Crossing the Disciplinary Boundaries of Physics (Bohr-100 Centennial Celebrations)

Report of Contributions

Contribution ID: **1** Type: **not specified**

Welcome

Presenter: JOAS, Christian (Niels Bohr Archive)

Session Classification: History Meeting

Contribution ID: **2** Type: **not specified**

Session 1

Session Classification: History Meeting

Contribution ID: **3** Type: **not specified**

Session 4

Session Classification: History Meeting

Contribution ID: **4** Type: **not specified**

Session 5

Session Classification: History Meeting

Contribution ID: **5** Type: **not specified**

Session 6

Session Classification: History Meeting

Contribution ID: **6** Type: **not specified**

Session 7

Session Classification: History Meeting

Contribution ID: **7** Type: **not specified**

Welcome

Monday, August 7, 2023 9:00 AM (5 minutes)

Presenter: JOAS, Christian (Niels Bohr Archive)

Contribution ID: **8** Type: **not specified**

Welcome

Presenter: JOAS, Christian (Niels Bohr Archive)

Session Classification: Opening Remarks – History Meeting

Contribution ID: **9** Type: **not specified**

Welcome

Monday, August 7, 2023 9:05 AM (10 minutes)

Presenter: ODDERSHEDE, Lene B.

Contribution ID: **10** Type: **not specified**

Some Treasures at the Niels Bohr Archive

Monday, August 7, 2023 9:15 AM (15 minutes)

Presenter: BOHR, Vilhelm A.

Contribution ID: **11** Type: **not specified**

Crossing the disciplinary boundaries of physics: Introductory reflections on interdisciplinarity per se

Monday, August 7, 2023 9:30 AM (25 minutes)

In this talk I will start with a brief review of recent discourse about interdisciplinarity, especially focusing on a popular distinction between inter- and multidisciplinarity and the related notion of 'integration'. Next, I will present an analytical approach that can be used for examining research activities that cross boundaries between disciplines, subdisciplines or research fields. I shall argue that compared to the standard taxonomy of inter-, multi- and transdisciplinarity, this analytical approach provides a more nuanced understanding of the crossing of intellectual boundaries, and of how balances between benefits and drawbacks may vary depending on both cognitive and social factors.

Presenter: ANDERSEN, Hanne (University of Copenhagen)

Session Classification: Session 1

Contribution ID: **12** Type: **not specified**

Interacting Fields: Crossing the Disciplinary and Subdisciplinary Boundaries of Physics

Monday, August 7, 2023 9:55 AM (25 minutes)

Presenter: JOAS, Christian (Niels Bohr Archive)

Session Classification: Session 1

Contribution ID: **13** Type: **not specified**

Discussion

Monday, August 7, 2023 10:20 AM (20 minutes)

Session Classification: Session 1

Contribution ID: **14** Type: **not specified**

The postwar fortunes of biophysics

Monday, August 7, 2023 11:15 AM (25 minutes)

In the decades following World War II, biophysics flourished as a field. The paper will review the historical constellations that propelled this development. It will consider the scientific promise and the cultural and political appeal of the field, the careers of the scientists that were attracted to work at the intersection of physics and biology, the techniques and practices they brought with them and the institutions that supported their work. Building on this analysis, the paper will reflect on what the episode can tell us about interdisciplinary boundary crossings.

Presenter: DE CHADAREVIAN, Soraya (UCLA)

Session Classification: Session 2

Contribution ID: **15** Type: **not specified**

Light and Life: Interactions between Physics and Biology, 1900–1950, Part I

Monday, August 7, 2023 11:40 AM (25 minutes)

These two papers present a joint argument exploring how scientists with expertise in physics and/or biology ventured beyond the boundaries of their fields. Our primary focus is on research surrounding a debated question during the first half of the twentieth century: the impact of light on living organisms. Notable figures such as Selig Hecht, Otto Warburg, Frits Went, James Franck, Eugene Rabinowitch, and, of course, Niels Bohr are included as examples. The analysis aims to examine the nature of these interdisciplinary encounters and provide tentative explanations for their varying degrees of success. The claim made is that significant factors contributing to the outcomes included, firstly, the successful translation of phenomena into resolvable "problems"; secondly, the resonance of these problems with shared or positively interdependent goals of all participants; and thirdly, the recognition that achieving these goals necessitated the combination of resources and expertise from both fields.

Presenter: NICKELSEN, Kärin (Munich)

Session Classification: Session 2

Contribution ID: **16** Type: **not specified**

Light and Life: Interactions between Physics and Biology, 1900–1950, Part II

Monday, August 7, 2023 12:05 PM (25 minutes)

These two papers present a joint argument exploring how scientists with expertise in physics and/or biology ventured beyond the boundaries of their fields. Our primary focus is on research surrounding a debated question during the first half of the twentieth century: the impact of light on living organisms. Notable figures such as Selig Hecht, Otto Warburg, Frits Went, James Franck, Eugene Rabinowitch, and, of course, Niels Bohr are included as examples. The analysis aims to examine the nature of these interdisciplinary encounters and provide tentative explanations for their varying degrees of success. The claim made is that significant factors contributing to the outcomes included, firstly, the successful translation of phenomena into resolvable "problems"; secondly, the resonance of these problems with shared or positively interdependent goals of all participants; and thirdly, the recognition that achieving these goals necessitated the combination of resources and expertise from both fields.

Presenter: SCHÜRCH, Caterina (Berlin)

Session Classification: Session 2

Contribution ID: **17** Type: **not specified**

Christian Bohr and Niels Bohr —physics and biology

Monday, August 7, 2023 2:00 PM (25 minutes)

Christian Bohr was an eminent and successful professor of physiology at the University of Copenhagen. At the time when Georg Brandes trailblazed the Modern Breakthrough in literature opening Danish inward-looking mentality to European culture, Christian Bohr contributed crucially to elevate Danish medical science from its secluded, provincial state to a field to be reckoned with on the international scene. Being an innovative instrument maker who made it his trademark to employ chemical and physical methods in physiology, Christian Bohr's pioneering research epitomized interdisciplinarity between biology, physics, and chemistry. He was nominated twice for the Nobel Prize in physiology, and he firmly institutionalized experimental physiology in Denmark.
It springs to mind drawing a parallel to his son Niels Bohr, who a few decades later introduced and institutionalized modern physics in Denmark and even propelled Copenhagen into one of this discipline's undisputed international centers. I will suggest that The Physiological Institute, where Niels Bohr spent his childhood and early youth, in some sense served as role model for his later Institute for Theoretical Physics.
Employing methods of physics and chemistry in physiology made Christian Bohr ponder epistemological problems concerning the dichotomy between exact physical, empirical description and teleological explanation of processes in living organisms, and he discussed these issues with his philosophically inclined son. When Niels Bohr introduced the concept of complementarity in 1927 as a kind of new logic that could accommodate the rival particle/wave descriptions in atomic physics, he tried to elucidate the new situation in microphysics with an analogy to the epistemological situation in biology and psychology.

Presenter: JACOBSEN, Anja Skaar (University of Copenhagen)

Session Classification: Session 3

Contribution ID: **18** Type: **not specified**

Bohr's Institute: Interdisciplinarity and missed opportunities

Monday, August 7, 2023 2:25 PM (25 minutes)

Bohr's deep and in some respects fruitful interest in the interface between physics and biology should not overshadow the fact that he and his institute was in general remarkably foreign to inter- or crossdisciplinary aspects of physics. Thus, despite some work was done on quantum chemistry in the late 1920s (Ø. Burrau), it was not followed up. Likewise, there were a few early contributions to astrophysics (S. Rosseland; S. Chandrasekhar), but soon the interest vanished. No-one expressed the slightest interest in cosmology. As a third and different example, solid-state physics was almost completely ignored until after Bohr's death. Given that solid-state physics is not separate from physics, in the latter case it makes more sense to speak of 'intersubdisciplinarity'than interdisciplinarity. In all three cases (geophysics could also be included), by ignoring borderline areas of what in Copenhagen was considered mainstream physics, largely atomic and nuclear physics, the institute missed the opportunity to contribute to new and important branches of research.

Presenter: KRAGH, Helge (University of Copenhagen)

Session Classification: Session 3

Contribution ID: **19** Type: **not specified**

Discussion

Monday, August 7, 2023 12:30 PM (30 minutes)

Session Classification: Session 2

Contribution ID: **20** Type: **not specified**

Discussion

Monday, August 7, 2023 2:50 PM (20 minutes)

Session Classification: Session 3

Contribution ID: **21** Type: **not specified**

Sam Schweber –From Physics to the History of Science

Monday, August 7, 2023 3:45 PM (25 minutes)

Schweber was an accomplished historian of science, with seminal contributions to the 20th-century history of science. Before, he had been a great physicist for more than 20 years. While he was not the single case of such a transition from science to humanities (Abraham Pais, Léon Rosenfeld and Ernst Mayr are the names to be evoked, as well as other cases from physics to philosophy, and vice-versa, such as Abner Shimony, Bernard d'Espagnat, Mario Bunge, Jeffrey Bub, and Michel Paty), he was outstanding in the sense of the excellence in both fields. Thus, I want to ask, what kind of skills and values he brought from physics to history and how these features shaped his trajectory as a historian of physics. I conjecture Schweber's later career was constrained, among other factors, by his concerns with ethical issues, which included research with military implications, and his long attachment to the role of theories in science, which was related to his training in quantum field theories. In order to do this, I first make a summary of his contributions to the history of science, then I review his training and contributions to physics to, finally, discuss how the latter contributed to the former career.

Presenter: FREIRE JR., Olival (Salvador da Bahia)

Session Classification: Session 4

Contribution ID: **22** Type: **not specified**

Gravity, gardens and gifts: Knowledge economies and Machian thought across disciplinary space and time

Monday, August 7, 2023 4:10 PM (25 minutes)

This paper explores several historical and methodological implications of the unusually thoroughgoing cross disciplinary arguments that Ernst Mach developed as a result of his work between physics, physiology and psychology from the 1860s through the 1880s, by examining legacies of Mach's approach in the development of theories of gravity and economic anthropology by Albert Einstein and Bronislaw Malinowski. Historically it is helpful to recognise that Mach's famous critiques of absolute time, space and ego were initiated in psychophysical research projects at the intersections of physics, physiology and psychology; these point to the widespread significance of relations between medicine and physics in studies of perception in the mid nineteenth century. Although Mach's emphasis on the economy of thought has usually been understood primarily as a form of anti-metaphysical empiricism when assessed with the interplay of theory and experiment in early twentieth century physics in mind, I will argue that rather than merely stamping out vermin (as Einstein put it), Mach's unusually broad aim to provide a philosophy fit for the whole of science helped his work bear fruit in social thought as well as physics. To develop an appreciation of the methodological implications of Mach's unusual interdisciplinary aims, I will trace legacies of Mach's approach in the work of Einstein, whose imagination was shaped by Mach's thought experiments, but also in Malinowski's argument that Australian aboriginal Intichiuma ceremonies as well as Trobriand Islanders' garden work and Kula ring of ceremonial exchange should be understood as economic relations, even if they were not money based. My reflections on the methodological implications of these historical relationships will draw on Jim Secord's and Warwick Anderson's accounts of knowledge in transit and post-colonial exchange, arguing that we need to track subtle but significant interrelations between circulatory practices and the caesurae consequent on power imbalances, in order to understand the specific challenges that interdisciplinary practitioners face.

Presenter: STALEY, Richard (Copenhagen and Cambridge)

Session Classification: Session 4

Contribution ID: **23** Type: **not specified**

Discussion

Monday, August 7, 2023 4:35 PM (20 minutes)

Session Classification: Session 4

Contribution ID: **24** Type: **not specified**

Keynote Lecture: Physics and History

Monday, August 7, 2023 5:15 PM (1 hour)

Physicists and, before their existence, natural philosophers and applied mathematicians, made fundamental contributions to the development of the historical sciences as well as to the history of science. That was not mere coincidence: both the historical and experimental sciences had their origins in the Scientific Revolution. I shall give a few Indicators of the parallel rise of the historical and experimental sciences before giving examples of serious contributions to historiography by early modern natural philosophers; of applications of history to epistemology and religious controversy by physicists around 1900; and of support by physicists and their organizations of the study of the history of physics by historians.

Presenter: HEILBRON, John L (UC Berkeley)

Contribution ID: **25** Type: **not specified**

Secret Clocks: The U.S. Military, Einstein's Relativity, and the Global Positioning System

Tuesday, August 8, 2023 9:00 AM (25 minutes)

For nearly a decade, beginning in the mid-1970s, a debate unfolded among physicists and engineers over how best to include effects from Einstein's general theory of relativity in the new military technology now known as the Global Positioning System (GPS). Although some exchanges were published in the open scientific literature, much of the debate played out behind the scenes, in memos, reports, and special review sessions arranged by the U.S. military. Theoretical physicists who had no relationship with the project criticized early efforts to incorporate relativistic effects within GPS designs, complaining that significant information was not shared by military contractors. Other experts in relativity, who consulted more closely with the U.S. Air Force while GPS was under development, responded that the outside critics had little relevant experience with real-world engineering applications, and that their criticisms amounted to mathematical irrelevancies. Throughout the debate, few doubted that relativity—with its counterintuitive notions of space and time—needed to be taken seriously in the design and operation of GPS. Rather, they disagreed over how best to incorporate deep lessons from relativity in an engineering-relevant way, at a time when the stakes for the new military technology loomed large.

Presenter: KAISER, David (MIT)

Session Classification: Session 5

Contribution ID: **26** Type: **not specified**

The definition of time from astronomy to physics

Tuesday, August 8, 2023 9:25 AM (25 minutes)

The definition of time was traditionally the domain of astronomers who determined the exact length of the (average) day. Combining observations and gravitational theory of the solar system, astronomers inferred in the 1920s that the Earth's rotation around its axis is not uniform. Physicists did not contribute to this rather complicated argument until the mid-1930s when they were able to detect irregular fluctuations in the rate of Earth's rotation. Astronomy continued to suggest a 'dynamic'basis for defining time, based on the motion of the Earth around the Sun as determined by celestial mechanics ('ephemeris time'). Magnetic resonance methods of atomic beams developed in the 1930s suggested a new basis for defining time, grounded in a physical phenomenon deemed uniform and highly stable theoretically and empirically, i.e. the frequency of transition between two energy levels in an atom. In the 1950s, while astronomers were working on the exact definition of the 'ephemeris second,'physicists and engineers constructed and improved the atomic clock. The physics-based definition had some clear metrological advantages over the 'ephemeris second'that allowed its acceptance as the basis for time in 1967, a mere seven years after the second was defined by the Earth's ephemeris. I will suggest the reasons for the quick change, pointing at connections between metrology and physics, and the adoption of a physical ideal in the latter.

Presenter: KATZIR, Shaul (Tel Aviv)

Session Classification: Session 5

Contribution ID: **27** Type: **not specified**

Physics and/or chemistry? The entangled situation of the Nobel Prizes 1903

Tuesday, August 8, 2023 11:40 AM (25 minutes)

Marie Curie was awarded half of the 1903 Nobel Prize in physics together with her husband Pierre Curie "in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel". Becquerel was awarded half of the prize "in recognition of the extraordinary services he has rendered by his discovery of spontaneous radioactivity". The Nobel Prize in chemistry this year was awarded to the physical chemist Svante Arrhenius "in recognition of the extraordinary services he has rendered to the advancement of chemistry by his electrolytic theory of dissociation". These two areas of research do not seem that entangled, so why the heading? The complication was rather the challenge for the two Nobel committees (physics and chemistry) to make their suggestions this year and to coordinate these suggestions. Top candidates this year was Arrhenius both in physics and chemistry, and he would not have mind to receive both prizes at the same time. Furthermore, he was a member of the five person Nobel committee in physics. Another strong physics and chemistry duo was the physicist Rayleigh and the chemist Ramsay that had both worked on noble gases. Both committees saw the advantage in synchronizing Nobel prizes to them the same year. Another issue was the perpetuated narrative that Marie Curie's Nobel prize was the result of some clever manipulation by a Swedish mathematician but was rather the careful manoeuvring by "a scientific nobody"from Uppsala. The chemists also managed to change the wording for the Nobel price to the Curies to the specifically physical "radiation phenomenon"rather than the discovery of radium, thus allowing for a chemistry Nobel prize to Marie Curie 1911. So physics and chemistry were quite entangled in view of the awarding of Nobel prizes in 1903.

Presenter: GRANDIN, Karl (Stockholm)

Session Classification: Session 6

Contribution ID: **28** Type: **not specified**

Discussion

Tuesday, August 8, 2023 10:15 AM (30 minutes)

Session Classification: Session 5

Contribution ID: **29** Type: **not specified**

Misreading biological complementarity: Bohr and his interpreters

Tuesday, August 8, 2023 9:50 AM (25 minutes)

In his August 1932 lecture to the second meeting of the International Congress for Light Therapy, Bohr made in public the transfer of his concept of "complementarity,"originally applied in physics in his paper of 1927 to the wave-particle duality, to the domain of biology. This lecture, subsequently published in English (1932, 1933), Danish (1933) and German (1933), positioned "complementarity"as a way of reconciling the current "mechanism-vitalism"debate over the relations of the biological and physical sciences. In the audience was the young theoretical physicist, Max Delbrück (1906-1981), who in all of his autobiographical remarks, commented that his attendance at this lecture motivated his shift in careers from theoretical physics to biophysics, and animated his research program into phage genetics (Nobel Prize in Physiology and Medicine, 1969).

Bohr, however, remarked on more than one occasion that his arguments concerning biological complementarity had never been correctly understood, but he never offered a detailed explanation of the origins and application of this concept. Consequently scholars have been in disagreement about the sources and interpretation of Bohr's meaning (Faye 1976, 1979; Favrholdt 1976,1979; Kaiser 1992; Folse 1985,1990; McKaughan 2005, 2011; Roll-Hansen 2000, 2011; Sloan 2012). This paper will discuss the contrasting interpretations of Bohr's arguments in the 1930s by fellow physicist Ernst Pascual Jordan (1902-1980), in contrast to those of Delbrück. It will be argued in conclusion that Bohr's positions on the relation of biological and physical explanations supply viable options today for dealing with the issues of biological reductionism.

Presenter: SLOAN, Phillip R. (University of Notre Dame)

Session Classification: Session 5

Contribution ID: **30** Type: **not specified**

Hevesy –and the making of early nuclear medicine in Copenhagen

Tuesday, August 8, 2023 11:15 AM (25 minutes)

George de Hevesy (1885-1966), Hungarian-born chemist and Nobel laureate, developed the use of radioactive indicators in 1913 while working in Rutherford's lab in Manchester, where he also met Niels Bohr. After World War I, Hevesy came to Copenhagen to work at Bohr's Institute, where he and the Dutch physicist Dirk Coster discovered element 72 of the periodic table, hafnium. In the 1920s, Hevesy pioneered the use of radioactive tracers in biology using plants and animals. This happened in the context of an interdisciplinary collaboration with the physicochemist I. A. Christiansen from the University and the dermatologist Dr. Svend Lomholt at the Finsen Institute (now Rigshospitalet). When Hevesy in 1934 returned to Copenhagen from Freiburg, he worked with Bohr and developed the use of the tracer technique with radioactive isotopes in biology and medicine. Hevesy's close collaborator Hilde Levi states: "It is interesting to note, that Hevesy's ventures into biology as the most obvious field of application of radioactive indicators began in collaboration with medical people"(1).

This talk will report on preliminary observations on the making of early nuclear medicine in Copenhagen, where Hevesy initiated studies on the use of the tracer technique in collaboration with researchers in physics, chemistry, biology, physiology, and medicine. Hevesy and Ole Chievitz, chief surgeon at the Finsen Institute, jointly wrote the seminal paper on the use of P-32 for studies of bone formation (2). The zoophysiologist August Krogh (Nobel Prize 1920), and his young assistant Hans H. Ussing developed the use of tracers for studies of membrane transport. Was it a large multi- and interdisciplinary network, with smaller independent interdisciplinary groups? The main protagonists were all leaders in their respective fields, and all were connected to Bohr, whose importance Hevesy in 1963 emphasized in a handwritten manuscript (3), characterizing Bohr as generous, unselfish, and modestly staying in the background.

References

1. Levi H. Georg von Hevesy Memorial Lecture. Eur J Nucl Med. 1976;1:3-10.

2. Chievitz O, Hevesy G. Radioactive indicators in the study of phosphorus metabolism in rats. Nature 1935;136:754 .

3. Georg de Hevesy Archive, Niels Bohr Archive, box autobiography, handwritten in blue ink „Gamle dage"(English „Old days"), 1963.

Presenter: HØJGAARD, Liselotte (University of Copenhagen)

Session Classification: Session 6

Contribution ID: **31** Type: **not specified**

A Travelling Technology: Radiocarbon dating between nuclear physics and climate science

Tuesday, August 8, 2023 12:05 PM (25 minutes)

The history of post-war climate science has been written with a strong focus on the role of global geopolitics and global climate models. In this talk, I will broaden this perspective with a smaller scale approach and a different technology. Drawing on the history of a specific radiocarbon dating laboratory, I show, on the one hand, how also local conditions influenced global climate science and, on the other hand, how the cross-disciplinary journey of this dating technology affected climate research and understanding. In doing so, I suggest to understand such "Travelling Technologies" as a means to study processes of interdisciplinarisation –in climate science and beyond.

Presenter: ACHERMANN, Dania (Wuppertal and Bern)

Session Classification: Session 6

Contribution ID: **32** Type: **not specified**

Discussion

Tuesday, August 8, 2023 12:30 PM (30 minutes)

Session Classification: Session 6

Contribution ID: **33** Type: **not specified**

The Origins of Geophysics in the 19th Century

Tuesday, August 8, 2023 2:00 PM (25 minutes)

Presenter: GOOD, Gregory A. (West Virginia University)

Session Classification: Session 7

Contribution ID: **34** Type: **not specified**

A ‘guessing science’? Physics, physicists, and modern meteorology

Tuesday, August 8, 2023 2:25 PM (25 minutes)

Despite the interest of natural philosophers-turned-physicists in the physical nature of the atmosphere and the development of instruments to measure it since at least the 16th century, physicists were often not overly enamored of meteorology as a topic of serious merit. Thus, in the US, meteorology was relegated to geography departments and physicists like Theodore von Kármán felt compelled to malign it as a ‘guessing science.’One might think that physicists had divorced themselves from the atmosphere early on, but that was not the case on the theoretical side –just on the prediction side. Norwegian physicist-turned-meteorologist Vilhelm Bjerknes and his Bergen School of Meteorology brought those two strands together in the early 20th century, but those efforts didn’t mean that physics was fully integrated into ‘everyday meteorology’until much later. What made the leap possible? Big data, big computers, big models···and big money.

Presenter: HARPER, Kristine C. (University of Copenhagen)

Session Classification: Session 7

Contribution ID: **35** Type: **not specified**

Constructions of Weather and Climate: Epistemic challenges and shifts in investigating the atmosphere

Tuesday, August 8, 2023 2:50 PM (25 minutes)

Efforts to investigate, understand and, eventually, predict weather and climate have changed significantly from the late 18th to the late 20th century. For a long time, physicists struggled and failed to establish a causal understanding of weather and climate based on the laws of physics. Instead, observation and experienced-based research traditions emerged, culminating in synoptic meteorology and a geographical tradition of climatology. Only during the twentieth century, theoretical advances as well as the technology of digital computers caused an increasingly deep transformation from empirical geographical to theory-based physical science. This fundamental shift produced not only a new understanding of weather and climate, including new and very different research interests and strategies such as climate change. It also largely marginalized geographical interests in weather and climate, which receives new interest and importance for understanding and managing local challenges of adaptation to climate change.

Presenter: HEYMANN, Matthias (Aarhus)

Session Classification: Session 7

Contribution ID: **36** Type: **not specified**

Discussion

Tuesday, August 8, 2023 3:15 PM (30 minutes)

Session Classification: Session 7

Contribution ID: **37** Type: **not specified**

Welcome

Presenter: DOOSTMOHAMMADI, Amin

Contribution ID: **38** Type: **not specified**

Welcome

Thursday, August 10, 2023 9:40 AM (10 minutes)

Presenter: MATHIESEN, Joachim (NBI)

Contribution ID: **39** Type: **not specified**

The Other Bohr and Biology's Greatest Model

Thursday, August 10, 2023 9:50 AM (50 minutes)

Only ten years after the discovery of the iconic structure of DNA, new questions were on biologist's minds, namely, how are the macromolecules of the cell regulated so that they do what they are supposed to when and where they are needed. The initial resolution of the challenging question of biological regulation came in the form of the notion of "allostery", an idea that its discoverer Jacques Monod himself referred to as "the second secret of life". We recently celebrated the 50th anniversary of the classic paper of Monod, Changeux and Jacob that introduced this far reaching idea. That important paper was followed shortly thereafter by a second one that revealed their musings on how simple statistical mechanical models can be used to capture how such allosteric transitions work mechanistically. In this talk, I will review the key features of the famed Monod-Wyman-Changeux (MWC) model and then describeits broad reach across many different domains of biology including the famed Bohr effect in hemoglobin. In this talk I will make special reference to the physics underlying how genes are turned on and off. One of the intriguing outcomes of this class of models is a beautiful and predictive scheme for collapsing data from entire libraries of mutants. Once we have considered some of the traditional uses of the MWC model, I will turn to more speculative recent ideas which use the MWC approach to consider the nature of kinetic proofreading.

Presenter: PHILLIPS, Rob B. (Caltech)

Contribution ID: **40** Type: **not specified**

Building molecules and the ingredients for life in space

Thursday, August 10, 2023 12:00 PM (50 minutes)

Thousands of planets have been discovered around stars other than our Sun. But how and where are these exo-planets born, and why are they so different from those in our own solar system? Which ingredients are available to build them? Thanks to powerful new telescopes, including the James Webb Space Telescope, astronomers can now zoom in to planetary construction sites and study their composition. Water and a surprisingly rich variety of organic materials are found near forming stars, including simple sugars, ethers, alcohols and hydrocarbons. How are these molecules made under the extreme conditions in space and can they be delivered to new planets to form the basis for life elsewhere in the universe?

Presenter: VAN DISHOECK, Ewine (Leiden)

Contribution ID: **41** Type: **not specified**

Topological puzzles in cell biology

Thursday, August 10, 2023 11:10 AM (50 minutes)

Recreational mathematics is a century-old field which involves mathematical puzzles and games, often appealing to children and untrained adults, inspiring deep study of the subject. Can a similar analogy be drawn in biology? One place to explore these ideas is the role of geometry and topology (geometric properties invariant to continuous change in shape or size) in biological form and function. Without making any claims of usefulness, in this talk I will explore a wide range of topological and geometrical puzzles in cellular physiology: Can single cells be toroidal in nature? Can cellular geometry (cytoskeleton) explain complex behavior in single cells? Can "Klein bottles" help us understand a fungal pathogen? Do cells get stuck forever in topological traps? Finally, we will reflect on the role of curiosity as an engine for discovery in life sciences.

Presenter: PRAKASH, Manu (Stanford)

Contribution ID: **42** Type: **not specified**

Modelling collective cell dynamics using active matter physics

Thursday, August 10, 2023 2:00 PM (50 minutes)

The motion of epithelial cells is key to many life processes from morphogenesis to wound healing. Despite its importance, and considerable recent attention, much remains to be understood about collective cell motility, both in terms of elucidating the underlying biochemistry, and at a more coarse-grained level of identifying the primary forces involved.
In this talk I will describe recent work modelling confluent cell layers and tissues using phase field and hydrodynamic models and discuss the extent to which approaches based on active matter physics are proving useful in interpreting tissue dynamics and patterning.

Presenter: YEOMANS, Julia (Oxford)

Contribution ID: **43** Type: **not specified**

Active Antagonism: Reproducing Microorganisms and Fluid Flows

Thursday, August 10, 2023 2:50 PM (50 minutes)

The growth and evolution of microbial populations is often subject to advection by fluid flows in spatially extended environments, with immediate consequences for spatial population genetics in marine ecology, planktonic diversity and fixation times. We review recent progress made in understanding this rich problem in the simplified setting of two competing genetic microbial strains subjected to fluid flows. We first review microbial range expansion experiments on liquid substrates and then move on to discuss antagonism, i.e., two killer microorganism strains, each secreting toxins that impede the growth of their competitors (competitive exclusion), both with and without stationary fluid flows. Recent experiments that reveal the presence of a genetic line tension are described.

Coupled reaction-diffusion equations that include advection by simple steady cellular flows composed of characteristic flow motifs in two dimensions reveal how local flow shear and compressibility effects can interact with selective advantage to have a dramatic influence on genetic competition and fixation in spatially distributed populations. We analyze a variety of 1d and 2d flow geometries including sources, sinks, vortices and saddles, and show how simple analytical models of the dynamics of the genetic interface can be used to shed light on the nucleation, coexistence and flow-driven instabilities of genetic drops.

Presenter: NELSON, David (Harvard)

Contribution ID: **44** Type: **not specified**

Randomness and precision: using experiment and theory to understand epigenetic regulation

Thursday, August 10, 2023 4:10 PM (50 minutes)

I am a molecular biologist on a journey towards theoretical biology. My field of research is epigenetic gene regulation by the Polycomb and Trithorax groups of proteins. I am fascinated by the apparently incompatible properties of randomness and precision in this system, both of which have been observed experimentally.
The field of Polycomb and Trithorax regulation has seen a rapid expansion in the last 20 years, fuelled in part by an explosion of high-throughput technologies enabling the generation of vast amounts of data. Like any large, fast moving field, different ideas have risen to popularity, not only due to their scientific merits but also for more esoteric reasons. These latter include catchy names for ideas, misconceptions of journalists about the magical properties of the epigenome, and a tendency amongst scientists to assume that things must be very different between mammals and fruit flies.
I will use examples from the field and from my own research to present the case for biologists to make more use of mathematical modeling and theoretical thinking, as a way to question dogma, to reconcile apparently conflicting experimental observations, to convert information into understanding, and perhaps most importantly, to raise good questions about what we still don't understand.

Presenter: RINGROSE, Leonie (Humboldt Univ. Berlin)

Contribution ID: **45** Type: **not specified**

Dinner for Science Speakers

Thursday, August 10, 2023 6:00 PM (3 hours)

Contribution ID: **46** Type: **not specified**

Welcome dinner for all History-of-Science speakers and organizers

Monday, August 7, 2023 6:30 PM (3h 30m)

Contribution ID: **47** Type: **not specified**

Sticky liquids make soft solids

Friday, August 11, 2023 9:00 AM (50 minutes)

This talk will discuss new observations of the role of weak interactions in liquids that can transform them into solids. This includes interactions between oil and water that can lead to anomalous stability of water-oil mixtures and the interactions of of proteins that can lead to phase separation, gelation and self-assembly of proteins.

Presenter: WEITZ, David (Harvard)

Contribution ID: **48** Type: **not specified**

Broken symmetries in living matter

Friday, August 11, 2023 10:20 AM (50 minutes)

Active processes in living systems create a novel class of nonequilibrium matter composed of many interacting components that individually consume energy and collectively generate motion or mechanical stress. In this talk, I will discuss experimental tools and conceptual frameworks we develop to uncover laws governing fluctuations, order, and self-organization in systems in which individual components break time reversal symmetry. I will describe how such frameworks provide powerful insight into dynamics of nonequilibrium living systems across scales, from the emergence of thermodynamic arrow of time to spatiotemporal organization of signaling protein patterns and discovery of odd elasticity.

Presenter: FAKHRI, Nikta (MIT)

Contribution ID: **49** Type: **not specified**

Structure formation in molecular and organoid systems

Friday, August 11, 2023 11:10 AM (50 minutes)

Living matter relies on the self organization of its components into higher order structures, on the molecular as well as on the cellular, organ or even organism scale. Collective motion due to active transport processes has been shown to be a promising route for attributing fascinating order formation processes on these different length scales. Here I will present recent results on structure formation on actively transported actin filaments, as well as the cell migration induced structure formation in the developmental phase of organoids.

Presenter: BAUSCH, Andreas (TU Munich)

Contribution ID: **50** Type: **not specified**

Festive reception

Wednesday, August 9, 2023 4:20 PM (1h 30m)

Contribution ID: **51** Type: **not specified**

Selected short talks by Early Career Researchers

Friday, August 11, 2023 1:00 PM (1h 15m)

Contribution ID: **52** Type: **not specified**

Closing remarks

Friday, August 11, 2023 2:15 PM (20 minutes)

Presenter: JENSEN, Mogens H. (NBI)

Contribution ID: **53** Type: **not specified**

All participants must be seated by 13.45 for the arrival of HRH Crown Prince Frederik

Wednesday, August 9, 2023 1:00 PM (45 minutes)

Contribution ID: **54** Type: **not specified**

HRH Crown Prince Frederik arrives

Wednesday, August 9, 2023 2:00 PM (5 minutes)

Contribution ID: **55** Type: **not specified**

Welcome by Mogens Høgh Jensen (NBI, UCPH, Organizing committee)

Wednesday, August 9, 2023 2:05 PM (3 minutes)

Contribution ID: **56** Type: **not specified**

Opening by HRH Crown Prince Frederik

Wednesday, August 9, 2023 2:08 PM (7 minutes)

Contribution ID: **57** Type: **not specified**

Mads Krogsgaard Thomsen (CEO Novo Nordisk Foundation)

Wednesday, August 9, 2023 2:15 PM (10 minutes)

Contribution ID: **58** Type: **not specified**

Stinus Lindgreen (Member of the Danish Parliament)

Wednesday, August 9, 2023 2:25 PM (10 minutes)

Contribution ID: **59** Type: **not specified**

Emil Bjerrum-Bohr (NBIA, Organizing committee) introduces Henrik Wegener, Vilhelm Bohr, Amin Doostmohammadi

Wednesday, August 9, 2023 2:35 PM (1 minute)

Contribution ID: **60** Type: **not specified**

Henrik C. Wegener (Rector UCPH)

Wednesday, August 9, 2023 2:36 PM (9 minutes)

Contribution ID: **61** Type: **not specified**

Vilhelm Bohr (UCPH, Bohr family, Organizing committee) –Niels Bohr: Biomedicine and History

Wednesday, August 9, 2023 2:45 PM (10 minutes)

Contribution ID: **62** Type: **not specified**

Amin Doostmohammadi (NBI, UCPH, Organizing committee) introduces Nobel Laureate Morten Meldal

Wednesday, August 9, 2023 2:55 PM (5 minutes)

Member of the organizing committee. Will introduce Nobel Laureate Prof. Morten Meldal

Contribution ID: **63** Type: **not specified**

Lecture by Prof. Morten Meldal (UCPH, Nobel Laureate in Chemistry 2022)

Wednesday, August 9, 2023 3:00 PM (1h 15m)

Contribution ID: **64** Type: **not specified**

Final remarks by Christian Joas (Niels Bohr Archive, Organizing committee)

Wednesday, August 9, 2023 4:15 PM (5 minutes)

Contribution ID: **65** Type: **not specified**

Emerging diversity in a population of evolving dice

Friday, August 11, 2023 1:00 PM (15 minutes)

Exploiting the mathematical curiosity of intransitive dice, I will present a simple theoretical model for coevolution that captures scales ranging from the genome of the individual to the system-wide emergence of species diversity. In this simple model, evolving agents interact competitively in a closed system, in which both the dynamics of mutations and competitive advantage emerge directly from interpreting a genome as the sides of a die. The model demonstrates how simple ingredients can lead to a host of complex features, including sympatric speciation and the emergence of metastable states of finite diversity.

Presenter: KIRKEGAARD, Julius (NBI)

Contribution ID: **66** Type: **not specified**

Filopodia rotate and coil by actively generating twist in their actin shaft

Friday, August 11, 2023 1:15 PM (15 minutes)

The cells in our bodies are highly dynamic: Myriads of vital processes take place inside a cell every second. An individual cell can use filopodia, dynamic ‘cellular fingers’, to ‘feel’, explore, and manipulate its close by environment for instance during development as well as during cancer invasion.
In this talk I will explain how we use optical tweezers in combination with fluorescence microscopy, to visualize the rotational dynamics of single filopodia as we simultaneously measure the forces they exert. I will furthermore show that a simple active mechanism is sufficient to explain much of the observed filopodial dynamics.

Presenter: Dr LEIJNSE, Natascha (NBI)

Contribution ID: **67** Type: **not specified**

Oscillations and condensation in cellular regulation

Friday, August 11, 2023 1:30 PM (15 minutes)

The fundamental mechanisms that control and regulate biological organisms exhibit a surprising level of complexity. The protein, p53, is a master regulator of DNA damage response and when the cell is exposed to multiple DNA double-strand breaks, it exhibits sustained oscillations.
A characteristic hallmark of the response is the formation of sub-compartments around the site of damage, known as foci. Following multiple DNA breaks, the transcription factor p53 exhibits oscillations in its nuclear concentration, but how this dynamics can affect the repair remains unknown.
In this talk, I will present different ways in which the the oscillations can be stimulated and how complex dynamics might stimulate groups of genes.
Finally I will discuss the future prospects and how we aim to investigate the possibilities of oscillatory transcription factors.

Presenter: Dr HELTBERG, Mathias (NBI)

Contribution ID: **68** Type: **not specified**

Collective cell communication via intercellular force transmission

Friday, August 11, 2023 1:45 PM (15 minutes)

The emergence of organization from the collective interactions of cells with no central guidance is a fundamental question in developmental biology, regeneration and biomedicine. Though widely studied from biochemistry and genetics perspectives, the interplay of mechanical interactions and the dynamics of self-organization remains elusive. In this talk, I will focus on the role of intercellular force transmission in three-dimensional, dense and squishy cell collectives. Using both a high-fidelity computational model and experimental data, I will show how altering local mechanical interactions at the single cell scale affects intercellular force transmission and order with consequences for biological functions: (1) cell extrusion program and (2) solid-to-fluid transition in active cell layers.

Presenter: Dr MONFARED, Siavash (NBI)

Contribution ID: **69** Type: **not specified**

Dynamics of active nematic defects on cones

Friday, August 11, 2023 2:00 PM (15 minutes)

Cones with orientational order in the local tangent plane provide a soft matter analog of the Aharonov-Bohm effect. We investigate the dynamics of a compressible active nematic on a cone. Imposing strong anchoring boundary conditions at the base gives rise to a rich phase diagram of periodic orbits of one or two +1/2 flank defects, with transitions between these states mediated by defect absorption, defect unbinding, or defect pair nucleation at the apex. Numerical simulations confirm theoretical predictions of not only the nature of the circular orbits but also defect unbinding from the apex.

Presenter: Dr VAFA, Farzan (Harvard)