José Monteiro da Rocha
A Portuguese astronomer and mathematician. The work on comets.

José Monteiro da Rocha was born in a small town in the north of Portugal, named Canavezes (Amarante), in the 25th of June, 1734. We could not find relevant information about his early years. However it is known that the young José went to Brasil as part of the "*Companhia de Jesus*". In 1752 we find him as a teacher in the Jesuit school "*Colégio da Baía*". Coincidentally to the Marquês de Pombal laws against the Jesuits in 1759, José Monteiro da Rocha leaves the religious institution and returns to Portugal. In 1770 he gets the degree of "*bacharel*" from the University of Coimbra.

Monteiro da Rocha had a major impact on the development of the University of Coimbra in the XVIII and XIX centuries. In particular, he gave a fundamental contribution to the creation of the new "*Faculdade de Matemática e Filosofia Natural*" in 1772 by writing the "*Estatutos*" of the faculty. In that same year he becomes a teacher of Physics and Applied Mathematics and later on (1783) we can find him teaching Astronomy. The ability of Monteiro da Rocha in astronomy was particularly appreciated and he was nominated director of the *Astronomical Observatory of the University of Coimbra* in 1785. Until the end of the XVIII century, Monteiro da Rocha was nominated to other important academic positions such as "*Decano e Director Perpétuo da Faculdade*" (1795) and "*Vice-Reitor da Universidade de Coimbra*" (from 1796 to 1799).

Besides his main contribution to the creation of the faculty of mathematics, we can find other improvements in the different university aspects (administration, teaching and science) directly related to Monteiro da Rocha. Among these, we emphasize the creation of the Astronomical Observatory (Fig. 1). The document containing the scientific motivations and administrative rules was written by Monteiro da Rocha. The choice of astronomical instruments was also supervised by him.

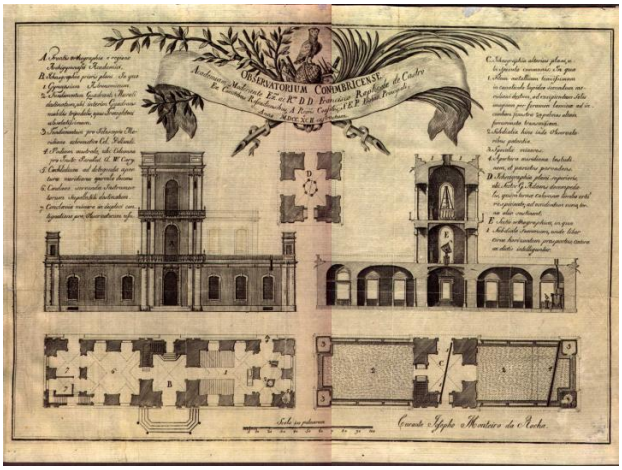

Figure 1. Drawings of the *Astronomical Observatory* of the University of Coimbra, built in 1799 under the supervision of Monteiro da Rocha. In the lower right corner one may read the name of "Monteiro da Rocha".

The scientific work of José Monteiro da Rocha spans between quite different mathematical and astronomical domains. First of all we emphasize the translation to Portuguese of some fundamental textbooks in order to help students and professors from the university. We point out the books of Bézout on arithmetic and trigonometry (both with different editions, respectively from 1773 to 1826 and from 1774 to 1817), the hydrodynamic compendium from Bossut (with two editions in 1775 and 1813) and the text of Marie on mechanics (edited in 1775 and 1812). We can also mention a textbook written by himself, entitled "*Elementa Mathematica*".

Concerning his research work it is also possible to find an interesting sample of publications. Three of them appeared in the first proceedings of the Academy of Sciences of Lisbon (founded in the 24th of December, 1779; Monteiro da Rocha was elected member one month later!) published in 1797 and 1799, namely:

"*Solução geral do problema de Kepler sobre a medição das pipas e tonéis*", "*Aditamentos à regra de Fontaine para resolver por aproximações os problemas que se reduzem às quadraturas*" and "*Determinação das órbitas de Cometas*".

In the sequel, we will focus on the latter publication, taking into account our particular interest in the subject. First of all, let us precise that the determination of a comet orbit means the quantification of the six orbital elements (perihelion distance, eccentricity, orbital inclination, ascending node longitude, perihelion longitude and time at the perihelion) assuming as observables the distances comet-Earth and Earth-Sun in three different epochs. Many famous mathematicians and astronomers were interested in this problem "*hocce longe difficillimum*" (in the own words of Newton, in 1687), even in the case where the orbits of comets are assumed to be parabolas reducing the number of orbital elements from six to five. Among the most famous, we can name Euler, Clairaut, Condorcet, Boscovich, Pingré, Delambre, d'Alembert, Lambert, Lalande and Laplace. The solution appeared only in 1797 by the hand of the Baron of von Zach, presenting the work of Wilhelm Olbers titled "*Abhandlung über die leichteste und bequemst Methode, die Bahn eines Cometen aus einigen Beobachtungen zu berechnem von Wilhelm Olbers*", which gives an easy method to solve the problem. The interesting point concerning Monteiro da Rocha is the following: his work, on the same subject, was effectively published in 1799 (so two years later than the publication of Olbers' work) but the method proposed by Monteiro da Rocha had been, in fact, orally presented to the Academy of Sciences much before, in 1782. This method is formally similar to the one presented by Olbers (both based on the Euler-Lagrange Theorem [3]) and the results are numerically consistent [1]. In order to illustrate this particular point we present, in Table 1, a comparison between three different determinations for the comet *1830 V* (observed by James Watson).

A detailed paper on these comparisons is in preparation [2]. We must add that the work of Monteiro da Rocha was written in Portuguese. This fact certainly was the major cause of the little diffusion of his work at the epoch.

There are other astronomical works of Monteiro da Rocha that deserve to be emphasized: "*Exposição dos métodos particulares no cálculo das Efemérides*" (1797), "*Tábua Náutica para o cálculo das longitudes*" and "*Memórias sobre o uso do retículo romboidal e do instrumento de passagem*" (1806). But it is, probably, "*Efemérides Astronómicas do Observatório de Coimbra*" the contribution of Monteiro da Rocha with major impact in the future of the astronomy in Coimbra and Portugal. In fact, the astronomical ephemeris (including the calculations for the Sun, the Moon, the planets and the brightest stars) have been published during almost 200 years, between 1803 and 2001. The earlier editions were published under the initiative and supervision of Monteiro da Rocha (Fig. 2).

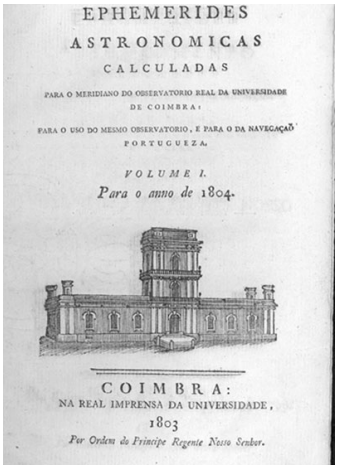
EPHEMERIDES
ASTRONOMICAS
CALCULADAS
PARA O MERIDIANO DO OBSERVATORIO REAL DA UNIVERSIDADE DE COIMBRA:
PARA O USO DO MESMO OBSERVATORIO, E PARA O DA NAVEGAÇÃO PORTUGUEZA.
VOLUME I.
Para o anno de 1804.
COIMBRA:
NA REAL IMPRENSA DA UNIVERSIDADE,
1803
Por Ordem do Principe Regente Nosso Senhor.

Figure 2. The first edition of the Coimbra astronomical ephemeris, published in 1803 for the year 1804 (copy of the cover).

The global work of José Monteiro da Rocha received the applause and distinction from the Portuguese monarchy at the epoch. In 1800 he was nominated counsellor of the Prince Regent D. João and, four years later, he left the academy and moved to Lisbon, to become a preceptor of the future King D. Pedro IV and his brothers. He also received the "*Comenda da Ordem de Cristo*" in 1802.

José Monteiro da Rocha died in Lisbon in the 11th of December, 1819. According to his will, his manuscripts and scientific works were donated to the Academy of Sciences of Lisbon. His personal library may be found, nowadays, in the Ajuda Palace, in Lisbon.

Orbital Elements	J. Watson	W. Olbers	J. Monteiro da Rocha
perihelion distance (AU)	0.771575	0.7313995	0.777129
orbital inclination	64°31'27.7"	63°43'25"	65°16'29"
ascending node longitude	304°43'11.5"	305°4'55.8"	305°0'16.2"
perihelion longitude	60°23'17.8"	64°24'6"	60°29'23"
time at the perihelion	27-12-1863 (13h33m11s)	28-12-1863 (20h52m)	27-12-1863 (8h13m14s)

Table 1.

References

[1] Fernando Figueiredo, *A contribuição de José Monteiro da Rocha para o cálculo das órbitas de cometas*, Master Thesis, FCT-UNL, 2006.

[2] F. Figueiredo, J. Fernandes, and J. Carvalho e Silva, *On the contribution of Monteiro da Rocha to the comet orbits determination*, 2007 (in preparation).

[3] Duarte Leite, *Pour l'histoire de la détermination des orbites cométaires*, in: Anais Científicos da Academia Politécnica do Porto, vol. X, 1915.

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