LIGHT TOUCH

Jean-Paul Marat: A Revolutionary in Politics—and Optics

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Jean-Paul Marat, a motivational figure in the French Revolution, was also a disruptive force in optics.

If you've heard of Jean-Paul Marat, you likely gleaned that knowledge from studying the French Revolution or Jacques-Louis David's famous painting *The Death of Marat*. Marat called for the dissolution of the 18th century French monarchy and championed basic human rights for the poor.

However, few realize that he started out as a scientific trailblazer. Marat posed an intriguing criticism to Newton's work and found new ways to visualize heat.

Man of science

Marat studied medicine in Paris and developed a popular practice among the French aristocracy—which is ironic in light of his later revolutionary activities. He even used his contacts to further his work: Marat was awarded a laboratory space in a marquise's house and his aristocratic sponsor, the Comte de Maillebois, arranged to get him hearings at the Academy of Sciences.

In April 1786, Marat quit medicine and devoted himself entirely to experimental research. He was particularly interested in the hot topics of the day—the nature of fire, optics and electricity. To investigate the former, he used a device called a solar microscope, which sent rays of sunlight in a collimated bundle to illuminate an object and project its enlarged image onto a screen. When Marat looked at a candle flame with the scope, he was astonished by what he saw: "…the candle's flame in the form of a whitish cylinder, bordered by a white halo and crowned with a tuft of swirling jets that were less white."

Marat's drawings are almost photographic in quality. He hypothesized that the swirling jets he observed were "igneous fluid," an essential component of heat. His solar microscope acted as a modern Schlieren system, and he was seeing what we now know to be the convection of heated air rising from a flame.

When Marat substituted a hot piece of iron for the lit candle—to confirm that his observation was not simply an artifact of the flame—he saw the same swirls. He had similar results when he used heated objects within an evacuated bell jar to show that he was not seeing an atmospheric effect. Marat's use of the scientific method was impressive.

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To establish credibility, Marat asked the Academy of Sciences to review his work. The Academy members visited his laboratory and replicated his experiments. One of them was the American scientist Benjamin Franklin, who volunteered his bald head as a subject for the solar microscope. True to Marat's observations, they saw plumes of heat rising from Franklin's scalp. After they reviewed his work, the Academy issued a glowing report, which Marat published along with a note that the Academy had supported his research. The note was a misstep, however, since the Academy had not technically endorsed Marat's opinions about igneous fluid. Several members turned against Marat as a result of his exaggeration.

Marat's next project made matters worse with the Academy. It was a criticism of Isaac Newton's work on diffraction—a risky proposition given how well

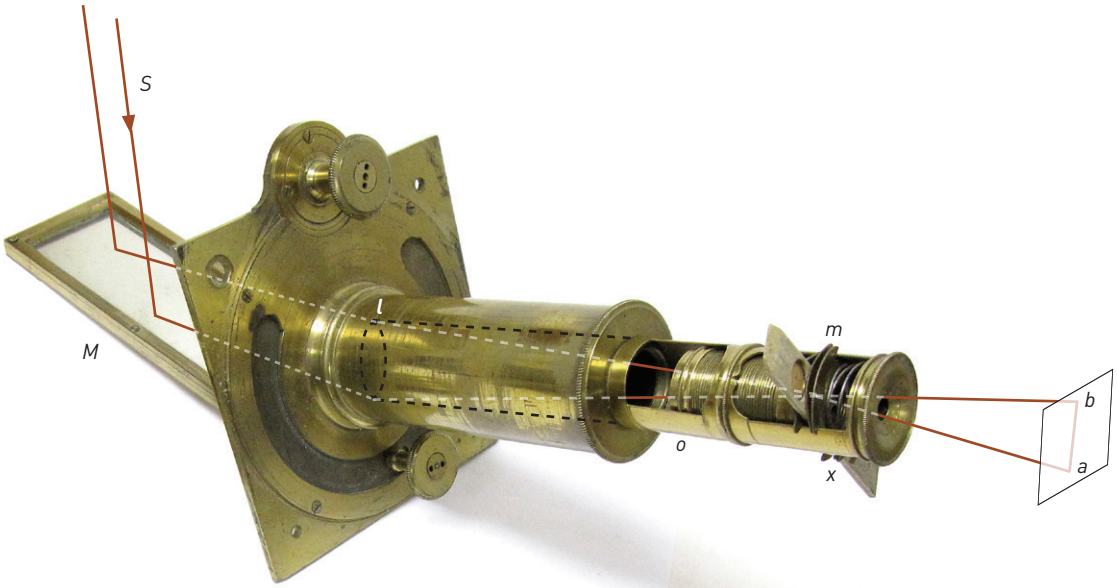
The Death of Marat by Jacques-Louis David (1748–1825).

Wikimedia Commons

regarded Newton was in the scientific community. Marat believed that Newton had downplayed the importance of diffraction by labeling it as merely one type of refraction. He was convinced that light passing by an edge was somehow attracted to it, and he sought to intensify the effect by increasing the number of edges. Thus, he cut multiple slits into cards, passing light through them onto a screen.

According to Marat, Newton had also incorrectly interpreted the results of one of his most famous experiments, in which he used a prism to break sunlight into its component colors. It wasn't the dispersion of the prism that split the light, Marat claimed, but rather the effect of diffraction from the light passing through the slit. Some historians have called Marat's cards the first manufactured diffraction gratings.

When Marat asked the Academy to review his work this time, they were not so positive. After a long delay, they issued a curt, three-paragraph statement that they did not endorse his criticism and that his assertions were "… generally contrary to what is best known in the field of optics."



French Solar Microscope

A solar microscope uses sunlight to project images of magnified small objects on a screen.

Sunlight (*S*) hits the mirror (*M*) and is reflected toward the condensing lens (*l*) and then a second lens (*o*). The point where the two lenses focus the light is where the magnification occurs. The sample is placed at this point between glass plates, held in place by two metal plates (*m*). The magnified image passes through three condensing lenses (*x*); it is then inverted and projected onto a screen (*ab*).

Courtesy of Allan Wissner, www.antique-microscopes.com

With the benefit of hindsight, it's easy to see how Marat could have discovered the errors in his analysis using the tools in his own laboratory. For example, he could have found that slits disperse light on both sides, while the prism only does so on one. Nevertheless, he certainly raised interesting points worthy of further examination.

In other work, Marat investigated the optics of soap bubbles and translated Newton's *Opticks* into French.

"Their heads will fall within a fortnight," Marat had supposedly remarked.

Man of the people

In 1788, Marat set research aside to focus on politics. He was one of the intellectual leaders of the French Revolution and a prolific publisher, including his own newspaper *l'Ami du peuple* ("The Friend of the People," 1789). Through his writings, he became a voice of the Revolution. His distaste for his political opponents, the Girondists, became so extreme that he made a public plea for people to use violence against them.

In 1793, Marat was visited by Charlotte Corday, who claimed that she would give him the names of wanted Girondists. "Their heads will fall within a fortnight," Marat had supposedly remarked. And perhaps they would have, had Corday, a Girondist herself, not stabbed him in the breast, severing his carotid artery and killing him instantly.

Jacques-Louis David, Marat's friend and associate, later painted what would become a well-known portrait of the slain revolutionary. The deceased Marat is depicted in a medicated bath because that is where he spent much of his time due to a skin infection. The idealized image elevated his status as a political martyr and became an early example of modernist painting.

Nearly two centuries after his death, a playwright would bring together Marat's disparate interests through musical theater. In 1963, Peter Weiss linked his work with light and heat to his revolutionary activities in *The Persecution and Assassination of Jean-Paul Marat as Performed by the Inmates of the Asylum of Charenton under the Direction of the Marquis de Sade* (mercifully abbreviated to *Marat/Sade*):

> *He wants to pronounce*
> *the whole of firm and fixed creation invalid*
> *And instead he wants to introduce*
> *a universe of unbridled activation*
> *in which electrified magnetic forces*
> *whizz about and rub against each other.*
>
> *—Lavoisier, section 32, lines 155-160*
> *Peter Weiss, Marat/Sade*

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- C.D. Connor (translation). *Jean-Paul Marat: Scientist and Revolutionary*, Humanities Press, 2nd edition (2012).
- S.R. Wilk. "Diffraction, the Silk Handkerchief, and a Forgotten Founder," Opt. Photon. News **21**, 16-17 (October 2010).