INFINITE ENERGY
The Magazine of New Energy Science and Technology

The Mysteries of Myths of Heat: A Brief History of Hot and Cold

Published in Issue #37, May/June 2001

by Eugene F. Mallove

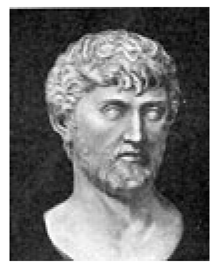
> *It is astonishing to realize that many modern conceptions (or "laws") in the science of heat- thermodynamics- arose during the nineteenth century, a period of utter confusion about the fundamental nature of heat. How could it have been otherwise, given that the very existence of atoms was still in question!*

Democritus.
Greek Philosopher

Our knowledge of heat is as old as the history of contemplating whether atoms, "smallest units of matter," exist. Much of what we know-or think we know-about heat came about in the nineteenth century, but thinking about what heat really is goes much further back. Primitive peoples clearly knew that rubbing sticks together could make heat and then fire, but connecting the idea of atoms to this "heat" was beyond even the imaginative ancient Greeks.

A brief perusal of Isaac Asimov's *Biographical Encyclopedia of Science and Technology*[1] unearthed this ancient background of atomic and pre-atomic theory: Greek philosopher Anaximander (610-546 BC) imagined "a formless mass that was both the source and destination of all material things." His name for this unobservable substance was *apeiron*, translation: infinite. Indeed, the precursor of later 19th century theories of the *aether*, and their present emergent forms after their twentieth century Einsteinian demise, traces that far back. It will most likely be determined in the affirmativeafter many more bloody battles-that an energetic aether gives rise to matter and is also the repository of its localized extinction. This aether, forming a universe perhaps infinite in time, is nearly certain to vanquish the unsupported myth of Big Bang cosmology.

Another Greek philosopher, Leucippus (born 490 BC), is generally regarded as the primary authorof "atomism." Greek philosopher Democritus (440-371 BC), a student of Leucippus, put forth the idea of a void in which atoms moved and interacted. Finally, influenced by this early Greek thinking, atomism was codified and elaborated by Roman writer Lucretius (Titus Lucretius


Titus Lucretius Carus

Carus- 95-55 BC) in his work "DeRerum Natura"("On the Nature of Things"). Atomism continued to play a role in scientific thinking into the Second Millennium, but since no one had seen atoms or knew their nature, it was possible even for some leading scientists, e.g. Ernst Mach (1838-1916), to doubt their existence into the second decade of the twentieth century. With kinetic theory of gases theorist Ludwig Boltzmann listening in January 1897 at the Imperial Academy of Sciences in Vienna, Mach had loudly announced, "I don't believe atoms exist!"[2]

It is fascinating that the first known heat engine (a machine that converts heat to work) was also of ancient Greek vintage-the primitive *aeolipile* of Hero (sometime in the first century AD, about year 75, some think), which used the jet action of steam to produce the rotation of a sphere. In a remarkable example of how an invention can arise and then disappear if it is not manufactured and then used widely, it was not until the seventeenth and eighteenth centuries that heat engines came into being as utilitarian devices, initially to drive crude water pumps. A fascinating story of their development is told by John F. Sandfort in *Heat Engines*.[3] In the process of developing the early heat engines, few people seem to have given much thought to what was this "heat" produced from burning wood or coal. The so-called "father of chemistry," French scientist Antoine Laurent Lavoisier (1743-1794), is perhaps most identified with the invisible fluid concept of heat, which acquired from him the famous name "*caloric*." It was supposed that driving this caloric out of material by rubbing, or by combustion, produced the manifestations of heat-caloric was heat. That led to the obvious question: how much caloric could be contained within a given mass of material?


William Thompson
(Lord Kelvin)

Lavoisier in his *Elementary Treatise on Chemistry* (published posthumously in 1798) listed the then known "elements"-even though the very reality of atoms was still at issue. In that list of elements Lavoisier included, believe it or not, *light and heat*! Now as Asimov remarks, "He had eradicated one imponderable fluid, phlogiston, but it was only partly through his influence that caloric, just as false, remained in existence in the minds of chemists for a half a century." We might add that Lavoisier's dogma of the non-transmutability of "elements"-as he then knew them-has also endured. This two-hundred year-old dogma combined (in the late twentieth and early twenty-first centuries) with modern theories of atomic structure to deny experimental proof of low-energy nuclear reactions. Strong myths and dogmas, once begun, have rather long lives.

The caloric theory of heat was surprisingly enduring. It survived far into the nineteenth century, despite many experiments which showed that caloric, if it existed, had no weight. And there were theorists who founded the kinetic theory of gases, James Clerk Maxwell (1831-1879) and Ludwig Boltzmann (1844-1906), whose theories provided very strong support for atomism. Even the convincing experimental work of Benjamin Thompson (1753-1814), an expatriate from England's American colonies (what are now Massachusetts and New Hampshire) who became Count Rumford in Bavaria, could not kill the idea of caloric. In his work in the late 1790s boring brass cannon barrels for his German patron, Rumford determined that the metallic shavings from this horse-driven boring appeared to have the same heat capacity after the drilling action as before. He suggested that the supply of heat in matter was *without limit*-an exceedingly revolutionary concept that contradicted the caloric theory. He wrote: "The more I meditated on these phaenomena [*sic*], the more they appeared to me to bid fair to give a farther insight into the hidden nature of Heat; and to enable us to form some reasonable conjectures respecting the existence or non-existence of an igneous fluid: a subject on which the opinions of philosophers have, in all ages, been much divided. . . It is hardly necessary to add that anything which any insulated body, or system of bodies, can continue to furnish without limitation, cannot possibly be a material substance: and it appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited or communicated, in the manner the Heat was excited and communicated in these Experiments, except in MOTION." (quoted by J.F. Sandfort[3]).

Today a scientifically literate person understands that the excited, chaotic motion of atoms and molecules creates in our bodies or in measuring instruments a sensation of hot or cold. But this concept of heat is relatively modern-an outgrowth of the work of Rumford and other knowledge developed in the nineteenth century, in particular the work of James Prescott Joule (1818-1889). According to Isaac Asimov, earlier scientists had conceived of heat as a form of motion, among them Francis Bacon (1561-1626), Robert Boyle (1627-1691), and Robert Hooke (1635-1703), but caloric endured, until Maxwell, it is said, finally killed it off.

Nicolas Léonard Sadi Carnot, French Engineer

It is astonishing to realize that many modern conceptions (or "laws") in the science of heat- thermodynamics- arose during the nineteenth century, a period of utter confusion about the fundamental nature of heat. How could it have been otherwise, given that the very existence of atoms was still in question! One sees the shakiness of the claim that the laws of thermodynamics had reached a state of "near perfection" in the twentieth century (see Von Baeyer[4]), when they in fact rested on this very flawed foundation.

Much before the nineteenth century there was only a very weak conception of a relationship between heat and energy. So it is not surprising that the important paradigm of the conservation of energy, which later became known as the First Law of Thermodynamics, was long in coming. The name firmly associated with introducing the conservation of energy are German physicist Julius Robert Mayer (1814-1878), who predated both James Joule's and Hermann Ludwig Ferdinand von Helmholtz's (1821-1894) statements of the conservation of energy. Mayer in 1842 had published a paper on the general equivalence of all forms of energy and he gave the first estimate of the mechanical equivalent of heat. Because Mayer was not of the scientific establishment, his then heretical concept of the conservation of energy was not accepted. It was James Joule who performed the definitive exhaustive series of experiments that showed the convertability of mechanical action to a heat equivalent. Though Joule began lecturing about and publishing his work in 1843, it was not until a critical meeting at Oxford University on June 27, 1847 at which he lectured that his ideas began to receive acclaim. There, man of the establishment William Thomson (1824-1907), already well-published by his then age twenty-three, became impressed with Joule's solid work on the mechanical equivalent of heat. (William Thomson was knighted as Lord Kelvin in 1866, by which name he is more commonly known.)

But for three years after that meeting there continued a deep confusion in Thomson's mind, based on the earlier work of French engineer Nicolas Léonard Sadi Carnot (1796-1832), with which he was also impressed. Carnot in 1824 (the year Thomson was born) had published a remarkable paper, which mathematically defined the upper limit in efficiency of steam engines of the time-and, by extension, the maximum efficiency of all heat engines. Carnot stated that the most general heat engine required a high temperature input reservoir (at T_{high}) and it had to exhaust its wasted heat to a lower temperature reservoir (at T_{low}). His formulation that the maximum efficiency of a heat engine was $(T_{high}-T_{low})/T_{high}$ later became enshrined as dogma in both physics and in practical engineering. A heat engine that could convert heat to work at 100% efficiency from a single temperature reservoir would be deemed impossible under this Carnot restriction. This is the basis for contemporary mockery of attempts to make what are called "perpetual motion machines of the second kind," of which Xu Yelin's device (see p. 31) is one type.

So what was William Thomson's problem? Thompson in 1847 was still a firm believer in the caloric theory! After all, Carnot had been too, and Thomson firmly believed Carnot-Thompson in fact had rediscovered Carnot's obscure paper and had promoted Carnot's ideas. But Carnot had developed his efficiency limitation on heat engine performance from the perspective of the caloric theory. So here James Joule was presenting in 1847 material that was equally convincing to Kelvin, but energy conservation flew in the face of the caloric theory. Just as Thomson's ideas on resolving the paradox were jelling three years later, German mathematical physicist Rudolf Clausius (1822-1888) published the solution to the paradox in May 1850, "On the Moving force of Heat and the Laws of Heat Which May be Deduced Therefrom."

Rudolph Clausius
German mathematical physicist

In one fell swoop Clausius "scooped" Kelvin and cast into precise form *both* the First and Second Laws of Thermodynamics-energy conservation, and the limitation of Carnot efficiency. The actual form of Clausius' statement of the Second Law is: "It is impossible for a self-acting machine, unaided by an external agency, to convey heat from one body to another at a higher temperature." In 1851, Thomson would claim independent discovery of the Second Law. His statement of it would be: "It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects." Both the Clausius and Kelvin statements are said to be equivalent. Clausius' collected thermodynamic theory was published in 1865; it included introducing the seminal concept of entropy, a measure of disorder that, it is said, stays constant or inevitably increases, but never decreases in a closed system.

From that time forward, physics moved in lock-step with the presumed inviolability of the Second Law. It is true enough that the Second Law, in general, mandates that heat cannot spontaneously flow from a cold body to a hot body (but be aware, there may be exceptions even to this connected with "advanced Maxwell's Demons"). Generations of students had this Second Law and Carnot's maximum efficiency formula "proved" to them by a mathematical demonstration that is nothing short of circular reasoning: If Carnot's principle concerning the maximum efficiency of a reversible heat engine were violated in such and such system (elaborately diagrammed in colorful and expensive thermodynamics texts), that would violate the Second Law. Ergo, Carnot's efficiency limit is supposedly proved by reductio ad absurdum. The proof is used the other way around too-to prove the Second Law from Carnot! Isaac Asimov, for one, is embarrassingly clear in admitting the circular logic that is implicit: "It is possible from Carnot's equation to deduce what is now called the Second Law of Thermodynamics and Carnot was first to be vouchsafed a glimpse of that great generalization."[1]

Sad to say for the physics establishment and the technology establishment, that turned out not to be the case. For the sake of Humankind, it is very good news indeed that this almost two hundred year old dogma will now come crashing down. As Maurizio Vignati in his exhaustive book5 and Xu Yelin in his experiments show (and in the work of others still to come no doubt), the Second Law is simply this: *A limitation based on the belief that no macroscopic violation of that limitation had ever been seen or would ever be seen*.

As we will see in the paper Dr. Paulo and Alexandra Correa published in this issue, another much more serious challenge to the Second Law of Thermodynamics has arisen. It appeared in January 1941, as I have outlined in my editorial, when Wilhelm Reich attempted, in vain, to get Einstein to "look through his telescope" to see a persisting temperature anomaly that was in direct violation of the Second Law.[6] Einstein, in effect, refused to "look through that telescope" and we have been suffering delayed awareness of an energetic aether and sound thermodynamics ever since. But now a pathway to a much greater understanding of fundamental physics has opened. We have barely begun to reformulate the theory of heat that will extend far beyond the useful but highly limiting concepts we inherited from the nineteenth century.

Through new physical descriptions of the energetic aether and other emerging understandings of the flaws of classical thermodynamics, all the textbooks will need to be rewritten. If anyone thinks this will be easy, given the behavior of the scientific establishment since the discovery of low-energy nuclear reactions, think again. As with cold fusion, to get the ossified scientific establishment even to listen will require irrefutable devices embodying these principles. It is now certain that these will come.

References

1. Asimov, I. 1982. *Asimov's Biographical Encyclopedia of Science and Technology* (Second revised Edition), Doubleday & Company, Garden City, New York.
2. Lindley, D. 2001. *Boltzmann's Atom: The Great Debate That Launched a Revolution in Physics*, The Free Press, New York.
3. Sandfort, J.F. 1962. *Heat Engines: Thermodynamics in Theory and Practice*, Doubleday & Company, Inc., Garden City, New York.
4. Von Bayer, H.C. 1998. *Maxwell's Demon: Why Warmth Disperses and Time Passes*, Random House, New York.
5. Vignati, M. 1993. *Crisis of a Dogma: Kelvin and Clausius Postulates at the Settling of Accounts*, Astrolabium Associazione Culturale.
6. 1953. *The Einstein Affair*. Orgone Institute Press, Rangeley, Maine, the correspondence between Albert Einstein and Wilhelm Reich, in original German and in English translation.

TOP