivated as radio pulsar (recycled) following a phase of acceleration of the spin determined by the accretion of matter and angular momentum from the secondary (see eg Bhattacharya and van den Heuvel 1991, for a review). In a broad sense, the Recycling Scenario suggests that AMPs are at least a part of the progenitors of MSPs. From the observational point of view, Burderi and his group have developed temporal analysis techniques (Timing) specifically designed to analyze data of accreting AMPs collected in the X-ray band, which allowed them to determine the spin of the NS and the orbital parameters with enormous precision (see for example Burderi et al 2007, Papitto et al 2007, Riggio et al., 2007). This allowed them to observe the behavior of the NS in response to accretion over a time-scale of dozens of days (Burderi et al., 2006, Papitto et al., 2008).

Furthermore, the analysis of subsequent outbursts of the same AMP allowed them to study the secular evolution of the spin and of the orbital parameters (see for example Burderi et al 2009, Hartman et al 2009, Papitto et al., 2011). The theoretical interpretation of these high quality data allowed Burderi and his group to verify different assumptions of the Recycling Scenario and to outline, also, new evolutionary phases of these systems. In particular, the secular spin-down of the NS spin, found in some AMP, has allowed them to determine that the intensity of the (dipolar) magnetic field is of some hundreds of millions of Gauss (see for example Riggio et al., 2011), demonstrating how the NSs in the AMPs have magnetic fields comparable to those of the MSPs, as predicted by the Recycling Scenario. On the other hand, the significant orbital expansion discovered in SAXJ1808.4-3658 (Burderi et al., 2009) seems to indicate that mass transfer is highly non-conservative: short accretion episodes (outburst), are followed by long phases of quiescence during which the matter, which continues to overflow from the secondary RL, is swept away by the radiation pressure exerted by the rapidly rotating NS which acts as a magneto-dipole rotator (i.e. a rotating magnetic dipole that emits electromagnetic waves and high energy relativistic particles, see e.g. the classical model of Goldreich and Julian (1969), developed immediately after the discovery of the first pulsar radio). Burderi and collaborators called this evolutionary phase Radio-Ejection (Burderi et al., 2001). Since the pressure exerted by the magneto-dipole rotator increases as the cube of the spin frequency, the Radio-Ejection is very effective in fastly spinning NSs. This is therefore a promising mechanism to inhibit the formation of magnetic NSs with spin less than one millisecond, which, in fact, have never been observed, although thoroughly searched. In this context, in order to effectively limit the NS spin-up process, it is not necessary to invoke ad hoc limiting factors such as the occurrence of non-axi-symmetric rotational instabilities and the consequent emission of gravitational waves from the rapidly rotating NSs. Therefore, the onset of the Radio-Ejection phase allows to stop the spin-up process before the NS attains its centrifugal limit, which is below one millisecond for realistic models of NSs.

The 2001 work by Burderi et al. was quoted by Virginia Trimble in his review *Astrophysics in 2002* (Trimble and Aschwanden 2003). Burderi quickly realized that this evolutionary phase could play a crucial role in determining the transient nature of the AMPs. In fact, the application of the DIM to the AMPs raises great difficulties. Observations indicate periods of quiescence of several years, but since all matter, poured during quiescence from the secondary into the RL of the primary, should accrete on the NS during the outbursts, the mass transfer rates mediated over time are very low (often only lower limits can be placed for the duration of the quiescence). Such low rates are marginally compatible, or not compatible, at least in one case (Marino et al. 2017), with the predicted rates assuming that the RL of the secondary shrinks because of losses of angular momentum due to the emission of gravitational waves, particularly intense in the AMPs of short orbital periods. Furthermore, if the orbital expansion of SAXJ1808.4-3658 is the result of a substantial mass loss rate from the secondary, only a tenth of this flow of matter would have been seen to accrete on the NS during the seven outbursts observed so far. This apparent paradox is solved if DIMs do not play a significant role in the transience of AMS. On the other hand, transient behavior can be easily explained by long phases of Radio-Ejection alternating with short accretion episodes (Burderi et al., 2009). A further evidence of the presence of a magneto-dipole rotator in the AMPs has been suggested by Burderi and collaborators with a study of the optical counterpart of SAXJ1808.4-3658 in quiescence (Burderi et al., 2003, A & A, 404, L43). Observations indicated that the secondary was over-bright. This extra brightness is perfectly compatible with the reprocessing of the radiation of a magneto-dipole rotator by the secondary surface, when a magnetic field of some hundreds of millions of Gauss is assumed. This value is consistent with the constraints imposed by the presence of pulses during outbursts, (Di Salvo and Burderi 2003) and with the aforementioned secular spin evolution. Subsequently, this method of investigation was applied successfully by other researchers (e.g. Campana et al 2004, Campana et al 2005, D'Avanzo et al., 2009) to determine the intensity of the magnetic field in AMPs. The idea is to use the secondary as a bolometer that measures the power of the (otherwise elusive) rotating magneto-dipole radiation.

A spectacular confirmation of the existence of a phase of Radio-Ejection, during the evolution of a compact binary system that harbours a NS with a rapidly rotating magnetic field, was obtained with the discovery of PSR J1740, an eclipsing MSP (D'Amico et al., 2001).

The long and variable eclipses, the widening of the shape of the pulsed profile, the high and variable dispersion, suggest the presence of plasma on the orbital plane. Furthermore, an ellipsoidal periodic modulation of the optical counterpart indicates that the secondary is not spherical and therefore fills its RL, although the absence of X-ray emission and the presence of an active MSP indicate that the matter is not accreted by the NS.

Burderi, D'Antona and Burgay (2002) have interpreted this peculiar observational picture as evidence of a phase of Radio-Ejection. They have indeed calculated that the pressure of the magnetic rotator is sufficient to halt the mass transfer from the Inner Lagrangian Point, determining the mass losses in the orbital plane required to explain the observations in the radio band. This work was cited by Virginia Trimble in her review *Astrophysics in 2002* (Trimble and Aschwanden 2003).

The Radio-Ejection phase was invoked to explain the scarcity of systems with orbital periods between 20 and 60 days in the distribution of binaries that contain a MSP. Also this work was cited by Virginia Trimble in *Astrophysics in 2006* (Trimble, Aschwanden, and Hansen 2007). Over the last few years, Burderi and his group have underlined the importance of highly non-conservative mass transfer phases during the evolution of LMXBs. In these phases significant losses of angular momentum, caused by the loss of mass, induce a greater contraction of the RL around the surface of the secondary, which increases the mass-transfer rate. This feedback can dramatically amplify the secular mass-transfer rate. If the NS is not able to accrete this huge flow of matter, either because it reaches the Eddington limit or because of the onset of a Radio-Ejection phase, the flow in excess is expelled from the system. This can result in a brief phase of unstable mass transfer, during which accretion occurs at the Eddington limit or does not happen at all. Burderi et al. (2010) argue that this is a promising framework to interpret the phenomenology of the Bright X-ray Sources of the Galactic Bulge, the so-called Z sources, a group of less than ten LMXBs, all with luminosity close to the Eddington limit. On the other hand, if growth is prevented by Radio-Ejection, unstable mass transfer can lead to the expulsion of most of the secondary mass (Di Salvo et al., 2008). This evolutionary channel for the formation of isolated MSPs is an alternative to the Black Widow scenario proposed by Tavani (Tavani 1991, Tavani 1991, Tavani and Brookshaw 1991) in which the magneto-dipole radiation is capable to "evaporate" the secondary of small mass.

The peculiarity of the model proposed by Burderi lies in the fact that, once the unstable transfer begins, NS rotational energy is no more required to destroy the secondary since this occurs at the expense of the enormous binding energy released by the secondary during the dramatic orbital shrinking. Once most of the secondary mass has been expelled, the small residual core, now in a very close orbit, can be easily "evaporated" by the magneto-dipole radiation emitted by the rapidly rotating pulsar. This makes the formation of isolated MSPs much easier. Recently, the research group of Burderi and collaborators has obtained very relevant experimental results in the study of the connections between the MSPs and the AMPs. In particular, in 2013 (Papitto et al., 2013), these researchers have discovered the source IGR J18245-2452, which alternates outburst phases in which it is visible in the X band as a AMP to phases of quiescence in which it is detectable in the radio band as a MSP. This source seems to be the connecting link that shows that AMPs and MSPs can be different phases in the evolution of the same system.

In 2017 (Ambrosino et al., 2017), these researchers have discovered millisecond optical pulsations from PSR J1023+0038, a transitional millisecond pulsar, i.e. a LMXB harboring a fast spinning NS that shows transitions from X-ray to radio phases. This discovery shows that NSs in an MSP phase can emit pulsed optical emission. The opening of this new window in the pulsed electromagnetic spectrum of rapidly spinning NS is of paramount importance for our understanding of the complex rotating magneto-dipole phenomenon.

In the last years the research interests of Burderi have extended to fundamental physics issues and, in particular, to the problems concerning an operative definition for the measurements of arbitrarily short space and time intervals. In particular Burderi et al. (2016) have published a work in which they propose a critical discussion on the measurement of these fundamental quantities through a Gedankenexperiment that illustrates the construction of an appropriate clock that the authors have named Quantum Clock. Measuring very small-time intervals means experimenting with very high-energy particles, but we do not know if in this case the two fundamental theories, quantum mechanics and general relativity theory, can get along. Indeed, at very high energies (technically speaking at the Planck scale) it is necessary to consider both quantum effects and general relativity (which is still a theory based on classical mechanics). While we know that, for not too high energies, quantum mechanics and general relativity are more or less consistent, for energies at the Planck scale the problem is still far from being solved.

The work starts from an ideal experiment designed by the authors, a Quantum Clock that, in principle, could measure small time intervals with all the accuracy requested. The "trick" is to measure, rather than the time elapsed, the number of decays of a large mass of radioactive atoms. This type of measures, in principle, can be done with a suitable Geiger counter. It must be considered, however, that the mass of this "clock" influences the structure of the space-time in which it is inserted, and, in particular, that this "clock" cannot have arbitrarily small spatial dimensions (because otherwise the photons that signal the emission of radioactive particles could not escape from the radioactive mass that would be subjected to a complete gravitational collapse). It follows that it is not possible to simultaneously determine the spatial and temporal coordinates of an event with arbitrary accuracy. The indeterminacy relationship that is obtained is the main result of the work. The interest in Quantum Gravity and on its possible experimental consequences, have recently led Burderi and collaborators to propose an ambitious experiment of High Energy Astrophysics, capable of revealing possible effects of a granular structure of space-time on a very small scale. In particular, this structure could imply a dispersion law for photons, whose group velocity would tend only asymptotically to the constant value postulated by Einsteinian theories, for photonic energies tending to zero. This miniscule effect, would be detectable if we consider high energy photons that have traveled distances comparable with the radius of the visible Universe. The astrophysical objects that are the best candidates for this type of investigation are the Gamma Ray Bursts that emit flashes of light in the gamma ray band from the edge of the visible Universe (cosmological redshift up to 8). To carry out this type of measurements, we intend to use a modular network of tens/hundreds of nano-satellites (up to a few kilograms of weight) in a low orbit. The project called HERMES (High Energy Rapid Modular Ensemble of Satellites) is currently in a feasibility study phase, and a pathfinder experiment involving six satellites will be carried out by the end of 2021, fully financed by the Italian Space Agency and the European commission. This project has received considerable interest from the international astrophysical community. Along this project Burderi and his group explored the compelling possibility to use of a fleet of X-Gamma ray detectors with all-sky field of view and high temporal resolution to perform temporal triangulation on events in the X-Gamma ray band to obtain an all-sky monitor of transients sources. This is an important issue since the discovery of a X-ray transient associated with a Gravitational Wave event detected by the LIGO Virgo interferometers. As the location accuracy scales with the baseline, Burderi and his group have recently proposed a medium-size mission to the European Space Agency to accomplish this task. ALBATROS (Astonishingly Long Baseline Array Transient Reconnaissance Observatory from Space) is conceived as a fleet of three satellites in Cartwheel orbits (similar to those proposed for the LISA gravitational waves interferometer from space) with baselines of few millions of km. ALBATROS will be an all-sky monitor of transient X-Gamma ray sources capable to localize each transient with positional accuracies in the range of few arcseconds (Burderi et al., 2021).

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Data e firm

