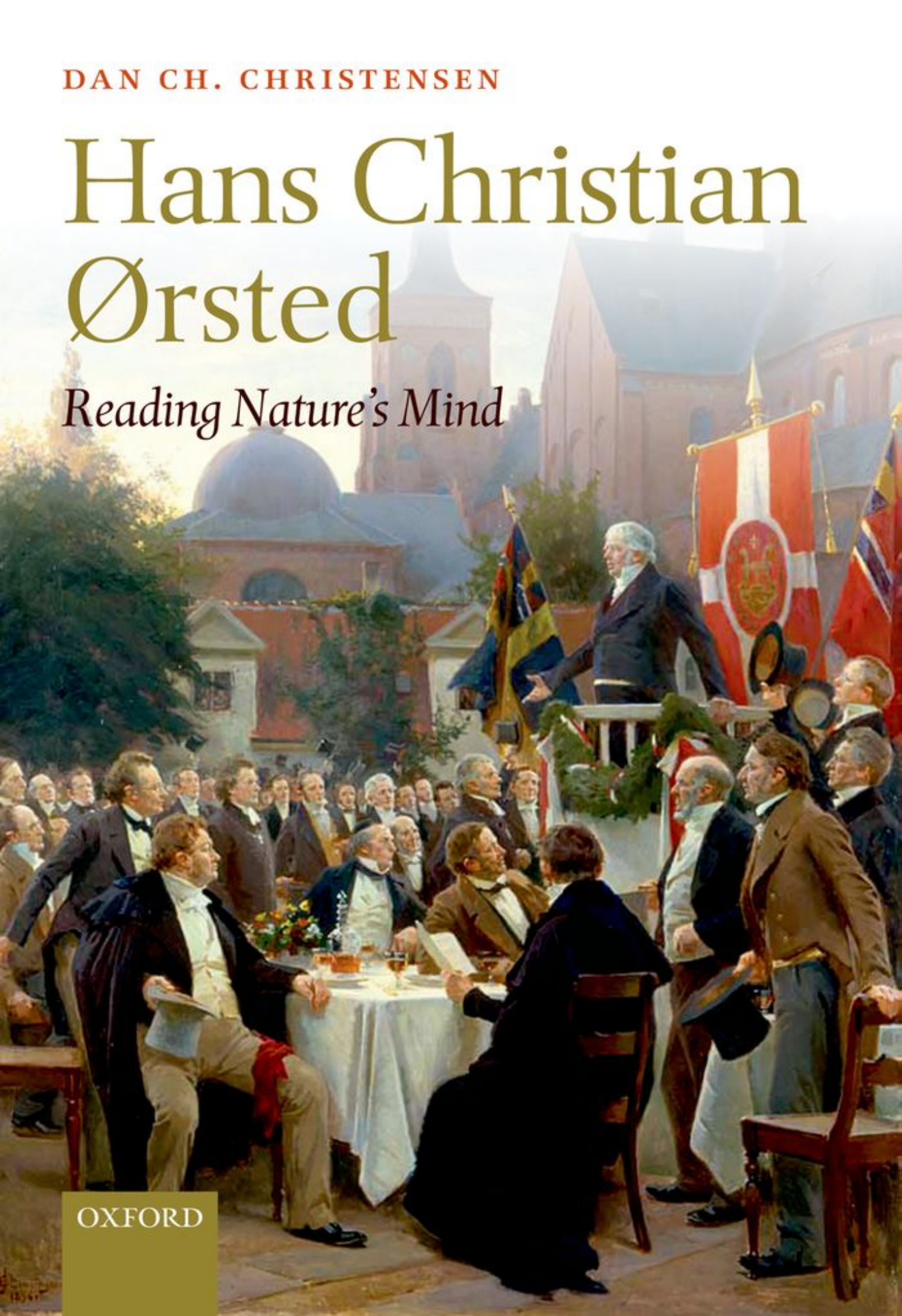
DAN CH. CHRISTENSEN

Hans Christian Ørsted

Reading Nature's Mind



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HANS CHRISTIAN ØRSTED

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DAN CHARLY CHRISTENSEN

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LIST OF ABBREVIATIONS

ADB	Allgemeine Deutsche Biographie
AOe	Adam Oehlenschläger
ASØ	Anders Sandøe Ørsted
BAAS	British Association for the Advancement of Science
BAS	Bibliotheca Academia Sorana, Sorø [Library of Sorø Academy]
BPK	Bildarchiv Preussischer Kulturbesitz, Berlin [Prussian Picture Archive]
BT	Berlingske Tidende
C I-II	*Correspondance de H.C. Örsted avec divers savants* [HCØ's Correspondence with sundry scholars], vols.i–ii, ed. by M.C. Harding, Copenhagen 1920
CCA	Copenhagen City Archive
CCM	Copenhagen City Museum
CF	Prince Christian Frederik, (King CVIII, 1839–48)
CH	Christopher Hansteen
CM	Christian Molbech
DBL	Dansk Biografisk Leksikon
DCC	Dan Ch. Christensen
DFO	Den danske Frimurerorden [Danish Masonic Order]
DHS	Den Hirschsprungske Samling, Copenhagen
DNB	Dictionary of National Biography
DPB	Danske Politiske Breve [Danish Political Letters]
DSB	Dictionary of Scientific Biography
DTM	Danmarks Tekniske Museum, Ellsinore
DTU	Danmarks Tekniske Universitet, Lundtofte
EA	Erhvervsarkivet, Aarhus
EAS	E.A. Scharling
FVI	King Frederik VI (1808–1839)
FMA	Den store danske Frimurerordens arkiv [Masonic Archive]
FRM	Frederiksborgmuseet, Hillerød
FCS	F.C. Sibbern
FPL	Frederiksberg Public Library
FRS	Fellow of Royal Society
FWJS	F.W.J. Schelling
GDNÄ	Gesellschaft Deutscher Naturforscher und Ärtzte
HCA	Hans Christian Andersen
HCA SV	Hans Christian Andersen, *Samlede Værker 1–17,* Cph. 2003–2007
HCØ	Hans Christian Ørsted

IBØ	Inger Birgitte Ørsted, née Ballum
JC	Jonas Collin
JFS	Joakim Frederik Schouw
JGF	Johan Georg Forchhammer
JJB	Jöns Jacob Berzelius
JLH	Johan Ludvig Heiberg
JWR	Johann Wilhelm Ritter
KDVS	Det Kongelige Danske Videnskabernes Selskab [The Royal Danish Society of Sciences and Letters, Copenhagen]
KLE	*Kjøbenhavns Lærde Efterretninger* [Copenhagen Learned News]
KU	Københavns Universitet
KUJ	*Kjøbenhavns Universitetsjournal*
LAB	Landesarchiv, Berlin
LAS	Landsarkivet for Østifterne, Copenhagen
LHS	Landhuusholdningsselskabet [Royal Danish Agricultural Society]
LM	Ludvig Manthey
MØI-II	*Breve til og fra HCØ*, [Letters to and from HCØ], ed. by Mathilde Ørsted, vols.i–ii, Copenhagen 1870
NBD	Nyere Brevsamling Dansk [New Collection of Letters, RL]
NFSG	N.F.S. Grundtvig
NKS	Nye Kongelige Samling [New Royal Collection, RL]
NPG	National Portrait Gallery, London
NS I-III	*HCØs Naturvidenskabelige Skrifter*, [HCØ's Scientific Writings], vols. i–iii, ed. by K. Meyer, Copenhagen, 1920
OBM	Odense Bys Museer [Museums of Odense]
PLA	Polytechnisk Læreanstalt [Polytechnic Institute, Copenhagen]
PRO	Rigsarkivet [Public Record Office, Copenhagen]
RL	Royal Library, Copenhagen
RMN	Agence photographique de la réunion des musées nationaux
RS	Royal Society, London
RUB	Roskilde Universitetsbibliotek
SAK	Søren Aabye Kierkegaard
SCØ	Søren Christian Ørsted
SES	*Samlede og Efterladte Skrifter af H.C. Ørsted* [Collected and Posthumous Works by HCØ], vols. i–ix, ed. by M. Ørsted, Copenhagen 1852–53
SLS	Skandinavisk Litteraturselskab [Scandinavian Literary Society]
SMK	Statens Museum for Kunst, Copenhagen
SNU	Selskabet for Naturlærens Udbredelse i Danmark [The Society for the Dissemination of Science in Denmark]
SP	Sophie Probsthein

SSW	*Selected Scientific Works of Hans Christian Ørsted*, transl. and ed. by K. Jelved, A.D. Jackson, and O. Knudsen with an Introduction by A.D. Wilson, Princeton 1997
SØ	Sophie Ørsted
TL	*The Travel Letters of H.C. Ørsted*, ed. and transl. by K. Jelved and A.D. Jackson, Copenhagen 2011
WCZ	W.C. Zeise
ØC	The Ørsted Collection, RL

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LIST OF ILLUSTRATIONS

To Karin Bastian

PART I

THE STUDENT

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He was a man carved out of one piece,
he did not subscribe to one belief in his writings
and another one at home for everyday use.[1]

1 | 1777–1851
Introduction

Ørsted is probably one of only three internationally well-known Danish figures in the history of science, the others being Tycho Brahe and Niels Bohr. So though his career invites a painstaking and comprehensive biography, strange as it may seem there has been no profound study of his life and works, no biography that takes full advantage of the enormous, though scattered, body of source materials he left behind. Of course there are separate studies of his research, his discovery of electromagnetism in particular, of his achievements in the field of scientific education, and of his influential position in Danish cultural life. Still, there is no biography that tries to understand the complete human being and to assess his importance as a scholar and as an organiser, philosopher, poet, and aesthete. As we can tell from what we find out about him, his life and works formed a coherent whole and took place in a close and continuous collaboration with his brother Anders Sandøe. It is hardly an overstatement to suggest that the two Ørsted brothers headed the nation's intellectual elite during the dramatic period from the turn of the eighteenth century to the middle of the nineteenth, the period posterity has dubbed the Danish Golden Age. His fame was the fruit of an unfailing and life-long store of energy which was channeled to benefit Danish science and culture in the broadest sense, and which did not diminish with the many honours heaped upon him. His biographer does not need to build him up with flattering words. He was a man of sterling character marked by a rare harmony of conviction and action. In all its aspects Ørsted's life story is an edifying tale.

It is hard not to admire his accomplishments in scientific research and education. When he matriculated in 1794, there was no degree in physics, chemistry, or any other individual

scientific discipline on offer at the University of Copenhagen. By the time of his death the Polytechnic Institute as well as a Faculty of Science at the University had been established thanks to his efforts. Although his career was launched in direct opposition to the sparse research activities of individual fellows of the Royal Danish Society of Sciences and Letters, who kept all doors closed to the young and critical undergraduate, by the end of his life he succeeded in occupying one of the highest positions in Denmark.

In his dissertation Ørsted took as his point of departure Kant's metaphysical philosophy of nature, which offered a critical analysis of Newton's laws of motion. The small scientific community in Copenhagen was oriented towards Paris, which was generally recognised as the universal headquarters of mechanical and mathematical physics. No other Danish philosopher of nature had immersed himself in Kant's critical epistemology (nor had any been attracted to it), apart from Hans Christian Ørsted, whose brother had equally thrown himself into Kant's moral philosophy. Inspired by Kantian metaphysics he worked out a research programme for a dynamical physics that focused on the study of immaterial phenomena such as light, heat, electricity, and magnetism. Against the technological utility conventionally demanded by Denmark's absolutist regime, Ørsted maintained that the study of natural philosophy should be justified for its cognitive and aesthetic benefits. Technological gains were allocated only third place. As a teacher of science he was convinced that natural philosophy equips its students with the best method to distinguish between true and false. To him the laws of nature enshrined a particular beauty and harmony—an aesthetic dimension that would open the eyes of artists and art-lovers to the beautiful in nature and in art. Ørsted visualised an intimate relationship between science and the arts. A natural philosopher would take his point of departure a priori in the metaphysics of nature and would demonstrate the empirical reality of the laws of nature, while an artist would embrace phenomena with his sensory organs in order to reveal subtle ideas to the art-lover. He believed scientific research per se to be closely akin to religious worship. For some people miracles serve as proofs of the existence of God. For Ørsted, however, the absence of miracles reflected divine intelligence. The fact that nature is intelligible and that she abides by laws was awe-inspiring to him. To Ørsted the rationality of the laws of nature and the harmony of all existence revealed God. Moreover, the rationality of laws of nature, which every research effort takes for granted, must be equivalent to human rationality as but a small part of divine rationality. Ørsted's character embodied this awe and a self-confidence which made him consider the laws of nature, including electromagnetism of course, to be 'nature's thoughts' or 'nature's mind'. It is this which is reflected in the subtitle of this biography: *Reading Nature's Mind*.[2]

*

Hans Christian Ørsted revolutionised natural science when in 1820 he observed the deflection of a magnetic needle caused by the electrical force in a wire. His discovery flabbergasted the international community of physicists, particularly the French Académie des Sciences, who had long been convinced that the two phenomena, magnetism and electricity, are embodied in two different, imponderable fluids and are therefore independent. Consequently, all attempts at discovering interaction between them must be doomed to failure. Moreover,

everybody, including Ørsted himself, was utterly surprised to learn that the interaction took place in a snail-like orbit which deviated from the rectilinear attraction/repulsion observed in Coulomb's electrometer.

Ørsted's discovery opened the gates to an entirely new field of scientific research. One decade later Michael Faraday discovered that a magnet wound with an electrical wire would induce the inverse effect. Five decades later James Maxwell gave a mathematical treatment to Ørsted's and Faraday's theories of electrical and magnetic forces. The interaction of these forces was subsequently exploited in a range of technological innovations that fundamentally changed everyday life for ordinary people all over the world.

Initially, let me briefly sketch some main points in the historiography of our protagonist. An appropriate first question is this: Can we be sure that the discovery was actually made by Ørsted? His priority has been contested by a few historians of science, notably J.J. Hamel writing in 1859 about early telegraphy. They have argued that two Italians, Giuseppe Mojon and Gian Domenico Romagnosi deserve the honour bestowed upon Ørsted or at least came very close to discovering electromagnetism. These claims have subsequently been repudiated.[3] Although Ørsted owned a book published in Paris 1804 by J. Aldini briefly reporting that 'Romagnosi has made experiments with the magnetic needle', in all probability Ørsted remained unaware of them, hidden away as they are on page 340.[4] Romagnosi never came anywhere near discovering electromagnetism and stated in a letter of 1827 'I was only an amateur physicist and I do not want the honour due to Ørsted'.[5]

Having ascertained Ørsted's priority I shall turn to various views that remain etched in current historiography. Some argue that Ørsted stumbled over the discovery by chance. Wilhelm Ostwald for one labelled Ørsted a *Naturphilosoph* and remarked condescendingly, 'Sometimes nature whispers its secrets into the ears of researchers in the most absurd way'. In Ostwald's eyes 'Naturphilosophie ravaged Germany like a plague in the first years of the 19th century', and he considered Ørsted to be contaminated by this disease, thus implying that he was merely a lucky man, not a sound scientist.[6]

Conversely, Faraday, who redirected his field of research for the rest of his life in consequence of the discovery, found in 1821 already that Ørsted, due to 'constancy in his pursuit of his subject—both reasoning and experiment—was well rewarded . . . by the discovery of a fact of which not a single person beside himself had the slightest suspicion.'[7] In other words Faraday, as opposed to Ostwald, stressed the singlemindedness and originality of Ørsted's epoch-making discovery. A similar view was entertained by John Herschel who compared Ørsted's perseverance to that of Columbus. Both discoverers obstinately anticipated the necessary existence of hitherto unknown phenomena, and when they found them they realised at the same time that what they eventually found differed not only from their initial expectations, but also from contemporary doctrines.[8]

Oswald's degrading view that the discovery was a lucky accident is a world apart from Faraday's and Herschel's unreserved acknowledgement of originality. Still they have one thing in common. Ørsted acted single-handedly. Their explanations require there to be no impact from the scientific community. But for almost a century other historians of science have been on the look-out for sources of influence, taking it for granted that scientists do not act in a vacuum,

but are in fact intellectually influenced by encounters with other scientists or their works. This may be true, but leaves open the question of degree of influence, varying from imitation or even plagiarism to relative independence or even originality.

For the past five decades controversy among historians of science has revolved around the impact from Kantian metaphysics and/or *Naturphilosophie*, although in ambiguous ways, because attitudes towards the two sources of inspiration—sometimes perceived as lying outside the field of proper scientific investigation, sometimes not—have oscillated between two extremes. K. Meyer claimed (1920) that Ørsted was deeply influenced by Kant or by Schelling or by both at least in his younger days, but also that he came to realise the futility of their speculative approach to science as he matured and headed for empirical research.[9]

B. Gower in his penetrating article 'Speculation in Physics' (1973) aimed at demonstrating that *Naturphilosophie* represents a cul-de-sac in the history of science. Schelling's 'baffling abstruseness' cannot possibly have been conducive to enduring scientific knowledge, and in any case Ørsted's enthusiasm for *Naturphilosophie* waned before his discovery. T. Shanahan in his reassessment (1989) of Schelling's intellectual influence raised equally strong objections and to underpin his scepticism quoted Ørsted as follows: 'He [Dr J.J. Wagner, a German philosopher] wants to give us a complete philosophical system of physics, but without any knowledge of nature except from text-books and without possessing the same rigorousness of philosophical construction as Kant, exactly like his master [Schelling]... These people all bring to market lame philosophical proofs and lopsided physical theories, and then they grumble when others will not accept them.'[10] Shanahan argued that Ørsted drew his inspiration from Kantian epistemology and metaphysics, which was fully sufficient to have inspired his great discovery. G. Buchdahl(1986), finally, stated that Ørsted's discovery was probably the only conspicuous example to show that Kantian metaphysics was to some extent instrumental, thus proving its scientific fruitfulness.[11]

However, the pendulum had already started to swing to the opposite extreme from the 1950s. The virtues of *Naturphilosophie* were vindicated by a number of American historians of science. R. Stauffer (1953 and 1957) was perhaps the first to claim that Ørsted had been influenced (not only by Kant, but also) by 'Schelling's beautiful and great ideas... (that) should be recognized as factors involved in a major discovery in physics'.[12] P.L. Williams followed suit in his authoritative article in the *Dictionary of Scientific Biography* (1974) stating, 'Since both Oersted and the *Naturphilosophen* drew their inspiration and basic ideas from Kant, it is no coincidence that Oersted's later [*sic*!] philosophy closely resembled *Naturphilosophie*.'[13]

The next generation of American historians pursued this line, but stopped to dig a little deeper. Reasonably, K.L. Caneva(1997, 2007), A.D. Wilson 1998, 2007), and M. Friedman (2007) inquired:[14] 'if it is true that Schelling's ideas had an impact on Ørsted's discovery it must be possible to clarify more precisely what idea helped him'. In looking for an answer to this question they point out Schelling's tripartite scheme, and Friedman calls special attention to the publication of this scheme in the 1803 edition of Schelling's *Ideas*. So, we have now moved from Stauffer's suggestion that Kant's and Schelling's ideas in general influenced Ørsted to the assertion that Ørsted's discovery was even conditioned by Schelling's specific scheme, without which there would be no path leading from Kant's metaphysics to the discovery of

electromagnetism. Friedman concluded: 'The crux of the matter, of course, is that Schelling's *Naturphilosophie* was in fact an intelligent, perceptive, and appropriate response to both the tensions in Kant's system and the new empirical results. Viewed in this particular context, I believe, there is indeed much of "philosophical value" to be gained by studying it.'[15]

Since the discovery of electromagnetism was so completely at odds with contemporary doctrines, one wonders why other physicists or chemists under the spell of *Naturphilosophie* did not make scientific discoveries of any significance. In 1829 Steffens, perhaps Schelling's most ardent disciple and once Ørsted's rival, congratulated Ørsted on his scientific success while regretting that *Naturphilosophie* had achieved so very little (ch. 52).

This introduction is not the right place to comment on this multipolar, complicated, and ongoing controversy. Throughout this biography I shall aim at elucidating my claim that Ørsted was open-minded, cosmopolitan, and under a wide range of influences, but never became a partisan of any established intellectual movement let alone of *Naturphilosophie*. I believe that this debate has strongly exaggerated the issue of 'influence'. Furthermore, the stronger the dependency on a particular authority the more the autonomy and originality (qualities Ørsted valued highly) of our protagonist are dwarfed. This study will explore practically all available source material illuminating Ørsted's persona and works by focusing on the epistemology and experimentation of his scientific work, by scrutinizing his many personal relationships with the scientific community at home and abroad, by bringing to light his many activities as an organizer of academic and political institutions, and finally by unravelling his particular interests relating to religion, ethics, and aesthetics.

*

Since Ørsted was the only chemist/physicist in Denmark who considered himself a Kantian, it is hardly surprising that he received very limited response from domestic academia. Court Steward Adam Hauch, who had studied under Lavoisier, was an independent amateur scientist, open-minded and of high renown, and he was one of the very few with whom young Ørsted entered into a fruitful dialogue. Professor Manthey, the pharmacist, protected him and provided the travel grant that enabled his protegé to go abroad. But Thomas Bugge, professor of mathematics and astronomy found Kantian metaphysics irrelevant, if not harmful for science, so Ørsted's early career at the University was most uncertain. What mattered most of all to him was the opportunity to meet natural philosophers in the German states and in Paris, to escape provincialism, and to encounter philosophers and experimenters who might become collaborators on his dynamical project. In the five decades from 1800 to 1850 Ørsted spent more than five years abroad, that is more than ten per cent of his adult life. And he did make friends as well as enemies. The first journeys were primitive *Wanderjahre,* years of apprenticeship, whereas his travels after his discovery were veritable triumphal entries into Berlin, Paris, and London.

Ørsted was well equipped to engage with foreign communities of scholars. His German which he had picked up in childhood was fluent, and when he arrived in Paris he paid a tutor to give him instruction in French every morning. Soon he would write articles for scientific journals in French and there seems to have been no problem for him in conversing with the

members of the French Académie. His first visit to Britain took place as late as 1823, and his problems with English were considerable. At that time English ranked third as a foreign language in Denmark, and in the beginning he was utterly confused by the relationship between English spelling and pronunciation, and struggled to spell what he heard and to pronounce what he read. His speeches were flat and formal for want of vocabulary and the letters he sent John Herschel in the late '40s testify that he never quite overcame these initial difficulties.

His journeys abroad meant everything to him, because now he encountered his peers and found role-models. He gave special attention to the styles in which lectures were delivered and experiments made. He saw laboratories and collections of instruments he had never seen before, and he picked up useful social competences in the salons and societies he joined.

He experienced the enormous social differences between natural philosophers in Germany and France. The worlds of Ritter and Laplace could hardly be further apart. But of course he also noticed the different modes of thinking about and practising science in Germany where *Naturphilosophie* had a strong foothold and France where Laplacean pre-positivism ruled supreme. Ørsted could not help observing the opportunism that impregnated French science in the post-revolutionary period and as a Nordic puritan he was almost bound to criticise the well rewarded members of the French Académie who unlike his friend Ritter—did not have to work hard to make a living. Moreover, their philosophies were so different. In France it was as if Kant had lived on another planet, whereas the Germans were better informed about their neighbours thanks to their ability to read French.

Crossing the borders between these diverse scientific cultures alerted Ørsted to the particularities of paradigmatic differences across Europe. Representatives of these cultures were part of his vast network of colleagues, and they did not speak the same scientific language. Humboldt and Ørsted were probably the two natural philosophers who communicated with the greatest number of scientists across Europe. I have found it of great interest to study how Ørsted managed to cope with this state of affairs. He found it necessary to adapt his major work to the two contending cultures, the German and the French, by publishing it in two different versions. Having made this discovery he immediately saw its potential in supporting the dawning opposition to Laplacean supremacy in French science. In the end Ørsted's electromagnetism was certainly a contributory factor in bringing about the fall of Laplace. In Britain his discovery was immediately acclaimed as a revolutionary conquest, but his interpretation of it was met with some reservation, as being less interesting. Towards the end of his life he urged Herschel to help him find a publisher for his aesthetic and religious philosophy (*The Soul in Nature*), but to no avail, and when the book finally landed on the British market it fell on barren ground. Darwin found it 'dreadful'.

*

Ørsted's achievement, however, went further than taking advantage of his discovery of electromagnetism to secure a place for the sciences at the University. Already as undergraduates Hans Christian and his brother Anders had immersed themselves in Kantian philosophy, the elder in the metaphysics of science, the younger in the philosophy of morality. Belonging to two different camps, science and moral philosophy, this interdisciplinary collaboration was from first

to last obviously attracted by one of Kant's most essential problems: the apparent antinomy between the determinism of the laws of nature ('the starry heaven above me') and the freedom of the will ('the moral law within me') so crucial to upholding the dignity of man. Like their master who sought after the desirable possibility of joining his three critiques into one philosophy, both brothers were engaged in trying to find out whether these realms, so opposite at the outset, could be unified.

One of the reasons that some historians of science have included Ørsted in the movement of *Naturphilosophie*, I think, stems from the observation that this movement embarked on a similar endeavour. So what is the difference between Schelling's solution and Ørsted's? The decisive difference, as I shall try to show, is that Schelling already from the beginning founded a philosophy of identity according to which he justified the imposition of speculative ideas upon nature in order to invest it with consciousness. If Ørsted was sometimes tempted to embrace Schelling's philosophy of identity (objective idealism) or parts of it, he more often rebuked it for ignoring the importance of empirical investigation. He never adopted Schelling's philosophy of identity, but remained faithful to Kant's dualism, and in particular to his distinction between nature and mind, and between the phenomenal and the noumenal realms (chs 25 and 52).

Nevertheless, Kant did bridge the gulf between the determinism of natural laws and the freedom of morality by the following chain of arguments: the laws of nature, apparently, are endowed with reason in so far as—according to human reflection—there seems to be a plan in nature and consequently design and plot. Also the categorical imperative—based on human reason—presupposes that it is at least possible to realise the moral objectives in freedom in this phenomenal world as otherwise it would lose its meaning. Hence, the freedom (to intend at least) to live a morally good life in an ambience determined by laws of nature is open to us as a possibility. This view, of course, is a product of practical philosophy. It is not knowledge, but an idea fostered by human reason. And it is different from the bridge established by Schelling's *Identitätsphilosophie* or objective idealism, which eliminated the possibility of moral freedom by ascribing a theoretical identity between nature and mind to an Absolute Godhead, to which human morality (and empirical science) is irrelevant.[16]

The practical lives of the brothers seem to have been governed by Kantian and Fichtean ideas. Apart from his many scientific activities Hans Christian dedicated most of his time after 1820 to cultural activities in the broad sense: 1, dissemination of scientific knowledge to the general public; 2, aesthetics of nature; 3, religion; and 4, politics and the rule of law.

1. To start with, Ørsted gave public lectures because he had to make a living. But they continued beyond that need for the rest of his life. The scientific culture for Ørsted was the challenge of disseminating scientific knowledge to the entire population. He was convinced that knowledge of the laws of nature would help people understand the importance of distinguishing between true and false. He started in 1815 to lecture to the scientific laity on Sundays. Inspired by voluntary associations he visited in London, he founded in 1824 the Society for the Dissemination of Science in Denmark; this provided the leverage for the establishment of the Polytechnic Institute five years later, which in turn facilitated the establishment of a Faculty of

Science at the University in 1850. Ørsted's lectures enjoyed large audiences. Series of lectures he delivered to fora of young artists in collaboration with the Academy of Arts took as their theme the significance of knowledge of laws of nature for the creative arts.

2. Although Ørsted was burdened with technological assignments laid upon his shoulders by the government, he opposed the public demand for the sciences to take on the role of a servant to technology. Aside from the intrinsic value of the sciences, he considered them basic to the arts. For to him art imitates nature, so how can the artist paint the idea of a natural landscape without understanding at least the fundamentals of optics and the theory of light and colours? He also formed an editorial board from members of the learned republic to publish a critical journal of the arts, theology, new and disputed sciences such as phrenology, and literature. The intention was to set a course to influence public taste and inspire cultural life.

3. As boys the two brothers had already shown an active interest in theological issues. Anders wrote sermons and planned to study divinity. As students they frequented the services of Dr Marezoll, the German and Kantian vicar at St Petri. Grundtvig, the theologian, mythologist, and hymn writer so provoked the Ørsted brothers by launching an impetuous attack on the new German school of philosophy that Hans Christian engaged him in a long debate on pantheism. Both took part in theological clashes between the state church and dissenting movements, asserting their opposition to smug dogmatism and advocating instead a minimalist creed and an unorthodox concept of God. Here, too, Hans Christian thought like a Kantian. God cannot be an object of theoretical knowledge, but it may accord with human reason to imagine God as the creator of nature. As such we may perceive him as revealed in nature, but nothing can be deduced from theology to science. In the end his unorthodox concept of God brought him on a collision course with the supreme authority of the state church.

4. When eventually the absolutist regime opened its doors to popular participation in politics he became a 'fiery soul' (a term he invented) in The Society for Liberty of the Press, seeking to influence the government in order to advance the protection and extension of the freedom of the press and the rule of law. He worked closely with his brother Anders who in 1826 had been forbidden to take part in public debate, so they agreed on a secret plan to work closely together. Anders would be the mole in the government and feed Hans Christian with the insider's knowledge necessary for him to act as a mouthpiece for both. Much to Hans Christian's annoyance, however, the National Liberal movement gradually succeeded in dominating the society, and he resented their nationalistic programme and power-seeking aspirations. He ranked the rule of law above democratic rule and ended up disillusioned with the political events taking place in Denmark in 1848, leading to a premature constitutional change and a devastating civil war.

*

Given this background, I endorse the image of Ørsted as a man of two cultures. This is probably not his image outside his native country. I think one of the reasons that Ørsted's persona has been split into two is that his works have been published in that way. His daughter Mathilde Ørsted edited a posthumous collection of her father's cultural works in nine volumes [*Samlede og Efterladte Skrifter*]. Most of the first two volumes were published in English under the title *The Soul in Nature*. They contain his philosophical, religious, aesthetical, pedagogical,

and political thoughts. At the end of the ninth volume comes Hauch's unsurpassed biography, carefully depicting his protagonist as one who bridged the gap between two cultures and distinguished himself in both.

By 1920, the centenary of his discovery, the dualism of the Golden Age had long lost general support in favour of positivism. The celebration of Ørsted, the national icon of Danish science, that year (which coincided with the reunification of part of Schleswig with the Danish monarchy), was used as an opportunity to harness him to a political project to promote engineering and scientific education. The Royal Danish Society of Sciences and Letters asked Dr Kirstine Meyer to edit and introduce Ørsted's scientific writings, while completely ignoring the cultural parts of his oeuvre. Meyer's publication of Ørsted's collected scientific writings [*Naturvidenskabelige Skrifter*, translated as *Selected Scientific Works of H.C.Ørsted* (1998)] widened the gap in his life, a gap that was more than simply formal. According to positivism, the prevailing paradigm of the 1920s, science must be cleansed of values. Hence, complete separation of science from metaphysics and cultural values was considered not only reasonable but virtuous.

The gap between the sciences and the arts reflects C.P. Snow's well-known division between two cultures as having two languages that are mutually incomprehensible. Piet Hein, the Danish architect and poetic philosopher, has amused his readers by calling the scientific and technological camp 'technocists' and their adversaries 'cultists'. The two terms deliberately echo 'idiots' and 'occultists', hinting at the reciprocal prejudices of the two camps. According to this animosity 'technocists' only take an interest in exact and material problems and their concrete solutions whereas they lack aesthetic education and taste. 'Cultists' on the other hand wander aimlessly about engaged in metaphysical speculation and even approach the occult, while boasting of their incapacity to appreciate technology at the same time as making use of high-tech gadgets. Sadly, Snow claimed, this cultural gap is widening. Ørsted, however, exerted a strong influence in both camps insisting on uniting the scientific and cultural elite. Members of the learned republic of the Golden Age were still on speaking terms across cultural borders. For Ørsted human reason bridged the two camps.

Ørsted was a formidable, original, and ambitious character in Danish science and culture. Nevertheless he maintained a child-like, almost naive and trustful attitude that endeared him even to people who did not share his convictions. Am I depicting some kind of saint and are you about to read a hagiography? In fact it is hard to find examples of unpleasantness or accusations of selfishness being levelled at Ørsted, and I have searched meticulously for them in the archives. What personal benefit could he possibly hope to gain from fostering a fourteen-year-old chemist's son and a hypochondriac in his own house, or from supporting Hans Christian Andersen, an anxious cobbler's son and budding poet of sixteen? What ulterior motive could he possibly have in discreetly but open-handedly sharing his money with Ritter, a German pauper and amateur scientist, or with Anders Sandøe, his sick brother, or in exercising his influence in favour of young talents such as Oehlenschläger, Heiberg, and Carsten Hauch to promote their careers? His readiness to help reflected a well-developed ability to spot talent and a conviction that just as he had previously sought and found shelter under the protective wings of others, so it was now his obligation to pay off that debt. According to Ørsted it was a

Fig. 1. Oxford University Museum had planned the Ørsted statue to be carved in marble by A. Monro and to be paid for by Queen Victoria, like the other statues. Unfortunately, the sculptor had to give up for want of a model and he was unable to get hold of Ørsted's death mask. This was no wonder, because the requisition had been sent to Sweden (Phillip's letter of 10.07.1861, The Oxford University Museum Archive). Meanwhile Monro had already been paid a sum in advance according to the contract of 1859, so a protracted dispute ensued and the statue was only erected in 1885 after a lot of fuss. According to archival material kept by the museum the statue is modelled by a certain K. Jobhen (B. Haward 1991, F. O'Dwyers.a. 257, and personal information from curator Stella Brecknell). 'K. Jobhen' is a sloppy transcription of a Danish hand. Actually, the artist was J.A. Jerichau (1816–83), who had been commissioned to model and cast a bronze statue for erection in the Ørsted Park, where it was unveiled in 1876 (fig. 2). When J.C. Jacobsen, founder of the Carlsberg Breweries, became aware of the problem at the Museum he took the trouble to buy an unused design in clay from Jerichau's estate and had it shipped to Oxford (Nos. 103a and b in *Fortegnelse over de af afdøde Professor Jerichau efterladte Kunstværker* [Catalogue of posthumous artworks by the deceased Professor Jerichau], 1885, Studiesamlingen, SMK). Obviously, both statues are made by the same artist (similar facial features, but different positions of hands). Jacobsen had been attending Ørsted's lectures in the Society of the Dissemination of Science for many years. Photo by Oxford University Museum. I am grateful to Stella Brecknell for her help.

Fig. 2. In 1861 a committee consisting of Hans Christian Andersen, the storyteller, G. Forchhammer, geologist, O.B. Suhr, merchant, and F. Tillisch, Privy Councillor organized a collection of voluntary contributions to erect a monument in honour of Ørsted. The committee soon approached Professor Jerichau, whose first design showed four bas-reliefs representing subterranean forces of nature and allegorical women from antiquity, with Ørsted dressed in a Greek chiton on top of the pedestal. The committee rejected this classical design, demanding Nordic norns and a modern scientist dressed in contemporary clothes. Jerichau's new design shows Ørsted in a didactic position and with a magnetic needle on a pillar and at his feet a galvanic apparatus. The statue rests on a base of granite on a hill in the new park established on the site of the former moat surrounding Copenhagen. (Anne Christiansen, *Skønhed og skrøbelighed. Værker af billedhuggeren J.A. Jerichau fra museets samling* [Beauty and Frailty. Works by the Sculptor J.A. Jerichau from the Museum's Collections], OBM 2003.) Photo by the author.

personal duty to develop a talent bestowed by nature for the common good. His trust in individual perfectibility was strong and emanated from reason, for it would be contrary to reason to let gifts of nature vanish. Genius (like noblesse) obliges.

In his biography of Niels Bohr, Abraham Pais notes that a reproduction of a painting of Ørsted speaking at the meeting of Scandinavian Scientists at Roskilde 1847(fig. 131) decorated Bohr's office at The Institute of Theoretical Physics in Copenhagen. Pais regrets that he never asked Bohr what precisely this picture meant to him, but assumes that Bohr felt a certain

affinity with Ørsted. Both had done epoch-making scientific research, both were internationally recognised and widely travelled; both had leading roles in The Royal Danish Society of Sciences and Letters and in The Society for the Diffusion of Science, both were home-loving persons, and both had lifelong ties to brothers who also had important roles in academia. Finally, both of them had something boyish about them, some trait of straightforward innocence and plain modesty.

Ørsted's international image resembles a sketch or a draft, not unlike the statue of him in the Oxford University Museum of Natural History, which is also symptomatic of his position in the history of science. In this great hall thirty-four statues of famous scientists from history have been erected. There are three Greeks from Antiquity (Aristotle, Hippocrates, and Euclid), twenty-six Britons, and four Europeans (Galileo, Leibniz, Linnaeus, and Ørsted) as well as Albert, the Prince Consort, who was neither quite British nor quite a scientist. It is a mark of merit, of course, that Ørsted is categorised on an equal footing with Newton and Darwin; but it is hard to escape the notion that the British have been over-generous towards their fellow countrymen as, for instance, no French scientist has been given the honour. Most conspicuous, however, is the fact, that whereas all other statues are carved in stone, Ørsted's is modelled in plaster. He stands out as an emergency solution. Thus Ørsted is incorporated into the international company of immortal scientists in this hall of fame, but nevertheless he is represented as an outsider.

Most of the questions raised in this introductory chapter are deliberately left open. They will find answers in the following chapters, which are basically structured chronologically, but also, where appropriate, with due regard to thematic coherence. The epilogue is particularly intended to discuss Ørsted's position in international historiography. This life of Ørsted endeavours to put him in his proper niche in the history of science by elucidating all aspects of his many faceted life: scientific, religious, aesthetic, educational, and political, private and public, as well as national and international.

What is the most distinguished thing one can be in the world?[1]

2 | 1777–94

A Childhood without Playing

Before the boy was seven years old, his private teacher, a German wig-maker living in Rudkøbing, asked him the standard question:

'What do you want to be when you grow up?'

Immediately, the reply came in the form of another question: 'What is the most distinguished thing one can be in the world?'

'The Emperor of Rome!' the teacher replied.

'All right, then I'll be the Emperor of Rome.'

'Impossible!' the wig-maker objected: 'It's hereditary.'

The boy found the objection unreasonable and asked what other highly distinguished things one could be.

'General-superintendent in Lybeck!' said the teacher who had been born in Lybeck himself. 'He is an exceedingly important man.'

'Well. Then I want to be the Bishop of Lybeck!' the boy burst out enthusiastically, knowing that a general-superintendent in Germany is equal to a Danish bishop.

'Then you have to learn a great deal first', the teacher exhorted.

'Of course' the boy said, determined to become a student of theology.[2]

Hans Christian was the boy's name. His parents were terribly busy taking care of the pharmacy at Rudkøbing, far too busy to educate their offspring, who were increasing by nearly one a year. So they sent their first-born and his siblings to private education at Oldenburg's,

the wig-maker, and his wife living just across from the pharmacy. But let us begin with the boy's earliest memories.

Hans Christian recalled a summer night when he and his exhausted family landed at Stigsnæs, the nearest point on the coast of Zealand, having sailed from Hov at the northern end of Langeland. The head of the family was the chemist of Rudkøbing, Søren Christian Ørsted. The other members of the family were Karen, his wife, and their three sons, Hans Christian (aged 4), Anders (3) and Jacob (1). The sea had been rough, waves had dashed their boat hither and thither, the children were drenched to the skin and seasick, and everybody yearned for a bed. Lightning flashed across the sky, and thunder and pouring rain made them feel even worse.

From how far back in our childhood can we remember things? *Really* remember things, that is, not 'recall' episodes that have been recounted to us so many times by our parents that it seems as if we remember them ourselves. The eldest of the young boys claimed to remember this landing, and that his father knocked with his stick on a door to wake up people at the guesthouse near the jetty. Inside, the soaked family was offered beer, but after the first pull Hans Christian pushed the mug away insisting that the beer had gone flat and was distasteful.[3]

The Ørsteds had come to visit branches of their family on Zealand that summer. First they saw Karen's relatives in Holbæk and then went on to see Søren Christian's in Slagelse and Copenhagen. Hans Christian retained a few scattered memories from these visits.. His mother was the daughter of a merchant, the well-to-do Herman Hansen, and her wedding to Søren Christian in Saint Nicolai's Church, Holbæk, had been followed by a celebration in Herman Hansen's general store on 24th July 1776, little more than a year before Hans Christian was born. The couple had fallen in love in Holbæk, where the groom had been in charge of the Elephant Pharmacy at Ahlgade, assisting the widow of its former owner until the pharmacy was sold to another chemist.[4] Unfortunately Søren Christian had not been able to afford to buy it.

Karen Hermansdatter came from a large family, since her father had been married three times and had fifteen children, five with each wife. At Holbæk the Ørsteds saw Aunt Bodil who was married to another merchant, Anders Sandøe. Bodil and Karen were the first and last children respectively of their father's second marriage.

Hardly anything about Karen has survived among the memories of the two elder brothers. Yet young Hans Christian wrote her a poem for her birthday:

> The day you saw light for the first time
> We shall honour and celebrate.
> It is a festive day for your young ones
> And will ever remain so.
>
> To make us children happy is your pleasure
> You wish to teach us all that is best.
> You'll guide us towards duty and virtue,
> And we shall always remain obedient to you.

We wish you joy, we wish you luck!
Let far more than we can ask for
Descend upon you from above.
May every day be a pleasure to you.'[5]

This poem hardly goes beyond what many other well-brought-up children could have written for their mother. Søren Christian was only allowed to keep her for fifteen years. Karen died in 1791, at 46 years of age, when Hans Christian was fourteen. By that time she had already presented the chemist with eight children and Hans Christian with seven younger siblings.[6]

The Ørsted family went on to Slagelse where they paid a visit to Søren Christian's mother, Barbara Albertine (née Witth) who had been a widow for twenty years after the death of Christian Sørensen Ørsted, pastor at Saint Peter's Church and Antvorskov Castle.

Christian and Barbara had thirteen children in fifteen years, and at the time she was widowed seven of them between the age of three and seventeen had survived, among them Søren Christian. When he visited his mother and proudly introduced his three sons, she lived in her own house in Slagelse, which her considerate husband, who was older than her, had bought and refurbished after a fire. Hans Christian recalled that he was offered sandwiches by his grandmother in the basement of her house, but refused them and demanded to be served upstairs, not in the company of servants. Even as a child he held a high opinion of himself, he later admitted.

In this house Søren Christian grew up with his siblings—aunts and uncles to Hans Christian. Those that the children knew best were the aunts Engelke and Benedikte and the uncles Lauritz Gerhard and Jacob Albert. In 1778 Engelke moved to Copenhagen and married a dyer who died the same year, after which she married another dyer, and when after a few years he died as well she probably concluded that enough was enough and took charge of the dye-works at Vestergade herself. She had no children, and nor did her sister, Benedikte, who had stayed at home to help her mother. After their mother died Benedikte moved to her sister Engelke's to take care of the big household of the dye-works. By common consent she was not a complete success because she suffered from somnolence, which was somewhat of a handicap (particularly when falling asleep in the kitchen). Engelke's dye-works eventually became the rendezvous where the two brothers met with other students.

Søren Christian and his brothers began their education at home and continued at Slagelse Grammar School. Jacob Albert became a student of divinity while Lauritz Gerhard and the youngest brother did not make it into university. Søren Christian was apprenticed to a chemist at Aabenraa and later worked as a pharmacist at Faaborg and Holbæk until eventually he passed the pharmaceutical exam at the University of Copenhagen. Their mother supported the boys to the best of her ability selling off parcels of land and buildings of her estate. In 1776 Søren Christian borrowed 250 rixdollars from her to buy the pharmacy at Rudkøbing, and Lauritz Gerhard spent his advance on setting up a silk and cloth store on Købmagergade in Copenhagen.[7] The Ørsted family maintained an attitude of mutual help.

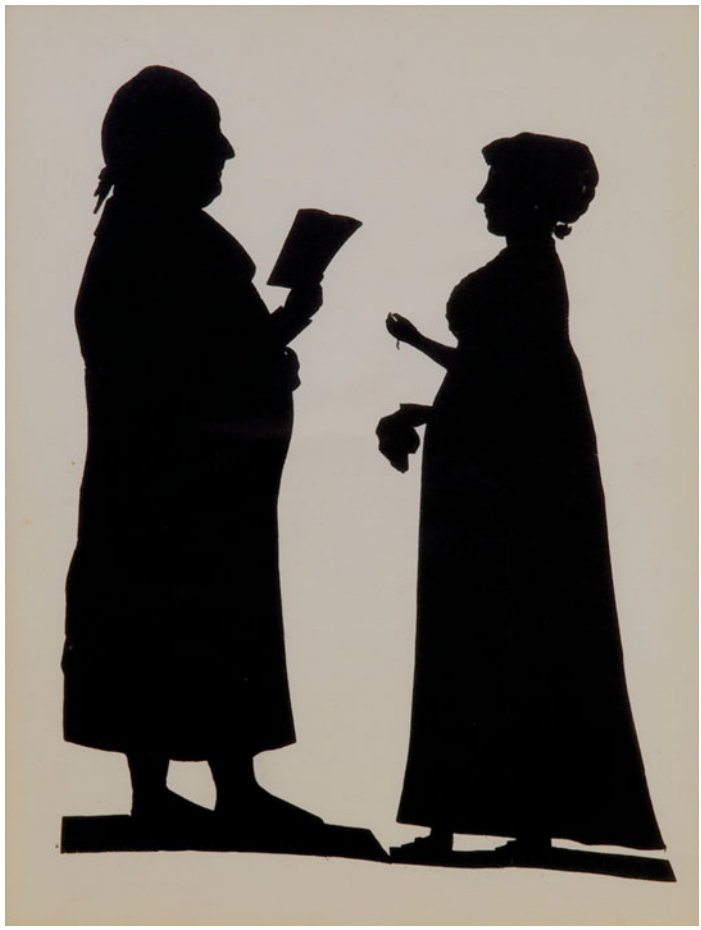

Fig. 3. HCØ's father, Søren Christian Ørsted, the pharmacist (1750–1822) and stepmother Anne Dorothea Borring (1764-*c.*1817). There is no picture of Karen, his mother, who died in 1791, three years before the two brothers moved to Copenhagen. Silhouette by unknown artist. DTM.

From Slagelse the family proceeded to Copenhagen to Aunt Engelke Møller, by then a widow and running the dye-works close to Vester Port, one of the gates through the rampart. Hans Christian remembers sailing about in a wooden tub in one of the large vats used for dying the cloth woven by peasants at home and brought in to the city. Another incident testifies to his childish conceit. He was put to bed in a clothes basket, but he refused to sleep so primitively and demanded a proper alcove with a curtain. Only when he was persuaded that a clothes basket was most suitable for a nobleman did he acquiesce.

From Copenhagen the family's itinerary continued to Northern Zealand to see Uncle Jacob Albert, minister to the congregations of Kirke Helsinge and Drøsselberg. 'Who are you?' Jacob Albert asked Hans Christian. As a young student of divinity he had carried the little boy to the baptismal font at Rudkøbing six days after his birth on 14th August 1777.[8] 'I am Hans Christian

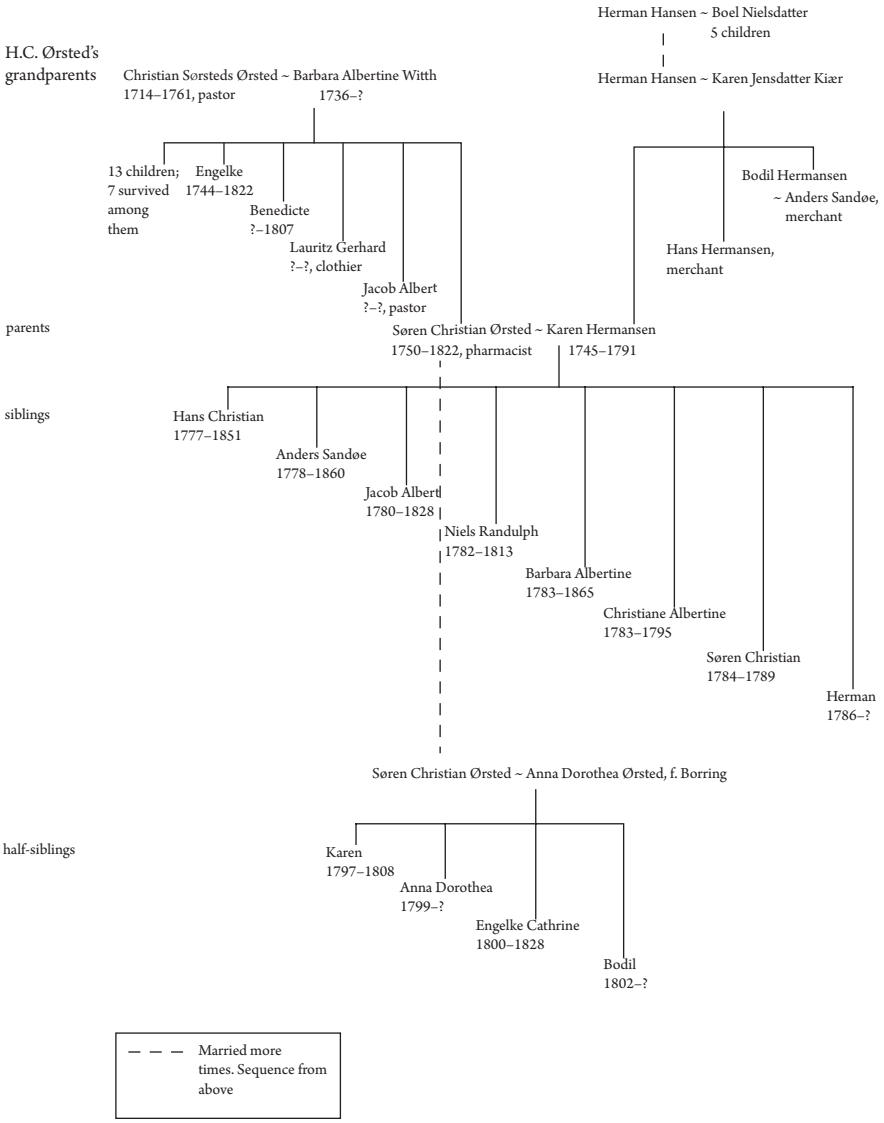

Fig. 4. HCØ's pedigree.

Bravkarl [Brave Fellow]!' the boy answered smartly.[9] This honorific nickname became a firm attachment to his name. Thirteen years later when as a student he would sit down at Aunt Engelke's dinner table, his friends, Adam Oehlenschläger for one, would often address him jokingly as 'Hans Christian Bravkarl'.

The family visits that summer had a purpose. Karen and Søren were proud to show off their boys and give them an impression of belonging to the wider family into which they were born.

This family extended from their mother's parents and siblings in Holbæk to their father's mother in Slagelse, Aunts Engelke and Benedikte in Copenhagen, and Uncle Jacob Albert at Kirke Helsinge. Afterwards the Ørsted family returned to their everyday life at Rudkøbing, Søren Christian to his pharmacy, Karen to more pregnancies and births, and the boys to the wig-maker. Between 1782 and 1786 Hans Christian acquired five more siblings, two sisters and three brothers. Mother Karen was not strong enough to survive this and died in 1791. By then one of the children had died aged 5. Their father could not possibly look after all these children as well as his pharmacy and guesthouse on his own, and three years later he married Anna Dorothea Borring, his junior by fourteen years.

These family relations may be difficult to take in, but it becomes even harder to grasp the individual names because Søren Christian and his two wives chose to recycle the names of their forebears when their own children were baptised. For instance the double name of our protagonist probably derives from his uncle, Hans Hermansen, and his grandfather, Christian Ørsted.

The Ørsteds were not alone in following this custom and the next generation continued this recycling of names. It served the purpose of strengthening family ties at a time when the different branches of the family were difficult to keep together for geographical reasons, because well-educated fathers had to take up jobs as medical doctors, pastors, and chemists wherever vacancies were available. Secondly, parents were often replaced by step-parents owing to the early death of the father or (more often) the mother. Family ties were useful, even indispensable, in a society without public social security, when mothers passed away in childbirth or breadwinners died young, making it impossible for a single parent to manage both to work and to bring up a crowd of children. Indeed, the summer's tour of Zealand was precisely an attempt to maintain and strengthen the ties of kinship between the scattered sections of the family.

The family name refers to the village of Ørsted outside the town of Randers, where Søren Olufsen had been a pastor at the time of King Christian IV (1588–1648), a post held both before and after by many members of the family. So the Ørsteds could look back on a pedigree of Lutheran priests. Among their forebears were bishops in both Norway and Denmark: a Randulph, a Wandal and a Winstrup. Thanks to their stepmother's descent from bishop Wandal, Hans Christian and Anders Sandøe enjoyed the obvious privilege of a scholarship at Elers' College in Copenhagen founded by the bishop.[10]

In 1776 Søren Christian had bought the small pharmacy in Rudkøbing, when the court ordered it to be sold for the fourth time. The price was a trifling 600 rixdollars, less than the insured value. Rudkøbing was a desolate place, but its pharmacy—one of the cheapest in the kingdom and surviving as a distillery rather than a pharmacy—was as much as the newly-wed chemist could afford. The young couple had their hands full just keeping it afloat. At first the employment of servants was out of the question, so Karen had to take care of the guesthouse that soon turned out to be the most popular accommodation in the town. The pharmacy and guesthouse were close to the harbour just a few steps up the hill. Søren was an industrious chemist, he set up a distillery and a packing room and gradually hired women to collect and dry medicinal plants and aromatic herbs; he also built a small lab to carry out simple chemical

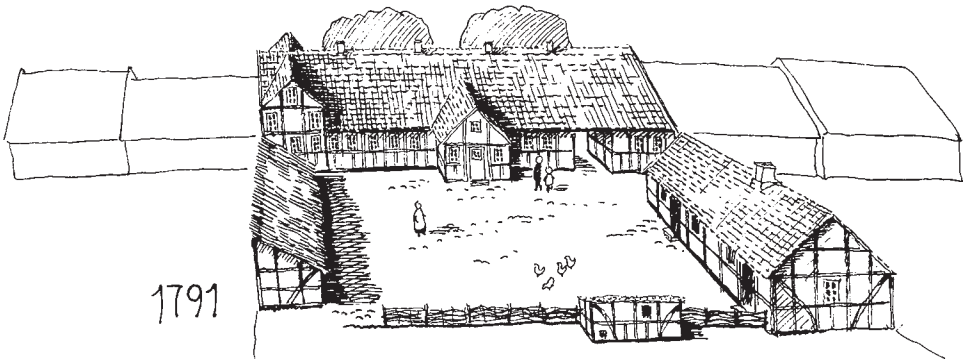

Fig. 5. The pharmacy of Rudkøbing which Søren Christian Ørsted bought in 1776 in a desolate state, but soon modernised by establishing a lab in the wing to the right of the courtyard. Drawing by Jens Kortermann Jauch, Museum of Langeland.

analyses and where he would introduce his sons to the enchanting world of chemistry. The Royal Agricultural Society awarded him their gold medal in 1785 for his initiative in collecting plants and herbs and thus creating new jobs on the island.[11]

Even though Rudkøbing had been granted a municipal charter in the Middle Ages, its population of less than a thousand inhabitants was insufficient for it to have its own grammar school. A former grammar school had been closed in 1739 and its premises made available to the parish clerk for the instruction of confirmands. Subsequently, the parish clerk had been persuaded to establish a primary school where no Latin was taught. However, though the town had appointed a schoolmaster, what kind of education could be expected from a school that was only able to charge two to four skillings a week per pupil? 'What dire wages for such dismal work', the district judge noted resignedly, suggesting that the posts of schoolmaster and undertaker were merged as soon as they became vacant. For want of a reasonable livelihood it would be impossible to obtain a schoolmaster who would teach 'without sighing [for poverty]'. The district judge demanded regular examinations in public, 'because true enlightenment can only be expected where honour is spurred on by diligence'.[12] The chemist craved a good school for his sons, but no such thing was available in Rudkøbing.

Hence, on the family's return from Zealand, Hans Christian and Anders Sandøe were sent to the infant school run by Christian Oldenburg and his wife just a few steps away.[13] They were not the only untrained teachers offering private education in the market place. Oldenburg was an immigrant from Lybeck and a wig-maker whose clientele in a town with two competing wig-makers was dwindling. As is often the case with immigrants who are no longer in a position to take advantage of their native language and professional skills, they cling to the values they brought with them to safeguard their threatened identity. Oldenburg, as we can imagine, tried to get to grips with his disappointment at the lack of demand for his noble craft by sticking to the indestructible values of his past: the grandeur of Lybeck compared to the mediocrity of Rudkøbing, the genuine spirituality of German Pietism compared to the stolid rationalism on Langeland, and above all the superiority of the German language and culture over plain

and boorish Danish and the local cultural wasteland. His know-all attitude was a source of irritation to his Danish wife whose language he refused to learn.

What then could be more conducive to his comfort than to dedicate himself to satisfying the chemist's boys' eager thirst for knowledge? The wig-maker took on the task of teaching Hans Christian and Anders Sandøe to read and write German through the language of the Bible, and he fulfilled this task thoroughly and conscientiously so that his pupils not only attained a perfect command of the German language, but also acquired a knowledge of scriptural passages by heart that they never lost. In the garden of the pharmacy was a huge chestnut tree with a complex crown that offered everything that climbing boys could wish for, but this was not the place where Oldenburg's two pupils exercised their talents when school was over. Playing and socialising with other boys seemed less attractive to them than bookish activities, and in any case they were happiest in each other's company.

Latin was a language that Oldenburg had not mastered at all, so the boys had to turn to other teachers to make sure that their knowledge of Latin did not let them down in life. Nevertheless, right from their childhood they put more emphasis on learning languages that were alive rather than dead. Years later, when he was a professor, Hans Christian took a relatively relaxed view concerning the role of Latin as an academic lingua franca.

Both brothers read German books, such as *Hübner's History of the World* and *Frederick the Great's Posthumous Writings* as easily as Danish ones; nobody asked them to do so, they just consumed them voluntarily. They would ask their parents, or local citizens with a library, if they could borrow their books, or they would empty their 'piggy bank' and buy their own. They would swap the fruits of their effort. Anders was only Hans Christian's junior by sixteen months so they lived practically like twins, and when both parents slaved away day and night they were on their own and left to their mutual instruction once the indoctrination at the Oldenburgs' was over. Their independent rewading shows that they did not automatically accept Oldenburg's beatification of Lybeck nor his pietistic fundamentalism and national pride. Gradually they would develop a sceptical attitude towards authority. They did not cease to respect Oldenburg as a human being and enthusiastic teacher, but they did begin to examine his prejudices. They learnt to wonder why authorities disagree and to summon up courage to seek answers to their own questions. This development was brought about by literature such as P.A. Heiberg's *Rigsdaler-Sedlens Hændelser* ['Adventures of a Rixdollar-Note'] mocking patriotic self-complacency, and Jens Baggesen's *Labyrinten* ['The Maze'] drawing a benevolent picture of German culture without glorifying it at the expense of other nations.

When they turned twelve, Hans Christian and Anders were released from Oldenburg's infant school, and their younger siblings took their places. Both boys were asked to help their parents at the pharmacy, a job Hans Christian came to appreciate more and more, particularly working in the small lab, while Anders's interest was not equally aroused. The pharmaceutical work bound the oldest son and the father closely together and their mutual interest in chemistry established an enduring affection between them.[14]

At this stage further educational opportunities were wide open for both brothers and their interests had ramifications as complex as the crown of the chestnut tree in their back garden. Anders delved especially into matters of divinity and morality; he wrote weekly sermons that

he showed to his mother, indeed he even delivered some of them, although later in life he did not find them particularly edifying.[15] At this time both brothers dreamt of following the footsteps of their forefathers and becoming students of theology. In Hans Christian's mind the post of a general-superintendent kept running alongside that of a chemist.

After infant school their reading and reflections took new directions. For a while they were instructed by a Norwegian student in chemistry and literature, and they buried themselves in more demanding works. Like Oldenburg, the Norwegian was obsessed with national pride and contempt for everything Danish, but previous experience of such prejudices had already warned them against reacting too rashly. Steffen Jørgensen, the district judge lent Anders a book on natural law by Nørregaard (a professor at the University of Copenhagen) based on Wolffian philosophy; and Jørgensen was impressed by the independent study of his borrower.[16] Hans Christian studied the aesthetics of Charles Batteux, a four-volume translation of French Enlightenment thought on poetry, music, architecture, and sculpture.[17] 'He still remembers his reflection that poetry must rank far higher among the arts than Batteux seems to be aware', he wrote much later.[18] A rather curious comment in so far as Batteux founded the entire aesthetics on poetry; but he had particularly mentioned the possibility that music (or dance) might merit a higher rank if the arts were brought together in the same performance. This bookworm must have appeared rather eccentric as a child, for as an adult he was unable to recall even one boyish prank, though he was fully aware of which branch of the arts deserved priority over the others.

A land surveyor who parcelled out fields in summer was put up at the guesthouse of the pharmacy in winter, when he gave maths classes to the two brothers. A convinced freethinker, this land surveyor was unpopular at Rudkøbing, but welcomed by the Ørsted family who recognised him for his honesty and skill. He made a lasting impression upon the boys by refuting the theology of revelation in favour of a natural religion according to Enlightenment thinking. And Jørgensen, the district judge, who had been travelling all over Western Europe and so knew the importance of speaking foreign languages, gave lessons in French to the older brother and English to the younger one. Afterwards they would swap the skills they had picked up. It is doubtful whether they gained much proficiency in either.

Now there was no more for them to learn at Rudkøbing. They had absorbed a wide range of knowledge from the few people who had something to offer. On top of that their intellectual hunger had to be satisfied by independent study and mutual instruction. The older brother was something of a prize pupil and Oldenburg's favourite. While his schoolmates were called by their christian names only, Hans Christian was called Ørsted. The admiration he received from his schoolmaster and others provoked a certain conceit, but he was also reminded that one has to deserve one's merits and live up to one's reputation.

An elderly woman who had once served at the royal court told him that he was as polite as a prince, and the boy was flattered by that compliment. He was never beaten by anybody, and his school mates were told to pay him particular respect. So, early on Hans Christian learnt to feel like a prince destined not to inherit but, after his apprenticeship and in due course, at least to merit a throne. On the one hand he could not help impressing those around him, on the other he made an effort to be polite to all, including those to whom deep down he felt superior.

The unconventional schooling with his brother at Rudkøbing and his close ties to his father had already determined Hans Christian's preferences: chemistry, theology, and aesthetics. Furthermore, the foundations of crucial features of his character had already been laid: ambition, eccentricity, independence, will power, diligence, and loyalty towards his family.

Nobody at Rudkøbing thought that the two brothers lacked any knowledge required for the University of Copenhagen entrance exam other than what they could acquire in a short time in the capital. With the approval of their father and a small allowance they left the island in spring 1794. In Copenhagen they went to see Professor Børge Riisbrigh who pointed them in the direction of appropriate tutors in Greek and Latin. They carried on with their mutual education and that autumn both passed the entrance exam with top marks.

The laboratory is so small and so ill provided with apparatus that it cannot possibly be considered worthy of a university as rich as ours.[1]

3 | 1794–6

A University without Science

In spring 1794 our two boys broke up from school in Rudkøbing to enter the University of Copenhagen. They walked along the flat country road, they passed through Roskilde to Valby Hill, and from its top they overlooked the capital lying at their feet, with its characteristic spires and towers and its hundred thousand inhabitants still squeezed in behind its narrow ramparts. Further on they walked past the Shooting Range and along the lime alley past the Memorial of Liberty—in the course of erection in commemoration of the abolition of villeinage—and finally crossed the bridge over the moat to be let into the city through Vester Port, one of the four town gates, on payment of the usual entry fee. On Vestergade near the gate they soon found themselves seated around Aunt Engelke's table in her dye-works enjoying her food.

The next day they witnessed with their own eyes what they had only heard about: Christiansborg, the royal castle, had burnt down and all that was left was a charred ruin. The following summer when the boys were away seeing their father on Langeland another great fire broke out in Copenhagen. This time the houses of citizens were destroyed in great numbers. Temporary huts were erected in front of the ruined castle to provide shelter for thousands of homeless Copenhageners. A large part of the Latin Quarter including most of the University fell victim to the flames. For years to come the city was crowded with homeless victims billeting themselves anywhere they could find.

Lodgings were no problem for the youngsters. Elers' College in Store Kannikestræde accommodated sixteen students, of which only the Ørsteds enjoyed right of priority as

Fig. 6. Vester Port, one of the four town gates of Copenhagen, through which the Ørsted brothers passed on their way to aunt Engelke Møller, whose dye-works were situated in Vestergade in the background of the picture to the right. Coloured drawing by C.W. Eckersberg (1783–1853). RL.

descendants of the founder of the college. There were eight double rooms and Hans Christian and Anders shared one of these; each room had a table, six chairs, an iron stove, a cupboard with a lock, and a wide bed shared by the roommates. Two cords of firewood a year were included. Every morning the porter would supply boiling water as well as embers for the tea-machine for three marks a month. He also lit the stove and twice a week he would clean the rooms and remove ends of tallow candles from the candlesticks.

The *inspector collegii* was formally appointed by the master, but in reality elected by the alumni. Thomas Bugge was master during the years the Ørsteds lodged there. He was Professor of astronomy and head of the cartographical project conducted by the Royal Danish Society of Sciences and Letters. Soon Hans Christian was elected inspector, and his duty was to liaise between master and students. He was keeper of the keys to the garden, the fountain, the gate, and the library and lecture hall. Every morning (at six o'clock in summer and seven o'clock in winter) he would ring the great bell in the ceiling of the hall to announce the morning prayers (*preces solennes*). The students also assembled for evening prayers, though after the great fire in 1795 homeless citizens moved into the lecture hall on the second floor and often disrupted the prayers. Under normal circumstances the students were charged four skillings, payable to the *fiscus*, the college coffer administered by the inspector. He received an increased *distributus* in return for his trouble. Hans Christian's share of the college revenue was 70 rixdollars, while ordinary students had to make do with 40. They also benefited from the so-called 'community

Fig. 7. The great fire of Copenhagen 1795. The fire broke out at Gammel Holm, site of the Royal Navy Dockyard. The first evening it leaped across Holmens Kanal to the Admiralty, through the windows of which drawings made by naval architects were thrown out. On the other side of the canal is the heartrending view of the areas on fire. Mothers and wet nurses flee with their suckling babies, pets, and utensils. Two watchmen have dropped their spiked maces and seize a looter, and at the far right a wounded man is carried away on a ladder. Drawing by C.F.F. Stanley (1769–1805), KBM.

grant', that is the current income from the University's landed property, which provided the financial support for students of that time. This amounted to four marks a week, too little to feed them, so they were lucky to be within reach of their aunt's hospitable kitchen.

The lecture hall was also the setting for debating and declamation exercises in which all had to participate once a year. In the past these exercises, conducted in Latin and ridiculed by Ludvig Holberg in his comedy *Erasmus Montanus*, had been printed in booklets of a score or so of pages, but this custom had ended. Now the students restricted themselves to defeating their opponents orally in public and celebrating their triumphs afterwards at a drinking spree.

Every evening supper was served by Engelke Møller, their widowed aunt, whose dye-works were situated, as polluting industries had to be, close to the city moat. It was here thirteen years

Fig. 8. The Ørsted brothers on their way from Elers' College to lectures at the University. Drawing by E.L. Hemmingsen (1855–1939).

earlier that Hans Christian had sailed in the wooden tub. Their college rooms and dinner table were conveniently located a few minutes walk from each other. They just had to cross Vor Frue Plads and Gammel Torv and their food was ready. 'They walked in long frocks almost reaching their heels like dressing-gowns; they clung to one another arm in arm looking like conjoined twins', as Adam Oehlenschläger, their mutual friend, described them.[2] They put their money in the same chest where it would lie unspent, since their expenses were limited as long as they had free lodgings and meals.

The college gate opened towards Store Kannikestræde. To the right they saw Round Tower and Regensen, the largest college, and to the left the dominating spire of Vor Frue Kirke,

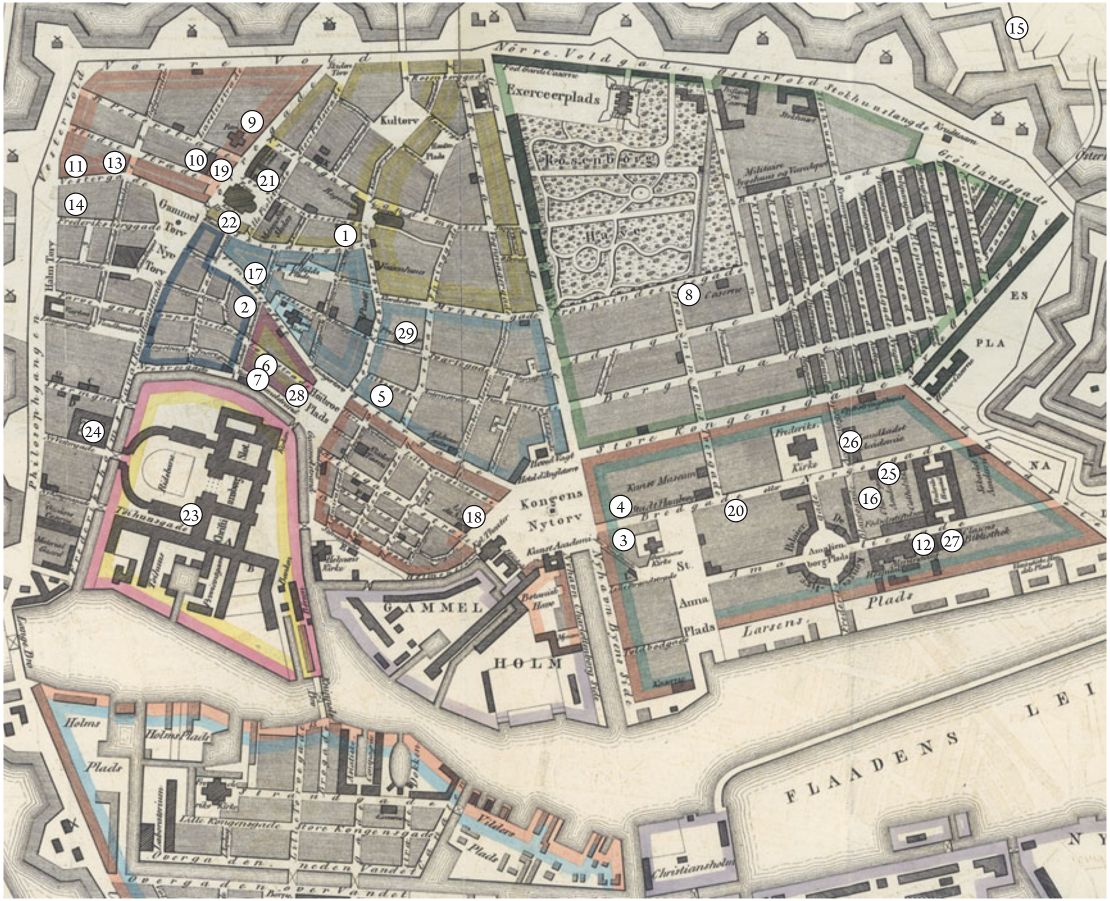

Fig. 9. Map of Copenhagen by Sterm, 1839.

HCØ'S ADDRESSES 1794–1851

1. Elers' College	Store Kannikestræde	1794–1800
2. The Lion Pharmacy	Hyskenstræde/ Vimmelskaftet	1800–1801
3. Collin's Court	Bredgade (Norgesgade) 159	1804–1806
4. Thott's Palace	Bredgade (Norgesgade) 201–202	1806–1809
5. Rubens's yard	Østergade 68	1809–1812
6.	Gammel Strand 12	1813
7.	Læderstræde 38	1813–1814
8.	Dronningens Tvergade 401B	1815–1819
9. Pingel's yard	Nørregade 35	1819–1824
10. Professor's yard	Studiestræde 106	1824–1851
Other important addresses		
11. Engelke Møller, née Ørsted, Vestergade 26		-1822
12. Søren Christian Ørsted	the pharmacy of Alm. Hospital, Amaliegade	1815–1823
13. Anders Sandøe Ørsted	Vestergade 23	1801–1812
14.	Frederiksberggade	1812–1817
8.	Dronningens Tvergade 401B	1817–1818
15.	Østerbro	1818–1824
10.	Studiestræde 106	
9.	Nørregade 35	
16. Thomasine Gyllembourg	Blancogade	
2. Sophie Probsthein	The Lion Pharmacy	
17.	Klosterstræde/ Vimmelskaftet	
18. H.C. Andersen,	Hotel du Nord, Kgs. Nytorv	
19. Adam Oehlenschläger	The Bishop's Palace, Nørregade/ Studiestræde 1820–1834	
19. Balle/Münter/Mynster	The Bishop's Palace, Nørregade/ Studiestræde	
20. Schimmelmann's palace	Bredgade (Norgesgade)	
21. Th. Bugge's professor's yard, Lille. Fiolstræde/ Store Kannikestræde		
22. B. Riisbrigh's professor's yard, Dyrkøb		
23. Videnskabernes Selskab [Royal Danish Society of Sciences and Letters]	Royal Stables, Christiansborg	

24. Skandinavisk Litteraturselskab [Scandinavian Literary Society], The Prince's Palace	
25. Chirurgisk Academi [Academy of Surgery], Bredgade (Norgesgade)	
26. Landcadetacademiet	Academiegade
27. Det classenske Bibliotek	Amaliegade
28. Dreyer's Club	Læderstræde
29. Free Masons' Lodge	Kronprinsensgade

120 metres high. Normally, they would turn left and pass by a row of similar professorial courts with stables and cart sheds, and large gardens with old trees. The first court was inhabited by Friedrich Münter, the professor of theology, who would unpretentiously run slowly down the street, unlike Professor Moldenhawer, who would rush forward snorting with his puffy face like a turkey cock.[3] Still on the left-hand side, but further down towards Frue Plads they would meet Jacob Baden, the invalid rhetorician, leaning on his servant's arm. Before they reached Fiolstræde they would pass two more professorial courts followed by Master Bugge's house adjacent to the main building of the University, merely a modest two-storey house with a small belfry. Inside the courtyard was the medieval house of the senate and facing Nørregade the community building with its lecture halls.

At Borch's College they might turn left down Lille Kannikestræde and pass by the seventh court inhabited by Riisbrigh, the professor of philosophy. H.N. Clausen describes him as a rather old fogey with a face looking as if it were carved in wood.[4] But if they continued straight on towards Frue Plads (a cemetery at that time) they would have to pass the bishop's court. Bishop Balle is reported to have been a priceless sight when pompously stalking across the street to Vor Frue Kirke wearing his long cassock and his tricorn hat on top of his wig. It was said that Balle owned no garment other than his cassock.[5] Having passed the church the brothers would cross Gammel Torv and enter Vestergade with its many guesthouses side by side. Following this route they would miss the two last professorial courts situated in Studiestræde and Skt. Pederstræde and inhabited by Anders Gamborg, another professor of philosophy, and C.G. Kratzenstein, the professor of experimental physics, their gardens bordering each other. This is exactly the location where thirty years later Ørsted had the University extended, in the form of his Polytechnic Institute.

The daily walk through the Latin Quarter to their aunt's dinner table was a mixed experience. There were no shop windows displaying consumer goods, just a few signs indicating a guild or a commodity. There were still several cemeteries inside the ramparts of the city, but they were poorly maintained and people showed a shameful lack of respect by hanging out their washing in them. Stinking open gutters, cowpats, pig manure and horse droppings were everywhere. Walking dry-shod on the muddy pavement was nearly impossible. If a stroll was

to be taken for pleasure, the only options available were along the top of the ramparts or beside the lakes outside the city where the air was tolerable.

It would be wrong to imagine student life in Copenhagen as a romance. There were no student clubs, no student choirs, no particular places to socialise for students; they resorted to alehouses and clubs for entertainment or they gathered in colleges. Another meeting place outside the lecture hall was St Petri, the church of the German-speaking congregation. Here J.G. Marezoll, a fashionable preacher siding with Kant in his controversy with Lutheran orthodox censorship in Prussia, attracted a good many students including the Ørsted brothers. They found that his sermons provided more food for thought than those of the rationalist bishop Balle.[6]

Before matriculation, however, Hans Christian and Anders had to pass the entrance exam of the University. Upon their arrival in the city, they knocked on Professor Riisbrigh's door to ask for guidance. He recommended a tutor of Greek and Latin (their weakest areas). In October they both passed the oral exam in religion, Latin, Greek, history, geography, and astronomy, and the written exam in translation from Latin, with top marks.[7] All oral exams took place on one day in the assembly hall of the Senate, where the examiners sat side by side along a big table. At the written exam the invigilation was so minimal that the students could help one other or cheat if need be.[8]

The next hurdle was the basic education all students had to go through. It had two parts. The first part, *philologicum*, was more Greek, Latin, and history; the second, *philosophicum*, consisted of philosophy, mathematics, physics, and astronomy. Each part would normally take half a year. Anders immersed himself deeply in philosophy; Hans Christian had a predilection for physics and astronomy. So, they continued their previous practice of mutual instruction and again passed everything with flying colours. Both attended Professor Riisbrigh's lectures on Kant's *Critique of Pure Reason*. In the next chapter we shall go further into the corpus of philosophical knowledge our two protagonists encountered while preparing themselves for *philosophicum*. Lecture fees were usually paid directly to the professor the day before the exam, and this practice was suspected of corruptly influencing the outcome. Rather than the usual four rixdollars, sons of noblemen would easily pay five or more, while the simple son of a public servant had to hand his *testimonium paupertatis* to the professor in return for free access.[9]

After the basic education the paths of the two brothers parted. Hans Christian took a particular interest in chemistry, a subject that could be studied together with pharmacology in the Faculty of Medicine. Anders decided to study law. However, their mutual attraction to religious, aesthetic and philosophical issues never faded, and it brought them together to talk about the books they read. So, one is fully justified in saying that they were free and independent students, philosophical minds fully devoted to their hunger for knowledge as opposed to bread-and-butter students looking upon such activity as a waste of time.

Adam Oehlenschläger found the brothers sitting in their room, just the two of them, 'as if in a dark monk's cell—serious and silent—studying!'. Adam was about to be trained as an actor at the Royal Theatre. They became friends even before he got to know their names; he noted in his diary: 'Today I made the acquaintance of two young students; there are excellent

people, and we are likely to become the best of friends'. Adam, too, was served his daily dinner at Mrs Møller's where he lodged on the first floor. Only the next day did he become aware of their names.

One day, Oehlenschläger recounts, he was in the library of Elers' College which Hans Christian took care of, feeling down in the mouth. He had lost all desire to perform at the Royal Theatre and was worried about the low status of the acting profession. He felt unable to stand the rather silly (but nevertheless common) prejudice against the easy virtue ascribed to actors.

Fig. 10. The University of Copenhagen framed by Skidenstræde and Vor Frue Plads, Nørregade and Lille Fiolstræde. Fragment of Christian Gedde's elevated map of Copenhagen, 1760–1761, KBM.

Seeing the many erudite works on the shelves aroused in him a feeling of having betrayed his talent for poetry since he had left school. Hans Christian recognised this sentiment in himself. He, too, felt attracted to poetry, and the two friends had frankly shown each other their first, tender attempts as poets. In fact, Hans Christian was wrestling with his prize essay on aesthetics for the University's gold medal. However he felt it might be safer in his case to go for a bread-and-butter subject like pharmacology which would lead to a secure post as a chemist like his father, and perhaps the ability to begin his career by offering him a helping hand. Besides he could always pursue poetry in his private life *con amore*. He took his disheartened friend in hand and advised him to abandon the stage in favour of studying law. Anders could tutor him and he would then have the opportunity to become a lawyer or a judge. Adam easily grasped the point, especially as he had realised that the man he hoped would become his father-in-law, the erudite brewer and jurist Hans Heger, might be more inclined to give his daughter away to a lawyer than to an actor.

Once again the impulsive Adam was in paradise. The diligence of the two bookworms was contagious, and with their help he swotted up the examination requirements for *artium* and *philosophicum*. After Mrs Møller's dinner he would entertain the entire house performing the roles in Holberg's comedies one after the other.[10]

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The University of Copenhagen was not a place to cultivate the sciences, but rather a national institution for educating civil servants, priests, medical doctors and jurists. The Faculty of Theology was set up according to Lutheran principles and the Faculty of Law according to the absolutism of the Danish-Norwegian monarchy. There was no Faculty of Science and hence relations with universities abroad were rather limited. The University catered for bread-and-butter students who were aiming at bourgeois safety for the graduate. Critical voices claimed that what really took place at the three faculties was an introduction to the practice of each profession. At the Faculty of Theology the undergraduates would learn to preach Christianity as the road to salvation and eternal life without having to bother about a pious or ethical way of life. At the Faculty of Medicine the undergraduates were taught to cure diseases and prolong lives with pharmaceuticals, but not to care about healthy living, and finally the student of law would acquire lawful devices to win a court case without having justice on his side. This ironical judgment had been made by Kant and taken over by critical students who dreamt of a university of reason where the Faculty of Philosophy should be ranked above the professional faculties, to provide tools for critical reflection on practice rather than adapting to prevailing circumstances. '*Sapere aude*!' was the Kantian watchword: commit yourself to your personal enlightenment and have the courage to reason for yourself![11]

It is hard to state the exact number of active students at the University, since their studies were often interrupted when they needed to work, typically as private tutors. But we know exactly how many students were matriculated each year. In 1795 when Hans Christian joined the Faculty of Medicine he only had three or four fellow students, while ten entered the Academy of Surgery. At the Faculty of Law, Anders was one of nearly seventy. The Faculty of

Theology was by far the largest with about 110 new undergraduates.[12] No science degree was available. Physics, chemistry, and botany were regarded as auxiliary disciplines of medicine, and mathematics and astronomy were only studied as part of *philosophicum*.

The University was the object of severe criticism not only because of tedious lectures and the absence of research, but also because of the economic administration and policy of appointment of staff. The course catalogue distinguished between free public lectures and lectures *privatim* taking place at a professor's residence in return for a payment, and finally lectures *privatissime* arranged for a narrow circle of fee-paying students.[13] Professors were tempted to supplement the public lectures they were obliged to offer free of charge with *privatim* lectures to make more money. There are no figures to indicate the share of income a professor could earn from fees (typically charged by his assistant), but their significance is testified to by the fact that several posts were unsalaried, meaning that the postholder's entire livelihood depended on students' fees. It was hinted that staff contrived to cut the number of their public lectures in order to force students into private ones.[14]

After the coup d'état in 1784 the way was paved for the 1788 reform which encouraged professors to write textbooks and students to read them rather than struggle with the notes they had taken down from soporific lectures read aloud from the same script year after year. Students would resort to their notes when they prepared for exams and try to sell them to younger fellow-students afterwards. Textbooks could be taken down from the shelf whenever needed, and saved lecture fees. However, this did not interfere with the professors' freedom to choose their methods of teaching. Neither did it oblige them to carry out research. No independent external examiners were introduced and marks were decided exclusively by the professors. Accusations of bribery were still on the lips of many.[15] Yet there was one important innovation. Prize essays were introduced to enable undergraduates and young graduates to draw attention to their research talent.

Most undergraduates were spending fees on tutors, that is older students or graduates who kept an eye on the exam questions posed by the professors. Normally, these questions would be the same every year. So the tutors would be on the alert at the exam board to take note of the answers required and find out if (unexpectedly) new questions turned up. This system was rather unfortunate for undergraduates like the Ørsted brothers who acclaimed and practised free and independent studies. But they were astute enough to take advantage of the system by using each other as tutors free of charge and soon they would add to their income by tutoring their fellow students.

Appointment of staff continued to be solely in the hands of the Chancellor of the University. Already prior to the 1788 reform abortive projects had been launched to pool the *corpora* of the University and pay the staff a fixed salary. At that time each of the fifteen professors was paid the surplus (his so-called *corpus*) of the landed property owned by the University. This system implied that if a new professorship was wanted it would have to be funded by existing *corpora*. Consequently, all fifteen professors (four theologians, two jurists, two medical doctors, and seven for the disciplines at the Faculty of Philosophy) resisted tooth and nail when new professorships, for instance of science or modern languages, were

proposed, since these would inevitably harm their well-established interests. Therefore useful disciplines such as science, a crucial vehicle for progress according to Enlightenment thought, were refused admittance at the gate whenever anybody tried to get them into the University.

The statute of 1788 allowed *corpora* to be pooled as they gradually became available on the death of each professor. Professorships were for life. If old age prevented them from teaching they did not have to retire. They were entitled to employ a private substitute who had to make do with a fraction of the professor's salary. When *corpora* were no longer earmarked for the fifteen ordinary professorships, the sum available was more flexibly disposable, for instance to fund extraordinary posts that might in due course be converted to ordinary ones. Aesthetics, history of literature, and statistics benefited from this reform, but still there was no hope within sight for the sciences.[16]

Appointments at the Universities of Kiel and Copenhagen were not decided according to intellectual capacity, but by aristocratic bureaucrats without genuine academic knowledge. In 1795, thanks to the still existing freedom of the press, J.C. Fabricius, professor of Natural History and Economics at Kiel, published a devastating critique of the University of Copenhagen.[17] Flattery, lobbying, nepotism, and letters of recommendations meant everything; the research efforts of the applicant came second or did not count at all. Such were the circumstances the Ørsteds had to face and ponder when planning their careers.

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Yet, for some time there had been a range of initiatives designed to bring the sciences under the aegis of the University. Government leaders of German descent such as Court Steward A.G. Moltke and Dr J.F. Struensee had pressed for the improvement of agriculture and had established two new professorships in botany and experimental physics, appointing two foreigners, G.C. Oeder and C.G. Kratzenstein, for want of qualified Danes. As expected, the Senate found the appointments provocative. Not only were sciences favoured at the expense of established disciplines, but the two professorships were even staffed by foreigners. Oeder's candidature was cleverly blocked. A fellow of Elers' College was set up against the German to demonstrate his inadequate Latin in a disputation.[18] Moltke and his candidate were defeated, and Oeder's capabilities were instead deployed as director of the botanical gardens of Frederik's Hospital. The other German, Professor Kratzenstein, had to dip into his own pocket in order to provide scientific instruments, which he did—motivated by expectations that electrical experiments would not only heal people but entertain them as well and thus attract many well-to-do spectators. Henrich Steffens for one was a guinea pig exposed to shocks from Kratzenstein's electrostatic generator.[19]

In 1759 Moltke again took the initiative to promote the sciences. Once again the University was obstinate, so he had to find leverage, for which he used The Natural Cabinet at Charlottenborg.[20] The King's Particular Coffer would pay for scientific instruments as well as for two professors appointed to teach natural history and economics respectively, both pupils of Linnaeus.[21] Three years later it became obvious that The Natural Cabinet and its staff were intended

to provide leverage, when Oeder among others was assigned to work out 'A proposal to establish a fifth faculty at the University of Copenhagen to be called the Faculty of Economics'.[22] Whether the sciences were to be financed by the University's *corpora* or by the King's Particular Coffer remained an open question. Lectures and exams were to be in Danish as opposed to Latin and aimed at future civil servants and private industrialists. Once again the Senate succeeded in quashing the initiative.

The third time the matter was put on the agenda was during the short tenure of Struensee (1771–72). The Bishop of Trondheim, E. Gunnerus, famed for his interest in natural philosophy, was called in to work on a compromise. The Natural Cabinet was to amalgamate with the University. In the long run costs were to be met by the University at the expense of professorships of Oriental Languages, Greek, and Latin. It is well known that soon Struensee was broken on the wheel, so once again the Senate could breathe a sigh of relief. The threat posed by science was scattered in all directions. Oeder was downgraded to police officer in Oldenburg; Brünnich was appointed Oberhauptbergmann at the silver mines of Kongsberg, Fabricius became professor of economics at Kiel, and Gunnerus who had optimistically taken the opportunity to propose a new university in Norway, returned crestfallen to his bishopric.

Even the most powerful men were unable to create room for the sciences at the University. Surgeons were not allowed into the Faculty of Medicine; in 1785 they established a new institution for themselves, the Academy of Surgeons, in order to obtain an anatomical theatre where instruction in dissection could be offered. A laboratory for chemistry was only built in 1778 in Skidenstræde. It consisted of two rooms, each about 25 metres square, a lab and a lecture hall. There was a well and a shed for firewood, but there is no evidence that it was ever used for any significant purpose. Ørsted was unimpressed by it: in 1813 he characterised the laboratory as 'so small and so ill provided with apparatus that it cannot possibly be considered worthy of a university as rich as ours.'[23]

By 1789 a circle of natural philosophers, most of them pupils of Linnæus, had become frustrated that the regime—otherwise so keen on reforms—had totally capitulated vis-à-vis the challenge to modernise the University when adopting the 1788 statutes.[24] Around 250 of them became members of a new voluntary association, Naturhistorieselskabet [The National History Society]; they paid ten rixdollars a year for their membership, and published *Skrifter af Naturhistorieselskabet*. Its function in providing leverage for a faculty of science was mentioned in an anonymous article in *Minerva*.[25] Steffens became its first graduate.

So, in 1794 when Hans Christian entered the University, the sciences were still private hobbies for well-to-do amateurs who did not care about a safe post or a salary. The most renowned experimenter of physics in the kingdom was Court Steward Adam W. Hauch, whose collection of scientific instruments was second to none. It gained for him the kind of prestige that can only be obtained by an amateur studying for pleasure even at a cost. In 1791 Hauch was elected a member of the Royal Danish Society of Sciences and Letters. This was an honour, although he remained largely isolated because his interest in Lavoisier's chemical revolution was shared by only a few others, while far more members were busy surveying

Fig. 11. *The Clover Leaf or the Masked Jesuits* showing three distinguished civil servants. To the left Court Steward A.W. Hauch sitting on a chamber pot with the inscription 'Oxygen or Life Air' breaking wind while smelling a flask containing 'science'. In the centre the opinionated minister of state C.D.F. Reventlow, on whose hat is inscribed 'Projects' and on the paper he is handing to the genius 'you are an animal allowed to exist'. To the right the malicious surveyor C.F. Hansen with compasses and a windmill in his right hand, his left hand cutting the wings of the kneeling genius, who is being tested on a touchstone while his hand is threatened by a snake. An angel whirls copious notes. The caricature is annotated by the artist: 'To annihilate all possible charges that Jesuit-minded people might bring up against this drawing of mine I shall leave it entirely to would-be buyers to add shadows and colours according to their own taste . . .' Caricature by O.P. Gram, 1813, the year of the Danish-Norwegian bankruptcy, RL.

and mapping the country. Hauch was probably the only Danish chemist to have accomplished original research and written textbooks on his subject.[26] He had no connection with the University.

In 1794 a small club decided to fill a vacuum by publishing a new journal of natural philosophy called *Physikalsk-oeconomisk og medico-chirurgisk Bibliothek for Danmark og Norge*. The editors did not dare to focus on natural philosophy alone, thinking that their target group must be extended to civil servants and the medical profession in order to attract a sufficient number of subscribers. Membership of the club was limited to the authors of prize-winning essays at the University. This prerequisite reduced the number of potential members to four. Ørsted was

not invited to take part and had to look for like-minded natural philosophers outside the University, for instance at the punch bowl in Dreyer's Club or in the Scandinavian Literary Society.[27]

The reform of 1788 had rendered the orthodox University a little more efficient. That was all. Its range of disciplines was unchanged. Natural philosophy had been unable to open up even the smallest crack in the defensive walls of the alma mater. Its future appeared hopeless when Ørsted took up his studies of physics and chemistry.

Two things fill the mind with ever new and increasing admiration and awe . . . : the starry heavens above me and the moral law within me.[1]

4 | 1796–8
Two Philosophical Minds

As inspector of Elers' College, it fell to Hans Christian's lot to buy books for the library for the tidy sum of 300 rixdollars a year. This grant stretched to around 250 books, and his choice was in no small degree determined by his and his brother's preferences. Although there are historical, medical, and theological books on his list, philosophical and aesthetical works are in the majority. First of all we notice the complete works of Kant followed by the moral philosophers Fichte and Tetens as well as Montaigne, Locke, Hume, Ferguson, and Adam Smith in German translation, and finally writers of fiction such as Lessing, Wieland, and Schiller.[2] Presumably, most of these books would appear on the shelves of our two brothers on long-term loan for the years to come. The master of the college, Professor Bugge, must have disapproved of the ostentatious priority given to philosophical and aesthetical works at the expense of the mathematical sciences. Moreover, Hans Christian neglected his series of lectures on astronomy and mechanics. Master and inspector had already started to look askance at each other.

While they were still in their teens, Oehlenschläger wrote about the Ørsted brothers that 'to all fellow students they shone like the Dioscuri and even older scholars soon noticed their extraordinary capabilities'.[3] In other words their friend compared them to Castor and Pollux, twin sons of Jupiter, twinkling in the starry heavens as the constellation Gemini. This star quality had been acquired by shutting themselves away in their monk's cell, like philosophical minds renowned for their wit and reflection. Kant's critical philosophy, which they encountered while preparing themselves for *philosophicum*, spurred on their curiosity, inspired their discussions, and constituted their frame of reference for the rest of their lives.

Even prior to their entry to the University, Christian Hornemann, a law student, had already drawn attention to Kant's critical philosophy, which had shaken the very foundations of the intellectual world. In 1784 he had studied the first edition of *Critique of Pure Reason* (1781) carefully and had become a devoted disciple of Kant, so devoted that in 1791 thanks to a recommendation from the Chancellor, the Duke of Augustenborg, he was awarded a travel grant and went off to the University of Jena. This was the place where the critical philosophy took root for the first time outside Königsberg, Kant's hometown in distant East Prussia.

Kant's philosophy was a heroic attempt to save Enlightenment confidence in human reason. On the one hand he turned against Christian Wolff's dry rationalism, which held to the view that the force of thinking alone was conducive to true knowledge. On the other hand he opposed Locke and Hume, the British empiricists, who argued that true knowledge must be based on sense-experience only. This dichotomy was resolved by Kant. Hornemann's admiration for Kant particularly hinged on his criticism of existing theodicies which resulted in a separation of religious belief and scientific knowledge. In 1793, when members of the Prussian censorship commission reproved Kant for parts of his *Religion within the Limits of Reason Alone*, their rebuke was grounded on the author's alleged atheism.[4] Hornemann's sympathy, by contrast, was motivated by the refuge Kant had created for religion. For just as science cannot prove the existence of God, it cannot disprove it either.

Hornemann was an enquiring soul who, though he realised that falling in love with a young woman, Miss Schlegel, would require him to finish his education in order to be able to provide for his future family, was however so profoundly immersed in the contemporary debate on philosophical and aesthetical issues that he prioritised the inner demands of his mind above the outer demands of his studies, money matters, and career. Hornemann never got ready for his exam; he overstretched himself and he died in 1793. Sadly, his promising series of lectures on Kantian philosophy, delivered in Copenhagen for the first time, was thus cut short, but his presentation of the critical philosophy had already attracted the attention of many students.[5] Hans Christian and Anders benefited from Hornemann's introductory lectures, which were collected posthumously by his friend J.H. Splet and published by his brother-in-law, J.F.W. Schlegel, professor of law.[6]

Preparing themselves for the *philosophicum*, both brothers attended Professor Riisbrigh's lectures on Kantian philosophy in his residence on Dyrkøb, behind Vor Frue Kirke. For thirty years Riisbrigh had taught the Wolffian rationalism which had now been swept aside by Kant. It must have been an embarrassment for him to appear like a weathervane by abjuring a philosophy for which he had previously held hundreds of students accountable at his exams.

He gained some popularity from lecturing in Danish rather than Latin. Kant, too, wrote and lectured in his native language. Many insinuated that Danish was unsuitable for philosophy, that Denmark had never produced an original philosopher, and hence, Danes had to philosophise in a foreign language. The Ørsted brothers could not disagree more. They found, by contrast, that since it is the objective of *philosophicum* to develop independent thinking, the native language must be the appropriate one simply because it is the language in which people express themselves naturally and adequately. So, to them the abolition of Latin in favour of Danish was definitely a step forward.[7]

Riisbrigh would welcome his students to Kant's philosophy by pointing immediately to its difficulty: Kant's critique had totally revolutionised epistemology and to appreciate this one had to overcome many obstacles, since Kant delves deeply into difficult problems. His terminology is obscure, the professor would continue, exceptionally using the Latin *obscuritas verborum*.[8] We know quite a lot about Riisbrigh's dispassionate interpretation of Kant's critical philosophy, because one of his students, Jonas Collin, took notes from his lectures in 1793. This source makes it obvious that Kant's 'Copernican Revolution' was set out unequivocally: true knowledge cannot be derived either from rational thinking alone (as Wolff believed), or from sense-experience alone (as Locke and Hume claimed), but only from a combination of both.

This insight was the essence of the philosophy course that Hans Christian and Anders passed with top marks, but they soon discovered that this 'combination' was more complicated than Riisbrigh seemed to be aware of, especially when applied to subjects like natural and moral philosophy. Riisbrigh's lectures had to be supplemented by an independent scrutiny of Kant's own writings to trace the difficulties; they divided the work between them and swapped the fruits of their industry. Hans Christian read his *Metaphysical Foundations of Natural Science* (1786), which resulted in his dissertation (ch. 8), while Anders studied *Groundwork of the Metaphysics of Morals* (1785), which inspired his prize essay and won him the gold medal (ch. 6).

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Kantian epistemology is no manual of instructions, but a philosophical answer to the question: how can we know, what we (think we) know, and how can we be sure it is true?

In other words, it is not a methodology but metaphysics, in the sense that the human ability to acquire knowledge cannot in itself be made an object of investigation, since neither mind nor senses are empirical phenomena. When Kant analysed how Newton had discovered his famous laws of motion, he inferred that they had been found a priori, using mathematics, not by means of empirical observation. Newton used neither binoculars nor telescope, and he did not carry out experiments. The innocent anecdote about the apple dropping on his head is fictitious, but has a point in so far as the apple initiated a thought that came first. Proof came later on. The laws were established when the equations were solved on Newton's desk in the Master's Lodge at Trinity College Cambridge (that is, a priori), as indicated by the very title of his book *Principia Mathematica Philosophiæ Naturalis*. Mathematical principles begin in the human mind, not in nature.

Kant called the revolution in epistemology his Copernican conversion, hinting at the decisive prerequisite for Copernicus's idea of the heliocentric world picture. This Copernican prerequisite turned up when during his observations of the universe it occurred to him to divert his attention from the object to his own mind and to its function. It had been believed that the Earth was stationary at the centre of the universe and that the heavenly globe moved round, which is empirically true. Everybody could watch the sun rise in the morning and set in the evening, while nobody observed the observer who was in fact revolving around the axis of the Earth while the sun stood still. It took a new epistemology to realise that the geocentric world picture was an empirical deception.[9]

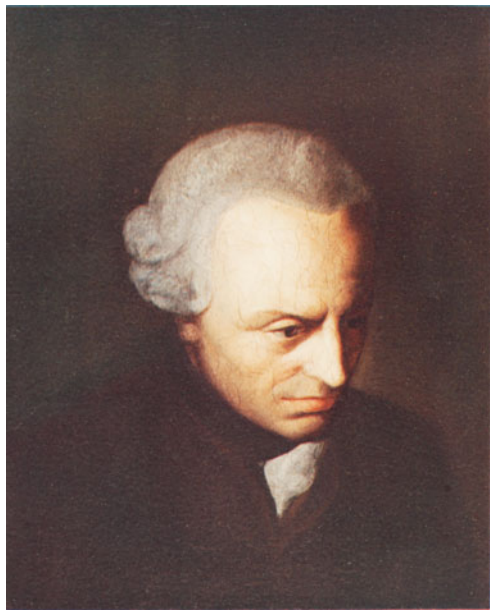

Fig. 12. Immanuel Kant (1724–1804), Professor of Philosophy at the University of Königsberg. The painting was bought by the city of Königsberg when it turned up in 1896 and was put on sale as 'das Gemälde aus dem Dresdener Kunsthandel [A painting from the Dresden Art Gallery]'. Portrait in oils *c.*1790 by unknown artist. *Kant-Bildnisse* 1924. RL.

Kant presented a popular outline of his Copernican conversion in several allegories. He compared the process of research with the investigation of a judge. Scientists only get the answers from nature that their questions, formulated by their own reason, ask. Answers are not arrived at when a schoolboy reels off the lesson with which his teacher has indoctrinated him. In a court case they become apparent because the judge interrogates and cross-examines the witnesses by demanding answers to his considered questions. The initiative does not emanate from nature that is passive, like the witnesses who are only allowed to reply when they are asked. Hence the researcher is governing the entire investigation in the same way as the judge is in charge of the court—in Newton's case by taking advantage of observations made by other witnesses (astronomers) and inserting them into a mathematical equation.[10]

By means of a colloquial example Kant sheds light on another aspect of his epistemological scheme. Imagine that you knock on a door on a cold winter's day. You feel the heat stream towards you before you realise that the host has lit a fire, because you expect to enter a warm room. Without watching the thermometer you take off your coat and find out that a table has been laid for six people. The hostess approaches you, now only four guests are lacking, who will they be? You understand intuitively the difference between outdoors and indoors, between cold and warmth, and that the number of plates tallies with the number of hosts and guests. How is this understanding possible? The situation does not make sense due to sense impressions alone, because they appear as a manifold of incoherent phenomena. Your

understanding of what is going on depends on your mind, which by means of its innate concepts, including space and time, establishes a meaningful and coherent picture out of separate sense impressions.

What are these concepts? They are his famous categories of the understanding, guiding our mind, through which the multiplicity of impressions must pass to make sense. Without these categories the world would remain totally chaotic according to Kant. He pointed out time and again that our cognitive capability depends on two prerequisites: 'Without sense impressions no physical object would appear to us, and without concepts we would be unable to make sense of them. Thoughts without content are empty; intuition without concepts is blind. . . . Only if they are united can they produce knowledge.'[11] Hans Christian embraced Kant's categories of the understanding and dubbed them 'Ariadne's Clew' because to him they were the equivalent of the thread that Ariadne had presented to Theseus to enable him to escape from the labyrinth. These categories are applied unconsciously, but guided by human reason, like rules of grammar and syntax that gradually build up in the baby's mind to govern our speech although we are not aware of them as we speak.

The Ørsteds encountered yet another famous pair of concepts belonging to Kantian epistemology. They were not part of Riisbrigh's lectures but were learned about independently. They are the concepts 'phenomenon' and 'noumenon' that will appear time and again in this biography. For Kant a phenomenon is an object leaving a sense-impression and which, filtered through the relevant categories of the understanding, is cognizable. The noumenal, on the other hand, cannot be known, because it does not appear in time and space and hence leaves no sense-impression. Although we do not know anything about it, we may need the concept for purely intellectual reasons. The force of gravity serves as an example of a noumenon. It is insensible in time and space, and neither Newton nor Kant nor anybody else knows what it is. In physics it means 'something' that is beyond our knowledge, but still a necessary epistemological concept, because without the noumenon that we call gravity we would be unable to understand the reciprocal attraction of celestial bodies or the movement of tides. The concept of 'physical force' that is not represented by an object amenable to experience by the senses is a necessary epistemological concept (noumenon).

This pair of concepts was basic to Kant's dualist philosophy and influenced the natural and moral philosophy of both Ørsted brothers. Kant reflected on another dualism between the strikingly lawful determinism in nature contrasted with the not less striking freedom of the human mind. On this schism he wrote a famous passage the first sentences of which were carved unto his tombstone: 'Two things fill the mind with ever new and increasing admiration and awe, . . . : The starry heavens above me and the moral law within me.'[12] None of them lend themselves as objects amenable to immediate empirical investigation. The starry heavens throw us into imaginations of unfathomable distances and infinite times. The moral law is invisibly bound to our individual consciousness and free will. The greatness of the starry heavens reduces the individual to an insignificant point in the universe. The moral law, by contrast, elevates the individual far above its physical nature and endows it with a freedom to pursue goals in life according to individual choice.[13] The starry heavens are determined by laws of

nature and are the study object of theoretical philosophy, while our moral law is subject to our own free will and to practical philosophy.

In critical philosophy the universal foundation of moral philosophy can be constituted neither by laws of nature nor by any religion, but only by secular reason. Why so? Because natural laws are indifferent to morality; they do not distinguish between good and evil. The sciences can only be descriptive (how people actually behave), not prescriptive (how they ought to behave). Nor can any religion be prescriptive to mankind, because it does not emanate from universal reason, but from individual belief in revealed 'truths' such as the Ten Commandments, the Sermon on the Mount, or the Koran. Principles guiding human action must be deduced a priori, that is, before we act. Thus moral philosophy diverges basically from natural philosophy. Whereas 'homo phenomenon' is subjected to the laws of nature, 'homo noumenon' sees himself as a self-governing moral agent. This, above all, is the distinguishing feature of humanity.

Human freedom is the alpha and omega of Kantian philosophy.[14] As a noumenal being man has a potential of autonomy, because he is endowed with reason. He is in no need of authorities to tell him what to do. To Kant the essence of enlightenment is the courage to throw away the yoke of tutelage and to emancipate oneself from religious and political authorities.[15] Man's reason is his inner compass that will guide his moral steps. He has complete freedom to set up goals for his life and to motivate his vocation. To allow himself to be governed by the carrots of guardians or to be threatened by the stick of tyrants deprives man of his dignity.

Kant's moral philosophy is totally concerned with the moral agent and is formal, general, and categorical, that is, unconditional. His categorical imperative ('Act as if the maxim of your action were to become through your will a universal law!'[16]) is a formal and general principle relating to the agent, not to the ends and means of an action. If the latter had been the case it would have been hypothetical: 'If you want to retain your credibility, it is stupid to lie'. 'No!' Kant would say, 'You should never tell a lie!'. The obligation to tell the truth is unconditional. The reason is simple. If sometimes you resort to lying, nobody will be able to know when you speak the truth, and as a consequence you can never make people believe a lie either. A general maxim authorising both truths and lies would turn out to be a universal law deprived of all meaning. It would make a mockery of all communication between people. Kant's categorical imperative is unconditional and serves to test a concrete action a priori. If the maxim of the action could become—through your will—a universal law practised by everybody, make it happen! If not, reject it! Kant supplemented his categorical imperative with another principle: 'act in such a way that you treat humanity, whether in your own person or in the person of another, never simply as a means, but always at the time as an end!'.[17] This means that one should never treat other people only as means to advancing one's own interests (instrumental action). The rights and obligations of others to pursue their own moral goals must also be respected.

'Obligation' is an important word in critical philosophy. The term 'homo noumenon' implies that man is endowed with reason and free will. Of course, Kant's contention that man is endowed with free will cannot be substantiated by any empirical evidence. Free will is no phenomenon. But a man could decide to conceive of himself purely as 'homo phenomenon' that

is as driven entirely by instinct. In Kant's eyes such individuals give up their dignity as human beings, reducing themselves to morally indifferent phenomena on an equal footing with animals. What Kant means by free will is man's choice to see himself *as if* he had a free will or to put it more metaphorically, to see himself as equipped with an inner compass, the magnetic needle of which points towards his self-imposed obligation to follow his maxims and defy his instinct.[18] If the human will were bound—determined by instinct—his action would be neither laudable nor responsible, because individuals cannot reasonably be blamed for actions they cannot help. Such individuals would be totally exempted from responsibility, slaves of their own instincts. But then again, they would also have abandoned their human freedom and dignity and reduced themselves to marionettes of nature that could not be made accountable for their actions.

Such—very crudely—were the challenges that the Ørsted brothers took on during their first years at university. Kant's dualism became their clue not only to their approaches to studying physics and law, but also to the frame of reference they were to share for the rest of their lives.

5 | 1796–7
Hans Christian's Gold Medals

Both Ørsted brothers spent the winter months of 1795-6 on Langeland, Hans Christian giving his father a helping hand in his pharmacy. On their return to Copenhagen their roads diverged, Hans Christian studying pharmacy at the Faculty of Medicine and Anders studying law, choices corresponding to the interests they had already developed as they grew up. However it was not written in the stars that Hans Christian would become a mind reader of nature. As already mentioned, physics and chemistry were subjects that were not taught per se at the University. He admired poets and had a poetic vein himself. As an older boy he had read Jens Hvas's translation of Batteux's aesthetics (1773–4). Charles Batteux had published his *Les beaux-arts réduits à un même principe* (1746), and J.E. Schlegel had translated it into German.[2] In 1774 Batteux had written a new five-volume *Principes de la littérature* that included his first book.[3] Batteux's works became trend-setting for the aesthetical debate in Germany and Scandinavia and his central ideas were embraced by the Swiss thinker J.G. Sulzer in his four-volume encyclopaedia of aesthetics (1792–4) which Ørsted ploughed through. Batteux's overall principle conformed to the Aristotelian idea of mimesis and was expressed by Sulzer as follows:

> 'As the artist is the servant of nature and his goals are the same, he is bound to use the means of nature to achieve them. Nature is the primary and most perfect artist, and invariably she chooses the best method to serve her purpose. It is impossible to find a better method. Hence, artists must take Nature as their model . . . That is the true school where the artist can learn the rules of his art by imitating the universal method of Nature.'[4]

Batteux's principle, however, was far from as unequivocal as he seemed to imagine. Imitating nature is highly ambiguous. Heeding the Enlightenment cult of Newton one might think of this principle as scientific and rational, but to Batteux imitation was rather a form of idealisation. By 'nature' he meant '*la belle nature*', that is an embellishment of nature affirming the cosmic order created by God, not recalcitrant, sombre or even catastrophic nature. The principle of '*la belle nature*' was intended as a mirror, in which people could recognise themselves as individuals in accordance with or in contrast to the embellishment of nature.[5]

Early on Ørsted had been absorbed by the thought that the beauty of the arts was modelled on the beauty of nature, a thought that combined his two main interests, aesthetics and science. So he was no novice when Jacob Baden, the professor of rhetoric, set the following prize essay title for 1796: 'How can prosaic language be corrupted by moving too close to poetry; and where are the boundaries between poetic and prosaic expression?'.

The term 'aesthetic' does not appear in the title of Batteux's works. This concept comes from the German philosopher of aesthetics, A.G. Baumgarten, and it means that artistic representations of nature are not directed to our intellect (as with laws of nature), but to our emotions and taste via our senses. However, since some representations of nature address the cool brain while others appeal to the heart as the seat of emotion, they tend to be inconsistent. In other words, poetry is likely to be at variance with prose. If the boundaries between the two are blurred then confusion arises. The correspondent, the scientist, and the historian are expected to be precise while the composer and the lyric poet touch our emotions. Batteux and Sulzer provide an abundance of examples of the different genres. So when Ørsted had grasped Batteux's point, his prize essay was almost writing itself. He appreciated the ambiguity of Batteux, who represented all of nature poetically and as a consequence spoke artistically, that is elaborately, about simple nature, which he actually despised as something low, adding that 'to seem high one must walk on stilts'.[6]

Hans Christian disagreed with the view that the poet could use metre alone to define poetry because orators or correspondents appealing to the senses would also express themselves poetically although not in metric style. He was well aware, of course, that logic, mathematics, and metaphysics must be prosaic due to their purely abstract and intellectual character. He embraced Baumgarten's definition of poetry: 'A genre aiming at a sensual representation of its objects'.[7]

In short: whereas it is the aim of poetical language to titillate the senses, prosaic language serves to communicate scientific knowledge. Ørsted listed a number of texts which crossed the barrier between poetic and prosaic language and thus offended good taste. He drew attention to the flawed use of poetic language when poetry exaggerated its means of expression and became purple.[8] On the other hand, prosaic language often failed to achieve its intention if it renounced poetic expressions altogether, because it is hard to persuade reason without having moved the emotions first.[9]

The Chancellor of the University presented the gold medal to Ørsted, who stood out from the anonymous crowd of students with this modest claim to fame.

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Ørsted's prize essay was brief and close to his sources, which is understandable in view of the fact that he was busily involved in other activities: his work as inspector, and lectures at the

University. More important, no doubt, were Ludvig Manthey's tutorials on chemistry at the Academy of Surgery. Ørsted had made chemistry his main subject, and in Professor Manthey (his senior by only nine years) he found a patron for life. Manthey used F.A.C. Gren's *Handbuch der gesamten Chemie*, the most up to date textbook at the time and preferable to the Danish translation of Macquer as well as to Tychsen's textbook of chemistry. Through marriage, Manthey had become the owner of The Lion Pharmacy that had burnt down in the great fire of 1795 and was only rebuilt in 1799, so for four years coinciding with Hans Christian's intense studies of chemistry, Manthey took it upon himself to teach chemistry at the Academy of Surgery, thereby also enhancing his own knowledge in the light of his designated post as head of the Royal Porcelain Factory in Copenhagen.[10] The relationship between Manthey and Ørsted developed into a warm and confident friendship.

At the exam on 20th May 1797 Ørsted impressed the three examining professors. The *chemico-pharmaceuticum* exam was divided into two main disciplines: chemistry and botany. Strange, therefore, that three medical professors were the examiners, while the professors of chemistry (Manthey) and botany were not. The reason was that chemistry and botany were regarded as stepchildren of the Faculty of Medicine. In addition, a state of rivalry existed between the University and the Academy of Surgery. Ørsted had acquired his knowledge at home in his father's laboratory and at the Academy of Surgery. To testify to his practical skills he presented a letter of apprenticeship issued by his father, who had passed the same exam twenty years before in front of almost the same panel; it declared his son to be a journeyman chemist by virtue of a five-year apprenticeship between the ages of twelve and seventeen, with additional practical experience in the lab during the winter of 1795–6.

Hans Christian impressed his examiners. Professor Saxtorph awarded him a *laudabilis* and the other professors a *laudabilis præ ceteris*. According to the rules *laudabilis* was the highest average of marks to appear on the diploma. Therefore, Professor Tode took steps to provide the graduate with a separate testimony that would make the holder blush and any rival blanch. Tode listed all Ørsted's academic merits, praised his knowledge on the modern anti-phlogistic chemistry as well as the previous Stahlian, and he stressed that on top of this bookish knowledge he was also well versed in practical skills in the lab. He had identified all fresh plants and explained their pharmaceutical properties correctly. Tode had examined 160 undergraduates in 28 years, he stated, but it was a long time since he had had the pleasure of meeting such a bright and at the same time such a young pharmaceutical student. He could hardly be expected to dedicate himself to the pharmaceutical profession solely, since he was endowed with an unusually fertile genius, indeed born for the sciences.[11, 12]

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So, Hans Christian was not entirely unprepared when he threw himself into writing his second prize essay on 'The Origin and Function of the Amniotic Fluid' for the Faculty of Medicine in 1797. The deadline was set at the beginning of December, and preparations for his exam prevented him from starting until June. In the course of six months he carried out a series of chemical experiments with amniotic fluid that was easily available from the maternity hospital

on Amaliegade and could be analysed at the Academy of Surgery, perhaps with the help of Manthey.

No doubt Mathias Saxtorph, the professor of obstetrics, had chosen the prize essay topic. Hans Christian took '*chemia oculus medicinae alter*' ['chemistry is the second eye of medicine'] as his motto, alluding to Paracelsus and the iatrochemists of the sixteenth century. 'Use your own eyes!' Paracelsus had said, 'and burn the Galenic textbooks that lead the doctor astray.' In other words, Ørsted was determined not to rehash outdated testbooks, but to examine chemical reactions with his own eyes. This method took a sly dig at the Faculty of Medicine which still considered a chair of chemistry superfluous.

Where does the amniotic fluid originate: from the embryo or from the uterus? And what does it do? Does it nourish the embryo or is it conducive to the delivery by adding weight to the embryo and making the birth canal smoother? Is chemistry able to answer these questions 'lying in an almost impenetrable, Egyptian darkness?'. Textbooks offered several hypotheses of a speculative nature, but they often contradicted each another and Ørsted preferred natural philosophers, who relied on empirical investigations, even though he recognised that empiricists fought each other as well. He particularly took note of the works of Albrecht von Haller and J.F. Blumenbach, but hoped that his own chemical analyses might contribute to the solution.

According to the examiners, his finished report was 'well-structured, well-written and carefully worked out'. His initial chemical analyses of the elements of the amniotic fluid were particularly laudable. The outcome of his many experiments with excipient acid, salt, alcohol, and acidic quicksilver, cooling, heating, and distillation was that the amniotic fluid contained hydrogen, oxygen, carbon, and ammonium, as well as various salts, oils, phosphorus, and chalky soil. Hence, according to his analyses the fluid was 'a thin water-like solution of albumen'.[13]

The problem of the origin of the amniotic fluid was the most difficult. Nobody had found the right answer, neither Haller nor Blumenbach. If it stemmed from the embryo, there were the following possibilities: sweat, urine, phlegm and saliva. They were all rejected by the argument that the quantity of amniotic fluid decreased in proportion to the weight of the embryo during pregnancy. Moreover, the chemistry of these secretions did not match that of the amniotic fluid. If they originated in the uterus the elements of the fluid must be traceable to the cellular tissue of the uterus or to the navel string, foetal membrane, or placenta. Ørsted concluded that the amniotic fluid had several sources such as the blood via arteries in the amnion, but realised that he did not have sufficient data to reach a definitive answer. 'During our investigations experience—this faithful guardian—abandoned us, while—surrounded by a chaos of hypotheses—we did not know where to turn to.'[14] The author gained much praise for his reluctance to come up with speculative conclusions.

The amniotic fluid was useful for the protection of the embryo during pregnancy and as 'a moving force' during the birth, when the birth canal was expanded and greased to ease the liberation of the child 'from its prison'. But was the fluid nourishing, too? This was the hardest issue. The author repudiated the idea that the embryo would absorb nourishment by swallowing amniotic fluid arguing that no excrements could be traced. But he was uncertain about this as well. The essay was a methodologically sober piece of work. There were no

hasty guesses, but concrete analyses, and whenever knowledge was insufficient or uncertain Ørsted concluded with reservations. He was awarded his second gold medal.

Kant was not mentioned at all. His epistemology was irrelevant to chemical analysis. Moreover, unfortunately, according to Kant, chemistry was no science and was unlikely to become one. No Danish scientist, including Ludvig Manthey, had so far taken any interest in the critical philosophy. Soon, however, when Ørsted started working on his dissertation on atomic theory, the fundamental problem of physics, he would assign a major role to Kantian metaphysics.

Ørsted's gold medals nearly suffered the same fate as that of the famous golden horns that were stolen by a goldsmith and scandalously melted down. In the 1820s his Norwegian nephew, Søren Christian Ørsted Bull, who lived with his uncle on Studiestræde at that time, seized the occasion to steal the two gold medals from a desk drawer and sell them. The theft was discovered before the treasure was melted down, and the culprit was punished by being sent to sea as a simple sailor for two years.[15] Such behaviour was not to be expected from any member of the Ørsted family.

Act in respect of duty according to maxims
that can become a universal law.[1]

6 | 1798

Anders's Gold Medal

Having passed *philosophicum* with Riisbrigh, Anders became a student of law and followed Anders Gamborg's lectures on moral philosophy in his professorial court in Studiestræde. To be sure, his moral philosophy touched on Kant's critical philosophy in passing, but to judge from students' notes it appears to have been an eclectic jumble of Nørregaard's natural law, which Anders had already read as a boy, and the rules of conduct of eudaemonism. Reputedly, the course was based on this maxim: 'Man should live according to nature. Consequently, all men must aspire towards perfection without harming other people, but they must also promote the happiness of other people to the best of their ability considering their individual relationship to them.'[2] This was the conventional programme of natural law at the time. For Anders, with his philosophical mind, Gamborg's series of lectures gave him material against which he could hone his arguments.

According to the maxim of natural law man must aspire towards perfection, that is, exploit his talents. This implied that he must keep himself alive (hence suicide was forbidden) and live a healthy life, be moderate in enjoyment, and work hard. Sexual desire was designed for reproduction, and as a consequence it was contrary to natural law to satisfy this desire in ways not leading to reproduction, such as masturbation. On the other hand polygamy and civil marriages did not violate natural law since they both served the purpose of reproduction. In a way veracity was an absolute obligation, Gamborg also asserted,, but he did not consider it contrary to reason 'to say something that in order to be true must be understood against the normal meaning of words, but nevertheless under particular circumstances could be thus understood as well.'[3]

Natural law referred to the 'analogy of animals', so Gamborg inferred that parents are obliged to provide for their children until they are capable of providing for themselves. This was not to say that mothers ought to breast-feed or parents bring up their children if 'the purpose of nature, that is, the well-being of children, could be otherwise achieved.' At this point Anders found that Gamborg failed completely. His maxim 'the analogy of animals' was at odds with Kant's moral philosophy in so far as animals, unlike humans, are not intelligent beings but are driven by instinct, and consequently the analogy is irrelevant for a morality of reason.

It is unclear whether Gamborg's concept of reason was rooted in obligation or religious faith. The analogy of animals, one of his hobby horses, excluded both possibilities. He gave a paper at the Scandinavian Literary Society quite seriously suggesting how to improve the quality of bird song in our forests. The idea was to let eggs from unmusical birds be hatched by musical ones, nightingales for instance. The professor had come to understand an English ornithologist to the effect that birds' voices are not innate, but acquired. So the point was to take advantage of musical parent birds and make them foster unmusical offspring. This trick would combine the useful with the agreeable, for a promenade in the forest to the accompaniment of beautiful bird song would ennoble the human mind.[4] This was the Enlightenment idea of letting the improvement of nature and the enhancement of happiness go hand in hand.

Anders also followed J.W.F. Schlegel's lectures, which he found far more profitable. Schlegel was a keen Kantian. As already mentioned, he had published the posthumous writings of his brother-in-law Christian Hornemann on Kantian epistemology, which he followed up in his own journal, *Astræa*. Anders had familiarised himself with all this. Schlegel was also the cousin of the Schlegel brothers in Jena, renowned for their journal, *Athenäum*, voicing early romanticism. Unfortunately, no records of his lectures survive. As a rule, close relations between professors and students were rare, but here was an exception. Schlegel became the patron of Anders, on a par with the Manthey-Hans Christian patronage, but there is no evidence to shed light on the way Schlegel actually supported Anders.[5] In the beginning Anders held Schlegel in high esteem calling him 'the honourable editor of *Astræa*',[6] but soon the relationship cooled, because on some points Anders was inclined to follow Fichte, while Schlegel did not tolerate the slightest deviation from Kant.

While Hans Christian was writing about the amniotic fluid, Anders pondered the problems of moral philosophy. The Faculty of Philosophy had set this prize question: '*Ostendatur nexus inter principium ethices et principius juris naturae*' ['Show the connection between the principles of ethics and the principles of natural law']. Riisbrigh and Gamborg together had initiated it and were to evaluate it. When a year later Anders was encouraged to publish his essay *Over Sammenhængen mellem Dydelærens og Retslærens Princip* ['On the Connection between the Principle of the Doctrines of Virtue and Jurisprudence'][7] he had elaborated his text considerably in the light of the criticisms put forward by his examiners.

Like Kant, Anders criticised eudaemonism as superficial, but he did not agree with Kant on his distinction between doctrines of virtue and jurisprudence. According to Kant there was a division between the duties prescribed by individual reason and fulfilled by his free will, and the obligations of jurisprudence that the citizen is punished for disobeying. Hence virtue is the moral strength by which one controls an instinctive aversion to obey the maxim of reason.

Abiding by the law is not virtuous according to Kant; it just provides a clean criminal record. Obligations of virtue are conditioned by the free will, whereas obligations of jurisprudence are unconditional. Another important difference for Kant was that obligations of virtue are infinite, because actions live up to maxims only imperfectly, whereas obligations of jurisprudence are finite: One either obeys the laws of the state, or breaks them.

Anders criticised Kant for including a large group of unconditional obligations in the doctrine of jurisprudence. In other words he was more favourably disposed towards the legislative power of the state and its motives than Kant, and a grouping together of the doctrines of virtue and jurisprudence under a superior moral philosophy was therefore less problematic for Anders.

A doctrine of virtue expresses a moral teleology for the individual way of life as a homo noumenon. But it does not answer the question as to which concrete action is necessary to reach the goal. The difference between the doctrines of jurisprudence and virtue is significant. Whereas the law orders or forbids the citizen to do something specific such as paying his taxes, not stealing, etc., nobody is entitled to set the rules and goals for somebody else's behaviour. Only the individual can do that. On the other hand, jurisprudence totally ignores the individual life-projects of citizens and applies the same yardstick to everybody.

By way of contrast, the categorical imperative, 'act according to a goal-oriented maxim that can become a universal law', takes a different direction from that which a life would take if the individual was merely following his natural instinct as a homo phenomenon. It is the prerogative of man to be guided by his own reason and free will in pursuance of his own goal by fighting the impulses in him that oppose his maxim. Kant's famous dictum, 'Enlightenment is man's emancipation from his own self-imposed tutelage', means exactly that. Man should be his own lawgiver. That is his mark of distinction.

It is obvious that Kantian moral philosophy played a crucial role in the lives of the Ørsted brothers. In addition, they were further inspired by Fichte's writings on the vocation of humans and scholars (ch. 20).

*

The following summer Anders graduated having already tutored a number of fellow students, who passed the *examen juridicum* with top marks. He had scarcely left the exam room before he took part in a competition for a position in the Faculty of Law. Delivering his trial lecture Anders revealed that subsequent to his gold medal he had come to favour some of Fichte's answers to problems Kant seemed to have left unsolved. Professor Schlegel, his patron, was one of the experts judging the candidates and he became so disappointed at his protégé's desertion of Kant that any chance of an appointment totally vanished. M.H. Bornemann won the competition. He swiftly climbed the academic ladder and was appointed professor. Anders considered him highly qualified, but the fact that Anders only came in fifth in the competition was a humiliating defeat. Part of the blame was placed on his health. A severe strain on his nerves weakened his preparations, but the real cause was his unclear or even paradoxical attitude towards jurisprudence. His prize essay had convinced Riisbrigh and Gamborg, the examiners, more than the author himself. He plunged into the writings of Fichte who in 1799 had

become a hot topic in Copenhagen, partly because he had been dismissed from his professorship at Jena accused of atheism, and partly because Jonas Collin had translated and edited his book on the vocation of the scholar. Anders was already acquainted with his *Wissenschaftslehre* [theory of knowledge], and he joined the Fichtean view on jurisprudence. This cost him a career as a scholar. The University's refusal of a candidate of the first water like Anders was then and later considered one of the most embarrassing mistakes in its history.

The gold medal was a trophy and one would assume that the glorious exam he had passed (he gave the best performance since the 1788 reform) had given him satisfaction. But it did not. From the winter's day when he decided to enter for the gold medal to the trial lecture in the summer two years later, he failed to thrive. This was not only due to his overstraining himself mentally, but also because he was haunted by an increasing and painful doubt. The printed version of his prize essay ran to 470 pages, while by comparison the two prize essays of his brother were 30 and 60 pages long respectively. No doubt, Anders's workload had damaged his health.

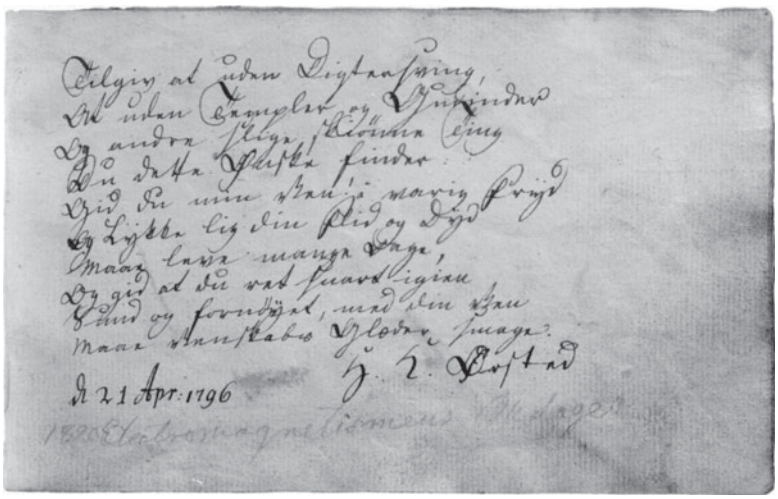

Fig. 13. The first known writing by eighteen-year-old student Hans Christian. The recipient is unknown or perhaps his brother. DTM.

Tilgiv at uden Digtersving,
At uden Templer og Gudinder
Og andre slige skiønne Ting
Du dette Ønske finder:
Gid Du min Ven! i varig Fryd
Og Lykke lig din Flid og Dyd
Maae leve mange Dage.
Og gid at du ret snart igien
Sund og fornøyet, med din Ven
Maae Venskabs Glæder smage.
d. 21 Apr:1796 H.C. Ørsted

Forgive me that without a poet's skills
And without temples and goddesses
And similar beautiful things
You find these wishes:
May you, my friend, in lasting bliss
And happiness, like your diligence and virtue,
Live for many days!
And may you pretty soon,
Healthy and cheerful,
Enjoy the pleasures of fellowship!
April 21st 1796 H.C. Ørsted.

The periods Anders spent at Langeland with his father and his younger siblings were not holidays, but just a change of workplace.[8]

Anders's diligence was legendary and tough on his health. Doctors called it nervous fever. It forced him to bed and for a while it was feared that his life was at risk. But even when he was sick he was unable to let go of a philosophical challenge. A fellow student watching at Anders's bedside argued against Fichte. The drowsy patient turned sharply and refuted his friend's objections eloquently—then fell back into apathy. The tremendous problems arising in the wake of Kant's philosophy gave Anders a headache. Adam and Hans Christian called a prominent doctor, because obviously Anders was suffering from a deep depression. Several times he found himself on the brink of suicide. 'For a long time I did not dare to walk near water or where otherwise there was a chance of precipitation', he confessed.[9]

We do not know the name of this doctor but he certainly practised Brunonianism, a cure that was fashionable at the time and was practised at Frederik's Hospital. John Brown was a Scottish doctor whose simple theory became popular in parts of the medical profession, and above all by followers of the German *Naturphilosophie*. Briefly, Brunonianism tried to explain human life-processes as a function of external stimuli of the body. Brown theorised that too many or too few stimuli were conducive to sickness. To counterbalance these external stimuli by means of drugs was the doctor's task. It was a theory of human disease that allegedly reduced previous medical wisdom to a disordered mess of empirical contingencies. However Kant was impressed, seeing in Brunonianism a real opportunity that medicine might in due course become a science, that is a system of knowledge governed by theory.[10]

Anders was treated according to Brown's theory. The doctor was certain that his patient's brain was overstrained by philosophical speculation and his body under stimulated by sedentary studying. Anders was told to take Madeira and China (opium) intended to control his fever. The cure failed. Before Brunonianism Anders had tried to overcome his spleen by rational means, because what other means were available? When reason is the distinguishing feature of man, why cannot reason redeem the pain that his obsession with it has inflicted upon him? Studying Kant's 'The power of the mind to master one's sick feelings by means of mere intentions' was laborious but for a while it seemed hopeful, 'although the effect was rather slow and imperfect'.[11] Now, Adam and Hans Christian forced him to take long daily walks and to read less. It helped him a lot to walk away from the stinking streets of the city to the park surrounding Frederiksberg Castle where old Oehlenschläger, Adam's father, lived, his house being kept by his bright and beautiful daughter, Sophie.[12] Fortunately, Anders recovered while Brunonianism were discredited. Sophie was, perhaps, his best cure.

What frustrated Anders above all was the failure of his efforts to reach the serenity he had expected or at least hoped for. Instead he had descended into an intellectual despair that enervated him and gave him migraine. Could the doctrines of virtue and jurisprudence really be contained within the bounds of one system of moral philosophy, the maxim of which was the categorical imperative? His essay had convinced Riisbrigh and Gamborg, and to that extent he had won. But he had not convinced himself. And Kant's second treatise did not help him. He turned to Fichte, believing that he could solve the problem. Anders was well aware that Fichte's theory of knowledge had not answered all his questions, but yet he hoped for solutions