SPECTRAL ANALYSIS OF THE DISTRIBUTION OF NEAR EARTH ASTEROIDS SEMI-MAJOR AXES.

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Introduction: For now, there are theories which state that a space of possible orbits in gravitational systems of planetary type is discrete, so there are systems of stable and unstable orbits [1]. This should be evident in distributions of orbital energy, angular momentum and some elements of orbits [2]. According to such theories, groups of stable and unstable orbits should have semimajor axis that is a product of $a_0/2$ and natural number, where a_0 is a fundamental harmonic.

Main part: The easiest way to test such theories is to look for harmonic components in frequency histograms of energy, angular momentum, semimajor axis etc. Near Earth asteroids (NEAs) are selected as the objects of study of this work. They don't undergo of such strong gravitational influence as asteroids of the main belt. And sample size is satisfactory for necessary statistical analysis (for now, more than 8000 of orbits [3]).

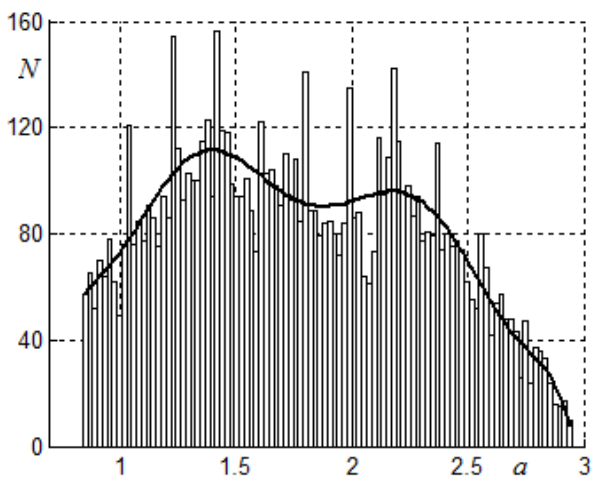

Figure 1

The frequency histogram in Fig. 1 shows distribution of asteroid semi-major axes. A solid black line shows a trend that was calculated as a polynomial approximation of a histogram.

The range of variation of a semi-major axis in Fig. 1 is divided into $n = 100$ intervals. We are only interested in the relative variation of a number of orbits hitting a particular interval in relation to the trend. By removing the trend from the histogram, we obtain a series with a zero mean value. This series then is used for searching of supposed periodicity.

Because of lacking of any initial information about the series, discrete furier tranform was used for further analysis.

Fig. 2 shows the normalized to unity spectrum of the series that was obtained from the histogram in Fig. 1. Frequency is measured in oscillations per astronomical unit.

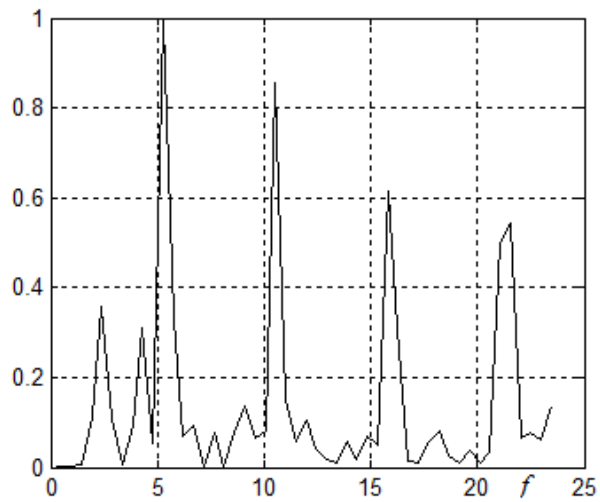

Figure 2

As we can see, in Fig.2 spectral components with frequencies $f_1 = 5.27$, $f_2 = 10.53$, $f_3 = 15.80$, $f_4 = 21.54$ are well recognizable. It is very likely that f_2, f_3, f_4 are higher-order harmonics of the main harmonic f_1. Then required value of a fundamental harmonic a_0 would be:

$$a_0 = \frac{1\,\text{a.u.}}{f_0} = 2\frac{1\,\text{a.u.}}{f_1} \approx 2\frac{1\,\text{a.u.}}{5.27} \approx 0.38\,\text{a.u.}$$

Conclusion: Without a doubt, the distribution of asteroid semi-major axes in addition to the constant component contains some components that have a periodic nature. But now it's hard to say what is the reason of such phenomenon. Therefore further studying are necessary.

References:

[1] Gulak Yu. K. (1986) Commensurability and macro quantum phenomena in the Solar System. I. The problem, principles, model, Institute for Theoretical Physics, USSR Academy of Sciences.

[2] Voloshchuk Yu. I. et al. (1989) Meteors and meteor matter, Kyiv: Naukova Dumka.

[3] http://neo.jpl.nasa.gov/cgi-bin/neo_elem.