A LESSON FOR COPENHAGEN TODAY

Hans Christian Ørsted's Scientific Method

by Tom Gillesberg

The great Danish scientist Hans Christian Ørsted (1777-1851) in a 19th Century portrait. He is depicted with his experiment on the patterns sound waves produce in a powder on a metal plate.

Throughout 2009, Denmark has been under a siege of climate hysteria. There has been a great effort to try to delude the public into thinking that Denmark's great mission is to secure a binding global climate agreement during the United Nations Climate Summit, to be held in Copenhagen Dec. 7-18, 2009. If this were to occur, it would force the nations of world to spend much of their economic resources on "renewable energy," and other wasteful actions, because it is claimed that such actions would reduce the human CO_2 destruction of the Earth. The shrill rhetoric is supposed to make people feel that the world would be nearly annihilated, if this were not to succeed.

Fortunately, the growing political revolt in the United States has made it close to impossible to get this policy through. It is not only likely that the climate summit will become a Danish climate flop, but also that, in coming years, people will look back with shame at the absurd rhetoric about human-induced global warming, which is a repeat of the famous Hans Christian Andersen story, "The Emperor's New Clothes." And, in time, people will be embarrassed, and try to forget how much of the world's resources were sacrificed on the altar of climate superstition.

If the great Danish scientist Hans Christian Ørsted (1777-1851)

Library of Congress

The city of Copenhagen in an 1895 photo. Today the city has been chosen to host the United Nations Climate Summit, whose delegates are charged with securing binding economic agreements based on superstitions that Ørsted would have derided as nonsense.

Instead of today's climate superstition, we must return to the classical humanist scientific method propounded by the great Danish scientist Ørsted and his cothinkers.

were present today, he would be shaking his head at the ongoing pseudo-scientific debate, and the intimidating brainwashing campaign that accompanies it. He would have immediately realized that it is not science that is paramount, but that the whole debate is skewed by a prejudicial assumption that humanity is an evil that must be culled. This is the philosophy of the environmental movement, and its royal backers, Prince Philip and Prince Charles, and this is what has driven them to wish to limit human development through CO_2 allowances and expensive energy, thus undermining the very basis of the existence of present and future humanity.

To counter the media, politicians, and well-paid researchers who persist in their superstitions, and ignore the scientific research showing that it is the Sun which is causing climatic fluctuations on Earth (as documented by the contemporary Danish scientist Henrik Svensmark), Ørsted would have taken out his 1850 book, *The Spirit in Nature,* which he wrote to try to fight the superstition of his day. As he wrote:

> No proof is necessary to show that a worldview is a fundamental element of philosophy, but it is no less certain that this must be either fruitless, or in many respects false, if this worldview does not possess, in itself, the most essential truths taught by natural science. Even if the philosophers of the present day are not unacquainted with the results of the natural sciences, they generally pay so little attention to them, that it exercises almost no influence on their inquiries.[1]

A monument memorializing Ørsted and his love of science and truth, created by Jens Adolf Jerichau in the 19th Century. It is in Copenhagen's Ørsted Park.

In Ørsted's time, it was people like the Danish Reverend N.F.S. Grundtvig (1783-1872), who despised science, and in its place created his own mythological universe. Today, the environmentalists and climate fanatics, instead of using modern science and technology to improve the environment and living conditions of the population, prefer to use climate superstition to deceive them. They erroneously claim that human activities destructively interfere with nature's delicate balance, and that man, therefore, is nature's worst enemy. Ørsted would have protested, and emphasized how studies of nature and the Earth show something quite different. He would have insisted that the environmental ideologists' idea that we must have zero growth, and stop human development, is contrary to the very laws of the universe. Everything changes and develops. As he wrote:

> The Earth has not always been as it is now; its internal structure testifies to the fact that it has been developing from one condition to another for thousands of years, and the attentive inquirer must be aware that it constantly continues to develop itself, and that now, as at any other moment, it is passing from one state to another. We may easily conceive that the same thing is taking place with all the other heavenly bodies, which are, therefore, not only in constant motion, but, at the same time, are in an unceasing state of development. Inaction or rest does not exist in the universe.[2]

"It is one of the fundamental laws of nature, that everything must be developed over time,"[3] concluded Ørsted. That is the most fundamental universal law. Everything in this universe must be in constant flux and development. Instead of trying to subject humans to the limitations that apply to other living creatures on this Earth, we must therefore recognize that man is not just a part of nature, but through his creative reason, is above it.

"In as much as a person thinks, he is free. His freedom grows with his thinking. Without this, he is subject to the laws of unconscious nature."[4]

If we use our reason, we are the unique life form here on

Gillesberg is chairman of The Schiller Institute in Denmark, and Copenhagen mayoral candidate, who led The Friends of the Schiller Institute list in the Nov. 17 municipal elections. This article first appeared in Danish in the Schiller Institute's campaign newspaper, No. 10, Fall, 2009 (www.schillerinstitut.dk/ka10). It was translated by Michelle Rasmussen and Carol Jensen.

Earth, which has been granted free will. If we deny ourselves reason, we reduce ourselves simply to being animals, and then, as the environmental movement tries to make us believe, we are reduced to blindly subjecting ourselves to nature.

Ørsted's point would later be developed in greater detail by the great Russian scientist Vladimir Vernadsky. The entire universe is developing, but there are three very distinct and different types of developmental dynamics we find coexisting on the Earth: 1) the non-living abiotic lithosphere, which consists of dead stones and matter; 2) the biosphere, which is the result of living biological processes; and finally 3) the noösphere (the sphere of spirit and reason) which is the result of cognitive life in the form of human activity. These three principles and spheres work simultaneously and are interlocked, but are fundamentally different, and have different rank and power in the universe.

Ørsted's philosophical opponent, Reverend Grundtvig, in an 1843 portrait by Christian Albrecht Jensen.

Living processes "eat" abiotic non-living material, which is thus incorporated into the biosphere, and the volume of the biosphere, in relation to the lithosphere, grows day by day. Similarly, the lithosphere and the biosphere are subjected to the noösphere, where man is constantly incorporating an increasing proportion of them into his activities. But if man stops using his reason, he loses his free will, and will be subjected to the biosphere and the lithosphere.

Ørsted's Worldview

Like the great astronomer and thinker Johannes Kepler (1571-1630), Ørsted is convinced that we do not live in a universe ruled by anarchy and randomness. On the contrary. The universe is a beautiful process of development, which is guided by a higher idea. Ørsted had therefore called natural laws, "natural thoughts," and in a sharp polemic against people like Reverend Grundtvig, Ørsted said: "natural laws are thoughts of nature.... These thoughts of nature are also God's thoughts."[5]

Grundtvig had attacked Ørsted for undermining Christianity through the dissemination of science, for, according to Grundtvig, one could not both study science and believe in God. Ørsted had replied to this with a lecture titled "The Cultivation of Science Considered as Religious Devotion." The lecture, he said, contained "in brief, the author's thoughts concerning the inner connection between the True, the Beautiful, and the Good, and their common divine source." Ørsted thought that Grundtvig's problem was that he did not understand "how the scientist, when he fully understands his own endeavor, must regard the cultivation of science as religious devotion."

For Ørsted, there is no contradiction between belief in God, who created the universe and its laws of nature, and natural science laying bare natural thoughts, and the deeper reason in that which has been created. The great and beautiful natural thoughts we find through science (the universally valid natural laws) are not inaccessible to us human beings, because our reason is akin to the creative principles behind them:

> Were the laws of our reason not found in Nature, we would strive, in vain, to force them therein; were the laws of nature not found in our reason, we would not understand them.[6]

We humans, and only we, are able to find the laws of nature, understand the natural thoughts, and apply them in our service.

Ørsted's Genius

This does not sound like a cold scientist, who objectively considers nature around him, and believes that it is merely a series of random events, without cause and purpose. Ørsted was not like that; on the contrary. The reason that Ørsted could find that which his contemporaries looked for in vain, namely a connection between the diffuse phenomena of electricity and magnetism, was that he knew they were part of an overall harmony, and therefore, there must be a correlation which he could find, if he could understand the idea that lay behind it. Just as Kepler, in his pioneering works, *The New Astronomy* and *The Harmony of the World*, had described how he discovered the harmonic principles underlying the

A depiction of Ørsted and his most famous electromagnetic experiment, from the Deutsche Museum.

planetary orbits in our Solar System, Ørsted believed that discoveries in astronomy are the role model for how we create a deeper understanding of all the other scientific fields. Science, of course, implies the use of our senses, in order to look at the phenomena around us through sensory impressions, and we even build better tools to enhance these senses. But this alone does not give us insight into the coherence of things. It requires something more, namely human genius. We are able to go beyond the sum of sensory impressions, and create a hypothesis about the principle, the thought, or idea, that lies behind the phenomena we observe.

Ørsted understood this early. He began his work, "The First Foundations of Natural Philosophy," published in 1799, while he was a student:

> When a collection of knowledge, gained through experience, shall make claim to be science, in the genuine meaning of that word, then these observations have to be connected, according to certain general and necessary laws, which cannot be deduced from experience itself, but must be proven without its help (a priori). If that is not the case with an ordered body of knowledge, then the thinker is not at all satisfied with the result, but it leaves him at a boundary, which he is not certain is the outermost, and it shows him laws, which he dares not assume to be general and necessary, because he knows that experience can only teach us what is, but not what necessarily must be.

A contemporary view of Denmark's Technical University, the successor of the Polytechnic University which was founded by Ørsted in 1829. Ørsted fought to keep science, not mathematics, primary in the curriculum.

Ørsted's first love was poetry, and Friedrich Schiller (1759-1805) was an influential figure in his philosophy.

Poetry and Science

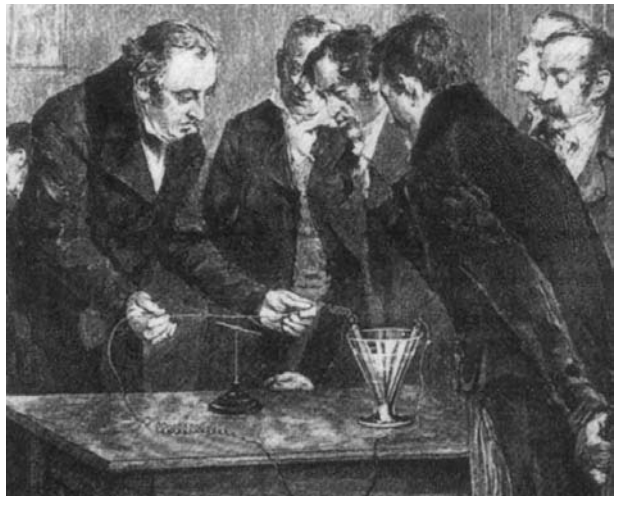
As Ørsted himself never tired of pointing out, his first love was not cold mathematics, but warm poetry:

> Don't you know that since I was a child, I have been writing poetry, even before I could write prose?... Know that I only left poetry, because it seemed to me, that there were too many lies and affectation in most of it, and that, nevertheless, I have always felt attracted by its harmony.[7]

For Ørsted, there is no strict separation between science and art. They are both products of human creativity and reason, each in its own field. And it is through developing ourselves in both areas, that we are able to break the narrow limits of our thinking that have prevented us from capturing the deeper reality behind our sense impressions. Both are products of human reason. Through our capacity for critical self-reflection and a review of our *a priori* axioms and assumptions, we philosophize and reflect about the larger connections and higher harmony. And then, when we seek to create a hypothesis about the invisible underlying coherence that causes our physical observations—the shadows we see on the wall—then it is our imagination, trained through art, which will enable us to do this. For example, Albert Einstein always started playing his violin when he was stuck on a problem, and needed to be inspired to solve it.

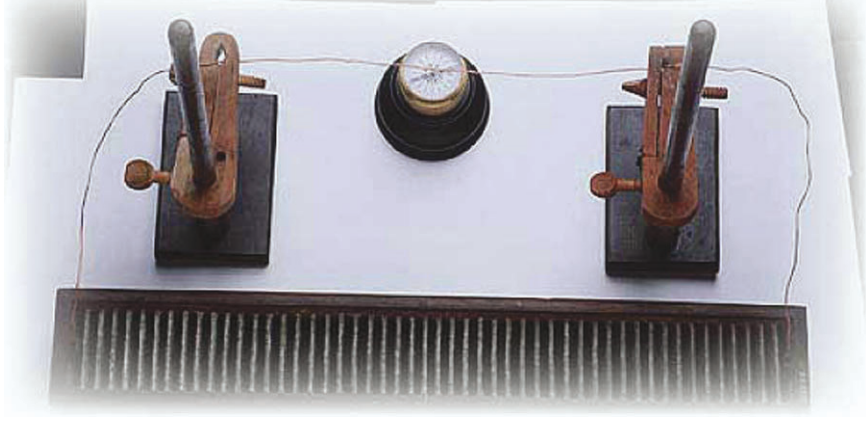
Subsequently, we use physical experiments to confirm or refute our theory, where

> Its importance is due to the fact that it is not only our reason, which tests the creations of our own reason, but



Ørsted's discovery of electromagnetism sent a shock wave throughout Europe. Here a French engraving depicting the experiment (right) and (above) a German illustration of the experiment.

Below left: A reconstruction of Ørsted's 1820 experiment demonstrating electromagnetism. A compass placed next to a closed electrical circuit, with the needle parallel to the wire, caused the compass needle to shift, indicating a relationship between electricity and magnetism. Readers can reproduce this effect for themselves.



> that we are testing how well our reason is in harmony with a creation which we certainly know, for sure, our reason has not produced.[8]

After that, the new knowledge can be turned into new mathematical formulas and principles that we can use in our ongoing activities. But if we try to let mathematics lead us to reality, putting the cart before the horse, then we will get mirages, instead of science, as we see among many contemporary researchers.

That was already a problem in Ørsted's time, and in 1811, he wrote a warning in his *First Introduction to General Natural Science*:

> Many of the most excellent of those who work with natural science, have tried too hard to impress mathematics onto it, or more correctly, the form of Euclidean geometry, whereby it has been regarded as applied mathematics. By doing so, science is robbed of its natural form.

And when a group of mathematicians in 1844 tried to introduce changes in teaching at the Polytechnic University, to be grounded in mathematics instead of physics, Ørsted clearly refused. He declared himself in fundamental disagreement with

> those mathematicians who think that physics should only be treated mathematically. In contrast to this, throughout my whole scientific life, and even more so, the further I progressed, I have tried to elevate a treatment emanating from the nature of physics itself, in which mathematics steps backward, as much as possible, in favor of experimental treatment. At the same time, I have constantly declared, that it is exceedingly important for physics, that its truths are also put in a mathematical form, and I encourage those listeners, who would be willing to go further in this direction, to make use of mathematical

> teaching for this purpose. In contrast to this, I cannot advise anyone to start with mathematics, in order to become a physicist.

Until his death, Ørsted prevented the Polytechnic University and the Danish scientific community from being taken over by the mathematicians. Ørsted had a dynamic holistic worldview in which all parts of our existence must necessarily be interdependent. There is no false separation between science and art, or knowledge and belief. In 1833, he concluded a letter to Hans Christian Andersen, in connection with his first trip abroad, with these words:

> Reason with Reason = The Truth;
> Reason within the Will [intention] = The Good;
> Reason within the Imagination = The Beautiful.

We see here the dynamic holistic idea that was a hallmark of the Danish Golden Age, in which Ørsted was a great driving force, and which, in reality, was a renaissance, a rebirth of classic Greek art and philosophy. It was living by the Greek idea, that one should be καλο'ς και αγατθο'ς, beautiful and good, and seek the truth, the beautiful and the good, which was the source of the explosion of creativity and development during the Golden Age. And this was largely the result of Ørsted and others being inspired by that standpoint through the great influence of Friedrich Schiller's ideas in Denmark.[9]

Reason with Reason

Already as a student, Ørsted published interesting philosophical thoughts, and during his subsequent educational trip throughout Europe, he was able to visit 70 of the great scientists and thinkers of the time. He was immediately attracted by the great incomprehensible phenomena of his time, such as electricity and magnetism, but also all other natural scientific phenomena. From early on, he loved to verify all experiments, and published one of the first chemistry books in German of his time, in order to make the many new speculations and discoveries accessible to a wider audience. The book was soon translated into French.

Ørsted quickly became the focal point in Copenhagen, when it came to reenacting international physics experiments, both for students who needed to have a minimal insight into chemistry and physics, and for other scientifically interested people. He built up an ever more extensive collection of experiments. In 1806, he published a scientific study of the graphics of sound waves (how metal plates, which are set into motion by certain sound waves, create harmonious patterns in powder placed on the plates), which is illustrated in the portrait of Ørsted from 1842. That was the reason he was accepted, in 1808, into the Royal Danish Academy of Sciences, together with scientists and scholars from many fields.

Ørsted quickly became a very active figure in the Academy, and was engaged in ensuring that discoveries and studies were not buried in desk drawers, but were circulating, and published, if possible. He believed that

> The announcement of a new thought, is just as much an event as the publication of a new experiment; that [the experiment] will only gain its importance, which can be very large or very small, by its relation to the world of thoughts.[10]

In 1815, he became secretary of the Academy, a post he held until his death in 1851. Ørsted tried to continue his independent scientific research, but more and more of his time was devoted to disseminating natural science to the entire society around him. Then came "The year 1820 [which] was the happiest in Ørsted's scientific life,"[11] as he wrote in his autobiography—his seminal discovery of electromagnetism.

Discovery of Electromagnetism

There are those who say that it was pure coincidence that Ørsted discovered electromagnetism, but that is a hoax. Ørsted was constantly on the lookout for such a deeper understanding, and already in 1812, in *Ansicht der Chemischen Naturgesetze,* he had reasoned that electricity and magnetism are "produced by the same forces." Then, in the Spring of 1820, when he was preparing an experiment for his students, he got an idea for a modified experimental arrangement that might demonstrate the connection. Ørsted hypothesized that if a closed electrical circuit would have an effect on a nearby compass needle, it would not make the needle align parallel to the wire, but at an angle. Therefore, before the circuit was closed, he wanted to place the compass needle parallel to the wire, instead of perpendicular, so that any movement away from the parallel would be noticeable. He had no time to verify the result before the lecture, but when they performed the experiment, it showed that the needle did move slightly.

Ørsted did not have the possibility of making a systematic study of the phenomenon before the Summer, when his further studies confirmed the phenomenon, and he mapped it out in detail. Thereafter, as he described it:

> He rushed to publish his work. That occurred in the form of a very short Latin prospectus, on two tightly written quartos. . . . He now sent this half-of-a-sheet of paper out by one-day mail to the important scientific places in the world.[12]

Ørsted's discovery immediately sent scientific shock waves across Europe, and, with André-Marie Ampère's continued work based on Ørsted's discovery, a new scientific field was launched. Along with it came an understanding of how phenomena like electricity and magnetism, which are invisible to our senses, are "visible" to our reason, and enable us to better understand and subdue the physical universe.

Understanding electromagnetism had enormous consequences for scientific knowledge, as well as the further development of the human economy and our society. Since Johannes Kepler had identified gravitation as a universally valid physical principle, which is present and acting everywhere, although it is invisible to our senses, the hunt was on for other similar principles, including the two diffuse phenomena of electricity and magnetism. The ability to show that the two phenomena are connected, and operate based on the same underlying laws, was a major step forward in understanding the underlying universal principles, and the beginning of the process of creating a

André-Marie Ampère
(1775-1836)

Carl Friedrich Gauss
(1777-1855)

Ørsted's discovery was furthered by the work of the European leaders in classical science, laying the basis for modern industrial society.

Wilhelm Eduard Weber
(1804-1891)

Bernhard Riemann
(1826-1866)

unified field theory (still the big challenge today), where physically verifiable universally valid physical principles are collected in a single space-time.

One of the thinkers in this direction was Carl Friedrich Gauss, who began his life with great discoveries in geometry and mathematics, and then used his extraordinary genius to shed light on astronomy, geodesy, and Earth magnetism, among other fields. Gauss, like Ørsted, had already at a young age, rejected the traditional Euclidean geometry, and secretly developed his own physical-geometric methods to circumvent the mathematics of his time, which, like the Euclidean system, was based on arbitrary axioms and postulates. Gauss held his work to give mathematics a new physical scientific fundament hidden from the public, because Europe was increasingly being brought under a political and scientific dictatorship, which did not want any challenges to the generally accepted doctrines. It was therefore Gauss's student, Bernhard Riemann, who publicly challenged and overthrew the arbitrary axioms and postulates within mathematics and physics, which Einstein and Vernadsky later continued working on.

Together with his younger collaborator Wilhelm Weber, Gauss investigated electromagnetism, and the two invented the telegraph in 1833, based on Ørsted's discovery, enormously improving communication possibilities. One could now telegraph messages with the speed of light over long distances.

Subsequently, the spread of electricity meant that town and country were illuminated, and also, with the use of the electric motor, the foundation was laid for modern industrial society, and the opportunity for the prosperity we have today.

The Reason of the Will

For Ørsted, research was always alluring and exciting, but it was not an end in itself. Like the godfather of the American nation, Benjamin Franklin (1706-1790), whom he greatly admired, Ørsted put the general welfare in the seat of honor. Natural science is a means to turn the forces of nature into our tools, and thus be better able to ensure all people a better life. Simultaneously, it can also set us free, by liberating society from superstition. When Ørsted graduated in 1801, natural science was not something you could study, and therefore, Ørsted spent most of his life, and most of his time, trying to ensure that the gifts of science could reach the whole society. Single-handedly, he built up instrument collections, and was a chemistry and physics teacher for both university students and the general public.

Ørsted used his great fame after 1820, to reach the public in Denmark, and internationally. After a trip to England in 1824, he became the initiator and driving force behind the founding

Ørsted, the Magnetic Association, and H.C. Schumacher

Ørsted did not work alone in his magnetic measuring, but collaborated with the Danish astronomer and geodesist Heinrich Christian Schumacher (1780-1854), among others. In 1808, the 27-year-old Schumacher made a request to the world famous Gauss, to be allowed come to Göttingen to be trained by him. He had already been granted 600 Danish crowns by the Danish king, to study with Gauss for one year. After a long hesitation, Gauss answered that Schumacher was welcome to come and use the astronomical facilities, as long as he did not expect formal instruction from Gauss. This was to be of great importance for the future, because while Schumacher worked with Gauss, they developed a close cooperation and friendship, which continued through the next 42 years, including the exchange of 1,319 letters, one of our primary sources today for an understanding of Gauss's thoughts on many subjects.

Danish astronomer Heinrich Christian Schumacher (1780-1850) was a close friend of Ørsted, and arranged Ørsted's meeting with Gauss, which launched the Magnetic Association.

Schumacher had to leave Gauss after a year, but he became the director of the Mannheim Astronomical Observatory in 1813-1815, and then was appointed professor of astronomy at the University of Copenhagen. Quite extraordinary, he was given permission to perform this function from Altona, on the extreme southern border of the Danish kingdom, where, with funds provided by the Danish king, he bought a property that served as both his home and a guest house, and where he established an observatory. Schumacher later became a member of the Royal Danish Academy of Sciences, and closely collaborated with Ørsted.

Schumacher had a unique ability to get the Danish king and various finance ministers to allocate money for scientific projects, not only of importance for Denmark, but also for Germany, and the world. In 1821, Schumacher was allocated money from the Danish state treasury for the publication of an astronomical scientific journal *Astronomische Nachrichten* (Astronomical News), which he published from Altona. This quickly became the leading international scientific journal, and a vital pivot for astronomical, magnetic, and other vital basic research. It still exists today, and is the oldest continuously published scientific journal. Schumacher became Ørsted's link to German scientific circles such as Gauss, Bessel, Olbers, and so on, with whom Schumacher, from his advanced position in Altona, was in almost daily contact.

Magnetic Studies

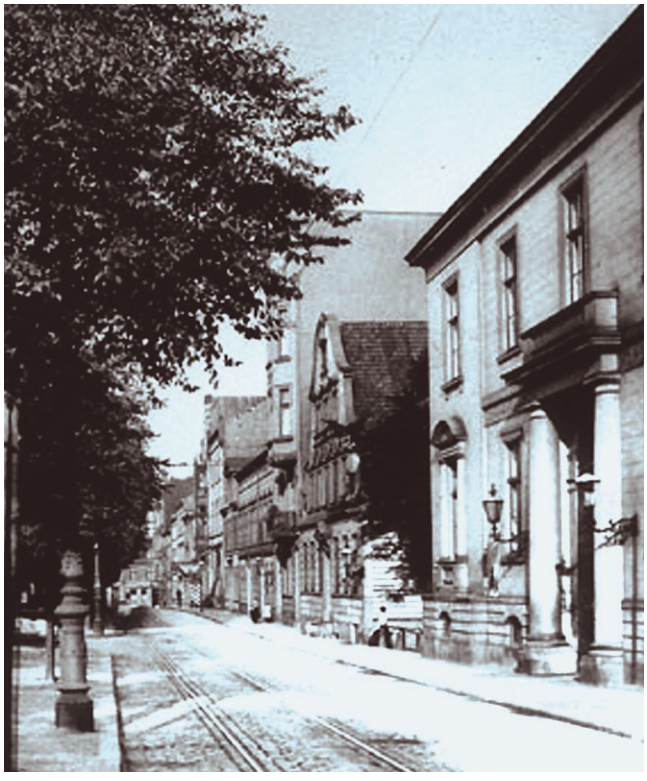
Gauss, as part of his extensive magnetic studies, decided in 1834, that precise international studies of the Earth's magnetic field were necessary, in order to make sound scientific hypotheses about the phenomenon. He designed a magnetic observatory, and a new set of scientific instruments, capable of measuring magnetic changes with "astronomical precision." Then, he had to arrange to have a series of similar observatories built around the world, which would be able to measure changes in Earth's magnetic field, according to a series of clearly defined principles.

As a natural part of that project, Schumacher contacted Ørsted in the spring of 1834, and urged him to come to Göttingen, and to make the preparations to build such an observatory in Copenhagen. Ørsted replied that he would like come to Göttingen for that purpose, but could depart only in July, at which point he would visit Gauss. Schumacher arranged that money was allocated for an extra assistant, Poulsen, to travel with Ørsted to Göttingen, to learn what would be necessary to construct and operate the observatory. Also, he arranged for the necessary funds to be granted from the Danish treasury to build a fully equipped observatory at the Polytechnic Institute in Copenhagen, complete with the construction of Gauss's newly designed instruments.

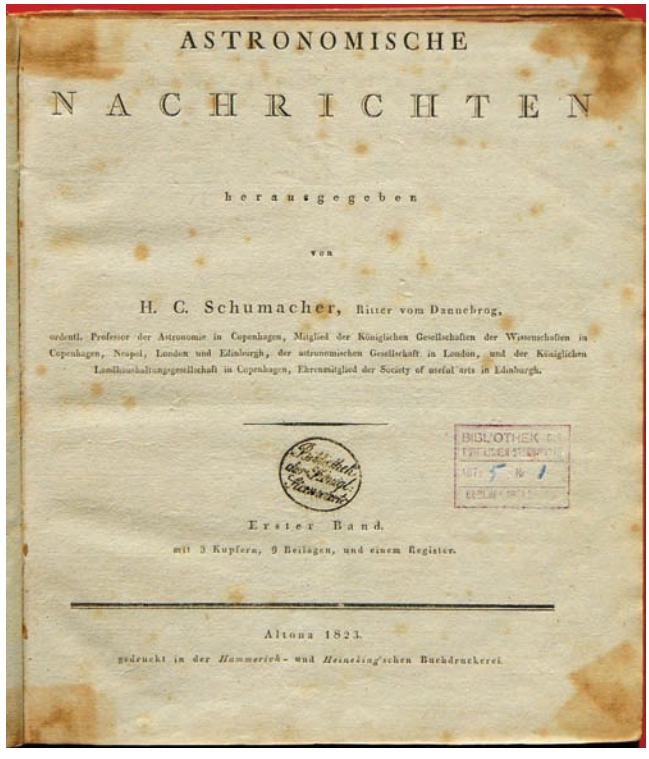
Schumacher was the intermediary in this exchange of correspondence between his two "dear friends," as he called them in private correspondence, and the result was that the plan was successfully put into practice.

While Ørsted visited Gauss, they founded the Magnetische Verein, the Magnetic Association, together with five other scientists. Under the direction of Gauss and Weber, the Association organized the construction of similar observatories throughout Europe, and the mapping of the Earth's magnetic field and magnetic fluctuations. This scientific evidence allowed Gauss to write his groundbreaking scientific descriptions of the phenomena of magnetism and Earth magnetism.

Shortly after Ørsted returned from his trip, the magnetic observatory was established, and in November of the same year, the first surprising results were obtained. As part of the project, it was agreed to measure the magnetic field for 24 hours, with 5-minute intervals, on November 5-6. Because of a mistake, only the observatories in Copenhagen and Milan made the measurements, but they showed that there was an amazing coincidence between the fluctuations in the magnetic field at the two locations, despite the great distance. This was later confirmed by extensive studies during the following years, as recorded in the Magnetische Verein.



Schumacher's house and observatory in Altona, at the southern border of Denmark, from where he served as a professor of astronomy at the University of Copenhagen.



ASTRONOMISCHE

NACHRICHTEN

herausgegeben

von

H. C. Schumacher, Ritter vom Dannebrog,

ordentl. Professor der Astronomie in Copenhagen, Mitglied der Königlichen Gesellschaften der Wissenschaften in Copenhagen, Neapel, London und Edinburgh, der astronomischen Gesellschaft in London, und der Königlichen Landhaushaltungsgesellschaft in Copenhagen, Ehrenmitglied der Society of useful arts in Edinburgh.

Erster Band.

mit 3 Kupfern, 9 Beilagen, und einem Register.

Altona 1823.

gedruckt in der *Hammerich*- und *Heineking*'schen Buchdruckerei.

The title page of the first issue (1823) of Astronomische Nachrichten *(Astronomical News), the astronomical journal published by Schumacher with Danish state funds. It is still in publication today.*

of The Association for the Dissemination of Natural Sciences, and the founding of the Polytechnic University in 1829, of which he, of course, became the rector. Ørsted's lectures to the students were in Danish, as often as possible, and open to the public. When Ørsted stood at the blackboard, or performed new experiments, which he often did, there was usually a rich mixture of people in the audience from many different backgrounds. This meant that new scientific discoveries could soon be made useful, and transform the society and its activities.

A well known example is the founder of the Carlsberg brewery, J.C. Jacobsen, who was an enthusiastic spectator at these lectures, and used the new knowledge gained to improve and streamline the art of brewing. In an 1844 letter, Ørsted presented his own teaching philosophy:

> Associated with the specific scientific treatment I have used in physics, I have tried to make it as accessible to as many readers as the subject would allow; I have made it as popular, and as Danish, as was in my power. Besides, I have endeavored to place the teaching of nature in the context of all of science, yes, even within the entirety of the education of the spirit.

Ørsted strove not only to translate his lectures on scientific discoveries into everyday Danish, to make them available to the public, but throughout his life, he also coined the Danish names of many of the newly found chemical substances and scientific processes, constructing such meaningful words as oxygen (in Danish "ilt," from "ild" the word for fire), hydrogen (in Danish "brint," from "at brende" which means to burn), and hundreds of others in our scientific and everyday language. That way, the society could avoid using a language of science which was incomprehensible for ordinary people (as Latin was), and instead, integrate scientific language into everyday speech. This was not to lower the scientific level, but to lift ordinary people out of the power of their world of senses, up to the level of science. (It also indeed turns out that even if professional researchers use a myriad special scientific terms, they often do not understand them, before they have translated them into their mother tongue.)

Ørsted was also often involved in the practical application of science as, for example, inventing a method for producing aluminum, a study of the possibility of exploiting deposits of coal on the Danish Baltic Sea island of Bornholm, and the production of the liquor aquavit, together with Brondum, the famous Danish liquor manufacturer.

Ørsted's International Work

But Ørsted played a major role not only in Denmark. He was a central figure in the international network of researchers and scientists, which, in spite of the Congress of Vienna's attempts to stifle all freedom and development, created the foundation for functioning European nations of the future. Already on his first trip abroad in 1801, he had met leading scientists and intellectuals across Europe, and he continued to have contact with a

vast international network until his death 50 years later. In addition to publishing his own books in both German and French, and sending scientific papers in Latin to leading scientific institutions, Ørsted made sure that prominent scientists, like Alexander von Humboldt, Gauss, and many others, were members of the Royal Danish Academy of Sciences, where he served as secretary. He also arranged financial assistance for research, and gave prizes and monetary rewards for major works, as when Gauss received a big prize in 1822.[13]

Hans Christian Andersen (1805-1875) was inspired by his intellectual father, Ørsted.

In 1834, Ørsted was on an official trip to visit Gauss in Göttingen, arranged by his close friend Heinrich Christian Schumacher.[14] During the visit, Gauss and Ørsted, together with five other scientists, founded the Magnetische Verein, the Magnetic Association. It was actually the first international scientific association, and was tasked with mapping the Earth's magnetic field. After the visit, Ørsted built a magnetic observatory at the Polytechnic University in Copenhagen, with a set of new advanced instruments developed by Gauss, which could measure the changes in the magnetic field with "astronomical precision."

The Magnetic Association was also thought to have had a secret mission, which was concealed from its contemporaries: namely, to spread natural sciences and new technologies in society, not only hoping to benefit the general welfare of humanity, but also, over time, to establish intellectual and political freedom in Europe.

Anders Sandøe Ørsted (1778-1860), Ørsted's brother and closest friend, was a jurist and government minister.

The Reason Within the Imagination

When Ørsted collected his main considerations in his book *The Spirit of Nature,* it was not only natural science that had the place of honor, but also philosophy and poetry. Ørsted tries here, as throughout his life, to promote poetry in natural science, and natural science in poetry. Like Schiller, he tries to bring art onto much firmer ground than simply being an expression of arbitrary, indifferent taste. Ørsted was a patron, and an intellectual father, for the great Danish poet Hans Christian Andersen, and he convinced him that it were far better to write stories with scientific, philosophical, and metaphorical insight, than to follow the contemporary popular story trend and write stories based on magic and hocus pocus (like Harry Potter and similar fantasy today).

Under Ørsted's influence, Andersen's genius flourished, and Ørsted would pronounce the prophetic words that Andersen's novels would make him famous, but his fairy tales would make him immortal.

Adam Oehlenschläger (1779-1850), another Danish poet, was also a lifelong friend of Ørsted.

Throughout his life, Ørsted also had a close relationship and dialogue with the major Danish poet Adam Ohlenschläger, whose sister, Sophie, married Ørsted's brother, Anders Sandøe Ørsted, who was his closest discussion partner and also played a leading role in Danish society in his own right, as a lawyer, and Minister.

In his central position in Danish society, Ørsted, along with other lovers of Schiller, like Finance Minister Count Ernst Schimmelmann, ensured that although Denmark went through many deep crises—for example, the British military attacks on Copenhagen in 1801 and 1807, national bankruptcy in 1813, and the painful loss of Norway at the Congress of Vienna in 1815—there were always resources for an obvious talent to have the opportunity to develop himself, by sending him on a state-financed educational journey throughout Europe. This enabled a young talent to travel to wherever he could get the best education and intellectual nutrition for further development, whether in science, poetry, painting, or some other field. When such a grand tour were over, the homecomer could illuminate the Danish environment, and reproduce his talent here.

Simultaneously, Ørsted was a central source of inspiration for his time. In most societies, the bright minds and warm hearts get inspiration and spiritual guidance from great philosophical poets. Schiller was such a pure and unspoiled source of inspiration for his time. That can be seen with musicians such as Beethoven and Schubert, but it also applied to the great minds in all other fields, including Ørsted. And for the Danish poets, it also went the other way. Andersen, Oehlenschläger, and others, tapped ideas, inspiration, and courage, from Ørsted. As Hans Christian Andersen beautifully described it in several locations, in much detail, "Ørsted is probably the man whom I have loved the most."[15]

Ørsted was always ready to inspire Andersen with new cour-

The famous experiment of Benjamin Franklin, assisted by his son, showed the electricl nature of thunder and lightning. Ørsted proposed it as an exciting subject for a great poet.

age and hope when he had one of his many periods of depression. Ørsted also tried to get contemporary poets to help spread a fascination of natural science, by draping it in poetry. He made the experiment himself, with his poem, "The Airship," and he thought that Benjamin Franklin must certainly be a good subject for such a poem or drama:

> For instance, it is remarkable that the discovery of the electrical nature of thunder and lightning has never inspired a great poet to write an exciting description of it. The discovery was the fruit of scientific thought, but it was proclaimed to the world by an heroic act, for the discoverer conducted the electric fire from a cloud by means which endangered his own life. He was assisted by his youthful son: We can conceive of the inner tension the father must have felt before the experiment, the innocent or heroic participation of the son, and the feeling of triumphant joy when it was concluded. Concerning the son's participation, the poet is free to choose whether he will suppose the father has not spoken to his son about the danger, or has spoken to him about it, but to test him, has concealed the precautions which he has taken to protect him, while he must necessarily expose himself to danger.[16]

Hans Christian Andersen, who shared Ørsted's enthusiasm for scientific and technological progress, was the poet who most directly accepted Ørsted's challenge, as can be seen, for example, in his fairy tale "The Drop of Water" and writings like "The Millennia," "Poetry's California," and "The Thorny Road of Honor."

Like Schiller, Ørsted had a deep trust in the goodness of mankind, that reason would eventually be victorious and give us a better world. In *The Spirit of Nature,* he says directly:

> The highest a person can reach in education, is the capability to thoroughly penetrate a limited circle of knowledge with deep insight, and, aided by the spiritual development attained, joined to an eager love of inquiry, to gain a reasonably clear picture of the entirety of existence.[17]

And elsewhere he writes that "Insight is the greatest pleasure of our spiritual existence." Ørsted believed that science gives individuals

> impressions of irresistible power, thoughts which appear in undeniable clarity, [and] force him to understand a great deal in a new way. This gives rise to two opposite feelings: either joy, from the new light, or dissatisfaction, from the disruptive interference with their usual worldview.[18]

Therefore, he dreamed about establishing numerous polytechnic schools, so the whole population could get access to science, and not be content with the folk high schools based on Grundtvig's model, where the rural population should only have the most elementary skills to cope with their daily life, read the Bible, and sing hymns.

Human Creativity

For Ørsted, man and his cognitive ability were something fundamentally good. Consequently, we humans can do stupid, and through our ignorance, evil things, but not in the long run.

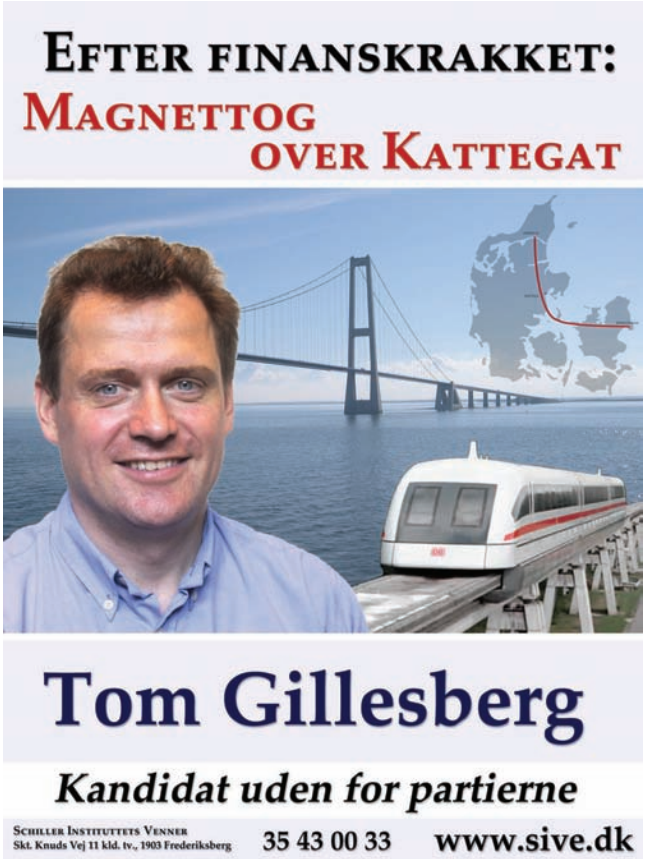
> The process of thinking, according to its nature, must act according to the eternal laws of nature, so that its unreasonable excesses, contradict its fundamental essence. There is already located an urge there, to weaken the power of evil, within the willing person himself.[19]

Of course, Ørsted wanted rapid change, but did not let himself be discouraged by temporary setbacks.

> Therefore, we must assume from all that has been said, that the human race develops itself according to the laws of reason, and that the series of changes which take place, despite alternating between progress and decline, lead to actual development, and that the intervention of free will, notwithstanding apparent disturbances, must obey the eternal order of Reason.[20]

And, "We must . . . remind ourselves, that centuries are short periods in the history of mankind."[21]

In *The Spirit of Nature,* Ørsted wrote about the unique hu-



The author, pictured in his 2007 campaign poster for member of parliament from Copenhagen. Gillesberg is well known in Denmark for his campaigns warning of the coming financial collapse, and urging Denmark to support a Maglev train to link Zealand to the Jutland Peninsula. "After the financial crash: maglev across the Kattegat," was his 2007campaign slogan.

man ability to make hypotheses about the deeper principles that underlie the physical phenomena we can observe, and afterwards to confirm them through scientific experimentation, "You could, with some changes, use an expression of Schiller, and say: What the spirit promises, nature fulfills."[22]

We humans are not shabby underlings who must simply let ourselves submit to the world order of our time or nature, he said, but are God's helping hand in the process of continuing creation, and can, through our senses and our genius, both understand and use the laws of nature. And we live in a good and lawful universe, where nature is predetermined to submit, and to listen to us, when we act based on reason. As Schiller put it in his poem "Columbus":

> Steer, courageous sailor!
> Although the wit may deride thee,
> And the skipper at the helm lower his indolent hand—
> Ever, ever to the West!
> There the coast soon appears,
> There it so clearly lies. Your mind sees the land.
> Trust in the guiding God and follow the silent ocean!
> Were it not yet, it would rise from the streams below.
> Genius stands with Nature in everlasting union:
> What is promised by one, the other surely fulfills.[23]

A New Renaissance

Today, we are faced with a decisive choice. The great climate superstition is just one result of the paradigm shift that occurred in 1968, where the institutions of higher learning were flooded with a new anti-scientific, anti-human worldview. Instead of using our creative reason to come to deeper cognitive insights, and to test our hypotheses through physical experiments, so that we may ensure continued scientific and technological progress, we acquired on some totally new and destructive values. After 40 years, these have led to the collapse of the world economy and financial system, and now threaten the future survival of a large part of mankind.

Inspired by Ørsted, that is the challenge we must accept today. We must have a generation of young enthusiastic defenders of humanity, which commands the greatest human cognitive insight in both natural science, as well as art. We can honor Ørsted's memory, by using his discovery of electromagnetism not only to create a Danish magnetically levitated (maglev) train network, with a top speed of 500 kilometers/hour but also an international maglev network, that stretches all the way from Europe, throughout Asia, to North and South America. And then, of course, we should not just have a satellite named after Ørsted, but also one of the next spaceships that, with Danish participation, will travel to Mars, and beyond, into the great expanses of outer space.

Footnotes

1-6. These quotations are from Hans Christian Ørsted, *The Spirit of Nature,* 1856, Third edition (Copenhagen). They were translated into English, using some phrases from the 1852 English translation of L. and J. Horner, *The Soul in Nature,* 1852. (London: Henry G. Bohm).

7. In a letter to theologian and government official A.C. Gierlew, Feb. 13, 1808

8. See Notes 1-6.

9. Friedrich Schiller had a towering influence on Danish intellectual life. As described in this author's article "The Danish Help to Schiller," two leading Danish statesmen, Prince Friedrich Christian of Augustenburg and Ernst von Schimmelmann, financed Schiller throughout six critical years, from 1791-1796.

   In appreciation of this generous help, Schiller wrote the "Letters on the Aesthetical Education of Man" to Augustenburg, who lived at the royal palace, Christiansburg, in Copenhagen, at that time. As he received each letter, Augustenburg would carefully study it and then pass it on to Schimmelmann and the other ministers in the government. Thus Schiller's work made a lasting impression on the later educational reforms in which Augustenburg was a leading force.

   At this time, Denmark was also still a bilingual nation, so all the works of Schiller directly had a huge and grateful audience.

10-12. These quotations are from Ørsted's autobiography, translated into English by Michelle Rasmussen.

13. Gauss won with the paper "Theoria attractionis corporum sphaeroidicorum ellipticorum homogeneorum methodus nova tractata," which presents a general theory of how to map a spherical or elliptical surface onto other surfaces, without distorting its internal properties.

14. See box, p. 33.

15. *Nicolaj Boegh in Danmark*, Illustreret Kalender for 1887.

16-22. These quotations are from Hans Christian Ørsted, *The Spirit of Nature,* 1856, Third edition (Copenhagen). They were translated into English, using some phrases from the 1852 English translation of L. and J. Horner, *The Soul in Nature,* 1852. (London: Henry G. Bohm). Note 20 is taken from the latter, p. 126.

23. The author has adapted here a translation of the poem found at http://www.schillerinstitute.org.