libratory motion, or to slew upwards towards the main stream, and therefore perpendicularly to their length.

Nothing could suggest to the mind more strongly the idea of converging streams of infinitely minute particles of matter passing through space at a distance from the earth less than that of the moon, and at which the earth's aërial envelope may still have a density sufficient, by its resistance, to give to cosmic dust passing through it with planetary velocity that slight illumination which it possessed.

The rapid development of the luminosity of these streams on this occasion is evidenced by the fact that they were observed at the time of leaving church, namely, 8 P.M. to 8.20 P.M., by none of the several congregations of this town and Perth, but were observed by many persons from a quarter to half an hour after that time, so far as I have yet been able to ascertain by a rather extensive inquiry. On coming out of church I myself certainly looked round the whole visible horizon and the higher portion of the heavens, and I made to a companion some observations on the clearness of the stars and dark blue colour of the sky; but about twenty minutes after my exit from church these streams of light had attained their maximum of illumination.

Their apparent figure was that of a nearly circular (slightly flattened) arc of an amplitude of 15° or 20°, as viewed from the middle point of its chord. Both the brightness and the convergence of the streams towards the western horizon were more marked than those towards the eastern horizon.

Fremantle, West Australia, May 17 J. W. N. LEFROY

PS.—Since writing the above, in the Supplement of the *South Australian Register* of Thursday, May 20, I have found the following paragraph :—

"A beautiful lunar rainbow was visible in the western heavens on the evening of Sunday, the 16th inst., a few minutes after 8 o'clock. For a short time the arch was nearly perfect, but for upwards of fifteen minutes the limbs were very bright. The southern limb also appeared visible for some time after the upper portion of the arch had faded away."

Now, allowing for the difference of local time between Fremantle and Adelaide, I think it fairly assumable that this paragraph must refer to the same phenomenon which I have attempted to describe as above; and, if so, it clearly shows that it was *not* a lunar rainbow. I can find no allusion to it in any Melbourne paper yet received here, and which reach to the 19th inst. There the sky may that evening have been cloudy, and thus have rendered it invisible. All intelligent persons here who observed it, and with whom I have had opportunity of conversing since the 16th inst. to this day, concur in my impression that minor lateral streams or feathers of light on the north side of the main stream intervened between the earth and the moon, and one or more of them in its slow librations swept the surface of the moon and sensibly obscured its light.—J. W. N. L.

May 31

"Instinct" and "Reason"

A FEW facts came under my observation during the spring of this year that strikingly illustrate this subject. A pair of blackbirds built a nest on the top of my garden wall, which is thickly covered with ivy and within three yards of the drawing-room window. When the young birds were about three parts fledged one of them by some mishap left the nest and fell into the flower garden. My cat (seven years old, and which has killed scores of small birds) immediately found it, and at the same time a kitten (about three months old, but not belonging to the cat) began to pay rather rude attentions to the young blackbird, and would have used it as kittens are wont, but the old cat would not suffer her to touch it. The cause of this was the old cock blackbird, being aware of the peril of its young, made a great noise and kept flying here and there around the scene of action, crying and scolding with might and main. It then became evident to me that the cat had two or three objects in view, and a purpose to gain. Firstly, not to allow the kitten to touch, or kill, or make off with the young bird. Secondly, to use the young bird as a decoy to entrap the old one. Thirdly, to make the young bird cry sufficiently from fear or pain to induce the parent's affection to overcome its discretion.

During the manœuvres old Tom repeatedly made unsuccessful springs to catch the cock-bird, alternately running to give the kitten a lesson of patience, or self-denial, or impose a fear of punishment. The young bird repeatedly hopped out of sight amongst the flowers and stinted its cries; then anon the cat touched it again and made it flutter about and cry again, which from time to time brought the old bird down with cries of terror, or wrath, or a blending of both emotions, and almost into the very mouth of the cat. Two or three times I thought old Tom was successful, but no, he missed his object most surprisingly. It became evident to me that the cat was using the young bird as a decoy to catch the old one. After I had watched some ten or fifteen minutes, it became too painful for me to witness, so I caught the young bird and put it again into its nest, which was about ten feet from the ground.

In less than an hour the young bird was again on the ground, the cat, kitten, and parent bird performing the same drama, with this difference in the acting: the cat lay down, rolled about, or sat at a convenient distance from the young bird, yet with eyes alert, though half shut, and otherwise giving an assurance that he did not intend to make another bound without succeeding to catch his prey. He was, however, disappointed, and made four without achieving his purpose. At this juncture the mother-bird came on the stage with cries of distress, but kept aloof on the branches of a tall cherry-tree that rises above the wall; and if her boldness were less than the cock-birds's, her discretion was greater, for she kept far aloft. Once it seemed to me that the cock-bird actually struck the back or head of the cat with his wing and mandible. This scene continued about seven or ten minutes, when I again caught the young bird and threw it over the wall, and the exhibition of animal thought, emotion, and passion ceased.

Here were manifested phenomena of a more remarkable kind than those seen in the cases cited by the Duke of Argyll in the *Contemporary Review* for July, in an article to illustrate "Animal Instinct in relation to the Mind of Man," for the cat showed an amount of reasoning which he probably never before exercised, because never before placed in the same circumstances. That he had used young sparrows, of which he must have caught scores, as decoys to catch the old ones is possible, but I am perfectly sure that no kitten ever was in the garden during his reign as "monarch of all he surveyed" in the shape of birds. Hence his authority over the kitten, which was full of life and eagerness to appropriate the young bird, the killing of which would have defeated the purpose of the cat in using the young bird as a decoy to catch the old one, was indeed remarkable, and disclosed a combination of mental forces of self-conscious reason of no trifling order, and, as it appears to me, conclusive that the difference—and only difference—between instinct and reason is one of degree. JAMES HUTCHINGS

Banbury, Aug. 16

OUR ASTRONOMICAL COLUMN

DOUBLE STARS.—Dr. Doberck, of Markree Observatory, has published a first approximation to the elements of ζ Aquarii, on measures between 1781 and 1870, in which long interval, however, the angle of position has only changed 45°—a case where very great latitude must be allowed to any orbit that may be deduced. Dr. Doberck fixes the peri-astron passage to 1924·15, and assigns a period of revolution of upwards of 1,500 years. The latest measures we have met with are those of Nobile, taken at the Observatory of Naples in November 1873, giving the angle 335°·5, or 3°·4 greater than that calculated.—There appears now a probability that the smaller component of 44 Bootis has passed its greatest apparent distance from the primary several years since: if good measures of distance have been made this year, they ought to be sufficient to enable us to pronounce definitely upon this point. That this star forms a true binary there can be no doubt, though it is Sir W. Herschel's measures in 1781 and 1802 alone, that afford conclusive evidence of the physical connection of the components. Thus we might represent the measures between Struve's earliest in 1819 and the present time by the formulæ

$$\Delta\,\alpha = -\,3''\cdot4233 - [8\cdot8968]\,(t - 1830\cdot88)$$
$$\Delta\,\delta = -\,1\cdot6979 - [8\cdot3115]\,(t - 1830\cdot88)$$

But if we calculate from the same formulæ for Sir W. Herschel's epochs we find,

1781·62	Position	156°·1	Distance 0″·75
1802·25	,,	214·8	,, 1·35

These are greatly at variance with the positions observed, which show that the companion was then in the following semi-circle, and by the estimates of distance had approached the primary between 1781 and 1802. Barclay's epoch 1871·4 assigns a distance less by o″·35 than was observed at Leyton in 1866, which is confirmed by Dembowski's measures about the same time. There is in the case of this star a very unusual discordance between the distances of Struve and Dawes, which attains a maximum, o″·45, about 1836-5; in deducing the above formulæ Struve's measures were employed. The rate of increase in the distance has been diminishing, until by Dembowski's measures, 1863-68, it was less than o″·01 annually; the orbit is evidently inclined only a few degrees to the line of sight, so that the companion made a very close approach between 1802 and 1819.—If the angles of position, in the case of Σ 1819 between 1828 and 1870 are projected, it will appear that the velocity has been diminishing from about 2°·1 in 1840, to 0°·85 at the end of the period, which with the accompanying increase of distance confirms Struve's judgment as to orbital motion; there is already a diminution of angle of nearly 70° since the first Dorpat measures.—It may be hoped that Σ 2107 has not been forgotten this year.

M. LEVERRIER'S THEORY AND TABLES OF SATURN.—We learn that M. Leverrier has completed his long-continued and exhaustive investigations on the motion of Saturn, and that his theory is reduced into tables, which will of course speedily take the place of those of Bouvard, or of provisional tables which have been used in the preparation of one or two of our ephemerides, pending the publication of others founded upon a more complete theory and discussion of the observations from the time of Bradley. As in all Leverrier's previous researches of a similar nature, he has made use of the rich store of observations accumulated at the Royal Observatory, Greenwich during upwards of 120 years, and also of the long series which has been formed at the Observatory of Paris. The mathematical astronomer will await the publication of M. Leverrier's researches in detail with extreme interest. The Tables of Saturn are understood to be necessarily of considerable extent, with the view to their convenient application.

THE GREAT COMET OF 1819.—The parabolic orbits so far computed for this comet, which was observed from the beginning of July to the middle of October, do not represent the observations with sufficient precision, and it is probable that no parabola will be found to do so. The following may, perhaps, be closer than any yet published:—

Perihelion passage 1819, June 27·71547, Greenwich M. T.					
Longitude of perihelion	...	287°	8′	11″	Mean equinox July 0
Ascending node		273	41	57	
Inclination	...	80	44	38	
Log. perihelion distance	...	9·533233			
Heliocentric motion	... ...	direct.			

But this orbit exhibits differences from the observations of a kind that should probably be attributed to deviation from parabolic motion, and as we are in possession of many of the original observations, it would be desirable to discuss them with the view of determining the true character of the orbit in which the comet was moving. Its transit over the sun's disc, a nearly central transit, early on the morning of June 26, and the suspicion that it was actually observed upon the disc by Pastorff at Buchholz, or, as is even more probable, by Stark at Augsburg, give it a peculiar interest. The diagram of the comet's path across the sun, which appears in the "Berliner Astronomisches Jahrbuch," is erroneous; it would pass in greater longitude than that of the sun's centre, as indicated by the above elements, which in this respect are confirmed by the orbits of Nicolai, Dirksen, and Cacciatore. For the centre of the earth the ingress took place June 25 at 16h. 52m·9 mean time at Greenwich, 172° from the sun's north point towards the east (direct image), and the egress at 20h. 29m·9, about 9° from the same point to the east. For the time of transit the elements, no doubt, assign the comet's position within 15″ or 20″. The larger differences from observation are in August.

SCIENCE IN GERMANY

(*From a German Correspondent.*)

IN continuation of the previously reported investigations of the formation of cells in the ovum, we may mention some observations of Kupffer, which relate to a hitherto rather unknown yet doubtless very widely spread structure of the animal cell. ("On the differentiation of protoplasm in the cells of animal tissues," from "Schriften des naturwissenschaftlichen Vereins für Schleswig Holstein," Heft. iii.; and "The salivary glands of *Periplaneta orientalis* and its nervous system," from "Beiträge zur Anatomie und Physiologie, als Festgabe Carl Ludwig zum 15 Oct. 1874, gewidmet von seinen Schülern.") Kupffer first discovered that the body of the cells from the liver of a frog, which coat the biliary vessels, consists of two substances which chemically and physically are widely different, while hitherto it had been considered homogeneous throughout and had been called protoplasm. A hyaline ground substance (Paraplasm) gives to the body of the cell its relatively firm exterior shape, while in its interior a moveable, grained protoplasm is found in varying arrangement. It appears as a central mass round the nucleus, from which ramified or reticular threads radiate to the exterior side of the liver-cells which is turned towards the blood-vessels, or to that which borders the biliary vessels. From this arrangement of the protoplasm, which slowly flows in the well-known manner, Kupffer surmised that these were the ways in which certain matters were conveyed from the blood into the biliary vessels; and he found his opinion confirmed when he introduced soluble colouring matter into the blood of the living animals. As the colour entered through the liver-cells into the biliary vessels, it indicated its course through the cells in most cases in exactly the same way in which formerly the protoplasm proper had been found arranged. Similar facts were found in respect to the liver and kidneys of other Vertebrata, in the young back-teeth of calves, in certain glands of insects (Malpighian bodies). In the salivary glands of the well-known "black beetle" (*Periplaneta*), Kupffer not only found a very soft net of protoplasm-threads inside the ground-substance of the cells, but he also proved their connection with nerve ends. This likewise supports the view that the substance of the animal cell is differentiated in a manner similar to that of the vegetable cell, viz., that it consists of an active material which remains moveable and fulfils the special physiological functions of the single cell (protoplasm), and of a more passive material which forms a sort of protecting receptacle, as it were, for the tender protoplasm (Kupffer's paraplasm).

The "Archiv für mikroskopische Anatomie," edited by La Valette St. George and Waldeyer, has produced the following papers in its eleventh volume, up to this date:—Part I. On Radiolaria and fresh-water Radiolaria-Rhizopoda, by Greeff.—On bone growth, by Strelzow.—Researches on the physiology of the kidneys, by Wittich.—Studies on Rhizopoda, by F. E. Schulze.—Researches on the ganglion globules of the spinal ganglia, by Arndt.—On Heitzmann's hæmatoblasts, by Neumann.—On tissue cells by Waldeyer. Part II. The Ventriculus terminalis of the spinal marrow, by Krause.—Remarks on the nerves of dura mater, by Alexander.—Studies on the development of bones and of bone-tissue, by Stieda.—On the peripherical part of vertebræ, by Ehrlich.—The perivascular lymph-spaces in the central nervous system, and in the retina, by Riedel.—On cement layers in the tissues