Physical properties of the dust in the comet atmospheres

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Физически свойства на праха в кометните атмосфери

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The study of physics of the formation of comet atmospheres is of crucial scientific importance for two reasons. First, for clarification of the physical processes in the atmospheres themselves and, second, for our knowledge of comet nuclei, which is based on observations of comet tails and coma.

Nucleus of the comet, and all other bodies in our Solar System are expected to be inhomogeneous and irregularly shaped. The observed gas and dust have a relatively simple structure – in practice they are slightly aspherical.

The study of comets has a goal to answer some very important and fundamental questions related to the cosmogony of the Solar System:

- Whether comets were formed before the condensation of the Sun protoplanetary nebula or after?
- Understanding the physical characteristics can give us an idea of the primary substance of the Solar System.
- Especially, understanding the rotation of comet nuclei gives us an idea about the transmission of torque to the distant parts of Solar System ($\approx 10^5 AU$).
- The comparative analysis of the rotational properties of asteroids and comets can answer some questions about the formation of the bodies in the Solar System and their evolution.

The PhD thesis presents the results of research of the dust in the near nucleus region of the comet C/NEAT (2001 Q4). Dust particles disperse sunlight and therefore information about them is derived from the continuum in the comet spectra. Therefore, observations of the comet were obtained with two narrow-band interference filters passing only light in continuum 'windows' and blocking many comets emissions of neutral and ionized gases.

The aim of the thesis is to analyze the spatial distribution of surface brightness in the continuum of the comet C/NEAT (2001 Q4) and model the observed structures to determine their parameters – coordinates and size of the active region on the surface of the comet nucleus.

In the introduction of the PhD Thesis, general information for the comets as a part of the Solar System is presented as well as their characteristics and the actuality of the investigations of the physical properties of the dust in the comets.

The methods of CCD image data reduction are described, starting with basic data reduction, going through absolute calibration, and at the end

methods for numerical filtration of images for enhancing the dust structures in the comets atmosphere.

In the PhD Thesis, the original observations of the comet C/NEAT (2001 Q4) obtained with 2-channel focal reducer attached at 2m telescope of the Rozhen National Astronomical Observatory Rozhen and a set of narrow-band interference filters, prepared especially for investigation of comets (centered on specific comets emissions and windows free of them where the light scattered from the dust is dominated continuum) are presented. A Monte-Carlo method for modeling enhanced dust structures in the comet coma, varying as free parameters the initial conditions for their formation as well as physical parameters of comets dust, is presented.

The results from surface photometry of the continuum, which have not only scientific value by themselves but are used for limitation of the range for varying free parameters in the Monte-Carlo model, are presented. On the bases of the enhanced structure and the Monte-Carlo model, the coordinates and the size of the active region on the comets nucleus surface, from where the dust structures are borne, as well as the orientation of the axis of rotation in the space are determined. For the first time, the level of activity of the active region on comet surface compared with the rest of the kernel is defined. The comparison of our results with results from missions to Halley's comet, we can conclude that active area is about 10 times more active than the rest of the comet nucleus.

References

Borisov, G. and Bonev, T. 2006, *Proceedings of XVIIIemes Rencontres de Blois - Planetary Science: challenges and discoveries 28th May - 2nd June 2006*, proceedings in preparation

Borisov, G. and Bonev, T. 2007, *Proceedings of 5th Bulgarian–Serbian Cinference on ASTRONOMY AND SPACE SCIENCE, edited by, Tsvetkov, M. K., Filipov, L. G., Dimitrijevic, M. S., Popovic, L. C., HERON PRESS SCIENCE SERIES*, 139

Bonev, T.; Boehnhardt, H. and Borisov, G. 2006, *A&A*, **480**, 277

Bonev, T.; Jockers, K.; Petrova, E.; Delva, M.; Borisov, G.; Ivanova, A. 2002, *Icarus*, **160, 2**, 419

Borisov, G. and Bonev, T. 2002, *Proceedings of Asteroids, Comets, Meteors - ACM 2002. International Conference, 29 July - 2 August 2002, Berlin, Germany. Ed. Barbara Warmbein. ESA SP-500. Noordwijk, Netherlands: ESA Publications Division, ISBN 92-9092-810-7*, 583

Waniak, W.; Borisov, G.; Drahus, M.; Bonev, T.; Czart, K.; Küppers 2009, M., *Earth, Moon and Planets*, **105, 2-4**, 327