THE ISODENSITY ANALYSIS OF THE COMETS

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Introduction: Comet nuclei are remnants of the primary matter of the Solar System that formed the protoplanetary disc. Their study therefore allows building up an evolutionary picture of the formation of planets. Structures and physical properties of cometary atmospheres are mainly investigated using the observations of bright near-Earth comets. However, the modern studies of near-Earth comets and the ones at significant heliocentric distances have shown a considerable difference in their activity [1]. The analysis of structural features of various comets will allow building a more accurate theory of their evolutionary parameters [2].

Methods: The isodensity analysis was applied to produce equidensites with the difference that for isophotes of the second stage was used not the isophote of the first stage, but its contact negative obtained on the same photographs as equidensites of the first stage. This was done to enhance the contrast and produce narrower and closer isophotes. This allowed selecting isophotes that were rather close to each other. Isodensity models were constructed for Bennett, 45P/Honda, and Arend-Roland comets.

Results: Simulation of isophotes for Bennett comet allowed producing the structure of the brightest part of the nucleus and coma. Two isophotes have the form of circles. The rest of isophotes have ledges in the same direction, which obviously corresponds to the ejection from the comet nucleus. Luminance rays are clearly seen. The optical center is located asymmetrically. The map of isophotes was produced with a 17.85 times magnification. The isophotes are tightly arranged. The mean difference between isophotes is 0.06 stellar magnitude. The total fall in brightness from the first isophote to the last one is 3.40 stellar magnitude. The comet tail is clearly observed at a significant distance from the head as well as its radiant structure. When simulating isophotes for 45P/Honda the accuracy of the method appeared to be 0.045^m. This accuracy is also confirmed by the fact that in some cases are observed the isophotes differing by 0.02, 0.025, and 0.03 of the relative magnitude. For all the isophotes, the consistent change in the form of isophotes is observed from the center to the periphery. Near the nucleus, isophotes resemble circles. Closer to the edge appear ledges in the direction of the comet tail. In the periphery areas, particularly closer to the tail, isophotes have the form of wide stripes, while in the central areas, closer to the comet nucleus, they represent narrow lines. For Arend-Roland it was managed to detect rather narrow and close isophotes using the contact negatives with isophotes. This method was applied for producing isophotes of the second and third stages. Isophotes differeing by 0.03 stellar magnitude and 0.02^m difference in densities were revealed. The reproducibility of isophotes using this method is 0.02 stellar magnitude.

Discussion: The isodensity method allows comparing isophotes for various comets, and on the basis on data collected also allows conducting a comparative analysis of cometary activity. Depending on the results of this analysis, it is possible to estimate the evolutionary parameters of cometary bodies, dynamical evolution, and processes in the Solar Nebula more accurately [3]. Generally speaking, some comets may have come to our Solar System from the interstellar space and this fact should therefore be considered when drawing final conclusions [4].

Conclusions: Comets are the time capsules. They contain the information on the time when the Sun was young and the Earth was just being born [5]. Comet nuclei conserve the initial matter from which the Solar System was formed 4,5 billion years ago. Comets accumulated ice, frozen gases, solid particles. Even the amino acid glycine, which is essential for all living creatures, has been found in the comet [6]. Modern theories consider the process of converting asteroids into comets [7, 8]. The study of the genetic relationships of comets with meteorites is impotant for the theory of planetary evolution [9]. The determination of structural, physical, and chemical cometary parameters is therefore very important to comprehend dynamical evolution and processes in the Solar Nebula [10].

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