

is bound up with light-signalling. When two bodies are moving with respect to one another, their operational simultaneities are not identical. It follows that length (space) and t (chronological time) as numerical quantities always require a reference to the frame from which the measurements are made. It is for this reason that physicists speak of space-time. They mean that length and t as quantities are not separable.

I have no criticism to pass upon this so long as measurement is not confused with what is being measured. Measurement gives knowledge about Nature. The philosopher—and I hope the physicist also—needs likewise to think clearly about the structure of Nature. It is here that the question of the real nature of time appears. Is the Astronomer Royal's time—to use Eddington's expression—as basic as supposed? I take it that physicists like Jeans, Eddington, and Millikan are aware of this problem.

It is my thesis that real time is simply the fact of change or eventness in the universe and is always local. There is no change which runs instantaneously across the universe. The unity of the universe is spatial rather than temporal, and is of the nature of substantial coexistence and continuity. Nevertheless, it is correct to speak of a cosmic time if we simply mean the *class of events* coactual with any given event. In real time, simultaneity is the fact of co-occurrence and is not a kind of cosmic temporal relation. It is in this sense only that the universe moves abreast. Past events are those which have perished and are no longer actual. Future events are those which are not yet actual. *Simultaneous events are just the class of actual events.* This is what the philosopher and the physicist must mean by absolute simultaneity. But the physicist has a job of an empirical sort which the philosopher does not have: that of dating and measuring. The job of the philosopher is essentially that of analysis of categories. For him, real time involves the order of succession and the class of actual events in the universe. He is as much opposed as the modern physicist is to Newtonian conceptions of time.

It follows that the fusion of space and time must not be taken as valid for anything but chronological knowledge about Nature. In Nature itself, only the actual exists. I am also led to believe in determinate size apart from measurement. Quantities are cases of knowledge about and are relative to a frame; but not so the intrinsic properties of things. I am also led to believe in gravitational forces and to distinguish them from the kinematic description in terms of space-time. It follows also that relational movements have meaning as well as relative motion. Relational movements are changes of neighbourhood, while relative motion is an affair of epistemic reference, which presupposes actual movement.

Finally, so far as I can see, cosmic time has no arrow of an entropic sort. It is merely the fact of dispersed change in a substantial, extended world. I expect to find that Millikan, Lewis, and Bridgman will turn out to be right in their criticism of the application of entropy to the universe.

ROY WOOD SELLARS.

Department of Philosophy,
University of Michigan,
Ann Arbor.

The Absorption Spectrum of Hexuronic Acid

As part of a systematic study¹ of Prof. Szent-Györgyi's 'hexuronic acid' we have investigated quantitatively the absorption spectra of hexuronic acid, glycuronic acid, galacturonic acid, tetramethyl γ -fructose, and other carbohydrate derivatives. In view of the fact that hexuronic acid has been identified

with vitamin C,² we have paid special attention to the possibility of contamination by small traces of impurity. We find that the single broad band at about 263 m μ reported qualitatively by F. P. Bowden and C. P. Snow³ is found in equal intensity with the sample of hexuronic acid supplied by Prof. Szent-Györgyi and with rigorously purified material. It appears, therefore, that this band is definitely associated with hexuronic acid. The nature of the band in methyl alcohol (c. 0.002 per cent) is indicated by the accompanying table:

Mol. Extinction Coefficient (ϵ).	Wave-length (m μ).
1000	295
2000	220, 290
3000	228, 285
4000	235, 280
5000	241, 278
6000	245, 272
7000	254, 268
7500	263

Marked deviations from Beer's law were observed, the solutions becoming relatively less transparent on dilution. For example, at 280 m μ the molecular extinction coefficient has the values 800, 2000, and 4400 for solutions of concentration 0.02, 0.005, and 0.002 per cent respectively. Dilute methyl alcoholic solutions of hexuronic acid are unstable and show, when kept, a gradual diminution in the intensity of the band.

In water a single broad band is displayed at 260 m μ . The value of ϵ is about 7000 for freshly prepared solutions (c. 0.002 per cent), but in this solvent a rapid diminution in the intensity takes place, ϵ falling to 4000 within three hours.

The absorption of hexuronic acid resembles that of many ketonic substances, but differs completely from that shown by aldose or ketose sugars of the pyranose type,⁴ which show no absorption bands. We have now proved that a typical keto-furanose sugar (tetramethyl γ -fructose) shows no selective absorption. Similar results were obtained with glycuronic acid and with galacturonic acid. All these substances are highly transparent in water and display weak continuous absorption, with ϵ in each case less than 5 at 260 m μ .

The tentative formula for 'hexuronic acid' previously suggested⁵ envisages a possible keto-furanose sugar structure with the carboxyl group in position 6. In view of the above results, it seems improbable that such a structure would account for the absorption band observed with hexuronic acid, and some rearrangement of the formula may therefore be necessary. Experiments to decide this are now well advanced.

R. W. HERBERT.
E. L. HIRST.

Chemistry Department,
University of Birmingham,
July 1.

¹ E. L. Hirst and R. J. W. Reynolds, *NATURE*, April 16, 1932, p. 576.

² J. L. Svirbely and A. Szent-Györgyi, *ibid.*, p. 576.

³ *NATURE*, May 14, p. 720.

⁴ L. Kwiecinski and L. Marchlewski, *Bull. Acad. Polonaise*, 1927, 379.

⁵ *NATURE*, April 16, p. 576.

Crystalline Structure of Hexuronic Acid

FROM a purified specimen of 'hexuronic acid' (identified by Szent-Györgyi with vitamin C) available in this laboratory I have been able to obtain sufficiently good crystals to carry out an X-ray examination by the single-crystal rotation method. The substance is monoclinic sphenoidal, with $a = 17.71$, $b = 6.32$, $c = 6.38$ A., and $\beta = 102\frac{1}{2}^\circ$, while the space-group is C_2^2 ($P2_1$), since the only true halving is