Spiegel, Edward A. and Lawrence H. Aller.
Turbulence in the atmosphere of 31 Cygni.

We have been attempting to utilize data gathered in the 1951 atmospheric eclipse of 31 Cygni to investigate the hydrodynamics in the atmosphere of the K star. From radial velocities measured during the egress of the 1951 eclipse¹ we have calculated correlation coefficients as defined below. The observations here used are velocities at separate points in space-time; hence the correlation coefficients depend on space-time intervals. Moreover, the measured velocities are not velocities at single points in the atmosphere, but are mean velocities along the line of sight, the means being weighted with respect to the contribution of each element of atmosphere to the line intensities.

For our purposes, the correlation coefficient is

$$R_{zz}(n) = \frac{\sum_{t=1}^{T-n} v_z(t) v_z(t+n)}{\left[\sum_{t=1}^{T-n} v_z^2(t) \sum_{t=n}^T v_z^2(t+n) \right]^{1/2}},$$

where n is a time interval in days, T is the number of days over which observations are made, t is the index (from 1 to T), the z direction is the line of sight direction, and v_z is the observed velocity corrected for orbital motion. The correlation coefficient is expressed as a function of n alone, since the transverse velocity of the B star is very nearly constant during the observation period. In this case, n completely specifies the space-time interval on which the correlation depends.

If there exists turbulence in the hydrodynamical sense in the giant's atmosphere, moderately large eddies, i.e., those whose characteristic lengths are comparable to half the thickness of the atmosphere, will dominate the observed velocities. Smaller eddies than these will have effects analogous to those of thermal broadening, and larger ones will, if they are much larger than the transverse distance spanned by the observations, alter the observed mean velocities.

In terms of this turbulence model, the length scale of the energy-containing eddies can be obtained, if the eddies lie within the detectable range discussed in the preceding paragraph. This is accomplished by replacing n by a corresponding space interval. The space interval is linearly related to n through the transverse velocity of the B star.

We have calculated the above correlation for velocities derived from the calcium K line.¹ Twenty-two observations, taken over a 39-day

period, were used. The calculated correlation coefficients imply that, on the basis of this provisional turbulence model, the length scale of the energy-containing eddies is of the order of 2×10^7 km.

1. D. B. McLaughlin, *Ap. J.* **116**, 550, 1952.

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Strand, K. Aa. Dynamical parallaxes from photographic observations.

The superior accuracy of photographic observations obtained with long-focus refractors of wider double stars (separations $> 3''.0$) as compared with the conventional micrometer observations, allows a check on possible systematic errors in the dynamical parallaxes obtained from visual observations.

The most complete list of dynamical parallaxes has been published by Russell and Moore.¹ These parallaxes were usually determined from visual observations made since 1830, thus including one hundred years of observations.

The dynamical parallaxes determined from the photographic observations were based upon a first-epoch series taken by Hertzsprung from 1914-18,² while the second epoch plates were taken by the writer during the intervals 1938-42³ and 1946-52.⁴

Since the accuracy of the visual normal places is approximately $\pm .06$ (m.e.) in distance as compared with $\pm .006$ for the photographic observations, the dynamical parallaxes derived from a 25-year interval of photographic observations carry a weight of 4.6 (inverse mean error squared) as compared with a weight of 1.0 for the dynamical parallax computed from a 100-year interval of visual observations for the pairs where the motions have been essentially linear over the intervals considered.

Comparing the hypothetical parallaxes derived from the visual observations (h_{vis}) with the same values derived from the photographic observations (h_{phot}) we find for the 82 pairs which the two systems have in common:

$$h_{phot}/h_{vis} = 0.90 \pm .03 \text{ (m.e.)}$$

The comparison was limited to the pairs with hypothetical parallaxes less than $.050$ to avoid any effect which might arise from the difference in curvature of the orbital motion during the two intervals under consideration.

It appears from this comparison that the dynamical parallaxes derived from the visual obser-