Excerpts from "The Single Eye: Reevaluating Ancien Régime Science",
by Jimena Canales, Harvard University.

In Press, *History of Science*, 2001.

. . .

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. . . .

. . . 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 labor 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, it 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]

. . .