

Edited by Chaokang Tai, Bart van der Steen,
and Jeroen van Dongen

Anton Pannekoek: Ways of Viewing Science and Society



Amsterdam
University
Press

FOR PRIVATE AND PUBLIC USE
AMSTERDAM UNIVERSITY

Anton Pannekoek: Ways of Viewing Science and Society

FOR PRIVATE AND NON-COMMERCIAL USE
AMSTERDAM UNIVERSITY PRESS

Studies in the History of Knowledge

This book series publishes leading volumes that study the history of knowledge in its cultural context. It aspires to offer accounts that cut across disciplinary and geographical boundaries, while being sensitive to how institutional circumstances and different scales of time shape the making of knowledge.

Series Editors

Klaas van Berkel, University of Groningen

Jeroen van Dongen, University of Amsterdam

Anton Pannekoek: Ways of Viewing Science and Society

*Edited by
Chaokang Tai, Bart van der Steen, and Jeroen van Dongen*

Amsterdam University Press

FOR PRIVATE AND NON-COMMERCIAL USE
AMSTERDAM UNIVERSITY PRESS

Cover illustration: (Background) Fisheye lens photo of the Zeiss Planetarium Projector of Artis Amsterdam Royal Zoo in action. (Foreground) Fisheye lens photo of a portrait of Anton Pannekoek displayed in the common room of the Anton Pannekoek Institute for Astronomy.
Source: Jeronimo Voss

Cover design: Coördesign, Leiden

Lay-out: Crius Group, Hulshout

ISBN 978 94 6298 434 9

e-ISBN 978 90 4853 500 2 (pdf)

DOI 10.5117/9789462984349

NUR 686



Creative Commons License CC BY NC ND (<http://creativecommons.org/licenses/by-nc-nd/3.0>)

© The authors / Amsterdam University Press B.V., Amsterdam 2019

Some rights reserved. Without limiting the rights under copyright reserved above, any part of this book may be reproduced, stored in or introduced into a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording or otherwise).

FOR PRIVATE AND NON-COMMERCIAL USE
AMSTERDAM UNIVERSITY PRESS

Table of Contents

1	Anton Pannekoek: Ways of Viewing Science and Society <i>Chaokang Tai, Bart van der Steen, and Jeroen van Dongen</i>	9
2	Anton Pannekoek's Astronomy in Relation to his Political Activities, and the Founding of the Astronomical Institute of the University of Amsterdam <i>Edward P.J. van den Heuvel</i>	25
3	Anton Pannekoek: A 'Principled Theorist' <i>Gerrit Voerman</i>	51
4	Utopianism in Anton Pannekoek's Socialism and Astronomy <i>Klaas van Berkel</i>	75
5	Pannekoek's One Revolution: Anton Pannekoek and the Modernization of the Dutch Astronomical Community <i>David Baneke</i>	87
6	Astronomy in the Time of Pannekoek and Pannekoek as an Astronomer of his Times <i>Robert W. Smith</i>	109
7	'A New Scientific Conception of the Human World': Anton Pannekoek's Understanding of Scientific Socialism <i>Bart van der Steen</i>	137
8	From Science to Science: Anton Pannekoek, Willem Bongers, and Scientific Socialism <i>Annemarie Rullens</i>	157
9	Popularizing the Cosmos: Pedagogies of Science and Society in Anton Pannekoek's Life and Work <i>Jennifer Tucker</i>	173
10	Anton Pannekoek as a Pioneer in the Sociology of Knowledge <i>Bart Karstens</i>	197

11	The Milky Way as Optical Phenomenon: Perception and Photography in the Drawings of Anton Pannekoek <i>Chaokang Tai</i>	219
12	The Labour of Handwork in Astronomy: Between Drawing and Photography in Anton Pannekoek <i>Omar W. Nasim</i>	249
13	Cross-Fading the Milky Way <i>Johan Hartle in conversation with Jeronimo Voss about universal- ism and a realist economy of time</i>	285
14	A Galaxy of Appearances: Anton Pannekoek and the Planetary Cinema of Jeronimo Voss <i>Alena J. Williams</i>	305
	Index	319

List of Figures

Figure 2.1	First page of Anton Pannekoek's diary, 31 August 1888	28
Figure 2.2	Anton Pannekoek and his wife Anna Pannekoek- Nassau Noordewier in the garden of their Leiden home around 1903-1906	30
Figure 2.3	Opening of the SDP Party School in Berlin on 15 November 1906	32
Figure 2.4	Pannekoek in the library of Leiden Observatory in 1916	36
Figure 2.5	Technician David Koelbloed (1905-1977)	41
Figure 2.6	The solar eclipse team on Sumatra in January 1926, with soldiers of the Netherlands Indies Colonial Army	43
Figure 2.7	Anton Pannekoek and his wife Anna Pannekoek- Nassau Noordewier	44
Figure 10.1	The observed orbit of Neptune compared with the calculated orbit of Neptune, as drawn by Pannekoek	204
Figure 11.1	Naturalistic drawing of a section of the Milky Way by Pannekoek	230
Figure 11.2	Isophotic diagram of the mean subjective image	233

Figure 11.3	Extrafocal photographic plate of a portion of the southern Milky Way, taken at the Bosscha Observatory in Lembang by Joan Voûte	238
Figure 11.4	Small part of one of Pannekoek's working sheets for photographic photometry	239
Figure 11.5	Naturalistic drawing of the southern Milky Way based on measurements of photographic plates	240
Figure 12.1	Published drawing of the nebula in Orion as drawn by George P. Bond	259
Figure 12.2	Printed descriptive map of η Argus, published in John Herschel's Cape Results	261
Figure 12.3	Drawing of the nebula in Orion by Samuel Hunter based on collaborative efforts of Robert Ball, William Parsons, and Lawrence Parsons	264
Figure 12.4	Naturalistic drawing of a region of the northern Milky Way by Pannekoek	267
Figure 12.5	Isophotal map by Pannekoek of the same region of the northern Milky Way based on his own observations	268
Figure 12.6	The mean subjective image of the northern Milky Way, which combined the drawings of Pannekoek with those of others	269
Figure 12.7	Naturalistic drawing of a region of the southern Milky Way, published in negative	270
Figure 12.8	The corresponding isophotic map of the same region of the southern Milky Way	271
Figure 12.9	Published reproductions of the northern Milky Way photographs	276
Figure 12.10	A plate with schematic translations of one of the photographs used	277
Figure 12.11	Isophotic map that is derived from the schematic translations of the Milky Way photographs	278
Figure 12.12	Isophotic map derived from photographs of the southern Milky Way	279
Figure 12.13	Naturalistic drawing of the southern Milky Way derived from photographs of the southern Milky Way	280
Figure 13.1	Charcoal Drawing of the Milky Way by Anton Pannekoek	287
Figure 13.2	Construction of the Zeiss Planetarium in Jena, 1924	288

Figure 13.3	Construction Plans of a Milky Way Projector in the Zeiss Planetarium from 1964	288
Figure 13.4	Milky Way projection film of the Zeiss Planetarium, 1927	289
Figure 13.5	Eternity through the Stars (2012) by Jeronimo Voss	290
Figure 13.6	The Sun was Captured, yet no Victory (2011) by Jessica Sehrt and Jeronimo Voss	291
Figure 13.7	Illustration by J.J. Grandville from <i>Un autre monde</i> , 1844	293
Figure 13.8	Aspects of the Milky Way (2016) by Jeronimo Voss	297
Figure 13.9	Inverted Night Sky (2016) by Jeronimo Voss	298
Figure 13.10	Various stills from Inverted Night Sky (2016) by Jeronimo Voss	299
Figure 13.11	Communal Villa (2015) by Dogma and Realism Working Group	301
Figure 14.1	Inverted Night Sky (2016) by Jeronimo Voss	308
Figure 14.2	Восстание рыбаков (<i>Aufstand der Fischer</i>) by Jeronimo Voss (2011)	313

1 Anton Pannekoek: Ways of Viewing Science and Society

Chaokang Tai, Bart van der Steen, and Jeroen van Dongen

Astronomer and Marxist Anton Pannekoek was a remarkable figure. As an astronomer, he pioneered quantitative astrophysics and founded the renowned Astronomical Institute in Amsterdam that now carries his name. Before World War I, however, he was employed as a Marxist theorist by the Social Democratic Party of Germany, making him one of the leading intellectuals of international socialism. Because of his significant contributions to such diverse subjects as astronomy and socialism, Pannekoek's life and work uniquely capture the fascinating connections between conceptions of nature, society, and their representations in the early decades of the twentieth century. This book aims to study these connections through the prism of Pannekoek's biography. In doing so, it sets out to explain Pannekoek's particular epistemic, aesthetic, and political choices, while placing them in the broader context of the early twentieth century.

Pannekoek tried to keep connections between his political and academic life hidden from view. He had pragmatic reasons to do so. His academic career had suffered from his controversial political reputation on more than one occasion, most dramatically in 1919 when his appointment to deputy director of the Leiden Observatory was obstructed by the Dutch government.¹ From the mid-1910s onwards, he kept his socialist efforts at a distance from his career in astronomy, and even ended up writing two separate autobiographies: one focusing on his career in the labour movement, while the other discussed his astronomical research.²

Remarkably, this separation has been carried over into scholarship on his life and work. This either discusses Pannekoek's role in the labour

¹ This episode is discussed in detail in: Baneke 2004; and his 'Pannekoek's One Revolution', in this volume, 87-108.

² Pannekoek 1982.

movement, or in astronomy – but rarely their possible relations.³ This book, on the other hand, seeks to identify and elucidate the relations between Pannekoek's various contributions to science and political theory. This offers the opportunity to gauge the unity and singularity of Pannekoek's work on the one hand, while providing more insight into the wider relations between academia, politics, and ways of viewing the world on the other. Finally, to address the last aspect, the book will also engage the visual arts, both historically and in its attempts to capture the social and natural world.

Multiple chapters in this volume draw attention to the visual aspect of Pannekoek's work – in particular to his engagement with photography and his drawings of the Milky Way. This focus on aesthetics and the visual offers insight into Pannekoek and his time, as well as in current relations between the arts and sciences. Throughout the modern era, both have influenced each other in crucial ways. This was especially true in the early modern period, but even after their institutional separation began to emerge in the nineteenth century, their mutual influence never fully disappeared.⁴ This may be exemplified by the way in which Pannekoek's drawings of the Milky Way have captured not only the scientific, but also the artist's imagination, as revealed by the work of contemporary artist Jeronimo Voss, who engaged with Pannekoek's images to find novel representations of both the cosmos and the ideals of communism.⁵ These were presented in the installation *Inverted Night Sky*, which was exhibited at the Stedelijk Museum Bureau Amsterdam in May and June of 2016.⁶ At the same time, the conference 'Anton Pannekoek. Ways of Viewing Science and Society' was held at the Royal Netherlands Academy of Arts and Sciences in Amsterdam, of which this book is the result.

By engaging with the aesthetics of Pannekoek's drawings, we can learn more about the relation between science and art as they persist into the present. Moreover, a focus on the visual aspect of Pannekoek's work elucidates key elements of his scientific methodology. For a long time, historians of

3 When Pannekoek's autobiography was published in 1982, for example, it contained two introductions that separately discussed his socialism and his astronomy. The lack of any attempt to combine the two was already criticized by Klaas van Berkel (1984). For recent scholarship that does attempt to arrive at a unified understanding of Pannekoek, see Tai and van Dongen 2016; Tai 2017.

4 On the mutual development of art and science in the early modern period, see, e.g. Bennett 1982; Edgerton 1991; Kwa 2005; Smith 2006; Long 2011; for their separation in the nineteenth century, see Daston 1998; Jones and Galison 1998; for examples of their mutual influence in the late modern period, see Henderson 1983; Galison 1990; Wilder 2009; Kojevnikov 2016.

5 For more on Pannekoek's influence on artists, see Lütticken 2018.

6 Voss 2016; For descriptions and images of the exposition, see SMBA 2016; Voss 2017.

science ignored images as mere tools, intended only to illustrate knowledge that was mainly conveyed in words and equations. Yet, scientific images are objects worth studying in their own right when trying to understand how science is practised.⁷ In particular, the aesthetic and technical choices scientists make in producing and reproducing images do not just reveal aspects of the knowledge that they wish to convey; they also reflect how scientists believe nature should be observed – indeed, what skills and virtues are required to do these observations.⁸ Thus, by looking at how Pannekoek decided to represent the Milky Way, it becomes possible to explore what he believed proper scientific practice was and how he believed scientific knowledge should be constructed.

Pannekoek's life is a rich source of information on the relations between visual culture, scientific scholarship, and leftist politics in the early twentieth century. Of course, he was not the only left-wing radical who moved among these various domains.⁹ Similar connections can be found in the lives of socialist physicists like Friedrich Adler, Léon Rosenfeld, and Yakov Frenkel, to name only three examples. Adler was trained as a physicist and at one time had been in close contact with Albert Einstein. He is perhaps best known, however, for his assassination of the Austrian Prime Minister Karl von Stürgkh in 1916, which he hoped would start a socialist revolution in Austria. While imprisoned, he struck up a correspondence with Einstein on the foundations of relativity theory. He tried to reconcile Einstein's relativity principle with the classic concept of a privileged reference frame, much like he attempted to reconcile the revolutionary ideals of the Bolsheviks with his support of the social-democratic Second International.¹⁰ In the case of Belgian quantum theorist Rosenfeld, the connection can be found in his vehement defence of the principle of complementarity in quantum mechanics – mainly against criticism by Soviet physicists, who considered it idealist and subjective; Rosenfeld argued that the principle was the result

7 For an overview of how historians started to research scientific images, see Pang 1997; Jones and Galison 1998; Kusakawa 2016.

8 See, e.g. Daston and Galison 1992; 2007; Winkler and van Helden 1992; Schaffer 1998; Nasim 2013.

9 It is worth mentioning that two of Pannekoek's closest socialist companions, Herman Gorter and Henriette Roland Holst, were also key members of the innovative and progressive impressionist 'Tachtigers' movement in Dutch literature; thus, they moved between literary and socialist circles, as Pannekoek crossed the boundaries between the sciences and socialism. In their case, the subject matter and purpose of their poetry was drenched in socialist themes. For Herman Gorter, see de Liagre Böhl 1996; Zwart 2019; for Henriette Roland Holst, see Etty 1996.

10 Galison 2008.

of a practical application of the dialectic method.¹¹ Soviet condensed matter physicist Frenkel, finally, used the social concept of collectivism, as it was understood by early twentieth-century radicals, as a metaphor to explain the collective behaviour of electrons in metals, crystals, and plasmas.¹² These examples raise the question whether a similar close connection between political thought and scientific work can be revealed in the case of Pannekoek. Can we get a better understanding of both Pannekoek's astronomy and his Marxism if we investigate how they might relate to one another?

The role of aesthetics at the crossroads of scholarship and political activism is particularly pertinent in the case of Otto Neurath and Rudolf Carnap. Neurath was a socialist philosopher and political economist who famously visualized statistical data through the invention of pictorial 'isotypes', in collaboration with modernist artist Gerd Arntz. By displaying statistical information visually, he strove to enable the masses to access and interpret it.¹³ Carnap was the author of *Der logische Aufbau der Welt* (1928), in which he attempted to develop a framework that reduced all empirical knowledge to direct sensory experience. His philosophy brought him in close contact with the architects of the Bauhaus art school, who shared his left-technocratic vision of the world as built up from simplest elements; at the invitation of Walter Gropius, Carnap gave several lectures at the Bauhaus in Dessau.¹⁴ Both Neurath and Carnap were prominent members of the Vienna Circle, the group of philosophers who shared the explicit goal of making philosophy 'scientific' by stripping it of its metaphysical content. This desire was shared by Pannekoek and it is therefore no coincidence that he published an article on the 'essence of natural laws' in *Erkenntnis*, the journal co-edited by Carnap and affiliated with the Vienna Circle.¹⁵

A scientist's (presumed) close relations with radical politics and avant-garde art could be cause for suspicion for both the authorities and the public at large. This is not only illustrated by Pannekoek's thwarted Observatory position, but also by the delayed appointment of Albert Einstein to a visiting professorship at Leiden University in 1920. In that year, politically charged debates on the truth and significance of relativity theory reached their apex. Einstein was first appropriated by the Dada art movement in a collage by artist Hannah Höch, while reactionary critics of relativity accused

11 Jacobsen 2007.

12 Kojevnikov 1999.

13 Cartwright et al. 1996; Leonard 1999; Mattick 2016.

14 Galison 1990; 1996. For a discussion of Neurath's connections with the Dessau Bauhaus, see Potochnik and Yap 2006.

15 Pannekoek 1932.

him of being a political revolutionary and giving a false representation of nature, which they identified as 'scientific Dadaism'. Einstein himself had a somewhat traditional taste in art and was not a communist but rather a democrat and pacifist – but this did not stop others from labelling him as a radical and accusing his scientific theories of being politically subversive.¹⁶ Influenced by these debates in Germany, the Dutch government, in turn, confused Albert Einstein with the German art critic Carl Einstein, who was in fact a true far-left revolutionary. Carl Einstein, an early promotor of cubism and African tribal art, had been a leading member of the German soldiers' council that had mutinied during the retreat from Brussels in 1918. As a result of this confusion, Albert Einstein's appointment as visiting professor to the Leiden physics department was held up for nearly a year in 1920. Dutch officials wished to be absolutely certain about his political persuasions, as they wished to avoid a repetition of the botched appointment of Pannekoek at the Leiden Observatory a year earlier.¹⁷

In 1934, there was yet another incident in which a leftist scientist was barred from a Dutch university. This time, Marxist mathematician Dirk Jan Struik was withdrawn as candidate for a guest professorship at Delft University of Technology following objections from the Dutch government.¹⁸ Although Struik was more than two decades younger than Pannekoek, their lives and careers show remarkable similarities. Struik, too, strove to keep socialism and science separate domains of his activity. After deciding to become a socialist professional, rather than a professional socialist, Struik's Marxist beliefs were mainly reserved for his historical writings. He founded the interdisciplinary Marxist journal *Science and Society* and pioneered a dialectic-materialistic approach to the historiography of science in his monograph *Yankee Science in the Making*.¹⁹

As the above examples show, studying Pannekoek and others at similar junctures in the early twentieth century offers us not only biographical insights, but it also promises to elucidate the ways in which Pannekoek and his contemporaries balanced scientific and political ambitions. Furthermore, it will show us how contemporaries reflected on how progressive, 'revolutionary' science and politics interacted, and the role that the era's innovations in visual culture played in this. These scholars all advanced extraordinary intellectual innovation, while sharing the tumultuous rhetoric of revolution

16 Goenner 2005; van Dongen 2007.

17 van Dongen 2012.

18 Alberts 1994, 281.

19 Alberts 1994.

– for which they were considered a vanguard by some yet abhorred by others. This book focuses exactly on these themes: on how understanding the links between science and society informed representations of nature as well as scientific and political choices in the revolutionary cultures of the early twentieth century. Clearly, Pannekoek offers a uniquely rich starting point for such an endeavour.

Although Pannekoek worked as an astronomer for most of his professional life, it is his political career that has received the largest share of attention from historians and biographers so far. Interest in his political work was revived in late 1960s as the New Left began to pay attention to Pannekoek due to his opposition to both moderate social democrats such as Karl Kautsky and to dogmatic Marxists such as Vladimir Lenin. Former collaborators of Pannekoek subsequently republished his work, and provided a synthesis of his ideas in an effort to rekindle the council communist programme.²⁰ In the following decades, scholarly reconstructions of Pannekoek's political development were produced, while activist interest in council communism mostly subsided.²¹ Contemporary historiography is of course less interested in reconstructing the council communist programme but rather aims to understand the council communist movement in its proper historical context.²²

Pannekoek's astronomical career has received less attention. Although some of his contributions have found their way into more general surveys in the history of astronomy,²³ these do not offer more than a superficial indication of his research and methodology. Only recently historians of science have attempted more thorough investigations of Pannekoek's astronomical research in an effort to understand and contextualize his scientific research.²⁴ Yet, there is still much left to be explored before a comprehensive overview of all of his major contributions to astronomy can be provided. This volume indeed aspires to deepen our understanding of Pannekoek's scientific contributions, and to do so by engaging equally his contributions to epistemology and socialist theory. Only then can we begin to unravel their intricate relations.

Astronomer Edward P.J. van den Heuvel, former director of the Anton Pannekoek Institute for Astronomy, first offers a biographical overview of

20 See Brendel 1970; Kloosterman 1972; Smart 1978; Bricianer 1978; Sijes 1982.

21 See, in particular, Boekelman 1980; Gerber 1989; Malandrino 1987; Bock 1992; 1993.

22 See, e.g. van der Linden 2004; van der Steen 2006.

23 See, e.g. Hearnshaw 2014; Baneke 2015.

24 Houziaux 2001; Tai and van Dongen 2016; Tai 2017.

Pannekoek's life based on many conversations with former colleagues and students of Pannekoek. Van den Heuvel shows how Pannekoek's rejection for the Leiden position turned out to be a blessing in disguise as he subsequently was offered a position at the University of Amsterdam, where he had the opportunity to shape his own research agenda independently (in Leiden, he would have had to work under Willem de Sitter). Because his newly founded Astronomical Institute lacked an observatory, Pannekoek became involved in the emerging field of theoretical astrophysics, which developed in tandem with highly innovative studies in atomic physics.

Focusing more on Pannekoek's political career, Gerrit Voerman asks why Pannekoek ended up in numerous heated conflicts with socialist leaders such as Pieter Jelles Troelstra, Karl Kautsky, and Lenin – conflicts that effectively marginalized him as a socialist activist. Voerman points to the principled nature of Pannekoek's character and his preference for theoretical analysis over practical considerations. This meant that he rejected any form of compromise and would become frustrated when the outcomes of his analyses were not acceded to. He was willing to accept the personal consequences of his steadfastness and break off relations with close collaborators if consistency of his political positions dictated such a course of action.

Klaas van Berkel searches for commonalities between Pannekoek as astronomer and Pannekoek as socialist by reflecting on why he made this distinction in his biography in the first place. Van Berkel finds that the distinction is a historical construct that had been created by Pannekoek because of the incidents in which his socialist activism had hindered his astronomical career – not just in 1919 when his Leiden appointment was blocked, but also in 1903 when he was reprimanded by Dutch prime minister Abraham Kuyper for his outspoken support of a general labour strike that year. According to Van Berkel, the most fundamental element that was shared between Pannekoek's approaches to astronomy and socialism was an emotional commitment: a utopian longing for wholeness and purity in both nature and society.

The historical context of Pannekoek's astronomy is the focus of the following contributions. David Baneke provides an overview of Pannekoek's influence on the astronomy community in the Netherlands. After a detailed analysis of Pannekoek's role in the reorganization of the Leiden Observatory and his rejection as assistant director there, he discusses Pannekoek's close relations with Utrecht's Marcel Minnaert, another communist astronomer. Together they established the Dutch school of astrophysics, which first focused on the properties of stellar atmospheres. Pannekoek further contributed to Dutch astronomy by supporting the creation of a Dutch

astronomical society and journal. Baneke contends that Pannekoek's actual 'revolution' is found not in the political realm but in the modernization of Dutch astronomy, both institutionally and academically.

Robert W. Smith situates Pannekoek in the wider development of astronomy in the early twentieth century, during which it underwent rapid changes. Not only were ideas about the shape and size of the galaxy in flux, the notion of what astronomy should study, and how and where this should be studied changed as well. Pannekoek, as Smith argues, was at the forefront of many of these developments: his methods and concerns were both influential and representative of the era. Not only was he one of the first astronomers to provide supporting evidence for Harlow Shapley's new model of the galaxy, he was also one of the earliest practitioners of the new quantitative astrophysics that applied the latest developments in atomic physics and quantum mechanics to the stars. Smith concludes that, as an astronomer, 'Pannekoek [...] was both very much of, as well as a maker of, his time.'

Pannekoek considered Marxism to be a science in its own right. This position was shared by many of his socialist contemporaries and predecessors, including, as Bart van der Steen explains, Karl Marx and Friedrich Engels. They had introduced the term 'scientific socialism' for their own approach to socialism. Engels had contended that their approach was preferable because, rather than simply imagining better societies, they used a scientific method to analyse how socialism would evolve out of the contradicting tendencies inherent to capitalism. Even so, the exact content and method of scientific socialism remained strongly contested. In his contribution, Van der Steen reconstructs Pannekoek's understanding of what scientific socialism implied. He finds that three distinct but closely related definitions of scientific socialism can be found in Pannekoek's writing. Socialism was 'scientific' because 1) it made predictions about the future (which entailed that the socialist revolution was imminent); 2) it provided a method for analysing past and present social developments; and 3) because it argued for a worldview that strove for truth through scientific research. This final position offered Pannekoek the opportunity to align his socialism with his astronomical research.

Pannekoek's understanding of scientific socialism deviated from that of many of his contemporaries, as Annemarie Rullens shows. Pannekoek considered scientific socialism a method for analysing human behaviour, which had to be developed further by the working classes. Thus they would gain the consciousness that would enable them to establish a socialist society. Rullens contrasts this view with that of Pannekoek's contemporary Willem Bongers, a prominent Dutch socialist and professor of criminology at the

University of Amsterdam. According to Bongers, society had to be transformed by using the latest insights offered by statistics, social science, economics, and even biology. As member of the Social Democratic Workers' Party (SDAP), he advocated for policies aimed at this goal. For Bongers, scientific socialism was not a philosophical stance, as it was for Pannekoek. Instead, it contained a practical imperative. This position was shared by many of the generation of Dutch leftist ideologues that came after Pannekoek, and of which Bongers can be seen as a representative.

One of Pannekoek's struggles was to make his astronomical research socially relevant. Jennifer Tucker argues that Pannekoek found a way to achieve this by engaging the public and broadening its understanding of science. Pannekoek outlined a method for amateur astronomers to observe and record the Milky Way in his earlier life, for example. He later wrote several popular histories of astronomy. These emphasized the socio-economical context in which astronomy had developed and the progressive values it promoted – in line with the work of other Marxist historians like Boris Hessen, Edgar Zilsel, and J.D. Bernal. In these studies, Pannekoek highlighted the collaborative and elaborate practical effort involved in astronomical research, and he discussed at length the struggles and errors involved in the scientific process. As such, he intended to show the scientific worker 'in overalls'.

Pannekoek's historical studies are also the subject of Bart Karstens' contribution. He addresses how Pannekoek's research should be positioned within contemporary developments in historical sociology of science. As Karstens indicates, Pannekoek's historical research has been appropriated by members of the so-called 'strong programme' in the sociology of scientific knowledge, like Stevin Shapin and Barry Barnes: they saw in Pannekoek an early example of their preferred type of analysis. According to the strong programme, both the development and the content of scientific knowledge is strongly determined by social factors. After analysing Pannekoek's discussion of the discovery of the planet Neptune, Karstens argues that this appropriation of Pannekoek was misguided: far from an early example of the strong programme, Pannekoek's approach most closely resembles that of contemporary sociologist Robert Merton. In his case, too, social factors may influence the direction and pace of scientific research but not its content.

Pannekoek's Milky Way drawings provide an excellent opportunity to establish the deeper epistemic links between his astronomy and Marxism. An analysis of these drawings is provided by Chaokang Tai, who argues that Pannekoek's methods of investigating and depicting the Milky Way reflected his Marxist understanding of how the mind processes information.

According to Pannekoek, the mind instinctively and intuitively synthesizes valuable information about the world from the continuous flow of disparate human observations. To forego such insights would leave a scientist without a well of knowledge, which was the reason Pannekoek held that drawings of the Milky Way could display insights that photographic images could not. When Pannekoek did employ photography, he used a method that allowed the photographic plate to mimic the properties of the human eye, effectively mechanizing human observation – but even then, the end result had to be displayed through drawings.

Omar W. Nasim also searches for the connection between Pannekoek's astronomy and socialism in his Milky Way research. But rather than discussing the role of the mind in Pannekoek's research, Nasim focuses on the role of the hand. He points out that both in his *Marxism and Darwinism* and in *Anthropogenesis*, Pannekoek assigned great significance to the role of manual labour in the development of mankind. According to Pannekoek, the use of increasingly sophisticated tools led to the development of speech and abstract thought. Nasim shows that this emphasis on the value of manual labour was reflected in Pannekoek's Milky Way research, in which hand drawn images of the Milky Way were to be trusted over mechanically produced photographs: it is by the hand that we know. Like Tai, Nasim recognizes that Pannekoek indeed employed photography in his Milky Way studies, but that in the end, his methods were really grounded in laborious handwork.

In combination with his socialist writings, Pannekoek's Milky Way drawings also provided a crucial inspiration for Jeronimo Voss' work *Inverted Night Sky*. In his conversation with cultural theorist Johan Hartle, included in this volume, Voss reflects on his exhibition and the inspiration that Pannekoek's life and drawings of the Milky Way offered. It leads Voss to explore the historical ties between imaginations of the cosmos and communism, and reflect upon how these can enrich both contemporary art and social criticism. Voss is used to transgressing boundaries and aspires to, in his own words, 'a universalist perspective that goes beyond [...] the traditionally separated domains of visual art, documentarism, science, politics, and every-day life' – just as Pannekoek did, one may add. Thus, Voss has created dome structures with projections of Pannekoek's Milky Way drawings that collapse various techniques and that offer both a unique inverted perspective on our nearby cosmos, while they are blended and framed with social commentary.

Alena J. Williams offers a 'close reading' of Voss's art, which she relates to how revolutionaries from Pannekoek's time to today have used images and conceptions of the cosmos to imagine both revolutionary ideals and their catastrophes. A case in point was Louis Auguste Blanqui, a revolutionary

who played a leading role in the Paris Commune of 1871: he took to astronomical musings to process the dramatic defeat of the Commune and to rekindle his hopes for a revolutionary future. Williams shows how Voss is inspired by Blanqui's hypothesis 'that all possible variations of our own past, present, and future are real material facts located within infinite space' as it promotes 'a worldview that conceptualizes history as a product of collective decisions rather than as an independent stream of time'. Voss investigates Pannekoek's life, politics, and especially his visualisations of the Milky Way from this perspective, according to Williams. Voss's work and Williams's contemplations on them give greater urgency to Pannekoek's aesthetic choices and their possible political implications.

The articles in this volume reaffirm that Pannekoek's contributions to astronomy and socialism cannot be considered as independent from each other. By investigating his work in both science and political theory, along with his broader epistemology, a multifaceted view emerges that not only reveals the many connections and similarities between his socialist and scientific career, but also clearly shows that they are deeply interconnected in Pannekoek's approach, methods, and goals. Moreover, Pannekoek's case uniquely illustrates the arrival of modernity, and its upheavals: as new ways of being were introduced, new ways of viewing were required – as has famously been documented in the arts, reflected in the sciences, and expressed in the social revolutions that spread across Europe. Pannekoek stood at the epicentre of these developments and contributed to them at least as much as he reflected them: innovation in perspective was often translated into the language of revolution, and Pannekoek was a revolutionary in spirit at least as much as he was an intellectual in temperament.

Acknowledgements

We thank the Royal Netherlands Academy of Arts and Sciences (KNAW), the Amsterdam University Fund (AUF), the Netherlands Research School for Astronomy (NOVA), the Leids Kerkhoven-Bosscha Fonds (LKBF), and Stichting Pieter Zeeman Fonds for their support of the 2016 conference 'Anton Pannekoek (1873-1960): Ways of Viewing Science and Society' of which this book is the result. We are also grateful to the Vossius Fund for the History of the University of Amsterdam, the Anton Pannekoek Institute for Astronomy, and the Jan van Paradijs Fund for their generous financial support to make the open access publication of this book possible.

Bibliography

- Alberts, Gerard. 1994. 'On Connecting Socialism and Mathematics: Dirk Struik, Jan Burgers, and Jan Tinbergen'. *Historia Mathematica* 21(3): 280-305.
- Baneke, David. 2004. "Hij kan toch moeilijk de sterren in de war schoppen". De afwijzing van Anton Pannekoek als adjunct-directeur van de Leidse Sterrewacht in 1919'. *Gewina* 27 (1): 1-13.
- . 2015. *De ontdekkers van de hemel. De Nederlandse sterrenkunde in de twintigste eeuw*. Amsterdam: Prometheus Bert Bakker.
- Bennett, Jim A. 1982. *The Mathematical Science of Christopher Wren*. Cambridge: Cambridge University Press.
- Berkel, Klaas van. 1984. Review of *Herinneringen. Herinneringen uit de arbeidersbeweging. Sterrekundige herinneringen*, by Anton Pannekoek. *BMGN – Low Countries Historical Review* 99(3): 465-467.
- Bock, Hans Manfred. 1992. 'Die Marx-Dietzgen-Synthese Anton Pannekoeks und seines Kreises'. In *Die Rezeption marxschen Theorien in den Niederlanden*, ed. by Marcel van der Linden. Trier: Karl-Marx Haus, 106-123.
- . 1993. *Syndikalismus und Linkskommunismus von 1918 bis 1923. Ein Beitrag zur Sozial- und Ideengeschichte der frühen Weimarer Republik*. Darmstadt: Wissenschaftliche Buchgesellschaft.
- Boekelman, Marinus A.M. 1980. 'The Development of the Social and Political Thought of Anton Pannekoek, 1873-1960: From Social Democracy to Council Communism'. PhD Thesis, Toronto: University of Toronto.
- Brendel, Cajo. 1970. *Anton Pannekoek, theoretikus van het socialisme*. Nijmegen: Socialistische Uitgeverij Nijmegen.
- Bricianer, Serge. 1978. *Pannekoek and the Worker's Councils*. Saint Louis: Telos Press.
- Cartwright, Nancy, Jordi Cat, Lola Fleck, and Thomas E. Uebel. 1996. *Otto Neurath: Philosophy between Science and Politics*. Cambridge: Cambridge University Press.
- Daston, Lorraine. 1998. 'Fear and Loathing of the Imagination in Science'. *Daedalus* 127(1): 73-95.
- Daston, Lorraine, and Peter Galison. 1992. 'The Image of Objectivity'. *Representations* 40: 81-128.
- . 2007. *Objectivity*. New York: Zone Books.
- Dongen, Jeroen van. 2007. 'Reactionaries and Einstein's Fame: "German Scientists for the Preservation of Pure Science", Relativity, and the Bad Nauheim Meeting'. *Physics in Perspective* 9(2): 212-230.
- . 2012. 'Mistaken Identity and Mirror Images: Albert and Carl Einstein, Leiden and Berlin, Relativity and Revolution'. *Physics in Perspective* 14(2): 126-177.
- Edgerton, Samuel Y. 1991. *Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution*. Ithaca, NY: Cornell University Press.

- Etty, Elsbeth. 1996. *Liefde is heel het leven niet: Henriette Roland Holst, 1869-1952*. Amsterdam: Balans.
- Galison, Peter. 1990. 'Aufbau/Bauhaus: Logical Positivism and Architectural Modernism'. *Critical Inquiry* 16(4): 709-752.
- . 1996. 'Constructing Modernism: The Cultural Location of Aufbau'. In *Origins of Logical Empiricism*, ed. by Ronald N. Giere and Alan W. Richardson. Minnesota Studies in the Philosophy of Science 16. Minneapolis: University of Minnesota Press, 17-44.
- . 2008. 'The Assassin of Relativity'. In *Einstein for the 21st Century: His Legacy in Science, Art, and Modern Culture*, ed. by Peter Galison, Gerald Holton, and Silvan S. Schweber. Princeton: Princeton University Press, 185-204.
- Gerber, John P. 1989. *Anton Pannekoek and the Socialism of Workers' Self-Emancipation, 1873-1960*. Dordrecht: Kluwer.
- Goenner, Hubert. 2005. *Einstein in Berlin 1914-1933*. Munich: C.H. Beck.
- Hearnshaw, John B. 2014. *The Analysis of Starlight: Two Centuries of Astronomical Spectroscopy*. New York: Cambridge University Press.
- Henderson, Linda Dalrymple. 1983. *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*. Princeton, NJ: Princeton University Press.
- Houziaux, Léo. 2001. 'Schuster-Schwarzschild's and Milne-Eddington's Viewpoints on the Physical Structure of Stellar Atmospheres'. In *Optics and Astronomy*, ed. by Gérard Simon and Suzanne Débarbat. Proceedings of the XXth International Congress of History of Science (Liège, 20-26 July 1997) 12. Turnhout: Brepols, 217-228.
- Jacobsen, Anja Skaar. 2007. 'Léon Rosenfeld's Marxist Defense of Complementarity'. *Historical Studies in the Physical and Biological Sciences* 37 (suppl.): 3-34.
- Jones, Caroline A., and Peter Galison, eds. 1998. 'Introduction'. In *Picturing Science, Producing Art*. New York: Routledge, 1-23.
- Kloosterman, Jaap, ed. 1972. *Anton Pannekoek: Partij, raden, revolutie*. Amsterdam: Van Gennep.
- Kojevnikov, Alexei. 1999. 'Freedom, Collectivism, and Quasiparticles: Social Metaphors in Quantum Physics'. *Historical Studies in the Physical and Biological Sciences* 29(2): 295-331.
- . 2016. 'Universe in Upheaval: Relativistic Cosmology in the Context of the Russian Revolution', lecture at 'Anton Pannekoek (1873-1960): Ways of Viewing Science and Society', Royal Netherlands Academy of Arts and Science, Amsterdam.
- Kusukawa, Sachiko. 2016. 'Classics from This Journal: Martin Rudwick's "The Emergence of a Visual Language for Geological Science 1760-1840"'. *History of Science* 54(1): 98-104.
- Kwa, Chunglin. 2005. 'Alexander von Humboldt's Invention of the Natural Landscape'. *The European Legacy* 10(2): 149-162.

- Leonard, Robert J. 1999. "Seeing Is Believing": Otto Neurath, Graphic Art, and the Social Order'. *History of Political Economy* 31 (suppl.): 452-478.
- Liagre Böhl, Herman de. 1996. *Met al mijn bloed heb ik voor U geleefd. Herman Gorter 1864-1927*. Amsterdam: Balans.
- Linden, Marcel van der. 2004. 'On Council Communism'. *Historical Materialism* 12(4): 27-50.
- Long, Pamela O. 2011. *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600*. Corvallis, OR: Oregon State University Press.
- Lütticken, Sven. 2018. 'Council Aestheticism? Pannekoek, the Avant-Garde and Contemporary Art'. *Studi di estetica* 46(12): 173-197.
- Malandrino, Corrado. 1987. *Scienza e socialismo. Anton Pannekoek (1873-1960)*. Milan: Franco Angeli.
- Mattick, Paul. 2016. 'Socialism, Art, and Science in the Work of Otto Neurath', lecture at 'Anton Pannekoek (1873-1960): Ways of Viewing Science and Society', Royal Netherlands Academy of Arts and Science, Amsterdam.
- Nasim, Omar W. 2013. *Observing by Hand: Sketching the Nebulae in the Nineteenth Century*. Chicago, IL: University of Chicago Press.
- Pang, Alex Soojung-Kim. 1997. 'Visual Representation and Post-Constructivist History of Science'. *Historical Studies in the Physical and Biological Sciences* 28(1): 139-171.
- Pannekoek, Anton. 1932. 'Das Wesen des Naturgesetzes'. *Erkenntnis* 3(1): 389-400.
- . 1982. *Herinneringen: herinneringen uit de arbeidersbeweging; sterrenkundige herinneringen*. Eds. Ben A. Sijes, Johanna M. Welcker, and J.R. van der Leeuw. Amsterdam: Van Gennep.
- Potochnik, Angela, and Audrey Yap. 2006. 'Revisiting Galison's "Aufbau/Bauhaus" in Light of Neurath's Philosophical Projects'. *Studies in History and Philosophy of Science Part A* 37(3): 469-488.
- Schaffer, Simon. 1998. 'On Astronomical Drawing'. In *Picturing Science, Producing Art*, ed. by Caroline A. Jones and Peter Galison. New York: Routledge, 441-474.
- Sijes, Ben A. 1982. 'Anton Pannekoek 1873-1960'. In *Herinneringen: herinneringen uit de arbeidersbeweging; sterrenkundige herinneringen*, by Anton Pannekoek, ed. by Ben A. Sijes, Johanna M. Welcker, and J.R. van der Leeuw. Amsterdam: Van Gennep, 11-69.
- Smart, D.A., ed. 1978. *Pannekoek and Gorter's Marxism*. London: Pluto Press.
- Smith, Pamela H. 2006. 'Art, Science, and Visual Culture in Early Modern Europe'. *Isis* 97(1): 83-100.
- SMBA. 2016. *Jeronimo Voss – Inverted Night Sky*. SMBA Newsletter 146.
- Steen, Bart van der. 2006. 'Anton Pannekoek en het orthodoxe marxisme'. *Vlaams Marxistisch Tijdschrift* 40(2): 73-82.

- Tai, Chaokang. 2017. 'Left Radicalism and the Milky Way: Connecting the Scientific and Socialist Virtues of Anton Pannekoek'. *Historical Studies in the Natural Sciences* 47(2): 200-254.
- Tai, Chaokang, and Jeroen van Dongen. 2016. 'Anton Pannekoek's Epistemic Virtues in Astronomy and Socialism: Personae and the Practice of Science'. *BMGN – Low Countries Historical Review* 131 (4): 55-70.
- Voss, Jeronimo. 2016. *Inverted Night Sky*. Installation at Stedelijk Museum Bureau Amsterdam.
- . 2017. *Inverted Night Sky*. Dortmund: Verlag Kettler.
- Wilder, Kelley E. 2009. *Photography and Science*. London: Reaktion.
- Winkler, Mary G., and Albert van Helden. 1992. 'Representing the Heavens: Galileo and Visual Astronomy'. *Isis* 83(2): 195-217.
- Zwart, Hub. 2019. 'Poetry, Science and Revolution: The Enigma of Herman Gorter's Pan'. *Journal of Dutch Literature* 10(1): 24-49.

About the Authors

Chaokang Tai is a PhD researcher in history of science at the University of Amsterdam. He is a member of the Vossius Center for History of Humanities and Sciences, University of Amsterdam, and the Descartes Centre for the History and Philosophy of the Sciences and the Humanities, Utrecht University. His current research focuses on the astronomical research of Anton Pannekoek in historical and societal context.

Bart van der Steen is University Lecturer at Leiden University's Institute of History. His research focuses on interwar labour movements and New Social Movements from 1968 to the present. His most recent publications include: *In Leiden moet het anders. Geschiedenis van een SP-afdeling, 1970-1982* (2019), and *A European Youth Revolt. European Perspectives on Youth Protest and Social Movements in the 1980s* (2016), edited with K. Andresen.

Jeroen van Dongen is Professor of History of Science at the University of Amsterdam, where he also obtained his PhD in 2002. He has taught at Utrecht University and has held research positions at the Max Planck Institute for the History of Science and the Einstein Papers Project at the California Institute of Technology. He currently serves as co-director of the Vossius Center for the History of Humanities and Sciences at the University of Amsterdam.