3. On the other hand, the idea of a permanent cavity in which our galaxy should rest seems to encounter a serious difficulty. The radial velocities of about thirty spirals have been measured by Slipher and Pease, and have been found in some cases to be greater than 600 kilometres per second. Hence it would seem as if our stellar system could not remain in the hollow of cosmic matter resulting from its original formation.

Yet this relative motion between the spirals and our own system rather strengthens the theory. A preliminary computation by Young and Harper in the *Journal of the R.A.S. of Canada,* **10** (1916), p. 134, and by Truman in *Pop. Astr.*, **24** (1916), p. 111, puts the apex of this motion in the constellation of Capricornus, close to the Milky Way. As the motion is undoubtedly tangential to some orbit, it points to a rotation of the galaxy (or part of it) in its own equatorial plane. Similar rotations have been found in spiral nebulæ, like that of Andromeda.

It follows that a rotation of our Milky Way not only agrees with the theory of our stellar system being the result of concentration from previously existing cosmic matter, but that it is, in all probability, even a dynamical exigency of the process described.

Evidently this view of the universe favours the idea that the spiral nebulæ are cosmic formations outside and independent of our Milky Way.

Vatican Observatory:
1920 *October* 15.

Changes in the Lunar Craters Aristillus and Eratosthenes observed at the Harvard College Observatory, Mandeville, Jamaica. By Sir W. H. M. Christie, K.C.B., F.R.S. (Plates 10, 11.)

During a visit to Professor W. H. Pickering at Mandeville, Jamaica, last February, I was fortunate in having the opportunity to note with the 11-inch Draper refractor remarkable changes in the lunar craters Aristillus and Eratosthenes, and also in the Bradley Snow-Field, and thus to confirm Professor W. H. Pickering's observations made under similar conditions of illumination by the sun at corresponding co-longitudes.

I was able to observe the craters and the snow-field on Feb. 18, 21, 22, 23, and 26 (civil), 5–6 a.m., though the seeing was generally only 9 on a scale 1 to 12,* and overcast sky cut short the available observing time. This year the weather was quite exceptionally unfavourable during my visit to Jamaica, as, after prolonged drought, the rains with heavy thunder-showers and cloudy skies came in February and March instead of in May as usual.

* Seeing 9 would mean that the star disk is sharply defined but inner ring in constant motion.

Aristillus.—On Feb. 18 the "double canal" which starts within the crater and extends some distance outside was seen distinctly divided *inside* the crater and quite sharp throughout. The co-longitude was then 47° (9 p.m. Jamaica time, which is five hours earlier than Greenwich), the co-longitude for its noon being 89°, corresponding to its summer solstice. It is to be noted that for the moon the day and the year are the same, each being the lunation.

Professor Pickering describes the "double canal" at this co-longitude as starting at a point half way up the inner slope of the crater (which is $34\frac{1}{2}$ miles in diameter), 5 miles within the rim where the "canals" are $0''{\cdot}7$ apart (centre to centre), and $0''{\cdot}25$ or 1500 feet wide, being of the same width as outside. Their length from origin to rim is 5 miles, from rim to bottom of outer slope 3 miles, and 3 miles more out, making 11 miles in all. Professor Pickering has also at this phase noted other dark streaks or so-called "canals" outside the crater, but my attention was concentrated on the double canal. The sky clouded over by 11 p.m.

On Feb. 21 I noted some changes in Aristillus, though the seeing was too variable for a sketch.

On Feb. 22, between 10 and 12 p.m., co-long. 96°, I noted remarkable developments outside the crater, and I made a sketch at the telescope of dark streaks and patches or "fields" which had appeared since Feb. 18. The "double canal" in particular had increased in width and spread into a dark patch on the north side, which was crossed by several broad dark streaks. There also appeared on the north side, outside the crater, a curious marking exactly like a short ladder with four treads, equally spaced. On the south-west side two dark streaks were noted.

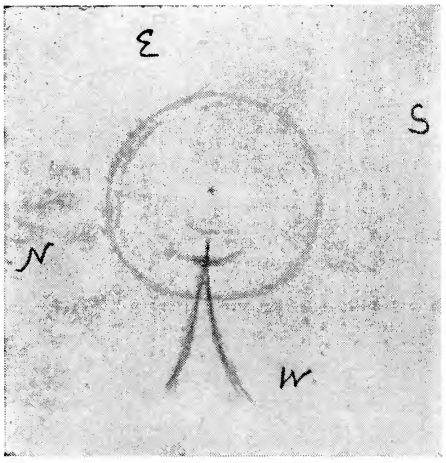
By Feb. 23, 11–12 p.m., co-long. 109°, the dark streaks and patches seen the night before had still further developed and darkened, as shown by a sketch I made at the telescope, which I made quite independently of Professor Pickering, as I had by now grown sufficiently familiar with the crater at full moon to identify it without reference to him.

My next chance of observing Aristillus after a completely cloudy night on Feb. 24 was on Feb. 26, 5–6 a.m., civil reckoning, co-long. 136°, when the sky began to clear shortly before sunrise, after being persistently cloudy up to 5 a.m. The dark patches had then faded, and the dark streaks grown narrower. A striking change was noted in the "short ladder" on the north side of the crater, this marking having grown much narrower, while the four cross streaks had disappeared. It had also grown fainter. A sketch was made at the telescope of the appearance of the markings on this morning.

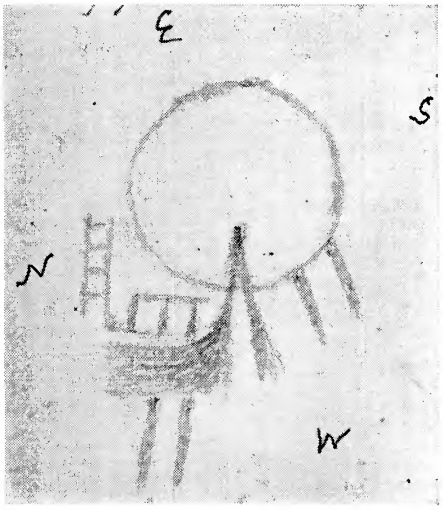
Eratosthenes.—This crater is in longitude 11° E. and latitude 14° N., so that the co-longitude for its noon is 101°, corresponding to its summer solstice. Its diameter is 37 miles, and the height of its walls 3 miles, the steepest slope of wall inside being less than 20°.

I observed it on Feb. 18, co-long. 47°, and Feb. 21, co-long. 84°, when Professor Pickering made rough sketches to enable me

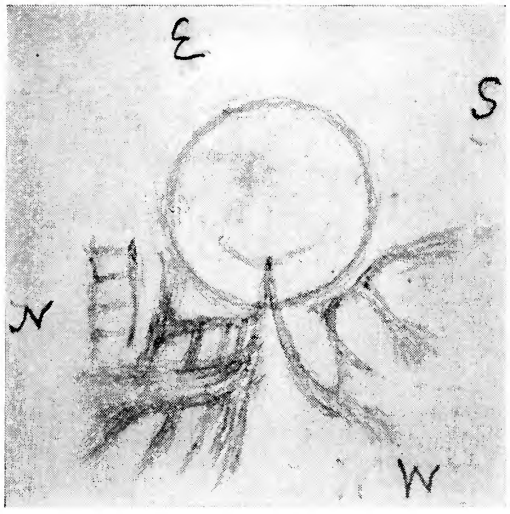
ARISTILLUS.



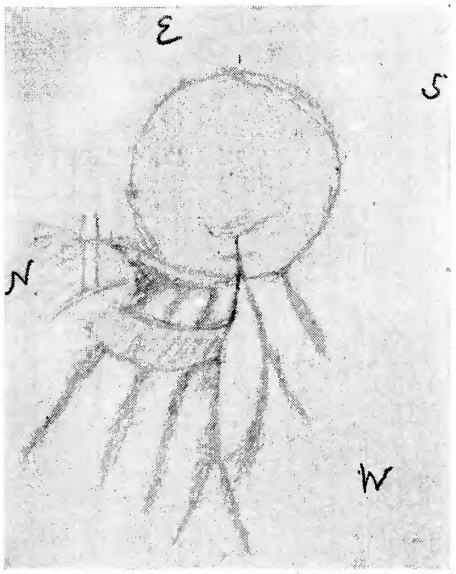
1921 Feb. 18, 11–12 p.m.
Co-long. 47°.



1921 Feb. 22, 11–12 p.m.
Co-long. 96°.

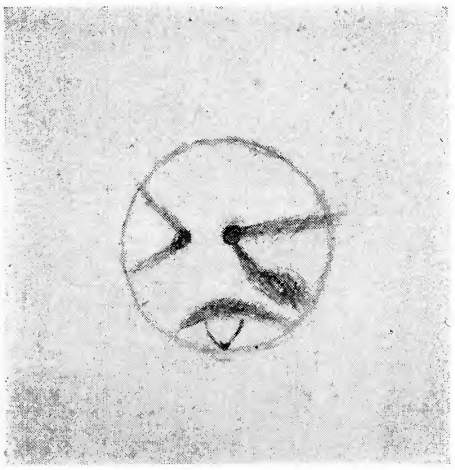


1921 Feb. 23, 11–12 p.m.
Co-long. 109°.



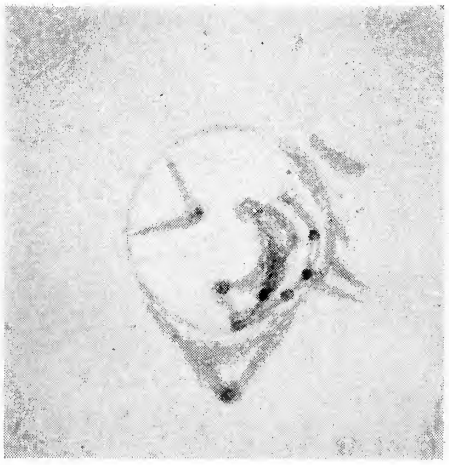
1921 Feb. 26, 5–6 a.m.
Co-long. 136°.

ERATOSTHENES.



1921 Feb. 22, 10–12 p.m.
Co-long. 96°.

1921 Feb. 23, 11–12 p.m.
Co-long. 109°.



1921 Feb. 26, 5–6 a.m.
Co-long. 136°.

to identify the crater; and on Feb. 22, 23, and 26 a.m., when I made sketches which are reproduced.

On Feb. 22, 10 p.m. to midnight, co-long. 96°, the dark markings inside the crater had developed, and in particular a V-shaped marking was seen inside the crater. I have not shown in my sketch any of the patches seen outside.

On Feb. 23, 11 p.m to midnight, co-long. 109°, the dark markings both inside and outside the crater had developed, as indicated in the sketch, which was made at a time when the sun was nearly vertical for the crater.

By Feb. 26, 5–6 a.m., co long. 136°, my next chance of observing, there was a remarkable development in the dark markings, as my sketch made at the telescope, quite independently, indicates. On this morning, as on Feb. 23, Professor Pickering did not make any sketch to guide me. The dark streaks, with small round patches in their course, made a very complex formation, which I copied as carefully as I could; and in the outer streak, within the crater on the west, there was a portion where it was distinctly divided into two very narrow streaks. A comparison made *afterwards* with a much earlier drawing of Professor Pickering's, at the same longitude, shows a very remarkable agreement in *all* the details both inside and outside the crater, which gives striking evidence of the permanence of these markings under similar conditions of co-longitude, corresponding to similar seasons of the lunar year for the crater.

It is to be noted that the three bright spots, presumably snow-covered peaks, shown on the sketch on Feb. 23, were also seen on Feb. 22 and 26, though not put in the sketches on these days, for lack of time.

In some of the markings on the figures the slight differences of tint have been somewhat exaggerated in reproduction.

Changes were also noted in the mountain-ridge Bradley, which lies to the north-east of the small crater Conon, near the crest of the highest portion of the Apennines. On Feb. 21 and 22 a bright extension of the range to the south-west was noted, indicating a fresh fall of snow since Feb. 18, when Bradley was first examined; while on Feb. 23 the end of the ridge was seen separated as a round bright spot, which appeared more distinctly separated on the morning of Feb. 26, indicating a melting of the snow under the influence of the sun's rays after noon, which occurred for the crater between Feb. 21 and Feb. 22.

The reappearance of Saturn's ring after the passage of the earth from the dark to the bright side was noted on Feb. 22, when it was seen as a very fine bright line, of estimated breadth 1″·0. On Feb. 23 it was brighter, and its estimated breadth had increased to 2″·0. The ring was quite invisible, though carefully looked for on Feb. 21, 10–12 p.m.

Downe, Kent:
1921 *April* 8.

Observations of Level with the Transit-Circle of the Radcliffe Observatory, Oxford, during the Great Earthquake of 1920 *December* 16. By Dr. A. A. Rambaut, F.R.S., Radcliffe Observer.

During my absence from home Mr. Robinson, first assistant at the Radcliffe Observatory, informed me of an unusual phenomenon observed by him in the course of his observations with the Transit-Circle on the early afternoon of December 16, which puzzled him considerably at the time, but which was traced by him to the passage of earth tremors from the great Chinese earthquake of that date, reported in the papers on the following day.

With a view to putting these observations on record, I asked him to send me a detailed account of the phenomenon, which seemed to me of unusual interest. His letter, practically as it was written, follows :—

"*Radcliffe Observatory, Oxford.*
"1920 *December* 16.

"DEAR DR. RAMBAUT,—In accordance with your desire I will give a few details of the remarkable phenomenon observed with the Transit-Circle on December 16, which caused so much perplexity at the time.

"Requiring a new determination of level-error by the ordinary Nadir observations, I seized an opportunity, indicated by the steadiness of the magnetometer, when the engine at the University Press was at rest.

"The images of the R.A. wires reflected from the mercury were found to be perfectly sharp, but after making one setting, *i.e.* by placing the wires, direct and reflected, in close juxtaposition, I was astonished to see the reflected image slowly move away until it reached a distance of about 4″ : it then, as slowly, returned to the direct wire, repeating this many times during the half-hour's observation from $0^h\ 55^m$ p.m. to $1^h\ 25^m$ p.m. At times the amplitude of the oscillation was rather greater than 4″, possibly 5″.

"There was a complete absence of tremor, or quick vibration and diffusion, such as those ordinarily observed, caused at certain times by the Press engine, and occasionally by heavy traffic.

"Mr. Balk's observations corroborated mine. I remarked to him that I had never seen a similar phenomenon, and that its cause must be investigated. I also said it might be traced to some defect in the mercury-trough, or, which seemed unlikely, the axis of the instrument must be changing its level.

"At first I thought that possibly the oxidation of the mercury was sluggishly seeking equilibrium, or perhaps that the mercury itself was too shallow in the trough. But after cleaning the surface I found the same variations proceeding as before. Urgent duties forbade our making further tests at the time. We therefore proposed to experiment on the following day with another mercury vessel. This was, however, rendered unnecessary