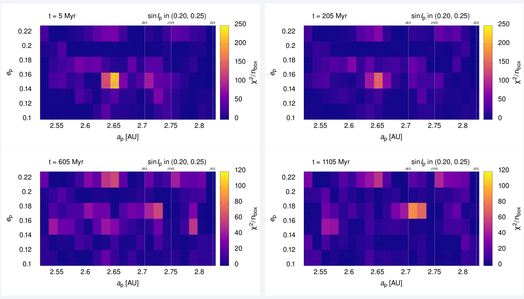
Age of the Eunomia family

Black-box method [5]

We divide asteroids of the observed and the simulated family into „boxes“ in space (a_p, e_p, $\sin I_\mathrm{p}$) and we compare the number of asteroids in individual **boxes**. Additionally, we „mix“ the simulated population with a sample of **background**, while keeping the **size-frequency distribution**. After this simple procedure, we calculate the chi-squared distribution (χ^2) of the data — for every **box**, we compute its contribution to the χ^2 value as

$$\frac{(N_\mathrm{sim} - N_\mathrm{obs})^2}{N_\mathrm{sim} + N_\mathrm{obs}}.$$

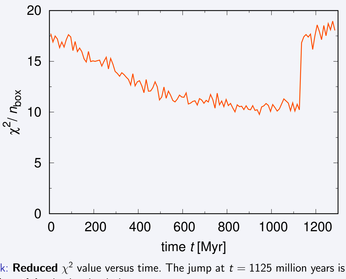


Obrázek: The χ^2 value for every **box** in space (a_p, e_p) for $t = 5$, 205, 605, 1105 million years. The dots show the **synthetic** population with the added **background**.

We can see, that at the beginning, the core around 2,65 AU differs the most (too many **synthetic** particles).

Due to a strong **contamination** from the *Adeona* family in the region $0.16 < e < 0.18$, we were forced to manually remove the observed members of this family.

We successfully described the **structure** of the *Eunomia* family, that can be seen on the graphs (a_p, e_p), (a_p, $\sin I_\mathrm{p}$) and (e_p, $\sin I_\mathrm{p}$). Some Unfortunately, we have to attribute some phenomena (e.g. compactness of the core) to the **insufficient length of the simulated period**. With almost complete probability, we can say, the the *Eunomia* family **is not younger** than 500 million years, but we can not yet estimate an upper limit (due to the flat dependency of the χ^2 value on time).



Obrázek: **Reduced** χ^2 value versus time. The jump at $t = 1125$ million years is due to a **loss of particles** in the simulation.

In future, we plan to simulate the *Eunomia* family for a **longer period** (4 billion years). Probably, we will get a minimal (statistically significant) value of the χ^2, from which we will be able to accurately estimate an upper limit for the age of the *Eunomia* family.

Another option is an analysis of the **surrounding families**, especially the *Adeona* family.
We can also focus on specific **taxonomic types** of asteroids (the *Eunomia* family is **S-type**) or try an **anisotropic initial velocity field** — simulate different types of breakup (**cratering**, **reaccumulation**, **catastrophic breakup**). Furthermore, we can try **different background samples** for different regions (between the J8/3 and J13/5 resonances, the concentration of asteroids is smaller than between the J3/1 and J8/3 resonances).

After **finishing the long-term simulation**, we plan to **publish** the results in a scientific journal (*Icarus*).

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