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ON THE NECESSITY OF FURTHER RESEARCHES ON THE MILKY WAY.

A. PANNEKOEK.

FOR POPULAR ASTRONOMY.

As there is a tendency to restrict the working field on which amateur astronomers may make themselves useful to science, it is, perhaps, a matter of some importance to point out a subject which affords an excellent opportunity and for which no instrument whatever is required; nothing indeed except a pair of rather sharp eyes and a sky of tolerable clearness, viz., observations of the Milky Way with the naked eye.

All accurate drawings of the Milky Way are comparatively modern. It is true that Ptolemy (130 B. C.) had already recognized its invariability as a whole, and he has given a rather careful description of it in his Almagest; Easton in his historical review of the drawings and descriptions of the Milky Way remarks that Ptolemy's description is certainly superior to all the rather fantastic representations given in the maps published before the last quarter of our century.

But up to 1867 no serious attempt at a study of the northern part of the Milky Way seems to have been undertaken; and this is the more astonishing because Sir John Herschel had published his admirable observations of the southern portion as early as 1847. Argelander in Germany and Lassell and Mark in England endeavored, for many years in vain, to direct the attention of amateurs to this neglected branch of astronomical research. In 1867 Dr. Klein in Colonia, (Cologne,?) published the first part of a very remarkable description of the northern Milky Way, but he has not been able to bring it to a conclusion. Edward Heis was the first to undertake for the northern hemisphere what Sir John Herschel had already done for the southern part of the Milky Way. In Heis's maps the absence of detail is however conspicuous; as is still more the case with the maps of Houseau, which were constructed at Jamaica and contain both hemispheres. Therefore it was very satisfactory to receive the admirable drawings of Dr. Boeddicker, who, observing at the Earl of Rosse's Observatory at Birr Castle, was able to publish his atlas of the northern Milky Way in 1892.

One might think the question settled by Dr. Boeddicker's publication, and that the drawings executed in Lord Rosse's Observatory completed, by far more detail, the sketch made by Dr. Heis. On comparing Boeddicker's with that of Weis however more discrepancies are shown between these two, than was ever the case with the drawings of other celestial objects; it seemed as if they had nothing in common. Where Boeddicker's maps revealed the existence of numerous streams; dark spots were visible in that of Heis, and the contrary happened also. In certain parts the two drawings seem to represent wholly different objects; it is true that in a few places the same features may be detected in both drawings.

Now it is clear that no real changes of such importance and extent can have occurred in the Milky Way in so short a time. Nor can inability of one of these observers account for such differences. Boeddicker had already a very good name as a delineator of nebulae and planets, and that Heis was gifted by nature with exceptionally sharp eyes needs not to be dwelt upon. And still we might be inclined to believe, that, the delineation of the Milky Way being after all a matter of secondary importance for Heis, and his engraver and printer having executed their task certainly not to his own contentment, the discrepancies were due to one of the observers—if there had not been the fact that the drawings of Trouvelot and Houseau presented also considerable differences between them and the drawings of Boeddicker and Heis. Moreover a perfectly independent series of observations were made about the same time by Easton, and his maps, though offering in some points a remarkable agreement with those of Boeddicker, show in so many instances a totally deviating structure, that it seems very difficult to decide between two observers who have both spent considerable skill, patience and time upon the matter. I may perhaps add that I have myself laid down a great many observations in a drawing which was exhibited at the October meeting 1893 of the "Vereinegung für Freunde der Astronomie und Kosmischen Physik" and that this drawing also presents many differences from the maps of Boeddicker as well as those of Easton.

And it is not merely differences in detail of structure, but many characteristic features of the Milky Way are shown in two or three drawings but are absent in the fourth. For instance the conspicuous patch of luminosity between β and γ Cygni is somewhat difficult to trace on Dr. Boeddicker's maps—as are indeed all the great divisions in Aquila and Cygnus, owing

to the abundance of detail—but the drawings of Heis and Easton show it at the first glance, though they give less detail here and there. The intensities of the various parts of the Milky Way in Cassiopeia, as represented in Boeddicker's maps do certainly not agree with the distribution of luminosity in that part of the heavens; on the other hand, Easton's drawings fail to show the offsets and outlying branches in several parts of the girdle; particularly those in Draco, seen by Heis and confirmed by Boeddicker. These examples could easily be added to insist upon the fact that the discrepancies do not concern mere trifles, but often the main points.

There may be two explanations of these extensive divergences between the existing drawings of the Milky Way. They may be the consequence of the different methods employed by the observers, their unequal skill and experience, but it may also be that the character of the galactic phenomenon precludes its being fixed by delineation. This was the opinion of Professor E. E. Barnard in 1890: "It is only necessary," he said, "to mention the very great differences in delineation of even the more conspicuous parts of the Milky Way, as shown on different star charts, to see, that we have not the means in such charts to make anything like a comprehensive study of the Milky Way. Eyes differ so much and astronomers as a rule are such very poor artists, that we may never expect to get anything like a fair delineation of the Milky Way by the human hand alone." This was written, however, before the publication of Easton's and Boeddicker's drawings, which, though they give a very different representation of some parts of the Milky Way, show in other parts a fair resemblance even of detail. Moreover Mr. Easton communicated to me, some time ago, a letter from one of his correspondents, showing a very remarkable agreement in the results of two independent observers in detail, as minute as the dark spot about η Cygni and the curve limiting to the east the brilliant region between ρ and π' Cygni, both distinctly visible in Easton's and Boeddicker's maps. Besides, as it is evident that the difference between the visual power of the observers can have but a slight effect on the delineation of the greater masses of the galactic luminosity and as the remaining disturbing causes manifestly do not prevent a remarkable agreement even in detail, we must look elsewhere for the true explanation of the discrepancies in the drawings now available. I am convinced that these discrepances may be satisfactorily accounted for by the great differences in style (method of drawing) and by the difficulties adherent as well to this kind of observations as to an adequate publication of the results.

Plassmann, the well known observer of variable stars, has already pointed out how much the subjectivity of the delineator influences the result of his observations. Houseau, for instance, shows a tendency to represent the conspicuous patches of luminosity in the form of ellipses or shields; in Heis' drawings we see a sort of mosaic-work; Trouvelot has indistinct wadded patches; in Boeddicker's drawings the revealing of narrow strips and streams is manifest; Easton has a succession of broader streams and patches of luminosity. In an object so difficult to lay down in a drawing, this method of the observer must have a very great influence on the general aspect of the drawing. Then we have to deal with the slightly different aims of the observer; Houseau endeavored to follow his "isophotic lines," Boeddicker searched after as many details as his eye was able to detect, Easton seems to have had in view the graduation of the intensity of the greater masses. It is obvious that much depends on the particularity whether the spaces between the luminous patches are more or less filled in.

Next we have the difficulties resulting from difference of scale, the errors unavoidable in printing and publishing the maps, the intervention of the engraver, and so many additional causes of error of every kind.

But the influence of all these causes of error may be greatly diminished by the co-operation of many persons with a certain ability of observing and much good will for the sake of science. It would be superfluous, I think, to explain that a representation as true as possible of the whole girdle of the Milky Way by drawing and description, is greatly needed, even now that photography has given a series of representations of somewhat different nature. Not only will it afford an opportunity to posterity to find out variations, when they should occur, but now also it will be of much value in researches about the structure of the universe. "The results," obtained by the Herschels, by Struve, Proctor and Easton, while they had much more imperfect materials to deal with, show what may be expected from a better knowledge of the Milky Way. There is a useful field of work open to enthusiasts. As Mr. W. H. Wesley wrote after the publication of Easton's drawings: "It is much to be desired that others may undertake the very difficult task of delineating independently the naked eye appearance of the Milky Way. It can only be by the accumulation of independent drawings, that personality can be eliminated and a representation obtained sufficiently certain and satisfactory to be used with confidence in the future discussion of possible changes."

In a following article I will describe the new charts which Mr. Easton has provided after the catalogue of Marth for the use of observers who will take up this line of research, and the best methods to use for this purpose.

THE STUDY OF THE VARIABLE STARS. IX.

PAUL S. YENDELL.

FOR POPULAR ASTRONOMY.

ALGOL. 4.

In the third of my papers on Algol, at the head of page 307 of the current volume of this periodical, I have made a statement of the hypothesis known as Tisserand's, which is incorrect, having at the time never seen Tisserand's original paper. Since that article was printed, I have had opportunity to examine the communication, and a brief abstract of and comment upon it are a part of the purpose of this supplementary paper.

In the second part of Chandler's paper, quoted on p. 306 (*Astronomical Journal*, Vol. XI, p. 121) occurs the following statement:

"Whatever the nature of the pure elliptic motion, the times of conjunction must follow each other at exactly equal periods, unless (*a*), one or both components are not spherical; or unless (*b*), there is at least one more body in the system. While by (*a*), inequalities in the times of conjunction would necessarily result, this hypothesis seems to be insufficient, since it would be inadequate to explain the character and magnitude of the observed irregularities; and it could not account for the observed variations in the place." So that the original suggestion of the idea came from Chandler.

What Tisserand did was to re-examine Chandler's first reason, and show that a moderate flattening of one or both components of the system would account for the phenomena, if the orbit of the satellite were not circular.

Tisserand's communication appeared 1895, Jan. 21, in the *Comptes Rendus*, Vol. CXX, p. 125. After stating Chandler's theory and formula (see my paper above cited, p. 303), he goes on to say:

"He" (Chandler) "has sought to demonstrate the reality of this orbit by the variations in Algol's proper motion. But the proof of this displacement is difficult; in fact, it rests upon the