



Fig. 2. Generalized geometry of a Bermuda, wind-blown, lobate sand body.

sand body as it built forward. This convex upward cross-bedding is preserved because of the relatively rapid stabilization of wind-blown, calcareous sand due to surface cementation by percolating rain water. Intraformational breccias are a result of this early surface cementation and later reworking. If stabilization was slow, the cross-strata were eroded and appear in some sections like planar or festoon cross-bedding.

Convex upward cross-stratification characterizes the Bermuda calcareous dunes. I have also observed it in the

Bahamian eolian limesands. Its occurrence as a predominant type in siliceous sandstones has not been reported.

FRED T. MACKENZIE

Bermuda Biological Station for Research, St. George's West

References and Notes

1. E. D. McKee and G. W. Weir, *Bull. Geol. Soc. Am.* **64**, 381 (1953); J. R. L. Allen, *Sedimentology* **2**, 93 (1963).
2. A. E. Verrill, *Conn. Acad. Arts Sci. Trans.* **12**, 45 (1907); R. W. Sayles, *Proc. Am. Acad. Arts Sci.* **66**, 382 (1931); J. H. Bretz, *Bull. Geol. Soc. Am.* **71**, 1729 (1960); F. T. Mackenzie, *Sedimentology*, in press.
3. Contribution No. 345, Bermuda Biological Station for Research, St. George's West.

27 March 1964

Contraction Hypothesis Consistent with the Kennedy-Thorndike Experiment

Abstract. *A Lorentz-Fitzgerald contraction augmented by an equal isotropic contraction gives a null result for all interferometric ether-drift experiments.*

Grünbaum (1) has pointed out that an ether theory amended by the Lorentz-Fitzgerald contraction and the time-dilation hypotheses is consonant with the null result of the Kennedy-Thorndike (2) experiment, so that a rejection of the doubly amended ether theory in favor of special relativity rests upon philosophical grounds.

As an addendum to Grünbaum's paper, it may be observed that the situation is further complicated by the fact

that there also exists a singly amended ether theory which does the same thing with Newtonian concepts only.

To find the amendment, consider an interferometer arm *OP* and require the transit time of light for the round-trip *OPO* to be independent of both the orientation and speed of *OP* relative to the ether. Suppose the interferometer arm *OP* to be of unit length and directed along the *x*-axis; a pulse of light goes from *O* to *P*, where a mirror

reflects it back to *O*. With *O* and *P* fixed in the ether the time for the round trip is $2/c$, where c is the velocity of light relative to the ether. Now suppose the ether to flow along the negative *x*-axis with speed u ; if the time $1/(c-u) + 1/(c+u)$ is to remain the same as before, *OP* must shrink by the amount u^2/c^2 . Next, suppose the ether to flow along the negative *y*-axis with speed v . The ray of light which makes the round trip *OPO* is inclined at an angle whose sine is v/c to the *x*-axis so that the *x*-component of velocity is $(1-v^2/c^2)^{1/2}$. To keep the time the same as before, *OP* must contract by this factor. When both components of drift exist, the total contraction is the sum of the separate ones to the second order in the drift components, so that the contraction of *OP* is $(u^2/c^2 + v^2/2c^2)$.

If the drift velocity \mathbf{V} makes an angle θ with the *x*-axis, $u = V \cos \theta$, $v = V \sin \theta$ and the contraction is $(V^2/c^2) (1 - \frac{1}{2} \sin^2 \theta)$.

The contraction is V^2/c^2 for $\theta = 0$ and $\frac{1}{2} V^2/c^2$ for $\theta = 90^\circ$. A sphere which has unit radius for $V = 0$ shrinks into an oblate spheroid altogether inside the original sphere, with the minor axis in the direction of \mathbf{V} . The total contraction can be resolved into an isotropic contraction, $\frac{1}{2} V^2/c^2$, and a superimposed Lorentz-Fitzgerald contraction of $\frac{1}{2} V^2/c^2$ along the direction of motion.

For observations lasting only a small fraction of a day, such as the Michelson-Morley or the Trouton-Noble experiments, only the Lorentz-Fitzgerald part of the contraction applies, since the isotropic contraction will presumably already have taken place and will not change appreciably during the experiment. The hypothesis is therefore equivalent to the Lorentz-Fitzgerald contraction for short-term experiments.

It is apparent that such a contraction suffices to yield null results for any interferometric ether-drift experiment, for if fringes are once established, no changes in speed or orientation can alter them.

E. M. KELLY

Physical Sciences Department, California State Polytechnic College, Kellogg-Voorhis Campus, Pomona

References

1. A. Grünbaum, *Science* **143**, 1406 (1964).
2. R. J. Kennedy and E. M. Thorndike, *Phys. Rev.* **42**, 400 (1932).

20 April 1964