If $dN/dg$ is negative, the line should increase in intensity as $g$ decreases, that is, from dwarfs to giants; and vice versa if $dN/dg$ is positive. In calculating $dN/dg$ two alternative assumptions may be made: either we may take $\kappa$, the coefficient of general absorption of the stellar atmosphere, to be constant, or we may attribute opacity to photoelectric processes and put $\kappa = \alpha P/(kT)^{9/2}$ according to the calculations of Kramers and Eddington, $\alpha$ being a universal constant, $T$ the temperature, and $P$ the electron pressure.

If $\kappa$ is taken as constant, the sign of $dN/dg$ is found in every case to be in accordance with the qualitative predictions of the simple Saha theory; for neutral atoms we find $dN/dg > 0$, which is, however, in contradiction with observation. But if we take $\kappa = \alpha P(kT)^{9/2}$, $dN/dg$ is found to be negative. This is in agreement with observation. Thus observation decides against the assumption $\kappa =$ constant and in favour of the physically acceptable law $\kappa = \alpha P/(kT)^{9/2}$. The origin of this marked difference resides in the differing behaviour of $P_0$, the partial electron pressure at the constant optical depth $\tau_0$, on the two assumptions.

The strontium anomaly is similarly removed when we take $\kappa = \alpha P/(kT)^{9/2}$. Whether the observations confirm the values of $dN/dg$ in amount as well as in sign cannot be stated until more detailed spectro-photometric determinations of line-contours are available for sequences of stars of constant $T$ but differing $g$. The theory predicts, however, that the Balmer lines should be much more sensitive to $g$ in stars of low effective temperature than in the earlier types, as appears to be the case.

The new formulæ, if confirmed by observation on stars of known $g$, will afford a method of comparing the $g$-values of any two stars of the same temperature, and so ultimately give a rational basis to the determination of spectroscopic parallaxes. The possibility of thus determining $g$-values from line-intensities was pointed out some years ago by Pannekoek.

Full details will be communicated to the Royal Astronomical Society.

E. A. MILNE.

The University, Manchester,
Nov. 15.

### Vortices on the Monsoon Front.

THE south-west monsoon advances in most years from the south-east Arabian Sea first towards Malabar and then gradually northwards along the west coast of the Indian Peninsula with a clear discontinuous boundary, the monsoon air being relatively cool, moist, and highly unstable, and the air on the other side hot, dry, and less unstable. It has been known to move northwards in some years with a well-marked ‘ depression ’ in front, a few hundred miles in diameter, and cause a burst of the monsoon on the west coast, but it was never recognised that innumerable little whirls, 20-30 miles in diameter, formed on the discontinuous boundaries, and passed undetected, except those which left their traces in the Colaba autographic records. Even at Colaba they were unknown until two very typical vortices passed through Bombay on June 17, 1927, and forced attention to their existence. A search was made of the past records, and several others were discovered to have passed through Bombay in previous years. They were looked for during the burst of this year's monsoon, and a feeble one was noticed passing through Bombay shortly after midnight on June 11.

The monsoon fronts undoubtedly represent typical discontinuities in the tropics analogous, though not quite similar, to the polar fronts in the extra-tropical region, the theory of which has been so elaborately developed by the Norwegian meteorologists. The vortices formed on the monsoon fronts are therefore of peculiar interest; for, when the detailed synoptical investigations of the fronts are available, they will eventually be found to be waves as well as vortices like those on the polar fronts (V. Bjerknes, *Geofysiske Publikationer*, vol. 2, No. 4), and thus throw considerable light on the nature of the transition layer between the different air masses.

Assuming that the vortex, which passed through Bombay between 7 and 8.30 A.M. on June 17, 1927, had travelled with the velocity of the mean wind which prevailed before and after its passage, it would appear that it had a diameter of about 22 miles. The sharp rise in wind velocity from 15 to 57 miles per hour, followed by a sharp fall to 12 miles and another sharp rise to 48 miles, and then a quick return to normal condition, all occurring within an hour and a half, during which the direction changed from south to north through west, and pressure dropped by 0·173 inch of mercury, suggest that the centre of the vortex must have passed within 2 or 3 miles of the Observatory. The velocity distribution in this vortex can be very approximately represented by that of a Rankine's combined vortex. A velocity of 50 miles per hour in its ring of maximum velocity will thus account for a central barometric depression of 0·19 inch of mercury. In a similar manner the observed barometric depression in the other vortices which passed through Bombay could be explained by working out a theoretical vortex having approximately the observed distribution of velocity. There can thus be very little doubt that all of them had the structure of an atmospheric vortex.

The air temperature near the ground during the passage of the vortex of June 17, 1927, dropped from 79·5° F. to 77·3° F. This vortex was followed by another after about 14 hours, and the temperature again dropped, from 79·7° F. to 76·5° F. The succession of vortices, some well defined and others not so well defined, which passed through or near Bombay in this year, and also in some previous years, during the northward movement of the monsoon fronts along the west coast, lends strong support to the view that they are also waves on surfaces of discontinuity. A detailed account of these vortices will be published in due course.

S. K. BANERJI.

The Observatory, Bombay,
Oct. 17.

THE interesting letter of Dr. S. K. Banerji on the appearances of vortices at Bombay before the arrival of the monsoon is based for its theory on a fairly strict acceptance of V. Bjerknes' view that a cyclone is a product merely of dynamical instability of Helmholtz waves on a widely extended front between cold and warm air. But many still accept the earlier view, due to Dove, Helmholtz, Margules, Bigelow, Exner, and others, that a cyclone merely requires the juxtaposition of two air-masses at different temperatures, the latent heat of condensation providing energy in addition to that from the descent of the centre of gravity of the system when the cold air flows under the warm. The conventional statement regarding the area in front of the oncoming monsoon when disturbed was that it is one ‘ of squally weather in which a storm may be forming ’; and the corresponding explanation was that at first light variable airs prevailed there for two or three days, so that the air near the sea surface became very hot and moist, conditions favourable for instability.

I welcome Dr. Banerji's letter, however, for its reminder of the temperature contrast between this