mercury connected metallically to the earth; and the wire on the inside of the tube was connected to a quadrant electrometer. Under these conditions, positive electricity was discharged from the wire, for five or six minutes, and the electrometer indicated the accumulation of a negative charge. After the expiration of ten minutes, the electrometer indicated the accumulation of a positive charge, and the emission from the wire of negative electricity. This is in accord with the accepted views as to the charges carried by the α and β rays. Radium A radiates α rays only, and radium C, both α and β rays. Further, radium A disappears in ten minutes, so that the α rays, coming from radium A and radium C, passing through the rubber, caused a negative charge to appear on the wire for the first few minutes. After ten minutes radium A disappeared, and the positive charge appearing at that time was due to the β rays of radium C, the β rays passing through the rubber more easily than the α rays.

In the second series of experiments, a wire was made radioactive as before, and placed inside of and coaxial with a metal tube, the diameter of which was very slightly greater than that of the wire. The metal tube was made air-tight, and the air within it rapidly exhausted to a pressure of about one tenth of a millimeter of mercury. The wire being connected to the electrometer, and the tube to earth, the deflections of the electrometer indicated a continual accumulation of a positive charge from the very start. A series of careful measurements were made of the rate of discharge of negative electricity from the wire at different instants of time after the wire had been taken out of the emanation. These measurements showed plainly that the rate of discharge of negative electricity was not proportional to the ordinary ionization effect of the induced activity; that is, was not proportional to the quantity of radium A and C present on the wire. The curves, representing the decay of the rate of emission of electricity, are much steeper than those representing the rate of decay of the ionization currents, except for the first ten minutes. They agree, approximately, with the theoretical curves, given by Rutherford, representing the sum of the quantities of radium B and radium C on the wire. From this we may conclude that radium B, which hitherto has been considered non-radioactive, emits, approximately, as much negative electricity as does radium C.

If the tube and wire are placed in a magnetic field, so that the lines of force of the field are parallel to the axis of the tube, the rate of emission of electricity is considerably decreased. Further, an electromotive force of a few volts will stop a portion of the discharge of electricity. From these two experiments, it appears, using the usual formulas, that the ratio of the charge to the mass of the carriers of this negative electricity is, at least roughly, equal to that of the β rays. The experiments, however, give only the order of magnitude of this ratio. The velocity, too, of the carriers is very much smaller than that of the β rays, which explains the fact that the rays do not pass through the thin rubber tube, and do not produce a sufficient ionizing effect, to have been discovered by the ionization of gases. The small velocity indicates that the carriers are probably similar to those called by J. J. Thomson δ rays.

A much more detailed account of the experiments will be published as soon as the absolute quantity of electricity emitted by a given quantity of induced activity has been measured.

WILLIAM DUANE.

THE USE OF ASTRONOMICAL TELESCOPES IN DETERMINING THE SPEEDS OF MIGRATING BIRDS.

DURING the spring and fall of 1905 there was developed at the University of Illinois Observatory a method of determining the heights of migrating birds. Two observers watched the moon's disk at night through small telescopes placed some distance apart, and from the different paths seen projected against the moon from the two stations, it was possible to compute the height and direction of flight for each bird. These methods and results are given in papers by Messrs.

Stebbins[1] and Carpenter.[2] It was found that the migrating birds flew much lower than has hitherto been supposed, most of them being less than 1,500 feet from the ground at the time of observation.

The writers of the present article have recently used the same instruments for the purpose of measuring the speeds of migrating birds. The theory of the method is simple enough. Observer F. with a three-inch telescope, was stationed 200 feet south of S., who used a four-inch instrument. On seeing a bird, F. would call 'time' when it left the disk, and S. estimated the interval in seconds until the bird had passed off the moon's edge from his point of view. By drawing a figure it may easily be seen that in the observed interval, the bird had crossed a space not less than the distance between the stations. The lines joining the two observers with the moon were parallel and 200 feet apart, measured horizontally from south to north. From the time required to pass 200 feet, the speed of the bird in miles per hour was derived.

We were successful with this method on only one night during the last migrating season, May 18, 1906. F. at the south station called 'time' for ten different birds, of which three were seen by S. At the signal 'time,' S. would count seconds to himself: 'and, one, and, two, and,' etc., the first 'and' being a half second after 'time,' another half second interval to 'one' and so on. Both of us have had some years' experience in observing transits of stars by the 'eye and ear method,' and we believe these results more accurate than could be obtained with a stop watch.

Two birds crossed the space of 200 feet in one second, and the third in a second and a quarter. The data and results may be summed up in the following table where a correction of 0.2 second has been added to the observed interval to allow for the velocity of sound.

MAY 11, 1906. WIND S.W., 14 MILES PER HOUR.

Bird	1	2	3
Time of observation	11.30	11.38	11.50
Time to travel 200 ft. (in sec.)	1.0	1.25	1.0
Corrected time	1.2	1.45	1.2
Speed in miles per hour	114	94	114

It should be remembered that these are minimum speeds, for if the birds were not traveling due north they passed over more than 200 feet between observations. From the directions of their projected paths we would conclude that they were actually flying northeast, but we devoted nearly all of our attention to the estimate of times. We consider these results to be correct within ten or fifteen per cent., and, therefore, place the observed minimum speeds between 80 and 130 miles per hour. To obtain the actual motion through the air, these quantities should perhaps be reduced by fourteen miles per hour, the velocity of the wind as shown by an anemometer. The birds were flying nearly with the wind.

To one who has not tried this method, the question at once presents itself: How was it known that both observers saw the same bird? When one has kept his eye fixed at the end of a telescope for five or ten minutes seeing nothing but the moon, and a bird appears within a second after his companion calls 'time,' there is no doubt in his mind that one and the same bird was seen. Moreover, it is possible to show that the path seen by the second observer was in prolongation of that recorded by the first.

It is unfortunate that we did not secure more observations. The observers interchanged places and watched for another half hour, but no more birds were seen from both stations. In all F. saw about thirty-five birds and S. fifteen during the period $11^h\,20^m$ to $12^h\,20^m$ on the above night. We tried on the two succeeding nights, but there were passing clouds, and apparently fewer birds were flying.

So far as we know this is the first time that two telescopes have been used to determine the speed of birds at night. Professor F. W. Very,[3] working at the Ladd Observatory,

[1] Stebbins, Joel, 'A Method of Determining the Heights of Migrating Birds,' *Popular Astronomy*, **14**, 65, February, 1906.

[2] Carpenter, F. W., 'An Astronomical Determination of the Heights of Birds during Nocturnal Migration,' *The Auk*, **23**, 2, April, 1906.

[3] Very, F. W., 'Observations of the Passage of Migrating Birds across the Lunar Disk on the

Providence, R. I., deduced from the time required to pass across the moon's disk, a speed of about 130 miles per hour for some birds. Our results agree closely with his, although the methods are very different. He had to assume the size of the birds in order to compute their distances and speeds, while with two telescopes the results are independent of any assumption as to size or distance. On the other hand, it is possible to secure many more observations with a single instrument than with two, so there are disadvantages in both methods.

With three telescopes it would be possible to measure both the heights and speeds of birds as they fly across the moon. Two observers about ten feet apart in an east-and-west line could obtain data for the heights, while the speeds could be determined by a third observer situated a hundred yards north or south of the others. In short, given a clear night, the moon about full, plenty of birds in flight, and a battery of telescopes, the conditions are perfect for an easy solution of the problem of the heights and speeds of migrating birds; but it will be seldom that all of these requirements are fulfilled at the same time.

JOEL STEBBINS,
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UNIVERSITY OF ILLINOIS OBSERVATORY,
May, 1906.

A WORKABLE BED OF COAL IN NEBRASKA.

ALTHOUGH for years past the state legislature of Nebraska has offered a bounty amounting to four thousand dollars for the discovery of a twenty-six-inch bed of workable coal, and five thousand for a thirty-six-inch bed, it is only within the past few days that any one has filed with the governor legitimate claims for the bounty. The bed of coal recently exposed, near Peru, Neb., extending some forty-two feet along the sides of a tunnel back from the banks of Honey Creek, seems to be fully thirty-four inches in thickness, as measured by the writer. This is known as the Honey Creek or Peru coal mine. The seam is level and readily accessible; the mine, being ten feet above the creek, is easily drained and transportation is at hand. While the extent of the newly discovered bed is a matter of conjecture, the farms near and adjacent to the Peru coal bed are likewise underlaid probably with the same seam of coal, judging from scattered surface indications. It is reasonably certain that a resource of local interest will be developed, and for a time at least Nebraska may lose its distinction 'the state without a mine.' As to the quality of the coal, whether good or bad, matters little, for any coal is good in a state supposed to be destitute of natural fuel. Analyses of the Honey Creek coal made by Mr. L. J. Pepperberg, a fellow in the department of geology in the University of Nebraska are given in the table.

It must be remembered that the following analyses are made from samples which are close to the surface, badly weathered, therefore representing the worst rather than the best of this coal.

By the time the tunnel has been extended one hundred feet the overlying shales will be about fifty feet in thickness and the coal will presumably be of better quality. Across the

	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Total.	B. T. U. per Pound of Coal.	Volatile Matter Per Cent. of Combustible.	Fixed Carbon Per Cent. of Combustible.
Sample No. I., air-dried	10	45.25	36.28	8.47	100	12,621	55.50	44.50
Sample No. II., water-soaked as mined	32.22	28.54	19.38	19.86	100	7,492	54.80	45.20
Sample No. III., lignitic coal, Cumberland, Wyo., for comparison	3.65	44.27	46.18	5.90	100	14,100	54.90	45.10

Nights of September 23 and 24, 1896,' SCIENCE, N. S., 6, 409, September 10, 1897.