measurement of the Earth carried out personally by Al-Birûni in India.

Having, owing to practical difficulties, failed in his attempts to verify Al-Mâmûn's results by resorting to direct measurements of an arc, Al-Birûni had recourse to a novel method of his own contrivance, which, before he actually carried it out into practice, had already been fully indicated by him in his earlier book on the astrolabe (الكتاب فى الاسطرلاب)[1]

و فى معرفة ذٰلك طَريق قايم فى الوهم صحيح بالبرهان، و الوصول الى عَمله صَعب لصغر الاُسطُرلاب (او الآلات)[2]، و قلّة مقدار الشّىء الّذى يبنى عليه فيه، و هو ان تصعد جَبَلاً مشرفاً على بحر او برية مَلْسَأ، و ترصُدُ غروب الشّمس، فتَجد فيه ما ذكرناه من الانحطاط، ثم تعرف مقدار عمود ذلك الجبل و تضربه فى الجيب المستوى لتمام الانحطاط الموجود، و تقسم المجتمع على الجيب المنكوس لذلك الانحطاط نفسه، ثم تضرب ما خرج[3] من القسمه فى اثنين و عشرين ابداً و تقسم المبلغ على سبعة، فيخرج مقدار احاطة الارض بالمقدار الذى به قدّرت عمود الجبل *

و لم يقع لنا بهذا الانحطاط و كَميّته فى المواضع العاليه تَجربة - و جرّانا على ذكر هذا الطريق ما حكاه ابو العبّاس النّيريزى عن ارسطولس ان اطوال اعمدة الجبال خمسه اميال و نصف بالمقدار الذى به نصف قُطر الارض ثلثه آلاف و مائتا ميل بالتقريب، فانّ الحساب يقضى لهٰذه المقدّمه ان يوجد الانحطاط فى الجبل الذى عموده هذا القدر ثلث درجات بالتقريب *

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[1] This is quite a different book from Al-Biruni's الكتاب الاستيعاب الوجوه الممكنه فى صنعة الاسطرلاب another book on the same subject, a unique copy of which exists in Leyden (B.d, 1908, p. 67). I have quoted the whole passage in the above from Nallino (Lectures, pp. 289–292):

' ان ذلك العالم الاجلّ جعل فى آخر كتابه فى الاسطرلاب فصلاً فى معرفة مقدار استداره الارض ' و لقد وصف الطريق الاعتيادى المدّفق لذلك ' (نالينو) ٥

[2] و فى الاصل '' الالاب '' ٥

[3] و الصواب '' ضعف ما خرج '' ان خارج القسمة هو نصف قطر الارض ، و لا القطر كله ٥

(Nallino)

و الى التّجربة يُلتجأ فى مثل هذه الاشياء، و على الامتحان فيها يعوّل *

و ما توفيقى الّا من عند الله العزيز الحكيم *

'To know this method is quite conceivable in imagination, and it rests on sound deductions. It is difficult to carry it out in practice only owing to the smallness of the astrolabe (or other instruments) and the little size of the thing on which we have to base our solution. And that method is this: You climb a mountain situated close to the sea or a level plain, and then observe the setting of the sun and find out the dip of the horizon we have already mentioned, and then find the value of the perpendicular of this mountain. You multiply this height into the sine of the complementary angle of the dip, and divide the total by the versed sine of this dip itself. Then multiply (the double of) the quotient into 22 and divide the result of this multiplication by 7. You will get the length of the Earth's circumference (in the same terms or proportion) in which the height of the mountain has been fixed.

We have not so far been able to experiment with this dip, and its value in any high place. We were led to this method by Abul Abbas Al-Nairizi[1] who states, that Aristothenes (?) has mentioned that the heights of the peaks of the mountains would be $5\frac{1}{2}$ miles when the length of the radius of the Earth is 3,200 miles approximately.

For the solution of this problem it is necessary mathematically that the dip of the horizon in the mountain wherein the perpendicular is so high should be about $\frac{1}{3}$ degree.

Such matters, however, need actual experiments, and could be verified only by testing.

The Almighty and Wise God alone can help me (in obtaining success in such ventures).[2]'

At the time of writing the 'Book on the Astrolabe' (الكتاب فى الأُسطُرلاب) Al-Birûni had not yet made any actual attempt to put his theory into practice owing to, what he thought, the smallness of the instruments of observations, and lack of suitable site, and competent helpers. The method required the presence of a mountain either situated on a level plain or adjacent to the sea, and on the peak of it the observations of the sun setting in the horizon.

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1 Al-Nairizi died shortly after 300 A.H. (early tenth century A.D.).

2 Nallino has demonstrated Al-Birûni's methods on pp. 291-292 of his Lectures. See Appendix I of this book.