Chapter 2 :

Lord Kelvin's little grey clouds

This brings us to a pivotal year which we will place in 1898. Indeed, we know that the beginning of this century is accompanied by a great scientific upheaval. If the way of looking at things is going to be changed, it is because there are problems that escape the thinking tools of scientists.

The first problem we will mention was known for a long timeThis is the advance of Mercury's perihelion. A profound paradigm shift represents the abandonment of the assumption that planets could only follow circular paths. As Plato stated, for the simple reason that they were perfect. Therefore their orbits had to be circular, the circle being an excellent image of perfect things.

Thanks to the sky, the fact that these trajectories are ellipses, where the Sun is located on one of the foci, eventually becomes clear. Finally, Newton's mechanics explained that if it was so, it could not be otherwise. After having identified these planets with divine beings, men decided to reduce them to the simple manifestation of celestial mechanics.

There was, however, the question of the stability of the orbits. Indeed, any planet, acting on the orbits of its neighbours thanks to its gravitational field, was likely to disturb this harmonious assembly. Isaac Newton had his own answer to this question. He thought that when something tended to cause a planet to deviate from its orbit, God would immediately put it back.

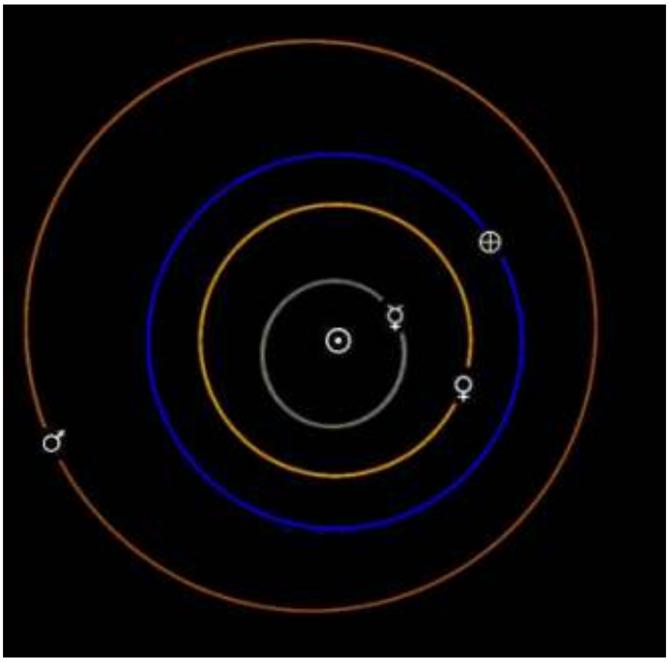
This is a mixed attitude, combining science and religion.

The Frenchman Laplace put an end to this intervention of the divine in the cosmic thing, with the help of more elaborate works. To the First Consul Bonaparte, who had asked him about the place of God in these things in the sky, the scientist had replied:

- "Mr. First Consul, I did not need this hypothesis in my calculations."

In any case, these orbits had to remain as they were. An ellipse has two axes, a small and a large. When this ellipse represents the orbit of a planet, one end of the major axis represents the point where the planet is farthest from the Sun. This is called aphelion. The other point is the orbit where the planet passes closest to the sun. It is called perihelion. But how eccentric are the orbits of the different planets? I mean how far these orbits deviate from the circle (which corresponds to zero eccentricity).

The figure below shows the orbits of the planets, represented by their symbols. At the centre is the Sun. In order of distance, the orbits shown are those :



- of mercury
- from Venus
- from Earth
- from Mars

The difference with a circular orbit only begins to be vaguely appreciated for Mercury. But in fact the difference is only apparent in the decentring from the Sun, which is also noticeable for the orbit of Mars.

Nevertheless, astronomers had long been able to determine the precise orbits of the various planets. It was known at the time that Mercury had an anomaly that could not be explained by Newtonian mechanics.

The figure below shows a drift of the trajectory of a mass around a neutron star.

Advancing perihelion of a mass orbiting a neutron star.

This effect is then very important. For Mercury this drift is only 43 arc seconds per century. What does the angle represent? This is equivalent to a human hair held at arm's length. This means that if we wanted to show the drift of Mercury's orbit, the variation would be less than the thickness of the line at each turn.

But telescopes are very precise observation devices and in the Napoleonic era in which Urbain Le Verrier lived such a discrepancy could not be disputed.

Urban le Verrier 1819-1892

The latter is interested in variations in the trajectory of Uranus in its orbit. He opts for the hypothesis that these are caused by the interaction with the mass of another, as yet unknown, planet. By calculation he managed to determine his position and submitted a memorandum on this issue to the Academy of Sciences on 31 July 1846. Now he needs to find an astronomer who can point his instrument in that direction.

As will be seen later, this book could be considered above all as dealing with the sociology of science. Le Verrier could not find a French astronomer who was willing to try to verify his theory. As he was in contact with a German astronomer in Berlin, Johann Gottfried Galle, he communicated his assessment of the coordinates of this new planet to which he gave the name of the god Neptune. Galle received his letter on 23 September 1846. That evening he pointed his telescope in the direction determined by Le Verrier and immediately found the planet.

Because of their lack of reaction, French astronomers lost the opportunity to write their name in the history of science. But this inertia, although customary in France, is not unique to this country. In England, a young astronomer, J.C. Adams, who made calculations similar to those of Le Verrier, and who also assumed that the variations in the trajectory of Uranus were due to the presence of a planet, also determined its accuracy. Although his figures are less precise than those of Le Verrier, if the English astronomers at Cambridge had deigned to pay attention to him, they too would have detected the presence of the star, and this historic discovery would have been English.

In the course of these pages, we will dwell here and there on facets of the history of science. Thanks to this discovery, Le Verrier immediately became famous and was presented to the emperor. As he did not have a suit of clothes, François Arago, an academician, who was about the same size, offered to lend him his. But, contemplating his image in a mirror, the glassmaker exclaims:

"But I don't have any medals!"

And Arago replied:

- Here, choose. I put mine, which I never wear, in this box.

He never failed to present those that were given, as can be seen in the portrait above.

In 1854 he was appointed director of the Paris Observatory where he behaved like a real tyrant. About the work and discoveries of the observatory he writes:

- The names of the assistant astronomers who make discoveries for which all credit is due to the director, under whose orders they are placed, must not be made public.

He multiplied the vexations, the arbitrary suspensions of treatment, dismissed two astronomers, Mathieu and Laugier, set up by Arago. They complain about this to the government. The controversy has reached the public arena. Le Verrier is a typical example of a psychologically rigid personality. In the face of this criticism he hardened his position.

Finally, fourteen astronomers resigned at the same time, hoping to get the Senate to react. Le Verrier counter-attacks by asking to intervene in person in the Senate. But the Senate dismissed him on 6 February 1870. and is replaced a month later.

Apart from these anecdotal aspects, and to return, after this digression, to the question of the advance of the perihelion of the planet Mercury, Le Verrier then imagined that the effect observed could be due to a small planet, orbiting closer to the Sun, to which he gave the name Vulcan.

It determined its mass and the parameters of its orbit, and astronomers tried in vain to see it. It was not until the emergence of Einstein's General Relativity in 1915-1916 that this vernier's interpretation put an end to this quest.

However, one thing should be noted. If this special relativity had not appeared in 1915 and if the scientists of that time had had the mindset of those of today, we might have attributed this effect to a darkplanet, who knows?

Leaving aside this minimal inadequacy of Newtonian mechanics to the observations, let's move on to a second point.

In 1881 Abraham Michelson, born in Prussia, was 22 years old. In Berlin, he devised a very clever set-up that would make it possible to demonstrate the speed at which the Earth moves in relation to a medium called the ether, where the waves that make up light propagate.

We know that light is a wave, since we can create interference, etc. The demonstration of the propagation time of a wave in a medium is the classic image of the measurement of the propagation time of a sound wave, emitted by two experimenters posted on the roof of a moving train, depending on whether this wave propagates in the direction of movement or against the current. The sound only travels at 340 metres per second. The experiment could very well be carried out and prove successful.

Michelson emigrates to the United States. The experiment was then repeated with greater precision with the American Morley. This time, the movement of the Earth in relation to the aether, due to its speed on its orbit around the Sun, is no longer in question. The speed of light is found to be constant in all directions.

To these two "little grey clouds" mentioned by Lord Kelvin we will add a third.

At the end of the nineteenth century the existence of atoms was still a matter of belief. This thesis has its strong opponents. These include the French chemist Marcellin Berthelot. He carried out the first synthesis of alcohol in 1854. Its activities cover a wide range, including politics. He saw this atomic theory as an attempt at simplification that reminded him of the medieval model of the four elements. He believes that there are substances, but does not believe in the discrete.

His favourite phrase is:

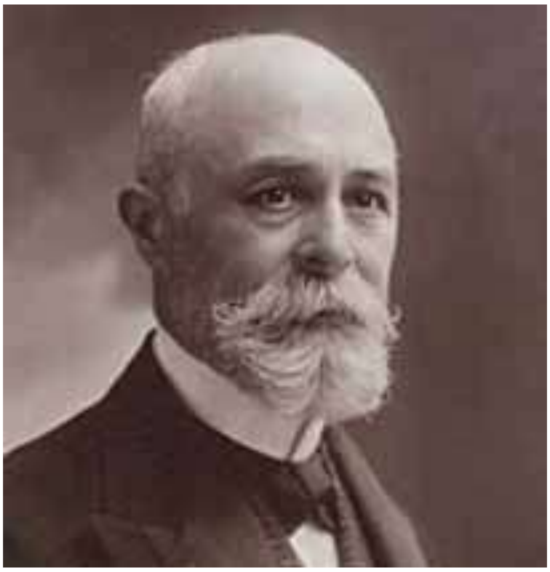
- I will fight this absurd atomic theory to my last breath.

Marcellin Berthelot

France owes him a certain delay in chemistry, compared to countries like England and Germany. We know that it was the New Zealander Ernest Rutherford who put an end to the debate in 1905 by demonstrating the corpuscular nature of matter.

In 1895, therefore, there was no 'grey cloud' in chemistry. The Austrian Joachimstal Mine provided experimenters in many countries with samples of a new substance, radium. It was given this name because it emits radiation. But this phenomenon is not fundamentally disconcerting. Other bodies emit light and the phenomenon is called phosphorescence.

Many major discoveries are made by chance. On 26 February 1896, the chemist Henri Becquerel locked some pebbles containing uranium in a drawer and found them resting on a photographic plate.



Henri Becquerel

Normally, the sensitive film is only impressed by light. But when you develop it, the silhouette of the stones appears. Becquerel deduced that these emitted an unknown radiation, capable of passing through the opaque envelope in which the film was stored. He described the phenomenon as hyper phosphorescence and understood that radium emitted radiation of an unknown nature. Without knowing it, Becquerel had just discovered the first manifestation of what would be called nuclear physics.

I have retained these three examples of 'small grey clouds' in the sense that these phenomena seemed peripheral, minor at the time. While each of them, in its own way, will constitute the starting point of major conceptual revolutions.