SHORTER CONTRIBUTIONS

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A Method of Measurement of Size Distribution of Particles in Air or in Other Medium, whose Concentration is Fairly Large

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Suppose that particles disperse uniformly in a chamber at time $t=0$. Let n_1, n_2, ···, n_i, ···, ··· be the number per unit volume of particles with radii r_1, r_2, ···, r_i, ··· respectively $(r_1>r_2>\cdots>r_i>\cdots)$. Now we count all of the particles falling across a horizontal area A at a vertical distance L from the top wall of the chamber (Fig. 1).

Large particles would fall rapidly, small particles slowly. From the volume $A\times L$ columned upon the area A, the largest particles, with radius r_1 in this case, would be missed wholly in time $t_1=L/v_1$, the next largest particles with radius r_2 in time $t_2=L/v_2$, ···, and generally the particles with radius r_i in time $t_i=L/v_i$, where v_1, v_2,···, v_i,··· are fall velocities of particles with radius r_1, r_2,···, r_i··· respectively.

Let ΔN_1, ΔN_2, ···, ΔN_i, ··· be the number of particles fallen across the area A from time $t=0$ to t_1, from t_1 to t_2, ···, from t_{i-1} to t_i, ···respectively, then

$$(1)\qquad \begin{cases} \Delta N_1=At_1(n_1v_1+n_2v_2+\cdots+n_iv_i+\cdots), \\ \Delta N_2=A(t_2-t_1)(n_2v_2+n_3v_3+\cdots+n_iv_i+\cdots), \\ \qquad\qquad \cdots\cdots\cdots\cdots, \\ \Delta N_i=A(t_i-t_{i-1})(n_iv_i+n_{i+1}v_{i+1}+\cdots), \\ \qquad\qquad \cdots\cdots\cdots\cdots, \end{cases}$$

because for ΔN_1 the particles of all sizes are counted, but for ΔN_2 the largest particles with radius r_1 are not counted, and generally for ΔN_i the particles with radius $\geqq r_i$ are not counted.

From equations (1) we have

$$(2)\qquad \begin{cases} n_1=\dfrac{1}{Av_1}\left(\dfrac{\Delta N_1}{t_1}-\dfrac{\Delta N_2}{t_2-t_1}\right), \\ n_2=\dfrac{1}{Av_2}\left(\dfrac{\Delta N_2}{t_2-t_1}-\dfrac{\Delta N_3}{t_3-t_1}\right), \\ \qquad\qquad \cdots\cdots\cdots\cdots \\ n_i=\dfrac{1}{Av_i}\left(\dfrac{\Delta N_i}{t_i-t_{i-1}}-\dfrac{\Delta N_i+1}{t_{i+1}-t_i}\right), \\ \qquad\qquad \cdots\cdots\cdots\cdots \end{cases}$$

It will be practical to read the values of ΔN_1, ΔN_2, ···, ΔN_i, ··· on a diagram indicating an increase with time of the number of particles fallen across the area A, which will be obtained by counting the particles at any intervals of time regardless of t_1, t_2, ···, t_i, ···. In the case when r_1, r_2, ···, r_i, ··· represent somewhat wide ranges of particle radius it is desirable to take the values of small limits of respective radius ranges for r_1, r_2, ···, r_i, ··· in equations (2) in order to find an exact distribution of particle size.

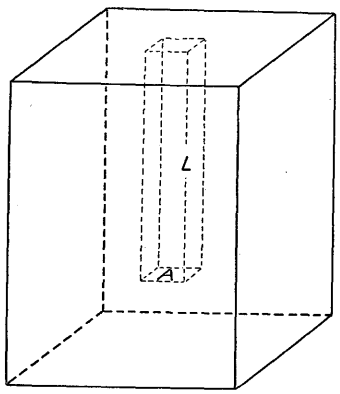

Fig. 1

The present method, though inapt for the case when the total number of particles in the volume $A \times L$ columned upon the area A is small, will be valid in the case when the number of particles is so large that fall velocities of all particles are hardly measured.

In the experiments of artificial rainfall the present method was adopted, with good results in the ultramicroscopic measurement of concentration and size distribution of silver iodide smoke particles [1][2]. In this case the breadth of the area in Fig. 1 corresponds to the length of a base line in the view field of ultramicroscope across which falling particles are counted, and the depth of the area A to the depth of illumination in a smoke cell. An example of the results of the measurement is shown in Figs. 2 and 3.

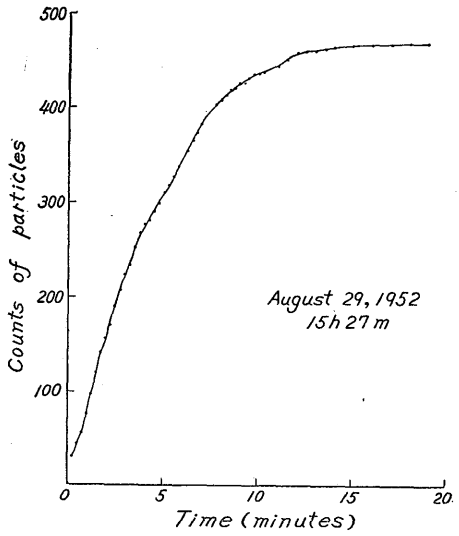

Fig. 2. Result of counting Ag I smoke particles crossing the base area, 1.60 mm × 0.171 mm, which were involved initially in the volume, 8.4 mm in height, columned upon the area (on Mt. Norikura· Aug. 29, 1952).

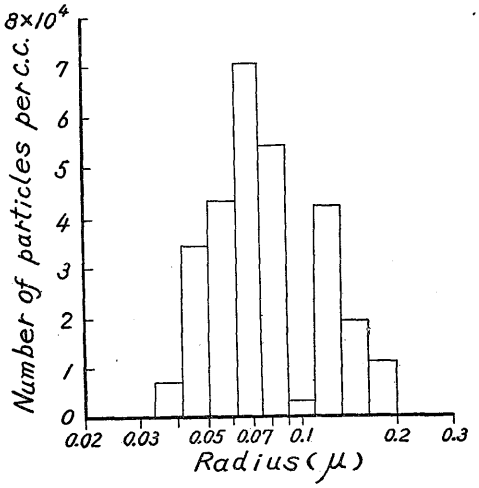

Fig. 3. Size distribution of Ag I smoke particles measured by the present method (on Mt. Norikura, 2,800 m above sea-level, air pressure 735 mb, and air temperature 17°C).

Reference

[1] Takahashi, Y., 1954: On the Cloud Seeding Experiments in Kanto and Chubu Districts in the Summer of 1952. Pap. Met. Geophys., 5, p. 165.

[2] ＿＿＿＿＿＿, 1954: On the Cloud Seeding Experiments in Kanto and Chubu Districts in Summer of 1952. Rep. Rain-Ma king in Japan. 1, p. 69.