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THE MEASUREMENT OF VELOCITY WITH ATOMIC CLOCKS[1]

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ABOUT twenty-five years ago the Physical Society held a discussion of the theory of relativity, at which widely divergent views were expressed. I recollect that Professor E. W. Morley, speaking of the Michelson-Morley experiment, declared with great emphasis that this was a *physical* experiment and must have a *physical* explanation. On the same occasion a distinguished chemist, still living, declared, as his only contribution to the discussion, that the meeting would be known in history as the last time a scientific gathering treated the ether as a subject for serious discussion.

In spite of this discouragement I shall venture to discuss my subject as Professor Morley would, in terms of an ether or fixed framework. I do this partly because I know of no way to discuss the behavior of variable measuring instruments, such as atomic clocks, except by comparison with real or postulated invariant instruments. Partly also I do this because of the belief, for which I shall attempt some justification, that the ether has not yet been "abolished." I hope that even if I do not convert you to this point of view, I can enlist your sympathy for my preference for it.

It is my purpose, in the next few minutes, to discuss what happens to the measurement of *velocity* when the clocks we use for the determination of time are atomic clocks, which vary in their rate, when moving, according to a relation for which experimental evidence has recently been obtained from a study of the Doppler effect in hydrogen canal rays.[2]

As a preliminary to this discussion we must look at the concept of velocity and velocity measurement, as it

[1] Address of the retiring vice-president and chairman of the Section on Physics, American Association for the Advancement of Science, Columbus, December 29, 1939.

[2] *Jour. Optical Soc. America*, p. 215, July, 1938.

inches), *g*, is detached, and the glass bead and plug, *h*, removed to facilitate filling. The weighed unit is inserted into a long cylindrical glass hood whose side arms connect to the metabolism system. By means of the bead, *i*, the level of the absolute methyl alcohol is maintained at the lower end of the wick, thus insuring a small, non-luminous flame. Near the end of the check, after the spark coil switch has been closed again to avoid escape of unburnt vapors, the supply is discontinued. When the flame dies out, to prevent evaporation, the alcohol in the tube is allowed to drop back into the reservoir created below the bead. Weighings are performed without delay. Used in testing a closed circuit respiratory metabolism apparatus, this method gave on seven checks values of 100 ± 0.5 per cent. for oxygen, carbon dioxide and water.

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DEFOLIATION OF ROSE PLANTS WITH ETHYLENE GAS[1]

INVESTIGATIONS by the Oregon Experiment Station have shown that ethylene gas can be used to remove the foliage from field-grown rose plants. The treatment is used after the roses have been dug for shipment or storage. One Oregon nurseryman has defoliated over 200,000 rose plants by this method this year; 50,000 of these were defoliated in a single room in four days' time. By other methods commonly used by the growers it would have taken several weeks to defoliate this same number of plants.

The fact that ethylene will defoliate rose plants is not new. Wilcox[2] in 1911 reported that illuminating gas would defoliate greenhouse roses. Since that time other workers have noted a similar effect on rose plants grown in greenhouses. In 1931 Zimmerman, Hitchcock and Crocker[3] demonstrated that ethylene present in illuminating gas or pure ethylene would cause epinasty and defoliation of potted rose plants. Roses thus treated would recover and show no effects of the treatment other than the forcing of more of the latent buds.

The above findings have been reinvestigated and procedures developed whereby this same principle can be used on a commercial scale to defoliate large numbers of nursery-grown rose plants. A fairly airtight room or chamber is provided, and ripe apples are used as the chief source of ethylene gas, although the hypanthia of the rose plants are known to produce some ethylene. One bushel of apples is sufficient for each 300 to 400 cubic feet of space. A temperature of 65° to 70° Fahrenheit is maintained during the treatment by electric or kerosene heaters. Where 50 per cent. or more of the space is filled with rose bushes the heat liberated by the rose plants, once the defoliation process has been started, is sufficient to maintain this temperature in insulated rooms. The plants can be stacked close together in large piles of single rows, but they must be kept in a moist condition to prevent wilting of the foliage. Defoliation with most varieties requires three to five days, but a few varieties require a longer treatment.

Numerous tests have been conducted to determine the behavior of rose plants following the treatment with ethylene. Treated and untreated lots of plants have been grown under field and greenhouse conditions. The treatment apparently has no significant effect upon the subsequent growth of the plants.

Preliminary trials with other plants suggests the possible application of the method to a number of nursery stocks other than roses.

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[1] Published as Technical Paper No. 328 with approval of Director, Oregon Agricultural Experiment Station, contribution from Departments of Horticulture and Plant Pathology.

[2] E. Mead Wilcox, Nebraska State Hort. Soc. Ann. Rept., pp. 278–285, 1911.

[3] P. W. Zimmerman, Wm. Crocker and A. E. Hitchcock, Contr. from Boyce Thompson Institute, 3: 459–481, 1931.

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National Bureau of Economic Research. *Textile Markets; Their Structure in Relation to Price Research.* Report of the Committee on Textile Price Research to the Conference on Price Research. Pp. xx + 266. $3.00. *Price Research in the Steel and Petroleum Industries.* Prepared for the Conference on Price Research. Pp. xiii + 170. $2.00. *Studies in Income and Wealth; Vol. III.* By the Conference on Research in National Income and Wealth. Pp. xxiii + 479. $3.50. The Bureau.

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