Interactions of Interwar Physics: Technology, Instruments and Other Sciences

List of Abstracts:

Yoel Bergman, **The contributions of technology R&D to thermionics in the Interwar**

The study underscores the importance of technology research and development (R&D) to the advancement of Interwar thermionic physics ("thermionics"). In the first two decades of the twentieth century, the R&D introduced new types of thermionic tubes with composite phenomena that became objects for thermionics research. Other new technologies also helped thermionics, as a new lamp filament in GE which helped to resolve thermionics question. A significant part of the ensuing studies in the Interwar on the new tubes and their phenomena was carried out by R&D engaged-industry based researchers. Many thermionics publications came out of the labs of GE, Bell and other known corporates. The contributions will be examined through selected cases, some exemplifying the scientific importance of the private sector in the Interwar.

Michael Eckert, '**Turbulence Research in the 1920s and 1930s between Mathematics, Physics and Engineering**'

In the interwar period research on turbulence met with interest from different areas: in aeronautical engineering turbulence became a subject of experimental study in wind tunnels; in naval architecture and hydraulic engineering turbulence research was on the agenda because of its role for skin friction; applied mathematicians and theoretical physicists struggled with the problem to determine the onset of turbulence from the fundamental hydrodynamic equations; experimental physicists developed techniques to measure the velocity fluctuations of turbulent flows. In my presentation I attempt to discern the main trends of turbulence research in the 1920s and 1930s and the interests which motivated the research efforts in this hetero-disciplinary field of science and engineering.

Karl Hall (Central European University, Budapest), **'"Out of the labyrinth of recipe commerce": applied physics and insulation failure in the 1920s'**

The manufacture of insulating materials employed more than 60,000 people in Germany alone in the 1920s, when certain applied physicists hoped to develop a science of high-voltage insulators, briefly signaling the "dawn of industrio-physics." Their hopes turned out to be premature. No immediate predecessor to materials science emerged in this "declared borderland" where physics, chemistry, and electrical engineering overlapped, and these failures subsequently vanished from narratives of modern physics, though some of the protagonists were well versed in atomic theory. But this was more than a matter of brute empirical intractability in the early days of the quantum theory of solids. This episode, properly situated in the industrial research laboratory, can tell us much about the shifting meaning of "applied science" between the wars—and what patent lawyers have to teach us historians about the "artisan, handwork character of science."

Kenji Ito, **'Electron theory' and electrical engineering in Japan**

Why did Japan develop a strong research tradition in the field of atomic and nuclear physics? This paper aims to give a partial answer by pointing out its relations to engineering. It claims that, in the early 20th century, atomic theory was first introduced into

Japan mainly as the theory of electron, hence it was recognized as relevant to electrical engineering. Since electrical engineering was a discipline essential to develop new technologies, it was considered fundamental to Japan's industry and empire building. Therefore, atomic physics, too, was able to receive social recognition and support. This paper explores reception and development of 'electron theory' in Japanese physics since the early twentieth century until the 1920s. It also examines developments in electrical engineering in Japan, in particular, in the field of wireless telegraphy. The paper analyzes how Japanese physicists popularized atomic physics as 'electron theory.' Their efforts bore a fruit when a new research Institute, RIKEN, was decided to include physics and electrical engineering in addition to chemistry. Established in 1917, RIKEN became the most important center for research in physics and chemistry. In particular, it was a home of Nishina Yoshio's group, the most prominent research group in Japan in the field of atomic physics.

Shaul Katzir (Tel Aviv University), '**The shaping of interwar physic by technology – the case of piezoelectricity**'

In this talk I will explore the effect of technological aims on one field of interwar physics, namely piezoelectricity, and the channels by which practical aims influenced the research in the field. I will use the example to suggest tentative general conclusions about the manners by which physicists oriented their research to the perceived aims of technology and their reasons for doing that, stemming from the inner dynamic of research programmes within the discipline to the outside pressure of their funding institutes.

Invented during WWI, sonar was the first practical application of piezoelectricity. It was soon followed by crystals frequency control and its derivative quartz clock and a few audio-electrical methods. Consequently technologies based on piezoelectricity became an important interest for electronic communication by the early 1920s. This interest and the novel discoveries regarding oscillating piezoelectric crystals, first observed in the research directed at developing practical methods, led to unprecedented research in the field in the interbellum. Most of the research was related to and stimulated by practical devices. In particular, the major technological role of piezoelectric vibrations attracted many to its examination. Yet, crystal vibrations opened also new vistas for research, connected to other interests of the period, like that in the lattice structure of crystals explored with the help of x-rays. Moreover, scientists often sought a deeper and more extended knowledge about this and other phenomena, beyond the needs of technology. Technological aims, thus, stimulated research on particular questions within the field but did not limit their exploration to the needs of technological design. Agents with interest in practical results, such as industry and government, could influence research but did not have direct control on the researchers, as most of them worked at universities and research institutes. That physicists still oriented much of their research to technology testify to the power of more subtle channels of influence like personal contacts and financial support from foundations and industry.

Jaume Navarro (University of the Basque Country), **'One phenomenon, three settings. The early days of electron diffraction'**

In his memoirs, Clinton J. Davisson recalled his shock when, in the summer of 1926, at the meeting of the British Association for the Advancement of Science, Max Born suggested that the strange result of his experiments at the Bell Labs might be related to one of the strangest predictions of the new quantum mechanics: the diffraction of electrons. For some time, Davisson and his fellow co-worker Lester Germer had been working on the scattering of electrons in metallic surfaces, obtaining results they could not interpret from their engineering point of view. It was in the same meeting that the Cambridge-trained physicist George P. Thomson decided to re-adjust his experimental setup in the University of Aberdeen in order to pursue an experimental proof of electron diffraction according to de Broglie's theory. Davisson and Thomson shared the Nobel Prize in 1937 for their separate discovery of electron diffraction. However, neither Davisson and Germer nor Thomson followed up the phenomenon in their respective researches.

It was at Imperial College, among other places, that electron diffraction turned into a tool rather than simply an experimental phenomenon. After George P. Thomson moved to London, people at the Departments of Physics and of Engineering developed a technique to use electron diffraction as a tool to analyse metallic surfaces. In only a few years, and thanks to the entrepreneurship of people such as George Ingle Finch, electron cameras began to be commercialised by instrument manufacturers. In this paper I intend to trace the development of electron diffraction from anomaly to experimental phenomenon and into a technological device. I shall discuss the interactions between theory and experiment in the three settings (Bell Labs, Aberdeen and Imperial College) so as to better understand the way particular research cultures shaped the development of this phenomenon.

Richard Staley (University of Cambridge), '**Machines, modernity and the new physics in post-war discourse**'

Machines and mechanics have been at the same time a fact of everyday experience, an abstract discipline, a symbol and metaphor – both celebrated and descried. They have been discussed, displayed and portrayed by philosophers, sociologists, economists, socialists, museum curators, filmmakers and cultural commentators as well as by physicists. In this paper I will examine the varied ways that machines, mechanism and the new mechanics were treated in post World War I discourse, as one means of examining how new technologies and societal aims shaped physics. A short set of critical contributions to the technical history of physics and the cultural history of the interwar years have long been important to the way historians of science have understood the period, including amongst them writings from Einstein, Spengler, Lenard, Bohr and Hessen. But they have usually been discussed in relative isolation. By treating these well-known works in a broader and more comparative framework as contributions to a multifaceted and multivalent cultural history of mechanics that nevertheless had an international scope and was discussed with varying levels of urgency throughout the interwar period, I aim to offer some fresh perspectives on how mechanics mattered, exploring temporal continuities and establishing a discursive breadth of reference that has often escaped more narrowly focused histories of science.

Scott Walter (Nantes) **Scientist-engineers, electron theory, and early wireless technology**

The scientists and engineers who studied wireless waves in the early days of wireless relied on several theoretical frameworks, some of which served, like the electron theories of H. A. Lorentz, Joseph Larmor, and J. J. Thomson, as a guide to extending knowledge, or to improving the efficiency of electronic devices. The pioneers of wireless science and technology, including Hertha Ayrton, William Duddell, J. A. Fleming, André Blondel, Heinrich Barkhausen, Ferdinand Braun, Reginald Fessenden, Lee de Forest, Peder Pedersen, Valdemar Poulsen, Henri Poincaré, Edwin Armstrong, and Irving Langmuir, were all trained in, or were familiar with electron theory, and many of them sought to understand wireless waves in terms of electron behavior. American research journals in wireless phenomena featured electron-theoretical models of wireless phenomena as a matter of course. My talk will review the role of electrons and electron theory in engineering and laboratory practice, with a focus on related publications in the Proceedings of the Institute of Radio Engineers, from 1913 to 1934.