CUMULATIVE DISTRIBUTIONS OF ASTEROIDS IN THE FAMILIES. I. Wlodarczyk[1] and J. Leliwa-Kopystynski[2], [1]Chorzów Astronomical Observatory, Al. Planetarium 4, 41-500- Chorzów, Poland, astrobit@ka.onet.pl, [2]Warsaw University, Institute of Geophysics, Pasteura 7, 02-093 Warszawa, Poland, jkopyst@mimuw.edu.pl.

Introduction: This work is continuation of our precedent presentation [1]: From the dataset of 292003 asteroids [2] we extracted five families for farther consideration. They are the families of: Eunomia, Eos, Themis, Vesta, and Koronis. Moreover the Karin cluster being a sub-family of Koronis family is considered. Identification of families were done by means of Hierarchical Clustering Method (HCM) invented by [3] (see also [4] and the references herein). HCM allows to identify the family members (FMs) in the vicinity of the largest member (LM) in the proper elements space a, e, i (major semiaxis, eccentricity, inclination). Identification of individual members ought to be verified, if possible, to eliminated the interlopers. We have checked that all identified members of the Karin cluster are belonging to Koronis family.

Results: The crucial parameter of HCM is so-called the cut-off velocity v_{cut}. We have found individual values of v_{cut} for each considered family by means of numerical experiments, see Fig. 1 and Tab. 1: The breaking point of the curve (population of family) vs. (assumed value of v_{cut}) determines the adopted value of the parameter v_{cut}.

Tab. 1. Parameters characterizing the families. Densities and albedo of all FMs are assumed to be equal to density and albedo of the LM of that family.

	Eunomia	Eos	Themis	Vesta	Koronis	Karin
v_{cut} [m s^{-1}]	89	92	79	57	74	7.5
Population	19991	24278	5492	14728	6998	545
Density [kg m^{-3}]	3880	2500	2780	3456	2600	2500
Geometric albedo	0.2094	0.14	0.067	0.423	0.277	0.21
Total mass [10^{18} kg]	43.87	32.58	32.24	160.20	1.26	0.017
Mass ratio M_{LM}/M_{PB}	0.734	0.090	0.285	0.995	0.063	0.36
Radius R_{PB} [km]	140	146	140	228	48.8	11.8

Figures 2, 3, and 4 present examples of the cumulative size distributions. We fit the power-like formula

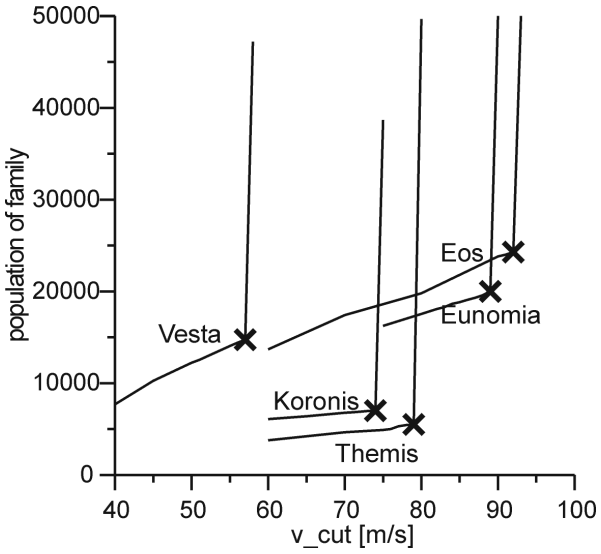
$$(N > m) \propto m^{-p}, \text{ or equivalently } (N > r) \propto r^{-3p} \quad (1)$$

for individual quasi rectilinear segments of the size distributions. Equation (1) presents the number N of asteroids in the family that are more massive than m or that are larger than r. Three rectilinear segments of different exponent p are well distinguishable for Eunomia (Fig. 2) and Eos families, as well as for Karin (Fig. 3) cluster. For Themis, Vesta (Fig. 4), and Koronis families there are only two segments. Linear fitting in particular size ranges of the FMs is commonly applied, see e.g. [5]

Tab. 2. Fitting of Eq. (1) for different size intervals of the family members.

The asteroids' number N in three intervals of size	Eunomia	Eos	Themis	Vesta	Koronis	Karin
Smallest members; N	59-798	180-10000	9-549	6-60	31-465	26-297
Exponent p	1.200	0.832	0.904	2.459	0.929	0.989
Mean-sized members; N	10-42	35-180	---	---	---	8-26
Exponent p	0.427	0.632	---	---	---	1.712
Largest members; N	2-10	10-35	2-9	2-6	4-31	2-8
Exponent p	0.958	1.300	0.904	0.160	0.726	0.404

Fig. 1. Determination of the values of the parameter v_cut. Chosen values corresponds to crosses.



Conclusions: As it is shown in Tab. 2 and on Fig. 5 the exponent p for the small members of a family is larger when the impact-due damage of the PB is smaller. (The ratio M_{LM}/M_{PB} stands as the measure of damage.) So, our results suggest that the non-catastrophic event produces smaller (in dimensionless units) fragments (the cases of Vesta and Eunomia) more efficiently than the catastrophic impact (the cases of Eos and Koronis).

Fig. 2. Cumulative size distribution for Eunomia Family

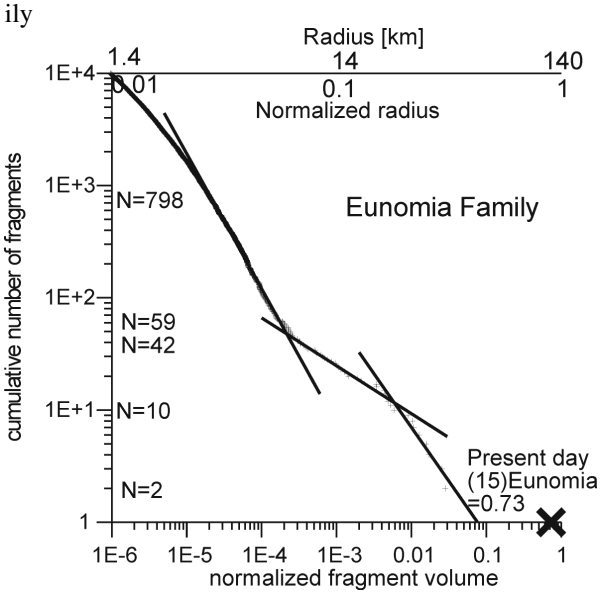


Fig. 3. Cumulative size distribution for Karin cluster

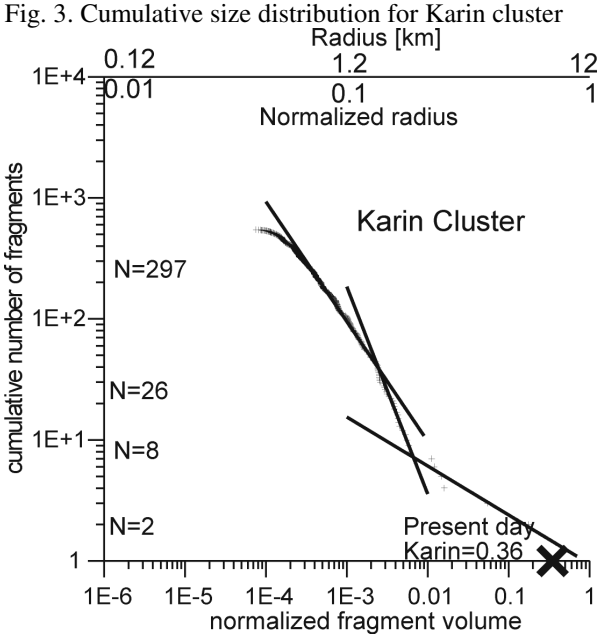


Fig. 4. Cumulative size distribution for Vesta Family

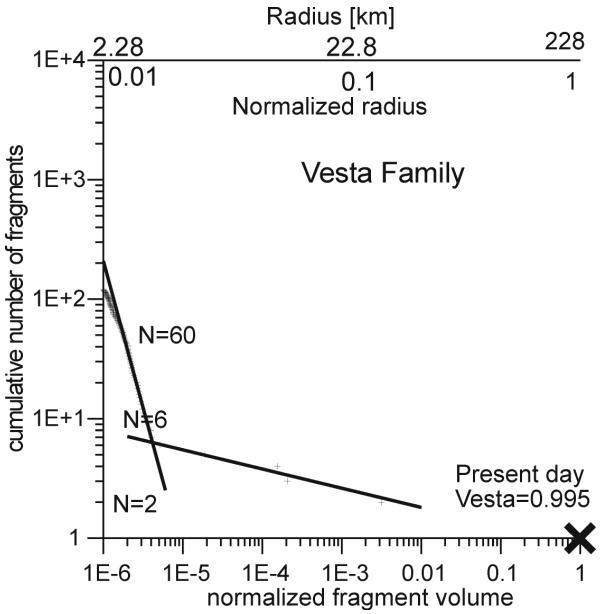
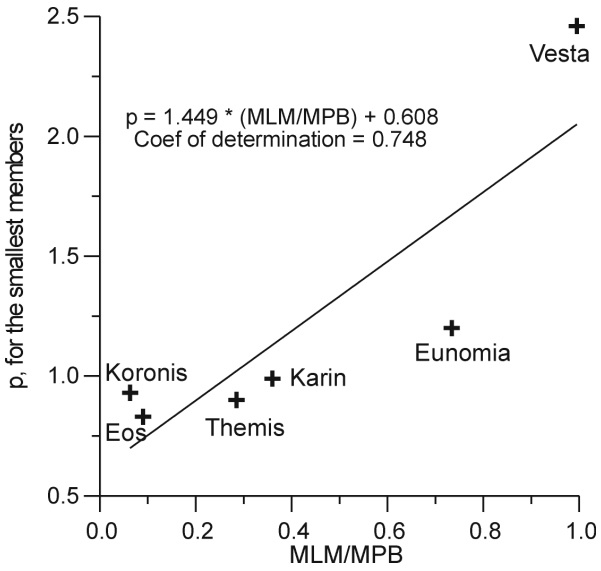


Fig.5. Exponent p (from the third row of Tab. 2, therefore for the smallest members of AF) vs. the mass ratio M_{LM}/M_{PB} (from the last but one row of Tab. 1).



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