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AN UNUSUAL USE OF AN ASTRONOMICAL INSTRUMENT: THE DREYFUS AFFAIR AND THE PARIS 'MACRO-MICROMÈTRE'

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The year 1994 marked the centenary of what was called in France "L'Affaire Dreyfus"¹ and of what was, around the beginning of the present century, a decade of difficulties for the French Government and its army. The year 1904 saw the beginning of the end of these troubles. These circumstances led the Library of the Paris Observatory to arrange a display of documents discovered in the notebooks of astronomers, documents that show that a scientific instrument designed to measure astronomical plates was — surprisingly — used at that time for non-scientific purposes.

The Scientific Background

In 1882 a comet was observed at the Cape Observatory and superb photographs of it were obtained there by David Gill (1843–1914). These he sent to Admiral E. B. Mouchez (1821–92), Director of the Paris Observatory, as revealing how photography might help in mapping the heavens. Two years later, at the Paris Observatory, the Henry brothers, Paul and Prosper, obtained with a 16cm equatorial a plate that showed stars down to the 13th magnitude, including 500 stars in the Perseus cluster.

In 1885 a small coudé equatorial of 7m focal length was installed in the grounds of the Paris Observatory, followed in 1889 by a larger one, of 18m focal length. The latter would be used by Maurice Loewy (1833–1907) and Pierre Puiseux (1855–1928) between 1894 and 1907 for the *Atlas photographique de la Lune*.

Meanwhile, the international *Carte du ciel* was being organized.² The instruments, installed in a number of observatories throughout the world, were similar to the prototype made in 1885 by Paul Gautier for the Paris Observatory. This was a double astrograph, the photographic having an objective of 33cm and the visual, one of 25cm, the optical parts being made by the Henry brothers.

However, accurate measuring machines were necessary for the plates that were to be obtained with these astrographs. Several were built, and in Paris a 'macro-micromètre' was brought into service in 1886. The annual report of the Observatory for that year describes it as capable of very high accuracy. As an example, the mean errors for the double star ζ Ursae Majoris were 0".077 for the distance, instead of the 0".12 for previous instruments, and 0°.55 for the position angle.

The Controversy Over the Dreyfus Affair

The “Dreyfus Affair” originated in 1894, over espionage between France and Germany following the French defeat in the war of 1870–71. It was complicated by the fact that Captain Alfred Dreyfus (1859–1935), on whom the case centred, was a French Jew from Alsace, part of his family having had to stay in the German zone following the war.

After being arrested on 15 October 1894, Dreyfus, a graduate of the *École Polytechnique*, was found guilty on 22 December after a brief court martial, following an examination of his writings on a sheet of paper termed ‘*Bordereau*’ in which he was convicted of transmitting military information to the Germans. On the ‘*Bordereau*’ (Figures 1 and 2) were the phrases “je vous adresse cependant”, “une note relative à Madagascar”, “responsables”, “doit remettre le sien après les manoeuvres”, and “Je vais partir en manoeuvres”.

After Dreyfus was deported to an island close to French Guyana, Frenchmen began to take sides over the case, those who supported him becoming known as the “Dreyfusards” and those against as the “Antidreyfusards”. Memoirs, books and articles were published on both sides, culminating in the famous “*J’accuse*” by the writer *Émile Zola* published on 13 January 1898 in the newspaper *L’Aurore*. Legal action against Zola was instigated on 7 February, and a fortnight later he was found guilty. Further proceedings opened on 18 July 1898, and, following a second condemnation, Zola left France for England. The case continued to arouse intense controversy, and eventually, following an appeal by Dreyfus’s wife, a new trial of Dreyfus began on 8 August 1899. A month later he was again found guilty, but this time with circumstances in mitigation of his offence, and a presidential pardon was granted.

In 1904, two years after the accidental death of Zola, Dreyfus himself asked for a new examination of his case. His request was granted on 5 March, experts being nominated to examine the ‘*Bordereau*’.³ These were very different from those chosen in 1894, who had mostly been handwriting experts together with the “*chef du service de l’identité judiciaire*”. The conclusion in 1894 had of course been unfavourable to Dreyfus.

The experts nominated on 18 April 1904 were Paul Appell (1855–1930), a mathematician specializing in mechanics, currently dean of the Faculty of Sciences in the Sorbonne; Gaston Darboux (1842–1917), a mathematician specializing in infinitesimal geometry, and currently perpetual secretary of the *Académie des Sciences*; and Henri Poincaré (1854–1912), the renowned mathematician, later to be the author of *Méthodes nouvelles de la mécanique céleste*.

The 1904 Notebooks of the Paris Observatory

Notebooks relating to the “Grand équatorial coudé” constitute a collection of 45 items, covering the period from 1891 to 1913. They are at present in the archives of the Paris Observatory, but this was not yet the case in 1939 when a

young astronomer, Théo Weimer, was attempting to work on the profiles of the Moon. His intention had been to study the plates taken by Loewy and Puiseux around 1900 but, because of the war, these were in boxes, in a safe place and not available for use.

As this situation continued for a number of years, Weimer made a careful search of the corresponding notebooks. He soon discovered that their contents were very useful for his task,⁴ for they included remarks on the observations and on the plates themselves, the measurements with the macro-micromètre, and so on. But he also noticed that three of the notebooks included measurements made on the handwriting of the famous 'Bordereau', and he marked their cover pages, "Mesures bordereau Affaire Dreyfus T.W."

An examination of these notebooks (which are numbered 25–27) shows that they contain astronomical data, with comments such as "ciel brumeux, série très médiocre" or "on insiste sur le terminateur [de la Lune]". Under the date "17 mai 1904", following the drawing of a large square, separated into small numbered ones, there are the remarks "coin le plus étroit du papier", "bord inférieur difficile", and "trait mal défini" with the initials M. L. (Maurice Loewy, then director of the Paris Observatory).⁵ The various zones of the paper are measured, not only by M. L. but also by L. M. (Le Morvan, a collaborator of Loewy and Puiseux in the *Atlas de la Lune*).

After 22 pages of such measures reported in pencil, there is written in black ink, "Echantillon du papier sur lequel a été établie la lettre incriminée [Bordereau]", from which it becomes clear that the previous measurements were made in relation to the Dreyfus Affair, and specifically for the second proceedings. Six more pages of measures are in notebook no. 25. In the next (no. 26), measures are made from 19 May; on the following day are measured "l'épaisseur des traits [filigrane]", then the "décimètre étalon" and the micrometer for both screws in both coordinates.

On 23 May astronomical observations took place of the Ramsden Gassendi region of the Moon, and there are also further references to the Affair, such as "Abcisse de la ligne mesurée à partir du coin", and "On est sur une déchirure raccommodée". Loewy and Puiseux were responsible for the new measurements and, for 20 June, there are more explicit indications of how they went about their work: "bas du J (dans Je vais partir en manœuvres)", with measurements by Puiseux and Le Morvan of the centre of the upper line, the upper part of the letter J, and its lower part, including an enlarged drawing of the letter J.

Similar measurements were made of other handwriting, and signed with the initials M. L., L. M., and P. The watermarks were carefully examined: "filigrane passant par je vous adresse cependant", with the remark "on a pris comme orient.[ation] le filigrane passant par Madagascar et très comme plus loin", and likewise "déchirure", "bout du collage", "l'autre côté du collage", "1er bord du collage", "bord de la déchirure", "coin replié".

Indeed, notebook no. 26 (40 pages, 15.5cm × 11.5cm) is almost entirely

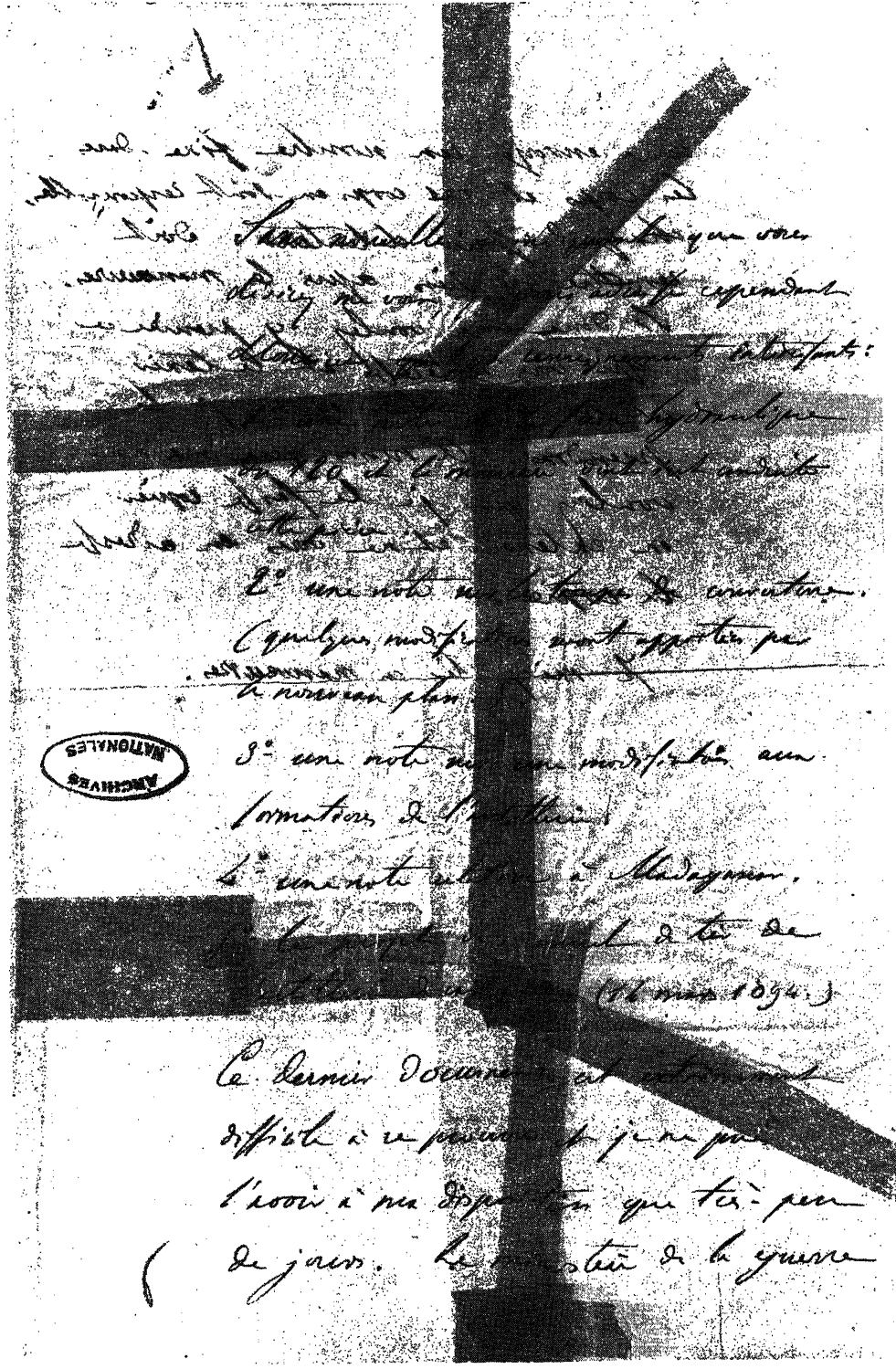


FIG. 1. Recto of the 'Bordereau' (courtesy of Archives Nationales, Paris).

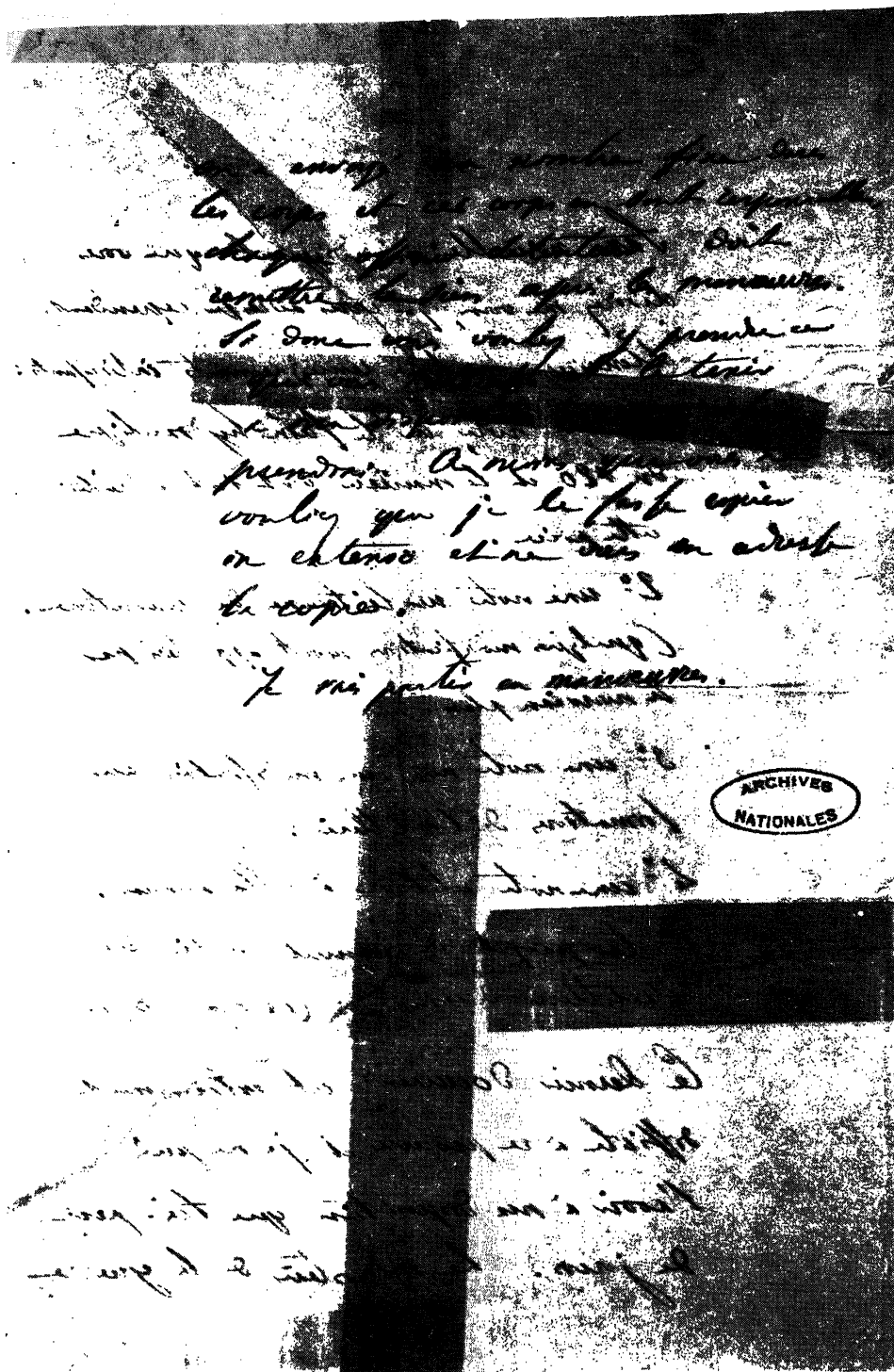


FIG. 2. Verso of the 'Bordereau' (courtesy of Archives Nationales, Paris).

devoted to the subject. On 24 June a comment informs us: “Mesures faites directement sur le bordereau même.” At the end, “l’*m* du mot manœuvres dans je vais partir en manœuvres” is followed by “doit remettre le sien après les manœuvres”.

The conclusion is written (in black ink) to the right of the last page:

1° Distance du filigrane à la lettre *m* du mot manœuvre de : (je vais partir en manœuvres) $129.17\text{mm} - 128.75\text{mm} = 0.42\text{mm}$.

2° Distance du filigrane à la lettre *m* de : doit remettre le sien après les manœuvres $128.55\text{mm} - 128.12\text{mm} = 0.43\text{mm}$.

The next notebook, no. 27 begins on the same day, with four pages (in black ink) where Loewy, Le Morvan and Puiseux made measurements on a Bertillon copy of the ‘Bordereau’; these are followed, this time, by values obtained “directement sur le bordereau”. This is confirmed by the following comment: “Mesures faites sur le bordereau même, des intervalles entre traits parallèles au grand côté. Le dernier trait mesuré passe un peu avant le *b* de responsable (mesures faites avec la grande vis). Ces mesures n’ont pas été faites sur le même filigrane, à cause des altérations du bordereau.”

Given the number of measurements, the poor state of the ‘Bordereau’ is hardly surprising! Two days later (26 June) new values were derived for “vérification de quelques filigranes” and the Bertillon copy was measured by Le Morvan and Loewy in an exercise that occupied 24 pages in all. After the return to astronomical observations on 28 July, there were no further measurements related to the Dreyfus Affair, and the notebook ends on 1905 January 15. The task had engaged the attention of astronomers of the Paris Observatory for over a month, from 17 May to 24 June.

The purpose of the measurements was apparently to determine if the ‘Bordereau’ was, or was not, a forgery. A further year would be required before the situation was clarified. On 12 July 1906, after further proceedings, Dreyfus would be rehabilitated and reintegrated into the French army. The same year the Légion d’Honneur, as *officier*, would be bestowed on him, and in 1908 the ashes of Zola would be transferred to the Panthéon. The ‘bordereau’ had at last been recognized as a counterfeit letter, written for devious ends and part of a plot of anti-semitic character.

The Scientific Instrument Used for the Dreyfus Affair

The macro-micromètre is described and illustrated in the 1886 annual report of the Paris Observatory, with the subtitle “Appareil de mesure pour les photographies stellaires”. It was made, under the direction of the Henry brothers, by the firm of Gautier, and was immediately put to use. The report tells us that readings could be made at $0''.01$ with the microscope, whose length was 200mm. The method for taking the readings is shown in the picture included in the report.

Later, the macro-micromètre was moved, as indicated in the 1903 report: “La machine à mesurer [macro-micromètre] a été installée dans le pavillon du Grand coude pour être employée, avec le micromètre spécial fourni en 1902, à la mesure des clichés de la Lune.” Some of these plates remain to this day in the collections of the Paris Observatory. Nobody then knew that two years later, the measuring machine installed in the Grand Coude building would be used to determine distances of the watermarks and letters on a wholly non-astronomical object....

In the reports for 1904, 1905 and 1906, written by Maurice Loewy who had himself participated in the measurements, nothing was said about either the macro-micromètre or its applications — there was silence concerning the task that had engaged the attentions of three astronomers, including the director of the Paris Observatory, for more than a month.

It should be noted that the experts designated in April 1904 were mathematicians who had links with the Observatory: Darboux was then vice-president of the Council of the Observatory, while Poincaré was one of the Council members. Later on, in 1907, Darboux would become president and Poincaré vice-president of this Council.

The macro-micromètre was still in existence in 1939 and, during the Second World War, Weimer used it — in modified form — to determine the lunar profiles and the positions of craters, for incorporation in the doctoral thesis he submitted in 1953. At the end of the 1960s, the instrument was destroyed to make space.

The End of the Dreyfus Affair

The expert mathematicians nominated for the second proceedings (Darboux, Appell and Poincaré) wrote a “Rapport” in response to a request from the Cour de Cassation dated 18 April 1904 “mettre en œuvre, en un mot, tous moyens d’ordre scientifique pouvant contribuer à la manifestation pleine et entière de la vérité”. This became available in print in 1908.⁶ It occupies over one hundred pages, and reveals the relationship between the measurements made by the astronomers of the Paris Observatory and the report by these three mathematicians.

For example, the statement, “A cet effet, un morceau de papier détaché du bordereau ne portant aucune trace de pli ou de déchirure, fut confié à M. Loewy, directeur de l’Observatoire, qui, aidé de M. Puiseux, astronome titulaire, et de M. Morvan, et se servant de l’appareil de précision construit pour l’étude des photographies de la lune, a mesuré la largeur et l’équidistance des traits”, corresponds to the measurements that began on 17 May 1904. The results are summarized in two-and-a-half pages, which conclude: “Pour toutes ces raisons, la reconstitution [par Bertillon] est inexacte; ici encore nous devrions arrêter notre travail et considérer la question comme tranchée; mais nous croyons devoir pousser notre examen jusqu’au bout.”

The “examen” is supported by most of the measurements made on the “clichés Tomps”, the “cliché Bertillon” or “la lettre du buvard” as depicted in the report; also used are the measurements made of letters, and of the distances between the lines or to the edges of the sheets of paper examined. “Malheureusement les mesures prises sur le mot de la lettre du buvard par MM. Loewy et Puiseux, avec l’appareil de précision employé pour la lune, n’ont pas confirmé ses vues [celles de M. Bertillon].” They conclude:

En résumé, tous ces systèmes [ceux de Bertillon] sont absolument dépourvus de toute valeur scientifique:

- 1° Parce que l’application du calcul des probabilités à ces matières n’est pas légitime;
- 2° Parce que la reconstitution du bordereau est fausse;
- 3° Parce que les règles du calcul des probabilités n’ont pas été correctement appliquées.

En un mot, parce que les auteurs ont raisonné mal sur des documents faux.

So ended the Dreyfus Affair.

Acknowledgements

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