# Auguste Laurent. Radical and radicals

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**ABSTRACT**
Auguste Laurent (1807-1853) was one of the most important chemists of the nineteenth century. He discovered and synthesized a large number of aromatic organic compounds, among them naphthalene derivatives, anthracene, phenanthrene, stilbene, benzil, phthalic acid, phthalic anhydride, and pyrene. His theories about equivalents and radicals were fundamental for destroying the dualistic approach and establish the modern approach of organic chemistry. He proposed a new rational method of organic classification based on the functional groups present in the molecule that became the basis of the Geneva nomenclature for organic chemistry adopted in 1892, His radical political ideas and his acrid commentaries on the opinion and errors of fellow chemists curbed his academic progress and were an important reason for the poor reception of his advanced ideas during his lifetime.

**KEYWORDS:** Naphtahlene and derivatives, phthalic acid, coal tar distilation, radicals, type theory, chemical classification and rules

**Resumen (Augusto Laurent. Radical y radicales)**
Auguste Laurent (1807-1853) fue uno de los químicos más importantes del siglo diecinueve. Fue responsable del descubrimiento y la síntesis de un gran número de compuestos orgánicos aromáticos, entre ellos derivados del naftaleno, antraceno, fenantreno, estilbeno, benzilo, ácido ftálico, anhidrido ftálico y pireno. Sus teorías sobre los equivalentes y los radicales fueron fundamentales para destronar el enfoque dualista y establecer el enfoque moderno de la química orgánica. Propuso un nuevo método racional de clasificación orgánica, basado en los grupos funcionales característicos presentes en la molécula, que fue la base de la nomenclatura de Ginebra para la química orgánica, adoptada en 1892. Sus ideas políticas radicales y sus ácidos comentarios sobre las opiniones y errores de otros químicos frenaron su avance académico y fueron una razón importante para que sus avanzadas ideas no fueran reconocidas adecuadamente en su tiempo.

## Life and career

Auguste (Augustin) Laurent was born on November 14, 1807, in Folie (today St.-Maurice-les-Langres), near Langres, Haute Marne, the second of the four sons of Jean Baptiste Laurent, a wholesale wine merchant and farmer, and Marie-Jeanne Maître, the daughter of a merchant from Burgundy. His parents passed away when he was very young. Laurent early attracted the attention of his teachers, who persuaded his father and then his maternal uncle, to let him proceed to higher studies (Potter, 1953). After completing traditional classical studies at the collège of Gray he passed the entrance examination for the École des Mines in Paris and was admitted in 1826. During the summer of 1828 he made a study trip to Germany to learn the techniques used in the cobalt mines. The results of this visit were the subject of a thesis submitted together with Guy Adolphe Arrault (1806-), a fellow student, in partial fulfilment of the requirements for the degree *ingénieur des mines* (granted to him on December 20, 1830), and also of his first publication (Arrault and Laurent, 1830; Jacques, 1954).

In 1831, instead of taking an industrial job or becoming a civil servant, Laurent followed his scientific inclinations and accepted the position of répétiteur (lecture assistant) for the course given by Jean-Baptiste André Dumas (1800-1884) at the École Centrale des Arts et Manufactures. There he became an expert experimentalist and dedicated himself to research. Already in 1832 he published with Dumas his first memoir on naphthalene that he isolated from coal tar (Laurent, 1832). He quitted his job in 1832 after having his first misunderstandings with Dumas, and accepted the position of *directeur des essais chimiques* (chief analyst) at the Sèvres Porcelain Factory, which was directed by Alexandre Brongniart (1770-1847), Dumas's brother in law. At Sèvres he familiarized himself with the chemistry of silicates and developed a method for the analysis of alkaline silicates, simpler and more precise than the ones used then, involving treatment with hydrofluoric acid. It consisted basically of preparing the acid in a platinum tube and directing the fumes produced into the silicate sample. The fluoride generated was then converted into sulfate, and the latter dried completely. The following steps were the standard ones for a sulfate mineral (Laurent, 1835b).

Interested in gaining his independence he became a partner in an industry manufacturing cupric sulfate and also opened a small private school for paying students; both initia-

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**Recibido:** 29 de julio de 2008; **aceptado:** 12 de septiembre de 2008.


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tives proved to be an economic failure. In 1836 he worked for a short time for a friend, the Parisian perfume manufacturer Ed. Laugier, distilling essences. While at Laugier's, he began his work for the degree of *docteur-ès-sciences*, which led to the granting of the degree of bachelier and licencié (October 31, 1837) and to the successful defence of his doctoral thesis at the Sorbonne on December 28, 1837, in front of a committee composed of Pierre-Louis Dulong (1785-1838), César Despretz (1791-1863), and François Sulpice Beudant (1787-1850). According to Stumper (Stumper, 1953) his doctoral theses were two, one entitled *Recherches Diverses de Chimie Organique et Sur la Densité des Argiles Mixtes*, and the second, *Des Considérations Générales sur les Propriétés Physiques de Atomes et sur leur Forme*, but Jacques (Jacques, 1954) claims that the actual titles were *Recherches Diverses de Chimie Organique et Sur la Densité des Argiles Cuites â Diverses Températures*. In the first thesis Laurent developed the principal ideas of his theory of fundamental and derived radicals in organic chemistry and published it as a memoir in *Annales de Chemie* (Laurent, 1837a).

In 1836, before defending his doctoral thesis, Laurent directed for 18 months a porcelain factory in Eich, near Luxemburg. There he met M.-L. Schrobilgen, councillor of Supreme Court of Justice and on July 23, 1838 he married his daughter, Anne-Francoise (1820-1914). They had a daughter and a son, Mathieu Paul Hermann (1841-1908). Hermann followed a military career, rising to the rank of officer before he resigned in 1865 to devote himself to mathematics where he achieved prominence (Stumper, 1953).

The porcelain factory closed down in 1838 and on November of the same year Laurent moved from Luxemburg to Bordeaux, where he was appointed to the newly created chair of chemistry at the Faculté des Sciences. He held this position for 10 years, during which he published about 100 papers (Stumper, 1953).

In 1846 he worked for some time at the Collège de France and also he gave a free course on chemistry at the Faculté de Médecine. Afterwards he worked at Antoine-Jerôme Balard's (1802-1876) laboratory in the new École Normale. In 1848 he obtained a modest position as assayer at the Mint (Potter, 1953).

In 1851 Laurent presented his candidature for the chair of chemistry at the Collège de France left vacant by the resignation of Théophile-Jules Pelouze (1807-1867) and defeated François Ernest Balard (1833-1894), the discoverer of bromine [although Justus von Liebig (1803-1883) claimed that Balard was discovered by bromine!] by thirteen votes to nine. This election had to be ratified by the Académie des Sciences. In spite the clear recommendation of the Collège and the favorable opinion of Jean-Baptiste Biot (1774-1862), the famous physicist (Biot, 1850), the Académie disregarded the advice and voted for Balard (35 to 11), probably a sign of the opposition to Laurent's radical political and chemical ideas (Stumper, 1953).

Having fallen seriously ill, in 1852 he went to recuperate in the south of France, but died in Paris of tuberculosis on April 15, 1853, and was buried in the Montparnasse cemetery. His family was awarded a state pension. The town of Langres erected a monument in his memory, which was destroyed during the German occupation of 1940-1944, and rebuilt after the war by the town authorities (Stumper, 1953).

In 1845 Laurent was elected Chevalier de Légion d'Honneur and also corresponding member of the Académie des Sciences, replacing Faraday who had been promoted to Foreign Member. In 1849 he became member of the Chemical Society of London. In 1858 the Académie des Sciences awarded posthumously to Laurent and Gerhardt the Jecker Prize for the Advancement of Organic Chemistry (6140 francs to each of the two widows) (Stumper, 1953).

Laurent left unpublished the manuscript of his book *Méthode de Chimie*, which was edited by François Joseph Jerôme Nicklés (1821-1899) and published posthumously in 1854 with an introduction by Biot, and subsequently translated into English by William Odling (1828-1921) (Potter, 1953).

## Scientific activities

The scientific work of Laurent is reflected in more than 200 memoirs and notes and the books *Précis de Cristallographie Suivi d'une Méthode Simple d'Analyse au Chalumeau d'Après des Leçons Particulières* (Laurent, 1847), *Théorie des Radicaux Dérivés et Mémoires sur les Séries Naphthalique et Stilbique* (Laurent, 1850), and *Méthode de la Chimique* (Laurent, 1854). Grimaux's book (Grimaux, 1900) contains a copy of a large number of the letters exchanged between Laurent and his close friend and collaborator, Charles-Frédéric Gerhardt (1816-1856). Some of his most significant contributions are described below.

### 1. Organic chemistry

Laurent first incursions in organic chemistry were his thorough and meticulous experimental investigations of naphthalene and its derivatives. In 1831, Dumas, who was studying the reactions of halogens upon various hydrocarbons (Dumas, 1828-1846), suggested that Laurent undertook the isolation of naphthalene from coal tar, its purification, analysis, and its reaction with the halogens and nitric acid. John Kidd (1775-1851) discovered naphthalene in 1821 when passing coal tar over an incandescent tube (Kidd, 1821), a procedure yielding very small amounts of the compound. Laurent compared several methods of extracting naphthalene from coal tar and found that the yield could be improved significantly if a current of chlorine was passed over fractional distillates of the tar. The resulting process was of low cost and could be used for the commercial production of naphthalene, if a suitable use was found for it. The method was based on Dumas' opinion that naphthalene exists preformed in coal tar and can be crystallized when the oils that hold it in solution are destroyed (Dumas, 1828-1846). Using the same method Laurent and Dumas discovered anthracene (paranaphthalene) in 1832 (Laurent, 1835a). Analysis of both naphthalene and

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