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Book of Abstracts

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La cosmografia dantesca fra antico e moderno

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Dante aveva una grande passione e conoscenza dell'astronomia, fra le pochissime cose che condivido con lui, oltre al cognome. Da uomo medioevale si trovava in mezzo fra le credenze degli antichi e le conoscenze moderne, che ha più volte anticipato, come mostrerò con alcuni esempi: la nostra Galassia, le macchie lunari e l'universo curvo, illimitato ma finito, che anticipa l'ipersfera di Einstein.

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DANTE. L'EREDITA'COSMOLOGICA DI UN CRISTIANO

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Dante, basandosi sull'insegnamento dei filosofi greci trasmesso dagli astronomi arabi, disponeva della conoscenza cosmologica appropriata a una persona colta del suo tempo.
Nella Commedia, però, egli si trova nella necessità di innestare gli elementi specifici della cosmologia cristiana in quella delle sfere cristalline della tradizione greca. Si trattava di conciliare un mondo meccanico nel quale le rotazioni dei cieli avvengono essenzialmente senza ragione con un mondo nel quale tutto è determinato dalla distanza, sia fisica che ideologica, dal Creatore.
Dante si è trovato quindi a concepire una realtà nella quale lo spazio è costituito, oltre che dalle tre coordinate usuali (alto-basso, avanti-dietro, destra-sinistra), dalla nuova coordinata "virtù", cioè la distanza dal Creatore.
Esamino quindi il singolare parallelismo fra il cosmo concepito da Dante e quello einsteiniano che si rivela attraverso il semplice cambiamento fra coordinata "virtù"e coordinata "tempo".

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L'astronomia nella Divina Commedia

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"Stelle" è la parola con cui si concludono tutte e tre le Cantiche dantesche. Il sistema Tolemaico è al centro della visione dell'Universo di Dante e i riferimenti astronomici sparsi nella Divina Commedia sono più di cento. Partendo da alcuni di questi bellissimi passi di poesia, entreremo nell'Universo di Dante e lo osserveremo con gli occhi degli astronomi moderni.

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LA SCESA ALL'INFERNO: DANTE E GALILEO VERSO LA GRAVITAZIONE

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Il canto XXXIV dell'Inferno di Dante descrive il percorso di due esseri "gravi", Virgilio e Dante, al centro della Terra e oltre questo punto estremo degli abissi. Galileo affronterà il problema del pozzo che perfora la Terra quasi tre secoli dopo proponendo, attraverso un esperimento mentale (gedankenexperiment), di immaginare l'esistenza di un pozzo che attraversa tutta la Terra e dove può cadere qualsiasi corpo grave. Dice Galileo, con la voce di Salviati:

SALV. Vi gusterà il sentirlo, ma ve lo dirò poi; intanto seguitiamo. Io vi ho proposta l'osservazione di questo pendolo, acciò che voi intendiate che l'impeto acquistato nell'arco descendente, dove il moto è naturale, è per sè stesso potente a sospignere di moto violento la medesima palla per altrettanto spazio nell'arco simile ascendente; è tale, dico, per sè stesso, rimossi tutti gl'impedimenti esterni. Credo anco che senza dubitarne s'intenda, che sì come nell'arco descendente si va crescendo la velocità sino al punto infimo del perpendicolo, così da questo per l'altro arco ascendente si vadia diminuendo sino all'estremo punto altíssimo (...). Di qui parmi (discorrendo con una certa convenienza) di poter credere, che quando il globo terrestre fusse perforato per il centro, una palla d'artiglieria scendendo per tal pozzo acquisterebbe sino al centro tal impeto di velocità, che trapassato il centro la spignerebbe in su per altrettanto spazio quanto fusse stato quello della caduta, diminuendo sempre la velocità oltre al centro con decrementi simili a gl'incrementi acquistati nello scendere; ed il tempo che si consumerebbe in questo secondo moto ascendente credo che sarebbe eguale al tempo della scesa. [GALILEI, 1897, p.161]

Il problema del pozzo dantesco era nella mente di Galileo fin dagli ultimi anni del XVI secolo. Nel 1587 Galileo aveva prodotto la difesa di un'opera di Antonio Manetti (1506) che descriveva la "geografia"e la "geometria"dell'Inferno di Dante, contro gli attacchi di Alessandro Vellutello (1544). Sebbene la geometria galileiana sia impossibile, Galileo giustifica le sue scoperte fisiche descrivendo come cadono i corpi, immaginando analogie tra piani inclinati, pendoli e, infine, discutendo l'incommensurabile pozzo che trapassa tutta la Terra. Al di là della questione "pozzo", Galileo sintetizzerà le critiche aristoteliche sull'immobilità del mondo, soprattutto quelle già fatte da Jean Buridan e Nicole Oresme. Galileo dopo la "scesa all'Inferno"lo lascia per aiutare a costruire la nozione del sistema inerziale e della gravitazione universale.

Bibliografia:
GALILEI, G. I Due Massimi Sistemi del Mondo (Le Opere di Galileo Galilei). [a cura di Antonio Favaro]. Vol VII, 1897 [trovato su e-book nel sito web: www.liberliber.it/mediateca/libri/g/galilei/le_opere_volume_vii/ Acesso: 10/06/2021.
DANHONI NEVES, M.C. História da Ciência: Dante e Galileo descem ao Inferno da Física. Caderno de Metodologia e Técnica de Pesquisa: Questões Epistemológicas. n.9, 1999, 75-88.
GERMANO, E.T. & NEVES, M.C.D. O Ensino de Física Usando o Simulador Algodoo: possibilidades e reflexões. In. FRASSON et al., Reflexões em Ensino de Ciência e Tecnologia: Abrindo horizontes. Ponta Grossa: Editora da UTFPR, P. 145-160, 2016.
LÉVY-LEBLOND, J-M. A velocidade da sombra nos limites da ciência. Rio de Janeiro: DIFEL, 2009

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Dante, scienza e tecnologia

Author: Santori Claudio[None]

Siamo abituati per l'impostazione fornita dalla scuola a considerare Dante soltanto un poeta, anzi, il sommo poeta. Vero, ma non sufficiente: Dante è anche lo scienziato in possesso di tutte le cognizioni di geometria e matematica all'epoca disponibili, indispensabili per indagare il cielo e penetrarne i segreti.
La Commedia termina con la più celebre delle similitudini dantesche: Qual è il geometra che tutto s'affige / per misurar lo cerchio e non ritrova, / pensando, il principio ond'elli indige, / tal era io ⋯È il problema della cosiddetta quadratura del cerchio: Dante aveva ragione di credere che l'esatto rapporto di π, corrispondente a 22/7 (3,14285714285), fosse stato individuato da Brisone, da lui chiamato Brisso e citato nel Paradiso insieme con Parmenide e Melisso: E di ciò sono al mondo aperte prove / Parmenide, Melisso e Brisso e molti / li quali andavano e non sapean dove: non può essere per altro motivo che Dante non esita a mettere Brisone, illustre sconosciuto per i più, accanto a Parmenide e Melisso, filosofi a tutti ben noti!
Dante conosceva il cielo attraverso la dottrina di Tolomeo, che ha profondamente assimilato: non certo a caso conclude tutte e tre le cantiche, e quindi la Commedia stessa, con la parola stelle e i riferimenti astronomici che vi inserisce ad ogni piè sospinto sono addirittura un centinaio e crescono di numero e di qualità dall'Inferno, dove sono relativamente pochi e legati principalmente all'esigenza di precisare il giorno e l'ora, al Purgatorio (dove sono molti di più), al Paradiso (dove se ne registra il massimo numero, e principalmente legati ad una precisa visione dottrinale e teologica). La crescita nel numero e nella qualità dei riferimenti astronomici va di pari passo con i riferimenti musicali: nell'Inferno non c'è musica, solo urla bestiali, bestemmie e rumori (Quivi sospiri, pianti e alti guai/ risonavan per l'aere sanza stelle); nel Purgatorio c'è musica principalmente monodica; nel Paradiso c'è un tripudio di musica polifonica: l'astronomia e la musica procedono in Dante di pari passo.
Dante ha chiaro il concetto di antipodi, di sfera terrestre e di sfera celeste, nonché il concetto di longitudine e di latitudine; è al corrente anche della precessione degli equinozi: giunge a Dio contemperando le certezze del tomismo col dettato agostiniano, in quella linea che gli veniva da lontano, dalla speculazione pitagorica e platonica assimilata attraverso Boezio e, appunto, Sant'Agostino e San Bonaventura.

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Orologi meccanici al tempo di Dante ed i suoi sviluppi

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Il MUMEC Museo dei Mezzi di Comunicazione, in collaborazione con l'Accademia Petrarca di Lettere Arti e Scienze di Arezzo, presenta come evento di punta per il 2021 "Tin tin sonando con sì dolce nota"; esposizione di storia dell'orologeria al tempo di Dante ed i suoi sviluppi. Per il museo aretino si apre, dopo un 2019 dedicato a Leonardo da Vinci ed un felliniano 2020, un 2021 dedicato al grande poeta Dante Alighieri. Lo stesso, infatti, all'interno del suo capolavoro principe, la Divina Commedia, in alcuni passi del Paradiso tratta il tema dell'orologeria paragonando il cosmo ad un complesso orologio meccanico. "Dove e quando potè Dante vedere gli orologi meccanici che descrive?"è il grande storico G. Boffito a porsi questa domanda e ad incuriosirne un forte approfondimento nell' amplio filone collezionisti della storia dell'orologeria. I manufatti meccanici primordiali, a pesi, modelli arcaici per la misura del tempo, sono i protagonisti di quanto ripetutamente descritto. Nasce così un doppio fronte di studio: uno letterale ed umanistico sull'individuazione e interpretazione nella Divina Commedia dei Canti, nei Versi interessati alla descrizione della macchina orologistica, ed uno scientifico e tecnico a descrivere la meccanica degli antichi Svegliatori Monastici, cercando di riprodurne quel Dolce Tintinnio che tanto emozionò il Sommo Poeta. Venti rari oggetti vengono così messi a disposizione, dalle "collezione Fausto Casi di Arezzo", del MUMEC e di Accademia Petrarca, per creare, a poche centinaia di metri, due esposizioni strettamente connesse. L'iniziativa è parte del circuito La Toscana di Dante ideato e coordinato da Regione Toscana tramite il comitato "Dante O Tosco, 700°", presieduto dal Presidente della Giunta Regionale Eugenio Giani.

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Filippo Angelitti: un astronomo dantista

Author: Manuela Coniglio[1]

Co-authors: Donatella Randazzo [2]; Ileana Chinnici [1]

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Durante le operazioni di riordino dell'Archivio Storico dell'Osservatorio Astronomico di Palermo, è emerso un nutrito corpus di documenti relativi all'astronomo Filippo Angelitti (1856 - 1931), Direttore della Specola dal 1898 fino alla morte, avvenuta nel 1931. All'interno del suo Fondo, sono così confluite più di 40 cartelle, cui si aggiunge una vasta corrispondenza di lettere in entrata, ordinate dallo stesso Angelitti in fascicoli mensili o annuali, e di lettere in uscita, trascritte in copialettere e in registri. Oltre all'ingente quantità di carte lasciate dall'astronomo, ciò che colpisce è la natura di tali documenti: accanto a quelli di carattere scientifico e a quelli legati all'Osservatorio, infatti, sono presenti documenti di ricerca letteraria su Dante Alighieri. Sono ben dodici i faldoni contraddistinti da tale tematica e che lasciano trasparire la vocazione scientifico-letteraria degli interessi di Angelitti. Egli, infatti, si occupò in larga parte di astronomia dantesca, dando il proprio importante contributo sia alla datazione del viaggio affrontato dal Sommo Poeta nella *Commedia*, sia nello stabilire la paternità dell'opera *Quaestio de aqua et terra* che, anche per mezzo delle sue rigorose ricerche, fu infine attribuita a Dante. Angelitti, socio molto attivo della Società Dantesca Italiana, entrò nel vivo dei dibattiti dell'epoca, divenendo una delle voci più autorevoli sull'argomento grazie alle sue analisi scrupolose, oggi testimoniate dai numerosi documenti custoditi presso l'Osservatorio Astronomico di Palermo.

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Cesare Minerbi's «Kontinuirlicher Resonatoren-Apparat nach Schaefer E. Zimmermann, Leipzig-Berlin» now part of the Collection of Historical Scientific Instruments of the University of Ferrara

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The aim of this research is to reconstruct the past of the «Kontinuirlicher Resonatoren-Apparat nach Schaefer», a particular instrument preserved in the CISFIS –Collection of Historical Scientific Instruments of the University of Ferrara, highlighting the physics behind it.
This CISFIS item consists of a box of four resonators developed by Karl Ludolf Schaefer and manufactured by E. (Ernst? Emil?) Zimmermann in Leipzig-Berlin around 1912. We found evidence that this apparatus had been purchased by Cesare Minerbi, 'Primario'at the Arcispedale Sant'Anna in Ferrara and Professor of Medical Semeiotics, shortly after it was launched on the market. At the end of his long career, he donated the box to the University of Ferrara on 11th March 1950, as it is attested in the «Registro Inventario dei beni infruttiferi di proprietà della R. Università "Italo Balbo„ di Ferrara».
The first part of the thesis focuses the attention on resonators as scientific instruments. In order to understand how Schaefer resonators work, the physical principles and the functioning of the resonators before them have been analysed. Great attention has been given to Hermann Helmholtz, the first scientist to 'rethink'resonators as true scientific devices. Schaefer resonators are, in fact, a later refinement of Helmholtz ones.
The second part of the study is devoted to the description and reconstruction of the events concerning the apparatus now part of the CISFIS. We came to the conclusion that these instruments represented a fundamental work tool for Minerbi during his researches dedicated to the development of acoustical diagnostics.

Basic bibliography:
HELMHOLTZ, H. (1863), Die Lehre von den Tonempfindungen als Physiologische Grundlage für die Theorie der Musik, Braunschweig;
PASSOW, A., SCHAEFER, K. L. (1910), Beiträge zur Anatomie, Physiologie, Pathologie und Therapie des Ohres, der Nase und des Halses, III, Berlin;
PANTALONY, D. (2001), Altered Sensations. Rudolph Koenig's Acoustical Workshop in Nineteenth-Century Paris, Dordrecht, Heidelberg et al.;
MINERBI, C., MINERBI, G. (1937), I problemi principali di acustica diagnostica generale normale e tisiologica. Studî clinico-sperimentali, Roma.

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La formazione degli insegnanti: un urgente impegno a cui assolvere

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Una vasta letteratura di ricerca ha evidenziato come la professionalità docente vada considerata l'aspetto specifico caratteristico più importante nell'istruzione e come determini la possibilità di migliorare l'apprendimento degli studenti, di rinnovare i curricula effettivamente attuati nelle scuole, di introdurre innovazione didattica e metodologica, anche basata sugli esiti della ricerca. Per questo, negli ultimi 30 anni si è sviluppato molto interesse per la formazione insegnanti e molto lavoro è stato fatto su di essa: linee guida e progetti EU hanno affiancato le ricerche, sempre più numerose. La formazione iniziale degli insegnanti è stata messa in campo molto tardi nel nostro Paese, rispetto alle previsioni del dopoguerra e, mentre nella formazione degli insegnanti primari vi è stata continuità, nella formazione degli insegnanti secondari vi è stata molta discontinuità e differenziazione nelle modalità. Neanche la formazione in servizio degli insegnanti è stata particolarmente curata. E' urgente, come scritto nel PNRR l'istituzione di questo importante compito dell'università in forma organica, stabile e qualificata. Un'analisi delle esperienze effettuate alla luce di questioni cardine evidenziate dalla ricerca didattica ha portato recentemente una vasta comunità di università, associazioni scientifiche e di insegnanti ad un'analisi mirata all'intesa per l'individuazione dei principi base da salvaguardare in questa importante mission: il libretto azzurro, esito del Convegno CRUI-GEO del giugno scorso ce li propone.

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History of Physics for Physics Education: challenges, opportunities and research directions

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A number of arguments have been put forward over the past decades to support the use of history of physics into the teaching of physics among students and pre-service teachers (Matthews 2014,2015). For example, it has been written that history of physics makes physics more attractive to many students, can enhance reasoning and critical thinking skills and can improve teacher education. Also, history of physics can assist teachers appreciate the learning difficulties of students and may offer substantial benefits in enabling people to develop scientific literacy and an understanding and appreciation both in science and about science. Finally, history of physics and the wider domain of the history of material culture, as represented by the collections of old scientific instruments in schools and universities, may prove to be useful both at the cognitive and the meta-cognitive level. Notwithstanding this awareness, this approach is not implemented in many ministries of education policies

(only scant references are made in the Italian National Guidelines) and remains largely un-adopted by many physics teachers.
In this speech, we will address the main challenges posed by the use of history of physics into the physics education through some intriguing historiographical case-studies (as the so-called "Rutherford's experiment"on alpha particles scattering) and through a survey of physics teachers as to the feasibility of the historical method. We will also address the opportunities of such an approach for both students and teachers, and, finally, the most promising research directions in this domain through an analysis of the various ways in which the interplay between history of physics and physics education can be conveyed.

Matthews M R (ed.) (2014). International Handbook of Research in History, Philosophy and Science Teaching (Dordrecht: Springer)
Matthews M R (2015). Science Teaching: The Contribution of History and Philosophy of Science 2nd edn (New York: Routledge)

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Il ruolo della Storia nella formazione in Fisica: motivazioni e prospettive future. Una discussione introduttiva.

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Tra le sfide più importanti che l'evoluzione della nostra società, dominata dallo sviluppo dell'intelligenza artificiale, dalla tecnologia dei big data e dai social network, pone alla formazione dei giovani, una delle più importanti, per la sua natura trasversale rispetto a qualsiasi tema specifico, è a mio avviso quella di stimolare e preservare una capacità di pensiero libera e indipendente e di coltivare il senso della bellezza e la fiducia nella possibilità di costruire un futuro sempre migliore grazie alla creatività e all'immaginazione umana. Alla luce dei recenti accadimenti legati alla pandemia, questa necessità sta diventando sempre più cogente, e si accompagna alla questione, tornata di attualità, di cosa sia la scienza. In questo contesto, vorrei condividere alcune riflessioni, che traggono spunto anche dalle mie esperienze che vanno dall'insegnamento della Fisica alla formazione insegnanti al Piano Lauree Scientifiche fino al ruolo istituzionale come membro del Consiglio Universitario Nazionale, sulle molteplici ragioni che io vedo per una crescente importanza del ruolo della Storia, della Storia delle Scienze e della Storia della Fisica in particolare nella formazione delle nuove generazioni, a partire proprio dal livello universitario, e sulle possibili prospettive future di una formazione scientifica che comprenda questa dimensione in modo esplicito e stabile.

Bibliografia essenziale
George Orwell, "What is Science?", in Tribune, 26 October 1945
Michael R. Matthews, "Science teaching: the role of history and philosophy of science", Routledge (1994)
Igal Galili, "History of Physics as a tool for teaching", (2008)
Laura Branchetti et al., "The I SEE project: An approach to futurize STEM education", Visions for sustainability (2018) 10-26

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Enhancing students' understanding of "science in the making" within a historical perspective

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The role of history in enhancing the understanding of scientific rationality is acknowledged from scholars in the field of didactics, both general (Martini B., Pedagogia dei saperi, 2011) and disciplinary (e.g. Matthews M.R., Science Teaching: The Role of History and Philosophy of Science, 1994) . However, the problem of how to use history to design effective teaching-learning activities is still open. The working hypothesis we propose in this contribution is the project of a historical-didactic workshop on physical sciences at the University of Urbino, to be carried out in collaboration with the Physics Laboratory: Urbino Museum of Science and Technology (Mantovani R. et al., Una realtà dimenticata: il Gabinetto di Fisica dell'Università di Urbino, 1991). We justify our proposal on the basis of the following:
a) The historical perspective is conveyed by having students interact with artifacts that are "objectified knowledge". Insofar the process of de-capsulating the knowledge therein can allow students to develop a deeper epistemological awareness about the role of instruments in scientific progress, these artefacts can work as powerful didactic mediators (Damiano E., La mediazione didattica, 2013).
b) While performing experiments using modern scientific apparatuses, with a design similar to the ancient scientific instruments exhibited in the Urbino museum, students can become acquainted with disciplinary epistemic practices and understand the reasons for their reliability. By actively working with these instruments, students can access scientific knowledge as the historical correlate of expert practices shared within the scientific community (Kitcher P., The advancement of science,1993).
In summary, we argue that the workshop can improve students'practical epistemologies (Sandoval, W. A., Science Education, 89(4), 2005), while helping them replace the static image of science provided by textbooks with that dynamic of an ever-developing human enterprise.

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Laboratorio "povero" di storia della scienza: un'esperienza in DAD

Author: Matteo Torre[None]

Uno dei rischi nella didattica della fisica è il dogmatismo: lo studente accetta passivamente la regola fissa e immutabile che l'insegnante gli trasmette. Questo pericolo si corre quando si fa percepire agli studenti un impianto teorico astratto, privo di legami storico-sociali, dove il ruolo dello scienziato è secondario. Per superare questo problema, è possibile sfruttare le potenzialità degli esperimenti storici. Il contributo descrive una sperimentazione realizzata nell'a.s. 2020-21 (in DAD e in presenza) in una classe 1° Liceo Scientifico Quadriennale, in cui sono stati ricostruiti alcuni esperimenti storici di Galileo e altri esperimenti più "tradizionali". Gli esperimenti "tradizionali"riguardavano la conservazione dell'energia, mentre quelli storici di Galileo il moto dei proiettili e il piano inclinato. La ricostruzione di quest'ultimi si è basata sul famoso manoscritto "Folio 116v"del 1608. L'intento didattico mirava a valorizzare il "fare per capire"attraverso l'uso dei materiali poveri, i quali hanno il grande merito di migliorare l'attivazione di tutti quegli aspetti emotivi e motivazionali suggeriti dalla letteratura pedagogica per il laboratorio scientifico.

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Principles of physics for philosophers

Author: Carlo Cosmelli[1]

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In recent years I have held a Physics Course for students of the Degree in Philosophy at Sapienza University.
The need for this course arose from a series of Science Cafés held at Sapienza in 2007. From those meetings it appeared that the students of Philosophy, who were very capable and prepared in their field, often did not know what the historical-conceptual path of physics was from Galilei to the present day. They did not know not only the historical development of Physics from Galilei onwards,

but in particular they ignored the developments in the last century regarding Special and General Relativity and Quantum Mechanics, or, if they knew, they often had a partial or distorted idea of them.
The idea was therefore to create a course aimed at students from non-scientific degree courses that would present, in a simplified but mathematically correct form, the Principles of Physics in their historical path. Discussing the Principles allows us to avoid the formal explanations necessary to treat all the themes and laws that make up the corpus of Physics. The discussion of the themes was therefore developed by deepening, in addition to a necessary formal part, the meaning that should be attributed to the Principles and the evolution in their understanding / description.
This course led to a book (1) which combines the topics covered with historical-philosophical sections written by the philosopher Paolo Pecere, from Roma Tre University. In these sections is briefly treated, for each chapter, the point of view of the philosophers at that time.

(1) Carlo Cosmelli, Fisica per filosofi, (Carocci, 2021)

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«Non ci basta studiare le cose nei libri; vogliamo guardarle nel libro vivo della natura». Francesco De Sanctis propone per tutti l'educazione esperienziale.

Author: Pietro Cerreta[None]

L'approccio attivo, che si è andato via via affermando nella pedagogia scientifica degli ultimi cinquant'anni, specialmente attraverso l'Exploratorium e i Science Centre in ogni parte del mondo, sembra trovare una straordinaria anticipazione nelle parole di De Sanctis, da lui pronunciate nel corso della sua conferenza su «Il Darwinismo nell'arte» nel 1883, allorché egli affermava tra l'altro: «il maestro non ci dà la scienza bella e fatta; la scienza vogliamo cercarla ed elaborarla noi, vogliamo vederla non come è fatta, ma come si fa». L'itinerario che conduce De Sanctis a queste sorprendenti conclusioni comincia da lontano, cioè dai suoi primi interessi giovanili per le scienze di ogni tipo, passa per la sua partecipazione al Settimo Congresso degli Scienziati Italiani che si tenne a Napoli nel 1845 e continua per tutto il corso della sua vita. Non si trattò di un gesto occasionale, se si legge il resoconto parlamentare, la decisione presa nel 1878 da Ministro della Pubblica Istruzione di dotare l'Osservatorio di Brera di un telescopio moderno affinché Schiaparelli potesse meglio svolgere i suoi importanti studi astronomici. Ma quel che risalta di più in questa conferenza è la lettura storica della dirompente novità dell'evoluzione che Darwin gli ha mostrato, una "forza"da applicare non solo nell'apprendimento delle scienze, ma allo stesso modo anche nell'arte, negli studi letterari e finanche nella vita comune.

Bibliografia
Francesco De Sanctis, «Il darwinismo nell'arte", in Saggi critici, vol. III, a cura di L. Russo, Laterza, Bari 1953
Gerardo Bianco, "«L'Onorevole ministro, che tanto protegge e intende di svolgere il movimento scientifico in Italia». De Sanctis e l'Osservatorio di Brera"Studi Desanctisiani. Rivista internazionale di letteratura, politica, società, 2015 3, p. 101-113

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The musical systems by Rameau and Tartini. Creativity and inconsistency

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The 18th century saw important developments in musical theory and practice. In addition to the inevitable change in tastes, there was also a change favored by the new scientific acquisitions. Music began —more clearly than in the past —to be considered from two different points of view: the physical point of view that could be the object of scientific, physical and mathematical inquire, the perceptual point of view that was the object of aesthetics. The first point of view framed music in the nascent science of acoustics, a term spread by Sauveur, studied by mathematicians; a theory that concerned not only music but also any kind of sound. The second point of view framed music in the arts and was developed by professional musicians, instrumentalists or composers.
However, this dichotomy was not a clear-cut. Some musicians (and some philosophers of nature) believed that the two spheres of competence were connected. Particularly interesting, in this regard, are the contributions of two of the greatest musicians of the century, the French Philip Rameau and the Italian Giuseppe Tartini, who believed that physics and mathematics could also have something to say on the aesthetic aspect. Both musicians approached musical theory with the conceptual tools of physics and mathematics; both believed they could have their opinion as natural philosophers as well. Both discussed their theories with the leading mathematicians of the time, with an animated contradiction to say the least. Rameau with Euler, d'Alembert, Mairan, Castel; Tartini with Euler, Giordano Riccati, Paolo Battista Balbi.
In this work the musical systems of Rameau and Tartini are compared in more depth than as found in the literature and the criticisms of mathematicians are commented.

References

Rameau JP (1750) Démonstration du principe de l'harmonie, servant de base à tout l'art musical théorique & pratique. Durand and Pissot, Paris
Tartini G (1754) Trattato di musica secondo la vera scienza dell'armonia. Stamperia del Seminario, Padova
Capecchi D (2020) Epistemology and natural philosophy in the 18th century. Springer, Cham

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The combination tones: from Tartini to Helmholtz

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The so-called "Tartini tone"(or "Tartini third sound") is a particular acoustic phenomenon occurring when two notes are simultaneously played on a violin, making a bichord. In this case, an unexpected "third sound"(usually much deeper than the first two) is audible. The discovery of this phenomenon, due to Giuseppe Tartini (1692-1770), one of the greatest violinists of all times, produced a large scientific debate during the second half of the XVIII century and the first half of the XIX century. In this period, other "unusual"sounds (generically called combination tones) were discovered, also by means of other musical instruments. Many scientists took part in the development of a physical explanation for such phenomenon. Among them, Euler, Giordano Riccati, Joseph-Louis Lagrange, Thomas Young, George Simon Ohm and especially Hermann von Helmholtz. Interestingly, many musicians, as for instance Rameau and of course Tartini, got involved. Nowadays, it is established that the phenomenon is due to the intrinsic non-linearities existing in both the musical instrument and in the human ear, which lead to combinations between different Fourier components of the sound. As well as a scientific interest, the Tartini tones have a relevant interest in music theory and practice. In this work the scientific debate about the combination tones is critically reviewed, showing its historical development. Deep interconnections between the evolution of the musical thinking and of the scientific thinking are found.

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Viviani. Prospettive di uno scienziato

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Inside the field of history of science, a historiography that talked about brilliant minds was often chosen by academics and consequently, leaving behind many of so-called "minor figures of science" whom had worked side by side with those geniuses and trailblazers; sometimes these figures had also passed to posterity their ideas.
That is the case of Florentine scientist Vincenzo Viviani.
Recently, his biography had sparked my interest and he had become, firstly, the topic of my master' s degree thesis and then, the topic of this paper.
This article analyzes, from a historical point of view, the life and work of Viviani, regarding his relationship with several key figures of patrons and scientists of the seventeenth century in order to point out, using Viviani as a case study, the significance of these "minor figures of science"and their role in the transmission process of many trailblazing ideas, in this specific case the ideas of Galileo. Furthermore, inside this paper, it will be pointed out several contributions Viviani had made, through an interdisciplinary way, in the scientific field such as his renovation work of the Dome of the Basilica of Santa Maria del Fiore.

Bibliography

- Favaro A., Cenni biografici inediti intorno a Vincenzo Viviani, in Favaro Antonio 1847- 1922. Scampoli Galileiani, Trieste, Lint, 1992, vol.2, pp. 558-562;
- Feingold M., The Accademia del Cimento and the Royal Society, in The Accademia del Cimento and its European context, a cura di Beretta Marco, Clericuzio Antonio, Principe Lawrece M., Sagamore Beach(USA), Science History Publications, 2009, cap. 15, pp.229-242
- Robinet A., Les rencontres de G.W. Leibniz avec V. Viviani et leurs suites: Florence, novembre-décembre 1689, in Bollettino di storia delle scienze matematiche, A. 7, n.1, 1987, p.61-92;
- Roero C.S., Viviani rival de Leibniz, in Géométrie, atomisme et vide dans l'école de Galilée, Fontenay-Saint Cloud, ENS, 1999; EAD., Leibniz and the Temple of Viviani, in Annals of Science, vol.47, 1990, pp.423-443;
- Segre M., Viviani's Life of Galileo, in ISIS, vol.80, 2, Chicago(US), The University of Chicago Press, giugno 1989,p.206-231;
- Tenca L., Evangelista Torricelli e Vincenzo Viviani, Faenza, [s.n.], 1954.

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Giovan Battista Amici, astronomer optician, naturalist and instrument maker in Modena from 1809 to 1831

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After the exhibitions and conferences organized by the University of Modena between 2014 and 2015, significant events with which we wanted to celebrate the 150th anniversary of the death of Giovan Battista Amici (1786-1863), this year, in which the 235th anniversary of his birth in Modena falls, it seems appropriate remember his career in Modena, where he was born in 1786 and where he remained until 1831 when he moved to Florence at the invitation of Leopold II of Habsburg Lorraine Grand Duke of Tuscany to fill the post of director of the Observatory of the Museum of Physics and

Natural History,. After obtaining in 1808 the title of Engineer Architect at the University of Bologna, between 1811 and 1825 Amici taught Algebra, Geometry and Plane Trigonometry at the University of Modena.
Meanwhile since 1809, thanks to the urging of the professor of Physics at the University of Modena Giovanni Battista Tomaselli, began his career as scientific instruments's maker by installing his laboratory in his house in Via dei Servi, where before Royal Printing House Eredi Soliani has been located.
Already in 1811 he made his Newtonian reflecting telescope, the largest ever built in Italy, for the National Exhibition organized in Milan by the Royal Institute of Sciences. The following year he made his catadioptric, or reflecting, microscope, and between 1812 and 1813 several reflecting telescopes came out of Amici's laboratory in Modena: for the forthcoming Capodimonte Observatory in Naples, for the Specola in Bologna and for the Astronomical Observatory of Padua.
After the first long journey in 2017, which took him from Modena to Naples through Bologna, Florence and Rome, he made important acquaintances among officials, astronomers, naturalists, geodesists and cartographers. This enabled him to gain an appreciation for his instruments and secure numerous orders for the construction of microscopes, telescopes, micrometers, repeating circles and 'camere lucide', of which he made 270 examples that were particularly successful. The 1824 is considered the year of birth of the modern compound achromatic microscope.
For the Astronomical Observatory of Modena, inaugurated in 1827 in the east tower of the Ducal Palace, under Giuseppe Bianchi's direction, he made several instruments including a passage instrument still preserved in situ.
Before moving to Florence, in the spring of 1827 Amici had undertaken his first trip to Paris and London to meet with a lot of scolars and colleagues: his son Vincenzo kept an accurate diary of this trip.

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Francesco Zantedeschi and Macedonio Melloni: a dispute in the history of Italian electrostatics

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Francesco Zantedeschi (1797-1873) taught Physics and Mathematics at Royal Lyceum "S. Caterina" of Venice from 1838 to 1849. He subsequently held the chair of Physics at University of Padua, where he remained until 1857. He dealt with various research topics, from Optics to Photography, from Acoustics to Meteorology. He also wrote a Trattato di fisica elementare (1843-1846). He was a tireless experimenter and the inventor of original instruments. Much of his research concerned Electricity and Magnetism. Zantedeschi eliminated imponderable fluids from physics. Following Ambrogio Fusinieri, he argued that all phenomena required physico-chemical reactions carried out in matter. He considered electricity as priority effect of the movement of matter particles; light and heat as secondary effects. In order to explain electrostatic phenomena he took up concepts of "vindictive electricity"(elettricità vindice) and "pressure atmospheres"(atmosfere di pressione) used by Beccaria and Volta.
In 1854 he attacked Macedonio Melloni, who had proposed to reformulate classical electrostatics, reinterpreting some experiences with the principles set out by Faraday. Zantedeschi expounded a third explanation of electrostatic induction phenomena. He devised a new electroscope to prove his idea.
This dispute allows us to grasp the variety of aspects of Italian electrostatics research in the second half of the 19th century.

References
Colombini G. (a cura di) (1989). La fisica a Padova nell'800. Vita e opere di Francesco Zantedeschi. Padova, Dip. di fisica "G. Galilei".
Curi E. (a cura di) (2001). La figura e l'opera di Francesco Zantedeschi. Verona, Accademia di agricoltura, scienze e lettere.
Tinazzi M. (1999). Francesco Zantedeschi: manoscritti e lettere veronesi, in Atti del XVIII Congresso SISFA. Milano, Università degli Studi, pp. 1-15.
Zantedeschi F. (1843-1846). Trattato di fisica elementare. Venezia, Tip. Armena di S. Lazzaro.

Zantedeschi F. (1850). Nuova teoria statica e dinamica dei minimi, o molecolare. Padova, Sicca.
Zantedeschi F. (1854). Nuovi esperimenti risguardanti l'origine della elettricità atmosferica e dell' induzione elettro-statica nei conduttori solidi isolati. Ateneo Italiano, 1 (15 settembre).
Zantedeschi F. (1855). Nuovo elettroscopio per le due elettricità d'influenza, Sitzungsberichte der Mathematisch-naturwissenschaftlichen, klasse der K. Akademie der Wissenschaften, 17, pp. 171-173.

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Il De stella nova (1606) di Kepler e il dibattito sulla natura e i moti delle 'novità celesti.' / Kepler's De stella nova (1606) on the nature and motions of the 'celestial novelties'.

Author: Dario Tessicini[None]

Questa relazione prenderà in esame le tesi fisico-cosmologiche del De stella nova (1606) di Kepler nel contesto delle discussioni sulla natura delle 'novità celesti'(comete e nuove stelle) e sui loro moti. Al centro dell'attenzione sarà la discussione critica di alcune tesi sulla natura fisica e i moti della nova che lasciavano aperta la possibilità che l'universo fosse infinito. La risposta di Kepler a queste ipotesi, che rimandavano pericolosamente alla filosofia di Giordano Bruno, chiama in causa alcuni punti centrali del dibattito cosmologico dell'epoca, quali la centralità e la singolarità del sistema solare, la teoria delle comete ('corpi evanescenti'), e la revisione della fisica celeste aristotelica (in particolare la distinzione tra moti retti e circolari).

This paper will discuss some physical and cosmological aspects of Kepler's De stella nova (1606) in the wider context of the sixteenth and early-seventeenth century debates on the 'celestial novelties' (comets and new stars) and on their motions. In particular, the paper will address issues related to the physical nature and the motions of the new star that paved the way to the notion of the infinity of the universe. Kepler's arguments against these hypotheses (whose implications led to the 'dangerous' philosophy of Giordano Bruno) call into questions the main issues of the early modern cosmological debate, namely the centrality and singularity of the solar system, the theory of comets (as 'evanescent bodies') and the reconsideration of Aristotle's celestial physics (the distinction between rectilinear and circular motion, in particular).

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The Legacy of Clavius: Giovanni Paolo Lembo's Reaction to Galileo's Celestial Novelties (1610-15)

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In the last edition of his *Commentarius in sphaeram Ioannis de Sacrobosco*, published in 1611, Christoph Clavius urged astronomers to work out an astronomical solution that integrated the ground-breaking Galilean novelties of 1610. As the Collegio Romano mathematics professor stated, « since this is so, astronomers ought to see how the celestial orbs may be arranged in order to save the phenomena ». What was the real meaning of Clavius's plea? This paper approaches this question by analysing the astronomical work of the Jesuit Giovanni Paolo Lembo. In addition to being an accomplished telescope maker and astronomical observer, having played a crucial role in the telescopic observations carried out at the Collegio Romano between 1610 and 1611, Lembo was one of the closest collaborators of Clavius and an advocate of his astronomical ideas. Shortly after Clavius passed away, Lembo set forth a geo-heliocentric system of Capellan inspiration that came to terms with the Galilean novelties (and particularly with the phases of Venus and Mercury) while simultaneously retaining intact the foundations of Clavius's astronomical and cosmological ideas.

Bibliography:
James M. Lattis, *Between Copernicus and Galileo. Christoph Clavius and the Collapse of Ptolemaic Cosmology*, Chicago and London, The University of Chicago Press, 1994.
Michel-Pierre Lerner, "L'entrée de Tycho Brahe chez les jésuites ou le chant du cygne de Clavius", in Luce Giard (ed.), *Les Jésuites à la Renaissance. Système éducatif et production du savoir*, Paris, Presses Unversitaires de France, 1995, pp. 145-185.
Eileen Reeves and Albert van Helden, "Verifying Galileo's Discoveries: Telescope-making at the Collegio Romano" in Jürgen Hamel and Inge Keil (eds.), *Der Meister und die Fernrohre: das Wechselspiel zwischen Astronomie und Optik in der Geschichte*, Frankfurt am Main, H. Deutsch, 2007, 127-141.

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The Riccioli-Borelli-Angeli controversy and the deviation of free falling bodies

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The controversy between the Jesuit Giovanni Battista Riccioli and the Galileans, Giovanni Alfonso Borelli and Stefano degli Angeli is part of the broader question of the opposition to the Copernican system on the part of Catholic orthodoxy. However, it had a fundamental role in highlighting an unresolved crucial question of Galilean dynamics: the "true" or "absolute" motion of falling bodies distinct from the apparent motion with respect to the rotating Earth. The starting point of the controversy was the proof of the immobility of the Earth, sustained by Riccioli in his *Almagestum Novum* (1651) and reaffirmed in the *Astronomia Reformata* (1665), which criticized Galileo's hypothesis of a semicircular trajectory, travelled with uniform motion. Riccioli's argument was based on the impact of a falling body on the ground, which varied with height. Borelli in *De vi percussionis liber* (1667) affirmed that the trajectory could be neither circular nor spiral, but opposed Riccioli's objection since this was based on the uniformity of the absolute motion while the variation of the impetus concerned the relative motion. A few months later, Angeli intervened against both Riccioli's demonstration and Borelli's arguments and the controversy developed into a long series of cross replicas (1666-1669). All the participants in the controversy were convinced that the trajectory should arrive at the center of the Earth, but, at a certain point within the debate, the consideration of a deviation emerged. It was Angeli, who, believing that the angular velocity was conserved during the fall, highlighted the consequence of Borelli's hypothesis, namely, that by maintaining the transverse velocity constant, the body would fall east of the vertical. The deviation of a falling body later became the experimental proof in favor of the rotation of the Earth, and the trajectory of a body in absolute space the theme of the famous correspondence exchanged between Newton and Hooke (1679-1680).

References

M.T. Borgato. La traiettoria dei gravi nella polemica tra Borelli, Angeli e Riccioli. In: *Galileo e la scuola galileiana nelle Università italiane del Seicento* (ed. by L. Pepe) CISUI Studi 14 (2011): 263-291
M.T. Borgato, Gli esperimenti di Giambattista Riccioli sulla caduta libera e il pendolo. *Giornale di Fisica della Società Italiana di Fisica* 55/4 (2014): 267-295
A. Koyré. A Documentary History of the Problem of Fall from Kepler to Newton. *Transactions of the American Philosophical Society* 45/4 (1955): 329-395.
P. Galluzzi. Galileo contro Copernico: Il dibattito sulla prova "galileiana"di G.B. Riccioli contro il moto della Terra. *Annali dell'Istituto e Museo di Storia della Scienza di Firenze* 2 (1977): 87-148

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Representing the Truth: The Case of a Jesuit Astronomer and a Jesuit Polymath

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« It is a grave error to believe that our mental representations of the truth are unique as if several different images could not be exhibited of a single statue » (F. Lana Terzi, 1684). This eclectic epistemology was shared by several Jesuit confrères in the second half of the 17th century. I will discuss the case of Riccioli and that of Kircher. With the exception of his beloved proof of the immobility of the Earth, the *argumentum physicum-mathematicum*, in his *Almagestum novum* the former often seemed to draw inspiration from a similar criterion, without however evoking it openly. As in the case of the locations and trajectories of comets, or of new stars'locations, or for the semi-dark light observed at the new moon etc. The latter described his cosmology and his astronomical and philosophical theses in his *Itinerarium extaticum*, albeit through an imaginary journey characterized by an ecstatic dimension with echoes of Cusan or Brunian cosmology. In the background stood out the Revisori Generali and the *Ordinatio pro studiis superioribus* (1651), which attempted to impose guidelines that had to be strictly followed by Jesuit scholars. The difficult balance between one's *curiositas* towards the natural world on the one hand, and the theological tradition and the pervasive influence of the higher authorities of the Order on the other, often resulted in contradictory outcomes for various reasons.

Bibliography:
Findlen Paula. *Athanasius Kircher: The Last Man Who Knew Everything*. New York: Routledge, 2004.
Gambaro Ivana. "Geo-heliocentric Models and the Society of Jesus: From Clavius's Resistance to Dechales's Mathesis Regia". *Annals of Science*, 2021. DOI: 10.1080/00033790.2021.1919760.
Kircher Athanasius. *Athanasij Kircheri [...]Itinerarium exstaticum*. Romae: typis Vitalis Mascardi, 1656.
Kircher Athanasius, Schott Gaspar. *R.P. Athanasii Kircheri [...] Iter extaticum coeleste*. Herbipoli: sumptibus Joh. Andr. & Wolffg. jun. Endetorum haeredibus, 1660.
Lana Terzi Francesco. *Magisterium naturae, et artis*. Brixiae: per Io. Mariam Ricciardum, 1684.
Riccioli Giovanni Battista. *Almagestum nouum*. Bononiae: ex typographia haeredis Victorij Benatij, 1651.

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Understanding, disseminating, and interpreting Kepler: Riccioli and the three laws of planetary motion

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In his *Histoire de l'astronomie moderne* (II, 1785, p. 211), J. Bailly argued that Riccioli had not understood Kepler's laws. This has been questioned (J.L. Russell, 1964) and deserves consideration. Riccioli played an important role in the comprehension and dissemination of Kepler's works, at least in the Italian context. Riccioli seriously discussed Kepler's ideas in his *Almagestum Novum* and the *Astronomia Reformata*, and he gives Kepler more importance than Copernicus or Galileo.
In this talk, we will see how Riccioli understood Kepler's three laws of planetary motions. We will show the difference between the technical solutions of the two astronomers and evaluate these differences with reference to the position of the sun, the different ways of using the eccentricity of the orbits, the ellipticity of the trajectories and the calculation of the periods. We will explain why Riccioli did not accept the physical interpretation of Kepler astronomy.

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The History on the Moon

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The History *on* the Moon
Over the time, the lunar nomenclature presented by Giambattista Riccioli (1598-1671) in his *Almagestum novum*, in the mid-seventeenth century, outperformed contemporary proposals, such as that developed by Michael Florent van Langren (1600-1675) or the even more famous *Selenographia* by Johannes Hevelius (1611-1687). His idea of associating the various lunar spots with the names of famous astronomers of ancient and contemporary times was successful, so much so that it was chosen by the International Astronomical Union as the starting point for the modern nomenclature of the Moon, in 1932.
But what savants does Riccioli places on the Moon, and what can they tell us about the historical and astronomical culture of the 17th century? This is the subject of this work.

References
RICCIOLI G. B., *Almagestum novum astronomiam veterem novamque*, Bononiae, ex typographia haeredis Victorij Benatij, 1651.
MACDONALD T. L., *Riccioli and lunar nomenclature*, in "Journal of the British Astronomical Association', Vol. 77 (1967), pp.112-117
MARAZZINI C., *I nomi della Luna. Tecnicismi astronomici e selenografia da Galileo a Riccioli*, in "Studi Linguistici Italiani"XXXI (X della III serie), fascicolo II, 2005, pp. 161-93.

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How do celestial bodies interact? Looking for Kepler's astronomical physics on a page of his Epitome

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Johannes Kepler compiled the *Epitome Astronomiae Copernicanae* (*Summary of Copernican Astronomy*) in the years of his maturity. He had already developed his three astronomical laws, and he had understood how the adoption of a new astronomy, founded upon the Copernican point of view, compelled the astronomers to also introduce a new physics. Kepler's celestial physics permeates this masterpiece, and the unprecedented alliance between physics and astronomy can be seen as its characteristic feature.
The *Epitome* is organized in an original way, as it is divided into questions and answers; the present analysis focuses on a precise question/answer, relating to the mechanism that makes some celestial objects (here referred to as secondary planets) revolve around other bodies (here called primary).
Even if we lack an Italian translation, this is a well known page, as here Kepler showed how his Third Law, the one relating the squares of the orbital period of the planets to the cubes of the semi-major axes of their orbits, applies also to the moons of Jupiter.
But, as it often happens with Kepler, the agreement of the Third Law to the data of Jupiter's satellites, the discovery of which was still recent and represented an important element in favor of the Copernican system, is extrapolated from the context.
I propose here an investigation of the whole paragraph. Once again, Kepler will be able to amaze us with a mixture of arguments that are still scientific in our eyes, with others still connected to his philosophical, archetypal, "not so modern"cosmology. I would point out how the universality of his Third Law was, according to Kepler, an important contribution towards the understanding of the mechanism by which celestial objects can interact with each other.

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The Dream of Kepler: a retrospective work on the human side of the scientist

Author: Luisa Lovisetti[None]

The compendium *Epitome astronomiae copernicanae*, published between 1618 and 1621, is considered the most complete and influential work of Johannes Kepler (1571-1630), introducing the reader to the heliocentric theory and the whole astronomical work of its author. However, another much less known masterpiece exists deserving comparable attention: the *Somnium, seu opus posthumum de astronomia lunari* (published posthumously, in 1634), depicting Kepler not only as a scientist but also as a man. It is the short tale of a dream, which troubled drafting lasted for almost forty years, describing the journey to the Moon made by a fictional young man, whose life shows several affinities with Kepler's one. Within its pages and its rich apparatus of explanatory notes, added by Kepler himself, several references to the major works and the life of the astronomer can immediately be found. The *Somnium* is thus a journey through Kepler's theories, providing the reader with an accurate portrait of an exceptionally modern character (defender of both the Copernican model and the central role of science) but still tied to the past (in his Platonic and Pythagorean ideas). Thanks to the *Somnium* is possible to draw the fundamental steps in Kepler's life and in his work, surely deserving a special place in the history of astronomy.

Synthetic bibliography

[1] Kepler, Johannes. (1596) *Prodromus dissertationum cosmographicarum, continens mysterium cosmographicum* [···]. Tübingen, Georg Gruppenbach.
[2] Kepler, Johannes. (1604) *Ad vitellionem paralipomena, quibus astronomiae pars optica traditur* [···]. Frankfurt, Claudium Marnium & Ioannes Aubrium
[3] Kepler, Johannes. (1609) *Astronomia nova aitiologetos, seu Physica coelestis, tradita commentariis de motibus stellae Martis [···].* Prague.
[4] Kepler, Johannes. (1619) *Harmonices Mundi.* Frankfurt, Godofredo Tampachio & Johannes Plancus.
[5] Kepler, Johannes. (1618-1621) *Epitome astronomiae copernicanae.* Linz, Johannes Plancus.
[6] Kepler, Johannes. (1634) *Somnium, seu opus posthumum de astronomia lunari.* Frankfurt, Sagan typography.

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Kepler's astronomy: an interplay between kinematics and dynamics

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The fundamental elements of Kepler's dynamics will be explained. They were offered by Kepler in Astronomia Nova and Epitomae Astronomiae Copernicanae. Afterwards, I will analyse the connections among such elements and the first two Kepler laws. For, an interesting conceptual and historiographic problem exists: is it possible that a "wrong"dynamics is the basis of a "correct"kinematics? Or, rather, Kepler developed independently the kinematical and the dynamical aspects and, after that, tried to arrive at a synthesis in order to offer a complete physical theory of the planetary movements? In the final part of my talk, I will try to provide an answer to this profound and fascinating questions.

Essential bibliography

Kepler, J. (1937–2012). Gesammelte Werke, Van Dyck W,

Caspar M. et al. (eds). Revised April 2013. 10 Vols. München: Deutsche Forschungsgemeinschaft und Bayerische Akademie der Wissenschaften. Beck'sche Verlagsbuchhandlung. Abbreviated as

KGW.

Kepler, J. (1609) Astronomia Nova. In KGW, III. English translation (1992). New Astronomy. Translation by William H. Donahue. Cambridge: The Cambridge University Press.

Kepler, J. (1618–1621). Epitome astronomiae copernicanae. In KGW, VII.

Koyré, A. (1973). The Astronomical Revolution: Copernicus –Kepler –Borelli. London. Methuen. Ithaca (NY): Cornell University Press. First edition 1961.

Pisano, R. - Bussotti, P. (2018). On the Conceptualization of Force in Johannes Kepler's Corpus: An Interplay Between Physics/Mathematics and Metaphysics, in R. Pisano, J. Agassi, D. Drodzova (Eds.), in Hypotheses and Perspectives in the History and Philosophy of Science. Homage to Alexandre Koyré 1892-1964: 295-345. Cham: Springer.

Stephenson, B. (1987). Kepler's Physical Astronomy. New York - Berlin - Heidelberg - London - Paris - Tokyo: Springer.

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BOSCOVICH ON ORBIT DETERMINATION FOR COMETS AND PLANETS (1746-1785)

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The problem of comet orbit determination has been one of the most important challenges in early modern astronomy since Newton's Principia at least, but came to an apex in the mid-eighteenth century, when many comets were being observed and a plurality of methods for calculating their paths with increasing precision emerged. The present paper studies Ruggiero Boscovich's contribution to this field from the early 1740s until his 1782 solution for Uranus orbit. He started with a modified form of Chéseaux's method of cometary path determination (*Dissertatio de cometis*, 1746), presented a more sophisticated version in the early 1770s (*De orbitis cometarum determinandis*, 1774), and finally advanced a method that could be applied to cometary and planetary paths as well (*Teoria del nuovo astro osservato prima in Inghilterra*, 1782; *Opera pertinentia ad opticam et astronomiam*, III, 1785). I will show that (a) Boscovich was aware of the peculiarities of the problem of determining the orbit of a comet compared to that of a planet and the advancements made by other astronomers, but (b) at a certain point he changed his initial approach and strove for a method of growing generality. I will claim that this feature was the most important merit of his last paper, making of it one of the most significant contributions of his time —despite some flaws and the limits of Boscovich's mainly geometric style of orbit determination.

SISFA Prize 2021 / 70

Bruno Pontecorvo: Dalle scoperte di via Panisperna alle prospezioni petrolifere dell'Oklahoma

Author: Luigi Renna[None]

During his American and Canadian period between 1940 and 1947, Bruno Pontecorvo was involved with mineral and oil survey to a degree that has often been overlooked in his biographies and other research work about his studies. This essay dissects patents and papers from that period authored by Pontecorvo himself and his collaborator at Well Surveys inc. William Russell to bring into light Pontecorvo's contributions to the then newly born branch of science and technology called petrophysics, the influence that his periods in Rome with Fermi and in Paris with Curie and Joliot had on his work, and the consequences and implications of his inventions for the mining and oil industries as well as the war effort with radioactive sample prospecting in Canada to support the Tube

Alloy and Manhattan projects. Towards the end we explore documented connections between Pontecorvo and the Italian conglomerate AGIP/ENI, and throw an open question (supported by hints in later publications) that might suggest similar involvement with Soviet authorities after his defection in 1950. Such connections have (and might have, respectively) introduced the neutron-gamma and neutron-neutron prospection methods to Italy, and USSR.

SISFA Prize 2021 / **72**

Astronomy in the Jesuit mission to Ming China

Author: Valentina Bottanelli[None]

The representation of the physical world has historically played a crucial role in the constitution of the alterity and of inter-states relations, but it has often been neglected by anthropological studies and ethnographies. An analysis of the jesuit mission to Ming China (1577-1644) offers an outstanding opportunity to tackle this issue.
In fact, the contextual study of both private letters and publications shows the deep influence of mathematical astronomy and cosmographies on the self-representation of missionaries as intellectuals and astronomers, on the opposition to Christianity by contrasting the penetration of Western science, and on the influence of the European scientific and astronomical revolution in the transmission of different cosmological models by the Jesuit fathers.
Furthermore, the representation of Chinese astronomy in the missionaries' accounts contributed to the creation of a new, negative image of China, that influenced the diplomatic relations between Chinese empire and European power, in particular the outcome of the first British embassy, and the academic debate until the twentieth century.

Bibliography
Cranmer-Byng J., Levere Trevorcu H (1981). A case study in cultural collision: Scientific apparatus in the Macartney embassy to China, 1793. Annals of Science, 38 (5), pp. 503-525.
D'Elia Pasquale (1960). Galileo in China. Harvard University Press, Cambridge.
Needham Joseph, Wang Ling (2005b). Science and Civilisation in China. Mathematics and the sciences of the heavens and the earth, 3rd vol. Cambridge University Press, Cambridge, 7th ed., (1956).
Sir Staunton George (1797). An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China. W. Bulmer and Co., London.
Saraiva Luis, Jami Catherine (2008).The jesuits, the Padroado and east asian science. World Scientific Publishing, Singapore.
Trigault Nicolas (1622). Entrata nella China de'padri della Compagnia del Gesv, Napoli.

Historiography of physics / **55**

Towards a Biography of the Ether

Author: Theodore Arabatzis[1]

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In this talk I will make a case for the pertinence of a biographical approach to the history of the concept of ether. In the first half of the talk, I will lay out the rationale of that approach by revisiting and extending my earlier work on the topic. I will consider the characteristics of scientific objects that motivate the biographical metaphor, and I will indicate its virtues and limitations by bringing out the positive and negative analogies between biographies of scientific objects and ordinary biographies. I will then point out various ways in which scientific objects may pass away and argue that their demise should be conceptualized as a process. In the second half of the talk, I will sketch the history of the concept of ether in 19th and early 20th century physics and suggest that it lends itself particularly well to a biographical treatment. To that effect, I will discuss three aspects of the ether: its identity over time, its heuristic role in the practice of physics, and its recalcitrance as an

object of theoretical and experimental research. Finally, I will close by examining the reasons that may have led to the ether's passing.

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Il Nuovo Cimento in the changing landscape of physics: A network-historical analysis

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In the last years, historians have increasingly turned to network concepts and methods for analyzing historical sources and assessing past dynamics. Our group has further extended these approaches by applying multi-layer network techniques to the study of recent science combining social network analysis, citation network analysis and the analysis of the knowledge space generated by scientific publications. This approach, called socio-epistemic networks, is particularly useful to evaluate the role of specific journals in the general system of knowledge production.
In this talk, I use this approach to analyze the changing position of Il Nuovo Cimento in the global field of physics through the 20th century. I discuss how the role of the journal of the Italian Physical Society developed both in the publications' co-citation network and in the knowledge space of topics created by all physics journals indexed by on-line repositories. By comparing these results with those retrieved from the analysis of Physical Review journals, this approach allows to highlight the specificities of Il Nuovo Cimento and to identify crucial moments of transformation.

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Franco Selleri revealed: what his unpublished archives said

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In the doctoral work I completed last October, I analyzed for the first time in a comprehensive manner the role of the Italian physicist Franco Selleri (1936-2013) in the fields of particle physics, foundations of quantum mechanics and foundations of the theory of relativity during the years 1960-2010. Having had access to his unpublished archives, I found a considerable amount of contributions, handwritten notebooks and correspondence with scientists and Nobel laureates around the world. It emerged the deep connection between Selleri's research and historical and philosophical approach, and the contemporary socio-political environment in which he worked. All the results of this research as well as the historiographic followed approach will be shown here. The complete bibliography of all his scientific works will also be presented, as well as a series of annexes with all his writings, the conferences in which he participated and some of the above-mentioned correspondence.

Bibliography:
All references are included in:
- Romano L. (2020), Franco Selleri and his contribution to the debate on Particle Physics, Foundations of Quantum Mechanics and Foundations of Relativity Theory. Università degli studi di Bari, Tesi dottorato in Storia della scienza.

Historiography of physics / 12

Looking stereoscopically at Goethe vs. Newton: Heisenberg and Pauli on the future of physics

Author: Rocco Gaudenzi[1]

Co-author: Stefano Furlan [1]

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Goethe's polemics against Newtonian optics is not rarely mentioned as a singular instance of incompetent stubbornness, or quickly dismissed as an embarrassing incident, not worthy of Goethe's stature. Goethe's presence in the mind of 20th-century physicists is however not a negligible chapter, as systematic omissions of some kind of historians seem instead to suggest. From E.Schrödinger to F.London, from A.Einstein to W.Heisenberg, and even in later generations in far-away Japan – e.g., Y.Nambu –, Goethe's presence can be assessed, not only due to the pre-eminence of his literary work but to a suffused Naturphilosophie as well, not easily expressible in barren analytical terms – and why would one need to rephrase it otherwise, when Goethe himself expressed it magnificently in his own words? Even more significantly, physicists of the calibre of Heisenberg and Pauli, as well as the former's disciple von Weizsäcker, although recognizing the 'mistakes'of the Goethean polemics in optics, tried to extract from that episode important lessons and expectations about the future of science. While some commentary on the essay that Heisenberg dedicated to the topic ("Die Goethesche und die Newtonsche Farbenlehre im Lichte der modernen Physik") does exist, but in a form that is often a mere paraphrasis of it, in this paper we intend to discuss critically some of the few attempted contextualizations, such as C.Carson's, and comment on Heisenberg's view in the light of other crucial texts of his as well as some letters, also putting it for the first time in relation to Pauli's much less known similar considerations.

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THE LAST 30 YEARS OF HISTORIOGRAPHY OF PHYSICS: QUO VADIS?

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"History of science without philosophy of science is blind. Philosophy of science withouth history of science is useless."This Lakatos'motto (of Kantian origin) dominated the panorama of the historians of science in the period 1960-1980. This effort to connect history and philosophy about the study of physics however was only a partial success.
The externalist view of the history of science was able to suggest only some case study of interest. About the internalist view, Koyré study of the birth of modern science gained the position of a classic, but it concerns the birth only, not even Newton's case. The celebrated Kuhn's analysis failed face at quantum mechanics, and also its account of classical physics was contested on the base of radical criticisms. Lakatos'was unsuccessful in find out a case-study confirming his methodological suggestions. The structuralist view of Physics built a brilliant spiderweb which however is detached from the common view on the physical theories.
A disenchantment followed. A new panorama followed. By assuming that classical physics is unproblematic the growing the number of professional historians focused the attention on the accumulation of even more studies of quantum mechanics and contemporary physics. What was unachievable from the top of a philosophical categories, is looked for from the bottom of an inductive attitude from detailed studies of as more as possible historical cases and event. In such a way what has not been achieved by the above philosophical viewpoint - i.e. to decisively turn the attention of physicist community to history of physics -, was achieved by a quantitative growth of historical

case-studies on the physics of the last times.
However, historians of science have no detailed mathematical and no scientific knowledge, and whereas physicists write "historical papers"without any history. History of science, and in particular history of physics, was reduced to a mere "historical history", a philosophically neutral history centered on some myths of foundations (Galileo, Newton, Darwin, Einstein) and on micro-histories without any macro-historical meaning. The application of complexity theory to history was used to deconstruct the "great narratives": scientific method, modern science, scientific revolution, incommensurability became lost concepts. There is no longer a general frame. But in such a way history of science remained undertheorized, when compared with other fields. Actually, history of physics has not really had achieved a defining methodology. In our opinion this is the main weakness of our discipline.
In present communication we will analyse the main attempts in the last 30 years to renew the program of achieving an account of history of physics capable to answer the profound question that this history suggests? We take in account the following viewpoints: 1) the feminist one on science; 2) the new analyses of classical physics suggesting a new view on modern physics; 3) the complexity theory. The analysis takes as main case-study the historical role of thermodynamic theory which as first seemed to exit out the Newtonian paradigm.
We look for the possibility of a new conceptual frame for history of science: theological, philosophical (ontological and gnoseological), ethical, conscious and unconscious presuppositions of physics, and the technical-experimental, mathematical, logical practices of modern physics as a new philosophy of Nature with its synthax, semantics and pragmatics dimensions.

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The Institute of Physics in Milan during the Fascist Regime

Author: Leonardo Gariboldi[1]

[1] *Università degli Studi di Milano, Dipartimento di Fisica "Aldo Pontremoli"*

The Institute of Physics in Milan was established by Giovanni Polvani after he was called as professor of Experimental Physics by the Royal University of Milan after Aldo Pontremoli's death declaration in 1929. In this communication I will sketch the educational and research activities up to the end of World War II as well as some issues of the impact of the Fascist Regime on the life of the Institute of Physics.

L. Belloni, "Giovanni Polvani e l'Istituto di Milano", Il Nuovo Saggiatore, 1988, 4: 35-49.
L. Gariboldi, "La nascita e i primi sviluppi degli studi di fisica", Annali di storia delle università italiane, 2007, 11: 261-276
L. Gariboldi, "Polvani, Giovanni", Dizionario Biografico degli Italiani, 2015, 84: ad vocem.
L. Gariboldi, "L'impatto del Fascismo sull'Istituto di Fisica di Milano: Il caso della borsa di studio Aldo Pontremoli", Quaderni di Storia della Fisica, 2020, 1: 117-138.
C. Salvetti, "Commemorazione del M.E. Giovanni Polvani", Rendiconti dell'Istituto Lombardo, 1970, 104: 115-124.

20th century physics / **27**

Aurorae borealis and cosmic rays: from Vannevar Bush's Differential Analyzer to digital simulation

Author: Benedetta Campanile[1]

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Independent research, like studies on aurorae borealis and cosmic rays, founded their point of union in the use of Differential Analyzer, an analog computer invented by Vannevar Bush () in 1931, for

measurements. In fact, the computers answered a growing demand for computing fundamental to prove new cosmological hypotheses whit scientific measurements. The Analyzer was used by Manuel Vallarta (1899-1977) and Georges LeMaître (1894-1966) to numerically solve the complex system of differential equations describing the trajectories of cosmic rays. Bush promoted the engineering of the analyzer and obtained funding from the Rockefeller Foundation for a redesign of the instrument and its electrification. The approximated calculations provided a new image of the cosmos and demonstrated the power of the computer. After the World War Two, the analogic machine revealed their limit with respect to new digital technologies. Now scientific research required different performances that the new electronic and digital computers could offer, as the MANIAC I, built under the direction of Nicholas Metropolis.
The new frontier of computation offered the new perspective of simulation.

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Alcuni aspetti della ricezione di Enrico Fermi in Unione Sovietica

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La prematura morte di Enrico Fermi (1954) lo stroncò nel pieno dell'attività e all'apice della fama, non solo in Occidente: se era noto in tutto il mondo per i suoi risultati, vi sono tuttavia alcuni interessanti e trascurati aspetti della ricezione della sua figura di scienziato al di là della Cortina di Ferro. Grande promotore della conoscenza della vita e delle opere di Fermi in Unione Sovietica fu, come prevedibile, il suo allievo lì emigrato nel 1950, Bruno Pontecorvo. Ciò tuttavia non si limitò ad essere un'operazione meramente "informativa" o, a livello scientifico, celebrativa. Oltre a scrivere un memoriale all'indomani della morte del maestro, Pontecorvo curò poi personalmente l'edizione russa (1971) dei "Collected Papers" di Fermi, aggiungendo le proprie considerazioni ai commentari già presenti dopo ogni articolo, oltre che redigendo la cospicua introduzione. Oggi questo può sembrare una pratica comune, ma non bisogna trascurare l'eccezionalità e l'impatto di quella operazione editoriale, resa in parte possibile dalla relativamente giovane età di Fermi al momento della sua scomparsa e dalla partecipazione di vari allievi e collaboratori ancora in vita e attivi. Grazie a Pontecorvo, questo esempio si diffuse anche in Unione Sovietica. Prima ancora, inoltre, sempre su sua spinta, vennero presto (1959) tradotte in russo le memorie di Laura Fermi; a testimonianza dell'onestà e della devozione dell'allievo, venne mantenuto integralmente anche il capitolo in cui si parlava con toni piuttosto duri della scelta di Pontecorvo. Questa operazione di riflessione sulla figura del maestro non fu un semplice omaggio, ma anche un'occasione di riflessione per così dire metodologica; aspetto che, a testimonianza della risonanza avuta dal personaggio anche in quel contesto e al di là di specifici risultati, ricorre curiosamente in alcuni parallelismi tra Fermi e Zel'dovich, riscontrabili in una raccolta di reminiscenze su quest'ultimo.

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A look inside Feynman's approach to gravitation

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We discuss part of Feynman's work in classical and quantum gravity, first presented at the Chapel Hill Conference of 1957 [1]. Being concerned with the relation of gravitation with the rest of physics, Feynman embraced a field-theoretical and non-geometrical approach to general relativity in which, after the recognition that the gravitational interaction must be mediated by quanta of a massless spin-2 field, Einstein's non-linear equations follow from the general properties of Lorentz invariant quantum field theory and self-consistency requirements. Quantum effects are then included by considering diagrams with closed graviton loops in the computation of physical processes. These ideas were fully developed in the famous Caltech lectures on gravitation, delivered in 1962-63 [2], where also a more conventional formulation is discussed, and in a handful of published papers, devoted to quantization of gravity, where some field-theoretical tools which were soon found to be of general interest, namely ghosts and the tree theorem, were introduced. Also, an original introduction to general relativity, which complements the one given in the Caltech lectures, appeared in a set of unpublished lectures which Feynman delivered at the Hughes Aircraft Company in 1966-67, devoted primarily to astrophysics and cosmology [3].
In addition, we draw a comparison between Feynman's approach and other previous and subsequent work, and we include some comments on his ideas about the quantum foundations of the fundamental interactions.

Bibliography
[1] C. DeWitt-Morette, D. Rickles, The Role of Gravitation in Physics, Report from the 1957 Chapel Hill Conference. Ed. Open Access (2011).
[2] R. P. Feynman, F. B. Morinigo, W. G. Wagner, The Feynman Lectures on Gravitation, Addison-Wesley (1995).
[3] R.P. Feynman. Lectures on Astronomy, Astrophysics, and Cosmology. Lectures at the Hughes Aircraft Company; notes taken and transcribed by John T. Neer.

20th century physics / 63

Feynman on "Planetary Motions"

Author: Fabrizio Pinto[1]

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Both casual readers and long-time enthusiasts of Feynman's Lectures on Physics, when reaching the section entitled "Planetary Motions"[1], sense they are experiencing content rarely available elsewhere, delivered via a strategy quite unique in the history and practice of introductory physics pedagogy and basic scientific computing. In fact, a careful reading makes it obvious that, although this piece by Feynman is not so widely known as other writings by him, it is scientifically, historically, and philosophically even more exciting today than six decades ago. In this paper, we review and place within the proper context several aspects of this seemingly elementary and yet stunningly rich Section by analyzing the powerful tools it introduces, their connections with the traditions of classical celestial mechanics, and their profound meaning in current computational dynamics research. As we shall see while analyzing Feynman's handwritten Lectures Notes, as well as photographs and audio recordings in the collection curated at Caltech, "Planetary Motions"became recognized as the most exemplary and ambitious such presentation within a genre populated by very few peers. As such, it was reproduced, in its entirety and verbatim, by several other authors. Feynman, bound shortly to share the physics Nobel prize, only appears to his readers to be toying with arithmetic and a slide rule. In fact, while solving a difficult problem ultimately closely connected to Kepler's equation, he presents us with crucial philosophical issues regarding the potential of simulations to reproduce physical reality with arbitrary accuracy so as to represent an independent source of knowledge additional to experimentation and theory.

Bibliography

[1] R. P. Feynman, R. B Leighton, and M. Sands, Feynman's Lectures on Physics (Caltech, Pasadena, 1963). Sec. 9-7.

20th century physics / 39

Intertheoretic relations, singular limits and emergence: a critical overview of the relation between classical and quantum mechanics

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An interesting issue in the history and philosophy of science concerns possible relations between scientific theories, in particular reductions of theories. According to Nickles [1], a possible notion of reduction is the physicist's one, according to which a theory is reduced to another theory by a mathematical limiting process on a parameter. When the correspondence relation between theories involves a singular limit, it may be more appropriate to speak of intertheoretic relations (Batterman) [2], since the notion of reduction is not applicable. The relevance of singular limits and their consequences have been pointed out by Berry [3], who recognized the role of singularities as a source of richness for the region of transition between two theories. In this respect, a paradigmatic example is the semiclassical limit of quantum mechanics which leads to the emergence of the classical world according to the correspondence principle [4]. Further problems arise when considering a quantum system whose classical counterpart is chaotic, because in this case also a long-time limit leading to a highly complex behavior is involved [4].
In this contribution we focus on the relation between classical and quantum mechanics [5] and give a critical and historical overview of the relevant results.

[1] Nickles T., 1973, "Two concepts of intertheoretic reduction", The Journal of Philosophy, 70: 181.
[2] Batterman R.W., 1991, "Chaos, quantization and the correspondence principle", Synthese, 89: 189.
[3] Berry M.V., 2002, "Singular limits", Phyiscs Today, 55: 10.
[4] Berry M.V., 2001, "Chaos and the Semiclassical Limit of Quantum Mechanics", in Quantum Mechanics: Scientific perspectives on divine action, R.J. Russell et al (eds), Vatican Observatory CTNS publications, pp. 41–54.
[5] Bokulich A., 2008, Reexamining the Quantum-Classical Relation, Cambridge University Press, Cambridge (UK).

History of nuclear and particle physics / 65

L'evoluzione della Fisica Nucleare (dei Nuclei) in Italia dopo Fermi

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Vengono esaminati gli aspetti rilevanti dell'evoluzione storica della Fisica dei nuclei in Italia dopo l' avvio delle ricerche genericamente intese di fisica nucleare del gruppo di via Panisperna che ne segnano sostanzialmente la nascita con la scoperta della radioattività artificiale indotta da neutroni e l' avvio delle ricerche con reazioni (nucleari) indotte appunto da neutroni. Dopo Fermi le vicende della fisica nucleare italiana si caratterizzano nei due filoni: la fisica dei raggi cosmici , da cui discenderà il vasto campo di ricerche sulle particelle elementari e la fisica nucleare propriamente detta (da cui la fisica dei nuclei) facenti capo, oltre che all'Istituto di Fisica di Roma , a quelli di Milano, Padova e Firenze. La fisica dei nuclei (detta anche delle "basse energie") trova origine presso l'Istituto Superiore di Sanità con l'utilizzo di un impianto elettrostatico da 1,1 milioni di Volt come generatore di neutroni costruito da Amaldi e Rasetti. Le ricerche con neutroni si espandono nel dopoguerra con l'uso di acceleratori elettrostatici (Cokroft-Walton e Van de Graaf) , usati come generatori di neutroni veloci (14 MeV) a Milano (Cise e Istituto di Fisica),Torino,Trieste, Catania e, in seguito Napoli

e Firenze, con particolare riguardo a ricerche su vari tipi di reazioni nucleari e sulle proprietà di struttura dei nuclei atomici. Contemporaneamente (anni 50-60) si affermavano anche le iniziative tese alla costruzione e all'utilizzo di macchine circolari a RF come il Ciclotrone di Milano per esperimenti di dinamica nucleare e il Betatrone di Torino per esperimenti di fotoreazioni che preludono alle ricerche sulle proprietà nucleari ad energie intermedie condotte presso il Laboratorio LEALE di Frascati nonché presso l'Istituto Superiore di Sanità . Viene mostrata la dotazione strumentale dei vari gruppi di fisica nucleare negli anni 50-60 con riferimento alla fondazione dell'INFN e all' inserimento delle attività di fisica dei nuclei nel Contratto EURATOM-CNEN e alle relative luci ed ombre per lo sviluppo delle ricerche di fisica nucleare fondamentale. Si segnala il punto di svolta portato dall'avvento a Catania (promotore Ricamo) e a Padova (promotore Rostagni) con l'acquisizione rispettivamente , del Van de Graaf da 2.5 MV da parte del Centro Siciliano di Fisica Nucleare e del Van de Graaf da 5.5 MV con la costruzione del Laboratorio del'Acceleratore di Ioni nell'ambito del Centro di Ricerche Nucleari della Regione Veneto. Da allora le ricerche di fisica dei nuclei in Italia,(buona parte di esse erano svolte in collaborazione presso istituzioni estere) sostanzialmente riconosciute come attività rilevante all'interno dell'INFN, escono da posizioni ancillari e si sviluppano entrando nel novero delle più importanti imprese internazionali nel campo della spettroscopia nucleare e delle proprietà dinamiche nella grande varietà di reazioni nucleari . Legnaro e Catania diventano i due centri nazionali di riferimento con la trasformazione in Laboratori Nazionali dell'INFN (LNL,1968 e LNS 1979) con la prospettiva di inserirsi nel novero delle facilities internazionali di ioni pesanti con il progetto di un Acceleratore Tandem da 16 MV a Legnaro e di uno da 15 MV al Laboratorio del Sud. A ciò si accompagna il progetto di costruzione di un Ciclotrone superconduttore a Milano, e lo sviluppo a Frascati delle facilities per l'utilizzo di fasci di elettroni. L'evoluzione delle macchine acceleratrici è accompagnata da quella dei sistemi di rivelazione e di analisi (spettrometria gamma a scintillazione, rivelatori a stato solido, analisi computerizzate, misure in linea ecc.)
Gli anni 80 e 90 vedono una situazione generale della fisica dei nuclei ormai di tutto rilevo con l' avvento dell'acceleratore Tandem di Legnaro potenziato dalla costruzione e accoppiamento di un Acceleratore lineare superconduttivo (ALPI) accompagnato dall'installazione di sistemi di rivelazione all'avanguardia (Gamma Arrays), del Tandem del Sud accoppiato con il ciclotrone superconduttivo trasferito da Milano e l'inserimento delle ricerche italiane nell"ambito della fisica dei nuclei esotici e radioattivi (prodotti e accelerati), alle soglie di nuove prospettive per la fisica del nuclei: Laboratorio SPES presso i LNL e progetto FRIBs@LNS In Flight fragment separator presso i LNS. Citiamo inoltre, le rilevanti possibilità applicative come, ad esempio, le tecniche nucleari nel campo della fisica della materia, dei beni culturali, il progetto di produzione di radioisotopi per medicina a Legnaro e la proton terapia Catania, ... ecc.
Una visione aggiornata di tali possibilità nonché dei risultati e dei contributi di rilievo sperimentali e teorici della fisica dei nuclei in Italia viene presentata a conclusione della rassegna storica.

History of nuclear and particle physics / 1

Masters and students: the Felici-Bartoli-Stracciati-Corbino case

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In the second half of the 19th century, a special practice of research and training in physics took shape in Pisa, characterized by a peculiar attention to theoretical studies and to combining experimental activity with a profound mastery of mathematical tools.
This approach, carried on especially by Riccardo Felici, Enrico Betti, Adolfo Bartoli and Vito Volterra, was quite an exception in the contemporary Italian physics community, generally marked by strict experimentalism and positivist empiricism.
We highlight a special path connecting this tradition of the Pisan school to the scientific environment formed in the early years of the 20th century at thr Physics Institute in via Panisperna in Rome, through the interaction of Orso Mario Corbino with Volterra, and also thanks to the imprinting left on Corbino by Adolfo Bartoli and his student and collaborator Enrico Stracciati.

History of nuclear and particle physics / 26

With a source so small to fit in one hand": Fermi and the discovery of neutron-induced radioactivity

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"With a source so small to fit in one hand": Fermi and the discovery of neutron-induced radioactivity"
On the 120th anniversary of the birth of Enrico Fermi (1901-1954), we will try to reconstruct the extraordinary discovery of neutron-induced radioactivity made by him, working alone, in March 1934.
For this discovery, together with that, in the following October, of the effect of the slowing down of neutrons in activating various substances, Fermi was awarded the Nobel Prize for Physics in 1938. This was the second Nobel Prize given to an Italian in this discipline, after that to Guglielmo Marconi in 1909, on an equal merit with Carl Ferdinand Braun.
In this contribution, we will focus mostly on the experimental equipment Fermi used, like the original neutron sources preserved in Italy and abroad. Particular attention is paid to the role played by the Radium Office of the Istituto Superiore di Sanità in Rome in providing Fermi with the "radium emission" (Radon-222) used to make his radon-beryllium neutron sources. This particular type of investigation allows us to reconstruct what Fermi actually achieved in his laboratory, to gain a better insight into his methodological choices, and, ultimately, to understand how special circumstances conspired to make the discovery of neutron-induced radioactivity possible.

History of nuclear and particle physics / 43

Bruno Touschek (1921 - 1978): A perspective review of his life and science at the centennial of the birth

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The presentation will highlight Bruno Touschek's path towards his fundamental contribution to the birth of matter-antimatter colliders in Europe, from his early years in Vienna, until the conception, building and operation of the first electron-positron collider AdA in the early 1960's, and the proposal for the larger machine Adone. Since then, particle colliders have become a major research and discovery tool, a long lasting legacy left by Touschek's pioneering ideas, whose impact has contributed to shape Europe's way to LEP and LHC.
Touschek's life spans in time and space through war-ravaged Europe up to the post-war reconstruction and relaunch of physical sciences. During this period he acquired what was a unique expertise for that time, merging competences both as a theoretical physicist and an expert of accelerators. When he moved to Italy in the early 1950s, the peculiarity of his scientific profile made him a key figure in the ongoing efforts to reestablish the pre-war leading position, contributing to the renewal and explosive development of Italian physics with his original thought, his multifaceted personality and his very special cultural asset, which made him an unforgettable figure for all who had come in contact with him as friends, colleagues and students.

History and epistemology of physics / **14**

A transition in the notion of interaction in classical mechanics

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The aim of this contribution is to show a transition in the notion of interaction among bodies from early Newtonian to Post-Newtonian theory of (no-relativistic) mechanics. In Newton's early mechanics, the two notions of impenetrable body or solid and interaction by shock or contact had the role of elementary concepts. The interaction at a distance had the value of phenomenological model, useful to describe the measurable effects of accelerations of separated (in space) bodies. In the post-Newtonian mechanics, the notion of interaction at a distance assumes the value of fundamental interaction as can be deduced in the framework of massive ideal point-like interacting particles.

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A RATIONAL RE-CONSTRUCTION OF DIRAC'S BOOK OF QUANTUM MECHANICS ACCORDING TO TWO RECENT RESULTS

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In the first edition of his celebrated book, The Principles of Quantum Mechanics Paul Dirac rejected the axiomatic method as inadequate to the new theory; he implicitly applied, although in an approximative way, a new model of theoretical organization which was later discovered through a comparison of some past mathematical and physical theories . However, being unable to formalize this new organization, in the next editions of his book he conformed his presentation of the theory to an axiomatic organization.
In the year 2009 Franco Strocchi discovered a suitable Poisson algebra inside which Dirac's analogy between commutators and Poisson brackets is represented by an exact proportion.
These two novelties suggest to rationally re-formulate Dirac's book on the above C*-algebra and according to the new kind of organization. A new textbook on quantum theory results, which may be compared with the previous didactic textbook of this kind of approach, T.F. Jordan's .

Commemoration of Erasmo Recami (1939-2021) / **71**

ERASMO RECAMI: DELLA PASSIONE DELLA FISICA

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Vorrei qui presentare alcuni ricordi personali di Erasmo, relativi al periodo in cui facevo parte del suo gruppo all'Istituto di Fisica dell'Università di Catania in Corso Italia 57, e, attraverso questi ricordi, delineare le sue più importanti prospettive di ricerca, la sua metodologia, la sua epistemologia, il suo modo concreto di operare. In particolare, i rapporti fra fisica classica e fisica contemporanea, fra cosmologia e fisica delle particelle, fra causalità e ordine temporale, l'interpretazione della funzione

d'onda e dello spazio-tempo, i problemi delle teorie alternative saranno discussi. Ritengo che ne emergano delle conclusioni di carattere generale anche sull'importanza della storia della fisica e sui rapporti fra fisica teorica e storia della fisica.

History and epistemology of physics / 8

EINSTEIN AND HUSSERL An approach to the study of the problem of the Unobservables in the Theory of General Relativity and Phenomenology

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The development of physics shows its highly theoretical character through the participation of unobservable entities in opposition to the physicalist conception. In this sense, the problem of the unobservables becomes a core issue, opening fierce debates in the philosophy of science. Despite the positions and ideologies, men of science construct unobservable entities from certain indicative manifestations of a possible existent. Under this perspective, in sciences intelligibility must admit the participation of 'unobservable intelligible'. Space, time, field, potential, etc. are the cornerstones in physical theories. From this point of view, Husserl's phenomenology is presented as a possible philosophical framework to elucidate meanings of foundational theoretical terms in relativistic physics, emphasizing a priori character, its contingent aspect (language) and intersubjectivity of intelligible unobservables. Assuming the consideration of the phenomenon-subject-object trinomial, the action of phenomenological intersubjectivity in the constitution of essences proposed by J. Mastrobisi is illustrated. I consider the constitution of intersubjective essences as a possible case to build a real world and show the theoretical terms (space, time and field). I specifically assume two key theoretical terms in general relativity and cosmology: Matter and Field. I take as a starting point the physical nature of space-time and the use, by physics, of notions of symmetry and invariance, accounting for unobservable or foundational theoretical terms through the pure phenomenological analysis of essences. In reference to the manifestations of an existent (which is illustrated from the intersubjective essences of Mastrobisi) we approach the processual character of the subject and the Reality through the ontological categories Extension-Change in Raphael Neelamkavil. This assumption is brought in as a natural consequence of the need to account for the constitution in the real world of the intersubjective essences (theoretical terms) under the consideration of the Extension-Change ontological categories. In this sense, illustrating the foundational notions in physics (Matter and Field) under the universal physical-ontological categories (Extension-Change) of Neelamkavil facilitated by the intersubjectivity action essence in Mastrobisi contribute to account for Husserl's phenomenology as a philosophical framework in relativistic physics and cosmology. An analysis of the constitution of intersubjective essences through ontological categories (Extension-Change) in the study of relativistic physics and cosmology (gravitation) through two key conceptions such as Matter and Field makes it possible to account for the importance of the philosophy of physics in elucidating intelligible unobservables or theoretical terms that support physical theories. The intention of the proposal is to address this blind spot of the connection between essences and Reality through the Husserl-Mastrobisi-Neelamkavil triadic.

References

Husserl, E. (2013). Ideas relativas a una fenomenología pura y una filosofía fenomenológica: Introducción general a la fenomenología pura. Libro Primero. (Trad.) Antonio Zirión Quijano. Ciudad de México: UNAM/FCE.
Mastrobisi, J. (2015). Fenomenología e Relativitá: Studi su possibilitá ed essenza nella fisica contemporanéa. Roma: Stalmen.
Neelamkavil, R. (2018). Gravitational Coalescence Paradox and Cosmogenetic Causality in Quantum Astrophysical Cosmology. Berlin: Peter Lang.
Zirión, A. (2017). Breve Diccionario Analítico De Conceptos Husserlianos. Ciudad de México: UNAM.
Weyl, H. (1952). Space, Time and Matter. (Trad.) Henry Brose. New York: Dover.

History and epistemology of physics / 35

Italian Influence on Venezuelan Science and Physics

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Although the Italian presence in the history of Venezuela can be traced back at its very beginning, with figures like Cristoforo Colombo (1451-1506), who discovered the country in 1498, followed by Amerigo Vespucci (1454-1512), who in 1499 provided its name as "Little Venice"when he saw the Indian palafittes on the Guajira Peninsula, the arrival of Italians in Venezuela became particularly important in numbers by the second half of the 19th century and even more during the first half of the 20th century. In this way, they became as an immigrant community, one of biggest of the country, with a very solid cultural heritage and it was combined, in an unusual way, with a very broad openness in the approach of problems in their new home. Certainly, this fact contributed to their fast social integration but, at the same time, it also had an impact on their synergy with other immigrant communities in Venezuela. Of Italian descent or first-generation immigrants and along the Venezuelan history, we found independence leaders, constitution writers, presidents, legislators, academics, scientists, business entrepreneurs, journalists, athletes and artists. In this work we are going to examine the role of academics and scientists like Francisco De Venanzi (1917-1987) as a promoter of modern science in the second half of the 20th century, how his interest in scientific research led him to the creation of the Venezuelan Association for the Advancement of Science (ASOVAC) in 1950, the Cancer Research Center of the Anticancer Society of Venezuela, also in the same year, and as rector-president of the Central University of Venezuela, the creation of the Faculty of Science in 1958, which was a cornerstone in the development of science and physics in the country. In the same way, we are going to take a closer look to the impact of the contributions in science and particularly in physics made by other actors like, among others, Mario Vecchi, who co-authored the original work on simulated annealing with Scott Kirkpatrick and Daniel Gelatt in 1983, as well as the efforts made in the development of research and development schools and infrastructure in applied physics and related areas.

Scientific instruments / 58

Skilled Scientific Instrument Makers in Rome in the 19th Century: the Lusvergh Family

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There are numerous scientific instruments scattered in museums, scientific institutions, schools and private collections in Italy and throughout the world, which bear the signature of the Lusvergh family. This distinctive family, originally from Munich, settled in Rome around the middle of the seventeenth century and worked there from father to son until the first half of the nineteenth century. Their surname is known in different variants: from Lusuerg to Lusverg and then, especially in the 19th century, Luswergh or Lusvergh. It was undoubtedly the most extraordinary and long-lived family of scientific instrument makers operating in Italy. Their production initially focused on mathematical, gnomonic, astronomical and surveying instruments, became specialized in the nineteenth century in physical, astronomical, and, towards the middle of the century, photographic ones. In this period, four members of the family worked as makers, machinists and keepers of scientific instruments: the brothers Domenico and Luigi, then Angelo, Domenico's son, and finally Giacomo, Angelo's son. Their presence is documented in all the strategic places in Rome where studies in physics and astronomy were cultivated, i.e. the Observatory of the *Collegio Romano*, the Observatory of the University on the Capitoline Hill, the *Accademia dei Nuovi Lincei*, the *Collegio Nazareno*

and the Physics Cabinet of the *Sapienza* University. During the century the Lusverghs collaborated with important Roman scientists such as Feliciano Scarpellini, Saverio Barlocci, Paolo Volpicelli, Angelo Secchi, Giambattista Pianciani and Ignazio Calandrelli. Angelo and Giacomo also worked in the Rome fire brigade, making themselves useful in constructing some models of portable hydraulic fire pumps. In 1829, Angelo personally tested with a singular experiment for this brigade, the effectiveness of a new fireproof suit having an asbestos head protection designed in Rome by Marquis Origo.

Short bibliography

Volpicelli, P. (1855). *Sopra un modello di macchina a vapore, inventato e costrutto dal Sig. Giacomo Lusvergh.* Atti dell'Accademia Pontificia de Nuovi Lincei, Tomo VI, Anno VI (1852-1853). Roma: Tipografia delle Belle Arti.

Scarpellini, E. F. (1857). *La Scienza Contemporanea nello Stato Pontificio. Memoria di Erasmo F-Scarpellini.* Roma: Tipografia della Reverenda Camera Apostolica.

Mantovani, R. (1994). *Liceo Ginnasio "Conti Gentili" Alatri (FR). Il Filo del Tempo: l'Antico Laboratorio fisico instrumenta selecta*. Alatri: Arti Grafiche Tofani.

Todesco, P. (1995). *La Famiglia Lusverg dal '600 all'800.* Memorie della Società Astronomica Italiana, Astronomical Observatories and Institutions in Italy, Milano, 21-22 April 1995, E. Proverbio (Ed.), Vol. 66, n. 4, pp. 895-901.

Casi, F. (2012). *Costruttori di strumenti scientifici a Roma dal XVI al XIX Secolo. Da Adam Heroldt ai Lusuerg*. Arezzo: 3emmegrafica Snc.

Scientific instruments / 2

L'inventario degli astrolabi in Italia - descrizione del progetto e primi risultati

Author: Giancarlo Truffa[1]

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L'astrolabio e'stato per molti secoli lo strumento principale per lo studio del cielo, sia come strumento di calcolo sia come strumento di osservazione. A partire dagli anni 30 del secolo scorso sono stati fatti vari tentativi di compilare un inventario degli strumenti esistenti al mondo. I più recenti studi sono stati dedicati agli strumenti costruiti in India ed a quelli di origine spagnola, sia islamici che latini. Partendo da questi documenti, e dalle pubblicazioni disponibili, cataloghi di musei e di mostre, ho iniziato a raccogliere le informazioni per aggiornare l'inventario degli strumenti esistenti in Italia e fornire descrizioni il piu possibile dettagliate di questi strumenti. Dopo aver descritto il contenuto del progetto, presenterò alcuni degli strumenti che ho potuto studiare direttamente ed alcune ipotesi che si possono formulare in base alle informazioni finora raccolte.

Scientific instruments / 20

The planetary models of Jupiter, Venus, Moon and Sun and the Eighth Sphere in the Musei Civici di Vicenza: notes on their discovery and descriptive historical and educational aspects.

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[1] *Independent researcher*

This communication presents four mid-16th-century planetary models found during an investigation, started in 2015, on a 19th-century composite apparatus of Physics objects and machines that is now part of the *Musei Civici di Vicenza* collection.
Planetary models were tools used to represent the Cosmos according to the Ptolemaic system, and each one of them was designed to show the movements of a single celestial body in conformity with the observations gathered by astronomers up to that time.
The Vicenza planetary models were probably made in Venice around the third quarter of the 16th century and can be attributed to A. Descrolieres, a manufacturer who had trained in Leuven. They were conceived as interpretative tools of the Ptolemaic system as illustrated in G. Peurbach's *Theoricæ Novæ Planetarum* (1472) and later *Commentaries*. Sparse bibliographic traces can only allow to speculate that they belonged to the Paduan *Wunderkammer* of archpriest Paolo Gualdo –who we now know maintained a friendly relationship with Galileo –in the early 17th century; in 1621, they were inherited by the Museum of *Palazzo Gualdo in Pusterla* in Vicenza; in later times, they were dispersed following the dismemberment of the Museum from 1650 on and returned to Vicenza in 1708.

Essential bibliography:
M-P Lerner, *Il mondo delle sfere*, Milano, 2000.
E. Poulle, «La produzione di strumenti scientifici», in *Il Rinascimento Italiano e l'Europa*, Angelo Colla Editore, 2007.
A. Magrini, *Il Museo Civico di Vicenza*, Vicenza, 1855.
Catalogo Mostra *Rivoluzione Galileo*, Padova, 2017.
Astrum 2009, *Astronomia e strumenti*, Roma, 2009.

Scientific instruments / 29

The KN3000 accelerator and the history of the nuclear physics in Florence in the last three decades of the past century through a museum itinerary

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The "Garbasso"building housed the Institute (later Department) of Physics of the University of Florence from 1921 to the early 2000s. It was built on the hill of Arcetri, close to the Astronomical Observatory and to the Villa that many years earlier had hosted Galileo in the final phase of his life.

Among many research activities developed here during almost the entire 20th century, the history of the KN3000 accelerator is of particular interest. In fact, the electron-injector of the electrosynchrotron installed by CNEN in Frascati, once dismissed, was assigned in 1971 to the nuclear physics group in Florence and here was converted to a positive-ion accelerator, exploiting the locally available technological expertise. Afterwards, it has been used for research in pure and applied nuclear physics for three decades. Details about this research activity can be found in [1,2].

After the installation in 2003 of a Tandem 3-MV accelerator in the new Physics Department of the University, in Sesto Fiorentino, the KN3000 was decommissioned and left in the room where it has served for years. After a long period of inactivity and associated degradation, part of the original staff (F. Celletti, P. Del Carmine, G. Poggi and N. Taccetti) suggested to restore the accelerator and associated equipment to create around it a museum itinerary dedicated to the history of nuclear physics in Florence.

In the planned museum the accelerator is one of the stages of a wider route (named "The Path of Science in Arcetri") which, starting from Villa Galileo, also includes two institutions whose operations are still based on the hill of Arcetri: Observatory (OAA-INAF) and National Institute of Optics (INO-CNR). The project, mainly funded by Fondazione Cassa di Risparmio di Firenze, is in an advanced stage of realization and will be completed by 2022.

1. N. Taccetti, Fisica con gli acceleratori in Arcetri - Il Colle di Galileo vol. 6, 1 (2017) 19-38
2. P. A. Mandò, Nascita e prime fasi della attività di fisica nucleare applicata a Firenze - Il Colle di Galileo vol. 2 , 2 (2013) 27-42

Scientific museums / **45**

Behind the Exhibit: Displaying Science and Technology at the National Museum of Science and Technology Leonardo da Vinci in Milan

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Science and technology museums are important places of production, appropriation, and dissemination of scientific and technical knowledge. Created in the nineteenth century, these museums expanded in the interwar years thanks to the financial support of both the state and private industry. Many industrial museums opened in those years, while many existing museums planned to transfer their collections and exhibitions into new and more spacious buildings. From the very beginning, politics had a significant impact on the history of these museums and on the narratives they wanted to communicate. After World War I, as temples of progress, innovation and political and economic supremacy, many of these museums flourished, directed by two opposing drives: on the one hand, a growing technological nationalism, and on the other hand, a strong ideal of internationalism among nations. My talk focuses on the case study of the Italian National Museum of Science and Technology Leonardo da Vinci in Milan and the great interest in science and technology exhibitions and museums that spread throughout Italy during the 1930s. The museum was established in 1953 in Milan under the auspices of Guido Ucelli, an influential engineer working as general manager at Riva. Ucelli had been trying for a long time to create a museum of technical and industrial devices following the main examples in the field. The opening of the museum dedicated to the "genius"of Leonardo was the result of a long and complex planning phase that lasted more than twenty years and had its roots in the 1930s. The story of this museum allows us to retrace the long-term and complex process that in post-unification Italy has led to recognize, also by the law, scientific collections and museums as cultural heritage.

Bennett, The Exhibitionary Complex. New Formations 4 1988: 73–102
Canadelli, Beretta, Ronzon, eds, Behind the Exhibit: Displaying Science and Technology at World's Fairs and Museums in the Twentieth Century, Smithsonian Institution Scholarly Press 2019
Macdonald, ed, A Companion to Museum Studies, Blackwell Publishing 2006

Scientific museums / **46**

The new History of Physics Museum in Padua - Exploring the potentialities of a university physics collection

Author: Sofia Talas[1]

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The Museum of the History of Physics holds thousands of scientific instruments that were used for physics research and teaching in Padua from the 18th century onwards. It was founded in 1995. We have just developed a project to renovate the Museum, with the aim of shedding new light on the potentialities of Padua university physics collection.
The paper will discuss some of the main peculiarities of the new display, which actually brings the

public into Padua's Cabinet of Physics and shows how physics was taught and studied in Padua from the 18th century onwards. We will see how connections with the global developments of physics emerge throughout the visit, as well as links with other disciplines, such as art and architecture. Stories of successes and failures come to light, often connected to the political, social and economic context, and we will see how instruments themselves offer food for thought on current issues in science and society.

Scientific museums / 25

Al Museo della Specola di Palermo con la realtà virtuale e aumentata

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Seguendo le indicazioni del Ministero dei Beni Culturali, l'INAF - Osservatorio Astronomico di Palermo ha recentemente implementato contenuti digitali e immersivi in VR e AR per valorizzare e diffondere la conoscenza del Museo della Specola.
Questi strumenti innovativi offrono forme di apprendimento personalizzate, rendendo accessibili a richiesta informazioni aggiuntive (per esempio, legate alla storia dell'astronomia o a documenti d' archivio).
Grazie a queste soluzioni, non soltanto è possibile la fruizione di numerosi contenuti anche da remoto, ma migliora anche l'esperienza di visita in loco.
Tra le innovazioni più recenti:
- Modelli 3D di preziosi volumi di astronomia e di alcuni strumenti astronomici custoditi all'interno del Museo. L'utente può interagire con i modelli pubblicati, ruotandoli e osservandoli da tutti i punti di vista, avvicinandoli per osservarne i dettagli e, in alcuni casi, visualizzando le parti disassemblate;
- Un tour virtuale del Museo della Specola (bilingue), realizzato utilizzando la fotografia panoramica, nel quale il visitatore è libero di scegliere il percorso di visita suggerito o decidere in autonomia cosa vedere. Il tour offre anche contenuti audio e approfondimenti e consente di interagire con alcuni degli strumenti ricostruiti in 3D.
- Video con effetti di VR e AR. Sono stati realizzati dei prodotti multimediali con effetti di realtà aumentata e realtà virtuale per condividere informazioni scientifiche con altri studiosi/ricercatori nel campo della storia dell'astronomia e della fruizione dei beni culturali, in occasione di meeting internazionali di specialisti del settore (ATS e SIC). Tali prodotti sono stati altamente apprezzati per il tipo di comunicazione efficace e di impatto, tanto da essere richiesti per essere pubblicati su web.
Altre esperienze sono state testate con successo e saranno implementate in futuro:
- Selfie al museo: un'app in realtà aumentata realizzata con Metaverse che permette al pubblico di fotografarsi in vari ambienti con gli strumenti del Museo o con il panorama e le cupole della Specola.
- Codici QR al Museo: all'interno del Museo sono stati implementati degli Zapcodes che possono essere letti da qualunque smartphone e tablet scaricando l'app dedicata per attivare contenuti aggiuntivi, sia in italiano che in inglese.
È inoltre attualmente in fase di studio la realizzazione di pannelli esplicativi in AR.
Questi strumenti sono stati particolarmente preziosi durante la fase di non-accessibilità del Museo per ragioni dovute alla pandemia, e hanno permesso di allargare la platea dei fruitori del patrimonio storico conservato alla Specola. Essi si collocano peraltro all'interno di un ampio progetto comunicativo del Museo che ha incluso di recente anche l'apertura delle pagine Facebook ed Instagram.

Scientific museums / 62

Scientific collections and Preventive Conservation

Author: Anna Giatti[None]

Cultural objects can be prone to degradation as a result of the environment in their enclosures such as display cases or crates. Scientific instruments are no different, and their preservation must take into consideration the variety of materials they are made from as well as the condition of their exhibition spaces and storage areas. A Preventive Conservation (1) approach foresees a series of measures aimed at containing or avoiding the elements of degradation in cultural heritage and is now considered a core objective especially for small- and medium-sized museums. These collection spaces are often far from ideal because they are in historical buildings, often without accurate climate control systems. Preventive conservation often struggles to become an integrated part of collections management and this may be linked to a lack of skilled or specifically allocated professionals in charge of the collections. The European Apache (Active & intelligent PAckaging materials and display cases as a tool for preventive conservation of Cultural Heritage) Project aims to contribute to widespread adoption of Preventive Conservation by identifying and disseminating novel and affordable approaches, materials, and sensors. The Fondazione Scienza e Tecnica (FST) of Florence is a member of the project consortium, contributing case studies from their scientific and technological collections and in my presentation I will provide an overview of the research carried out there. I will also briefly explain the Apache project general results, such as the App, the innovative sensors, the cutting-edge materials and the training programme that has been developed to disseminate best practice as broadly as possible.
(1) Please see ICOM-CC resolution Terminology http://www.icom-cc.org/54/document/icom-cc-resolution-terminology-english/?id=744#.YNr0FUzOPIU

Science communication and its history / 60

Divulgazione e comunicazione dell'astronomia a Napoli: da Ernesto Capocci ai social media

Authors: Mauro Gargano[1]; Amata Mercurio[1]

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La disseminazione delle conoscenze scientifiche è per gli astronomi partenopei una consuetudine che affonda le sue radici ai tempi in cui Napoli non aveva ancora una specola e che continua ad animare l'iniziativa dei ricercatori dell'Osservatorio di Capodimonte nella diffusione della cultura astronomica verso platee sempre più ampie di curiosi e appassionati della scienza delle stelle.
Ernesto Capocci è stato senz'altro il principale protagonista di iniziative letterarie per educare all'astronomia. Figura di spicco della vita scientifica e culturale a Napoli nella prima metà dell'Ottocento, fu uno studioso accurato e dalla mentalità aperta, guardò con attenzione alle esperienze europee del tempo, combinando "l'amore della bella letteratura ... col culto della scienza". Egli produsse una serie di pubblicazioni utili all'educazione e alla divulgazione delle conoscenze scientifiche. Precursore dei romanzi di fantascienza, l'astronomo di Capodimonte fu, inoltre, tra i primi scienziati a tradurre in un testo divulgativo le nozioni astronomiche della Divina Commedia, spiegando in maniera semplice e accessibile a tutti le profonde conoscenze cosmografiche di Dante Alighieri.
Nel XXI secolo le modalità di comunicazione hanno subito una radicale trasformazione, in particolare per l'affermazione delle piattaforme social e dei sistemi di messaggistica. Gli astronomi di Capodimonte, mantenendo rigorosità scientifica e efficacia comunicativa, hanno adattato la divulgazione dei temi scientifici ai nuovi modi di disseminali.
Questa comunicazione percorre la tradizione culturale dell'Osservatorio di Capodimonte nell'utilizzo dei tradizionali strumenti per la diffusione del sapere astronomico sino ai moderni mezzi multimediali come il web, la radio e i canali social, con cui gli astronomi napoletani dialogano con i "follower" divulgando risultati scientifici e stimolando l'interesse di giovani e curiosi verso lo studio del cosmo.

Bibliografia essenziale / Short Bibliography

- Capaccioli M., Longo G., Olostro Cirella E. 2009, *L'astronomia a Napoli dal Settecento ai giorni nostri*, Napoli, Guida Editore.
- Fontaine G., Maheu-Cadotte M., Lavallée A., Mailhot T., Rouleau G., Bouix-Picasso J., Bourbonnais A. 2019, Communicating science in the digital and social media ecosystem: scoping review and typology of strategies used by health scientists, *JMIR Public Health Surveill*, **5**(3):e14447
- Olostro Cirella E., Gargano M. 2015, *Viaggiatori del cosmo : dagli infiniti mondi di Giordano Bruno al primo viaggio alla Luna di Ernesto Capocci*, Napoli, INAF-Osservatorio Astronomico di Capodimonte.

Science communication and its history / 10

Astronomy and card-games: between education and science popularization (XVIIIth-XIXth century)

Author: Ilaria Ampollini[1]

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In 1790, the Abbé Paris signed the cards game *Elements d'astronomie et geographie*, which five years later was translated and published in London by John Wallis, a famous books, maps and games seller. The contribution aims at analysing the contents of the game and the astronomical information provided (both through the images and texts) to the players, but also the way the game was changed from the French to the English edition. It will be discussed how these modifications, introduced by Wallis, should be interpreted. Finally, a fundamental question will be addressed, that is, what place in the history of education and in the history of science popularization should be accorded to this game and, more in general, to science-themed cards and board games conceived and printed in the Early Modern Age.

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"Seconda stella a destra"–un progetto culturale per attirare l'interesse del pubblico verso la storia dell'astronomia, valorizzando l'arte e il patrimonio culturale

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Intendiamo presentare il progetto di astro-turismo ''Seconda stella a destra"ideato dall'Istituto Nazionale di Astrofisica (INAF) e dall'agenzia creativa Bas Bleu Illustration, per diffondere l'importanza che lo studio del cielo e dei suoi movimenti ha sempre avuto per l'uomo e il suo impatto sulla cultura, società, religione, arte, storia e su altre scienze.
Basato su un lungo lavoro di ricerca nella storia dell'astronomia, ''Seconda stella a destra"è un progetto culturale innovativo che intende coinvolgere un pubblico molto variegato, invitandolo a passeggiare nel centro storico di città come Padova, Firenze e Palermo per scoprire i vari modi in cui l'astronomia è presente nelle opere d'arte e nella cultura: il sole, la luna, i pianeti, le costellazioni e i corpi minori sono spesso nascosti all'interno di chiese e palazzi, raffigurati negli intarsi marmorei

o nei mosaici o dipinti nei soffitti. Orologi, meridiane, segni zodiacali, cieli dipinti e costellazioni, antiche carte geografiche, luoghi legati a scienziati come Galileo Galilei o grandi esploratori come Amerigo Vespucci, telescopi e strumenti scientifici e altri "segreti astronomici"che il patrimonio culturale italiano racchiude testimoniano come l'astronomia non solo abbia ispirato l'arte con la sua bellezza, ma sia profondamente legata all'arte, alla storia, alla società; infatti alcuni di questi elementi sono stati pensati per la "pubblica utilità", per rispondere alle esigenze della società del tempo e riflettono i progressi scientifici.
A partire dalle conoscenze astronomiche, storiche e storico-artistiche, INAF e Bas Bleu hanno costruito un format innovativo di comunicazione e disseminazione della scienza, con un progetto legato all'astro-turismo declinato in chiave culturale, per avvicinare e coinvolgere anche pubblici diversi e non necessariamente esperti.

Il progetto include:
- La collana di guide turistiche "Seconda stella a destra", prodotti editoriali pensati per accompagnare cittadini e visitatori alla scoperta delle città italiane "da un punto di vista astronomico"(Padova, 2015; Firenze, 2019; Palermo, presumibilmente settembre 2021).
- Le mappe delle città, che rappresentano i percorsi astronomici ed evidenziano i luoghi di maggior interesse scientifico, culturale, storico, artistico.
- Eventi come le "passeggiate con l'astronomo", attività per famiglie, visite degli studenti, laboratori hands on, ecc. Realizzate in collaborazione con le istituzioni competenti, queste attività stanno creando nuove importanti sinergie culturali a livello locale.
- La guida della città di Padova rivolta ai bambini (8-11 anni), con elementi grafici e illustrazioni ("Padova a testa in su", 2017).

Inoltre si prevede di implementare nel progetto le nuove tecnologie come la Realtà Virtuale e la realtà aumentata per consentire l'accesso a contenuti aggiuntivi, sempre aggiornati, e per attrarre pubblici diversi, soprattutto giovani

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The History of Astronomy, fil rouge of the INAF Palermo guide: "Palermo, second star to the right"

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Third in order of publication, after Padua and Florence, in the "Second star to the right"program, with an editorial project by the creative agency Bas Bleu Illustration, the guide of the INAF Astronomical Observatory "G. S. Vaiana "in Palermo was promoted as part of communication, teaching and dissemination activities, of which Laura Daricello is responsible, with the intention of presenting to the general public monuments, people and events that link the city to the Science of Heaven. I collaborated with the Observatory for the identification and study of sites related to Astronomy as well as for the preparation of most of the guide texts.
In the five selected itineraries in the city, some monumental contexts stand out for their astronomical tradition: first of all the INAF-G. S. Vaiana Astronomical Observatory whose significant history is documented in the Specola Museum, part curated by Ileana Chinnici.
Other circumstances dealt with are those linked above all to the History of the Measurement of Time, recurrent in the urban fabric of Palermo. Over the years they had been the subject of study and of my reports at the annual SISFA conferences. (Urbino, Acireale, Florence, Arezzo, Bari and online)
During the documentary investigation and the interpretation, I made of some iconographic representations, further evidence emerged that lead back to particular themes of the History of Astronomy. The current report refers to two of them: the mosaic of the Creation of the stars in the Palatine Chapel of Palazzo dei Normanni, linked to the astronomical culture of King Roger II and the basrelief of the Botanical Garden which alludes to the discovery of the planet Uranus by Herschel with the related debate for the choice of the name.

References

Schiaparelli G., *Scritti sulla Storia dell'Astronomia antica*, T.I
Tuscano M.L., *King Ruggero II and the Reform of the Calendar*, Congresso SISFA, Bari
Flammarion C., *Astronomia popolare*, L.IV

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La sinestesia musica-colore alla luce di vecchie e nuove tecnologie.

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Viene analizzata quella particolare capacità del cervello, chiamata sinestesia, alla luce dei più recenti studi. Tra le due scuole di pensiero –quella neurofisiologica e quella psicolinguistica –prevale senz' altro la prima soprattutto per le caratteristiche di automaticità, di costanza nel tempo dei fenomeni sinestetici e perché è corroborata dalle immagini ottenute con le più moderne tecniche di risonanza magnetica.
Le nuove tecnologie della realtà virtuale inoltre permettono di creare connessioni artificiali tra le diverse aree sensoriali che sono diventati nuovi mezzi di terapia del dolore e di aiuto per la disabilità di non vedenti e non udenti. Si mostrerà come già nel 1725 quest'idea fosse venuta a padre Castel con il suo organo colorato che avrebbe permesso ai sordi di gioire della bellezza di una musica tramite i colori.
Per quanto riguarda in particolare la sinestesia "musica-colore", musicisti e pittori, tra la fine dell' ottocento e gli inizi del novecento, realizzarono opere in cui suoni e colori interferissero fortemente; non c'è alcuna prova, neanche nei loro scritti più famosi, che fossero dei "sinesteti"nel senso neurologico del termine. Pensiamo, invece, che le loro opere fossero il frutto del tentativo di realizzare un' opera d'arte globale.
Gli studi sulla sinestesia hanno anche consentito di creare strategie didattiche che permettono anche all'allievo di capire quanto vicine siano le diverse materie di studio. Molti sono i progetti attuati in scuole e musei in cui si svolgono laboratori di musica e colore per bambini di diverse età scolari con attività che aiutano a sviluppare la capacità di comprendere i diversi codici comunicativi. I processi cognitivi elementari sono rafforzati grazie all'esperienza musicale, che diventa una guida per le altre attività espressive come il disegno e la danza.

Bibliografia essenziale

Elena Buldrini (2017). Sinestesia, ovvero la contaminazione reciproca tra i sensi. Tesi presentata dal relatore Prof. Ing. Cristiano Cuppini, Università di Bologna, campus di Cesena, https://amslaurea.unibo.it/13280/1/Tesi.pdf
L. Franchini, S.von Arx (2013). Musica e Colore, in Scientificamente, Messina 22-27 luglio 2013, a cura di Michele Floriano e Giovanni Magliarditi.
Quaderni in Ricerca e Didattica (Scienze) numero speciale 6, University of Palermo (Italy), pp.35- 43.
Oliver Sachs (2008). Musicofilia - Adelphi 522
Kandiskij (2005). Lo spirituale nell'arte, a cura di E. Pontiggia - SE
Cristina Ceroni (2003). La sinestesia nella poetica di Scrjabin –Parol, quaderni di arte, http://www.parol.it/articles/cristina.htm
R. Cytowic (1995). Synestesia: Phenomenology and Neuropsycology, Psyche 2(10), 2-10.

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Time in Stoic Physics.

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The basic assumption of modern science is that the world has its own rationality and that man can understand it with some means made available by his mind. The origin of this idea must be sought in Greek Philosophy and the Stoics (especially the First Stoa) had a notable influence in defining it. In fact, they believed that the universe is the work of a reason, a *logos*, and from this they inferred that man, as endowed with articulated thought, has the faculty of formulating propositions such as to reflect cosmic events. Language is part of nature and allows man to express his relationship with the world. The Greeks - and the Stoics in particular - were the only ones in ancient times who used language as a technical tool to understand the world.
An example of this approach is the concept of motion, as an expression of change, which was studied by Greek Philosophy not with mathematical tools as did the science of 600/700 but precisely through language. Time represents a pivotal theme in this vision and the Stoics gave their contribution - even if we have little information of their research [2] and several borrowed from thinkers who oppose their philosophy [3]. In this presentation we will try to deepen and give a complete picture of what was the Stoic position on time [1, 7]; we will evaluate why in Diogenes Laertius time is indicated as an incorporeal entity (so not completely real) and then we will present the background ontology of the Stoics and in particular their idea of continuity in contrast with a discrete approach to reality typical of Epicurus and his followers [4, 5]. Through the theme of the continuum we will see the Stoic conception of the temporal instant and how they tried to answer Aristotle's aporias on time [8, 9]. Finally we will present the cosmological vision of the Stoics [6] which is based on a cyclic universe and which takes up some cosmological ideas currently being studied in the scientific community.

Bibliography:
1. Sambursky S.,1988, "*Physics of the Stoics*", Princeton Legacy Library.
2. Diogenes Laertius, 2017, "*Lives of Eminent Philosophers*", Cambridge University Press.
3. Plutarch, 1976, "*Moralia, Volume XIII: Part 2: Stoic Essays*", Harvard University Press.
4. Inwood B., 2003, "*The Cambridge Companion of the Stoics*", Cambridge University Press.
5. Long A, Sedely D., 1987, "*The Ellenistic Philosophers*", Cambridge University Press.
6. Long A., 2006, "*The Stoics on World Conflagration and Everlasting Recurrence*", in "From Epicurus to Epictetus: Studies in Hellenistic and Roman Philosophy", Oxford University Press, 256-282
7. Rist J., 1969, "*Threee Stoic Views on Time*" in "Stoic Philosophy", Cambridge University Press, 273-288.
8. Sorabji R., 1983, "*Time, Creation and the Continuum: Theory in Antiquity and the Early Middle Age*", Cornell University Press.
9. Aristotle, 1991, "*The complete works of Aristotle: The revised Oxford Translation*", Princeton University Press.

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The Earth expansion links with the old concepts of hydrodynamic gravitation and tired light

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From Earth Sciences come clues on a role of the aether in the evolution of Earth, planets, and universe. Paleogeographic reconstructions allow a rough evaluation of the new ordinary matter added to the planet in the unity of time, and some inferences on the inner energy balance of the Earth.

The need of central flow of aether is considered here. Its origins can be found in Isaac Newton (1643-1727) and in John Bernoulli (1667-1748). An interrelations of aether's density, flow rate, and velocity with the cosmological parameters (Ho, G, c) is found. Fundamental elements of a new cosmology descending from Expanding Earth are:

i) The constant ratio between any Q (aether flow rate) and its associated mass M:
$$\frac{Q}{M} = 4\pi \frac{G}{H_o} = l = 3.6 \cdot 10^8 \quad \mathrm{m}^3/(\mathrm{kg}\cdot\mathrm{s});$$
with l a constant of "transfer" from the world of the masses to the real hydrodynamic one of the flow rates.
ii) The density of the aether:
$$\rho = \frac{1}{4\pi} \frac{{H_o}^2}{G} = 0.647 \cdot 10^{-24} \quad \mathrm{kg/m}^3.$$
iii) The superluminal velocity of the aether at the Earth surface:
$$v = \frac{M_T \cdot l}{4\pi \cdot {R_T}^2} = \frac{M_T \cdot G}{H_o \cdot {R_T}^2} = 4.2 \cdot 10^{18} \quad \mathrm{m/s}.$$
Experiments (De Sangro et al., 2015) confirmed fields superluminal speed of propagation.

The presence of this fluid and of the consequent dissipative term $f = \rho Q v$ (a static fluid tends to slow down the motion of sinks or sources singularities) means that the principle of inertia, conservative field, escape velocity, etc., are only stated as local good approximations of a more complex reality. The expansion of the celestial bodies is linked with a revision of the concepts of physics and cosmology, in which a role play the preferred conception of Hubble and several of his colleagues of the time (Kragh, 2017) in explaining the cosmological redshift: the idea of "tired light".

More details and more complete bibliographic references can be found in Scalera (2020, 2021).

REFERENCES
De Sangro R., Finocchiaro G., Patteri P., Piccolo M., Pizzella G.; 2015: Measuring propagation speed of Coulomb fields. Eur. Phys. J. C, 75:137.
Kragh H.S.; 2017: Is The Universe Expanding? Fritz Zwicky And Early Tired-Light Hypotheses. Journal of Astronomical History and Heritage, 20 (1), pp. 2-12.
Scalera G.; 2020: An Expanding Earth –A reply to two recent denial papers. Rendiconti Online Società Geologica Italiana, Vol. 52, pp. 103-119.
Scalera G.; 2021: La Gravitazione Idrodinamica Come Causa Della Espansione Terrestre. https://www.researchgate.net/publication/351443253. DOI: 10.13140/RG.2.2.23345.30565

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History of SISFA

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The Italian Gruppo Nazionale di Storia della Fisica (GNSF), later (1999) Società
Italiana degli Storici della Fisica e dell'Astronomia (SISFA), was born in 1981, with the organization of two conferences (in April and October) at the Collegio Ghislieri in Pavia. Since then, the Italian Society of the Historians of Physics and Astronomy has produced over 1500 contributions, published in the proceedings of the uninterrupted series of its yearly national congresses. On the occasion of the 40th anniversary of the SISFA, I here briefly recount how the scientific, cultural and institutional experience of the history of physics has developed in Italy, along with its origins, and a discussion is presented of its relationships with the community of physicists.

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Le radici sociali e politiche dell'istituzionalizzazione della storia della fisica in Italia

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L'obiettivo del mio intervento è quello di tracciare le precondizioni socio-politiche che sono state alla base dell'emergere di un interesse da parte della comunità dei fisici italiani verso la storia della fisica. Nel mio intervento focalizzerò la mia attenzione sugli avvenimenti di maggiore rilevanza nel campo della fisica italiana occorsi nei 10 anni precedenti alle prime due edizioni del convegno di storia della fisica di Pavia del 1981. In particolar modo traccerò una linea di continuità fra le summer school di Varenna del 1970 e del 1972 [dedicate ai fondamenti della MQ e in Storia della fisica], il convegno organizzato dalla SIF "La scienza nella società capitalistica", la nascita di movimenti radicali per la scienza attorno a riviste come "Sapere"e "Testi e contesti"e le querelles occorse fra gli storici e filosofi della scienza italiani come Ludovico Geymonat e Paolo Rossi con una nuova generazione di fisici interessati alla dimensione storica, sociale e politica della loro disciplina.
Tali precondizioni mi sembrano le ragioni essenziali tramite le quali la "storia della fisica" si è istituzionalizzata come disciplina a sé stante in italia in opposizione al storia della scienza praticata nei dipartimenti di filosofia e scienze umane dando a questo campo di studio. Tale posizionamento ne determina anche la sua peculiare originalità nonché la sua estrema rilevanza sul piano internazionale. La storia della fisica praticata in in Italia è stata infatti per molti versi all'avanguardia con le tendenze che a livello internazionale si stavano sviluppando a livello internazionale nell'ambito dei Social Studies of Science.

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