XLII National Congress of the Italian Society for the History of Physics and Astronomy

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Book of Abstracts

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Cosmology in about 1958: The Solvay conference

Author: Helge Kragh[None]

During the 1950s physical cosmology was in a state of transition characterized by the rivalry between relativistic evolution theories and the new, radically different steady-state theory. Remarkably, theories of the big-bang type played almost no role at all. The Solvay physics congress in June 1958 on "The Structure and the Evolution of the Universe"was the first international conference ever devoted to cosmology, a field which was still widely considered as semi-philosophical rather than genuinely scientific. The question of whether the universe could be ascribed a definite age was typically evaded or denied scientific legitimacy. The congress in Brussels offers an interesting perspective of the state of art of cosmology at the time and how mainstream physicists looked upon the possibility of establishing a theory of the universe as a whole. The invited participants in Brussels included the leading steady-state theorists (F. Hoyle, T. Gold, H. Bondi, W. McCrea), whereas G. Gamow was not invited and his nuclear-physical explosion theory of the early universe not even mentioned. With the Solvay conference as the pivotal point, the talk will discuss how cosmology changed in the pre-big-bang era from about 1950 to the early 1960s, before the cosmic microwave background radiation entered the scene.

From Herschel to Hubble: A long debate / **23**

The End of Greatness: A Brief History of the Hierarchical Universe (c. 1700-2000)

Author: Stefano Salvia[1]

[1] *University of Pisa*

The idea of a well-ordered and hierarchically structured Cosmos dates back to the very origins of astronomy and cosmology in remote antiquity. Independently from the questions of whether our Universe is finite or infinite, built up with the same matter of our local world or not, geocentric or heliocentric, bounded or boundless, with a definite age or eternal, stationary or expanding, until the most recent versions of the Multiverse hypothesis and their quest for an ultimate Theory of Everything, this heuristic ideal have always guided astronomers, cosmographers, natural philosophers, as well as later astrophysicists and cosmologists throughout the centuries. It can be regarded as inherent to any knowledge of the (meta-)physical Whole as such. However, in modern astronomy and mathematical physics, this Hierarchical Principle only became a coherent theory of the overall structure of the Universe under the pressure of finding a solution to four main puzzles, already contained in Newton's Principia: 1) the three-body problem; 2) the long-term stability of the "world system"; 3) the darkness of the night sky; 4) the nature of gravity itself. I will follow these deeply intertwined problems that shaped the cosmological debate of the last three centuries, before and after Einstein's General Relativity, along with the main developments in observational astronomy and experimental astrophysics: from Messier's nebulae to Hubble's red-shifted galaxies, from the large-scale isotropy of the CMB and homogeneity of the Cosmic Web to the theoretical speculations on the fractal structure and transfinite hierarchy of the Multiverse(s).

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 56

Masterpiece makers: the role and legacy of the Della Volpaia family in the production of scientific instruments in the Renaissance

Author: Sara Taglialagamba[1]

[1] *Università di Urbino*

Between the XV e il XVI century, three generations of architects, engineers, and manufacturers of machines, clocks, astronomical and measuring instruments stood out in the Della Volpaia family. The Salviati, Rucellai, the Medici, and other Florentine noble families estimated their works. Many members of the Della Volpaia family were in relationships with numerous established artists, such as Verrocchio, Leonardo, Michelangelo, and the Sangallo family. These artists, in turn, sometimes favored the fortune of friends, such as the painter Francesco Salviati and the sculptor Niccolò Pericoli, better known as Tribolo, presenting them to their powerful protectors. This talk aims to reconstruct the flourishing activity of the Della Volpaia family through the published and unpublished documents and, above all, through their workshop notebooks that provide valuable information passed down from generation to generation. On several occasions, Benvenuto, Eufrosino, and Camillo Della Volpaia faithfully transcribed the papers and notes of their father Lorenzo, in some cases updating them in the light of new inventions. The corpus of the drawings and annotations of the Volpaia consists of a central nucleus of four manuscripts kept in Florence, in the Biblioteca Laurenziana and the Biblioteca Nazionale Centrale, and Venice, in the Biblioteca Marciana. The latter, the Codice Marciano 5363, is the most important and was transcribed by Carlo Pedretti in 1953 and is currently under review (publication expected in 2023).

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 33

The models of the orb of Mercury made by Girolamo Della Volpaia: Perugia and Chicago

Author: Giancarlo Truffa[1]

[1] *Member of SISFA*

Girolamo Della Volpaia (1530-1614), member of one of the most important families of instrument and clock makers based in Florence during the Renaissance, made many instruments now disseminated in public and private collections around the world. There are sundials of different kinds, nocturlabes, horary quadrants and armillary spheres, all made with great skill, both technical and artistic.
He has also been one of the few makers of a specific category of instruments, the models of the orbs of the planets, or orbaria, a representation in three dimensions of the geocentric universe proposed by Ptolemy and revised by Georg Puerbach in the XV century.
In the Department of Physic and Geophysics of the University of Perugia the model of the orb of Mercury made by Della Volpaia is preserved while another model for the same planet is extant in the historical collections of the Adler Planetarium in Chicago.
In my presentation I will consider the origin of these models and the different solutions made by Girolamo della Volpaia and the other instrument makers of which these instruments are currently known.

From Herschel to Hubble: A long debate / 13

From Santini to GAIA: the improvement of the modern astrometric data with the use of XIX century stellar catalogues

Authors: Federico Di Giacomo[1]; Valeria Zanini[1]; Simone Zaggia[1]

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Hipparcos and GAIA missions have revolutionised modern astrometry. With EDR3, GAIA allowed milli-arcsec accuracy on positions, parallaxes and proper motions for over 1 billion objects over ~15mag of dynamic range. However, GAIA offers poorer astrometry for the brightest sources (G<5). A possible way to improve the astrometric knowledge about these objects is to analyse historical astrometric catalogues with a long baseline time (>150 yr). In this framework the five Paduan Catalogues, obtained by Giovanni Santini from 1836 to 1863, can play an important role. These catalogues, one of the most important works of classical astronomy accomplished during the XIX century in Italy, collect the positions and visual magnitudes of over 10,000 stars down to magnitude 10, observed with the Starke's Meridian Circle of the Padua Observatory.
In this talk we will describe the analysis that is being conducted on these catalogues, already praised at the time for their great precision. The first results show that the data collected by the Paduan astronomers were very accurate and could now make it possible to update the positions and proper motions of the brightest stars observed by GAIA. Furthermore, it will be possible to carry out a specific study about some stars which show variability or apparently anomalous movements from the mid-XIX century to the present.

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 41

Mercury, the different models of the cosmos, the theoricae of Girolamo della Volpaia

Author: Flavia Marcacci[1]

[1] *Pontifical Lateran University*

Mercury and Venus are the closest planets to the Sun and the Earth. In the geocentric model, they were situated near the Earth: above the Moon and below the Sun; for this reason, they were called "inferior"planets according to the Ptolemaic system. Following the Platonic system, those planets were located above the Moon and the Sun and below Mars. In the so-called "Egyptian"system, derived from Marcianus Capella's astronomy, Mercury and Venus run around the Sun, while the Sun rotated around the Earth as the Moon and the other planets. In the Renaissance and the Modern Age, the question of the order of inferior planets took a new form after the novelty introduced by the Copernican theory. There was a revival of geocentrically oriented astronomical instruments, especially the so-called orbarium, a model of planetary orbs concerned explicitly with the individual celestial bodies. The Italian instrument maker Girolamo della Volpaia made a few orb-models to represent the three-dimensional motions of the planets, including two of the orbs of Mercury. In this talk this Mercury-orb model will be compared to Georg von Peuerbach's *Theoricae novae planetarum* (1474). Della Volpaia *theorica* was a particular combination of an eccentric three-orb-system which is part of a concentric five-orb system. The planet Mercury, also so important for astrological influences, was particularly interesting for fixing or overcoming old world models.

From Herschel to Hubble: A long debate / **48**

Jacques Merleau-Ponty, a pioneer of a historical-philosophical approach to cosmology

Author: Giovanni Macchia[1]

[1] *University of Urbino*

Jacques Merleau-Ponty (1916-2002) was a French philosopher and historian of science, professor of epistemology at the University of Paris X-Nanterre since 1967, for years president of the French Philosophical Society, and a great supporter of the dialogue between philosophy, history and science. Attracted from physics from his early studies, he, on the advice of his more famous cousin Maurice, turned to philosophy to face the physics revolutions of the twentieth century, entering, in particular, the school of science which in the 1950s was the newest and challenging: relativistic cosmology. And he did it in 1965 with a book born from his doctoral thesis: *Cosmologie du XXe siècle. Étude épistemologique et historique des théories de la cosmologie contemporaine.*
In this text, of rare and elegant historical-scientific-philosophical competence, the most recent cosmological hypotheses dialogue in a masterly way with philosophical thought, in an authentic exchange, focusing on the epistemological status of this peculiar science, on the methodologies of its protagonists, on the ontological consequences of its concepts. Unfortunately, this text has not received the deserved international recognition, perhaps due to some unfortunate editorial contingency, since it has never been translated into English, but only in Italian and Spanish. Actually, much of his most recent work (on the history of physics and astronomy as well) has remained confined to the French sphere. This is a serious shortcoming for a field of research that, by its nature, requires a deep historical-philosophical understanding, which is often lacking. I think we should recover this scholar.

Astronomy and Physics in Perugia / **31**

Today Physics in Perugia

Author: Sara Palmerini[1]

[1] *INFN, University of Perugia*

The research lines currently active in the Physics section of the Physics and Geology Department of the University of Perugia will be presented.
These research activities results from the evolution of the skills acquired over the years in the department and rooted in its history.
The crucial role of research institutions (INFN and CNR in particular) in this process will be underlined

Astronomy and Physics in Perugia / **55**

Passato e presente dell'Astronomia e dell'Astrofisica a Perugia

Authors: Maurizio Busso[1]; Gino Tosti[1]

[1] *Department of Physics and Geology, Univ. Perugia*

Si riassumono la storia passata e la ricerca attuale nel campo dell'Astronomia e dell'Astrofisica presso l'Ateneo Perugino, uno dei più antichi d'Italia, fondato nel 1308. Una storia così lunga non può

trascurare eventi rilevanti anche extra-accademici, come quelli che caratterizzarono l'attività del noto astronomo e cartografo Ignazio Danti, ispiratore del calendario gregoriano e munifico donatore all'Ateneo di una celebre sfera armillare, tuttora detenuta dal Dipartimento di Fisica e Geologia. Il secolo successivo è contraddistinto dall'opera di Galileo Galilei in Umbria e dai suoi rapporti con l'Accademia dei Lincei e col suo fondatore, Federico Cesi, duca di Acquasparta. In Umbria, tra l' altro, sul lago di Piediluco, si svolse effettivamente l'esperimento della caduta di un grave rispetto ad una barca in moto uniforme, fondamento del principio di relatività galileiana. La ricostruzione del passato termina idealmente con l'illustre figura del prof. Paolo Maffei, docente a Perugia fino al 1997, grande divulgatore e pioniere dell'astronomia infrarossa. Il seguito è costituito dall'attività dei docenti ancora oggi in servizio, che hanno arricchito l'Ateneo con studi di Astrofisica Nucleare e Astrofisica delle Alte Energie, che saranno brevemente descritti nella presentazione.

Astronomy and Physics in Perugia / 30

For a history of physics in the University of Perugia: between specialization, cultural policy and relations with other disciplines.

Author: Marco Maovaz[1]

[1] *University of Perugia*

The history of physics has always accompanied university teachings from the beginning, initially in the form of natural philosophy and gradually over the centuries as an increasingly specialized and autonomous discipline. In the chronology of the University's museums and cabinets, the Physics Cabinet, founded in 1759, holds a respectable place as it is the second university museum after the botanical garden founded in 1720. For the foundation of the Cabinet the model of the reference was the counterpart of Sapienza and this circumstance introduces an interesting concept: that of the relationship with the capital and consequently with the government cultural policy. The revolutionary storm of the late eighteenth century also affected the approach to the discipline which until the mid-twentieth century was interpreted differently by the conservative and progressive camps, also in relation to the other disciplines that were emerging among the university teachings of Perugia

Astronomy and Physics in Perugia / 53

Natural Philosophy and Surviving Instruments (1730-1850): the case of Physics Cabinet at Perugia University

Author: Roberto Mantovani[1]

Co-author: Flavia Marcacci [2]

[1] *University of Urbino*

[2] *Pontifical Lateran University*

The origin of Physics teaching in Perugia took place long ago. As early as 1730, the physician and mathematician Virgilio Cocchi held a University physics lecture. In 1759, Perugia's Studium acquired some physics machines from La Sapienza University in Rome, later used to reproduce some innovative "philosophical experiences". The priest and philosophy lecturer Luca Antonio Pellicciari oversaw the purchase. Pellicciari had studied in Rome at the school of the Minim Friars Thomas Le Seur and François Jacquier, famous editors and commentators on Newton's works. Thus, he became a professor of experimental physics at the University of Perugia. In May 1763, Pellicciari inaugurated the University's 'Experimental Theatre' (*Theatri formam referens*) to hold public experiments, disputes, and dissertations on experimental physics. Famous visitors such as Joseph-Jerome Lalande

and Johann Bernoulli spread the news about this new teaching and experimental facility, which acquired new equipment over the years. Pellicciari retired in 1799. His pupil Luigi Canali took over the chair of physics, as well as that of chemistry. In the first decades of the 19th century, Canali owned a famous collection of minerals, visited and praised by Georges Cuvier in 1813. The talk will retrace the main historical stages of the birth of experimental physics in Perugia, also linking them to the historical collection of scientific instruments, now preserved at the University's Physics Department.

Astronomy and Physics in Perugia / **39**

The renewed exposition of the instruments of the hystorical "Gabinetto di Fisica" of UniPG

Author: GIOVANNI CARLOTTI[1]

[1] *University of Perugia - Dept of Physcis and Geology*

In this talk I will present the collection of hystorical instruments of the Gabinetto di Fisica of UniPG, whose construction and acquisition spans from the end of the XV century to the first half of the XX century. I will also introduce the new exposition of these instruments that has been recently set up at the first floor of the Physics Dept. building, in coordination with the Science Museums Center (CAMS) of UniPG. CAMS was founded in the mid- nineties with the primary purpose of conserving, document and valorize the cultural heritage represented by the scientific collections of Perugia University.

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Presentazione al museo POST del libro "Da via Panisperna all'America: I Fisici Italiani e la Seconda Guerra Mondiale" a cura di Battimelli, De Maria, La Rana.

Physics and diplomacy: a chain reaction / **9**

"We must opt for survival. No substitute for negotiation." Some reflections on the civil commitment of nuclear physicists during the Cold War: the Italian case

Author: Lodovica Clavarino[1]

[1] *Università Roma Tre*

My talk will focus on the peace activism of the Italian scientists during the Cold War.

With the beginning of the nuclear age, several scientists claimed a specific role in raising awareness of the perils of their times, both in their countries and at a transnational level. After brief reflections on some prominent international efforts in this field (as Pugwash, established as consequence of the Russell Einstein Manifesto), the aim of my speech is to depict the "social activation"of the Italian community of physicists in the arms control and disarmament field.

In Italy, a community of physicists around these topics emerged during the Non-Proliferation Treaty' s debate (mid 1960s). Afterwards, we can observe another significant period of commitment to arms control during the crisis of détente (end of 1970s/early 1980s). Connected with associations and

groups based in other countries, these Italian scientists pursued the purposes of 1) educating citizens about nuclear weapons; 2) pushing their government for progress in arms control and détente; 3) strengthening a transnational network of likeminded activists.

Being an historian of international relations, I will describe the key projects promoted by the Italian scientists (such as ISODARCO, USPID, the activities based at the Accademia dei Lincei), highlighting the main tensions and thorniest issues of each specific historical phase. Although some publications are available, scientists'advocacy of arms control and détente is not a theme that has been extensively investigated yet from a historical point of view.

Physics and diplomacy: a chain reaction / 29

I fisici italiani e la bomba atomica

Author: paolo rossi[1]

[1] *Dipartimento di Fisica Università di Pisa*

L'evoluzione dell'atteggiamento della comunità dei fisici italiani nei confronti dei problemi suscitati dalle armi nucleari è esaminata con particolare attenzione al passaggio verso una più diffusa consapevolezza collettiva a seguito dei test nell'atmosfera tra la fine degli anni Cinquanta e l'inizio degli anni Sessanta.

History and didactics of physics and astronomy / 2

C'erano una volta le nebulose. Episodi del viaggio oltre i bastioni della Galassia

Authors: Roberto Rampazzo[1]; Valeria Zanini[2]

[1] *Istituto Nazionale di Astrofisica (INAF)*

[2] *INAF Osservatorio Astronomico di Padova*

We are preparing a book that introduces the reader to the history of extra-galactic astronomy. The evolution of telescopes in 1700s and the introduction of the photographic plate in the first decades of the 1800s led to the debate on the nature of nebulae in 1920. The last century, widely referred to as The Cosmic Century, has seen unimaginable developments in the study of galaxies, starting with the Milky Way and ending almost as far back as the Big Bang. Aimed at high school students, born out of the experience of "alternanza scuola-lavoro", the book focuses on astronomers, their ideas and techniques. Although rigorous, the book aims to have the lightness of a watercolour, which is why we have chosen to illustrate it only with drawings and explanatory plates.

Physics and diplomacy: a chain reaction / 4

Physicists and Vietnam

Author: Gerardo Ienna[1]

[1] *University of Verona & University of Maryland*

The criticism of the use of science and technology for military purposes (especially by the U.S. in the Vietnam War) was one of the transversal themes of the various Radical Science Movements at the national level. On this point have insisted many publications of the time in journals such as Radical Science Journal, Science for the People, Sapere, Survivre et Vivre.
The presence in Europe in 1972 of some scientists of the Jason Commission was the trigger for the emergence of a series of protest activities coordinated between Italy, France, United States. In this context the community of militant physicists has been particularly active, exposing themselves in first person to face the "non-neutral" activity of their colleagues. Here are some examples:
- on June 13 the Nobel Prize for Physics Murray Gell-Mann was expelled from the Collège de France.
- During the summer schools of physics of Erice (Italy) and Cargèse (France) the presence of John Archibald Wheeler, Gell-Mann, Sidney Drell creates tensions.
- During the summer school of Varenna (Italy) a collective manifesto entitled "Statement on Vietnam" is drawn up.
- Violent protests during the international conference in Trieste entitled Development of the Physicist's Conception of Nature.
- Varenna's Statement on Vietnam was distributed during the Conference on High-Energy Physics in Batavia held in September (US).
With this paper my aim is to reconstruct how the theme of the war in Vietnam has favored a synchronization of the activities and claims of local Radical Science Movements.

Physics and diplomacy: a chain reaction / 5

From diplomacy to physics and back again: The changing roles of IUPAP in the second half of the 20th century

Author: Roberto Lalli[1]

[1] *Max Planck Institute for the History of Science*

The talk discusses the changing structures and functions of the International Union for Pure and Applied Physics (IUPAP) from its re-establishment after World War II until the late 20th century in relation to broad historical processes based on ongoing studies within the *IUPAP 100 history project*. IUPAP restarted its activities in 1947 after World War II had dramatically altered the social and political implications of physics research. The establishment of a new world order and the new social and political role of science led to a reconfiguration of international institutionalization of scientific cooperation and exchange. The umbrella organization of international scientific unions, the International Council of Scientific Unions (ICSU), had just re-established its activities in formal cooperation with UNESCO. The new formal agreement between ICSU and UNESCO dramatically changed the nature and range of activities of IUPAP. While IUPAP had been rather inactive in the interwar period, the post-WWII period saw the emergence and rapid blossoming of various committees devoted to specific sectors of physics. After discussing the major features of this transformation, the talk chronicles main developments of the activities of IUPAP and its committees in the following decades. These highlights from the history of IUPAP demonstrate the delicate balance between scientific goals and diplomatic concerns shaping the way in which IUPAP officers and its committees operated in different historical contexts.

History and didactics of physics and astronomy / 44

Introdurre la cosmologia come scienza sperimentale e osservativa intrecciando storia ed esperimenti: dalla scarica dell'elettroscopio alla camera di Wilson

Author: Francesca Monti[1]

Co-authors: Claudia Daffara [1]; Sara Mazzocato [1]; Adele La Rana [1]; Claudia Erbisti [2]

[1] *Università di Verona*

[2] *Liceo G. Fracastoro-Verona*

Nell'ambito del Progetto nazionale Lauree Scientifiche dell'Università di Verona abbiamo progettato un percorso didattico che, intrecciando la storia della scoperta dei raggi cosmici ad attività di laboratorio, consente di introdurre la cosmologia come scienza sperimentale e osservativa, quale si è andata gradualmente affermando nel corso del Novecento, anziché esclusivamente teorica. Il percorso storico e sperimentale inizia con la scarica spontanea dell'elettroscopio osservata da Charles Augustin de Coulomb nel 1785, che gli studenti sperimentano direttamente e in modo autonomo in laboratorio. Le tappe storiche successive passano attraverso le misure di Domenico Pacini (1908-1912) e di Victor Hess (1911-1913) e culminano nell'osservazione delle tracce create dal passaggio di radiazioni ionizzanti nella camera di Wilson (1911-1912). Qui l'aggancio fra storia ed esperimento è dato dalla ricostruzione, fatta dagli studenti con materiale povero da loro stessi procurato, della camera a nebbia (Bertozzi, 2021) in una versione attualizzata secondo le istruzioni fornite dal manuale del CERN (Woithe, 2016), a cui segue la diretta osservazione delle diverse tipologie di tracce. Ne scaturisce la domanda sulla loro origine e quindi il riconoscimento della cosmologia, appunto, come scienza sperimentale e osservativa. La sequenza didattica proposta risulta avere una forte valenza formativa in quanto gli studenti ripercorrono in prima persona e in modo consapevole le tappe storiche più significative affrontando le molteplici difficoltà sperimentali delle attività proposte insieme agli aspetti concettuali connessi.

Physics and diplomacy: a chain reaction / 27

Nuclear encounters: Italian and German physicists during WWII

Author: Adele La Rana[1]

Co-author: Giovanni Battimelli [2]

[1] *Università di Verona*

[2] *Sapienza University of Rome*

This contribution aims at giving a special perspective on the relationships between Italian and German nuclear scientists during WWII. It considers and analyzes for the first time two significant gatherings organized in Rome by the Kaiser-Wilhelm Institut für Kunst- und Kulturgeschichte: a lecture by Otto Hahn on nuclear fission, in March 1941, and one by Max Planck on the meaning and limits of the exact sciences, in April 1942. Both lectures were held at Palazzo Zuccari, formerly the seat of the prestigious Bibliotheca Hertziana, which had been recently renamed and restructured by the Hitler regime. A varied assortment of guests participated in these events: alongside Nazi political figures and authorities, and high exponents of the cultural life of the institute, Italian and German physicists such as Edoardo Amaldi, Gian Carlo Wick, Arnold Sommerfeld. Hitherto unpublished documents and letters allow to add meaningful pieces to the story of the interactions between Italian and German nuclear scientists during the world conflict, and to follow the evolution of these relationships in the post-war period, preluding to the role that physicists like Amaldi would play in the reorganization of science in Europe.

History and didactics of physics and astronomy / **20**

Principles and Equations of Physics

Author: Marco Giliberti[1]

[1] *Università degli studi di Milano*

Each discipline has its own particular way of approaching the world that, although does not present great shortcuts or royal roads, is linked by indissoluble threads to other disciplines in a network that evolves and creates new connections that highlight its limits and potentiality, and, above all, its human aspects. We will discuss a didactic project of the University of Milan, addressed to high school students and teachers, titled "Principles and Equations of Physics". The aim of the project is to provide students with opportunities for orientation and help them grasp the charm, the creative and the exciting aspects of physics in a surprising humanistic, cultural landscape that identifies a scientific theme starting from the history of physics seen as a complex path of logical, philosophical, musical, literary type that describes a development process of the whole mankind. So far the project has had two editions, one about Newton's laws of motion and the other about Maxwell's equations, which, given the pandemic, were carried out remotely. Each edition consisted of 5 to 8 online meetings one hour and a half each that were held by two voices (the author of this communication together with a professional actor) and were attended by more than 650 teachers and students per each meeting. The potentiality and peculiarities of the project will be presented together with some of its first results.

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / **73**

Of anomalous planets and heavenly mechanisms: Realizing true Ptolemaic motion with wondrous gearing.

Women, Sciences, Scenario / **72**

Raffaella Simili: in memoriam

Women, Sciences, Scenario / **45**

Caterina Scarpellini (1808-1873): a woman astronomer on the Campidoglio.

Author: Federica Favino[1]

[1] *Sapienza Università di Roma*

Caterina Scarpellini (1808-1873) spent all her private life and scientific activity in Rome at the Tower of Pope Nicholas V on the Campidoglio. There, she acted first as the assistant guardian of the astronomical instruments of the local Observatory and then as the holder of a meteorological station. During her lifetime, that same place hosted several scientific institutions and took on opposite connotations (first private, then public, then private again) in relation to the political choices of the papal government, but also based on the role that Catherine played within them. My contribution focuses on this story to reflect more broadly on the social dimension of the work of the first female scientists.

Women, Sciences, Scenario / 35

Daria e Nella: due donne nella fisica romana del Novecento

Author: Giovanni Battimelli[1]

[1] *Università di Roma La Sapienza*

Si presentano la carriera scientifica e la vicenda personale di Nella Mortara (1893-1988) e di Daria Bocciarelli (1910-2006). Nonostante la scarsa documentazione al riguardo, è possibile ricostruire attraverso le loro storie un pezzo significativo, se pur "minore", della storia della fisica romana, tra l'Istituto di via Panisperna e il laboratorio fisico della Sanità, negli anni a cavallo della metà del secolo scorso.

Women, Sciences, Scenario / 10

Bologna in the Eighteenth Century: a 'Paradise' for Women.

Author: miriam focaccia[1]

[1] *Museo Storico della Fisica e Centro Studi e Ricerche 'Enrico Fermi'*

The XVIII Century has been a century with profound transformations that affected the female universe traditional behavioral models. In this context, Bologna played a leading role.
In fact, during this century the memory of acknowledged women, such as Accorsa, Bitisia Gozzadini and Alessandra Giliani, who lived between the XII and XIII Centuries, re-emerged and constituted a very strong citizen myth.
Besides, thanks to Prospero Lambertini's - future Pope Benedict XIV - skillful direction and to his project of political, social and cultural renewal and revitalization of the city, some women's career was encouraged and supported.
Lambertini was inspired in his project by a group of progressive and advanced scientists coming from the Bolognese scene such as Iacopo Bartolomeo Beccari, Francesco Maria Zanotti, Domenico Gusmano Galeazzi, Eustachio and Gabriele Manfredi and Giovanni Antonio Galli.
Differently from the previous decades model of aristocratic feminism, a new female model was proposed. Both Laura Bassi and Anna Morandi fit perfectly into this picture: they were mothers, but also scientists who, coming from modest social and economic contexts, claimed the importance and 'public' utility of their competences.
The protagonist was the Academy of Sciences of Bologna. Here, starting from 1732, it was set up a special class of fellows called the 'Honored' that included foreigners and women such as Laura Bassi, Faustina Pignatelli, Émilie du Châtelet, Maria Gaetana Agnesi and Marguerite Le Comte.

Early modern Physics and astronomy / 8

The unpublished physical and astronomical notes of the Accademia del Cimento

Author: Elisabetta Rossi[1]

[1] *University of Milan*

The Florentine Accademia del Cimento (1657-1667) was the first European academy of the Modern Era: its motto, "*Provando e riprovando*", embodies the choice to put experimentalism at the core of the ten-year activity. From 1657 to 1667, the academicians carried out hundreds of experiments (during more than 600 academic sessions): while pneumatics and thermology were the predominant research

lines, the Cimento also paid attention to physical phenomena and other areas, such as meteorology, natural sciences, and astronomy, making extensive use of scientific instruments. Despite this, only a small part of this whole set is collected in the only official publication of the Cimento, the *Saggi di Naturali Esperienze* (1667), and the reason for this choice is one of the ongoing issues and subject of historical studies.

Fortunately, the experimental history of the Academy can be studied through the unpublished manuscript diaries kept in the Florentine Archives at the BNCF (Biblioteca Nazionale Centrale di Firenze). Starting from some of these selected documents, my speech will focus on physical experiments on magnetic and electrical properties ("*virtù*") of substances, pendulum motions, light and sound behaviours, all carried out at the Medicean Court. I will also present some astronomical observations of planets and other celestial phenomena (lunar and solar eclipses, comets) and the related correspondence with important European astronomers that brought to light evidence against the centuries-old tradition of the Ptolemaic geocentric model.

Women, Sciences, Scenario / **62**

Between the salon and the laboratory (and beyond). The "new chemistry" of Marie-Anne Paulze-Lavoisier (1758-1836)

Author: Francesca Antonelli[1]

[1] *University of Bologna*

Marie-Anne Paulze-Lavoisier (1758-1836) is known today as an active promoter of the so-called "new chemistry", a set of theoretical and methodological assumptions that affected chemistry in the late eighteenth-century. This reputation is largely due to her collaboration with her husband, the French chemist Antoine-Laurent Lavoisier (1743-1794), whom she supported through illustration and translation of chemical texts and laboratory assistance. This presentation aims to provide a more complex picture, highlighting Paulze-Lavoisier's attempts to gain a reputation of her own. I will focus, in particular, on the spaces in which the Lavoisiers lived, worked, and experimented together, especially their residence at the Arsenal, in the eastern outskirts of Paris. We will then move beyond the domestic walls, following the couple in some of their trips in the French provinces. Finally, I will focus on Paulze-Lavoisier's trajectories as a widow, when her working routine underwent profound changes. Even in this phase, as we shall see, spaces remained crucial, both as sites for knowledge-production and as resources for the construction of personal reputations.

Early modern Physics and astronomy / **12**

Venus moon: an astronomical tale of illusions and deceptions

Author: Luisa Lovisetti[1]

[1] *University of Milan, Department of Physics*

What do a Neapolitan lawyer, a famous Italian astronomer, a Scottish instrument maker, the greatest French writer of adventure novels and a curious Belgian journalist have in common? Perhaps it may be surprising to discover that they all are main characters of a story concerning the mysterious satellite of Venus. And if the attentive reader must have immediately (and correctly) thought "But Venus has no satellite!", it will be even more astonishing to realize that, for more than two centuries, some of the most eminent scholars really believed in the existence of such a celestial body. In fact, starting from the seventeenth century, recurrent sightings of a hypothetical satellite occurred, leading several astronomers to go looking for it. Among them, the Italian Giovanni Domenico Cassini (1625-1712), who claimed to have seen something resembling a moon once in 1672, and again in

1686. 2022 is the 350th anniversary of his first alleged sighting; this work is thus aimed to trace the most relevant and curious passages of such a long and fascinating astronomical research.

Women, Sciences, Scenario / 51

"Qui siamo tutti astronomi"?

Author: Benedetta Campanile[1]

[1] *Università degli Studi di Bari Aldo Moro*

The first women to have scientific recognition in the space of astronomy belonged to the Harvard College Observatory. But in other cases, women have remained nameless faces, relegated to the role of helpers to dispose of the amount of data produced by photographic applications. They do not appear in publications and it is difficult to reconstruct their presence in the laboratories because only a few oral testimonies remain, tainted by the lability of memory.
In this report, two Italian cases are brought to light. The first concerns the four nuns who worked at the Specola Vaticana and contributed to the creation of the part of the Astrographic Catalog of the "La Carte du Ciel" project, entrusted to the observatory of the Catholic Church. The second concerns a dozen young women, called scanners, who worked in the laboratory of the Institute of Physics of the University of Bari and contributed to the international research program on high-energy particles coordinated by CERN of Geneva.
This work aims to bring out the contribution of these "petites mains", because from their daily work, carried out side by side with scientists, research methods can be reconstructed and some aspects can be reflected on: the progressive specialization of the work of the "Handyman boy" in the scientific laboratory; if the structuring of the work that distinguishes between anonymous helpers and manager-scientist is so clear-cut in reality; at last, if the hierarchical structuring of work has determined a professional, intellectual and social "supremacy" within the scientific community.

Early modern Physics and astronomy / 57

The concept of inertia in Huygens

Author: Paolo Bussotti[1]

[1] *University of Udine*

Generally, three scientists in the 17th century are associated to the concept of inertia: Galileo, Descartes and Newton. However, Christiaan Huygens developed a profound reflection on this fundamental notion. The Dutch scientist developed a train of thought which is less direct and clear than Newton's, but not less interesting. The literature on Huygens' concept of inertia is by far less abundant than that on Galileo's, Descartes' and Newton's conception. Mormino Barbour and Stan are the authors who have given some of the most remarkable contributions. In this period, I am developing a research on this notion which will be published as a chapter of a book on the cosmology in the 17th century I am writing with a colleague of mine, Prof. Brunello Lotti, and which will appear between Autumn 2022 and Winter 2023. In my talk I will expound the main results of our research, which leads to a conclusion different from that proposed by Stan in his paper "Huygens on Inertial Structure and Relativity", *Philosophy of Science*, 83: 277-298.

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Visita M.A.N.U. e Spettacolo teatrale

Visita al Museo Archeologico Nazionale dell'Umbria per vedere alcuni strumenti di astronomia, tra i quali il quadrante orario di Gerolamo della Volpaia ed altri pezzi unici.
A seguire spettacolo teatrale sulla straordinaria vita del fisico Bernard Dessau, che curò il Gabinetto di Fisica di Perugia. Interprete: Alessio Stollo. Scrittura e regia Paola Tortora - Vintuleratеatro.

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 40

What is an "Armillary Sphere" and What It Is Not: The Case of the Great Armillary Instrument by Antonio Santucci of 1588-1593

Author: Giorgio Strano[1]

[1] *Museo Galileo: Istituto e Museo di Storia della Scienza*

Antonio Santucci of Pomarance (d. 1613), cosmographer of the Grand Duke of Tuscany Ferdinando I de 'Medici, went down in history for a *New Treatise on Comets* published in 1611 and reprinted posthumously in 1619. Another of his treatises "Above the New Invention of the Armillary Sphere" has instead remained in manuscript form. The making of the object described therein is believed to coincide with the large armillary instrument preserved in the Museo Galileo in Florence. It should be noted that the name "armillary sphere" was combined with the object by virtue of a very superficial examination of the manuscript. The comparison of the document with Santucci's large instrument leads more generally to think on what an "armillary sphere" is and what it is not. In fact, it is possible to identify two moments of misunderstanding, which have led to calling "armillary spheres" even quite different objects. The first moment can be placed at the end of the Sixteenth century. The second moment, on the other hand, can be placed in the 1980s and features some Anglo-Saxon scholars.

Twentieth Century Physics and Astronomy / 36

Storia e ricordi nelle Memorie di Constance Dilworth e Giuseppe Stanislao Occhialini

Author: Pasquale Tucci[1]

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La cartella contenente i fogli delle Memorie di Dilworth/Occhialini è conservata nell'Archivio Dilworth-Occhialini presso la Biblioteca BICF dell'Università degli Studi di Milano. Esse coprono i due periodi inglesi di Giuseppe Paolo Stanislao Occhialini (1907 - 1993): a Cambridge tra il 1931 e il 1934 e a Bristol tra il 1945 e il 1948.
Le Memorie sono state scritte tra un giorno imprecisato nel 1992 e il 16 aprile 1993. Non hanno la forma organica di una ricostruzione storica ma sono ricordi e chiarimenti di Occhialini non collegati tra loro. Constance Dilworth (1924-2004) era la forza trainante. Occhialini, che viveva a Parigi, dettava a Marianne Labeyrie le sue considerazioni. Esse venivano inviate a Dilworth che preparava una bozza. Quest'ultima veniva inviata a Occhialini che dettava a Marianne Labeyrie i suoi commenti che tornavano a Dilworth che preparava il dattiloscritto.
Nelle considerazioni di Occhialini spesso mancano riferimenti a date o documenti specifici. Come evidenziato da molti storici della scienza, una ricostruzione storica basata solo sulle memorie tende a

favorire un percorso lineare e razionale verso quelli che lo scienziato pensa siano stati i suoi migliori risultati. Per Dilworth/Occhialini era un modo per riaffermare l'importanza di alcune acquisizioni che, secondo loro, erano state trascurate.
Nella comunicazione evidenzierò come, su uno sfondo storico-politico e storico-scientifico noto, si collochino i ricordi di un protagonista di uno dei momenti più alti dello studio dei raggi cosmici. Ma come, nello stesso tempo, soprattutto dalle considerazioni di Dilworth, emerga l'importanza e la pervasività di nuovi strumenti di indagine.

Twentieth Century Physics and Astronomy / 15

On Eduardo R. Caianiello's Cybernetic Physics

Author: enrico giannetto[1]

[1] *Università di Bergamo*

Contemporary physics developed in the twentieth century through a succession of revolutions that upset its epistemological status with the prospect of a new ontology and a new gnoseology. From the physics of chaos to the theories of relativity, from quantum physics to quantum-relativistic field theory and the theory of the S matrix ("scattering matrix"). Recently, the transversal scientific paradigm of information has been definitively establishing itself: above all, through its concretization in the realization of machines, as widespread as personal computers, capable of processing and transmitting information up to an even greater ability to virtually simulate any type of physical reality. A new informational conception of Nature emerged, of the Universe as a potentially infinite computer. However, there is still a lack of a mathematical formulation of physics and cosmology in terms of information. In recent years, the research of Eduardo R. Caianiello (1921-1993), a Neapolitan physicist and cybernetist, has been linked to this goal, who, in 1980, formulated quantum theory in an 8-dimensional non-Euclidean relativistic phase space. The operators of Heisenberg algebra (also position and time) are expressed in a quantization by means of covariant derivatives and the quantum commutation relations are interpreted as components of the curvature tensor. The geometric curvature thus expresses the quantum uncertainty in terms of informational entropy (it is a complex information geometry: the ds2 coincides with the cross-entropy). The algebra is that of the octonions. Caianiello reformulated physics on the basis of information theory opening a way to a great revolution.

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 59

FATHER EGNATIO DANTI AND PERUGIA

Author: Simonetta Ercoli[None]

Why talk about Egnatio Danti in Perugia? Danti was an exemplary protagonist of the Renaissance *homo faber* and also author of important treatises on mathematics and optics. Carlo Pellegrino was born in Perugia in 1536 and changed his name to Egnatio when he entered the Dominican Order to take up the priesthood. As a boy with his aunt Teodora, he studied Mathematics, Geometry and Astronomy. Thanks to these studies he taught mathematics and science in Florence and Bologna, was a cosmographer and cartographer, and constructed many astronomical instruments for different types of measurements. It was he who mapped the first topography of the Perugia area and most probably was in contact with Girolamo della Volpaia, whose scientific instruments are well-known. For this and for many other reasons it is important to bring this fellow citizen of ours back to the forefront of science.

Collections, exhibitions and material culture for the history of physics and astronomy / 18

A possible future for the Physics Museums in Italy: the National Museum System

Author: Elena Corradini[1]

[1] *Università di Modena e Reggio Emilia*

I propose to present the significant opportunity for Physics Museums in Italy to become part of the National Museum System. The System, established by Decree 113/2018 of the then Ministry of Cultural Heritage (MIBACT), now MIC, envisages the creation of an inclusive network of cultural sites that includes state-owned museums and cultural places, as well as museums and places not belonging to the state, both public and private, that apply to be accredited to promote a unified vision of the development of Italian museums, regardless of their ownership, size, type and form of management. The aim is a heritage governance based on sustainability, innovation, participation and accessibility.
The tool for accreditation in the System is a questionnaire to be filled in on a voluntary basis, based on quality levels defined as minimum because they are considered indispensable but in reality very advanced, the LUQ (Uniform Quality Levels). It allows each museum to verify its organisation, the management of both legal and economic profiles and of its collections, and its relations with the local area.
This opportunity is relevant for University Physics Museums, which according to the recent census conducted by CRUI between 2017 and 2018 number 22. Physics Museums by linking up with other Italian museums will be able to take advantage of economies of scale, for the sharing of professional skills and services like the staff training, and could contribute to the consolidation of the significance and value of cultural heritage and to the promotion of cultural tourism development.

Collections, exhibitions and material culture for the history of physics and astronomy / 63

About the collections and exhibitions of physics and astronomy at the Museum of Science and Technology in Milan (MUST)

Author: Vincenzo Iannone[1]

[1] *Fondazione Museo Nazionale Scienza e Tecnologia Leonardo da Vinci*

In 1955, two years after the inauguration of the Leonardo da Vinci Museum in Milan, the Physics Section opened with the three galleries Ottica, Elettricità and Apparecchi storico-didattici. The Physics Section exhibited a good part of the material sent on display at the Chicago Expo in 1933 by the CNR and donated to the Museum in 1947, and of the collection of didactic instruments of the Physics Institute of the University of Padua, granted to the Museum in 1954.
The MUST collection of scientific equipment and instruments, born from these two collections and now called the "Strumentazione Tecnico Scientifica" Collection, consists of over 2000 item from various sources, including the "Centro Didattico di Fisica Sperimentale", a prestigious activity of the Museum between 1955 and the end of the 1980s.
Recent research apparatuses by CERN and INFN are among the latest acquisitions conferred on this collection.
The MUST Astronomy collection is essentially made up of instrumentation from the Brera Observatory (OAB) and exhibited since 1961 in the Museum's Astronomy Section, now included in the Museum Space Area. The latest instrument to arrive from the OAB, in 2017, is the Merz Repsold refracting telescope used by Schiaparelli.
A cultural heritage education project: MUST and the Liceo Scientifico Vittorio Veneto in Milan are experimenting with the students a path that starts from the objects of the Liceo's collection of scientific instruments, present since 1923, to get to know them and use them as historical sources, according to the working method of the museum.

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 34

A new look at the Antikythera Mechanism

Author: Alessandro Amabile[1]

[1] *Università degli Studi di Napoli Federico II*

In this talk I'll sketch the outlines of a new interpretation of the Antikythera Mechanism (II cent. BC). My aim is twofold: 1. To reassess the role of *sphairopoiia* (i.e. construction of spheres) in the development, reception, and transmission of Greek mathematical astronomy. 2. To reconstruct the astronomical theory embedded in the Antikythera Mechanism, following the constraints imposed by the specific purposes of *sphairopoiia* and by the methods of Hellenistic mathematics, as exemplified by the extant works of Euclid, Archimedes, and Apollonius. My conjecture is that the Antikythera Mechanism embedded a *dynamical* and *relational* theory of heavenly motions, with the Sun-Earth system working as a reference-motion for all the others. My general claim is that *sphairopoiia* shaped as much as geometry the theoretical structure of Greek mathematical astronomy, the ground on which the edifice of classical mechanics was built. In a wider philosophical perspective, a thorough study of *sphairopoiia* is expected to provide key insights into the nature and purposes of Greek astronomy, with far-reaching consequences for the long-term history of western science.

Collections, exhibitions and material culture for the history of physics and astronomy / 42

A "Cosmic Touch": a project for the enhancement of INAF's historical astronomical atlases

Authors: Antonella Gasperini[1]; Mauro Gargano[1]

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The astronomical observatories are the most ancient scientific institutions in Italy. They preserve a significant heritage of star atlases and cartographic maps. Two projects led by INAF: *Touch-Sky* (funded by the Ministry of Education) and *Cosmic Pages* (by a PRIN INAF), aim to identify a particularly relevant group of atlases and rare and valuable books to show a clear view of the development of scientific knowledge of the universe. Atlases have been studied, cataloged, and digitized. In addition to the publication of a printed catalog, a virtual exhibition is the final goal of the two projects. Stellar Atlases, Terrestrial cartography, and Selenography, Martian and Comet cartography are the three sections of the virtual exhibition showing the fundamental stages of this process of knowledge and representation of the near and distant universe. The exhibit will develop specific educational initiatives, some of which will be organized in collaboration with Save the Children Italy, to reach students and a segment of the population that has suffered most from the hurt of the digital divide.

Planetary theories and astronomical instruments: mechanizations and visualizations between geocentrism and heliocentrism (1400-1700) / 17

Federico Commandino and Ptolemy's De Analemmate

Author: Argante Ciocci[1]

[1] *Seminario di Storia della Scienza.Università di Bari*

Federico Commandino's Latin editions of the mathematical works of the ancient Greeks constituted an essential point of reference for the scientific research of the moderns. Thanks to his tireless

work of understanding and reestablishing the texts of Euclid, Archimedes, Ptolemy, Apollonius and Pappo, the mathematics of the moderns was able to lift its sails to overcome the Hercules columns of the geometry of the ancients. In his Latin editions of the Greek classics, Commandino cleverly integrated his philological skills with the mathematical ones. The two disciplines, moreover, nurtured each other. I analyze the manuscripts and the printed edition of Ptolemy's De analemmate to evaluate the interaction between philology and mathematics characteristic of Commandino, but also to highlight in a specific case study the role of the editions of the classics in the renaissance of modern mathematics. After the publication of De analemmate there occurred a revival of interest in gnomonic studies, necessary for the understanding of the scientific principles underlying the construction of sundials.

Twentieth Century Physics and Astronomy / 16

The Model of Thin Shell in General Relativity.

Author: Enrico Gasco[1]

[1] *Zirak*

Models are of central importance in many scientific contexts and scientists spend significant amounts of time in building, testing, comparing, and revising models. The study of models and how they are used in scientific practice is a widely debated topic in the actual philosophy and history of science. A physical model is an abstract non-linguistic structure created from general principles –such as the principles of physics - and whose elements can be identified with properties of the real world; in this way a model represents some aspects of reality.
An example of a model that we will consider is that of thin shell that is now widely used both in General Relativity and in Astrophysics.
The first who analyzed this problem was Lanczos who emphasized how some discontinuities of the metric were spurious and not effective. Darmois and Lichnerowicz later clarified - from a more general and geometric point of view - how the choice of suitable coordinates facilitated the solution of the problem. Then Synge showed how the use of such coordinates was not the best choice and proposed a scalar invariant to determine the metric junction conditions. Finally Israel gave an elegant formulation of all these problems for a non-zero hypersurface and apply this model to shock waves and thin shell of dust in General Relativity.

Physics and other sciences / 1

Between acoustics and music: Two letters of Giovanni Battista Benedetti to Cipriano de Rore

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In two letters written to the famous musician Cipriano de Rore (c 1515–1565), Giovanni Battista Benedetti (1530-1590) afforded two different kinds of problems: one mathematical, raised by just intonation (a system of tuning where the goal is pure intervals with simple acoustical ratios) and the other physical, raised by the nature of observed consonances of two different tones having particular ratio. The letters were published in the Diversarum speculationum mathematicarum et physicarum liber of 1585, after de Rore's death. In them, Benedetti with a mathematical approach 'demonstrated' in a clear way the well-known phenomenon for which some passages of counterpoint played in just intonation cause inevitably the music ascend or descend by a syntonic comma. He also formulated the physical law for which the frequency of vibration of a string is inversely proportional to its length by drawing on experience and not on a rigorous proof. Moreover, he succinctly wrote something that explained, or at least which could be interpreted as an explanation of, the consonances of two tones:

consonance is due to periodic matching of vibration, what goes under the name of correspondence law. Benedetti's letters ended with a mathematical formulation of a rule to express the goodness of consonances. It is the purpose of the present paper to understand how much Benedetti was original and to search from where he drew conclusions: his empirical observations, his mixed mathematical vocation, his knowledge of the philosophy of nature of the time, his connection with Aristotelian conception of music.

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Luigi G. Jacchia: from the starry skies of Loiano to the American Moon race of the 60's

Author: Alberto Buzzoni[1]

Co-authors: Fabrizio Bonoli [2]; Agnese Mandrino [3]; Giuseppe Pisana

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We will briefly review the amazing story of Luigi G. Jacchia (Trieste, 1910 - Cambridge MA, 1996), an Italian astronomer who started his career at the Bologna Observatory in 1928 and found then his new life in the US, since 1939 by escaping, as a Jewish, the WWII's tragedy in Europe. With Fred Whipple, along his Harvard/SAO years, Jacchia joined the pioneering group of scientists that led to the NASA venture in the 50's.
Jacchia's seminal contribution to high-atmosphere modelling was crucial for a safe re-entry of Mercury's, Gemini's and Apollo's manned missions, and greatly helped paving the way to the successful American space race in the 60's, that led man to the Moon.

Physics and other sciences / 37

Physics for neuroscience: the story of Huxley and Hodgkin before any interpretation

Author: Michał Oleksowicz[1]

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In 1952 A.L. Hodgkin and A.F. Huxley published what has become known as the model of the action potential. It was subsequently considered as the cornerstone of electrophysiology and neuroscience, since concerning the ionic mechanisms involved in the nerve cell membrane. The history of the HH model on the one hand is an example of use of scientific experiment and laws of physics within life sciences, i.e., proposed the total current equation is derived from laws of electricity (Coulomb's and Ohm's laws) under specifiable conditions. On the other hand, the HH history has become the key point of reference for the contemporary philosophical debate on adequacy of scientific models, especially within the new mechanical philosophy. In his pivotal paper on explanatory models, C. Craver has interpreted HH model as the instrumentalist one which only "saves phenomena"via the application of mathematical formulas. The aim of this paper is twofold. First of all, we reconstruct the story of HH model counterarguing the claim that HH model does not explain. Secondly, our analysis will point out that the problem with Craver's reading of HH model stems from the unwarranted assumption that explanations and descriptions should always proceed hand in hand. We conclude that although HH model resulted to be incomplete in various respects, it does not follow that it was just inaccurate and non-explanatory. The requirements of unqualified understanding and completeness posed by Craver on HH model are never to be found in actual scientific practice. At best, they are ideal ones.

Physics and other sciences / **43**

The noise/disturbance uncertainty as a paradigm of scientific controversy

Author: Francesco Comotti[None]

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The present work reconstructs the history of the so-called uncertainty principle, from its first formulation to a recent diatribe on its correct mathematical formalization. In his 1927 paper, Heisenberg proposed two different kinds of uncertainty. One is called "statistical"or "intrinsic", due to the mathematical structure of quantum mechanics and rigorously demonstrated by Robertson. The second one is called "error/disturbance"or "operational", and defines the relation between the intrinsic error ε(A) with which a physical quantity is experimentally known and the disturbance η(B) induced by the first measurement on a second, not compatible, physical quantity. The later has never been tested experimentally, nor mathematically demonstrated. The first obstacle in treating the error/disturbance uncertainty is to define what it is meant by "error" and "disturbance", a problem avoided even by Heisenberg. In 2003, Masanao Ozawa proposed a definition of "error"and "disturbance"as the root mean squares of appropriate operators, depending on the initial state of the physical system. From these definitions, Ozawa obtained a universal uncertainty relation, which does allow, in specific cases, the violation of the Heisenberg inequality as expressed in von Neuman' s formalism: $\varepsilon(A) \cdot \eta(B) \geq \frac{1}{2}|\langle[\hat{A}, \hat{B}]\rangle|$. This approach was disputed by Busch, Lahti and Werner, proposing in 2013 a definition of error and disturbance as figures of merit of a measuring instrument, based on the distances of probability distributions. The following debate represents an exemple of clash between competing paradigms and a case of underdetermination of two scientific theories by evidence.

Twentieth Century Physics and Astronomy / **7**

Trespassing Boundaries in Tartu, 1962: Pontecorvo, Zel'dovich and the future of astrophysics

Author: Giulia Carini[1]

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During the summer of 1962, the new observatory of Tartu –today in Estonia, back then part of the USSR –was under construction, to be inaugurated the following year. Given its importance in the subsequent decades, as well as its (by now) bicentenary historical tradition, this alone would be a fact worth historical investigation. In July of that year, a sort of summer school (other sources call it a 'theoretical workshop') was organized, to which a number of distinguished Soviet physicists –not just astronomers or astrophysicists –took part. Curiously enough, this has not received historical attention per se. In the present paper, we stress and comment the contributions to that event given by Ya.B. Zel'dovich and B.M. Pontecorvo. The former, right then, was embarking on a phase of his career in which he was going to direct an impactful group of general relativists and astrophysicists, and it is therefore highly meaningful to consider the survey of questions and problems he presented to that audience. The latter illustrated instead some astrophysical implications of neutrinos: how fruitful such a perspective was soon going to prove is, by now, common knowledge. We intend in this way to offer a proper contextualization of those contributions, respectively at the dawn of relativistic astrophysics and neutrino astrophysics, thus calling the historians'attention not just on a noteworthy institution and its renewal, but also on the remarkable ideas that flowed together during that occasion.

Twentieth Century Physics and Astronomy / 24

On Stanley Deser's role in the development of quantum gravity

Authors: Marco Di Mauro[1]; Adele Naddeo[2]

[1] *University of Trento*

[2] *INFN, Sezione di Napoli*

Stanley Deser's multifaceted contributions to quantum gravity are here analyzed, starting from his contribution to the famous 1957 Chapel Hill conference on "The Role of Gravitation in Physics". The main idea of his talk, as also summarized in Peter G. Bergmann's introduction, was the possibility offered by the development of quantum gravity to provide a way of imposing a cut-off to ultraviolet divergences in quantum field theory, and thus to make a contribution to the theory of elementary particles. Deser's subsequent stay at Harvard, as Julian Schwinger's assistant, was crucial in that it led to the first seeds of the celebrated ADM (Arnowitt-Deser-Misner) formulation of general relativity, brought to completion in 1962-63. The influential role of this work in unveiling the canonical structure of general relativity and in triggering the development of the canonical approach to quantum gravity is here fully elucidated. Deser's contributions to the formulation of general relativity as a quantum field theory and to the covariant approach to quantum gravity are considered as well, with particular emphasis on his use of the first order formalism, which also led to an alternative route to Supergravity.

Physics and other sciences / 46

The hidden history of classical symmetries: their link with intuitionist logic

Author: Antonino Drago[1]

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Previous scholars all studied symmetries according to classical logic; yet, the same word "symmetry", coming from the Greek "συμμετρία"= "measuring together", means measuring according to a modality; hence, this word belongs to modal logic. In its turn modal logic is equivalent through its S4 model to intuitionist logic (Hughes and Cresswell 1996, pp. 224ff.), where the double negation law fails. As a fact, the subject of symmetries is unwarily treated through many doubly negations (e.g. the word in-variants, stressed by Leibniz (1692) and L. Carnot at the origin of the symmetries in physics; plus equivalence (= not-unequal), in-difference and ambiguity) or doubly negated propositions whose corresponding affirmative ones lack of evidence. The use of intuitionist logic introduces to a kind of theoretical organization which is different from the deductive-axiomatic organization: a problem-based one, aimed at discovering a new scientific method capable of solving the given problem. The model of the new kind of organization has been recently discovered by a comparative analysis of all past theories suggested by the respective authors in a non deductive-axiomatic way (Drago 2012). Pierre Curie's paper (1984) is investigated under the light of these novelties. Its main propositions all are doubly negated propositions of intuitionist logic. However his theory results to be a mixture of features of both models of a theory; this ambiguity explains the difficulties met by scholars in analyzing this paper. A rational re-construction of Curie's paper according to the model of a problem-based theory is performed.

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A Glimpse into Feynman's Contributions to the Debate on the Foundations of Quantum Mechanics

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Although the common lore unofficially (and erroneously) credits Feynman with the famous quote "shut up and calculate!", he did not avoid foundational questions in quantum mechanics. The first records of his considerations on such issues are in the report of the 1957 Chapel Hill conference on "The Role of Gravitation in Physics", where foundational quantum issues were widely debated, especially in connection with the problems of quantum gravity and quantum cosmology. In fact, Feynman discussed quantum foundations again in his 1961 letter to V. F. Weisskopf, and in the 1962-63 Lectures on Gravitation. In this contribution, we reconstruct and analyse this aspect of Feynman' s work, starting with his many interventions in the debate at Chapel Hill. In particular, we analyse Feynman's arguments in favour of the quantization of the gravitational field, based essentially on a series of gedanken experiments. Then we consider the problem of wave function collapse, for which Feynman hinted at decoherence as a possible solution. Finally, another issue is considered, concerning the role of an internal observer in a closed Universe. In this respect, Feynman's many-worlds characterization of H. Everett's approach is discussed, together with his later reflections on this matter, involving a version of Schrödinger's cat paradox. Philosophical implications of Feynman's ideas in relation to foundational issues are also discussed, as well as some subsequent development.

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Subterranean electric fire: Giuseppe Saverio Poli and the first Italian way to scientific studies of seismology

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In the second half of the XVIII century, during a period that was strongly characterized by studies on electric phenomena, a hypothesis appeared about an electric origin of earthquakes, based on empirical evidence considered solid, and apparently also confirmed by model experiments. While developing into an explanatory theory of a strongly empirical nature, it nevertheless presented a "clean"scientific reasoning and referred to Franklin's studies on atmospheric electricity. The electric hypothesis about the causes of earthquakes was particularly supported by Italian scholars, well accustomed to observations of seismic events. Among these the Franklinist Giuseppe Saverio Poli was able to provide an accurate and comprehensive explanation of both the disastrous Calabrian earthquake of 1783 and the equally ruinous "St. Anne earthquake"of 1805, making use of all the relevant phenomenology available, not limited to the electric one. In the present contribution we reconstruct the birth, development and subsequent evolution of the "electric earthquake"paradigm until the beginning of the XIX century. We focus on several works by Poli, including a previously unknown manuscript containing an in-depth account of the Calabrian earthquake, prepared by the Neapolitan scholar for the Royal Society of London.

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Tavola Rotonda. Quale futuro per la storia delle discipline scientifiche? Prospettive e sinergie tra cultura, scuola e ricerca.

Interverranno:

Maria Teresa Borgato, Presidente SISM
Elena Canadelli, Presidente SISS
Salvatore Esposito, Presidente SISFA
Vincenzo Fano, Presidente SILFS
Marisa Michelini, Direttore GEO

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Visita facoltativa Perugia sotterranea

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Apparenza e realtà della forza centrifuga: una questione didattica ancora attuale

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La prima rappresentazione geometrica della Forza Centrifuga si deve a Christian Huygens (1629-1695) e all'italiano Giovanni Alfonso Borelli (1608- 1679). Importanti considerazioni sulla Forza centrifuga si trovano in Maggi (1926) e Scott (1957). Nella didattica moderna essa è generalmente accennata in capitoli che introducono le forze inerziali, ed in particolare in relazione ai sistemi di riferimento ruotanti rispetto ad un asse fisso. In un noto manuale di didattica (Mazzoldi et al. 2013, p. 121) si legge: "Le forze vere sono equilibrate dalla forza centrifuga mwˆ2 r , apparente"; ma non si capisce come una forza "apparente"possa opporsi ad una forza "vera". Una forza apparente, in contrasto ad una forza vera, è tale da sparire con un opportuno cambiamento del sistema di coordinate, come ad esempio accade alle forze di Coriolis. Nella comunicazione, dopo un breve excursus storico vengono analizzati alcuni semplici esempi di moto rotatorio (uniforme) che illustrano il concetto di forza centrifuga contrapposto a quello di forza centripeta, in accordo alla III legge sulla dinamica di Newton, quando si considerino correttamente i punti di applicazione.

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Evolution of induction machines technology in the Nineteenth Century

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In the first half of the 19th century, physicists were not very interested in induction generators. On the contrary, starting in the 1860s, numerous prototypes of electrostatic influence machines were invented, such as the Holtz or Toepler influence machine, both from 1865. These devices were soon put aside, because others were invented, which had higher performances, such as that of Voss (1880) or

that of Wimshurst (1883) or that of Bonetti (1894). Interest in the new generators gave rise to many studies on electrostatic induction, although most of these dealt with technical problems or only described new experiences with these machines. However, such a radical change in high-voltage machine technology cannot be considered a technical matter alone. These instruments were generally used in scientific laboratories as devices for demonstrations or for teaching, that is, for mainly scientific purposes. The description of the performance of these devices led to heated contrasts between physicists. On the other hand, the interpretation of the new influence machines has made it possible to discuss the action of insulators in the different research perspectives developed in the second half of the 19th century.

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Rossi's coincidence circuit: a reconstruction for educational purposes, with period instruments

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The Path of Science in Arcetri is being set up: it is a museum itinerary on the hill of Arcetri, near Florence, which includes the old headquarters of the Physics Department of the University, the National Institute of Optics (INO), the Arcetri Astrophysical Observatory (OAA-INAF) and the Villa, where Galileo spent the last years of his life.
As part of this project, a small museum will be located in the premises housing the old particle accelerator KN3000. This stage of the path will focus on the history of particle and nuclear physics in Florence, from about 1930 to the beginning of the new millennium.
In recent months, we fortunately recovered at the Fondazione Scienza e Tecnica in Florence some large Geiger tubes and a number of different vacuum tubes that had belonged to the University's Institute of Physics. In this context, we considered to reconstruct the Rossi's coincidence circuit, which had been conceived just within the walls of the Arcetri Institute. Apart from the power supply for vacuum and Geiger tubes based on modern technology, the design approach was as philological as possible. The apparatus will be part of the detectors of background radiation and cosmic rays, running in the museum and showing the relevant spectra and counting rates to visitors.
In this communication we describe the phases of design, assembly and test of the circuit, which is actually fully efficient and allows the detection of cosmic rays, providing realistic estimates of their flux at the ground level.

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The Johansson blocks: Guns, cohesion, and market disruption

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In 1898, Carl Evard Johansson, a rifle maker based at a factory based in Eskilstuna, Sweden, filed for a patent for Gauge Block Sets for Precision Measurements."The invention was as simple as it was powerful. Instead of relying on thousands of different mechanical gauges, as was the practice in the small arm industry, he introduced a set of only 102 accurately polished blocks. Such blocks, which became known as "Johansson blocks,"could be combined to yield approximately 20,000 different measurements of accuracy adequate to the demanding task of high precision rifle manufacturing. What Johansson had not anticipated was that lapping flat metal surfaces so finely as was needed would have led the blocks to interact with such mysteriously strong forces that they could be later separated only with extreme effort. This probably accidental discovery, which occurred a couple of years later, led to a technological revolution. These measurement devices, still manufactured

today, make a surprising appearance in the Feynman's Lectures on Physics as a demonstration of intermolecular forces that can only be explained by means of quantum mechanics. In this paper, we examine the history, physics, and market trajectory of the Johansson block industry –possibly the first example of a product enabled by the existence of dispersion forces.

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Ancient collection of scientific instruments from Franciscan's didactic laboratories in Umbria: how Franciscan friars taught physics and astronomy from the early 19th century until now.

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Monteripido Convent in Perugia collected scientific instruments from schools'laboratories placed in the different Franciscan convents in Umbria for decades. Friars used to teach science (physics, chemistry, mathematics, geology···) for a long time, from the early 19th century to the present day and before the extensive development of public high schools. We will discover the ancient treasures currently undergoing reorganization for a project of a physic science museum placed in the ss.ma Annunziata convent, near the Franciscan Planetarium of Amelia.

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Astronomy and Physics in the photographs of the National Exhibition of the History of Science of 1929

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The First National Exhibition of the History of Science, held in Florence from May to November 1929, was a significant moment in the long and complex process of enhancing and protecting the Italian scientific heritage, as well as an important opportunity to celebrate the scientific and technological primacy of Italy.
Among the sciences covered at the exhibition, Astronomy and Physics undoubtedly
played a fundamental role, since Italian scientists had stood out for their theories and inventions.
This contribution aims to show how, along with the numerous astronomy and
physics-themed objects, texts and portraits, a large number of photographs provided by the participants was also exposed. Photographs often replaced tools or equipment impracticable to send, being too bulky, delicate or fragile.
While some instruments were shown by means of photography, many others,
exhibited as objects, were photographed during the exhibition. The Alinari brothers immortalized not only instruments, but also texts, portraits and entire rooms, providing valuable visual documentation of the exhibition and the objects that are nowadays situated in various locations, if not even lost.

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1950s–1990s: Carbon Nanotubes Studies into Historiography of Nanoscience–Nanotechnology

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One of the most significant discoveries of the NanoWorld are Carbon Nanotubes. Crossing the history of nanotubes through its historiographical—and—scientific literature, we analysed a) Radushkevich and Lukyanovich's research On the Carbon Structure Formed by the Thermal Decomposition of Carbon Monoxide on an Iron Contact. In 1952, they observed and described tubular structures of carbon, through electron microscopy; b) Structural Improvement of Carbon Fibers Prepared form Benzene by Endo, Koyama and Hishiyama. In 1976, they developed and reinforced carbon tubular structures using benzene aromatic rings. In 1985, Kroto, Heath, O'Brien, Curl, Liu and Smalley enriched carbon studies, discovering the Buckminsterfullerene, molecule of almost spherical shape and formed by 60 carbon atoms. This discovery was published in C60: Buckminsterfullerene obtaining Nobel Chemistry Prize in 1996, as well. In 1991, in Helical Microtubules of Graphitic Carbon Iijima, the father of carbon nanotubes discovery, described needle–like structures with multiple coaxial walls; the article dealt with helical–walled carbon nanotubes. In this talk, we present a historiographical debate into history of Nanosciences—Nanotechnology on the Carbon Nanotubes studies (1950s–1990s), also looking back to post–Maxwellan methods in the end of 19th century. The content of this presentation is part of a current doctoral research (AD) at Lille University (supervised by RP) in History of Nanoscience and Nanotechnology, since 1950s.

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Assemblea generale

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Premio Sisfa

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The many lives of an old instrument: the armillary sphere refigured and recontextualized

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This paper explores how, from the seventeenth century onwards, the armillary sphere was refigured and recontextualized into a Copernican mindset, while retaining its symbolic character as an emblem of astronomy, and its educational value as a model to demonstrate the essential celestial motions from a geocentric perspective. The modern history of the armillary sphere is addressed in its intersections with the development of the orrery, the growth of market niches for educational instruments and toys, and the emergence of the notion of discovery as a driving force of astronomical science. Overall, it is shown how, through the agency of varied practitioners, educators, and instrument makers and traders, an ancient instrument was repurposed so that it could fit into the tenets and discourses of modernity –even if with varying, and often limited success.

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Paper devices: scientific instruments in the Ancient Book Collection of the Sacro Convento Library in Assisi

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As is well known, Franciscans have been interested in and often directly concerned with science over the centuries. Many wrote treatises on astronomy, physics, mathematics, chemistry, and medicine, demonstrating competence and originality. Regarding astronomy, in particular, famous members of the Order, from John Peckham and Pietro Gallego to Ilario Altobelli and Teofilo Bruni, wrote about it as early as the 13th century.
These texts, manuscripts, incunabula, sixteenth and seventeenth-century are preserved in some prestigious libraries. This paper is a brief foray into one of the most precious of the Franciscan library collections, that of the Sacro Convento Library in Assisi. The volumes can be grouped according to two main types. One the one hand, volumes of more theoretical contents, on the other of practical and applied approaches. Notes and projects by Franciscan masters and friar inventors will be shown, but also handbooks about the use of "instruments" for scientific practice and astronomy are discussed. Indeed, Franciscan sources for scientific knowledge were also treatises about the theory and the technique for constructing astrolabes, armillary spheres, and sundials. The Sacro Convento Library preserves medieval manuscripts mostly devoid of images, up to the more articulate and richly illustrated texts of the 17th century. The exploration will conclude with a quick mention of some 18th-century volumes to understand the evolution of Franciscan scientific interests.