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Bošković's determination of the solar rotation elements in the 18th century using his own observations of sunspot's positions

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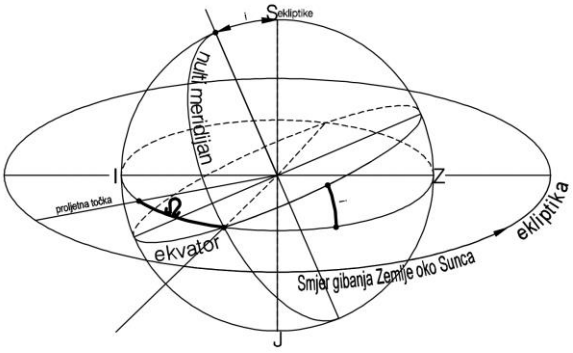
Figure 1: Sunspots on the disk of the Sun.

Abstract

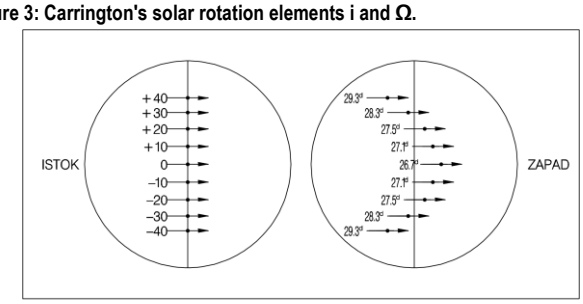
Ruđer Bošković (1711-1787) observed sunspots on the disk of the Sun during 12th to 29th September 1777 in France. His method is based on: 1) his first dissertation about Sunspots *De Maculis solaribus* (1736) in Latin, describing his geometrical and planar trigonometrical methods in 7 pages with 6 pictures, and 2) detailed calculations elaborated in *Opera pertinentia astronomiam ad opticam*, *Tomus V*, *Opuscule II* (1785) in old Franch, recently translated in Croatian, in 104 pages and 9 pictures. Bošković's method, formulas and drawings are described in detail in the Opuscule II with an example numerically elaborated in detail, containing his own observational data. In the appendix all his observations are presented. In the 8th and 14th chapters Bošković describes his reflexions on science in the view of contemporary scientific research and related to the scientists which were then active. One of the milestones of this work is the translation of the old French text into Croatian language which reveals Bošković's way of thinking about the topic under consideration.

Keywords: Sunspots, Bošković, solar rotation.



$$\Omega = 74{,}40° + (Y - 1850) \cdot 0{,}014°$$
$$i = 7{,}25°$$

Figure 3: Carrington's solar rotation elements i and Ω.



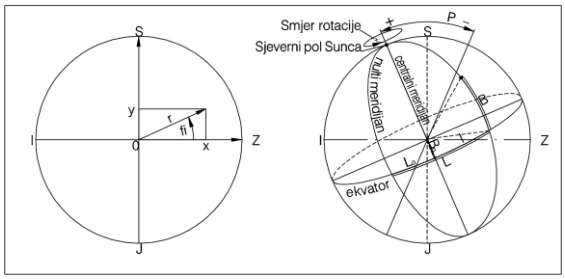


Figure 4: Solar differential rotation (up) and helliographic coordinates (down).

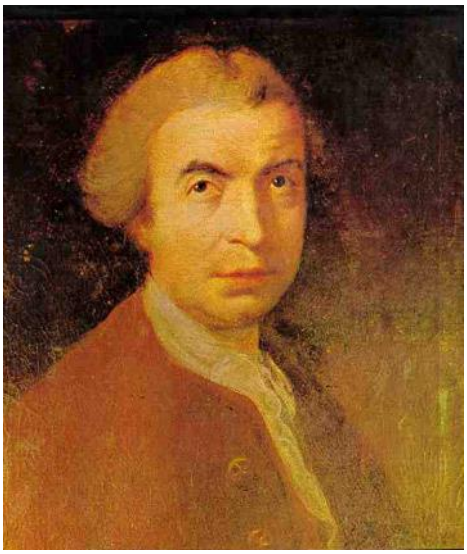
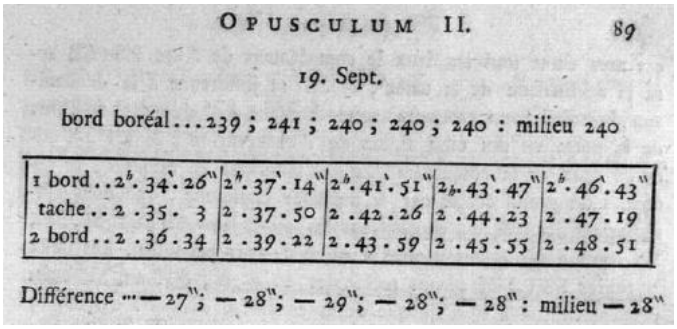


Figure 2: Ruđer Bošković (1711-1787).



OPUSCULUM II. 89

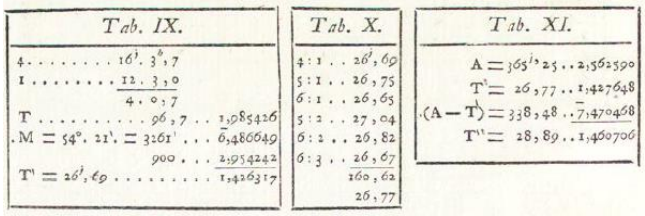
19. Sept.

bord boréal...239 ; 241 ; 240 ; 240 ; 240 : milieu 240

1 bord	2h. 34'. 26"	2h. 37'. 14"	2h. 41'. 51"	2h. 43'. 47"	2h. 46'. 43"
tache	2 . 35 . 3	2 . 37 . 50	2 . 42 . 26	2 . 44 . 23	2 . 47 . 19
2 bord	2 . 36 . 34	2 . 39 . 22	2 . 43 . 59	2 . 45 . 55	2 . 48 . 51

Différence ... — 27"; — 28"; — 29"; — 28"; — 28" : milieu — 28"

Figure 5: Typical set of observations for a day (Bošković, R. J. 1785, 89).



Tab. IX.

4 . . . . . 16', 3", 7
1 . . . . . 12 . 3 , 0
4 . 0 , 7
T . . . . . 96 , 7 . . 1,985426
M = 54°. 21'. = 3261' . . . 6,486649
900 . . . 2,954242
T' = 26', 69 1,426317

Tab. X.

4 : 1 . . 26', 69
5 : 1 . . 26 , 75
6 : 1 . . 26 , 65
5 : 2 . . 27 , 04
6 : 2 . . 26 , 82
6 : 3 . . 26 , 67
160 , 62
26 , 77

Tab. XI.

A = 365' 25 . . 2,562590
T' = 26 , 77 . . 1,427648
(A — T') = 338 , 48 . . 7,470468
T'' = 28, 89 . . 1,460706

Figure 6: Sidereal rotation period of the Sun was determined to be 26.77 days, which is different from the previous value of 25.5 days (Bošković, R. J. 1785, 168, *Tab. IX.*, *Tab. X.* and *Tab. XI.*).

REFERENCES

Bošković, R. J. (1736): *De maculis solaribus*. Rim. Typographia Komarek, Romae.

Bošković, R. J. (1760): *De Solis ac Lunae defectibus.* Apud Andream Millar, in the Strand, et R. Et J. Dodsleios in Pall-mall, London.

Bošković, R. J. (1785): *Sur les éléments de la rotation du soleil sur son axe déterminés par l'observation de ses taches* (75-178) in *Opera pertinentia ad opticam et astronomiam*, I-V. Venetiis apud Remondini, Bassano.

Acknowledgements

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