west winds. Between two and three o'clock in the afternoon, about three hours after the fire started, the updraft was sufficiently strong to overcome the high wind and occasionally to carry water vapor to the level of cloud formation. Cumulus clouds resulted, capping the smoke, and appearing or disappearing according as the latter rose or failed to rise to the necessary altitude. So near to this altitude was the average summit of the smoke that it was possible for the writer, on seeing an especially vigorous puff from the fire, to predict the formation of a cloud some seconds in advance of its appearance. The clouds did not, as far as could be seen from a position directly to windward of the fire, attain to well-rounded, typical cumulus forms. They varied from mere flecks of white to moderately large but flattish masses and were usually dissipated within five minutes from the time they became visible. Their bases were more or less mingled with and hardly distinguishable from the summit of the smoke-cloud; it was therefore impossible to tell whether or not they were typically flat-based. The clouds appeared to be formed not directly over the fire, but a very considerable distance to leeward, where the high wind first permitted the rising air to reach its dew-point altitude.

The occurrence of these cumuli recalls a similar phenomenon over the burning coal pockets of the Boston & Maine Railroad close by at Charlestown in December, 1896, and noted by Professor R. DeC. Ward in SCIENCE for January 8, 1897. In this instance the greater concentration of the fire and the consequent greater proportion of water-vapor carried aloft, caused the development of a far more perfect cumulus cloud than that formed over the widely scattered Chelsea fire.

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April 30, 1908

THE INFALLIBILITY OF NEWTON'S LAW OF RADIATION AT KNOWN TEMPERATURES

ALTHOUGH there is no direct reference to "the absolute temperature of space" (on which hinges the whole question of the sun's *effective* surface temperature) in Professor Very's paper published in the last number of SCIENCE, it is clear that he is still inclined to favor the claim that the temperature of space is in the neighborhood of 300° C., notwithstanding the demonstration I have given, showing that the temperature is probably less that 2° C.

The title of the present article gives evidence that I wholly disagree with Professor Very when he claims that Stefan's law is in better agreement with actual observation than is Newton's law.

Just why I regard Stefan's law as wholly wrong will appear from the theoretical results given below. How such erroneous laws similar to that of Stefan's ever came to be deduced can be largely inferred from the contents of a paper on "The Earth as a Heat-radiating Planet," sent to the editor of SCIENCE on December 25, 1907, but not yet published at the time of this writing.[1] In that paper (where, for obtaining the terrestrial radiation into space, the *effective* surface-temperature of the earth is provisionally placed at 200° C.) it is made evident that according to my results "serious changes in the constants of radiation in the formulæ accepted to-day" (to quote part of a sentence from Professor Very's article) must actually be made.

I shall now demonstrate that both theoretically and experimentally *Newton's law gives uniformly consistent results when the observations are properly interpreted,* and that Stefan's law leads to absurd and unintelligible results at known temperatures.

Let us first conceive that the observations were made in free space, the two totally different expressions for the absolute temperature of space will then read

For Newton's law $t = T(d/D)^2 = 0°.7$
For Stefan's law $t = T\sqrt{d/D} = 300°$.

Since the temperature of space must be taken as constant in each case we obtain for comparison the two sets of values of T, for different values of D, given in the second and third columns of the following table:

[1] Published in SCIENCE for March 6, 1908.

$\frac{D}{d}$	T Absolute		Newton $T_0 = 300°$
	Newton	Stefan	
	°	°	°
1	0.7	300	300.7
2	2.8	424	302.8
3	6.3	520	306.3
4	11.2	600	311.2
10	70	949	370
20	280	1,342	580
30	630	1,643	930
40	1,120	1,897	1,420
53.4	2,000	2,192	2,300

Considering now, for example, the temperatures corresponding to the values 1 and 2 for D/d, the total failure of Stefan's law is at once apparent, for while the increase of temperature corresponding to an increase in the aperture from $D = 0.337$ in. to $D = 0.674$ in. is consistently 2°.1 C. according to Newton's law, the increase according to Stefan's laws is 124°.0 C., an absurd result! Again, as the other waves direct from the sun enter and reach the bottom of the earth's atmosphere the focal temperature due to these *direct* waves must evidently be measured from a totally different starting-point. If the absolute temperature of air at the place of observation is T_0, then T_0 must be taken as the origin from which the temperatures, properly belonging to the *direct* solar radiations alone, must be measured. If for the present case we have $T_0 = 300°$ C., the theoretical values given in the fourth column will result from Newton's law. Now when we come to apply this same line of reasoning to Stefan's law, the data given in the third column become both absurd and unintelligible for ordinary temperatures (corresponding to small values of D)!

Much of the confusion heretofore existing regarding the temperature of space can, in my opinion, also be traced to the largely prevalent but mistaken idea that the ordinary mercurial thermometer is a suitable instrument for measuring *direct* radiations, when in fact this thermometer then simply measures the stored-up energy trapped in the "hot-house"-like form of this particular instrument. The ideal thermometer will be one which gives instantaneous results, since the intensity of the ether vibration is independent of the time. For this reason the platinum plate in my observations was hammered so thin that the evidence of melting was secured from practically instantaneous exposures in the solar focus. It will be noticed that for the value 53.4, corresponding to $D = 18$ inches, I have assumed the actually measured focal temperature to be 2,300° C.; the excess over the accepted value for the temperature of melting platinum I have roughly estimated to be equal to the losses resulting from causes similar to those which Professor Very mentions in the second paragraph of his paper.

In any case, I hold that however great the possible error of my measured value for the focal temperature may be, this error can not affect the validity of my theoretical formulas.

J. M. SCHAEBERLE

ANN ARBOR, MICH.,
February 17, 1908

SPECIAL ARTICLES

THE HEREDITY OF SEX

IN *Proceedings of the Zoological Society*, 1906, I., p. 125, Doncaster and Raynor described certain remarkable experiments respecting the inheritance of the moth *Abraxas grossulariata* and its variety *lacticolor*. This variety was originally known in the female form only. Experimental crossings showed the following results:

1. *Lact.* ♀ × *gross.* ♂ gave F_1 ♂s and ♀s all *gross.*

2. F_1 *gross.* ♀ × F_1 *gross.* ♂ gave *gross.* ♂s, *gross.* ♀s and *lact.* ♀s; no *lact.* ♂ being formed.

3. *Lact.* ♀ × F_1 *gross.* ♂ gave all four possible forms, *gross.* ♂s, *gross.* ♀s, *lact.* ♂s, *lact.* ♀s. The ♂ lacticolor thus raised were the first that had ever been seen.

4. F_1 *gross.* ♀ × *lact.* ♂ gave *all* ♂s *gross.* and *all* ♀s *lact.*

In discussing this curious series of facts Doncaster adopted Castle's view that each sex was heterozygous in sex, and that each gives off male-bearing and female-bearing gametes. He then shows that if it be assumed (1) that in the F_1 ♀ there is coupling such that the male ova all bear the *grossulariata* factor and the female ova all bear *lacticolor;* (2) that in