by the definite tidal oscillations of the Atlantic Ocean and the North Sea at the two ends of the Channel; this view had been contested by Börgen, but the consequences of the view were misinterpreted by the latter. Dr. Defant shows that not only the co-tidal lines and tidal ranges, but also the phase and speed of the tidal currents in the Channel, can be explained on the basis of Airy's ideas, taking surface friction at the channel-bed into account, and also the rotation of the earth. He finds that the latter affords an explanation of why the tidal range on the French coast of the Channel is greater than that on the English coast. For the sections of the Channel near the east opening into the North Sea the calculations cannot be executed with the accuracy elsewhere obtained, owing to the approximation of the ocean-tidal period to the free period of lateral oscillation across this broad part of the Channel. But even here the chief features can be derived by interpolation, and throughout the remainder of the Channel all the important features of the complex Channel tides receive satisfactory theoretical explanation.

THE paper read by Gen. Squier to the U.S. National Academy on April 27 on "Multiplex Telephony and Telegraphy over Open-circuit Bare Wires Laid in the Earth or Sea" has excited great interest amongst radio-telegraphists, who find it difficult to make out whether we are on the eve of important developments or not. Gen. Squier has established communication for a distance of three-quarters of a mile over the Potomac River by means of a bare No. 12 phosphor-bronze wire laid directly in the water. The transmitter consisted of an electron tube oscillator, which produced a current of about 270 milliamperes at a frequency of 600,000. At the receiving end of the line an electron tube and a six-stage amplifier were used without any earth connection. With this arrangement good tuning could be obtained at either end of the line, and satisfactory telegraphic and telephonic transmissions secured by means of the bare wire immersed in fresh-water. In another experiment telegraphic and telephonic transmission were obtained between two stations three-quarters of a mile apart by means of a No. 16 copper wire buried in the earth to a depth of about 8 in. It will be seen that if the method develops satisfactorily it will have commercial possibilities. The best Atlantic cable cannot operate at a frequency greater than 10 per second, and 80 volts is the highest voltage that can be applied to work it. There is scope, therefore, for development in submarine telegraphy. Gen. Squier suggests that experiments should be made with bare wires in sea-water to determine what arrangement will give the best results. He points out that with this method there will be no distortion of the signals, and so there is no limit to the distance of transmission, and the receiving apparatus will be comparatively simple. It is also possible to transmit simultaneously several signals, both telephonic and telegraphic, over the same wire by using different frequencies. The method is an attractive one, and seems to have arrived at the stage where commercial research can usefully be started.

Our Astronomical Column.

PHOTOGRAPHS OF THE BRORSEN-METCALF COMET.—The *Astrophysical Journal* for March contains some photographs of this comet taken by Prof. Barnard on 1919 October 5, 6, 20, and 22. The tail is shown as fully 6° long, composed of several narrow straight streamers forming a fan. They radiate from a point somewhat behind the centre of the head. About October 20 the comet discarded its tail, and formed a new one inclined 12° to the old. Prof. Barnard notes that similar phenomena have been observed in Borrelly's comet, 1903 July 24, in Morehouse's comet on several dates in 1908, and in Halley's comet on 1910 June 6 (probably also in April).

In each case the new tail appears to move out faster than the rear portion of the old tail. Prof. Barnard conjectures that the latter is formed of larger particles, the motion of which would be slower.

He has combined successive cometary photographs in the stereoscope in the endeavour to determine the configuration of the tail in three dimensions. Care is, of course, required to distinguish true stereoscopic effects from spurious ones. It is stated that the tail of Morehouse's comet on October 15, 1908, resembled "part of an open sack, or a partly opened scroll."

THE PLANETARY FAMILIES OF COMETS.—The report of the nineteenth meeting of the American Astronomical Society contains a paper on this subject by Prof. H. N. Russell. He notes that the orbits of the six comets of the Neptune group all pass considerably closer to the orbits of Jupiter and Saturn than they do to that of Neptune. His first conclusion was that these comets had been captured not by Neptune, but by Jupiter. He analysed the orbits of the periodic comets with the following result:—

Thirty-six comets on his list have periods of less than ten years. The orbits of all these, except Encke's, pass within 0·65 of Jupiter's orbit, while seventeen of them pass within 0·15 of it.

Thirty-one comets have periods between ten and one thousand years. Of these, seven pass within 0·5 of Jupiter's orbit, five within the same distance from Saturn's orbit, and two within this distance from Uranus's orbit, the nearest approach to Neptune's orbit being 1·22.

Prof. Russell has calculated the proportion of the thirty-one comets that would pass within 0·5 of each orbit on the hypothesis of chance approach, and finds that it is six for Jupiter, three for Saturn, one and a half for Uranus, and one for Neptune. Hence he concludes that the observed figures give little evidence of capture by any of the planets.

There is, however, a point not noticed by Prof. Russell, which is that the periods under a century range themselves into four definite groups, the mean period of each group being about 0·4 of that of one of the giant planets. This gives strong ground for postulating a connection with these planets. Since Halley's comet has been observed for more than two thousand years, there is no difficulty in assigning to it a life dating back to the time when its orbit intersected that of Neptune. The longer the period of a comet the less frequent are the occasions when it is subject to serious disruptive influences, and consequently its disintegration is likely to be less rapid. It appears to the writer of this note that Proctor's suggestion that the periodic comets are the products of eruptions from the giant planets deserves more attention than it has generally received.