REFERENCE MERIDIAN OF THE COPERNICAN ASTRONOMY

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As is well known, Copernicus referred the parameters of the heliocentric astronomy to the meridian of Cracow, which he considered to be identical with that of his observing site in Warmia. For all parameters, ancient and contemporary determinations were reduced to the meridian of Cracow - Frombork and combined (with the sole exception of the longitude of Mercury) with the observations made by Copernicus. For this purpose longitudes of various towns had to be known. However, because of the limited accuracy of naked-eye observations the reduction was insensitive against errors of the longitude determination; in actual computations only solar and, in the first place, lunar observations called for appropriate correction. Because of this relation all references to terrestrial longitudes in "De revolutionibus" are to be found in Books III and IV, dealing with the theory of motion of the Sun and of the Moon (the only exception being Mercury observations in Nuremberg, quoted in Book V). Thus differences of longitude for Alexandria and Ar Raqqa (Arata) can be found in Book III, chapter 13, the co-ordinates of European sites in Book IV. The reference meridian is described in chapter 7:

...Frueburgum [...] ubi plerumque nostras habuimus observationes ad ostia Istolae fluvii positae huic [Cracoviae] subest meridiano ut nos Lunae Solisque defectus utrobique simul observati docent[1].

Whatever sources were used by Copernicus for the computation[2] the whole set of longitude differences depended ultimately on the accepted longitude of Cracow. As a rule the value of $32^{\circ}36'$ east of Fortunate Islands was used, other values appearing occasionally. The distance from Toledo ($21^{\circ}36'$) was more important in practical use, as the astronomical tables of king Alfonso X - the most universal tool of 13-14th century astronomers - were referred to the meridian of Toledo, following the example of former West Islamic authors.

Within this mode of reckoning the Cracow longitude was determined indirectly by a hybrid procedure, described by an anonymous 15th century author[3]:

...inter meridianum Toletanum et Cracoviensen sunt 21 gradus et 36 minuta [...] hoc sic ostenditur modo facili: computum est enim per varia instrumenta in studio pragensi quod inter meridianum Toleti et Pragae sunt 18 gradus et 30 minuta [...] Si autem vis scire longitudinem inter meridianum pragensem et cracoviensem vide quot sunt miliaria theutonicalia [...] que queritur distantia sunt 60 [...] que via sepius obliquatur propter multitudinem collium et vallium [...] sunt ergo 49 miliaria cum 1/2.

This distance converted into arc amounted to $3^{\circ}5'37$, "et valet longitudo inter toletum et Cracoviam scl. $21^{\circ}36'$"[4].

The close relation of Cracow and Prague meridians is shown also by the analysis of extant MS copies of the "Alfon-

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[1] L. A. B i r k e n m a j e r discussed probable eclipse observations linking Cracow and Frombork in M. Kopernik, 1, Kraków 1900, p. 449-479.

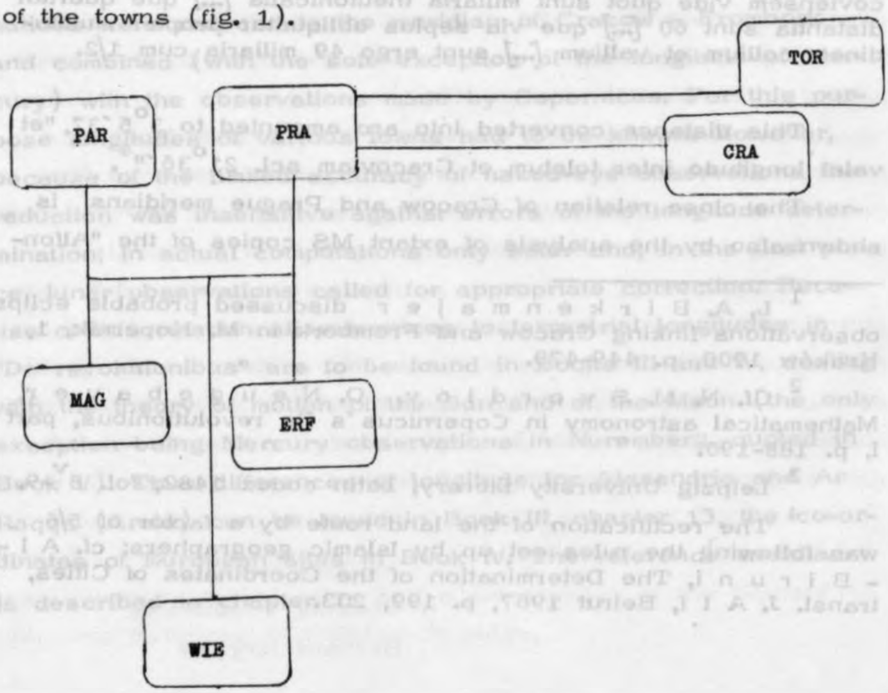
[2] Cf. N. M. S v e r d l o v, O. N e u g e b a u e r, Mathematical astronomy in Copernicus's De revolutionibus, part I, p. 188-190.

[3] Leipzig University Library, Latin codex 1482, fol. 8^{v}-9.

[4] The rectification of the land route by a factor of 5/6 was following the rules set up by Islamic geographers; cf. A l - B i r u n i, The Determination of the Coordinates of Cities, transl. J. A l i, Beirut 1967, p. 199, 203.

sine Tables". Using astronomical tables at various locations the late medieval practitioner had to reduce the data from Toledo to the meridian of his place. The appropriate "radices" used to be written as glossae within the "Alfonsine Tables". On a simple recomputation those notes yield geographical co-ordinates of various towns, mostly of poor precision, sometimes one set of "radices" contradicting another. They may be more revealing in another context: listing several towns in a manuscript must have reflected the writer, the degree of his preference and the level of importance attached to particular places.

To check this possibility a sample was investigated, comprising 39 MS Alfonsines from Central European libraries (for the larger part from Cracow - 16 and Munich - 13 MSS). Of the twenty towns names appearing in the glossae only nine were listed more than six times, viz. Cracow, Erfurt, Magdeburg, Paris, Prague, Toruń Vienna, Worms and Wrocław. Parallel appearance of a pair of towns in the same list was taken as measure of their affinity. The resulting graph (a dendrite) displays for every town its closest partner, the length of connecting lines being inversely proportional to the number of joint listing of the towns (fig. 1).



With appropriate reservations some comments may be called for. A striking feature is the symmetry of relations for Paris and Magdeburg (the most frequent pair of all). Other towns display the same affinity to each of them. This symmetry holds also, to a lesser extent, to the pair Prague-Erfurt. Somewhat unexpected is the large number of quotations for Magdeburg, as the astronomical traditions of that town cannot compare with university centers like Erfurt, Prague and Cracow. Otherwise the historical sequence of the transmission of mathematical astronomy in Latin Europe is well reflected, corroborating the link between Cracow and Prague.

Within the scientific community at Cracow the (numerical) link with Toledo as the main reference meridian lessened considerably during the 15^{th} century, with the quickly growing popularity of the simplified form of "Alfonsines", the "Tabulae resolutae". These tables listed mean longitudes of celestial bodies for 400 years in 20 years intervals, directly for the meridian of Cracow. This form of tables, too, was of Prague provenance, but only in Cracow they were provided with a series of explanatory canons and became an important part of the academic astronomical curriculum. Over 20 copies of the "Resolutae" are extant in Cracow; other can be found in Italy, Germany and England, witnessing to the vogue for learning astronomy (and astrology) in Cracow in the late 15^{th} century. At that time also Cracow scholars referred the longitudes of other towns to the meridian of Cracow (e.g. H. Virdung for Heidelberg). To Copernicus its use must have been a fully natural choice.