CHONDRULES: ARE THEY FRACTALS? B.Lang and K.Franaszczuk, Warsaw University, Department of Chemistry, 02-089 Warsaw.

Masses and sizes of chondrules are physical properties that do not attract any permanent attention of students [cf.1, p.63]. However, the data on themselves can be used in a way differing from a routine statistical procedure: in terms of a fractal approach, provided the validity of the latter would be proved. Double proof is required: purely geometric and material one. Geometry involves self-similarity over some size range supported by scaling with non-integer exponent. The necessary material homogeneity includes mineral composition, texture and microstructure. Otherwise the geometric self-similarity would be meaningless.

Our study covered four L-chondrites: Saratov(L4), Nikolskoe (L4), Elenovka(L5) and Bjurböle(L4). The basic data as used by us were originally published in [2]. The joint masses of groups of chondrules fractionated according to their sizes were communicated to us by Dr.Yu.Stakheev.

For our purposes we adapted the method of Matsushita[3]. Accordingly the cumulative number N(r) and the cumulative mass $N_m(r)$ of grouped chondrules were plotted against their sizes in log-log plots. The r-ranges of self-similarity, which is a statistical quantity[4], were found as underlying the appropriate regression straight lines. These were fitted to plots with relative percent standard deviation not exceeding 20% - the adopted tolerance limit. In log-log plots x and y are the slopes of the involved local regression lines N(r) and $N_m(r)$ respectively. For the fractal dimension D we have $D = x - y$.

The results of our study are tabulated in Table 1. In Fig.1 the method is illustrated as applied to chondrules from the Elenovka chondrite. For all four considered meteorites the subset I of plots is likely to correspond with a supposed growth. One can assume stepwise aggregation of solid particles to produce grains while preceding their melting - apparently more probable than coalescence of droplets of molten material. The subsets II - viewed in order of decreasing sizes - could be interpreted as fracture cascades originating from disintegration of a larger progenitor. One can imagine grains decreasing in size while made of finer and finer clastic material. However, the appearance of two distinct types of origin within a single meteorite body seems to be irrealistic. To find explanation to such a dilemma, without mineralogical-petrologic arguments, we can invoke the values for the fractal dimensions. For the subsets I we have: 1.674, 1.549, 1.671 and 1.493. They are in fair agreement with the value range 1.5 - 2.5 as specified by Witten and Cates for tenuous structures from disorderly growth processes [5]. They are in agreement too with the data for fractal clusters based on both computer simulations and experimental work as compiled by Smirnov [6]. On the other hand the data for subsets II need a cautious insight. The D-value for Nikolskoe with 367% uncertainty must be rejected. The high value for Saratov rather suspected, for Elenovka and Bjuböle met with reservation. We feel that our results being at the moment very preliminary can be reconciled with the concepts of Wood.

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Table 1.
Chondrules from four L-chondrites as fractals

Meteorite	Chondrules					Fractal parameters		
	total number	sizes 10^{-4}m	number of groups plotted	sub-set	groups /plots/ in sub-set	x	y	D
1	2	3	4	5	6	7	8	9
Saratov	1199	4.5 - - 25.5	22	I	1 - 7	2.803 4.76%	1.129 8.46%	1.674 9.80%
				II	14 - 12	9.692 11.94%	5.461 7.16%	4.23 28.88%
Nikolskoe	334	4.5 - - 22.5	21	I	1 - 7	1.96 4.93%	0.411 14.27%	1.549 5.77%
				II	18 - 14	6.726 4.53%	6.553 8.18%	0.173 (?) 357% (??)
Elenovka	345	5.5 - - 29.5	20	I	2 - 7	2.571 5.49%	0.901 7.51%	1.671 9.82%
				II	20 - 12	5.420 3.74%	3.801 3.69%	1.619 10.13%
Bjurböle	658	3.5 - - 26.5	30	I	1 - 9	1.938 5.78%	0.446 11.32%	1.493 8.23%
				II	18 - 10	4.965 2.86%	2.496 5.53%	2.005 9.88%

EXPLANATION: 1. Symbols x, y and D are explained in the text. 2. Groups are numbered in the order of increasing sizes; column 6 refers to these numbers. 3. Size differences per group are 10^{-4}m.

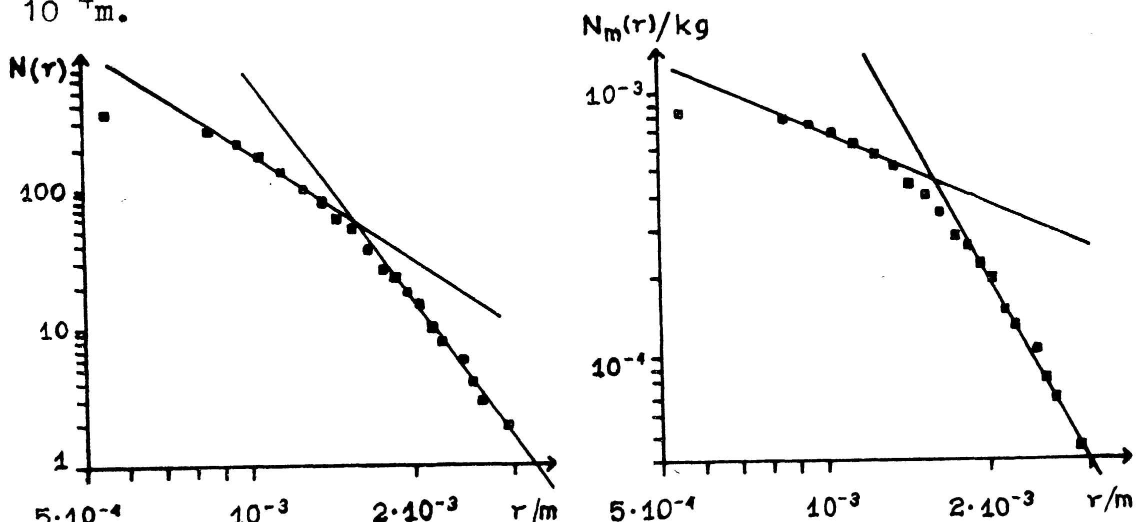

Fig.1 Chondrules from Elenovka
a/ cumulative number b/ cumulative mass

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