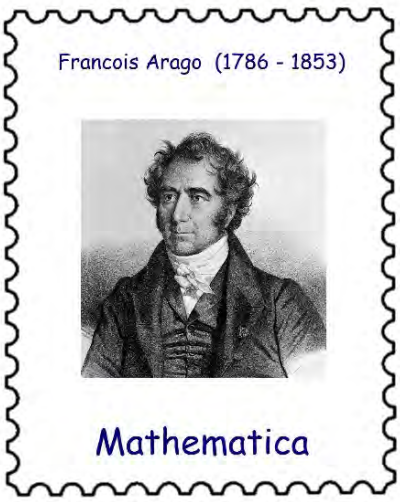
**FRANÇOIS ARAGO** (February 26, 1786 – October 2, 1853)

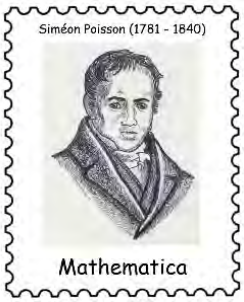
by HEINZ KLAUS STRICK, Germany




DOMINIQUE FRANÇOIS JEAN ARAGO grew up with eight siblings in the small town of Estagel (Roussillon), where his father was mayor and justice of the peace. At the *Collège* in Perpignan, 18 kilometres away, he discovered his love of mathematics.

At the age of 17, he successfully passed the entrance examination for the *École Polytechnique* in Paris. His examiner was LOUIS MONGE, brother of GASPARD MONGE, the head of the elite Parisian school at the time.

In Paris, FRANÇOIS was able to stay with a friend of his father's, where he also met SIMÉON DENIS POISSON, five years his senior. This was the beginning of a lifelong friendship between ARAGO and the young lecturer at the *École Polytechnique*.




In 1805 POISSON made his friend an offer: ARAGO was to finally complete an elaborate surveying project – nothing less than the surveying of the meridian of longitude running through Paris. Between 1792 and 1798, JEAN-BAPTISTE DELAMBRE and PIERRE MÉCHAIN had been commissioned by the *Bureau des Longitudes* to measure the length of the meridian between Dunkirk and Barcelona – the basis for determining the length of the original metre (= a ten-millionth part of a quarter of the circumference of the earth).

MÉCHAIN's surveying work in the south – especially because of the turmoil of the French Revolution and the consequences of the war with Spain – was fraught with great difficulties, and MÉCHAIN was plagued by considerable doubts as to whether the last data determined were actually correct. From 1803 onwards, he was allowed to resume his surveys south of Barcelona. After working in Ibiza and Mallorca, however, MÉCHAIN died unexpectedly, and PIERRE-SIMON LAPLACE asked POISSON to help him find a successor for MÉCHAIN.

Together with JEAN-BAPTISTE BIOT, ARAGO prepared for the expedition for 18 months. BIOT had attracted great attention in 1804 when, together with JOSEPH-LOUIS GAY-LUSSAC, he ascended to an altitude of 4000 metres in a hydrogen balloon to take measurements.


In September 1806, the two began their measurements south of Barcelona and finally arrived on the Balearic Islands two years later. It was at this time that NAPOLEON began his campaign of conquest through Spain and Portugal. When NAPOLEON proclaimed his brother JOSEPH BONAPARTE (King of Naples since 1806) King of Spain in May 1808, the resistance of the Spanish against the French occupiers grew.

BIOT fled to France while ARAGO was still trying to make the last measurements – from Formentera across to the Spanish mainland.

It was not surprising that someone who carried unusual equipment and also had a signal fire lit on a mountain attracted the attention of the population. ARAGO was arrested as a spy and taken to prison. However, he was able to convince the prison warden that he is not an enemy spy and he was given an opportunity to escape.

On a fishing boat he arrived in Algiers, at that time firmly in the hands of Mediterranean pirates. ARAGO found a sailing ship that could take him to Marseille. However, it was captured by a Spanish warship on the way and he fell into Spanish captivity again.

And this time, too, he was able to convince those responsible of the scientific background of his presence in Spain, and he was released onto a ship that departed for Marseille. However, the ship got caught in a storm and was stranded in Bougie (today Bejaja) on the Algerian coast. Disguised, ARAGO reached Algiers by land and for the third time he boarded a ship that was to take him to Marseille. And finally – a year after his first arrest – he returned to France in July 1809.

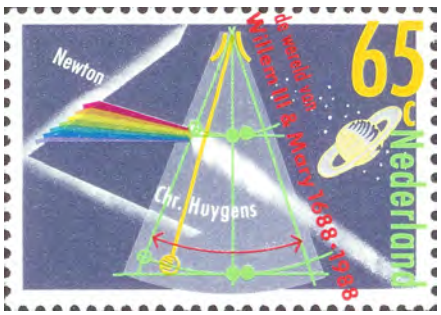
The members of the *Académie des Sciences* celebrated him as a hero when he presented his undamaged logbook with the entries of the survey results. The 23-year-old ARAGO was elected by an overwhelming majority to a vacant position as a member of the *Académie* and in the same year was appointed to the chair of geometry at the *École Polytechnique*, succeeding GASPARD MONGE.


ARAGO also soon took on important tasks at the *Paris Observatory*. From 1834 onwards, he was the main person responsible for the celestial observations, and from 1843 until his death he directed this institution. Through his annual lectures for the interested public, he contributed to a growing general interest in astronomical questions.

From 1830 onwards, in addition to his political activities, he coordinated the work of the *Académie des Sciences* as permanent secretary and he gave up his teaching position at the *École Polytechnique*. In 1835 he founded a journal documenting the work of the *Académie* (*Comptes rendus de l'Académie des sciences*).


Throughout his life, ARAGO was interested in all scientific phenomena and he found a like-minded person in ALEXANDER VON HUMBOLDT, with whom he shared a flat in Paris until his marriage in 1811.

ISAAC NEWTON and CHRISTIAAN HUYGENS had developed different theories about the nature of light – the phenomena of refraction and reflection of light could be explained both in the particle and the wave model. The question of which of the two models was correct could be decided if it were possible to determine the speed of light in different media:




According to the NEWTONian corpuscle theory, the speed should increase after the transition into the denser medium; according to the HUYGENSian theory, it should decrease.

In December 1810, ARAGO presented a problem to the *Académie* for which he had no explanation:

> *If we aim at a star at six o'clock in the morning, the light from this star should reach us with the speed c + v where v is the rotation speed of the Earth around its own axis, at six o'clock in the evening this is correspondingly c – v. The same applies to measurements in spring and in October, where this time v is the orbital speed of the Earth around the Sun.*

In his measurements, however, he was unable to detect any differences (which was not due to measurement inaccuracies, as we know today thanks to EINSTEIN).


When the British inventor CHARLES WHEATSTONE succeeded in 1834 in determining the speed of a flowing stream with the help of a rotating mirror, ARAGO tried to apply this idea to the measurement of the speed of light.

However, he still lacked the necessary technical prerequisites. In 1850, at a meeting of the *Académie*, he was proud to announce that JEAN BERNARD LÉON FOUCAULT had succeeded in implementing this idea. (The year before, ARAGO's student HYPOLYTE FIZEAU had already measured the speed of light with the help of a rotating gear wheel – based on an idea by GALILEO GALILEI).

In 1811, ARAGO demonstrated the rotation of the plane of polarisation in experiments with rock crystals. He also found that blue sky light was only partially polarised, and:

> *The bluer the sky, the greater the proportion of polarised light*.

The collaboration with the engineer AUGUSTIN JEAN FRESNEL led to the discovery of what are now known as FRESNEL-ARAGO laws:

> *When two polarised light beams with mutually perpendicular planes of polarisation meet, no interference occurs.*

In 1818, the *Académie* announced a competition to finally settle the dispute about the nature of light. The commission was chaired by ARAGO and other members were POISSON, BIOT, LAPLACE and GAY-LUSSAC.


FRESNEL won the competition, but POISSON was still not convinced; he claimed:

> *If light had the character of a wave, there should also be a spot of light in the centre of the shadow of a sphere because of interference but this is not the case.*

ARAGO carried out the experiment in front of the members of the *Académie*, and demonstrated that this spot, which fitted the theory, actually *exists* (this is the so-called POISSON spot or ARAGO spot).

In 1820, ARAGO reported on the discovery of the Danish physicist HANS CHRISTIAN ØRSTED:

*A compass needle is deflected when current flows through a nearby conductor.*


ARAGO and ANDRÉ-MARIE AMPÈRE, professor at the *École Polytechnique*, discovered that the magnetic needle always aligned itself perpendicularly to the conductor and that two conductors through which current flows attracted or repelled each other – depending on the direction in which the current flowed through the conductors. AMPÈRE refined these observations into AMPÈRE's law of forces, named after him.

In further experiments, ARAGO discovered the principle of the electromagnet and the existence of eddy currents – experiments that MICHAEL FARADAY summarised in 1830 under the phenomenon of electromagnetic induction.


When, in 1845, URBAIN LE VERRIER, one of ARAGO's students, suspected the existence of another planet because of some irregularities in the orbit of URANUS, he was encouraged by ARAGO to investigate this further. The new planet (Neptune) was found by the German astronomer JOHANN GOTTFRIED GALLE on the basis of the orbital coordinates precisely calculated by LE VERRIER.

ARAGO's happy marriage to LUCIE CARRIER-BESCOMBES produced three sons. After the death of his wife in 1829, ARAGO's political career began:

After the 1830 Revolution, he was elected to the National Assembly as a candidate for the moderate republicans in his home department of Pyrénées-Orientales. Here he was concerned with the general expansion of railway lines and canals as well as the promotion of new technical developments.

In 1839, for example, he ensured that all rights to the invention of photography were acquired by the French state and made available free of charge as a *gift to mankind*; LOUIS DAGUERRE received a pension for life (as did the son of JOSEPH NICÉPHORE NIÈPCE, who died prematurely).

During the 1848 Revolution, he temporarily assumed the post of *Minister of War* as well as heading the *Ministry of the Colonies and the Navy*. During his few weeks in office, he abolished corporal punishment in the navy and slavery in the French colonies.

After NAPOLEON III seized power in 1851, he refused to take the oath of allegiance to the new ruler and resigned from his posts as head of the Observatory and permanent secretary of the *Académie*. Napoleon III did not accept this, but gave orders to leave the deserving scientist alone.

ARAGO, whose health had deteriorated dramatically in his later years, revisited his old home to recuperate. When there was no improvement, he returned to Paris and died a few weeks later. Tens of thousands of people attended his funeral at the *Père Lachaise* cemetery.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https://www.spektrum.de/wissen/francois-arago-abenteuerlicher-forscher/1820111

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