

THE SINGLE EYE: RE-EVALUATING ANCIEN RÉGIME SCIENCE

Jimena Canales

Harvard University

Free astronomy is almost as dangerous as the free press.
Victor Hugo

INTRODUCTION

In his historical work Victor Hugo, and many careful observers since then, have seen the Paris Observatory as a crucial site of interaction between science and the state. His distressing history was one of failure: once again the dream of 1789 had been crushed, and for the second time, by a Napoleon. Napoleon III's paranoid regime brutally controlled everything — even astronomy. Hugo exposed the illicit relations between the Second Empire (1851–70) and astronomy by denouncing the fall from power of François Arago, the Director of the Observatory who refused to support the Imperial regime, and by lamenting his replacement by Urbain Le Verrier, also known as the “Hausmann of the stars” after Napoleon III's urban planning strong hand.¹ In *Napoleon the Little*, Victor Hugo explained: “Free astronomy is almost as dangerous as the free press.”²

While posterity has forgotten Hugo's history of the Paris Observatory, historians still consider the Observatory an exemplary site for linking science and the state. In fact, French politics seemed to map almost seamlessly onto the different regimes of the Paris Observatory, where directors came and went with the nineteenth-century's tortuous succession of revolutions and *coups d'état*. Three of the Observatory's directorships appeared to be especially at the mercy of different political regimes: Cassini IV to Louis XVI, Arago to the July Monarchy and the Second Republic, and Le Verrier to the Second Empire. Cassini IV's directorship, for example, was so dependent on royal patronage that after the fall of Louis XVI he was expelled from the Observatory (1793) and imprisoned. Decades later, after the fall of the Second Republic, Arago (1852) stood by his republican principles and refused to swear allegiance to the Second Empire. Napoleon III's rise was accompanied by Le Verrier's appointment as Director of the Observatory (1854) and Imperial Senator (1852). Yet, like the others', his fate also turned for the worse with a change in the political climate, and he was dismissed (1870) shortly before the demise of the Second Empire.

Historians exploring the connections between the Paris Observatory and the state have largely focused on Charles Wolf's *Histoire de l'Observatoire de Paris de sa fondation à 1793*, “still the only full-length account of that institution”, which deals with the period from the *Ancien Régime* to the French Revolution.³

Since its publication, Wolf's work has been considered a faithful narrative of how revolutionary politics affected the Observatory. But readers of Wolf's historical work have ignored that he was a participant-observer: president since 1898 of the prestigious Académie des Sciences and an important astronomer.⁴ They also have ignored how his work on science and his own experience in the Observatory during the second half of the nineteenth century directly affected his historical account.

Wolf's *Histoire de l'Observatoire de Paris de sa fondation à 1793* was innovative in one essential respect. While previous post-revolutionary histories virulently denounced the astronomy and the astronomers of the *Ancien Régime*, Wolf applauded them. In particular he defended Cassini IV (1748–1845), director of the Observatory and descendant of the illustrious family of astronomers who had headed the Observatory since its founding years.⁵ Historians who draw on Wolf's seminal work have followed the trend, always ignoring the question of why Wolf, an astronomer who worked under Le Verrier and a statesman of science, may have wanted to reevaluate pre-revolutionary science, and why he repeatedly drew a connection between Cassini IV (of the *Ancien Régime*) and Le Verrier (of the Second Empire and the Third Republic).

Wolf found many parallels between the Paris Observatory before and after the Revolution. Schematically, the parallels drawn by Wolf were very simple: he equated the *Ancien Régime* era of Cassini I – Cassini IV with the century after the Revolution. According to Wolf, the Revolution (in particular the Terror that followed it) obliterated all the progress astronomy had accumulated during the *Ancien Régime*. In 1795, after the most brutal phase of the Terror, astronomy's development was back at the “early modern” stage of the seventeenth century, under Cassini I. Thus, Wolf equated the period from Cassini I to Cassini III (1669–1784) to the years 1795–1854 and Cassini IV's directorship (1784–93) to Le Verrier's administration (1854–70 and 1873–77). By drawing these parallels, Wolf's account became a statement about both astronomy during the *Ancien Régime* and astronomy during the nineteenth century. Wolf's history of the Paris Observatory was more than an account of the events around 1789, it was a way of understanding Le Verrier's administration and of stating the right way, according to him, to conduct an observatory.

By the time Wolf's historical work was published in 1902, Le Verrier had been dead for almost thirty years, and Wolf was able to praise him by comparing him to Cassini IV. Yet during the years he worked under Le Verrier, their relationship was not as smooth as it may seem from his later account: both Le Verrier and Napoleon III were repeatedly attacked for their excessive authoritarianism and anti-republicanism. During this period the Paris Observatory faced a political crisis similar to that of the Empire. In 1870, shortly before the fall of Napoleon III, a recently established Conseil de l'Observatoire finally curbed Le Verrier's despotic regime. Wolf and other astronomers bravely fought Le Verrier in order to impose “the true organization of the Astronomical Republic”.⁶

Wolf's early differences with Le Verrier disappeared as the Conseil and the Republic gained strength, and they were completely absent from his later work. Despite initial tensions, eventually Wolf succeeded in establishing "the Astronomical Republic" under Le Verrier's directorship by retaking certain practices that had been politicized and interrupted during the French Revolution. The egalitarian organization of labour imposed during the Terror, for example, was totally abandoned, and the *ancienne* hierarchy between astronomers and observers was revived. Yet these *Ancien Régime* practices reemerged in an Observatory radically different from the previous centuries'. In this new atmosphere Wolf fought to reestablish a certain type of objectivity based on organizing many observers under a single, strong director. From this type of organization, founded on the corporatist traditions of the *Ancien Régime*, he hoped a "single eye" would emerge. In fact, it was precisely the concept of the "single eye" that the revolution had destroyed, and which Wolf sought to reestablish in all its pre-revolutionary glory. This paper explores Wolf's double vision, presentist yet historical, by explaining how his experience as an astronomer in the late nineteenth century informed his reevaluation of the French Revolution.⁷

The paper starts with a section titled "Cassini's ghost" where I explore how throughout the nineteenth century the fame of the *Ancien Régime*'s family of court astronomers popularly called "the Cassinis" dropped as republican sentiment grew, until Wolf published his revisionist history in 1902. In the years immediately following the Revolution it would have been dangerous to defend the Cassinis and their hereditary privileges, but by the time Wolf published his book, his defence of the *Ancien Régime*'s aristocratic astronomers no longer created any controversy. According to Wolf, revolutionary ideals had been disastrous for science in general and for the Observatory in particular, and astronomy could profit by adopting the methods of the last Cassini, whose prescriptions flew in the face of the principle of equality by advocating an abysmal power differential between the head astronomer and his subjugated observers. In this section, I also focus on the parallels drawn by Wolf between Cassini IV and Le Verrier in order to show how his experience as an astronomer under Le Verrier informed his reevaluation of Cassini IV. In the end, Wolf's experience as Le Verrier's astronomer convinced him of the benefits of a heavy-handed administration akin to Cassini IV's.

"Égalité" compares Wolf's and Cassini IV's views on how to organize the Observatory and focuses on their insistence on hierarchy and subordinate observers. Wolf detested the eras of rampant *égalité* and admired the periods with stiff hierarchies and strong directors such as the time from Cassini III to Cassini IV and after Arago became director in 1834. Cassini IV's disdain for *égalité*, however, nearly cost him his life, and after the Revolution strong directors continued to meet a formidable opposition from their employees. In order to combat these century-old labour problems, many astronomers pushed for an increased mechanization of observation. Yet Wolf had a more practical solution: discipline. By turning the observatory into a military style, disciplinary institution, he hoped to solve the

problem of traditionally insurrectionary personnel.

This section is followed by “Liberté” where I trace Wolf’s views on the Observatory’s institutional dependence. Since its founding, the Observatory was subordinated to the Académie des Sciences, and after the Revolution, it was put under the tutelage of the Bureau des Longitudes. The Observatory’s “slavery” to other institutions was violently contested by Cassini IV and Le Verrier, and Wolf admired these attempts. His views on dependency can only be understood in the context of the Observatory’s and the Bureau’s competition for determining longitudes, which intensified after French defeat in the Franco-Prussian War was partially blamed on the deficiency of French maps. Wolf was thoroughly implicated in this competition against the Bureau, especially through his work on personal differences in observation, which I explore in “The personal equation”.

The second half of the nineteenth century saw a marked increase in the astronomers’ awareness that different observers saw differently, affecting most dramatically the meridian transit work used to determine longitudes, and astronomers debated on the ways to eliminate the “personal equations”, as personal differences in observations were technically called.⁸ Wolf’s solution to the problem of the personal equation competed against Hervé Faye’s of the Bureau. While Faye advocated the use of telegraphy and photography for eliminating these differences, Wolf, once again, thought the solution was discipline. In order to eliminate the personal equation, Wolf created an artificial star machine used to educate observers through a disciplinary training regime. Wolf’s solution to the problem of the personal equation proved to him, once again, the benefits of instituting a hierarchical, disciplinary organization at the Observatory.

Although Wolf believed in subordinating disciplined observers to a strong director, he also believed the authority of a director should always be kept in check. In the section titled “Fraternité” I explain how he fought for the establishment of a Conseil de l’Observatoire which, by preventing directors from becoming too dictatorial, would eliminate the harmful revolutions that had plagued the Observatory — and the rest of France. According to Wolf each revolution created in the Observatory a *tabula rasa*, stunting astronomy’s precious advances. To secure progress the Observatory needed to establish legitimate, and not revolutionary, successions of directors. Here the problem of the Observatory was the same as that of the French Republic: could one have a leader and subordinates without falling into the dreaded dialectic of revolutions and coups? Wolf’s solution to the problem of legitimate succession involved working on two fronts. To prevent revolutions from below, he helped transform the Observatory into a disciplinary “school of astronomy” which, by recruiting directors from a student pool, would give beginning astronomers the opportunity, or at least the illusion, of future advancement. For preventing *coups d’état* from above, he fought for the establishment of the Conseil de l’Observatoire which would ensure continuity by curbing the napoleonic tendencies of the directors.

In the final section titled “Against personality” I explore how Wolf was able to

reconcile Cassini IV's *Ancien Régime* practices to a new republican setting. To end the eras of revolutions and ensure continuity from one regime to the next, Wolf needed observations performed under one administration to be translatable into the next one. In the past astronomers had tried to minimize personal differences in observations by calibrating their observations against those of the "best" astronomer, making it difficult to compare observations from different administrations. Wolf, instead, urged observers to calibrate their observations against a more durable standard: his personal equation machine. In short, Wolf wanted to eliminate the "personal" element *in both observations and administrations* by empowering the Conseil and by enforcing an educational regime based largely on his personal equation machine. Throughout his life, Wolf was able to institute in the Observatory certain ideals of objectivity that brought the *Ancien Régime*'s concept of a "single eye" and the Third Republic closer than ever.

CASSINI'S GHOST

In 1902 Wolf inaugurated a revisionist history to set the past straight by restoring the name of France's dynasty of court astronomers who had headed the Observatory for more than a hundred and twenty-five years (1669–1793). Throughout his historical work, Wolf repeatedly remarked: "There are few savants whose personalities have been so strangely deformed by their historiographers, and where fallacies have been as cruelly and as unjustly raised."⁹ In particular, Wolf wanted to absolve Cassini IV since he sided with him in one important respect: "An Academy whose members have equal rights is unable to direct an Observatory."¹⁰ This point, moreover, was accompanied by many others with which Wolf wholly agreed. In order for the Observatory to function *à la* Cassini IV, and therefore to Wolf's satisfaction, the fate of Louis XIV's court astronomer had to be vindicated: "I have dedicated a whole chapter to defend J.-D. Cassini. I hope the reader does not find it has come too late."¹¹ By siding with the Cassinis (especially with Cassini IV), Wolf stood in favour of the *Ancien Régime* and against the Revolution — a bold position even in the *fin-de-siècle*. Through Wolf's work, Cassini IV's views on the revolution and on science reverberate today.¹²

Wolf's historical account focused almost exclusively on Cassini IV's own *Mémoires pour servir à l'histoire des sciences et à celle de l'Observatoire Royal de Paris*, published at the height of the first Napoleon's Empire and written for the sole purpose of acquitting himself of any counter-revolutionary behaviour. In the introduction Cassini IV explained, "If I can not acquit myself of my former involvements, and if I was not able to give the sciences all that was expected of me, I have the consolation of being able to say it was due to circumstances beyond my control. The following *Mémoires*, I hope, provide a convincing proof".¹³ For this reason Cassini IV's ingratiating *Mémoires* were a prodigious choice for Wolf, since in them Cassini IV convincingly defended his right against others' wrong. Their publication was timely, for after the Revolution the fame of the Cassinis was at an all-time low.

During the *Ancien Régime*, the situation had been radically different. Bernard de Fontenelle and the marquis de Condorcet lavishly praised Cassini IV's great-grandfather, Gian Domenico Cassini (Cassini I), and in 1764 the astronomer Jérôme de Lalande described him as follows:¹⁴

Cassini was one of those rare men who seem to have been created by nature in order to give a new face to science. The science of astronomy was increased and perfected in all its branches by the discoveries of Cassini.... This man was the pride of Louis XIV's kingdom ... and in France the name of Cassini is almost synonymous with creator of astronomy.¹⁵

Up to 1787 the fame of the Cassinis was unrivalled in astronomy. Even Louis XVI commissioned a statue of Cassini I with which he honoured the leading astronomer in Europe during the seventeenth century and his descendants.¹⁶ A few years later, however, the favourable opinion of the Cassinis was quickly waning. In contrast to Louis XVI and Lalande's eulogy, during the Revolution, Cassini IV's telescopes were seen as counter-revolutionary cannons aimed towards Paris:

According to [the revolutionaries], the basement of the Observatory was a storehouse for gunpowder, and of flour and rifles that I concealed. My telescopes were cannons aimed towards Paris, and the towers, which I lit for observing during the night, were nothing else than rooms where I brought together aristocrats.¹⁷

Yet, after the tumultuous years of the Terror, things improved for Cassini IV. Robespierre's fall from power on 27 July 1794, inaugurating the softer phase of the Terror often called the Thermidorean Reaction, changed the tide of Cassini IV's fate. On 15 August he was removed from prison where he had remained for almost six months, and Jean Perny de Villeneuve, a former student who had turned against him earlier, was now remorseful.¹⁸ Furthermore, deputy — and regicide — Joseph Lakanal, who had forced Cassini's resignation from the Observatory, had turned around. In November he wrote to Lalande, then temporary director of the observatory, telling him that he intended to reinstall Cassini IV at the Observatory and get rid of the "intriguers and usurpers" whom he had previously supported.¹⁹ Things continued to get better. After the Observatory was put under the tutelage of the newly created Bureau des Longitudes, Cassini IV was named one of its four astronomers, a position that he accepted, shortly thereafter resigned, and then fruitlessly attempted to regain.²⁰ This unforthcoming re-nomination effectively ended his career as astronomer, but inaugurated his mission to set the past straight through his *Mémoires*. Under Napoleon's wing, when he published his *Mémoires*, he no longer lived in fear of the guillotine, where his cousin Mlle de Forceville had met her untimely death.

These, however, were unheeded until Wolf revived them almost a hundred years later. By 1821 the histories eulogizing the Cassinis were long gone. Describing their discoveries, Jean Baptiste Delambre wrote: "In the end, all these novelties were nothing else than isolated phenomena, infinitely curious things which all

astronomers want to know but which will contribute nothing to the progress of the true astronomy.”²¹ Later, Claude Louis Mathieu, Jean Baptiste Biot and Le Verrier followed Delambre’s diatribe, and even Arago derided Cassini I for placing the Earth in the centre of the universe and for his excessive expenditures.²² To top it all off, Cassini I was called a charlatan in the *Revue des deux mondes* by Rodolphe Radau, astronomer and famed popularizer of science.²³

Wolf’s experience as an astronomer provided him with ample arguments for upgrading the Cassinis, but defending the legitimacy of their nobility titles was more difficult. Nobody could argue against the almost total extinction of French nobility in Cassini IV, who conspicuously called himself “Comte de Cassini”, and against the dubiousness of his Italian titles. Yet Wolf had a strong argument in his defence: “... they could have bravely responded with what Cassini IV said in 1820...”²⁴ In fact when Cassini IV was questioned by the Société de Généalogistes about the legitimacy of his nobility titles, he allegedly responded that proof of his *noblesse* was present *not* in the dictionaries of the nobility, but in the *Mémoires* of the Académie des Sciences:

I do not care about the genealogical note which you talk about. Nor do I think I should pay any attention to what the genealogists say, since it is not in their files where I cared to register our titles. They exist in a work more famous in Europe than all the dictionaries of the nobility. This work is the collection of *Mémoires* from the renowned Académie Royale des Sciences de Paris from 1666 to these days. It is there where you will find the exact filiations of seven members of my family. Voilà, Monsieur, the true titles that I zealously uphold.²⁵

For Wolf, Cassini IV’s response closed the debate on the validity of their nobility titles. And it spoke volumes about the status of scientists at the turn of the nineteenth century. During the Third Republic the *Ancien Régime* concept of nobility appeared in a new — and scientific — garb. Wolf’s replacement of their nobility titles with their scientific ones illustrated how this important concept slowly rolled down the nineteenth century, like a red carpet.

Wolf saw the period after the creation of the Bureau des Longitudes in 1795 to the appointment of Le Verrier and the Observatory’s partial emancipation from the Bureau as equivalent to the regime started by Cassini I and ended by Cassini IV: “The history of the Observatory under that direction seems identical to that of the same establishment during the time of the Cassinis.”²⁶ This equivalence, furthermore, gave the history of the Cassinis an important relevance to Wolf and his era. Cassini IV’s pre-revolutionary attempts to reorganize the Observatory (according to Wolf) were equivalent to Le Verrier’s directorship at the Paris Observatory: “One cannot help but relate this period of Cassini [IV]’s life to the corresponding phase in Le Verrier’s, and to see the same causes bring about the same effects.”²⁷ They, Wolf continued, were both summoned to save the Observatory from ruin and from its slavery to the Académie des Sciences before the Revolution, and, afterwards, to the Bureau des Longitudes: “Both were called by the Government to

save the Observatory from the state of deterioration in which the learned institution on which it depended had left it.”²⁸ And both unjustly suffered for their deeds: “Both were victims of resentment and libels from those who had been dispossessed of the [Observatory’s] direction.”²⁹ By noting the similarities that Wolf attributed to Cassini IV and Le Verrier, I want to underscore a point that has escaped historians of the Paris Observatory. The history of the Cassinis told by Wolf was motivated by his particular views on the how an observatory should be conducted.

ÉGALITÉ

The first point of agreement between Cassini IV and Wolf was with respect to the harmful effects of equality in the Observatory. For Wolf, the evils of *égalité* were evident during the time of Cassini I to Cassini III, when the Observatory lacked a superior authority: “The great tragedy of the Observatory was its lack, since its founding, of a blueprint imposed by a superior authority, and whose execution would be entrusted to a responsible director....” This mistake, Wolf continued, was repeated after Cassini IV’s dismissal and corrected only with Arago’s appointment in 1834: “We will see the same effect reappear later, when the Bureau des Longitudes was called to direct the Observatory.”³⁰ Except for the brief enlightenment from Cassini III when a directorship was created to Cassini IV when it was revoked, the Observatoire’s foundational sin reigned supreme until 1834, when *égalité* was abolished and the astronomers were put under Arago’s thumb: “Better informed than the old Académie, the Bureau recognized on its own the need to subject the *élèves* to a sole authority, and named Arago director of observations on 9 April 1834.”³¹

Along with having a supreme authority in the form of a single director, Cassini and Wolf wanted subordinate *élèves*. In his proposal for reforming the Observatory, Cassini had specifically asked for three *élèves* — a proposal which the Académie vetoed. In particular, the Académie reacted *against the subordination* of the *élèves* to the director of the Observatory. According to the Académie, instituting subordinate positions “by the nature of their status ... could result in certain drawbacks which would eliminate any advantages, and which could be harmful in many other respects”.³²

The Académie’s veto on Cassini IV’s petition for subordinate *élèves* was overruled by M. de Breteuil (minister of Louis XVI and personal friend of Cassini IV) in what Wolf victoriously called a “coup d’État” and compared it to Le Verrier’s triumphal entrance as director of the Observatory in 1854.³³ Momentarily, thanks to de Breteuil’s intervention, Cassini IV succeeded. The first article of the new regulations of the Royal Observatory backed his goal: the director of the observatory was the sole and absolute master of his *élèves*. Yet these new regulations, like Louis XVI’s head, soon came tumbling down. Shortly after Cassini IV’s “coup d’État”, his proposal confronted a violent resistance. This time, the reason was not merely the subordination of observers to a director, but the lack of *égalité* reigning amongst them.

Cassini IV did not propose equality amongst his *élèves*. On the contrary, he took

advantage of what Tocqueville called the “democratic disease of envy” to organize his observers in three tiers, and by giving the best behaved an extra bonus:³⁴ “Moreover, if you give to three *élèves* the same treatment, there is no longer an object of emulation for learning and for advancing one’s rank.”³⁵ In Wolf, Cassini’s principle of inequality became more than a means to motivate *élèves*. It was a way to achieve legitimate succession. And, for Wolf — as for the rest of France — legitimate succession was essential in a republic, astronomical or not. During the Third Republic, inequality and legitimate succession became inseparable: “The order and the legitimacy of a succession, in guaranteeing respect for scientific traditions, creates a noble and friendly rivalry between the candidates for arriving at the second level, and from there to the first. *Voilà*, I believe that constitutes the true organization of the Astronomical Republic.”³⁶ Inequality and legitimate succession, however, had had vastly different meanings during the Terror.

During the revolutionary period, Dominique Joseph Garat, Ministre de la Justice, did not tolerate the unequal salaries assigned to Cassini’s *élèves*, and forced him to level them. When Cassini resisted, deputy Lakanal joined Garat’s republican cause and on 31 August 1793 (under the presidency of Robespierre the “*Incorruptible*”) decreed *égalité* amongst Cassini and his *élèves*.³⁷ According to the new regime, Cassini IV and his *élèves* would each year rotate the place of Director.³⁸ More importantly, Cassini IV’s previously subordinate *élèves* were chosen to be the astronomers with whom he would share the directorship, instead of members of the Académie, Cassini IV’s *confrères*, with which he would have gladly shared his post. Seeing his *élèves* pass from trade apprentices to *sans culottes* to full-blown astronomers, Cassini IV helplessly exclaimed: “Was this decision made with the intention of sanctioning this famous levelling system, this great principle of equality, so clearly *à la mode* these days?”³⁹ A few days later, Cassini IV resigned.⁴⁰

Almost a hundred years after Cassini’s resignation, Wolf sided with him against “this great principle of equality, so clearly *à la mode*”, and agreed that *égalité* in the Observatory was disastrous for “the Astronomical Republic”. For example, he reprinted and endorsed a “Note” written by Cassini IV that included his proposal for reform and explained the reasons why *égalité* was pernicious:

... each astronomer would want to work on the side, have his own instruments, and observe how and when he pleases. That was precisely what happened before, from which the need to establish *élèves* and a director was recognized. Moreover, I guarantee, based on more than one example, that between four *savants* whose position and talent make them absolutely equal amongst themselves and independent from each other, the agreement necessary for common work will be repeatedly disturbed, and will soon become harmful.⁴¹

During Wolf’s era the subordination of *élèves* continued to be a controversial topic. For example, in 1868, the year workers won the right to strike, Faye of the Bureau des Longitudes protested during a meeting of the Conseil against naming the astronomers “chefs de division”. Faye found “the designation ‘chefs de division’ inappropriate since it does not convey the family spirit that should prevail between

the astronomer and his collaborators”.⁴² And in 1871, after the Conseil was able to momentarily dethrone Le Verrier, Wolf sent to the Secrétaire Général a “Note on the principles on which to model the type of Government of an Observatory”, where he acknowledged the delicacy of the situation: “In the collaboration between a superior and a subordinate, the distinction between their roles and the fair distribution of credit is a delicate and difficult affair. Experience has always shown that human nature has not overcome the appropriation of the work of the weak by the strong.”⁴³ Wolf, furthermore, had closely experienced the perils of having “the strong” appropriate his work. While Le Verrier admired Wolf’s plan for the Observatory’s undertakings (“M. Wolf has sent me his plan ‘Observe as much as possible’. I am pleased by it and find it excellent”), Wolf ridiculed Le Verrier’s proposals.⁴⁴ In a letter to the controversial Ministre de l’Instruction Publique Victor Duruy, he wrote: “I have read attentively the copy of M. Le Verrier’s letter which you wanted me to have. It is impossible for me to take it seriously, especially the work-plan which should be the glory of France.”⁴⁵ Yet despite the difficulties in establishing a fair relationship between the “puissant” and the “plus faible”, Wolf defended this hierarchical division against rampant *égalité*.

Cassini IV wanted an independent director in the observatory “for the same reason one places a captain on a ship”, and Wolf echoed his plea.⁴⁶ In endorsing and reprinting Cassini IV’s “Note”, Wolf fought for another point which, from then on, would characterize modern astronomy: the separation between astronomers and observers. Cassini IV and Wolf relegated a whole era in astronomy to the past — an astronomer would no longer need Galileo’s lynx eyes to make important discoveries. The observer was, for the first time, effectively banned from pure astronomy:

*In astronomy one distinguishes between the astronomer and the observer: the first embraces all of science, knows and deepens all its theories, collects and compares the facts, the givens, and draws conclusions. The observer is especially dedicated to observation: it suffices to have good eyes, skill, strength and energy....*⁴⁷

The two principles present in Cassini IV’s project for reorganizing the Observatory, the necessity of a superior and independent authority and the separation of astronomers from observers, were also the guiding rules of Wolf’s “Astronomical Republic”: “[In this Note] Cassini states, with clear sight and an authority based on twenty years of experience, the true principles of an observatory’s organization....”⁴⁸ Wolf’s agreement with Cassini IV with respect to the role of subordinate observers was informed by his earlier experiences — and successes — as an astronomer.

LIBERTÉ

Wolf explained how the problem of *égalité* was compounded to the problem of the Observatory’s dependency on another institution. Cassini IV, for example, had believed that in denying the position of *élèves* the Académie had “acted in

favour of its own interests and not of the sciences”, and Wolf agreed.⁴⁹ According to Wolf, progress in astronomy was stunted twice in history: first in the observatory’s subjugation to the Académie during the reign of the Cassinis, and second, in its subjugation to the Bureau after 1795. The solution had to wait until its partial emancipation from the Bureau des Longitudes, started in 1854 with “Le Verrier, director free from supervision”.⁵⁰ Wolf equated Cassini IV’s coup against the Académie des Sciences to Le Verrier’s struggle for independence from the Bureau, and sided with their heroic mission.

Wolf was not alone in his criticism of the Observatory’s relationship to the Bureau. A note from the Ministre de l’Instruction Publique written at the height of Le Verrier’s directorship acknowledged the harmful effects of the bitter, age-old competition between the two institutions: “The situation between the Bureau des Longitudes and the Observatory is well-known. After Arago’s death, the antagonism between the two establishments did not lessen, and instead of turning to a common goal and of giving each other support, they were exhausted by debate, they railed in front of the Académie, and compromised, in futile disputes, both the dignity of persons and interests which should have been safeguarded.”⁵¹ The debate on independence, started during the reign of the Cassinis, would carry on for more than a century. Defeat in the hands of Germans only exacerbated it,⁵² and after the war Wolf weighed the different options for reorganizing the Bureau and the Observatoire and decided on *liberté*. In his “Note on the principles on which to model the type of Government of an Observatory” he wrote: “I do not see in the annexation of the Observatoire to the Bureau des Longitudes, or more precisely ... in the absorption of the Bureau des Longitudes by the Observatoire, any advantage for either one of these two institutions.”⁵³

Wolf’s defence of *liberté*, like his disdain for *égalité*, was also tempered by his experience during the years he worked at the Observatory. In 1862, when Le Verrier called Wolf from his post as professor of physics at the Faculty of Sciences of the University of Montpellier to head the Meridian Service of the Observatory and to train beginner astronomers, Le Verrier was in the midst of a long struggle to liberate it from the control of the Bureau des Longitudes. The struggle had started in 1854 with his appointment and was not completed until 1873 when, after the accidental death of his arch-enemy Delaunay, he was reinstated by the President of the Republic Adolphe Thiers, who despite “the present financial situation of our unfortunate country”, was “vividly interested ... in Science and in the Observatory”.⁵⁴

Wolf’s focus on the dependency of the Observatory as the culprit holding back the astronomy of the *Ancien Régime*, can be better understood in the light of his own experience in dealing with the Bureau. The competition between the Bureau des Longitudes and the Observatory reached a high point with respect to the role that the two institutions should take in the patriotic endeavour of determining the longitudes of France. In 1862, the same year Wolf was called by Le Verrier to work in Paris, the Ministre d’État alerted the Académie des Sciences to the fact

that France's situation with respect to longitude determinations was urgent, since the Germans were getting ahead, and (as the Franco-Prussian War later proved) national security was at stake.⁵⁵ In Berlin, the *Ministre d'État* warned, General J. J. Baeyer had organized a conference with the Director of the Viennese *Dépôt de la Guerre* and many *savants* from Saxony and Austria for linking together the geodesic triangulations of Germany and Italy. Faye, then member of the *Bureau des Longitudes*, and Le Verrier seized the *Ministre d'État*'s call to action and started the "debate between Le Verrier and Faye" — a bitter fight for control.⁵⁶

The debate grew more vicious when Le Verrier accused Faye of a fault in the longitude determinations performed in France with the first underwater electric telegraph linking Paris and Greenwich. Faye defended both himself, and the role of the *Bureau des Longitudes* in the affair.⁵⁷ One day, taking advantage of the fact that Le Verrier was tied up at the Imperial Senate, Faye explained his position, and when Le Verrier arrived late, he could no longer contest Faye's claims directly. Nevertheless, Le Verrier was prepared with another salvo, a general exposition of systematic errors in astronomy, which included Faye's alleged mistake in the Paris–Greenwich affair.⁵⁸ In his article Le Verrier stated that "the imperfection of observers is ... the preoccupation of every astronomer concerned with passing on durable results to his successors",⁵⁹ and as the debate showed, the imperfection of observers was also the Achilles's heel of any opponent. Faye responded with his article "On physiological errors", in which he put forth his views on the personal equation.⁶⁰ The stakes were high: a solution to the problem of the personal equation would settle the debate as to who, the *Observatoire* or the *Bureau*, should undertake one of the major tasks in astronomy, longitude determinations.

THE PERSONAL EQUATION

By investigating Wolf's work in astronomy, his pronouncement that Cassini IV "presented the true principles for organizing an observatory" can be seen not as a self-evident truth (as the previous historiography claims) but as a highly contested issue. The reevaluation of Cassini IV started by Wolf and continued by later historians, hinged on his successes during his years as an astronomer. Wolf's competition against the *Bureau*, for example, can explain his desire for independence from it, and his solution to the problem of the personal equation — which involved establishing a disciplined cadre of observers — can explain his views on *égalité*.

In the acrid atmosphere of the Le Verrier–Faye debate, Wolf undertook his "classic research"⁶¹ on the personal equation.⁶² In every instance he, and therefore the *Observatoire*, sided against Faye, and therefore against the *Bureau*. Wolf's work on the personal equation hinged on an important question that later occupied him in his *Histoire de l'Observatoire de Paris*: the role of observers in astronomy. His solution to the problem of the personal equation, *contra* Faye, involved reviving the *ancienne* division of labour inaugurated by Cassini IV.

Wolf disagreed with Faye's paper in two important respects: the role of discipline

and the replacement of the observer by a photographic apparatus. The idea of discipline was absent in Faye, who based most of his paper on the work of the Swiss astronomers Adolph Hirsch and Émile Plantamour. While in their original paper Hirsch and Plantamour suggested that the personal equation prior to each observation be measured and corrected with the aid of an instrument using artificial stars, Faye drew other conclusions. Instead of having to “determine the error of almost every observation”, Faye “asked astronomers instead to eliminate the human machine, whose imperfections are revealed to us in an alarming way”.⁶³ With Le Verrier’s accusation of his personal error in the Paris–Greenwich affair still looming over him, Faye continued to preach the benefits of eliminating the observer — an idea that had occurred to him years before.⁶⁴ In order to “eliminate the human machine” in time and longitude determinations, Faye had attached a photographic apparatus to the meridian telescope. By pressing a key, photographic film was automatically exposed and, using an elaborate clockwork, the time of the “spontaneous” exposure was registered telegraphically: “*Voilà* a completely automatic observation produced under our eyes by a young apprentice who had no idea what he was doing. We could have done it with a machine.”⁶⁵ Furthermore, Faye speculated how the personal equation of an observer could be found by comparing the photo-telegraphic results against normal observations. Yet despite some initial successes, technical difficulties prevented his automatic machine from succeeding, but Faye could still dream about eliminating “the human machine” in the near future.

For Wolf the idea of mechanizing observations was, if anything, absurd. *Contra* Faye, he believed photography would never replace the (albeit expensive and sometimes dangerously revolutionary) observers employed in astronomy. Unfortunately, photography could not solve the Observatory’s century-old labour problems. As Wolf stated in a paper written in 1886, photography and direct observation would always complement each other: “The two types of observation complement each other. Both of them are necessary for attaining an absolute and authentic knowledge of the present state of the heavens.”⁶⁶ The failure of Faye’s dream of mechanizing observation convinced him that astronomy would always need observers, subordinate and disciplined.

Discipline could solve the problems mechanization could not. Wolf contested Hirsch and Plantamour’s claims on the dangerous variations of personal differences in observations. This variability, Wolf claimed, was due to the lack of education of observers, and could be eliminated through a strict disciplinary regime. Wolf used an instrument almost identical to Hirsch and Plantamour’s for a radically different purpose. While they used it to measure and correct for the personal equation, Wolf used it “for the education of young astronomers”.⁶⁷ Hirsch, however, was bewildered by Wolf’s focus on discipline. Why not, he asked, just measure and correct for the differences in observations, and “resign oneself to accept the sluggishness of the mind ... as an unfortunate characteristic of every astronomer’s nervous system”.⁶⁸ Despite Hirsch’s initial criticisms, Wolf’s views on discipline were deeply influential. Hirsch’s theory was later tempered by Wolf’s work, and even Faye belatedly acknowledged how discipline — and not only mechanization —

might solve the problem of personal differences in observation. Following Wolf, he admitted that the personal equation, after all, was nonexistent in the skilled musician or the disciplined soldier.⁶⁹ Wolf won this battle, vindicating, to some extent, Cassini IV's insistence on the separation between observers and astronomers. His work on the personal equation, in contrast to Faye's and Hirsch's, defended the need for subordinate and disciplined *élèves*.

When Wolf wrote his *Histoire de l'Observatoire de Paris*, he blamed "indiscipline" as a main cause behind the revolutionary delirium that had gripped Cassini IV's *élèves* and had plunged the Observatory into impotence until Le Verrier's rescue. In those revolutionary years, Wolf wrote, "indiscipline started to penetrate the mind of the *élèves*, incorporated to the national guard and lured into the revolutionary clubs".⁷⁰ But before he wrote these historical lines, Wolf was the first astronomer to propose discipline as the panacea for eliminating personal differences in observation. In both instances, indiscipline had to be eliminated from astronomy.

Wolf's work on the personal equation was not only tied to his views on the organization of labour in the Observatory, but it was also related to the issue of institutional independence. With the presentation of Wolf's "Investigations on the personal equation" to the Académie des Sciences a decisive battle was won in the Le Verrier–Faye debate, which tainted even further the Observatoire's uneasy relationship to the Bureau. Le Verrier's presentation of Wolf's work slyly included Wolf's criticisms of Faye's previous paper on the personal equation.⁷¹

FRATERNITÉ

Although Wolf advocated a lone directorship and institutional independence, unbridled authority also had its dangers. And Le Verrier had gone too far. Wolf, along with many other astronomers, fought against the dictatorship of Le Verrier until they succeeded in creating a Conseil de l'Observatoire to curb his power.⁷²

During the Second Empire, however, the republican Conseil was only partially successful, since it was powerless in the face of Le Verrier's constant boycotts.⁷³ Furthermore, many questions regarding the Conseil's powers vis-à-vis the Director of the Observatory were left unanswered. In the years following its establishment, Wolf worked hard to clarify these issues and to give the Conseil sufficient authority. Two main questions, hinging on the common axis of authority, plagued most of the debates. The first was with respect to the "Director's Authority" and the second with respect to the "Initiative Rights of the Members of the Conseil". A note on the "Contentious Issues" between the Conseil and the Observatoire posed the following question: "Can the director, without approval from the Conseil, impose on the Observatory's workers chores other than those present in the general plan decreed by the Conseil...?" With respect to the second issue, the note asked: "Do the initiative rights of the Conseil's members include things besides the work-plan and the division of work? Do they encompass the administration itself?"⁷⁴ To further complicate these contentious issues, Le Verrier had the deliberate strategy of not showing up at the meetings of the Conseil, voiding

all of its considerations.

Without Le Verrier's presence the Conseil was powerless, and Wolf complained. On 8 January 1869 he wrote to the Ministre and asked him to force Le Verrier to comply: "The meeting's minutes have no authority because they do not carry your signature. What I ask is for a document written and signed by Your Excellency..."⁷⁵ The Ministre himself, Victor Duruy, embarked on a campaign against Le Verrier, whom he described as "a teacher, but he does not teach; a general inspector, but does not inspect, a director, but directs too much. Le Verrier does not recognize the minister. He refuses to obey orders".⁷⁶ The situation was unbearable, and despite these pleas, it remained unchanged for almost a year. This time, Wolf turned to the new Ministre de l'Instruction Publique, Émile Segris: "You alone, Monsieur le Ministre, can enforce the Regulations. And I beg you — in the name of Science and of the Observatory, where all our work is frustrated by the Director's viciousness — to do something."⁷⁷ Wolf and the rest of the astronomers (Yvon Villarceau, Hippolyte Marie-Davy, and Maurice Loewy) signed a letter written by Wolf and sent it to the new Ministre where they complained how "the decree of 3 April 1868" was "repeatedly violated", affecting most negatively the meridian service charged with longitude and time determinations: "Among all these things, we would like to focus particularly on those which have created the disorganization of the most important service of the Observatory, meridian transit work."⁷⁸ By January 1870, however, the protests from Wolf and the others were beginning to have an effect, and Le Verrier was starting to hurt. In a letter to the Secrétaire Général, Wolf wrote "M. Le Verrier can only defend himself through deception".⁷⁹ Soon the astronomers would turn to their last recourse: they collectively threatened to resign unless something — anything — was done to curb the "Haussmann of the stars".⁸⁰ Shortly thereafter, and in response to their collective threat, Le Verrier was dethroned.⁸¹

The struggle against Le Verrier escalated in tandem with the republican fight against the Second Empire. Victor Hugo, in his scathing critic of Napoleon III, was one of the first to denounce the duo between "Napoléon le petit" and Le Verrier and to mourn the death of Arago, who by refusing to support the new regime, became a symbol of the failed republic.⁸² In the work of Victor Hugo and others, the Observatory was seen as a theatre that mirrored French politics, and political comparisons continued even after the demise of the Second Empire.⁸³ For example, *La revue scientifique* explicitly connected the evils of Le Verrier and Napoleon III. Le Verrier's directorship, said *La revue*, was established "according to the dictatorial values of the second Empire which placed [the Observatory] under the absolute and unchecked domination of a director, imminently endangering French astronomy".⁸⁴ Not only the astronomers, but also the whole "liberal Empire felt it had an obligation to destroy" his brass-knuckles regime.⁸⁵ Shortly before the Paris Commune and the collapse of the Second Empire, Charles Delaunay replaced Le Verrier. Yet a few years later, after Delaunay's unexpected death, the coveted position was again vacant. This time, with ample support from Versailles, the Conseil was poised to face Le Verrier's reappointment in 1873.⁸⁶ Under the control of a

strengthened Conseil, the feared Director reemerged, once again, as a Napoleon, but this time, ageing and powerless. The editor of *La revue scientifique* now remarked: “Le Verrier returns converted, like Napoleon after Elba.”⁸⁷

Wolf’s views on legitimate succession were coloured by the tragic outcome of the Franco-Prussian War, since the deficiency of French science had implicated astronomers for endangering French sovereignty. In his demands of 1871 to the Secrétaire Général, Wolf urged both the *astronomical* and *martial* communities in Paris to follow the example of the enemy German observatories:⁸⁸ “What, then, is the plan to follow in establishing hierarchical positions in the Observatory? It is extremely simple, and it exists right under our eyes in the German Observatories.”⁸⁹ In Berlin, Franz Encke’s death had suddenly opened up the post of Director, which was quickly filled “with no revolution” by Wilhelm Förster, “an unknown man, but chief assistant to the Observatory”. Wolf advocated the student-to-director succession and criticized the French way of outsourcing talent from the *Écoles* and *Facultés* as was the case with Le Verrier, and again with his temporary successor Delaunay. In 1871 criticizing his superior, the newly appointed Delaunay, was clearly risky for Wolf, but he did not stay quiet: “Recently, another example has presented itself. Although I have less liberty to speak of it, I will trust your utmost discretion and tell you the whole truth. M. Delaunay is even more of a stranger than his predecessor to the science of observation.”⁹⁰ The “illegitimate” succession of Delaunay, furthermore, represented to Wolf the main danger in revolutions, forgetting the lessons of the past: “[Delaunay] does not pay attention to the lessons of the past. A single thought seems to dominate him: destroy everything done by M. Le Verrier.”⁹¹

French defeat made the reorganization of the army imminent, and in this respect Wolf also made suggestions regarding the Observatory’s organization. He suggested that the Observatory follow the army in its hierarchical structure, and thus in instituting legitimate succession. Astronomers, Wolf claimed, had pioneered in establishing the hierarchical organization later used in the army, and Wolf continued to preach its benefits: “[The hierarchical organization] existed in the Observatory before it was adopted by the army.”⁹²

AGAINST PERSONALITY

The danger in having directors arrive with revolutions such as Le Verrier and Delaunay was that they would do everything in their power to destroy what came before them. Even observations done in one regime would sometimes be untranslatable in the next one. By mid-century astronomers all over Europe were well aware that different observers saw differently, and, to solve this problem, they recommended that observers try to imitate the observations of a particular astronomer. This solution, however, made it difficult to compare observations across time. Wolf solved this problem by creating a personal equation machine, which used artificial stars to train observers in the meridian transit work used for determining longitudes. Instead of trying to calibrate their observations against those of another astronomer, observers could instead calibrate themselves against Wolf’s apparatus.

Why should observers calibrate their observations against a person, if they could calibrate them against a machine? With Wolf's artificial star apparatus, an "absolute" machine standard could replace the previously "relative" personal equations (the absolute personal equation was later renamed "reaction time" by Sigmund Exner). After months of training with artificial stars, observers could decrease their personal equations until they nearly reached an absolute zero value. Wolf asked: "Shouldn't young astronomers try to imitate the estimations of the astronomer considered most perfect, like they should try to reach their absolute zero correction once it is known?"⁹³ The education of astronomers with his apparatus would remain for Wolf of prime importance, and his method was soon imitated worldwide.⁹⁴

In his recommendations to the *Ministre* on the organization of the Observatory, Wolf preached how "an observatory should be a school for astronomers — in fact, outside of an observatory it is impossible to form observers". The *Écoles* and *Facultés* could certainly train geometers to occupy themselves with celestial mechanics, like Le Verrier and Delaunay, but "that which makes an astronomer, is the telescope".⁹⁵ An unsigned article appearing in *La revue scientifique* (showing clear marks of Wolf's authorship) repeated his recommendations verbatim: "The National Observatory should be, first and foremost, a school of astronomy..."⁹⁶ This same article, not coincidentally, also advocated the use of Wolf's personal equation apparatus for the education of astronomers. And, most importantly, it clamoured for the *elimination of personality in observations as well as in administration*: "the desideratum is to have an organization which will run the observatory independently of any personality."⁹⁷

In order to have the Observatory be "indépendante de toute personnalité" Wolf worked hard to create bridges linking the different regimes through which he lived. His insistence on recruiting directors from the best *élèves* was one way of having legitimate successions and of eliminating harmful revolutions. Establishing a strong *Conseil* to survey the director's initiatives would also guarantee continuity from one regime to the next. His insistence on pedagogy, based largely on his artificial star machine, could assure a certain standard in the education of *élèves*, who, in turn, would one day be in charge of running the observatory.⁹⁸ Finally, his artificial star machine could make observations translatable in different administrations.

Despite Wolf's own attempt to ally his thoughts with those of Cassini IV, important differences remained. While Wolf wanted a strong director and subordinate observers *à la* Cassini IV, his views on achieving legitimate succession were decidedly original. Turning the Observatory into a military style "school for Astronomers" (and *not* mechanizing observations as in Faye), for example, would help establish legitimate succession and solve the "great difficulty in finding and recruiting personnel".⁹⁹ His personal equation machine lay at the heart of an astronomer's education and, therefore, it constituted an important aspect of legitimate succession. With his apparatus, observations could be calibrated against a fixed standard, and not against the best observer. In this way (according to Wolf), the "personality" of observations could be eliminated. By turning the Observatory

into a school for astronomers with the help of his personal equation machine, Wolf could “run the observatory independently of any personality”, guaranteeing objectivity, legitimate succession, and continuity.

CONCLUSION

Wolf’s experience as an astronomer led him, towards the end of his life, to side wholeheartedly with Cassini IV. His defence for Cassini IV was in many ways revolutionary. As the tortured historiography shows, Cassini IV’s popularity dropped dramatically during the first half of the nineteenth century. This drop, furthermore, was accompanied by views — differing radically from Cassini IV — on how to conduct an observatory. These views dominated the times, and justified more than a cold shoulder towards the Cassinis. Cassini IV’s emergence as a hero in Wolf’s 1902 work marked a victory in a prolonged struggle for finding the correct way to run an observatory. Before Wolf published his book, consensus on this issue was hard to come by, and contradictory opinions were rampant.¹⁰⁰ In many ways Wolf’s “République Astronomique” encountered the same problems as the larger French Republic. To establish the “Republic of Astronomy” Wolf advocated a strong Conseil that would curb the Napoleonic tendencies of the Observatory’s directors. And, most importantly, Wolf’s work as an astronomer permitted his views on the Observatory’s organization to become dominant.

The type of objectivity that emerged victorious in Wolf was characterized by Cassini IV’s ideal of a single eye. When Cassini IV argued for *élèves*, he envisaged an organization that would have *a single disembodied eye emerge from all eyes*: “... a complete and perpetual course of observations made ... by observers who, united under one director, should naturally have the same method, the same tenets, and, so to speak, the same eye!”¹⁰¹ Cassini IV’s “same eye” characterized Wolf’s ideal of a sovereign objectivity. This ideal, for example, was consistent with his work on photography and on personal differences in observation. According to Wolf, astronomers would always need observers, subordinate and disciplined. These observers, furthermore, instead of calibrating their observations against those of a superior, should calibrate them against his personal equation machine. Along with eliminating the “personality” in observations in this way, training students to become directors would solve in the Observatory the problem that plagued the rest of France: legitimate succession. With Wolf’s successes in the Observatory, the *Ancien Régime*’s “same eye” was able to reemerge, but this time, fit for a republic.

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Abbreviations: AN = Archives Nationales; AOP = Archives Observatoire de Paris; AAS = Archives de l'Académie des Sciences; PSB = Preußischer Staatsbibliothek zu Berlin.

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2. Victor Hugo, *Napoleon the Little* (New York, 1992), 170.
3. Jacques R. Lévy, "Charles Joseph Étienne Wolf", *Dictionary of scientific biography*, xiv (New York, 1970), 480. For other accounts of the Paris Observatory during this period see Raymonde Bartholot, "L'Observatoire de Paris: Histoire, science, politique (1667–1795)", (Ph.D. diss., Université de Paris, 1982), and Seymour L. Chapin, "The vicissitudes of a scientific institution: A decade of change at the Paris Observatory", *Journal for the history of astronomy*, xxi (1990), 235–74.
4. For biographical information see, "M. Charles Wolf et la longévité astronomique", *Bulletin de la Société Astronomique de France et revue mensuelle d'astronomie, de météorologie et de physique du globe*, xxxii (1918), 255–6; Paul Painlevé, "Mémoires et communications des membres et des correspondants de l'Académie", *Comptes rendus hebdomadaires*, clxvii, issue of 8 July 1918, 45–46; Guillaume Bigourdan, "Notice sur la vie et travaux de M. Ch. Wolf", *ibid.*, 46–48; Lévy, *op. cit.* (ref. 3), 480.
5. An earlier anonymous article already hinted at how Cassini IV's "grands services" were "malheureusement si mal récompensés". Since this article reevaluates Cassini IV, and since it deals extensively with the danger in revolutions, I believe it was written by Wolf. [Charles Wolf?], "Histoire de l'Observatoire de Paris", *La revue scientifique*, ix (1872), 1149–59.
6. Charles Wolf to the Secrétaire Général, "Note sur les principes qui doivent régler le mode du Gouvernement d'un Observatoire", 3 March 1871, AN, F17-3720, folder Organisation 1872 (Decret du 5 mars), 3.
7. Methodologically, this paper is indebted to Mario Biagioli, "The Scientific Revolution is undead", *Configurations*, vi (1998), 141–8.
8. For the personal equation see Simon Schaffer, "Astronomers mark time: Discipline and the personal equation", *Science in context*, ii (1988), 115–45, and Jimena Canales, "Exit the frog, enter the human: Physiology and experimental psychology in nineteenth century astronomy", *The British journal for the history of science* (in press).
9. Charles Wolf, *Histoire de l'Observatoire de Paris de sa fondation à 1793* (Paris, 1902), 210.
10. Wolf, *op. cit.* (ref. 9), 210.
11. Wolf, *op. cit.* (ref. 9), p. ix.
12. Wolf's views on how to manage the Observatory were not only his, the astronomer "M. Yvon Villarceau les partage entièrement, et ce que je vis dire n'est que le résumé de fréquentes conversations que j'ai eues avec lui". A review of Wolf's "histoire véridique et impartiale" in the *Revue des deux mondes* supported the main points of the book: the defence of Cassini IV and the need for an independent director. Similarly, a review in *La revue scientifique* lauded Wolf's re-evaluation of Cassini IV. Later in 1906 the astronomer Maurice Loewy still repeated Wolf's views when debating on the organization of other observatories. The first point he recommended was to follow Paris in its "situation morale" of having an "autorité Scientifique autonome", and in tempering the director with "un Conseil unique établi sur des bases analogues à celles du Conseil de l'Observatoire de Paris". For Loewy the prestige "acquis aujourd'hui" of the Paris Observatory "prouve que le régime actuel, tout en soumettant la gestion administrative et scientifique au contrôle d'un Conseil permanent, lui a été des plus profitable". His second main point (also present in Wolf) was with respect to defending the constant funding which permitted the "travaux de longue haleine qu'il a pour mission spéciale d'accomplir". Edouard Doublet continued Wolf's defence of the Cassinis in his *Histoire de l'astronomie* (Paris, 1922).

- After citing Wolf's support, Doublet also condemned the unfair portrayal of Cassini I: "Le reproche de charlatanisme est donc fort injuste et s'explique par la rancune qu'on voua à ses descendants, lorsque la direction de l'Observatoire leur fut confiée." When writing about the Cassinis, Doublet repeated Wolf's conclusions about the need for a director: "Nous avons dit que l'Observatoire, dans son organisation primitive, n'avait pas de directeur, et nous avons fait voir les inconvénients qui en résultaient." From the time of its publication Wolf's *Histoire* left a profound mark in the historiography, even to this day. Seymour L. Chapin's history of the Observatory during the Revolution published in 1990, for example, relied squarely on Wolf's account, which he called "the most fundamental study of the Observatory". Like previous authors, he also uncritically accepted Wolf's recommendations. Wolf's defence of Cassini IV was also present in Chapin. For example, about Cassini IV's project for improving the observatory, Chapin wrote: "... it is clear that Cassini IV's project would have filled a gap in French astronomy." And later, speaking about the division of labour that Cassini wanted to institute in the observatory, Chapin again remarked: "In the main, Cassini seems to have been correct." Similarly in his doctoral thesis Raymonde Barthalot also agreed with Cassini's views on inequality which he believed were based on an "argumentation irréfutable". In contrast to Chapin *et al.*, in this paper I question Wolf's motivations for reviving Cassini IV's *Mémoires* and defending his views. Wolf to the Secrétaire Général, *op. cit.* (ref. 6), 1; "Causerie bibliographique", review of *Histoire de l'Observatoire de Paris de sa fondation à 1793* by Charles Wolf, *La revue scientifique*, xvii (1902), 593–4; "Histoire de l'Observatoire de Paris, de sa fondation à 1793, par M. C. Wolf", review of *Histoire de l'Observatoire de Paris de sa fondation 1793* by Charles Wolf, *Revue des deux mondes*, viii (1902), inside back cover; Maurice Loewy, "Note présentée par M. Loewy sur le projet d'organisation des Observatoires Astronomiques soumis à la Réunion convoquée par M. le Ministre de l'Instruction publique", 11 December 1906, AOP, MS 1060, Carton No. 1, I–A, Organisation Général: 1852–1906, 1–2; Edouard Doublet, *Histoire de l'astronomie* (Paris, 1922), 371–2, 425; Chapin, *op. cit.* (ref. 3), 263 n. 3, 236, 254; Barthalot, *op. cit.* (ref. 3), 156.
13. Jean Dominique Cassini, *Mémoires pour servir à l'histoire des sciences et à celle de l'Observatoire Royal de Paris* (Paris, 1810), p. viii.
 14. Fontenelle, "Note lue par M. l'abbé Bignon, à l'assemblée publique de l'Académie des Science, le 16 novembre 1712, après la lecture de l'éloge de J.-D. Cassini, par M. de Fontenelle, secrétaire", cited in Cassini, *op. cit.* (ref. 13), 309–10; Condorcet, "Note lue à la rentrée publique de l'Académie, le 13 novembre 1776, par M. le marquis de Condorcet, secrétaire", cited in Cassini, *op. cit.* (ref. 13), 311–12.
 15. Joseph Jérôme le Français de Lalande, *Astronomie* (Paris, 1764), i, 172, cited in Jean Baptiste Joseph Delambre, *Histoire de l'astronomie moderne* (Paris, 1821), ii, 804.
 16. Wolf, *op. cit.* (ref. 9), 218.
 17. Cassini, *op. cit.* (ref. 13), 35–36.
 18. Chapin, *op. cit.* (ref. 3), 256–7.
 19. Joseph Jérôme Le Français de Lalande, *Bibliographie astronomique; avec l'histoire de l'astronomie depuis 1781 jusqu'à 1802* (Paris, an XI [1803]), 640, cited in Chapin, *op. cit.* (ref. 3), 262.
 20. The new Bureau des Longitudes was formed by Lagrange and Laplace as geometers, Lalande, Cassini, Mechain and Delambre as astronomers, Borda and Bougainville as retired navigators, Buache as geographer and Carocher as instrument-maker. Each of the astronomers supervised one of four "astronomes adjoints". See Henri Grégoire, *Rapport sur l'établissement du Bureau des Longitudes, suivi du décret de la Convention nationale* (Paris, an III [1795]).
 21. Delambre, *op. cit.* (ref. 15), 804.
 22. Urbain Le Verrier, "Rapport sur l'Observatoire Imperial de Paris et projet d'organisation",

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23. Rodolphe Radau, "L'Observatoire de Paris depuis sa fondation", *Revue des deux mondes*, lxxiii (1868), 751–2.
 24. Wolf, *op. cit.* (ref. 9), 81.
 25. Wolf, *op. cit.* (ref. 9), 82. For Cassini IV's conflict with the genealogists see Bartholot, *op. cit.* (ref. 3), 149.
 26. Wolf, *op. cit.* (ref. 9), 21.
 27. Wolf, *op. cit.* (ref. 9), 259.
 28. Wolf, *op. cit.* (ref. 9), 259.
 29. Wolf, *op. cit.* (ref. 9), 259.
 30. Wolf, *op. cit.* (ref. 9), 210.
 31. Wolf, *op. cit.* (ref. 9), 210.
 32. "Procès-verbaux des séances de l'Académie", cited in Wolf, *op. cit.* (ref. 9), 257.
 33. Wolf, *op. cit.* (ref. 9), 258. Cassini IV's proposal was accepted on 26 February 1785.
 34. Alexis de Tocqueville, "Souvenirs", in *De la démocratie en Amérique, souvenirs, L'Ancien Régime et la Révolution* (Paris, 1986), 762.
 35. Jean Dominique Cassini, "Letter to Lebrun", cited in Wolf, *op. cit.* (ref. 9), 264. The salaries of the *élèves* were 900, 700, and 600 livres with a bonus of 200 livres for one of them.
 36. Wolf to the Secrétaire Général, *op. cit.* (ref. 6), 3.
 37. For the role played by Lakanal with respect to the observatory see John Charles Dawson, *Lakanal the Regicide* (University, Ala., 1948), 43–47.
 38. This new regulation was preceded by the abolition of the *Académie des Sciences* on 9 August 1793 and by the establishment of *égalité* among the professors of the Jardin des Plantes on 10 June 1793.
 39. Cassini, *op. cit.* (ref. 13), 2.
 40. Cassini IV resigned on 6 September 1793. He was replaced with a man who, although he later proved himself competent, at that time had only occupied himself with astronomy for six months, Jean Perny de Villeneuve. He was temporary director of the observatory and was later replaced by Nouet, Bouquier and Bouvard. In 1795 the Convention Nationale placed the Observatory under the Bureau des Longitudes with Lalande as administrative director.
 41. Jacques Dominique Cassini, "Projet d'organisation et de décret pour l'Observatoire National, communiqué au Comité d'Instruction Publique", in *Mémoires pour servir à l'histoire des sciences et à celle de l'Observatoire Royal de Paris* (Paris, 1810), 206–7. Reprinted in Wolf, *op. cit.* (ref. 9), 342.
 42. Even the name given to the "élèves" has a history of controversy. The *Règlement de l'Académie* of 26 January 1699, for example, instituted three "astronomes pensionnaires" (J. D. Cassini, Ph. De la Hire, Lefèvre), three "associés" (Gabriel Philippe de la Hire, Jacques Cassini, Maraldi), and three "élèves" (Monti and later Guillaume Delisle for Cassini and Lieutaud for Ph. de la Hire). In 1716 the Académie suppressed the position of the "élèves" and instituted twelve (renamed "adjoints") for all of the Académie, two for each of the six departments of science. The two adjoint astronomers were Jacques Lieutaud and Joseph Nicolas "le cadet" Delisle. Later, the name of "élèves" was changed again, and replaced with "professeurs". See Wolf, *op. cit.* (ref. 9), 222–7, 352; Hervé Faye, "Procès-verbaux du Conseil de l'Observatoire", 22 May 1868, AOP, MS 1068, i, 16.
 43. Wolf to the Secrétaire Général, *op. cit.* (ref. 6), 2.
 44. Le Verrier to the Ministre, 5 December 1868, AN, F17-3719, folder Conseil de l'Observatoire:

- Arrêté du 12 avril 1868 en execution du decret du 3 avril 1868.
45. Charles Wolf to the Ministre, 10 December 1868, AN, F17-3719, folder Conseil de l'Observatoire: Arrêté du 12 avril 1868 en execution du decret du 3 avril 1868. Victor Duruy, the controversial Ministre de l'Instruction Publique for most of the Second Empire, resigned his post on 17 July 1869 and Émile Segris filled the vacant post. Under the new *Ministre*, Le Verrier and Wolf would continue to disagree. For example, Le Verrier prevented Wolf from seeing the 1874 transit of Venus in Japan. Wolf complained: "Ma position vis à vis de l'observatoire et de m. Le Verrier est entièrement délicate." Le Verrier insisted Wolf should not leave. Charles Wolf, 1 February 1874, AAS, dossier "C. Wolf" lettres (1872–74), folder 9, 1; Le Verrier to Jean Baptiste Dumas Membre de l'Institut, 4 February 1874, AAS, dossier "C. Wolf" lettres (1872–74), folder 9, lettre de Le Verrier (1874): conflit au sujet de son départ.
 46. Wolf, *op. cit.* (ref. 9), 342.
 47. Cassini, *op. cit.* (ref. 41), 206–7. Reprinted in Wolf, *op. cit.* (ref. 9), 342, italics mine.
 48. Wolf, *op. cit.* (ref. 9), 342.
 49. Cassini IV, D.5.37, AOP, cited in Wolf, *op. cit.* (ref. 9), 258.
 50. Wolf, *op. cit.* (ref. 9), 210.
 51. Ministre de l'Instruction Publique, "Note", 22 November 1868, AN, F17-3719, folder Commission institué par l'arrêté du 18 octobre 1867. See also E. Rank, "Revue des sciences", *Revue des deux mondes*, lxxxv (1870), 1040–7.
 52. See the later article "A quoi sert le Bureau des Longitudes?", *La revue scientifique*, x (1872), 481–3. Three weeks after this article was published, P. Bert, professor at the Faculté des Sciences de Paris and deputy of Yonne, brought the question of suppressing the Bureau des Longitudes to the National Assembly. See "Chronique scientifique", *La revue scientifique*, x (1872), 576.
 53. Wolf to the Secrétaire Général, *op. cit.* (ref. 6), 6.
 54. Letter from Barthelemy St Hilaire to Charles Delaunay, Versailles, 31 December 1871, AOP, MS 1060, Carton No. 1, I-A, 1–2. Barthelemy St Hilaire was charged to send Delaunay's letters to the President of the Republic, Adolphe Thiers.
 55. Hervé Faye, "Rapport verbal sur le Protocole de la Conférence géodésique tenue à Berlin en avril 1862 (Protocole adressé à l'Académie par M. le Ministre d'État)", *Comptes rendus hebdomadaires*, lv (1862), 28–34.
 56. Urbain Le Verrier, "Remarques", *Comptes rendus hebdomadaires*, lv (1862), 34–37; Hervé Faye, "Réponse aux observations de M. Le Verrier relativement à un Rapport lu dans la séance précédente sur les entreprises géodésiques en Allemagne", *Comptes rendus hebdomadaires*, lvi (1863), 66–72; Charles Delaunay, "Sur la géodesie française, et sur le rôle qu'y ont joué l'Académie des Sciences et le Bureau des Longitudes. – Note lue à l'occasion du débat entre MM. Le Verrier et Faye", *Comptes rendus hebdomadaires*, lvi (1863), 150–4.
 57. Hervé Faye, "Réponse à une inculpation de M. Le Verrier relativement à la part que M. Faye a prise à la détermination de la différence de longitude entre Londres et Paris", *Comptes rendus hebdomadaires*, lvi (1863), 154–8; Hervé Faye, "Réponse à la partie scientifique des deux derniers articles de M. Le Verrier", *Comptes rendus hebdomadaires*, lvi (1863), 158–63.
 58. Urbain Le Verrier, "De l'influence des erreurs systématiques dans quelques recherches d'astronomie", *Comptes rendus hebdomadaires*, lvi (1863), 164–70.
 59. Le Verrier, *op. cit.* (ref. 58), 164.
 60. Hervé Faye, "Sur les erreurs d'origine physiologique", *Comptes rendus hebdomadaires*, lix (1864), 473–80.
 61. Bigourdan, *op. cit.* (ref. 4), 46–48.
 62. Charles Wolf, "Recherches sur l'équation personnelle dans les observations de passages, sa

- détermination absolue, ses lois et son origine”, *Annales de l’Observatoire Impérial de Paris, Mémoires*, viii (1866), 153–208.
63. Faye, *op. cit.* (ref. 60), 478.
 64. In response to the work on the personal errors in the longitude determinations between the German towns Altona and Schwerin, Faye preached about the benefits of completely mechanized observation. Faye referred to Paschen, “Vorläufiger Bericht über die Chronometer-Reisen im Jahre 1848, zur Bestimmung des Längenunterschiedes zwischen Altona und Schwerin”, *Astronomische Nachrichten*, xxx (1850), cols 78–80; Paschen, “Bestimmung des Längenunterschiedes von Altona und Schwerin durch Chronometer-Reisen”, *Astronomische Nachrichten*, xxxi (1851), cols 177–90, 193–208. Also see, Paschen de Schwerin, “Emploi de la photographie pour l’observation du passage de Vénus, le 8 décembre 1874”, *La revue scientifique*, x (1872), 41–42.
 65. Hervé Faye, Paris, 31 October 1861, PSB, Sammlung Darmstädter I 1846(6) Faye, 3. Faye’s photo-telegraphic experiments were done with the help of Ignazio Porro, “a very talented engineer”.
 66. Charles Wolf, “Sur la comparaison des résultats de l’observation astronomique directe avec ceux de l’inscription photographique”, *Comptes rendus hebdomadaires*, cii (1886), 477.
 67. Wolf, *op. cit.* (ref. 62), 159.
 68. Adolph Hirsch, “Sur les erreurs personnelles: Lettre de M. A. Hirsch, directeur de l’Observatoire cantonal de Neuchâtel, à M. R. Radau”, *Le moniteur scientifique: Journal des sciences pures et appliquées*, viii (1866), 316.
 69. Hervé Faye, *Cours d’astronomie et de géodesie de l’Ecole Polytechnique* (Paris, 1883), 160.
 70. Wolf, *op. cit.* (ref. 9), 328–9.
 71. Charles Wolf, “Recherches sur l’équation personnelle dans les observations de passages, sa détermination absolue, ses lois et son origine”, *Comptes rendus hebdomadaires*, lx (1865), 1268–72.
 72. Letter accepting being part of the *Conseil*: Wolf, 13 April 1868, AN, F17-3719, folder Conseil de l’Observatoire: Arrêté du 12 avril 1868 en execution du décret du 3 avril 1868. The members of the Conseil de l’Observatoire Imperial for 1868 were: Le Verrier, president; Faye, vice-president; and Wolf, secrétaire. Le Ministre secrétaire de État to Département de l’Instruction publique, 12 April 1868, AN, F17-3719, folder Conseil de l’Observatoire: Arrêté du 12 avril 1868 en execution du décret du 3 avril 1868.
 73. Charles Wolf to the Secrétaire Général, “Enoncé des faites qui constituent une violation de décret de 3 avril 1868”, 31 January 1870, AN, F17-3720, folder Commission administrative provisoire, accused Le Verrier of sabotaging the Commission.
 74. “Observatoire impérial, Questions litigieuses”, 3 December 1868, AN, F17-3719, folder Conseil de l’Observatoire: Arrêté du 12 avril 1868 en execution du Décret du 3 avril 1868, 1.
 75. Wolf to the Ministre, 8 January 1869, *op. cit.* (ref. 45). See also Wolf to the Ministre, 12 December 1868, *op. cit.* (ref. 45), complaining of the absence of Le Verrier; Wolf to the Ministre, 4 February 1869, *op. cit.* (ref. 45), complaining that Le Verrier was not going to the monthly meetings and thus was boycotting them for the third time.
 76. Victor Duruy, *Journal de Paris, Journal général de l’instruction publique*, 1868, 242, cited in Sandra Horvath-Peterson, *Victor Duruy and French education: Liberal reform in the Second Empire* (Baton Rouge, 1984), 57. From the time of Duruy’s appointment by Napoleon III, Le Verrier was against him, see *ibid.*, 52–53, 55 n. 8, 57.
 77. Wolf to the Ministre, 2 November 1869, *op. cit.* (ref. 45), 2.
 78. Wolf, Yvon Villarceau, Hyppolyte Marie-Davy, and Maurice Loewy to the Ministre de l’Instruction publique, 27 November 1869, AN, F17-3720, folder Commission administrative provisoire.

79. Wolf to the Secrétaire Général, *op. cit.* (ref. 73).
80. Wolf, Yvon Villarceau, Hyppolyte Marie-Davy, and Maurice Loewy to Ministre, 7 January 1870, AN, F17-3720, folder Commission administrative provisoire, threatening to quit collectively if something was not done about Le Verrier.
81. Le Verrier was removed on February 1870. Bureau des Longitudes, “Extraits, Procès-Verbaux du Bureau des Longitudes concernant l’Observatoire de Paris 1795–1878”, AOP, MS 1022, 263.
82. Hugo, *op. cit.* (ref. 2), 164, 170–1. Napoleon III made an exception and dispensed the ageing and nearly blind Arago from taking the oath of allegiance to the new Empire.
83. The French press was deeply involved in the debate surrounding Le Verrier. See numerous newspaper clippings: AN, F17-3719, Dossier E, folder Journaux critiquant l’administration de l’Observatoire et réponse de M. Le Verrier; AN, F17-3720, folder Commission administrative provisoire.
84. [Wolf?], *op. cit.* (ref. 5), 1149–59.
85. É. A., “Réorganisation de l’Observatoire de Paris”, *La revue scientifique*, xi (1873), 789–90. The complete name of the author is Émile Alglave, director of *La revue scientifique*.
86. See the regulations of the *Conseil* signed by the President of the Republic Adolphe Thiers on 25 November 1872, in *La revue scientifique*, x (1872).
87. É. A., *op. cit.* (ref. 85), 790.
88. After the Franco-Prussian War, the German observatories were the main sites of comparison. See [Wolf?], *op. cit.* (ref. 5), 1158.
89. Wolf to the Secrétaire Général, *op. cit.* (ref. 6), 3.
90. *Ibid.*, 2.
91. *Ibid.*, 2–3.
92. *Ibid.*, 3.
93. Wolf, *op. cit.* (ref. 62), 171.
94. Peter A. Secchi and Emmanuel Fergola used Wolf’s apparatus for determining their personal equations in the longitude determinations between Naples and Rome, and Antoine Bréguet built a similar apparatus for the Lisbon Observatory.
95. Wolf to the Secrétaire Général, *op. cit.* (ref. 6), 1.
96. [Charles Wolf?], “Réorganisation de l’Observatoire National de Paris”, *La revue scientifique*, x (1872), 217.
97. [Wolf?], *op. cit.* (ref. 96), 218.
98. As part of his effort to educate astronomers, Wolf wrote the *Instructions* for performing observations with the meridian and mural circles. He also supported the publication in French of Franz Brünnow’s textbook, which was widely used in Britain and Germany. Yet the Observatory’s transformation into a fully-fledged military style school did not occur until after the admiral Ernest Mouchez replaced Le Verrier, and Wolf was named professor of physical astronomy. See E. Mouchez, “Observatoire de Paris: Organisation des études des élèves astronomes”, *La nature*, viii (1880), 1–2, and “Chronique: L’École d’Astronomie à l’Observatoire de Paris”, *La nature*, ix (1881), 239.
99. Charles Wolf, preface to *Traité d’astronomie sphérique et d’astronomie pratique*, by Franz Brünnow (Paris, 1869), p. xviii.
100. For other views on how to conduct the Observatory see Le Verrier, *op. cit.* (ref. 22), 1–68; É. A., *op. cit.* (ref. 85), 789–90.
101. Cassini, *op. cit.* (ref. 13), 8.