

POWER LAW DISTRIBUTION AND SELF-ORGANIZED CRITICALITY OF DISPERSED PARTICLES

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Abstract Research on particulate characteristics has been an important frontier in physics and chemistry during the past decades. It has however been mostly focused on granular materials with short-range interactions. In this work, it was found that the power law of particle size distribution applied to the long-range interacting system of floating dust in air, from which we deduced that self-organized criticality might hold for floating dust just as granular materials with short-range interactions. This feature may reveal underlying kinetic mechanisms, important in dispersed particle systems. In industry, power law of size distribution of dispersed particles can be used to investigate the change of dust size, and the power law parameter could be taken as an important index for dust separation.

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Keywords dispersed particle, floating dust, self-organized criticality, power law

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3. Experimental Results and Discussions Font: Arial; Size: 12 pt; Style: Bold

3.1 Natural size distribution of floating dust Font: Arial; Size: 10.5 pt; Style: Bold

Table 1 shows the results of test No.1 for three different time periods, indicating but few particles with diameters

Table 1 Cumulative number of dust particles of different sizes Font: Arial; Size: 7.5 pt; Style: Regular

No.	Air velocity/(m·s ⁻¹)	Cumulative particle number <i>N</i>						Index <i>D</i>	Deviation <i>R</i> ²	
		0.3 μm	0.5 μm	1.0 μm	3.0 μm	5.0 μm	10 μm			
No.1	1	1.5	2611335	1410251	140810	4792	1954	399	2.65	0.992
	2	1.5	2611113	1195751	77696	3258	1809	506	2.63	0.986
	3	1.5	2247398	851293	96933	4207	568	104	2.94	0.997
No.2	0	1.2	2247398	851293	96933	4207	568	104	2.94	0.997
	1	1.2	485583	65606	2631	124	18	3	3.42	0.992
	2	2.3	1062821	172033	5818	93	9	1	4.04	0.998
No.3	0	1.5	2611113	1195751	77696	3258	1809	506	2.63	0.986
	1	1.5	2611526	1174198	53908	728	348	81	2.99	0.974
	2	2.8	2506590	947778	40074	342	108	28	3.16	0.981

larger than 10 μm. Figure 2 is a log-log plot of cumulative particles size distribution for floating dust in air without filtration. The slope of a trend-line is equal to index *D*, and its error deviation is listed as *R*² in Table 1. The relation between the cumulative particle number and the particle diameter can be represented by the following equation:

$$\lg N(d_p) = -D \lg d_p + \lg C, \tag{1}$$

where *d_p* is diameter of floating dust (μm); *N(d_p)*, the cumulative number of particles with diameters > *d_p*; *C*, a constant representing the intercept; and *D*, the index. Alternately, Eq. (1) can be written as

$$N(d_p) = C d_p^{-D}. \tag{2}$$

Equation (2) signifies the power law, which is often recognized as the footmark of self-organized criticality. Evidently floating dust in air conforms to the power-law particle size distribution. A large value of index *D* means that most dust particles are small, while a small value shows the predominance of large dust particles.

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