of a few breakers with longer period, corresponding to a deep-water speed of 69·5 m.p.h. The interval between the beginning of the first and the end of the last was 52 minutes, which strongly suggests that they were waves from the squall-struck portions of the stormy sea which outran their neighbours. The time occupied in arrival by the individual groups was from 1 to 2 minutes, which is normal for the duration of a short squall. The figures so far given suggest that the maximum speed of waves is somewhere about $\frac{8}{10}$ths that of the wind as maintained for one hour, and that a squall lasting for a minute or two can speed-up waves which have already been developed. Once when the waves were flattening down in a dying storm in the North Atlantic, I actually saw a travelling squall increase by some feet the height of the few waves subject to its force.

The observations during the fine-weather voyage on which an anemometer was used provide important evidence of the effect of crossing swell in hampering the development of waves by wind. The restriction of height was palpable to the eye. The restriction of speed was measured. With no swell, or with a concurrent swell, as in the Trades, the speed of the wave was only 1·85 m.p.h. less than that of the wind, but with a swell following obliquely the difference was 3·725 m.p.h., and when crossing at right angles or meeting the waves, 7·2 miles per hour.

A result of practical importance to seamen and meteorologists emerged from the observations on days of crossing swell. When this was oblique to the waves the curl, or break, on the water was considerably deflected and therefore ceased to be a trustworthy indication of the direction of the wind.

The following explanation is suggested of the effect of swell to hinder the wave-making action of wind. When there is no swell and the waves have attained considerable steepness a series of travelling eddies is established in the adjacent air with permanent undulations above, and this arrangement nurses the waves. If, however, a swell be also running, the pattern of the inequalities changes all the time, continually deforming the superimposed air, and making its action irregular. If the swell meet the waves, the pattern undergoes rapid change, and the rhythmic action of the wind is greatly hindered; if it follow the waves their pattern changes slowly and the rhythmic action of the wind is less impaired. When the swell cuts squarely across the waves the surface is patterned in cups and cupolas instead of ridges and furrows, which tends to set up air-whirls with vertical instead of horizontal axis, a condition which imposes an additional hindrance to wave-making.

The extent to which swell kept down the waves when crossing obliquely or squarely suggests that the rapid rise of waves on large lakes is not solely due to peculiarities of local winds but is aided by the fact that no residual swell hampers the action of the wind, as usually happens when it comes on to blow at sea. There is one condition at sea, however, when the development of waves is more rapid than in lakes, namely, when it comes on to blow in the direction of the swell already running and with a speed greater than that of the swell. This was the condition which so quickly created the huge regular waves of December 21, 1911, in the Bay of Biscay.

OBSERVATIONS BETWEEN TRINIDAD AND USHANT.

(Speed of wind as maintained for about one hour measured by Robinson anemometer.)

DIFFERENCES OF SPEED BETWEEN WIND AND WAVE, GROUPED ACCORDING TO DIRECTION OF SWELL.

Direction of swell.	Character of swell.	Date of observation (1914).	Amount by which speed of wind exceeded that of wave.	Average difference of speed in statute miles per hour.
Concurrent with waves	High, quick period, slow progression	Feb. 18	1·2	1·85
		,, 19	2·5	
	Quick period, slow progression	,, 20	3·9	3·725
		,, 21	3·3	
Following the waves obliquely	Slow period, quick progression	,, 28 (P.M.)	3·3	
		Mar. 1	4·4	
One concurrent, one at right angles	That at right angles very slight	Feb. 23	3·1	3·1
One following obliquely, one at right angles	That at right angles very slight	,, 22	6·3	6·3
Swell at right angles, or meeting obliquely	High, with slow period and swift progression	,, 26	6·0	7·2
		,, 27	7·7	
		,, 28 (A.M.)	7·9	

Mars in 1926.

By Dr. W. H. STEAVENSON.

THE present apparition of Mars is, for observers in the northern hemisphere, the most favourable that has occurred for many years. The planet, which was at opposition on November 4, made its closest approach to the earth on October 27, on which date its distance was approximately 42,600,000 miles and its apparent diameter 20″·4. On August 22, 1924, the distance was 8,000,000 miles less and the apparent diameter so great as 25″·1 (practically the maximum possible), but on this date the planet, at its greatest altitude, was not more than 21° above the horizon of London; whereas, on October 27, 1926, it crossed the meridian at an altitude of 53°. This increase of 32° was more than sufficient to make up for the shrinkage in apparent diameter, with the result that observers in Great Britain have, in general, been able to obtain more satisfactory views than at the closer approach of two years ago. Not until 1941 will there occur an equally favourable combination of altitude and apparent diameter.

In 1926, as in 1924, it is the southern hemisphere of Mars that is presented most favourably for observation, and this always happens at close oppositions of the planet. The Martian season at the time of opposition was not, however, quite the same on each occasion. In 1924 the planet was most favourably placed for observation during the early summer of its southern hemisphere, whereas in 1926 the summer solstice of this hemisphere occurred more than two months before opposition, so that we have a satisfactory seasonal overlap in the observations made in the two years.

The results of this overlap have been very evident

this year in the reduced size of the South Polar cap at the date of opposition, and also in the more advanced development of the usual seasonal changes in the dark markings. These changes, both of colour and intensity, are now firmly established facts, and can be predicted with considerable accuracy. But almost more interesting are those less regular changes of form and intensity which have not yet been found to conform to any definite law. They thus provide an element of variety in our observations of the planet, and, as they are often on quite a large scale, afford opportunities of useful and interesting work to the possessors of moderate-sized telescopes.

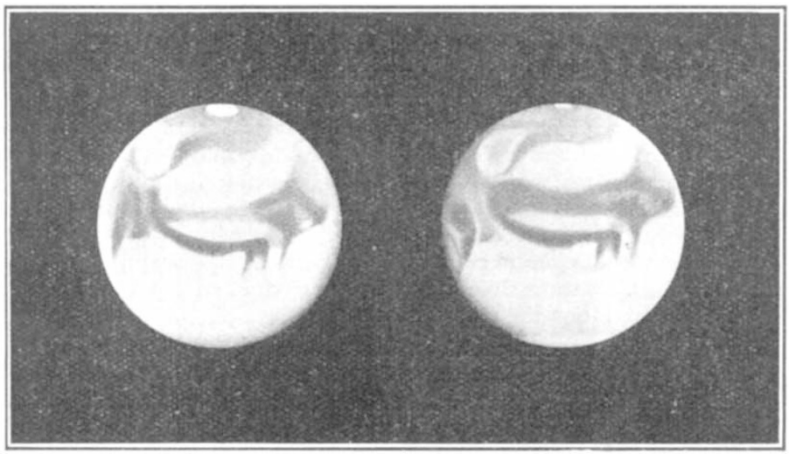

FIG. 1.—Aspects of Mars, September 1924 and October 1926, showing changes in the characters of *Sinus Sabaeus* and *Pandorae Fretum*.

Several changes of this kind have actually occurred since 1924, and some of them have been sufficiently extensive to be visible with quite small instruments. Figs. 1 and 2 show two of the more conspicuous alterations that have so far been noted. Just below the centre of the disc in the two views forming Fig. 1 is a dark belt-like marking. This, the *Sinus Sabaeus*, is nearly always a conspicuous feature; but above it, and separated from it by a lighter strip, is another dark streak, known as *Pandorae Fretum*, which is subject to marked changes from time to time. It will be observed that, whereas in 1924 it was faint and tapered towards the left, it was in 1926 much darker and approximately of the same breadth throughout. So far as the increase in intensity is concerned, the change is partly of a seasonal character, though the darkening took place earlier in 1926 than in 1924. But in the latter year the marking never attained quite the same breadth, so that to this extent the change is anomalous. More striking still has been the change observed in *Solis Lacus*, shown in Fig. 2. This marking, which lies in a region often referred to as the "Eye of Mars," will be readily recognised on both sketches just above the centre of the disc. Irregular changes in the size and outline of the *Lacus* have occurred several times during the past century, but for some years now it has generally appeared roughly pear-shaped, with a thick 'stalk' connecting it with the dark areas on the left. It was of this shape in 1924, as indicated by the first sketch, but since then a complete transformation of its outline has taken place. This, as will be seen, has been brought about by a wide extension of the free end of the 'pear' in a northerly direction, and this extension is much deeper in tone than was any part of the marking in 1924. Further, minor changes in the neighbouring regions will also be noted.

A satisfactory explanation of such gross changes as these, affecting thousands of square miles of the planet's surface, cannot at present be advanced; but if we assume, as now seems reasonable, that the dark areas of Mars represent tracts of vegetation, it appears possible that the irregular effects observed are due to seasonal abnormalities, such, for example, as the occurrence of unusually wet or dry summers.

There is need, however, for more study before we can reach confident conclusions upon the matter. Fortunately, the observations necessary are not of great delicacy, being in fact well within the range of the instruments commonly at the disposal of amateurs. In the writer's opinion, much valuable time and trouble has been wasted in the past in attempts to observe and delineate the more minute details of the surface of Mars. Such fine detail can at the best be only imperfectly seen in common instruments, and there is room for much difference of opinion as to its precise nature. On the other hand, the extensive modifications of outline and intensity already described are quite beyond all question, and present to us a most interesting problem to which there is good hope of an ultimate solution. Observations made on these lines will increase in value with the lapse of time, and will for many years to come provide profitable work for much smaller instruments than were at one time thought necessary for a successful study of the planet.

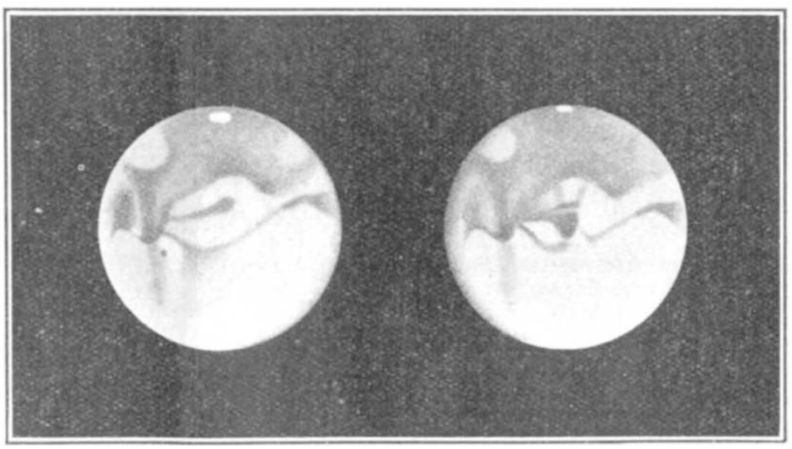

FIG. 2.—Aspects of Mars, October 1924 and October 1926, showing changes in the character of *Solis Lacus*.