select. It usually discourages a student somewhat to buy a large text-book, one half or one third of which is used in his classes, and the rest omitted.

W. J. BEAL

SPECIAL ARTICLES

THE PROBABLE ORIGIN AND PHYSICAL STRUCTURE OF OUR SIDEREAL AND SOLAR SYSTEMS[1]

MAINLY because of the very high, and for certain reasons inadmissible, temperature heretofore obtained when Newton's law of radiation is employed, astronomers and physicists hold that this law can not be used for determining the effective surface temperature of the sun.

That Newton's law of radiation is just as true for the sun as is the law of gravitation, and that the sun's surface temperature can only be determined by means of this law will now be demonstrated.

Let us conceive that the sun's total radiant energy S (per unit of time) is concentrated in an ether vibration at the sun's center. Let the temperatures t_0 and t be taken as the measures of the intensity of vibration at the distances r_0 and r; we can then at once write

$$\left(\frac{S}{t_0 r_0^2}\right)=\left(\frac{S}{tr^2}\right), \tag{1}$$

hence

$$t_0=t\left(\frac{r}{r_0}\right)^2. \tag{2}$$

Now let us conceive that a thin spherical shell of lampblack having the radius r_0, and coinciding with the sun's surface, receives and transmits in each unit of time the total energy S, the temperature t_0 of this shell will then be the same as the temperature of the sun's surface, and the temperature t in any exterior similar shell of radius r must necessarily be such as to satisfy equation (2), for to assume any gain or loss through the substitution of the total energy S given out by the surface shell in place of the energy S given out by the central vibration would be contrary to the law of the conservation of energy.

Now to find t_0 the temperature t, at the earth's distance from the sun, must first be found, and *just here is where inadmissible errors have been committed in past determinations.*

I offer the following extremely simple method for determining the absolute temperature of space:

Let D denote the diameter of a mirror (or objective) having the focal length F, the linear diameter d of the sun's focal image will then be $d=2F \tan \theta$, in which θ is the angular semi-diameter of the sun. (For our present purpose d depends only on F and θ and is independent of D.) Let T denote the measured absolute temperature in the sun's focal image, then, if we neglect for the present the effects due to atmospheric absorption, we can at once write for a theoretically perfect telescope

$$\frac{T}{t}=\left(\frac{D}{d}\right)^2. \tag{3}$$

The expression for the absolute temperature of space is therefore

$$t=T\left(\frac{d}{D}\right)^2. \tag{4}$$

Now let a denote the factor by which T must be multiplied in order that the product shall equal the surface temperature t_0 of the sun; we then have

$$a\frac{T}{t}=a\left(\frac{D}{d}\right)^2=\frac{t_0}{t}=\left(\frac{r}{r_0}\right)^2, \tag{5}$$

from which we find

$$a=\left(\frac{d}{D}\right)^2\left(\frac{r}{r_0}\right)^2, \tag{6}$$

in which all the quantities are known. The expression for the effective surface temperature t_0 of the sun is therefore

$$t_0=t\left(\frac{r}{r_0}\right)^2=aT. \tag{7}$$

My observational work has been carried on with the aid of three mirrors which I constructed to continue investigations under way at the time of my departure from the Lick Observatory. The first two of these telescopes are briefly described in No. 539 of the *Astronomical Journal;* the third mirror has an aperture of two feet and a focal length of three feet. The definition of this last-men-

[1] Extract from a still unfinished paper.

tioned telescope is such that images of the faintest-known isolated stars can (with the aid of a powerful magnifying glass) be plainly seen on a photographic plate exposed for less than five minutes in the focus. When this instrument is turned to the sun all known metals are melted and vaporized. A circular hole equal in size to the sun's focal image is almost instantly formed in a thin plate of sheet-iron held in the focus; by taking a much thicker piece the vaporization of the boiling-iron image of the sun (held in place by capillary action with the bordering plate of cold iron) can be observed at leisure until a hole is again formed.

To obtain a known value of T for a measured value of D the aperture of this mirror was gradually reduced (by means of circular openings, of different diameters, cut in cardboards placed centrally over the mirror) until a strip of platinum plate could just be melted when held in the focal plane. With the sun at 54° zenith distance, in a clear atmosphere, the corresponding diameter was found to be eighteen inches.

Neglecting for the present the corrections due to aberrations and absorptions in the telescope and in the atmosphere, we have the following approximate values for substitution in formulas (4), (6) and (7):

$$D = 18.0 \text{ in.}$$
$$d = 0.337 \text{ in.}$$
$$\left(\frac{r}{r_0}\right)^2 = 44000$$
$$T = 2000° \text{ C.}$$

The uncorrected results are, therefore,

Absolute temperature of space $= t = 0°.7$ C.
Effective surface temperature of the sun $=$
$t_0 = 30800°$ C.

The instrumental corrections (due mostly to absorption at the silver surface of the mirror) increase the value of t from 0°.70 to 0°.75. The effect of atmospheric absorption on the intensity of ether vibrations must next be considered. My information on this subject is based upon a long series of photographic observations (on certain fixed stars) which I made, reduced and discussed more than sixteen years ago; the work (8vo, pp. 89) was published in 1893 under the title "Terrestrial Atmospheric Absorption of the Photographic Rays of Light" and forms No. 3 of "Contributions from the Lick Observatory." The tabular data on page 86 of this work give, for 54° zenith distance, the intensity (or brightness) 0.61, the brightness at the zenith being unity. If the temperature of the sun's focal image varies according to the same law, the value of t is increased from 0°.75 to 1°.23 in the zenith; this value must, finally, be further increased by a still undetermined correction for absorption in the zenith; if we *assume* a one-fourth increase in the temperature due to this cause we have finally

Absolute temperature of space $= 1°.5$ C.
Effective surface temperature of the sun
$= 66000°$ C.

It should be explicitly stated that the formulas are derived for the theoretical case of the earth *without* an atmosphere, or of observations made in free space. In actual observations T denotes *the rise in temperature* above the temperature of the surrounding medium and, therefore, is equal to the absolute temperature of the sun's focal image minus the absolute temperature of the air at the place of observation.

J. M. SCHAEBERLE

ANN ARBOR,
November 24, 1907

A NOISELESS ROOM FOR SOUND EXPERIMENTS

FOR many experiments in laboratories of physics, physiology and psychology a place is needed from which all, or nearly all, external sound can be excluded. An absolutely noiseless room opens up numerous new possibilities of research, especially in the fields of sound physiology and psychology. For this reason rooms have been constructed in many laboratories, but all the attempts to produce a noiseless room that are known to the writer are more or less unsuccessful, with the exception of the room to be described here.

The room to which reference is made is in the Physiological Institute of the University of Utrecht, Holland. It has been constructed under the direction and has been used by Professor H. Zwaardemaker, to whom I am in-